Mark* VIeS Functional Safety Systems for General Market

Volume II: System Guide for General-purpose Applications

Jan 2021
These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met during installation, operation, and maintenance. The information is supplied for informational purposes only, and GE makes no warranty as to the accuracy of the information included herein. Changes, modifications, and/or improvements to equipment and specifications are made periodically and these changes may or may not be reflected herein. It is understood that GE may make changes, modifications, or improvements to the equipment referenced herein or to the document itself at any time. This document is intended for trained personnel familiar with the GE products referenced herein.

GE may have patents or pending patent applications covering subject matter in this document. The furnishing of this document does not provide any license whatsoever to any of these patents.

Public Information – This document contains non-sensitive information approved for public disclosure.

GE provides the following document and the information included therein as is and without warranty of any kind, expressed or implied, including but not limited to any implied statutory warranty of merchantability or fitness for particular purpose.

For further assistance or technical information, contact the nearest GE Sales or Service Office, or an authorized GE Sales Representative.

Revised: Jan 2021
Issued: July 2019


* Indicates a trademark of General Electric Company and/or its subsidiaries. All other trademarks are the property of their respective owners.

We would appreciate your feedback about our documentation. Please send comments or suggestions to controls.doc@ge.com
## Document Updates

<table>
<thead>
<tr>
<th>Rev</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>SRLYS2A Simplex Relay Output</td>
<td>Removed WROH2A option</td>
</tr>
<tr>
<td></td>
<td>342A3648PF40A28C FET-OR Modules</td>
<td>Corrected part number</td>
</tr>
<tr>
<td></td>
<td>342A3648PF80A28C FET-OR Modules</td>
<td>Corrected part number</td>
</tr>
<tr>
<td></td>
<td>UCSC Specifications</td>
<td>Updated NVSRAM</td>
</tr>
<tr>
<td></td>
<td>UDH Network Configuration</td>
<td>Updated USB flash device</td>
</tr>
<tr>
<td></td>
<td>LEDs</td>
<td>Removed reference to UCEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Updated VDC LED Indicator</td>
</tr>
<tr>
<td></td>
<td>Shared IONet</td>
<td>Updated for enhancements to the Shared IONet feature</td>
</tr>
<tr>
<td></td>
<td>Controller Common Diagnostic Alarms</td>
<td>Updated section title</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Updated the Note in alarm 547 concerning changing controller passwords</td>
</tr>
<tr>
<td></td>
<td>STAIS2A Simplex Analog Input</td>
<td>New section Installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New section Operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New section Specifications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New section Diagnostics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New section Jumper Configuration</td>
</tr>
<tr>
<td></td>
<td>Mark VIeS YDIA Discrete Input Pack</td>
<td>New section Installation</td>
</tr>
<tr>
<td></td>
<td>STCIS#A Simplex Contact Input</td>
<td>Removed Caution statement from section Installation. Does not apply to Mark VIeS.</td>
</tr>
<tr>
<td></td>
<td>YDOA Specific Alarms</td>
<td>Updated alarm 130–141 for WROH daughterboard support</td>
</tr>
<tr>
<td></td>
<td>TRLYS#F Installation</td>
<td>New section WPDF Power Distribution Board</td>
</tr>
<tr>
<td></td>
<td>SRLYS2A Simplex Relay Output</td>
<td>Updated for WROH daughterboard support</td>
</tr>
<tr>
<td></td>
<td>SRLYS2A Specifications</td>
<td>Updated for WROH daughterboard support</td>
</tr>
<tr>
<td></td>
<td>SRLYS2A Diagnostics</td>
<td>Updated for WROH daughterboard support</td>
</tr>
<tr>
<td></td>
<td>SRLYS2A Configuration</td>
<td>Added Note for WROG</td>
</tr>
<tr>
<td></td>
<td>SRLYS2A + WROF Isolated Contact Voltage Feedback</td>
<td>Added Attention statement</td>
</tr>
<tr>
<td></td>
<td>SRLYS2A + WROG</td>
<td>Added Note for WROG</td>
</tr>
<tr>
<td></td>
<td>SRLYS2A + WROH</td>
<td>New section for WROH daughterboard support</td>
</tr>
<tr>
<td></td>
<td>Mark VIeS YUAA Universal I/O Pack</td>
<td>Add Attention statement</td>
</tr>
<tr>
<td></td>
<td>YUAA Specifications</td>
<td>Updated to correct specifications and performance ratings</td>
</tr>
<tr>
<td></td>
<td>BPPx Processor LEDs</td>
<td>Removed Red ATTN flashing pattern of two 4 Hz pulses in the table Flash Codes for All Mark VIe I/O Packs and BPPC-based Mark VIeS I/O Packs. The Red ATTN LED does not do this application online blink, only the Green ATTN LED reflects this status.</td>
</tr>
<tr>
<td></td>
<td>JPDS I/O Characteristics</td>
<td>Corrected pin use for positive 28 V power from 8–9 to 7–9, corrected pin 6–7 not connected to pin 6 not used</td>
</tr>
<tr>
<td></td>
<td>JPDS Application Notes</td>
<td>Corrected bus size ampere from 25 A to 24 A</td>
</tr>
<tr>
<td>Doc #</td>
<td>Title</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>GEH-6860</td>
<td>Mark VIeS Control General Market Functional Safety Manual</td>
<td></td>
</tr>
<tr>
<td>GEH-6861</td>
<td>Mark VIeS Functional Safety System Equipment in Hazardous Locations (HazLoc) Instruction Guide</td>
<td></td>
</tr>
<tr>
<td>GEH-6862</td>
<td>ToolboxST User Guide for Mark VIeS Functional Safety Systems</td>
<td></td>
</tr>
<tr>
<td>GEI-100846</td>
<td>Mark VIeS Functional Safety System Release Notes</td>
<td></td>
</tr>
<tr>
<td>GEI-100862</td>
<td>Mark VIeS Functional Safety Contact Input Module Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100863</td>
<td>Mark VIeS Functional Safety Relay Contact Output Module Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100864</td>
<td>Mark VIeS Functional Safety Vibration Input Module Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100865</td>
<td>Mark VIeS Functional Safety Universal Analog I/O Module Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100866</td>
<td>Mark VIeS Functional Safety Analog I/O Module Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100867</td>
<td>Mark VIe and Mark VIeS Functional Safety UCSC Controller Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100868</td>
<td>Mark VIe Modbus Master Communication Module Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100869</td>
<td>Mark VIe Industrial Ethernet / IONet Switches Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GEI-100870</td>
<td>Mark VIe Power Distribution Module Summary Sheet</td>
<td></td>
</tr>
<tr>
<td>GFK-3006</td>
<td>UCSC/UCEC Installation and Maintenance Requirements (IMR)</td>
<td></td>
</tr>
<tr>
<td>GFT-870</td>
<td>Mark VIeS Functional Safety System Technical Specifications</td>
<td></td>
</tr>
<tr>
<td>Mark VIe DoC</td>
<td>EU Declaration of Conformity - Mark VIeS</td>
<td></td>
</tr>
</tbody>
</table>
Safety Symbol Legend

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

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

**Attention**
Indicates a procedure or condition that should be strictly followed to improve these applications.
Control System Warnings

Warning
To prevent personal injury or damage to equipment, follow all equipment safety procedures, Lockout Tagout (LOTO), and site safety procedures as indicated by Employee Health and Safety (EHS) guidelines.

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

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

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

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

Warning
Always ensure that applicable standards and regulations are followed and only properly certified equipment is used as a critical component of a safety system. Never assume that the Human-machine Interface (HMI) or the operator will close a safety critical control loop.
# Contents

1. **Orderable Part Numbers** ................................................................. 9

2. **Controllers** .................................................................................. 17
   2.1 UCSC Controllers ........................................................................ 17
   2.2 Controller Password Protection .................................................. 37
   2.3 Shared IONet .............................................................................. 37
   2.4 Black Channel Safety Communication ........................................ 37
   2.5 Controller Setup and Download .................................................. 38
   2.6 Initial Download to I/O Modules ................................................ 39
   2.7 Controller Common Diagnostic Alarms ....................................... 41

3. **Unmanaged Ethernet Switches** .................................................. 85
   3.1 Available Form Factors ............................................................. 86
   3.2 Installation ................................................................................. 86
   3.3 Configuration ............................................................................ 87
   3.4 IONet Switch Specifications ...................................................... 87
   3.5 Operation .................................................................................. 88
   3.6 Third-party Switch Replacement .............................................. 90

4. **YAIC Analog I/O Module** ............................................................ 91
   4.1 Mark VIeS YAIC Analog I/O Pack .......................................... 91
   4.2 YAIC Specific Alarms ................................................................. 101
   4.3 TBAIS1C Analog Input/Output .................................................. 106
   4.4 STAIS2A Simplex Analog Input ............................................... 113

5. **YDIA Discrete Input Module** ....................................................... 117
   5.1 Mark VIeS YDIA Discrete Input Pack ...................................... 117
   5.2 YDIA Configuration .................................................................. 122
   5.3 YDIA Specific Alarms ................................................................. 123
   5.4 TBCIS#C Contact Input with Group Isolation ......................... 124
   5.5 STCIS#A Simplex Contact Input ............................................ 130

6. **YDOA Discrete Output Module** .................................................. 133
   6.1 Mark VIeS YDOA Discrete Output Pack ................................ 133
   6.2 YDOA Configuration ................................................................. 139
   6.3 YDOA Specific Alarms ............................................................... 140
   6.4 TRLY Discrete Output Terminal Boards ................................ 144
   6.5 TRLYS1B Relay Output with Coil Sensing ............................... 145
   6.6 TRLYS1D Relay Output with Solenoid Integrity Sensing ........ 152
   6.7 TRLYS#F Relay Output – TMR Contact Voting ...................... 157
   6.8 SRLYS2A Simplex Relay Output ............................................ 163

7. **YUAA Universal I/O Module** ....................................................... 175
   7.1 Mark VIeS YUAA Universal I/O Pack .................................... 175
   7.2 YUAA Specifications ................................................................. 176
   7.3 YUAA Module Installation and Mounting ............................... 180
   7.4 YUAA Operation ....................................................................... 190
   7.5 Analog Inputs (Voltage or mA Current) .................................... 192
   7.6 Current Outputs ..................................................................... 193
8 YVIB Vibration Monitor Modules .........................................................231
  8.1 Mechanical Vibration Standards ................................................231
  8.2 Mark VleS YVIB Vibration Monitor I/O Pack ..................................232
  8.3 YVIB Functions ..........................................................................238
  8.4 YVIB Specific Diagnostic Alarms ..................................................274
  8.5 TVBA Vibration Input .................................................................279
9 PSCA Modbus Master (Serial Communication) Module.............................287
  9.1 PSCA Serial Communication I/O Pack ...........................................287
  9.2 PSCA Specific Alarms .................................................................293
  9.3 SSCA Simplex Serial Communication Input/Output ............................295
10 PDM Power Distribution Modules ......................................................303
  10.1 Power Distribution Overview ...................................................303
  10.2 PPDA Power Distribution System Feedback .................................308
  10.3 PPDA Specific Alarms ...............................................................321
  10.4 JPDD DC Power Distribution ......................................................364
  10.5 JPDE DC Battery Power Distribution ...........................................368
  10.6 JPDG Core Power Distribution ....................................................375
  10.7 JPDH High Density Power Distribution .......................................386
  10.8 JPDS Core 28 V DC Power Distribution .......................................390
  10.9 JGND Shield Ground ...............................................................397
  10.10 Phoenix Power Supplies (GE Part Number Series 342A3648) ............400
11 Common I/O Module Functionality .......................................................443
  11.1 BPpx Processor ......................................................................443
  11.2 I/O Module Common Diagnostic Alarms ......................................445
12 Maintenance and Replacement ............................................................479
  12.1 Maintenance .........................................................................479
  12.2 Replacement .........................................................................480
  12.3 Ordering Parts .....................................................................486
1 Orderable Part Numbers

The following tables provide the orderable part numbers for the Mark VIeS Functional Safety System product components, including I/O packs, modules, Terminal Boards (TB), and daughterboards.

Note For replacement and ordering instructions, refer to the sections Replacement and Ordering Parts.

Attention The information in this document applies to the Mark VIeS Functional Safety System general market products; however, your application may not be licensed to access full system capability and I/O packs as described in this document. For example, the Mark VIeS Functional Safety System for General Markets only utilizes the following I/O packs:

- Analog I/O (YAIC)
- Universal Analog (YUAA)
- Vibration Input Monitor (YVIB)
- Relay Output (YDOA)
- Discrete Contact Input (YDIA)
- Power Distribution System Diagnostics (PPDA)
- Serial Modbus Communication (PSCA)
- Mark VIeS Safety Controller (UCSCS2x)
- Mark VIe Controller for Gateway (UCSCH1x)
<table>
<thead>
<tr>
<th>I/O Pack/Part Number</th>
<th>Associated Base Assembly/Accessory</th>
<th>Description</th>
<th>Replacement Part within Module</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS420YDIAS1B</td>
<td>N/A</td>
<td>Contact Input Safety I/O pack</td>
<td>Board: IS400BPPCS1A</td>
<td></td>
</tr>
<tr>
<td>IS410STCIS2A</td>
<td>Simplex, 24 pt - 24 V dc Contact In, 4&quot; S-type TB, with cover and TB plugs, WROx posts</td>
<td>Board: IS400STCIS2A</td>
<td>Board: IS200BPDISS1A</td>
<td></td>
</tr>
<tr>
<td>IS410STCIS4A</td>
<td>Simplex, 24 pt - 48 V dc Contact In, 4&quot; S-type TB, with cover and TB plugs, WROx posts</td>
<td>Board: IS400STCIS4A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS410STCIS6A</td>
<td>Simplex, 24 pt - 125 V dc Contact In, 4&quot; S-type TB, with cover and TB plugs, WROx posts</td>
<td>Board: IS400STCIS6A</td>
<td>Board: IS400STCIS6A</td>
<td></td>
</tr>
<tr>
<td>IS410TBCIS1C</td>
<td>TMR, 24 pt - 125 V dc Contact In, 4&quot; T-type TB, with cover and TB blocks</td>
<td>Board: IS400TBCIS1C</td>
<td>UL Pending</td>
<td></td>
</tr>
<tr>
<td>IS410TBCIS2C</td>
<td>TMR, 24 pt - 24 V dc Contact In, 4&quot; T-type TB, with cover and TB blocks</td>
<td>Board: IS400TBCIS2C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS410TBCIS3C</td>
<td>TMR, 24 pt - 48 V dc Contact In, 4&quot; T-type TB, with cover and TB blocks</td>
<td>Board: IS400TBCIS3C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10 GEH-6855_Vol_II_B GEH-6855_Vol_II Mark VleS Functional Safety Systems Volume II
Public Information
### Module Part Numbers (continued)

<table>
<thead>
<tr>
<th>I/O Pack/Part Number</th>
<th>Associated Base Assembly/Accessory</th>
<th>Description</th>
<th>Replacement Part within Module</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS420YDOAS1B</td>
<td>N/A</td>
<td>Contact Output Safety I/O pack</td>
<td>Board: IS400BPPCS1A&lt;br&gt;Board: IS200BPD0S1</td>
<td></td>
</tr>
<tr>
<td>IS410SRLYS2A</td>
<td>Simplex, 12 Form C Contact Out, 7&quot; S-type TB, with cover and TB plugs</td>
<td>Board: IS400SRLYS2A&lt;br&gt;Cover: 151X1202YE04PP05BL&lt;br&gt;48 pt TB: 64G6940-224L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS410TRLYS1B</td>
<td>Simplex or TMR, 12 pt - Form C Relay, 1st 6 pts wetted, with cover and TB blocks</td>
<td>Board: IS400TRLYS1B&lt;br&gt;Cover: 151X1202YE08PP18BL&lt;br&gt;24 pt TB (1-24): 173C9123BB 003&lt;br&gt;24 pt TB (25-48): 173C9123BB 004&lt;br&gt;3.15 A fuse: 64G5005-011&lt;br&gt;10 A 2PDT Relay: 64G5600-003&lt;br&gt;Relay Clip: 65G2101-011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS410TRLYS1D</td>
<td>Simplex or TMR, 6 pt - Solenoid Out, ohm monitor, 7&quot; T-type TB, with cover and TB block</td>
<td>Board: IS400TRLYS1D&lt;br&gt;Cover: 151X1202YE08PP18BL&lt;br&gt;24 pt TB: 173C9123BB 003&lt;br&gt;3.15 A fuse: 64G5005-011&lt;br&gt;10 A 2PDT Relay: 64G5600-003&lt;br&gt;Relay Clip: 65G2101-011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS410TRLYS1F</td>
<td>TMR, 12 pt NO Voted Contacts, 7&quot; T-type TB, with cover and TB blocks, WPDF post</td>
<td>Board: IS400TRLYS1F&lt;br&gt;Cover: 151X1202YE08PP14BL&lt;br&gt;24 pt TB (1-24): 173C9123BB 003&lt;br&gt;24 pt TB (25-48): 173C9123BB 004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS410TRLYS2F</td>
<td>TMR, 12 pt NC Voted Contacts, 7&quot; T-type TB, with cover and TB blocks, WPDF post</td>
<td>Board: IS400TRLYS2F&lt;br&gt;Cover: 151X1202YE08PP14BL&lt;br&gt;24 pt TB (1-24): 173C9123BB 003&lt;br&gt;24 pt TB (25-48): 173C9123BB 004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS420YUAAS1A</td>
<td>N/A</td>
<td>Analog In / Out Safety I/O pack</td>
<td>Board: IS400BPPCS1A&lt;br&gt;Board: IS400BPAIS1A</td>
<td></td>
</tr>
<tr>
<td>IS410STAIS2A</td>
<td>Simplex, 10 Analog in / 2 Analog out, 4&quot; S-type TB, with cover and TB plugs</td>
<td>Board: IS400STAIS2A&lt;br&gt;Cover: 151X1202YE04PP01BL&lt;br&gt;48 pt TB: 64G6940-224L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS410TBAIS1C</td>
<td>TMR, 10 Analog in / 2 Analog out, 4&quot; S-type TB, with cover and TB blocks</td>
<td>Board: IS400TBAIS1C&lt;br&gt;Cover: 151X1202YE08PP16BL&lt;br&gt;24 pt TB (1-24): 173C9123BB 003&lt;br&gt;24 pt TB (25-48): 173C9123BB 004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS420YUAAS1A</td>
<td>N/A</td>
<td>Universal Analog Safety I/O pack</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS410SUAAS1A</td>
<td>Universal Analog Simplex, 16 Channel Volt/Current/TC/DI/Cntr, 3&quot; S-type TB</td>
<td></td>
<td>52 pt TB: 64G6946-226L</td>
<td></td>
</tr>
</tbody>
</table>
### Module Part Numbers (continued)

<table>
<thead>
<tr>
<th>I/O Pack/Part Number</th>
<th>Associated Base Assembly/Accessory</th>
<th>Description</th>
<th>Replacement Part within Module</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS420YVIBS1B</td>
<td>N/A</td>
<td>Vibration I/O pack</td>
<td>Board: IS400BPPCS1A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410TVBAS2B</td>
<td>Simplex or TMR, 8 Vib/Prox, 3 Pos, 2 Key/Pos, 7&quot; T-type TB, with cover and TB blocks</td>
<td>Board: IS400TVBAS2B&lt;br&gt; 24 pt TB (1-24): 173C9123BB 003&lt;br&gt; 24 pt TB (25-48): 173C9123BB 004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS420PSCAH1B</td>
<td>Serial Communication / Modbus Master I/O pack</td>
<td>Board: IS400BPPCS1A&lt;br&gt; Board: IS400BSCAH3A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410SSCAH2A</td>
<td>Simplex, 6 channel Serial Comm Termination Board, 4&quot; S-type TB, with cover and TB plugs</td>
<td>Board: IS400SSCAH2A&lt;br&gt; Cover: 151X1202YE04PP01BL&lt;br&gt; 48 pt TB: 64G6940-224L</td>
<td></td>
</tr>
</tbody>
</table>

### Power Distribution Module and Daughterboard Part Numbers

<table>
<thead>
<tr>
<th>I/O Pack/Part Number</th>
<th>Associated Base Assembly/Accessory</th>
<th>Description</th>
<th>Replacement Part within Module</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS420PPDAH1B</td>
<td>N/A</td>
<td>JPDT / JPDS Power Supply Diagnostics I/O pack</td>
<td>Board: IS400BPPCH1A&lt;br&gt; Board: IS400BPAH1A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410JPDG1A</td>
<td>28 V Control Power Distribution, with diagnostics I/O pack, with cover</td>
<td>Board: IS400JPDG1A&lt;br&gt; Cover: 151X1202YE12PP02BL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410JPDG1A</td>
<td>28 V Dual Control and 24 V (or 48 V) Wetting Power Distribution, with diagnostics, with cover</td>
<td>Board: IS400JPDG1A&lt;br&gt; Cover: 151X1202YE12PP02BL&lt;br&gt; 10 A fuse: 64G5002-001&lt;br&gt; 15 A fuse: 64G5003-001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410JPDDG2A</td>
<td>24 or 48 V dc wetting distribution via 6 switch branches, 5 x 20 mm fuse holder, with cover</td>
<td>Board: IS400JPDDG2A&lt;br&gt; Cover: 151X1202YE12PP04BL&lt;br&gt; Fuse: any 20.0 × 5.0 mm (0.79 × 0.20 in)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410JPDDG3A</td>
<td>24 or 48 V dc wetting distribution via 6 switch branches, 1.25 x 0.2 5in fuse holder, with cover</td>
<td>Board: IS400JPDDG3A&lt;br&gt; Cover: 151X1202YE12PP04BL&lt;br&gt; Fuse: any 31.75 × 6.35 mm (1.25 × 0.25 in)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410JPDEG1A</td>
<td>TMR Wetting Power System / Distribution module (24 or 48 V dc), with cover</td>
<td>Board: IS400JPDEG1A&lt;br&gt; Cover: 151X1202YE12PP01BL&lt;br&gt; 7 A fuse: 64G5001-001&lt;br&gt; 15 A fuse: 64G5003-001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IS410JPDHG1A</td>
<td>Control Power Fanout Distribution, with cover</td>
<td>Board: IS400JPDHG1A&lt;br&gt; Cover: 151X1202YE12PP03BL</td>
<td></td>
</tr>
</tbody>
</table>
### Power Distribution Module and Daughterboard Part Numbers (continued)

<table>
<thead>
<tr>
<th>I/O Pack/Part Number</th>
<th>Associated Base Assembly/Accessory</th>
<th>Description</th>
<th>Replacement Part within Module</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS400WROBH1A</td>
<td>IS400SRLYS2A</td>
<td>Optional daughterboard IS400SRLYS2A wetting and fusing, adds hi/lo fusing to 1st 6 relays</td>
<td>3.15 A fuse: 64G5005-011</td>
<td></td>
</tr>
<tr>
<td>IS400WROFH1A</td>
<td>IS400SRLYS2A</td>
<td>Optional daughterboard IS400SRLYS2A wetting and fusing, adds form-C COM fuses to all 12 relays</td>
<td>3.15 A fuse: 64G5005-011</td>
<td></td>
</tr>
<tr>
<td>IS400WROGH1A</td>
<td>IS400SRLYS2A</td>
<td>Optional daughterboard IS400SRLYS2A wetting and fusing, adds hi-side fusing to all 12 relays</td>
<td>3.15 A fuse: 64G5005-011</td>
<td></td>
</tr>
<tr>
<td>IS400WPDFH1A</td>
<td>IS400TRLYS#F</td>
<td>Optional daughterboard IS400TRLYS#F wetting and fusing, adds hi/lo fusing and sensed power to 2 groups of 6 relays</td>
<td>3.15 A fuse: 64G5005-005</td>
<td>UL Pending</td>
</tr>
<tr>
<td>IS400WPDFH2A</td>
<td>IS400TRLYS#F</td>
<td>Optional daughterboard IS400TRLYS#F wetting and fusing, Add hi side fusing and sensed power to 2 groups of 6 relays</td>
<td>3.15 A fuse: 64G5005-005</td>
<td>UL Pending</td>
</tr>
</tbody>
</table>

### Mark VIe and Mark VIeS Controllers Part Numbers

<table>
<thead>
<tr>
<th>I/O Pack/Part Number</th>
<th>Associated Base Assembly/Accessory</th>
<th>Description</th>
<th>Replacement Part within Module</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS420UCSCS2A</td>
<td>N/A</td>
<td>Mark VIeS Safety Controller</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420UCSCH1B</td>
<td>N/A</td>
<td>Mark VIe Gateway Controller</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>I/O Pack/Part Number</td>
<td>Associated Base Assembly/Accessory</td>
<td>Description</td>
<td>Replacement Part within Module</td>
<td>Notes</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------</td>
<td>-------------</td>
<td>--------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>IS420ESWAH1A</td>
<td>N/A</td>
<td>IONet Switch - 8 copper, 1 FX Multimode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWAH2A</td>
<td>N/A</td>
<td>IONet Switch - 8 copper, 2 FX Multimode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWAH3A</td>
<td>N/A</td>
<td>IONet Switch - 8 copper</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWAH4A</td>
<td>N/A</td>
<td>IONet Switch - 8 copper, 1 FX Singlemode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWAH5A</td>
<td>N/A</td>
<td>IONet Switch - 8 copper, 2 FX Singlemode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWBH1A</td>
<td>N/A</td>
<td>IONet Switch - 16 copper, 1 FX Multimode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWBH2A</td>
<td>N/A</td>
<td>IONet Switch - 16 copper, 2 FX Multimode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWBH3A</td>
<td>N/A</td>
<td>IONet Switch - 16 copper</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWBH4A</td>
<td>N/A</td>
<td>IONet Switch - 16 copper, 1 FX Singlemode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>IS420ESWBH5A</td>
<td>N/A</td>
<td>IONet Switch - 16 copper, 2 FX Singlemode Fiber (LC-type)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>259B2451BVP1</td>
<td>N/A</td>
<td>Option DIN-rail base for ESWA and ESWB, long edge of switch body parallel to DIN-rail</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>259B2451BVP2</td>
<td>N/A</td>
<td>Option DIN-rail base for ESWA, long edge of switch body perpendicular to DIN-rail</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>259B2451BVP4</td>
<td>N/A</td>
<td>Option DIN-rail base for ESWB, long edge of switch body perpendicular to DIN-rail</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>I/O Pack/Part Number</td>
<td>Associated Base Assembly/Accessory</td>
<td>Description</td>
<td>Replacement Part within Module</td>
<td>Notes</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------</td>
<td>-------------</td>
<td>---------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>342A3648P120W24</td>
<td>N/A</td>
<td>120W Power Supply 120/240AC//125/250DC &gt; 24DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P120W24C</td>
<td>N/A</td>
<td>120W Power Supply 120/240AC//125/250DC &gt; 24DC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P120W28</td>
<td>N/A</td>
<td>120W Power Supply 120/240AC//125/250DC &gt; 28DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P120W28C</td>
<td>N/A</td>
<td>120W Power Supply 120/240AC//125/250DC &gt; 28DC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P240W24</td>
<td>N/A</td>
<td>240W Power Supply 120/240AC//125/250DC &gt; 24DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P240W24C</td>
<td>N/A</td>
<td>240W Power Supply 120/240AC//125/250DC &gt; 24DC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P240W28</td>
<td>N/A</td>
<td>240W Power Supply 120/240AC//125/250DC &gt; 28DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P240W28C</td>
<td>N/A</td>
<td>240W Power Supply 120/240AC//125/250DC &gt; 28DC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P240W48</td>
<td>N/A</td>
<td>240W Power Supply 120/240AC//125/250DC &gt; 48DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P480W24</td>
<td>N/A</td>
<td>480W Power Supply 120/240AC//125/250DC &gt; 24DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P480W24C</td>
<td>N/A</td>
<td>480W Power Supply 120/240AC//125/250DC &gt; 24DC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P480W28</td>
<td>N/A</td>
<td>480W Power Supply 120/240AC//125/250DC &gt; 28DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P480W28C</td>
<td>N/A</td>
<td>480W Power Supply 120/240AC//125/250DC &gt; 28DC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P480W48</td>
<td>N/A</td>
<td>480W Power Supply 120/240AC//125/250DC &gt; 48DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P960W24</td>
<td>N/A</td>
<td>960W Power Supply 120/240AC//125/250DC &gt; 24DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648P960W28</td>
<td>N/A</td>
<td>960W Power Supply 120/240AC//125/250DC &gt; 28DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3647P960W48</td>
<td>N/A</td>
<td>960W Power Supply 120/240AC//125/250DC &gt; 48DC</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648PF20A28C</td>
<td>N/A</td>
<td>FET-ORing Module - 28VDC 2X10ADC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648PF40A28C</td>
<td>N/A</td>
<td>FET-ORing Module - 28VDC 2X20ADC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3648PF80A28C</td>
<td>N/A</td>
<td>FET-ORing Module - 28VDC 2X40ADC, Coated</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>342A3647PD40A48</td>
<td>N/A</td>
<td>Diode-ORing Module - 48VDC 2x20ADC</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
2 Controllers

2.1 UCSC Controllers

UCSC controllers are compact, stand-alone controllers that run application-specific control system logic used in a diverse range of applications, such as wind turbines, gas and steam turbines, and combined-cycle power plants.

The UCSC controller offers the following advantages:

- Single module
- No battery
- No fan
- No jumper settings required
- Flash memory can be conveniently updated
- Can be expanded to include seven additional I/O ports

The UCSC controller mounts in a panel and communicates with I/O modules through on-board I/O network (IONet), PROFINET, High-speed Serial Link (HSSL), and/or other interfaces.

Note For additional information, refer to the following documents:

- Mark VIe and Mark VIeS Functional Safety UCSC Controller Summary Sheet (GEI-100867)
- Mark VIeS Functional Safety System Release Notes (GEI-100846)
- UCSC/UCEC Installation and Maintenance Requirements (IMR) (GFK-3006)
2.1.1 Mark VIe UCSCH1B Controller

The Mark VIe IS420UCSCH1B quad core controller uses real-time hypervisor technology and QNX® Neutrino, a real-time, multi-tasking operating system (OS) to run high-speed, high-reliability industrial applications. Embedded Field Agent (EFA) technology is used to apply Predix™ cloud-based applications and/or locally hosted web applications over a secure connection and deliver real-time data.

The UCSCH1B controller is loaded with software specific to its application. As a turbine or balance of plant (BoP) controller, it runs the Mark VIe firmware and applications and utilizes IONet interfaces. IONet is a private special-purpose Ethernet that only supports Mark controls I/O packs and controllers. IEEE 1588 protocol is used through the IONet interfaces to synchronize the clock of the I/O modules and controllers to within ±100 microseconds. External data is transferred to and from the control system database in the controller over the IONet interfaces. This includes process inputs/outputs to the I/O modules. Unlike traditional controllers where I/O is on a backplane, the UCSC controller does not host any application I/O. In a redundant set, all I/O networks are attached to each controller, providing them with all input data. This hardware and software architecture guarantees that no single point of application input is lost if a controller is powered down for maintenance or repair.

The UCSCH1B is available beginning with ControlST® V07.01, and supports Simplex, Dual, and Triple Modular Redundant (TMR) redundancy.

### UCSCH1 Platform Configuration Supported Features

<table>
<thead>
<tr>
<th>Platform</th>
<th>Embedded PPNG</th>
<th>Embedded EtherCAT</th>
<th>EFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCSCH1B</td>
<td>X</td>
<td>X</td>
<td>✓</td>
</tr>
</tbody>
</table>

---

*Mark VIe UCSCH1B Controller*
2.1.2 **Mark VleS UCSCS2A Controller**

The IS420UCSCS2A dual core controller runs the Mark VleS Safety control applications used for functional safety loops to achieve SIL 2 and 3 capabilities. Mark VleS Safety equipment is used by operators that are knowledgeable in safety-instrumented system (SIS) applications to reduce risk in critical safety functions. Safety controllers and distributed I/O modules are specifically programmed for safety control use, and this specific control hardware and software is compliant with the IEC 61508 certification. The Mark VleS Safety controller runs on QNX Neutrino, a real-time, multi-tasking operating system (OS).

The UCSCS2A is available beginning with ControlST V07.02, and supports Simplex, Dual, and TMR redundancy.
## 2.1.3 UCSC Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>UCSC Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microprocessor</strong></td>
<td>IS420UCSCH1: quad core, 1.2 GHz AMD G-Series</td>
</tr>
<tr>
<td></td>
<td>IS420UCSCS2: dual core, 1.6 GHz AMD G-Series</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>IS420UCSCH1: 4 GB DDR3-1333 SDRAM</td>
</tr>
<tr>
<td></td>
<td>IS420UCSCS2: 2 GB DDR3-1066 SDRAM</td>
</tr>
<tr>
<td><strong>NVSRAM</strong></td>
<td>ControlST V07.05 and higher supports 6139 non-volatile program variables, 338 forces, and 128 totalizer</td>
</tr>
<tr>
<td></td>
<td>ControlST V07.04 and lower supports 3067 non-volatile program variables, 338 forces, and 64 totalizers</td>
</tr>
<tr>
<td></td>
<td><em>Beginning with ControlST V07.08, the Mark VIeS Safety control supports non-volatile program variables and totalizers</em></td>
</tr>
<tr>
<td></td>
<td>Non-volatile storage of forces not supported by Mark VIeS Safety control</td>
</tr>
<tr>
<td><strong>Ports</strong></td>
<td>• 5 Ethernet ports on front panel (Refer to the section Interface Details.)</td>
</tr>
<tr>
<td></td>
<td>• 1 Ethernet port on bottom used for connectivity to Predix</td>
</tr>
<tr>
<td></td>
<td>• 2 USB ports only used to initially set up UDH network IP address or for restore function</td>
</tr>
<tr>
<td></td>
<td>• 1 COM port is 115200 bit/s, 8N1, RJ-45 connector, no Flow-Control, serial redirection of UEFI-setup, and typically used by GE for troubleshooting in field</td>
</tr>
<tr>
<td></td>
<td>• 1 Display Port (disabled after startup)</td>
</tr>
<tr>
<td></td>
<td>• 1 microSD (not currently supported)</td>
</tr>
<tr>
<td><strong>LEDs</strong></td>
<td>Refer to the section LEDs.</td>
</tr>
<tr>
<td><strong>Input Power</strong></td>
<td>Refer to the section Power Requirements.</td>
</tr>
<tr>
<td><strong>HMI</strong></td>
<td>ControlST V07.00.00C or later</td>
</tr>
<tr>
<td><strong>Programming</strong></td>
<td>Control block language with analog and discrete blocks; Boolean logic represented in relay ladder diagram format. Supported data types include:</td>
</tr>
<tr>
<td></td>
<td>• Boolean</td>
</tr>
<tr>
<td></td>
<td>• 16-bit signed integer</td>
</tr>
<tr>
<td></td>
<td>• 16-bit unsigned integer</td>
</tr>
<tr>
<td></td>
<td>• 32-bit signed integer</td>
</tr>
<tr>
<td></td>
<td>• 32-bit unsigned integer</td>
</tr>
<tr>
<td></td>
<td>• 32-bit floating point</td>
</tr>
<tr>
<td></td>
<td>• 64-bit long floating point</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>UCSC: 168 x 150 x 55 mm (6.61 x 5.90 x 2.17 in) (H x D x W)</td>
</tr>
<tr>
<td></td>
<td>UCSC with mounting: 204 x 152 x 55 mm (8.03 x 5.99 x 2.17 in) (H x D x W)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>1,327 g (46.8 oz)</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td>Refer to the section Mounting Requirements.</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>Convection</td>
</tr>
<tr>
<td><strong>Operating temperature</strong></td>
<td>-40 to 70°C (-40 to 158 °F), ambient 25 mm (0.98 in) from any point on UCSC</td>
</tr>
<tr>
<td><strong>Storage Temperature</strong></td>
<td>-40 to 85°C (-40 to 185 °F)</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>95% non-condensing</td>
</tr>
<tr>
<td><strong>Altitude</strong></td>
<td>Normal Operation: 0 to 1,000 m (0 to 3281 ft) at 101.3 to 89.8 kPa</td>
</tr>
<tr>
<td></td>
<td>Extended Operation: 1,000 to 3,000 m (3281 to 9,843 ft) at 89.8 to 69.7 kPa; requires temperature derating up to 3000 m (9,843 ft) = 65°C (149 °F) max</td>
</tr>
<tr>
<td><strong>Reliability MTBF at 30°C (86 °F)</strong></td>
<td>IS420UCSCH1: 414,248 hours</td>
</tr>
<tr>
<td></td>
<td>IS420UCSCS2: 417,821 hours</td>
</tr>
<tr>
<td><strong>ECCN US Classification</strong></td>
<td>Can be supplied upon request</td>
</tr>
<tr>
<td><strong>Certifications</strong></td>
<td>Refer to the section Agency Certifications and Standards.</td>
</tr>
</tbody>
</table>
2.1.4 UCSC Mounting and Installation Requirements

2.1.4.1 Mounting Requirements

The following are requirements for mounting the UCSC controller:

- Directly mount the UCSC to the mounting base using the two mounting screws.
- Vertical mount with unobstructed air flow through fins.
- Leave a minimal 100 mm (3.94 in) air gap above and below the UCSC.
- Parallel mount UCSC to UCSC requires a minimal 50 mm (1.97 in) spacing to achieve full temperature rating.
- The operating temperature envelope is 25 mm (0.98 in) from any point on UCSC.
UCSC Mounting Requirements to Achieve 70°C Operating Temperature
UCSC Mounting Requirements to Achieve 65°C Operating Temperature
UCSC Controller Mounting Dimensions

- Height: 203.48 mm (8.01 in)
- Width: 41.75 mm (1.64 in)
- Depth: 150.00 mm (5.91 in)
- 24.39 mm (0.96 in)
- 8.13 mm (0.32 in)
- 8.61 mm (0.34 in)
- 11.80 mm (0.46 in)
- 5.54 mm (0.22 in)
- 9.87 mm (0.39 in)
- 5.80 mm (0.23 in)
- 5.80 mm (0.23 in)

UCSC Controller Mounting Dimensions
### 2.1.4.2 Power Requirements

#### Power Requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Min</th>
<th>Nom</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCSC Controller Input Power</td>
<td>—</td>
<td>18</td>
<td>30.8</td>
<td>Watts</td>
</tr>
<tr>
<td>Voltage</td>
<td>18</td>
<td>24/28</td>
<td>30</td>
<td>V dc</td>
</tr>
<tr>
<td>Input Capacitance</td>
<td>—</td>
<td>25</td>
<td>—</td>
<td>uF</td>
</tr>
</tbody>
</table>

**Surge Protection**
- Non-replaceable 4 A 125 V dc rated fuse
- Nominal melting: 26 A squared seconds (A² sec)

**Reverse Polarity Protection**
- Provided
- Reversing the + and - input will not damage the UCSC, nor will it power up.

#### 3-pin Power Plug

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 1</td>
<td>Ground</td>
</tr>
<tr>
<td>Pin 2</td>
<td>Negative&lt;br&gt;The UCSC case is bonded to power supply negative.</td>
</tr>
<tr>
<td>Pin 3</td>
<td>Positive</td>
</tr>
<tr>
<td>Wire Sizes</td>
<td>28 to 16 AWG</td>
</tr>
<tr>
<td>Screw Torque</td>
<td>0.23 Nm (2 in-lb)</td>
</tr>
<tr>
<td>Part Number</td>
<td>Phoenix Contact MC 1.5/3-STF-3.81 - 1827716</td>
</tr>
</tbody>
</table>
2.1.4.3 **Interface Details**

USB1 and USB2 connection ports used for initial setup of UDH IP address and to restore controller configuration and communication with ToolboxST.

Ethernet connections for R, S, and T I/O networks (ICNet) (3 ports) for communication to I/O modules, or High-speed Serial Link (HSSL) connections SL1, SL2, and SL3 (3 ports) for communication to I/O modules.

Note For further information, refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862), the section System Controller Platforms.
† COM serial port can be used as an alternate way to set up controller IP address instead of using a flash device.

**DisplayPort** provides signals for connecting a display monitor or video adapter (not currently supported).

**IICS Cloud Port** (Ethernet port) is used to configure the EFA and to communicate with the Predix cloud environment (not supported for Mark VIeS or MarkStat control).

**Energy Pack / 1-wire EEPROM** allows energy pack connection to enable the controller to save its current state in the event of power loss (not currently supported).

**24/28 V DC IN** input power connection.

---

**Note** † For instructions to set up the controller Internet Protocol (IP) address using the COM port, refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862), the section **Configure and Transfer IP Address to UCSC Controller**.
### Mark Vle UCSC1B Ethernet Ports

<table>
<thead>
<tr>
<th>Ethernet Port</th>
<th>Description</th>
</tr>
</thead>
</table>
| IONet Ethernet Interface (3 Ports) | UCSCH1B:  
T/SL3 is <T> network for TMR (using all three ports).  
S/SL2 is <S> network for Dual redundancy (used with R/SL1).  
R/SL1 is <R> network for Simplex redundancy.  
Twisted pair 10Base-TX/100Base-TX, RJ-45 connector is used.  
TCP/IP protocols is used to communicate between controllers and I/O modules.  
For TMR and Dual configurations, IONet redundancy is equal to controller redundancy.  
For Simplex configurations, both Simplex and TMR IONet redundancy are supported. |
| ENET 1 Primary Ethernet Interface to LAN | UDH  
Twisted pair 10Base-T/100Base-TX, RJ-45 connector is used.  
TCP/IP protocol is used for communication between controller and ToolboxST application.  
TCP/IP protocol is used for alarm communication to HMIs.  
Modbus TCP Slave and/or OPC UA  
EGD protocol is used for application variable communication to HMIs. |
| ENET 2 | UCSCH1B:  
Secondary plant network  
Twisted pair 10Base-T/100Base-TX, RJ-45 connector is used.  
Modbus TCP Slave, OPC UA, and/or EGD |

### Mark VleS UCSCS2A Ethernet Ports

<table>
<thead>
<tr>
<th>Ethernet Port</th>
<th>Description</th>
</tr>
</thead>
</table>
| IONet Ethernet Interface (3 Ports) | T/SL3 is <T> network for TMR (using all three ports).  
S/SL2 is <S> network for Dual redundancy (used with R/SL1).  
R/SL1 is <R> network for Simplex redundancy.  
Twisted pair 10Base-TX/100Base-TX, RJ-45 connector is used.  
TCP/IP protocols is used to communicate between controllers and I/O modules.  
For TMR and Dual configurations, IONet redundancy is equal to controller redundancy.  
For Simplex configurations, both Simplex and TMR IONet redundancy are supported. |
| ENET 1 Primary Ethernet Interface to LAN | UDH  
Twisted pair 10Base-T/100Base-TX, RJ-45 connector is used.  
TCP/IP protocol is used for communication between controller and the ToolboxST application.  
TCP/IP protocol is used for alarm communication to HMIs.  
Modbus TCP Slave  
EGD protocol is used for application variable communication to HMIs. |
| ENET 2 | Not supported |
2.1.5 UCSC Operation

2.1.5.1 UDH Network Configuration

The UCSC is typically set up for communications on the UDH network using a non-encrypted removable USB 2.0 flash device with a 4 GB minimum capacity that is configured with the ToolboxST application. The factory default IP address is 192.168.101.111. The correct UDH IP address must be properly set up so that the controller can communicate to the site HMIs.

**Note** The UCSC, as shipped from the factory, does not include the software on the controller to support communication from the PHY PRES button to the EFA. The user needs to download to the controller at least once (using ToolboxST) to enable this.

➢➢ **To change the UDH network IP address for the UCSC**

1. Verify that the HMI computer running the ToolboxST application has been configured (through Windows OS) with the correct IP address for the UDH network.
2. From the ToolboxST Component Editor, verify that the controller Platform is set as UCSCxxx.
3. From the Component Editor **General** tab Property Editor **Network Adapter 0**, configure the appropriate controller IP address as a relative subnet to the HMI’s UDH IP address from Step 1.
4. Insert a non-encrypted, USB 2.0 only flash drive with a minimum 4 GB capacity into a USB port of the computer that is running the ToolboxST application.
5. From the ToolboxST Component Editor, select **Device, Download**, and **Controller Setup** to launch the Controller Setup Wizard.
6. Follow the on-screen instructions to load the flash drive. Refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862), the section *Configure and Transfer IP Address to UCSC Controller* for further instructions.

➢➢ **To set the controller’s network address using the COM port**

**Attention**

Use a UCSC COM port *adapter*, a standard serial to USB cable, and/or a Cat5e or better Ethernet cable for this connection.

1. Connect the UCSC COM port adapter to the Ethernet cable and the other end of the cable to the UCSC COM port.
2. Connect the UCSC COM port adapter to the serial to USB cable, then to the computer that runs the ToolboxST application.
3. From the ToolboxST Component Editor **General** tab, select **Device, Download**, and **Controller Setup** to launch the Controller Setup Wizard.
4. Follow the on-screen instructions to transfer the UDH network address to the controller. Refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862), the section *Configure and Transfer IP Address to UCSC Controller* for further instructions.
2.1.5.2 LEDs

The locations and descriptions of the LED indicators that are located on the front panel of the UCSC controller are as follows.

- **Link LED** (RJ-45 connector) (qty 5):
  - Solid green = connection has been established
  - Solid green plus Boot LED solid red = startup in progress

- **Act LED** (RJ-45 connector) (qty 5):
  - Solid green = packet traffic
  - Solid green plus Boot LED solid red = startup in progress

- **On LED**:
  - Solid green = one of the USB drives is running the restore process
  - Flashing green = restore process failure

- **FAOK LED** indicates status of Embedded Field Agent (EFA)
  - Solid green = EFA connected to cloud.
  - Flashing green = refer to CPE400 Quick Start Guide (GFK-3002)
    (not supported for Mark VleS or MarkStat control)

- **Boot LED**:
  - Solid red = startup in progress
  - Off = startup completed
  - Flashing red = controller firmware failed to load properly
  - Flashing once every 3 seconds = Baseload signature verification failure

- **ONL LED**:
  - Solid green = controller is online and running the application

- **UFP LED** indicates status of FPGA program updates:
  - Off = normal operation
  - Solid amber† = internal software update in progress

- **DC LED**:
  - Solid green = controller is designated controller
    (always on for Simpler configurations)

- **Diag LED**:
  - Flashing red = active diagnostic alarm

- **OT LED**:
  - Solid amber‡ = temperature of internal components exceeds recommended limit

- **VDC LED**:
  - Solid green = full power on
  - Flashing green = all voltages asserted but system reset asserted

† An internal software update may take several minutes. Do not cycle controller power during this update because this could cause potential damage to the controller.

‡ A diagnostic alarm for temperature is also annunciated. When the temperature exceeds the max threshold, the controller automatically shuts down to prevent damage.
2.1.5.3 Over-temperature Protection

The UCSC controller uses internal temperature readings and logic to protect its internal electronics. Internal circuitry generates a warning at 85°C (185 °F) and shuts down at 95°C (203 °F). The UCSC will reboot once the internal circuitry detects the temperature has dropped below 75°C (167 °F). Independently, the microprocessor monitors its operating temperature and generates a warning at 105°C (221 °F) and shuts down at 107°C (225 °F). A power cycle is required to recover from a microprocessor over-temperature shut down. Both of these warnings drive the OT LED and are annunciated as diagnostic alarms.

2.1.5.4 UCSC COM Port

Typically used by GE to troubleshoot in the field, the UCSC COM port accepts a UCSC COM port adapter and a standard serial to USB cable is used to connect to another computer. Use Cat5e or better Ethernet cable for this connection. The COM port can also be used to set the controller’s UDH network address. For these instructions, refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862), the section Configure and Transfer IP Address to UCSC Controller.

2.1.6 UCSC Embedded Field Agent (EFA)

The Embedded Field Agent (EFA) provides connectivity to GE Predix* cloud-hosted applications and datastores through a local Predix machine interface that runs within a Linux virtual machine on the UCSCH1. The EFA has two primary functions:

- Collecting and transmitting machine data securely
- A platform for running Predix apps on the Edge directly on the machine

Once a Field Agent is up and running, data is transferred from the plant to the cloud over encrypted channels, preserving its time stamp, quality, and fidelity. It also provides a rich domain application environment for edge processing, so logic can be executed at the most appropriate place in the architecture — locally on the machine or in the cloud.

Note For more information, refer to the following documentation:

- Field Agents User Guide (GFK-2993)
- Field Agent Secure Deployment Guide (GFK-3009)
- Field Agents Upgrade Guide (GFK-3017)
2.1.7 UCSC Virtual Network

The virtual network is a feature of the hypervisor used in UCSCH1 controllers. The virtual network transfers data between the virtual machines (VMs) in the UCSCH1 controller like an Ethernet network transfers data between physical machines over a physical network. The virtual network in the UCSCH1 controller is used to transfer data between the Mark VIe control running in one VM, and the Embedded Field Agent (EFA) running in another VM. The EFA requires a connection to the Mark VIe control and a connection to the cloud. However, the Mark VIe control must not have a connection to the cloud, so a physical managed switch must be used to segment the networks. To resolve this issue, data is passed through the virtual network so the EFA can connect directly to the cloud and eliminate the need of a managed switch.

The virtual network transfers data through memory shared between the VMs instead of the wires of a physical network. The Mark VIe control uses a network firewall to prevent all other traffic.

Like a physical network, the virtual network must be configured with an IP address and subnet mask. The VMs in the UCSCH1 controller must be on the same subnet to function properly. The Mark VIe virtual network is configured using the ToolboxST application. The default configurations for the Mark VIe control and the EFA provide a working virtual network. However, changing the configuration in one VM may interrupt communication over the virtual network until a corresponding change is made to the other VM.

**Note** To configure virtual network adapters, refer to the *ToolboxST User Guide for Mark VIeS Functional Safety Systems* (GEH-6862), the section *Virtual Network Adapters*. To configure the virtual network in the EFA, refer to the *Field Agents User Guide* (GFK-2993).
### 2.1.8 Agency Certifications and Standards

Refer to the UCSC Installation and Maintenance Requirements (IMR) (GFK-3006) for conformance to these standards.

<table>
<thead>
<tr>
<th>Description</th>
<th>Marking</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Safety for Explosive Atmosphere, ATEX Directive</td>
<td>Category 3 equipment - [II 3 G], EN 60079-0: 2012 A+11:2013, EN 60079-7: 2015 [Type of Protection Ex ec]</td>
<td></td>
</tr>
<tr>
<td>European Waste &amp; Collection</td>
<td>Compliance with European WEEE Directive 2012/19/EU</td>
<td></td>
</tr>
<tr>
<td>China Restriction of Hazardous Substances</td>
<td>Compliance with &quot;Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products&quot;. (Jan 21, 2016) Declaration Table provided with equipment.</td>
<td></td>
</tr>
</tbody>
</table>
### 2.1.9 Accessories

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>121T8700P0002</td>
<td>UCSB to UCSC Power Cable Adapter</td>
</tr>
<tr>
<td>121T6659P0001</td>
<td>UCSC COM Port Adapter (RJ-45 to DB9F)</td>
</tr>
</tbody>
</table>
2.1.10 UCSC Hardware Replacement

Replacement parts may contain static-sensitive components. Therefore, GE ships replacement parts in anti-static bags. When handling electronics, make sure to store them in anti-static bags or boxes and use a grounding strap.

---

**Caution**

To prevent component damage caused by static electricity, treat all boards with static-sensitive handling techniques. Wear a wrist grounding strap when handling boards or components, but only after boards or components have been removed from potentially energized equipment and are at a normally grounded workstation.

---

**Warning**

In addition to information provided here, always follow all wiring and safety codes that apply to your area or your type of equipment. For example, in the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes will apply. For maximum safety to personnel and property you must follow these codes. Failure to do so can lead to personal injury or death, property damage or destruction, or both.

➢➢

To replace the UCSC with another UCSC

1. Loosen the screws holding the power connector in place.
2. Disconnect the power connector from the controller.
3. Disconnect all Ethernet cables (note which cable is connected to which port).
4. Loosen the screws holding the controller in place. The mounting is a keyhole design.
5. Remove the controller by lifting to align the large portion of the keyhole with the mounting screws and pull forward.
6. Verify that the hardware revision of the old UCSC is the same or compatible with the new UCSC for its particular application.
7. Reinstall the new controller by reversing steps 2 through 4. Do not apply power yet.
8. Perform the UCSC Restore procedure to initialize the new controller.
9. If restore was not successful, configure the new controller’s UDH network address.
10. Use the ToolboxST application to Build and Download to the controller as needed. Refer to the *ToolboxST User Guide for Mark VIeS Functional Safety Systems* (GEH-6862), the section *Download to Controller* for instructions.
2.1.11 UCSC Restore

After installing a replacement controller, perform the following procedure to apply the configuration to the UCSC controller and allow communication between the UCSC and the ToolboxST application. The Physical Presence (PHY PRES) button located on the front of the controller is used to initiate the procedure.

**Note** The UCSC, as shipped from the factory, does not include the software on the controller to support communication from the PHY PRES button to the EFA. The user needs to download to the controller at least once (using ToolboxST) to enable this.

➢➢➢

**To perform UCSC restore**

1. From the ToolboxST Component Editor **Device** menu, select **Download**, then select **Controller Setup**.
2. When the Controller Setup Wizard **Welcome** window displays, click **Next**.
3. Select **Initialize USB Flash Device**, then click **Next**.
4. Insert a non-encrypted removable USB 2.0 (only) flash device with a 4 GB minimum capacity into the HMI computer USB port.
5. Click **Scan** and select the listed flash drive.
6. Select the correct **Channel** (R, S, or T if using redundant controllers).
7. Click **Write**, then click **Next**.
8. Complete the controller restore process using the instructions provided on the **Controller Setup Wizard** window or using the remaining steps in this procedure.
9. Remove the USB flash device from the HMI computer.
10. Remove power from the controller.
11. Insert the USB flash device into either USB port of the controller.
12. Press and hold in the **PHY PRES** button, and apply power to the controller. Continue to hold in the PHY PRES button until the USB **On LED** is lit (~ 15 seconds).
13. Release the PHY PRES button and wait for the process to complete. (The USB On LED remains lit to indicate the restore is in progress. The procedure takes one to two minutes.) When the LED turns off, the restore has completed successfully.

**Note** If the LED flashes at a 1 Hz rate, a failure has occurred. Retry or remove the USB flash device.

14. Remove the USB flash device from the controller.
15. Cycle power on the controller.
16. From the ToolboxST **Controller Setup Wizard** window, click **Finish**.
17. Perform a **Download** to bring the controller back online and in the controlling state.
2.2 **Controller Password Protection**

Beginning with controller firmware V06.00.00C, password protection can be applied as a security measure to restrict access to the controller. The password has an eight-character limit and other requirements. For the instructions to set password protection, change the password, and other details, refer to the *ToolboxST User Guide for Mark VIeS Functional Safety Systems* (GEH-6862), the section **System Password Protection** for the component.

2.3 **Shared IONet**

Beginning with ControlST V04.06, sharing data between two controller sets on a single Ethernet input/output network (Shared IONet) is available for some Mark controllers, saving the cost of redundant sensors and I/O. Beginning with ControlST V07.06, some Shared IONet Groups may contain up to four controller sets (in accordance with supported controller combinations).

Only the following controller combinations are supported by Shared IONet:

- One Mark VIeS Safety controller and up to three Mark VIe controllers
- One MarkStat controller and one Mark VIe controller
- Up to four Mark VIe controllers

**Note** Refer to the *Mark Controllers Shared IONet User Guide* (GEH-6812) for more information.

2.4 **Black Channel Safety Communication**

Black Channel is a safety communications approach in which the new safety functionality is built over existing protocol without impact to existing safety applications. The Black Channel feature provides the transfer of Safety control data between two Mark VIeS Safety control devices without using the standard UDH network, providing a safer, less congested network. A matching pair of transmitter and receiver blocks, **BLACK_TX** and **BLACK_RX**, are configured for the two Mark VIeS Safety control devices in the application. The data is passed through Ethernet (similar to UDH EGD), and the **BLACK_TX** and **BLACK_RX** blocks run a data integrity check on each respective side of the Black Channel. For more information on these blocks, refer to the *Mark VIeS Safety Control Block Library* (GEI-100691), the chapters **Black Channel Transmitter (BLACK_TX)**, **Black Channel Receiver (BLACK_RX)**, and **Black Channel Example**.

![Example Black Channel Configuration](image-url)

---

*Controllers* GEH-6855_Vol_II_B System Guide 37

*Public Information*
2.5 Controller Setup and Download

After a controller and associated I/O modules have been added to the system, prepare the controller for use by configuring the IP address and redundancy information using the ToolboxST application. For further instructions and procedures, refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862), the sections Controller Setup and Build and Download to Controller.
2.6 Initial Download to I/O Modules

2.6.1 Update Terminal Boards

Prerequisites

- Successfully online with the associated controller set
- All I/O modules have been correctly added to the ToolboxST system
- Correctly connected IONet cables to all the I/O modules
- I/O modules are powered on

Complete this procedure to detect the terminal board barcodes.

➢➢ To update terminal boards online

1. If not already online, then from the Component Editor toolbar click the **Go On/Offline** icon to go online with the ToolboxST application.
2. Have available or create a written record of all installed terminal boards.
3. Enable the I/O modules for configuration.
   a. From the Component Editor Hardware tab, select all the I/O modules.
   b. From the Property Editor, under **Configuration, Required**, select True.
4. From the **Tree View**, double-click the I/O module icon to display the **Modify** dialog box.
5. From the **Bar Code** text box, click the ellipsis button to display the **Select Unassigned Terminal Board** dialog box with the available terminal boards.
6. From the dialog box, select the correct **Bar Code** and click **OK**.
7. Read the warning message, then click **Yes**.
8. Click **OK**.
9. Repeat this procedure for the remaining I/O modules.
10. Verify using the written record that all terminal boards have been identified by the ToolboxST application.

2.6.2 Initial Download to I/O Modules

➢➢ To perform an initial download

1. If using Shared IONet, save and close both Component Editors. From the System Editor **Tree View**, select the Shared IONet Group. Right-click and select **Download Shared IONet**, then complete the wizard. Go to step 4.
2. From the Component Editor, click **Build**.
3. Click **Download** and complete the wizard using the default settings.
4. Cycle power to the panel. Wait for all equipment to power on with correct status LEDs.
5. Click to go online.
6. Wait and reset any alarms, if needed.
7. Build and Download again, if needed.
8. Wait and reset any alarms, if needed.
9. Select the **Component InfoView Status** tab.
The color of the Status tab indicates overall health and equality status of the controller, including its associated I/O hardware. A major difference in controller equality means that the configuration in the ToolboxST application is different from the controller configuration.

- **Green** indicates that the ToolboxST configuration and the controller configuration are equal.
- **Orange** indicates the presence of inequalities or diagnostic warnings.
- **Red** indicates that the configuration in the ToolboxST system, which includes base load, firmware, application code, and I/O module configuration, is significantly different from the component configuration (a Download will correct this).

![Image of the Status tab with attributes and values: Attribute: R Controller, Control State: Controlling, Controller Equality: Major Difference, IO Equality: Indeterminate.]

**Note** Refer to GEH-6855_Vol_I, the chapter *Troubleshooting* for further assistance. For example, if a particular download fails, this may be fixed by selecting the pack individually from the download wizard and trying again.


## 2.7 Controller Common Diagnostic Alarms

These diagnostic alarms are common among Mark Controls Platforms. However, some alarms are not applicable to all controller platforms.

### 0

**Description**  Diagnostic Alarm Reset

### 20

**Description**  ToolboxST application detects unhealthy link or loss of communication between [ ] and controller.

**Possible Cause**
- I/O pack configuration files missing
- I/O pack restarted or did not complete startup
- I/O pack configured for dual networks, but only one network is connected
- Network issue preventing connection to ToolboxST application
- Power failure to the I/O pack
- Terminal board **Bar Code** entered incorrectly in ToolboxST configuration
- Wrong terminal board is configured in ToolboxST application
- I/O pack or module plugged into wrong jack on terminal board, or wrong jack number in ToolboxST configuration
- I/O pack configured in ToolboxST application, but configuration not downloaded to the controller
- I/O pack in program mode

**Solution**
- Verify that the Ethernet cables and network switch are operating correctly.
- Verify that the I/O pack configuration (such as Type, HW Form, Bar Code, position) matches the actual hardware.
- Manually restart the I/O pack or module.
- If ToolboxST communication is working correctly, any additional diagnostics should indicate the cause of the problem.
- Build and download parameters to the I/O pack or module.
- Download firmware and parameters to the I/O pack or module.
- Build and download the configuration to the controller, wait for I/O pack communication status to change, then scan and download to the I/O pack.

**Note**  This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the firmware.
Note This alarm is obsolete.

Description Control/Status communication failure between [ ] and controller

Possible Cause

• Asynchronous Drive Language (ADL) communication unhealthy
• Terminal board barcode typed incorrectly in the ToolboxST configuration
• Wrong terminal board is configured in the ToolboxST application
• I/O pack or module plugged into wrong jack on terminal board, or wrong jack number in ToolboxST configuration
• I/O pack or module is configured in the ToolboxST application, but configuration is not downloaded to the controller
• I/O pack or module in program mode

Solution

• Verify that the I/O pack or module configuration (such as Type, HW Form, Bar Code, position) matches the actual hardware.
• Perform a build and download the configuration to the controller, wait for pack communication status to change, then scan and download to the I/O pack or module.
• Manually restart the I/O pack or module.

Note This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the firmware.

Description ToolboxST application detects a diagnostic status signal (...L3DIAG, ATTN, and/or LINK_OK...) is [ ]; therefore, the status signal is inaccurate, unknown, or indeterminate

Possible Cause

• I/O status signal quality in warning state
• Signal quality unhealthy, forced, or being simulated
• Status information inaccurate

Solution

• Check status signal health.
• Remove the force or simulated condition applied to the status signal.

Note This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the firmware.
Description  ToolboxST application detects a major difference in [ ] controller application code

Possible Cause

- Compressing variables, EGD pages, distributed I/O, or NVRAM
- Changing frame or background period
- Changing controller or network redundancy
- Changing controller platform or NTP client mode
- Changing controller host name or IP address
- Changing IONet IP address
- Adding/removing first/last linking device (PFFA), respectively
- Removing a WCBM module
- Changing from multicast to broadcast (or vice-versa) I/O communication
- Adding the first Shared I/O module or connecting the first Controller to Controller I/O variable
- Removing the last Modbus Slave point
- Disabling controller web pages
- Disabling Wind Compress Data Log
- Disabling Wind Farm Management System

Solution  Rebuild the controller and download.

Note  This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the firmware.
Description  ToolboxST application cannot retrieve diagnostics information from I/O pack

Possible Cause

- Cannot get requested information from I/O pack or module
- Communication program failure
- I/O pack or module unable to retrieve IP address
- Terminal board Bar Code entered incorrectly in ToolboxST configuration
- Wrong terminal board configured in ToolboxST application
- I/O pack or module plugged into wrong jack on terminal board, or wrong jack number in ToolboxST configuration
- I/O pack or module configured in ToolboxST application, but configuration not downloaded to controller
- I/O pack or module in program mode
- I/O pack or module not able to load firmware
- Power failure to the I/O pack or module

Solution

- Verify that the I/O pack configuration (such as Type, HW Form, Bar Code, position) matches the actual hardware.
- Build and download the configuration to the controller, wait for pack communication status to change, then scan and download to the I/O pack or module.
- Manually restart the I/O pack or module.
- Check network cables for proper connection.
- Verify that the switch is functioning correctly.

Note  This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the firmware.
Note  This alarm is obsolete.

Description  Control/Status communication Error: [ ]

Possible Cause
• Cannot get diagnostic information from I/O pack or module
• I/O pack or module not able to load firmware

Solution
• Verify that the I/O pack or module configuration is correct.
• Rebuild the application and download the firmware and application to the I/O pack or module.
• Check network cables for proper connection.
• Verify that the switch is functioning correctly.

Description  Application Runtime Error - [ ] Frame overruns occurred

Possible Cause  Overloaded processor sequencer malfunction (one or more frame overruns occurred)

Solution
For a controller, perform the following to increase the frame idle time:
• Reduce the application or increase the EGD period.
• Upgrade the controller to one with a faster processor.
• Replace the controller.

For an I/O module, perform the following:
• From the ToolboxST application, rebuild the system, then download the application and configuration to the I/O module.
• Replace the I/O module.
260

Description  Application Runtime Error - [ ] Frame skips occurred

Possible Cause  There is an overloaded processor or a processor malfunction. Frame number skips were detected. The frame number should incrementally increase during Controlling state.

Solution
For a controller, do the following:
• Reduce the application or increase the EGD period to reduce the processor load.
• Upgrade the controller to one with a faster processor.
• Replace the controller.
For an I/O module, do the following:
• From the ToolboxST application, rebuild the system, then download the application and configuration to the I/O module.
• Replace the I/O module.

279

Description  Could not determine platform type from hardware

Possible Cause
• During commissioning/maintenance: Incorrect firmware version or hardware malfunction (firmware could not recognize host hardware type)
• During normal operation: Hardware failure

Solution
• Verify that all connectors are aligned properly and fully seated.
• Check the firmware version for compatibility with platform. If correct, replace the controller.
280

Description  Platform hardware does not match configuration

Possible Cause

- During commissioning/maintenance: Platform type identified in the application configuration does not match actual hardware
- During normal operation: Hardware failure

Solution

- Fix the platform type in the ToolboxST application. From the General tab, select General Properties and Platform.
- Rebuild and download the application.
- If problem persists, replace the controller.

282

Description  Firmware Load Error - application independent processes failed to initialize

Possible Cause  Runtime malfunction. An application-independent firmware process could not be started successfully.

Solution

- Reload firmware and application and restart.
- If controller is a UCSA, try formatting and reloading the flash memory.
- If I/O pack has diagnostic: try to re-download the base load.
- Replace the controller or I/O module.

283

Description  Firmware error - Internal process crashed

Possible Cause  Runtime or hardware malfunction (runtime process failed).

Solution

- Reload firmware and application and restart.
- If controller is a UCSA, try formatting and reloading the flash memory.
- If this does not work, replace the controller.
292

Description  Application Error - application overrunning the frame

Possible Cause  Application cannot start within frame.

Solution  Check application loading and reduce the amount of application code or frequency of execution. Build application and download to all controllers.

294

Description  Controller CPU overtemperature, Temp [ ] °C, Threshold [ ] °C

Possible Cause

• Excessive ambient temperature
• Hardware malfunction
• Fan loss

Solution

• Check the fan (if applicable), the ambient temperature, and for the presence of dust.
• Replace the controller.

300

Description  Application Code Load Failure

Possible Cause

During commissioning/maintenance:

• Invalid application configuration

During normal operation:

• Firmware or hardware malfunction

Solution

• Rebuild and download the application to all controllers.
• Reload firmware and application.
• If problem persists, replace the controller.
320

Description  Process Alarm Buffers Full - controller can miss alarm transitions

Possible Cause

• Multiple alarm variables changing state too quickly to transmit all transitions
• Excessive alarms in queue (Plant-wide system failures)

Solution
During commissioning/maintenance:

• Reduce the number of alarms that can change state at the same time (filter alarm variables in the application code).

During normal operation:

• Eliminate the conditions causing excessive process alarms.

321

Description  Internal Runtime error - Process Alarms not being scanned

Possible Cause  Runtime malfunction: alarms not being scanned. Controller may restart on software watchdog timeout due to processor overload.

Solution

• Reload firmware and application, and restart.
• If problem persists, replace the controller.

322

Description  Configuration Load error - Too many consumed EGD variables for Fault Tolerant EGD

Possible Cause  Number of relevant, consumed UDH EGD variables exceeds fault tolerant EGD limitation of 1400 bytes of data. Normal UDH EGD operation not affected; however, in the event of UDH EGD failure, some consumed variables may not be transmitted to redundant controllers over the IONet (if applicable).

Solution
During commissioning/maintenance:

• Reduce the amount of relevant, consumed UDH EGD data by removing the appropriate number of variables from EGD pages.

323

Description  EGD Error - Fault Tolerant EGD activated

Possible Cause  EGD exchange timeout occurred on requesting controller. Redundant processor (if applicable) is unable to receive UDH EGD inputs and requested that EGD data be transferred over the IONet.

Solution

• Verify that all redundant controllers on the UDH network are receiving all expected EGD exchanges.
• Verify that all relevant devices are powered on and producing data on the network.
### 324

**Description** EGD Error - Fault Tolerant EGD data requested

**Possible Cause** An EGD exchange timeout occurred on the requesting controller. Redundant processor (if applicable) unable to receive UDH EGD inputs and has requested that EGD data be transferred over the IONet.

**Solution**
- Check UDH network and verify that all redundant controllers are receiving all expected EGD exchanges.
- Verify that all relevant devices are powered on and producing data on the network.

### 326

**Description** Communication lost from R processor

**Possible Cause**
- IONet or hardware malfunction
- S or T processor in redundant system lost communication with R processor
- Missing cable from the controller to the Unit Data Highway (UDH) network switch

**Solution**
- Go online with the R processor. Verify that the processor is in the Controlling state. If not communicating or in Controlling state, restart the processor.
- Check for disconnected IONet cables or malfunctioning switches.
- Rebuild and download the application.
- Check for a defective Ethernet cable to network switch.
- Check for a defective network switch:
  - Place the Ethernet cable into empty port.
  - If the problem persists, replace the network switch.
327

Description  Communication lost from S processor

Possible Cause

• IONet or hardware malfunction
• R or T processor in redundant system lost communication with S processor
• Missing cable from the controller to the Unit Data Highway (UDH) network switch

Solution

• Go online with the S processor. Verify that the processor is in the Controlling state. If not communicating or in Controlling state, restart the processor.
• Check for disconnected IONet cables or malfunctioning switches.
• Rebuild and download the application.
• Check for a defective Ethernet cable to network switch.
• Check for a defective network switch:
  − Place the Ethernet cable into empty port.
  − If the problem persists, replace the network switch.

328

Description  Communication lost from T processor

Possible Cause

• IONet or hardware malfunction
• R or S processor in redundant system lost communication with T processor
• Missing cable from the controller to the Unit Data Highway (UDH) network switch

Solution

• Go online with the T processor. Verify that the processor is in the Controlling state. If not communicating or in Controlling state, restart the processor.
• Check for disconnected IONet cables or malfunctioning switches.
• Rebuild and download the application.
• Check for a bad Ethernet cable to network switch.
• Check for a bad network switch:
  − Place the Ethernet cable into empty port.
  − If the problem persists, replace the network switch.
Description  Startup sequence failed - Data initialization timeout R processor

Possible Cause  Controller unable to complete startup data initialization

- IONet malfunction
- Controllers have different application revisions
- One or more controllers powered down
- Controller overloaded by external command messages

Solution

- Check for disconnected IONet cables or malfunctioning network switches.
- Rebuild and download the application.
- Verify that all controllers are powered on.
- Disable all other command senders (for example, Modbus masters) until controller is online.

Description  Startup sequence failed - Data initialization timeout S processor

Possible Cause  Controller is unable to complete startup data initialization.

- IONet malfunction
- Controllers have different application revisions
- One or more controllers are powered down
- Controller is overloaded by external command messages.

Solution

- Check for disconnected IONet cables or malfunctioning network switches.
- Rebuild and download application.
- Ensure all controllers are powered up.
- Disable all other command senders (for example, Modbus masters) until controller is online.
331

Description  Startup sequence failed - Data initialization timeout T processor

Possible Cause  Controller is unable to complete startup data initialization.

• IONet malfunction
• Controllers have different application revisions
• One or more controllers are powered down
• Controller is overloaded by external command messages

Solution

• Check for disconnected IONet cables or malfunctioning network switches.
• Rebuild and download application.
• Ensure all controllers are powered up.
• Disable all other command senders (for example, Modbus masters) until controller is online.

332

Description  Overtemperature - Controller rebooted and throttled

Possible Cause

• Excessive ambient temperature
• Hardware malfunction
• Fan loss

Solution

• Check ambient temperature.
• Check for dust buildup on the cabinet filters, controller, and power supply.
• Replace the controller.
• Check fans.

334

Description  Application Error – [ ] Frame Skips Detected

Possible Cause

• Hardware or IONet malfunction
• Frame number skips detected. Frame number should monotonically increase until rollover; alarm occurs following a single frame number skips in successive frames.

Solution

• Check IONet (switches, cables).
• Replace the controller.
335

Description Memory Verification Failed – Firmware Processes

Possible Cause A modification has occurred in the code segment for one of the processes. This indicates that a hardware memory failure has occurred.

Solution Replace the controller.

336

Description Controller is Unlocked

Possible Cause

• Leaving Data Init control state and not locked
• The controller is unlocked through the ToolboxST application.

Solution From ToolboxST application, lock the controllers before running safety functions.

337

Description Output exchange disagreement detected

Possible Cause IONet malfunction or hardware problem. For at least one output, a difference was detected between the controller outputs. This alarm remains active until the controllers agree on all outputs. A difference for non-Boolean data generally indicates a deviation of more than 10% from the median value or no IONet EGD configuration is present. For median values near zero, the variation exceeds integer 2 or real value 0.2.

Solution

• For the Mark VIe runtime, use the ToolboxST disagreement display (View | Disagreements) to determine which variables are in disagreement.
• In the application, avoid use of global variable 'ControllerID' and avoid the use of sequencing block 'USB_HB'.
• Check IONet (switches, cables); rebuild and download application to all processors. If the problem persists, replace the processor module.

347

Description Running Application does not match the Branded Application

Possible Cause Application not branded or different from branded version.

Note The purpose of branding is to label a verified safety application, and to ensure that it is running.

Solution

• Reload the branded application to the controller and I/O packs.
• Use the ToolboxST application to brand the currently running application.
348

Description  Intermittent Communications on IONet1 – Packet Loss Exceeded [ ]%

Possible Cause

- Power cycled on I/O producer (controller or I/O module)
- Faulty Ethernet cable from I/O pack to IONet switch and/or from IONet switch to controller.
- Faulty IONet switch
- I/O message corruption
- Communication errors occurred on more than 5% of data transmissions on IONet1

Solution

- Check for evidence of I/O pack restart (diagnostic alarms, error logs).
- Replace Ethernet cable(s).
- Replace the I/O pack.
- Move the I/O pack’s Ethernet cable into an empty IONet switch port. If problem persists, replace the IONet switch.

349

Description  Intermittent Communications on IONet2 – Packet Loss Exceeded [ ]%

Possible Cause

- Power cycled on I/O producer (controller or I/O module)
- Faulty Ethernet cable from I/O pack to IONet switch and/or from IONet switch to controller.
- Faulty IONet switch
- I/O message corruption
- Communication errors occurred on more than 5% of data transmissions on IONet2

Solution

- Check for evidence of I/O pack restart (diagnostic alarms, error logs).
- Replace Ethernet cable(s).
- Replace the I/O pack.
- Move the I/O pack’s Ethernet cable into an empty IONet switch port. If problem persists, replace the IONet switch.

350

Description  Intermittent Communications on IONet3 – Packet Loss Exceeded [ ]%

Possible Cause

- Power cycled on I/O producer (controller or I/O module)
- Faulty Ethernet cable from I/O pack to IONet switch and/or from IONet switch to controller.
- Faulty IONet switch
- I/O message corruption
- Communication errors occurred on more than 5% of data transmissions on IONet3

Solution

- Check for evidence of I/O pack restart (diagnostic alarms, error logs).
- Replace Ethernet cable(s).
- Replace the I/O pack.
- Move the I/O pack’s Ethernet cable into an empty IONet switch port. If problem persists, replace the IONet switch.
Description Memory Validation Failed – Blockware Data Structures

Possible Cause A hardware memory failure because application process data was modified (data should not change after controller goes online)

Solution Replace the controller.

Description Memory Validation Failed – Configuration Shared Memory

Possible Cause A hardware memory failure because system process data was modified (data should not change after controller goes online)

Solution Replace the controller.

Description Memory Validation Failed – IONet Data Structures

Possible Cause There is a hardware memory failure because IONet process data was modified (data should not change after the controller goes online)

Solution Replace the controller.

Description State Exchange Voter disagreement detected

Possible Cause
  • State Exchange disagreement found
  • Application sequencing error
  • IONet malfunction or hardware problem

Solution
  • Use the ToolboxST disagreement display (View | Disagreements) to determine which variables are in disagreement.
  • In the application, avoid use of global variable 'ControllerID' and avoid the use of 'USB_HB' block.
  • Check IONet (switches, cables). If problem persists, replace the processor module.

Description NANs detected in CALC or NAN_BREAKER block

Possible Cause
  • NaN (Invalid floating point number) received from I/O interface
  • Hardware problem

Solution
  • Check for external devices that may be sending NaNs to the controller.
  • If conditions persists, replace the controller.
357

Description   Internal Runtime error - Sequencer out-of-order or overrun detected

Possible Cause   There is a possible hardware malfunction. Sequencer critical clients were scheduled out of order or were overrun. This alarm occurs following three successive frames of sequencer critical client out-of-order detections. After five, the controller is put into the FAILURE control state.

Solution   Replace the controller.

358

Description   Internal Runtime error - Sequencer client execution underrun

Possible Cause   Possible hardware malfunction. Sequencer critical client underrun detected. Alarm occurs after a sequencer critical client has been run slower than its nominal rate three times in a row; after five, controller put in FAILURE control state.

Solution
•   Ignore this alarm if it occurs during a restart of the controller.
•   If the alarm occurs during normal operation, then replace the controller.

359

Description   Internal Runtime error - Sequencer client execution overrun

Possible Cause   Possible hardware malfunction. Sequencer critical client overrun detected. Alarm occurs after a sequencer critical client has been run faster than its nominal rate three times in a row; after five, controller put in FAILURE control state.

Solution
•   Ignore alarm if it occurs during a restart of the controller.
•   Replace the controller, if the alarm occurs during normal operation.

360

Description   Internal Runtime error - Sequencer frame period out-of-bounds (±15%)

Possible Cause   Possible hardware malfunction. Frame period greater than ±15% of nominal. Alarm occurs following frame period out-of-bounds condition occurring three frames in a row; after five, controller put in FAILURE control state.

Solution
•   Ignore alarm if it occurs during a restart of the controller.
•   Replace the controller, if the alarm occurs during normal operation.
361

Description Internal Runtime error - Sequencer frame state timeout out-of-bounds (±15%)

Possible Cause Possible hardware malfunction. Sequencer frame state timeout greater than ±15% of nominal. Alarm occurs following a sequencer frame state timeout being out-of-bounds three frames in row; after five, controller put in FAILURE control state.

Solution

- Ignore alarm if it occurs during a restart of the controller.
- Replace the controller, if the alarm occurs during normal operation.

362

Description Internal Runtime error - Sequencer frame number skip detected

Possible Cause Possible hardware or IONet malfunction. Frame number skips detected. Frame number should monotonically increase until rollover; alarm occurs following three skips in a row, after five, controller put in FAILURE control state.

Solution

- Ignore this alarm if it occurs during a restart of the controller.
  During normal operation:
  - Check for hardware or network switch malfunction.
  - Check for loose or defective network cables.
  - Replace the controller.

363

Description Memory Validation failed - Sequencer data structures

Possible Cause Hardware memory failure. Sequencer process data was modified (data should not change after the controller is online).

Solution Replace the controller.

364

Description Too many state voter disagreements detected

Possible Cause

- State exchange voter disagreement overflow. System exceeded the limit of 128 simultaneous disagreements at once.
- Application error
- Hardware problem or IONet malfunction

Solution

- Use the ToolboxST disagreement display (View | Disagreements) to determine which variables are in disagreement.
- In the application, avoid use of global variable 'ControllerID' and avoid the use of 'USB_HB' block.
- Check IONet (switches, cables).
- If problem persists, replace the controller.
374

Description  Invalid Calibration Settings

Possible Cause
• Calibration file not detected
• Calibration file corrupted
• Calibration constants invalid
• Hardware Failure

Solution  Replace the module.

375

Description  Controller has entered Quality Control (QC) Mode

Possible Cause  The device has received a command to enter factory QC mode.

Solution  Reboot the device.

462

Description  Hardware Reconfigured: Reboot by removing and reapplying power

Possible Cause  Flash memory file system corruption.

Solution
• After reapplying power, Rebuild and download baseload, firmware and application.
• If the problem persists, replace the controller.

463

Description  Internal runtime error - Could not create the Command and Event Log (CEL) file

Possible Cause  Internal runtime error. Could not create the CEL file.

Solution
• Rebuild and download baseload, firmware, and application to the controller.
• If the problem persists, replace the controller.

464

Description  Ethernet Interface [ ] disabled due to excessive traffic

Possible Cause  Network interface has been disabled to protect itself from excessive activity on the network.

Solution
• Check for network loops.
• Monitor network activity and remove excessive traffic.
465

Description  Ethernet Interface [ ] disabled due to excessive traffic

Possible Cause  Network interface has been disabled to protect itself from excessive activity on the network

Solution

• Check for network loops.
• Monitor network activity and remove excessive traffic.

466

Description  Ethernet Interface [ ] disabled due to excessive traffic

Possible Cause  Network interface has been disabled to protect itself from excessive activity on the network

Solution

• Check for network loops.
• Monitor network activity and remove excessive traffic.

467

Description  Ethernet Interface [ ] disabled due to excessive traffic

Possible Cause  Network interface has been disabled to protect itself from excessive activity on the network

Solution

• Check for network loops.
• Monitor network activity and remove excessive traffic.

468

Description  Ethernet Interface [ ] disabled due to excessive traffic

Possible Cause  Network interface has been disabled to protect itself from excessive activity on the network

Solution

• Check for network loops.
• Monitor network activity and remove excessive traffic.
**469**

**Description**  UDH EGD fault detected by the R processor

**Possible Cause**

- UDH EGD producer is powered down
- Producer is unhealthy
- Ethernet connection(s) failure

**Solution**

- Ensure all EGD producers are powered on and healthy.
- Check for a defective Ethernet cable from producer to network switch. Replace the cable(s).
- Check for a defective network switch by placing the producer's Ethernet cable into an empty port. If the problem persists, replace the network switch.
- Replace the processor module.

**470**

**Description**  UDH EGD fault detected by the S processor

**Possible Cause**

- UDH EGD producer is powered down
- Producer is unhealthy
- Ethernet connection(s) failure

**Solution**

- Ensure all EGD producers are powered up and healthy.
- Check for a defective Ethernet cable from producer to network switch. Replace the cable(s).
- Check for a defective network switch by placing the producer's Ethernet cable into an empty port. If the problem persists, replace the network switch.
- Replace the producer processor module.

**471**

**Description**  UDH EGD fault detected by the T processor

**Possible Cause**

- UDH EGD producer is powered down
- Producer is unhealthy
- Ethernet connection(s) failure

**Solution**

- Ensure all EGD producers are powered up and healthy.
- Check for a defective Ethernet cable from producer to network switch. Replace the cable(s).
- Check for a defective network switch by placing the producer's Ethernet cable into an empty port. If the problem persists, replace the network switch.
- Replace the producer processor module.
486

Description  Auto-Reconfiguration server installation is incomplete

Possible Cause

• A download from the ToolboxST application to an I/O pack and/or the Auto-Reconfiguration server has failed
• Not all of the I/O packs were selected for download

Solution  Perform a scan and download using the ToolboxST application.

487

Description  Auto-Reconfiguration server failed scanning or downloading an I/O pack

Possible Cause  At least one I/O pack is in an unexpected state that the Auto-Reconfiguration server is unable to handle

Solution

• Cycle power on the I/O pack.
• Perform a scan and download using the ToolboxST application.
• Replace the I/O pack.

488

Description  EGD Error - Could not configure consumed exchanges from one or more Producers

Possible Cause

• Producer EGD Page(s) configured incorrectly
• Producer(s) powered down
• Network connectivity intermittent or severed
• Internal Firmware failure

Solution

• Rectify configuration error. Compress all pages and download application to Producer.
• Ensure each Producer is powered on and in the Controlling state.
• Refer to the Network Troubleshooting guide for possible solutions.
• Replace the Consumer and/or Producer hardware.
**489**

**Description**  
EGD Error - One or more consumed exchanges contain unbound variables

**Possible Cause**

- An EGD variable has been removed from a Producer's EGD configuration
- An EGD variable has been added to a different Producer's EGD Page from its original EGD Page

**Solution**

- Add the offending variable to the Producer's EGD configuration, compress the Page and download the application to the Producer.
- Remove the reference to the offending variable from the Consumer's application code; build and download application to the Consumer.
- Compress the EGD Page in the Producer where the variable has been added; build and download the application to the Producer.

**490**

**Description**  
Software watchdog has been disabled

**Possible Cause**

- A runtime malfunction has disabled the software watchdog protective function
- An invalid version of firmware has been downloaded

**Solution**

- Reload base load, firmware, and application and restart.
- If using a UCSA, reformat the flash and reload the firmware.
- I/O pack or module: re-download the base load.
- If this does not work, replace the controller or I/O module.

**491**

**Description**  
Hardware watchdog has been disabled

**Possible Cause**

- A runtime malfunction has disabled the hardware watchdog protective function
- A hardware failure has disabled the hardware watchdog protective function

**Solution**

- Reload firmware and restart.
- If problem persists, replace hardware.
493

Description  CDH EGD fault detected by the R processor

Possible Cause

- CDH EGD producer is powered down
- Producer is unhealthy
- Ethernet connection(s) failure

Solution

- Ensure all EGD producers are powered up and healthy.
- Check for a defective Ethernet cable from producer to network switch. Replace the cable(s).
- Check for a defective network switch by placing the producer's Ethernet cable into an empty port. If the problem persists, replace the network switch.
- Replace the producer processor module.

494

Description  CDH EGD fault detected by the S processor

Possible Cause

- CDH EGD producer is powered down
- Producer is unhealthy
- Ethernet connection(s) failure

Solution

- Ensure all EGD producers are powered up and healthy.
- Check for a defective Ethernet cable from producer to network switch. Replace the cable(s).
- Check for a defective network switch by placing the producer's Ethernet cable into an empty port. If the problem persists, replace the network switch.
- Replace the producer processor module.
**495**

**Description**  
CDH EGD fault detected by the T processor

**Possible Cause**

- CDH EGD producer is powered down
- Producer is unhealthy
- Ethernet connection(s) failure

**Solution**

- Ensure all EGD producers are powered up and healthy.
- Check for a defective Ethernet cable from producer to network switch. Replace the cable(s).
- Check for a defective network switch by placing the producer's Ethernet cable into an empty port. If the problem persists, replace the network switch.
- Replace the producer processor module.

**496**

**Description**  
Failed to incorporate the user-configured frame state timeouts

**Possible Cause**

- Invalid user-configured frame state timeout values
- Failed to parse the user-configured frame state timeouts file

**Solution**

- Timeout values configured by the user must satisfy the condition  
  \[ \text{Frame Rate} > \text{Output Timeout} > \text{App Timeout} > \text{Input Timeout} > 0. \]
- Rebuild the application and force an offline download of the application to the controller.

**497-498**

**Description**  
Fan loss detected for controller fan [ ]

**Possible Cause**

- Hardware malfunction
- Fan power not applied

**Solution**

- Check the fan.
- Verify that the power connector is properly inserted.
- Replace the fan.
501

Description  Total memory consumption has exceeded [ ] percent

Possible Cause  Memory usage is driven from three functions:

- The online download procedure temporarily stores the previous and new application configuration in memory.
- The footprint of the application configuration/code has been enlarged.
- Memory usage can grow over time if there is a memory leak.

Solution

- The alarm should return to normal state after download is complete.
- Reduce the content of the application configuration/code.
- To address a memory leak, reboot the device to reinitialize baseline memory use. Monitor for reoccurrence and contact your GE representative.

502

Description  Syspage inconsistency detected

Possible Cause  Memory corruption

Solution  Restart the controller to re-initialize QNX syspage.

503

Description  Communications timeout with Remote System Log Server

Possible Cause

- Remote Syslog server not in network
- Remote Syslog server down
- Incorrect Remote Syslog server IP address in system configuration
- Network issue (cables/switch) connecting controller to Remote Syslog server

Solution

- Verify that the Remote Syslog server is in operation.
- Verify that the correct Remote Syslog server IP address in the system configuration.
- Check the network connections.
504
Description  Unauthorized executable was detected and terminated

Possible Cause  When in Secure mode, the controller only permits authorized executables. An unauthorized executable has been detected and dismissed.

Solution
• Inspect the syslog/error log messages
• Rebuild and download the baseload, firmware, and application to the controller.
• Re-install the ControlST application, then rebuild and download the baseload, firmware, and application to the controller.

505
Description  R network shared I/O module inputs unhealthy

Possible Cause
• I/O module restarting or restarted
• I/O module application/configuration missing
• Application/configuration does not match in I/O module and controller
• Failed Ethernet connection between I/O module and controller
• Ethernet cable inserted into wrong connector on I/O module

Note  When using the Shared IONet feature, this alarm is generated if there is a problem with receiving inputs from any shared I/O module on the R IONet. Refer to Mark Controllers Shared IONet User Guide (GEH-6812).

Solution
• Rebuild and download application/parameters to all controllers and I/O modules.
• Reload firmware and parameters to the affected I/O module.
• Reload firmware and application to all controllers.
• If the problem persists, replace the affected I/O module, then replace the controller.
506

Description  S network shared I/O module inputs unhealthy

Possible Cause

- I/O module restarting or restarted
- I/O module application/configuration missing
- Application/configuration does not match in I/O module and controller
- Failed Ethernet connection between I/O module and controller
- Ethernet cable inserted into wrong connector on I/O module

**Note** When using the Shared IONet feature, this alarm is generated if there is a problem with receiving inputs from any shared I/O module on the S IONet. Refer to *Mark Controllers Shared IONet User Guide* (GEH-6812).

Solution

- Rebuild and download application/parameters to all controllers and I/O modules.
- Reload firmware and parameters to the affected I/O module.
- Reload firmware and application to all controllers.
- If the problem persists, replace the affected I/O module, then replace the controller.

507

Description  T network shared I/O module inputs unhealthy

Possible Cause

- I/O module restarting or restarted
- I/O module application/configuration missing
- Application/configuration does not match in I/O module and controller
- Failed Ethernet connection between I/O module and controller
- Ethernet cable inserted into wrong connector on I/O module

**Note** When using the Shared IONet feature, this alarm is generated if there is a problem with receiving inputs from any shared I/O module on the T IONet. Refer to *Mark Controllers Shared IONet User Guide* (GEH-6812).

Solution

- Rebuild and download application/parameters to all controllers and I/O modules.
- Reload firmware and parameters to the affected I/O module.
- Reload firmware and application to all controllers.
- If the problem persists, replace the affected I/O module, then replace the controller.
508

Description  Application mismatch between redundant controllers

Possible Cause

• One processor installed new application code while the other processor(s) did not
• Processor was replaced and application code was built with a different version of the ToolboxST application

Solution

• Rebuild and download the application code to all controllers.
• Verify that the Application Code checkbox is selected in the download wizard for all controllers prior to downloading.

509

Description  Controller certificate has been revoked

Possible Cause

• Controller certificate is in the Certificate Revocation List (CRL)
• Certificate Authority (CA) Administrator revoked the certificate

Solution

• Transition the controller from Secure to Open state then back to Secure to generate a new certificate and private key.
• Contact the Certificate Authority (CA) Administrator.

510

Description  Controller certificate will expire within 30 days

Possible Cause  Controller certificate will expire within 30 days

Solution

• Transition the controller from Secure to Open state then back to Secure to generate a new certificate and private key.
• Contact the Certificate Authority (CA) Administrator.
511

Description  Controller certificate will expire within seven days

Possible Cause  Controller certificate will expire within seven days

Solution

• Transition the controller from Secure to Open state then back to Secure to generate a new certificate and private key.
• Contact the Certificate Authority (CA) Administrator.

512

Description  Controller certificate will expire in one day

Possible Cause  Controller certificate will expire in one day

Solution

• Transition the controller from Secure to Open state then back to Secure to generate a new certificate and private key.
• Contact the Certificate Authority (CA) Administrator.

513

Description  Controller certificate has expired; controller is no longer in Secure state

Possible Cause

• Controller is not in Secure state
• Controller certificate has expired

Solution

• Place the controller in the Secure state.
• Contact the Certificate Authority (CA) Administrator.
514-537

**Description**  Controller To Controller (C2C) Inputs Unhealthy on IONet [ ] from ControlSet [ ]

**Possible Cause**
- Failed Ethernet connection between controllers
- Ethernet cable is inserted into the wrong connector on the IONet switch
- Controller to Controller (C2C) packet production is restarting or not occurring
- Application or configuration is missing in the controller or does not match in both controllers

**Note**  A control set is a controller in a Shared IONet group. There are 24 Controller to Controller (C2C) diagnostic alarms assigned for eight control sets. Each control set contains three diagnostics for its IONets.

**Solution**
- Check for Ethernet connectivity between the controllers.
- Rebuild and download the application to all controllers.
- Reload the firmware and application to all controllers.
- If the problem persists, replace the affected switch and Ethernet cables, then replace the controller.

538

**Description**  Certificate Authority (CA) certificate will expire within 30 days

**Possible Cause**  CA certificate will expire within 30 days

**Solution**  Contact the CA Administrator.

539

**Description**  Certificate Authority (CA) certificate will expire within seven days

**Possible Cause**  CA certificate will expire within seven days

**Solution**  Contact the CA Administrator.

540

**Description**  Certificate Authority (CA) certificate will expire within one day

**Possible Cause**  CA certificate will expire within one day

**Solution**  Contact the CA Administrator.
541
Description  Certificate Authority (CA) certificate has expired; controller is no longer in Secure state
Possible Cause  CA certificate has expired
Solution  Contact the CA Administrator.

542
Description  Certificate Revocation List (CRL) has expired
Possible Cause  CRL has expired
Solution
1. Contact the CA Administrator and request/confirm the renewal of the CRL.
2. After the CRL is renewed, from the Mark Vle Device menu select View | Diagnostics | Controller Advanced Diagnostics.
3. Expand the Commands tree, expand the Diagnostics tree, and double-click Get CRL for controller from CA Server.
4. Confirm the reply, CRL received successfully, which indicates that the Mark Vle to CA Server connection is healthy.
5. Close the Advanced Diagnostics Commands window.

543
Description  Total memory consumption has exceeded [ ] percent
Possible Cause
• Memory leak
• Application code is too large
Solution
• Decrease memory usage.
• Restart the controller.

544
Description  Communications error with Certificate Authority Server
Possible Cause
• Certificate Authority (CA) server not in network or not in operation (server is down)
• Incorrect CA server IP address in system configuration
• Network issue (cables/switch) connecting controller to CA server
Solution
• Verify that the CA server is in operation.
• Verify that the CA server IP address is correct in the system configuration.
• Check the network connections.
545

Description  Active PFFA diagnostics detected

Possible Cause  At least one configured PFFA module contains an active diagnostic. Since each controller within a control set monitors the diagnostic conditions of PFFA modules and connected Fieldbus devices, PFFA diagnostics may differ between the individual controllers.

Solution

• If there are active PFFA diagnostics in the WorkstationST Alarm Viewer, correct those issues.
• If there are no active PFFA diagnostics in the Alarm Viewer, go online specifically to the controller with this 545 diagnostic using the ToolboxST application. From the Component Editor Hardware tab, select the PFFA with active diagnostics, and correct the identified issues.

546

Description  This component is or has been in factory test mode.

Possible Cause  The controller or I/O pack has received the command to enter factory test mode.

Solution  Reboot the I/O pack or controller.

547

Description  Default user password detected

Possible Cause  The controller password is the default value.

Solution  From the ToolboxST application, set the password.

Note  To maintain a strong security posture GE recommends the user must change the factory default controller password for a device. The maximum number of characters for the new password is limited to 8 characters. The new password cannot be the factory default password. If you do not know the default password, contact the nearest GE Sales or Service Office, or an authorized GE Sales Representative.

To change the controller password, refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862), the section Controller Password Change.
Description  Inputs unhealthy on IO Module [], R pack IONet [], Message Timeout

Possible Cause
• I/O pack restarting or restarted
• I/O pack application/configuration is missing
• Application/configuration does not match in the I/O pack and controller
• Failed Ethernet connection between I/O pack and controller
• Ethernet cable inserted into wrong connector on I/O pack

Solution
• Reset all diagnostic alarms.
• Rebuild and download application to all controllers and I/O packs.
• Reload firmware and application.
• Verify that Ethernet cable on I/O pack matches the ToolboxST configuration.
• Check for faulty Ethernet cable from pack to network switch and/or from switch to controller. Replace cable(s) if necessary.
• Replace the I/O pack.
• Defective network switch, place I/O pack's Ethernet cable into empty port. If problem persists, replace network switch.
### 1000-2024

**Description**  Inputs unhealthy on IO Module [ ], S pack IONet [ ] - Message Timeout

**Possible Cause**
- I/O pack restarting or restarted
- I/O pack application/configuration is missing
- Application/configuration does not match in the I/O pack and controller
- Failed Ethernet connection between I/O pack and controller
- Ethernet cable inserted into wrong connector on I/O pack

**Solution**
- Reset all diagnostic alarms.
- Rebuild and download application to all controllers and I/O packs.
- Reload firmware and application.
- Verify that Ethernet cable on I/O pack matches the ToolboxST configuration.
- Check for faulty Ethernet cable from I/O pack to network switch and/or from switch to controller. Replace cable(s) if necessary.
- Replace the I/O pack.
- Defective network switch, place I/O pack's Ethernet cable into empty port. If problem persists, replace network switch.

### 1000-2024

**Description**  Inputs unhealthy on IO Module [ ], T pack IONet [ ] - Message Timeout

**Possible Cause**
- Pack restarting or restarted
- I/O pack application/configuration is missing
- Application/configuration does not match in the I/O pack and controller
- Failed Ethernet connection between I/O pack and controller
- Ethernet cable inserted into wrong connector on I/O pack

**Solution**
- Reset all diagnostic alarms.
- Rebuild and download application to all controllers and I/O packs.
- Reload firmware and application.
- Verify that Ethernet cable on I/O pack matches the ToolboxST configuration.
- Check for faulty Ethernet cable from I/O pack to network switch and/or from switch to controller. Replace cable(s) if necessary.
- Replace the I/O pack.
- Defective network switch, place I/O pack's Ethernet cable into empty port. If problem persists, replace network switch.
**1000-2024**

**Description**  Inputs unhealthy on IO Module [ ], IONet [ ] - Message Timeout

**Possible Cause**
- I/O pack restarting or restarted
- I/O pack application/configuration is missing
- Application/configuration does not match in the I/O pack and controller
- Failed Ethernet connection between I/O pack and controller
- Ethernet cable inserted into wrong connector on I/O pack

**Solution**
- Reset all diagnostic alarms.
- Rebuild and download application to all controllers and I/O packs.
- Reload firmware and application.
- Verify that Ethernet cable on I/O pack matches the ToolboxST configuration.
- Check for faulty Ethernet cable from I/O pack to network switch and/or from switch to controller. Replace cable(s) if necessary.
- Replace the I/O pack.
- Defective network switch, place I/O pack's Ethernet cable into empty port. If problem persists, replace network switch.

**1000-2024**

**Description**  Inputs unhealthy on IO Module [ ], R pack IONet [ ] - Message Length not valid

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**
- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.

**1000-2024**

**Description**  Inputs unhealthy on IO Module [ ], S pack IONet [ ] - Message Length not valid

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**
- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.
**1000-2024**

**Description**  Inputs unhealthy on IO Module [ ], T pack IONet [ ] - Message Length not valid

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**

- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.

---

**1000-2024**

**Description**  Inputs unhealthy on IO Module [ ], IONet [ ] - Message Length not valid

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**

- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.

---

**1000-2024**

**Description**  Inputs unhealthy on IO Module [ ], R Pack IONet [ ] - Major Signature Mismatch

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**

- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.
1000-2024

Description Inputs unhealthy on IO Module [], S Pack IONet [] - Major Signature Mismatch

Possible Cause Application/configuration does not match in the I/O pack and controller.

Solution

• Rebuild and download application/parameters to all controllers and I/O packs.
• Reload firmware and parameters to the affected I/O pack.
• Reload firmware and application to all controllers.
• If problem persists, replace affected I/O pack, then replace controller.

1000-2024

Description Inputs unhealthy on IO Module [], T Pack IONet [] - Major Signature Mismatch

Possible Cause Application/configuration does not match in the I/O pack and controller.

Solution

• Rebuild and download application/parameters to all controllers and I/O packs.
• Reload firmware and parameters to the affected I/O pack.
• Reload firmware and application to all controllers.
• If problem persists, replace affected I/O pack, then replace controller.

1000-2024

Description Inputs unhealthy on IO Module [], IONet [] - Major Signature Mismatch

Possible Cause Application/configuration does not match in the I/O pack and controller.

Solution

• Rebuild and download application/parameters to all controllers and I/O packs.
• Reload firmware and parameters to the affected I/O pack.
• Reload firmware and application to all controllers.
• If problem persists, replace affected I/O pack, then replace controller.
1000-2024

Description  Inputs unhealthy on IO Module [ ], R Pack IONet [ ] - Minor Signature Mismatch

Possible Cause  Application/configuration does not match in the I/O pack and controller.

Solution
•  Rebuild and download application/parameters to all controllers and I/O packs.
•  Reload firmware and parameters to the affected I/O pack.
•  Reload firmware and application to all controllers.
•  If problem persists, replace affected I/O pack, then replace controller.

1000-2024

Description  Inputs unhealthy on IO Module [ ], S Pack IONet [ ] - Minor Signature Mismatch

Possible Cause  Application/configuration does not match in the I/O pack and controller.

Solution
•  Rebuild and download application/parameters to all controllers and I/O packs.
•  Reload firmware and parameters to the affected I/O pack.
•  Reload firmware and application to all controllers.
•  If problem persists, replace affected I/O pack, then replace controller.

1000-2024

Description  Inputs unhealthy on IO Module [ ], T Pack IONet [ ] - Minor Signature Mismatch

Possible Cause  Application/configuration does not match in the I/O pack and controller.

Solution
•  Rebuild and download application/parameters to all controllers and I/O packs.
•  Reload firmware and parameters to the affected I/O pack.
•  Reload firmware and application to all controllers.
•  If problem persists, replace affected I/O pack, then replace controller.
1000-2024

**Description**  Inputs unhealthy on IO Module [], IONet [], - Minor Signature Mismatch

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**
- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.

1000-2024

**Description**  Inputs unhealthy on IO Module [], R Pack IONet [], - Timestamp Mismatch

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**
- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.

1000-2024

**Description**  Inputs unhealthy on IO Module [], S Pack IONet [], - Timestamp Mismatch

**Possible Cause**  Application/configuration does not match in the I/O pack and controller.

**Solution**
- Rebuild and download application/parameters to all controllers and I/O packs.
- Reload firmware and parameters to the affected I/O pack.
- Reload firmware and application to all controllers.
- If problem persists, replace affected I/O pack, then replace controller.
1000-2024

Description  Inputs unhealthy on IO Module [], T Pack IONet [], - Timestamp Mismatch

Possible Cause  Application/configuration does not match in the I/O pack and controller.

Solution
• Rebuild and download application/parameters to all controllers and I/O packs.
• Reload firmware and parameters to the affected I/O pack.
• Reload firmware and application to all controllers.
• If problem persists, Immediate Attention Required: Fieldbus I/O Module [], Not Detected on IoNet [], replace affected I/O pack, then replace controller.

1000-2024

Description  Inputs unhealthy on IO Module [], IONet [], - Timestamp Mismatch

Possible Cause  Application/configuration does not match in the I/O pack and controller.

Solution
• Rebuild and download application/parameters to all controllers and I/O packs.
• Reload firmware and parameters to the affected I/O pack.
• Reload firmware and application to all controllers.
• If problem persists, replace affected I/O pack, then replace controller.

1000-2024

Description  Inputs unhealthy on IO Module [], IONet [], - Message Timeout

Possible Cause  Application/configuration does not match in the I/O pack and controller.

Solution
• Rebuild and download application/parameters to all controllers and I/O packs.
• Reload firmware and parameters to the affected I/O pack.
• Reload firmware and application to all controllers.
• If problem persists, replace affected I/O pack, then replace controller.
1000-2024

Description  Immediate Attention Required: Fieldbus I/O Module [ ] Not Detected on IoNet [ ]

Possible Cause  Note: If this diagnostic is active, the module needs to be replaced immediately. If it is simplex, the devices under this PFF A have lost communication. If it is redundant and not replaced, and a controller on the remaining module's IoNet goes down, then control is lost for all devices under the PFF A modules.

- PFF A module did not complete Start
- PFF A module configuration files missing
- PFF A module restarted
- PFF A module configured for Hot Backup, but only one network is connected
- Serial connection between PFF A modules is broken
- Network issue

Solution

- If the Control/Status communication is working correctly, any additional diagnostics should indicate the cause of the problem.
- Build and download parameters to the PFF A module and controller.
- Verify Serial cable is attached correctly.
- Verify that the Ethernet cables and network switch are operating correctly.
- Manually restart the PFF A module.

2400

Description  EtherCAT scan bus error

Possible Cause

- EtherCAT device(s) is unplugged or without power
- An Ethernet cable is disconnected or damaged
- Redundancy mode is not set correctly
- Redundant Ring is broken

Solution

- Ensure all devices are connected and powered.
- Verify all Ethernet LINK lights are lit.
- Verify redundant configuration is correct.

2401

Description  EtherCAT All Ethernet links disconnected

Possible Cause

- Ethernet LINK between Mark Vle controller and EtherCAT network is lost
- EtherCAT device(s) are unplugged or without power

Solution

- Reconnect Ethernet cables.
- Verify all Ethernet LINK lights are lit.
- Verify all EtherCAT devices are powered.
2402
Description  EtherCAT linebreak detected between devices [ ] and [ ]

Possible Cause
• An Ethernet cable is disconnected or damaged
• EtherCAT device(s) is unplugged or without power

Solution
• Reconnect Ethernet cables.
• Verify all Ethernet LINK lights are lit.
• Verify all EtherCAT devices are powered.

2404
Description  EtherCAT limit for lost frames has been exceeded

Possible Cause
• A device or network component is corrupting the EtherCAT frame
• An Ethernet cable is damaged

Solution  Use Controller Advanced Diagnostic tool to determine where network issues are located in the device topology.

2405
Description  EtherCAT device disconnected

Possible Cause
• EtherCAT device(s) is unplugged or without power
• An Ethernet cable is disconnected or damaged

Solution
• Ensure all devices are connected and powered.
• Verify all Ethernet LINK lights are lit.

2406
Description  EtherCAT device in unexpected state

Possible Cause  EtherCAT device(s) have invalid configuration or have experienced a watchdog event.

Solution  Check the EtherCAT device configuration in the ENI file and EtherCAT Configuration Tool.

2407
Description  EtherCAT Master in unexpected state

Possible Cause  Bus does not match ENI file.

Solution  Download a new ENI file or plug in all devices.
2408

Description  EtherCAT ENI file does not match bus configuration

Possible Cause  ENI File imported in ToolboxST does not match the discovered network.

Solution

• Verify ENI file matches the network connected to the Mark VIe controller.
• Verify EtherCAT network is connected and intact.

2409

Description  EtherCAT redundant Ethernet links crossed

Possible Cause  Main and Redundant Ethernet links are swapped on the controller.

Solution  Switch the EtherCAT Network connections on the controller.

2410

Description  EtherCAT configuration is not supported

Possible Cause

• The ENI file contains unsupported commands or features
• The ENI file contains commands that are unsupported in redundancy

Solution

• Remove unsupported commands or disable unsupported features.
• In redundant operation, replace LRW commands with LRD / LWR.
3 Unmanaged Ethernet Switches

GE’s product line of industrial unmanaged Ethernet 10/100 switches, ESWA and ESWB, are specifically designed to meet the needs of real-time industrial control solutions. To meet the requirements for speed and functionality, the following features are provided:

- 802.3, 802.3u, and 802.3x compatibility
- 10/100 base copper with auto negotiation
- Full/half duplex auto-negotiation
- 100 Mbps FX uplink port
- HP-MDIX auto sensing
- LEDs for Link Presence, Activity and Duplex, and Speed per port (each LED has two colors)
- LED for Power
- Minimum 256 KB buffer with 4K media access control (MAC) addresses
3.1 Available Form Factors

The ESWx switch is available in the following form factors:

<table>
<thead>
<tr>
<th>Part #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS420ESWAH1A</td>
<td>8 ports 10/100BASE-TX + 1 port 100BASE-FX LC-type connection</td>
</tr>
<tr>
<td>IS420ESWAH2A</td>
<td>8 ports 10/100BASE-TX + 2 ports 100BASE-FX LC-type connection</td>
</tr>
<tr>
<td>IS420ESWAH3A</td>
<td>8 ports 10/100BASE-TX</td>
</tr>
<tr>
<td>IS420ESWAH4A</td>
<td>8 ports 10/100BASE-TX + 1 port 100BASE-LX10 LC-type connection</td>
</tr>
<tr>
<td>IS420ESWAH5A</td>
<td>8 ports 10/100BASE-TX + 2 ports 100BASE-LX10 LC-type connection</td>
</tr>
<tr>
<td>IS420ESWBH1A</td>
<td>16 ports 10/100BASE-TX + 1 port 100BASE-FX LC-type connection</td>
</tr>
<tr>
<td>IS420ESWBH2A</td>
<td>16 ports 10/100BASE-TX + 2 ports 100BASE-FX LC-type connection</td>
</tr>
<tr>
<td>IS420ESWBH3A</td>
<td>16 ports 10/100BASE-TX</td>
</tr>
<tr>
<td>IS420ESWBH4A</td>
<td>16 ports 10/100BASE-TX + 1 port 100BASE-LX10 LC-type connection</td>
</tr>
<tr>
<td>IS420ESWBH5A</td>
<td>16 ports 10/100BASE-TX + 2 ports 100BASE-LX10 LC-type connection</td>
</tr>
</tbody>
</table>

3.2 Installation

For new installations, mount the switch or switches onto the control system panel(s) using a DIN-rail. Connect the copper and/or fiber cables in accordance with system requirements and redundancy. Connect the 28 V dc power from the power distribution board to the switch.

Note: For system requirements, redundancy, and other related information, refer to the Mark VIe Industrial Ethernet / IONet Switches Summary Sheet (GEI-100869) and the Mark VIeS Functional Safety Systems for General Market Volume I: System Guide (GEH-6855_Vol_I), the chapter Ethernet Networks.

GE has qualified the following DIN-rail clips for use with the ESWx switches.

<table>
<thead>
<tr>
<th>Clip Part #</th>
<th>Switch Usage</th>
<th>Mounting Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>259B2451BVP1</td>
<td>ESWA (8-port) or ESWB (16-port)</td>
<td>Long edge of switch body parallel to rail</td>
</tr>
<tr>
<td>259B2451BVP2</td>
<td>ESWA (8-port)</td>
<td>Long edge of switch body perpendicular to rail</td>
</tr>
<tr>
<td>259B2451BVP4</td>
<td>ESWB (16-port)</td>
<td>Long edge of switch body perpendicular to rail</td>
</tr>
</tbody>
</table>
3.3 Configuration

The RJ-45 connectors support multiple insertions and removals with an estimated service life expectancy of 200 insertion/removal cycles. Connector components are exposed to torsion forces across any axis of the connector and tension forces that are static from cable weight and cable dressing. Dynamic stresses are imposed on the connectors from transients in assembled system transport to the plant site and operation in a high vibration power production environment. Connector design anticipated static forces of three pounds force (89.9 Newton) per connection while complying with the other dynamic operating load requirements.

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 V dc power</td>
<td>Phoenix® contact part number MC 1.5/S-STF-3.81</td>
</tr>
<tr>
<td>Copper</td>
<td>RJ-45 ports for Cat 5e UTP</td>
</tr>
<tr>
<td>Fiber</td>
<td>LC-type †</td>
</tr>
<tr>
<td></td>
<td>Single Mode Fiber (SMF) requires the additional IR SFP single-mode transducer, GE part # 65G2100–008.</td>
</tr>
</tbody>
</table>

† A port adapter is used if needing to interface an existing SC fiber termination to the LC fiber port. GE part # 336A5026P01 SC to LC adapter is required for multi-mode fiber (most common). GE part # 336A5026P02 SC to LC adapter is required for single-mode fiber.

3.4 IONet Switch Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td>DIN-rail mounted with separately purchased mounting clip. DIN-rail mounting meets vibration and shock specifications.</td>
</tr>
<tr>
<td>Dimensions (width x depth x height)</td>
<td>ESWA: 138 x 86 x 56 mm (5.45 x 3.40 x 2.20 in) ESWB: 188 x 86 x 56 mm (7.40 x 3.40 x 2.20 in)</td>
</tr>
<tr>
<td>Incoming power connection</td>
<td>Supports two redundant Diode-OR module power supply inputs of 18 to 36 V dc</td>
</tr>
<tr>
<td>Cooling</td>
<td>Convection cooled when mounted vertically or horizontally</td>
</tr>
<tr>
<td>Coating</td>
<td>Resistant to corrosion with provisions made for grounding per IEC 60721-3-3 Class 3C2</td>
</tr>
<tr>
<td>Ambient rating for enclosure design</td>
<td>IS420ESWAHxA and IS420ESWBHxA are rated for -40 to 70°C (-40 to 158 °F) Refer to the Mark VleS Functional Safety Systems for General Market Volume I: System Guide (GE-6855_Vol_I), the chapter Technical Regulations, Standards, and Environments for more details.</td>
</tr>
<tr>
<td>Absolute Maximum Current</td>
<td>IS420ESWAHxA: ≤ 0.5 A IS420ESWBHxA: ≤ 1.0 A</td>
</tr>
<tr>
<td>Shipping vibration, shock</td>
<td>The switch can survive 72 hours at 0.3 G rms between frequencies of 4 to 16 Hz. Three shocks of 15G, 2-millisecond impulse each repeated for all three axes as mounted on panel base.</td>
</tr>
<tr>
<td>Operating vibration</td>
<td>Can survive 1.0 G Horizontal, 0.5 G vertical at 15 to 120 Hz</td>
</tr>
</tbody>
</table>
3.5 **Operation**

The performance of a level 1 Ethernet switch is mainly centered on the ability to buffer packets. When a level 1 switch has a continuous stream of incoming broadcast or multicast packets, the switch must in turn send those packets out upon complete reception. A single incoming stream should require enough space to buffer one packet or at the most one packet per port. When the switch has multiple incoming streams, it is only able to relieve one of the incoming streams and must buffer the rest for later transmission.

### 3.5.1 Conformance Criteria

The packet traffic can be synchronized by IEEE 1588 timing and triggered to initiate within a 1-microsecond packet start window. The switch’s capability and conformance is tested to meet the following four criteria:

- Initiation of the required Multicast packet load on one port, without IEEE 802.3x flow control negotiated
- Initiation of the required Multicast packet load on one port, with IEEE 802.3x flow control negotiated
- Initiation of the required Multicast packet load distributed across all ports, packet count per port must average required per number of switch ports with no IEEE 802.3x flow control
- Initiation of the required packet Multicast load distributed across all ports, packet count per port must average 200 per number of switch ports with IEEE 802.3x flow control negotiated on half the ports

### 3.5.2 Flow Control (Pause)

The switch supports flow control between switches. It uses IEEE defined pause packets to receive and honor pause packets. The switch only sends the pause packets if it needs flow control on a port.

### 3.5.3 Reliability and Performance

Because high reliability is critical to any controls solutions business, the switch exceeds 4 million hours Mean Time Between Failures (MTBF) at 35°C (95 °F) ambient temperature, ground fixed controlled environment. The switch also meets the following performance criteria:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch latency</td>
<td>Switch packet latency does not exceed required application limits.</td>
</tr>
<tr>
<td>Switch architecture</td>
<td>The switch supports store and forward architecture, providing high data confidence.</td>
</tr>
<tr>
<td>Inrush current</td>
<td>The switch provides soft start capability that limits inrush current to less than 200% of the normal operating current.</td>
</tr>
</tbody>
</table>
3.5.4 Diagnostic LEDs

The following figure defines the LED functions on the ESWx switch.

For each of the 16 ports (and SPF ports), the **Power** LED functions as follows:
- Solid green when internal power supply is up and regulating

For each of the 16 ports (and SPF ports), the **Activity** LED functions as follows:
- flashes green for activity at full duplex
- flashes yellow for activity at half duplex

**Attention**

In certain conditions, an input voltage sag, known as a *brownout*, may cause the GE IS420ESWBH# (ESWB) I/O Network (IONet) switch to incorrectly reboot and fail to re-establish communication with the system. If the ESWB switch experiences a brownout condition that reduces the input 28 V line below the minimum operating voltage but not completely to 0 V, when the input voltage returns to above the minimum operating voltage, the switch may not correctly reboot. If this occurs, the ESWB LEDs will either remain on solid, flash in sync, or scroll from one side to the other, and the switch will not re-establish communication. If the site experiences a brownout, after the voltage returns and the IONet loses communication, observe the LEDs on the front of the switch. If they are solid, flashing in sync, or scrolling, cycle power to manually reboot the switch.
3.6 *Third-party Switch Replacement*

When the ESWA or ESWB is used to replace a different unmanaged switch, it uses the existing mounting brackets, which can either be panel or DIN-rail mounts. There are seven screw holes used on the existing switch to support panel mounting. The following drawing displays the pattern and dimensions for these holes.

*Holes to Support Panel Mounting*
4 YAIC Analog I/O Module

4.1 Mark VleS YAIC Analog I/O Pack

The Analog I/O pack (IS420Y AICS1B) provides the electrical interface between one or two I/O Ethernet networks and an analog I/O terminal board. The YAIC contains a common processor board and an acquisition board specific to the analog input function. The I/O pack is capable of handling up to 10 analog inputs, the first eight of which can be configured as ±5 V or ±10 V inputs, or 4-20 mA current loop inputs. The last two inputs can be configured as ±1 mA or 4-20 mA current inputs.

The load terminal resistors for current loop inputs are located on the terminal board and voltage is sensed across these resistors by the YAIC. The I/O pack also includes support for two 0-20 mA current loop outputs. The I/O pack receives or sends data through dual RJ-45 Ethernet connectors to the controller and has a three-pin connector to power it on. Output is through a DC-37 pin connector that connects directly with the associated terminal board connector. Visual diagnostics are provided through indicator LEDs.
4.1.1 YAIC Compatibility

The YAIC I/O pack contains an internal processor board.

### YAIC Version Compatibility

<table>
<thead>
<tr>
<th>I/O Pack</th>
<th>Processor Board</th>
<th>Compatible (Supported) Firmware</th>
<th>ControlST Software Suite Versions</th>
</tr>
</thead>
<tbody>
<tr>
<td>YAICS1B</td>
<td>BPPC</td>
<td>V05.01 and later</td>
<td>Supported in V06.01 and later versions</td>
</tr>
</tbody>
</table>

**Attention**

YAICS1A and YAICS1B I/O pack versions cannot be mixed on the same T-type terminal board.

All three YAIC I/O packs in a TMR set must be the same hardware form.

To upgrade or replace the YAIC, refer to the following replacement procedures for specific instructions:

- [Replace Mark VIeS Safety I/O Pack with Same Hardware Form](#)
- [Replace Mark VIeS Safety I/O Pack with Upgraded Hardware Form](#)

The YAIC I/O pack is compatible with the TBAIS1C and STAIS2A terminal boards.

### YAIC Terminal Board Compatibility

<table>
<thead>
<tr>
<th>Terminal Board</th>
<th>Description</th>
<th>I/O Pack Redundancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBAIS1C</td>
<td>TMR Analog input/output terminal board</td>
<td>Yes</td>
</tr>
<tr>
<td>STAIS2A</td>
<td>Simplex Analog input/output terminal board</td>
<td>Yes</td>
</tr>
</tbody>
</table>

I/O pack redundancy refers to the number of I/O packs used in a signal path, as follows:

- Simplex uses one I/O pack.
- TMR uses three I/O packs.
4.1.2 YAIC Installation

➢ To install a new YAIC I/O module into an existing Mark VIeS panel

1. Securely mount the desired terminal board.

2. Directly plug one YAIC I/O pack for simplex or three YAIC I/O packs for TMR into the terminal board connectors.

3. Mechanically secure the packs using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 connector between the pack and the terminal board. The adjustment should only be required once in the life of the product.

4. Plug in one or two Ethernet cables depending on the system configuration. The pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller. These choices are also defined in the ToolboxST configuration.

5. Apply power to the pack by plugging in the connector on the side of the pack. It is not necessary to insert this connector with the power removed from the cable as the I/O pack has inherent soft-start capability that controls current inrush on power application.

6. Configure the I/O pack as necessary using the ToolboxST application.

4.1.2.1 Connectors

The I/O pack contains the following connectors:

• A DC-37 pin connector on the underside of the YAIC connects directly to the discrete input terminal board. The connector contains the 24 input signals, ID signal, relay coil power, and feedback multiplex command.

• An RJ-45 Ethernet connector named ENET1 on the side of the pack is the primary system interface.

• A second RJ-45 Ethernet connector named ENET2 on the side of the I/O pack is the redundant or secondary system interface.

• A 3-pin power connector on the side of the pack is for 28 V dc power for the pack and terminal board.
4.1.3 YAIC Operation

4.1.3.1 Analog Input Hardware

The YAIC accepts input voltage signals from the terminal board for all 10 input channels. The analog input section consists of an analog multiplexer block, several gain and scaling selections, and a 16-bit analog-to-digital converter (ADC).

Inputs 1–8 can be individually configured as ±5 V or ±10 V, or 4–20 mA scale signals, depending on the input configuration. Inputs 9–10 can only be configured for ±1 mA or 4–20 mA. The terminal board provides a 250 Ω burden resistor when configured for current inputs yielding a 5 V signal at 20 mA. These analog input signals are first passed through a passive, low pass filter network with a pole at 75.15 Hz. Voltage signal feedbacks from the analog output circuits and calibration voltages are also sensed by the YAIC analog input section.
4.1.3.2 Analog Output Hardware

The YAIC includes two 0-20 mA analog outputs capable of 18 V compliance running simplex or TMR. A 14-bit digital-to-analog converter (DAC) commands a current reference to the current regulator loop in the YAIC that senses current both in the YAIC pack and on the terminal board. In TMR mode, the three current regulators in each YAIC share the commanded current loads among themselves. Analog output status feedbacks for each output include:

- Current reference voltage
- Individual current (output current sourced from within the YAIC)
- Total current (as sensed from the terminal board, summed current in TMR mode)

Each analog output circuit also includes a normally open mechanical relay to enable or disable operation of the output. The relay is used to remove a failed output from a TMR system allowing the remaining two YAICs to create the correct output without interference from the failed circuit. When the suicide relay is de-activated, the output opens through the relay, open-circuiting the analog output from the customer load that is connected to the terminal board. The mechanical relay has a second normally open contact that is used as a status to indicate position of the relay to the control and includes visual indication with an LED.
### 4.1.4 YAIC Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>YAIC Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Channels</td>
<td>12 channels per terminal board (10 AI, 2 AO)</td>
</tr>
<tr>
<td>AI Types Supported</td>
<td>Inputs 1 to 8: ±5 V dc, ±10 V dc, or 4–20 mA</td>
</tr>
<tr>
<td></td>
<td>Inputs 9 to 10: 4–20 mA or ±1 mA</td>
</tr>
<tr>
<td>Input Converter Resolution</td>
<td>16-bit ADC</td>
</tr>
<tr>
<td>I/O Scan Time</td>
<td>Supported Controller I/O Scan rates: 10 ms, 40 ms, 80 ms, 160 ms</td>
</tr>
<tr>
<td>Input Accuracy</td>
<td>0.1% of full scale over the full operating temperature range.</td>
</tr>
<tr>
<td>Noise Suppression on Inputs</td>
<td>The 10 circuits have hardware filter with single pole down break at 500 rad/s. A software filter, using a two pole low pass filter, is configurable for: 0.75 Hz, 1.5 Hz, 3 Hz, 6 Hz, 12 Hz</td>
</tr>
<tr>
<td>Common Mode Rejection</td>
<td>AC CMR 60 dB at 60 Hz, with up to ±5 V common mode voltage.</td>
</tr>
<tr>
<td></td>
<td>DC CMR 80 dB with -5 to +7 peak V common mode voltage</td>
</tr>
<tr>
<td>Common Mode Voltage Range</td>
<td>±5 V (±2 V CMR for the ±10 V inputs)</td>
</tr>
<tr>
<td>Output Converter</td>
<td>14-bit D/A converter with 0.5% accuracy</td>
</tr>
<tr>
<td>Output Load</td>
<td>800 Ω max for 0-20 mA output</td>
</tr>
<tr>
<td>Output Accuracy</td>
<td>±0.5% of full measurement range</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>5.3 watts typical, 6.2 watts worst case</td>
</tr>
<tr>
<td>Compressor Stall Detection</td>
<td>Not supported</td>
</tr>
<tr>
<td>Size</td>
<td>8.26 cm x 4.19 cm x 12.1 cm (3.25 in x 1.65 in x 4.78 in) H x W x D</td>
</tr>
<tr>
<td>Ambient Rating for Enclosure Design</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface mount</td>
</tr>
</tbody>
</table>

**Note** For further details, refer to the *Mark VIeS Functional Safety Analog I/O Module Summary Sheet* (GEI-100866).
4.1.5 YAIC Diagnostics

The YAIC performs the following self-diagnostic tests:

- A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and most of the processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set
- Each analog input has hardware limit checking based on configurable high and low levels for 4-20 mA inputs and preset (non-configurable) levels for ±5 V, ±10 V, and ±1 mA inputs. If the limit is exceeded, then the I/O pack raises an alarm and marks the input as unhealthy. A logic signal (L3DIAG_pack) is set, which refers to the entire board.
- Each input has configurable system limit checking with high and low levels, latching, and non-latching selection options. These limits can be used in the programming of the controller to generate process alarms. This controller logic requires using a RSTSYS pin on a SYS_OUTPUTS block to reset the out of limits status when the latch is enabled. System limit checking can be configured as Enable/Disable at point level, and are only functional only when system limits are enabled at module level (Parameters tab).
- The analog input hardware includes precision reference voltages in each scan. Measured values are compared against expected values and are used to confirm health of the analog to digital converter circuits.
- Analog output current is sensed on the terminal board using a small burden resistor. The I/O pack conditions this signal and compares it to the commanded current to confirm health of the digital to analog converter circuits.
- The analog output suicide relay is continuously monitored for agreement between commanded state and feedback indication.

Details of the individual diagnostics are available from the ToolboxST application. The diagnostic signals can be individually latched and then reset with the RSTDIAG signal if they go healthy.

4.1.5.1 Status LEDs

<table>
<thead>
<tr>
<th>LED</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>ENA1</td>
<td>Indicates the closure of the relay controlling output 1</td>
</tr>
<tr>
<td>Yellow</td>
<td>ENA2</td>
<td>Indicate the closure of the relay controlling output 2</td>
</tr>
</tbody>
</table>
## 4.1.6 YAIC Configuration

### 4.1.6.1 Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>SystemLimits</td>
<td>Enable or temporarily disable all system limit checks. Setting this parameter to Disable will cause a diagnostic alarm to occur.</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>Min_MA_Input</td>
<td>Select minimum current for healthy 4-20 mA input</td>
<td>0 to 22.5 mA</td>
</tr>
<tr>
<td>Max_MA_Input</td>
<td>Select maximum current for healthy 4-20 mA input</td>
<td>0 to 22.5 mA</td>
</tr>
</tbody>
</table>

### 4.1.6.2 Inputs

<table>
<thead>
<tr>
<th>Input</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>AnalogInput01</td>
<td>First of 10 Analog Inputs – board point. Point edit</td>
<td>(Input REAL)</td>
</tr>
<tr>
<td>through AnalogInput10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>InputType</td>
<td>Current or voltage input type</td>
<td>Unused or 4-20 mA (for all Analog Inputs) ±5 V or ±10 V (for AnalogInput01 to 08 only) ±1 mA (for AnalogInput09 and 10 only)</td>
</tr>
<tr>
<td>Low_Input</td>
<td>Value of input current (mA) or voltage (V) at low end of input scale</td>
<td>-10 to 20</td>
</tr>
<tr>
<td>Low_Value</td>
<td>Value of input in engineering units at Low_Input</td>
<td>-3.4082 e + 038 to 3.4028 e + 038</td>
</tr>
<tr>
<td>High_Input</td>
<td>Value of input current (mA) or voltage (V) at high end of input scale</td>
<td>-10 to 20</td>
</tr>
<tr>
<td>High_Value</td>
<td>Value of input in engineering units at High_Input</td>
<td>-3.4082 e + 038 to 3.4028 e + 038</td>
</tr>
<tr>
<td>InputFilter</td>
<td>Bandwidth of input signal filter</td>
<td>Unused, 0.75hz, 1.5hz, 3hz, 6hz, 12hz</td>
</tr>
<tr>
<td>TMR_DiffLimit</td>
<td>Difference limit for voted inputs in % of High_Value - Low_Value</td>
<td>0 to 200</td>
</tr>
<tr>
<td>SysLim1Enabl</td>
<td>Enable System Limit 1 fault check</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>SysLim1Latch</td>
<td>System Limit 1 fault latch - if set, requires a Reset System Limits (RSTSYS) on SYS_OUTPUTS block to clear</td>
<td>Latch, NotLatch</td>
</tr>
<tr>
<td>SysLim1Type</td>
<td>System Limit 1 Check Type</td>
<td>&gt;= or &lt;=</td>
</tr>
<tr>
<td>SysLim1</td>
<td>System Limit 1 in engineering units</td>
<td>-3.4082 e + 038 to 3.4028 e + 038</td>
</tr>
<tr>
<td>SysLim2Enabl</td>
<td>Enable System Limit 2 fault check</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>SysLim2Latch</td>
<td>System Limit 2 fault latch - if set, requires a Reset System Limits (RSTSYS) on SYS_OUTPUTS block to clear</td>
<td>Latch, NotLatch</td>
</tr>
<tr>
<td>SysLim2Type</td>
<td>System Limit 2 Check Type</td>
<td>&gt;= or &lt;=</td>
</tr>
<tr>
<td>SysLimit2</td>
<td>System Limit 2 in Engineering Units</td>
<td>-3.4082 e + 038 to 3.4028 e + 038</td>
</tr>
<tr>
<td>DiagHighEnab</td>
<td>Enables the generation of a high limit diagnostic alarm when the value of the 4-20 mA input is greater than the value of parameter Max_MA_Input</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>DiagLowEnab</td>
<td>Enables the generation of a low limit diagnostic alarm when the value of the 4-20 mA input is less than the value of parameter Min_MA_Input</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>TMR_DiffLimit</td>
<td>Diag limit, TMR input vote difference, in percent of (High_Value - Low_Value)</td>
<td>0 to 200 %</td>
</tr>
</tbody>
</table>
### 4.1.6.3 Outputs

<table>
<thead>
<tr>
<th>Output Name</th>
<th>Output Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>AnalogOutput01 - AnalogOutput02</td>
<td>First of two analog outputs - board point, Point edit</td>
<td>Output REAL</td>
</tr>
<tr>
<td>Output_MA</td>
<td>Output current, mA selection.</td>
<td>Unused, 0-20 mA</td>
</tr>
</tbody>
</table>
| OutputState         | State of the outputs when offline. When the YAIC loses communication with the controller, this parameter determines how it drives the outputs:  
  PwrDownMode - Open the output relay and drive outputs to zero current  
  HoldLastVal - Hold the last value received from the controller  
  Output_Value - Go to the configured output value set by the parameter Output_Value | PwrDownMode  
                      HoldLastVal  
                      Output_Value |
| Output_Value        | Pre-determined value for the outputs                                              | -3.4082 e + 038 to 3.4028 e + 038 |
| Low_MA              | Output mA at low value                                                             | 0 to 200 mA                  |
| Low_Value           | Output in Engineering Units at Low_MA                                              | -3.4082 e + 038 to 3.4028 e + 038 |
| High_MA             | Output mA at high value                                                            | 0 to 200 mA                  |
| High_Value          | Output value in Engineering Units at High_MA                                        | -3.4082 e + 038 to 3.4028 e + 038 |
| TMR_Suicide         | Enables suicide for faulty output current, TMR only                                | Enable, Disable              |
| TMR_SuicLimit       | Suicide threshold (Load sharing margin) for TMR operation, in mA                   | 0 to 200 mA                  |
| D/A_ErrLimit        | Difference between D/A reference and feedback, in % for suicide, TMR only          | 0 to 200 %                   |
| Dither_Ampl         | Dither % current of Scaled Output mA                                               | 0 to 10                      |
| Dither_Freq         | Dither rate in Hertz                                                               | Unused, 12.5hz, 25hz, 33.33hz, 50hz, 100hz |
### 4.1.6.4 Variables

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3DIAG_YAIC</td>
<td>Board diagnostic</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>LINK_OK_YAIC</td>
<td>I/O Link OK indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>ATTN_YAIC</td>
<td>Module Diagnostic</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>IOPackTmpr</td>
<td>I/O Pack Temperature (deg F)</td>
<td>Input</td>
<td>REAL</td>
</tr>
<tr>
<td>PS18V_YAIC</td>
<td>I/O 18V Power Supply Indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>PS28V_YAIC</td>
<td>I/O 28V Power Supply Indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>SysLimit1_1</td>
<td>System Limit 1</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>SysLimit1_10</td>
<td>System Limit 1</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>SysLimit2_1</td>
<td>System Limit 2</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>SysLimit2_10</td>
<td>System Limit 2</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>OutSuicide1</td>
<td>Status of Suicide Relay for Output 1</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>OutSuicide2</td>
<td>Status of Suicide Relay for Output 2</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Out1MA</td>
<td>Feedback, Total Output Current, mA</td>
<td>Input</td>
<td>REAL</td>
</tr>
<tr>
<td>Out2MA</td>
<td>Feedback, Total Output Current, mA</td>
<td>Input</td>
<td>REAL</td>
</tr>
</tbody>
</table>
4.2 YAIC Specific Alarms

The following alarms are specific to the YAIC I/O pack.

32-41

Description  Analog Input [ ] unhealthy

Possible Cause

- Excitation to transducer is wrong or missing.
- Transducer is defective.
- Analog input current/voltage input is beyond the specified range.
- Terminal board jumper settings do not match the ToolboxST configuration.
- Open or short-circuit on input

Solution

- Check the field wiring and connections to indicated analog input channel.
- Check the field device for failure.
- Verify that the configuration matches terminal board jumper settings for the indicated analog input channel.

44-45

Description  Output [ ] individual current feedback unhealthy

Possible Cause

- Commanded output is beyond the range of the output.
- Field wiring problem
- Field device problem
- Open loop or too much resistance in the loop
- I/O pack failed
- Terminal board failed

Solution

- Verify that the commanded output is within the range of the output.
- Confirm the correct I/O pack 28 V input power.
- Check the field wiring and device.
- Replace the I/O pack.
46-47

Description  Output [ ] total current feedback unhealthy

Possible Cause

• Commanded output is beyond the range of the output.
• Field wiring problem
• Field device problem
• Open loop or too much resistance in the loop.

Solution

• Verify that the commanded output is within the range of the output.
• Confirm the correct I/O pack 28 V input power.
• Check the field wiring and the component.
• Replace the I/O pack.

48-49

Description  Output [ ] Internal reference current unhealthy

Possible Cause  I/O pack failure

Solution

• Confirm the correct I/O pack 28 V input power.
• Replace the I/O pack.

66-67

Description  Output [ ] Individual current too high relative to total current

Possible Cause  In a TMR setup, the individual current feedback is greater than $\frac{1}{2}$ the total current feedback + TMR_SuicLimit.

• The TMR_SuicLimit is set too low.
• Hardware failure causing one I/O pack to drive too much output current

Solution

• Verify that the value of TMR_SuicLimit is set correctly.
• Replace the I/O pack.
70-71

Description  Output [ ] Total current varies from reference current

Possible Cause  The difference between the commanded output current and total feedback is greater than TMR_SuicLimit.

- Field wiring problem
- Open-circuit on output or total loop resistance is too high
- Command is beyond the range of the output.

Solution

- Check field wiring and device.
- Verify that the value of TMR_SuicLimit is set correctly.
- Verify that commanded output is within output range.

74-75

Description  Output [ ] commanded current feedback error

Possible Cause  The difference between the commanded output current and current feedback on the terminal board is greater than D/A_ErrLimit (%).

- Open-circuit on output
- Terminal board output jumper (JPO) setting is incorrect (for output 1).
- Command is beyond the range of the output.

Solution

- Check the field wiring and device.
- Check the JPO jumper setting on the terminal board.
- Verify that the value of D/A_ErrLimit is set correctly.
- Verify that the commanded output is within output range.
- Replace the I/O pack.

82-83

Description  Output [ ] Suicide relay non-functional

Possible Cause  The analog output suicide relay command doesn't match the feedback.

- Relay failure on the acquisition board.
- Hardware failure

Solution  Replace the I/O pack.
**90-91**

**Description**  
Output [ ] 20/200 mA suicide active

**Possible Cause**
- Suicide is enabled on analog output.
- Review any additional diagnostics for possible causes.
- The `$TMR_SuicLimit$` is set too low.
- Field wiring problem
- Command is beyond the range of the output.
- Analog output configuration does not match hardware jumpers.

**Solution**
- Verify that the value of `$TMR_SuicLimit$` is set correctly.
- Verify that the value of `$D/A_ErrLimit$` is set correctly.
- Verify the field wiring connections.
- Verify that the commanded output is within output range.

**92-93**

**Description**  
Output [ ] Suicide on overcurrent, check terminal board jumper

**Possible Cause**
- Incorrect setting of terminal board 20/200 mA jumper
- Hardware failure in I/O pack

**Solution**
- Check the terminal board jumper (JPO).
- Replace the I/O pack.

**99**

**Description**  
I/O pack internal power supply status not OK

**Possible Cause**  
The internal power supply that provides analog circuit control power is not operating correctly.

**Solution**
- Check the I/O pack ground quality through mounting bolts.
- Confirm that 28 V input power is within 26.6 - 29.4 V range.
- Replace the I/O pack.

**100**

**Description**  
Dither Time is frozen or out of range - [ ]

**Possible Cause**  
The time signal used to generate a dither on the valve output signal does not appear to being changing. This could cause a frozen valve.

**Solution**
- Cycle power to the I/O pack.
- Replace the I/O pack.
101

**Description**  I/O pack internal reference voltage out of limits

**Possible Cause**  The calibration reference voltage for the analog inputs is more than ±5% from the expected value, indicating a hardware failure.

**Solution**
- Check the I/O pack ground quality through mounting bolts.
- Cycle power to the I/O pack.
- Replace the I/O pack.

102

**Description**  I/O pack internal null voltage out of limits

**Possible Cause**  The calibration Null voltage for the analog inputs is more than ±5% from the expected value, indicating a hardware failure.

**Solution**
- Check the I/O pack ground quality through mounting bolts.
- Cycle power to the I/O pack.
- Replace the I/O pack.

128

**Description**  Logic Signal [ ] Voting Mismatch

**Possible Cause**  N/A

**Solution**  N/A

224-235

**Description**  Input Signal [ ] Voting Mismatch, Local=[ ], Voted=[ ]

**Possible Cause**
- Voter disagreement between the R, S and T I/O packs
- I/O pack is not seated correctly on the terminal board.

**Solution**
- Adjust the parameter `TMR_DiffLimt` or correct the cause of the difference.
- Re-seat the I/O pack to the terminal board.
- Replace the I/O pack.
4.3 TBAIS1C Analog Input/Output

The Analog Input/Output (TBAI) terminal board supports 10 analog inputs and 2 outputs. The 10 analog inputs accommodate two-wire, three-wire, four-wire, or externally powered transmitters. The analog outputs can be set up for 0-20 mA. Inputs and outputs have noise suppression circuitry to protect against surge and high frequency noise. The TBAI has three DC-37 pin connectors for TMR I/O packs. Simplex I/O redundancy is also supported using a single JR1 connection.

**Note** The TBAIS1C is IEC 61508 safety-certified when used with the Mark VleS YAIC.

With TMR I/O redundancy, the input signals are fanned to the three connectors for the R, S, and T I/O packs. TMR outputs combine the current of the three connected output drivers and determine the total current with a measuring shunt. TBAI then presents the total current signal to the I/O packs for regulation to the commanded setpoint.

<table>
<thead>
<tr>
<th>Board Revision</th>
<th>Mark VleS IS200YAIC</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBAIS1C</td>
<td>Yes</td>
<td>IEC 61508 safety certified with YAIC</td>
</tr>
</tbody>
</table>
4.3.1 TBAIS1C Installation

Connect the input and output wires directly to two I/O terminal blocks mounted on the terminal board. Each block is held down with two screws and has 24 terminals accepting up to #12 AWG wires. A shield terminal attachment point is located adjacent to each terminal block.

TBAI can accommodate the following analog I/O types:

- Analog input, two-wire transmitter
- Analog input, three-wire transmitter
- Analog input, four-wire transmitter
- Analog input, externally powered transmitter
- Analog input, voltage ±5 V, ±10 V dc
- Analog input, current 4-20 mA
- Analog output, 0-20 mA
The following figure displays the wiring connections, jumper positions, and cable connections for TBAI.

### Analog Input Terminal

<table>
<thead>
<tr>
<th>Analog Input Terminal</th>
<th>Board TBAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input 1 (20 mA)</td>
<td>Input 1 (24 V)</td>
</tr>
<tr>
<td>Input 1 (Ret)</td>
<td>Input 1 (Vdc)</td>
</tr>
<tr>
<td>Input 2 (20 mA)</td>
<td>Input 2 (24 V)</td>
</tr>
<tr>
<td>Input 2 (Ret)</td>
<td>Input 2 (Vdc)</td>
</tr>
<tr>
<td>Input 3 (20 mA)</td>
<td>Input 3 (24 V)</td>
</tr>
<tr>
<td>Input 3 (Ret)</td>
<td>Input 3 (Vdc)</td>
</tr>
<tr>
<td>Input 4 (20 mA)</td>
<td>Input 4 (24 V)</td>
</tr>
<tr>
<td>Input 4 (Ret)</td>
<td>Input 4 (Vdc)</td>
</tr>
<tr>
<td>Input 5 (20 mA)</td>
<td>Input 5 (24 V)</td>
</tr>
<tr>
<td>Input 5 (Ret)</td>
<td>Input 5 (Vdc)</td>
</tr>
<tr>
<td>Input 6 (20 mA)</td>
<td>Input 6 (24 V)</td>
</tr>
<tr>
<td>Input 6 (Ret)</td>
<td>Input 6 (Vdc)</td>
</tr>
<tr>
<td>Input 7 (20 mA)</td>
<td>Input 7 (24 V)</td>
</tr>
<tr>
<td>Input 7 (Ret)</td>
<td>Input 7 (Vdc)</td>
</tr>
<tr>
<td>Input 8 (20 mA)</td>
<td>Input 8 (24 V)</td>
</tr>
<tr>
<td>Input 8 (Ret)</td>
<td>Input 8 (Vdc)</td>
</tr>
<tr>
<td>Input 9 (20 mA)</td>
<td>Input 9 (24 V)</td>
</tr>
<tr>
<td>Input 9 (Ret)</td>
<td>Input 9 (1 mA)</td>
</tr>
<tr>
<td>Input 10 (20 mA)</td>
<td>Input 10 (24 V)</td>
</tr>
<tr>
<td>Input 10 (Ret)</td>
<td>Input 10 (1 mA)</td>
</tr>
<tr>
<td>PCOM</td>
<td>Output 1 (Sig)</td>
</tr>
<tr>
<td>PCOM</td>
<td>Output 2 (Sig)</td>
</tr>
</tbody>
</table>

### Board Jumpers

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Jumper</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mA/ V dc</td>
<td>Open/Ret</td>
</tr>
<tr>
<td>Input 1</td>
<td>JP1 A, JP1 B</td>
</tr>
<tr>
<td>Input 2</td>
<td>JP2 A, JP2 B</td>
</tr>
<tr>
<td>Input 3</td>
<td>JP3 A, JP3 B</td>
</tr>
<tr>
<td>Input 4</td>
<td>JP4 A, JP4 B</td>
</tr>
<tr>
<td>Input 5</td>
<td>JP5 A, JP5 B</td>
</tr>
<tr>
<td>Input 6</td>
<td>JP6 A, JP6 B</td>
</tr>
</tbody>
</table>

### J Ports

- For simplex, plug I/O pack into JR 1
- For TMR, use all three connectors

### Two-Wire Transmitter Wiring 4-20 mA

- Voltage input 4-20 mA
- Return J#A
- VDC J#B

### Three-Wire Transmitter Wiring 4-20 mA

- Voltage input 4-20 mA
- Return J#A
- VDC J#B

### Four-Wire Transmitter Wiring 5 V dc

- Voltage input 4-20 ma
- Return Max. common mode voltage is 7.0 V dc
- Misc return to PCOM
4.3.2 TBAIS1C Operation

TBAI provides a 24 V dc power source for all the transducers. The inputs can be configured as current or voltage inputs using jumpers (JP#A and JP#B). One of the two analog output circuits is 4-20 mA and the other can be configured as 4-20 mA.

<table>
<thead>
<tr>
<th>TBAI Analog I/O Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Quantity</strong></td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

**Note** With noise suppression and filtering, the input ac CMR is 60 dB, and the dc CMR is 80 dB.

Each 24 V dc power output is rated to deliver 21 mA continuously and is protected against operation into a short circuit. Transmitters/transducers can be powered by the 24 V dc source in the control system, or can be independently powered. Jumper JPO selects the type of current output. Diagnostics monitor each output, and a suicide relay in the I/O pack disconnects the corresponding output if a fault cannot be cleared by a command from the processor.
Simplex Analog Inputs and Outputs
In a TMR system, analog inputs fan out to the three I/O packs. The 24 V dc power to the transducers also comes from all three I/O packs and is diode shared on TBAI. Each analog current output is fed by currents from all three I/O packs. The actual output current is measured with a series resistor, which feeds a voltage back to each I/O pack. The resulting output is the voted middle value (median) of the three currents. The following figure displays TBAI in a TMR system.
### 4.3.3 TBAIS1C Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>TBAI Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>12 channels with 10 Analog Inputs (AI) and 2 Analog Outputs (AO)</td>
</tr>
</tbody>
</table>
| AI types supported          | Inputs 1 to 8: ±5 V dc, ±10 V dc, or 4–20 mA  
Inputs 9 to 10: 4–20 mA or ±1 mA                                                                                                                      |
| Input accuracy              | ±0.1% of full scale over the full operating temperature range                                                                                         |
| Outputs                     | 24 V outputs provide 21 mA each connection                                                                                                             |
| Maximum lead resistance     | 15 Ω maximum two-way cable resistance, cable length up to 300 m (984 ft)                                                                             |
| Output load                 | 800 Ω max for 4-20 mA output                                                                                                                           |
| Fault detection             | Monitor total output current  
Check connector ID chip for hardware incompatibility                                                                                                 |
| Size                        | 10.16 cm x 33.02 cm (4.0 in x 13.0 in) W x H                                                                                                           |

### 4.3.4 TBAIS1C Diagnostics

Diagnostic tests are made on the terminal board as follows:

- The terminal board provides the voltage drop across a series resistor to indicate the output current. The I/O pack creates a diagnostic alarm (fault) if either of the two outputs goes unhealthy.
- Each cable connector on the terminal board has its own ID device that is interrogated by the I/O pack. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and the JR, JS, JT connector location. When this chip is read by the I/O pack and a mismatch is encountered, a hardware incompatibility fault is created.

### 4.3.5 TBAIS1C Jumper Configuration

The terminal board is configured by jumpers. For the location of these jumpers, refer to the installation diagram. The jumper choices are as follows:

- Jumpers JP1A through JP8A select either current input or voltage input.
- Jumpers JP1B through JP8B select whether the return is connected to common or is left open.
- Jumpers JP9A and JP10A select either 1 mA or 20 mA input current.
- Jumpers JP9B and JP10B select whether the return is connected to common or is left open.
4.4 ST AIS2A Simplex Analog Input

The Simplex Analog Input (STAI) terminal board is a compact analog input terminal board that accepts 10 analog inputs and two analog outputs, and connects to the pack. The 10 analog inputs accommodate two-wire, three-wire, four-wire, or externally powered transmitters. The two analog outputs are 0-20 mA. High-density Euro style box terminal blocks are used. An on-board ID chip identifies the board to the pack for system diagnostic purposes.

### Compatibility

<table>
<thead>
<tr>
<th>Board Revision</th>
<th>Mark VleS YAIC</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST AIS2A</td>
<td>Yes</td>
<td>Plug in terminals, IEC 61508 safety certified with YAIC</td>
</tr>
</tbody>
</table>

4.4.1 ST AIS2A Installation

The STAI plus a plastic insulator mounts on a sheet metal carrier that then mounts on a DIN-rail. Optionally, the STAI plus insulator mounts on a sheet metal assembly and then bolts directly to a cabinet. The ST AIS2A has a right angle header accepting a range of commercially available pluggable Euro-style terminal blocks, with a total of 48 terminals.

**Note** Typically #18 AWG wires (shielded twisted pair) are used. I/O cable shield terminal is provided adjacent to the terminal blocks.

The following types of analog inputs and outputs can be accommodated:

- Analog input, two-wire transmitter
- Analog input, three-wire transmitter
- Analog input, four-wire transmitter
- Analog input, externally powered transmitter
- Analog input, voltage ±5 V, ±10 V dc
- Analog input, current 4-20 mA
- Two analog outputs, 0-20 mA current

The following figure displays the wiring connections, jumper positions, and cable connections for STAI.
Jumper | Circuit | Screw Connections | Jumper
--- | --- | --- | ---
JP1A | Input 1 | 1 | JP1A
JP1B | (20mA) | 2 |
 | Input 1 (Return) | 3 |
 | Input 2 (20mA) | 4 |
 | Input 2 (Return) | 5 |
 | Input 3 (20mA) | 6 |
 | Input 3 (Return) | 7 |
 | Input 4 (20mA) | 8 |
 | Input 4 (Return) | 9 |
 | Input 5 (20mA) | 10 |
 | Input 5 (Return) | 11 |
 | Input 6 (20mA) | 12 |
 | Input 6 (Return) | 13 |
 | Input 7 (20mA) | 14 |
 | Input 7 (Return) | 15 |
 | Input 8 (20mA) | 16 |
 | Input 8 (Return) | 17 |
 | Input 9 (20mA) | 18 |
 | Input 9 (Return) | 19 |
 | Input 10 (20mA) | 20 |
 | Input 10 (Return) | 21 |
 | PCOM | 22 |
 | Output 1 | 23 |
 | Output 1 (Return) | 24 |
 | Output 2 | 25 |
 | Output 2 (Return) | 26 |

DC-37 pin connector with latching fasteners

Vdc/20mA | Open/Return
--- | ---
JP0 | No jumper

Two-wire transmitter wiring 4-20mA

Three-wire transmitter wiring 4-20mA

Four-wire transmitter wiring 4-20mA

Externally powered transmitter wiring 4-20mA

Power Supply

Voltage input

VDC

JP#A

20 ma

4-20 mA

Return

Open

JP#B

+24 V dc

Open

JP#B

Max. common mode voltage is 7.0 V dc

Misc return to PCOM
4.4.2 STAI 2A Operation

24 V dc power is available on the terminal board for all the transmitters (transducers). There is a choice of current or voltage inputs using jumpers. One of the two analog output circuits is 4-20 mA, and the other can be jumper configured for 4-20 mA or 0-200 mA (only with the Mark Vle PAICH2).

Note The 200 mA output is not supported by the Mark VleS YAIC.

The following table displays the analog input/output capacity of the STAI terminal board.

<table>
<thead>
<tr>
<th>Quantity Inputs</th>
<th>Analog Input Types</th>
<th>Quantity Outputs</th>
<th>Analog Output Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>±10 V dc, or ±5 V dc, or 4-20 mA</td>
<td>1</td>
<td>4-20 mA or 0-200 mA (only with the Mark Vle PAICH2)</td>
</tr>
<tr>
<td>2</td>
<td>4-20 mA, or ±1 mA</td>
<td>1</td>
<td>0-20 mA</td>
</tr>
</tbody>
</table>
4.4.3 STAIS2A Specifications

Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>STAIS2A Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>12 channels with 10 Analog Inputs (AI) and 2 Analog Outputs (AO)</td>
</tr>
<tr>
<td>AI types supported</td>
<td>Inputs 1 to 8: ±5 V dc, ±10 V dc, or 4–20 mA</td>
</tr>
<tr>
<td></td>
<td>Inputs 9 to 10: 4–20 mA or ±1 mA</td>
</tr>
<tr>
<td>Input accuracy</td>
<td>±0.1% of full scale over the full operating temperature range</td>
</tr>
<tr>
<td>Maximum lead resistance</td>
<td>15 Ω maximum two-way cable resistance, cable length up to 300 m (984 ft)</td>
</tr>
<tr>
<td>Outputs</td>
<td>24 V dc outputs rated at 21 mA each</td>
</tr>
<tr>
<td>Load on output currents</td>
<td>800 Ω max burden for 4-20 mA output</td>
</tr>
<tr>
<td></td>
<td>Only with Mark VIe PAICH2: 50 Ω max burden for 200 mA output</td>
</tr>
<tr>
<td>Size</td>
<td>15.9 cm x 10.2 cm (6.25 in x 4.0 in) H x W</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface mount</td>
</tr>
</tbody>
</table>

4.4.4 STAIS2A Diagnostics

Diagnostic tests are made on the terminal board as follows:

- The board provides the voltage drop across a series resistor to indicate the output current. The I/O pack creates a diagnostic alarm (fault) if any one of the eight outputs goes unhealthy.
- Each cable connector on the terminal board has its own ID device that is interrogated by the I/O pack. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and the JR, JS, JT connector location. When this chip is read by the I/O pack and a mismatch is encountered, a hardware incompatibility fault is created.

4.4.5 STAIS2A Jumper Configuration

The terminal board is configured by jumpers. For the location of these jumpers, refer to the installation diagram. The jumper choices are as follows:

- Jumpers JP1A through JP8A select either current input or voltage input.
- Jumpers JP1B through JP8B select whether the return is connected to common or is left open.
- Jumpers JP9A and JP10A select either 1 mA or 20 mA input current
- Jumpers JP9B and JP10B select whether the return is connected to common or is left open.
- Jumper JP0 sets output 1 to either 20 mA or 0-200 mA (only with the Mark VIe PAICH2).
5 YDIA Discrete Input Module

5.1 Mark ViES YDIA Discrete Input Pack

The Discrete Input (IS420YDIA1B) I/O pack provides the electrical interface between one or two I/O Ethernet networks and a discrete input terminal board. The YDIA contains a common processor board and an acquisition board specific to the discrete input function. The YDIA I/O pack accepts up to 24 contact inputs and terminal board specific feedback signals, and supports three different voltage levels.

System input to the pack is through dual RJ-45 Ethernet connectors and a three-pin power input. Discrete signal input is through a DC-37 pin connector that connects directly with the associated terminal board connector. Visual diagnostics are provided through indicator LEDs.
5.1.1 YDIA Compatibility

The YDIA I/O pack contains an internal processor board. The following table lists the available versions of the YDIA.

<table>
<thead>
<tr>
<th>I/O Pack</th>
<th>Processor Board</th>
<th>Compatible (Supported) Firmware</th>
<th>ControlST Software Suite Versions</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS420YDIAS1B</td>
<td>BPPC</td>
<td>V05.01 and later</td>
<td>Supported in V06.01 and later versions</td>
</tr>
</tbody>
</table>

**Attention**

YDIAS1A and YDIAS1B I/O pack versions cannot be mixed on the same T-type terminal board.

All YDIA I/O packs in a Dual or TMR set must be the same hardware form.

To upgrade or replace the YDIA, refer to the following replacement procedures for specific instructions:

- Replace Mark VIeS Safety I/O Pack with Same Hardware Form
- Replace Mark VIeS Safety I/O Pack with Upgraded Hardware Form

The YDIA I/O pack is compatible with seven discrete contact input terminal boards, including the TBCI and STCI boards.

<table>
<thead>
<tr>
<th>Terminal Board</th>
<th>Description</th>
<th>I/O Pack Redundancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBCIS2C, S3C</td>
<td>TMR Contact input terminal board with group isolation</td>
<td>Yes</td>
</tr>
<tr>
<td>STCIS2A, S4A</td>
<td>Simplex Contact input terminal board</td>
<td>Yes</td>
</tr>
</tbody>
</table>

I/O pack redundancy refers to the number of I/O packs used in a signal path, as follows:

- Simplex uses one I/O pack.
- Dual uses two I/O packs.
- TMR uses three I/O packs.
5.1.2 YDIA Installation

➢ To install the YDIA pack

1. Securely mount the desired terminal board.

2. Directly plug one YDIA for simplex or three YDIAs for TMR into the terminal board connectors.

3. Mechanically secure the pack(s) using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 connector between the pack and the terminal board. The adjustment should only be required once in the life of the product.

4. Plug in one or two Ethernet cables depending on the system configuration. The pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.

5. Apply power to the pack by plugging in the connector on the side of the pack. It is not necessary to insert this connector with the power removed from the cable as the YDIA has inherent soft-start capability that controls current inrush on power application.

6. Use the ToolboxST application to configure the YDIA as necessary.

Note The YDIA mounts directly on a TBCI or STCI terminal board. Simplex terminal boards have a single DC-37 pin connector that receives the YDIA. TMR-capable terminal boards (TBCI) have three DC-37 pin connectors, with the JR1 connector used for Simplex operation; JR1 and JS1 are used for Dual operation; JR1, JS1, and JT1 are used for TMR operation.

5.1.2.1 Connectors

YDIA contains the following connectors:

- A DC-37 pin connector on the underside of the YDIA pack connects directly to the discrete input terminal board. The connector contains the 24 input signals, ID signal, relay coil power, and feedback multiplex command.
- An RJ45 Ethernet connector named ENET1 on the side of the pack is the primary system interface.
- A second RJ45 Ethernet connector named ENET2 on the side of the pack is the redundant or secondary system interface
- A 3-pin power connector on the side of the pack is for 28 V dc power for the pack and terminal board.

5.1.3 YDIA Operation

The following features are common to the distributed I/O modules:

- **BPPx Processor**
- **Processor LEDs**
- **Power Management**
- **ID Line**
- **I/O Module Common Diagnostic Alarms**
5.1.3.1 Input Signals

The discrete input acquisition board provides the second stage of signal conditioning and level shifting to interface the terminal board inputs to the control logic. Initial signal conditioning is provided on the terminal board. The discrete input acquisition input circuit is a comparator with a variable threshold. Each input is isolated from the control logic through an opto-coupler and an isolated power supply. The inputs are not isolated from each other. Each of the twenty-four inputs has filtering, hysteresis, and a yellow status LED, which indicates when an input is picked up. The LED will be OFF when the input is dropped-out.

![Comparator Circuit Diagram](image)

5.1.3.2 Variable Threshold

The input threshold is derived from the contact wetting voltage input terminal. In most applications this voltage is scaled to provide a 50% input threshold. This threshold is clamped to 13% to prevent an indeterminate state if the contact wetting voltage drops to zero. If the contact wetting voltage drops below 40% of the nominal voltage, the under-voltage detector annunciates this condition to the control. A special test mode is provided to force the inputs from the control pack. Every four seconds, the threshold is pulsed high and then low and the response of the opto-couplers is checked. Non-responding inputs are alarmed.
### 5.1.4 YDIA Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>YDIA Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of relay channels</td>
<td>24 dry contact voltage input channels</td>
</tr>
<tr>
<td>Input isolation in pack</td>
<td>Optical isolation to 1500 V on all inputs</td>
</tr>
</tbody>
</table>
| Input filter ac voltage rejection | Hardware filter, 4 ms  
60 V rms, 50/60 Hz at 125 V dc excitation                                       |
| Frame rate                    | Configured frame rate of the controller determines I/O scan rate for control       |
| Fault detection               | Loss of contact input excitation voltage  
Non-responding contact input in test mode  
Incorrect terminal board       |
| Size                          | 8.26 cm x 4.19 cm x 12.1 cm (3.25 in x 1.65 in x 4.78 in) H x W x D                  |
| Technology                    | Surface-mount                                                                       |
| Ambient rating for enclosure design | -40 to 70 °C (-40 to 158 °F)                                         |

**Note**  For further details, refer to the *Mark VIeS Functional Safety Contact Input Module Summary Sheet* (GEI-100862).

### 5.1.5 YDIA Diagnostics

The I/O pack performs the following self-diagnostic tests:

- A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set
- Monitoring for loss of contact input excitation voltage on the terminal board
- It detects a non-responding contact input during the diagnostic test. In this test, the threshold is pulsed high and low and the response of the opto-couplers is checked.

Details of the individual diagnostics are available in the ToolboxST application. The diagnostic signals can be individually latched, and then reset with the RSTDIAG signal if they go healthy.

#### 5.1.5.1 Status LEDs

**Discrete Input LEDs**

<table>
<thead>
<tr>
<th>LED</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Input #</td>
<td>Provided for each of the 24 inputs to indicate when they are energized</td>
</tr>
</tbody>
</table>

**Note**  For more information, refer to the section *Processor LEDs*.  

---

YDIA Discrete Input Module

Public Information

GEH-6855_Vol_II_B System Guide 121
5.2  YDIA Configuration

5.2.1  Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContactInput</td>
<td>Mark a specific contact input as Used or Unused.</td>
<td>Used, Unused</td>
</tr>
<tr>
<td>SignalInvert</td>
<td>Inversion makes signal true if contact is open</td>
<td>Normal, Invert</td>
</tr>
<tr>
<td>SeqOfEvents</td>
<td>Record contact transitions in sequence of events</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>DiagVoteEnab</td>
<td>Enable voting disagreement diagnostic</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>Signal Filter</td>
<td>Contact input filter in milliseconds</td>
<td>Zero, Ten, Twenty, Fifty, Hundred</td>
</tr>
</tbody>
</table>

5.2.2  Inputs

<table>
<thead>
<tr>
<th>Input</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact01</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Contact24</td>
<td>Input</td>
<td>BOOL</td>
</tr>
</tbody>
</table>

5.2.3  Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3DIAG_YDIA_x</td>
<td>I/O diagnostic indication, where x is R, S, or T</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>LINK_OK_YDIA_x</td>
<td>I/O link okay indication, where x is R, S, or T</td>
<td></td>
<td>BOOL</td>
</tr>
<tr>
<td>ATTN_YDIA_x</td>
<td>I/O attention indication, where x is R, S, or T</td>
<td></td>
<td>BOOL</td>
</tr>
<tr>
<td>IOPackTmpRx</td>
<td>I/O pack temperature, where x is R, S, or T</td>
<td></td>
<td>REAL</td>
</tr>
<tr>
<td>PS18V_YDIA_x</td>
<td>I/O 18 V power supply indication, where x is R, S, or T</td>
<td></td>
<td>BOOL</td>
</tr>
<tr>
<td>PS28V_YDIA_x</td>
<td>I/O 28 V power supply indication, where x is R, S, or T</td>
<td></td>
<td>BOOL</td>
</tr>
</tbody>
</table>

Note  The following variable names are displayed differently depending on redundancy of I/O pack (R, S, or T).
5.3  **YDIA Specific Alarms**

The following alarms are specific to the YDIA I/O pack.

**56-79**

**Description**  Contact Input [ ] not responding to self-test mode

**Possible Cause**  The input hardware internal to the I/O pack has experienced a failure.

**Solution**  Replace the I/O pack.

**80-143**

**Description**  Logic Signal [ ] Voting Mismatch

**Possible Cause**

- In a TMR application, the values for the specified contact do not agree between the R, S, and T I/O packs.
- A contact input is toggling at the same rate as the configured input filter.

**Solution**

- Verify that R, S, and T I/O packs are equal with ToolboxST configuration.
- Check the I/O pack power and networking.
- Check the I/O pack mounting on terminal board.
- Check to see if a contact input is toggling at the same rate as the input filter. If so, resolve the cause of the toggling contact input.
- Replace the I/O pack.

**240**

**Description**  Excitation Voltage not valid, Contact Inputs not valid

**Possible Cause**  The contact excitation voltage applied to the terminal board is not within the acceptable range for the board.

**Solution**  Check power distribution and wiring to ensure that the correct excitation voltage is applied to the terminal board.
5.4 **TBCIS#C Contact Input with Group Isolation**

The Contact Input with Group Isolation (TBCI) terminal board accepts 24 dry contact inputs wired to two barrier-type terminal blocks. For contact excitation, dc power is wired to TBCI. The contact inputs have noise suppression circuitry to protect against surge and high-frequency noise.

---

**Caution**

Some panels contain a mixture of ac and dc wetting voltages. To prevent misoperation and damage these terminal boards, care must be taken to avoid connecting the ac wetting voltages to the terminal board wetting voltage inputs. Furthermore, verify that the ac wetting voltages and the dc wetting voltages are not inadvertently cross-connected.

---

![Contact Input Terminal Board](image)
5.4.1 **TBCIS#C Compatibility**

The TBCI supports simplex, dual, and TMR redundancy. One, two, or three I/O packs can be plugged directly into the TBCI.

<table>
<thead>
<tr>
<th>Version</th>
<th>Wetting Voltage</th>
<th>Hazardous Locations Capability</th>
<th>IEC61508 certified with YDIA pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBCIS2C</td>
<td>24 V dc</td>
<td>Class 1, Div 2 / Class 2, Zone 2 / ATEX</td>
<td>Yes</td>
</tr>
<tr>
<td>TBCIS3C</td>
<td>48 V dc</td>
<td>For ratings and further details, refer to the Mark VIeS Functional Safety System Equipment in Hazardous Locations (HazLoc) Instruction Guide (GEH-6861).</td>
<td></td>
</tr>
</tbody>
</table>

5.4.2 **TBCIS#C Installation**

Connect the wires for the 24 dry contact inputs directly to two I/O terminal blocks on the terminal board. These blocks are held down with two screws and can be unplugged from the board for maintenance. Each block has 24 terminals accepting up to #12 AWG wires. A shield terminal strip attached to chassis ground is located immediately to the left of each terminal block.

In a Simplex system, connect the I/O pack into the TBCI connector JR1. In a Dual system, plug the I/O packs into JR1 and JS1. In a TMR system, plug the I/O packs into JR1, JS1, and JT1. The I/O pack(s) attach to side-mounting brackets. One or two Ethernet cables plug into the I/O packs. Connect TBCI to the contact excitation voltage source using plugs JE1 and JE2.
J-port Connections
Use all three for TMR

Use JR1 and JS1 for dual

Use JR1 for simplex

Terminal Blocks can be unplugged from terminal board for maintenance
Up to two #12 AWG wires per point with 300 volt insulation

TBCI Wiring and Cabling
5.4.3 TBCIS#C Operation

Filters reduce high-frequency noise and suppress surge on each input near the point of signal entry. The dry contact inputs on TBCIS1C are powered from a floating 125 V dc (100-140 V dc) supply from the control cabinet. The 125 V dc bus is current limited in the power distribution module prior to feeding each contact input. The other terminal board versions use lower voltages. Refer to the section TBCI Specifications.

Note A current limit resistor is only available on the TBCIH4C.

Discrete input voltage signals pass to the I/O pack, which sends them through optical isolators providing group isolation, and transfers the signals to the controller. The reference voltage in the isolation circuits sets a transition threshold that is equal to 50% of the applied floating power supply voltage. The tracking is clamped to go no less than 13% of the nominal rated supply voltage to force all contacts to indicate open when voltage dips below this level.

A pair of terminal points is provided for each input, with one point (screw) providing the positive dc source and the second point providing the return (input) to the board. The current loading is 2.5 mA per point for the first 21 inputs on each terminal board. The last three have a 10 mA load to support interface with remote solid-state output electronics. Contact input circuitry is designed for NEMA Class G creepage and clearance.
In the following figure, the TBCIH4C contact input section has a current limit resistor on each wetting voltage output.
5.4.4 TBCIS#C Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>TBCI Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>24 contact voltage input channels</td>
</tr>
<tr>
<td>Excitation voltage</td>
<td>S2: Nominal 24 V dc, floating, 20 V dc min, 32 V dc max</td>
</tr>
<tr>
<td></td>
<td>S3: Nominal 48 V dc, floating, 43 V dc min, 53 V dc max</td>
</tr>
<tr>
<td>Input current</td>
<td>S2 (for 24 V dc applications):</td>
</tr>
<tr>
<td></td>
<td>First 21 circuits draw 2.5 mA (10 kΩ)</td>
</tr>
<tr>
<td></td>
<td>Last three circuits draw 9.9 mA (2.40 kΩ)</td>
</tr>
<tr>
<td></td>
<td>S3 (for 48 V dc applications):</td>
</tr>
<tr>
<td></td>
<td>First 21 circuits draw 2.5 mA</td>
</tr>
<tr>
<td></td>
<td>Last three circuits draw 10 mA</td>
</tr>
<tr>
<td>Input filter</td>
<td>Hardware filter, 4 ms</td>
</tr>
<tr>
<td>Power consumption</td>
<td>20.6 W on the terminal board</td>
</tr>
<tr>
<td>Fault detection</td>
<td>Loss of contact input excitation voltage</td>
</tr>
<tr>
<td></td>
<td>Non-responding contact input in test mode</td>
</tr>
<tr>
<td></td>
<td>Unplugged cable or loss of communication with I/O board:</td>
</tr>
<tr>
<td></td>
<td>contact status is displayed as False and Unhealthy.</td>
</tr>
<tr>
<td>Size</td>
<td>33.02 cm x 10.16 cm (13.0 in x 4.0 in) H x W</td>
</tr>
</tbody>
</table>

5.4.5 TBCIS#C Diagnostics

Diagnostic tests to components on the terminal boards are as follows:

- The excitation voltage is monitored. If the excitation drops to below 40% of the nominal voltage, a diagnostic alarm is set and latched by the I/O pack.
- YDIA I/O pack performs periodic self test of all contact inputs. In an alternative sequence each contact is forced open or closed and reads the status, if any contact fails the test a fault is created.
- If the input from this board does not match the TMR voted value from all three boards, a fault is created.
- Each terminal board connector has its own ID device that is interrogated by the I/O pack. The connector ID is coded into a read-only chip containing the board serial number, board type, revision number, and the JR1/JS1/JT1 connector location. When the chip is read by the I/O pack and a mismatch is encountered with what is configured in the ToolboxST application, a hardware incompatibility fault is created.
5.5 STCIS#A Simplex Contact Input

The Simplex Contact Input (STCI) terminal board is a compact contact input terminal board designed for DIN-rail or flat mounting. The STCI board accepts 24 contact inputs that are supplied with a nominal 24/48 V dc excitation from an external source. The contact inputs have noise suppression to protect against surge and high-frequency noise. The I/O pack plugs into the D-type connector and communicates with the controller over Ethernet.

<table>
<thead>
<tr>
<th>Terminal Board</th>
<th>Wetting Voltage</th>
<th>Euro Style Box-type Terminals Blocks</th>
<th>Safety Rated</th>
</tr>
</thead>
<tbody>
<tr>
<td>STCIS2A</td>
<td>24 V dc</td>
<td>Pluggable</td>
<td>IEC 61508 safety certified when used with YDIA I/O pack</td>
</tr>
<tr>
<td>STCIS4A</td>
<td>48 V dc</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.5.1 STCIS#A Installation

The STCI plus a plastic insulator mounts on a sheet metal carrier that then mounts on a DIN-rail. Optionally, the STCI plus insulator mounts on a sheet metal assembly that then bolts in a cabinet. The contact inputs are wired directly to the terminal block, typically using #18 AWG wires. Shields should be terminated on a separate bracket. 52 terminals inputs are available.

Note: E1 and E2 are chassis grounding screws for SCOM.
Wiring to STCI Terminal Board

Euro-Block type terminal block
Plastic insulator and metal carrier
DIN-rail mounting

Contact excitation input
DC-37 pin connector with latching fasteners
JA1 Plug in Pack

Wiring to STCI Terminal Board
5.5.2 STCIS#A Operation

The function and on-board signal conditioning are the same as those on TBCI. The threshold voltage is 50% of the excitation voltage.

Contact input currents are resistance limited to 2.5 mA on the first 21 circuits, and 10 mA on circuits 22 through 24. The combined contact excitation current is current limited to 0.5 A using polymer positive temperature coefficient fuses that can be reset. Filters reduce high-frequency noise and suppress surge on each input near the point of signal entry. The discrete input voltage signals go to the I/O pack, which passes them through optical isolators, converts them to digital signals, and transfers them to the controller.

5.5.3 STCIS#A Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>STCI Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>24 dry contact voltage input channels</td>
</tr>
<tr>
<td>Excitation voltage</td>
<td>S2: Nominal 24 V dc, floating, 20 V dc min, 32 V dc max (Pluggable TB) S4: Nominal 48 V dc, floating, 43 V dc min, 53 V dc max (Pluggable TB)</td>
</tr>
<tr>
<td>Input current</td>
<td>S2 (for 24 V dc applications): First 21 circuits draw 2.5 mA Last three circuits draw 10 mA S4 (for 48 V dc applications): First 21 circuits draw 2.5 mA Last three circuits draw 10.4 mA</td>
</tr>
<tr>
<td>Input filter</td>
<td>Hardware filter, 4 ms</td>
</tr>
<tr>
<td>Fault detection in I/O board</td>
<td>Loss of contact input excitation voltage Non-responding contact input in test mode Unplugged cable or loss of communication with I/O board: contact status is displayed as False and Unhealthy.</td>
</tr>
<tr>
<td>AC voltage rejection</td>
<td>S2: 12 V rms at 24 V dc excitation S4: 24 V rms at 48 V dc excitation</td>
</tr>
<tr>
<td>Size</td>
<td>15.9 cm x 10.2 cm (6.25 in x 4.0 in) H x W</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface-mount</td>
</tr>
</tbody>
</table>

5.5.4 STCIS#A Diagnostics

The I/O pack monitors the following functions on STCI:

- The contact excitation voltage is monitored. If the excitation drops to below 40% of the nominal voltage, a diagnostic alarm (fault) is set and latched.
- YDIA performs periodic self-test of all contact inputs. In an alternative sequence each contact is forced open or close and reads the status, if any contact fails the test a fault is created.
- The terminal board connector has an ID device that is interrogated by the I/O pack. The connector ID is coded into a read-only chip containing the board serial number, board type, and revision number. If a mismatch is encountered with what is configured in the ToolboxST application, a hardware incompatibility fault is created.
6 YDOA Discrete Output Module

6.1 Mark VleS YDOA Discrete Output Pack

The Discrete Output (IS420YDOAS1B) I/O pack provides the electrical interface between one or two I/O Ethernet networks and a discrete output terminal board. The pack contains a common processor board and an acquisition board specific to the discrete output function. The YDOA is capable of controlling up to 12 relays and accepts terminal board specific feedback. Electromagnetic relays (with types TRLYS1B, D, and F terminal boards) are available. Input to the pack is through dual RJ-45 Ethernet connectors and a three-pin power input. Output is through a DC-37 pin connector that connects directly with the associated terminal board connector. Visual diagnostics are provided through indicator LEDs.

![Diagram of YDOA Discrete Output Module](image-url)
### 6.1.1 YDOA Compatibility

The YDIA I/O pack contains an internal processor board. The following table lists the available versions of the YDOA.

#### YDOA Version Compatibility

<table>
<thead>
<tr>
<th>I/O Pack</th>
<th>Processor Board</th>
<th>Compatible (Supported) Firmware</th>
<th>ControlIST Software Suite Versions</th>
</tr>
</thead>
<tbody>
<tr>
<td>YDOAS1B</td>
<td>BPPC</td>
<td>V05.00 and later</td>
<td>Supported in V06.01 and later versions</td>
</tr>
</tbody>
</table>

**Attention**

YDOAS1A and YDOAS1B I/O pack versions cannot be mixed on the same T-type terminal board.

All three YDOA I/O packs in a TMR set must be the same hardware form.

---

To upgrade or replace the YDOA, refer to the following replacement procedures for specific instructions:

- [Replace Mark VIeS Safety I/O Pack with Same Hardware Form](#)
- [Replace Mark VIeS Safety I/O Pack with Upgraded Hardware Form](#)

YDOA is compatible with several types of discrete (relay) output terminal boards.

#### YDOA Terminal Board Compatibility

<table>
<thead>
<tr>
<th>Terminal Board</th>
<th>Description</th>
<th>I/O Pack Redundancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRLYS1B</td>
<td>Relay output with coil sensing</td>
<td>Yes</td>
</tr>
<tr>
<td>TRLYS1D</td>
<td>Relay output with solenoid integrity sensing</td>
<td>Yes</td>
</tr>
<tr>
<td>TRLYS1F, S2F</td>
<td>Relay output with TMR contact voting</td>
<td>No</td>
</tr>
<tr>
<td>SRLYS2A</td>
<td>Form-C contact relay output</td>
<td>Yes</td>
</tr>
</tbody>
</table>

I/O pack redundancy refers to the number of I/O packs used in a signal path, as follows:

- **Simplex** uses one I/O pack.
- **TMR** uses three I/O packs.
6.1.2 YDOA Installation

➢ To install the YDOA pack

1. Securely mount the desired terminal board.
2. Directly plug one YDOA for simplex or three YDOAs for TMR into the terminal board connectors.
3. Mechanically secure the packs using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 connector between the pack and the terminal board. The adjustment should only be required once in the life of the product.
4. Plug in one or two Ethernet cables depending on the system configuration. The I/O pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.
5. Apply power to the pack by plugging in the connector on the side of the I/O pack. It is not necessary to insert this connector with the power removed from the cable as the YDOA has inherent soft-start capability that controls current inrush on power application.
6. Use the ToolboxST application to configure the YDOA as necessary.

6.1.2.1 Connectors

• A DC-37 pin connector on the underside of the YDOA connects directly to a discrete output terminal board.
• An RJ-45 Ethernet connector named ENET1 on the pack side is the primary system interface.
• A second RJ-45 Ethernet connector named ENET2 on the pack side is the redundant or secondary system interface.
• A 3-pin power connector on the pack side is the input point for 28 V dc power for the pack and terminal board.

Note The terminal board provides fused power output from a power source that is applied directly to the terminal board, not through this pack connector.
6.1.3 YDOA Operation

The following features are common to the safety I/O modules:

- **BPPx Processor Board**
- **Processor LEDs**
- **I/O Module Common Diagnostic Alarms**

6.1.3.1 Relay Command Signals

The YDOA relay command signals are the first stage of signal conditioning and level shifting to interface the terminal board outputs to the control logic. Each output is an open collector transistor circuit with a current monitor to sense when the output is picked up and connected to a load. The status LEDs and monitor outputs indicate when an output is picked up and connected to the terminal board. If an output is picked up and the correct load is not sensed, the status LED will be off and the monitor line will be false.

![Diagram of Relay Command Signals](image)

6.1.3.2 Output Enable

All of the outputs are disabled during power application until a variety of internal self-tests is completed. An enable line reflects the status of all required conditions for operation. This function provides a path independent of the command to ensure relays stay dropped-out during power-up and initialization.

6.1.3.3 Monitor Inputs/Control

There are 15 inverting level shifting monitor input circuits. On a typical TRLY terminal board, 12 of these circuits are used as relay contact feedbacks and the other three are used for fuse status. An inverting level shifting line is also provided from the control to the terminal board for status feedback multiplexing control allowing the pack to receive two sets of 15 signals from a terminal board.
### 6.1.4 YDOA Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>YDOA Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Relay Channels</td>
<td>12 relays (different types depending on the terminal board)</td>
</tr>
<tr>
<td>Relay and Coil Monitoring</td>
<td>12 relay/coil monitors, 3–fuse status feedbacks are multiplexed to read status from six fuses</td>
</tr>
<tr>
<td>I/O Pack Response Time</td>
<td>From Ethernet command to output is approximately 6 ms</td>
</tr>
<tr>
<td>SOE Reporting</td>
<td>Each relay can be configured to report operation in the Sequence of Events (SOE) record</td>
</tr>
<tr>
<td>Size</td>
<td>8.26 cm x 4.19 cm x 12.1 cm (3.25 in x 1.65 in x 4.78 in) H x W x D</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface-mount</td>
</tr>
<tr>
<td>Ambient Rating for Enclosure Design</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
</tbody>
</table>

**Note** For further details, refer to the *Mark VIeS Functional Safety Relay Contact Output Module Summary Sheet* (GEI-100863).
6.1.5 YDOA Diagnostics

The I/O pack performs the following self-diagnostic tests:

- A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set.
- A comparison is made between the commanded state of each relay drive and the feedback from the command output circuit.
- Relay board specific feedback is read by the pack and processed. The information varies depending on the relay board type. Refer to relay terminal board documentation for feedback specifics.

Details of the individual diagnostics are available in the ToolboxST application. The diagnostic signals can be individually latched, and then reset with the RSTDIAG signal if they go healthy.

6.1.5.1 YDOA Status LEDs

### Output LEDs

<table>
<thead>
<tr>
<th>Color</th>
<th>I/O Pack Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>1 – 12</td>
<td>Provided for each output to indicate the presence of a command to energize the relay</td>
</tr>
</tbody>
</table>

**Note** For more information, refer to the section Processor LEDs.
6.2 YDOA Configuration

6.2.1 Inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Select Option or Enter Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContactInput</td>
<td>Enables Relay#Fdbk</td>
<td>Unused, Used</td>
</tr>
<tr>
<td>SignalInvert</td>
<td>Inverts Relay#Fdbk signal and Relay#ContactFdbk signal (if available)</td>
<td>Normal, Invert</td>
</tr>
<tr>
<td></td>
<td>Do not rely on the SignalInvert property of digital inputs to invert the value. Implement this operation in the application code with the input connected to a NOT block.</td>
<td></td>
</tr>
<tr>
<td>SeqOfEvents</td>
<td>Record RelayFdbk transitions in sequence of events</td>
<td>Disable, Enable</td>
</tr>
<tr>
<td></td>
<td>Not available with TRLYS1D.</td>
<td></td>
</tr>
<tr>
<td>DiagVoteEnab</td>
<td>Enable voting disagreement diagnostic</td>
<td>Disable, Enable</td>
</tr>
</tbody>
</table>

6.2.2 Outputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Select Option or Enter Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RelayOutput</td>
<td>Enable relay output</td>
<td>Used, Unused</td>
</tr>
<tr>
<td>SignalInvert</td>
<td>Inversion makes relay closed if signal is false</td>
<td>Normal, Invert</td>
</tr>
<tr>
<td></td>
<td>Do not rely on the SignalInvert property of digital inputs to invert the value. Implement this operation in the application code with the input connected to a NOT block.</td>
<td></td>
</tr>
<tr>
<td>SeqOfEvents</td>
<td>Record relay command transitions in sequence of events</td>
<td>Disable, Enable</td>
</tr>
<tr>
<td>FuseDiag</td>
<td>Enable fuse diagnostic (if available)</td>
<td>PwrDownMode, HoldLastValue, Output_Value</td>
</tr>
<tr>
<td>Output_State</td>
<td>Select the state of the relay condition based on I/O pack going offline with controller</td>
<td>PwrDownMode, HoldLastValue, Output_Value</td>
</tr>
<tr>
<td>Output_Value</td>
<td>Pre-determined value for the outputs (only displayed if Output_State is set to Output_Value)</td>
<td>Off, On</td>
</tr>
</tbody>
</table>

6.2.3 Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3DIAG_YDOA_x</td>
<td>I/O diagnostic indication, where x = R, S, or T</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>LINK_OK_YDOA_x</td>
<td>I/O link okay indication, where x = R, S, or T</td>
<td>Input</td>
<td>BIT</td>
</tr>
<tr>
<td>ATTN_YDOA_x</td>
<td>I/O Attention Indication, where x = R, S, or T</td>
<td>Input</td>
<td>BIT</td>
</tr>
<tr>
<td>IOPackTmpr_x</td>
<td>I/O pack temperature, where x = R, S, or T</td>
<td>Input</td>
<td>REAL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay#</td>
<td>Relay# output command</td>
<td>Output</td>
<td>BIT</td>
</tr>
<tr>
<td>Relay#Fdbk</td>
<td>Relay# Driver Status (set of 12 relays)</td>
<td>Input</td>
<td>BIT</td>
</tr>
<tr>
<td>Relay#ContactFdbk</td>
<td>Relay# Contact Status (set of 12 relays), available for SRLY only</td>
<td>Input</td>
<td>BIT</td>
</tr>
<tr>
<td>Fuse#Fdbk</td>
<td>Fuse voltage (if available)</td>
<td>Input</td>
<td>BIT</td>
</tr>
<tr>
<td>Solenoid#Status</td>
<td>Solenoid# Resistance Sense (set of 6 relays), True means resistance within the range, False means resistance out of the range, available for TRLYS1D only</td>
<td>Input</td>
<td>BIT</td>
</tr>
</tbody>
</table>
6.3  YDOA Specific Alarms

The following alarms are specific to the YDOA I/O pack.

33-129

Description  Logic Signal [ ] Voting Mismatch

Possible Cause  In a TMR application, the values for the specified signal do not agree between R, S, and T I/O packs.

Solution

• Verify that R, S, and T I/O pack configurations are equal to ToolboxST configuration.
• Check the I/O pack power and networking.
• Check the I/O pack mounting on terminal board.
• Replace the I/O pack.

130-141

Description  Relay circuit [ ] fuse(s) blown

Possible Cause  The I/O pack fuse status feedback indicates a possible blown fuse.

Solution  Perform the following items in the following order:

• Using the following fuse table Terminal Board Fuses, check the fuse(s) in the appropriate terminal board for a possible blown fuse.
• Verify the contact wetting/input power to the terminal board.
• Verify the terminal board configuration and jumper settings (on TRLYH1B, S1B, or WROBH1A).
• Verify that the I/O pack output and fuse diagnostics are enabled properly in the ToolboxST configuration.
• Confirm that all connectors, power plugs, I/O packs, and daughterboards are fully seated.
• If the problem persists, perform the following:
  − Replace the I/O pack.
  − Replace the WROB, F, G, or H daughterboard or the WPDF daughterboard.
  − Replace the terminal board. (This requires a ToolboxST configuration Build and Download to update the terminal board serial number.)
## Terminal Board Fuses

<table>
<thead>
<tr>
<th>Relay Output Circuit #</th>
<th>TRLYH1B/-S1B</th>
<th>TRLYH#/-C</th>
<th>TRLYH1D/-S1D</th>
<th>TRLYH#F/-S#F with WPDF</th>
<th>SRLY_2A with WROB</th>
<th>SRLY_2A with WROF</th>
<th>SRLY_2A with WROG</th>
<th>SRLY_2A with WROH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FU1</td>
<td>FU1</td>
<td>FU1</td>
<td>FU1</td>
<td>FU1</td>
<td>FU1</td>
<td>FU1</td>
<td>FU1</td>
</tr>
<tr>
<td>2</td>
<td>FU2</td>
<td>FU2</td>
<td>FU2</td>
<td>FU2</td>
<td>FU2</td>
<td>FU2</td>
<td>FU2</td>
<td>FU2</td>
</tr>
<tr>
<td>3</td>
<td>FU3</td>
<td>FU3</td>
<td>FU3</td>
<td>FU3</td>
<td>FU3</td>
<td>FU3</td>
<td>FU3</td>
<td>FU3</td>
</tr>
<tr>
<td>4</td>
<td>FU4</td>
<td>FU4</td>
<td>FU4</td>
<td>FU4</td>
<td>FU4</td>
<td>FU4</td>
<td>FU4</td>
<td>FU4</td>
</tr>
<tr>
<td>5</td>
<td>FU5</td>
<td>FU5</td>
<td>FU5</td>
<td>FU5</td>
<td>FU5</td>
<td>FU5</td>
<td>FU5</td>
<td>FU5</td>
</tr>
<tr>
<td>6</td>
<td>FU6</td>
<td>FU6</td>
<td>FU6</td>
<td>FU6</td>
<td>FU6</td>
<td>FU6</td>
<td>FU6</td>
<td>FU6</td>
</tr>
<tr>
<td>7</td>
<td>Not fused</td>
<td>Not fused</td>
<td>N/A</td>
<td>FU7</td>
<td>Not fused</td>
<td>FU7</td>
<td>FU7</td>
<td>FU7</td>
</tr>
<tr>
<td>8</td>
<td>Not fused</td>
<td>Not fused</td>
<td>N/A</td>
<td>FU8</td>
<td>Not fused</td>
<td>FU8</td>
<td>Not fused</td>
<td>FU8</td>
</tr>
<tr>
<td>9</td>
<td>Not fused</td>
<td>Not fused</td>
<td>N/A</td>
<td>FU9</td>
<td>Not fused</td>
<td>FU9</td>
<td>Not fused</td>
<td>FU9</td>
</tr>
<tr>
<td>10</td>
<td>Not fused</td>
<td>Not fused</td>
<td>N/A</td>
<td>FU10</td>
<td>Not fused</td>
<td>FU10</td>
<td>Not fused</td>
<td>FU10</td>
</tr>
<tr>
<td>11</td>
<td>Not fused</td>
<td>Not fused</td>
<td>N/A</td>
<td>FU11</td>
<td>Not fused</td>
<td>FU11</td>
<td>Not fused</td>
<td>FU11</td>
</tr>
<tr>
<td>12</td>
<td>Not fused</td>
<td>Not fused</td>
<td>N/A</td>
<td>FU12</td>
<td>Not fused</td>
<td>FU12</td>
<td>Not fused</td>
<td>FU12</td>
</tr>
</tbody>
</table>

### Description
All fuses blown or no terminal board excitation

### Possible Cause
If fuse sensing indicates an open fuse, this may be due to loss of input power to the terminal board. Without power to the fuses, the sensing may indicate a false open-fuse condition.

### Solution
- Confirm the correct input power to the terminal board.
- Check the I/O pack connector alignment and seating.
- Check the I/O pack configuration.
- Check all fuses.
- Replace the I/O pack.
- Replace the terminal board.
**143-154**

**Description**  Relay Output Coil [ ] does not match commanded state

**Possible Cause**
- The relay feedback does not match the commanded state for TRLY_B, TRLY_F, or SRLY, or SRSA specific terminal boards.
- SRSA: The mechanical relay (1 or 7) is not picked up when the relay (2-6 or 8-12) is closed.
- SRSA: Wetting power A (relays 2-6) or B (relays 8-12) is not applied.
- SRSA: Relay is picked up but no current (minimum 100 mA) is flowing through the relay circuit.

**Solution**
- Clear the voter disagreements.
- Check the I/O pack connector alignment and seating.
- Check the I/O pack configuration.
- SRSA: Pick up the mechanical relay before closing the solid state relays.
- SRSA: Verify that the wetting power bank A and B have voltage applied.
- SRSA: Verify that a proper output circuit is connected to the relay.
- Replace the terminal board.

**155-166**

**Description**  NO [Normally Open] contact [ ] voltage disagreement with command

**Possible Cause**  Voltage is not detected across an open TRLY_C or TRLY_E output contact.

**Solution**
- Clear the voter disagreements.
- Check the application to ensure that voltage should be present when relay is open.
- Check that the voltage is within the published detection range. Refer to the terminal board help documentation.
- Check the I/O pack configuration.
- Replace the terminal board.

**167-178**

**Description**  Relay Driver [ ] does not match commanded state

**Possible Cause**  The relay command signal, displayed at the I/O pack output connector to the terminal board, does not match the commanded state.

**Solution**  The command signal feedback requires a properly connected terminal board.
- Check the I/O pack to terminal board connector alignment and seating.
- Replace the I/O pack.
- Replace the terminal board.
179-184

**Description**  Relay [ ] connected field device impedance outside of acceptable range

**Possible Cause**  A connected load does not fall within published impedance limits for TRLY__D-specific terminal boards.

**Solution**
- Clear the voter disagreements.
- Check for field wiring open or short circuits.
- Check the attached load to ensure that impedance is within the published limits for TRLY__D. Refer to the terminal board help documentation.
- Check TRL input power.
- Replace TRL__D.

191

**Description**  Config Mismatch: TRLY__F terminal board is configured for SIMPLEX redundancy

**Possible Cause**  The TRLY__F board is connected to an I/O pack that is configured as simplex. Due to the redundant nature of the TRLY__F terminal board, a TMR I/O pack module configuration is required.

**Solution**  From the ToolboxST application, configure the I/O pack redundancy as TMR. Build and download a new configuration.

192

**Description**  Peer to Peer Communication Failure Code [ ]

**Possible Cause**  PGEN peer-to-peer communication for the PLU function has been lost. Refer to the PGEN documentation for a description of peer-to-peer communication.

**Solution**
- From the ToolboxST application, select *None* for I/O Module Trip From as the source for a trip if the PLU function is not used. Build and download the parameters.
- If a PGEN is used as a source for I/O Module Trip From then check the online status of the PGEN, and correct this if it is not online.
- If other communication diagnostic alarms are active, check for issues with network cables, switches, and such.

194

**Description**  Peer to Peer Communication Compatibility mismatch: YDOA [ ], Received Message [ ]

**Possible Cause**  The firmware revision of PGEN used for the source of the PLU trip is not compatible with the YDOA firmware revision.

**Solution**  Upgrade the PGEN and YDOA to the latest firmware revision with the ControlST software suite, and download the firmware and parameters to both I/O packs.
Description  Peer to Peer Communication Initialization failure

Possible Cause  The peer-to-peer link with PGEN for the PLU function could not be initialized.

Solution  From the ToolboxST application, build and download parameters to the YDOA and PGEN that are used for the PLU function.

6.4  **TRLY Discrete Output Terminal Boards**

The following TRLY discrete output terminal boards work with the YDOA I/O pack:

- TRLYS1B Relay Output with Coil Sensing
- TRLYS1D Relay Output with Solenoid Integrity Sensing
- TRLYS1F/2F Relay Output with TMR Contact Voting
6.5 TRLYS1B Relay Output with Coil Sensing

The Relay Output with coil sensing (TRLYS1B) terminal board holds 12 plug-in magnetic relays. The first six relay circuits configured by jumpers for either dry, Form-C contact outputs, or to drive external solenoids. A standard 125 V dc or 115/230 V ac source, or an optional 24 V dc source with individual jumper selectable fuses and on-board suppression, can be provided for field solenoid power. The next five relays (7-11) are unpowered isolated Form-C contacts. Output 12 is an isolated Form-C contact, used for special applications such as ignition transformers.

**J-Port Connections:**
Plug in I/O packs
The number and location depends on the level of redundancy required

**Shieldbar**
Barrier type terminal blocks can be unplugged from board for maintenance

**Output12 isolated solenoid power**

**TRLYS1B Relay Output Terminal Board**
6.5.1 TRLYS1B Compatibility

The terminal board supports simplex and TMR applications. The I/O pack plugs into the DC-37 pin connectors on the terminal board. Connector JA1 is used on simplex, and connectors JR1, JS1, and JT1 are used for TMR.

<table>
<thead>
<tr>
<th>Board Revision</th>
<th>Mark VleS IS420YDOAS1B</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRLYS1B</td>
<td>Yes, all versions</td>
<td>IEC 61508 safety certified with Mark VleS YDOA</td>
</tr>
</tbody>
</table>

6.5.2 TRLYS1B Installation

Connect the wires for the 12 relay outputs directly to two I/O terminal blocks on the terminal board. Each block is held down with two screws and has 24 terminals accepting up to #12 AWG wires. A shield terminal strip attached to chassis ground is located on the left side of each terminal block.

Connect the solenoid power for outputs 1-6 to JF1. JF2 can be used to daisy chain power to other TRLYs. Alternatively, power can be wired directly to TB3 when JF1/JF2 are not used. Connect power for the special solenoid, Output 12, to connector JG1.

Note: These jumpers are also for isolation of the monitor circuit when used on isolated contact applications.

Jumpers JP1-JP6 are supplied with the board. The appropriate jumper should be installed if power to a field solenoid is required. Conduct individual loop energization checks as per standard practices and install the jumpers as required. For isolated contact applications, remove the fuses to ensure that suppression leakage is removed from the power bus. If both the jumpers and the fuses are not removed, external power will be connected to the suppression circuits in some operating conditions.
Relay Output Terminal Board

- Output 01 (COM) [2 1 1]
- Output 01 (SOL) [4 1 3]
- Output 02 (COM) [6 1 5]
- Output 02 (SOL) [8 1 7]
- Output 03 (COM) [10 1 9]
- Output 03 (SOL) [12 1 11]
- Output 04 (COM) [14 1 13]
- Output 04 (SOL) [16 1 15]
- Output 05 (COM) [18 1 17]
- Output 05 (SOL) [20 1 19]
- Output 06 (COM) [22 1 21]
- Output 06 (SOL) [24 23]

- Output 07 (COM) [26 27]
- Output 07 (SOL) [28 29]
- Output 08 (COM) [30 31]
- Output 08 (SOL) [32 33]
- Output 09 (COM) [34 35]
- Output 09 (SOL) [36 37]
- Output 10 (COM) [38 39]
- Output 10 (SOL) [40 41]
- Output 11 (COM) [42 43]
- Output 11 (SOL) [44 45]
- Output 12 (COM) [46 47]
- Output 12 (SOL) [48 49]

- Relays [FU1 1 1, FU2 2 2, FU3 3 3]
- Fuses [FU7 1 1, FU8 2 2, FU9 3 3, FU10 4 4, FU11 5 5, FU12 6 6]
- Jumper choices: power (JPX) or dry contact (dry)

To connectors JA1, JR1, JS1, JT1

Power to special circuit 12

JG1 [1 1, 2 2, 3 3, 4 4]

JF1, JF2, and JG1 are power plugs
6.5.3  TRLYS1B Operation with Multiple Power Sources

6.5.3.1  Dry Contacts

When these terminal boards are used as dry contacts to switch ac voltage using circuits 01 through 06, and are simultaneously supplied with 125 V dc power through JF1, JF2, or TB3, unless all the fuses and JPx jumpers for the relay contact being used as a dry contact with a separate supply are removed, the separate supply will be present on the Normally Open (NO) relay terminal. If the JPx jumpers and fuses for the ac powered dry contact are not correctly removed, it will tie the ac voltage to N 125 V dc when the contact closes. A similar situation exists for the P-125. Since most ac supplies operate with a grounded neutral, the sum of the ac peak voltage and the 125 V dc is applied to MOVs connected between the dc and ground. In 120 V ac applications, the MOV rating is sufficient to withstand that voltage.

When the board is also supplied with 125 V dc, the preferred solution is not to connect the circuits 01 through 06 to ac-powered control circuits. If there is insufficient spare availability, remove both the fuses and the jumper for the contact in use for ac switching, isolating the ac voltage on the contact circuit from the dc distribution voltage. Store the jumpers and fuseholder caps separately to reduce the possibility of inadvertent re-installation, (for example after some maintenance activity).

The risk of damage to the MOVs due to cross-connections between the ac and dc power systems is not limited to the TRLY, but is present anywhere the 125 V dc is exposed to cross-connection to 125 V ac. This is including but not limited to contact sensing in motor control centers and breaker close circuits.
6.5.3.2 Simplex

Relay drivers, fuses, and jumpers are mounted on the TRLYS1B. For simplex operation, D-type connectors carry control signals and monitor feedback voltages between the I/O pack and TRLYS1B through JA1.

Relays are driven at the frame rate and have a 3.0 A ac rating. The typical time to operate is 10 ms. Relays 1-6 have a 250 V metal oxide varistor (MOV) for transient suppression between Normally Open (NO) and the power return terminals. The relay outputs have a fail-safe feature that vote to de-energize the corresponding relay when a cable is unplugged or communication with the associated I/O pack is lost.

![RLYS1B Circuits, Simplex System](image_url)
6.5.3.3 TMR

For TMR applications, relay control signals are fanned into TRLYS1B from the three I/O processors R, S, and T through plugs JR1, JS1, and JT1. These signals are voted and the result controls the corresponding relay driver. Power for the relay coils comes from all three I/O packs and is diode-shared.

TRLYS1B Circuits, TMR
### 6.5.4 TRLYS1B Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>TRLYS1B Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Relay Channels (12 Qty)</td>
<td>6 relays with optional solenoid driver voltages</td>
</tr>
<tr>
<td></td>
<td>5 relays with dry contacts only</td>
</tr>
<tr>
<td></td>
<td>1 relay with 7 A rating</td>
</tr>
<tr>
<td>Rated Voltage on Relays</td>
<td>Nominal 125 V dc or 24 V dc</td>
</tr>
<tr>
<td></td>
<td>Nominal 115/230 V ac</td>
</tr>
<tr>
<td>Max Load Current</td>
<td>0.6 A for 125 V dc operation</td>
</tr>
<tr>
<td></td>
<td>3.0 A for 24 V dc operation</td>
</tr>
<tr>
<td></td>
<td>3.0 A for 115 / 230 V ac, 50/60 Hz operation</td>
</tr>
<tr>
<td></td>
<td>6 A at 115 V ac for relay 12 only</td>
</tr>
<tr>
<td>Relay Contact Current Rating</td>
<td>24 V dc voltage current rating 10 A, resistive current rating 2 A, L/R = 7 ms, without suppression</td>
</tr>
<tr>
<td></td>
<td>125 V dc voltage current rating 0.5 A, resistive current rating 0.2 A, L/R = 7 ms, without suppression</td>
</tr>
<tr>
<td></td>
<td>125 V dc voltage current rating 0.5 A, resistive current rating 0.65 A, L/R = 150 ms, with suppression (MOV) across the load</td>
</tr>
<tr>
<td></td>
<td>115 / 230 ac voltage current rating 3.0 A</td>
</tr>
<tr>
<td>Max Response Time On</td>
<td>25 ms typical</td>
</tr>
<tr>
<td>Max Response Time Off</td>
<td>25 ms typical</td>
</tr>
<tr>
<td>Maximum Inrush Current</td>
<td>10 A</td>
</tr>
<tr>
<td>Contact Material</td>
<td>Silver cad-oxide</td>
</tr>
<tr>
<td>Contact Life</td>
<td>Electrical operations: 100,000</td>
</tr>
<tr>
<td></td>
<td>Mechanical operations: 10,000,000</td>
</tr>
<tr>
<td>Fault Detection</td>
<td>Loss of relay solenoid excitation current</td>
</tr>
<tr>
<td></td>
<td>Coil current disagreement with command</td>
</tr>
<tr>
<td></td>
<td>Unplugged cable or loss of communication with I/O board: relays de-energize if communication with associated I/O board is lost</td>
</tr>
<tr>
<td>Size</td>
<td>17.8 cm x 33.02 cm (7.0 in x 13.0 in) W x H</td>
</tr>
</tbody>
</table>

### 6.5.5 TRLYS1B Diagnostics

Diagnostic tests to components on the terminal boards are as follows:

- The output of each relay (coil current) is monitored and checked against the command at the frame rate. If there is no agreement for five consecutive frames, then an alarm is generated.
- The solenoid excitation voltage is monitored downstream of the fuses and an alarm is latched if it falls below 12 V dc.
- If any one of the outputs goes unhealthy a composite diagnostics alarm, L3DIAG_xxxx occurs.
- Each terminal board connector has its own ID device that is interrogated by the I/O pack. The connector ID is coded into a read-only chip containing the board serial number, board type, revision number, and the JA1/JR1/JS1/JT1 connector location. When the chip is read by the I/O pack and mismatch is encountered, a hardware incompatibility fault is created.
- Relay contact voltage is monitored.
- Details of the individual diagnostics are available in the configuration application. The diagnostic signals can be individually latched, and then reset with the RSTDIAG signal if they go healthy.

### 6.5.6 TRLYS1B Configuration

Board adjustments are made as follows:

- Jumpers JP1 through JP12. If power is required for relay outputs 1-12, insert jumpers for selected relays.
- Fuses FU1 through FU12. If power is required for relays 1-6, two fuses should be placed in each power circuit supplying those relays. For example, FU1 and FU7 supply relay output 1.
6.6 TRLYS1D Relay Output with Solenoid Integrity Sensing

The Relay Output with Solenoid Integrity Sensing (TRLYS1D) terminal board holds six plug-in magnetic relays. The six relay circuits are Form-C contact outputs, powered and fused to drive external solenoids. A standard 24 V dc or 125 V dc source can be used. The board provides special feedback on each relay circuit to detect a bad external solenoid. Sensing is applied between the NO output terminal and the SOL output terminal.

TRLYS1D is similar to the standard TRLYS1B board except for the following:

- There are six relays.
- The board is designed for 24/125 V dc applications only.
- Relay circuits have a NO contact in the return side as well as the source side.
- The relays cannot be configured for dry contact use.
- Input relay coil monitoring is removed.
- The terminal board provides monitoring of field solenoid integrity.
- There is no special-use relay for driving an ignition transformer.

![TRLYS1D Block Diagram](image)
6.6.1 TRLYS1D Compatibility

Connector JA1 is used for a simplex I/O pack, and connectors JR1, JS1, and JT1 are used for TMR I/O packs.

<table>
<thead>
<tr>
<th>Board Revision</th>
<th>Mark VIeS IS420YDOAS1B</th>
<th>Safety Rated</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRLYS1D</td>
<td>Yes, all versions</td>
<td>IEC 61508 safety certified with Mark VIeS YDOA</td>
</tr>
</tbody>
</table>

6.6.2 TRLYS1D Installation

Connect the wires for the six relay outputs directly to the TB1 terminal block on the terminal board. The block is held down with two screws and has 24 terminals accepting up to #12 AWG wires. A shield terminal strip, attached to chassis ground, is located immediately to the left of the terminal block.

Connect the solenoid power for outputs 1-6 to JF1. JF2 can be used to daisy-chain power to other TRLYSs. Do not use TB3.

![TRLYS1D Terminal Board Wiring](image-url)
6.6.3 **TRLYS1D Operation**

The six relays have a MOV and clamp diode for transient suppression between the NO and power return terminals. The relay outputs have a fail-safe feature that votes to de-energize the corresponding relay when a cable is unplugged or communication with the associated I/O pack is lost.

The TRLYS1D monitors each solenoid between the NO and SOL output terminals. When the relay is de-energized, the circuit applies a bias of less than 8% nominal voltage to determine if the load impedance is within an allowable band. An alarm is generated when the contact is open and the impedance is too low or too high for 20 consecutive scans (500 ms frame rate = 10 seconds). The contacts must be open for at least 1.3 seconds to get a valid reading.

### **110 or 125 V dc Solenoid Voltage**

<table>
<thead>
<tr>
<th>Announce Solenoid Failure?</th>
<th>Yes</th>
<th>Unknown</th>
<th>No</th>
<th>Unknown</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solenoid Resistance (ohms)</td>
<td>80</td>
<td>350</td>
<td>1.8 k</td>
<td>3.05 k</td>
<td></td>
</tr>
</tbody>
</table>

For simplex operation, cables carry control signals and solenoid monitoring feedback voltages between the I/O pack and TRLYS1D through JA1. For TMR applications, relay control signals are fanned into TRLYS1D from the three I/O packs R, S, and T through plugs JR1, JS1, and JT1. These signals are voted and the result controls the corresponding relay driver. Power for the relay coils comes in from all three I/O packs and is diode-shared.

### **24 V dc Solenoid Voltage**

<table>
<thead>
<tr>
<th>Announce Solenoid Failure?</th>
<th>Yes</th>
<th>Unknown</th>
<th>No</th>
<th>Unknown</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solenoid Resistance (ohms)</td>
<td>5</td>
<td>11</td>
<td>148</td>
<td>153</td>
<td></td>
</tr>
</tbody>
</table>

(R NOM = 29)

**TRLYS1D Solenoid Fault Announcement**
### 6.6.4 TRLYS1D Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>TRLYS1D Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Relay Channels</td>
<td>Six relays with special customer solenoid monitoring</td>
</tr>
<tr>
<td>Rated Voltage on Relays</td>
<td>Nominal 125 or 24 V dc</td>
</tr>
<tr>
<td>Wetting Power, JF1/JF2</td>
<td>13.5 A max</td>
</tr>
<tr>
<td>Relay Contact Rating for 24 V dc</td>
<td>Current rating 2.25 A, resistive&lt;br&gt;Current rating 2 A, L/R = 7 ms, without suppression</td>
</tr>
<tr>
<td>Solenoids</td>
<td></td>
</tr>
<tr>
<td>Relay Contact Rating for 125 V dc</td>
<td>Current rating 0.5 A, resistive&lt;br&gt;Current rating 0.2 A, L/R = 7 ms, without suppression&lt;br&gt;Current rating 0.5 A, L/R = 150 ms, with suppression (MOV) across the load</td>
</tr>
<tr>
<td>Solenoids</td>
<td></td>
</tr>
<tr>
<td>Maximum Response Time On</td>
<td>25 ms typical</td>
</tr>
<tr>
<td>Maximum Response Time Off</td>
<td>25 ms typical</td>
</tr>
<tr>
<td>Contact Life</td>
<td>Electrical operations: 100,000</td>
</tr>
<tr>
<td>FU1 – FU12 Fuse Rating</td>
<td>3.15 A, 500 V ac / 400 V dc, 5 x 20 mm time-lag</td>
</tr>
<tr>
<td>Size</td>
<td>17.8 cm x 33.02 cm (7.0 in x 13.0 in) W x H</td>
</tr>
<tr>
<td>Fault Detection</td>
<td>Loss of solenoid voltage supply (fuse monitor)&lt;br&gt;Solenoid resistance measured to detect open and short circuits&lt;br&gt;Unplugged cable or loss of communication with I/O pack (relays de-energize if communication with associated I/O pack is lost)</td>
</tr>
</tbody>
</table>

### 6.6.5 TRLYS1D Diagnostics

Diagnostic tests to components on the terminal boards are as follows:

- The solenoid excitation voltage is monitored downstream of the fuses and an alarm is latched if it falls below 12 V dc.
- If any one of the outputs goes unhealthy a composite diagnostics alarm, L3DIAG_xxxx occurs.
- Each terminal board connector has its own ID device that is interrogated by the I/O pack. The connector ID is coded into a read-only chip containing the board serial number, board type, revision number, and the JA1/JR1/JS1/JT1 connector location. When the chip is read by the I/O pack and mismatch is encountered, a hardware incompatibility fault is created.
- Details of the individual diagnostics are available in the configuration application. The diagnostic signals can be individually latched, and then reset with the RSTDIAG signal if they go healthy.
6.7 TRLYS#F Relay Output – TMR Contact Voting

The Relay Output with TMR contact voting (TRLYS1F and TRLYS2F) terminal boards provides 12 contact-voted relay outputs. The board holds 12 sealed relays in each TMR section, for a total of 36 relays. The relay contacts from R, S, and T are combined to form a voted Form A (NO) contact with TRLYS1F or the voted contacts are Form B (NC) output with TRLYS2F. Either 24/125 V dc or 115 V ac can be applied. TRLYS#F boards do not support simplex applications and do not have power distribution.

To reduce confusion in troubleshooting this highly interactive board set and to reduce mean time-to-repair, for first-stage troubleshooting, the TRLYS#F should be treated as the lowest replaceable unit (LRU) and replaced as a set when the diagnostic messages indicate that either is involved. If necessary, when time and conditions permit, the individual failed board can be further isolated using *golden* boards (a board previously known to be good) to match with the individual suspect board.

TRLYS#F Block Diagram
6.7.1 **TRLYS#F Compatibility**

The TRLYS1F and TRLYS2F terminal boards only support TMR applications. Three TMR I/O packs plug into the JR1, JS1, and JT1 37-pin D-type connectors on the terminal board.

<table>
<thead>
<tr>
<th>Board Revision</th>
<th>Mark VleS IS420YDOAS1B</th>
<th>Safety Rated</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRLYS1F</td>
<td>Yes, all versions</td>
<td>Normally open (NO) contacts, IEC 61508 safety certified with Mark VleS YDOA</td>
</tr>
<tr>
<td>TRLYS2F</td>
<td>Yes, all versions</td>
<td>Normally closed (NC) contacts, IEC 61508 safety certified with Mark VleS YDOA</td>
</tr>
</tbody>
</table>

6.7.2 **TRLYS#F Installation**

Connect the wires for the 12 solenoids directly to two I/O terminal blocks on the terminal board. Each block is held down with two screws and has 24 terminals accepting up to #12 AWG wires. A shield termination strip attached to chassis ground is located immediately to the left side of each terminal block. Alternatively, customer power may be wired to the terminal block. The 28 V dc power for the terminal board relay coils and logic comes from the three I/O packs connected at JR1, JS1, and JT1.
6.7.2.1 WPDF Power Distribution Board

If using the optional WPDF power distribution board, mount it on top of the TRLY on the J1 and J2 connectors. Secure the WPDF to the TRLY by fastening a screw in the hole located at the center of WPDF. Connect the power for the two sections of the board on the three-pin connectors J1 and J4. Power can be daisy-chained out through the adjacent plugs, J2 and J3.

**Note**: Refer to the Mark VleS Control General Market Functional Safety Manual (GEH-6860) for restrictions when used with the Mark VleS Safety control.
6.7.3 TRLYS#F Operation

The 28 V dc power for the terminal board relay coils and logic comes from the three I/O packs connected at JR1, JS1, and JT1. The same relays are used for ac voltages and dc voltages. The TRLYS#F terminal board uses the same relays with differing circuits.

Relay drivers are mounted on the TRLYS#F and drive the relays at the frame rate. The relay outputs have a fail-safe feature that votes to de-energize the corresponding relay when a cable is unplugged or communication with the associated I/O pack is lost.

This board only supports TMR applications. The relay control signals are routed into TRLYS#F from the three I/O packs, R, S, and T, through plugs, JR1, JS1, and JT1. These signals directly control the corresponding relay driver for each TMR section R, S, and T. Power for each section’s relay coils comes in from its own I/O pack and is not shared with the other sections.

TRLYS#F features TMR contact voting. The relay contacts from R, S, and T are combined to form a voted Form A (NO) contact with TRLYS1F or a Form B (NC) output with TRLYS2F. 24/125 V dc or 115 V ac can be applied. The following figure illustrates the TMR voting contact circuit.
## 6.7.4 TRLYS#F Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>TRLYS#F Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Output Relay Channels</td>
<td>S1F: 12 NO contacts</td>
</tr>
<tr>
<td></td>
<td>S2F: 12 NC contacts</td>
</tr>
<tr>
<td>Rated Voltage on Relays</td>
<td>Nominal 100/125 V dc or 24 V dc</td>
</tr>
<tr>
<td></td>
<td>Nominal 115 V ac</td>
</tr>
<tr>
<td>Max Load Current</td>
<td>0.5/0.3 A resistive for 100/125 V dc operation</td>
</tr>
<tr>
<td></td>
<td>5.0 A resistive for 24 V dc operation</td>
</tr>
<tr>
<td></td>
<td>5.0 A resistive for 115 V ac</td>
</tr>
<tr>
<td>Max Response Time On</td>
<td>25 ms</td>
</tr>
<tr>
<td>Contact Life</td>
<td>Electrical operations: 100,000</td>
</tr>
<tr>
<td>Fault Detection</td>
<td>Coil Voltage disagreement with command</td>
</tr>
<tr>
<td></td>
<td>Unplugged cable or loss of communication with I/O pack; relays de-energize if communication with associated I/O pack is lost</td>
</tr>
<tr>
<td>Size</td>
<td>17.8 cm x 33.02 cm (7.0 in x 13.0 in) W x H</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>Refer to the following figure, Derating Voted Relay Contact Output Diagram.</td>
</tr>
</tbody>
</table>

The following figure illustrates derating the voted contact output channel quantity based on the maximum applied ambient.

![Derating Voted Relay Contact Output Diagram](image_url)
6.7.5 TRLYS#F Diagnostics

Diagnostic tests to components on the terminal boards are as follows:

- The voltage to each relay coil is monitored and checked against the command at the frame rate. If there is no agreement for five consecutive frames, an alarm is latched.
- The voltage across each solenoid power supply is monitored and if it goes below 16 V ac/dc, an alarm is created.
- If any one of the outputs goes unhealthy a composite diagnostic alarm, L3DIAG xxxx occurs.
- Each terminal board connector has its own ID device that is interrogated by the I/O pack. The connector ID is coded into a read-only chip containing the board serial number, board type, revision number, and the JR1/JS1/JT1 connector location. When an ID chip is read by the I/O pack and a mismatch is encountered, a hardware incompatibility fault is created.

The diagnostic signals can be individually latched, and then reset with the RSTDIAG signal if they go healthy.
6.8 SRLYS2A Simplex Relay Output

The Simplex Relay Output (SRLY) terminal board is a simplex S-type terminal board accepting a YDOA I/O pack and providing 12 form-C relay output circuits through 48 customer terminals. The SRLY has the same physical size, customer terminal locations, and I/O pack mounting as other S-type terminal boards. There will be no components higher than an attached I/O pack, permitting double stacking of terminal boards. Each relay on SRLY uses an isolated contact pair as position feedback to the I/O pack.

One SRLY group is approved for use with the YDOA: the IS410SRLYS2A terminal board has pluggable, Euro style box-type terminal blocks and two connectors that can accept a variety of optional daughterboards.

There are four optional daughterboards available to plug onto the SRLYS2A:

- IS400WROBH1A turns SRLY into the functional equivalent of the TRLYS1B. This option provides fused and sensed power distribution to the first six relays and dedicated power to the last relay.
- IS400WROFHV1A puts a single fuse in series with each relay common connection. Fuse voltage feedback is included.
- IS400WROGH1A distributes power from an input connector to each relay through a single fuse. Fuse voltage feedback is included.
- IS400WROH distributes power from an input connector to each relay through fuses on both positive and return lines. This option provides fused and sensed power distribution to all 12 relays. Dedicated power to Relay 12 can be provided by removing JP12 and JP13 using the JG1 connector.

**Note** When using WROB, WROF or WROG, the incoming wetting voltage can be either ac or dc. WROH supports only dc wetting voltage (24 V and 48 V dc).

### SRLY Compatibility

<table>
<thead>
<tr>
<th>Revision</th>
<th>YDOA I/O Pack</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRLYS2A</td>
<td>Yes, all versions</td>
<td>Pluggable terminals, IEC 61508 safety certified with YDOA</td>
</tr>
<tr>
<td>SRLYS2A + WROB</td>
<td>Yes</td>
<td>† Some restrictions apply.</td>
</tr>
<tr>
<td>SRLYS2A + WROF</td>
<td>Yes</td>
<td>† Some restrictions apply.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pluggable terminals, one fuse in series with each relay common terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can be used for feedback from 9 to 240 V ac or from 12 to 125 V dc</td>
</tr>
<tr>
<td>SRLYS2A + WROG</td>
<td>Yes</td>
<td>† Some restrictions apply.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pluggable terminals, twelve single-fused powered outputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can be used for feedback from 9 to 240 V ac or from 12 to 125 V dc</td>
</tr>
<tr>
<td>SRLYS2A + WROH</td>
<td>Yes, YDOAS1B only</td>
<td>† Some restrictions apply.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pluggable terminals, twelve dual-fused powered outputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can be used for feedback from 14 to 60 V dc.</td>
</tr>
</tbody>
</table>

† Refer to the *Mark VIeS Control General Market Functional Safety Manual* (GEH-6860) for restrictions.
6.8.1 SRLYS2A Installation

SRLY and a plastic insulator mounts on a sheet metal carrier and is then mounted to a cabinet by screws. If an option board is used, it plugs onto SRLYS2A and is held in place by the force of the connectors.

- NC: normally closed contact of a form C relay
- COM: common point of a form C relay contact
- NO: normally open contact of a form C relay
- SOL: return circuit path for a solenoid that is powered by the relay board
- VSENSE: the input to a voltage sensor that looks between VSENSE and COM
- RETURN: return power path for devices powered by the WROG option
### Function of Each Terminal Point as Related to an Option Board

<table>
<thead>
<tr>
<th>Output Terminal</th>
<th>Relay</th>
<th>SRLY</th>
<th>SRLY + WROB</th>
<th>SRLY/WROF with Fuses</th>
<th>SRLY/WROF without Fuses</th>
<th>SRLY + WROG</th>
<th>SRLY + WROH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>SOL</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>SOL</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>SOL</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>4</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>SOL</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>5</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>SOL</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>6</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>SOL</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>7</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>COM</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>8</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>COM</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>9</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>34</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>36</td>
<td></td>
<td>COM</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>10</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>38</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>39</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>COM</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>11</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>42</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>44</td>
<td></td>
<td>COM</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>12</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>46</td>
<td></td>
<td>COM</td>
<td>COM</td>
<td>COM (unfused)</td>
<td>COM</td>
<td>POWER</td>
<td>COM</td>
</tr>
<tr>
<td>47</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>48</td>
<td></td>
<td>SOL</td>
<td>COM (fused)</td>
<td>VSENSE</td>
<td>RETURN</td>
<td>SOL</td>
<td></td>
</tr>
</tbody>
</table>
6.8.2 SRLYS2A Operation

6.8.2.1 SRLYS2A

The SRLYS2A uses pluggable type terminals and has connectors JW1 and JW2 supporting option board connection. Electrically, the SRLYS2A has the following circuit for each of the 12 relays:

![Circuit Diagram]

Without an option board, the SOL terminal associated with each relay has no connection. SRLY is designed to support a current rating of 5 A and voltage clearance greater than is needed for 250 V ac on all customer screw and JW1 circuits. The relay rating is the limiting item for each application.

6.8.2.2 SRLYS2A + WROB

Optional daughterboard IS400WROBH1A adds capability to the SRLYS2A to yield a combination that has the same functionality as the TRLYS1B terminal board when used simplex. Included are fused sensed power distribution to the first six relays and dedicated power to the last relay. Electrically, the SRLYS2A plus IS400WROBH1A together have the circuitry displayed in the following figure. IS400WROBH1A has default fuse values of 3.15 A. Connector JW2 and its connections to JA1 are omitted for clarity.
Both sides of the power distribution on relays 1-6 are fused allowing the board to be used in systems where dc power is floating with respect to earth. Fuse voltage feedback is compatible with 24 V, 48 V, and 125 V dc applications as well as 120 V and 240 V ac applications.

The following table lists the relationship between fuses, jumpers, relays, and terminals.

<table>
<thead>
<tr>
<th>Relay</th>
<th>+Fuse</th>
<th>-Fuse</th>
<th>Jumper</th>
<th>Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FU7</td>
<td>FU1</td>
<td>JP1</td>
<td>1-4</td>
</tr>
<tr>
<td>2</td>
<td>FU8</td>
<td>FU2</td>
<td>JP2</td>
<td>5-8</td>
</tr>
<tr>
<td>3</td>
<td>FU9</td>
<td>FU3</td>
<td>JP3</td>
<td>9-12</td>
</tr>
<tr>
<td>4</td>
<td>FU10</td>
<td>FU4</td>
<td>JP4</td>
<td>13-16</td>
</tr>
<tr>
<td>5</td>
<td>FU11</td>
<td>FU5</td>
<td>JP5</td>
<td>17-20</td>
</tr>
<tr>
<td>6</td>
<td>FU12</td>
<td>FU6</td>
<td>JP6</td>
<td>21-24</td>
</tr>
</tbody>
</table>
### 6.8.2.3 SRLYS2A + WROF Fused in Series

Optional daughterboard IS400WROFH1A adds an optional fuse in series with the COM connection for each relay by using the SOL terminal in place of COM. Isolated voltage sensing that is not polarity sensitive is provided for each fuse. Refer to the [SRLY Compatibility](#) table for compatible applications. IS400WROFH1A has default fuse values of 3.15 A.

With the original application for this board, each relay output has a fuse in series with power applied from an external source. In the following figure, connector JW2 and its connections to JA1 are omitted for clarity. Fuses FU1 through FU12 are associated with relay circuits 1 through 12 respectively.

![Fused in Series Diagram](image)

**Fused in Series**

### 6.8.2.4 SRLYS2A + WROF Isolated Contact Voltage Feedback

With the alternate application of this board, if the fuse is removed from a circuit, the isolated voltage detector remains. The fourth terminal may now be wired to either the NC or NO terminal to provide isolated contact voltage feedback. I/O pack firmware has a configuration option to turn off fuse blown alarm generation for a given relay if it is being used in this fashion.

---

**Attention**

The fourth terminal must be wired to either NC or NO terminal on the load side connections. Connecting to the SRLY terminal block directly and bypassing the load may not provide enough current for the voltage detector to work properly. Refer to the following figures Normally Open Wiring and Normally Closed Wiring for proper wiring.

---

**Note**

The fourth screw is Vsense. Refer to the section [Installation](#).

---
Note These connections are application specific and can be connected in either the normally open or normally closed way.

Ensure FU1 is not in place when TB-4 is being used for Voltage Monitoring.
6.8.2.5 **SRLYS2A + WROG**

Optional daughterboard IS400WROGH1A adds fused power distribution for all twelve relays. Isolated voltage sensing that is not polarity sensitive is provided for each fuse. Refer to the *SRLY Compatibility* table for compatible applications. IS400WROGH1A has default fuse values of 3.15 A. Electrically, SRLYS2A plus IS400WROGH1A together have circuitry displayed in the following figure. Fuses FU1 through FU12 are associated with relay circuits 1 through 12 respectively. Connector JW2 and its connections to JA1 are omitted for clarity.

**Note** When the WROGH1A is in use, a relay cannot be configured as a dry contact.

---

6.8.2.6 **SRLYS2A + WROH**

Optional daughterboard IS400WROH adds dual-fused power distribution to all 12 relays. Isolated voltage sensing is provided on both positive and return lines for each of the relays. (Refer to the table *SRLY Compatibility* for compatible applications.) IS400WROH has default fuse values of 3.15 A. Relay 12 can be powered separately using connector JG1 by removing jumpers JP12 and JP13.

**IS400WROH Versions**

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS400WROHH1</td>
<td>Used for feedback voltage from 14 to 60 V dc</td>
</tr>
</tbody>
</table>

The following figure displays the circuitry provided by SRLYS2A with IS400WROH. Connector JW2 and its connections to JA1 are omitted for clarity.
The following table illustrates the relationship between fuses, jumpers, relays, and terminals.

<table>
<thead>
<tr>
<th>Relay</th>
<th>+Fuse</th>
<th>-Fuse</th>
<th>Jumper</th>
<th>Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FU2</td>
<td>FU1</td>
<td>JP1</td>
<td>1–4</td>
</tr>
<tr>
<td>2</td>
<td>FU4</td>
<td>FU3</td>
<td>JP2</td>
<td>5–8</td>
</tr>
<tr>
<td>3</td>
<td>FU6</td>
<td>FU5</td>
<td>JP3</td>
<td>9–12</td>
</tr>
<tr>
<td>4</td>
<td>FU8</td>
<td>FU7</td>
<td>JP4</td>
<td>13–16</td>
</tr>
<tr>
<td>5</td>
<td>FU10</td>
<td>FU9</td>
<td>JP5</td>
<td>17–20</td>
</tr>
<tr>
<td>6</td>
<td>FU12</td>
<td>FU11</td>
<td>JP6</td>
<td>21–24</td>
</tr>
<tr>
<td>7</td>
<td>FU14</td>
<td>FU13</td>
<td>JP7</td>
<td>25–28</td>
</tr>
<tr>
<td>8</td>
<td>FU16</td>
<td>FU15</td>
<td>JP8</td>
<td>29–32</td>
</tr>
<tr>
<td>9</td>
<td>FU18</td>
<td>FU17</td>
<td>JP9</td>
<td>33–36</td>
</tr>
<tr>
<td>10</td>
<td>FU20</td>
<td>FU19</td>
<td>JP10</td>
<td>37–40</td>
</tr>
<tr>
<td>11</td>
<td>FU22</td>
<td>FU21</td>
<td>JP11</td>
<td>41–44</td>
</tr>
<tr>
<td>12</td>
<td>FU24</td>
<td>FU23</td>
<td>JP12, JP13†</td>
<td>45–48</td>
</tr>
</tbody>
</table>

† Dedicated power to Relay 12 can be provided through the JG1 connector by removing jumpers JP12 and JP13.
### 6.8.3 SRLYS2A Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>SRLY Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Relay Channels</td>
<td>12 Form-C relays (12 DO)</td>
</tr>
</tbody>
</table>
| Rated Voltage on Relays     | Nominal 24, 48, or 125 V dc  
                            | Nominal 120 or 240 V ac |
| Max Load Current            | 0.6 A for 125 V dc operation  
                            | 1.2 A for 48 V dc operation  
                            | 2.25 A for 24 V dc operation  
                            | 2.25 A for 120/240 V ac, 50/60 Hz operation |
| Max Response Time On        | 25 ms typical |
| Max Response Time Off       | 25 ms typical |
| Contact Material            | Silver cad-oxide |
| Contact Life                | Electrical operations: 100,000  
                            | Mechanical operations: 10,000,000 |
| Fault Detection             | Relay position feedback using contact pair separate from load contacts. |
| Size                        | 15.9 cm x 17.8 cm (6.25 in x 7.0 in) H x W |
| IS400WROBH1A Option Board   | Powered Output Circuits  
                            | 6 fused, associated with relays 1-6, fed from parallel connectors JF1 and  
                            | JF2. Both sides of the power source are fused for each output.  
                            | 1 unfused, associated with relay 12, fed from connector JG1 |
| IS400WROFH1A Option Board   | Fused Output Circuits  
                            | 12 fused circuits, one per relay |
| IS400WROGH1A Option Board   | Powered Output Circuits  
                            | 12 fused circuits, one associated with each relay. Single side fusing of the  
                            | power is associated with the power input on JF1 pin 1. Return power path  
                            | through JF1pin 3 is not fused. |
| IS400WROH Option Board      | Powered Output Circuits  
                            | 12 fused circuits, associated with Relay 1-12, fed from connector J1. Power  
                            | input on J1 pin (1, 4 and 7) and return power through J1 pin (3, 6, and 9).  
                            | both sides are fused for each relay output. 12 jumpers (JP1-JP12) are used  
                            | to disconnect each relay (Relay 1-12) from power input through J1 pin (1,  
                            | 4 and 7). Relay 12 can be powered separately using connector JG1 by  
                            | removing JP12 and JP13. Cumulative max current should not exceed 18 A. |
| Wetting Voltage             | WROHH1: 14 – 60 V dc |
6.8.4 SRLYS2A Diagnostics

Terminal board connectors have their own ID device that is interrogated by the I/O pack. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and plug location. When the chip is read by YDOA and a mismatch is encountered, a hardware incompatibility fault is created. Each of the option boards also contains an ID device that uniquely identifies the board.

The SRLY provides diagnostic feedback to YDOA indicating each relay position by monitoring an isolated set of contacts on each relay.

- When WROB is used with SRLY, isolated voltage feedback is used to detect fuse status for the six fuse pairs on the board. The solenoid excitation is monitored downstream of the fuses and an alarm is latched if it falls below 9 V dc.
- When WROF is used with SRLY, isolated voltage feedback is used to monitor each fuse. If voltage is present and the fuse is open a diagnostic alarm is generated. This alarm can be disabled in the ToolboxST application for YDOA configuration to use the feedback circuit without the fuse.
- When WROG is used with SRLY, isolated voltage feedback is used to monitor each fuse. If voltage is present and the fuse is open, a diagnostic alarm is generated.
- When WROH is used with SRLY, isolated voltage feedback is used to detect fuse status for all 12 fuse pairs on the board. The solenoid excitation is monitored downstream of the fuses and a diagnostic alarm is generated.

6.8.5 SRLYS2A Configuration

There are no jumpers associated with the SRLY terminal board.

Jumper configuration for the optional daughterboards is as follows:

- WROB includes six jumpers that are used to apply or remove power from a relay. Boards are produced with all six jumpers in place. The jumper is removed from the board when a relay is to be used as dry contacts and power distribution is not applicable.
- There are no jumpers associated with the WROF board. For each relay, the inclusion or exclusion of a series fuse is determined by the terminal point used as the relay common. Additionally, for each relay the associated WROF fuse may be removed to allow direct use of the fuse voltage sensing circuit as a voltage detector.
- There are no jumpers associated with the WROG board.
- WROH includes 13 jumpers that are used to apply or remove power from a relay. Boards have all jumpers in place. The jumper is removed when a relay is to be used as a dry contact and power distribution is not applicable.

---

**Note**  When the WROG is in use, a relay cannot be configured as a dry contact.
7 YUAA Universal I/O Module

The Mark VIeS Functional Safety System is used in a wide range of process control and turbo-machinery applications. The YUAA (IS430SSUAH1A) module is an enhanced I/O device designed for distributed control systems (DCS) and balance of plant (BoP) control systems (where there are typically up to tens of thousands of I/O points, requiring high availability). The module offers a reduction of cost per I/O point as compared to traditional analog I/O modules (while maintaining high availability). A three-wire channel is located on a single terminal block section that fits onto a row of the header. Each block section can be independently wired and then inserted, allowing channel by channel commissioning. This enables much faster and more reliable terminations and decreases time to commission / maintain the system.

<table>
<thead>
<tr>
<th>Support for Universal I/O Modules in ControlST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td>YUAA</td>
</tr>
</tbody>
</table>

7.1 Mark VIeS YUAA Universal I/O Pack

The YUAA module consists of the YUAAS1A I/O pack connected to the SUAAS1A terminal board. The initial release of the module meets a variety of international regulations and standards, including RoHs components.

Sixteen Simplex analog channels can be configured individually as any of the following types: Thermocouple, RTD, Voltage Input (± 5 V or ± 10 V), 4–20 mA current input, 0–20 mA current output, pulse accumulator, or digital input. Configuration of I/O channels is accomplished with the ToolboxST* application.

The boards internal to the I/O pack include one BPPC processor, one BCAR carrier board, and four MIO- universal analog I/O boards. The BPPC processor is common to many Mark VIeS I/O packs. The SUAA terminal board provides removable terminal blocks to reduce maintenance down times. The YUAA module operates on simplex control side power as supplied by a 28 V source. There are no internal jumpers, switches, or fuses required to configure the module.

The YUAA continues to meet the same high level of reliability/availability standards as other Mark control system products. Savings to the customer include fewer panels/footprint and variations for replacement parts.

---

Attention

The operating voltage limits on the user terminals are -12 to 20 V with respect to power COM for analog modes. The digital input mode has an operating limit of 0 to 20 V for inputs with no series resistance and up to 30 V for inputs with line monitoring resistors added. Operation outside of these limits may impact operation of adjacent channels.
## 7.2 YUAA Specifications

### YUAA Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Channels</td>
<td>16 channels, with groups of three terminals per channel</td>
</tr>
<tr>
<td>Supported Redundancy</td>
<td>Simplex</td>
</tr>
<tr>
<td>Shared IONet</td>
<td>Supported</td>
</tr>
<tr>
<td>Required ControlST and YUAA</td>
<td>ControlST V07.02.00C or later</td>
</tr>
<tr>
<td>Versions</td>
<td>YUAA firmware V05.05.00C or later</td>
</tr>
<tr>
<td>Auto-Reconfiguration</td>
<td>Supported</td>
</tr>
<tr>
<td>RJ-45 Ethernet Ports</td>
<td>Supports dual Ethernet (IONet) networks</td>
</tr>
<tr>
<td>Fastest Frame Rate Supported</td>
<td>10 ms</td>
</tr>
<tr>
<td>Supported I/O Types</td>
<td></td>
</tr>
<tr>
<td>• Thermocouple</td>
<td></td>
</tr>
<tr>
<td>• RTD</td>
<td></td>
</tr>
<tr>
<td>• 4–20 mA current input with HART option</td>
<td></td>
</tr>
<tr>
<td>• ± 5 V or ± 10 V input</td>
<td></td>
</tr>
<tr>
<td>• 0–20 mA current output with HART option</td>
<td></td>
</tr>
<tr>
<td>• Digital inputs and outputs</td>
<td></td>
</tr>
<tr>
<td>• Pulse accumulators</td>
<td></td>
</tr>
<tr>
<td>Incoming Control Power</td>
<td>28 V dc source is required</td>
</tr>
<tr>
<td>Incoming Power Consumption</td>
<td></td>
</tr>
<tr>
<td>Power consumption is based on 8.1 watts quiescent plus power per channel modes as follows:</td>
<td></td>
</tr>
<tr>
<td>• TC, 5V, 10V, externally wetted discrete inputs, pulse accumulator inputs, or RTD modes = 0.02 watts per channel</td>
<td></td>
</tr>
<tr>
<td>• External fed mA input and internally wetted discrete inputs = 0.04 watts per channel</td>
<td></td>
</tr>
<tr>
<td>• Internal fed mA input or mA output = 0.68 watts per channel or less, depending on external loop resistance</td>
<td></td>
</tr>
<tr>
<td>Power Output to Field Device</td>
<td>From SUAA screws PWR_RTN, supply is a maximum 2 V less than the incoming control power to the YUAA I/O pack</td>
</tr>
<tr>
<td>I/O Pack Internal Current Limiter</td>
<td>2.5 A to limit impact to supply if a short circuit failure should occur</td>
</tr>
<tr>
<td>I/O Pack Hot Swap Replacement</td>
<td>Supported</td>
</tr>
<tr>
<td>28 V dc Power Connector</td>
<td>Phoenix® contact part number MC 1.5/S-STF-3.81</td>
</tr>
<tr>
<td>Rating for Ambient Temperature on Module Exterior During Operation</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
<tr>
<td>Storage Temperature Rating</td>
<td>-40 to 85 °C (-40 to 185 °F)</td>
</tr>
<tr>
<td>Relative Humidity Required</td>
<td>5 to 95% non-condensing</td>
</tr>
<tr>
<td>Lightning Strike Protection</td>
<td>UL61010-1</td>
</tr>
<tr>
<td>Operating Vibration</td>
<td>IEC/EN 60068-2-6</td>
</tr>
<tr>
<td>Flammability Rating</td>
<td>UL94V-2</td>
</tr>
<tr>
<td>I/O Pack Casing Protection Against Intrusion</td>
<td>Ingress Protection Code: IP20 per EN 60529</td>
</tr>
<tr>
<td>General I/O Pack Specifications</td>
<td>Refer to GEH-6855_Vol_I for technical regulations and standards that apply to all of the Mark VIeS Functional Safety System equipment</td>
</tr>
<tr>
<td>YUAA Module Dimensions</td>
<td>6.6 in x 3.4 in x 4.3 in (with I/O pack attached) L x W x H</td>
</tr>
<tr>
<td>Average panel area/channel is equal to small S card footprint per group of 16 channels</td>
<td></td>
</tr>
<tr>
<td>Mode Miswired Tolerance</td>
<td>Refer to the ToolboxST Configuration Modes section for details regarding YUAA resistance to damage when incorrectly wired or configured.</td>
</tr>
<tr>
<td>Channel Terminal Voltage</td>
<td>Operation is guaranteed only when channel terminals are connected to signal voltages between 20 to -12 volts with respect to COM. For voltages outside this range, an external resistor may be required for correct operation. Refer to the section Digital Inputs and Outputs.</td>
</tr>
<tr>
<td></td>
<td>Signals above 24.5 or below -13 V with respect to COM will affect performance across other channels and could cause long term degradation of the performance. Voltages beyond ± 28 V are clamped by transors for protection.</td>
</tr>
</tbody>
</table>
# YUAA mA/HART Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Channels</td>
<td>16 channels per terminal board possible as inputs or outputs</td>
</tr>
<tr>
<td>Input Span</td>
<td>4-20 mA dc with allowance for 0-24 mA to cover NAMUR fault conditions</td>
</tr>
<tr>
<td>Input Converter Resolution</td>
<td>16-bit analog-to-digital converter</td>
</tr>
<tr>
<td>HART Rx and Cx Values</td>
<td>250 Ω in parallel with 5000 pF for HART inputs</td>
</tr>
<tr>
<td></td>
<td>14 kΩ with 11000 pF for HART current outputs</td>
</tr>
<tr>
<td>Scan Time</td>
<td>Normal scan 5 ms (200 Hz). Note that controller frame rate is 100 Hz.</td>
</tr>
<tr>
<td>Measurement Accuracy</td>
<td>Better than 0.1% full scale over the temperature range -40 to 70 °C (-40 to 158 °F)</td>
</tr>
<tr>
<td>Noise Suppression on Inputs</td>
<td>A software filter, using a two-pole, low-pass filter, is configurable for: off (0), .75, 1.5 Hz, 3 Hz, 6 Hz, 12 Hz for mA and HART inputs</td>
</tr>
<tr>
<td>Common Mode Rejection</td>
<td>Ac common mode rejection 60 dB at 60 Hz, with up to ±5 V common mode voltage. Dc common mode rejection 80 dB with -5 to +7 peak V common mode voltage</td>
</tr>
<tr>
<td>Common Mode Voltage Range</td>
<td>±5 V</td>
</tr>
<tr>
<td>Output Converter</td>
<td>16-bit D/A converter with 0.5% accuracy over 0 to 24 mA possible span</td>
</tr>
<tr>
<td>Output Load</td>
<td>800 Ω for 0-20 mA output</td>
</tr>
<tr>
<td>Channel Configuration</td>
<td>Rating</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------</td>
</tr>
<tr>
<td>mA/HART Inputs</td>
<td>4 to 20 mA at 0.1% accuracy over temperature range. In presence of severe conducted RF interference (IEC 61000-4-6, 10 V rms), the accuracy may degrade to 1.5%. In presence of severe radiated RF interference (IEC 61000-4-3, 10 V/m), internal wetted mA input accuracy may degrade to 2% and external wetted mA input accuracy may degrade to 20%.</td>
</tr>
<tr>
<td>Voltage Inputs</td>
<td>± 5 V dc or ±10 V dc at 0.1% accuracy over temperature range.</td>
</tr>
<tr>
<td>mA Outputs</td>
<td>0 to 20 mA with 0.5% accuracy, compliance up to 18 V dc with 22 V or higher field supply. 0-800 Ω load with current monitoring as a variable OutxxMA with 3% accuracy. In the presence of severe radiated RF interference (IEC 61000-4-3, 10 V/m), the accuracy may degrade to 3%.</td>
</tr>
<tr>
<td>Thermocouple Inputs</td>
<td>Caution: The CJC sensor accuracy varies with the amount of power dissipated in the YUAA package. For a setting of 16 thermocouples, the CJC provide 2 °F accuracy. For best accuracy with local CJC, mount the YUAA at the bottom of the cabinet far from higher power devices or YUAA using higher power modes. If combining thermocouples with high power modes such as mA outputs, the CJC may degrade in accuracy up to 4 °F. A practical limit on mixing modes is to limit up to 8 mA outputs on any YUAA with other channels set for thermocouples. For best accuracy it is recommended that remote cold junctions be used due to heat dissipation from analog outputs and input modes. The remote cold junction value may be from either RTD channels on the same YUAA with variables passed to application code or from other devices read by the application code such as another YUAA.</td>
</tr>
<tr>
<td>RSS Accuracy</td>
<td>RSS Accuracy of 53 uV on 45 mV span (E, J, K, S, T)</td>
</tr>
<tr>
<td></td>
<td>RSS Accuracy of 115 uV on 95 mV span (B, N, R)</td>
</tr>
<tr>
<td></td>
<td>Open wire detection is supported</td>
</tr>
<tr>
<td></td>
<td>Wiring Resistance: round trip between channel terminals is less than 100 ohms for full accuracy</td>
</tr>
<tr>
<td>RTD Inputs</td>
<td>120 Ω Nickel ± 2°F at 400 °F</td>
</tr>
<tr>
<td></td>
<td>100 Ω Platinum ± 4°F at 400 °F</td>
</tr>
<tr>
<td></td>
<td>200 Ω Platinum ± 2°F at 400 °F</td>
</tr>
<tr>
<td></td>
<td>10 Ω Copper ± 10 °F at 400 °F</td>
</tr>
<tr>
<td></td>
<td>Resistance up to 450 Ω</td>
</tr>
<tr>
<td></td>
<td>Scan time: 500 ms</td>
</tr>
<tr>
<td></td>
<td>In the presence of severe conducted RF interference (IEC 61000-4-6, 10 V rms), the resistance accuracy may degrade to 2%. The associated temperature accuracy will similarly vary with the amount based on the type of sensor.</td>
</tr>
<tr>
<td>Discrete Inputs</td>
<td>10 to 20 V external wetted switches into 12.5 kΩ internal load</td>
</tr>
<tr>
<td></td>
<td>Sequence of Event (SOE) tagging per I/O frame for first, second, and last change with 1 msec resolution</td>
</tr>
<tr>
<td></td>
<td>20 to 30 V external wetted switches using a series 6.8 Ω or a series-parallel set of 8.2 kΩ resistors</td>
</tr>
<tr>
<td></td>
<td>Line monitoring (open/short detection) is optional for external wetting using two 8.2 kΩ resistors at contact</td>
</tr>
<tr>
<td></td>
<td>Internal wetted switches with 10 mA contact current, 22 V open contact voltage</td>
</tr>
<tr>
<td></td>
<td>Line monitoring (open/short detection) is optional for internal wetting using two 240 Ω resistors at contact</td>
</tr>
</tbody>
</table>
### YUAA Performance (continued)

<table>
<thead>
<tr>
<th>Channel Configuration</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrete Outputs</td>
<td>Up to 24 mA at up to 22 V using mA output mode, capable of driving control circuits of many external interposing electromagnetic (Phoenix Contact 2961105 on DIN base PLC-BSP-24DC/21) or solid state (Crydom DC60S7 60 V dc 7A) relays using under 22 mA control current with panel or DIN-rail mounting near the SUAA base. SOE is not supported on analog outputs to drive external interposing circuits.</td>
</tr>
<tr>
<td>Pulse Accumulators</td>
<td>16-bit accumulator</td>
</tr>
<tr>
<td></td>
<td>Voltage range: -10 to 20 V</td>
</tr>
<tr>
<td></td>
<td>Frequency range: 0 to 500 Hz</td>
</tr>
</tbody>
</table>

### YUAA Orderable Part Numbers

<table>
<thead>
<tr>
<th>Part Numbers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS430SSUAH1A</td>
<td>Complete assembled Simplex module made up of one IS420YUAAS1A attached to one IS410SUAAS1A, and includes the base/mounting and hardware/cover</td>
</tr>
<tr>
<td>IS420YUAAS1A</td>
<td>YUAA I/O module with captive mounting screws</td>
</tr>
<tr>
<td>IS410SUAAS1A</td>
<td>Simplex terminal board on DIN-rail mountable base</td>
</tr>
<tr>
<td>IS400SUAAS1A</td>
<td>Simplex terminal board only</td>
</tr>
</tbody>
</table>

**Note** For more information, refer to the *Mark VIeS Functional Safety Vibration Input Module Summary Sheet* (GEI-100865).
7.3 YUAA Module Installation and Mounting

Perform the procedures in this section to install and mount a new YUAA module into an existing control cabinet.

7.3.1 Installation

The 16-channel module can be mounted with terminal blocks facing either left or right direction when mounted on a vertical DIN-rail, using pluggable Euro-style terminal blocks. The average panel area/channel (dimensions) is approximately the same as an existing small S-terminal board footprint.

➢➢
To install the YUAA module into an existing control cabinet

1. Follow all standard safety and LOTO procedures and agency or specific area / location requirements for safety.
2. Securely mount the SUAA terminal board to the cabinet. It uses the same DIN mounting columns as existing Mark VIeS terminal boards. Refer to the section Mounting for mechanical dimensions and thermal management requirements.
3. If not already attached, connect the YUAA I/O pack to the terminal board using the two screws, and tighten to 2.146 Nm (19 in lb) torque.
4. Plug in one or two Ethernet cables to the RJ-45 connector(s) depending on the IONet configuration. The I/O pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.
5. Attach the appropriate (24 – 12 AWG) wires to the terminal board screws depending on channels and devices being used. Tighten field wiring to 0.45 Nm (4 in lb). The terminal blocks are removable on a channel by channel basis. Field wiring shield ground connections are available on the metal frame of the module, separate from but adjacent to the removable terminal block. This requires the use of a metal shield strip similar to existing Mark VIeS terminal block brackets. Be aware that there is no isolation between the control and field side analog electronics. Refer to the section SUAA Universal Analog Terminal Board for more information, including a diagram and complete terminal board screw definitions.
   a. For new installations, refer to the table Wiring and Configuration for New Installs for available modes, then refer to the appropriate wiring diagrams.
   b. For retrofit installations, refer to the instructions related to the existing terminal board being replaced by the SUAA: STAI/SHRA Retros, STAO Retros, STTC Retros, SRTD Retros, or 24 V STCI Retros.
6. Apply power to the I/O pack by plugging in the 28 V dc connector. It is not necessary to remove power from the cable before plugging it in because the I/O pack has inherent soft-start capability that controls current inrush on power application.
7. Using the ToolboxST* application, configure and download to the I/O pack as necessary. Be sure that the IONet configuration matches the cable connections to the I/O pack.
   a. For new installations, refer to the table Wiring and Configuration for New Installs, then refer to the appropriate ToolboxST configuration sections in this document for those Modes.
   b. For retrofit installations, from the ToolboxST application open the existing system with the I/O pack that is being replaced with the new module, then generate an I/O report and a Configuration Report for the existing I/O pack. Using these reports, configure the new YUAA I/O pack as a replacement to the existing I/O pack.
7.3.2 Mounting

The YUAA module can be mounted to either a standard 35 mm (1.38 in) DIN-rail or directly mounted to a panel using the two 5.2 mm (0.21 in) slotted holes on the module base.

**Mounting Dimensions**

The module can be mounted with the terminal strips either left or right facing. It cannot be mounted with the terminals top or bottom facing as this impedes the convection flow required to ensure adequate cooling of the internal components. There are no spacing requirements to ensure adequate module cooling. Spacing the modules at the standard Mark VIeS spacing of 170 mm (6.7 in) will allow for a small gap between the modules but is not required for cooling purposes.

The module can be assembled to standard 35 mm (1.38 in) DIN-rail (7.5 mm [0.30 in], and 15 mm [0.60 in] height). The module position relative to the DIN-rail center line is 23 mm (0.9 in). The module base is designed to lock onto the DIN-rail and resist sliding without the use of rail stops. Removal and reinstallation or transfer of the module from one rail to another can reduce the effectiveness of the locking features. In such cases, the addition of rail stops or base replacement may be required.
**YUAA DIN-rail Installation and Removal**

For **installation**, engage the rear DIN-rail guide over the edge of the module and rotate downward to snap the module onto the rail. First time installation may require extra force to engage the rail locking.

For **removal**, use a large flat bladed screwdriver to pull the rail clip away from the rail. Rotate the module back and slide away from the rail.
7.3.3  **Wiring and Configuration**

For available modes and wiring and configuration instructions for new installations, refer to the table in the section *Wiring and Configuration for New Installs*.

For wiring and configuration instructions for retrofit installations related to the existing terminal board being replaced by the SUAA, refer to the following sections:

- *Wiring and Configuration for STAI/SHRA Retros*
- *Wiring and Configuration for STAO Retros*
- *Wiring and Configuration for STTC Retros*
- *Wiring and Configuration for SRTD Retros*
- *Wiring and Configuration for 24 V STCI Retros*

### 7.3.3.1  **Wiring and Configuration for New Installs**

The following table provides a complete list of available Analog modes with links to the appropriate wiring and configuration instructions.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Field Device</th>
<th>Wiring Diagrams</th>
<th>ToolboxST Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Input</td>
<td>4–20 mA Input Internally and externally powered</td>
<td>Analog Inputs</td>
<td>Current Inputs</td>
</tr>
<tr>
<td>Voltage Input</td>
<td>± 5 V or ± 10 V input internally and externally powered</td>
<td>Voltage Inputs</td>
<td></td>
</tr>
<tr>
<td>Current Output</td>
<td>0–20 mA Output</td>
<td>Current Outputs</td>
<td>Current Outputs</td>
</tr>
<tr>
<td>RTD</td>
<td><em>RTD types</em></td>
<td>RTD Inputs</td>
<td>RTDs</td>
</tr>
<tr>
<td>Thermocouple</td>
<td><em>TC types</em> Local or Remote CJs</td>
<td>Thermocouple Inputs</td>
<td>Thermocouples</td>
</tr>
<tr>
<td>Digital Input</td>
<td>External switches</td>
<td>Digital Inputs</td>
<td>Digital Inputs</td>
</tr>
</tbody>
</table>

Refer the section *SUAA Universal Analog Terminal Board* for more information, including a diagram and complete terminal board screw definitions.
7.3.3.2  Wiring and Configuration for STAI or SHRA Retrofits

The following table provides field wiring and channel comparisons for retrofitting an existing STAI or SHRA with a SUAA terminal board to provide current or voltage inputs, and two current outputs. The YUAA and SUAA are not isolated as on the prior analog input module (YAI/C).

HART inputs are always referenced to ground, however mA inputs allow either floating or grounded style.

<table>
<thead>
<tr>
<th>STAI Screw</th>
<th>STAI Name</th>
<th>Channel</th>
<th>SUAA Screw</th>
<th>SUAA Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P24V</td>
<td>1</td>
<td>1</td>
<td>PWR_RET</td>
<td>PWR Out if internally powered not used if externally powered</td>
</tr>
<tr>
<td>2</td>
<td>20mA</td>
<td>1</td>
<td>3</td>
<td>IO+</td>
<td>mA In (Mode set from ToolboxST for YUAA)</td>
</tr>
<tr>
<td>3</td>
<td>VDC</td>
<td>1</td>
<td>3</td>
<td>IO+</td>
<td>V In (Mode set from ToolboxST for YUAA)</td>
</tr>
<tr>
<td>4</td>
<td>Ret</td>
<td>1</td>
<td>5</td>
<td>IO-</td>
<td>Ground for 3 wire devices Ground for externally powered 2 wire Ground for externally powered 4 wire Not used for 2 wire internally powered 2nd Al for special-case internally powered 4-wire device</td>
</tr>
<tr>
<td>5</td>
<td>P24V</td>
<td>2</td>
<td>2</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>6</td>
<td>20mA</td>
<td>2</td>
<td>4</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>7</td>
<td>VDC</td>
<td>2</td>
<td>4</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>8</td>
<td>Ret</td>
<td>2</td>
<td>6</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>9</td>
<td>P24V</td>
<td>3</td>
<td>7</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>10</td>
<td>20mA</td>
<td>3</td>
<td>9</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>11</td>
<td>VDC</td>
<td>3</td>
<td>9</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>12</td>
<td>Ret</td>
<td>3</td>
<td>11</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>13</td>
<td>P24V</td>
<td>4</td>
<td>8</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>14</td>
<td>20mA</td>
<td>4</td>
<td>10</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>15</td>
<td>VDC</td>
<td>4</td>
<td>10</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>16</td>
<td>Ret</td>
<td>4</td>
<td>12</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>17</td>
<td>P24V</td>
<td>5</td>
<td>13</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>18</td>
<td>20mA</td>
<td>5</td>
<td>15</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>19</td>
<td>VDC</td>
<td>5</td>
<td>15</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>20</td>
<td>Ret</td>
<td>5</td>
<td>17</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>21</td>
<td>P24V</td>
<td>6</td>
<td>14</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>22</td>
<td>20mA</td>
<td>6</td>
<td>16</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>23</td>
<td>VDC</td>
<td>6</td>
<td>16</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>24</td>
<td>Ret</td>
<td>6</td>
<td>18</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>25</td>
<td>P24V</td>
<td>7</td>
<td>19</td>
<td>PWR RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>26</td>
<td>20mA</td>
<td>7</td>
<td>21</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>27</td>
<td>VDC</td>
<td>7</td>
<td>21</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>28</td>
<td>Ret</td>
<td>7</td>
<td>23</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>29</td>
<td>P24V</td>
<td>8</td>
<td>20</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>30</td>
<td>20mA</td>
<td>8</td>
<td>22</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>31</td>
<td>VDC</td>
<td>8</td>
<td>22</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>32</td>
<td>Ret</td>
<td>8</td>
<td>24</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>33</td>
<td>P24V</td>
<td>9</td>
<td>25</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>34</td>
<td>20mA</td>
<td>9</td>
<td>27</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>35</td>
<td>VDC</td>
<td>9</td>
<td>27</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>36</td>
<td>Ret</td>
<td>9</td>
<td>29</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>37</td>
<td>P24V</td>
<td>10</td>
<td>26</td>
<td>PWR_RET</td>
<td>Same as SUAA screw 1</td>
</tr>
<tr>
<td>38</td>
<td>20mA</td>
<td>10</td>
<td>28</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
<tr>
<td>39</td>
<td>VDC</td>
<td>10</td>
<td>28</td>
<td>IO+</td>
<td>Same as SUAA screw 3</td>
</tr>
</tbody>
</table>
### 7.3.3.3 Wiring and Configuration for STAO Retrofits

The following table provides a field wiring and channel comparison for retrofitting an existing STAO with a SUAA terminal board to provide current outputs.

<table>
<thead>
<tr>
<th>STAI Screw</th>
<th>STAI Name</th>
<th>Channel</th>
<th>SUAA Screw</th>
<th>SUAA Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>Ret</td>
<td>10</td>
<td>30</td>
<td>IO-</td>
<td>Same as SUAA screw 5</td>
</tr>
<tr>
<td>41</td>
<td>PCOM</td>
<td>49</td>
<td>COM</td>
<td>Ground for special-use 4-wire internally powered devices</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>PCOM</td>
<td>50</td>
<td>COM</td>
<td>Ground for special-use 4-wire internally powered devices</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>PCOM</td>
<td>51</td>
<td>COM</td>
<td>Ground for special-use 4-wire internally powered devices</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>PCOM</td>
<td>52</td>
<td>COM</td>
<td>Ground for special-use 4-wire internally powered devices</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>OP1</td>
<td>11</td>
<td>33</td>
<td>IO+</td>
<td>current output 1</td>
</tr>
<tr>
<td>46</td>
<td>OR1</td>
<td>11</td>
<td>35</td>
<td>IO-</td>
<td>return for current output 1</td>
</tr>
<tr>
<td>47</td>
<td>OP2</td>
<td>12</td>
<td>34</td>
<td>IO+</td>
<td>current output 2</td>
</tr>
<tr>
<td>48</td>
<td>OR2</td>
<td>12</td>
<td>36</td>
<td>IO-</td>
<td>return for current output 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STAO Screw</th>
<th>STAO Name</th>
<th>Channel</th>
<th>SUAA Screw</th>
<th>SUAA Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AO</td>
<td>1</td>
<td>3</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>2</td>
<td>Ret</td>
<td>1</td>
<td>5</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>3</td>
<td>AO</td>
<td>2</td>
<td>4</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>4</td>
<td>Ret</td>
<td>2</td>
<td>6</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>5</td>
<td>AO</td>
<td>3</td>
<td>9</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>6</td>
<td>Ret</td>
<td>3</td>
<td>11</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>7</td>
<td>AO</td>
<td>4</td>
<td>10</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>8</td>
<td>Ret</td>
<td>4</td>
<td>12</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>9</td>
<td>AO</td>
<td>5</td>
<td>15</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>10</td>
<td>Ret</td>
<td>5</td>
<td>17</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>11</td>
<td>AO</td>
<td>6</td>
<td>16</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>12</td>
<td>Ret</td>
<td>6</td>
<td>18</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>13</td>
<td>AO</td>
<td>7</td>
<td>21</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>14</td>
<td>Ret</td>
<td>7</td>
<td>23</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>15</td>
<td>AO</td>
<td>8</td>
<td>22</td>
<td>IO+</td>
<td>AO Signal</td>
</tr>
<tr>
<td>16</td>
<td>Ret</td>
<td>8</td>
<td>24</td>
<td>IO-</td>
<td>Return</td>
</tr>
<tr>
<td>17</td>
<td>Chassis Ground</td>
<td>Chassis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Chassis Ground</td>
<td>Chassis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-36</td>
<td>No connects</td>
<td>n/c</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 7.3.3.4 Wiring and Configuration for STTC Retrofits

The following table provides a field wiring and channel comparison for retrofitting an existing STTC with a SUAA terminal board to provide thermocouple inputs. The YUAA and SUAA are not isolated.

<table>
<thead>
<tr>
<th>STTC Screw</th>
<th>STTC Name</th>
<th>Channel</th>
<th>SUAA Screw</th>
<th>SUAA Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TC_P</td>
<td>1</td>
<td>3</td>
<td>IO+</td>
</tr>
<tr>
<td>2</td>
<td>TC_N</td>
<td>1</td>
<td>5</td>
<td>IO-</td>
</tr>
<tr>
<td>3</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>4</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>5</td>
<td>TC_P</td>
<td>2</td>
<td>4</td>
<td>IO+</td>
</tr>
<tr>
<td>6</td>
<td>TC_N</td>
<td>2</td>
<td>6</td>
<td>IO-</td>
</tr>
<tr>
<td>7</td>
<td>TC_P</td>
<td>3</td>
<td>9</td>
<td>IO+</td>
</tr>
<tr>
<td>8</td>
<td>TC_N</td>
<td>3</td>
<td>11</td>
<td>IO-</td>
</tr>
<tr>
<td>9</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>10</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>11</td>
<td>TC_P</td>
<td>4</td>
<td>10</td>
<td>IO+</td>
</tr>
<tr>
<td>12</td>
<td>TC_N</td>
<td>4</td>
<td>12</td>
<td>IO-</td>
</tr>
<tr>
<td>13</td>
<td>TC_P</td>
<td>5</td>
<td>15</td>
<td>IO+</td>
</tr>
<tr>
<td>14</td>
<td>TC_N</td>
<td>5</td>
<td>17</td>
<td>IO-</td>
</tr>
<tr>
<td>15</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>16</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>17</td>
<td>TC_P</td>
<td>6</td>
<td>16</td>
<td>IO+</td>
</tr>
<tr>
<td>18</td>
<td>TC_N</td>
<td>6</td>
<td>18</td>
<td>IO-</td>
</tr>
<tr>
<td>19</td>
<td>TC_P</td>
<td>7</td>
<td>21</td>
<td>IO+</td>
</tr>
<tr>
<td>20</td>
<td>TC_N</td>
<td>7</td>
<td>23</td>
<td>IO-</td>
</tr>
<tr>
<td>21</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>22</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>23</td>
<td>TC_P</td>
<td>8</td>
<td>22</td>
<td>IO+</td>
</tr>
<tr>
<td>24</td>
<td>TC_N</td>
<td>8</td>
<td>24</td>
<td>IO-</td>
</tr>
<tr>
<td>25</td>
<td>TC_P</td>
<td>9</td>
<td>27</td>
<td>IO+</td>
</tr>
<tr>
<td>26</td>
<td>TC_N</td>
<td>9</td>
<td>29</td>
<td>IO-</td>
</tr>
<tr>
<td>27</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>28</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>29</td>
<td>TC_P</td>
<td>10</td>
<td>28</td>
<td>IO+</td>
</tr>
<tr>
<td>30</td>
<td>TC_N</td>
<td>10</td>
<td>30</td>
<td>IO-</td>
</tr>
<tr>
<td>31</td>
<td>TC_P</td>
<td>11</td>
<td>33</td>
<td>IO+</td>
</tr>
<tr>
<td>32</td>
<td>TC_N</td>
<td>11</td>
<td>35</td>
<td>IO-</td>
</tr>
<tr>
<td>33</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>34</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>35</td>
<td>TC_P</td>
<td>12</td>
<td>34</td>
<td>IO+</td>
</tr>
<tr>
<td>36</td>
<td>TC_N</td>
<td>12</td>
<td>36</td>
<td>IO-</td>
</tr>
<tr>
<td>37-40</td>
<td>No Connect</td>
<td></td>
<td></td>
<td>n/c</td>
</tr>
<tr>
<td>41</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
<tr>
<td>42</td>
<td>Shield</td>
<td></td>
<td></td>
<td>Chassis</td>
</tr>
</tbody>
</table>
### Wiring and Configuration for SRTD Retrofits

The following table provides a field wiring and channel comparison for retrofitting an existing SRTD with a SUAA terminal board to provide RTD inputs.

<table>
<thead>
<tr>
<th>SRTD Screw</th>
<th>SRTD Name</th>
<th>Channel</th>
<th>SUAA screw</th>
<th>SUAA Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EX01</td>
<td>1</td>
<td>5</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>2</td>
<td>SIG01</td>
<td>1</td>
<td>3</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>3</td>
<td>RET01</td>
<td>1</td>
<td>1</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>4</td>
<td>EX02</td>
<td>2</td>
<td>6</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>5</td>
<td>SIG02</td>
<td>2</td>
<td>4</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>6</td>
<td>RET02</td>
<td>2</td>
<td>2</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>7</td>
<td>EX03</td>
<td>3</td>
<td>11</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>8</td>
<td>SIG03</td>
<td>3</td>
<td>9</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>9</td>
<td>RET03</td>
<td>3</td>
<td>7</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>10</td>
<td>EX04</td>
<td>4</td>
<td>12</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>11</td>
<td>SIG04</td>
<td>4</td>
<td>10</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>12</td>
<td>RET04</td>
<td>4</td>
<td>8</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>13</td>
<td>EX05</td>
<td>5</td>
<td>17</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>14</td>
<td>SIG05</td>
<td>5</td>
<td>15</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>15</td>
<td>RET05</td>
<td>5</td>
<td>13</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>16</td>
<td>EX06</td>
<td>6</td>
<td>18</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>17</td>
<td>SIG06</td>
<td>6</td>
<td>16</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>18</td>
<td>RET06</td>
<td>6</td>
<td>14</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>19</td>
<td>EX07</td>
<td>7</td>
<td>23</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>20</td>
<td>SIG07</td>
<td>7</td>
<td>21</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>21</td>
<td>RET07</td>
<td>7</td>
<td>19</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>22</td>
<td>EX08</td>
<td>8</td>
<td>24</td>
<td>IO-</td>
<td>Excitation</td>
</tr>
<tr>
<td>23</td>
<td>SIG08</td>
<td>8</td>
<td>22</td>
<td>IO+</td>
<td>Signal</td>
</tr>
<tr>
<td>24</td>
<td>RET08</td>
<td>8</td>
<td>20</td>
<td>PWR_RET</td>
<td>Return</td>
</tr>
<tr>
<td>25-34</td>
<td>No connects</td>
<td>n/c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Chassis for shields</td>
<td>Chassis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Chassis for shields</td>
<td>Chassis</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Wiring and Configuration for 24 V STCI Retrofits

The 24 channels of the STCI cannot be fully mapped to the 16 channels of the SUAA due to fewer channels in the YUAA. The following table assumes that the first 16 channels of the STCI are mapped, where channels 17 to 24 would be wired to a second SUAA’s channels 1 to 8. The STCI is internally wired for internal wetted contacts using external supplies, while the SUAA allows for internal fed switches using internal supplies. Therefore, terminals 49 to 52 are not reconnected on the SUAA.

<table>
<thead>
<tr>
<th>STCI Screw</th>
<th>STCI Name</th>
<th>Channel</th>
<th>SUAA Screw</th>
<th>SUAA Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input 1 (Positive)</td>
<td>1</td>
<td>SUAA #1 screw 1</td>
<td>PWR_RET for Channel 1</td>
<td>Positive feed to switch #1</td>
</tr>
<tr>
<td>2</td>
<td>Input 1 (Signal)</td>
<td>1</td>
<td>SUAA #1 screw 3</td>
<td>I/O+ for Channel 1</td>
<td>Return path from switch #1</td>
</tr>
<tr>
<td>3</td>
<td>Input 2 (Positive)</td>
<td>2</td>
<td>SUAA #1 screw 2</td>
<td>PWR_RET for Channel 2</td>
<td>Positive feed to switch #2</td>
</tr>
<tr>
<td>4</td>
<td>Input 2 (Signal)</td>
<td>2</td>
<td>SUAA #1 screw 4</td>
<td>I/O+ for Channel 2</td>
<td>Return path from switch #2</td>
</tr>
<tr>
<td>5</td>
<td>Input 3 (Positive)</td>
<td>3</td>
<td>SUAA #1 screw 7</td>
<td>PWR_RET for Channel 3</td>
<td>Positive feed to switch #3</td>
</tr>
<tr>
<td>6</td>
<td>Input 3 (Signal)</td>
<td>3</td>
<td>SUAA #1 screw 9</td>
<td>I/O+ for Channel 3</td>
<td>Return path from switch #3</td>
</tr>
<tr>
<td>7</td>
<td>Input 4 (Positive)</td>
<td>4</td>
<td>SUAA #1 screw 8</td>
<td>PWR_RET for Channel 4</td>
<td>Positive feed to switch #4</td>
</tr>
<tr>
<td>8</td>
<td>Input 4 (Signal)</td>
<td>4</td>
<td>SUAA #1 screw 10</td>
<td>I/O+ for Channel 4</td>
<td>Return path from switch #4</td>
</tr>
<tr>
<td>9</td>
<td>Input 5 (Positive)</td>
<td>5</td>
<td>SUAA #1 screw 13</td>
<td>PWR_RET for Channel 5</td>
<td>Positive feed to switch #5</td>
</tr>
<tr>
<td>10</td>
<td>Input 5 (Signal)</td>
<td>5</td>
<td>SUAA #1 screw 15</td>
<td>I/O+ for Channel 5</td>
<td>Return path from switch #5</td>
</tr>
<tr>
<td>11</td>
<td>Input 6 (Positive)</td>
<td>6</td>
<td>SUAA #1 screw 14</td>
<td>PWR_RET for Channel 6</td>
<td>Positive feed to switch #6</td>
</tr>
<tr>
<td>12</td>
<td>Input 6 (Signal)</td>
<td>6</td>
<td>SUAA #1 screw 16</td>
<td>I/O+ for Channel 6</td>
<td>Return path from switch #6</td>
</tr>
<tr>
<td>13</td>
<td>Input 7 (Positive)</td>
<td>7</td>
<td>SUAA #1 screw 19</td>
<td>PWR_RET for Channel 7</td>
<td>Positive feed to switch #7</td>
</tr>
<tr>
<td>14</td>
<td>Input 7 (Signal)</td>
<td>7</td>
<td>SUAA #1 screw 21</td>
<td>I/O+ for Channel 7</td>
<td>Return path from switch #7</td>
</tr>
<tr>
<td>15</td>
<td>Input 8 (Positive)</td>
<td>8</td>
<td>SUAA #1 screw 20</td>
<td>PWR_RET for Channel 8</td>
<td>Positive feed to switch #8</td>
</tr>
<tr>
<td>16</td>
<td>Input 8 (Signal)</td>
<td>8</td>
<td>SUAA #1 screw 22</td>
<td>I/O+ for Channel 8</td>
<td>Return path from switch #8</td>
</tr>
<tr>
<td>17</td>
<td>Input 9 (Positive)</td>
<td>9</td>
<td>SUAA #1 screw 25</td>
<td>PWR_RET for Channel 9</td>
<td>Positive feed to switch #9</td>
</tr>
<tr>
<td>18</td>
<td>Input 9 (Signal)</td>
<td>9</td>
<td>SUAA #1 screw 27</td>
<td>I/O+ for Channel 9</td>
<td>Return path from switch #9</td>
</tr>
<tr>
<td>19</td>
<td>Input 10 (Positive)</td>
<td>10</td>
<td>SUAA #1 screw 26</td>
<td>PWR_RET for Channel 10</td>
<td>Positive feed to switch #10</td>
</tr>
<tr>
<td>20</td>
<td>Input 10 (Signal)</td>
<td>10</td>
<td>SUAA #1 screw 28</td>
<td>I/O+ for Channel 10</td>
<td>Return path from switch #10</td>
</tr>
<tr>
<td>21</td>
<td>Input 11 (Positive)</td>
<td>11</td>
<td>SUAA #1 screw 31</td>
<td>PWR_RET for Channel 11</td>
<td>Positive feed to switch #11</td>
</tr>
<tr>
<td>22</td>
<td>Input 11 (Signal)</td>
<td>11</td>
<td>SUAA #1 screw 33</td>
<td>I/O+ for Channel 11</td>
<td>Return path from switch #11</td>
</tr>
<tr>
<td>23</td>
<td>Input 12 (Positive)</td>
<td>12</td>
<td>SUAA #1 screw 32</td>
<td>PWR_RET for Channel 12</td>
<td>Positive feed to switch #12</td>
</tr>
<tr>
<td>24</td>
<td>Input 12 (Signal)</td>
<td>12</td>
<td>SUAA #1 screw 34</td>
<td>I/O+ for Channel 12</td>
<td>Return path from switch #12</td>
</tr>
<tr>
<td>25</td>
<td>Input 13 (Positive)</td>
<td>13</td>
<td>SUAA #1 screw 37</td>
<td>PWR_RET for Channel 13</td>
<td>Positive feed to switch #13</td>
</tr>
<tr>
<td>26</td>
<td>Input 13 (Signal)</td>
<td>13</td>
<td>SUAA #1 screw 39</td>
<td>I/O+ for Channel 13</td>
<td>Return path from switch #13</td>
</tr>
<tr>
<td>27</td>
<td>Input 14 (Positive)</td>
<td>14</td>
<td>SUAA #1 screw 38</td>
<td>PWR_RET for Channel 14</td>
<td>Positive feed to switch #14</td>
</tr>
<tr>
<td>28</td>
<td>Input 14 (Signal)</td>
<td>14</td>
<td>SUAA #1 screw 40</td>
<td>I/O+ for Channel 14</td>
<td>Return path from switch #14</td>
</tr>
<tr>
<td>29</td>
<td>Input 15 (Positive)</td>
<td>15</td>
<td>SUAA #1 screw 43</td>
<td>PWR_RET for Channel 15</td>
<td>Positive feed to switch #15</td>
</tr>
<tr>
<td>30</td>
<td>Input 15 (Signal)</td>
<td>15</td>
<td>SUAA #1 screw 45</td>
<td>I/O+ for Channel 15</td>
<td>Return path from switch #15</td>
</tr>
<tr>
<td>31</td>
<td>Input 16 (Positive)</td>
<td>16</td>
<td>SUAA #1 screw 44</td>
<td>PWR_RET for Channel 16</td>
<td>Positive feed to switch #16</td>
</tr>
<tr>
<td>32</td>
<td>Input 16 (Signal)</td>
<td>16</td>
<td>SUAA #1 screw 46</td>
<td>I/O+ for Channel 16</td>
<td>Return path from switch #16</td>
</tr>
<tr>
<td>33</td>
<td>Input 17 (Positive)</td>
<td>17</td>
<td>SUAA #2 screw 1</td>
<td>PWR_RET for Channel 17</td>
<td>Positive feed to switch #17</td>
</tr>
<tr>
<td>34</td>
<td>Input 17 (Signal)</td>
<td>17</td>
<td>SUAA #2 screw 3</td>
<td>I/O+ for Channel 17</td>
<td>Return path from switch #17</td>
</tr>
<tr>
<td>35</td>
<td>Input 18 (Positive)</td>
<td>18</td>
<td>SUAA #2 screw 2</td>
<td>PWR_RET for Channel 18</td>
<td>Positive feed to switch #18</td>
</tr>
<tr>
<td>36</td>
<td>Input 18 (Signal)</td>
<td>18</td>
<td>SUAA #2 screw 4</td>
<td>I/O+ for Channel 18</td>
<td>Return path from switch #18</td>
</tr>
<tr>
<td>37</td>
<td>Input 19 (Positive)</td>
<td>19</td>
<td>SUAA #2 screw 7</td>
<td>PWR_RET for Channel 19</td>
<td>Positive feed to switch #19</td>
</tr>
<tr>
<td>38</td>
<td>Input 19 (Signal)</td>
<td>19</td>
<td>SUAA #2 screw 9</td>
<td>I/O+ for Channel 19</td>
<td>Return path from switch #19</td>
</tr>
<tr>
<td>39</td>
<td>Input 20 (Positive)</td>
<td>20</td>
<td>SUAA #2 screw 8</td>
<td>PWR_RET for Channel 20</td>
<td>Positive feed to switch #20</td>
</tr>
<tr>
<td>40</td>
<td>Input 20 (Signal)</td>
<td>20</td>
<td>SUAA #2 screw 10</td>
<td>I/O+ for Channel 20</td>
<td>Return path from switch #20</td>
</tr>
<tr>
<td>41</td>
<td>Input 21 (Positive)</td>
<td>21</td>
<td>SUAA #2 screw 13</td>
<td>PWR_RET for Channel 21</td>
<td>Positive feed to switch #21</td>
</tr>
<tr>
<td>42</td>
<td>Input 21 (Signal)</td>
<td>21</td>
<td>SUAA #2 screw 15</td>
<td>I/O+ for Channel 21</td>
<td>Return path from switch #21</td>
</tr>
<tr>
<td>43</td>
<td>Input 22 (Positive)</td>
<td>22</td>
<td>SUAA #2 screw 14</td>
<td>PWR_RET for Channel 22</td>
<td>Positive feed to switch #22</td>
</tr>
<tr>
<td>STCI Screw</td>
<td>STCI Name</td>
<td>Channel</td>
<td>SUAA Screw</td>
<td>SUAA Name</td>
<td>Use</td>
</tr>
<tr>
<td>------------</td>
<td>---------------</td>
<td>---------</td>
<td>------------</td>
<td>-----------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>44</td>
<td>Input 22 (Signal)</td>
<td>22</td>
<td>SUAA #2 screw 16</td>
<td>I/O+ for Channel 22</td>
<td>Return path from switch #22</td>
</tr>
<tr>
<td>45</td>
<td>Input 23 (Positive)</td>
<td>23</td>
<td>SUAA #2 screw 19</td>
<td>PWR_RET for Channel 23</td>
<td>Positive feed to switch #23</td>
</tr>
<tr>
<td>46</td>
<td>Input 23 (Signal)</td>
<td>23</td>
<td>SUAA #2 screw 21</td>
<td>I/O+ for Channel 23</td>
<td>Return path from switch #23</td>
</tr>
<tr>
<td>47</td>
<td>Input 24 (Positive)</td>
<td>24</td>
<td>SUAA #2 screw 20</td>
<td>PWR_RET for Channel 24</td>
<td>Positive feed to switch #24</td>
</tr>
<tr>
<td>48</td>
<td>Input 24 (Signal)</td>
<td>24</td>
<td>SUAA #2 screw 22</td>
<td>I/O+ for Channel 24</td>
<td>Return path from switch #24</td>
</tr>
<tr>
<td>49</td>
<td>Excitation Positive</td>
<td>ALL</td>
<td>None</td>
<td>None</td>
<td>Leave disconnected, internally supplied by YUAA</td>
</tr>
<tr>
<td>50</td>
<td>Excitation Positive</td>
<td>ALL</td>
<td>None</td>
<td>None</td>
<td>Leave disconnected, internally supplied by YUAA</td>
</tr>
<tr>
<td>51</td>
<td>Excitation Negative</td>
<td>ALL</td>
<td>None</td>
<td>None</td>
<td>Leave disconnected, internally supplied by YUAA</td>
</tr>
<tr>
<td>52</td>
<td>Excitation Negative</td>
<td>ALL</td>
<td>None</td>
<td>None</td>
<td>Leave disconnected, internally supplied by YUAA</td>
</tr>
</tbody>
</table>
7.4 YUAA Operation

The following features are common to the distributed I/O modules:

- **BPPx Processor**
- **Processor LEDs**
- **Power Management**
- **ID Line**
- **I/O Module Common Diagnostic Alarms**

The YUAA I/O pack uses a switch block in each channel to configure signal flow to and from a DAC, a HART interface, a PGA, and current sources. The following diagram illustrates the channel organization.

Settings for the switches and circuitry vary by the selected mode of operation, as follows:

- Thermocouples and voltage inputs connect through the switch block to the PGA and A/D. The PGA is set for an appropriate gain based on the voltage span. Thermocouples are also periodically tested for burnout, where a multiplexed set of current source and sink pulses a weak 10 microamperes current through the external thermocouple. If the thermocouple has too high a resistance or has opened, the PGA senses the excessive shift in voltage. Voltage inputs do not use the burnout pulse test.

- RTD inputs use the multiplexed set of current sources to pass two equal currents to IO+ and IO-, as well as across the external resistor sensor. The third leg of the sensor is connected to RTN and ground using the switch block. The PGA senses the voltage between IO+ and IO-, where any voltage drops on the wiring are cancelled out.

- mA inputs connect a burden resistor in the current path with the PGA and A/D to sense the amount of current flow. If the input is internally fed, the DAC is set for 24 mA to drive the loop with the return path through the burden to ground, allowing the external device to regulate the current. An optional HART connects a bandpass filter to the burden resistor, sensing any tone signals sent from the external device. A switched transmit path driver also connects to the burden resistor for modulating the voltage on the burden resistor when YUAA communicates back to the external device.
• mA outputs connect the DAC to the external actuator with the return path passed to ground. Confirmation of the current is received by the PGA sensing the voltage drop on a series resistor at the DAC output. If the HART option is enabled, the DAC may be modulated with an AC tone to communicate to the external actuator with the response sensed by connecting a bandpass filter and A/D to the output terminal.

• Digital inputs are similar to the ma input settings, with specific paths set by the options:
  - Externally-fed switch inputs are connected to IO+ and then to a 12.5K input load to ground. The PGA has a 20 V limit so a series resistor is added for higher field supplies to avoid false error alarms for excess input voltage.
  - Externally-fed switches with line monitoring (open/short detection) use two external resistors in series with and parallel to the external switch. This connects to the 12.5K input load with the PGA/ADC path used to check for voltages in correct ranges. If too high or too low the external wiring is declared to be faulty.
  - Internally-fed switches use the DAC to drive a current through the external switch and back through the mA burden resistor to ground. For a simple switch input, the DAC is set for 10 mA flow. By sensing the burden resistor voltage, the switch state is determined. An option for line monitoring (open/short detection) with two resistors allows for fault checking, where the DAC is set for 5 V to allow for the current to change.
  - NAMUR style sensors use a device connected to the YUAA set for 8.2 V output with a 1K series resistance. By sensing the terminal voltage, the amount of current flow is derived and in turn the external device state is determined as on, off, or faulty.

All of the settings are provided through complex programmable logic device (CPLD) controlling groups of four channels, supporting commands to the switch block settings, dataflow to the DAC for output settings, dataflow from the PGA and HART ADC channels (one for low bandwidth signals covering DC to 20 Hz, and a second for bandpass energy on HART signaling), first stage of decimation and filtering, HART modulation output using a delta sigma bit output feeding a hardware low pass filter, and data transfers with the YUAA’s processor board’s FPGA. The processor and FPGA provide a second level of filtering and decimation down to the frame rate along with completion of the HART demodulation and UART functions.
7.5 Analog Inputs (Voltage or mA Current)

There are three connections per analog channel providing local power output with current limiting (PWR_RTN), IO+ signal, and IO- signal/return as needed for each functional mode (4–20 mA, ± 5 V dc, or ± 10 V dc). The following figures provide typical wiring options.

**Note** HART is optional for all internally powered mA input modes. HART is not supported for externally powered devices.

---

**Caution**

Internally powered 2 or 3 wire field devices use the analog output DAC set at 24 mA. While there is no thermal derating for number of active analog outputs at ambients up to 70 °C (158 °F), it is possible for a fault condition with shorted leads to cause all power dissipation to be within the YUAA package. In this situation, there may be thermal alarms annunciated for the processor board.
7.6 **Current Outputs**

The following are typical channel wiring options for mA outputs. HART option is supported. Dithering is not supported.

---

**PUAA/YUAA Powered Two-wire Receiver**

---

**Externally Powered Three-wire Receiver**

---

**External Powered Four-wire Receiver**

---

**0–20 mA Analog Current Outputs**

---

To avoid false heat alarms, ensure that the output loads are more than 600 ohms for the loop current (moving power dissipation and heat to outside of the YUAA package) when using more than 8 channels of Current Output at ambient temperatures above 60 °C (140 °F).

It is possible to drive into shorted loads causing all power dissipation to be within the YUAA package. In this situation, there may be thermal alarms generated from the processor board while in hot ambient conditions.
7.7 **HART-Enabled mA Inputs and Outputs**

All channels on the YUAA are HART capable when assigned to mA input or output. Therefore, there can be up to 16 individual HART channels, with the data delivery to the controller over IONet split into two groups of 8 points (data for IOPoints 1-8 is grouped together, and data for IOPoints 9-16 is grouped together).

From the ToolboxST Component Editor, there is no separate configuration tab for HART. Assigning channels to HART uses the same mA input or mA output configuration, where within the mA input or output tab there are additional settings for HART_Enable, HART_CtrlVars, HART_ExStatus, HART_MfgID, HART_DevType, and HART_DEVID.

In order to conserve the dataflow for the YUAA, there are three stages of deployment based on HART assignments:

- No channels are assigned to HART with no HART transfers used on IONET for maximum available number of channels per controller
- 1 up to 8 channels assigned to HART within a single group of 8 channels (1 to 8) or (9 to 16), requiring a pack reboot when first assigned to allocate data transfers for a single HART group of channels
- Channels assigned across both HART groups, requiring a second pack reboot upon the first channel assigned to the second group to allocate a second set of data transfers for both HART groups of channels.

The reboots for HART traffic are only required when first assigning a channel within a group as part of a download to the YUAA. Once the first channel is assigned in a group, additional channels may be assigned on following downloads without a reboot of the pack. If channels being assigned in a download are within both groups of HART channels, then only a single reboot is required.
7.8 RTD Inputs

The YUAA has an RTD input performance equivalent to the existing SRTD for RSS accuracy covering 100 to 200 ohm sensors, with slow speed only (no fast mode). Analog channels support RTD inputs covering resistance spans matching Nickel and Platinum sensors, as compared to the existing SRTD. Resistance input from RTD sensors can be from 60 to 450 ohms, using 3–wire connections, with or without a shared return line.

RTD (3–wire) processing uses a single channel, with the channel alternating between voltage and current measurements to derive the sensed resistance. The currents are provided by the dual current sources, while the DAC terminal on the SUAA is an active ground to return the current. The YUAA does not support Fast mode. A single Slow mode of operation is used, with an acquisition time of 500 milliseconds or faster for 16 channels.

RTD Wiring

The I/O pack configuration and the final ohms value is used to lookup a temperature value based on the type of RTD selected. This final value is returned in signal space as either ohms or a temperature in degrees (Celsius or Fahrenheit set by parameter TempUnits). The available RTD types are displayed in the following table, using a current source of up to 1 mA with a compliance voltage range of up to 5 V.

<table>
<thead>
<tr>
<th>Value</th>
<th>RTD Type</th>
<th>Compatible Device Types</th>
<th>Min Temp (°F)</th>
<th>Max Temp (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minco PD</td>
<td>PT100 DIN</td>
<td>-325.893</td>
<td>1566.553</td>
</tr>
<tr>
<td>2</td>
<td>Minco PA</td>
<td>PT100 PURE</td>
<td>-323.885</td>
<td>1167.418</td>
</tr>
<tr>
<td>3</td>
<td>Minco PB</td>
<td>PT100 USIND</td>
<td>-329.068</td>
<td>1166.875</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rosemount 104</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Minco NA</td>
<td>N 120</td>
<td>-113.662</td>
<td>499.599</td>
</tr>
<tr>
<td>5</td>
<td>Minco PIA</td>
<td>None</td>
<td>-413.319</td>
<td>1765.473</td>
</tr>
<tr>
<td>6</td>
<td>Minco SAMA</td>
<td>SAMA 100</td>
<td>-322.438</td>
<td>1112.704</td>
</tr>
<tr>
<td>7</td>
<td>Minco PK</td>
<td>PT 200</td>
<td>-101.918</td>
<td>511.573</td>
</tr>
<tr>
<td>8</td>
<td>Minco PN</td>
<td>None</td>
<td>-101.918</td>
<td>511.573</td>
</tr>
<tr>
<td>10</td>
<td>Minco CA</td>
<td>CU10</td>
<td>-153.768</td>
<td>531.560</td>
</tr>
<tr>
<td>9</td>
<td>Ohms</td>
<td>Not Applicable</td>
<td>&lt; 10 ohms</td>
<td>625 ohms</td>
</tr>
</tbody>
</table>
7.9 Thermocouple Inputs

YUAA reads temperature inputs from thermocouples with E, J, K, S, T, B, N, and R styles, and has open wire detection.

**Supported TC Types and Temperature Ranges**

<table>
<thead>
<tr>
<th>TC Type</th>
<th>Min Temp (ºF)</th>
<th>Max Temp (ºF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mV</td>
<td>-40</td>
<td>114</td>
</tr>
<tr>
<td>T</td>
<td>-328</td>
<td>752</td>
</tr>
<tr>
<td>K</td>
<td>-328</td>
<td>2501.6</td>
</tr>
<tr>
<td>J</td>
<td>-337.38</td>
<td>2192</td>
</tr>
<tr>
<td>E</td>
<td>-328</td>
<td>1832</td>
</tr>
<tr>
<td>S</td>
<td>-40</td>
<td>3214.4</td>
</tr>
<tr>
<td>B</td>
<td>32</td>
<td>3308</td>
</tr>
<tr>
<td>N</td>
<td>-454</td>
<td>2372</td>
</tr>
<tr>
<td>R</td>
<td>-58</td>
<td>3214.4</td>
</tr>
</tbody>
</table>

Burnout detection on the input is based on a periodic pulse of current forcing the open terminal voltage outside the normal -40 to 95 mV region. Therefore, there may be a delay of up to 1 second from the time a sensor fails to when the burnout is detected. When the input goes open, the input terminal voltage typically drops close to zero. If the thermocouple sensor is hotter than the YUAA screw temperature, the reported temperature reading will report colder (since the TC had been at a positive terminal input voltage). If the thermocouple sensor is colder than the YUAA screw temperature, the temperature reading will momentarily report a warmer temperature, until the pulsed current source causes detection of the open circuit and the behavior specified by the `ReportOpenTC` parameter is applied.

Burnout Detection is only enabled on E, J, K, S, T, B, N and R styles of thermocouples. When the `ReportOpenTC` parameter is set to Fail_Cold, the YUAA will report Extrapolated values from TC tables at -40 mV (Open TC threshold). When `ReportOpenTC` is set to Fail_Hot, the YUAA will report 2000 ºC (3632 ºF) depending on TempUnits selection. Burnout detection is disabled on mv selection. Therefore, ±312.5 mV can be read with mv type selection with healthy zone limited from -40 mV to 114 mV.
Cold Junctions

Two Cold Junction temperature sensors located on the SUAA terminal board provide local cold junction temperature for Cold Junction compensation for Thermocouple inputs. The YUAA products also supports the ability for the user to configure and use a Remote Cold Junction. The configuration between Local/Remote Cold Junction is determined by the ColdJuncType parameter on the YUAA Parameters tab (remote or local). The Remote cold junction value is provided by the application by using the CJRemote variable in the Variables tab. From the Parameters tab, the TempUnits determines if the application is using °F or °C.

In addition, support is provided for the user to specify a Backup cold junction that gets used if either the Local or Remote Cold Junction is deemed unhealthy (out of range). The Backup Cold junction value is provided by the application by using the CJBackup variable in the Variables tab.

The temperature units for both BackupCJ and RemoteCJ will be assumed as equivalent to the setting of the TempUnits parameter on the Parameters tab.

Normal operation uses the two internal CJC sensors. Due to package heating variation for varying channel assignments, the accuracy of the CJC is best when other channels are NOT assigned to high power modes such as mA outputs or internal fed mA inputs.

---

**Caution**

For best accuracy it is recommended that remote cold junctions be used due to heat dissipation from analog outputs and input modes. The remote cold junction value may be from either RTD channels on the same YUAA with variables passed to application code or from other devices read by the application code such as another YUAA.
7.10 Digital Inputs and Outputs

The YUAA supports several types of digital (discrete) inputs and outputs, as enabled by configuration including: Digital input modes of NAMUR, Externally Wetted, Internally Wetted, and Digital Outputs through using mA outputs and interposing relays. Terminal voltages for the YUAA must remain between 0 and 20 V for correct discrete input operation. To use inputs of higher than 20 V, such as for 24 V discrete inputs, the user must use a series resistor which would be part of the open wire detection. With the use of two resistors in parallel and series with the switch contact, external wetting voltages of up to 30 V are allowed.

7.10.1 NAMUR Style Sensor Inputs

The NAMUR sensor is connected between IO+ and IO-. NAMUR style implies that the sensor is designed in accordance with IEC60947-5-6 Control circuit devices and switching elements – DC Interface for proximity sensors and switching amplifiers (NAMUR).

![NAMUR Channel mA Zones](image)

The NAMUR load 1K resistor is located on the IO- side of the connection. This prevents the use of a shared return wire for multiple sensors as done on RTD devices – each sensor shall be wired separately to its channel’s two terminals.
The decision for the sensor state is based on the current sensing on the high side with thresholds set at 0.4 mA, 1 mA, 2.2 mA, and 5.85 mA. Faults as well as normal sensor low and high current states are detected as follows:

- If the current is seen to be less than 0.4 mA then an open circuit is declared with an alarm.
- Between 0.4 and 1 mA, the sensor is in a low current state
- Between 1 and 2.2 mA, the sensor is declared as faulty
- Between 2.2 and 5.85 mA, the sensor is in a high current state
- Above 5.85 mA, the sensor is faulty with a short or IO+ is miss-wired to ground.

NAMUR sensors come in both normally open and normally closed styles. The default polarity is for the channel's contact state value to be set if current is between 0.4 and 1 mA.
### 7.10.2 External Wetted Contact Inputs

The thresholds are based on the excitation voltage using optional external resistors, where the terminals are connected to an internal 12.5K load. There are three types of external wetted contact inputs, depending on source voltage and desired diagnostic support, as described in the following sections:

- External wetted contact inputs with 10–20 V field supply
- External wetted contact inputs with 20–30 V field supply requiring series resistance
- External wetted contact with line monitoring (open/short detection)

#### External Wetted Contact Inputs with 10 to 20 V Field Supply

For switches using a field supply of 20 V or lower, the simplest circuit to install is a switch with no resistors. There are no diagnostics for faults, just a decision at 50% of the specified field voltage for switch open or closed.

![Diagram of 10 to 20 V External Wetted Contact Input](image)

#### External Wetted Contact Inputs with 30 to 20 V Field Supply Requiring Series Resistance

For switches using a field supply of higher than 20 V, external resistance is required to limit current to a safe value (where the current is due to the higher voltage back-feeding the internal 20 V circuitry supply rail). It is highly recommended to use the line monitoring (open/short detection) scheme that uses two resistors and provides full diagnostic coverage for faults. Alternatively, a single series resistance of 4.7 KΩ ¼ watt can be used as shown in the following diagram solely to limit the current. To do this, the digit input parameter, `LineMonitoring`, on the input point should be set to `Disable` and the parameter `ExtWettingVoltage` should be set to 20 V to force a simple 10 V decision threshold. However, these settings will only provide fault coverage of over-voltage due to a short from the I/O+ screw to field supply. If this fault occurs, the Point Unhealthy alarm (64–95) and/or the IO Point Input Saturation alarm (2754–2785) will be annunciated.

![Diagram of 20 to 30 V External Wetted Contact Input](image)
External Wetted Contact Inputs with Line Monitoring (Open/Short Detection)

For full diagnostic coverage, the user can enable line monitoring. When line monitoring is enabled, a different circuit is required with two resistors added to allow detection of a loop break (too little current) or short (too high a current). This adds two 8.2K ¼ watt resistors in parallel and series with the switch. Even with a 30 V field supply (above normal operation as an extreme), the resistors limit fault current preventing any impairment of the internal 24 V circuitry supply rail. An additional limit is for 20 V at the terminals where this is the maximum linear voltage sensed by the channel’s A/D path.

For detection of open and/or short conditions, there are additional thresholds imposed based on the field voltage entered in the ToolboxST application and the external resistors. The dual resistor circuit allows for detection of open loop and short to field supply.

The field supply voltage is entered in the ToolboxST application as the ExtWettingVoltage parameter. Using 24 V as an example, the thresholds are determined as follows:

- Open circuit at 50% of typical open contact value or 5.06 V (21% of 24 V)
- Contact open/closed decision at average of open and closed values or 12.42 V (51.75% of 24 V)
- Short threshold at average of closed and field level or 19.38 V (80.75% of 24 V) where this is within the 20 V limit of the signal path's linear range. Therefore, field supplies greater than 24 V have a short threshold that is not supported by the 20 V limit of the path's linear range.

Examples of various field settings for line monitoring (open/short detection) are shown in the following plot, where the thresholds for open/contact decision/short are shown in dashed lines for entries of 10, 13, 18, 24, and 29 V field supplies for contacts using two resistors allowing for +/- 10% field voltage variation. The lower solid lines are for the open contact voltage at the terminals, upper is for the closed contact voltage.
This mode of input uses low currents due to the load resistance. If the user’s contact cannot support under 1 mA of current flow, use the YDIA/STCI combination with 2.5 or 10 mA current flow.

This mode of input cannot support a field supply higher than 30 V. If 48 V or 125 V operation is desired, use the appropriate YDIA/STCI combination supporting that supply level.

### 7.10.3 Internal Wetted Contact Inputs

The switch is connected between PWR_RET and IO+, where the channel’s DAC output is passed via the external switch circuit to IO+ into the burden resistor. There are two types of external switch circuits supported as follows:

- Simple switch only
- Line monitoring (open/short detection) with the switch having two resistors in parallel and series

For the simple switch, the channel DAC is set for the contact current to flow from PWR_RET through the switch to IO+ into the 250 ohm burden resistor to ground. The decision on switch state is based on current above or below 50% the set value as measured on the burden resistor.

For line monitoring with detection of an open connection compared to an open switch, the DAC is set in voltage output mode by firmware. The user adds two resistors to limit the current in normal operation with both set at the same value based on the choice of desired current through the contact.

![Internal Wetted Simple Contact](image1)

![Internal Wetted Contact with Line Monitoring (Open/Short) Wire Detection](image2)

The variations on internal fed switches have the following contact voltages and currents.

<table>
<thead>
<tr>
<th>Line Monitoring</th>
<th>Disabled</th>
<th>Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact current</td>
<td>10 mA</td>
<td>10 mA</td>
</tr>
<tr>
<td>Set by channel DAC in current output mode</td>
<td>Set by resistors, DAC is set to 5V</td>
<td></td>
</tr>
<tr>
<td>Resistor values (equal, 1% tolerance)</td>
<td>None</td>
<td>240 ohm ¼ watt</td>
</tr>
<tr>
<td>I/O+ for contact closed</td>
<td>2.5V</td>
<td>2.55</td>
</tr>
<tr>
<td>Open Contact voltage</td>
<td>Up to 24V</td>
<td>1.64</td>
</tr>
<tr>
<td>I/O+ for contact open</td>
<td>0</td>
<td>1.71</td>
</tr>
<tr>
<td>Threshold volts at IO+ for open loop</td>
<td>None</td>
<td>0.86</td>
</tr>
<tr>
<td>Threshold volts at IO+ for contact decision</td>
<td>1.25</td>
<td>2.13</td>
</tr>
<tr>
<td>Threshold volts at IO+ for short</td>
<td>None</td>
<td>3.78</td>
</tr>
</tbody>
</table>
Discrete Output Using mA Outputs and Interposing Relays

While no power output exists on the YUAA, the 24 mA output available on the mA output mode allows for driving interposing relays external to the YUAA. Examples of such devices available on the open market are as follows:

- Phoenix Contact PLC-RSC-24DC/21-296617, 6 Amps electromagnetic relay mounted on base terminal block
- Crydom DR24D06 280 V AC 6A solid state relay
- WAGO series 789 DIN mounted relay modules with various contacts, protection, and indicators available

**Note 1.** The user is responsible for validating the use of external devices within their application, these are only shown as examples of what a 24 mA output can control. The output will force either 22 V at lower currents or apply a constant current to the external relay coil, where the user should keep the current at a value matching the relay’s operating current.

2. Testing is recommended to set the mA level appropriately. If set for 24 mA into a solid state driver or high resistance coil, the actual current could differ triggering unhealthy flags.

3. User must include a flyback diode across any relay coil being driven by YUAA in mA output mode. The cathode goes to IO+ and anode to IO-, suppressing the high voltage spike possible when the current is turned off to the relay coil.
7.11 Pulse Accumulator

The YUAA support simple Pulse Accumulator inputs, which can count pulse edges on an input channel across a specified threshold voltage (user declares the threshold voltage with the \texttt{PATHreshold} parameter), up to a limited frequency. (Refer to the product specifications.) The connected device can be a dedicated externally-powered device that provides pulse inputs, or it can be an external power supply and contact, similar to the configuration supported for externally-wetted contact inputs.

![Wiring Details for Pulse Accumulator Inputs](image)

The YUAA firmware counts the pulse detected in an unsigned 16-bit integer and delivers it to the controller as a REAL input. This REAL input will only ever contain an integer value (0-65535). When the counter value reaches 65535, the next pulse seen will cause it to change to 0. In order to detect this rollover and accumulate counts beyond this, the user must write application blockware to keep track of the total accumulation separately. Refer to the section \textit{Pulse Accumulator Buffer Example} for an example of a simple way to do this.

The user can also use additional application blockware to determine the rate of the input. Refer to the example in the section \textit{Frequency Calculation Example}.

7.12 YUAA Configuration

The ToolboxST configuration for YUAA is different than most I/O packs. Since each point can process different types of I/O, there is a \textbf{Mode} selection in the \textit{Configuration} tab that has to be set in the ToolboxST application Component Editor for each IOPoint (or left Unused if not used). The ToolboxST application does not enforce any limitations for available mA outputs with respect to the potential ambient environment inside the cabinet.

7.12.1 Parameters

The following are global configuration options for the YUAA.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value { } = default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TempUnits</td>
<td>°C {°F}</td>
<td>Temperature unit selection is use for RTDs, Thermocouples, and Cold Junction values</td>
</tr>
<tr>
<td>ColdJuncType</td>
<td>(Local) Remote</td>
<td>Cold Junction source for thermocouple inputs</td>
</tr>
<tr>
<td>AMS_Mgs_Only</td>
<td>(Disable) Enable</td>
<td>AMS Messages only - do not send control messages if enabled.</td>
</tr>
<tr>
<td>AMS_Mux_Scans_Permitted</td>
<td>(Disable) Enable</td>
<td>AMS multiplexer scans for command 1 and 2 are allowed (command 3 always allowed)</td>
</tr>
<tr>
<td>Min_MA_Hart_Output</td>
<td>(4.0) 0 to 22.5</td>
<td>Minimum MA output for a Hart Enabled Device</td>
</tr>
</tbody>
</table>
7.12.2 Configuration (Modes)

Channel configuration can be done at any time, but requires a channel be taken from an Unused mode to an assigned mode (or from an assigned mode to Unused), but not directly from one mode to a different mode. This does not require a device reboot or impact adjacent channels.

The YUAA allows changing individual point configuration though an Online Load (parameter download without rebooting) without affecting any other point, however changing from any one type of point to another first requires that the point be configured as Unused. The product will protect against an invalid transition and will fail the download and issue a diagnostic alarm to indicate the issue.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mode { } = default</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOPoint01</td>
<td>Unused</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Universal I/O Point01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Universal I/O Point16</td>
</tr>
<tr>
<td>IOPoint16</td>
<td></td>
<td>AnalogInput</td>
<td>REAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AnalogInput</td>
<td>REAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AnalogInput</td>
<td>REAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AnalogInput</td>
<td>REAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AnalogInput</td>
<td>REAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AnalogInput</td>
<td>BOOL</td>
<td></td>
</tr>
</tbody>
</table>

Caution

To prevent damage to the SUAA, when the PWR_RET terminals are serving as a ground return for the channel, verify that the current to the ground is limited to 50 mA or less. If the ground path is capable of higher currents, then an external series resistor should be inserted in series with the terminal connection to serve as a current limit. As an example, if a 24 V circuit was capable of being incorrectly wired to the PWR_RET terminal, then a 510 ohm 2 watt resistor would be used in series as a protection device.

Caution

To prevent damage to field devices, verify wiring prior to configuring the I/O pack. Avoid any incorrectly wired channel that could act as an output driving back into an analog input device. The I/O pack is capable of acting as an output or input channel under software command. The terminal blocks are in groups of 3 screws to allow for channels to be attached one at a time as part of wiring checks.
### Current Inputs

<table>
<thead>
<tr>
<th>CurrentInputs</th>
<th>Low_Input</th>
<th>Low_Value</th>
<th>High_Input</th>
<th>High_Value</th>
<th>InputFilter</th>
<th>ExternPwrEnab</th>
<th>Min_MA_Input</th>
<th>Max_MA_Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptions</td>
<td>Input mA at Low Value</td>
<td>Low Input in Engineering Units</td>
<td>Input MA at High Value</td>
<td>High Input in Engineering Units</td>
<td>Filter Bandwidth in Hz</td>
<td>Enable External Power for 4-20ma inputs</td>
<td>Set the minimum mA for healthy input</td>
<td>Set the maximum mA for healthy input</td>
</tr>
<tr>
<td>Choices (defaults)</td>
<td>{4}</td>
<td>(0)</td>
<td>(20)</td>
<td>(100)</td>
<td>0.75hz 1.5hz 2hz 3hz 6hz (Unused)</td>
<td>Disable (Enable)</td>
<td>(3)</td>
<td>(22.5)</td>
</tr>
</tbody>
</table>

Low_Input, Low_Value, High_Input, High_Value settings are used by the YUAA firmware to define the linear relationship between mA and customer-defined engineering units. The I/O Point value will be in Engineering units. Engineering units are specific to the field device being used.

### Current Inputs (continued)

<table>
<thead>
<tr>
<th>Hart_Enable</th>
<th>Hart_CtrVars</th>
<th>Hart_ExStatus</th>
<th>Hart_MfgID</th>
<th>Hart_DevType</th>
<th>Hart_DevID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable Hart protocol on this channel</td>
<td>Number of control vars to read from Hart device Set to zero if not used.</td>
<td>Number of extended status bytes to read from Hart device Set to zero if not used.</td>
<td>Hart Field Device - Manufacture ID Note: For HART7 field devices, this is the upper byte of Expanded Device Type A diagnostic alarm is sent if the field device ID differs from this value and the value is non-zero. This value can be uploaded from the YUAA if the field device is connected. (Right-click on device name and select Update HART IDS)</td>
<td>Hart Field Device - Device Type Note: For HART7 field devices, this is lower byte of Expanded Device Type</td>
<td>Hart Field Device - Device ID</td>
</tr>
<tr>
<td>(Enable)</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
</tr>
<tr>
<td>Disable</td>
<td>0-5</td>
<td>0-26</td>
<td>0-255</td>
<td>0-255</td>
<td>0-116777215</td>
</tr>
</tbody>
</table>
\textbf{Current Outputs}

<table>
<thead>
<tr>
<th>Current Outputs</th>
<th>OutputState</th>
<th>Low_MA</th>
<th>Low_Value</th>
<th>High_MA</th>
<th>High_Value</th>
<th>Output_Value $\dagger$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>State of the output when offline</td>
<td>Output low in mA</td>
<td>Low output value in engineering units</td>
<td>Output high in mA</td>
<td>High output in engineering units</td>
<td>This field is only available if OutputState $=$ OutputValue</td>
</tr>
<tr>
<td>Choices</td>
<td>HoldLastValue</td>
<td>4</td>
<td>0</td>
<td>20</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>(defaults)</td>
<td>OutputValue</td>
<td>(PwrDownMode)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\dagger$ Scroll all the way to the right to find this value because the field does not appear directly right of the High\_Value as expected.

If the I/O pack loses communication with the controller, \textbf{OutputState} determines how it drives the outputs as follows:

- PwrDownMode: drive outputs to zero current
- HoldLastVal: hold the last value received from the controller
- Output\_Value: go to the configured output value set by the \textbf{Output\_Value} (units are Engineering Units, not mA)

Low\_MA, Low\_Value, High\_MA, High\_Value settings are used by the I/O pack firmware to define the linear relationship between customer-defined engineering units and output mA. The I/O Point value will be in Engineering units, and the firmware will convert it to mA. Engineering units are specific to the field device being used.
## Current Outputs (continued)

<table>
<thead>
<tr>
<th>Hart_Enable</th>
<th>Hart_CtrVars</th>
<th>Hart_ExStatus</th>
<th>Hart_MfgID</th>
<th>Hart_DevType</th>
<th>Hart_DevID</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Disable)</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
</tr>
<tr>
<td>Enable</td>
<td>0-5</td>
<td>0-26</td>
<td>0-255</td>
<td>0-255</td>
<td>0-116777215</td>
</tr>
</tbody>
</table>

- Enable Hart protocol on this channel
- Number of control vars to read from Hart device
- Number of extended status bytes to read from Hart device
- Set to zero if not used.
- Hart Field Device - Manufacture ID
- Note: For HART7 field devices, this is the upper byte of Expanded Device Type
- A diagnostic alarm is sent if the field device ID differs from this value and the value is non-zero. This value can be uploaded from the YUAA if the field device is connected.
- (Right-click on device name and select Update HART IDS)

**Attention**

‡ The first time any channel 1–8 is enabled, the I/O pack will require a reboot. The first time any channel 9–16 is enabled, the I/O pack will require a reboot.

The first time all channel 1–8 are disabled, the I/O pack will require a reboot. The first time all channel 9–16 are disabled, the I/O pack will require a reboot.
7.12.3 Voltage Inputs

<table>
<thead>
<tr>
<th>Description</th>
<th>InputType</th>
<th>Low_Input</th>
<th>Low_Value</th>
<th>High_Input</th>
<th>High_Value</th>
<th>InputFilter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Analog Input</td>
<td>Input Volts at Low Value</td>
<td>Low Input in Engineering Units</td>
<td>Input Volts at High Value</td>
<td>High Input in Engineering Units</td>
<td>Filter Bandwidth in Hz</td>
<td></td>
</tr>
<tr>
<td>Choices (defaults)</td>
<td>+/-10volt</td>
<td>(-5)</td>
<td>(0)</td>
<td>(5)</td>
<td>{100}</td>
<td>0.75, 1.5, 3, 6, 12, {Unused}</td>
</tr>
</tbody>
</table>

Low_Input, Low_Value, High_Input, High_Value settings are used by the I/O pack firmware to define the linear relationship between Volts and customer-defined engineering units. The I/O Point value will be in Engineering units. Engineering units are specific to the field device being used.

7.12.4 RTDs

<table>
<thead>
<tr>
<th>RTDType</th>
<th>Compatible Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINCO_NA</td>
<td>N 120</td>
<td>RTDType selects the type of RTD device connected to the input. The Ohms type returns a value of resistance, with the TempUnits parameter ignored.</td>
</tr>
<tr>
<td>MINCO_PA</td>
<td>PT100 PURE</td>
<td></td>
</tr>
<tr>
<td>MINCO_PB</td>
<td>PT100 USIND</td>
<td>The temperature units parameter, TempUnits, can be either Fahrenheit or Celsius, and is set from the Parameters tab.</td>
</tr>
<tr>
<td>(MINCO_PD)</td>
<td>PT100 DIN</td>
<td></td>
</tr>
<tr>
<td>MINCO_PIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MINCO_PK</td>
<td>PT 200</td>
<td></td>
</tr>
<tr>
<td>MINCO_PN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MINCO_CA</td>
<td>CU10</td>
<td></td>
</tr>
<tr>
<td>Ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT100_SAMA</td>
<td>SAMA 100</td>
<td></td>
</tr>
</tbody>
</table>

7.12.5 Thermocouples

<table>
<thead>
<tr>
<th>ThermCplType</th>
<th>ReportOpenTC</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>{Fail_Cold}</td>
<td>ThermCplType selects the type of TC device connected to the input. The mV type shall only return a value of millivolts, the Units parameter shall be ignored for this type, and no cold junction compensation shall be performed.</td>
</tr>
<tr>
<td>E</td>
<td>Fail_Hot</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>(mV)</td>
<td>ReportOpenTC is a Fail_Hot/Fail_Cold configuration to control the reported TC value when an open circuit occurs. On open circuit detection the I/O pack will report the calculated value at -40 mV (Open TC Threshold) when Fail_Cold in enabled, and will report 3632 °F (2000 °C) when Fail_Hot is enabled.</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>The temperature units parameter, TempUnits, can be either Fahrenheit or Celsius, and is set from the Parameters tab.</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Digital Inputs

<table>
<thead>
<tr>
<th>Digital Inputs</th>
<th>SignalInvert</th>
<th>SeqOfEvents</th>
<th>LineMonitoring</th>
<th>InputMode</th>
<th>SignalFilter</th>
<th>ExtWettingVoltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Inversion makes signal true if contact is open</td>
<td>Record contact transitions in sequence of events</td>
<td>Open/shorted input detection</td>
<td>Internal/ExternalWetting, NAMUR Sensor</td>
<td>Contact input filter in milliseconds</td>
<td>External wetting voltage</td>
</tr>
<tr>
<td></td>
<td>Does not apply when InputMode is set to NAMUR, as line monitoring is inherent in NAMUR operation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Only applicable if InputMode is set to External Wetting</td>
</tr>
<tr>
<td>Choices</td>
<td>(normal)</td>
<td>(Disable)</td>
<td>(Disable)</td>
<td>(Internal)</td>
<td>(Unfiltered)</td>
<td>(24.0)</td>
</tr>
<tr>
<td>(defaults)</td>
<td>Invert</td>
<td>Enable</td>
<td>Enable</td>
<td>External</td>
<td>10 ms</td>
<td>20 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NAMUR</td>
<td>50 ms</td>
<td>100 ms</td>
</tr>
</tbody>
</table>
7.12.7 Pulse Accumulators

<table>
<thead>
<tr>
<th>Pulse Accumulators</th>
<th>PATThreshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Pulse threshold voltage</td>
</tr>
<tr>
<td>Choices</td>
<td>(3.0)</td>
</tr>
</tbody>
</table>

This example configuration with connected variable is used in the following two example applications. It is recommended that the user set a threshold midway between the expected low and high input levels.
7.12.8 Pulse Accumulator Buffer Example

This user block example connects to YUAA pulse accumulator inputs to provide a Total Counts output that is a 32-bit integer. It handles 16-bit rollovers and implements a user reset of total counts to zero. The 16-bit accumulator resets to zero when the I/O pack reboots or the channel’s mode is changed. The counter increments when the input voltage transitions above the **PATThreshold** setting. The next pulse after accumulator is at 65535 will result in the accumulator rolling over to zero and continuing to count from there on following pulses.
7.12.9 **Frequency Calculation Example**

This user block example connects to YUAA pulse accumulator inputs to provide a frequency output. Rollover is handled. Three configuration values are offered.

![Diagram showing the configuration values](image)

<table>
<thead>
<tr>
<th>Name</th>
<th>Connection or Value</th>
<th>Controller Version</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MinCounts</td>
<td>2 (Initial Value)</td>
<td>(Offline)</td>
<td>REAL</td>
<td>Minimum number of counts between calcs allows for low freq</td>
</tr>
<tr>
<td>MinTime</td>
<td>3000 (Initial Value)</td>
<td>(Offline)</td>
<td>UDINT</td>
<td>Minimum time between calcs allows for better high freq calc (ms)</td>
</tr>
<tr>
<td>CurrCnt</td>
<td>0 (Initial Value)</td>
<td>(Offline)</td>
<td>REAL</td>
<td>Tie this pin to pulse accumulator input</td>
</tr>
<tr>
<td>Frequency</td>
<td>(Offline)</td>
<td></td>
<td>REAL</td>
<td>Calculated frequency (Hz)</td>
</tr>
<tr>
<td>ZeroOutTime</td>
<td>20000 (Initial Value)</td>
<td>(Offline)</td>
<td>UDINT</td>
<td>After this long without change in counts, zero out freq (ms)</td>
</tr>
</tbody>
</table>
### 7.12.10 Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3DIAG_YUAA_R</td>
<td>Input</td>
<td>BOOL</td>
<td>I/O Diagnostic Indication</td>
</tr>
<tr>
<td>LINK_OK_YUAA_R</td>
<td>Input</td>
<td>BOOL</td>
<td>I/O Link Okay Indication</td>
</tr>
<tr>
<td>ATTN_YUAA_R</td>
<td>Input</td>
<td>BOOL</td>
<td>I/O Attention Indication</td>
</tr>
<tr>
<td>OutxxMA</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Current Output Feedback in mA, where xx = the channel number</td>
</tr>
<tr>
<td>PS18V_YUAA_R</td>
<td>Input</td>
<td>BOOL</td>
<td>I/O 18V Power Supply Indication</td>
</tr>
<tr>
<td>PS28V_YUAA_R</td>
<td>Input</td>
<td>BOOL</td>
<td>I/O 28V Power Supply Indication</td>
</tr>
<tr>
<td>IOPackTmpmr_R</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>IO Pack Temperature (deg F)</td>
</tr>
<tr>
<td>CJBackup</td>
<td>AnalogOutput</td>
<td>REAL</td>
<td>Backup Cold Junction Temperature (Deg F/C based on Cold Junction config)</td>
</tr>
<tr>
<td>CJRemote</td>
<td>AnalogOutput</td>
<td>REAL</td>
<td>Remote Cold Junction Temperature, Used when ColdJuncType is set to Remote (Deg F/C based on Cold Junction config)</td>
</tr>
<tr>
<td>ColdJunc01</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Cold Junction sensor #1</td>
</tr>
<tr>
<td>ColdJunc02</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Cold Junction sensor #2</td>
</tr>
<tr>
<td>AckHartCfgChange</td>
<td>Output</td>
<td>BOOL</td>
<td>Toggle to True to reset Hart configuration change alarms on rising edge</td>
</tr>
<tr>
<td>HartMux_Health</td>
<td>Input</td>
<td>BOOL</td>
<td>Hart Mux Health</td>
</tr>
</tbody>
</table>

### 7.12.11 HART Signal Definitions

<table>
<thead>
<tr>
<th>Signal</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hxx_CommCnt</td>
<td>Integer</td>
<td>Number of times the CommStat signal was not zero after a HART message</td>
</tr>
<tr>
<td>Hxx_CommStat</td>
<td>Bit encoded integer</td>
<td>Most Recent Slave-Reported Communication Status Error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 1 – RX buffer overflow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 3 – Checksum error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 4 – Framing error Bit 5 – Overrun error Bit 6 – Parity error</td>
</tr>
<tr>
<td>Hxx_DevCnt</td>
<td>Integer</td>
<td>Number of times the DevStat signal was not zero after a HART message</td>
</tr>
<tr>
<td>Hxx_DevStat</td>
<td>Bit encoded integer</td>
<td>Most Recent Device Response Codes: bits 0-7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 0 – Primary variable out of limits Bit 1 – Non primary var out of limits Bit 2 – Analog output saturated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 3 – Analog output current fixed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 4 – More status available (ExStat) Bit 5 – Cold start</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 6 – Configuration changed Bit 7 – Field device malfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Command response byte: bits 8-15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Invalid selection requested</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Passed parameter too large</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4: Passed parameter too small</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5: Too few bytes received</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6: Device specific device error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7: In write protect mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8-15: Device specific</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16: Access restricted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32: Device is busy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>64: Command not implemented</td>
</tr>
<tr>
<td>Hxx_DevRev</td>
<td>Integer</td>
<td>Field Device - Device revision code as read from the device.</td>
</tr>
</tbody>
</table>
### Signal Types and Descriptions

<table>
<thead>
<tr>
<th>Signal</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hxx_HwSwRev</td>
<td>Integer</td>
<td>Byte 0 - Field device software revision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Byte 1 - Field device hardware revision</td>
</tr>
<tr>
<td>Hxx_mA†</td>
<td>Float</td>
<td>Field Parm 1 – current reading of the primary signal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Field Device Specific Control Parm 2 - Primary field device value</td>
</tr>
<tr>
<td>Hxx_PV†</td>
<td>Float</td>
<td>Field Device Specific Control Parm 3 - Secondary value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Field Device Specific Control Parm 4 - Third value</td>
</tr>
<tr>
<td>Hxx_SV†</td>
<td>Float</td>
<td>Field Device Specific Control Parm 5 - Fourth value</td>
</tr>
</tbody>
</table>

† To view these variables, the Hart_CtrVars parameter must have a value greater than zero.

### 7.12.12 HART Extended Status

The extended status bits are device-specific, and can be interrogated by using an AMS system. In general, the status bits are grouped as follows:

- Bytes 0-5: Device specific status
- Byte 6: Extended Device Status
- Byte 7: Device Operating Mode
- Byte 8: Standardize Status 0
- Byte 9: Standardize Status 1
- Byte 10: Analog Channel Saturated
- Byte 11: Standardize Status 2
- Byte 12: Standardize Status 3
- Byte 13: Analog Channel Fixed
- Bytes 14-26: Device-specific

Each field device supports a specific number of control parameters and extended status bits. Refer to the Field Device documentation to determine the correct number and configure the ToolboxST application accordingly. A diagnostic alarm message will be generated if the Field Device and ToolboxST configuration do not match.
7.13 YUAA Diagnostics

7.13.1 I/O Point Health Status

Each I/O point on the module has an associated health status. The health of each point is continuously monitored and marked unhealthy for the following conditions (and a per-point diagnostic alarm is generated):

- For mA inputs
  - if the user-defined Min/Max mA limits are exceeded.
  - if the currents through the burden resistor exceed 30 mA
- For voltage inputs, if the hardware input limits are exceeded
- For RTD inputs
  - if the input value exceeds the maximum or is below the minimum temperature range of the selected device
  - if the expected data received is missing or invalid.
  - if hardware limits are exceeded
- For each TC input
  - if the input value exceeds the maximum or is below the minimum temperature range of the selected device
  - if the temperature value is calculated using an extrapolated range beyond the device temperature curve table.
  - if the input voltage exceeds the HW input limits of -40 mV to 114 mV.
  - if the input is open, no sensor connected (burnout detection).
- For mA outputs
  - if commanded current exceeds the hardware limits
  - if current output feedback (from sense resistor) does not match the commanded current
- For Digital Inputs
  - if input voltage exceeds HW max or min limits
  - if an open wire is detected when using line monitoring
  - if a short is detected when using line monitoring
  - if sensor fault is detected when using a NAMUR input
- For Pulse Accumulator Inputs
  - if input voltage exceeds HW input limits of -11 V to 21 V

7.13.2 I/O Status LEDs

The following I/O status LEDs are driven by the I/O pack firmware. For common BPPC processor LEDs, refer to the section Common I/O Module Functionality.

<table>
<thead>
<tr>
<th>Channel Number</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–16</td>
<td>Green</td>
<td>Assigned/healthy</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>Unhealthy or point initialization in progress</td>
</tr>
<tr>
<td></td>
<td>Not Lit</td>
<td>Channel not used</td>
</tr>
</tbody>
</table>

Note: Refer to the illustration of the I/O pack faceplate in the section Mark VIeS YUAA Universal I/O Pack for the I/O status LEDs.
7.13.3 Other Diagnostic Monitors

- Channel configuration at startup and at online load time is verified and a diagnostic is issued when an error occurs.
- Cold Junction sensors are monitored for healthy range and are marked unhealthy and a diagnostic alarm is issued when they are out of range.
- Factory calibration data is validated and a diagnostic alarm is issued if the data is missing or corrupted (indicating product is not running with applied factory calibration).

7.14 YUAA Replacement

Replacement of the terminal board requires full reconfiguration of the changed component using the ToolboxST application. For this reason, it is generally preferable to replace only the I/O pack unless the terminal board is known to be the point of failure.

7.14.1 Replace YUAA I/O Pack with Another YUAA I/O Pack

YUAA I/O packs are hot-swappable, where a pull and replace may occur with power supplied to the power connector. It is online repairable, with no IONet disturbance due to removal or insertion of the I/O pack. It also supports auto-reconfiguration for I/O pack replacement (not terminal board replacement).

➢➢➢ To replace a YUAA I/O pack

1. Follow all applicable site safety procedures and the Cautions and Warnings published in the chapter Maintenance and Replacement.
2. Verify that the replacement I/O pack is compatible with one being replaced by comparing the model numbers.
3. Remove the power connector from the I/O pack.
4. Unplug the IONet cable(s) from the I/O pack, and mark the positions of the removed cables (if using dual IONets).
5. Remove the two mounting screws that hold the I/O pack onto the terminal board.
6. Unplug the I/O pack.
7. Plug in the replacement I/O pack. Make sure the I/O pack connector is fully seated on all sides, then properly tighten the mounting screws to 2.15 nm (19 in lb) torque to firmly hold the new I/O pack onto the terminal board.
8. Plug the Ethernet and power cables back into the I/O pack.
7.14.2 Replace SUAA Terminal Board

➢ To replace the SUAA terminal board

1. Follow all applicable site safety procedures and the Cautions and Warnings published in the chapter Maintenance and Replacement.

2. Perform LOTO procedures and isolate the power sources.

3. Check the voltage on each terminal to ensure that there is no voltage present.

4. Gently pry the segment of the terminal block containing the field wiring away from the part attached to the terminal board, leaving the wiring in place. If necessary, tie the block to the side out of the way.

5. If panel mounted, remove the mounting screws and terminal board.

6. If DIN-rail mounted, refer to the section Mounting for DIN-rail installation and removal instructions.

7. Remove the I/O pack from the old terminal board (if the I/O pack is in good working order).

8. Gently pry the segment of the new terminal block that would contain the field wiring away from the part attached to the new terminal board. Then, slide the segment containing the field wiring from the old board into the new terminal block. Ensure that the numbers on the segment with the field wires match the numbers on the terminal block. Press together firmly. Ensure that all field wiring is secure.

9. Install the new SUAA onto the mounting base or DIN-rail.

10. Install the I/O pack onto the terminal board (if not present).

7.14.3 Replace Existing Mark VleS I/O Module with YUAA I/O Module

Depending on application requirements and field devices used, some existing Mark VleS I/O modules can be replaced with the YUAA. Refer to the appropriate retrofit table in the section Wiring and Configuration for details on supported applications, and then the instructions for field wiring and configuration provided in this manual. Contact your nearest GE Sales or Service office, or an authorized GE Sales Representative for more information.
7.15 YUAA Diagnostic Alarms

The following diagnostic alarms are specific to the YUAA universal analog functions. Common Mark VIeS I/O module processor diagnostics are listed separately.

32-63

Description  Failed loading configuration for point [ ]

Possible Cause

• Attempted to change an already configured point to a different point type without making the point unused first.
• Hardware communication failure

Solution

• Set the PointType for the specified point to Unused and download before changing to desired PointType.
• Re-download configuration

64-95

Description  Point [ ] unhealthy

Possible Cause  Use the following table to identify the possible cause for this unhealthy point, based on the configured Mode of the channel and field device.

Solution  Use the following table to identify a solution for this unhealthy point, based on the configured Mode of the channel and field device.

### Point Unhealthy Troubleshooting

<table>
<thead>
<tr>
<th>Mode</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>CurrentInput</td>
<td>The excitation to transducer is wrong or missing.</td>
<td>Check the field wiring and connections to indicated analog input channel. Check the field device for failure. Check the YUAA power from terminal board screw.</td>
</tr>
<tr>
<td>CurrentInput</td>
<td>The transducer is defective.</td>
<td>Replace the transducer.</td>
</tr>
<tr>
<td>CurrentInput</td>
<td>There is an open or short-circuit on input.</td>
<td>Check the field wiring and connections to indicated analog input channel.</td>
</tr>
<tr>
<td>CurrentInput</td>
<td>The analog current input is beyond the specified range 4-20 mA</td>
<td>Check the field wiring and connections to indicated analog input channel. Check the field device for failure. If incorrectly configured, from the ToolboxST Component Editor, modify the specified range.</td>
</tr>
<tr>
<td>Current Input</td>
<td>The burden resistor protection has been activated, greater than 30 mA has been detected</td>
<td>Check the field wiring and connections to indicated analog input channel.</td>
</tr>
<tr>
<td>Current Input</td>
<td>Hardware failure in the I/O Module or Terminal Board.</td>
<td>Replace the I/O Module.</td>
</tr>
<tr>
<td>VoltageInput</td>
<td>The excitation to transducer is wrong or missing.</td>
<td>Check the field wiring and connections to indicated analog input channel. Check the field device for failure. Check the YUAA power from terminal board screw is correct.</td>
</tr>
<tr>
<td>VoltageInput</td>
<td>The transducer is defective.</td>
<td>Replace the transducer.</td>
</tr>
<tr>
<td>VoltageInput</td>
<td>There is an open or short-circuit on input.</td>
<td>Check the field wiring and connections to indicated analog input channel.</td>
</tr>
<tr>
<td>VoltageInput</td>
<td>The analog voltage input is beyond the specified range.</td>
<td>Check the field wiring and connections to indicated analog input channel. Check the field device for failure. If incorrectly configured, from the ToolboxST Component Editor, modify the specified range.</td>
</tr>
</tbody>
</table>
### Point Unhealthy Troubleshooting (continued)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>CurrentOutput</td>
<td>The commanded output is beyond the range of the output.</td>
<td>Verify that the commanded output is within the range of the output.</td>
</tr>
<tr>
<td>CurrentOutput</td>
<td>There is a field wiring problem</td>
<td>Check the field wiring and device.</td>
</tr>
<tr>
<td>CurrentOutput</td>
<td>There is an open loop or too much resistance in the loop.</td>
<td>Confirm the correct I/O pack 28 V input power. Check the field wiring and device.</td>
</tr>
<tr>
<td>CurrentOutput</td>
<td>The I/O pack has failed.</td>
<td>Replace the I/O pack.</td>
</tr>
<tr>
<td>CurrentOutput</td>
<td>The terminal board has failed.</td>
<td>Replace the terminal board.</td>
</tr>
<tr>
<td>RTD</td>
<td>RTD wiring/cabling open or high impedance.</td>
<td>Check the field wiring and connections to indicated RTD input channel.</td>
</tr>
<tr>
<td>RTD</td>
<td>Open on connections to the terminal board.</td>
<td>Check the field wiring and field device.</td>
</tr>
<tr>
<td>RTD</td>
<td>RTD device failed.</td>
<td>Replace the RTD device.</td>
</tr>
<tr>
<td>RTD</td>
<td>YUAA module internal hardware problem.</td>
<td>Replace the I/O pack.</td>
</tr>
<tr>
<td>RTD</td>
<td>Current source on YUAA for RTD faulty or measurement device failed.</td>
<td>Replace the I/O pack. Replace the field device.</td>
</tr>
<tr>
<td>RTD</td>
<td>Wrong type of RTD configured or selected by default.</td>
<td>From the ToolboxST application, modify the YUAA I/O pack to correct the configuration.</td>
</tr>
<tr>
<td>RTD</td>
<td>High-resistance values created by high voltage and/or low current.</td>
<td>Check the field wiring and field device.</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>Thermocouple millivolt input exceeds the limits of the YUAA hardware.</td>
<td>Check field wiring, including shields. Measure incoming mV signal and verify that it is within the specified thermocouple range. Check installation of the I/O pack on the terminal board. This problem is usually not an I/O pack or terminal board failure if other thermocouples are working correctly. Verify that the installed type of thermocouple device matches the configuration found in the ToolboxST application. Replace the field device.</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>Cold junction input to the analog-to-digital converter exceeded the limits of the converter. If a cold junctions fails, the CJ_Backup value is used.</td>
<td>Check installation of the I/O pack on the terminal board. If local CJ, replace the terminal board.</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>Thermocouple mV input exceeded range of linearization (lookup) table for this TC type. Refer to documentation for specified thermocouple ranges.</td>
<td>Check field wiring, including shields. Measure incoming mV signal and verify that it is within the specified thermocouple range. Check installation of the I/O pack on the terminal board. Note: The problem is usually not an I/O pack or terminal board failure if other thermocouples are working correctly. Verify that the installed type of thermocouple device matches the configuration found in the ToolboxST application. Replace the field device.</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>Thermocouple configured as wrong type.</td>
<td>Verify that the installed type of thermocouple device matches the configuration found in the ToolboxST application.</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>Board detected a thermocouple open.</td>
<td>Check field wiring, including shields. Replace the field device.</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>Stray voltage or noise caused the input to exceed its range.</td>
<td>Check field wiring, including shields. Replace the field device.</td>
</tr>
</tbody>
</table>
### Digital Input

<table>
<thead>
<tr>
<th>Unhealthy</th>
<th>Troubleshooting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Wetted Input exceeded range of operation</td>
<td>Check field wiring. Measure incoming mA signal and verify that it is 10 mA.</td>
</tr>
<tr>
<td>External Wetted Input exceeded range of operation</td>
<td>Check field wiring. Measure voltage across digital inputs terminal points and verify it is between -1 V and 21 V.</td>
</tr>
<tr>
<td>NAMUR input exceeded range of operation</td>
<td>Check field wiring. Verify mA signal through field device does not exceed 9 mA. Replace the field device.</td>
</tr>
<tr>
<td>Digital Input mode configured as wrong type</td>
<td>Verify field wiring and field device matches the configured Input Mode found in the ToolboxST application.</td>
</tr>
<tr>
<td>Open circuit detected on digital input signal</td>
<td>Check the wiring between the terminal board and the device. Verify that the recommended line monitoring resistors are being used.</td>
</tr>
<tr>
<td>Short detected on digital input signal</td>
<td>Check the wiring between the terminal board and the device. Verify that the recommended line monitoring resistors are being used.</td>
</tr>
</tbody>
</table>

#### Pulse Accumulator

| Description | Pulse input voltage exceeds the limits of the YUAA hardware | Check field wiring. Measure incoming signal and verify that it is within -11 V and 21 V. Replace the field device. |

### 96

**Description**  
Invalid calibration settings

**Possible Cause**

- Calibration file not detected
- Calibration file corrupted
- Calibration constants invalid
- Hardware Failure

**Solution**  
Replace the I/O pack.

### 97-98

**Description**  
Cold Junction temp [ ] exceeds range limit ([ ])

**Possible Cause**  
Cold junction input to the analog-to-digital converter exceeded the limits of the converter. If a cold junctions fails, the **CJ_Backup** value is used.

**Solution**

- Check the mounting of the I/O pack on the terminal board.
- Replace the terminal board.
- Replace the I/O pack.
**Description**  IOPoint [ ] - Current output commanded current feedback error

**Possible Cause**
- The measured current feedback does not match the commanded current.
- There is an open circuit on an output.
- Output impedance is too high (max allowed 800 Ohms).

**Solution**
- Check the field wiring and device.
- Verify that the commanded output is within output range.
- Replace the I/O pack.

**Description**  IOPoint [ ] - Open field wire detected

**Possible Cause**  An open circuit has been detected at the terminal board based on the sensor type.

**Solution**
- Digital Input:
  - Check the wiring between the terminal board and the device.
  - Verify that the recommended line monitoring resistors are being used (refer to the I/O pack user documentation).
- Thermocouple Input: verify the wiring of the thermocouple at the inputs.

**Description**  IOPoint [ ] - Thermocouple input millivolt exceeds hardware limit ([ ] mV)

**Possible Cause**
- Thermocouple millivolt input exceeds the hardware limit
- An open thermocouple was detected.

**Solution**  This is usually not a I/O pack or terminal board failure if other thermocouples are working correctly.
- Check the field wiring, including shields.
- Check the installation of the I/O pack on the terminal board.
- Replace the I/O pack.
195-226

Description  IOPoint [ ] - Thermocouple value beyond range of configured TC type ([ ] deg)

Possible Cause

• Thermocouple mV input exceeded range of linearization (lookup) table for this TC type. Refer to documentation for specified thermocouple ranges.
• Thermocouple configured as wrong type
• Stray voltage or noise caused the input to exceed its range.

Solution

• Check the field wiring, including shields.
• Check the thermocouple for an open circuit.
• Verify that the thermocouple type matches the configuration.
• Measure the incoming mV signal and verify that it is within the specified thermocouple range.

2400-2431

Description  IOPoint [ ] - RTD voltage out of range ([ ] mV)

Possible Cause

• There is a break in the RTD wiring/cabling or high impedance is blocking the signal.
• The sensor impedance is too high.
• The RTD device has failed.

Solution

• Check the field wiring for an open circuit or high impedance.
• Verify that the connections to the terminal board are correct.
• Check the RTD for proper operation and sensor type.
• Replace the I/O pack.

2432-2463

Description  IOPoint [ ] - RTD current out of range ([ ] mA)

Possible Cause

• There is a break in the RTD wiring/cabling open or high impedance is blocking the signal.
• There is a break in the connections to the terminal board.
• The current source on the I/O pack has failed.
• The measurement device has failed.

Solution

• Check the field wiring for an open circuit or high impedance.
• Verify that the connections to the terminal board are correct.
• Replace the I/O pack.
**2464-2495**

**Description**  IOPoint [ ] - RTD resistance beyond range of configured RTD type ([ ] Ohms)

**Possible Cause**
- RTD input exceeded range of linearization (lookup) table for this RTD type. Refer to documentation for specified RTD ranges.
- The wrong type of RTD has been configured or selected by default.
- High-resistance values were created by high voltage and/or low current.

**Solution**
- Check the field wiring and sensor.
- Verify that the RTD-type configuration matches the attached device type.
- Check the field wiring for high impedance.

**2496-2527**

**Description**  IOPoint [ ] - HART not initialized

**Possible Cause**  Unable to communicate with connected HART sensor

**Solution**
- Verify that the field device is attached to the correct I/O point.
- Using a HART handheld communicator, confirm that the field device is operating correctly and communicating.

**2528-2559**

**Description**  IOPoint [ ] - HART address mismatch

**Possible Cause**  One of configuration parameters (Hart_MfgID, Hart_DevTyp, or Hart_DevID) does not match the field device.

**Solution**  From the ToolboxST Component Editor, YUAA, Hardware tab, right-click the device and select **Upload the HART ID**.

**2560-2591**

**Description**  IOPoint [ ] - HART field device modified

**Possible Cause**  The configuration of the HART field device was externally modified with either an AMS or a HART handheld communicator.

**Solution**  Determine what modification was made and if it is correct, then clear the diagnostic. From the **Variables** tab, toggle the **AckHartCfgChange** to TRUE and then back to FALSE.

**2592-2623**

**Description**  IOPoint [ ] - HART control parameter mismatch - configured: [ ] received: [ ]

**Possible Cause**  The number of dynamic variables returned in Hart Message 3 (Read dynamic variables) does not agree with the ToolboxST configuration.

**Solution**  Verify that the correct device is attached, and set the ToolboxST configured value to either 0 or the received value.
2624-2655

Description  IOPoint [ ] - HART extended status mismatch - configured: [ ] received: [ ]

Possible Cause  The number of extended status bytes returned in Hart Message 48 (Read extended status) does not agree with the ToolboxST configuration.

Solution  Verify that the correct device is attached, and set the ToolboxST configured value to either 0 or the received value.

2656

Description  HART control messages disabled. AMS HART messages only

Possible Cause  The AMS_Mgs_Only parameter is Enabled. No control messages are sent. This parameter overrides the values in the Hart_Ctrl and Hart_ExStatus for each individual channel.

Solution  
- To send AMS messages only, but clear this alarm: Set the AMS_Mgs_Only parameter to Disabled and set each channel's Hart_Ctrl and Hart_ExStatus to zero.
- To allow control messages and AMS messages, set AMS_Mgs_Only to Disabled.

2657

Description  Cold junction temperature [ ] value beyond specified table limits (-40 to 102°C, -40 to 215 °F)

Possible Cause  
- Cold Junction temperature exceeds the lookup table range (-40 to 101.67°C) or (-40 to 215 °F)
- Ambient temperature is too hot/cold

Solution  
- If remote or backup cold junction is being used, then confirm those values are within the lookup table range.
- Check the ambient temperature. If the temperatures are too high or low, power off the I/O pack and restart it after the ambient temperatures are within (-40 to 101.67°C) or (-40 to 215 °F).

2658-2689

Description  IOPoint [ ] - Internal burden resistor protection activated

Possible Cause  
- The I/O pack has detected too much (> 30 mA) current flowing through the internal burden resistor on indicated I/O point and has opened an internal switch to protect the given I/O point. The I/O pack periodically closes the switch and checks again if the current has dropped below the threshold.
- Improper device operation or Improper wiring

Solution  
- Check the field wiring and determine if a connected device is sourcing currents beyond the specified range on the given I/O point.
- After checking and correcting the wiring, wait approximately 15 seconds for the error to correct itself.
2690-2721

**Description**  IOPoint [ ] - Shorted field wire detected

**Possible Cause**  A short circuit has been detected at the terminal board, based on the sensor type.

**Solution**  Digital Input:
- Check the wiring between the terminal board and the device.
- Verify that the recommended line monitoring resistors are being used (refer to the I/O pack user documentation).

2722-2753

**Description**  IOPoint [ ] - NAMUR Sensor Failure detected

**Possible Cause**  Detected NAMUR sensor operation is outside its two normal current levels (between 1.0 mA and 2.2 mA)

**Solution**  Digital Input:
- Check the wiring between the terminal board and the sensor.
- Check the sensor for proper operation.
- Replace the NAMUR device.

2754-2785

**Description**  IOPoint [ ] - Input Saturation detected

**Possible Cause**  An internal component's valid input range was exceeded. This could be due to the following reasons:
- Input signal equal to or exceeds the valid input range for the input type (improper sensor connected, sensor failure)
- Open-circuit field wiring
- Internal hardware failure

**Solution**
- Current Input: check field wiring and verify that the input source is between -11 V and 20 V (or 80 mA).
- Voltage Input:
  - For ± 5 V input, check field wiring and verify that the input source is between -11 V and 20 V.
  - For ± 10 V input, check field wiring and verify that the input source is between -11 V and 22 V.
- RTD Input:
  - For MINCO_CA type, check for open circuits in the field wiring and then verify that the input source is between -78.125 mV and 78.125 mV.
  - For all other RTD types, check field wiring and verify that the input source is between -1.25 V and 1.25 V.
- TC Input: check field wiring and verify that the input source is between -625 mV and 625 mV.
- Digital Input:
  - For externally wetted inputs, check field wiring and verify that the input source is between -11 V and 20 V.
  - For internally wetted inputs, check field wiring and verify input source is between -11 V and 20 V.
- Pulse Accumulator (PA) Input: check field wiring and verify that the input source is between -11 V and 22 V.
2786-2817

**Description**  
IOPoint [ ] - HART field device not write protected in locked mode

**Possible Cause**  
It is expected that field devices be put into locked mode via an AMS or HART handheld communicator when the Mark VleS is in locked mode. This alarm indicates that the device on the specified channel is not in a write-protected or secured mode while the controller is in locked mode.

**Solution**  
Refer to the field device manual to determine how to place the device in the write-protected mode. All devices used in a safety-protected system must be able to be placed in a read-only mode.

2818

**Description**  
Outputs are disabled

**Possible Cause**  
Input voltage dropped below 18 V. I/O pack or module input power is required to be within range 28 V ±5%.

**Solution**  
Check the I/O pack or module power within the control cabinet.

2819-2820

**Description**  
Cold Junction Sensor [ ] failure

**Possible Cause**  
The Cold Junction temperature sensor on the terminal board failed to deliver an updated reading, most likely due to hardware failure.

**Solution**

- Verify that the I/O module is properly seated on the terminal board.
- Replace the I/O module.
- Replace the terminal board.

2821

**Description**  
Cold Junction difference detected

**Possible Cause**  
The difference between the two local Cold Junction sensors on the terminal board exceeds 5°C (41 °F), indicating a failed sensor. If ColdJuncType is set to Local, then the BackupCj will be used instead.

**Solution**

- Check for abnormal ambient air heat sources close to the module.
- Replace the terminal board.

2822

**Description**  
Internal hardware issue detected (code[ ])

**Possible Cause**  
An internal hardware issue has occurred, most likely due to an internal hardware failure. Possible causes include:

- Internal power supply failure
- Internal data corruption (either due to a single-event upset or internal failure)

**Solution**

- Cycle power on the I/O module.
- Replace the I/O module.
The SUAA terminal board is a simplex universal analog I/O board that provides 48 terminals, grouped in threes to provide 16 channels or IO points. There are four additional screws (49, 50, 51, and 52) that provide a grounding option for special-case I/O pack-powered 4-wire field device applications. A single YUAA I/O pack mounts to the terminal board, using two screws. SUAA provides local cold junction sensing at the terminal block (two local cold junctions). The pack-supplied power from the terminals to the field devices is a current-limited 24 V supply.

The terminal blocks are removable on a per channel basis because of how the points are grouped together as PWR_RTN, IO+, and IO- respectively. For example, screws 1, 3, 5 provide channel 1, with screw 1 = PWR_RTN, screw 2 = IO+, and screw 3 = IO-.

Although this screw and channel assignment continues for the remaining screws and channels, there are certain modes where power is supplied from the IO+ screw, or where power is supplied at the device itself (in either case the first screw in the series is not used).

### SUAA Terminal Board Screw Definitions

<table>
<thead>
<tr>
<th>Screw</th>
<th>Name</th>
<th>Channel</th>
<th>Screw</th>
<th>Name</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>PWR_RTN 2</td>
<td>2</td>
<td>1</td>
<td>PWR_RTN 1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>IO+</td>
<td>2</td>
<td>3</td>
<td>IO+</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>IO-</td>
<td>2</td>
<td>5</td>
<td>IO-</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>PWR_RTN 4</td>
<td>4</td>
<td>7</td>
<td>PWR_RTN 3</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>IO+</td>
<td>4</td>
<td>9</td>
<td>IO+</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>IO-</td>
<td>4</td>
<td>11</td>
<td>IO-</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>PWR_RTN 6</td>
<td>6</td>
<td>13</td>
<td>PWR_RTN 5</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>IO+</td>
<td>6</td>
<td>15</td>
<td>IO+</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>IO-</td>
<td>6</td>
<td>17</td>
<td>IO-</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>PWR_RTN 8</td>
<td>8</td>
<td>19</td>
<td>PWR_RTN 7</td>
<td>7</td>
</tr>
<tr>
<td>22</td>
<td>IO+</td>
<td>8</td>
<td>21</td>
<td>IO+</td>
<td>7</td>
</tr>
<tr>
<td>24</td>
<td>IO-</td>
<td>8</td>
<td>23</td>
<td>IO-</td>
<td>7</td>
</tr>
<tr>
<td>26</td>
<td>PWR_RTN 10</td>
<td>10</td>
<td>25</td>
<td>PWR_RTN 9</td>
<td>9</td>
</tr>
<tr>
<td>28</td>
<td>IO+</td>
<td>10</td>
<td>27</td>
<td>IO+</td>
<td>9</td>
</tr>
<tr>
<td>30</td>
<td>IO-</td>
<td>10</td>
<td>29</td>
<td>IO-</td>
<td>9</td>
</tr>
<tr>
<td>32</td>
<td>PWR_RTN 12</td>
<td>12</td>
<td>31</td>
<td>PWR_RTN 11</td>
<td>11</td>
</tr>
<tr>
<td>34</td>
<td>IO+</td>
<td>12</td>
<td>33</td>
<td>IO+</td>
<td>11</td>
</tr>
<tr>
<td>36</td>
<td>IO-</td>
<td>12</td>
<td>35</td>
<td>IO-</td>
<td>11</td>
</tr>
<tr>
<td>38</td>
<td>PWR_RTN 14</td>
<td>14</td>
<td>37</td>
<td>PWR_RTN 13</td>
<td>13</td>
</tr>
<tr>
<td>40</td>
<td>IO+</td>
<td>14</td>
<td>39</td>
<td>IO+</td>
<td>13</td>
</tr>
<tr>
<td>42</td>
<td>IO-</td>
<td>14</td>
<td>41</td>
<td>IO-</td>
<td>13</td>
</tr>
<tr>
<td>44</td>
<td>PWR_RTN 16</td>
<td>16</td>
<td>43</td>
<td>PWR_RTN 15</td>
<td>15</td>
</tr>
<tr>
<td>46</td>
<td>IO+</td>
<td>16</td>
<td>45</td>
<td>IO+</td>
<td>15</td>
</tr>
<tr>
<td>48</td>
<td>IO-</td>
<td>16</td>
<td>47</td>
<td>IO-</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>COM</td>
<td>49</td>
<td>49</td>
<td>COM</td>
<td>51</td>
</tr>
<tr>
<td>52</td>
<td>COM</td>
<td>51</td>
<td>51</td>
<td>COM</td>
<td>51</td>
</tr>
</tbody>
</table>
8 YVIB Vibration Monitor Modules

8.1 Mechanical Vibration Standards

ISO 7919-4:2009 provides the standard for evaluation of machine vibration by measurements on the rotating shafts. The broad-band vibration is measured radially or transverse to the shaft axis of the Heavy Duty Gas Turbines (HDGTs) with fluid-film bearings. The frequency range is from one hertz to three times the maximum normal operating frequency. Eddy-current transducers are located orthogonal to each other, pointed radially at the shaft. Traditionally, either narrow-band or spectral analysis is used to monitor the mechanical vibration. The typical peak-to-peak, relative-vibration displacement values for a newly commissioned 3600 rpm machine is 3.15 mils.

ISO 10816-4:2009 defines a standard for the evaluation of machine vibration by measurements on the non-rotating parts. The broad-band vibration is measured radially or transverse to the shaft axis on all main bearing housings or pedestals and in the axial direction on thrust bearings. The measurement system must be capable of measuring broad-band vibration over a frequency range from 10 hertz to at least 500 hertz or six times the maximum normal operating frequency, whichever is greater. The common measurement parameter for assessing machine vibration severity is the broad-band root mean square (r.m.s.) velocity measurement. The vibration consists mainly of one frequency component, which is the rotating frequency. Typical values for bearing housing or pedestal vibration velocity for a newly commissioned gas turbines is 0.177 inches / sec.

### Index for Application Diagrams

<table>
<thead>
<tr>
<th>Sensor Tag</th>
<th>Measure</th>
<th>Sensor Type</th>
<th>Prox. Type</th>
<th>Function</th>
<th>Sensor Filter Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Seismic vibration</td>
<td>Metrix 5486C-008</td>
<td>N/A</td>
<td>Monitoring &amp; Protection</td>
<td>10 – 1000 Hz</td>
</tr>
<tr>
<td>V</td>
<td>X-Y radial vibration</td>
<td>Bently Nevada 330101</td>
<td>(3300 XL 8mm probe) 330100</td>
<td>Monitoring &amp; Protection</td>
<td>5 – 1200 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3300 Proximity transducer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Dual axial displacement</td>
<td>Bently Nevada 330101</td>
<td>(3300 XL 8mm probe) 330100</td>
<td>Monitoring &amp; Protection</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3300 Proximity transducer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Accelerometer</td>
<td>Bently Nevada 330400-01-05</td>
<td>N/A</td>
<td>Monitoring</td>
<td>10 – 20000 Hz</td>
</tr>
<tr>
<td>Kf</td>
<td>KeyPhasor</td>
<td>Bently Nevada 330101</td>
<td>(3300 XL 8mm probe) 330100</td>
<td>Monitoring</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3300 Proximity transducer)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The YVIB vibration monitoring module contains a local processor and data acquisition board, which are housed in an I/O pack. Either one or three I/O packs can be mounted on the TVBA terminal board, to provide either Simplex or TMR module redundancy. The TVBA provides two 24-point, barrier-type terminal blocks that accept two 3.0 mm² (#12AWG) wires with 300 V insulation and spade or ring type lugs.

Captive clamps are provided for terminating bare wires. Signal flow between the terminal blocks and the I/O packs is conditioned with passive suppression circuits and electromagnetic interference protection. In addition, a pull-up bias is applied to signals for open circuit fault detection.

The YVIB can monitor 13 sensors, and has the flexibility to mix sensor types based on specific channel configuration and YVIB processor type. The I/O pack has two RJ-45 Ethernet connectors, one 3-pin power input, and a DC-37 pin connector that connects directly to the TVBA terminal board. Visual diagnostics are provided through indicator LEDs.
8.2.1 YVIB Compatibility

The YVIB I/O pack contains an internal processor board. The following table lists the available versions of the YVIB.

### YVIB Version Compatibility

<table>
<thead>
<tr>
<th>I/O Pack</th>
<th>Processor Board†</th>
<th>Application Board†</th>
<th>Compatible (Supported) Firmware</th>
<th>ControlIST Firmware Versions</th>
<th>Enhanced Signal Mode‡</th>
<th>Channels</th>
<th>Sensor Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>YVIB-S1B</td>
<td>BPPC</td>
<td>BBAA</td>
<td>V05.01 and later</td>
<td>Supported in V06.02 and later</td>
<td>Yes</td>
<td>13</td>
<td>Refer YVIB Supported Sensor Inputs.</td>
</tr>
</tbody>
</table>

† Internal to the I/O pack and are not replaceable.
‡ YVIBS1B supports an additional KeyPhasor* input, a CDM input, and other enhanced processing capabilities.

---

**Attention**

YVIBS1B cannot be mixed on a TMR module.

---

**Attention**

If upgrading to YVIBS1B with an existing YVIBS1A configuration, use the ToolboxST application to correct the GAP12 configuration. Refer to the replacement procedure *To replace a YVIB I/O pack* in the section *YVIB I/O Pack Replacement*.

After upgrading existing YVIBS1A applications to YVIBS1B, the user may need to use the configurable low-pass filter to roll-off responses to match existing peak-to-peak calculations. This is because the YVIBS1B has an increased input signal bandwidth of 4500 Hz.

---

The YVIB I/O pack is compatible with the Vibration (TVBA) terminal board.

### YVIB Terminal Board Compatibility

<table>
<thead>
<tr>
<th>Terminal Board</th>
<th>Description</th>
<th>I/O Pack Redundancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVBAS2B</td>
<td>Safety vibration terminal board with buffered outputs; N28 function integrated into terminal board and YVIB S-position is lined up vertically with R and T positions.</td>
<td>Simplex: Yes, Dual: No, TMR: Yes</td>
</tr>
</tbody>
</table>

**Note** Refer to the section *TVBA Compatibility* for additional information.

---

I/O pack redundancy refers to the number of I/O packs used in a signal path, as follows:

- Simplex uses one I/O pack.
- TMR uses three I/O packs.
The following table displays the available sensor types per channel for YVIBS1B.

### YVIB Supported Sensor Inputs

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Typical Application</th>
<th>YVIB Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerometer</td>
<td>Aero-derivative gas turbines</td>
<td>1 - 8</td>
</tr>
<tr>
<td>Dynamic pressure probe</td>
<td>Land-Marine (LM) and Heavy-duty gas turbines (HDGT)</td>
<td>N/A</td>
</tr>
<tr>
<td>Proximitors* (Vibration)</td>
<td>Radial or axial measurements of turbine-driven generators, compressors, and pumps.</td>
<td>1 - 8</td>
</tr>
<tr>
<td>Proximitors (Position)</td>
<td>Axial measurements</td>
<td>1 - 8</td>
</tr>
<tr>
<td>Pedestal or slot-type Keyphasor</td>
<td>Rotor velocity and phase measurements</td>
<td>13, 12, 13</td>
</tr>
<tr>
<td>Seismics</td>
<td>Structural Vibration (mounted to case)</td>
<td>1 - 8</td>
</tr>
</tbody>
</table>

### 8.2.2 YVIB Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>YVIB Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orderable Part Numbers</td>
<td>Contact your nearest GE sales or service office, or an authorized GE sales representative. Refer to the table YVIB Supported Sensor Inputs.</td>
</tr>
<tr>
<td>Number of Channels</td>
<td>13 sensor inputs are supported. Refer to the table YVIB Supported Sensor Inputs.</td>
</tr>
<tr>
<td>Buffered Outputs</td>
<td>Amplitude accuracy is 0.1 % for signal to Bently Nevada* 3500 system&lt;br&gt;A -11 V dc ±5% bias is added to output when a seismic probe used&lt;br&gt;Sinks a minimum of 3 mA when interfacing a velomitor</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Refer to the tables Accuracy Vibration Inputs and Accuracy Position Inputs.</td>
</tr>
<tr>
<td>Functional Safety</td>
<td>Vibration functions shall be low and high demand SIL 3 capable when deployed with HFT=1. (1oo2 and 2oo3 architectures). Refer to the Mark VleS Control General Market Functional Safety Manual (GEH-6860) for safety instructions.</td>
</tr>
<tr>
<td>Probe Power</td>
<td>-24 V dc from the -28 V dc bus&lt;br&gt;Each probe supply is current limited with 12 mA load per transducer</td>
</tr>
<tr>
<td>Probe Signal Resolution</td>
<td>Minimum of 14-bit resolution for full scale ranges defined</td>
</tr>
<tr>
<td>Open Circuit Detection</td>
<td>Open circuit is defined as a gap voltage that is&lt;br&gt; &gt; 1.0 V for Proximity, Accelerometer, Keyphasor, and CDM BN at terminals&lt;br&gt; &gt; -1.0 V for Velomitor at terminals&lt;br&gt; &lt; -1.0 V for CDM PCB at terminals&lt;br&gt; &lt; -3.0 V for Seismic at terminals</td>
</tr>
<tr>
<td>Common Mode Voltage</td>
<td>Minimum of 5 V dc</td>
</tr>
<tr>
<td>CMRR at 50/60 Hz</td>
<td>-50 dB</td>
</tr>
<tr>
<td>Size</td>
<td>8.26 cm x 4.19 cm x 12.1 cm (3.25 in x 1.65 in x 4.78 in) H x W x D</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface-mount</td>
</tr>
<tr>
<td>Ambient rating for enclosure design</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
</tbody>
</table>

**Note** For further details, refer to the Mark VleS Functional Safety Vibration Input Module Summary Sheet (GEI-100864).
8.2.3 YVIB Installation

➢➢ To install a new YVIB module into an existing control cabinet

1. Securely mount the desired terminal board.

2. Directly plug the YVIB I/O pack into the terminal board connectors.

3. Mechanically secure the I/O packs using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 pin connector between the I/O pack and the terminal board. The adjustment should only be required once in the service life of the product.

*Note* The I/O pack mounts directly to a TVBA terminal board. This TMR-capable terminal board has three DC-37 pin connectors and can also be used in simplex mode if only one YVIB is installed to JR1.

4. Plug in one or two Ethernet cables depending on the system configuration. The I/O pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.

5. Apply power to the I/O pack by plugging in the connector on the side of the I/O pack. It is not necessary to remove power from the cable before plugging it in because the I/O pack has inherent soft-start capability that controls current inrush on power application.

6. Use the ToolboxST* application to configure the I/O pack. The following table provides links to some typical configurations examples based on application (not necessarily any site-specific configuration).

<table>
<thead>
<tr>
<th>Application</th>
<th>Configuration Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Heavy Duty turbine applications, Proximitors are used to monitor the position of a rotating shaft.</td>
<td>Position Application Example</td>
</tr>
<tr>
<td>In Heavy Duty turbine applications, a Keyphasor is used to calculate the position and rotating speed of a rotating shaft.</td>
<td>Keyphasor Application Example</td>
</tr>
<tr>
<td>In Heavy Duty turbine applications, Vibration Displacement algorithms report a filtered air gap value, and peak-to-peak displacement value, and an optional vibration phasor relative to a specified Keyphasor channel.</td>
<td>Vibration Displacement Application Example</td>
</tr>
<tr>
<td>In LM turbine applications, Velocity sensors are mounted on bearing housings or machine casing to provide measurements of vibration.</td>
<td>Velocity Application Example</td>
</tr>
<tr>
<td>In Heavy Duty turbine applications, Combustion Dynamics Monitoring is used.</td>
<td>CDM Application Example</td>
</tr>
</tbody>
</table>

8.2.4 YVIB Operation

The following features are common to the distributed I/O modules:

- *BPPx Processor*
- *Processor LEDs*
- *Power Management*
- *ID Line*
- *I/O Module Common Diagnostic Alarms*
8.2.5 YVIB I/O Pack Replacement

➢ To replace a YVIB I/O pack
1. Follow all site safety procedures.
2. Remove the power plug located in the connector on the side of the failed I/O pack.
3. Unplug the Ethernet cable(s) from the failed I/O pack, and mark the positions of the removed cable(s).
4. Loosen the two mounting nuts on the I/O pack threaded shafts.
5. Unplug the I/O pack.
6. Plug in the replacement I/O pack. Make sure the I/O pack connector is fully seated on all sides, then properly tighten mounting nuts.
7. Plug the Ethernet and power cables back into the I/O pack.

Use the following table to determine the correct replacement procedures for the I/O pack firmware.

<table>
<thead>
<tr>
<th>Module Redundancy</th>
<th>Failed Hardware Form</th>
<th>New Hardware Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplex</td>
<td>YVIBS1A</td>
<td>YVIBS1A</td>
</tr>
<tr>
<td></td>
<td>YVIBS1B</td>
<td>YVIBS1B</td>
</tr>
<tr>
<td>TMR</td>
<td>YVIBS1A</td>
<td>YVIBS1A</td>
</tr>
<tr>
<td></td>
<td>YVIBS1B</td>
<td>YVIBS1B</td>
</tr>
<tr>
<td></td>
<td>(all three must be replaced with S1Bs)</td>
<td></td>
</tr>
</tbody>
</table>

➢➢ To replace a YVIB I/O pack with the same firmware/configuration: use the ToolboxST application to download the existing configuration to the new I/O pack.

Do NOT upgrade the firmware of any YVIBS1A to a version beyond V04.06.03C. Making this mistake is extremely difficult to reverse, and would be best if the site then upgrades to YVIBS1B.
➢➢ To upgrade YVIB hardware forms (S1A to S1B)

Redundant Safety I/O packs mounted on the same terminal board must all be of the same hardware form, and running the same firmware version.

Attention

Do NOT attempt this replacement unless having enough I/O packs with the newer hardware form available, including spares.

It is also recommended to backup the ToolboxST.tcw file prior to upgrading the system.

1. The site’s ControlST software must be minimum V06.01. Verify the version and upgrade the system if needed.
2. Install the YVIBH1B I/O pack firmware from the ControlST V06.02 or later DVD.
3. Run an I/O report to capture the current configuration of the YVIB I/O module.
4. From the Component Editor, modify the hardware form of the YVIB I/O pack.
5. From the ToolboxST Component Editor, perform a YVIB firmware Upgrade.
6. From the Component Editor, make the changes to the YVIB configuration.
7. Refer to the I/O report generated prior to Upgrade and the Gap 9–12 configuration.

### Gap 9–12 Before Upgrade (example)

<table>
<thead>
<tr>
<th>Summary</th>
<th>Parameters</th>
<th>Variables</th>
<th>LM 1-3</th>
<th>Vb1 1-8</th>
<th>Vb2x 1-8</th>
<th>Vb1 8</th>
<th>Gap 1-3</th>
<th>Gap 4-8</th>
<th>Gap 9-12</th>
<th>KPH</th>
<th>ExtraCircuits</th>
<th>Diagnostics</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP9_POS1</td>
<td>PVIB21_GAP09</td>
<td>PosProx</td>
<td>0.2</td>
<td>5</td>
<td>1</td>
<td>Disable</td>
<td>8</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP10_POS2</td>
<td>PVIB21_GAP10</td>
<td>PosProx</td>
<td>2.0</td>
<td>6</td>
<td>2</td>
<td>Enable</td>
<td>9</td>
<td>4x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP11_POS3</td>
<td>PVIB21_GAP11</td>
<td>PosProx</td>
<td>0.2</td>
<td>7</td>
<td>3</td>
<td>Disable</td>
<td>10</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP12_POS4</td>
<td>PVIB21_GAP12</td>
<td>PosProx</td>
<td>2.0</td>
<td>8</td>
<td>4</td>
<td>Enable</td>
<td>11</td>
<td>4x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. GAP12_POS4 configuration is reset to defaults after the upgrade and renamed GAP12_KPH2. It will need to be manually reconfigured, and have the variable reattached after the upgrade. The variable has been moved from Gap 9-12 tab to KPH tab. Use the following screens as examples for making this correction.

### Gap 9–11 and KPH tabs After Upgrade Before Correction (example)

<table>
<thead>
<tr>
<th>Summary</th>
<th>Parameters</th>
<th>Variables</th>
<th>LM 1-3</th>
<th>Vb1 1-8</th>
<th>Vb2x 1-8</th>
<th>Vb1 8</th>
<th>Gap 1-3</th>
<th>Gap 4-8</th>
<th>Gap 9-11</th>
<th>KPH</th>
<th>ExtraCircuits</th>
<th>Diagnostics</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP12_KPH2</td>
<td>PVIB21_GAP12</td>
<td>PosProx</td>
<td>2.0</td>
<td>8</td>
<td>20</td>
<td>Slot</td>
<td>2</td>
<td>Disable</td>
<td>8</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP13_KPH1</td>
<td>PVIB21_GAP13</td>
<td>Key Phasor</td>
<td>0.5</td>
<td>6.0</td>
<td>2.0</td>
<td>Pedestal</td>
<td>2.0</td>
<td>Enable</td>
<td>-2</td>
<td>4x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### KPH tab After Upgrade After Correction (example)

<table>
<thead>
<tr>
<th>Summary</th>
<th>Parameters</th>
<th>Variables</th>
<th>LM 1-3</th>
<th>Vb1 1-8</th>
<th>Vb2x 1-8</th>
<th>Vb1 8</th>
<th>Gap 1-3</th>
<th>Gap 4-8</th>
<th>Gap 9-11</th>
<th>KPH</th>
<th>ExtraCircuits</th>
<th>Diagnostics</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP12_KPH2</td>
<td>PVIB21_GAP12</td>
<td>PosProx</td>
<td>2.0</td>
<td>8</td>
<td>20</td>
<td>Slot</td>
<td>4</td>
<td>Enable</td>
<td>11</td>
<td>4x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP13_KPH1</td>
<td>PVIB21_GAP13</td>
<td>Key Phasor</td>
<td>0.5</td>
<td>6.0</td>
<td>2.0</td>
<td>Pedestal</td>
<td>2.0</td>
<td>Enable</td>
<td>-2</td>
<td>4x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Perform and build and download from the ToolboxST Component Editor. Build errors will display if invalid configurations are chosen.
8.3  YVIB Functions

8.3.1  Vibration Monitoring Hardware

Internal to the YVIB I/O pack is application-specific hardware that provides signal conditioning to center and amplify signals for improved analog-to-digital resolution. Each of the 13 differential amplifier inputs has a digital analog converter (DAC) bias adjustment to null the dc content of the signal to better center the signal for the analog-to-digital (A/D) input range. The DAC bias command is stored in the microprocessor to be used in the gap calculation for the Proximitors sensors.

Each input channel has a configurable gain that allows the vibration signal to be amplified. Refer to the configuration section for a detailed listing of available gains based on channel number and I/O pack board revision. Analog processing provides A/D conversion, digital-to-analog (D/A) conversion, and the digital pre-processing of sensor inputs. Sensor inputs are digitally filtered, and then the sampled signals and the filtering information is passed on to microprocessor memory. Channels 1 through 8 and 13 use a multi-pole anti-aliasing filter with a band-pass frequency range of 7 kHz.

There is a tracking filter that is used to determine the vibration content of a turbine caused by a given rotation speed. This same internal application hardware also runs the high-frequency section of the tracking filter and the 1x and 2x functions. The 1x vibration is the peak-to-peak magnitude of the radial movement in sync with the turbine shaft speed. The 1x calculation also provides the phase relationship of the vibration phasor relative to the Keyphasor. The 2x calculation provides the radial vibration component that is at twice the speed of the shaft.

The internal hardware of the YVIBS1A is different than YVIBS1B. The SIB provides an additional Keyphasor input (channel 12) and support for Combustion Dynamic Monitoring (CDM) sensors, as well as the ability to run in an Enhanced mode that offers additional input resolution and other features.
### 8.3.1.1 Accuracy of Vibration Inputs

**Accuracy of Vibration Inputs for YVIBS1B**

<table>
<thead>
<tr>
<th>Vibration Inputs</th>
<th>Measurement</th>
<th>Range (V dc + V ac)</th>
<th>(V ac portion)</th>
<th>Default Hardware Gain</th>
<th>Default Hardware Offset</th>
<th>Accuracy at min &amp; max frequency range</th>
<th><strong>Notes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eddy-Current or Proximity (channels 1 - 8)</td>
<td>Displacement</td>
<td>-20.0 to 0.0 V peak</td>
<td>0 to 3.0 V pp</td>
<td>1x</td>
<td>10</td>
<td>+/-0.020 Vpp at 10 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.023 Vpp at 200 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.056 Vpp at 700 Hz</td>
<td></td>
</tr>
<tr>
<td>Seismic (channels 1 - 8)</td>
<td>Velocity</td>
<td>-2.5 to +2.5 V peak</td>
<td>0 to 1.0 V peak</td>
<td>4x</td>
<td>0</td>
<td>+/-0.010 Vp at 10 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.012 Vp at 200 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.012 Vp at 200 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.034 Vp at 700 Hz</td>
<td></td>
</tr>
<tr>
<td>Velomitor (channels 1 - 8)</td>
<td>Velocity</td>
<td>-17.0 to -7.0 V peak</td>
<td>0 to 5 V peak</td>
<td>2x</td>
<td>12</td>
<td>+/-0.010 Vp at 10 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.020 Vp at 200 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.130 Vp at 700 Hz</td>
<td></td>
</tr>
<tr>
<td>Accelerometer (channels 1 - 3)</td>
<td>Velocity</td>
<td>-12.5 to -7.5 V peak</td>
<td>0 to 2.5 V peak</td>
<td>4x</td>
<td>10</td>
<td>+/-0.010 Vp at 10 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.025 Vp at 350 Hz</td>
<td></td>
</tr>
<tr>
<td>Bently Nevada CDM</td>
<td>Dynamic Pressure</td>
<td>-15.0 to -5.0 V peak</td>
<td>-5.0 to 5.0 V peak</td>
<td>2x</td>
<td>10</td>
<td>+/-0.010 Vp at 10 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.132 Vp at 1000 Hz</td>
<td></td>
</tr>
<tr>
<td>PCB CDM</td>
<td>Dynamic Pressure</td>
<td>5.0 to 15.0 V peak</td>
<td>-5.0 to 5.0 V peak</td>
<td>2x</td>
<td>-10</td>
<td>+/-0.010 Vp at 10 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/-0.132 Vp at 1000 Hz</td>
<td></td>
</tr>
</tbody>
</table>

The accuracies specified are worst case numbers, and assume the Vibration module sample frequency is in sync with the input waveform frequency, preventing the A/D sample point from moving along the waveform and reading the actual peak value. The worst case accuracy is based on missing the maximum peak V ac measurement per the table by half the sample period relative to the input fundamental frequency.

### 8.3.1.2 Accuracy of Position Inputs

**Accuracy of Position Inputs for YVIBS1B**

<table>
<thead>
<tr>
<th>Position Inputs</th>
<th>Measurement</th>
<th>Range</th>
<th>Frequency</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Displacement</td>
<td>-0.5 to -20 V dc</td>
<td>N/A</td>
<td>+/-0.020 Vpp at 10 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keyphasor</td>
<td>Displacement</td>
<td>-0.5 to -20 V dc</td>
<td>N/A</td>
<td>+/-0.020 Vpp at 10 Hz</td>
</tr>
<tr>
<td></td>
<td>Speed</td>
<td>N/A</td>
<td>2 to 20,000 RPM</td>
<td>+/-0.1% of full scale speed</td>
</tr>
<tr>
<td></td>
<td>Phase</td>
<td>N/A</td>
<td>Up to 333 Hz</td>
<td>+/-0.5 degree</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>333 to 667 Hz</td>
<td>+/-1 degree</td>
</tr>
</tbody>
</table>

*Phase is only calculated when RPM is greater than approximately 250 RPM.*

1x vibration component with respect to key slot
8.3.1.3 Tracking Filters

The following table defines differences in the tracking filters with versions of the I/O pack.

<table>
<thead>
<tr>
<th>Item</th>
<th>YVIBS1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center frequency</td>
<td>-3dB bandwidth correctly matches configuration settings to meet application requirements</td>
</tr>
<tr>
<td>Filter roll off</td>
<td>Window attenuation increased to -36 dB / octave to meet application requirements</td>
</tr>
<tr>
<td>1X / 2X channels</td>
<td>Can base phase measurements off of channel 12 or 13</td>
</tr>
</tbody>
</table>

8.3.1.4 Wideband Filters & Velocity Conditioning

The following table defines differences in the Wideband Filters & Velocity Conditioning with versions of the I/O pack.

<table>
<thead>
<tr>
<th>Item</th>
<th>YVIBS1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported Sensors</td>
<td>Velomitors, Seismic &amp; LM Accelerometers with integrated outputs</td>
</tr>
<tr>
<td>Maximum octave attenuation</td>
<td>-60 dB for all filter configurations</td>
</tr>
<tr>
<td>Output of wideband filter</td>
<td>Can either be assigned to an RMS calculation or Peak-to-peak algorithm, using VIB_CalcSel</td>
</tr>
<tr>
<td>Notes</td>
<td>Peak-to-peak algorithm and RMS calculation use a Scan time of data. Update rate is equal Frame Rate. ISO for Vibration calls for RMS calculations</td>
</tr>
</tbody>
</table>

8.3.1.5 CDM Sensors

YVIBS1B adds support for CDM sensors. From the Parameters tab, CDM_scan_period is a selectable scan period for CDM sensor inputs.

<table>
<thead>
<tr>
<th>Item</th>
<th>YVIBS1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported sensors</td>
<td>Inputs 1-8 support the following:</td>
</tr>
<tr>
<td></td>
<td>Bently Nevada CDM Sensor (CDM_BN_ChgAmp)</td>
</tr>
<tr>
<td></td>
<td>PCB CDM Sensor (CDM_PCB_ChgAmp)</td>
</tr>
<tr>
<td>Maximum octave attenuation</td>
<td>-60 dB for all filter configurations</td>
</tr>
<tr>
<td>Output of wideband filter</td>
<td>Can either be assigned to an RMS calculation or Peak-to-peak algorithm, using VIB_CalcSel</td>
</tr>
<tr>
<td>Scan period selection</td>
<td>Peak-to-peak or RMS scan period configured by the CDM_Scan_Period parameter.</td>
</tr>
<tr>
<td>LM 1x tracking filter support</td>
<td>Peak-to-peak output supported for up to 3 frequency selections (Inputs 1-3 only)</td>
</tr>
</tbody>
</table>

8.3.2 Vibration Monitoring Firmware

The following subsections provide details for common firmware features using in vibration monitoring applications. For application-specific firmware use cases and procedures, refer to the section Vibration Monitoring Application Examples.
### 8.3.2.1 Signal Space Inputs for Sensor Types, with Firmware Version 5.01 or Later

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>GAPn_VIBn</th>
<th>GAPn_POSy (y = 1-3)</th>
<th>GAP12_KPH2</th>
<th>GAP13_KPH1</th>
<th>VIBn</th>
<th>VIB_1Xn</th>
<th>VIB_2Xn</th>
<th>VIB2xPHn</th>
<th>LVMibnA</th>
<th>LVMibnB</th>
<th>LVMibnC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PosProx</td>
<td>Inputs 1-8</td>
<td>Inputs 9-11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VibProx</td>
<td>Inputs 1-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VibProx-KPHx</td>
<td>Inputs 1-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VibLMAccel</td>
<td>Inputs 1-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VibSeismic</td>
<td>Inputs 1-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unused (H1A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VibVelomitor</td>
<td>Inputs 1-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unused (H1A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDM_BN_ChgAmp</td>
<td>Unused (H1A)</td>
<td></td>
<td>Unused (H1A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unused (H1A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H1B Only)</td>
<td>Inputs 1-8</td>
<td>(H1B)</td>
<td>Inputs 1-8</td>
<td>(H1B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inputs 1-3 (H1B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDM_PCB_ChgAmp</td>
<td>Unused (H1A)</td>
<td></td>
<td>Unused (H1A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unused (H1A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H1B Only)</td>
<td>Inputs 1-8</td>
<td>(H1B)</td>
<td>Inputs 1-8</td>
<td>(H1B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inputs 1-3 (H1B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KeyPhasor</td>
<td>Inputs 13 (H1A)</td>
<td></td>
<td>Inputs 12-13</td>
<td>(H1B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n = input number

### 8.3.2.2 System Limits

GAP, VIB, and LM 1x Tracking Filters each support System Limits for configurable limit checking. This function returns a Boolean value indicating whether the limit has been exceeded, with optional latching behavior. This function is intended to simplify application logic by moving common functionality into the YVIB configuration.

All system limits are implemented the same way, regardless of which input we are describing. System limits checks are executed at Frame Rate, on the value in signal space after it has been converted to the correct units. Based on the configuration, the system limits check will behave as greater than set point (>=) or less than set point (<=), and the result can be latching or non-latching. System Limit latches are SET dominant, so the results of the checks will be TRUE as long as the signal exceeds the set point.

**Note** Latching system limits are reset using the RSTSYS pin on the SYS_OUTPUTS block.
From the ToolboxST application, Component Editor, I/O pack, Parameters tab, there is a global System Limit disable parameter, SystemLimits. When this parameter is set to Disable, all system limits in the YVIB are set to False, and a diagnostic alarm is generated.

### Configuration of System Limits

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>SysLimit#</td>
<td>Set point for the System Limit check. Value is expressed in EU for that point.</td>
<td>Textfield</td>
</tr>
<tr>
<td>SysLimit#Enable</td>
<td>Enable or Disable this specific System Limit check. Value is an enumerated type.</td>
<td>Enable or Disable</td>
</tr>
<tr>
<td>SysLimit#Latch</td>
<td>Configure whether system limits should latch TRUE. Value is an enumerated type.</td>
<td>Latch or NotLatch</td>
</tr>
<tr>
<td>SysLimit#Type</td>
<td>Configure whether system limits checks are greater than set point or less than set point. Value is an enumerated type.</td>
<td>&lt;= or &gt;=</td>
</tr>
</tbody>
</table>

### 8.3.2.3 Legacy Peak-Peak Algorithm

The default vibration algorithm, which is the only vibration algorithm implemented by the YVIBS1A, is a windowed peak detection function. A window size (scan period) is determined by the current rotor speed on GAP13_KPH1. If there is no keyphasor input, 160 ms scan period is the default. As new input data is processed, it fills the window in. When the window is full, we calculate the peak-peak measurement, scale it, and send it to signal space. The window is then emptied and needs to be completely filled again before a new peak-peak value is computed. For this reason, the effective update rate is the scan period, not frame rate.
8.3.2.4 **Enhanced Peak-Peak Algorithm**

The enhanced peak-peak algorithm (only available with YVIBH1B) performs the same operation as the legacy peak-peak algorithm, but it executes using a sliding window, rather than a fixed window. New input data displaces old data in the windowed peak detection function. Window size (scan period) is determined by rotor speed on GAP13_KPH1. If there is no key-phasor #1 input, 160 ms scan period is the default. CDM sensors always use CDM_Scan_Period as defined in the configuration. As new data is processed, data older than the window size is displaced. At frame rate, the data within the window is used to calculate the peak-peak measurement value, which is scaled and sent to signal space. Since the window is continuously updated, the effective update rate is frame rate.

![Enhanced Peak-Peak Algorithm](image)

8.3.2.5 **Enhanced RMS Algorithm**

The Enhanced RMS algorithm (only available with YVIBH1B) uses the same sliding scan window logic as the Enhanced Peak-Peak algorithm. Data is passed through a 1-pole high-pass filter with a cutoff frequency of 0.1Hz. This removes sensor biasing voltage from the RMS value. The RMS calculation is performed on the windowed data. Window size (scan period) is determined by rotor speed on GAP13_KPH1. CDM sensors always use CDM_Scan_Period as defined in the configuration. As new data is processed, data older than the window size is displaced. At frame rate, the data within the window is used to calculate an RMS value, which is scaled and sent to signal space. Since the window is continuously updated, the effective update rate is frame rate.

8.3.2.6 **Default Sensor Gain and Bias**

Each sensor has a default Gain and DC Sensor bias which is based on firmware requirements. These values are chosen based on sensor data sheets and traditional field usage.

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Default Gain</th>
<th>Default Snsr_Offset</th>
<th>VinMin (Volts)</th>
<th>VinMax (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PosProx</td>
<td>1x</td>
<td>9</td>
<td>-19</td>
<td>1</td>
</tr>
<tr>
<td>VibLMAccel</td>
<td>2x</td>
<td>10</td>
<td>-15</td>
<td>-5</td>
</tr>
<tr>
<td>VibProx</td>
<td>1x</td>
<td>9</td>
<td>-19</td>
<td>1</td>
</tr>
<tr>
<td>VibProx_KPH1</td>
<td>1x</td>
<td>9</td>
<td>-19</td>
<td>1</td>
</tr>
<tr>
<td>VibProx_KPH2</td>
<td>1x</td>
<td>9</td>
<td>-19</td>
<td>1</td>
</tr>
<tr>
<td>VibSeismic</td>
<td>4x</td>
<td>0</td>
<td>-2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>VibVelomitor</td>
<td>2x</td>
<td>12</td>
<td>-17</td>
<td>-7</td>
</tr>
<tr>
<td>Keyphasor</td>
<td>1x</td>
<td>9</td>
<td>-19</td>
<td>1</td>
</tr>
<tr>
<td>CDM_BN_Chg_Amp</td>
<td>2x</td>
<td>10</td>
<td>-15</td>
<td>-5</td>
</tr>
<tr>
<td>CDM_PCB_Chg_Amp</td>
<td>2x</td>
<td>-12</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>GnBiasOvride = TRUE</td>
<td>G</td>
<td>S</td>
<td>((-10V/G) - S)</td>
<td>((10V/G) - S)</td>
</tr>
</tbody>
</table>
8.3.2.7 Sensor Gain and Bias Override

Depending on the specific application of a sensor, a different gain or DC bias may be needed. The YVIB provides a configurable override for the default values for Gain and Sensor Bias through the **GnBiasOvride** parameter. Setting GnBiasOvride = Enable will replace the default Gain and Sensor Offset with the configured Gain and Snsr_Offset parameters.

The sensor inputs relate to the YVIB Snsr_Offset and Input.Range values. Input.Range is a value determined by Gain through the following formula:

\[
\text{Input.Range} = \frac{20V_{pp}}{\text{Gain}}
\]

Input.Range is centered on -Snsr_Offset, which allows us to define the valid input voltage range with the following formulas:

**Maximum Input Voltage Definition**

\[
V_{\text{in max}} = \frac{10V}{\text{Gain}} - \text{Snsr.Offset}
\]

**Minimum Input Voltage Definition**

\[
V_{\text{in min}} = -\frac{10V}{\text{Gain}} - \text{Snsr.Offset}
\]

It is critical that the values of Gain and Snsr.Offset are chosen correctly to avoid saturating the A/D Converter on that input channel, which results in clipping the signal. Consider the following case, where Input Range is correctly determined, but Snsr_Offset is too low.
The bottom of the Input waveform exceeds the VinMin value for this configuration. This will result in this signal being clipped off, since the A/D Converter will saturate and return only VinMin. Second, VinMax greatly exceeds the high peak of this input signal. This won’t result in an error, but it indicates that the measurement window isn’t well adapted to this input. Increasing Snsr_Offset will reposition the measurement window, bringing VinMax closer to the input high peak, as well as lowering VinMin below the input low peak.

Consider this case, where the selected Gain is too high.

The Snsr_Offset is selected appropriately, but the Input_Range is too narrow. As a result, input signal amplitude exceeds Input_Range and we will read clipped values at both the high and low end. Verifying that Input_Range exceeds the sensor input AC amplitude is the most important factor in determining Gain.

In order to use the GnBiasOvride correctly, select a Gain such that Input_Range exceeds the AC amplitude of the input signal (Equation 1), and then select a Snsr_Offset to ensure that the measurement window defined by VinMax and VinMin contains the sensor input completely (Max. and Min. Voltage Definitions).
8.3.2.8 YVIB Firmware Changes

The following is a list of changes made to the YVIBS1B with firmware V05.01 and later.

- VibProx-KPH is renamed to VibProx-KPH1, to reflect that it uses KPH1 as source for 1x/2x tracking filters.
- LM Accelerometers are supported for Inputs 4-8, without computation of LM Tracking Filters.
- LM Tracking Filter refactored as -36 dB/oct Butterworth Filters.
- LM 1x Tracking Filters are recomputed as 6-pole filters with the correct cutoff points.
- ToolboxST Component Editor, Tab ‘Gap 9-12’ is renamed ‘Gap 9-11’ to reflect GAP12_POS4 becoming a possible Keyphasor input.
- New Parameters added to configure CDM Sensors.
- N28 Low power now affects Velomitor and CDM Bently Nevada Charge Amp health.
- Sensor out of range and Open circuit conditions hold input health low for 3 seconds after recovery.
- Default Sensor Gains and Offsets are changed, as an example: Prox biasing is -9 V dc by default, not -10 V dc. This is because the default bias value of 9 has been optimized for signal input range of +1 to -19 volts instead of optimizing for the actual BN sensor 50 ml setting.
- YVIB does not support mixed TMR module operation with YVIBS1B

8.3.2.9 YVIBS1B Firmware Enhancements

The following is a list of functional improvements made to the newer versions of YVIB.

- LM Tracking Filters are computed for Velomitor, Seismic, and CDM sensors for inputs 1-3 in the S1B only.
- Wideband Filters support 10-Pole Filters in the SIB only.
- Input passband increased from 1150 Hz to 4500 Hz with S1B only.

8.3.3 Vibration Monitoring Application Examples

The YVIB module supports a variety of sensor types and applications. Refer to the tables Supported Sensor Inputs and Signal Space Inputs for Sensor Types for the relevant I/O pack for valid sensor inputs and modes.

8.3.3.1 Position

Inputs 1-13 support Proximitor sensors to collect air gap value. In Heavy Duty turbine applications, Proximitors are used to monitor the position of a rotating shaft. Position algorithms report a filtered air gap value.

Input Processing

The signal space values GAPn_VIBn, GAPn_POSy, GAPn_KPH# are the filtered engineering units (EU) values.

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. Gap Values are converted from Volts to EU. For Position applications, Gap values have a Scale Offset parameter Scale_Offset applied after scaling.

In this application example, SysLim1GAPn, SysLim2GAPn provide System Limit status for GAPn_VIBn value as True/False.
Position Configuration

GAPn_VIBn, GAPn_POSy, GAPn_KPH#:
VibType - PosProx is used for Position applications.
Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/mils.

Scale_Off is a scale offset parameter used to remove the nominal Gap value from the measured Gap value. Units are engineering units (EU).

TMR_DiffLimit is a TMR voter disagreement detection diagnostic alarm threshold for GAPn_VIBn, GAPn_POSy, or GAPn_KPH# value. The keyphasor value is expressed as absolute difference in EU. Refer to the Keyphasor section for an explanation of how this value is calculated.

GnBiasOvride, Gain, Snsr_Offset – Refer to Gain/Bias Override.
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.

Position Application Example

Proximitor voltage inputs to a YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 9 as a PosProx input.

Example Proximitor Specifications

<table>
<thead>
<tr>
<th>Scale Factor</th>
<th>200mV/mil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Gap Setting</td>
<td>50 mils</td>
</tr>
</tbody>
</table>

Channel 9 is configured for the following behaviors:

- Return GAP9_POS1 as mils.
- Remove the nominal Gap value from GAP9_POS1.
- Set SysLim1GAP9 to LATCH True if GAP9_POS1 ≥ 5 mils.
- Set SysLim2GAP9 to LATCH True if GAP9_POS1 ≤ -5 mils.
➢ To configure GAP9_POS1

1. From the ToolboxST Component Editor, navigate to the **Gap 9-11** tab.
2. Select GAP9_POS1, and click the **Show Advanced Parameters** icon.

**Note** the Advanced Parameters are used if setting up system limits.

3. Configure it to match the following example.

If the YVIB firmware is receiving valid sensor data, then this is expected:

- Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will not affect either the 5Hz, 2Vpp vibration or the DC component of 9.5 V dc. The DC portion of the wave will be converted to 47.5 mils, and the AC portion of the wave will be converted to ±5.0 mils. We will remove 50.0 mils from the scaled wave, so the GAP9_POS1 value will be -2.5 ± 5.0 mils.

- SysLim1GAP9 is false and SysLim2GAP9 is true. Since SysLim2GAP9 is latching, it will remain true until the GAP9_POS1 signal is ≥ -5.0 and system limits are commanded to reset.
8.3.3.2 **Keyphasor**

Inputs 12-13 support Keyphasor sensors to collect air gap value and shaft rotation speed. In Heavy Duty turbine applications, a Keyphasor is used to calculate the position and rotating speed of a rotating shaft. Keyphasor algorithms report a conditioned air gap value and shaft rotation speed.

---

**Attention**

YVIBS1B does not support 1 Keyphasor on Input 13. YVIBS1B supports 2 Keyphasors on Inputs 12 and 13.

---

**Keyphasor Input Processing**

GAPn_KPH# – The conditioned Position or Gap value in engineering units (EU).

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. At low speeds (100 RPM with 10% hysteresis), the Gap values bypass the filter, instead using a median selection. This allows for visual inspection of the Gap signal to show the Keyphasor edge more clearly at low speeds, removing the time delay and distortion associated with the filter. The output of the gap filter is passed through a rolling average filter prior to scaling. Gap Values are converted from Volts to EU.

![Diagram of GAPn_KPH# Signal Path](image)

**Scale_Off** is the Scale Offset parameter used to remove the nominal Gap value from the measured Gap value. Units are engineering units (EU).

SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_KPH# value as True/False.

RPM_KPH# - The calculated shaft rotation speed in RPM.

Shaft rotation speed is calculated by detecting the time between Keyphasor transitions. Since there is only a single transition per shaft rotation, shaft rotation speed is computed once per rotation, however this requires two rotations of data for the computation. This value requires at least two full rotations before it can be computed.

At rotating speeds above 1000 RPM, RPM_KPH# is computed as the average of the speed over 4 rotations. This impacts the rate at which the RPM_KPH# signal will respond to changes in speed.

**Note**  Only RPM_KPH1 is used by the Wideband Vibration to perform Scan Filtering.
Keyphasor Configuration

GAPn_KPH#:

VibType - KeyPhasor is used for Keyphasor applications.
Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/mils.
Scale_Off – Scale Offset to remove from measured Gap value. Units are engineering units (EU).

KPH_Thrshld – Keyphasor detection threshold for GAPn_KPH#. Value is expressed as absolute difference in Volts.

KPH_Type – Keyphasor type selection. Values are Slot, indicating the shaft has a slot or trough, or Pedestal, indicating the shaft has a key above the shaft surface. Slot detection looks for a sharply increasing distance for the key. Pedestal looks for a sharply decreasing distance for the key.

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_KPH# value. Value is expressed as absolute difference in EU.

GnBiasOvride, Gain, Snsr_Offset – Refer to Gain/Bias Override.

SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.

Keyphasor Application Example

Keyphasor voltage inputs to a YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 13 as a KeyPhasor input. The shaft has a pedestal type key with a height of 15 mils above the shaft surface, so we will detect a lower air gap when the key passes by the sensor.

Example Keyphasor Specifications

<table>
<thead>
<tr>
<th>Scale Factor</th>
<th>200mV/mil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Gap Setting</td>
<td>50 mils</td>
</tr>
</tbody>
</table>

We will configure Channel 13 for the following behaviors:

- Return GAP13_KPH1 as mils.
- Configure the sensor as a Pedestal type Keyphasor with a threshold of 10 mils.
- Set SysLim1GAP13 to LATCH True if GAP13_KPH1 ≥ 55 mils.
- Set SysLim2GAP13 to LATCH True if GAP13_KPH1 ≤ 30 mils.
➢ To configure GAP13_KPH1

1. From the ToolboxST Component Editor, navigate to the KPH tab.
2. Select GAP13_KPH1, and click the Show Advanced Parameters icon.
3. Configure it to match the following example.

![Parameter configuration example](image)

If the YVIB firmware is receiving the data after this configuration, we would expect:

- Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz, since RPM is well above the 100RPM cutoff for median values. This will cut away nearly all of the Pedestal effect on Gap value, though the average Gap value will tend to be slightly lower than the shaft Gap. The normal DC level will be converted to 50.0mils, so the GAP13_KPH1 value will be slightly less than 50.0 mils.
- At low speeds, the Gap filter is bypassed and we can see the transition when the Pedestal clearly by monitoring the value of GAP13_KPH1. For this reason, it is important to take operating speed into account when using GAP13_KPH1 values.
- SysLim1GAP13 and SysLim2GAP13 are false, since (30.0 ≤ 50.0) and (50.0 ≤ 55.0). At low speeds, the Pedestal transitions will be much closer to the SysLim2GAP13 setpoint. For this reason, it is important to consider the operating speed when using System Limits on the Keyphasor channel. The Key will only be filtered out of the GAP13_KPH1 value when we approach running speed.
- RPM_KPH1 value is 3000 RPM. This value will be refreshed with the latest RPM measurement once every rotation, which is every 20 ms for this example.
8.3.3.3 Vibration Displacement

Inputs 1-8 support Proximiter sensors to collect air gap, wideband vibration, and 1x/2x vibration vectors relative to a specified Keyphasor channel. In Heavy Duty turbine applications, Proximiters are used to monitor the position of a rotating shaft. Vibration Displacement algorithms report a filtered air gap value, and peak-to-peak displacement value, and an optional vibration phasor relative to a specified Keyphasor channel.

Vibration Displacement Input Processing

GAPn_VIBn – The filtered Position or Gap value in engineering units (EU).

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. Gap Values are converted from Volts to EU. For Vibration Displacement applications, Gap values are magnitude quantities, so they are always positive.

VIBn – Wideband Vibration Displacement (Peak-Peak) in engineering units (EU).

Wideband vibration information is passed through a variable scan period peak detection function. The length of the peak detection is determined by the Keyphasor 1 detected speed in RPM.

Wideband Vibration Scan Period

<table>
<thead>
<tr>
<th>Shaft speed (RPM)</th>
<th>Scan period (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 60</td>
<td>160</td>
</tr>
<tr>
<td>60-480</td>
<td>2000</td>
</tr>
<tr>
<td>480-2250</td>
<td>250</td>
</tr>
<tr>
<td>&gt;2250</td>
<td>160</td>
</tr>
</tbody>
</table>

Attention

Peak Detection function always uses KPH1 RPM, even when the sensor is configured to use KPH2 for 1x/2x Vibration Phasor calculations.

The output of the peak detection function (V PK-PK) is passed through an adjustable 1-pole, low-pass filter prior to scaling. V PK-PK is converted from Volts to EU. For H1B systems, a lower latency peak detection function can be enabled by changing the OperatingMode parameter to Enhanced. This function will update every frame, instead of every scan period.

Note Sensors monitoring position of rotating elements typically measure Peak-to-Peak. RMS calculations can be used instead if needed.

VIB_1Xn, VIB_2Xn – Vibration Phasor Magnitude (Peak-Peak) for 1st/2nd harmonic of Keyphasor frequency in engineering units (EU).

Vib1xPHn, Vib2xPHn – Phase Angle between Keyphasor and VIB_1Xn/VIB_2Xn vibration phasor in degrees.

1x/2x Vibration Phasor function measures the peak-to-peak displacement component at both the Keyphasor frequency (VIB_1Xn) and twice the frequency (VIB_2Xn). The VIB_Type selection determines which Keyphasor is used as the source for this function. Selecting VibProx will disable this function, selecting VibProx-KPH1 will enable the 1x/2x Tracking Filter operation relative to KPH1 (Channel 13), and selecting VibProx-KPH2 will enable the 1x/2x Tracking Filter relative to KPH2 (Channel 12)
SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_VIBn value as True/False. SysLim1VIBn, SysLim2VIBn – System Limit status for VIBn value as True/False. Refer to System Limits feature for more information.

**Vibration Displacement Configuration**

GAPn_VIBn:
VibType - VibProx, VibProx-KPH1, and VibProx-KPH2 are used for Vibration Displacement.

**Note** VibProx-KPH1 enables the 1x/2x Tracking Filter operation relative to KPH1 (Channel 13) and VibProx-KPH2 enables the 1x/2x Tracking Filter relative to KPH2 (Channel 12)

Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/mils.
TMR_DiffLim – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_VIBn value. Value is expressed as absolute difference in EU.
GnBiasOvride, Gain, Snsr_Offset – See Gain/Bias Override
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.

**Note** Scale_Off, LMLp_cutoff – Unused for this sensor type.

VIBn:
VIB_CalcSel – Select calculation method for VIBn value between Peak Displacement and RMS Displacement.

**Note** Sensors monitoring position of rotating elements typically measure Peak-to-Peak.

TMR_DiffLim – TMR Voter Disagreement Detection Diagnostic alarm threshold for VIBn value. Value is expressed as absolute difference in EU.
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.

**Note** FilterType, Fltrhpattn, Fltirthpncutoff, Fltrlpattn, Fltirlpncutoff – Unused for this sensor type.
Vibration Displacement Application Example

In the following figure (Vibration Displacement Sensor), Proximitor voltage inputs to a YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 4 as a VibProx input (no Keyphasor).

Vibration Displacement Sensor

Example Proximitor Specifications

<table>
<thead>
<tr>
<th>Scale Factor</th>
<th>200mV/mil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Gap Setting</td>
<td>50 mils</td>
</tr>
</tbody>
</table>

We will configure Channel 4 for the following behaviors:

- Return GAP4_VIB4 and VIB4 signals as mils.
- Set SysLim1GAP4 to LATCH True if GAP4_VIB4 ≥ 55 mils.
- Set SysLim2GAP4 to LATCH True if GAP4_VIB4 ≤ 45 mils.
- Set SysLim1VIB4 to True if VIB4 ≥ 8 mils
- Set SysLim2VIB4 to LATCH True if VIB4 ≥ 15 mils
To configure GAP4_VIB4

1. From the ToolboxST Component Editor, navigate to the Gap 4-8 tab.
2. Select GAP4_VIB4, and click the Show Advanced Parameters icon.
3. Configure it to match the following example.

4. Click the Vib 1-8 tab.
5. Select VIB4 and click the Show Advanced Parameters icon.
6. Configure it to match the following example.

If the YVIB firmware is receiving the data successfully after competing this configuration, then the following occurs:

- Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will attenuate the 50Hz, 2Vpp vibration by nearly 40:1, and the DC component of 10 V dc will be unaffected. The DC wave will be converted to 50mils, and the 40:1 reduced AC wave will be converted to ±0.125 mils, so the GAP4_VIB4 value will be 50 ± 0.125 mils.
- SysLim1GAP4 and SysLim2GAP4 are false, since (45.0 ≤ 49.875) and (50.125 ≤ 55.0).
- Vibration Displacement is unaffected by the DC component of the signal. The 50Hz, 2Vpp AC portion will be passed through a peak detection with 160 ms scan period, which will capture 8 cycles. The Peak-to-Peak value will return 2Vpp, which will be converted to 10mils, so VIB4 value will be 10mils.
- SysLim1VIB4 will be true, since VIB1 ≥ 8.0 mils. SysLim2VIB4 is false.

8.3.3.4 Velocity

Inputs 1-8 support Velomitors, Seismic velocity, and Accelerometers with integrated outputs to collect wideband velocity. Inputs 1-3 also collect velocity magnitude relative to a specified rotor speed. In LM turbine applications, Velocity sensors are mounted on bearing housings or machine casing to provide measurements of vibration. Tracking filters for Inputs 1-3 can provide the magnitude of vibration at a specified frequency.

Velocity Input Processing

GAPn_VIBn – Sensor biasing voltage in Volts.

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. For Velocity sensors, the gap value is not scaled, and it will remain in Volts. This value can be used to monitor sensor health.

VIBn – Wideband Velocity (½*pk-pk or RMS) in engineering units (EU).

Wideband velocity information is passed through 1-pole, high-pass filter with a fixed cutoff frequency of .1Hz. This removes static information prior to wideband filtering. This data is passed through the wideband filter, which can be configured as a low-pass, high-pass, or band-pass filter. The high-pass and low-pass filters can be configured for 2, 4, 6, 8, or 10 pole Butterworth filters with a user-defined cutoff (-3dB) point.
Depending on the value of the VIB_CalcSel for each input, the filtered data will be used to provide Peak velocity within the scan period, or RMS Velocity within the scan period.

For Peak velocity calculations, the wideband filter output is sent through a variable length peak detection function. The length of the peak detection is determined by the Keyphasor 1 detected speed in RPM.

The output of the peak detection function (VPK) is passed through an adjustable 1-pole, low-pass filter prior to scaling. VPK is converted from Volts to EU.

Wideband vibration information is passed through a variable scan period peak detection function. The length of the peak detection is determined by the Keyphasor 1 detected speed in RPM.

### Wideband Vibration Scan Period

<table>
<thead>
<tr>
<th>Shaft speed (RPM)</th>
<th>Scan period (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 60</td>
<td>160</td>
</tr>
<tr>
<td>60-480</td>
<td>2000</td>
</tr>
<tr>
<td>480-2250</td>
<td>250</td>
</tr>
<tr>
<td>&gt;2250</td>
<td>160</td>
</tr>
</tbody>
</table>

**Attention**

Peak Detection functions and Capture Buffers always uses RPM_KPH1 speed.

The data in the buffer is used to compute an RMS voltage ($V_{RMS}$) over that capture length, which is passed through an adjustable 1-pole, low-pass filter prior to scaling. $V_{RMS}$ is converted from Volts to EU.

**Note** Sensors monitoring velocity typically measure RMS. Peak calculations can be used instead for legacy applications.

**Note** RMS calculations are only available with YVIBS1B systems, and can only be enabled by changing the OperatingMode parameter to Enhanced.

LMVibnA, LMVibnB, LMVibnC – Magnitude of 1X harmonic relative to specified rotor shaft in Engineering Units (EU). This function is available for Inputs 1-3 only.

1X LM Tracking Filters measure the $\frac{1}{2}$*pk-pk velocity component at a specified shaft speed in RPM. The YVIB module receives the shaft speed through the variables LM_RPM_A (for LMVib1A, LMVib2A, and LMVib3A), LM_RPM_B (for LMVib1B, LMVib2B, and LMVib3B), and LM_RPM_C (for LMVib1C, LMVib2C, and LMVib3C). The calculation is the same for all 9 inputs, with only the input channel or shaft speed source changing. Values are converted from Volts to EU.

SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_VIBn value as True/False.

SysLim1VIBn, SysLim2VIBn – System Limit status for VIBn value as True/False. SysLim1ACCn, SysLim2ACCn – System Limit status for LMVibnA/B/C value as True/False.

ACC1, ACC2, and ACC3 correspond to LMVib1A, LMVib1B, and LMVib1C.

ACC4, ACC5, and ACC6 correspond to LMVib2A, LMVib2B, and LMVib2C.

ACC7, ACC8, and ACC9 correspond to LMVib3A, LMVib3B, and LMVib3C.

**Velocity Input Configuration**
GAPn_VIBn:
VibType - VibLmAccel, VibVelomitor, and VibSeismic are used for Velocity.
Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/ips.
LMlpcutoff – LM 1X Tracking Filter low-pass cutoff. Effective LM 1X Tracking Filter bandwidth is twice the value of this field.
TMR_DiffLimit – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_VIBn value. Value is expressed as absolute difference in Volts.
GnBiasOvride, Gain, Snsr_Offset – See Gain/Bias Override
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.

Note  Scale_Off – Unused for this sensor type.

VIBn:
VIB_CalcSel – Select calculation method for VIBn value between Peak Velocity and RMS Velocity.

Note  If OperatingMode is Legacy, this value is ignored and legacy Peak-to-Peak algorithm is used.

FilterType – Select Wideband Filter type for Velocity data. Selections are None, Lowpass, Highpass, Bandpass.
Filtrhpcutoff, Filtrlpncutoff – Cutoff (-3dB) point for high-pass and low-pass filters, respectively.
Fltrhpattn, Fltrlpattn – Attenuation for high-pass and low-pass filters, expressed as number of poles to use in Butterworth filters. Selections are 2-pole, 4-pole, 6-pole, 8-pole, and 10-pole.
TMR_DiffLimit – TMR Voter Disagreement Detection Diagnostic alarm threshold for VIBn value. Value is expressed as absolute difference in EU.
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.
LMVibnA, LMVibnB, LMVibnC:
TMR_DiffLimit – TMR Voter Disagreement Detection Diagnostic alarm threshold for LMVibnA/B/C value. Value is expressed as absolute difference in EU.
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.
Velocity Application Example

In this example, Velomitor voltage inputs to a YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 1 as a VibVelomitor input.

**Example Velomitor Specifications**

<table>
<thead>
<tr>
<th>Scale Factor</th>
<th>100mV/ips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Response</td>
<td>6 Hz to 750 Hz</td>
</tr>
</tbody>
</table>

We will configure Channel 1 for the following behaviors:

- Utilize the RMS Velocity algorithm for computing VIB1 signal.

**Note** Refer to Peak Velocity mode.

- Return VIB1 signal in inches/sec.
- Apply 8-pole low-pass and high-pass wideband filters to pass only inputs within Velomitor frequency response.
- Set SysLim1VIB1 to True if VIB1 ≥ 3 inches/sec
- Set SysLim2VIB1 to LATCH True if VIB1 ≥ 5 inches/sec
- Utilize LM_RPM_A to return LMVib1A as Peak Velocity at shaft speed (3000RPM) with a filter bandwidth of 5Hz.

Navigate to Parameters tab. Set OperatingMode parameter to Enhanced.

Navigate to “Gap 1-3” tab. Select GAP1_VIB1.

Set VIB_Type parameter to VibVelomitor.
Set Scale to “0.100” (Units are V/ips).

Set LMlpCutoff parameter to 2.5Hz. If the LM 1X Tracking Filter is not desired, then this setting does not matter.

Navigate to the Vib 1-8 tab. Select VIB1.

Set VIB_CalcSel parameter to VIB_RMS.
Set FilterType to Bandpass. Set FiltrHPcutoff to “6.0” Hz.
Set FiltrLPcutoff to “750.0” Hz.
Set FiltrPattn and FiltrLPattn to 8-pole.
Click to Show Advanced Parameters.
Set SysLim1Enabl and SysLim2Enabl parameters to Enable.
Set SysLim1Latch to NotLatch and SysLim2Latch to Latch.
Set SysLim1Type and SysLim2Type to “>=".
Set SysLim1 to “3.0” ips and SysLimit2 to “5.0” ips.

Navigate to the Variables tab. Select LM_RPM_A and attach a variable containing the rotor speed of 3000 RPM to it. If the LM 1X Tracking Filter is not desired, omit this step.

If the YVIB firmware is correctly receiving the data, we would expect:

• Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will attenuate the 50Hz, 1Vpp vibration by nearly 40:1, and the DC component of -12 V dc will be unaffected. Since the units for GAP1_VIB1 are always Volts, and the 40:1 reduced AC wave will be ±0.025 volts, the GAP1_VIB1 value will be -12 ± 0.025 Volts.
• For Vib values, the DC removal filter will eliminate the DC component of -12 V. The 50Hz, 1Vpp AC portion will pass through the wideband filter unaffected and be sent to a 160ms capture window, which will capture 8 cycles. The RMS value computed for this input (ideal sine wave) will return 0.353VRMS, which will be converted to inches/sec, so VIB1 value will be 3.53 inches/sec. • SysLim1VIB1 will be true, since VIB1 ≥ 3.0 ips. SysLim2VIB1 is false.
• LMVib1A value is the magnitude of the 1X harmonic of the rotor speed in LM_RPM_A, which is 3000RPM. Since the input wave is an ideal sine wave with a frequency of 3000RPM, the value of LMVib1A will be 5.0 inches/sec.
8.3.3.5 **Combustion Dynamics Monitoring (CDM)**

Inputs 1-8 support CDM sensors to collect wideband dynamic pressure. Inputs 1-3 also collect dynamic pressure magnitude relative to a specified frequency in RPM. Combustion Dynamics applications rely on the higher bandwidth and enhanced algorithms which are only implemented in the YVIBS1B.

---

**Attention**

CDM Sensors are only supported on the YVIBS1B.

---

**CDM Input Processing**

GAPn_VIBn – Sensor biasing voltage in Volts.

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. For CDM sensors, the gap value is not scaled, and it will remain in Volts. This value can be used to monitor sensor health.

\[ V_{\text{GAP}} \rightarrow \text{Gap Filter} \rightarrow \text{Mvg Avg Filter} \rightarrow \text{GAPn_VIBn} \]

VIBn – Wideband Dynamic Pressure (pk-pk or RMS) in engineering units (EU).

Wideband dynamic pressure information is passed through 1-pole, high-pass filter with a fixed cutoff frequency of .1Hz. This removes static pressure prior to wideband filtering. This data is passed through the wideband filter, which can be configured as a low-pass, high-pass, or band-pass filter. The high-pass and low-pass filters can be configured for 2, 4, 6, 8, or 10 pole Butterworth filters with a user-defined cutoff (-3dB) point.

Depending on the value of the VIB_CalcSel for each input, the filtered data will be used to provide pk-pk dynamic pressure within the scan period, or RMS dynamic pressure within the scan period.

For pk-pk dynamic pressure calculations, the wideband filter output is sent through a variable length pk-pk detection function. The length of the pk-pk detection is determined by the CDM_Scan_Period value in configuration.

The output of the pk-pk detection function (VPK-pk) is passed through an adjustable 1-pole, low-pass filter prior to scaling. VPK-pk is converted from Volts to EU.

**Note** A lower latency pk-pk detection function can be enabled by changing the OperatingMode parameter to Enhanced. This function will update every frame, instead of every scan period.

For RMS dynamic pressure calculations, the wideband filter output is captured into a variable length buffer. The length of the RMS calculation is determined by the CDM_Scan_Period value in configuration.

The data in the buffer is used to compute an RMS voltage (VRMS) over that capture length, which is passed through an adjustable 1-pole, low-pass filter prior to scaling (this filter cannot be disabled). VRMS is converted from Volts to EU.

**Note** Sensors monitoring dynamic pressure typically measure RMS. Peak calculations can be used instead for legacy applications.

**Note** RMS calculations are not available with YVIB systems.
LMVibnA, LMVibnB, LMVibnC – Magnitude of 1X harmonic relative to specified frequency (RPM) in Engineering Units (EU). This function is available for Inputs 1-3 only.

1X LM Tracking Filters measure the peak velocity component at a specified frequency in RPM. The YVIB module receives the frequency through the variables LM_RPM_A (for LMVib1A, LMVib2A, and LMVib3A), LM_RPM_B (for LMVib1B, LMVib2B, and LMVib3B), and LM_RPM_C (for LMVib1C, LMVib2C, and LMVib3C). The calculation is the same for all 9 inputs, with only the input channel or shaft speed source changing. Values are converted from Volts to EU.

SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_VIBn value as True/False.
SysLim1VIBn, SysLim2VIBn – System Limit status for VIBn value as True/False.
SysLim1ACCn, SysLim2ACCn – System Limit status for LMVibnA/B/C value as True/False.

ACC1, ACC2, and ACC3 correspond to LMVib1A, LMVib1B, and LMVib1C.
ACC4, ACC5, and ACC6 correspond to LMVib2A, LMVib2B, and LMVib2C.
ACC7, ACC8, and ACC9 correspond to LMVib3A, LMVib3B, and LMVib3C.

**CDM Configuration**

GAPn_VIBn:

**VibType** – CDM_BN_ChgAmp, CDM_PCB_ChgAmp are used for CDM applications.

---

**Note**  CDM_PCB_ChgAmp expects a positively biased sensor and will use a pull-down to N28 for open circuit detection. CDM_BN_ChgAmp expects a negatively biased sensor, and will use a pull-up to P28. There is a TVBA jumper to select pull-up or pull-down voltage that must be in the correct position.

CDM_Probe_Gain – CDM Probe gain, typically expressed in pico-coulombs/PSI.
CDM_Amp_Gain – CDM Charge Amplifier gain, typically expressed in mV/pico-coulomb.

---

**Note**  CDM_Probe_Gain and CDM_Amp_Gain are hidden from view until a CDM Sensor is added.

LMlpcutoff – LM 1X Tracking Filter low-pass cutoff. Effective LM 1X Tracking Filter bandwidth is twice the value of this field.
TMR_DiffLimit – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_VIBn value. Value is expressed as absolute difference in Volts.
GnBiasOvride, Gain, Snsr_Offset – See Gain/Bias Override
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to System Limits feature.

---

**Note**  Scale, Scale_Off – Unused for this sensor type.

VIBn:

VIB_CalcSel – Select calculation method for VIBn value between Peak Dynamic Pressure and RMS Dynamic Pressure.
**Note** Sensors monitoring dynamic pressure typically measure RMS.

If OperatingMode is Legacy, this value is ignored and legacy Peak algorithm is used.

FilterType – Select Wideband Filter type for Dynamic Pressure data. Selections are None, Lowpass, Highpass, Bandpass.

Filtrhpcutoff, Filtrlp_cutoff – Cutoff (-3dB) point for high-pass and low-pass filters, respectively.

Fltrhpattn, Fltrlpattn – Attenuation for high-pass and low-pass filters, expressed as number of poles to use in Butterworth filters. Selections are 2-pole, 4-pole, 6-pole, 8-pole, and 10-pole.

TMR_DiffLimit – TMR Voter Disagreement Detection Diagnostic alarm threshold for VIBn value. Value is expressed as absolute difference in EU.

SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to *System Limits feature*.

LMVibnA, LMVibnB, LMVibnC:

TMR_DiffLimit – TMR Voter Disagreement Detection Diagnostic alarm threshold for LMVibnA/B/C value. Value is expressed as absolute difference in EU. SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – Refer to *System Limits feature*.
CDM Application Example

In this example, PCB CDM voltage inputs to a YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 1 as a CDM_PCB_ChgAmp input.

For this example, the input waveform is two 1 VPK-PK pure tones (500Hz sine wave and 2500Hz sine wave) summed together. This is for illustrative purposes only, and is not indicative of true sensor inputs.

**Example PCB Sensor Specifications**

<table>
<thead>
<tr>
<th>PCB Probe Gain</th>
<th>5.0 pC/PSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB Amp Gain</td>
<td>20.0 mV/pC</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>200 Hz – 4 kHz</td>
</tr>
</tbody>
</table>

We will configure Channel 1 for the following behaviors:

- Utilize the RMS Dynamic Pressure algorithm for computing VIB1 signal.
- Return VIB1 signal in PSI.
- Apply 10-pole low-pass and high-pass wideband filters to pass only inputs within PCB Sensor frequency response.
- Utilize LM_RPM_A to return LMVib1A as Peak Dynamic Pressure at 2500 Hz (150000 RPM = 2500 Hz * 60 RPM / Hz) with a filter bandwidth of 3Hz.

- Set CDM_Scan_Period to 640 ms

➢➢➢ To configure Channel 1

1. From the **Parameters** tab, set OperatingMode to Enhanced and set CDM_Scan_Period to 640 ms.
2. From the **Gap 1-3** tab, select GAP1_VIB1 and make the following configuration changes as displayed in the following screen.

   ![Configuration Screen](image)

   **Note** These parameters will appear when a CDM sensor is selected in the VIB_Type parameter.

3. Navigate to the **Vib 1-8** tab. Select VIB1. Click to Show Advanced Parameters.
4. To set the Wideband filter, make the configuration changes as displayed in the following screen.

5. If the LM 1X Tracking Filter is desired, then navigate to the Variables tab. Select LM_RPM_A and attach a variable containing the 1x Harmonic frequency of 150000 RPM to it.

**Note**  LM 1x Tracking Filter frequency input is always RPM, even for CDM applications. Be sure to convert the target frequency from Hertz to RPM.

If the VIB firmware is receiving the data correctly after this configuration, then the following is expected:

- Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will attenuate the AC waveform by at least 4000:1, and the DC component of 12 V DC will be unaffected. Since the units for GAP1_VIB1 are always Volts, and the 4000:1 reduced AC wave will be ±0.0005 volts, the GAP1_VIB1 value will be -12 ± 0.0005 Volts.
- The DC removal filter will eliminate the DC component of -12V. The 500Hz, 1 V PK-PK and 2500Hz, 1 V PK-PK AC waves will pass through the wideband filter unaffected and be sent to a 160ms capture window, which will capture 80 cycles (scan period * frequency of the lowest principle). The RMS value computed for this input (sum of ideal sine waves) will return 0.5 V RMS, which will be converted to PSI. Therefore the VIB1 value will be 5.0 PSI RMS.
- LMVib1A value is the magnitude of the 1X harmonic of the rotor speed in LM_RPM_A, which is 2500Hz (150000 RPM). Since the input wave is the sum of two ideal sine waves, one of which is at 2500 Hz with a magnitude of 1 V PK-PK , the value of LMVib1A will be 10 PSI PK-PK.
## 8.3.4 Component Editor

### 8.3.4.1 Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>SystemLimits</td>
<td>Allows user to temporarily disable all system limit checks for testing purposes. Setting this parameter to Disable will cause a diagnostic alarm to occur.</td>
<td>Enable (default) Disable</td>
</tr>
<tr>
<td>OperatingMode</td>
<td>Enhanced enables enhanced algorithms for YVIBS1B that are not compatible with YVIBH1A, including Low Latency Peak-Peak Algorithm and Vibration RMS Algorithm</td>
<td>Legacy (default) Enhanced</td>
</tr>
<tr>
<td>Vib_PP_Filtr</td>
<td>First order filter time constant (sec) — cannot be disabled</td>
<td>0.01 to 2 (default is 0.10)</td>
</tr>
<tr>
<td>MaxVolt_Prox</td>
<td>Maximum Input Volts (pk-neg), healthy Input, Prox</td>
<td>-4 to 0 (default is -1.5)</td>
</tr>
<tr>
<td>MinVolt_Prox</td>
<td>Minimum Input Volts (pk-neg), healthy Input, Prox</td>
<td>-24 to -16 (default is -18.5)</td>
</tr>
<tr>
<td>MaxVolt_KP</td>
<td>Maximum Input Volts (pk-neg), healthy Input, Keyphasor</td>
<td>-4 to 0 (default is -1.5)</td>
</tr>
<tr>
<td>MinVolt_KP</td>
<td>Minimum Input Volts (pk-neg), healthy Input, Keyphasor</td>
<td>-24 to -16 (default is -22.0)</td>
</tr>
<tr>
<td>MaxVolt_Seis</td>
<td>Maximum Input Volts (pk-pos), healthy Input, Seismic: Values &gt; 1.25 require use of GnBiasOvride</td>
<td>0 to 2.75 (default is 1.0)</td>
</tr>
<tr>
<td>MinVolt_Seis</td>
<td>Minimum Input Volts (pk-neg), healthy Input, Seismic: Values &lt; -1.25 require use of GnBiasOvride</td>
<td>-2.75 to 0 (default is -1.0)</td>
</tr>
<tr>
<td>MaxVolt_Acc</td>
<td>Maximum Input Volts (pk), healthy Input, Accel</td>
<td>-12 to 1.5 (default is -8.5)</td>
</tr>
<tr>
<td>MinVolt_Acc</td>
<td>Minimum Input Volts (pk-neg), healthy Input, Accel</td>
<td>-24 to -1 (default is -11.5)</td>
</tr>
<tr>
<td>MaxVolt_Vel</td>
<td>Maximum Input Volts (pk), healthy Input, Velomitor</td>
<td>-12 to 1.5</td>
</tr>
<tr>
<td>MinVolt_Vel</td>
<td>Minimum Input Volts (pk-neg), healthy Input, Velomitor</td>
<td>-24 to -1</td>
</tr>
<tr>
<td>MaxVolt_CDM_BN</td>
<td>Maximum Input Volts (pk), healthy Input, CDM Bently Nevada</td>
<td>-12 to 24</td>
</tr>
<tr>
<td>MinVolt_CDM_BN</td>
<td>Minimum Input Volts (pk-neg), healthy Input, CDM Bently Nevada</td>
<td>-24 to 12</td>
</tr>
<tr>
<td>MaxVolt_CDM_PCB</td>
<td>Maximum Input Volts (pk), healthy Input, CDM PCB</td>
<td>-12 to 24</td>
</tr>
<tr>
<td>MinVolt_CDM_PCB</td>
<td>Minimum Input Volts (pk-neg), healthy Input, CDM PCB</td>
<td>-24 to 12</td>
</tr>
<tr>
<td>CDM_Scan_Period</td>
<td>The scan period for CDM sensor inputs in seconds. Only assign as 0.01 increments</td>
<td>0.01 to 2.0</td>
</tr>
</tbody>
</table>
### 8.3.4.2 Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Direction and Datatype</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3DIAG_YVIB_x</td>
<td>I/O Pack Diagnostic Indicator where R, S, or T is the redundancy of pack</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>LINK_OK_YVIB_x</td>
<td>IONet Link Okay Indicator where R, S, or T is the redundancy</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>ATTN_YVIB_x</td>
<td>I/O Pack Status Indicator where R, S, or T is the redundancy</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>PS18V_YVIB_x</td>
<td>I/O Pack 18 V Power Supply Indication where R, S, or T is the redundancy</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>PS28V_YVIB_x</td>
<td>I/O Pack 28 V Power Supply Indication where R, S, or T is the redundancy</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>IOPackTmpR</td>
<td>I/O Pack Temperature at the processor where R, S, or T is the redundancy</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>RPM_KPH1</td>
<td>Speed (RPM) of KP#1, calculated from input#13</td>
<td>Analog Input REAL</td>
</tr>
<tr>
<td>LM_RPM_A</td>
<td>Speed A(RPM), calculated externally to the I/O Pack</td>
<td>Analog Output REAL</td>
</tr>
<tr>
<td>LM_RPM_B</td>
<td>Speed B(RPM), calculated externally to the I/O Pack</td>
<td>Analog Output REAL</td>
</tr>
<tr>
<td>LM_RPM_C</td>
<td>Speed C(RPM), calculated externally to the I/O Pack</td>
<td>Analog Output REAL</td>
</tr>
<tr>
<td>SysLim1GAPx</td>
<td>Boolean set TRUE if System Limit 1 exceeded for Gap x input</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>where x = 1 to 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SysLim2GAPx</td>
<td>Boolean set TRUE if System Limit 2 exceeded for Gap x input</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>where x = 1 to 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SysLim1VIBx</td>
<td>Boolean set TRUE if System Limit 1 exceeded for Vib x input</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>where x = 1 to 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SysLim2VIBx</td>
<td>Boolean set TRUE if System Limit 2 exceeded for Vib x input</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>where x = 1 to 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SysLim1ACCx</td>
<td>Boolean set TRUE if System Limit 1 exceeded for Accelerometer x input</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>where x = 1 to 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SysLim2ACCx</td>
<td>Boolean set TRUE if System Limit 2 exceeded for Accelerometer x input</td>
<td>Input BOOL</td>
</tr>
<tr>
<td>where x = 1 to 9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 8.3.4.3 Probe Nominal Settings

<table>
<thead>
<tr>
<th>Probe Type</th>
<th>Gain †</th>
<th>Snsr_Offset (Vdc)</th>
<th>Scale (typical value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity</td>
<td>1x</td>
<td>9</td>
<td>200 mv/mil</td>
</tr>
<tr>
<td>Seismic</td>
<td>4x</td>
<td>0</td>
<td>150 mv/ips</td>
</tr>
<tr>
<td>Velomitor</td>
<td>2x</td>
<td>12</td>
<td>100 mv/ips</td>
</tr>
<tr>
<td>Accelerometer</td>
<td>2x</td>
<td>10</td>
<td>150 mv/ips</td>
</tr>
<tr>
<td>Keyphasor</td>
<td>1x</td>
<td>9</td>
<td>200 mv/mil</td>
</tr>
<tr>
<td>Bently Nevada CDM</td>
<td>2x</td>
<td>10</td>
<td>170 mv/psi</td>
</tr>
<tr>
<td>PCB CDM</td>
<td>2x</td>
<td>-12</td>
<td>170 mv/psi</td>
</tr>
</tbody>
</table>

†These are the default settings used if GnBiasOvride=Disable.
### 8.3.4.4 LM 1–3

[ ] = defaults

<table>
<thead>
<tr>
<th>Name</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
<th>TMR_DiffLimit</th>
<th>SysLim1Enable</th>
<th>SysLim1Latch</th>
<th>SysLimit1Type</th>
<th>SysLimit1</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMVib#A</td>
<td></td>
<td>AnalogInput</td>
<td>REAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>↓</td>
<td></td>
<td>Magnitude of 1X harmonic relative to LM_RPM_A, B, or C calculated from input#1, 2, or 3 (9 total inputs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SysLim2Enable</th>
<th>SysLim2Latch</th>
<th>SysLim2Type</th>
<th>SysLimit2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable System Limit 2 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 2 Check Type [ &gt;= ], &lt;=</td>
<td>System Limit 2 – Vibration in mils (prox) or Inch/sec (seismic, accel) [0] -100 to 100</td>
</tr>
</tbody>
</table>

### 8.3.4.5 Vib1x 1-8

| Name     | Direction | Data Type | Description                                                                                       |                   |
|----------|-----------|-----------|---------------------------------------------------------------------------------------------------|                   |
| VIB_1X1  | AnalogInput | REAL | Magnitude of 1X harmonic relative to key phasor speed calculated from input#1 |                   |
| VIB_1X8  | AnalogInput | REAL | Magnitude of 1X harmonic relative to key phasor speed calculated from input#8 |                   |
| Vib1xPH1 | AnalogInput | REAL | Angle of 1X harmonic relative to key phasor calculated from input#1 |                   |
| Vib1xPH8 | AnalogInput | REAL | Angle of 1X harmonic relative to key phasor calculated from input#8 |                   |

### 8.3.4.6 Vib2x 1-8

| Name     | Direction | Data Type | Description                                                                                       |                   |
|----------|-----------|-----------|---------------------------------------------------------------------------------------------------|                   |
| VIB_2X1  | AnalogInput | REAL | Magnitude of 2X harmonic relative to key phasor speed calculated from input#1 |                   |
| VIB_2X8  | AnalogInput | REAL | Magnitude of 2X harmonic relative to key phasor speed calculated from input#8 |                   |
| Vib2xPH1 | AnalogInput | REAL | Angle of 2X harmonic relative to key phasor calculated from input#1 |                   |
| Vib2xPH8 | AnalogInput | REAL | Angle of 2X harmonic relative to key phasor calculated from input#8 |                   |
### 8.3.4.7 Vib 1-8

[ ] = defaults

<table>
<thead>
<tr>
<th>Name</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
<th>VIB_CalcSel</th>
<th>TMR_DiffLimit</th>
<th>Filter Type</th>
<th>FiltrhpCutoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIB1</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Vibration displacement (pk-pk) or velocity (pk), AC component of input#1</td>
<td></td>
<td></td>
<td></td>
<td>High Pass 3db point (cutoff in Hz) [6] 4 to 300</td>
</tr>
<tr>
<td>VIB2</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Vibration displacement (pk-pk) or velocity (pk), AC component of input#2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIB3</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Vibration displacement (pk-pk) or velocity (pk), AC component of input#3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** VIB_RMS is only valid when OperatingMode is Enhanced and when using YVIBS1B.

<table>
<thead>
<tr>
<th>fltrpattn</th>
<th>FiltrhpCutoff</th>
<th>SysLim1Enabl</th>
<th>SysLim1Latch</th>
<th>SysLim1Type</th>
<th>SysLimit1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope or attenuation of high pass filter after cutoff [2-pole], 4-pole, 6-pole, 8-pole, 10-pole</td>
<td>Low Pass 3db point (cutoff in Hz) [500] 15 to 4300</td>
<td>Enable System Limit 1 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 1 Check Type [ &gt; ], &lt;=</td>
<td>System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [50] -100 to 100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SysLim2Enabl</th>
<th>SysLim2Latch</th>
<th>SysLim2Type</th>
<th>SysLimit2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable System Limit 2 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 2 Check Type [ &gt; ], &lt;=</td>
<td>System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [0] -100 to 100</td>
</tr>
</tbody>
</table>
### 8.3.4.8 Gap 1-3

[ ] = defaults  
† is only valid with YVIBS1B  
‡ LM Tracking Filter magnitude value may be inaccurate at 160, 320 ms frame periods.

<table>
<thead>
<tr>
<th>Name</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
<th>VIB_Type4</th>
<th>Scale</th>
<th>Scale_Off</th>
<th>TMR_DiffLimit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP1_VIB1</td>
<td>AnalogIn-put</td>
<td>REAL</td>
<td>Average Air Gap (for Prox) or DC volts(for others),DC component of input#1</td>
<td>Type of vibration probe, group 4 †CDM_BN_ChgAmp, †CDM_PCB_ChgAmp, PosProx, [Unused], VibLMAccel, VibProx, VibProx-KPH1, VibProx-KPH2, VibSeismic, VibVelomitor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP2_VIB2</td>
<td>AnalogIn-put</td>
<td>REAL</td>
<td>Average Air Gap (for Prox) or DC volts(for others),DC component of input#2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP3_VIB3</td>
<td>AnalogIn-put</td>
<td>REAL</td>
<td>Average Air Gap (for Prox) or DC volts(for others),DC component of input#3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gain Bias Override</th>
<th>Snsr_Offset</th>
<th>Gain</th>
<th>LMlpCutoff</th>
<th>SysLim1Enabl</th>
<th>SysLim1Latch</th>
<th>SysLim1Type</th>
<th>SysLimit1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable, Enable</td>
<td>Amount of bias voltage (dc) to remove from input signal used to max. A/Ds signal range used only when GnBiasOvride is enabled [10] ±13.5</td>
<td>Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvride is enabled [1x], 2x, 4x, 8x</td>
<td>Low pass 3dB point (cutoff Hz) for LM tracking filters 1.5Hz, 2.0Hz, [2.5Hz], 3.0Hz, 3.5Hz, 4.0Hz, 4.5Hz, 5.0Hz</td>
<td>Enable System Limit 1 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 1 Check Type [ &gt;= ], &lt;=</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SysLim2Enabl</th>
<th>SysLim2Latch</th>
<th>SysLim2Type</th>
<th>SysLimit2</th>
<th>CDM_Probe_Gain</th>
<th>CDM_Amp_Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable System Limit 2 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100</td>
<td>System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100</td>
<td>PCB Probe Gain, pico-coulombs per psi [17] 1 to 100</td>
<td>PCB Charge amplifier Gain, millivolts per pico-coulomb [10] 1 to 100</td>
</tr>
</tbody>
</table>
## 8.3.4.9 Gap 4-8

[ ] = defaults
† is only valid with YVIBS1B

<table>
<thead>
<tr>
<th>Name</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
<th>VIB_Type</th>
<th>Scale</th>
<th>Scale_Offset</th>
<th>TMR_DiffLimit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP4_VIB4</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Average Air Gap (for Prox) or DC volts (for others), DC component of input #4</td>
<td>Type of vibration probe, group 1 †CDM_BN_ChgAmp, †CDM_PCB_ChgAmp, PosProx, [Unused], VibLMAccel, VibProx, VibProx-KPH1, VibProx-KPH2, VibSeismic, VibVelomitor</td>
<td>Volts/-mil or Volts/ips [0.2] to 2</td>
<td>Scale offset for Prox position only, in mils [0] to 90</td>
<td>Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100</td>
</tr>
<tr>
<td>↓ ↓ ↓ ↓</td>
<td>GAP8_VIB8</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Average Air Gap (for Prox) or DC volts (for others), DC component of input #8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GnBiasOvr-ide</th>
<th>Snsr_Offset</th>
<th>Gain</th>
<th>SysLim1E-nabl</th>
<th>SysLim1-Latch</th>
<th>SysLim1Type</th>
<th>SysLimit1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain Bias Override [Disable], Enable</td>
<td>Amount of bias voltage (dc) to remove from input signal used to max. A/Ds signal range used only when GnBiasOvr-ide is enabled [10] ±13.5</td>
<td>Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvr-ide is enabled [1x], 2x, 4x, 8x</td>
<td>Enable System Limit 1 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 1 Check Type [&gt;= ], &lt;=</td>
<td>System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [90] -100 to 100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SysLim2Enabl</th>
<th>SysLim2Latch</th>
<th>SysLim2Type</th>
<th>SysLimit2</th>
<th>CDM_Probe_Gain</th>
<th>CDM_Amp_Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable System Limit 2 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 2 Check Type [&gt;= ], &lt;=</td>
<td>System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100</td>
<td>PCB Probe Gain, pico-coulombs per psi [17] 1 to 100</td>
<td>PCB Charge amplifier Gain, millivolts per pico-coulomb [10] 1 to 100</td>
</tr>
</tbody>
</table>
### 8.3.4.10 Gap 9-11

[ ] = defaults

<table>
<thead>
<tr>
<th>Name</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
<th>VIB_Type2</th>
<th>Scale</th>
<th>Scale_Off</th>
<th>TMR_DiffLimit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP9_POS1</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Average Air Gap, DC component of input#9</td>
<td>Sensor Type, group 2 [Unused], PosProx</td>
<td>Volts/mil or Volts/ips [0.2] 0 to 2</td>
<td>Scale offset for Prox position only, in mils [0] 0 to 90</td>
<td>Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100</td>
</tr>
<tr>
<td>GAP10_POS2</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Average Air Gap, DC component of input#10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAP11_POS3</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Average Air Gap, DC component of input#11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### GnBiasOvride

<table>
<thead>
<tr>
<th>Gain Bias Override</th>
<th>Snsr_Offset</th>
<th>Gain</th>
<th>SysLim1Enabl</th>
<th>SysLim1Latch</th>
<th>SysLim1Type</th>
<th>SysLimit1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable, Enable</td>
<td>Amount of bias voltage (dc) to remove from input signal used to max. A/DS signal range used only when GnBiasOvride is enabled [10] ±13.5</td>
<td>Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvride is enabled [1x], 2x, 4x, 8x</td>
<td>Enable System Limit 1 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 1 Check Type [&gt;=], &lt;=</td>
<td>System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [90] -100 to 100</td>
</tr>
</tbody>
</table>

#### SysLim2Enabl

<table>
<thead>
<tr>
<th>Enable System Limit 2 [Disable], Enable</th>
<th>SysLim2Latch</th>
<th>SysLim2Type</th>
<th>SysLimit2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 2 Check Type [&gt;=], &lt;=</td>
<td>System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100</td>
<td></td>
</tr>
</tbody>
</table>
### 8.3.4.11 KPH

[ ] = defaults
† is only valid with YVIBS1B

<table>
<thead>
<tr>
<th>Name</th>
<th>Direction</th>
<th>Data Type</th>
<th>Description</th>
<th>VIB_Type3</th>
<th>Scale</th>
<th>Scale_Off</th>
<th>TMR_DiffLimit</th>
<th>KPH_Thrshld</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP12_KPH2</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Average Air Gap, DC component of input#9</td>
<td>Sensor Type, group 3 [Unused], PosProx, † KeyPhasor</td>
<td>Volts/- mil or Volts/- ips [0.2]</td>
<td>0 to 2</td>
<td>Voltage difference from gap voltage where keyphasor triggers [2.0] 1.0 to 5.0</td>
<td></td>
</tr>
<tr>
<td>GAP13_KPH1</td>
<td>AnalogInput</td>
<td>REAL</td>
<td>Average Air Gap, DC component of input#10</td>
<td>Sensor Type, group 3 [Unused], PosProx, KeyPhasor</td>
<td>Scale offset for Prox position only, in mils [0] 0 to 90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KPH_Type</th>
<th>GnBiasOvr-ide</th>
<th>Snsr_Offset</th>
<th>Gain</th>
<th>SysLim1Enabl</th>
<th>SysLim1Latch</th>
<th>SysLim1Type</th>
<th>SysLimit1</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Slot], Pedestal</td>
<td>Gain Bias Override [Disable], Enable</td>
<td>Amount of bias voltage (dc) to remove from input signal used to max. A/Ds signal range used only when GnBiasOvrId is enabled [10] ±13.5</td>
<td>Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvrId is enabled [1x], † 2x, 4x, † 8x</td>
<td>Enable System Limit 1 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 1 Check Type [ &gt;= ], &lt;=</td>
<td>System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [90] -100 to 100</td>
</tr>
</tbody>
</table>

‡Gain 2x and Gain 8x are **Never** valid on GAP12_KPH2.

<table>
<thead>
<tr>
<th>SysLim2Enabl</th>
<th>SysLim2Latch</th>
<th>SysLim2Type</th>
<th>SysLimit2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable System Limit 2 [Disable], Enable</td>
<td>Latch the alarm [Latch], NotLatch</td>
<td>System Limit 2 Check Type [ &gt;= ], &lt;=</td>
<td>System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100</td>
</tr>
</tbody>
</table>
**8.3.5 YVIB Diagnostics**

**Note** Details of the individual diagnostics are available from the ToolboxST application. The diagnostic signals can be individually latched and then cleared from the ToolboxST Component Editor, or by using the RSTDIAG signal on SYS_OUTPUTS block, or through the WorkstationST Alarm Viewer.

The I/O pack performs the following self-diagnostic tests:

- A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and most of the processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set
- Each vibration input has hardware limit checking based on preset (configurable) high and low levels near the end of the operating range. If this limit is exceeded, a logic signal is set. The logic signal, L3DIAG_xxxx, refers to the entire board. There are diagnostic alarms for this (Alarm 33-45).
- Each input has system limit checking based on configurable high and low levels. The Sys_Outputs block can be used to reset any latched system limits. System limits can be used to drive process alarms through users application code.
8.4 YVIB Specific Diagnostic Alarms

The following alarms are specific to the YVIB I/O pack.

32
Description Channel [ ] A/D Converter Calibration Failure
Possible Cause The I/O pack failed to auto-calibrate when powered on.
Solution Replace the I/O pack.

33-45
Description TVBA Analog Input [ ] exceeded limits
Possible Cause
• The terminal point voltage is outside of limits for the sensor type.
• The Bias level (DC offset), Gain, or sensor limits are improperly set for the sensor/channel.
• Open connection between sensor and terminal board
Solution
• Verify that the sensor configuration is correct.
• Check for the proper voltage at the terminal board point on the sensor.
• Check the electrical continuity between sensor and terminal board.
• Replace the I/O pack or terminal board.

46
Description Channel [ ] D/A Converter Calibration Failure
Possible Cause The board failed to auto-calibrate when powered on.
Solution Replace the I/O pack.

47
Description Initialization Error Detected
Possible Cause An I/O pack has failed.
Solution Replace the I/O pack.
**48**

**Description**  Internal data transfer error - Expected ID [ ] Read ErrCnt/ID [ ]

**Possible Cause**  There is an I/O pack failure or software process conflict that may be cleared by a hard reset.

**Solution**
- Cycle power on the I/O pack.
- Replace the I/O pack.

---

**49**

**Description**  Internal hardware failure - Status [ ]

**Possible Cause**  An I/O pack has failed.

**Solution**  Replace the I/O pack.

---

**50**

**Description**  Channel [ ] DC Isolation Test Failure

**Possible Cause**  The I/O pack failed to auto-calibrate when powered on.

**Solution**  Replace the I/O pack.

---

**51**

**Description**  I/O pack processor failure - Status [ ]

**Possible Cause**  The I/O pack failed.

**Solution**  Replace the I/O pack.

---

**52-64**

**Description**  TVBA Analog Input [ ] Open Circuit ([ ] Volts)

**Possible Cause**  An open circuit has been detected on the terminal board based on the sensor type.

**Solution**
- Check the wiring between the terminal board and the sensor.
- Check the sensor for proper operation.
- Replace the terminal board.
65
Description  Negative 28 Volt Power Low ([ ] Counts)

Possible Cause
• WNPS daughterboard failure (for TVBAH#A or S#A)
• Failure of N28 power supply on TVBAS2B or TVBAH#B
• I/O pack P28 voltage is low
• The terminal board has failed

Solution
• Check the power to the I/O pack.
• Replace the WNPS daughterboard.
• Replace the terminal board.
• Replace the I/O pack.

66
Description  Dual Ethernets not supported with 10 ms frame rate

Possible Cause  The second Ethernet port is connected, but not supported for a 10 ms frame rate.

Solution
• Remove the second Ethernet connection to the YVIB.
• Increase the frame rate to 20ms.
• Upgrade the I/O pack.

67
Description  Pack internal reference voltage out of limits

Possible Cause  The I/O pack failed to auto-calibrate when powered on.

Solution  Replace the I/O pack.

68
Description  Internal daughterboard temperature limit exceeded ([ ] °F)

Possible Cause
• The cabinet temperature is too high.
• The I/O pack overheated.
• If the cabinet temperature is within the specified temperature limits, the I/O pack internal daughterboard temperature sensor may have failed.

Solution
• Check the environmental controls applied to the cabinet containing the I/O pack. Operation will continue correctly beyond these temperature limits, but long-term operation at elevated temperatures may reduce equipment life.
• If the I/O pack internal daughterboard temperature sensor failed, then replace the I/O pack.
69
Description  Channels 1, 5, 9, 13 ADC Failure. Status [ ]
Possible Cause  The I/O pack failed.
Solution  Replace the I/O pack.

70
Description  Channels 2, 6, 10 ADC Failure. Status [ ]
Possible Cause  The I/O pack failed.
Solution  Replace the I/O pack.

71
Description  Channels 3, 7, 11 ADC Failure. Status [ ]
Possible Cause  The I/O pack failed.
Solution  Replace the I/O pack.

72
Description  Channels 4, 8, 12 ADC Failure. Status [ ]
Possible Cause  The I/O pack failed.
Solution  Replace the I/O pack.

73
Description  1x2x Phase Calibration Level [ ] Failure on Channel [ ]
Possible Cause  The I/O pack failed to auto-calibrate when powered on.
Solution  Replace the I/O pack.

74
Description  Current Operating Mode is incompatible with this hardware
Possible Cause  The selected Operating Mode is not supported by this module. This is likely caused by installing a replacement module without updating ToolboxST. This alarm may be accompanied by Voter Disagreement diagnostics.
Solution
•  Change the Operating Mode parameter to Legacy.
•  Replace this module with a functionally compatible module.
75-87

Description  Channel [ ] Sensor type is not supported with this hardware

Possible Cause  The selected sensor type (VIB_Type) is unsupported by this module. This is likely caused by installing a replacement module without updating ToolboxST. This channel will default to Unused behavior.

Solution

• Change the VIB_Type for the indicated channel to a value supported by all hardware forms being used. Review the documentation to see which sensor types can be used for each hardware form.
• Replace this module with a functionally compatible module.

88-95

Description  Channel [ ] Wideband Filters do not support [ ]-pole filter attenuation. Falling back to [ ]-pole filter attenuation.

Possible Cause  The filter attenuation selection for Fltrhpattn and/or Fltrlpattn is not supported by this module. This is likely caused by installing a replacement module without updating ToolboxST. This channel will run with the closest match it can support, rather than disable the filter.

Solution

• Change the Fltrhpattn and/or Fltrlpattn for the indicated channel to a value supported by all the hardware forms being used. Review the documentation to see which attenuation values can be used for each hardware form.
• Replace this module with a functionally compatible module.

192-221

Description  Input Signal [ ] Voting Mismatch, Local=[ ], Voted=[ ]

Possible Cause

• There is a voter disagreement between the R, S, and T I/O packs.
• The I/O pack is not seated on the terminal board correctly.
• The I/O pack has failed.

Solution

• Adjust the parameter TMR_DiffLimt or correct the cause of the difference.
• Re-seat the I/O pack to the terminal board.
• Replace the I/O pack.
8.5 **TVBA Vibration Input**

The Vibration Input (IS410TVBAS2B) terminal board acts as a signal interface board for the Mark VIeS YVIB I/O packs. The TVBA provides a direct vibration interface to Eddy-current (position & velocity), seismic (velocity), Velomitors (velocity) and accelerometers with integrated outputs (velocity) sensors. The TVBA also provides a dynamic pressure interface to charge amplifiers.

The terminal board input signals entering through the two 24-point screw terminals are protected against high voltages due to electrical disturbances via transient suppression. Powering the different sensors and detecting open circuits is accomplished by jumpers JPxA located to the left of the 37-pin I/O pack connectors and JPxC located to the right of the 24-point screw terminals.

The input signals are passed on to the I/O packs through 37-pin connectors located on the right side of the TVBA. The TVBA can be used for either simplex or TMR applications. TMR applications fan the signal to three I/O packs.

Buffered outputs of the input signals are provided to 9 and 25 pin DIN connectors to feed the Bently Nevada* 3xxx monitoring system. A bayonet nut connection (BNC) connection for each buffered output is also included to feed third party monitoring equipment. To configure the output buffers for the proper sensor, use the JPxB jumpers that are located to the left of the 37-pin I/O pack connectors. The I/O pack inputs channels 1 through 13 and channels 1 through 14 are routed to buffered outputs for external use. These BNC and DIN connectors, and the jumper are only available on TVBAH2A, TVBAH2B, TVBAS2A, and TVBAS2B.

Power is obtained from customer supplied +28 V through the I/O pack.

### 8.5.1 TVBA Compatibility and Attributes

The I/O pack works with the TVBA terminal board to provide all sensor input checks. The following terminal board revisions work with the I/O pack.

<table>
<thead>
<tr>
<th>Terminal Board</th>
<th>Compatibility</th>
<th>Buffered Output Circuits, DIN, and BNC Connectors</th>
<th>WNPS Connectors</th>
<th>IEC61508 Safety Certified</th>
<th>Allows Mixing of I/O Pack Revisions†</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVBAS2B‡</td>
<td>YVIBS1A and YVIBS1B</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

†Mixing I/O pack revisions on a TMR module does not allow for Enhanced mode of operation.
‡N28 power is generated internally to TVBAS2B.

### 8.5.2 TVBA Installation, Operation, and Jumper Configuration

The TVBA accepts 14 sensor inputs that are wired directly to two 24-point I/O terminal blocks. Each block is held down with two screws accepting up to #12 AWG wires. A shield termination attachment point is located adjacent to each terminal block. The I/O pack can only process 13 of the 14 channels. The 14th channel is forwarded to the buffered output stage for use by the Bently Nevada equipment.

#### 8.5.2.1 Accelerometers with Integrated Outputs

The TVBA supports accelerometers with integrated outputs on channels 1, 2 and 3 only when the Tracking filters are required. If broadband rms vibration is all that is required, then all eight channels are available to use. For example, Oil & Gas LM1600, LM2500 or LM6000 gas turbine applications use the Bently Nevada 86517 sensor. The 86517 is powered by -24 V and the velocity output is connected to the vibration inputs: PRxxH and PRxxL. Tie the shield on the Mark VIeS end and leave the shield open on the sensor side preventing ground loops.
8.5.2.2 Seismic Sensors

The TVBA can input a maximum of eight seismic sensor inputs on channels 1 through 8. Seismic sensors are usually moving-coil type probes that require no power. The heavy-duty gas turbines (HDGTs) use the Metrix 5235B, 5475C or 5485C sensors on the bearing housings to measure the non-rotating vibration. The Metrix 5485C or similar sensor’s output is connected directly to the PRxxH and PRxxL inputs. The seismic output is centered at 0 V dc. With a sensitivity range of 100 to 200 mV/in/sec. Tie the shield on the Mark VIeS end and leave the shield open on the sensor side.

JPxA jumper is in the “P,A” position providing a +28 V weak pull-up for sensor failure detection and the JPxC jumper is in the “PCOM” position to provide a closed circuit for the -28 V power applied to the sensor through the WNPS -28 V daughterboard for TVBAH#A or TVBAS#A terminal boards only. JPxB is set in the 'PVA' position.

JPxA jumper is in the ‘S’ position providing a -28 V weak pull-down for sensor failure detection and the JPxC jumper is in the ‘PCOM’ position to allow the corresponding buffered output to be scaled the same as the signal input. JPxB is set in the ‘S’ position.
8.5.2.3 Velomitor Sensors

The TVBA accepts a maximum of eight Velomitor sensors on channels 1 through 8. The Bently Nevada 190501 and 3305xx product line are a constant-current device requiring a -24 V power sourced from the WNPS power supply daughterboard(s) for TVBAH#A and TVBAS#A terminal boards only to drive the current. The two-wire termination of this sensor uses the N24xx and PRxxH screw points. The velocity or AC content of the Velomitor is riding on top of a negative DC bias in the -8 to -12 V dc range generated by the sensor. The shield is tied to chassis at the control end and left open on the sensor side to prevent circulating ground currents. The sensor device usually has a sensitivity of 100 mV/in/sec.

8.5.2.4 Eddy-current or Proximitor Sensors for Position and Velocity

The TVBA provides a maximum of 13 channels to connect an Eddy-current sensor to the terminal blocks. Channels 1 through 8 can condition both position and velocity information from the sensor and channels 9 through 13 can input only position information between the terminal screws PRxxH and PRxxL. The Bently Nevada Proximitor 3300 family and Metrix Model 5533 are -24 V powered devices with the output signal proportional to the gap between the rotating shaft and the head of the probe. Velocity information is extracted from the AC content riding on top of the DC gap signal. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.

The user can parallel the eddy-current signal to a second TVBA, but the N24xx power output would not be used from the second TVBA and JPxC would be in the “OPEN” position.
8.5.2.5 Eddy-current or Proximiter Sensors for Keyphasor

The TVBA provides channels 12 and 13 to connect an Eddy-current or Proximiter sensor used for a Keyphasor function. The Bently Nevada Proximiter 3300 family or Metrix Model 5533 are -24 V powered devices with the output signal proportional to the gap between the rotating shaft and the head of the probe. Velocity information is extracted from the AC content riding on top of the DC gap signal. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.

JPxA jumper is in the ‘P,A’ position providing a +28 V weak pull-up for sensor failure detection and the JPxC jumper is in the ‘PCOM’ position to provide a return for the -24 V power supply sourced from the -28 V WNPS daughter-boards for the TVBAF/A and TVBAF/A terminal boards only, and a low-side for the signal output of the sensor. JPxB is set in the ‘PVA’ position.
8.5.2.6 Bently Nevada 350500 Charge Amplifier

The TVBA vibration terminal board also supports the Bently Nevada 350500 charge amplifier used with dynamic-pressure sensors examining the combustion dynamics of the LM2500 DLE gas turbines. The TVBA can input combustion dynamics information on channels 1 through 8 where the I/O pack can provide band-passed, root-mean-squared (r.m.s.) dynamic-pressure data for the LM2500 DLE combustion. The charge amplifier is powered with -24 V and the AC dynamics output is riding on top of a negative DC bias signal that is used by the I/O module for signal health. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.

JPxA jumper is in the ‘PA’ position providing a +28 V weak pull-up. The JPxC jumper is in the ‘PCOM’ position to provide a return for the -24 V power supply sourced from the -28 V WNPS daughter-boards on the TVBAH#A and TVBAS#A terminal boards only, and a low-side for the signal output of the charge amplifier. JPxB is set in the ‘PVA’ position.

8.5.2.7 PCB Piezotronics 682A02 Signal Conditioner

The PCB 682A02 signal conditioner can be connected to the TVBA terminal board for channels 1 through 8. The PCB system is powered with +24 V instead of -24 V as applied to the Bently Nevada systems. The 682A02 signal conditioner is powered externally by a +24 V source. The 682A02 converts the 24 V power to a 4mA constant-current source to power the PCB 682M57 charge amplifier. The 682A02 ‘Out’ connects to the TVBA PRxxH/L terminal block screws. The AC dynamic pressure signal is riding on top of a 10 – 13 V dc bias voltage used to determine the health of the combustion sensing system. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.

JPxA jumper is in the ‘S’ position providing a -28 V weak pull-down. The JPxC jumper is in the ‘OPEN’ position to provide a true differential input eliminating ground current loops with the external power supply. JPxB is set in the ‘S’ position.
### Customer Terminal Points

<table>
<thead>
<tr>
<th>Channel</th>
<th>Signal Name</th>
<th>Pin #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP1_VIB1</td>
<td>N24V01</td>
<td>1</td>
<td>-24 V power supply output for channel #1</td>
</tr>
<tr>
<td></td>
<td>PR01H</td>
<td>2</td>
<td>Input #1 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR01L</td>
<td>3</td>
<td>Input #1 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP2_VIB2</td>
<td>N24V02</td>
<td>4</td>
<td>-24 V power supply output for channel #2</td>
</tr>
<tr>
<td></td>
<td>PR02H</td>
<td>5</td>
<td>Input #2 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR02L</td>
<td>6</td>
<td>Input #2 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP3_VIB3</td>
<td>N24V03</td>
<td>7</td>
<td>-24 V power supply output for channel #3</td>
</tr>
<tr>
<td></td>
<td>PR03H</td>
<td>8</td>
<td>Input #3 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR03L</td>
<td>9</td>
<td>Input #3 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP4_VIB4</td>
<td>N24V04</td>
<td>10</td>
<td>-24 V power supply output for channel #4</td>
</tr>
<tr>
<td></td>
<td>PR04H</td>
<td>11</td>
<td>Input #4 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR04L</td>
<td>12</td>
<td>Input #4 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP5_VIB5</td>
<td>N24V05</td>
<td>13</td>
<td>-24 V power supply output for channel #5</td>
</tr>
<tr>
<td></td>
<td>PR05H</td>
<td>14</td>
<td>Input #5 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR05L</td>
<td>15</td>
<td>Input #5 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP6_VIB6</td>
<td>N24V06</td>
<td>16</td>
<td>-24 V power supply output for channel #6</td>
</tr>
<tr>
<td></td>
<td>PR06H</td>
<td>17</td>
<td>Input #6 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR06L</td>
<td>18</td>
<td>Input #6 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP7_VIB7</td>
<td>N24V07</td>
<td>19</td>
<td>-24 V power supply output for channel #7</td>
</tr>
<tr>
<td></td>
<td>PR07H</td>
<td>20</td>
<td>Input #7 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR07L</td>
<td>21</td>
<td>Input #7 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP8_VIB8</td>
<td>N24V08</td>
<td>22</td>
<td>-24 V power supply output for channel #8</td>
</tr>
<tr>
<td></td>
<td>PR08H</td>
<td>23</td>
<td>Input #8 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR08L</td>
<td>24</td>
<td>Input #8 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP9_POS1</td>
<td>N24V09</td>
<td>25</td>
<td>-24 V power supply output for channel #9</td>
</tr>
<tr>
<td></td>
<td>PR09H</td>
<td>26</td>
<td>Input #9 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR09L</td>
<td>27</td>
<td>Input #9 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP10_POS2</td>
<td>N24V10</td>
<td>28</td>
<td>-24 V power supply output for channel #10</td>
</tr>
<tr>
<td></td>
<td>PR10H</td>
<td>29</td>
<td>Input #10 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR10L</td>
<td>30</td>
<td>Input #10 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP11_POS3</td>
<td>N24V11</td>
<td>31</td>
<td>-24 V power supply output for channel #11</td>
</tr>
<tr>
<td></td>
<td>PR11H</td>
<td>32</td>
<td>Input #11 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR11L</td>
<td>33</td>
<td>Input #11 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP12_KPH2</td>
<td>N24V12</td>
<td>34</td>
<td>-24 V power supply output for channel #12</td>
</tr>
<tr>
<td></td>
<td>PR12H</td>
<td>35</td>
<td>Input #12 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR12L</td>
<td>36</td>
<td>Input #12 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP13_KPH1</td>
<td>N24V13</td>
<td>37</td>
<td>-24 V power supply output for channel #13</td>
</tr>
<tr>
<td></td>
<td>PR13H</td>
<td>38</td>
<td>Input #13 signal high side to I/O pack and buffered output</td>
</tr>
<tr>
<td></td>
<td>PR13L</td>
<td>39</td>
<td>Input #13 signal low side to I/O pack and buffered output</td>
</tr>
<tr>
<td>GAP_KP_BN1</td>
<td>N24V14</td>
<td>40</td>
<td>-24 V power supply output for channel #14</td>
</tr>
<tr>
<td></td>
<td>PR14H</td>
<td>41</td>
<td>Input #14 signal high side to buffered output ONLY</td>
</tr>
<tr>
<td></td>
<td>PR14L</td>
<td>42</td>
<td>Input #14 signal low side to buffered output ONLY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>43-48</td>
<td>No connections</td>
</tr>
</tbody>
</table>
### 8.5.2.9 TVBAS2B Buffered Outputs

With the TVBAS2B, each channel provides additional outputs other than the standard 37-pin connection. The signal output is buffered from the signal used by the I/O module to prevent any corruption caused by third-party hardware connected to the output.

Each channel is output on a BNC connector with 10 kilo-ohms between the buffer out and BNC signal pin and 10 kilo-ohms isolation between signal low and the control power common, PCOM.

Each channel is also output through a 25-pin or 9-pin connectors JA1, JB1, JC1 and JD1 designed to interface with the Bently Nevada 3500 monitoring system. The TVBA buffered source impedance is approximately 40 ohms.

![Jumper, JPxB diagram]

The jumper, JPxB where x = 1 through 14 is used to configure the output for either seismic outputs with a -11 V dc bias voltage added to the velocity signal or positioned to output Proximitor, Velomitor or accelerometer with integrated output signals.

### 8.5.2.10 Bently Nevada Buffered DB Connector Points

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>Connector</th>
<th>Pin #</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPR01</td>
<td>JA1</td>
<td>3</td>
</tr>
<tr>
<td>PCOM</td>
<td>JA1</td>
<td>2</td>
</tr>
<tr>
<td>BPR02</td>
<td>JA1</td>
<td>7</td>
</tr>
<tr>
<td>PCOM</td>
<td>JA1</td>
<td>6</td>
</tr>
<tr>
<td>BPR03</td>
<td>JA1</td>
<td>11</td>
</tr>
<tr>
<td>PCOM</td>
<td>JA1</td>
<td>10</td>
</tr>
<tr>
<td>BPR04</td>
<td>JA1</td>
<td>23</td>
</tr>
<tr>
<td>PCOM</td>
<td>JA1</td>
<td>24</td>
</tr>
<tr>
<td>BPR05</td>
<td>JB1</td>
<td>3</td>
</tr>
<tr>
<td>PCOM</td>
<td>JB1</td>
<td>2</td>
</tr>
<tr>
<td>BPR06</td>
<td>JB1</td>
<td>7</td>
</tr>
<tr>
<td>PCOM</td>
<td>JB1</td>
<td>6</td>
</tr>
<tr>
<td>BPR07</td>
<td>JB1</td>
<td>11</td>
</tr>
<tr>
<td>PCOM</td>
<td>JB1</td>
<td>10</td>
</tr>
<tr>
<td>BPR08</td>
<td>JB1</td>
<td>23</td>
</tr>
<tr>
<td>PCOM</td>
<td>JB1</td>
<td>24</td>
</tr>
<tr>
<td>BPR09</td>
<td>JC1</td>
<td>3</td>
</tr>
<tr>
<td>PCOM</td>
<td>JC1</td>
<td>2</td>
</tr>
<tr>
<td>BPR10</td>
<td>JC1</td>
<td>7</td>
</tr>
</tbody>
</table>
### 8.5.3 TVBA Specifications

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Options</strong></td>
<td></td>
</tr>
<tr>
<td>Number of channels supporting position or gap inputs</td>
<td>13</td>
</tr>
<tr>
<td>Number of channels supporting velocity or dynamic pressure sensor inputs</td>
<td>8</td>
</tr>
<tr>
<td>Number of channels supporting Key Phasor inputs</td>
<td>2</td>
</tr>
<tr>
<td><strong>Sensors Supported</strong></td>
<td></td>
</tr>
<tr>
<td>Sensors Supported</td>
<td>1) Eddy-current or Proximitor</td>
</tr>
<tr>
<td></td>
<td>2) Accelerometer with integrated output</td>
</tr>
<tr>
<td></td>
<td>3) Seismic</td>
</tr>
<tr>
<td></td>
<td>4) Velomitor</td>
</tr>
<tr>
<td></td>
<td>5) Charge Amplifier</td>
</tr>
<tr>
<td><strong>Sensor Power Options</strong></td>
<td></td>
</tr>
<tr>
<td>Number of negative 24 V dc, N24 outputs to power sensors</td>
<td>14</td>
</tr>
<tr>
<td>N24 Nominal Voltage</td>
<td>-24.5 V dc</td>
</tr>
<tr>
<td>N24 maximum current</td>
<td>(-23 to -26) V dc</td>
</tr>
<tr>
<td><strong>Buffered Outputs</strong></td>
<td></td>
</tr>
<tr>
<td>Number of buffered outputs</td>
<td>14</td>
</tr>
<tr>
<td>Buffer Gain Accuracy</td>
<td>+/-0.1%</td>
</tr>
<tr>
<td>DB9 and DB25 Connector Output Load requirements to achieve less than 10% overshoot</td>
<td>1500 ohms minimum</td>
</tr>
<tr>
<td></td>
<td>1000 pF maximum</td>
</tr>
<tr>
<td>BNC Connector Load requirements to achieve less than 10% overshoot</td>
<td>2 Mohm minimum</td>
</tr>
<tr>
<td></td>
<td>1000 pF maximum</td>
</tr>
<tr>
<td><strong>Terminal Screws</strong></td>
<td></td>
</tr>
<tr>
<td>Wiring Sizes</td>
<td>22 to 12 AWG</td>
</tr>
<tr>
<td>Torque</td>
<td>9.6 in-lb (1.085 N-m)</td>
</tr>
</tbody>
</table>

### 8.5.4 TVBA Diagnostics

The TVBA terminal board provides weak pull-up and pull-down circuits configured based on the jumper position to allow the YVIB to detect an open circuit. The I/O pack creates the diagnostic alarm (fault) if any one of the inputs has an out-of-range voltage.

Each connector between the TVBA and the I/O pack has its own ID device that is interrogated by the Vibration pack. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and the R, S and T connector location. When this chip is read by the I/O pack and a mismatch is encountered, a hardware incompatibility fault is created.
9 PSCA Modbus Master (Serial Communication) Module

9.1 PSCA Serial Communication I/O Pack

The Serial Communication (IS420PSCAH1B) I/O pack provides the electrical interface between one or two I/O Ethernet networks and a serial communications terminal board. The I/O pack contains a BPPC processor board common to all Mark VIe distributed I/O packs and a serial communications board. The communications board contains six serial transceiver channels, each of which can be individually configured to comply with RS-232, RS-422, or RS-485 half-duplex standards.

Input to the I/O pack is through dual RJ-45 Ethernet connectors and a 3-pin power input. Output is through a DC-62 pin connector that connects directly with the associated terminal board connector. One of the Ethernet ports can be used to support Ethernet Modbus communication on Simplex networks. Visual diagnostics are provided through indicator LEDs.

The IS420PSCAH1B I/O pack contains a functionally compatible BPPC that is supported in ControlST V04.07 and later.
9.1.1  PSCA Installation

➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢➢ geli
9.1.2.3 Dataflow from PSCA to Controller

Dataflow from the PSCA to the Mark VIe controller is of two types: fixed I/O and Modbus I/O. Fixed I/O is associated with the smart pressure transducers and the Kollmorgen® electric drive data. This data is completely processed every frame, the same as conventional I/O. These signals are mapped into signal space, have individual health bits, and have offset/gain scaling. Several of these signals are configured to support system limit checking.

Modbus: Modbus I/O is the I/O associated with the Modbus ports. Because of the quantity of these signals, they are not completely processed every frame; instead they are packaged and transferred to the Mark VIe controller, over the IONet through a special service. This can accommodate up to 2400 bytes, at 4 Hz, or 9600 bytes at 1 Hz, or combinations thereof. This I/O is known as second class I/O, where coherency is at the signal level only, not at the device or board level. Health bits are assigned to individual points in the same fashion as the other protocols, and system limit checking is not performed. Three consecutive time-outs are required before a signal is declared unhealthy. Diagnostic messages are used to annunciate all communication problems. The input value is cleared for a given signal after four consecutive time-outs occur on that signal.

Honeywell® Pressure Transducers: Serial ports 1 and 2 support the Honeywell pressure configuration. It reads inputs from the Honeywell Smart Pressure Transducers, type LG-1237. As an option (pressure transducers or Modbus) this service is available only on ports 1 and 2. The pressure transducer protocol utilizes interface board DS200XDSAG#AC, and RS-422. Each port can service up to six transducers. The service is 375 kbaud, asynchronous, nine data bits, (11 bits including start and stop). It includes communication miss counters, one per device, and associated diagnostics as failsafe features.

After four consecutive misses, it forces the input pressure to 1.0 psi, and posts a diagnostic. After four consecutive hits (good values) it removes the forcing and the diagnostic.

Kollmorgen Electric Drive: Three ports (any three, but no more than three) support the Kollmorgen electric drive. It communicates with a Kollmorgen Electric Fast Drive FD170/8R2-004 at a 19200 baud rate, point-to-point, using RS-422.
9.1.2.4 Serial Modbus Master Service

The current Modbus design supports the Master mode on all six serial ports. It is configurable at the port level as follows:

- Physical connection: RS-232, RS-422, RS-485
- Baud Rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
- Parity: none, odd, even
- Data Bits: seven, eight
- Stop Bits: one, two
- Station addresses
- Multidrop is applicable only to RS-485 with up to eight devices per port; maximum of 18 devices per board
- For RS-232 or RS-422, only one station is supported for these protocols
- RTU
- Time-out (milliseconds) per device
- 32-bit data Word ordering (for example, Least Significant Word [LSW] or Most Significant Word [MSW] first)

**Note** First denotes which word is in the lower-numbered register. All 16-bit registers are Big-Endian per standard Modbus convention.

- Device response delay time

The Modbus service is configurable at the signal level as follows:

- Signal type
- Register number
- Read/write
- Transfer rate, 0.5, 1, 2, or 4 Hz
- Scaling: Raw min/max, Eng min/max

The service supports function codes 1-7, 15, and 16; it also supports double 16-bit registers for floating point numbers and 32-bit counters. It periodically (10 sec) attempts to reestablish communications with a dead station.

Type casting and scaling of all I/O signals to/from engineering units are supported on the PSCA and the ToolboxST* application, for both fixed I/O and Modbus I/O.
9.1.2.5 Ethernet Modbus Master Service

The PSCA can use one of its two Ethernet ports to support the Ethernet Modbus Master Protocol. This configuration can only be used with a simplex network. The Ethernet IP address for Modbus can not be included in the range of the IONet submask range. All Ethernet Modbus stations are configured on Port 7 through the ToolboxST application. The Ethernet Modbus implementation follows the Open Modbus/TCP Specification for a Class 1 device.

The ToolboxST application allows up to 18 Ethernet Modbus stations to be attached to the PSCA. The CPU loading for each station varies depending on the number of Modbus registers being requested and the update rate. Also, the field device connect and data response rate may vary. Data throughput should be validated in system test when multiple stations and/or large amounts of data are being transferred.

The following parameters are defined for all stations on the PSCA Ethernet port:

- TCP/IP address for PSCA Ethernet port
- TCP/IP subnet mask
- TCP/IP Gateway IP address of intermediate router (optional)

The following parameters are defined for each field device station:

- Field device TCP/IP address
- Field device TCP/IP port (Modbus default is 502)
- Modbus Station address (optional)
- TCP/IP Read time-out (default is 1s)

**Note** On initial wait for each Slave device response to a Modbus request, the PSCA will re-try its receive for up to six times for an effective time-out period of \((6 \times \text{TimeOut}) = \text{Total timeout}\) before indicating No Response and proceeding to the next message. After three No Responses have occurred, the connection will be closed, and the PSCA will periodically attempt to re-establish communications.

- 32–bit data Word ordering (for example, LSW or MSW first)

**Note** First denotes which word is in the lower-numbered register. All 16-bit registers are Big-Endian per standard Modbus convention.

- Open Modbus/TCP IP protocol

The Modbus service is configured at the signal level as follows:

- Signal type
- Register number
- Read/write
- Transfer rate, 0.5, 1, 2, or 4 Hz
- Scaling: Raw min/max, Eng min/max

The service supports function codes 1-7, 15, and 16. It also supports double 16-bit registers for floating point numbers and 32-bit counters. It periodically (10 sec) attempts to re-establish communications with a dead station.

Type casting and scaling of all I/O signals to/from engineering units are supported on the PSCA and the ToolboxST application, for both fixed I/O and Modbus I/O.
# 9.1.3 PSCA Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>PSCA Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channels</td>
<td>6 independently configured serial Modbus Master channels</td>
</tr>
<tr>
<td></td>
<td>1 Ethernet Modbus Master channel (with Simplex IONet configuration)</td>
</tr>
<tr>
<td>Communication Choices</td>
<td>RS-232 mode</td>
</tr>
<tr>
<td></td>
<td>RS-422 mode</td>
</tr>
<tr>
<td></td>
<td>RS-485 mode, half-duplex only</td>
</tr>
<tr>
<td></td>
<td>Ethernet Modbus mode</td>
</tr>
<tr>
<td>RS-232 Mode</td>
<td>Cable distance: 15 m (50 ft)</td>
</tr>
<tr>
<td></td>
<td>Communication Rate: up to 115.2 kbps</td>
</tr>
<tr>
<td>RS-422 Mode</td>
<td>Cable distance: 305 m (1000 ft)</td>
</tr>
<tr>
<td></td>
<td>Communication Rate: up to 115.2 kbps</td>
</tr>
<tr>
<td></td>
<td>Number of drops: 8</td>
</tr>
<tr>
<td>RS-485 Mode</td>
<td>Cable distance: 305 m (1000 ft)</td>
</tr>
<tr>
<td></td>
<td>Communication Rate: up to 375 kbps</td>
</tr>
<tr>
<td>Size</td>
<td>8.26 cm x 4.19 cm x 12.1 cm (3.25 in x 1.65 in x 4.78 in) H x W x D</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface-mount</td>
</tr>
<tr>
<td>Ambient Rating for Enclosure Design</td>
<td>-40 to 70 ºC (-40 to 158 ºF)</td>
</tr>
</tbody>
</table>

*Note* For further details, refer to the *Mark Vle Modbus Master Communication Module Summary Sheet* (GEI-100868).

# 9.1.4 PSCA Diagnostics

The I/O pack performs the following self-diagnostic tests:

- A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and most of the processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set
- Analog inputs such as pressure and position have system limit checking based on configurable high and low levels. These limits can be used to generate alarms, to enable/disable, and as latching/non-latching. RESET_SYS reset the out of limits details of the individual diagnostics are available from the ToolboxST application. The diagnostic signals can be individually latched, and then reset with the RESET_DIA signal if they go healthy.
9.2 PSCA Specific Alarms

The following alarms are specific to the PSCA I/O pack.

32-67

Description  Comm Port #[ ] Node #[ ] Communication Failure - No Response (see alarm help)

Possible Cause  A command was sent to a field device, but no response was received. The Node number refers to the position of the station or device as listed inside the port, as displayed from the Hardware Tab Tree View. The node number is usually the same as the station number, but may not be the same if stations were rearranged.

Solution

- Verify that the serial or Ethernet cable is connected to the field device.
- Verify that the device is powered-on and configured for the correct station ID.
- For serial connections, verify that the baud rate and parity are set correctly.
- For Ethernet connections, verify that the IP address is set correctly.
72-107

Description  Comm Port #[ ] Node #[ ] Communication Failure - Bad Data (see alarm help)

Possible Cause  The field device responded, but could not provide data for one or more points. The Node number refers to the position of the station or device as listed inside the port, as displayed from the Hardware Tab Tree View. The node number is usually the same as the station number, but may not be the same if stations were rearranged.

Solution

• Verify that the point mapping in the ToolboxST configuration matches the slave field device.
• Verify that float values request all 32 bits of the value. A float value requires two registers.

108-113

Description  Configuration Problem Port #[ ]

Possible Cause  The configuration file downloaded from the Toolbox ST application contained an error.

Solution

• Verify that the I/O and configuration compatibility codes agree between the ToolboxST configuration and the PSCA.
• Build and download the firmware and the configuration to the PSCA.
• If diagnostic persists, reboot the PSCA.

114-119

Description  Electric Drive Port #[ ] Save Command failed

Possible Cause  The last parameter set saved to the Kollmorgan drive was not successful.

Solution  The verify step failed after attempting to save parameters to the drive. Retry the Save command to the Kollmorgan drive.
9.3 **SSCA Simplex Serial Communication Input/Output**

### 9.3.1 **SSCA Functional Description**

The Simplex Serial Communication Input/Output (IS410SSCAH2A) terminal board is a compact serial communication terminal board that provides up to six communication channels. Each channel may be configured for RS-232C, RS-485, or RS-422 signaling. The I/O pack plugs into the DC-62 pin connector to communicate with the Mark VIe controller over Ethernet.

### 9.3.2 **SSCA Installation**

The SSCA is DIN-rail mounted using a sheet metal carrier and plastic insulator mount. This assembly will also bolt directly into a cabinet. SSCAH2 has a right-angle header accepting a range of commercially available pluggable terminal blocks, with 48 terminals.

**Note**  There is no shield termination strip with this design.

Typically, the SSCA uses #18 AWG (shielded twisted pair) wiring. The I/O cable shield termination is on an external mounting bracket supplied by the customer or by GE. The chassis ground connection uses E1 and E2 as mounting holes. One of the SCOM terminals (37-48) must be connected to a suitable shield ground.
9.3.3 SSCA Operation

The SSCA includes six connection points for each of the six serial communication channels. The points include four signal lines A-D, a signal return, and a shield common (SCOM).

### Signal Assignments

<table>
<thead>
<tr>
<th>Protocol</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Cable Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-422</td>
<td>TX+</td>
<td>TX-</td>
<td>RX+</td>
<td>RX-</td>
<td>Up to 305 m (1000 ft)</td>
</tr>
<tr>
<td>RS-485</td>
<td>TX/RX+</td>
<td>TX/RX-</td>
<td>Jumper from A</td>
<td>Jumper from B</td>
<td>Up to 305 m (1000 ft)</td>
</tr>
<tr>
<td>RS-232C</td>
<td>DTR/RTS</td>
<td>TX</td>
<td>CTS</td>
<td>RX</td>
<td>Up to 15 m (50 ft) or 2500 pF</td>
</tr>
</tbody>
</table>

The return for RS-232C is through the terminal called Ret. The signals for all six serial communication channels are arranged in the same order, which is SCOM, A, B, C, D, Ret when viewed from left to right.

The groups of six signals for a serial channel are assigned to terminals adjacent to each other. When viewed from left to right, the channels on the bottom set of terminals are 5, 4, and 1. The top set of terminals contain channels 6, 3, and 2 when viewed from left to right. The board SCOM connections are grouped on the right side of the terminals. A signal location diagram is included on the SSCA.

### Terminal Board Screw Connections

<table>
<thead>
<tr>
<th>Connection</th>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port 4</th>
<th>Port 5</th>
<th>Port 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCOM</td>
<td>26</td>
<td>25</td>
<td>13</td>
<td>14</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PT_A</td>
<td>28</td>
<td>27</td>
<td>15</td>
<td>16</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>PT_B</td>
<td>30</td>
<td>29</td>
<td>17</td>
<td>18</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>PT_C</td>
<td>32</td>
<td>31</td>
<td>19</td>
<td>20</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>PT_D</td>
<td>34</td>
<td>33</td>
<td>21</td>
<td>22</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Ret</td>
<td>36</td>
<td>35</td>
<td>23</td>
<td>24</td>
<td>12</td>
<td>11</td>
</tr>
</tbody>
</table>

When using RS-422 or RS-485, a termination resistor must be provided at either end of a transmission line. The SSCA provides selectable termination resistors for each pair of signal lines. Jumpers JP1A and JP1B apply or remove the termination resistors between signals A-B and C-D. The same function is repeated for each serial communication channel. The default jumper position includes a disconnected termination resistor. The SSCA is clearly marked to display the relationship of the termination jumpers and the serial communication channel signals as displayed in the following figure.
In RS-232C systems, it is often not desirable to have a hard ground of the Ret signal path on both ends of a cable. The SSCA includes jumper selectable grounding options for each of the six Ret lines. The line may be grounded through a 100 Ω resistor or through a 0.01 μF capacitor / 1M Ω resistor parallel combination. If the device attached to the SSCA has a hard ground of the Ret line, the capacitive ground should be selected on the SSCA. If there is not a hard ground on the connected equipment, the resistive ground (default position) should be selected on the SSCA.

Ret ground jumpers are identified on the SSCA as JP1R through JP6R. Positions are displayed as resistive (RES) and capacitive (CAP) return connection. All jumpers are clearly labeled.

<table>
<thead>
<tr>
<th>CHANNEL</th>
<th>6</th>
<th>5</th>
<th>3</th>
<th>4</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RES</td>
<td>RET</td>
<td>CAP</td>
<td>GND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**9.3.4 SSCA Specifications**

<table>
<thead>
<tr>
<th>Item</th>
<th>SSCA Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Channels</td>
<td>6</td>
</tr>
<tr>
<td>Termination Resistors</td>
<td>Jumper selectable between open and resistor of 121 Ω</td>
</tr>
<tr>
<td>RS-232C Return Path Ground</td>
<td>Selectable between resistive ground of 100 Ω, ½ W, 1% or 1M Ω, ½ W, 1% in parallel with 0.01 μF, 500 V, 10% capacitor</td>
</tr>
<tr>
<td>Max Drops in RS-485 Systems</td>
<td>8</td>
</tr>
<tr>
<td>Size</td>
<td>15.9 cm x 10.2 cm (6.25 in x 4.0 in) H x W</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface-mount</td>
</tr>
</tbody>
</table>

**9.3.5 SSCA Diagnostics**

The JA connector on the terminal board has its own ID device that is interrogated by the I/O pack. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and J connector location. When this chip is read by the I/O processor and a mismatch is encountered, a hardware incompatibility fault is generated.
9.3.6 **SSCA Configuration**

For the six serial communication channels:

- Jumpers JP1A through JP6A apply or remove termination resistors between signal lines A and B
- Jumpers JP1B through JP6B apply or remove termination resistors between signal lines C and D
- Jumpers JP1R through JP6R select whether the return has a resistive or capacitive connection to SCOM.

All other configuration is performed from the ToolboxST application. Electronic selection of the serial communications method, either RS-232C, RS-422, or RS-485, is internal to the I/O pack.

### 9.3.6.1 RS-232C (Point-to-point)

- It is often not desirable to have a hard ground of the Ret signal path on both ends of a cable. SSCA includes jumper selectable grounding options for each of the six Ret lines.
- The line may be grounded through a 100 Ω resistor or, through a 0.01 uF capacitor / 1 M Ω resistor parallel combination.
- If the device attached to SSCA features a hard ground of the Ret line then the capacitive ground should be selected on SSCA. If there is not a hard ground on the connected equipment then the resistive ground (default position) should be selected on SSCA.
- Ret ground jumpers are identified on SSCA as JP1R through JP6R. Positions are displayed as RES and CAP for resistive and capacitive return connection. The jumpers are clearly labeled on the SSCA.

In general, if the information on third-party side hardware configuration (hard ground or not) is available during pre-FAT, keep Ret with resistance ground. The JP#R stays connected to RES (Default), and configuration must match the ToolboxST application configuration, as displayed in the following diagram.

![Channel Diagram](image)

**Note** If a computer is connected as a test simulation device (with MODSIM running), the wire from Pin-5 of D-Type connector must be connected to SCOM1.

#### Terminal Board Screw Connections

<table>
<thead>
<tr>
<th>Channel</th>
<th>SCOM</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>RET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel 1</td>
<td>26</td>
<td>28</td>
<td>30</td>
<td>32</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>Channel 2</td>
<td>25</td>
<td>27</td>
<td>29</td>
<td>31</td>
<td>33</td>
<td>35</td>
</tr>
<tr>
<td>Channel 3</td>
<td>13</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>Channel 4</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Channel 5</td>
<td>02</td>
<td>04</td>
<td>06</td>
<td>08</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Channel 6</td>
<td>01</td>
<td>03</td>
<td>05</td>
<td>07</td>
<td>09</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protocol</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Cable Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-422</td>
<td>TX+</td>
<td>TX-</td>
<td>RX+</td>
<td>RX-</td>
<td>Up to 305 m (1000 ft)</td>
</tr>
<tr>
<td>RS-485</td>
<td>TX/RX+</td>
<td>TX/RX-</td>
<td>Jumper from A</td>
<td>Jumper from B</td>
<td>Up to 305 m (1000 ft)</td>
</tr>
<tr>
<td>RS-232C</td>
<td>DTR/RTS</td>
<td>TX</td>
<td>CTS</td>
<td>RX</td>
<td>Up to 15 m (50 ft) or 2500 pF</td>
</tr>
</tbody>
</table>
### 9.3.6.2 RS-232C to Third-party Device (Slave)

- B (TX) to third-party device (Slave) RX
- D (RX) to third-party device (Slave) TX
- A (DTR/RTS) to third-party device (Slave) CTS
- C (CTS) to third-party device (Slave) RTS
- I/O pack SSCA out (TX) —+———–+– (RX)
- I/O pack SSCA out (RX) —+———–+– (TX)
- I/O pack SSCA out (DTR/RTS) —+———–+– (CTS)
- I/O pack SSCA out (CTS) —+———–+– (RTS)

<table>
<thead>
<tr>
<th>Protocol RS-232C</th>
<th>DTR/TRS</th>
<th>TX</th>
<th>CTS</th>
<th>RX</th>
<th>SCOM</th>
<th>RET</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSCA SIDE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHANNEL 1</td>
<td>28</td>
<td>30</td>
<td>32</td>
<td>34</td>
<td>26</td>
<td>36</td>
</tr>
<tr>
<td>CHANNEL 2</td>
<td>27</td>
<td>29</td>
<td>31</td>
<td>33</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>CHANNEL 3</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>CHANNEL 4</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>CHANNEL 5</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>CHANNEL 6</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>
9.3.6.3 **RS-422**

- There is the need to provide a termination resistor at either end of a transmission line.
- SSCA provides selectable termination resistors for each pair of signal lines.
- Jumpers JP#A and JP#B apply or remove the termination resistors between signals A-B and C-D.
- Above Point 3 function is repeated for each serial communication channel. The default jumper position is to disconnect the termination resistor.
- The SSCA is clearly marked to display the relationship of the termination jumpers and the serial communication channel signals.

The configuration at SSCA jumper (JP#A, JP#B set to IN) must match the ToolboxST configuration as displayed in the following diagram. The 120 Ω resistance selection is used as an example.

![Terminal Board Screw Connections](image)

<table>
<thead>
<tr>
<th>Channel</th>
<th>SCOM</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>RET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel 1</td>
<td>26</td>
<td>28</td>
<td>30</td>
<td>32</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>Channel 2</td>
<td>25</td>
<td>27</td>
<td>29</td>
<td>31</td>
<td>33</td>
<td>35</td>
</tr>
<tr>
<td>Channel 3</td>
<td>13</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>Channel 4</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Channel 5</td>
<td>02</td>
<td>04</td>
<td>06</td>
<td>08</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Channel 6</td>
<td>01</td>
<td>03</td>
<td>05</td>
<td>07</td>
<td>09</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protocol</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Cable Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-422</td>
<td>TX+</td>
<td>TX-</td>
<td>RX+</td>
<td>RX-</td>
<td>Up to 305 m (1000 ft)</td>
</tr>
<tr>
<td>RS-485</td>
<td>TX/RX+</td>
<td>TX/RX-</td>
<td>Jumper from A</td>
<td>Jumper from B</td>
<td>Up to 305 m (1000 ft)</td>
</tr>
<tr>
<td>RS-232C</td>
<td>DTR/RTS</td>
<td>TX</td>
<td>CTS</td>
<td>RX</td>
<td>Up to 15 m (50 ft) or 2500 pF</td>
</tr>
</tbody>
</table>
9.3.6.4 **RS-485 Half-duplex to Third-party Device (Slave)**

- A (TX/RX+) to third-party device (Slave) TX/RX+
- B (TX/RX-) to third-party device (Slave) TX/RX-
- C – Jumper from A
- D – Jumper from B

**Note**  Put A/B termination **In**, but leave C/D termination **Out** on the terminal board.

<table>
<thead>
<tr>
<th>Protocol RS-485</th>
<th>Slave Device Side</th>
<th>TX/RX+</th>
<th>TX/RX-</th>
<th>N/A</th>
<th>N/A</th>
<th>SCOM</th>
<th>RET</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSCA SIDE</td>
<td>Media converter pins</td>
<td>DATA +</td>
<td>DATA -</td>
<td>JUMPER</td>
<td>JUMPER</td>
<td>SGND</td>
<td></td>
</tr>
<tr>
<td>CHANNEL 1</td>
<td>RS-485</td>
<td>28</td>
<td>30</td>
<td>28-32</td>
<td>30-34</td>
<td>26</td>
<td>36</td>
</tr>
<tr>
<td>CHANNEL 2</td>
<td>RS-485</td>
<td>27</td>
<td>29</td>
<td>27-31</td>
<td>29-33</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>CHANNEL 3</td>
<td>RS-485</td>
<td>15</td>
<td>17</td>
<td>15-19</td>
<td>17-21</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>CHANNEL 4</td>
<td>RS-485</td>
<td>16</td>
<td>18</td>
<td>16-20</td>
<td>18-22</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>CHANNEL 5</td>
<td>RS-485</td>
<td>4</td>
<td>6</td>
<td>4-8</td>
<td>6-10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>CHANNEL 6</td>
<td>RS-485</td>
<td>3</td>
<td>5</td>
<td>3-7</td>
<td>5-9</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channel</th>
<th>A (TX/RX+)</th>
<th>B (TX/RX-)</th>
<th>C (Jumpered with A)</th>
<th>D (Jumpered with B)</th>
<th>Jumper (JP#A)</th>
<th>Jumper (JP#B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHANNEL 1</td>
<td>28</td>
<td>30</td>
<td>32</td>
<td>34</td>
<td>JP1A - IN</td>
<td>JP1B – OUT</td>
</tr>
<tr>
<td>CHANNEL 2</td>
<td>27</td>
<td>29</td>
<td>31</td>
<td>33</td>
<td>JP2A - IN</td>
<td>JP2B – OUT</td>
</tr>
<tr>
<td>CHANNEL 3</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>JP3A - IN</td>
<td>JP3B – OUT</td>
</tr>
<tr>
<td>CHANNEL 4</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>JP4A - IN</td>
<td>JP4B – OUT</td>
</tr>
<tr>
<td>CHANNEL 5</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>JP5A - IN</td>
<td>JP5B – OUT</td>
</tr>
<tr>
<td>CHANNEL 6</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>JP6A - IN</td>
<td>JP6B – OUT</td>
</tr>
</tbody>
</table>

**Diagram:**

- **Channel A (TX/RX+)**
- **Channel B (TX/RX-)**
- **Channel C (Jumpered with A)**
- **Channel D (Jumpered with B)**
- **Jumper (JP#A)**
- **Jumper (JP#B)**
9.3.6.5  **RS-485 (Half-duplex) – Point-to-point**

A Jumpered C

```
+---------+       +---------+       +---------+       +---------+
PSCA     SSCA IN  RX+   ---       ---       ---       ---       (TX+)   ---       ---       (TX/RX+)
+---------+       +---------+       +---------+       +---------+
```

Remove the termination resistor at
SSCA end if Slave Device (Dev)
has terminator resistor built in

```
<table>
<thead>
<tr>
<th>120 ohm</th>
<th>I/O Pack, SSCA Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dev</td>
<td></td>
</tr>
</tbody>
</table>
```

B Jumpered D

```
PSCA     SSCA IN  RX-   ---       ---       ---       ---       (TX/-)   ---       ---       (TX/RX-)
```

9.3.6.6  **RS-485 (Half-duplex) – Multidrop**

```
(TX/RX+)   ---       (TX/RX+)   ---       (TX/RX+)   ---       (TX/RX+)   ---       (TX/RX+)
```

I/O Pack, SSCA
termination required

```
<table>
<thead>
<tr>
<th>Dev1</th>
<th>Dev2</th>
<th>Dev N-1</th>
<th>Dev N</th>
</tr>
</thead>
</table>
```

Termination resistor
required (unless
device has
terminator built in)

```
(TX/RX-)   ---       (TX/RX-)   ---       (TX/RX-)   ---       (TX/RX-)   ---       (TX/RX-)
```
10  PDM Power Distribution Modules

10.1  Power Distribution Overview

The Power Distribution Modules (PDM) are designed specifically for the Mark control systems. The term PDM is used as a name for all of the individual pieces forming the power distribution for a control system. The PDM uses individual boards to accept and condition primary control power inputs of 125 V dc, 48 V dc, 24 V dc, and 100 to 250 V ac for use in redundant combinations. Applied power is distributed to system terminal boards for use in field circuits and converted to 28 V dc for operation of the Mark VIeS I/O modules. The PDM is divided into two different categories: core and branch.

Core distribution circuits are a portion of the PDM serving as the primary power management for a cabinet or series of cabinets. Input power from one or more sources is received by a corresponding module or board. The power is distributed to terminal boards and one or more bulk power supplies producing 28 V dc power to operate the control electronics. The 28 V power is monitored and distributed by one or more 28 V output boards.

The 28 V dc control power output boards (JPDS and JPDG) can host an IS420PPDAH1B I/O pack to provide power system feedback. Ribbon cables can daisy chain other core boards in the system to the board holding the PPDA. Complete monitoring and system feedback sets this power system apart from conventional methods of power distribution. Bulk power supplies are considered a part of the core PDM system.

Branch circuit boards split the power output from the PDM core components into individual ac and dc circuits for use in the cabinets. Elements receiving power from the branch circuits provide their own power status feedback signals to the control system. Branch circuit elements are usually single circuit boards. Branch circuits do not connect to the PPDA I/O pack for system feedback.

Note  For more information, refer to the Mark VIeS Functional Safety Control Systems Power Distribution Modules (PDM) Application Guide for General Market (GEI-100861) and the Mark VIe Power Distribution Module Summary Sheet (GEI-100870).

10.1.1  Core Components

The following core components have primary control power inputs of 125 V dc, or 24 V dc:

- **IS410JPDE** 24/48 V dc input board mounts on a sheet metal structure. Power input is accepted from a battery and two dc power supplies. An optional dc circuit breaker and filter are available for use with a battery power source. The JPDE board distributes the dc power to terminal boards and other loads. In small systems, JPDE can be used between a battery and 150 W dc power supplies. The JPDE board uses ribbon cable connections for system feedback through the PPDA, including dc bus voltage, ground fault detection, and individual branch circuit status.

- **IS410JPDG** provides distribution of 28 V dc (control power) and 48 V or 24 V dc (wetting power) to other boards within the control system. For both control and wetting power, the JPDG supports dual redundant power supply inputs through external diodes. JPDG provides fuse protection for all 28 V dc and 24/48 V dc outputs. The PPDA I/O pack mounts on the JPDG board.

For wetting power distribution, the JPDG is able to operate at either 24 V dc or 48 V dc. The JPDG supports a floating dc bus for wetting power that is centered on earth by using resistors. It provides voltage feedback through the PPDA to detect system ground faults, and integrates into the PDM system feedback. JPDG can support sensing and diagnostic for two ac signals, which are distributed outside this board.

- **IS410JPDS** 28 V dc control power output board mounts on a sheet metal structure. The JPDS circuit board contains three independent 28 V dc power buses with one bulk power supply input for each bus. Barrier screw terminals connect the power buses when a single bus with multiple supplies is desired. Output circuits from JPDS do not contain fuses with the exception of three auxiliary circuits.
The JPDS uses the current limit of the attached power supplies for branch circuit protection. The PPDA I/O pack mounts on the JPDS board. The JPDS board uses ribbon cable connections for system feedback through the PPDA, including dc bus voltage, power supply status contact feedback, and auxiliary circuit status.

- **IS420PPDA** I/O pack – The optional power diagnostic I/O pack can mount on a JPDG or JPDS board.
- **Vendor Manufactured Control Power Supplies (VMCPS)** – There are only certain VMCPS used with the Mark VIeS control system.

### 10.1.1 PPDA Status Feedback

The Mark VIeS control system can use a PPDA I/O pack for power distribution system feedback. The core JPDx boards can function without a working connection to the PPDA making it a non-critical element of the system. There are no provisions for PPDA redundancy without using a fully redundant set of JPDx boards. The PPDA provides timely information supporting system maintenance. Refer to the section *PPDA Power Distribution System Feedback*.

The PPDA provides five analog signal inputs with an electronic ID for each connected core PDM component. The PPDA checks the ID lines to determine what boards are attached and then populates the corresponding signal space values. The PPDA also operates local indicator lamps displaying system status.

Ribbon cables are used to daisy chain other core boards to the board hosting the PPDA. The I/O pack can identify connected core boards and pass feedback signals to one or two IONet connections. The PPDA has numerous indicator LEDs, providing visual power distribution status. The PPDA does not take direct protective actions. It only reports information to the Mark VIeS controller where corrective action can be programmed. Refer to the section *Valid PDM Core Board Combinations*.

### 10.1.2 Valid PDM Core Board Combinations

The PPDA can receive feedback from as many as six connected core PDM components. The following rules apply when cabling components into a PPDA:

- JPDS or JPDG is selected as the power distribution main board that hosts a PPDA I/O pack.
- A maximum of six boards can be used with a single PPDA I/O pack.
- A single JPDG board counts as three boards due to the large number of PPDA feedback signals.
- A maximum of two of any given board type can be used, with the exception of JPDG; only one of each type of these boards is allowed in chain.
- When JPDG is used in the system, JPDS cannot be used along with JPDG. Only one JPDE can be used along with JPDG. Two JPDGs cannot be used in the power distribution diagnostic daisy chain.

### 10.1.3 Branch Circuit Boards

Branch circuit boards provide additional distribution of dc/ac power for output of the core PDM elements. These boards are not connected to the PPDA feedback cable. Branch circuit boards are identified as:

- **IS410JPDD** distributes a single dc power output into multiple loads. It can be used with a single input of 24 V, 48 V, or 125 V dc. Each load has a switch for maintenance purposes and fuses with a local indicator light.
- **IS2410JPDH** is a 28 V dc power distribution board. This board receives 28 V dc power from the R, S and T power source. It provides up to 24 output connectors of 28 V dc for I/O packs, eight each for R, S and T. These outputs are protected with a positive temperature coefficient fuse. The JPDH board also provides three unprotected 28 V dc outputs to be connected to R, S and T Ethernet switches. The JPDH may also be used in daisy-chain mode to distribute 28 V dc power to more than 24 I/O packs.
10.1.3 Circuit Protection

Circuit protection for the PDM includes:

- Fault current protection limits the current to the capability of the system components.
- Branch circuit system feedback
- Ground fault protection in floating systems
- Redundant applications, if possible

Systems using multiple power applications create the possibility of applying the wrong power to a load or interconnecting power buses. The PDM use specific connector conventions to eliminate this problem. Refer to the Mark VIeS Functional Safety Control Systems Power Distribution Modules (PDM) Application Guide for General Market (GEI-100861) for the specific connectors.

10.1.3.1 P28 Control Power Protection

JPDS and JPDG control power characteristics are as follows:

- The negative side of the JPDS/JPDG is grounded at every I/O pack to functional earth (FE). This grounding aids in the conduction of transient noise to earth. Similarly, the negative side of the 28 V dc distribution section of the JPDG is grounded at every I/O pack to FE. It is impossible to float the JPDS/JPDG power supply.
- The supply voltage provided by the approved power sources can be 28 V ±5%.
- The I/O packs are designed with minimal power disturbance ride-through capability.
- Bulk energy storage is provided by the control power supplies.
- Control power cannot be used for tasks such as contact wetting for field inputs. External connections are controlled and filtered by the terminal board/pack combination.
- JPDS/JPDG support independent control power systems for each controller and associated I/O pack. A redundant control system maintains a separation of control power ensuring system reliability.

P28 System Monitoring

Incoming power is monitored as follows:

- Incoming power is monitored by every I/O pack. An alarm will signal any incoming power that falls below 28 V – 5%. The control can continue to operate with depressed voltage in most cases.
- Depressed voltage effects are dependent on the connected field devices. Determining the voltage required for failure can only be accomplished if the entire system is analyzed.
- A second alarm will be sounded if the control power falls below 16 V. The 16 V alarm can help isolate the source of failure during further analysis.
- JPDS/JPDG provide voltage monitoring for R, S, and T power buses.
- VMCPs include a dry contact status feedback circuit. This contact will be closed when the power supply is operating normally and will open if it is not. The YDIA or other contact input I/O pack reads the status signals as a Boolean value. These values are necessary when multiple supplies are connected in parallel for redundant systems. They provide the only way to determine when one supply is not functioning correctly.
- JPDS power supplies provide four test points, with current limited by 10 kΩ series resistors, used to connect external test equipment.
- JPDG power distribution board provides distribution of 28 V dc (control power) and 48/24 V dc (wetting power) to other boards within the control system. For both control and wetting power, the JPDG supports dual redundant power supply inputs through external diodes. The JPDG provides fuse protection for all 28 V dc and 24/48 V dc outputs. The voltage at common 28 V bus is monitored by the JPDG, and it supports feedbacks for eight fuses in the 28 V dc distribution section.
P28 Branch Circuit Protection

Branch circuit protection, starting at the terminal board and working back toward the power source, is displayed below:

- Terminal boards supplying output power to field devices provide individual branch circuit protection using a small three terminal regulator. The regulator includes a thermal shut down feature that responds quickly to any overload condition.
- All I/O packs have a fast acting solid-state circuit breaker at the power input point. This breaker ensures that any problem with a connected terminal board can not propagate to other system components.
- The pack circuit breaker is used as a soft-start feature for the pack. Hot-plugging the 28 V dc power into a pack results in a very gradual turn-on of the pack. This ensures no other system component can be affected.
- The JPDS board does not use fuses. It is rated for Class I Division 2 (potentially explosive atmosphere) and the use of fuses is not desired. The JPDS wiring is protected by self-restarting devices rate at 1.4 A.
- Each power supply has current limiting on the output. When JPDS is used for distribution, this current limit protects branch circuit wiring. Multiple supplies, exceeding 500 W, use JPDS with external fuses.

Distribution component design provides control power branch circuit protection. Specific areas that require monitoring are:

- Supply current limit protecting wiring cannot exceed 500 W. The maximum allowable wire size must be used in the Mate-N-Lok connectors.
- Maximum allowable wire sizes must also include wiring to Ethernet switches and control rack power supplies.
- Parallel or single 28 V supplies, yielding a total capability greater than 500 W, must include branch circuit protection using JPDG where the protection is included, or JPDS with added external branch circuit protection.

10.1.3.2 125 V dc Power Protection

Characteristics for using a 125 V dc battery as a power source for the PDM are as follows:

- A nominal 125 V dc battery is used as a dc power source for the PDM.
- The maximum voltage the dc battery can feed to the system is 140 V dc.
- The 125 V dc input to 28 V dc output supply, used to supply control electronics, can function down to 70 V dc. Field devices must be reviewed on an individual basis.

**Note** The Mark VIeS control systems can go into over-voltage shutdown should the supplied dc power exceed 145 V dc.

- The 125 V dc battery must be floating with respect to earth. This arrangement eliminates a hard ground on both the positive and negative bus. A single ground fault applied to the system can pass current defined by the centering resistor value and dc bus magnitude. Shift in bus voltage, in respect to earth, can then be detected to indicate a ground fault.
- Ground fault current in a floating battery system is defined by the fixed centering resistance value. The control system is classified as non-hazardous Live because the ground fault current is below dangerous levels.
- The DACA module is designed to coordinate power delivery with a 125 V dc battery. One or two DACA modules, powered by a reliable ac power source, could be used to provide backup power if battery failure occurs.

125 V dc Branch Circuit Protection

JPDD provides branch circuit protection for the 125 V dc power system. JPDD has six switched and fused dc outputs (12 fuses of type depending on board revision).
10.1.3.3 24/48 V dc Power Protection

Characteristics of the 24 V dc power protection system are as follows:

- 24 V dc power distribution is a utility system using a 24 V nominal dc battery. A typical ac system uses one or more dc power supplies for contact wetting and relay outputs.
- The maximum allowable battery voltage is 36 V dc. The Mark VIE controllers can initiate over-voltage shutdown when the battery output voltage exceeds the allowable limit.
- The 24 V dc input to 28 V dc output powers Mark VIEs control electronics.
- The 24 V dc battery has no hard ground on either the positive or the negative dc bus. A high resistance from the positive and negative dc is applied to earth to center the bus on earth. A single ground fault applied to this system can pass current defined by centering resistor value and dc bus magnitude. The shift in voltage, with respect to earth, can be detected and signal the presence of a ground fault.
- The JPDE board provides centering resistors selected by using JP1. In the event the battery has external centering resistors on the battery bus, JP1 could be eliminated to avoid higher ground fault currents.
- The JPDE board is designed application using dc input filtering. Additional input filters are not needed.
- The JPDG power distribution board provides distribution of 28 V dc (control power) and 48 V/24 V dc (wetting power) to other boards within the control system. For both control and wetting power, the JPDG supports dual redundant power supply inputs through external diodes. The JPDG provides fuse protection for all 28 V dc and 24/48 V dc outputs. The voltage at common 24/48 V bus is monitored by the JPDG, and it supports feedbacks for 14 fuses in the 24/48 V dc distribution section.

For the 48 V dc power protection system, the JPDE may be configured to operate correctly using 48 V dc input power for power distribution.
10.2 PPDA Power Distribution System Feedback

The Power Distribution Diagnostic Feedback I/O pack (IS420PPDAH1B) produces system feedback signals for power bus voltages, branch circuit status, ground fault detection, and bulk power supply health from the connected core distribution board(s). The I/O pack accepts inputs from up to a maximum of six power distribution boards or up to six sets of feedback signals. It conditions the board feedback signals and provides a dual redundant Ethernet interface to the controllers. The PPDA feedback is structured to be plug and play, using electronic IDs to determine the power distribution boards wired into it. This information is then used to populate the IONet output providing correct feedback from connected boards.

The PPDA I/O pack is hosted by the JPDS or JPDG 28 V dc control power distribution board. Additional boards are connected using 50-pin ribbon cable jumpers that are wired pin 1 to pin 1. Each board contributes one feedback group to the PPDA. The PPDA I/O pack is compatible with the feedback signals created by the JPDE.

10.2.1 PPDA Compatibility

At the heart of the core PDM is the PPDA I/O pack. This I/O pack is designed to accept inputs from up to six different power distribution boards, condition the signals, and provide a dual redundant Ethernet interface to the controllers. The feedback is structured to be plug and play meaning the PPDA is able to check the power distribution boards that are wired into it using electronic IDs. It uses this information along with ToolboxST configuration to populate the IONet signal space output with the correct feedback signals from connected boards.

The PPDA I/O pack is hosted by the JPDS or JPDG 28 V dc control power boards on the PDM. It is compatible with the feedback signals created by JPDE.

The following are PPDA I/O pack versions and minimum software requirements:

- The PPPDAH1B contains BPPC processor board that is supported in the ControlST software V04.07 and later.
- With PPDAH1B and ControlST software V05.02 or later, the PPDA can be used to send power distribution feedback data to the Mark VIeS Safety controller.
- With ControlST V5.02 or later, the PPDA no longer supports a board-mounted accelerometer. Be aware if upgrading from a previous version, the ToolboxST application does not identify existing use of connected accelerometer variables.
10.2.2 PPDA Signal Input

The PPDA I/O pack features a 62-pin connector to the host board. It is helpful to review the pin assignments on that connector:

The signals shown in red are predefined for all I/O packs that use the 62-pin connector. This ensures that if a I/O pack is mounted to an incorrect board, there will not be power or ID wiring problems. The diagram arrangement displays six clear groups of signals. Each group consists of a feedback ground reference, five analog signals, and two wires for an ID line. Each group originates on a JPDx board with each board type providing a different set of signal definitions. On the PPDA each analog signal is sensed differentially with respect to the group Fdbk_Ground providing substantial immunity to common mode noise and differences between the I/O pack ground (FE) and the JPDx board ground (sometimes PE). The ID line for each group allows the PPDA to identify the board that is driving the signals of each group and respond accordingly. The PPDA provides a modest amount of output power using DINPWR and SCOM to support boards where a fully passive feedback circuit is not possible. This power passes straight through the ribbon cable to all connected boards.
### 10.2.3 PPDA LED Control

The PPDA I/O pack includes a full set of 24 LEDs to indicate power supply status. The function of most is fixed in firmware, while four provide an opportunity for application specific indications.

<table>
<thead>
<tr>
<th>LED</th>
<th>I/O Pack Text</th>
<th>Signal Content</th>
<th>Firmware</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pb R</td>
<td>Pbus R is in regulation</td>
<td>Magnitude is 28 ±5%</td>
</tr>
<tr>
<td>2</td>
<td>Pb S</td>
<td>Pbus S is in regulation (not used on JPDG)</td>
<td>Magnitude is 28 ±5%</td>
</tr>
<tr>
<td>3</td>
<td>Pb T</td>
<td>Pbus T is in regulation (not used on JPDG)</td>
<td>Magnitude is 28 ±5%</td>
</tr>
<tr>
<td>4</td>
<td>RSrc</td>
<td>All R Pbus Sources OK</td>
<td>R PBUS power supply status switch OK</td>
</tr>
<tr>
<td>5</td>
<td>SSrc</td>
<td>All S Pbus Sources OK</td>
<td>S PBUS power supply status switch OK</td>
</tr>
<tr>
<td>6</td>
<td>TSrc</td>
<td>All T Pbus Sources OK (not used on JPDG)</td>
<td>T PBUS power supply status switch OK</td>
</tr>
<tr>
<td>7</td>
<td>Aux</td>
<td>Aux 28 outputs OK</td>
<td>All three aux boolean OK</td>
</tr>
<tr>
<td>8</td>
<td>125V</td>
<td>125 V battery volts OK</td>
<td>Magnitude is 125 V ± configurable</td>
</tr>
<tr>
<td>9</td>
<td>125G</td>
<td>125 V battery floating</td>
<td>Volts centered within ± V configurable</td>
</tr>
<tr>
<td>10</td>
<td>125D</td>
<td>125 V JPDD feeds OK</td>
<td>Output to JPDD boolean values OK</td>
</tr>
<tr>
<td>11</td>
<td>125P</td>
<td>125 V Pbus feeds OK</td>
<td>Booleans on pwr supply feeds OK</td>
</tr>
<tr>
<td>12</td>
<td>App1</td>
<td>Application driven</td>
<td>Driven by signal space input boolean</td>
</tr>
<tr>
<td>13</td>
<td>24V</td>
<td>24 V battery volts OK</td>
<td>Magnitude is 24 V ± configurable</td>
</tr>
<tr>
<td>14</td>
<td>24G</td>
<td>24 V battery floating</td>
<td>Volts centered within ± V configurable</td>
</tr>
<tr>
<td>15</td>
<td>24D</td>
<td>24 V JPDD feeds OK</td>
<td>Output to JPDD boolean values OK</td>
</tr>
<tr>
<td>16</td>
<td>24P</td>
<td>24 V Pbus feeds OK</td>
<td>Booleans on pwr supply feeds OK</td>
</tr>
<tr>
<td>17</td>
<td>App2</td>
<td>Application driven</td>
<td>Driven by signal space input boolean</td>
</tr>
<tr>
<td>18</td>
<td>App3</td>
<td>Application driven</td>
<td>Driven by signal space input boolean</td>
</tr>
<tr>
<td>19</td>
<td>AC 1</td>
<td>AC input 1 is OK</td>
<td>Magnitude is OK, config range</td>
</tr>
<tr>
<td>20</td>
<td>AC 2</td>
<td>AC input 2 is OK</td>
<td>Magnitude is OK, config range</td>
</tr>
<tr>
<td>21</td>
<td>AC A</td>
<td>AC1 Outputs OK</td>
<td>JPDB AC1 output boolean values OK</td>
</tr>
<tr>
<td>22</td>
<td>AC P</td>
<td>AC2 Outputs OK</td>
<td>JPDB AC2 output boolean values OK</td>
</tr>
<tr>
<td>23</td>
<td>JPDR</td>
<td>JPDR Src. Select OK</td>
<td>Status feedback from JPDR is OK</td>
</tr>
<tr>
<td>24</td>
<td>Fault</td>
<td>Application driven</td>
<td>Driven by signal space input boolean</td>
</tr>
</tbody>
</table>
Unless specified, each LED is turned on to indicate OK operation. In order to keep the LED operation simple, the LEDs only reflect the status of the first board of any type in the system. The application driven LEDs are used if there is a desire to visually indicate some aspect of a dual-board arrangement.

Using the LED number as a reference, a detailed description of the operation of each LED follows:

1. This LED indicates that the PBUS power on JPDS that feeds the R control is within 28 V ±5%. In the case where two JPDS boards are used the LED reflects the status of the board that holds the PPDA I/O pack. Since JPDS is the host for the PPDA this LED should always be functional.

2. This is the same as LED #1, except it uses the magnitude of the S power bus.

3. This is the same as LED #1, except it uses the magnitude of the T power bus.

4. This LED is driven from the status feedback switch that may be wired into the JPDS R power bus power supply input connector. The sense of the LED is to turn it on when the switch is closed.

5. This is the same as LED #4, except it uses the switches from the S power supplies.

6. This is the same as LED #4, except it uses the switches from the T power supplies.

7. The JPDS has three Aux outputs protected by self-resetting fuses. This LED indicates that all three outputs, JAR, JAS, and JAT, are providing output voltage.

8. This LED is driven by a signal space input to the PPDA from application code.

9. The JPDE creates a high-reliability 24 V or 48 V dc bus using a battery input and other sources. This LED indicates that the bus is above a specified threshold that indicates sufficient voltage. Voltage is read as the difference between the positive and negative dc voltage inputs.

10. The JPDE dc voltage is typically centered on earth such that each voltage input indicates about half of the total dc volts. If there is a ground on the dc system most of the voltage will appear on one or the other dc signal. This LED is turned on when the dc is centered within a specified threshold.

11. This LED indicates that JPDE connectors JS1, JS2, and JS3 have voltage present.

12. This LED indicates that JPDE connectors JFA, JFB, and JFC have voltage present.

13. This LED is driven by a signal space input to the PPDA from application code.

14. This LED is driven by a signal space input to the PPDA from application code.

15. Placeholder for future ac source selector status indication.

16. This LED is driven by a signal space input to the PPDA from application code.
10.2.4 PPDA Installation

In 240 V ac applications, do not inadvertently cross-connect the 240 V ac and the dc voltages. The peak voltage will exceed the Transorb rating, resulting in a failure.

Most ac supplies operate with a grounded neutral, and if an inadvertent connection between the 125 V dc and the ac voltage is created, the sum of the ac peak voltage and the 125 V dc is applied to Transorbs connected between dc and ground. However, in 120 V ac applications, the Transorb rating can withstand the peak voltage without causing a failure.

➢➢ To install the PPDA I/O pack

1. Securely mount the desired terminal board.

2. Directly plug the PPDA I/O pack into the JA1 terminal board connectors. The PPDA I/O pack mounts on a JPDG or JPDS 28 V dc control power distribution board. Refer to the section **Valid PDM Core Board Combinations**.

3. Mechanically secure the I/O pack using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-62 pin connector between the I/O pack and the terminal board. The adjustment should only be required once in the service life of the product.

4. Plug in one or two Ethernet cables depending on the system configuration. The I/O pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.

5. Apply power to the pack by plugging in the connector on the side of the pack. It is not necessary to remove power from the cable before plugging it in because the I/O pack has inherent soft-start capability that controls current inrush on power application.

6. Connect ribbon cables from connector P2 on JPDG or JPDS to daisy chain other core boards feeding information to PPDA.

**Note** Additional power distribution feedback signals may be brought into the PPDA I/O pack through the P2 connector on the host board. The P1 connector is never used on a board that hosts the PPDA I/O pack, PPDA must always be at the end of the feedback cable daisy chain.

7. Use the ToolboxST application to configure the I/O pack as necessary. From the Component Editor, press F1 for help.
10.2.4.1 Signal Routing

The PPDA I/O pack is mounted to either a JPDG or JPDS board. Additional boards can be connected using 50-pin ribbon cable jumpers that are wired pin 1 to pin 1. Each board contributes one feedback group to PPDA. This connection passes through up to five previous boards. In the following figure, feedback groups are displayed as bold lines and connectors P1 and P2 of each board are displayed. From right to left, the JPDS board hosts the PPDA I/O pack and hookups are as follows:

- Local feedback from JDPS is connected to signal group A
- An additional board would use signal group E

![PPDA Basic Signal Routing Example](image)

**Note** The maximum length of the FRC is supported. If one end of the FRC is open, the PPDA may read incorrect values.

10.2.5 PPDA Operation

The following features are common to the distributed I/O modules:

- **BPPx Processor**
- **Processor LEDs**
- **Power Management**
- **ID Line**
- **I/O Module Common Diagnostic Alarms**
### 10.2.6 PPDA Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>PPDA Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback Signals</td>
<td>The PPDA can read feedback signals from different power distribution boards like JPDS, JPDG, and JPDE.</td>
</tr>
<tr>
<td>Number of Boards</td>
<td>Accepts inputs from up to a maximum of six power distribution boards or up to six sets of feedback signals</td>
</tr>
<tr>
<td>JPDS</td>
<td>It uses one set of feedback signals. If JPDS is used in the system, a maximum of five other boards can be supported.</td>
</tr>
<tr>
<td>JPDG</td>
<td>It uses three sets of feedback signals. If JPDG is used in the system, a maximum of three other boards can be supported.</td>
</tr>
<tr>
<td>Number of Channels</td>
<td>5 channels per feedback set, total 30 channels for six feedback sets</td>
</tr>
<tr>
<td>Input Converter Resolution</td>
<td>16 bit analog-to-digital converter</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>5.3 W typical, 6.2 W worst case</td>
</tr>
<tr>
<td>Size</td>
<td>8.26 cm x 4.19 cm x 12.1 cm (3.25 in x 1.65 in x 4.78 in) H W X D</td>
</tr>
<tr>
<td>Technology</td>
<td>Surface mount</td>
</tr>
<tr>
<td>Ambient Rating for Enclosure Design</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
</tbody>
</table>

**Note** For further details, refer to the Mark VIe Power Distribution Module Summary Sheet (GEI-100870) and the Mark VIeS Functional Safety Control Systems Power Distribution Modules (PDM) Application Guide for General Market (GEI-100861).
10.2.7 PPDA Diagnostics

The PPDA performs the following self-diagnostic tests:

- A power-up self-test including checks of RAM, flash memory, Ethernet ports, and most of the processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition card, and processor card confirming the hardware set matches, followed by a check confirming the application code loaded from flash memory is correct for the hardware set
- The analog input hardware includes precision reference voltages in each scan. Measured values are compared against expected values and are used to confirm health of the A/D converter circuits.
- Details of the individual diagnostics are available from the ToolboxST application. The diagnostic signals are individually latched, and then reset with the RESET_DIA signal if they go healthy.

### Power Distribution LEDs

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Description</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb R</td>
<td>Yellow</td>
<td>Pbus R is in Regulation</td>
<td>Pbus_R_LED</td>
</tr>
<tr>
<td>Pb S</td>
<td>Yellow</td>
<td>Pbus S is in Regulation (not used on JPDG)</td>
<td>Pbus_S_LED</td>
</tr>
<tr>
<td>Pb T</td>
<td>Yellow</td>
<td>Pbus T is in Regulation (not used on JPDG)</td>
<td>Pbus_T_LED</td>
</tr>
<tr>
<td>RSrc</td>
<td>Yellow</td>
<td>All R Pbus Sources OK</td>
<td>Src_R_LED</td>
</tr>
<tr>
<td>SSrc</td>
<td>Yellow</td>
<td>All S Pbus Sources OK</td>
<td>Src_S_LED</td>
</tr>
<tr>
<td>TSrc</td>
<td>Yellow</td>
<td>All T Pbus Sources OK (not used on JPDG)</td>
<td>Src_T_LED</td>
</tr>
<tr>
<td>Aux</td>
<td>Yellow</td>
<td>Aux 28 outputs OK</td>
<td>Aux_LED</td>
</tr>
<tr>
<td>125V</td>
<td>Yellow</td>
<td>125 V battery volts OK</td>
<td>Batt_125V_LED</td>
</tr>
<tr>
<td>125G</td>
<td>Yellow</td>
<td>125 V battery floating</td>
<td>Batt_125G_LED</td>
</tr>
<tr>
<td>125D</td>
<td>Yellow</td>
<td>125 V JPDD feeds OK</td>
<td>JPDD_125D_LED</td>
</tr>
<tr>
<td>125P</td>
<td>Yellow</td>
<td>125 V Pbus feeds OK</td>
<td>Pbus_125P_LED</td>
</tr>
<tr>
<td>App1</td>
<td>Yellow</td>
<td>Application driven</td>
<td>App_1_LED</td>
</tr>
<tr>
<td>24V</td>
<td>Yellow</td>
<td>24/48 V battery volts OK</td>
<td>Batt_24V_LED</td>
</tr>
<tr>
<td>24G</td>
<td>Yellow</td>
<td>24/48 V battery floating</td>
<td>Batt_24G_LED</td>
</tr>
<tr>
<td>24D</td>
<td>Yellow</td>
<td>24/48 V JPDD feeds OK</td>
<td>JPDD_24D_LED</td>
</tr>
<tr>
<td>24P</td>
<td>Yellow</td>
<td>24/48 V Pbus feeds OK</td>
<td>Pbus_24P_LED</td>
</tr>
<tr>
<td>App2</td>
<td>Yellow</td>
<td>Application driven</td>
<td>App_2_LED</td>
</tr>
<tr>
<td>App3</td>
<td>Yellow</td>
<td>Application driven</td>
<td>App_3_LED</td>
</tr>
<tr>
<td>AC1</td>
<td>Yellow</td>
<td>Ac input 1 OK</td>
<td>AC_Input1_LED</td>
</tr>
<tr>
<td>AC2</td>
<td>Yellow</td>
<td>Ac input 2 OK</td>
<td>AC_Input2_LED</td>
</tr>
<tr>
<td>ACA</td>
<td>Yellow</td>
<td>Ac JPDA feeds OK</td>
<td>AC_JPDA_LED</td>
</tr>
<tr>
<td>ACP</td>
<td>Yellow</td>
<td>Ac Pbus feeds OK</td>
<td>AC_Pbus_LED</td>
</tr>
<tr>
<td>Fault</td>
<td>Red</td>
<td>Fault Led - Application driven</td>
<td>Fault_LED</td>
</tr>
</tbody>
</table>
10.2.8 PPDA Configuration

The PPDA I/O pack uses configuration values for operation with desired PDM boards. The ToolboxST application provides the correct options for the version of PDM hardware in use in a given system. A brief summary of the types of configurations encountered are as follows:

• JPDG:
  − P28 feedback and diagnostics can be turned on/off. Keeping them on is recommended.
  − The 24/48 V bus magnitude and centering tolerance can be configured, and the diagnostic associated with switched branch circuit fuse status can be turned on or off.
• JPDE: The 24 V bus magnitude and centering tolerance can be configured, and the diagnostic associated with switched branch circuit fuse status can be turned on or off.
• JPDS: The PPDA needs to know if P28R, S, and T can be present in a system. If it is indicated that one is not present, the low voltage diagnostics for that power bus can be turned off.
• PPDA: The I/O pack needs to know what PDM boards are in the diagnostic daisy chain.

**Note** If two JPDS boards are present, it is recommended that one of the boards' inputs be disabled.
### 10.2.8.1 Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3DIAG_PPDA_R</td>
<td>I/O Diagnostic indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>LINK_OK_PPDA_R</td>
<td>I/O Link Okay indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>ATTN_PPDA_R</td>
<td>I/O Attention indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>PS18V_PPDA_R</td>
<td>I/O 18 V Power Supply indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>PS28V_PPDA_R</td>
<td>I/O 28 V Power Supply indication</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>IOPackTmpr_R</td>
<td>I/O pack temperature (° F)</td>
<td>AnalogInput</td>
<td>REAL</td>
</tr>
<tr>
<td>Pbus_R_LED</td>
<td>Pbus R is in Regulation</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Pbus_S_LED</td>
<td>Pbus S is in regulation</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Pbus_T_LED</td>
<td>Pbus T is in regulation</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Src_R_LED</td>
<td>All R Pbus sources OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Src_S_LED</td>
<td>All S Pbus sources OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Src_T_LED</td>
<td>All T Pbus sources OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Aux_LED</td>
<td>Aux 28 outputs OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Batt_125V_LED</td>
<td>125 V battery volts OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Batt_125G_LED</td>
<td>125 V battery floating</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>JPDD_125D_LED</td>
<td>125 V JPDD feeds OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Pbus_125P_LED</td>
<td>125 V Pbus feeds OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Batt_24V_LED</td>
<td>24 V battery volts OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Batt_24G_LED</td>
<td>24 V battery floating</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>JPDD_24D_LED</td>
<td>24V JPDD feeds OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Pbus_24P_LED</td>
<td>24 V Pbus feeds OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>AC_Input1_LED</td>
<td>AC input 1 OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>AC_Input2_LED</td>
<td>AC input 2 OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>AC_JPDA_LED</td>
<td>AC JPDA feeds OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>AC_Pbus_LED</td>
<td>AC Pbus feeds OK</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>App_1_LED</td>
<td>Application driven</td>
<td>Output</td>
<td>BOOL</td>
</tr>
<tr>
<td>App_2_LED</td>
<td>Application driven</td>
<td>Output</td>
<td>BOOL</td>
</tr>
<tr>
<td>App_3_LED</td>
<td>Application driven</td>
<td>Output</td>
<td>BOOL</td>
</tr>
<tr>
<td>Fault_LED</td>
<td>Fault Led - application driven</td>
<td>Output</td>
<td>BOOL</td>
</tr>
<tr>
<td>SrcSel_Stat_1</td>
<td>JPDR #1</td>
<td>Input</td>
<td>BOOL</td>
</tr>
</tbody>
</table>

### 10.2.8.2 JPDS Inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS28vEnable</td>
<td>PS 28 V feedback enable; Enable – Enables feedback</td>
<td>Enable, Disable, NoDryCnt</td>
</tr>
<tr>
<td></td>
<td>Disable – Disables feedback and diagnostics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NoDryCnt – Enables feedback, but disables dry contact diagnostics</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable**</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS28vStat_x_y</td>
<td>PS 28 V feedback from Pbus x input</td>
<td>AnalogInput</td>
<td>REAL</td>
</tr>
</tbody>
</table>

** x = R, S, T and y = 1, 2
### 10.2.8.3 JPDS Contact/Fuse

<table>
<thead>
<tr>
<th>Variable**</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>DryCntStat_x_y</td>
<td>Pbus x dry contact status (connector Jx)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>AuxFuseStat_x_y</td>
<td>Pbus x fuse status (connector JAx)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
</tbody>
</table>

** x = R, S, T and y = 1, 2

### 10.2.8.4 JPDG Inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>InputDiagEnable</td>
<td>DC or AC volt diagnostics enable</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>PS28vEnable</td>
<td>PS 28 V feedback enable;</td>
<td>Enable – Enables feedback</td>
</tr>
<tr>
<td></td>
<td>Enable – Enables feedback</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable – Enables feedback and diagnostics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NoDryCnt – Enables feedback, but disables dry contact diagnostics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applicable only to PS28vStat</td>
<td></td>
</tr>
<tr>
<td>DC_24v_Trig_Volt</td>
<td>DC 24 V fault trigger voltage</td>
<td>10 to 60</td>
</tr>
<tr>
<td>Gnd_Mag_Trig_Volt</td>
<td>Ground magnitude fault trigger voltage</td>
<td>1 to 30</td>
</tr>
<tr>
<td>ACFdbkInVoltage</td>
<td>AC feedback input voltage</td>
<td>100 to 250 V</td>
</tr>
<tr>
<td>ACFdbkInTol</td>
<td>AC feedback tolerance</td>
<td>0pct, 5pct, 10pct, 20pct</td>
</tr>
</tbody>
</table>

** x = R, S, T and y = 1, 2
## 10.2.8.5 JPDG Fuse/Dry Contacts

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>FU1_Stat</td>
<td>Main JPDG - FU1 fuse status (connector J1)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU2_Stat</td>
<td>Main JPDG - FU2 fuse status (connector J1)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU3_Stat</td>
<td>Main JPDG - FU3 fuse status (connector J2)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU4_Stat</td>
<td>Main JPDG - FU4 fuse status (connector J2)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU5_Stat</td>
<td>Main JPDG - FU5 fuse status (connector J3)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU6_Stat</td>
<td>Main JPDG - FU6 fuse status (connector J3)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU7_Stat</td>
<td>Main JPDG - FU7 fuse status (connector J4)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU8_Stat</td>
<td>Main JPDG - FU8 fuse status (connector J4)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>DryCntStat_1</td>
<td>Main JPDG - P28 V bus dry contact - 1 status</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>DryCntStat_2</td>
<td>Main JPDG - P28 V bus dry contact - 2 status</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU10_FU11_Stat</td>
<td>Main JPDG - FU10/FU11 fuse status (connector JFA)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU12_FU13_Stat</td>
<td>Main JPDG - FU12/FU13 fuse status (connector JFB)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU14_FU15_Stat</td>
<td>Main JPDG - FU14/FU15 fuse status (connector JFC)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU16_FU17_Stat</td>
<td>Main JPDG - FU16/FU17 fuse status (connector JFD)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU18_FU19_Stat</td>
<td>Main JPDG - FU18/FU19 fuse status (connector JFE)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU20_FU21_Stat</td>
<td>Main JPDG - FU20/FU21 fuse status (connector JFF)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU22_FU23_Stat</td>
<td>Main JPDG - FU22/FU23 fuse status (connector JFG)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>DryCntStat_3</td>
<td>Main JPDG - P24/48 V bus dry contact - 1 status</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>DryCntStat_4</td>
<td>Main JPDG - P24/48 V bus dry contact - 2 status</td>
<td>Input</td>
<td>BOOL</td>
</tr>
</tbody>
</table>

## 10.2.8.6 JPDE Inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>InputDiagEnab</td>
<td>Input diagnostic enable</td>
<td>Enable, Disable</td>
</tr>
<tr>
<td>DC_24v_Trig_Volt</td>
<td>DC 24/48 V fault trigger voltage</td>
<td>10 to 60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable**</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC_24VFdbkMag_x</td>
<td>JPDE x - DC 24/48 V magnitude</td>
<td>AnalogInput</td>
<td>REAL</td>
</tr>
</tbody>
</table>

** x = 1, 2

## 10.2.8.7 JPDE Gnd Volts

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gnd_Mag_Trig_Volt</td>
<td>Ground magnitude fault trigger voltage</td>
<td>1 to 30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable**</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC_24VGnd_FdbkMag_x</td>
<td>JPDE x - ground feedback magnitude</td>
<td>AnalogInput</td>
<td>REAL</td>
</tr>
</tbody>
</table>

** x = 1, 2
## 10.2.8.8 JPDE Fuse

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>FuseDiag</td>
<td>Enable/Disable fuse diagnostic alarm</td>
<td>Enable, Disable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable**</th>
<th>Description</th>
<th>Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>FU11_FU12_Stat_x</td>
<td>JPDE x - FU11/FU12 fuse status (connector JS1)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU21_FU22_Stat_x</td>
<td>JPDE x - FU21/FU22 fuse status (connector JS2)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FU31_FU32_Stat_x</td>
<td>JPDE x - FU31/FU32 fuse status (connector JS3)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FUA1_FUA2_Stat_x</td>
<td>JPDE x - FUA1/FUA2 fuse status (connector JFA)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FUB1_FUB2_Stat_x</td>
<td>JPDE x - FUB1/FUB2 fuse status (connector JFB)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>FUC1_FUC2_Stat_x</td>
<td>JPDE x - FUC1/FUC2 fuse status (connector JFC)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Dry_Cnt_JPS1_Stat_x</td>
<td>JPDE x - Dry Cnt 1 status (connector JPS1)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
<tr>
<td>Dry_Cnt_JPS2_Stat_x</td>
<td>JPDE x - Dry Cnt 2 status (connector JPS2)</td>
<td>Input</td>
<td>BOOL</td>
</tr>
</tbody>
</table>

** x = 1, 2
10.3 PPDA Specific Alarms

The following alarms are specific to the PPDA I/O pack.

32, 35

**Description**  JPDS-[ ] P28v-R volt fdbk (JR/PR connector) out of range

**Possible Cause**
- The 28 V Power supply input is out of range. It is expected to be within ±5% of 28 V.
- The 28 V R power supply has not been connected.
- There could be a power supply problem.

**Solution**
- The input is not used. Set `PS28vEnable` to `Disable`.
- Verify the power supply connections (JR/PR) to the terminal board.
- Verify that the power supply feedback on the **JPDS/M Inputs** tab in the ToolboxST application is within the expected tolerance (±5%).

33, 36

**Description**  JPDS-[ ] P28v-S volt fdbk (JS/PS connector) out of range

**Possible Cause**
- The 28 V Power supply input is out of range. It is expected to be within ±5% of 28 V.
- The 28 V S power supply has not been connected.
- There could be a power supply problem.

**Solution**
- The input is not used. Set `PS28vEnable` to **Disable**.
- Verify the power supply connections (JS/PS) to the terminal board.
- Verify that the power supply feedback on the **JPDS/M Inputs** tab in ToolboxST is within the expected tolerance (±5%).
Description  JPDS-[ ] P28v-T volt fdbk (JT/PT connector) out of range

Possible Cause
- The 28 V Power supply input is out of range. It is expected to be within ±5% of 28 V.
- The 28 V T power supply has not been connected.
- There could be a power supply problem.

Solution
- The input is not used. Set $PS28vEnable$ to $Disable$.
- Verify the power supply connections (JT/PT) to the terminal board.
- Verify that the power supply feedback on the JPDS/M Inputs tab in the ToolboxST application is within the expected tolerance (±5%).

Description  JPDS-[ ] P28v-R contact input (JR connector) indicates PS problem

Possible Cause
- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the terminal board JR connector.
- The power supply contact is not used.

Solution
- Verify the status of the power supply contact and that the power supply is operating correctly.
- Verify the connections between the power supply and the JR connector on the terminal board.
- The JR Input is not used. Set $PS28vEnable$ to $Disable$.
- The power supply is used, but the JR contact feedback is not connected. Set $PS28vEnable$ to $NoDryCnt$ to disable this alarm, but continue to monitor the 28 V power supply input.
**39, 42**

**Description**  JPDS-[ ] P28v-S contact input (JS connector) indicates PS problem

**Possible Cause**

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the terminal board JS connector.
- The power supply contact is not used.

**Solution**

- Verify the status of the power supply contact and that the power supply is operating correctly.
- Verify the connections between the power supply and the JS connector on the terminal board.
- The JS Input is not used. Set $PS28vEnable$ to $Disable$.
- The power supply is used, but the JS contact feedback is not connected. Set $PS28vEnable$ to $NoDryCnt$ to disable this alarm, but continue to monitor the 28 V power supply input.

**40, 43**

**Description**  JPDS-[ ] P28v-T contact input (JT connector) indicates PS problem

**Possible Cause**

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the terminal board JT connector.
- The power supply contact is not used.

**Solution**

- Verify the status of the power supply contact and that the power supply is operating correctly.
- Verify the connections between the power supply and the JT connector on the terminal board.
- The JT Input is not used. Set $PS28vEnable$ to $Disable$.
- The power supply is used, but the JT contact feedback is not connected. Set $PS28vEnable$ to $NoDryCnt$ to disable this alarm, but continue to monitor the 28 V power supply input.
44, 47

Description  JPDS-[ ] P28v-R aux output fuse (JAR connector) not OK

Possible Cause
• The auxiliary output JAR fuse has exceeded its current rating (1.6 A at 20°C) and disabled the auxiliary output.

Solution
• Disconnect the auxiliary output connections and troubleshoot the loading of the auxiliary output beyond 1.6 A.
• The fuse is self-resetting. Refer to help documentation.

45, 48

Description  JPDS-[ ] P28v-S aux output fuse (JAS connector) not OK

Possible Cause
• The auxiliary output JAS fuse has exceeded its current rating (1.6 A at 20°C) and disabled the auxiliary output.

Solution
• Disconnect the auxiliary output connections and troubleshoot the loading of the auxiliary output beyond 1.6 A.
• The fuse is self-resetting. Refer to help documentation.

46, 49

Description  JPDS-[ ] P28v-T aux output fuse (JAT connector) not OK

Possible Cause
• The auxiliary output JAT fuse has exceeded its current rating (1.6 A at 20°C) and disabled the auxiliary output.

Solution
• Disconnect the auxiliary output connections and troubleshoot the loading of the auxiliary output beyond 1.6 A.
• Fuse is self resetting. Refer to help documentation.
50, 53

**Description**  JPDM-[ ] P28v-R volt fdbk (JR/PR connector) out of range

**Possible Cause**
- The 28 V power supply input is out of range. It is expected to be within ±5% of 28 V.
- The 28 V R power supply has not been connected.
- There could be a power supply problem.

**Solution**
- The input is not used. Set PS28vEnable to Disable.
- Verify the power supply connections (JR/PR) to the terminal board.
- Verify that the power supply feedback on the JPDS/M Inputs tab in the ToolboxST application is within the expected tolerance (±5%).

51, 54

**Description**  JPDM-[ ] P28v-S volt fdbk (JS/PS connector) out of range

**Possible Cause**
- The 28 V power supply input is out of range. It is expected to be within ±5% of 28 V.
- The 28 V S power supply has not been connected.
- There could be a power supply problem.

**Solution**
- The input is not used. Set PS28vEnable to Disable.
- Verify the power supply connections (JS/PS) to the terminal board.
- Verify that the power supply feedback on the JPDS/M Inputs tab in the ToolboxST application is within the expected tolerance (±5%).
52, 55

Description  JPDM-[ ] P28v-T volt fdbk (JT/PT connector) out of range

Possible Cause

- The 28 V power supply input is out of range. It is expected to be within ±5% of 28 V.
- The 28 V T power supply has not been connected.
- There could be a power supply problem.

Solution

- The input is not used. Set PS28vEnable to Disable.
- Verify the power supply connections (JT/PT) to the terminal board.
- Verify that the power supply feedback on the JPDS/M Inputs tab in the ToolboxST application is within the expected tolerance (±5%).

56, 59

Description  JPDM-[ ] P28v-R contact input (JR connector) indicates PS problem

Possible Cause

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the terminal board JR connector.
- The power supply contact is not used.

Solution

- Verify the status of the power supply contact, and that the power supply is operating correctly.
- Verify the connections between the power supply and the JR connector on the terminal board.
- The JR input is not used. Set PS28vEnable to Disable.
- The power supply is used, but the JR contact feedback is not connected. Set PS28vEnable to NoDryCnt to disable this alarm, but continue to monitor the 28 V power supply input.
57, 60

**Description**  JPDM-[ ] P28v-S contact input (JS connector) indicates PS problem

**Possible Cause**

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the terminal board JS connector.
- The power supply contact is not used.

**Solution**

- Verify the status of the power supply contact and that the power supply is operating correctly.
- Verify the connections between the power supply and the JS connector on the terminal board.
- The JS input is not used. Set $PS28vEnable$ to *Disable*.
- The power supply is used, but the JS contact feedback is not connected. Set $PS28vEnable$ to *NoDryCnt* to disable this alarm, but continue to monitor the 28 V power supply input.

58, 61

**Description**  JPDM-[ ] P28v-T contact input (JT connector) indicates PS problem

**Possible Cause**

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the terminal board JT connector.
- The power supply contact is not used.

**Solution**

- Verify the status of the power supply contact, and that the power supply is operating correctly.
- Verify the connections between the power supply and the JT connector on the terminal board.
- The JT input is not used. Set $PS28vEnable$ to *Disable*.
- The power supply is used, but the JT contact feedback is not connected. Set $PS28vEnable$ to *NoDryCnt* to disable this alarm, but continue to monitor the 28 V power supply input.
62, 65

Description  JPDM-[ ] P28v-R aux output fuse (JAR connector) not OK

Possible Cause

• The auxiliary output JAR fuse has exceeded its current rating (3.75 A at 20°C, 83 °F) and disabled the auxiliary output.

Solution

• Disconnect the auxiliary output connections and troubleshoot the loading of the auxiliary output beyond 3.75 A.
• The fuse is self-resetting. Refer to the help documentation.

63, 66

Description  JPDM-[ ] P28v-S aux output fuse (JAS connector) not OK

Possible Cause

• The auxiliary output JAS fuse has exceeded its current rating (3.75 A at 20°C, 83 °F) and disabled the auxiliary output.

Solution

• Disconnect the auxiliary output connections and troubleshoot the loading of the auxiliary output beyond 3.75 A.
• The fuse is self-resetting. Refer to the help documentation.

64, 67

Description  JPDM-[ ] P28v-T aux output fuse (JAT connector) not OK

Possible Cause

• The auxiliary output JAT fuse has exceeded its current rating (3.75 A at 20°C, 83 °F) and disabled the auxiliary output.

Solution

• Disconnect the auxiliary output connections and troubleshoot the loading of the auxiliary output beyond 3.75 A.
• The fuse is self-resetting. Refer to the help documentation.
68, 71

Description  JPDM-[ ] fuse FU4 (J1 connector) is blown

Possible Cause
- The specified fuse is blown.
- The 28 V R power supply input is not connected.

Solution
- Replace the fuse.
- Verify the power supply connections to the terminal board.

69, 72

Description  JPDM-[ ] fuse FU5 (J1 connector) is blown

Possible Cause
- The specified fuse is blown.
- The 28 V R power supply input is not connected.

Solution
- Replace the fuse.
- Verify the power supply connections to the terminal board.

70, 73

Description  JPDM-[ ] fuse FU6 (J1 connector) is blown

Possible Cause
- The specified fuse is blown.
- The 28 V R power supply input is not connected.

Solution
- Replace the fuse.
- Verify the power supply connections to the terminal board.
74, 77

**Description**  JPDM-[] fuse FU7 (J2 connector) is blown

**Possible Cause**
- The specified fuse is blown.
- The 28 V S power supply input is not connected.

**Solution**
- Replace the fuse.
- Verify the power supply connections to the terminal board.

75, 78

**Description**  JPDM-[] fuse FU8 (J2 connector) is blown

**Possible Cause**
- The specified fuse is blown.
- The 28 V S power supply input is not connected.

**Solution**
- Replace the fuse.
- Verify the power supply connections to the terminal board.

76, 79

**Description**  JPDM-[] fuse FU9 (J2 connector) is blown

**Possible Cause**
- The specified fuse is blown.
- The 28 V S power supply input is not connected.

**Solution**
- Replace the fuse.
- Verify the power supply connections to the terminal board.
80,83

**Description**  JPDM-[ ] fuse FU10 (J3 connector) is blown

**Possible Cause**
- The specified fuse is blown.
- The 28 V T power supply input is not connected.

**Solution**
- Replace the fuse.
- Verify the power supply connections to the terminal board.

81,84

**Description**  JPDM-[ ] fuse FU11 (J3 connector) is blown

**Possible Cause**
- The specified fuse is blown.
- The 28 V T power supply input is not connected.

**Solution**
- Replace the fuse.
- Verify the power supply connections to the terminal board.

82,85

**Description**  JPDM-[ ] fuse FU12 (J3 connector) is blown

**Possible Cause**
- The specified fuse is blown.
- The 28 V T power supply input is not connected.

**Solution**
- Replace the fuse.
- Verify the power supply connections to the terminal board.
86,89

Description  JPDM-[] fuse FU1 (JCR connector) is blown

Possible Cause

• The specified fuse is blown.
• The 28 V R power supply input is not connected.

Solution

• Replace the fuse.
• Verify the power supply connections to the terminal board.

87,90

Description  JPDM-[] fuse FU2 (JCS connector) is blown

Possible Cause

• The specified fuse is blown.
• The 28 V S power supply input is not connected.

Solution

• Replace the fuse.
• Verify the power supply connections to the terminal board.

88,91

Description  JPDM-[] fuse FU3 (JCT connector) is blown

Possible Cause

• The specified fuse is blown.
• The 28 V T power supply input is not connected.

Solution

• Replace the fuse.
• Verify the power supply connections to the terminal board.
Description  JPDB-[ ] AC In-[ ] [ ]V fdbk (J1 connector) out of range

Possible Cause

- The specified ac input is configured to the wrong nominal voltage value.
- The ac input voltage is out of tolerance from the nominal voltage value.
- The ac source voltage is out of range.
- The ac input is not connected.

Solution

- Verify that the nominal ac input voltage matches the value configured in ACFdbkInVoltage.
- The ac tolerance is set too low. Check that ACFdbkInTol is set to the proper value.
- Verify that the ac supply is within the specified parameters (Refer to the JPDB help documentation.)
- If the ac input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (AC_Fdbk#.Volt) to Disabled.

Description  JPDB-[ ] fuse FU[ ] is blown or SW[ ] switched OFF

Possible Cause

- The specified switch is turned off and FuseDiag is enabled.
- The specified fuse is blown.
- The ac input is not connected.

Solution

- If the switch is turned off (the output is not used), disable the diagnostic by setting FuseDiag to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the ac input connections to the terminal board.
- If the ac input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (AC_Fdbk#.Volt) to Disabled.
**102-103, 110-111**

**Description**  JPDB-[ ] fuse FU-[ ] is blown

**Possible Cause**
- The specified fuse is blown.
- The ac input is not connected.

**Solution**
- Replace the fuse.
- Verify the ac input connections to the terminal board.
- If the ac input is not used, this diagnostic alarm can be disabled by setting the `InputDiagEnab` parameter on the associated input (AC_Fdbk#_Volt) to Disabled.

**112,114**

**Description**  JPDF-[ ] DC 125V magnitude (JD1/JZ2/JZ3 connector) out of range

**Possible Cause**
- The 125 V dc input is less than DC_125v_Trig_Volt.
- DC_125v_Trig_Volt is set too high.
- The 125 V dc source voltage is out of range.
- The 125 V dc input is not connected.

**Solution**
- Verify that DC_125v_Trig_Volt is set correctly.
- If fed from the dc battery Input, check the connections to JD1 and TB1.
- If fed from DACA, check the connections to JZ2 and/or JZ3.
- Verify the grounding of the dc input signals. Refer to the JPDF help for more info.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the `InputDiagEnab` parameter on the associated input (DC_125VFdbkMag) to Disabled.
113, 115

**Description**  JPDF-[] DC 125V Ground magnitude (JD1/JZ2/JZ3 connector) out of range

**Possible Cause**

- The 125 V ground feedback magnitude is greater than Gnd_Mag_Trig_Vol.
- Gnd_Mag_Trig_Vol is set too low.
- One side of the dc 125 V source voltage is grounded.

**Solution**

- Verify that Gnd_Mag_Trig_Vol is set correctly.
- Check the connections to the specified connector.
- Verify the grounding of the dc input signals. Refer to the JPDF help documentation.
- If DC 125V input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.

116, 125

**Description**  JPDF-[] fuse FU1R or FU2R (J1R connector) is blown or SW1R switched OFF

**Possible Cause**

- The SW1R is turned off and FuseDiag is enabled.
- The FU1R or FU2R fuse is blown.
- The 125V dc input is not connected.

**Solution**

- If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.
117, 126

Description  JPDF-[] fuse FU1S or FU2S (J1S connector) is blown or SW1S switched OFF

Possible Cause
- The SW1R is turned off and **FuseDiag** is enabled.
- The FU1S or FU2S fuse is blown.
- The 125 V dc input is not connected.

Solution
- If the switch is turned off (output is not used), disable the diagnostic by setting **FuseDiag** to **Disable**.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.

118, 127

Description  JPDF-[] fuse FU1T or FU2T (J1T connector) is blown or SW1T switched OFF

Possible Cause
- The SW1R is turned off and **FuseDiag** is enabled.
- The FU1T or FU2T fuse is blown.
- The 125 V dc input is not connected.

Solution
- If the switch is turned off (output is not used), disable the diagnostic by setting **FuseDiag** to **Disable**.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the **InputDiagEnab** parameter on the associated input (**DC_125VFdbkMag**) to **Disabled**.
119, 128

**Description**  JPDF-[ ] fuse FU71 or FU72 (J7X connector) is blown or SW7X switched OFF

**Possible Cause**

- The SW7X is turned off and **FuseDiag** is enabled.
- The FU71 or FU72 fuse is blown.
- The 125 V dc input is not connected.

**Solution**

- If the switch is turned off (output is not used), disable the diagnostic by setting **FuseDiag** to **Disable**.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the **InputDiagEnab** parameter on the associated input (DC_125VFdbkMag) to **Disabled**.

120, 129

**Description**  JPDF-[ ] fuse FU73 or FU74 (J7Y connector) is blown or SW7Y switched OFF

**Possible Cause**

- The SW7Y is turned off and **FuseDiag** is enabled.
- The FU73 or FU74 fuse is blown.
- The 125 V dc input is not connected.

**Solution**

- If the switch is turned off (output is not used), disable the diagnostic by setting **FuseDiag** to **Disable**.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the **InputDiagEnab** parameter on the associated input (DC_125VFdbkMag) to **Disabled**.
121, 130

Description  JPDF-[ ] fuse FU75 or FU76 (J7Z connector) is blown or SW7Z switched OFF.

Possible Cause

• The SW7Z is turned off and FuseDiag is enabled.
• The FU75 or FU76 fuse is blown.
• The 125 V dc input is not connected.

Solution

• If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
• If the output is used, verify that the switch is turned on.
• Replace the fuse.
• Verify the 125 V dc input connections to the terminal board.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.

122, 131

Description  JPDF-[ ] fuse FU81 or FU82 (J8A connector) is blown.

Possible Cause

• The FU81 or FU82 fuse is blown.
• The 125 V dc input is not connected.

Solution

• Replace the fuse.
• Verify the 125 V dc input connections to the terminal board.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.
123, 132

Description  JPDF-[ ] fuse FU83 or FU84 (J8B connector) is blown.

Possible Cause

• The FU83 or FU84 fuse is blown.
• The 125 V dc input is not connected.

Solution

• Replace the fuse.
• Verify the 125 V dc input connections to the terminal board.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.

124, 133

Description  JPDF-[ ] fuse FU12 or FU13 (J12 connector) is blown.

Possible Cause

• The FU12 or FU13 fuse is blown.
• The 125 V dc input is not connected.

Solution

• Replace the fuse.
• Verify the 125 V dc input connections to the terminal board.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.

135

Description  PPDA Invalid Combination: More than 2 JPDS boards present

Possible Cause  PPDA allows up to two JPDS boards to be connected as part of the Power Distribution module. The PPDA has detected more than two JPDS boards connected through ribbon cables to the PDM.

Solution

• Verify that only one or two JPDS terminal boards are connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.
136
Description  PPDA Invalid Combination: More than 2 JPDE boards present

Possible Cause  PPDA allows up to two JPDE boards to be connected as part of the Power Distribution module. The PPDA has detected more than two JPDE boards connected through ribbon cables to the PDM.

Solution
• Verify that only one or two JPDE terminal boards are connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.

137
Description  PPDA Invalid Combination: More than 2 JPDF boards present

Possible Cause  PPDA allows up to two JPDF boards to be connected as part of the Power Distribution module. The PPDA has detected more than two JPDF boards connected through ribbon cables to the PDM.

Solution
• Verify that only one or two JPDF terminal boards are connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.

138
Description  PPDA Invalid Combination: More than 2 JPDB boards present

Possible Cause  PPDA allows up to two JPDB boards to be connected as part of the Power Distribution module. The PPDA has detected more than two JPDB boards connected through ribbon cables to the PDM.

Solution
• Verify that only one or two JPDB terminal boards are connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.

139

Note  This alarm is obsolete.

Description  PPDA Invalid Combination: More than 2 JPDR boards present.

Possible Cause  PPDA allows up to two JPDR boards to be connected as part of the Power Distribution module. The PPDA has detected more than two JPDR boards connected through ribbon cables to the PDM.

Solution
• Verify that only one or two JPDR terminal boards are connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.
Note This alarm is obsolete.

**Description**  
PPDA Invalid Combination: Terminal board JPDR-[ ] present without JPDB.

**Possible Cause**  
PPDA requires that a JPDB board be connected to the PDM for each JPDR connected.
- A JPDR board is connected without a JPDB present.
- Two JPDR boards are connected with only one JPDB present.

**Solution**
- Verify that for each JPDR connected through ribbon cable, there is one JPDB present.
- Verify that the ToolboxST configuration matches the hardware configuration.
- Reboot the PPDA after the hardware connections are corrected.

**141-145**

**Description**  
Configured TB at Phy Position-[ ] doesn't match actual H/W.

**Possible Cause**
- The auxiliary terminal board at the specified physical position does not match the ToolboxST configuration.
- The auxiliary terminal boards have been added in the wrong order.

**Solution**
- Verify that the actual hardware matches the auxiliary terminal board configuration in the ToolboxST configuration.
- Verify that the auxiliary board *physical position* matches the *Phy Pos* value in the ToolboxST configuration. (Right-click the PPDA and click **Modify**...)
- **NOTE:** JPDM and JPDC boards assume two feedback channels, so the first connected auxiliary terminal board is in *Phy Pos 2* rather than *Phy Pos 1*. 
146

Description  PPDA Invalid Combination: More than 2 JPDM boards present.

Possible Cause  PPDA allows up to two JPDM boards to be connected as part of the Power Distribution module. The PPDA has detected more than two JPDM boards connected through ribbon cables to the PDM.

Solution
• Verify that only one or two JPDM terminal boards are connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.

147

Description  PPDA Invalid Combination: Both JPDS and JPDM Terminal boards present.

Possible Cause  PPDA does not allow JPDS and JPDM terminal boards to be mixed. The PPDA has detected both JPDS and JPDM terminal boards connected through ribbon cables to the PDM.

Solution
• Verify that there are only JPDS or JPDM boards present, but not both.
• Verify that the ToolboxST configuration matches the hardware configuration.
• Reboot the PPDA after the hardware connections are corrected.

148, 150

Description  JPDE-[ ] 24/48 VDC magnitude (JD1/JPS1/JPS2 connector) out of range.

Possible Cause
• The 24/48 V dc input is less than \texttt{DC\_24v\_Trig\_Volt}.
• \texttt{DC\_24v\_Trig\_Volt} is set too high.
• The 24/48 V dc source voltage is out of range.
• The 24/48 V dc input is not connected.

Solution
• Verify that \texttt{DC\_24v\_Trig\_Volt} is set correctly.
• Check the connections to the specified connector.
• Verify the grounding of the dc input signals. Refer to the JPDE help documentation.
• If 24/48 VDC input is not used, this diagnostic alarm can be disabled by setting the \texttt{InputDiagEnab} parameter on the associated input (\texttt{DC\_24VFdbkMag}) to \texttt{Disabled}.
149, 151

**Description**  JPDE-[ ] DC Voltage Gnd fdbk mag (JD1/JPS1/JPS2 connector) out of range.

**Possible Cause**
- The 24/48 V dc ground feedback magnitude is greater than Gnd_Mag_Trig_Volt.
- Gnd_Mag_Trig_Volt is set too low.
- One side of the 24/48 V dc source voltage is grounded.

**Solution**
- Verify that Gnd_Mag_Trig_Volt is set correctly.
- Check the connections to the specified connector.
- Verify the grounding of the dc input signals. Refer to the JPDE help documentation.
- If 24/48 VDC input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

152, 160

**Description**  JPDE-[ ] fuse FU11/FU12 (JS1 connector) is blown or SWS1 switched OFF.

**Possible Cause**
- The SWS1 is turned off and FuseDiag is enabled.
- The FU11 or FU12 fuse is blown.
- The 24/48 V dc input is not connected.

**Solution**
- If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 24/48 V dc input connections to the terminal board.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.
Description  JPDE-[ ] fuse FU21/FU22 (JS2 connector) is blown or SWS2 switched OFF.

Possible Cause

- The SWS2 is turned off and FuseDiag is enabled.
- The FU21 or FU22 fuse is blown.
- The 24/48 V dc input is not connected.

Solution

- If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 24/48 V dc input connections to the terminal board.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

Description  JPDE-[ ] fuse FU31/FU32 (JS3 connector) is blown or SWS3 switched OFF.

Possible Cause

- The SWS3 is turned off and FuseDiag is enabled.
- The FU31 or FU32 fuse is blown.
- The 24/48 V dc input is not connected.

Solution

- If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 24/48 V dc input connections to the terminal board.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.
155, 163

Description  JPDE-[ ] fuse FUA1/FUA2 (JFA connector) is blown.

Possible Cause

- The FUA1 or FUA2 fuse is blown.
- The 24/48 V dc input is not connected.

Solution

- Replace the fuse.
- Verify the 24/48 V dc input connections to the terminal board.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the `InputDiagEnab` parameter on the associated input (`DC_24VFdbkMag`) to `Disabled`.

156, 164

Description  JPDE-[ ] fuse FUB1/FUB2 (JFB connector) is blown.

Possible Cause

- The FUB1 or FUB2 fuse is blown.
- The 24/48 V dc input is not connected.

Solution

- Replace the fuse.
- Verify 24/48 V dc input connections to the terminal board.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the `InputDiagEnab` parameter on the associated input (`DC_24VFdbkMag`) to `Disabled`.

157, 165

Description  JPDE-[ ] fuse FUC1/FUC2 (JFC connector) is blown.

Possible Cause

- The FUC1 or FUC2 fuse is blown.
- The 24/48 V dc input is not connected.

Solution

- Replace the fuse.
- Verify the 24/48 V dc input connections to the terminal board.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the `InputDiagEnab` parameter on the associated input (`DC_24VFdbkMag`) to `Disabled`. 
158, 166

Description  JPDE-[ ] DC Voltage contact input 1 (JPS1 connector) indicates PS problem.

Possible Cause

• The power supply contact is open. The power supply is not operating normally.
• The power supply dry contact feedback is not connected to the terminal board JPS1 connector.

Solution

• Verify the status of the power supply contact, and that the power supply is operating correctly.
• Verify the connections between the power supply and the JR connector on the JPDE.
• If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

159, 167

Description  JPDE-[ ] DC Voltage contact input 2 (JPS2 connector) indicates PS problem.

Possible Cause

• The power supply contact is open. The power supply is not operating normally.
• The power supply dry contact feedback is not connected to the terminal board JPS2 connector.

Solution

• Verify the status of the power supply contact, and that the power supply is operating correctly.
• Verify the connections between the power supply and the JR connector on the JPDE.
• If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

169

Description  Invalid Terminal board ID at Physical Position [ ].

Possible Cause

• The terminal board ID is not recognized or supported by the current firmware version.
• The electronic terminal board ID is not programmed, or is programmed incorrectly.

Solution

• Upgrade the PPDA firmware to a version that supports the terminal board at the specified physical position. Refer to the help documentation for a list of supported terminal boards.
• Replace the terminal board hardware.
170-171

Description  Input Src Mismatch on JPDF-[ ]: AC src detected at input instead DC.

Possible Cause

• The ac voltage has been detected at the 125 V dc input.

Solution

• Verify the 125 V dc input connections. Use a DVM to verify dc voltage on the input connections.
• Verify that the positive and negative inputs to the 125 V dc bus are connected to the proper terminals. Refer to the JPDF help documentation.

172

Description  JPDC-DC 125V fdbk mag (JD1/JZ2 connector) out of range.

Possible Cause

• The 125 V dc input is less than DC_125v_Trig_Volt.
• DC_125v_Trig_Volt is set too high.
• The 125 V dc source voltage is out of range.
• The 125 V dc input is not connected.

Solution

• Verify that DC_125v_Trig_Volt is set correctly.
• If fed from the dc battery input, check the connections to JD1 and TB1.
• If fed from DACA, check the connections to JZ2.
• Verify the grounding of dc input signals. Refer to the JPDC help documentation.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.
173

Description  JPDC-DC 125V Gnd fdbk mag (JD1/JZ2 connector) out of range.

Possible Cause

• The dc 125 ground feedback magnitude is greater than Gnd_Mag_Trig_Volt.
• Gnd_Mag_Trig_Volt is set too low.
• One side of the DC 125 V source voltage is grounded.

Solution

• Verify that Gnd_Mag_Trig_Volt is set correctly.
• Check the connections to the specified connector.
• Verify the grounding of the dc input signals. Refer to the JPDC help documentation.
• If DC 125V input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.

174

Description  JPDC-Fuse FU71 or FU72 (J7A connector) is blown or SW7A switched OFF.

Possible Cause

• The specified switch is turned off and FuseDiag is enabled.
• The specified fuse is blown.
• The 125 V dc input is not connected.

Solution

• If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
• If the output is used, verify that the switch is turned on.
• Replace the fuse.
• Verify the 125 V dc input connections to the terminal board.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.
Description    JPDC-Fuse FU73 or FU74 (J7B connector) is blown or SW7B switched OFF.

Possible Cause

• The specified switch is turned off and FuseDiag is enabled.
• The specified fuse is blown.
• The 125 V dc input is not connected.

Solution

• If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
• If the output is used, verify that the switch is turned on.
• Replace the fuse.
• Verify the 125 V dc input connections to the terminal board.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.

Description    JPDC-Fuse FU75 or FU76 (J7C connector) is blown or SW7C switched OFF.

Possible Cause

• The specified switch is turned off and FuseDiag is enabled.
• The specified fuse is blown.
• The 125 V dc input is not connected.

Solution

• If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
• If the output is used, verify that the switch is turned on.
• Replace the fuse.
• Verify the 125 V dc input connections to the terminal board.
• If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.
177

Description JPDC-Fuse FU1R or FU2R (J1R connector) is blown or SW1R switched OFF.

Possible Cause

- The specified switch is turned off and FuseDiag is enabled.
- The specified fuse is blown.
- The 125 V dc input is not connected.

Solution

- If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.

178

Description JPDC-Fuse FU1S or FU2S (J1S connector) is blown or SW1S switched OFF.

Possible Cause

- The specified switch is turned off and FuseDiag is enabled.
- The specified fuse is blown.
- The 125 V dc input is not connected.

Solution

- If the switch is turned off (output is not used), disable the diagnostic by setting FuseDiag to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_125VFdbkMag) to Disabled.
**179**

**Description**  JPDC-Fuse FU1T or FU2T (J1T connector) is blown or SW1T switched OFF.

**Possible Cause**

- The specified switch is turned off and **FuseDiag** is enabled.
- The specified fuse is blown.
- The 125 V dc input is not connected.

**Solution**

- If the switch is turned off (output is not used), disable the diagnostic by setting **FuseDiag** to **Disable**.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the 125 V dc input connections to the terminal board.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the **InputDiagEnab** parameter on the associated input (**DC_125VFdbkMag**) to **Disabled**.

**180**

**Description**  Input Src Mismatch on JPDC: AC src detected at input instead DC.

**Possible Cause**

- The ac voltage has been detected at the 125 V dc input.

**Solution**

- Verify the 125 V dc input connections. Use a DVM to verify the dc voltage on the input connections.
- Verify that the positive and negative inputs to the 125 V dc bus are connected to the proper terminals. Refer to the JPDC help documentation.
- If the 125 V dc input is not used, this diagnostic alarm can be disabled by setting the **InputDiagEnab** parameter on the associated input (**DC_125VFdbkMag**) to **Disabled**.
181

**Description**  JPDC-AC [ ]V fdbk (JAC connector) out of range.

**Possible Cause**
- The specified ac input is configured to the wrong nominal voltage value.
- The ac input voltage is out of tolerance from the nominal voltage value.
- The ac source voltage is out of range.
- The ac input is not connected.

**Solution**
- Verify that the nominal ac input voltage matches the value configured in `ACFdbkInVoltage`.
- The ac tolerance is set too low. Verify that `ACFdbkInTol` is set to the proper value.
- Verify that the ac supply is within the specified parameters. Refer to the JPDC help documentation.
- If the ac input is not used, this diagnostic alarm can be disabled by setting the `InputDiagEnab` parameter on the associated input (`AC_VFdbk1_Volt`) to Disabled.

182

**Description**  JPDC-Fuse FUAC1 (JAC1 connector) is blown or SW AC1 switched OFF.

**Possible Cause**
- The specified switch is turned off and `FuseDiag` is enabled.
- The specified fuse is blown.
- The ac input is not connected.

**Solution**
- If the switch is turned off (output is not used), disable the diagnostic by setting `FuseDiag` to Disable.
- If the output is used, verify that the switch is turned on.
- Replace the fuse.
- Verify the ac input connections to the terminal board.
- If the ac input is not used, this diagnostic alarm can be disabled by setting the `InputDiagEnab` parameter on the associated input (`AC_VFdbk1_Volt`) to Disabled.
183

Description  JPDC-Fuse FUAC2 (JAC2 connector) is blown.

Possible Cause

• The specified fuse is blown.
• The ac input is not connected.

Solution

• Replace the fuse.
• Verify the ac input connections to the terminal board.
• If the ac input is not used, this diagnostic alarm can be disabled by setting the \texttt{InputDiagEnab} parameter on the associated input (\texttt{AC_VFdbk1_Volt}) to \texttt{Disabled}.

184

Description  JPDC-P28v-R volt fdbk (JR/PR connector) out of range.

Possible Cause

• The 28 V power supply input is out of range. It should be within ±5% of 28 V.
• The 28 V power supply has not been connected.
• There may be a power supply problem.

Solution

• The input is not used. Set \texttt{PS28vEnable} to \texttt{Disable}.
• Verify the power supply connections (specified connector) to the terminal board.
• Verify that the power supply feedback on the \texttt{JPDC Inputs} tab in the ToolboxST configuration is within the expected tolerance (±5%).
185

Description  JPDC-P28v-S volt fdbk (JS/PS connector) out of range.

Possible Cause

• The 28 V power supply input is out of range. It should be within ±5% of 28 V.
• The 28 V power supply has not been connected.
• There may be a power supply problem.

Solution

• The input is not used. Set PS28vEnable to Disable.
• Verify the power supply connections (specified connector) to the terminal board.
• Verify that the power supply feedback on the JPDC Inputs tab in the ToolboxST configuration is within the expected tolerance (±5%).

186

Description  JPDC-P28v-T volt fdbk (JT/PT connector) out of range.

Possible Cause

• The 28 V power supply input is out of range. It should be within ±5% of 28 V.
• The 28 V power supply has not been connected.
• There may be a power supply problem.

Solution

• The input is not used. Set PS28vEnable to Disable.
• Verify the power supply connections (specified connector) to the terminal board.
• Verify that the power supply feedback on the JPDC Inputs tab in the ToolboxST configuration is within the expected tolerance (±5%).
Description  JPDC-P28v-R contact input (JR connector) indicates PS problem.

Possible Cause

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the specified terminal board connector.
- The power supply dry contact is not used.

Solution

- Verify the status of the power supply contact, and that the power supply is operating correctly.
- Verify the connections between the power supply and the specified connector on the JPDC.
- The input is not used. Set PS28vEnable to Disable.
- The power supply is used, but the dry contact feedback is not connected. Set PS28vEnable to NoDryCnt to disable this alarm, but continue to monitor the 28 V power supply input.

Description  JPDC-P28v-S contact input (JS connector) indicates PS problem.

Possible Cause

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the specified terminal board connector.
- The power supply dry contact is not used.

Solution

- Verify the status of the power supply contact, and that the power supply is operating correctly.
- Verify the connections between the power supply and the specified connector on the JPDC.
- The input is not used. Set PS28vEnable to Disable.
- The power supply is used, but the dry contact feedback is not connected. Set PS28vEnable to NoDryCnt to disable this alarm, but continue to monitor the 28 V power supply input.
Description: JPDC-P28v-T contact input (JT connector) indicates PS problem.

Possible Cause

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the specified terminal board connector.
- The power supply dry contact is not used.

Solution

- Verify the status of the power supply contact, and that the power supply is operating correctly.
- Verify the connections between the power supply and the specified connector on the JPDC.
- The input is not used. Set PS28vEnable to Disable.
- The power supply is used, but the dry contact feedback is not connected. Set PS28vEnable to NoDryCnt to disable this alarm, but continue to monitor the 28 V power supply input.

Description: PPDA Invalid Combination: More than 1 JPDC board present.

Possible Cause

The PPDA allows only one JPDC board to be connected as part of the Power Distribution module. The PPDA has detected more than one JPDC boards connected through the ribbon cables to the PDM.

Solution

- Verify that only one JPDC terminal boards is connected to the PPDA. The PPDA should be plugged into the JPDC terminal board.
- Reboot the PPDA after the hardware connections are corrected.

Description: PPDA Invalid Combination: JPDC and JPDS boards present together.

Possible Cause

The PPDA does not allow JPDC and JPDS terminal boards to be mixed. The PPDA has detected both JPDC and JPDS terminal boards connected through ribbon cables to the PDM.

Solution

- Verify that there are only JPDC or JPDS boards present, but not both.
- Verify that the ToolboxST configuration matches the hardware configuration.
- Reboot the PPDA after the hardware connections are corrected.
192

Description  PPDA Invalid Combination: More than one JPDF Connected to JPDC board.

Possible Cause  The PPDA allows only one JPDF board to be connected to a JPDC as part of the Power Distribution module. The PPDA has detected more than one JPDF boards connected through ribbon cables to the PDM.

Solution

• Verify that only one JPDF terminal board is connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.

193

Description  PPDA Invalid Combination: More than one JPDB Connected to JPDC board.

Possible Cause  The PPDA allows only one JPDB board to be connected to a JPDC as part of the Power Distribution module. The PPDA has detected more than one JPDB boards connected through ribbon cables to the PDM.

Solution

• Verify that only one JPDB terminal board is connected to the PDM through ribbon cables.
• Reboot the PPDA after the hardware connections are corrected.

194

Description  PPDA Invalid Combination: JPDC and JPDM boards present Together.

Possible Cause  The PPDA does not allow JPDC and JPDM terminal boards to be mixed. The PPDA has detected both JPDC and JPDM terminal boards connected through ribbon cables to the PDM.

Solution

• Verify that there are only JPDC or JPDM boards present, but not both.
• Verify that the ToolboxST configuration matches the hardware configuration.
• Reboot the PPDA once the hardware connections have been corrected.
195

**Description**  JPDG-P28v volt fdbk (JR/JS connector) out of range.

**Possible Cause**

- The 28 V power supply input is out of range. It should be within ± 5% of 28 V.
- The 28 V power supply has not been connected.
- There may be a power supply problem.

**Solution**

- The input is not used. Set the PS28v Enable to *Disable*.
- Check the power supply connections (specified connector) to the terminal board.
- From the ToolboxST application JPDG **Inputs** tab, verify that the power supply feedback configuration is within the expected tolerance (± 5%).

196 – 197

**Description**  JPDG-P28v dry contact input [ ] (P3 connector) not OK

**Possible Cause**

- The power supply contact is open. The power supply is not operating normally.
- The power supply contact feedback is not connected to the specified terminal board connector.
- The power supply dry contact is not used.

**Solution**

- Verify the status of the power supply contact, and that the power supply is operating correctly.
- Check the connections between the power supply and the specified connector on the JPDG.
- If the input is not used, set the PS28v Enable to Disable.
- If the power supply is used but the dry contact feedback is not connected, set the PS28vEnable to NoDryCnt to disable this alarm. Continue to monitor the 28 V power supply input.

198

**Description**  JPDG fuse FU1 (J1 connector) is blown

**Possible Cause**  The specified fuse is blown.

**Solution**  Replace the fuse.

199

**Description**  JPDG fuse FU2 (J1 connector) is blown

**Possible Cause**  The specified fuse is blown.

**Solution**  Replace the fuse.
200
Description  JPDG fuse FU3 (J2 connector) is blown
Possible Cause  The specified fuse is blown.
Solution  Replace the fuse.

201
Description  JPDG fuse FU4 (J2 connector) is blown
Possible Cause  The specified fuse is blown.
Solution  Replace the fuse.

202
Description  JPDG fuse FU5 (J3 connector) is blown
Possible Cause  The specified fuse is blown.
Solution  Replace the fuse.

203
Description  JPDG fuse FU6 (J3 connector) is blown
Possible Cause  The specified fuse is blown.
Solution  Replace the fuse.

204
Description  JPDG fuse FU7 (J4 connector) is blown
Possible Cause  The specified fuse is blown.
Solution  Replace the fuse.

205
Description  JPDG fuse FU8 (J4 connector) is blown
Possible Cause  The specified fuse is blown.
Solution  Replace the fuse.
Description  JPDG ACIn-[ ] [ ]V fdbk (JAC1 connector) out of range

Possible Cause

- The specified ac input is configured to the wrong nominal voltage value.
- The ac input voltage is out of tolerance from the nominal voltage value.
- The ac source voltage is out of range.
- The ac input is not connected.

Solution

- Verify that the nominal ac input voltage matches the value configured in the ACFdbkInVoltage.
- The ac tolerance is set too low. Check that the ACFdbkInTol is set to the proper value.
- Verify that the ac supply is within the specified parameters.
- If the ac input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (AC_Fdbk#_Volt) to Disabled.

Description  JPDG DC 24V Voltage fdbk mag (JPS1/JPS2 connector) out of range

Possible Cause

- The 24/48 V dc input is less than the DC_24v_Trig_Volt.
- The DC_24v_Trig_Volt is set too high.
- The 24/48 V dc source voltage is out of range.
- The 24/48 V dc input is not connected.

Solution

- Verify that the DC_24v_Trig_Volt is set correctly.
- Check the connections to the specified connector.
- Check the grounding of the dc input signals.
- If 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.
209

Description  JPDG DC 24V Voltage GND fdbk mag (JPS1/JPS2 connector) out of range

Possible Cause

• The 24/48 V dc ground feedback magnitude is greater than the Gnd_Mag_Trig_Volt.
• The Gnd_Mag_Trig_Volt is set too low.
• Only one side of the 24/48 V dc source voltage is grounded.

Solution

• Verify that the Gnd_Mag_Trig_Volt is set correctly.
• Check the connections to the specified connector.
• Check the grounding of the dc input signals.
• If 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

210 – 211

Description  JPDG DC 24V Voltage dry contact input [ ] (P4 connector) not OK

Possible Cause

• The power supply contact is open. The power supply is not operating normally.
• The power supply dry contact feedback is not connected to the terminal board P4 connector.

Solution

• Verify the status of the power supply contact, and that the power supply is operating correctly.
• Check the connections between the power supply and the P4 connector on the JPDG.
• If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

212

Description  JPDG fuse FU10/FU11 (JFA connector) is blown

Possible Cause  The FU10 or FU11 fuse is blown.

Solution

• Replace the fuse.
• If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.
**Description**  JPDG fuse FU12/FU13 (JFB connector) is blown.

**Possible Cause**  The FU12 or FU13 fuse is blown.

**Solution**
- Replace the fuse.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

**Description**  JPDG fuse FU14/FU15 (JFC connector) is blown.

**Possible Cause**  The FU14 or FU15 fuse is blown.

**Solution**
- Replace the fuse.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

**Description**  JPDG fuse FU16/FU17 (JFD connector) is blown.

**Possible Cause**  The FU16 or FU17 fuse is blown.

**Solution**
- Replace the fuse.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

**Description**  JPDG fuse FU18/FU19 (JFE connector) is blown.

**Possible Cause**  The FU18 or FU19 fuse is blown.

**Solution**
- Replace the fuse.
- If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.
217

Description  JPDG fuse FU20/FU21 (JFF connector) is blown.

Possible Cause  The FU20 or FU21 fuse is blown.

Solution

• Replace the fuse.
• If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

218

Description  JPDG fuse FU22/FU23 (JFG connector) is blown.

Possible Cause  The FU22 or FU23 fuse is blown.

Solution

• Replace the fuse.
• If the 24/48 V dc input is not used, this diagnostic alarm can be disabled by setting the InputDiagEnab parameter on the associated input (DC_24VFdbkMag) to Disabled.

219

Description  Invalid Board Combination with the JPDG

Possible Cause  The PPDA has detected invalid board combination connected through the ribbon cables to the JPDG board. The invalid board combination connected to JPDG may be one of the following:

• More than one JPDG board
• JPDS mixed with JPDG
• JPDM mixed with JPDG
• JPDC mixed with JPDG
• More than one JPDE board
• More than one JPDB board
• More than two JPDF boards

Solution  When the PPDA I/O pack is hosted by the JPDG board, verify that the following valid board combination are connected to JPDG:

• Only one JPDE board.
• Only one JPDB board.
• Only two JPDF boards.
• Maximum three auxiliary boards can be connected at any given time.
• Reboot the PPDA after the hardware connections have been corrected.
10.4  JPDD DC Power Distribution

The IS410JPDD dc power distribution board provides dc power distribution, power isolation, and branch circuit protection for control or I/O functions requiring 125 V dc, 48 V dc, or 24 V dc power. Typical applications include dc relay and solenoid control power, and contact wetting. Each output includes a fuse, a switch, and a lamp to indicate the presence of output voltage. JPDD is not intended for power distribution to the I/O packs.

Board version JPDDG1 provides fuses that are coordinated with the rating of the system wiring and connectors. JPDDG2, G3, and G4 have fuse ratings coordinated for specific applications. Two different fuse sizes are provided to accommodate local fuse preferences.

### JPDD Board Versions

<table>
<thead>
<tr>
<th>Terminal Board</th>
<th>Fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPDDG1A</td>
<td>Each circuit provided with 31.75 x 6.35 mm (1.25 x 0.25 in) 15 A 250 V fuse</td>
</tr>
<tr>
<td>JPDDG2A</td>
<td>Empty fuse holders with black caps accepting 5 x 20 mm (0.20 x 0.79 in) fuses</td>
</tr>
<tr>
<td>JPDDG3A</td>
<td>Empty fuse holders with grey caps accepting 31.75 x 6.35 mm (1.25 x 0.25 in) fuses</td>
</tr>
<tr>
<td>JPDDG4A</td>
<td>Each circuit provided with 31.75 x 6.35 mm (1.25 x 0.25 in) 0.5 A fuses for wire protection</td>
</tr>
</tbody>
</table>
10.4.1 JPDD Installation

JPDD is held in a plastic holder, which mounts on a vertical DIN-rail. When installing the JPDD, it is important to provide a ground lead from TB1 to the system ground. This creates a ground path for the metal switch bodies.

Power input can be 24 V dc, 48 V dc, or 125 V dc, but only one voltage level at any given time. Do not mix voltages. For cable destinations, refer to the circuit diagram. TB1 should be connected to system ground.
10.4.2 JPDD Operation

The following figure explains how the 125 V dc, 48 V dc, or 24 V dc power is distributed in JPDD, and how it reaches the TRLY and TBCI boards.

10.4.2.1 Inputs

Multiple JPDD boards can receive power from a single Main Power Distribution Module branch circuit. Power input can be either 125 V dc, 48 V dc, or 24 V dc nominal.

---

**Caution**

Both inputs share a common electrical path. Only a single voltage (24, 48, or 125) can be applied at one time to both inputs.

---

Two 2-Pin Mate-N-Lok connectors are provided for 125 V dc power. One connector receives input power and the other can be used to distribute 125 V dc power to another JPDD board in daisy chain fashion.

Two 4-pin Mate-N-Lok connectors are provided for 24/48 V dc power. These perform functions similar to those of the 2-pin connectors above. The 4-pin connector permits parallel connection of two pin-pairs for increased current capacity. It is expected that neither side of the dc power input is grounded.
10.4.2.2 Outputs

Six identical output circuits are provided. Each output circuit includes two fuses, a switch with a pair of isolation contacts in each side of the output, and a green lamp to indicate the presence of voltage across the output terminals. The provision of a fuse and switch contact in each side of the dc path allows use of this board with floating power sources.

10.4.3 JPDD Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>JPDD Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs</td>
<td>One 2-pin connection for input power from JPDx or another JPDD</td>
</tr>
<tr>
<td></td>
<td>One 4-pin connection for input power from JPDx or another JPDD</td>
</tr>
<tr>
<td></td>
<td>125 V dc, 15 A</td>
</tr>
<tr>
<td></td>
<td>24 or 48 V dc, 30 A</td>
</tr>
<tr>
<td>Outputs</td>
<td>Six 2-pin connections for power to TRLY or TBCI</td>
</tr>
<tr>
<td></td>
<td>One 2-pin connection for output power to another JPDD</td>
</tr>
<tr>
<td></td>
<td>One 4-pin connection for output power to another JPDD</td>
</tr>
<tr>
<td></td>
<td>24 V dc or 125 V dc, fused</td>
</tr>
<tr>
<td></td>
<td>125 V dc</td>
</tr>
<tr>
<td></td>
<td>24 or 48 V dc</td>
</tr>
<tr>
<td>Fuses</td>
<td>Refer to the table <a href="#">JPDD Board Versions</a></td>
</tr>
<tr>
<td>Ambient Rating for</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
<tr>
<td>Enclosure Design†</td>
<td></td>
</tr>
<tr>
<td>Board Dimensions</td>
<td>23.495 cm x 10.795 cm (9.25 in x 4.25 in) H x W</td>
</tr>
<tr>
<td>Mounting</td>
<td>DIN-rail, card carrier mounting Base mounted steel bracket, 4 holes</td>
</tr>
</tbody>
</table>

10.4.4 JPDD Configuration

There are no jumpers on JPDD. Check the position of the six output load switches.

It is possible to use other fuse ratings with this board to provide specific branch circuit ratings. A typical series of fuses that work with this board are the Bussmann ABC series of fuses with ratings from ¼ A through 15 A. Fuses above 15 A shall not be used with this board. If alternate fuse ratings are used, configuration of the board requires the insertion of the proper fuse in each branch circuit.
10.5 JPDE DC Battery Power Distribution

10.5.1 JPDE Functional Description

The DC Battery Power Distribution (IS410JPDE) board receives dc power from a battery or power supplies and distributes it to terminal boards and other system loads. JPDE supports a floating dc bus that is centered on earth using resistors and provides voltage feedback through PPDA to detect system ground faults. It provides inputs for two power supplies. JPDE is able to operate at either 24 V dc or 48 V dc. JPDE integrates into the PDM system feedback offered through the PPDA I/O pack.

This board is limited by the current that can be passed through it using conventional board construction. JPDE does not supply power to bulk 500 W - 24 V input/28 V output power supplies providing I/O pack control power.

JPDE is the PDM element that receives dc power from a battery or power supplies and distributes it to I/O such as relay and contact input boards. JPDE supports a floating battery bus that is centered on earth using resistors, and provides voltage sensing to detect system ground faults. It provides inputs for two power supplies including their associated status contact feedback. The design is compatible with applications using either 24 V or 48 V dc.

The current that can be passed through the board (using conventional board construction techniques) limits the amperage capabilities of this board. For this reason, the JPDE is not intended to supply power to bulk 500 W - 24 V input / 28 V output power supplies providing I/O pack control power. Each one of these supplies will consume approximately 25 A at full load. A set of three for R, S, and T would then use 75 A, exceeding the conventional capability of circuit boards. While special board construction is possible to address the high current, the resulting high product cost would exceed the cost of using more simple and readily available commercial components.

When power distribution is needed for I/O, it is more functional to have a board that provides centering resistors for a floating bus, voltage feedback for magnitude and ground detection, status feedback from dc power supplies, and fused output monitoring. The JPDE addresses these needs.

10.5.2 JPDE I/O Characteristics

- For JPDE battery applications, four battery input screw terminals located adjacent to the board on a barrier terminal strip are used. Nominal rating of the dc input path is 30 A, and the voltage is not expected to exceed 60 V. Protection of the branch circuit (supplying power to this input) is expected to be no greater than a 30 A breaker. This is the primary power input.
- JD1 is a six pin Mate-N-Lok connector that accepts the power input from external dc power sources such as a battery when a wire harness is to be used. Three connector pins are used for each side of the dc input to provide adequate current rating.
- Two power supply inputs are provided on JPS1 and JPS2. The connector uses pins 8 and 9 for positive 24 V or 48 V. Pins 1-3 are used for 24 return, providing 24 A steady state capacity. These connectors include low level signals capable of detecting status switches on each supply and generating a feedback signal to PPDA. Pin 4 provides positive 10 V wetting to the switch, and the return is on pin 5.
- There are three fused, switched, four-pin Mate-N-Lok output connectors: JS1, JS2, and JS3. Positive power is on pins 1 and 2, negative power is on pins 3 and 4. This matches the pin use on JPDD J28 and J28X. Fuse rating is 7 A.
- There are three fused four pin Mate-N-Lok output connectors JFA, JFB, and JFC. Positive power is on pins 1 and 2, negative power is on pins 3 and 4. This matches the pin use on JPDD J28 and J28X. Fuse rating is 15 A.
- Ground reference jumper JP1. The dc bus is normally operated without a hard ground connection. It is desirable to center the dc on earth as part of the ground fault detection scheme. In normal 24 V operation, the dc positive terminal would measure ½ * 24 V above ground, while the negative terminal would measure the same magnitude below ground potential. The resistors to center the bus on earth may either be supplied external to the JPDE, or on-board resistors may be used by closing jumper JP1.
- Diagnostic daisy chain 50 pin ribbon cable connectors P1 and P2 on top and bottom of the board for pass-through of the diagnostic signals are discussed in the next section.
10.5.2.1 Diagnostic Features

The signals that will be routed into PPDA through P1 for diagnostics include:

- An electronic ID is used to identify the board type, revision, and serial number.
- There are two analog dc voltage feedbacks. One is used for the positive bus with respect to earth, and one is used for the negative bus with respect to earth (2 analogs). PPDA uses these signals to create two signals with $DC_{24VFdbkMag}$ indicating total magnitude (difference between positive and negative) and $DC_{24VGnd_FdbkMag}$ indicating voltage offset for a system ground. Voltage feedback accuracy is specified at ±1% of 48 V and exceeds ±0.25% of 48 V or ±0.12 V.
- Each fused output drives an optocoupler circuit. The optocouplers are combined into two multiplexed fuse indications (multiplexed on two analog signals). They yield six Boolean values after PPDA decodes the signal.
- Test points HW1 and HW2 provide impedance limited connections to the positive and negative dc power for voltage measurements.
- Two dc power converter output status dry contact indications (multiplexed on one analog) yield two Boolean values after PPDA decodes the signal. These may be used to identify that one of two redundant power supplies has failed and requires attention.

Other core PDM board feedback may pass through JPDE using the P2 connector.

10.5.2.2 JPDE Grounding

Mark VIeS control systems separate ground into a functional earth (FE) and a protective earth (PE). The protective earth is intended for power distribution functions such as JPDE, while functional earth is used for quiet uses such as the control electronics and field signals.

Grounding of the JPDE takes place through metal mounting standoffs. The ground is applied to the metal switch bodies on JPDE. In addition, the ground is used as a local reference when creating the magnitude feedback signals appearing on P2.

10.5.2.3 JPDE Physical Arrangement

JPDE is designed to accept power input from the right hand side and deliver power output from the left hand side. The P1 and P2 ribbon cable headers on all of the JPDx boards are designed so the JPDS holding the PPDA I/O pack is best located at the top of the arrangement. This allows ribbon cables to flow from one to the next, exiting the top and entering the bottom of the next until the PPDA host is reached.

10.5.2.4 PPDA Configuration for JPDE Feedback

An alarm is generated if the value of $DC_{24VFdbkMag}$ drops below the voltage specified by $DC_{24V_Trig_Volt}$. The value of $DC_{24V_Trig_Volt}$ should be coordinated with the application voltage and expectations for voltage regulation. An alarm is generated if the value of $DC_{24VGnd_FdbkMag}$ exceeds the voltage specified by $Gnd_Mag_Trig_Volt$. This sets up the sensitivity of the ground fault detection. To disable fuse monitoring in the three switched output circuits, change the FuseDiag from the default Enable to Disable. These setting changes are needed for battery-powered applications.

10.5.3 JPDE Installation

The JPDE board is compatible with the feedback signal P1/P2 connectors on JPDS and JPDG leading to a PPDA I/O pack. The JPDE is base-mounted vertically on a metal bracket in a cabinet used by the PDM. Refer to the wiring diagrams for power input and output routing. There is a 50-pin diagnostic connector mounted on the top and bottom of the board.

10.5.3.1 JPDE Grounding

The JPDE board is grounded through the sheet metal bracket to the underlying back base. In most cases, this is the system FE.
10.5.3.2 JPDE Physical Arrangement

The location of JPDE is not critical in a panel. Connector P1 transmits feedback signals to a board hosting a PPDA I/O pack. Connector P2 receives feedback from other power distribution boards and passes the signals out of P1 to the PPDA. If a cable connection from JPDE to a board containing PPDA is planned, consideration should be given to the feedback cable routing between JPDE P1 and the P2 connector on the board receiving the feedback cable.

10.5.3.3 JPDE Application Notes

JPDE can be used with one or two power supplies to create a dc power system for terminal boards and other system loads. When this is done, float the dc power system and use the grounding resistors on JPDE to center the bus on earth. This permits detection of ground faults through the PPDA bus voltage feedback. Jumper JP1 is required to be in place, connecting the centering resistors to earth. When JPDE is used to distribute battery power, it is supplied with a dc circuit breaker and a 30 A input filter.

10.5.4 JPDE Operation

![JPDE Simplified Electrical Diagram](image-url)
10.5.4.1 JPDE Connections

- JD1 is a 6-pin Mate-N-Lok connector that accepts power input from a battery. Three connector pins each are used for positive and negative connections to provide adequate current rating.
- JFA, JFB, and JFC are fused four-pin Mate-N-Lok output connectors. Positive power is on pins 1 and 2, and negative power is on pins 3 and 4. This matches the pin use on JPDD J28 and J28X. These connectors have a fuse rating of 15 A.
- JP1 is the ground reference jumper. The dc bus is normally operated without a hard ground connection. The dc bus is centered on earth as part of the ground fault detection scheme. Normally, the 24 V operation of the dc positive terminal would measure $\frac{1}{2} \times 24$ V above ground and the negative terminal has the same magnitude below ground potential. Resistors to center the bus on earth are supplied externally to the JPDE, or on-board resistors can be used by closing jumper JP1.
- JPS1 and JPS2 are nine-pin Mate-N-Lok connectors used for power supply input. The connector uses pins 8 and 9 for positive 24/48 V dc and pins 1-3 for 24 V return providing 24 A steady state capacity. Pin 4 provides positive 10 V dc wetting to a supply status feedback switch and pin 5 provides the return.
- JS1, JS2, and JS3 are fused and switched four-pin Mate-N-Lok output connectors. Positive power is on pins 1 and 2, and negative power is on pins 3 and 4. This matches the pin use on JPDD J28 and J28X. The fuse rating for these switched connectors is 7 A.
- Two 50-pin diagnostic ribbon cable connectors, P1 and P2, are supplied on the top and bottom of the board. Connector P1 transmits feedback signals to a board hosting a PPDA I/O pack. Connector P2 receives feedback from other power distribution boards and passes the signals out of P1 to the PPDA.

10.5.5 JPDE Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>JPDE Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Board Rating</td>
<td>30 A total dc current from all branch circuits</td>
</tr>
<tr>
<td></td>
<td>50 V maximum nominal voltage</td>
</tr>
<tr>
<td>Fuse for Connectors JS1-JS3</td>
<td>7 A, 250 V, Bussmann ABC-7 typical</td>
</tr>
<tr>
<td>Fuse for Connectors JFA, JFB</td>
<td>15 A 250 V, Bussmann ABC-15 typical</td>
</tr>
<tr>
<td>Board Dimensions</td>
<td>16.51 cm x 17.8 cm (6.5 in x 7 in) H x W</td>
</tr>
<tr>
<td>Mounting</td>
<td>six mounting holes</td>
</tr>
<tr>
<td>Ambient Rating for Enclosure</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
</tbody>
</table>
10.5.6 JPDE Diagnostics

Diagnostic signals routed into PPDA through connector P1 include:

- An electronic ID identifying the board type, revision number, and serial number
- Two analog battery voltage feedbacks. One is for positive bus and one is for negative bus. Voltage feedback accuracy is ±1%.
- Three switched/fused dc branch circuit status signals
- Two dc power converter output status dry contact status signals
- Three fused branch circuit status signals
- Two test points with series 2.15 kΩ resistors are provided on the 24/48 V dc bus for external test equipment. HW1 is connected to the positive bus and HW2 is connected to the negative bus.

**Note** Fuse and dry contacts failure diagnostics will not be generated if InputDiagEnab on the dc input is set to Disable or the dc input is below 42 V.

10.5.7 JPDE Configuration

When jumper JP1 is in place, the JPDE provides 6 kΩ voltage-centering resistors from positive and negative dc to the local earth connection. When JP1 is removed, the connection to earth is opened. Insert JP1 when a floating dc bus needs to be centered on earth.
10.6 JPDG Core Power Distribution

The IS410JPDHG Power Distribution board provides distribution of 28 V dc (control power) and 48 V / 24 V dc (wetting power) to other boards within the control system. It also provides sensing circuitry for two channels of ac distribution. The JDPG 28 V dc distribution section is designed to accept two separate power supply inputs through external diodes. With the PPDA I/O pack, the JPDG integrates into the PDM system feedback. JPDG can support sensing and diagnostic for two ac signals, which are distributed outside this board.

For control power distribution, the JPDG board receives 28 V dc input power from external ac/dc or dc/dc converters and distributes power to the control system. The JPDG provides fuse protection for all 28 V dc outputs. For wetting power distribution, the JPDG is able to operate at either 24 V dc or 48 V dc. The board receives dc power from two power supplies through external diodes and distributes it to terminal boards and other system loads.

The JPDG does not supply power to bulk 500 W - 24 V input / 28 V output power supplies that provide I/O pack control power. The JPDG supports a floating dc wetting power bus that is centered on earth by using resistors. It provides voltage feedback through the PPDA to detect system ground faults.

10.6.1 JPDG Compatibility

The JPDG can host a Power Distribution System Feedback (PPDA) I/O pack. It can also receive diagnostic feedback signals from up to three other distribution boards and route these signals to the PPDA I/O pack. Since the PPDA I/O pack is mounted on the JPDG module, there is no need to transmit diagnostic signals from JPDG to other power distribution boards.

The following table lists all valid combinations of the JPDG with other power distribution boards.

<table>
<thead>
<tr>
<th>Main Board</th>
<th>Auxiliary Board Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPDG</td>
<td>JPDE1 24 V</td>
</tr>
<tr>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

Two JPDGs cannot be used in the diagnostic daisy chain for the power distribution system, and JPDS cannot be used along with JPDG. Only one JPDE can be used along with JPDG. Two JPDEs are not allowed with JPDG in the power distribution scheme. Two JPDFs can be used along with JPDG.
### 10.6.2 JPDG Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>JPDG Specification</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>28 V dc Control Power Inputs</strong></td>
<td>Two 6-pin Mate-N-Lok connectors for 28 V dc power supply inputs: (JR, JS)</td>
<td>Total bus capacity 40 A max steady state at 55 °C (131 °F) / 30 A at 70 °C (158 °F)</td>
</tr>
<tr>
<td></td>
<td>One 50-pin ribbon cable with diagnostic data from upstream boards (P2)</td>
<td>15 V max</td>
</tr>
<tr>
<td></td>
<td>One 4-pin connector for power supply status contact input (P3)</td>
<td>10 V</td>
</tr>
<tr>
<td></td>
<td>Four 4-pin Mate-N-Lok connectors for a JPDH board (J1-J4)</td>
<td>13 A max per pin connector capacity, 10 A slow blow fuse in positive line, typically Bussmann MDA-10; 7 A continuous at 70 °C (158 °F)</td>
</tr>
<tr>
<td></td>
<td>Four 2-pin Mate-N-Lok connectors for network switch (JC1-JC4)</td>
<td>Fused with self-resetting fuse 1.875 A; 1.5 A continuous at 70 °C (158 °F); 2.0 A continuous at 55 °C (131 °F)</td>
</tr>
<tr>
<td></td>
<td>Five 2-pin Mate-N-Lok connectors for I/O packs and controller (JD1-JD5)</td>
<td>Fused with self-resetting fuse 0.8 A; 0.5 A continuous at 70 °C (158 °F); 0.9 A continuous at 55 °C (131 °F)</td>
</tr>
<tr>
<td></td>
<td>One 62-pin D-shell connection for the PPDA I/O pack (JA1)</td>
<td></td>
</tr>
<tr>
<td><strong>28 V dc Control Power Outputs</strong></td>
<td>Two 9-pin Mate-N-Lok connectors for 24/48 V dc power supply inputs: (JPS1, JPS2)</td>
<td>Total bus capacity 40 A max steady state, accepts 24 V dc or 48 V dc</td>
</tr>
<tr>
<td></td>
<td>One 4-pin connector for power supply status contact input (P4)</td>
<td>10 V</td>
</tr>
<tr>
<td></td>
<td>Impedance to ground from positive and return line</td>
<td>JP1 jumper in place; 12 kΩ</td>
</tr>
<tr>
<td><strong>24/48 V dc Wetting Power Inputs</strong></td>
<td>Seven 2-pin Mate-N-Lok connectors for a wetting power distribution for contact I/Os board (JFA-JFG)</td>
<td>There is a 15 A fuse in both lines, typically Bussmann ABC-15 or Littelfuse 314015P. The maximum current drawn through each connector must not exceed 10 A at 55°C (131 °F); 8 A at 70°C (158 °F).</td>
</tr>
<tr>
<td><strong>24/48 V dc wetting power outputs</strong></td>
<td>One 4-pin Mate-N-Lok connector, 2 channels (JAC1)</td>
<td>Only for sensing feedback, no ac distribution through JPDG board</td>
</tr>
<tr>
<td><strong>Inputs for AC Sensing</strong></td>
<td>JPDGH1A provides standard Mark VleS circuit board vibration protection rating, and should be used for most applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JPDGH2A is enhanced to provide more vibration protection for use in some GE Drilling applications. The purchase price is higher for this version.</td>
<td></td>
</tr>
<tr>
<td><strong>Vibration Protection</strong></td>
<td>Ambient Rating for Enclosure Design†</td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
<tr>
<td></td>
<td>Board Dimensions</td>
<td>16.51 cm x 17.8 cm (6.5 in x 7.0 in) H x W</td>
</tr>
<tr>
<td></td>
<td>Mounting</td>
<td>DIN-rail mounting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Base mounted steel bracket</td>
</tr>
</tbody>
</table>
10.6.3 JPDG Installation

The JPDG is base-mounted vertically on a metal bracket in a cabinet used by the PDM. There is a 50-pin diagnostic connector, P2, mounted on the bottom of the board. JPDG is attached with four screws using the mounting holes located at the top and bottom of the module base. Location within the control cabinet is not critical, however, distribution boards are usually mounted low in the cabinet to facilitate grounding.

The PPDA I/O pack is plugged into connector JA1. It is secured to the JPDG base using an angle bracket, and held in place with nuts threaded onto studs that are permanently attached to the base for that purpose. Diagnostic feedback inputs from other distribution boards are routed to JPDG through a 50-pin ribbon cable attached to connector P2.

Input power connections include:

- Either one or two 28 V dc control power input connections through connectors JR and JS. The JPDG has a common 28 V dc bus.
- 115 or 230 V ac input applied to connector JAC1 only for sensing and diagnostic purpose. The ac voltage is not distributed on the JPDG.
- One or two 24 V dc wetting power input connections or one or two 48 V dc input connections through connectors JPS1 and JPS2. The JPDG has a common 24/48 V dc wetting voltage bus.

---

**Caution**

There is a common electrical bus. Only a single voltage (either 24 V dc to both inputs or 48 V dc to both inputs) can be applied at one time to both inputs through JPS1 and JPS2, through ORed diodes.

---

**Attention**

If two dc supplies are connected, external diodes must be used upstream. If external diodes are not used and the voltage levels between the two supplies differ, one supply can drag down the other supply. If one supply fails shorted, then the power bus is likely to also be shorted. Diodes are external to JPDG and may be inside the power supplies or an external assembly.

---

**Note**

A battery connected directly as wetting voltage is not supported by the JPDG. If a battery needs to be connected with the JPDG for wetting power, the required filter, upstream fuse, and rectifier (the same as that used for the JPDE) must be installed in the panel with proper connections.
JPDG Mechanical Board Layout
10.6.3.1 JPDG Grounding

The Mark VIeS control system divides grounding into protective earth (PE) and functional earth (FE). The PE ground must be connected to an appropriate earth connection in accordance with all local standards. The minimum grounding must be capable of carrying 60 A for 60 seconds with no more than a 10 volt drop. The FE grounding must be bonded to the PE grounding at one point or connected to an independent functional earth grounding system according to local regulations.

The JPDG board is grounded through the sheet metal bracket to the underlying back base. In most cases, this is FE grounding. The FE ground is used as a local reference point when creating the feedback signals appearing on P2. The use of functional earth as a ground reference does not affect the accuracy of the ac voltage detection on JAC1.

10.6.3.2 JPDG Physical Arrangement

The cabinet location of the JPDG is not critical. Connector P2 receives feedback from other power distribution boards and passes the signals to the PPDA. The JPDG is vertically mounted, and the PPDA I/O pack is connected to the right side of the JPDG. All the indicator lights on PPDA I/O pack are easily visible.

10.6.3.3 JPDG Ground Fault Detection

The JPDG board supports the use of a wetting voltage dc bus that is centered on ground potential by a high resistance. This arrangement allows the detection of a ground fault when the positive bus or negative bus voltage goes to ground potential. In support of this arrangement, the JPDG includes separate voltage feedback sensing for positive and negative power with respect to ground. When the feedback is provided by a PPDA I/O pack, detection of ground faults is provided to the control system.

The resistance used to center the dc bus on ground sets the ground detection sensitivity and the flow of ground fault currents. The JPDG contains centering resistors selected by jumper JP1. If centering resistance is provided elsewhere, this jumper should be open. The JPDG is designed to insert minimal centering resistance in the system. If JPDG is providing the centering function, JP1 should be closed. If a JPDE is also used for distribution of the same wetting power along with a JPDG, only one of the two should have a closed JP1 jumper.
10.6.4 JPDG Operation

10.6.4.1 JPDG Control Power Distribution 28 V DC

The following I/O characteristics apply to the 28 V dc distribution section of the JPDG:

- Two six-pin connectors (JR and JS) are used for input. Each connector uses pins 1-3 for 28 V dc return and pin 4-6 for positive 28 V dc to provide steady state current capacity of 40 A at 55°C (131 °F) / 36 A at 70°C (158 °F). Two redundant power supplies feed a single power bus through external ORed diodes.

- Four fused Mate-N-Lok connectors (J1, J2, J3, and J4 having four pins each) are provided to supply 28 V dc power to remote JPDP or JPDH boards. They can also supply power to JPD boards when using the proper wire harness. Pins 1-2 are 28 V dc return, pin 3 and 4 are positive 28 V dc. Each positive output is fused for 10 A to protect the circuits downstream.

- Five fused Mate-N-Lok connectors (JD1-JD5 with self-resetting fuses of 1.6 A in positive lines) are provided to supply the 28 V power to I/O packs (including PPDA), controllers, and other loads. Pin 1 is positive 28 V dc, and pin 2 is 28 V dc return. The self resetting fuse rating is temperature dependent. It is 1.6 A at 20 °C, 0.9 A at 55°C (131 °F), 0.5 A at 70°C (158 °F) ambient temperatures.

- Four Mate-N-Lok connectors (JC1-JC4 with self-resetting fuses of 3.75 A in positive lines) are provided to supply the 28 V power to network switches. Pin 1 is positive 28 V dc, and pin 2 is 28 V dc return. The self resetting fuse rating is temperature dependent. It is 3.75 A at 20°C (68 °F) ambient and derated to 2.0 A at 55°C (131 °F) and 1.5 A at 70°C (158 °F) ambient temperature.

- Connector P3 is used to connect low-level signals capable of monitoring status switches on each 28 V dc power supply and sending feedback signals to the PPDA. Pin 1 provides +10 V dc wetting to the status switch for supply 1. The return is on pin 3. For status switch on power supply 2, pin 2 provides +10 V dc wetting, and the return is on pin 4.

- A 50-pin diagnostic ribbon cable connector P2 is supplied at the bottom of the board. When connected, P2 receives feedback from another power distribution board along with JPDG.

### 28 V DC Control Power Distribution

<table>
<thead>
<tr>
<th>Serial #</th>
<th>Connector name</th>
<th>Function</th>
<th>Pins</th>
<th>Notes/Fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JR</td>
<td>28 V dc input 1</td>
<td>Pin 1–3 common / return, Pin 4–6 – positive</td>
<td>These connectors are rated for 50 A under fault conditions with current limiting provided by the power source</td>
</tr>
<tr>
<td>2</td>
<td>JS</td>
<td>28 V dc input 2</td>
<td>Pin 1–3 common / return, Pin 4–6 – positive</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>J1</td>
<td>28 V dc output 1 to JPDH/JPDP</td>
<td>Pins 1–2 dc return, pin 3–4 positive</td>
<td>Pin 3 through FU1, Pin 4 through FU2. 10 A replaceable fuses</td>
</tr>
<tr>
<td>4</td>
<td>J2</td>
<td>28 V dc output 2 to JPDH/JPDP</td>
<td>Pins 1–2 dc return, pin 3–4 positive</td>
<td>Pin 3 through FU3, Pin 4 through FU4. 10 A replaceable fuses</td>
</tr>
<tr>
<td>5</td>
<td>J3</td>
<td>28 V dc output 3 to JPDH/JPDP</td>
<td>Pins 1–2 dc return, pin 3–4 positive</td>
<td>Pin 3 through FU5, Pin 4 through FU6. 10 A replaceable fuses</td>
</tr>
<tr>
<td>6</td>
<td>J4</td>
<td>28 V dc output 4 to JPDH/JPDP</td>
<td>Pins 1–2 dc return, pin 3–4 positive</td>
<td>Pin 3 through FU7, Pin 4 through FU8. 10 A replaceable fuses</td>
</tr>
<tr>
<td>7</td>
<td>JD1</td>
<td>28 V dc output 1 to I/O pack, Controller</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR1, 0.8 A self-resetting fuse</td>
</tr>
<tr>
<td>8</td>
<td>JD2</td>
<td>28 V dc output 2 to I/O pack, Controller</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR2, 0.8 A self-resetting fuse</td>
</tr>
<tr>
<td>9</td>
<td>JD3</td>
<td>28 V dc output 3 to I/O pack, Controller</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR3, 0.8 A self-resetting fuse</td>
</tr>
<tr>
<td>10</td>
<td>JD4</td>
<td>28 V dc output 4 to I/O pack, Controller</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR4, 0.8 A self-resetting fuse</td>
</tr>
<tr>
<td>11</td>
<td>JD5</td>
<td>28 V dc output 5 to I/O pack, Controller</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR5, 0.8 A self-resetting fuse</td>
</tr>
<tr>
<td>Serial #</td>
<td>Connector name</td>
<td>Function</td>
<td>Pins</td>
<td>Notes/Fuses</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>----------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>12</td>
<td>JC1</td>
<td>28 V dc output 1 to network switch</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR6, 1.875 A self-resetting fuse</td>
</tr>
<tr>
<td>13</td>
<td>JC2</td>
<td>28 V dc output 2 to network switch</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR7, 1.875 A self-resetting fuse</td>
</tr>
<tr>
<td>14</td>
<td>JC3</td>
<td>28 V dc output 3 to network switch</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR8, 1.875 A self-resetting fuse</td>
</tr>
<tr>
<td>15</td>
<td>JC4</td>
<td>28 V dc output 4 to network switch</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 through TR9, 1.875 A self-resetting fuse</td>
</tr>
<tr>
<td>16</td>
<td>P3</td>
<td>28 V dc Power supply status inputs</td>
<td>Pin 1 10 V output for supply 1 status contact Pin 2 10 V output for supply 2 status contact Pin 3 return for supply 1 status contact Pin 4 return for supply 2 status contact</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>TP1</td>
<td>28 V dc Test point</td>
<td>Positive</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>TP2</td>
<td>28 V dc Test point</td>
<td>Common / return</td>
<td></td>
</tr>
</tbody>
</table>
10.6.4.2 **Wetting Power Distribution 24/48 V DC**

The following I/O characteristics apply to the 24/48 V dc wetting power distribution section of the JPDG:

- Two 9-pin connectors (JPS1 and JPS2) are used for input. Each connector uses pins 1-4 for return and pins 6-9 for positive 24/48 V dc to provide steady state current capacity of maximum 40 A. Pin 5 is not connected. Two redundant power supplies feed a single power bus through external ORed diodes. A directly connected battery as wetting voltage input is not supported. If a battery needs to be connected with the JPDG for wetting power, the required filter, upstream fuse, and rectifier (all are the same used for the JPDE) must be properly installed and used.

- JP1 is the ground reference jumper. The dc bus is normally operated without a hard ground connection. The dc bus is centered on earth as part of the ground fault detection scheme. Normally the 24 V dc positive terminal measures 12 V above ground, and the negative terminal has the same magnitude below ground potential. Close jumper JP1 to use onboard resistors to center the bus on earth, or JP1 is open when resistors are supplied externally to the JPDG or when the JPDE is used with its JP1 jumper closed.

- There are seven (JFA through JFG) fused 2-pin Mate-N-Lok output connectors. They are fused for 15 A in both the lines. Positive power is on pins 1 and negative power is on pins 2. Even though the fuses are of 15 A capacity, the actual current drawn through each branch must not be more than 10 A at 55°C (131 °F); 8 A at 70°C (158 °F). The total current drawn from JFA through JFG must not exceed 40 A steady state.

- Connector P4 is used to connect low-level signals capable of monitoring status switches on each 24/48 V dc power supply and sending feedback signals to the PPDA. Pin 1 provides +10 V dc wetting to the status switch for supply 1, and the return is on pin 3. For status switch on power supply 2, Pin 2 provides +10 V dc wetting, and the return is on pin 4.
<table>
<thead>
<tr>
<th>Serial #</th>
<th>Connector Name</th>
<th>Function</th>
<th>Description — Pin numbers</th>
<th>Fuses†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JPS1</td>
<td>24/48 V dc input 1</td>
<td>Pin 1–4 — Return, Pin 6–9 — positive</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>JPS2</td>
<td>24/48 V dc input 2</td>
<td>Pin 1–4 Return, Pin 6–9 — positive</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>JFA</td>
<td>24/48 V dc output 1</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 goes through FU10. Pin 2 goes through FU11.</td>
</tr>
<tr>
<td>4</td>
<td>JFB</td>
<td>24/48 V dc output 2</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 goes through FU12. Pin 2 goes through FU13.</td>
</tr>
<tr>
<td>5</td>
<td>JFC</td>
<td>24/48 V dc output 3</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 goes through FU14. Pin 2 goes through FU15.</td>
</tr>
<tr>
<td>6</td>
<td>JFD</td>
<td>24/48 V dc output 4</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 goes through FU16. Pin 2 goes through FU17.</td>
</tr>
<tr>
<td>7</td>
<td>JFE</td>
<td>24/48 V dc output 5</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 goes through FU18. Pin 2 goes through FU19.</td>
</tr>
<tr>
<td>8</td>
<td>JFF</td>
<td>24/48 V dc output 6</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 goes through FU20. Pin 2 goes through FU21.</td>
</tr>
<tr>
<td>9</td>
<td>JFG</td>
<td>24/48 V dc output 7</td>
<td>Pin 2 dc return, pin 1 positive</td>
<td>Pin 1 goes through FU22. Pin 2 goes through FU23.</td>
</tr>
<tr>
<td>10</td>
<td>P4</td>
<td>24/48 V dc power supply status inputs</td>
<td>Pin 1 is 10 V output for supply 1 status contact Pin 2 is 10 V output for supply 2 status contact Pin 3 is return for supply 1 status contact Pin 4 is return for supply 2 status contact</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>TP3</td>
<td>24/48 V dc Test point</td>
<td>Positive</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>TP4</td>
<td>24/48 V dc Test point</td>
<td>Return</td>
<td></td>
</tr>
</tbody>
</table>

† These are 15 A replaceable fuses, however the actual current drawn through each of these branches must not be more than 10 A.
10.6.4.3 AC Power Diagnostic

An input of either 115 V ac or 230 V ac (distributed external to the JPDG) is supplied to the JPDG through connector JAC1. The JPDG does not distribute the ac power but provides only the diagnostics for two channels of ac. The low or neutral side of the input power should be grounded. Neutral is not grounded on the JPDG.

<table>
<thead>
<tr>
<th>Serial #</th>
<th>Connector Name</th>
<th>Function</th>
<th>Description — Pin Numbers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JAC1</td>
<td>Two inputs for ac sensing</td>
<td>Pin 1 — Channel 1 phase Pin 2 — Channel 1 neutral Pin 3 — Channel 2 phase Pin 4 — Channel 2 neutral</td>
<td>No ac power distribution, only diagnostics</td>
</tr>
</tbody>
</table>

**JPDG Electrical One-line Diagram**

28 V dc power supply

28 V dc power supply

JPDG

PPDA

48 or 24 V Wetting Power

48 or 24 V Wetting Power

JPS1

JPS2

Jumper

JFA – JFG
7 connectors
2-pin

JFC — JFG
7 connectors
2-pin

JAC1
ac diagnostics
10.6.5 JPDG Diagnostics

The feedback wiring on the JPDG is different from the other PDM core boards. Using the JA1 connector, the JPDG hosts the PPDA I/O pack. The P1 connector is not there on JPDG. The P2 connector provides feedback signals from other core PDM boards. The following signals are created by the JPDG:

- An electronic ID identifying the board type, revision, and serial number
- Control voltage (28 V dc) measurement reading with accuracy specified at ±1% of full scale
- Fuse feedback status for FU1-FU8 in 28 V dc power distribution section
- Two dc power converter output status (dry contact status) signals for two (28 V dc) power supplies in control power distribution section
- Two testpoints with series 10 kΩ resistors are provided on the 28 V dc bus for external test equipment. TP1 is connected to the positive bus and TP2 is connected to the negative bus. They are used by external test equipment to measure the 28 V power voltage.
- Two analog 24/48 V dc voltage feedbacks are provided. One is for positive bus and one is for negative bus, with the dc bus centered on earth as part of the ground fault detection scheme. Voltage feedback accuracy is ±1%.
- Fuse feedback status for FU10-FU23 in 24/48 V dc power distribution section
- Two testpoints with series 10 kΩ resistors are provided on the 24/48 V dc bus for external test equipment. TP3 is connected to the positive bus and TP4 is connected to the negative bus.
- Two ac supply measurement readings with accuracy specified at ±4% of full scale.

**Note** Due to a large signal count present on the JDPG, a single set of board feedback signals is not adequate to transmit the signals to a PPDA I/O pack. Each JPDG consumes three sets of feedback signals out of the six available sets.

**Note** FU1 to 8 and DryCnt1 and 2 are on the 28 V dc input. FU10 to 21 are on the 24 V dc input. Fuse and dry contacts failure diagnostics will not be generated if InputDiagEnab on the respective dc input is set to Disable or the dc input is below the low limit threshold. The low limit threshold on 28 V is pre-fixed at 5 V. The low limit threshold on 24 V is pre-fixed at 10 V.

Also, dry contact diagnostics will not be generated if the user selects NoDryCnt on the input on which a dry contact exists.

10.6.6 JPDG Configuration

When jumper JP1 is in place, the JPDG provides 12 kΩ voltage-centering resistors from positive and negative dc to the local earth connection. When JP1 is removed, the connection to earth is opened. Insert JP1 when a floating dc bus needs to be centered on earth.
10.7 JPDH High Density Power Distribution

The High Density Power Distribution (JPDH) board provides 28 V dc power to 24 Safety I/O modules and three Ethernet switches from a 28 V dc supply. Additional JPDHs can be connected in a daisy-chain arrangement to provide power to more I/O modules as required. The circuit for each I/O module connector is protected with a positive temperature coefficient fuse device.
10.7.1 JPDH Installation

Mount JPDH on a vertical surface by inserting #6 machine screws through the mounting holes at each corner of the board. Insert Mate-N-Lok connectors as described in the following figure. The 6-pin and larger 2-pin connectors have a nominal rating of 600 V and 13 A, while the smaller two-pin connectors have a nominal rating of 600 V and limited by fuse rating to 0.8 A max.

![JPDH Connections Diagram]
10.7.2 JPDH Operation

JPDH is designed to provide TMR I/O packs with adequate 28 V dc power distribution while taking up as little space as possible. Additional JPDHs can be connected in a daisy-chain arrangement through the unfused J1X connector.

Note The user must provide suitable branch circuit protection when connecting multiple JPDHs. Each pin is rated at 13 A.

The 6-pin J1 connector brings in three separate 28 V dc feeds on three different pins for triple redundancy. The return current is common among the TMR and daisy-chain feeds and is brought in on the remaining three pins. The following figure explains how the R, S, and T 28 V dc power is distributed by JPDH to the I/O packs and Ethernet switches.

JPDH has 24 identical output circuits to provide power to the individual I/O packs. The R, S, and T feeds each provide power to eight circuits. Each I/O pack circuit includes a positive temperature coefficient fuse device for branch circuit protection. The board also has three identical unfused output circuits to provide power to each Ethernet switch.
The following figure displays an example application with 72 I/O packs and nine Ethernet switches powered through three daisy-chained JPDH boards.

### 10.7.3 JPDH Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>JPDH Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inputs</strong></td>
<td>One 6-pin connection for 28 V dc power input Mate-N-Lok 600 V, 13 A</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td>Three 2-pin connections for Ethernet switches Mate-N-Lok 600 V, 13 A</td>
</tr>
<tr>
<td></td>
<td>Twenty-four 2-pin connections for I/O packs Mate-N-Lok 600 V, 0.8 A at 70 °C</td>
</tr>
<tr>
<td><strong>Output Fuses</strong></td>
<td>1.6 A at 20 °C (derated to 0.8 A at 70 °C) positive temperature coefficient fuse or equivalent on each I/O pack output</td>
</tr>
<tr>
<td><strong>Ambient Rating for Enclosure Design†</strong></td>
<td>-40 to 70 °C (-40 to 158 °F)</td>
</tr>
<tr>
<td><strong>Relative Humidity</strong></td>
<td>5 – 95% non-condensing</td>
</tr>
<tr>
<td><strong>Safety Standards</strong></td>
<td>UL 508A Safety Standard Industrial Control Equipment</td>
</tr>
<tr>
<td></td>
<td>CSA 22.2 No. 14 Industrial Control Equipment</td>
</tr>
<tr>
<td></td>
<td>EN 61010-1 Safety of Electrical Equipment, Industrial Machines (Low Voltage Directive)</td>
</tr>
<tr>
<td><strong>Board Dimensions</strong></td>
<td>15.875 cm x 10.795 cm (6.25 in x 4.25 in) H x W</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td>DIN-Rail, card carrier mounting</td>
</tr>
<tr>
<td></td>
<td>Base mounted steel bracket, 4 holes</td>
</tr>
</tbody>
</table>
10.8 JPDS Core 28 V DC Power Distribution

10.8.1 JPDS Functional Description

The IS410JPDS power distribution board receives 28 V dc power from chosen supplies and distributes it to system controllers and branch circuit I/O pack power distribution boards. It has no fuses or switches and can maintain three separate power buses for R, S, and T controls, or optionally it can be jumpered to provide a single bus with redundant supplies. It is also possible to wire two adjacent JPDS boards together. JPDS integrates into the PDM system feedback offered through the PPDA I/O pack.

The JPDS power distribution board receives 28 V dc power from chosen supplies and distributes it to system controllers and branch circuit I/O pack power distribution boards. It is designed for Class I Division 2 applications, so it has no fuses or switches. It can maintain three separate power buses for R, S, and T controls, or optionally it can be jumpered to provide a single bus with redundant supplies. It is also possible to wire two adjacent JPDS boards together.

10.8.1.1 JPDS Compatibility

The JPDS board is compatible with the feedback signal P1/P2 connectors on JPDE leading to a PPDA I/O pack. The DC-62 connector on JPDS is compatible with the PPDA I/O pack.
10.8.2 JPDS I/O Characteristics

- Three power supply inputs are provided on JR, JS, and JT. The connector uses pins 7, 8, and 9 for positive 28 V power. Pins 1-3 are used for 28 return, providing 24 A steady state capacity. These connectors include low level signals capable of detecting status switches on each supply and generating a feedback signal to the PPDA. Pin 4 provides positive 10 V wetting to the switch, and the return is on pin 5. Pin 6 is not used.

- Terminal boards TB1 and TB2 at the bottom and top of the board provide access to the three power buses. If two adjacent JPDS boards are used, jumpers may be placed between TB1 and TB2 on the boards to parallel the bus on the two boards. For a single power bus fed by redundant supplies, jumpers may be placed between PR, PS, and PT terminals to tie the positive bus terminals together.

---

Attention

Do not exceed the maximum available fault current out of the JPDS board when tying the positive bus terminals together. For applications requiring greater available fault current, the JPDM is a better choice.

---

- Three two-pin Mate-N-Lok connectors (JCR, JCS, and JCT) are provided to power the controllers or other loads. Pin 1 is 28 V, and pin 2 is the return.

- Three two-pin Mate-N-Lok connectors (JAR, JAS, and JAT) with filtering and fusing are provided for auxiliary loads. These outputs feature a series common mode filter inductor, and they have self-resetting polysilicon fuses rated for 1.6 A at 20 °C, derated to 0.8 A at 70 °C. Pin 1 is 28 V, and pin 2 is the return.

- Six Mate-N-Lok connectors with six pins each are provided to supply R, S, and T power to remote JPDP or JPDH boards, or directly to JPDL boards when used with the appropriate wire harness. On all six connectors, pins 1-3 are 28 V return, pin 4 is 28 R, pin 5 is 28 S, and pin 6 is 28 T.

- The DC62 connector JA1 is used for a PPDA power diagnostic I/O pack. It contains the status feedback signals for up to six core power distribution boards.

- P4 supplies power to the PPDA I/O pack. It is a power circuit formed from R, S, and T power using a Diode-OR arrangement followed by a polysilicon self-resetting fuse rated for the PPDA power requirements. This ensures that the I/O pack receives power if any of the three power buses are active.

- Diagnostic daisy chain 50 pin ribbon cable connectors P1 and P2 are located on top and bottom of the board. They are used for pass-through of the diagnostic signals.

10.8.2.1 JPDS Diagnostic Features

JPDS have feedback wiring that is different from the other core PDM boards. One JPDS will host the PPDA I/O pack on the JA1 connector. On that board, the P1 connector is not used because the output signals are sent to the PPDA. If a second JPDS board is used, the P1 connector on the second board will be used to conduct its feedback into P2 of the board hosting PPDA. In either case, the P2 connector provides passage of feedback signals from other core PDM boards. The following signals are created by JPDS:

- An electronic ID identifies the board type, revision, and serial number.
- PS28vStat_R, _S, _T are three analog P28 voltage readings for R, S, and T bus. Separate analog feedback signals are used. Accuracy is specified to be ±1% of full scale and calculated accuracy is ±0.2% at 3 sigma.
- One dry contact from each of the three power supplies (DryCntStat_R, _S, _T) yields three Boolean values.
- Three Aux output fuse status signals (AuxFuseStat_R, _S, _T) multiplexed into a single analog value yields three Boolean values after PPDA decodes the signal.

JPDS provides the following four test point outputs for connection of external test equipment:

- HW1 - 28PR
- HW2 - 28PS
- HW3 - 28PT
- HW4 - 28N

The positive side test points include series 10 kΩ current limiting resistors. These allow access to all three 28 V power buses and the common return circuit.
10.8.2.2 JPDS Grounding

Mark VIeS control systems separate ground into a functional earth (FE) and a protective earth (PE). The PE is intended for power distribution functions such as JPDF, while functional earth is used for quiet uses such as the control electronics and their power as on JPDS.

The JPDS board is grounded through the sheet metal bracket to the underlying back base. In most cases, this can be the system FE.

Grounding of the JPDS takes place through metal mounting standoffs fastened to the underlying sheet metal. The ground is used as a local reference when creating the magnitude feedback signals appearing on P2 and JA1. This is done because the JPDS is expected to be part of the FE system in a control and mounting on a FE potential back-base is normal practice.

Note This is different than JPDF where a PE connection is desired.

10.8.2.3 JPDS Physical Arrangement

JPDS accepts power from cables and distributes it to the JR, JS, and JT connectors. JPDS, when hosting a PPDA I/O pack, is mounted so indicator lights on the pack are easily visible. Two JPDS boards, when used together, are mounted so that any terminal board connections are easily accessible. The location of JPDS is not critical in a panel. Connector P1 transmits feedback signals to a board hosting a PPDA I/O pack. Connector P2 receives feedback from other power distribution boards and passes the signals out of P1 to the PPDA. If a feedback cable connection from JPDS P2 to another power distribution board is planned, consideration should be given to the feedback cable routing.

JPDS is designed to accept power input from cables into the JR, JS, and JT connectors so it exhibits less mounting position sensitivity than some other boards. The mounting surface is expected to at functional earth potential. If the board hosts a PPDA I/O pack, consideration should be given to maintain the visibility of the indicator lights located on the top of the PPDA. If two boards are used together, arranging them next to each other will make any needed barrier terminal strip connections easier to use. The P1 and P2 ribbon cable headers on all of the JPDx boards are designed so the JPDS holding the PPDA I/O pack is best located at the top of the arrangement. This allows ribbon cables to flow from one to the next, exiting the top and entering the bottom of the next until the PPDA host is reached.

10.8.3 JPDS Application Notes

The internal wiring permits either three independent 28 V dc power buses to be maintained, or all three combined into a single internal bus. Each bus is sized to handle 24 A. They share a common ground that is sized for 75 A. With three supplies, it is possible to operate R, S, and T controllers and their I/O from separate power supplies. Failure of a supply can take one controller and I/O but not affect the other two channels. There is a dedicated 28 V Diode-OR power output for the PPDA I/O pack to avoid losing power system feedback if a channel power failure occurs.

A second method of operation has jumpers between the R, S, and T 28 V bus connection screws on TB1 and TB2. The board provides a single highly reliable source of 28 V. Up to three supplies could power this bus with parallel operation capability designed into the external supplies.

The screw terminals could also be used to parallel the power buses from two adjacent JPDS boards. Two boards offer the following features:

- Two sets of control rack output for Duplex or TMR applications using redundant supplies in the control racks, or systems where more than three supplies are to be paralleled
- Twelve JPDP outputs instead of six
- Separated R, S, and T power could now have two input power supplies providing supply redundancy on each bus.

In some applications, a battery bus can be applied as a power backup. A grounded battery system can also be used as input to this board using the screw terminals on the end of the board. This requires diodes not on JPDS to provide isolation between the battery and internal bus. During installation or repair, any configuration performed through the barrier terminal strips must match system documentation.
In TMR systems, it is generally desirable to maintain separate R, S, and T power systems throughout the control. When used this way, JPDS will have three power supply inputs. The barrier terminal at the top and bottom of the board will not be used to connect the three separate supplies. In dual systems, it is common to use dual redundant power supplies for 28 V power, and to connect the positive side of the P28 R, S, and possibly T buses using jumpers applied to one of the barrier terminal strips. It is also possible to use three supplies tied together into a single supply bus if desired.

Because JPDS does not have any output circuit fusing, it depends on the current limit of the power supplies to limit fault current on outputs. If two power supplies of 500 W or greater are used in a diode or configuration, there will be too much available fault current so the JPDM board with fusing must be used.

### 10.8.3.1 PPDA Configuration with JPDS

If one or two of the 28 V circuits are not powered, the undervoltage detection for that circuit can be disabled by changing the value of PS28vEnable from **Enable** to **Disable**. This also removes the alarm driven by the power supply dry contact monitor associated with that circuit.

**Note** If the Dry Contact status feedback from the Power supply are not used, the PS28vEnable can be set to NoDryCnt to continue to allow the 28 V input to be used, but disable diagnostic alarms driven by the power supply dry contact monitor.

### 10.8.4 JPDS Installation

JPDS mounts in a metal holder, which fits on a vertical DIN-rail next to other power distribution boards. Optionally, JPDS is also available with a metal holder designed for direct mounting. Refer to the wiring diagrams for power input and output routing. There is a 50-pin diagnostic connector mounted on the top and bottom of the board.
10.8.5 JPDS Operation

The JPDS is the power distribution board that receives 28 V dc power from the selected supplies and distributes it to the JPDP boards (for power to the I/O packs) and to the control racks. The normal 28 V power input to JPDS is through JR, JS, JT connectors.

JPDS Simplified Circuit Diagram
The JPDS I/O characteristics are as follows:

- Three 28 V power input connectors, JR, JS, JT. The connectors on the power supplies have two connections for positive and three connections for negative power. In addition, there are three power supply health inputs each with two dry contact inputs per power source, which become diagnostic signals.
- Three dc outputs, JCR, JCS, and JCT, to control rack CPCI power supplies.
- Three outputs JAR, JAS, JAT, to auxiliary power connectors, each with a positive temperature coefficient fuse for current limiting and containing a common-mode choke for noise suppression.
- Access to the internal 28 V bus at the board top and bottom using individual screw terminals on TB1 and TB2. Screw terminals for R, S, and T are sized to handle a maximum of 35 A continuous current. These terminals can be used to jumper boards together. The screw terminal for ground is sized for 75 A.
- DC-62 connector for PPDA power diagnostic I/O pack. The PPDA monitors JPDS and up to five additional power distribution boards connected to JPDS with a 50-pin diagnostic ribbon cable.
- P28 power output, P4, diode ORed for the PPDA power diagnostic pack.
10.8.6 JPDS Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>JPDS Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inputs</strong></td>
<td></td>
</tr>
<tr>
<td>Three 9-pin connections for 28 V dc Power Supply inputs</td>
<td>25 A max each</td>
</tr>
<tr>
<td>One 50-pin ribbon cable with diagnostic data from upstream boards</td>
<td>±5 V max</td>
</tr>
<tr>
<td>One 5-screw terminal block for daisy chaining power distribution boards</td>
<td>35 A max per screw</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td></td>
</tr>
<tr>
<td>Six 6-pin connections for either JPDP or JPDL boards</td>
<td>13 A max per pin</td>
</tr>
<tr>
<td>Three 2-pin connections for CPCI control rack power</td>
<td>12.5 A max per pin</td>
</tr>
<tr>
<td>Three 2-pin connections, filtered and fused, for auxiliary devices</td>
<td>1.6 A at 20 °C (derated to 0.8 A at 70 °C) positive temperature coefficient fuse</td>
</tr>
<tr>
<td>One 50-pin ribbon cable with diagnostic data to downstream boards</td>
<td>±5 V max</td>
</tr>
<tr>
<td>One 5-screw terminal block for daisy chaining power distribution boards</td>
<td>35 A max per screw</td>
</tr>
<tr>
<td>One 2-pin connection for 28 V dc power to the PPDA pack</td>
<td>0.25 A max</td>
</tr>
<tr>
<td>One 62-pin D-shell connection for PPDA power diagnostic pack</td>
<td>±5 V max</td>
</tr>
<tr>
<td><strong>Ambient Rating for Enclosure Design</strong></td>
<td>-40 to 70 ºC (-40 to 158 °F)</td>
</tr>
<tr>
<td><strong>Board Dimensions</strong></td>
<td>16.51 cm x 17.8 cm (6.5 in x 7.0 in) H x W</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td></td>
</tr>
<tr>
<td>DIN-rail mounting</td>
<td></td>
</tr>
<tr>
<td>Base mounted steel bracket</td>
<td></td>
</tr>
</tbody>
</table>

10.8.7 JPDS Diagnostics

Diagnostic signals are obtained and routed into the PPDA I/O pack as follows:

- An electronic ID identifying the board type, revision, and serial number
- Three analog P28 voltage readings for R, S, and T bus
- Each power supply connector (JR1, JS1, JT1) has provisions for a dry contact indicating power supply status. JPDS conditions these signals and places them in the feedback signal set.
- Auxiliary supply status feedback from downstream of the fuses provides three feedback signals to PPDA.

JPDS contains test rings for 28 V dc power from the three internal circuits, 28PR, 28PS, and 28PT. Each test ring has a series 10k resistor isolating the ring and a single grounded ring, 28N, for the return path. These can be used to measure the 28 V dc power voltage using external test equipment.

**Note** Fuse and dry contacts failure diagnostics will not be generated if InputDiagEnab on the respective dc input (R/S/T) is set to Disable or the dc input is below the low limit threshold, 5 V.

Also, dry contact diagnostics will not be generated if the user selects NoDryCnt on the input on which a dry contact exists.
10.9 JGND Shield Ground

10.9.1 JGND Functional Description
The Shield Ground (JGND) terminal board mounts along side the terminal board and provides convenient ground connections for the customer’s shield drain wires.

10.9.2 JGND Installation
JGND mounts on a sheet metal bracket attached to the plate, which holds the terminal board. JGND is grounded to the bracket with the two screws at each end of the terminal board. The customer's shield wires connect to terminals in the Euro-type terminal block.

One or two JGND can be located on the side of the terminal board mounting bracket, for a maximum of 48 ground connections.

JGND provides a path to sheet metal ground at the board mounting screw locations. The default mechanical assembly of this board to its mount includes a nylon washer between the board and the sheet metal. This isolates JGND from the sheet metal and allows wiring of the board ground current into any desired grounding location. Removal of the washer permits conduction of the ground currents into local sheet metal and does not require any additional grounding leads.

At the time a JGND board is installed, a choice must be made to conduct ground currents through a wire to designated ground (washer present) or to conduct directly to sheet metal (washer absent). A direct connection to sheet metal is preferred. If a wire connection is used, it should be as short as possible, not exceeding 5 cm (2 in).
Terminal Board, top view

TB1
Customer wiring connections

Connection screws on Euro terminal block
Terminal board, side view

Shield wire connections

IS200JGNDG1

Sheet metal grounding bracket
Grounding screws at each end of board

JGND Mounting
10.9.3 JGND Operation

All 24 connectors on the Euro block are connected to ground through the two grounding screws at the ends of JGND. These make contact with the metal mounting bracket, which is connected to ground. If nylon washers are used to isolate the board, ground currents must be wired into an alternate system location.

10.9.4 JGND Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>JGND Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminals</td>
<td>24 terminals on Euro type terminal block</td>
</tr>
<tr>
<td>Ambient Rating for Enclosure Design</td>
<td>-40 to 70 ºC (-40 to 158 ºF)</td>
</tr>
<tr>
<td>Board Dimensions</td>
<td>3.175 cm x 12.7 cm (1.25 in x 5.0 in) H x W</td>
</tr>
<tr>
<td>Mounting</td>
<td>Held with three screws to sheet metal bracket on side of terminal board</td>
</tr>
</tbody>
</table>
10.10  Phoenix Power Supplies (GE Part Number Series 342A3648)

The control system is powered by vendor manufactured control power supplies (VMCPS), manufactured by Phoenix Contact®.

<table>
<thead>
<tr>
<th>Power Supply</th>
<th>Control Power</th>
<th>Available Ratings</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC or DC input / DC output</td>
<td>Input: 115/230 V ac (auto switch), 90-350 V dc or 120-350 V dc (model dependent)</td>
<td>120 to 960 W</td>
<td>Phoenix Contact</td>
</tr>
<tr>
<td></td>
<td>Output: 24, 28, or 48 V dc</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Phoenix power supplies provide the following features:

- Convection cooling – no cooling fans are used
- Ambient rating for enclosure design: -40 to 70°C (-40 to 158 °F) free convection (no fans).
- ±2% voltage regulation
- Compatible with required environmental and agency standards
- Normally Open dry contact and LEDs for status feedback. When the power supply is working correctly, the contact is closed. When a problem is detected, the contact is open.
- Power supply outputs can be paralleled (Phoenix does not current share but supports redundant operation using an external FET-OR redundancy module.)
- Current limit and over-voltage protection of outputs. The current limit is rectangular rather than being a fold-back limit. The current limits at the defined value and output voltage is decreased.
- Input filtering for EMC compliance for incoming and out-going conducted EMI
- CE Mark for Low Voltage Directive (LVD) and EMC
- UL 508 listing

The following table provides a list of the Phoenix (QUINT) Contact power supplies and FET-OR redundancy modules (GE Part Number Series 342A3648), including a summary of each supply’s features and ratings.
<table>
<thead>
<tr>
<th>Item #</th>
<th>GE Part #</th>
<th>Description</th>
<th>Rated W (≤60°C, 140 °F)</th>
<th>Rated V DC</th>
<th>Boost W (&lt;40°C, 104 °F)</th>
<th>I&lt;sub&gt;rated&lt;/sub&gt; A DC</th>
<th>Clamp V</th>
<th>Input Surge (I&lt;sup&gt;2&lt;/sup&gt;T at 25°C, 77 °F)</th>
<th>Hold-up Time mS</th>
<th>Coated</th>
<th>HazLoc¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>342A3648P120W24</td>
<td>Power Supply 120W AC/125DC&gt;24DC</td>
<td>120</td>
<td>24</td>
<td>180</td>
<td>5</td>
<td>35</td>
<td>1</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>2</td>
<td>342A3648P120W24C</td>
<td>Power Supply 120W AC/125DC&gt;24DC</td>
<td>120</td>
<td>24</td>
<td>180</td>
<td>5</td>
<td>35</td>
<td>1</td>
<td>&gt;20</td>
<td>Yes</td>
<td>ATEX IECEx</td>
</tr>
<tr>
<td>3</td>
<td>342A3648P120W28</td>
<td>Power Supply 120W AC/125DC&gt;28DC</td>
<td>120</td>
<td>28</td>
<td>180</td>
<td>4.2</td>
<td>35</td>
<td>1</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>4</td>
<td>342A3648P120W28C</td>
<td>Power Supply 120W AC/125DC&gt;28DC</td>
<td>120</td>
<td>28</td>
<td>180</td>
<td>4.2</td>
<td>35</td>
<td>1</td>
<td>&gt;20</td>
<td>Yes</td>
<td>ATEX IECEx</td>
</tr>
<tr>
<td>5</td>
<td>342A3648P240W24</td>
<td>Power Supply 240W AC/125DC&gt;24DC</td>
<td>240</td>
<td>24</td>
<td>360</td>
<td>10</td>
<td>35</td>
<td>1.5</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>6</td>
<td>342A3648P240W24C</td>
<td>Power Supply 240W AC/125DC&gt;24DC</td>
<td>240</td>
<td>24</td>
<td>360</td>
<td>10</td>
<td>35</td>
<td>1.5</td>
<td>&gt;20</td>
<td>Yes</td>
<td>CID2</td>
</tr>
<tr>
<td>7</td>
<td>342A3648P240W28</td>
<td>Power Supply 240W AC/125DC&gt;28DC</td>
<td>240</td>
<td>28</td>
<td>360</td>
<td>8.5</td>
<td>35</td>
<td>1.5</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>8</td>
<td>342A3648P240W28C</td>
<td>Power Supply 240W AC/125DC&gt;28DC</td>
<td>240</td>
<td>28</td>
<td>360</td>
<td>8.5</td>
<td>35</td>
<td>1.5</td>
<td>&gt;20</td>
<td>Yes</td>
<td>CID2</td>
</tr>
<tr>
<td>9</td>
<td>342A3648P240W48</td>
<td>Power Supply 240W AC/125DC&gt;48DC</td>
<td>240</td>
<td>48</td>
<td>360</td>
<td>5</td>
<td>60</td>
<td>1.5</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>10</td>
<td>342A3648P480W24</td>
<td>Power Supply 480W AC/125DC&gt;24DC</td>
<td>480</td>
<td>24</td>
<td>624</td>
<td>20</td>
<td>35</td>
<td>3.2</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>11</td>
<td>342A3648P480W24C</td>
<td>Power Supply 480W AC/125DC&gt;24DC</td>
<td>480</td>
<td>24</td>
<td>624</td>
<td>20</td>
<td>35</td>
<td>3.2</td>
<td>&gt;20</td>
<td>Yes</td>
<td>CID2</td>
</tr>
<tr>
<td>12</td>
<td>342A3648P480W28</td>
<td>Power Supply 480W AC/125DC&gt;28DC</td>
<td>480</td>
<td>28</td>
<td>624</td>
<td>17</td>
<td>35</td>
<td>3.2</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>13</td>
<td>342A3648P480W28C</td>
<td>Power Supply 480W AC/125DC&gt;28DC</td>
<td>480</td>
<td>28</td>
<td>624</td>
<td>17</td>
<td>35</td>
<td>3.2</td>
<td>&gt;20</td>
<td>Yes</td>
<td>CID2</td>
</tr>
<tr>
<td>14</td>
<td>342A3648P480W48</td>
<td>Power Supply 480W AC/125DC&gt;48DC</td>
<td>480</td>
<td>48</td>
<td>624</td>
<td>10</td>
<td>60</td>
<td>3.2</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>15</td>
<td>342A3648P960W24</td>
<td>Power Supply 960W AC/125DC&gt;24DC</td>
<td>960</td>
<td>24</td>
<td>1080</td>
<td>40</td>
<td>35</td>
<td>1.7</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>16</td>
<td>342A3648P960W28</td>
<td>Power Supply 960W AC/125DC&gt;28DC</td>
<td>960</td>
<td>28</td>
<td>1080</td>
<td>34</td>
<td>35</td>
<td>1.7</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
</tbody>
</table>
### Phoenix Power Supplies and FET-OR Modules (continued)

<table>
<thead>
<tr>
<th>Item #</th>
<th>GE Part #</th>
<th>Description</th>
<th>Rated W (560°C, 140 °F)</th>
<th>Boost W (&lt;40°C, 104 °F)</th>
<th>I&lt;sub&gt;max&lt;/sub&gt; A DC</th>
<th>Clamp V</th>
<th>Input Surge (I&lt;sub&gt;P&lt;/sub&gt;T at 25°C, 77 °F)</th>
<th>Hold-up Time mS</th>
<th>Coated</th>
<th>HazLoc&lt;sup&gt;4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>342A3648PF20A28C</td>
<td>FET-OR Module 28VDC 2X10ADC</td>
<td>N/A</td>
<td>28&lt;sup&gt;6&lt;/sup&gt;</td>
<td>N/A</td>
<td>20&lt;sup&gt;2&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td>CID2</td>
</tr>
<tr>
<td>18</td>
<td>342A3648PF40A28C</td>
<td>FET-OR Module 28VDC 2X20ADC</td>
<td>N/A</td>
<td>28&lt;sup&gt;6&lt;/sup&gt;</td>
<td>N/A</td>
<td>40&lt;sup&gt;2&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td>CID2</td>
</tr>
<tr>
<td>19</td>
<td>342A3648PF80A28C</td>
<td>FET-OR Module 28VDC 2X40ADC</td>
<td>N/A</td>
<td>28&lt;sup&gt;6&lt;/sup&gt;</td>
<td>N/A</td>
<td>80&lt;sup&gt;2&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td>CID2</td>
</tr>
<tr>
<td>20</td>
<td>342A3648P400W40</td>
<td>Power Supply 400W AC/125DC&gt;40DC</td>
<td>400&lt;sup&gt;3&lt;/sup&gt;</td>
<td>40</td>
<td>520&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10</td>
<td>60</td>
<td>&gt;20</td>
<td>No</td>
<td>CID2</td>
</tr>
<tr>
<td>21</td>
<td>342A3648P960W48</td>
<td>Power Supply 960W AC/125DC&gt;48DC</td>
<td>960&lt;sup&gt;3&lt;/sup&gt;</td>
<td>48</td>
<td>1080&lt;sup&gt;3&lt;/sup&gt;</td>
<td>20</td>
<td>60</td>
<td>3.2</td>
<td>&gt;20</td>
<td>CID2</td>
</tr>
</tbody>
</table>

**Notes**

1. Output voltage tolerance is ±2%, drift from set point ±1%.
2. Linear derating to 75% x P<sub>rated</sub> at 70°C (158 °F) (2.5% per K above 60°C [140 °F]).
3. Boost Wattage is continuously available for T<sub>AMB</sub> < 40°C (104 °F), and for a limited time for T<sub>AMB</sub> > 40°C (104 °F).
4. Hazardous (classified) Location approvals: All units: CID2 (Class I Division 2 Groups A,B,C,D; T4); units 2, 4, 6, 8, 11, 13, 14, 15: ATEX (II 3G Ex nA IIC T4 Gc) and IECEx (Ex nA IIC T4 Gc).
5. 960 W supplies require additional power derating for low input voltage: AC < 100 V ac: 1% / V; DC < 120 V dc: 0.5% / V.
6. Output voltage is 0.2 V less than input voltage.
7. Output has varistor protection against static surge voltages > 32 V.
8. Items 6, 8, 11, 13 have input over-voltage protection to PE by a varistor in series with a gas discharge tube (GDT). The GDT must be removed for a surge test that exceeds 1500 V peak, or else its conduction current will indicate a test failure. When the GDT is removed, the power supplies are protected by surge capacitors to pass the test. In normal operation, if the GDT is triggered into its conducting state by a voltage surge, it will be turned off by the impedance of the varistor when the voltage to PE drops below 320 V dc.
9. At the nominal DC output voltage and above, the output has a constant power characteristic. Adjusting the DC output voltage below the nominal value puts the output into a constant current mode. For example, for a 480W, 48V nominal, 10A supply with the output voltage adjusted to the nominal or a higher value, there is 480W available no matter what the output voltage is, up to 60°C (140 °F). When the output voltage is adjusted to 40V, only 10A is available (40x10 = 400W). At 40°C (104 °F) or less, the standard boost current is still available. So, there is 624/48 = 13A available (40x13 = 520W) up to 40°C (104 °F).
## 10.10.1 Specifications

### Inputs

<table>
<thead>
<tr>
<th>Input Data</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Voltage</strong> — All Power Supplies Excluding P960Wxx</td>
<td></td>
</tr>
<tr>
<td>Input Voltage Range: AC Nominal</td>
<td>100 – 240 V ac</td>
</tr>
<tr>
<td>Input Voltage Limits: AC Min–Max</td>
<td>85 – 264 V ac</td>
</tr>
<tr>
<td>Input Voltage Range: DC Min–Max</td>
<td>90 – 350 V dc</td>
</tr>
<tr>
<td><strong>Input Voltage</strong> — Only P960Wxx</td>
<td></td>
</tr>
<tr>
<td>Input Voltage Range: AC Nominal</td>
<td>100 – 240 V ac</td>
</tr>
<tr>
<td>Input Voltage Limits: AC Min–Max, derating &lt; 100 V ac: 1%/V</td>
<td>85 – 264 V ac, derating &lt; 120 V dc: 0.5%/V</td>
</tr>
<tr>
<td>Input Voltage Range: DC Min–Max</td>
<td>90 – 300 V dc, derating &lt; 120 V dc: 0.5%/V</td>
</tr>
<tr>
<td><strong>Input Frequency</strong></td>
<td></td>
</tr>
<tr>
<td>Input Frequency for AC Nominal</td>
<td>50 – 60 Hz</td>
</tr>
<tr>
<td>Input Frequency for AC Min-Max</td>
<td>45 – 65 Hz</td>
</tr>
<tr>
<td><strong>Input Current at Full Load, Typical</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>120 V ac</td>
</tr>
<tr>
<td>P120Wxx</td>
<td>1.2</td>
</tr>
<tr>
<td>P240Wxx</td>
<td>2.8</td>
</tr>
<tr>
<td>P480Wxx, P400Wxx</td>
<td>5.1</td>
</tr>
<tr>
<td>P960Wxx</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Inrush Current Surge, Typical</strong></td>
<td>Inrush Current Limit (A) I² x T (A²s)</td>
</tr>
<tr>
<td>P120Wxx</td>
<td>15</td>
</tr>
<tr>
<td>P240Wxx</td>
<td>15</td>
</tr>
<tr>
<td>P480Wxx, P400Wxx</td>
<td>20</td>
</tr>
<tr>
<td>P960Wxx</td>
<td>15</td>
</tr>
<tr>
<td><strong>Protection Elements</strong></td>
<td></td>
</tr>
<tr>
<td>P120Wxx</td>
<td>Input Slow Blow Fuse (Internal): 5 A</td>
</tr>
<tr>
<td>P240Wxx</td>
<td>Input Slow Blow Fuse (Internal): 6.3 A</td>
</tr>
<tr>
<td>P480Wxx, P400Wxx</td>
<td>Input Slow Blow Fuse (Internal): 12 A</td>
</tr>
<tr>
<td>P960Wxx</td>
<td>Input Slow Blow Fuse (Internal): 20 A</td>
</tr>
<tr>
<td>All</td>
<td>Input Surge Protection: Metal Oxide Varistor (MOV)</td>
</tr>
<tr>
<td></td>
<td>Refer to the table Phoenix Power Supplies and FET-OR Modules, Note 8.</td>
</tr>
<tr>
<td><strong>Voltage Adjustment</strong></td>
<td>Externally accessible potentiometer</td>
</tr>
<tr>
<td><strong>Voltage Adjustment Potentiometer</strong></td>
<td>P120W24,28, P240W24,28, P240W48, P480-W24,28, P480W48, P400W40, P960W24,28</td>
</tr>
<tr>
<td>Adjustment Range (V dc)</td>
<td>18 – 29.5, 18 – 29.5, 30 – 56, 18 – 29.5, 30 – 56, 18 – 29.5</td>
</tr>
<tr>
<td><strong>Load Protection</strong></td>
<td>P120W24,28, P240W24,28, P240W48, P480-W24,28, P480W48, P400W40, P960W24,28</td>
</tr>
<tr>
<td>Electronic Short Circuit Protection (A)</td>
<td>7.5</td>
</tr>
<tr>
<td>Over-voltage Protection (V)</td>
<td>35</td>
</tr>
<tr>
<td>Holdup Time at Rated Load (ms)</td>
<td>&gt; 20</td>
</tr>
<tr>
<td><strong>Efficiency / Voltage Regulation</strong></td>
<td>P120W24,28, P240W24,28, P240W48, P480-W24,28, P480W48, P400W40, P960W24,28</td>
</tr>
<tr>
<td>Efficiency at Full Load</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>Output Voltage Regulation with:</td>
<td>&lt; 0.1%</td>
</tr>
<tr>
<td>Input Variation (±10%)</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Load Variation (Static 10 – 90%)</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Load Variation (Dynamic 10 – 90%)</td>
<td>—</td>
</tr>
</tbody>
</table>
### Outputs

<table>
<thead>
<tr>
<th>Output Data</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parallel Operation</strong></td>
<td></td>
</tr>
<tr>
<td>Current Sharing</td>
<td>For ( n ) parallel connected devices, the output current can be increased to ( n \times I_{\text{rated}} ). A maximum of five devices can be connected in parallel.</td>
</tr>
<tr>
<td>( N + 1 )</td>
<td>If a fault occurs in the primary circuit of the first power supply unit, the second device automatically takes over the entire power supply, without interruption, and vice versa.</td>
</tr>
<tr>
<td>Redundancy</td>
<td>Fully redundant with external decoupling Diode module</td>
</tr>
</tbody>
</table>

**Performance Requirements**

<table>
<thead>
<tr>
<th>Derating</th>
<th>Refer to the curve in the applicable section, Power Supply Power Boost and Output Derating Curve or FET-OR Module Output Derating Curve.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switching Frequency</td>
<td>Variable with load – resonant switching</td>
</tr>
<tr>
<td>Turn on Delay After Applying Input Power</td>
<td>(&lt; 0.5 \text{ s (typical)})  (&lt; 1 \text{ s (typical)}) for P480W48 and P960Wxx</td>
</tr>
<tr>
<td>Min Output Load</td>
<td>None</td>
</tr>
<tr>
<td>Ripple and Noise (20 MHz Bandwidth)</td>
<td>P120Wxx: (&lt; 40 \text{ mV pp})  P240Wxx: (&lt; 50 \text{ mV pp})  P480W24, P480W28: (&lt; 30 \text{ mV pp})  P480W48, P400W40: (&lt; 80 \text{ mV pp})  P960Wxx: (&lt; 100 \text{ mV pp})</td>
</tr>
</tbody>
</table>

**Reliability**

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean-time-between-failure (MTBF)</td>
<td>Power Supply: ( &gt; 500,000 \text{ h, according to IEC61709 (SN29500)})  FET-OR Module: ( &gt; 1,000,000 \text{ h at 40\degree C (104 \degree F)})</td>
</tr>
</tbody>
</table>

**Mounting**

<table>
<thead>
<tr>
<th>Item</th>
<th>Phoenix Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting Position</td>
<td>Horizontally on all DIN-rails, according to EN 60715</td>
</tr>
<tr>
<td>Mounting Location</td>
<td></td>
</tr>
<tr>
<td>Recommended Clearance Around Power Supply for Full Power Output</td>
<td>25 mm (1 in) on either side, 127 mm (5 in) above and 76 mm (3 in) below</td>
</tr>
<tr>
<td>Vertical Stacking of Power Supplies Operating at Full Power</td>
<td>Not recommended. The convection cooling path is through the bottom and out the top. The difference between inlet and exhaust air can be as high as 28°C (82°F) at full power.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Refer to the specific power supply or redundancy module section in this chapter for unit dimensions.</td>
</tr>
</tbody>
</table>

**Attention**

It is very important that each supply is mounted in a location with adequate space for free convective airflow and away from other heat sources.
<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>-25°C to +70°C (-13 to 158 °F) Free Convection (no fans), de-rate 2.5%/K above 60°C (140 °F)</td>
</tr>
<tr>
<td>Storage Temperature (non-operating)</td>
<td>-40 to 85°C (-40 to 185 °F)</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>95% ( at 25°C [77 °F] non-condensing)</td>
</tr>
<tr>
<td>Environmental Compatibility</td>
<td>Pollution Degree 2 according to EN 50178</td>
</tr>
<tr>
<td></td>
<td>Climatic Class 3K3 according to EN 60721</td>
</tr>
<tr>
<td></td>
<td>Coated Units: G3 Harsh Environment, according to ANSI/ISA 71.04</td>
</tr>
<tr>
<td>Housing</td>
<td>Steel sheet, zinc-plated, closed</td>
</tr>
<tr>
<td>Degree of Protection</td>
<td>IP20</td>
</tr>
<tr>
<td>Protection class</td>
<td>Power Supply: I, with PE connection</td>
</tr>
<tr>
<td></td>
<td>FET-OR Module: III</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td>&lt; 15 Hz, amplitude ±2.5 mm, according to IEC 60068-2-6</td>
</tr>
<tr>
<td></td>
<td>15 Hz - 150 Hz, 2.3g, 90 minutes</td>
</tr>
<tr>
<td>Shock</td>
<td>30g in all directions, per IEC 60068-2-27</td>
</tr>
<tr>
<td>Seismic Universal Building Code (UBC)</td>
<td>Not applicable at the power supply (component) level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Safety of Industrial Equipment</td>
<td>EN 60204</td>
</tr>
<tr>
<td>Electrical Safety of Information Technology Equipment</td>
<td>EN 60950-1/VDE 0805 (SELV)</td>
</tr>
<tr>
<td>SELV</td>
<td>IEC 60950-1 (SELV) and EN 60204 (PELV)</td>
</tr>
<tr>
<td>cULus</td>
<td>UL 508; ANSI/ISA 12.12.01 (Class I, Division 2, Groups A, B, C, D; T4)</td>
</tr>
<tr>
<td>cURus</td>
<td>UL 60950</td>
</tr>
<tr>
<td>ATEX</td>
<td>EN 60079-0, EN 60079-15 (II 3 G Ex nA IIC T4 Gc)</td>
</tr>
<tr>
<td>IECEx</td>
<td>Refer to the table Phoenix Power Supplies and FET-OR Modules, Note 4.</td>
</tr>
<tr>
<td>CE</td>
<td>EN 61000-6-2, EN 61000-6-3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LED</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td></td>
</tr>
<tr>
<td>DC OK – Active output</td>
<td>18 – 24 V dc, 20 mA</td>
</tr>
<tr>
<td>DC OK – Floating NO contact</td>
<td>30 V ac/dc, 1 A</td>
</tr>
<tr>
<td>POWER BOOST – Active output</td>
<td>18 – 24 V dc, 20 mA</td>
</tr>
<tr>
<td>FET-OR Module</td>
<td></td>
</tr>
<tr>
<td>Redundancy OK – Floating NO contact</td>
<td>30 V ac/dc, 100 mA</td>
</tr>
<tr>
<td>Automatic Current Balancing (ACB) OK – Floating NO contact</td>
<td>30 V ac/dc, 100 mA</td>
</tr>
</tbody>
</table>
10.10.2 Mounting and Installation

Most units are supplied ready for installation in a narrow mounting position.

Power Supply Mounting and Installation

The power supply unit can be snapped onto all DIN-rails in accordance with EN 60715 (units are supplied with universal DIN-rail adapter UTA 107/30). They must be mounted horizontally, connecting terminal blocks top and bottom, with input terminals facing upward. The following figure displays the default mounting position for Phoenix power supplies.

➢ To mount the power supply unit: position the module with the DIN-rail mounted guideway on the top edge of the DIN-rail and then snap it downwards.

➢ To remove the unit: release the snap-on catch using a screwdriver and detach the module from the bottom edge of the DIN-rail.

Typical Mounting Position

Power Supply Mounting Position and Installation Depth

<table>
<thead>
<tr>
<th>Power Supply</th>
<th>Mounting Position and Installation Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>P120Wxx</td>
<td>Slim-style: 125 mm (4.92 in) (+ DIN-rail) (state at delivery)</td>
</tr>
<tr>
<td></td>
<td>Low-profile: 43 mm (1.70 in) (+ DIN-rail)</td>
</tr>
<tr>
<td>P240Wxx</td>
<td>Slim-style: 125 mm (4.92 in) (+ DIN-rail) (state at delivery)</td>
</tr>
<tr>
<td></td>
<td>Low-profile: 63 mm (2.48 in) (+ DIN-rail)</td>
</tr>
<tr>
<td>P480Wxx</td>
<td>Slim-style: 125 mm (4.92 in) (+ DIN-rail) (state at delivery)</td>
</tr>
<tr>
<td>P400Wxx</td>
<td>Low-profile: 90 mm (3.54 in) (+ DIN-rail)</td>
</tr>
<tr>
<td>P960Wxx</td>
<td>Slim-style: 125 mm (4.92 in) (+ DIN-rail) (state at delivery)</td>
</tr>
<tr>
<td></td>
<td>Rotated 90°: 180 mm (7.08 in) (+ DIN-rail)</td>
</tr>
</tbody>
</table>
To ensure sufficient convection, adhere to the following guidelines for distance between power supply units and other modules.

### Power Supply Convection Specifications

<table>
<thead>
<tr>
<th>Mounting Position</th>
<th>Minimum Distance Between Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>5 cm (2.0 in)</td>
</tr>
<tr>
<td>Lateral</td>
<td>5 mm (0.20 in), 15 mm (0.60 in) between active components</td>
</tr>
</tbody>
</table>

![Power Supply Convection](image)

**Warning**

Depending on the ambient temperature and the load of the module, the power supply housing may become very hot.
FET-OR Module Mounting and Installation

The FET-OR redundancy module can be snapped onto all DIN-rails according to EN 60715 (units are supplied with universal snap-on foot for DIN-rails). The module should be mounted horizontally, connecting terminal blocks on top and bottom, with input terminal blocks facing upwards. The following figure displays the default mounting and removal position for the redundancy module.

---

**FET-OR Module Mounting and Removal Position**

---

**FET-OR Module Mounting and Installation Depth**

<table>
<thead>
<tr>
<th>FET-OR Module</th>
<th>Mounting Position and Installation Depth</th>
</tr>
</thead>
</table>
| PF20A         | Normal: 125 mm (4.92 in) (+ DIN-rail) (state at delivery)  
               | Rotated with 270° Y-axis: 35 mm (1.38 in) (+ DIN-rail) |
| PF40A         | Normal: 125 mm (4.92 in) (+ DIN-rail) (state at delivery)  
               | Rotated with 270° Y-axis: 41 mm (1.61 in) (+ DIN-rail) |
| PF80A         | Normal: 125 mm (4.92 in) (+ DIN-rail) (state at delivery)  
               | Rotated with 270° Y-axis: 69 mm (2.71 in) (+ DIN-rail) |

---

To ensure sufficient convection, adhere to the following guidelines for distance between the FET-OR module and other modules.

**FET-OR Module Convection Specifications**

<table>
<thead>
<tr>
<th>Mounting Position</th>
<th>Minimum Distance Between Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>50 mm (2.0 in)</td>
</tr>
<tr>
<td>Lateral</td>
<td>5 mm (0.20 in), 15 mm (0.60 in) between active components</td>
</tr>
</tbody>
</table>
Depending on the ambient temperature and the load of the module, the module housing may become very hot.
10.10.3 Operation

Warning

The device contains dangerous live elements and high levels of stored energy. Never carry out work when power is applied.

Warning

Risk of burns. The housing temperature can reach high values depending on the ambient temperature and the load of the device.

Attention

Make sure that all output cables are the correct size for the maximum output current or have separate fuse protection. The cable cross sections in the secondary circuit must be large enough to keep the voltage drops on the cables as low as possible. Further recommendations are given with the individual power supply descriptions provided in this document.

Before startup, verify that the following conditions have been met:

- The Mains has been connected correctly and protection is provided against electric shock.
- The device can be switched off outside the power supply according to EN 60950 regulations (such as by the line protection on the primary side).
- The protective conductor is connected.
- All supply lines have sufficient fuse protection and are the correct size.
- All output cables are the correct size for the maximum device output current or have separate fuse protection.
- Sufficient convection is ensured.

Attention

An internal fuse is provided for device protection. Branch circuit protection external to the supply is recommended to guard wiring and connections. For dc input applications, the external fuse or circuit breaker must be rated for dc operation. Further recommendations are given with individual supply descriptions provided in the following sections of this document.

If the internal fuse is blown, this is most probably due to component failures in the power supply. In this case, the power supply should be checked in the factory.
10.10.3.1 Block Diagrams

Power Supply Block Diagram

FET-OR Diode Module Block Diagram
10.10.3.2 Cable Wiring

**Caution**

Input power must be removed before changing I/O connections.

Use a screwdriver with the correct blade width for wiring. Refer to the following table for cable cross sections. For reliable and safe-to-touch connections, strip the cable ends in accordance with the table.

### Power Supplies Cable Wire Sizes Summary

<table>
<thead>
<tr>
<th>Power Supply</th>
<th>I/O Group</th>
<th>Max Wire AWG</th>
<th>Wire Stripping Length</th>
<th>Screw Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 and 240 W</td>
<td>Input</td>
<td>14</td>
<td>7 mm (0.3 in)</td>
<td>0.5 - 0.6 Nm (4.4 - 5.3 in-lb)</td>
</tr>
<tr>
<td></td>
<td>Output</td>
<td>14</td>
<td>7 mm (0.3 in)</td>
<td>0.5 - 0.6 Nm (4.4 - 5.3 in-lb)</td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td>14</td>
<td>7 mm (0.3 in)</td>
<td>0.5 - 0.6 Nm (4.4 - 5.3 in-lb)</td>
</tr>
<tr>
<td>480 W</td>
<td>Input</td>
<td>10</td>
<td>7 mm (0.3 in)</td>
<td>0.5 - 0.6 Nm (4.4 - 5.3 in-lb)</td>
</tr>
<tr>
<td></td>
<td>Output</td>
<td>6</td>
<td>10 mm (0.4 in)</td>
<td>1.2 - 1.5 Nm (10.6 - 13.3 in-lb)</td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td>6</td>
<td>10 mm (0.4 in)</td>
<td>1.2 - 1.5 Nm (10.6 - 13.3 in-lb)</td>
</tr>
<tr>
<td>960 W</td>
<td>Input</td>
<td>10</td>
<td>8 mm (0.31 in)</td>
<td>0.5 - 0.6 Nm (4.4 - 5.3 in-lb)</td>
</tr>
<tr>
<td></td>
<td>Output</td>
<td>6</td>
<td>10 mm (0.4 in)</td>
<td>1.2 - 1.5 Nm (10.6 - 13.3 in-lb)</td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td>10</td>
<td>8 mm (0.31 in)</td>
<td>0.5 - 0.6 Nm (4.4 - 5.3 in-lb)</td>
</tr>
</tbody>
</table>

### Diode-OR Module Cable Cross Sections

<table>
<thead>
<tr>
<th>Cable</th>
<th>Solid</th>
<th>Flexible</th>
<th>AWG</th>
<th>Torque</th>
<th>Stripping Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>0.2 - 16 mm (0.01 - 0.6 in)²</td>
<td>0.5 - 10 mm (0.02 - 0.4 in)²</td>
<td>14 - 6</td>
<td>1.2 - 1.5 Nm (10.6 - 13.3 in-lb)</td>
<td>10 mm (0.4 in)</td>
</tr>
<tr>
<td>Output</td>
<td>0.2 - 16 mm (0.01 - 0.6 in)²</td>
<td>0.5 - 10 mm (0.02 - 0.4 in)²</td>
<td>14 - 6</td>
<td>1.2 - 1.5 Nm (10.6 - 13.3 in-lb)</td>
<td>10 mm (0.4 in)</td>
</tr>
</tbody>
</table>

10.10.3.3 System Connections

The connection for 100 – 240 V ac is established using the L, N, and P screw connections. The device can be connected to 1–phase ac networks, or to two of the phase conductors of 3–phase systems (TN, TT, or IT systems in accordance with VDE 0100–300/IEC 60364–3) with nominal voltages of 100 — 240 V ac. The device also continues to work on short–term input voltages greater than 300 V ac.

![Power Supply System Connections Architecture](image-url)
Attention

For operation on two of the phase conductors of a 3-phase system, an isolating facility for all poles must be provided.

10.10.3.4 Power Supply Power Boost and Derating

The power supply unit works with the static power reserve, Power Boost, as indicated in the U/I characteristic curve in the following figure. At ambient temperatures of $T_{\text{amb}} < 40^\circ\text{C} (104^\circ\text{F})$, Boost output current ($I_{\text{BOOST}}$) is available continuously. At higher temperatures, it's available for a few minutes. In the event of a secondary-side short circuit or overload, the output current is limited to $I_{\text{BOOST}}$. Therefore, the module does not power down but rather supplies a continuous output current, and the secondary voltage is reduced until the short circuit is eliminated. The U/I characteristic curve with the power reserve Power Boost ensures that both high inrush currents of capacitive loads and consumers with dc to dc converters in the Primary circuit can be supplied.

To trip standard power circuit breakers magnetically and very quickly, power supplies must supply a multitude of nominal current for a short period: $I < I_N$, $I > I_N$, and $U < 0.9 \times U_N$. (Refer to the section Diagnostic LEDs for more information.)

![Power Supply Output (U/I) Characteristic Curve](image)

<table>
<thead>
<tr>
<th>Item</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_N$</td>
<td>24 V</td>
</tr>
<tr>
<td>$I_N$</td>
<td>5 A</td>
</tr>
<tr>
<td>$I_{\text{BOOST}}$</td>
<td>7.5 A</td>
</tr>
<tr>
<td>SFB Technology</td>
<td>30 A</td>
</tr>
<tr>
<td>$P_N$</td>
<td>120 W</td>
</tr>
<tr>
<td>$P_{\text{BOOST}}$</td>
<td>180 W</td>
</tr>
</tbody>
</table>

At an ambient operating temperature of up to $40^\circ\text{C} (104^\circ\text{F})$, the unit continuously supplies Boost output current ($I_{\text{BOOST}}$). Nominal output current ($I_N$) is supplied with ambient temperatures up to $60^\circ\text{C} (140^\circ\text{F})$. At higher temperatures ($> 60^\circ\text{C}$), the output power must be decreased by 2.5% per Kelvin temperature increase. At ambient operating temperatures above $70^\circ\text{C} (158^\circ\text{F})$ or in the event of a thermal overload, the unit does not switch off. Reduce the output power enough to ensure the protection of the device. Once the unit has cooled down, the output power is increased again.
10.10.3.5 FET-OR Module Derating

The active redundancy module can be operated with the maximum current of 2 x 15 A up to an ambient temperature of 40°C (104 °F). The device can be operated continuously with the nominal current (I_N) with ambient temperatures up to 60°C (140 °F). At higher temperatures (> 60°C), the output power must be decreased by 2.5% per Kelvin temperature increase. At ambient operating temperatures above 70°C (158 °F) or in the event of a thermal overload, the unit does not switch off. Reduce the output power enough to ensure the protection of the device.

When using the 10 A power supply unit, the derating curve is automatically maintained.

Position-dependent Derating

If the redundancy module is mounted in a position other than horizontally with input terminals facing upward, derating applies. Refer to the derating curve to determine the maximum output power to be applied for each ambient temperature with alternative mounting positions.
Normal FET-OR Module Mounting Position Derating

Rotated FET-OR Module Mounting Position Derating for 90°X-axis
Rotated FET-OR Module Mounting Position Derating for 180° X-axis

Rotated FET-OR Module Mounting Position Derating for 270° X-axis
10.10.3.6  Diagnostic LEDs

Power Supply Diagnostics

An active DC OK switching output signal, a floating DC OK signal contact, and an active POWER BOOST switching signal output monitor power supply functionality as defined in the following table. Additionally, the DC OK LED and the Boost LED can be used to evaluate power supply functionality directly at the installation site.

<table>
<thead>
<tr>
<th>Signal/LED</th>
<th>I &lt; I_N</th>
<th>I &gt; I_N</th>
<th>U_{OUT} &lt; 0.9 \times U_N</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC OK</td>
<td>On</td>
<td>On</td>
<td>Flashing</td>
</tr>
<tr>
<td>Boost</td>
<td>Off</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Active DC OK switching output</td>
<td>On</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Floating DC OK output</td>
<td>Closed</td>
<td>Closed</td>
<td>Open</td>
</tr>
<tr>
<td>Active POWER BOOST switching output</td>
<td>On</td>
<td>Off</td>
<td></td>
</tr>
</tbody>
</table>

| Indication                           | Normal operation of power supply (U_{OUT} > 21.5 V) | POWER BOOST operation (such as start loads) | Overload mode (such as consumer short circuit or overload) |

When the floating DC OK output contact opens, the DC OK LED indicates that the set output voltage has fallen below 10%. Signals and ohmic loads of up to 30 V max and currents of 1 A max (or 60 V max with 0.5 A max) can be switched. For heavily inductive loads, such as a relay, a suitable protection circuit (such as a damping diode) is needed.

Floating DC OK Contact and DC OK LED Operation

The 18 – 24 V dc active signal output is applied between the DC OK signal and the negative (-) connection terminal blocks or between I < I_N and the negative (-) connection terminal blocks, and can carry up to 20 mA. After switching from active high to low, the DC OK LED indicates that the output voltage has fallen below 10%.

The DC OK output signal is decoupled from the power output to ensure that an external supply does not enter from devices connected in parallel.

The POWER BOOST output signal I < I_N indicates that the nominal current has been exceeded, which places the power supply unit in POWER BOOST mode. This monitors critical operational status to prevent a voltage dip. The 18 – 24 V dc signal can be directly connected to a logic input for evaluation.

Active Signal Outputs and DC OK LED Operation
To create a signal loop, when monitoring two devices, use the active signal output of device 1 and loop in the floating signal output of device 2. In the event of malfunction, a diagnostic alarm is generated. Any number of devices may be looped in. This signal combination saves wiring costs and logic inputs.

![Active Signal Loop](image)

**FET-OR Module Diagnostics**

The Redundancy OK (13/14) and ACB OK floating (23/24) floating signal contacts monitor FET-OR module functionality as defined in the following table. Additionally, the Redundancy OK LED, I \(<\) I_{N} LED, and the bar graph can be used to evaluate redundancy module functionality on site. To monitor redundancy, the nominal current of the upstream power supply units can be set on the module using the rotary selection switch.

![FET-OR Module Diagnostic LED Indications](image)
When the Redundancy OK floating signal contact opens, it indicates the loss of redundancy. Loss of redundancy may be a result of the following issues:

- The decoupled component is defective.
- At least one input voltage is too low or does not exist.
- If the load current is higher than the set threshold value of $I_N$, a single power supply unit can no longer sustain the load (indicated after 4 sec).

When the ACB OK floating signal contact opens, it indicates that the load current is not distributed symmetrically on both parallel connected power supply units.

10.10.3.7 Power Supply Redundant Operation

Redundant power supplies are recommended for use in systems with especially high requirements for operational safety. With redundant power supplies, if a fault occurs in the Primary circuit of the first power supply, the second device automatically takes over supplying power, without interruption, and vice versa. For this purpose, the power supply units to be connected in parallel are dimensioned so that the total current requirement of all consumers is completely covered by one power supply unit. However, 100% redundancy makes external decoupling diodes (GE Part Number 342A3648PD40A48) necessary.
10.10.3.8 Power Supply Parallel Operation

Power supplies are shipped from the factory with parallel operation enabled. Devices of the same type can be connected in parallel to enable redundancy and to increase efficiency. If the output voltage is adjusted, all parallel operated power supply units are automatically set to ensure uniform distribution of power. To ensure symmetrical current distribution, make sure all cable connections from the power supply unit to the busbar are the same length and have the same cross-section.

**Note** Depending on the system, for parallel connection of more than two power supply units, a protective circuit should be installed at each individual device output (such as decoupling diode, dc fuse, or power circuit breaker). This prevents high return currents in the event of a secondary device fault.

For increased performance in parallel connected devices, the output current can be increased to $N \times I_N$. Parallel connection is used to expand existing systems and increase efficiency. GE recommends that users use parallel connection if the power supply unit does not cover the current requirement of the most powerful consumer. Otherwise, consumers should be spread among individual devices independent of one another.

**Note** A maximum of five devices can be connected in parallel.

---

![Parallel Connection for Increased Performance](image)
10.10.3.9 FET-OR Module Redundant Operation

The FET-OR module decouples the output of two power supply units and ensures safe redundancy. One redundancy module is needed to decouple two parallel connected power supplies (device 1 and 2) with nominal currents of up to 10 A.

![Redundancy Diode Decoupling](image)

**Redundancy Diode Decoupling**

The Auto Current Balance (ACB) technology is used to double the operation life of redundant power supply units. The load current is automatically distributed symmetrically to evenly load both power supply units. Use connection cables of the same length and cross section.

**Surge Protection**

Inputs IN 1 and IN 2 are equipped with a protective circuit that is triggered in the event of static surge voltages greater than 30 V. Two input voltages must be present that are independent of each other.
10.10.4 342A3648P120Wxx Power Supplies

The 342A3648P120Wxx power supply provides 24 or 28 V dc. It is a DIN-rail mounted, single-phase, switching power supply. Refer to the section *Specifications* for power supply specifications.

### Connections

<table>
<thead>
<tr>
<th>Item</th>
<th>Solid (mm²)</th>
<th>Stranded (mm²)</th>
<th>AWG</th>
<th>Torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>0.2 – 2.5</td>
<td>0.2 – 2.5</td>
<td>20 – 12</td>
<td>0.5 – 0.6</td>
</tr>
<tr>
<td>Output</td>
<td>0.2 – 2.5</td>
<td>0.2 – 2.5</td>
<td>20 – 12</td>
<td>0.5 – 0.6</td>
</tr>
<tr>
<td>Signal</td>
<td>0.2 – 2.5</td>
<td>0.2 – 2.5</td>
<td>20 – 12</td>
<td>0.5 – 0.6</td>
</tr>
</tbody>
</table>
Input
The device must be installed in accordance with EN 60950 regulations. It must be possible to disconnect the device using a suitable isolating facility outside of the power supply, such as the Primary side line protection. An internal fuse provides device protection; no additional device protection is necessary.

Caution
If an internal fuse is triggered, there may be a malfunction with the device. Return the device to the GE for inspection.

The recommended backup fuse for Mains protection is power circuit-breaker 6 A, 10 A, or 16 A, characteristic B or identical function.

Attention
Be sure to connect a suitable fuse upstream for DC applications.

Output

Caution
Make sure that all output lines are dimensioned according to the maximum output current or they are separately protected. The cables on the Secondary side must have sufficiently large cross sections to keep the voltage drops on the lines as low as possible.

Connection is established using the screw connections on the DC output as follows:

• 24 V dc: + and –
• Active DC OK switching output: DC OK LED and –
• Floating DC OK output: 13 and 14
• Active POWER BOOST switching output: I < I

The default output voltage is 24 V dc. However, output voltage may be modified using the potentiometer.

The device is electronically protected against short-circuit and idling. If a malfunction occurs, the output is limited to 35 V dc.
342A3648P120Wxx Power Supply Dimensions
10.10.5 342A3648P240Wxx Power Supplies

The 342A3648P240Wxx power supply provides 24, 28, or 48 V dc. It is a DIN-rail mounted, single-phase switching power supply. Refer to the section Specifications for power supply specifications.

![P342A3648P240Wxx Power Supply]

**Connections**

<table>
<thead>
<tr>
<th>Item</th>
<th>Solid (mm²)</th>
<th>Stranded (mm²)</th>
<th>AWG</th>
<th>Torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>0.2 – 2.5</td>
<td>0.2 – 2.5</td>
<td>16 – 12</td>
<td>0.5 – 0.6</td>
</tr>
<tr>
<td>Output</td>
<td>0.2 – 2.5</td>
<td>0.2 – 2.5</td>
<td>16 – 12</td>
<td>0.5 – 0.6</td>
</tr>
<tr>
<td>Signal</td>
<td>0.2 – 2.5</td>
<td>0.2 – 2.5</td>
<td>16 – 12</td>
<td>0.5 – 0.6</td>
</tr>
</tbody>
</table>
Input

The device must be installed in accordance with EN 60950 regulations. It must be possible to disconnect the device using a suitable isolating facility outside of the power supply, such as the Primary side line protection. An internal fuse provides device protection; no additional device protection is necessary.

**Caution**

If an internal fuse is triggered, there may be a malfunction with the device. Return the device to the GE for inspection.

The recommended backup fuse for Mains protection is power circuit-breaker 10 A or 16 A, characteristic B or identical function.

**Attention**

Be sure to connect a suitable fuse upstream for DC applications.

Output

Make sure that all output lines are dimensioned according to the maximum output current or they are separately protected. The cables on the Secondary side must have sufficiently large cross sections to keep the voltage drops on the lines as low as possible.

Connection is established using the screw connections on the DC output as follows:

- For P240W24 and P240W28 units 24 V dc: + and –
- For P240W48 units 48 V dc: + and –
- Active DC OK switching output: DC OK LED and –
- Floating DC OK output: 13 and 14
- Active POWER BOOST switching output: I < Iₙ and –

For P240W24 and P240W28 units, the default output voltage is 24 V dc. For P240W48 units, the default output voltage is 48 V dc. However, output voltage may be modified using the potentiometer.

The device is electronically protected against short-circuit and idling. If a malfunction occurs, the output voltage for P240W24 and P240W28 units is limited to 35 V dc, and to 60 V dc for P240W48 units.
342A3648P240Wxx Power Supply Dimensions
10.10.6 342A3648P480Wxx, 342A3648P400W40 Power Supplies

The 342A3648P480Wxx power supply provides 24, 28, or 48 V dc.
The 342A3648P400W40 power supply provides 40 V dc.

Both units are a DIN-rail mounted, single-phase switching power supply. Refer to the section Specifications for power supply specifications.

---

### 342A3648P480Wxx Power Supply

#### Connections

<table>
<thead>
<tr>
<th>Item</th>
<th>Solid (mm²)</th>
<th>Stranded (mm²)</th>
<th>AWG</th>
<th>Torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>0.2 – 6</td>
<td>0.2 – 4</td>
<td>18 – 10</td>
<td>0.5 – 0.6</td>
</tr>
<tr>
<td>Output</td>
<td>0.2 – 6</td>
<td>0.2 – 4</td>
<td>12 – 10</td>
<td>0.5 – 0.6</td>
</tr>
<tr>
<td>Signal</td>
<td>0.2 – 6</td>
<td>0.2 – 4</td>
<td>18 – 10</td>
<td>0.5 – 0.6</td>
</tr>
</tbody>
</table>

---

342A3648P480Wxx Power Supply

- AC input
- DC output
- DC OK output, floating
- DC OK switching output active
- Power Boost
- Universal DIN-rail adapter (UTA 107/30) (not shown)
- Boost LED
- DC OK LED
- Potentiometer 18 to 29.5 V dc
Input
The device must be installed in accordance with EN 60950 regulations. It must be possible to disconnect the device using a suitable isolating facility outside of the power supply, such as the Primary side line protection. An internal fuse provides device protection; no additional device protection is necessary.

![Caution]
If an internal fuse is triggered, there may be a malfunction with the device. Return the device to the GE for inspection.

The recommended backup fuse for Mains protection is power circuit-breaker 10 A or 16 A, characteristic B or identical function.

![Attention]
Be sure to connect a suitable fuse upstream for DC applications.

Output

![Caution]
Make sure that all output lines are dimensioned according to the maximum output current or they are separately protected. The cables on the Secondary side must have sufficiently large cross sections to keep the voltage drops on the lines as low as possible.

Connection is established using the screw connections on the DC output as follows:

- For P480W24 and P480W28 units 24 V dc: + and –
- For P480W48 and P400W40 units 48 V dc: + and –
- Active DC OK switching output: DC OK LED and –
- Floating DC OK output: 13 and 14
- Active POWER BOOST switching output: \( I < I_N \) and –

For P480W24 and P480W28 units, the default output voltage is 24 V dc. For P480W48 and P400W40 units, the default output voltage is 48 V dc. However, output voltage may be modified using the potentiometer.

The device is electronically protected against short-circuit and idling. If a malfunction occurs, the output voltage for P480W24 and P480W28 units is limited to 35 V dc, and to 60 V dc for P480W48 and P400W40 units.
342A3648P480Wxx, 342A3648P400Wxx Power Supply Dimensions
10.10.7 342A3648P960Wxx Power Supplies

The 342A3648P960Wxx power supply provides 24, 28, or 48 V dc. It is a DIN-rail mounted, single-phase, primary switching power supply used for universal use. Refer to the section Specifications for power supply specifications.

![342A3648P960Wxx Power Supply]

<table>
<thead>
<tr>
<th>Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Input</td>
</tr>
<tr>
<td>Output</td>
</tr>
<tr>
<td>Signal</td>
</tr>
</tbody>
</table>
Input

The device must be installed in accordance with EN 60950 regulations. It must be possible to disconnect the device using a suitable isolating facility outside of the power supply, such as the Primary side line protection. An internal fuse provides device protection; no additional device protection is necessary.

Caution

If an internal fuse is triggered, there may be a malfunction with the device. Return the device to the GE for inspection.

The recommended backup fuse for Mains protection is power circuit-breaker 6 A, 10 A, or 16 A, characteristic B or identical function.

Attention

Be sure to connect a suitable fuse upstream for DC applications.

Output

Caution

Make sure that all output lines are dimensioned according to the maximum output current or they are separately protected. The cables on the Secondary side must have sufficiently large cross sections to keep the voltage drops on the lines as low as possible.

Connection is established using the screw connections on the DC output as follows:

- 24 V dc: + and –
- Active DC OK switching output: DC OK LED and –
- Floating DC OK output: 13 and 14
- Active POWER BOOST switching output: I < I_N and –

The default output voltage is 24 V dc. However, output voltage may be modified using the potentiometer.

The device is electronically protected against short-circuit and idling. If a malfunction occurs, the output is limited to 35 V dc.
10.10.8 342A3648PF20A28C FET-OR Modules

The 342A3648PF20A28C FET-OR module is a redundancy module that can be used to FET-OR and decouple two power supplies of the same type to increase power or provide redundancy. The FET-OR module provides 100% decoupling of power supplies connected in parallel. The module is supplied ready for DIN-rail mounting. Refer to the section Specifications for power supply specifications.
10.10.9 342A3648PF40A28C FET-OR Modules

The 342A3648PF40A28C FET-OR module is a redundancy module that can be used to FET-OR and decouple two power supplies of the same type to increase power or provide redundancy. The FET-OR module provides 100% decoupling of power supplies connected in parallel. The module is supplied ready for DIN-rail mounting. Refer to the section Specifications for power supply specifications.
342A3648PF40A28C FET-OR Module Dimensions
10.10.10 342A3648PF80A28C FET-OR Modules

The 342A3648PF80A28C FET-OR module is a redundancy module that can be used to FET-OR and decouple two power supplies of the same type to increase power or provide redundancy. The FET-OR module provides 100% decoupling of power supplies connected in parallel. The module is supplied ready for DIN-rail mounting. Refer to the section Specifications for power supply specifications.
342A3648PF80A28C FET-OR Module Dimensions
10.10.11 342A3647PD40A48 Diode-OR Modules

The 342A3647PD40A48 Diode-OR redundancy module can be used to diode-OR and decouple two power supplies of the same type to increase power or provide redundancy. The Diode-OR module provides 100% decoupling of power supplies connected in parallel. The module is supplied ready for DIN-rail mounting. The following photograph displays the features of the Diode-OR module.

![Diode-OR Module](image)

**Note** This module provides redundant power supply configurations. At any given time, only one of the two supplies provides 100% of the load current. This module will not force load sharing between the supplies.
Diode-OR Module Dimensions

DC Input 1: 48 V dc, 20 A
DC Input 2: 48 V dc, 20 A
DC Output
DIN-rail latching foot, universal

342A3647PD40A48
11 Common I/O Module Functionality

11.1 BPPx Processor

The BPPx processor board is used with most Ethernet-based I/O modules. It contains the following:

- High-speed processor with RAM and flash memory
- Two fully independent 10/100 Ethernet ports with connectors
- Hardware watchdog timer and reset circuit
- Internal temperature sensor
- Status-indication LEDs
- Electronic ID and the ability to read IDs on other boards
- Input power connector with soft start and current limiter
- Local power supplies

The processor board connects to an acquisition board specific to the I/O module function. When input power is applied, the soft-start circuit ramps up the voltage available on the processor board. The local power supplies are sequenced on, and the processor reset is removed. The processor completes self-test routines, and then loads application code specific to the I/O module type from flash memory.

The processor reads board ID information to ensure the correct matching of firmware, acquisition board, and terminal board. With a good match, the processor attempts to establish Ethernet communications, starting with request of a network address. The address request uses the industry standard dynamic host configuration protocol (DHCP) and the unique identification read from the acquisition and terminal boards. After Ethernet initialization, the processor programs the on-board logic, runs the application, and enables the acquisition board to begin operation. This network redundancy function is more tolerant of faults than a classic Hot Backup where the second port is only used after a primary port failure.

The processor application code contains all the logic necessary to allow the I/O module to operate from one or two Ethernet inputs. When operated from two Ethernet inputs, both network paths are active all the time. A failure of either network will not result in any disturbance to the I/O module operation, and the failure is indicated through the working network connection. The Ethernet ports on the processor auto-negotiate between 10 and 100 Mbps speed, and between half-duplex and full-duplex operation.

11.1.1 Power Management

The processor includes power management of its 28 V input circuit. The management function provides soft start to control current inrush during power application. After applying power, the circuit provides a fast current limit function to prevent a failure from propagating back onto the 28 V power system. When power is present and working properly, the green PWR LED is lit. If the current limit function operates, the PWR LED will be out until the problem is cleared.

11.1.2 ID Line

The processor board and acquisition board(s) within the I/O pack contain electronic ID parts that are read during power initialization. A similar part located with each terminal board pin connector allows the processor to confirm correct matching of I/O pack to terminal board and report board revision status to the controller.
11.1.3 **BPPx Processor LEDs**

<table>
<thead>
<tr>
<th>Color</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>PWR</td>
<td>Displays the presence of control power</td>
</tr>
<tr>
<td>Green</td>
<td>LINK</td>
<td>Provided for each Ethernet port to indicate if a valid Ethernet connection is present</td>
</tr>
<tr>
<td>Yellow</td>
<td>TxRx</td>
<td>Provided for each Ethernet port to indicate when the I/O module is transmitting or receiving data over the port</td>
</tr>
<tr>
<td>Red and Green</td>
<td>ATTN</td>
<td>Displays I/O module status</td>
</tr>
</tbody>
</table>

**Flash Codes for All Mark Vle I/O Packs and BPPC-based Mark VleS I/O Packs**

<table>
<thead>
<tr>
<th>LED</th>
<th>Flashing Pattern</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red ATTN</td>
<td>Solid</td>
<td>Booting - prior to reading board ID</td>
</tr>
<tr>
<td></td>
<td>4 Hz 50%</td>
<td>Diagnostic alarm active</td>
</tr>
<tr>
<td></td>
<td>2 Hz 50%</td>
<td>Awaiting an IP address</td>
</tr>
<tr>
<td></td>
<td>1 Hz 50%</td>
<td>No firmware to load (Program mode)</td>
</tr>
<tr>
<td></td>
<td>0.5 Hz 50%</td>
<td>Application code not loaded to the I/O module</td>
</tr>
<tr>
<td></td>
<td>LED out</td>
<td>Initializing, no problems detected</td>
</tr>
<tr>
<td>Green ATTN</td>
<td>Solid</td>
<td>BIOS (at power on), but if it remains in this state, the I/O module is not functioning properly and should be replaced</td>
</tr>
<tr>
<td></td>
<td>2 Hz 50%</td>
<td>Awaiting Auto-Reconfiguration release</td>
</tr>
<tr>
<td></td>
<td>1 Hz 50%</td>
<td>I/O module in WAIT or STANDBY</td>
</tr>
<tr>
<td></td>
<td>Two 4 Hz pulses every 4 sec</td>
<td>Application online</td>
</tr>
</tbody>
</table>

**Flash Codes for BPPB-based Mark VleS I/O Packs**

<table>
<thead>
<tr>
<th>LED</th>
<th>Flasiching Pattern</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red ATTN</td>
<td>LED out</td>
<td>There are no detectable problems with the I/O pack.</td>
</tr>
<tr>
<td></td>
<td>LED solid on</td>
<td>A critical fault is present that prevents the I/O pack from operating. There could be hardware failures on the processor or acquisition boards, or there is not any application code loaded.</td>
</tr>
<tr>
<td></td>
<td>4 Hz 50%</td>
<td>An alarm condition is present in the I/O pack. These alarms include: wrong I/O pack/terminal board combination, terminal board is missing, or errors in loading the application code.</td>
</tr>
<tr>
<td></td>
<td>1.5 Hz 50%</td>
<td>The I/O pack is not online.</td>
</tr>
<tr>
<td></td>
<td>0.5 Hz 50%</td>
<td>This is used during factory testing.</td>
</tr>
<tr>
<td></td>
<td>Two 4 Hz pulses every 4 sec</td>
<td>Application online</td>
</tr>
</tbody>
</table>
11.2 I/O Module Common Diagnostic Alarms

The following alarms are common, but not all of these alarms are applicable for every I/O module.

0

Description    Diagnostic Alarm Reset
Possible Cause  N/A
Solution        N/A

2

Description    Flash memory CRC failure
Possible Cause
During commissioning or maintenance:
  • A firmware programming error occurred. The I/O pack or module did not go online with the controller.
  • The hardware failed.
Solution
During commissioning or maintenance:
  • Rebuild the system, then download the application and the configuration to the I/O pack or module.
During normal operation:
  • Replace the I/O pack or module.

3

Description    CRC failure override is active
Possible Cause
During commissioning or maintenance:
  • A firmware programming error occurred. The I/O pack or module did not go online with the controller.
  • The hardware failed.
Solution
During commissioning or maintenance:
  • Rebuild the system, then download the application and the configuration to the I/O pack or module.
During normal operation:
  • Replace the I/O pack or module.
4

**Description**  I/O pack in stand alone mode

**Possible Cause**  
During commissioning or maintenance:

- The I/O pack or module configuration is invalid.

During normal operation:

- The hardware failed.

**Solution**  
During commissioning or maintenance:

- Rebuild the system, then download the application and the configuration to the I/O pack or module.

During normal operation:

- Replace the I/O pack or module.

5

**Description**  I/O pack in remote I/O mode

**Possible Cause**  
During commissioning or maintenance:

- The I/O pack or module configuration is invalid.

During normal operation:

- The hardware failed.

**Solution**  
During commissioning or maintenance:

- Rebuild the system, then download the application and the configuration to the I/O pack or module.

During normal operation:

- Replace the I/O pack or module.

6

**Description**  Special User Mode active. Now: [ ]

**Possible Cause**  
During commissioning or maintenance:

- The I/O pack or module configuration is invalid.

During normal operation:

- The hardware failed.

**Solution**  
During commissioning or maintenance:

- Rebuild system, then download the application and the configuration to the I/O pack or module.

During normal operation:

- Replace the I/O pack or module.
Description  The I/O pack has gone to the Offline state

Possible Cause
During commissioning or maintenance:
- Ethernet cable disconnected or connected to wrong port
During normal operation:
- Controller is offline or restarted.
- Faulty Ethernet switch/cable

Solution
During commissioning or maintenance:
- Check the Ethernet cable.
During normal operation:
- Verify that the controller is not offline.
- Replace the Ethernet switch/cable.

Description  System limit checking is disabled

Possible Cause  System checking disabled by configuration

Solution  System checking was disabled by the configuration.
**Description**  
ToolboxST application detects unhealthy link or loss of communication between [ ] and controller

**Possible Cause**
- I/O pack or module did not complete start up
- I/O pack or module configuration files missing
- I/O pack or module restarted
- I/O pack or module configured for dual networks, but only one network is connected
- Network issue preventing ToolboxST application connection
- Power failure to the I/O pack or module
- Terminal board barcode typed incorrectly in the ToolboxST configuration
- Wrong terminal board is configured in the ToolboxST application
- I/O pack or module is plugged into wrong jack on terminal board, or wrong jack number is configured in the ToolboxST application
- I/O pack or module configured in ToolboxST application, but configuration not downloaded to the controller
- I/O pack or module in program mode

**Solution**
- If the ToolboxST communication is working correctly, any additional diagnostics should indicate the cause of the problem.
- Perform a build and download parameters to the I/O pack or module.
- Download firmware and parameters to the I/O pack or module.
- Verify that the Ethernet cables and network switch are operating correctly.
- Verify that the I/O pack configuration (such as Type, HW Form, Bar Code, position) matches the actual hardware.
- Manually restart the I/O pack or module.
- Perform a build and download the configuration to the controller, wait for I/O pack communication status to change, then scan and download to the I/O pack.

**Note**  
This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the I/O pack or module.
**Description**  Control/Status communication failure between [ ] and controller

**Possible Cause**
- Asynchronous Drive Language (ADL) communication unhealthy
- Terminal board barcode is typed incorrectly in the ToolboxST configuration
- Wrong terminal board is configured in the ToolboxST application
- I/O pack or module is plugged into the wrong Jack on the terminal board, or the wrong jack number is configured in the ToolboxST application
- I/O pack or module is configured in the ToolboxST application, but the configuration is not downloaded to the controller
- I/O pack or module is in program mode

**Solution**
- Verify that the I/O pack or module configuration (such as Type, HW Form, Bar Code, position) matches the actual hardware.
- Perform a build and download the configuration to the controller, wait for communication status to change, then scan and download to the I/O pack or module.
- Manually restart the I/O pack or module.

**Note**  This alarm is obsolete.

---

**Description**  ToolboxST application detects a diagnostic status signal (...L3DIAG, ATTN, and/or LINK_OK...) is [ ]; therefore, diagnostic status for this I/O module may be inaccurate, unknown, or indeterminate

**Possible Cause**
- I/O pack or module status signal quality is in warning state
- Signal quality is unhealthy, forced, or being simulated
- Status information is inaccurate

**Solution**
- Check status signal health
- Remove the force or simulated condition that is applied to the status signal.

**Note**  This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the I/O pack or module.
**Description**  ToolboxST application detects a major difference in [ ] controller application code

**Possible Cause**
- Compressing variables, EGD pages, distributed I/O, or NVRAM
- Changing frame or background period
- Changing controller or network redundancy
- Changing controller platform or NTP client mode
- Changing controller host name or IP address
- Changing IONet IP address
- Adding/removing first/last linking device (PFFA), respectively
- Removing a WCBM module
- Changing from multicast to broadcast (vice-versa) I/O communication
- Adding the first shared I/O module or connecting the first Controller to Controller I/O variable
- Removing the last Modbus Slave point
- Disabling controller web pages
- Disabling Wind Compress Data Log
- Disabling Wind Farm Management System

**Solution**  Rebuild the controller and download.

**Note**  This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the I/O pack or module.
Description  ToolboxST application cannot retrieve diagnostics information from I/O pack [ ]

Possible Cause

- Cannot get the requested information from I/O pack or module.
- Communication program failure
- I/O pack or module unable to retrieve the IP address
- Terminal board barcode is typed incorrectly in the ToolboxST configuration
- Wrong terminal board is configured in the ToolboxST application
- I/O pack or module is plugged into the wrong Jack on the terminal board, or the wrong jack number in the ToolboxST configuration
- I/O pack or module is configured in the ToolboxST application, but the configuration is not downloaded to the controller
- I/O pack or module is in program mode
- I/O pack or module not able to load firmware
- Power failure to the I/O pack or module

Solution

- Verify that the I/O pack or module configuration (such as Type, HW Form, Bar Code, position) matches the actual hardware.
- Perform a build and download the configuration to the controller, wait for communication status to change, then scan and download to the I/O pack or module.
- Manually restart the I/O pack or module.
- Check the network cables for proper connection.
- Verify that the switch is functioning correctly.

Note  This alarm is not reported to the WorkstationST Alarm Viewer. This alarm is generated by the ToolboxST application, not by the I/O pack or module.

Description  Control/Status communication Error: [ ]

Possible Cause

- Cannot get diagnostic information from I/O pack or module
- I/O pack or module is not able to load firmware

Solution

- Check the I/O pack or module configuration.
- Rebuild the application and download the firmware and the application to the I/O pack or module.
- Check the network cables for proper connection.
- Verify that the switch is functioning correctly.

Note  This alarm is obsolete.
30

**Description**  Firmware/Configuration Incompatibility Error; Firmware: [ ] Config: [ ]

**Possible Cause**  I/O pack or module configuration files are incompatible with the firmware. Files have wrong revision.

**Solution**

- Confirm the correct installation of the ToolboxST application.
- Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack or module and selecting Upgrade.
- Rebuild the application and download the firmware and the application code to the affected I/O pack or module.

31

**Note**  This alarm is obsolete.

**Description**  Firmware/IO Configuration Incompatible; Firmware: [ ] IO Config: [ ]

**Possible Cause**

- I/O pack or module configuration files are incompatible with the firmware.
- The files have the wrong revision.

**Solution**

- Confirm the correct installation of the ToolboxST application.
- Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O module and selecting Upgrade.
- Rebuild the application, and download the firmware and application code to the affected I/O pack or module.

256

**Description**  [ ] V Pwr supply voltage is low

**Possible Cause**  Input voltage dropped below 18 V. I/O pack or module input power is required to be within range 28 V ±5%. I/O pack or module operation will be compromised or may stop completely.

**Solution**

- If PPDA is available to monitor control cabinet power, check the I/O pack or module for active alarms.
- Check the I/O pack or module power within the control cabinet; begin with power supplies and work toward the affected I/O pack or module.
Description: Pwr supply voltage is low

Possible Cause:
- For BPPB-based I/O packs, input voltage has dropped below 26.5 V. Input voltage is required to be within the range 28 V ±5%.
- For BPPC-based I/O packs, input voltage has dropped below 24 V. Input voltage is required to be within the range 24 V ±10%.

Note: In most cases, normal pack operation continues below this voltage, but field devices that require 24 V from the terminal board may begin to experience reduced voltage operation with undetermined results.

Solution:
- If PPDA is available to monitor control cabinet power check the I/O pack or module for active alarms.
- Check I/O pack or module power within the control cabinet; begin with power supplies and working toward the affected I/O pack or module.

Description: Temperature is out of range

Possible Cause:
- Temperature went outside -35°C to 66°C (-31 to 151 °F) limits for PCNO or PPRF.
- Temperature went outside -40°C to 90°C (-40 to 194 °F) limits for Mark VIe BPPC-based I/O modules.
- Temperature went outside -35°C to 85°C (-31 to 185 °F) limits for BPPB-based I/O modules, and for Mark VIeS Safety I/O modules.

Solution: Check the environmental controls for the cabinet containing the I/O pack. The I/O pack does continue to operate beyond these temperature limits, but long-term operation at elevated temperatures may reduce equipment life.
259

Description  Application Runtime Error - [] Frame overruns occurred

Possible Cause  Overloaded processor sequencer malfunction (one or more frame overruns occurred)

Solution
For a controller, do the following to increase the frame idle time:
• Reduce the application or increase the EGD period.
• Upgrade the controller to one with a faster processor.
• Replace the controller.
For an I/O module, do the following:
• From the ToolboxST application, rebuild the system, then download the application and configuration to the I/O module.
• Replace the I/O module.

260

Description  Application Runtime Error - [] Frame skips occurred

Possible Cause  There is an overloaded processor or a processor malfunction. Frame number skips were detected. The frame number should monotonically increase during Controlling state.

Solution
For a controller, do the following:
• Reduce the application or increase the EGD period to reduce the processor load.
• Upgrade the controller to one with a faster processor.
• Replace the controller.
For an I/O module, do the following:
• From the ToolboxST application, rebuild the system, then download the application and configuration to the I/O module.
• Replace the I/O module.

261

Description  Unable to read configuration file from flash

Possible Cause
During commissioning or maintenance:
• The I/O pack or module does not have the correct configuration file stored in its flash file system.
• There is a hardware problem.
During normal operation:
• There is a hardware failure.

Solution
During commissioning or maintenance:
• Confirm the correct installation of the ToolboxST application.
• Rebuild the system and download the application and the configuration to the I/O pack or module.
During normal operation:
• Replace the I/O pack or module.
**262**

**Description**  
Bad configuration file detected

**Possible Cause**  
During commission/maintenance:

- The configuration file in the I/O pack or module is not compatible with loaded application code

During normal operation:

- There is a hardware failure

**Solution**  
During commissioning or maintenance:

- Rebuild the system and download the application and the configuration to the I/O pack or module.

During normal operation:

- Replace the I/O pack or module.

---

**263**

**Note**  
This alarm is obsolete.

**Description**  
Invalid configuration file

**Possible Cause**  
During commissioning or maintenance:

- The downloaded configuration file is for a different type of I/O module.

During normal operation:

- There is a hardware failure.

**Solution**  
During commissioning or maintenance:

- Rebuild the control system and download the application and configuration to the I/O module.

During normal operation:

- Replace the I/O pack.
**Note**  This alarm is obsolete.

**Description**  Firmware/Configuration Incompatibility Error

**Possible Cause**
- I/O pack or module configuration files are incompatible with the firmware.
- The files have the wrong revision.

**Solution**
- Confirm the correct installation of the ToolboxST application.
- Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack and selecting **Upgrade**.
- Rebuild the application, and download the firmware and application code to the affected I/O pack or module.

**Description**  Configuration file load error - invalid I/O header size

**Possible Cause**
During commissioning or maintenance:
- Build error
- Controller EGD revision code is not supported
- Incompatible version of the I/O pack or module firmware was downloaded

During normal operation:
- There is a hardware failure.

**Solution**
During commissioning or maintenance:
- Confirm the correct installation of the ToolboxST application.
- Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack and selecting **Upgrade**.
- Rebuild the application, and download the firmware and application code to the affected I/O module.

During normal operation:
- Replace the I/O pack or module.
Description  Configuration file load error - invalid file length

Possible Cause
During commissioning or maintenance:

• The configuration file in the I/O pack or module does not have the correct size to match the application code that is loaded.

During normal operation:

• Hardware failure

Solution
During commissioning or maintenance:

• Confirm the correct installation of the ToolboxST application. Rebuild the application and download the firmware and the application code to the affected I/O pack or module.

During normal operation:

• Replace the I/O pack or module.

Description  Firmware Load Error

Possible Cause
During commissioning or maintenance:

• Incompatible version of firmware downloaded

During normal operation:

• There is a hardware failure.

Solution
During commissioning or maintenance:

• Confirm the correct installation of the ToolboxST application.

• Ensure that each I/O pack or module is upgraded to the latest version. From the ToolboxST application, right-click each I/O pack or module and selecting Upgrade.

• Rebuild the application and download the firmware and the application code to the affected I/O pack or module.

During normal operation:

• Replace the I/O pack or module.
268

**Description**  Firmware Load Error - Incompatible FPGA Revision: Found [ ] Need [ ]

**Possible Cause**
During commissioning or maintenance:

- Incompatible version of firmware downloaded

During normal operation:

- There is a hardware failure.

**Solution**
During commissioning or maintenance:

- Confirm the correct installation of the ToolboxST application.

During normal operation:

- Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack or module and selecting Upgrade.
- Rebuild the application and download the firmware and the application code to the affected I/O pack or module.
- Replace the I/O pack or module.

269

**Note**  This alarm is obsolete.

**Description**  EGD communication Initialization Failure

**Possible Cause**  Internal runtime error

**Solution**
- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.

270

**Note**  This alarm is obsolete.

**Description**  EGD communication terminated

**Possible Cause**  Internal runtime error

**Solution**
- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.
271

**Description**  Internal communication error - Exchange [ ] Export failed

**Possible Cause**
During commissioning or maintenance:

- I/O pack or module does not have correct configuration file stored in flash file system
- Internal runtime error

During normal operation:

- Internal runtime error

**Solution**
During commissioning or maintenance:

- From the ToolboxST application, confirm the correct configuration of the I/O pack or module.
- Rebuild the system, and download the application and configuration to the I/O pack or module.

During normal operation:

- Restart the I/O pack or module.
- If problem persists, replace the I/O pack or module.

272

**Note**  This alarm is obsolete.

**Description**  Internal EGD communication error - Exchange [ ] Import failed.

**Possible Cause**  Internal runtime error

**Solution**
- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.

273

**Note**  This alarm is obsolete.

**Description**  Unsupported EGD message - Invalid EGD version

**Possible Cause**  EGD protocol version incorrect, greater than current version

**Solution**
- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.
**274**

*Note*  This alarm is obsolete.

**Description**  IONET-EGD - Received Redundant Exchange from unknown address

**Possible Cause**  Controller received EGD message from unknown address

**Solution**

- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.

---

**275**

*Note*  This alarm is obsolete.

**Description**  IONET-EGD - Out of order Exchange [ ] from Producer [ ], Rcvd [ ], Last [ ]

**Possible Cause**  Message sequence number was out of order, less than required

**Solution**

- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.

---

**276**

*Note*  This alarm is obsolete.

**Description**  IONET-EGD - UNHEALTHY (Bad Configuration Time) Producer [ ], Exchange [ ]

**Possible Cause**  Message version mismatch

**Solution**

- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.
277

Note  This alarm is obsolete.

Description  IONET-EGD - Exchange [ ] Signature mismatch from Producer [ ], expected [ ], received [ ]
Possible Cause  Message version mismatch
Solution
  • Restart the I/O pack or module.
  • Upgrade the I/O pack or module firmware and application code.
  • If the problem persists, replace the I/O pack or module.

278

Note  This alarm is obsolete.

Description  IONET-EGD - Producer [ ] gave bad length Exchange [ ], expected [ ], got [ ]
Possible Cause  Exchange message wrong length
Solution
  • Restart the I/O pack or module.
  • Upgrade the I/O pack or module firmware and application code.
  • If the problem persists, replace the I/O pack or module.

279

Description  Could not determine platform type from hardware
Possible Cause
  • During commissioning or maintenance, there is an incorrect firmware version or hardware malfunction (firmware could not recognize host hardware type)
  • During normal operation, there is a hardware failure
Solution
  • Verify that all connectors are aligned properly and fully seated.
  • Check the firmware version for compatibility with platform. If it is correct, replace the I/O pack or module.
**280**

**Description**  Platform hardware does not match configuration

**Possible Cause**
- During commissioning or maintenance, the platform type identified in the application configuration does not match actual hardware
- During normal operation, there is a hardware failure

**Solution**
- From the **General** tab, select **General Properties**, and **Platform** and fix the platform type.
- Rebuild and download the application.
- If the problem persists, replace the I/O pack or module.

**281**

**Description**  Firmware Load Error - FPGA not programmed due to platform errors

**Possible Cause**  File downloaded to configure the Field Programmable Gate Array (FPGA) not successfully applied

**Solution**
- Verify that all connectors are aligned properly and fully seated.
- Check the firmware version for compatibility with platform. If it is correct, replace the I/O pack or module.

**282**

**Description**  Firmware Load Error - application independent processes failed to initialize

**Possible Cause**  Runtime malfunction. An application-independent firmware process could not be started successfully.

**Solution**
- Reload firmware and application and restart.
- Controller: If the failure persists, remove the Compact Flash module and reprogram the boot loader using the ToolboxST configuration. Download using the Device | Download | Controller setup | Format Flash selection. After reinstalling the flash module and restarting, reload the firmware and application.
- Replace the module.
- I/O pack or module: Re-download the base load.

**283**

**Description**  Firmware error - Internal process crashed

**Possible Cause**  Runtime or hardware malfunction (runtime process failed)

**Solution**
- Reload firmware and application and restart.
- Re-download the baseload and the firmware.
284

Description  Firmware error - Internal process failed

Possible Cause  Runtime or hardware malfunction (runtime process failed)

Solution
  • Reload the firmware and application, and restart the controller and/or I/O module.
  • Re-download the baseload and the firmware.
  • If this does not work, replace the I/O module or controller.

285

Description  Unexpected reboot occurred - hardware fault

Possible Cause
  • Runtime or hardware malfunction
  • Runtime process stalled

Note  This diagnostic alarm is detected on a processor startup after the processor or hardware has malfunctioned and caused a processor to reboot. Therefore, the diagnostic alarm timestamp may be delayed from when the actual fault occurred.

Solution
  • Reload firmware and application and restart.
  • If the problem persists, replace the processor module.

292

Description  Application Error - application overrunning the frame

Possible Cause  Application cannot start within frame.

Solution  Check application loading and reduce the amount of application code or frequency of execution. Build application and download to all controllers.
Waiting on IP address before continuing

Possible Cause

- Network problem
- Controller problem
- I/O pack or module not configured correctly, or incorrect ID (barcode)
- I/O pack or module is configured with 2 network addresses in the ToolboxST application, but only has one network physically connected.

Solution

- Verify that the controller is online.
- Confirm that the correct terminal board ID is present in the ToolboxST configuration.
- Check IONet (switches, cables).
- From the ToolboxST application, verify that the I/O pack or module network configuration matches the physical network configuration.

The FPGA is not generating an I/O interrupt

Possible Cause

There is a FPGA inside the I/O pack or module that controls I/O or module hardware. The logic in the FPGA generates an interrupt to the processor requesting that the I/O or module be serviced. That interrupt is not occurring as expected.

Solution

- Rebuild system and download to the I/O pack or module. If the problem persists, replace the I/O pack.

Application Code Load Failure

Possible Cause

During commissioning or maintenance:

- Invalid application configuration

During normal operation:

- There is a firmware or hardware malfunction

Solution

- Rebuild and download the application to all processors.
- Reload the firmware and application.
- If the problem persists, replace processor module.
301

Description  Configuration Load Failure

Possible Cause

• I/O pack or module I/O configuration files missing
• I/O pack or module reseated on the terminal board (clears configuration from I/O pack or module)

Solution

• Rebuild and download the application to all the processors.
• Reload the firmware and application.
• If the problem persists, replace processor module.

338

Description  Pack Firmware Error - Inputs are not being updated

Possible Cause

During commissioning or maintenance:

• The I/O pack or module application process is not providing system signal inputs to EGD every frame.

Solution

During commissioning or maintenance:

• Rebuild and download the firmware and the application.
• Verify that the idle time is adequate for the I/O pack or module and that the frame rate does not exceed defined limits.
• If the problem persists, replace the I/O pack or module.

339

Description  Outputs are not being received

Possible Cause

• I/O pack or module not receiving outputs from the controller after previously receiving outputs
• Controller is restarting or has restarted
• Failed Ethernet connection between the I/O pack or module and controller
• Internal firmware failure

Solution

• Check for disconnected IONet cables or malfunctioning network switches.
• Verify that the controller is online and operating correctly.
• Rebuild and download the firmware and configuration to the I/O pack or module.
340

Description Memory Verification failed - Data structures

Possible Cause Hardware memory failure (data that should not change after I/O pack or module has gone online has been modified)

Solution

• Rebuild and download the application to all affected I/O packs or modules.
• Reload the firmware and application code.
• If problem persists, replace the I/O pack or module.

341

Note This alarm is obsolete.

Description Firmware or I/O Configuration Incompatibility

Possible Cause I/O pack or module configuration files incompatible with firmware (files do not contain necessary revision)

Solution

• Confirm the correct installation of the ToolboxST software.
• Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack or module and selecting Upgrade.
• Rebuild the application, and download the firmware and application code to the affected I/O pack or module.

342

Description Firmware or Configuration Incompatible

Possible Cause I/O pack or module configuration files incompatible with firmware (files do not contain necessary revision)

Solution

• Confirm the correct installation of the ToolboxST application.
• Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack and selecting Upgrade.
• Rebuild the application, and download the firmware and application code to the affected I/O pack or module.

343

Description Memory Verification failed - Firmware Libraries

Possible Cause Hardware memory failure (data that should not change after the I/O pack or module has gone online was modified)

Solution

• Rebuild and download the application to all affected I/O packs or modules.
• Reload the firmware and application code.
• If the problem persists, replace the I/O pack or module.
Description  Intermittent communications on IONet1 - Packet loss exceeded [ ]

Possible Cause

- Power cycled on I/O producer (controller or I/O pack or module)
- IONet malfunction
- I/O message corruption
- Communication errors occurred on more than 5% of data transmissions on IONet1

Solution

- Check for evidence of pack restart (diagnostic alarms, error logs).
- Faulty Ethernet cable from pack to network switch and/or from switch to controller. Replace cable(s).
- Replace the I/O pack or module.
- Faulty network switch; place the I/O pack or module's Ethernet cable into an empty port. If problem persists, replace the network switch.

Description  Intermittent communications on IONet2 - Packet loss exceeded [ ]

Possible Cause

- Power cycled on I/O producer (controller or I/O pack or module)
- IONet malfunction
- I/O message corruption
- Communication errors occurred on more than 5% of data transmissions on IONet2

Solution

- Check for evidence of pack restart (diagnostic alarms, error logs).
- Faulty Ethernet cable from pack to network switch and/or from switch to controller. Replace cable(s).
- Replace the I/O pack or module.
- Faulty network switch; place the I/O pack or module's Ethernet cable into an empty port. If problem persists, replace the network switch.

Description  Intermittent communications on IONet3 - Packet loss exceeded [ ]

Possible Cause

- Power cycled on I/O producer (controller or I/O pack or module)
- IONet malfunction
- I/O message corruption
- Communication errors occurred on more than 5% of data transmissions on IONet3

Solution

- Check for evidence of pack restart (diagnostic alarms, error logs).
- Faulty Ethernet cable from pack to network switch and/or from switch to controller. Replace cable(s).
- Replace the I/O pack or module.
- Faulty network switch; place the I/O pack or module's Ethernet cable into an empty port. If problem persists, replace the network switch.
351

Description  Internal Firmware error - Thread [ ] timing overrun

Possible Cause  An application task scheduled with a scan rate either occurred twice as fast or twice as slow as the expected rate.

Solution
• Check the idle time on the I/O pack or module, and verify that the frame rate is correct.
• Reload the firmware and application code.
• If the problem persists, replace the I/O pack or module.

357

Description  Internal Runtime error - Sequencer out-of-order or overrun detected

Possible Cause  There is a possible hardware malfunction. Sequencer critical clients were scheduled out of order or were overrun. This alarm occurs following three successive frames of sequencer critical client out-of-order detections. After five, the I/O module is put into the FAILURE control state.

Solution  Replace the I/O module.

358

Description  Internal Runtime error - Sequencer client execution underrun

Possible Cause  Possible hardware malfunction. Sequencer critical client underrun detected. Alarm occurs after a sequencer critical client has been run slower than its nominal rate three times in a row. After five in a row, the I/O module is put into FAILURE control state.

Solution
• Ignore alarm if it occurs during a restart of the I/O module.
• Replace the I/O module, if the alarm occurs during normal operation.

359

Description  Internal Runtime error - Sequencer client execution overrun

Possible Cause  Possible hardware malfunction. Sequencer critical client overrun detected. This alarm occurs after a sequencer critical client has been run faster than its nominal rate three times in a row. After five times in a row, the I/O module is put into FAILURE control state.

Solution
• Ignore this alarm if it occurs during a restart of the I/O module.
• Replace the I/O module, if the alarm occurs during normal operation.
360
Description  Internal Runtime error - Sequencer frame period out-of-bounds (±15%)

Possible Cause  Possible hardware malfunction. Frame period greater than ±15% of nominal. This alarm occurs following frame period out-of-bounds condition occurring three frames in a row. After five frames in a row, the I/O module is put into FAILURE control state.

Solution
• Ignore this alarm if it occurs during a restart of the I/O module.
• Replace the I/O module, if the alarm occurs during normal operation.

361
Description  Internal Runtime error - Sequencer frame state timeout out-of-bounds (±15%)

Possible Cause  Possible hardware malfunction. Sequencer frame state timeout greater than ±15% of nominal. This alarm occurs following a sequencer frame state timeout being out-of-bounds for three frames in row. After five frames in a row, the I/O module is put into FAILURE control state.

Solution
• Ignore this alarm if it occurs during a restart of the I/O module.
• Replace the I/O module if the alarm occurs during normal operation.

362
Description  Internal Runtime error - Sequencer frame number skip detected

Possible Cause  Possible hardware or IONet malfunction. Frame number skips detected. Frame number should monotonically increase until rollover. This alarm occurs following three skips in a row. After five skips in a row, the I/O module is put into FAILURE control state.

Solution
• Ignore alarm if it occurs during a restart of the I/O module.
  During normal operation:
  • Check for hardware or network switch malfunction.
  • Check for loose or defective network cables.
  • Replace the I/O module.

363
Description  Memory Validation failed - Sequencer data structures

Possible Cause  Hardware memory failure (sequencer process data that should not change after the I/O module is online was modified).

Solution  Replace the I/O module.
**Note**  This alarm is obsolete.

**Description**  EGD communication terminated

**Possible Cause**  Internal runtime error

**Solution**
- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- If the problem persists, replace the I/O pack or module.

**Description**  Initialization failure - IO firmware

**Possible Cause**  I/O pack or module did not initialize correctly

**Solution**
- Restart the I/O pack or module.
- Upgrade the I/O pack or module firmware and application code.
- Download the firmware and application code.
- If the problem persists, replace the I/O pack or module.

**Description**  Internal communications error - HSSL Comm link down

**Possible Cause**  Internal runtime error

**Solution**
- Check the High Speed Serial Link (HSSL) cables.
- Upgrade the I/O pack or module firmware and application code.
- Download the firmware and application code.
- If the problem persists, replace the I/O pack or module.
Description  Configuration file load error - invalid header size

Possible Cause  
During commissioning or maintenance:

• Build error
• Controller EGD revision code not supported
• Incompatible version of I/O pack or module firmware was downloaded

During normal operation:

• There is a hardware failure.

Solution  
During commissioning or maintenance:

• Confirm the correct installation of the ToolboxST application.
• Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack and selecting "Upgrade."
• Rebuild the application, and download the firmware and application code to the affected I/O pack or module

During normal operation: Replace the I/O pack or module.

Description  Internal communication error - Exchange [ ] Export failed

Possible Cause  Internal runtime error

Solution

• Restart the I/O pack or module.
• Upgrade the I/O pack or module firmware and application code.
• If the problem persists, replace the I/O pack or module.

Note  This alarm is obsolete.

Description  Internal EGD communication error - Exchange [ ] Import failed

Possible Cause  Internal runtime error

Solution

• Restart the I/O pack or module.
• Upgrade the I/O pack or module firmware and application code.
• If the problem persists, replace the I/O pack or module.
371

**Description**  IONet-EGD signal inputs are not being updated

**Possible Cause**  
During commissioning or maintenance:

- The I/O pack or module application process is not providing system signal inputs to EGD every frame.

**Solution**  
During commissioning or maintenance:

- Rebuild and download the firmware and application code.
- Verify that the idle time is adequate for the I/O pack or module, and that the frame rate does not exceed defined limits.
- If the problem persists, replace the I/O pack or module.

372

**Description**  Memory Validation failed - Data structures

**Possible Cause**  Hardware memory failure (process data that should not change after the controller goes online was modified)

**Solution**  Replace the I/O pack or module.

373

**Description**  Firmware/IO Configuration Incompatible

**Possible Cause**  I/O pack or module configuration files are incompatible with the firmware (files do not contain necessary revision)

**Solution**  
During commissioning or maintenance:

- Confirm the correct installation of the ToolboxST application.
- Verify that each I/O pack or module is upgraded to the latest version by right-clicking each I/O pack or module and selecting *Upgrade*.
- Rebuild the application, and download the firmware and application code to the affected I/O pack or module.

During normal operation:

- Replace the I/O pack or module.

445

**Description**  Incorrect or Missing Acquisition Board on HSSL link 1

**Possible Cause**  The acquisition board on High Speed Serial Link 1 is not connected or does not agree with the ToolboxST configuration.

**Solution**  
- Verify that the correct acquisition board is connected to the specified HSSL connector on the UCSA.
- Verify that the ToolboxST configuration for the appropriate HSSL connector matches the hardware.
446

Description Incorrect or Missing Acquisition Board on HSSL link 2

Possible Cause The acquisition card on High Speed Serial Link 2 is not connected or does not agree with the ToolboxST configuration.

Solution

• Verify that the correct acquisition card is connected to the specified HSSL connector on the UCSA.
• Verify that the ToolboxST configuration for the appropriate HSSL connector matches the hardware.

447

Description Incorrect or Missing Acquisition Board on HSSL link 3

Possible Cause The acquisition card on High Speed Serial Link 3 is not connected or does not agree with the ToolboxST configuration.

Solution

• Verify that the correct acquisition card is connected to the specified HSSL connector on the UCSA.
• Verify that the ToolboxST configuration for the appropriate HSSL connector matches the hardware.

448

Description Acquisition Board barcode mismatch on HSSL link 1

Possible Cause The barcode on the acquisition card connected to High Speed Serial Link 1 does not agree with those provided in the ToolboxST application

Solution Verify that the correct acquisition card is connected to the link and that the correct barcode has been entered in the ToolboxST application

449

Description Acquisition Board barcode mismatch on HSSL link 2

Possible Cause The barcode on the acquisition card connected to High Speed Serial Link 2 does not agree with those provided in the ToolboxST application

Solution Verify that the correct acquisition card is connected to the link and that the correct barcode has been entered in the ToolboxST application

450

Description Acquisition Board barcode mismatch on HSSL link 3

Possible Cause The barcode on the acquisition card connected to High Speed Serial Link 3 does not agree with those provided in the ToolboxST application

Solution Verify that the correct acquisition card is connected to the link and that the correct barcode has been entered in the ToolboxST application
451
Description  Communication Lost on HSSL Link 1
Possible Cause  The UCSA can no longer communicate with the acquisition card on High Speed Serial Link 1
Solution  Verify that the Ethernet cable is connected and that the acquisition card is healthy.

452
Description  Communication Lost on HSSL Link 2
Possible Cause  The UCSA can no longer communicate with the acquisition card on High Speed Serial Link 2
Solution  Verify that the Ethernet cable is connected and that the acquisition card is healthy.

453
Description  Communication Lost on HSSL Link 3
Possible Cause  The UCSA can no longer communicate with the acquisition card on High Speed Serial Link 3
Solution  Verify that the Ethernet cable is connected and that the acquisition card is healthy.

485
Description  Configuration mismatch with Auto-Reconfiguration server
Possible Cause  Some or all of the I/O pack or module configuration files do not match those on the Auto-Reconfiguration server
Solution  Perform a scan and download using the ToolboxST application

490
Description  Software watchdog has been disabled
Possible Cause
• A runtime malfunction has disabled the software watchdog protective function.
• An invalid version of firmware has been downloaded.
Solution
• Reload the base load, firmware, and application code to the I/O pack or module, and restart.
• If failure persists, remove the flash memory from the controller and reprogram the boot loader using the ToolboxST application. Download using the Device | Download | Controller setup | Format Flash selection. After reinstalling the flash memory and restarting, reload the firmware and application code.
• If the problem persists, replace the I/O pack or module or the controller.
491

Description  Hardware watchdog has been disabled

Possible Cause

• A runtime malfunction has disabled the hardware watchdog protective function.
• A hardware failure has disabled the hardware watchdog protective function.

Solution

• Reload the firmware and restart the I/O pack or module.
• If the problem persists, replace the I/O pack or module or the controller.

499

Description  I/O pack is connected to an unknown board

Possible Cause

• The terminal board or auxiliary terminal board connected to the I/O pack or module is not recognized by this version of firmware.
• This can occur if a new terminal board has been connected but the I/O pack is configured with firmware that does not support the new hardware.

Solution

• Upgrade the ControlST software suite to a version that supports the new hardware.
• Download latest firmware and parameters to the I/O pack or module.

500

Description  I/O pack is connected to the wrong terminal board

Possible Cause  The I/O pack or module is connected to a recognized terminal board that is not supported.

Solution

• Refer to one of the following system guides for a list of supported hardware combinations: GEH-6721_Vol_II, GEH-6855_Vol_II, GEH-6800, or GEH-6779. From the Start menu, select All Programs, GE ControlST, Documentation.
• Verify that the I/O pack is connected to a terminal board that is supported.
• Replace the I/O pack or terminal board to create a supported combination.
• Use the ToolboxST application to reconfigure the I/O module.
Description: Outputs unhealthy on IONet [ ] - Message Timeout

Possible Cause

- Controller is rebooting or has rebooted
- Application/configuration does not match in I/O pack or module and controller.
- Failed Ethernet connection between the I/O pack or module and the controller.

Solution

- Reset all diagnostic alarms.
- Rebuild and download the application to all the processors, including I/O packs or modules.
- Reload the firmware and the application.
- Verify that the Ethernet cable on the I/O pack or module matches the ToolboxST configuration.
- Check for a faulty Ethernet cable from the I/O pack or module to the network switch and/or from the switch to the controller. Replace cable(s) if necessary.
- Replace the I/O pack or module.
- Faulty network switch; place the I/O pack or module's Ethernet cable into an empty port. If the problem persists, replace the network switch.

Description: Outputs unhealthy on IONet [ ] - Message Length not valid

Possible Cause: Application/configuration does not match in I/O pack or module and controller

Solution

- Rebuild and download the application/parameters to all controllers and I/O packs or modules.
- Reload the firmware and parameters to the affected I/O pack or module.
- Reload the firmware and the application to all controllers.
- If the problem persists, replace affected I/O pack or module, then replace the controller.

Description: Outputs unhealthy on IONet [ ] - Major Signature Mismatch

Possible Cause: Application/configuration does not match in I/O pack or module and controller

Solution

- Rebuild and download the application/parameters to all the controllers and I/O packs or modules.
- Reload the firmware and the parameters to the affected I/O pack or module.
- Reload the firmware and the application to all controllers.
- If the problem persists, replace affected I/O pack or module, then replace the controller.
Description  Outputs unhealthy on IONet [ ] - Minor Signature Mismatch

Possible Cause  Application/configuration does not match in I/O pack or module and controller

Solution
- Rebuild and download the application/parameters to all the controllers and I/O packs or modules.
- Reload the firmware and the parameters to the affected I/O pack or module.
- Reload the firmware and the application to all the controllers.
- If the problem persists, replace affected I/O pack or module, then replace the controller.

Description  Outputs unhealthy on IONet [ ] - Timestamp Mismatch

Possible Cause  Application/configuration does not match in I/O pack or module and controller

Solution
- Rebuild and download the application/parameters to all the controllers and I/O packs or modules.
- Reload the firmware and the parameters to the affected I/O pack or module.
- Reload the firmware and the application to all the controllers.
- If the problem persists, replace affected I/O pack or module, then replace the controller.
12 Maintenance and Replacement

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

12.1 Maintenance

Do not use compressed air to clean the boards. The compressed air may contain moisture that could combine with dirt and dust and damage the boards. If the compressed air pressure is too strong, components could be blown off the boards or delicate solder runs could be damaged.

12.1.1 Terminal Boards and Cables

The control system should be inspected every 30000 hours (3.4 years) to ensure the components are functioning properly. This inspection should include, but is not limited to terminal boards and cables.

➢ To clean terminal boards: remove the dirt and dust from the boards using a grounded, natural bristle drapery brush or paint brush.

➢ To clean cables: remove dirt and dust with a lint free cotton cloth.

12.1.2 Ethernet Switches

The UDH, PDH, and IONet use fast Ethernet switches that are pre-configured specifically for the control system. Any replacement switch must also be configured with the appropriate configuration for the controls application. Redundant switches provide multiple communications links to the controllers and HMI systems.

Some basic troubleshooting techniques are useful in the diagnosis and repair of these systems as follows:

In the event of a network link failure, check the status LEDs at both ends of the link. Unlit LEDs indicate a failure in that specific link. Troubleshoot the switch, cable, HMI, or controller by substituting known working Ethernet components until the link status LEDs display health.

On large systems, there may be many switches. It will be necessary to pursue a half-interval (binary search) technique when troubleshooting the network system. This half-interval approach involves isolating different local areas of the network by removing the cables between different areas. These individual areas can then be diagnosed using the method described above. Once all of the individual areas are functioning, they can be connected one at a time until the complete network is restored.
12.2 Replacement

Replacement parts may contain static-sensitive components. Therefore, GE ships replacement parts in anti-static bags. When handling electronics, make sure to store them in anti-static bags or boxes and use a grounding strap (per the following Caution criteria).

![Caution]

To prevent component damage caused by static electricity, treat all boards with static-sensitive handling techniques. Wear a wrist grounding strap when handling boards or components, but only after boards or components have been removed from potentially energized equipment and are at a normally grounded workstation.

![Warning]

To prevent personal injury or damage to equipment, follow all GE safety procedures, Lockout Tagout (LOTO), and site safety procedures as indicated by Employee Health and Safety (EHS) guidelines.

![Warning]

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

Troubleshooting should be done at the system component level. The failed system component (least replaceable part) should be removed, returned to GE, and replaced with a known good spare. Do not attempt to repair system components.

![Warning]

To prevent electric shock, turn off power to the equipment, then test to verify that no power exists in the board before touching it or any connected circuits.

![Caution]

To prevent equipment damage, do not remove, insert, or adjust board connections while power is applied to the equipment.

![Attention]

Replacement of the terminal board requires full reconfiguration of the changed component using the ToolboxST application. For this reason, it is generally preferable to replace only the I/O pack unless the terminal board is known to be the point of failure.
12.2.1 Replacement Procedures

Refer to the following sections for replacement instructions for specific components:

- YVIB I/O Pack Replacement
- SUAA Terminal Board Replacement

12.2.1.1 Mark VIeS Safety I/O Pack Replacement (Same Hardware Form)

Never upgrade the I/O pack firmware to a version that is not supported by the hardware form. Refer to the applicable I/O pack Compatibility section of this document for more information.

➢➢ To replace a Mark VIeS Safety I/O Pack with the same hardware form

1. Verify that the replacement I/O pack is compatible with one being replaced.
2. Follow all site safety procedures.
3. Remove the power connector on the side of the failed I/O pack.
4. Unplug the Ethernet cable(s) from the failed I/O pack and mark their positions.
5. Loosen the two mounting nuts on the I/O pack threaded shafts.
6. Unplug the I/O pack.
7. Plug in the replacement I/O pack. Make sure the I/O pack connector is fully seated on all sides, then properly tighten mounting nuts.
8. Plug the Ethernet and power cables back into the I/O pack.
9. From ToolboxST, download the firmware and application code to the replacement I/O pack.
12.2.1.2 Mark VleS Safety I/O Pack Replacement (Upgraded Hardware Form)

If upgrading to YVIBS1B from an existing YVIBS1A configuration, be sure to correct the GAP12 configuration using ToolboxST. Refer to the sections YVIB Compatibility and YVIB I/O Upgrade for further details.

Attention

Redundant Safety I/O packs mounted on the same terminal board must all be of the same hardware form, and running the same firmware version.

Do NOT attempt this replacement unless there are enough I/O packs with the newer hardware form available, including spares.

Note

It is recommended to backup the ToolboxST .tcw system file prior to upgrading the system.

➢➢➢ To replace a Mark VleS Safety I/O Pack with an upgraded hardware form

1. Follow all site safety procedures.
2. Verify that the replacement I/O pack is compatible with one being replaced.
3. Verify that the site’s ControlST software version has been upgraded to V06.01 or later.
4. Remove the power connector on the side of the I/O pack(s).
5. Unplug the Ethernet cable(s) from the failed I/O pack(s) and mark their positions.
6. Loosen the two mounting nuts on the I/O pack threaded shafts.
7. Unplug the I/O pack(s).
8. Plug in the replacement I/O pack(s). Make sure the I/O pack connector is fully seated on all sides, then properly tighten mounting nuts.
9. Plug the Ethernet and power cables back into the I/O pack(s) and re-energize the equipment.
10. From ToolboxST, perform a firmware upgrade. Select the correct firmware revision as listed in the applicable I/O pack Compatibility section. The upgrade loads the correct I/O pack firmware and application code to the Mark VleS Safety controller.
11. From ToolboxST, download the firmware and application code to the replacement I/O pack(s).
12.2.1.3 Replacing Other I/O Packs

Replacement of the terminal board requires full reconfiguration of the changed component using the ToolboxST application. For this reason, it is generally preferable to replace only the I/O pack unless the terminal board is known to be the point of failure.

➢➢ To replace an I/O pack

1. Verify that the replacement I/O pack is compatible with one being replaced.
2. If replacing a BPPB-based I/O pack with a functionally compatible BPPC-based I/O pack:
   a. The site’s ControlST software must be minimum V04.04. Verify the version and upgrade the site if needed.
   b. If needed, download the BPPC I/O Upgrade package from the GE Intelligent Platforms Support website or check the version of ControlST software suite at site to verify that it contains the required I/O pack firmware version.
   c. If needed, install the required I/O pack firmware to the HMI.
   d. From the ToolboxST application, perform an upgrade of the firmware. This modifies the .tcw system file on the HMI. Do this prior to physically replacing the I/O pack hardware. Refer to the ToolboxST User Guide for Mark VIeS Functional Safety Systems (GEH-6862) for help with this upgrade feature.
3. Lockout tagout the field equipment and isolate the power source.
4. Remove the power to the I/O pack. Remove the power plug located in the connector on the side of the I/O pack.
5. Unplug the Ethernet cables and mark the positions of the removed cables.
6. Loosen the two mounting nuts on the I/O pack threaded shafts.
7. Unplug the I/O pack.
8. Plug in the replacement I/O pack. Make sure the I/O pack connector is fully seated on all sides, then properly tighten mounting nuts.
9. Plug the Ethernet and power cables back into the I/O pack and re-energize the equipment.
10. If replacing a BPPB-based I/O pack with a functionally compatible BPPC-based I/O pack: from the ToolboxST application, change the hardware form, build, and download the application code to the controller.

12.2.1.4 ESWx to ESWx Switch Replacement

➢➢ To replace an ESWx switch

1. Remove the power connector(s) from the ESWx, located on the right side of the switch.
2. Remove the Cat 5e cable connections, recording the port where the cables were installed.
3. Remove the fiber-optic cable connections (if present), recording the port where the cables were installed.
4. Remove the switch module from the panel.
5. If replacing a DIN-rail mounted ESWx, transfer the DIN-rail mounting clip from the failed unit to the replacement unit.
6. If replacing a standard panel mounted ESWx, transfer the mounting bracket from the failed unit to the replacement unit.
7. Mount the replacement switch module into the panel.
8. Reconnect the Cat 5e cables and fiber-optic cables.
9. Reconnect the power connections.
12.2.1.5 Replacing D-type Boards

➢➢ To replace the board

1. Lockout and/or tag out the field equipment and isolate the power source.
2. Unplug the I/O cable (J-plugs).
3. Disconnect all field wire and thermocouples along with shield wire.
4. Remove the terminal board and install the new board.
5. Reconnect all field wire and thermocouples as before.
6. Plug the I/O cable (J-plug) back.

12.2.1.6 Replacing J-type Boards

1. Lockout and/or tag out the field equipment and isolate the power source.
2. Check the voltage on each terminal to ensure no voltage is present.
3. Verify the label and unplug all connectors.
4. Loosen the two screws on each of the terminal blocks and remove the top portion leaving all field wiring in place. If necessary, tie the block to the side out of the way.
5. Remove the mounting screws and the terminal board.
6. Install a new terminal board. Check that all jumpers, if applicable, are in the same position as the ones on the old board.
7. Tighten it securely to the cabinet.
8. Replace the top portion of the terminal blocks and secure it with the screws on each end. Ensure all field wiring is secure.
9. Plug in all wiring connectors.

12.2.1.7 Replacing Other S-type Boards

➢➢ To replace the S-type terminal board

1. Perform lockout/tagout procedures and isolate the power sources.
2. Check the voltage on each terminal to ensure that there is no voltage present.
3. Unplug the I/O cable (J-plugs)
4. If applicable, unplug JF1, JF2, and JG1.
5. If applicable, remove the TB3 power cables.
6. If removable terminal block, gently pry the segment of the terminal block containing the field wiring away from the part attached to the terminal board, leaving the wiring in place. If necessary, tie the block to the side out of the way.
7. Remove the mounting screws and terminal board.
8. Install a new terminal board. Check to ensure that all jumpers (if applicable) are in the same position as the ones on the old board.
9. Tighten it securely to the cabinet.
10. If removable terminal block, from the new board, gently pry the segment of the terminal block that would contain the field wiring away from the part attached to the terminal. Then, slide the segment containing the field wiring from the old board into the new terminal block. Ensure that the numbers on the segment with the field wires match the numbers on the terminal block. Press together firmly. Ensure that all field wiring is secure.
12.2.1.8 Replacing T-type Boards

1. Lockout tagout the field equipment and isolate the power source.
2. Check the voltage on each terminal and ensure no voltage is present.
3. Unplug the I/O cable (J-Plugs).
4. If applicable, unplug JF1, JF2, and JG1.
5. If applicable, remove TB3 power cables.
6. Loosen the two screws on the wiring terminal blocks and remove the blocks, leaving the field wiring attached.
7. Remove the terminal board and replace it with a spare board, check that all jumpers are set correctly (the same as in the old board).
8. Screw the terminal blocks back in place and plug in the J-plugs and connect cable to TB3 as before.

12.2.1.9 Replacing Fuses

➢➢ To replace a fuse

1. Lockout and/or tagout the field equipment and follow all equipment and site safety guidelines including use of safety glasses and any additional PPE.
2. Using a flat blade screwdriver, twist the fuse holder cap 1/8 turn counterclockwise.
3. Remove the fuse and cap from the circuit board mounted holder.
4. Remove the old fuse from the fuse holder cap.
5. Inspect the new fuse to verify that the fuse being replaced has the same voltage, current, and interrupting current (IC) ratings. Confirm that this rating matches the specification for the board or values provided in the application system elementary. There is also a table in GEH-6855_Vol_I that lists fuses and terminal boards.
6. Insert the new fuse into the fuse holder cap in the same orientation as the one removed.
7. Place the fuse and cap into the fuse holder. Using the flat blade screwdriver, quickly push-in and twist 1/8 turn clockwise.

Note If the fuse opening fault condition has not been removed, you may fail the new fuse when it is inserted into the holder.
12.3 Ordering Parts

To order renewals and spares (or those not under warranty), contact the nearest GE Sales or Service Office or an authorized GE Sales Representative, or contact the Parts Super Center.

Parts Super Center:

- Phone: 877-903-1151
- Online: https://www.partssupercenter.com/contact-us

Prior to ordering a replacement part:

- Determine if the part is under warranty
- Identify the part
- Refer to the *Mark VIeS Functional Safety Systems for General Market Volume I: System Guide* (GEH-6855_Vol_I), the section *Component Part Numbers*.

Control system electronics are identified by a 12-character alphanumeric part number and a single revision letter. When ordering, be sure to include the complete part number and revision letter. All digits are important when ordering or replacing any device. The factory may substitute newer versions based on availability and design enhancements; however, GE ensures backward compatibility of replacements.

Many IS2xx board and module part numbers are being replaced with IS4xx forms, indicating their potential to be RoHS certified. There is no difference in functionality, although there may be differences in appearance. For example, while IS2xx parts are typically constructed of green circuit boards with black enclosures, IS4xx parts are typically constructed of blue circuit boards with blue or silver enclosures.

IS4xx parts are compatible with and interoperable with IS2xx parts. ToolboxST does not need to be updated to accept IS4xx parts where equivalent IS2xx parts are already supported.