**Instruction Manual**
Doc Number CI-ControlWave
Part Number D301381X012
August 2015

# ControlWave®
# Process Automation Controller

## IMPORTANT! READ INSTRUCTIONS BEFORE STARTING!

Be sure that these instructions are carefully read and understood before any operation is attempted. Improper use of this device in some applications may result in damage or injury. The user is urged to keep this book filed in a convenient location for future reference.

These instructions may not cover all details or variations in equipment or cover every possible situation to be met in connection with installation, operation or maintenance. Should problems arise that are not covered sufficiently in the text, the purchaser is advised to contact Emerson Process Management, Remote Automation Solutions for further information.

## EQUIPMENT APPLICATION WARNING

The customer should note that a failure of this instrument or system, for whatever reason, may leave an operating process without protection. Depending upon the application, this could result in possible damage to property or injury to persons. It is suggested that the purchaser review the need for additional backup equipment or provide alternate means of protection such as alarm devices, output limiting, fail-safe valves, relief valves, emergency shutoffs, emergency switches, etc. If additional information is required, the purchaser is advised to contact Remote Automation Solutions.

## RETURNED EQUIPMENT WARNING

When returning any equipment to Remote Automation Solutions for repairs or evaluation, please note the following: The party sending such materials is responsible to ensure that the materials returned to Remote Automation Solutions are clean to safe levels, as such levels are defined and/or determined by applicable federal, state and/or local law regulations or codes. Such party agrees to indemnify Remote Automation Solutions and save Remote Automation Solutions harmless from any liability or damage which Remote Automation Solutions may incur or suffer due to such party's failure to so act.

## ELECTRICAL GROUNDING

Metal enclosures and exposed metal parts of electrical instruments must be grounded in accordance with OSHA rules and regulations pertaining to "Design Safety Standards for Electrical Systems," 29 CFR, Part 1910, Subpart S, dated: April 16, 1981 (OSHA rulings are in agreement with the National Electrical Code).

The grounding requirement is also applicable to mechanical or pneumatic instruments that include electrically operated devices such as lights, switches, relays, alarms, or chart drives.

## EQUIPMENT DAMAGE FROM ELECTROSTATIC DISCHARGE VOLTAGE

This product contains sensitive electronic components that can be damaged by exposure to an electrostatic discharge (ESD) voltage. Depending on the magnitude and duration of the ESD, this can result in erratic operation or complete failure of the equipment. Read supplemental document S14006 for proper care and handling of ESD-sensitive components.

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# Chapter 1 – Introduction

This manual focuses on the hardware aspects of the ControlWave® Process Automation Controller (called the "ControlWave" throughout the rest of this manual). For information about the software used with the ControlWave, refer to the *ControlWave Quick Setup Guide* (D5084), the *ControlWave Designer Programmer's Handbook* (D5125), and the online help in ControlWave Designer.

This chapter details the structure of this manual and provides an overview of the ControlWave and its components.

## In This Chapter



ControlWave products have been designed and integrated as a highly adaptable, high performance distributed open controller family with exceptional networking capability that provides a complete process automation management solution for the natural gas, water, and wastewater industries. The ControlWave was designed with an emphasis on providing high performance with low power consumption, scalability, and modularity.

**Features** ControlWave process automation controllers have the following key features:

- Low power consumption
- Wide operating temperature range: (–40 to +70°C) (–40 to 158°F)
- Small size (enabling panel mount or 19 inch rack-mount installations)
- Two RS-232 ports
- One 10/100 MB Ethernet port
- Optional secondary communication board (SCB) provides additional options for RS-232, RS-485, and Ethernet communications
- Housings to support four or eight I/O modules
- Variety of I/O modules and support for hot swapping of I/O modules
- Support for redundant operation with another ControlWave process automation controller
- LED status indicators on the CPU, PSSM, and certain I/O modules

- Port 80 display to present status codes
- Battery backup for the real-time clock and the system's static RAM (SRAM)
- Class I, Division 2 Hazardous Location approvals

## 1.1 Scope of the Manual

This manual contains the following chapters:

| | |
|---|---|
| **Chapter 1**<br>**Introduction** | Provides an overview of the hardware and general specifications for the ControlWave. |
| **Chapter 2**<br>**Installation** | Provides information on the housings, the Power Supply/Sequencer module (PSSM), and the CPU module. |
| **Chapter 3**<br>**I/O Modules** | Provides general information and wiring diagrams for the I/O modules. |
| **Chapter 4**<br>**Operation** | Provides information on day-to-day operation of the ControlWave. |
| **Chapter 5 Service and Troubleshooting** | Provides information on service and troubleshooting procedures. |

## 1.2 Physical Description

Each ControlWave has a printed circuit board (PCB) backplane mounted in a stainless steel housing, a Power Supply/Sequencer Module (PSSM), a CPU module which may include an optional Secondary Communication Board (SCB) and—depending on the backplane and housing size—up to eight I/O modules.

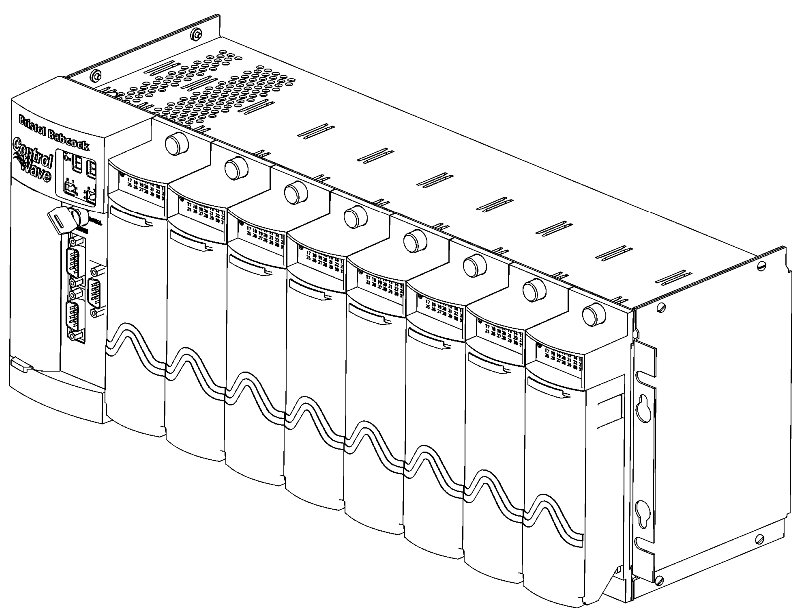



*Figure 1-1. ControlWave with 8 I/O Modules*

Refer to the following sections in this chapter or to other chapters in this manual for further information:

- Housings (chassis) with backplanes (see *Section 1.3* and *Chapter 2)*

- Power Supply/Sequencer module (PSSM) (see *Section 1.5* and *Chapter 2)*
- CPU module (see *Section 1.4* and *Chapter 2*)
- One or more I/O modules (see *Section 1.6* and *Chapter 3*)

## 1.3 Housings

ControlWave housings are stainless steel designed for panel-mounting or for some versions, for mounting in a 19-inch equipment rack. They contain the printed circuit board (PCB) backplane into which you connect the PSSM, the CPU module, and any I/O modules.

The following housings are available:

- 6-slot backplane supports one PSSM, one CPU, and up to four I/O modules.
- 10-slot housing supports one PSSM, one CPU, and up to eight I/O modules. The 10-slot housing is suitable for mounting in a 19-inch equipment rack.

**Note:** For detailed technical specifications, please see document CWPAC available on our website http://www.emersonprocess.com/remote.

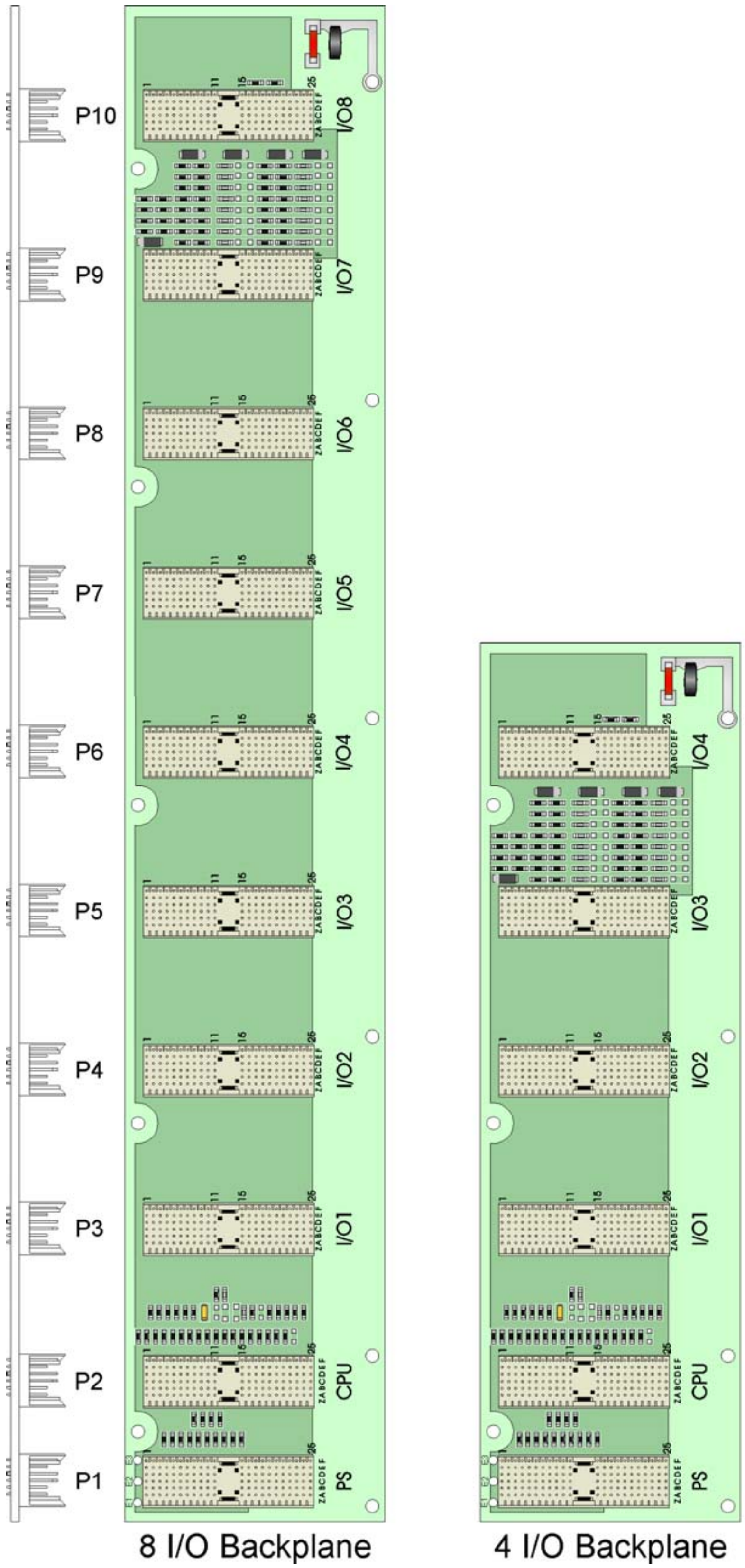



*Figure 1-2. ControlWave Housing Options*

## 1.4 CPU Module

The CPU (central processing unit) module houses the multi-layer PCB, which contains the ControlWave CPU, I/O monitor/control, memory, and communication functions. It also may include the optional Secondary Communications Board (SCB).

The CPU module includes:

- AMD Elan SC520 microprocessor running at 100 MHz
- two RS-232 communication ports
- one 10/100baseT Ethernet port
- 2 MB of battery backed Static RAM (SRAM)
- 64 MB of Synchronous Dynamic RAM (SDRAM)
- 512 KB boot/downloader FLASH
- 32 MB simultaneous read/write FLASH memory
- transmit (TX) and receive (RX) LEDs for each communication port
- Keyed run/remote/local operation switch
- configuration DIP switches (described in *Chapter 2*)
- Port 80 display to show status codes

You can order the CPU module with the optional secondary communication board (SCB) for additional communication ports. See *CPU Module Configurations*.

**CPU Module Configurations** The CPU module has several basic configurations, all of which have an on-board backup battery and different combinations of communications ports.

*Table 1-1. CPU Module Configurations*

| Part Number | Number of RS-232 Ports | Number of RS-485 Ports | Number of Ethernet Ports | Notes |
|---|---|---|---|---|
| 396359-21-3 | 2 | 0 | 1 | No SCB. |
| 396359-26-4 | 3 | 1 | 1 | For this port count, 1 RS-232 port and 1 RS-485 port reside on the SCB. |
| 396359-25-6 | 3 | 1 | 3 | For this port count, 1 RS-232 port,1 RS-485 port, and 2 Ethernet ports reside on the SCB. |
| 396359-32-9 | 2 | 2 | 3 | For this port count, both RS-485 ports and 2 Ethernet ports reside on the SCB. |

**CPU Backup Battery** The CPU module includes a 3.6V, 950 mA-hr lithium ½ AA battery. This battery provides backup power for the real-time clock, CMOS RAM (within the microprocessor) and the system's Static RAM (SRAM).

## CPU Memory

There are several different types of memory used on the CPU module:

### Boot/Downloader FLASH

Boot/download code is contained in a single 512 Kbyte FLASH chip. Boot FLASH also holds the value of soft switches, audit/archive file configurations, and user account and port information.

### FLASH Memory

The CPU module contains 32 MB of FLASH memory. The FLASH memory holds the system firmware and the boot project. Optionally FLASH memory also stores the zipped ControlWave project (*.zwt), user files, and historical data (audit/archive files).The FLASH does not support hardware write protection.

### System Memory (SRAM)

The CPU module has 2 MB of static random access memory (SRAM). During power loss periods, SRAM enters data retention mode (powered by the CPU backup battery). Critical system information that must be retained during power outages or when the system has been disabled for maintenance is stored here. This includes the last states of all I/O points, audit/archive historical data (if not stored in FLASH), the values of any variables marked RETAIN, the values of any variables assigned to the static memory area, and any pending alarm messages not yet reported.

### SDRAM

The CPU module contains 64MB of synchronous dynamic random access memory (SDRAM). SDRAM holds the running application (ControlWave project) as well as a copy of system firmware and the current values of any variables not marked RETAIN or stored in the static memory area. This allows the system to run faster than it will from the SRAM memory. SDRAM is not battery-backed.

### CMOS RAM

The Elan microprocessor includes 124 bytes of complementary metal oxide semiconductor (CMOS) RAM to hold various internal parameters.

## 1.5 Power Supply/Sequencer Module (PSSM)

The Power Supply/Sequencer module (PSSM) takes power from an external bulk DC power supply and then provides power through the ControlWave housing/backplane to all installed modules.

You can order it with either a single on-board power supply or dual on-board power supplies to support hot-swapping of a power supply if one should fail.

The PSSM operates from +22.2 to +30V (dc) and ships from the factory with a nominal input supply configuration of 24V.

The PSSM includes:

- ON/OFF system supply switch(es)
- Pluggable terminal block to connect the external power supply
- Watchdog output connector to signal a watchdog failure to an external device
- Status LEDs

*Chapter 2* includes instructions for installing and configuring the PSSM.

## 1.6 I/O Modules

The ControlWave supports analog input, analog output, digital input, digital output, universal digital input, isolated RTD, and isolated low level analog (thermocouple and mV) input modules for either local or remote field device wiring termination.

Refer to *Chapter 3* for information on specific I/O modules. *Figure 1-3* shows a typical I/O module housing.

Terminations are pluggable and accept a maximum wire size of #14 AWG. All I/O modules have surge protection that meets either C37.90-1978 or 472-1978 IEEE specifications.

Each I/O module connects to the backplane using a 110-pin male connector and to its associated terminal block assembly using a 44 pin header.

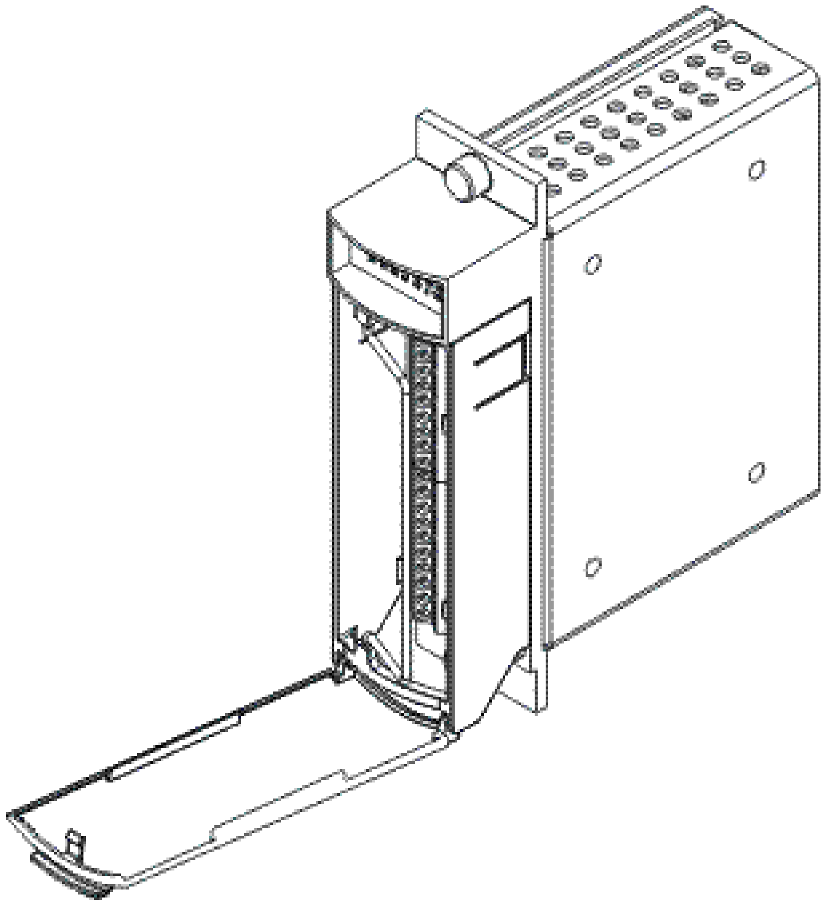


*Figure 1-3. I/O Module (with door open)*

## 1.7 Software Tools

The ControlWave programming environment consists of a set of integrated software tools which allow you to create, test, implement, and download complex control strategies for use with the ControlWave. *Figure 1-4* graphically presents the programming environment.

The tools which make up the programming environment include:

- **ControlWave Designer** is your load-building package. It offers several different methods for you to create control strategy programs that run in your ControlWave. You can use pre-made function blocks, ladder logic, or structured languages. The resulting process control strategy programs (called **projects**) are fully compatible with **IEC 61131** standards. For information on ControlWave Designer, see the *Getting Started with ControlWave Designer* manual (document D5085), the *ControlWave Quick Setup Guide* (document D5084), and the *ControlWave Designer Programmer's Handbook* (document D5125).

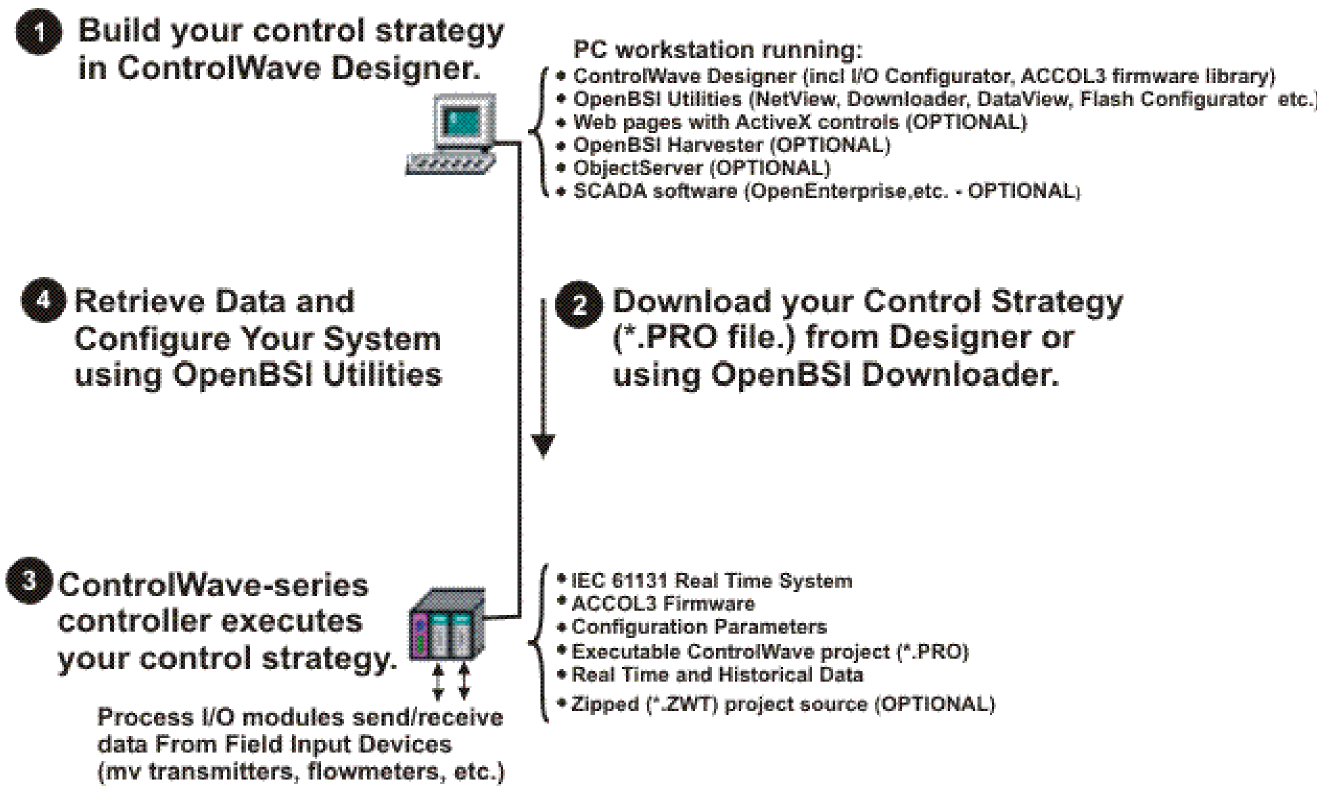



*Figure 1-4. ControlWave Programming Environment*

- The **I/O Configurator**, accessible via a menu item in ControlWave Designer, allows you to define process I/O modules in the ControlWave and configure the individual mapping of I/O points for digital and analog inputs and outputs. For information on the I/O Configurator see the *ControlWave Designer Programmer's Handbook* (document D5125).
- The **ACCOL3 Firmware Library,** available within ControlWave Designer, includes a series of ControlWave-specific function blocks. These pre-programmed function blocks let you accomplish various tasks common to most user applications including alarming, historical data storage, as well as process control algorithms such as PID control. For information on individual function blocks, see the online help within ControlWave Designer.
- **OpenBSI Utilities** provides a set of programs that allow you to configure a communication network of ControlWave controllers, download files to the controllers, and collect data from the network. OpenBSI also exports data from the network to a SCADA/host package, such as **OpenEnterprise**. For information on configuring OpenBSI communications, see the *OpenBSI Utilities Manual* (document D5081).
- **OpenBSI Harvester** is a special add-on package that allows scheduled data collections from large networks. For information on the Harvester, see the *OpenBSI Harvester Manual* (document D5120).

- A series of **web page controls** are available for retrieval of real-time data values and communication statistics. These controls utilize ActiveX technology and are called through a set of fixed web pages, compatible with Microsoft® Internet Explorer. Alternatively, developers can place the controls in third-party ActiveX compatible containers such as Visual BASIC or Microsoft® Excel. For information on the ActiveX controls, see the *Web_BSI Manual* (document D5087).
- **User-defined web pages** - If desired, you can use the ActiveX web controls in your own user-defined web pages you can store at the PC to provide a customized human-machine interface (HMI).
- **Flash Configuration Utility –** Parameters such as the BSAP local address, IP address, etc. are set using the Flash Configuration Utility, accessible via OpenBSI LocalView, NetView, or TechView. For information on the Flash Configuration Utility, see *Chapter 5* of the *OpenBSI Utilities Manual* (document D5081).

**Communication Protocols**

In addition to the **Bristol Synchronous/Asynchronous Protocol (BSAP)**, ControlWave supports communications using:

**Internet Protocol (IP)** - You can use an Ethernet port or use a serial port using serial IP using **Point-to-Point Protocol (PPP)**.

Other supported protocols include: Modbus, Allen-Bradley DF1, CIP, DNP3, and Hex Repeater. See the ControlWave Designer online help for details and restrictions.

## 1.8 Secure Gateway

For enhanced data security when using an IP/Ethernet connection, Emerson Remote Automation Solutions recommends adding an industrial router with VPN and firewall security. Recommended solutions include the MOXA EDR-810, the Hirschman Eagle One, or the Phoenix mGuard rs4000 (or equivalents). An example of how to install one of these devices to the RTU can be found in the Emerson Remote Automation Solutions *MOXA® Industrial Secure Router Installation Guide* (part number D301766X012). For further information, contact your Local Business Partner or the individual vendor’s website.

# Chapter 2 – Installation

This chapter discusses the physical configuration of the ControlWave, considerations for installation, wiring instructions for the PSSM module, and instructions for setting switches and jumpers on the CPU module. For instructions on I/O installation, see *Chapter 3*.

In This Chapter



## 2.1 Site Considerations

When choosing an installation site, check all clearances. Ensure that the ControlWave is accessible for wiring and service.

**⚠ Caution**

**To ensure safe use of this product, please review and follow the instructions in the following supplemental documentation:**

- **Supplement Guide - ControlWave Site Considerations for Equipment Installation, Grounding, and Wiring (S1400CW)**
- **ESDS Manual – Care and Handling of PC Boards and ESD Sensitive Components (S14006)**

**Specifications for Temperature, Humidity and Vibration**

- See document CWPAC available on our website for detailed technical specifications for temperature, humidity, and vibration for the ControlWave. This document is available on our website at: http://www.emersonprocess.com/remote.
- Ensure that the ambient temperature and humidity at the installation site remains within these specifications. Operation beyond the specified ranges could cause output errors and erratic performance. Prolonged operation under extreme conditions could also result in failure of the unit.
- Check the mounted enclosure, panel, or equipment rack for mechanical vibrations. Make sure that the ControlWave is not exposed to a level of vibration that exceeds that provided in the technical specifications..

**⚠ Caution**

**Placement of the ControlWave in Class 1, Division 2 (Group A, B, C, and D) hazardous locations requires that you select an appropriate enclosure that meets NEMA Type 3X or 4X specifications.**

### 2.1.1 Class I, Div 2 Installation Considerations

Underwriters Laboratories (UL) lists the ControlWave as non-incendive and suitable **only** for use in Class I, Division 2, Group A, B, C, and D hazardous locations and non-hazardous locations. Read this chapter and *Appendix A* carefully before you install a ControlWave in a hazardous location.

Perform all power and I/O wiring in accordance with Class I, Division 2 wiring methods as defined in *Article 501-4 (b)* of the *National Electrical Code, NFPA 70* (for installations within the United States) or as specified in *Section 18-152* of the *Canadian Electrical Code* (for installation in Canada).

**⚠ WARNING**

**EXPLOSION HAZARD**

**Substitution of components may impair suitability for use in Class I, Division 2 environments.**

**When the ControlWave is situated in a hazardous location, turn off power before servicing or replacing the unit and before installing or removing I/O wiring.**

**Do not connect or disconnect equipment unless the power is switched off or the area is known to be non-hazardous.**

## 2.2 Installation Overview

Installing a ControlWave involves several general steps:

1. Unpacking, assembling, and configuring the hardware
2. Installing PC-based software (ControlWave Designer)
3. Establishing communications
4. Creating an application-specific control strategy (ControlWave project).
5. Creating application-specific web pages (optional)
6. Adding the ControlWave to an OpenBSI network
7. Downloading the application-specific ControlWave project into the ControlWave

**Note**: Steps 2 through 7 require that you install and use ControlWave Designer software on your PC. This manual focuses on hardware installation and preparation. Software installation and configuration is beyond the scope of this manual. Refer to the *ControlWave Quick Setup Guide* (D5084) for material related to software installation and use.

### 2.2.1 Unpacking Components

**Packaging**

Depending upon how you order it, the ControlWave may arrive pre-assembled, with all modules installed in the housing, or as individual components in a number of separate boxes. In the latter case, you must identify, unpack, and assemble the components. Unless otherwise noted, you can place I/O modules in any slot in a base or expansion housing.

**Note**: Do **not** install modules in the housing until you have mounted and grounded the housing at the designated installation site.

Delivered boxes may include:

- Housing assemblies
- Power Supply/Sequencer module (PSSM)

  **Note**: The PSSM must reside in slot #1 in the base housing.

- CPU module

  **Note**: The CPU module must reside in slot #2 in the base housing.

- I/O Modules

**Notes:**

- There are many different types of I/O modules available. *Chapter 3* contains detailed instructions on each I/O module.
- Universal Digital Input (UDI) modules can only reside in the first four I/O slots.

- One or more bezel assemblies; each bezel covers two I/O modules.

### 2.2.2 Color Coding of Slot Connectors

A color tab on each backplane connector matches the color on the module which you can place in that slot.

- PSSM goes in the first slot (Yellow tab)
- CPU goes in the second slot (Blue tab)
- I/O modules go in any other slot (Green tab)

### 2.2.3 Mounting the Housing

You can install a ControlWave equipped with a 4-I/O module housing on a wall or panel. See *Figure 2-2* for mounting hole patterns for a 4-I/O unit.

You can install a ControlWave equipped with an 8-I/O module housing in a 19-inch equipment rack, a panel or a wall. These units ship from the factory with the end plates configured for 19-inch rack mounting. Remove the end plates, rotate them 180° and then reinstall them to accommodate panel or wall mounting. See *Figure 2-1* for hole patterns and dimensions.

When you install any of these units on a panel or wall, position it according to the following restrictions:

- Position the unit so that you can see the front of the assembly and so it is accessible for service such as installing a module or replacing a battery.
- Do not install ControlWave modules until you mount the housing and ground it properly.

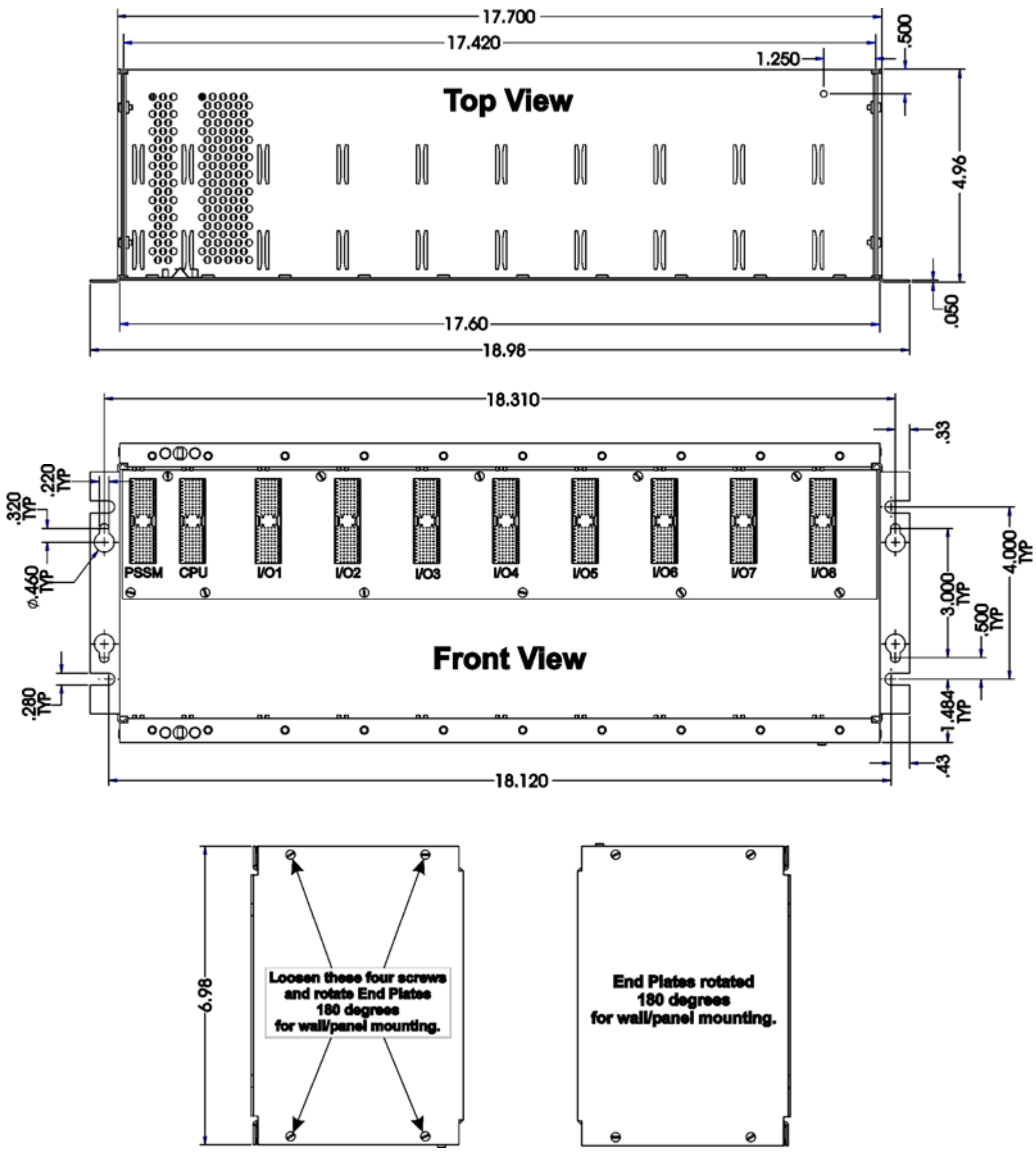



*Figure 2-1. 8-I/O Module ControlWave - Mounting Diagram*

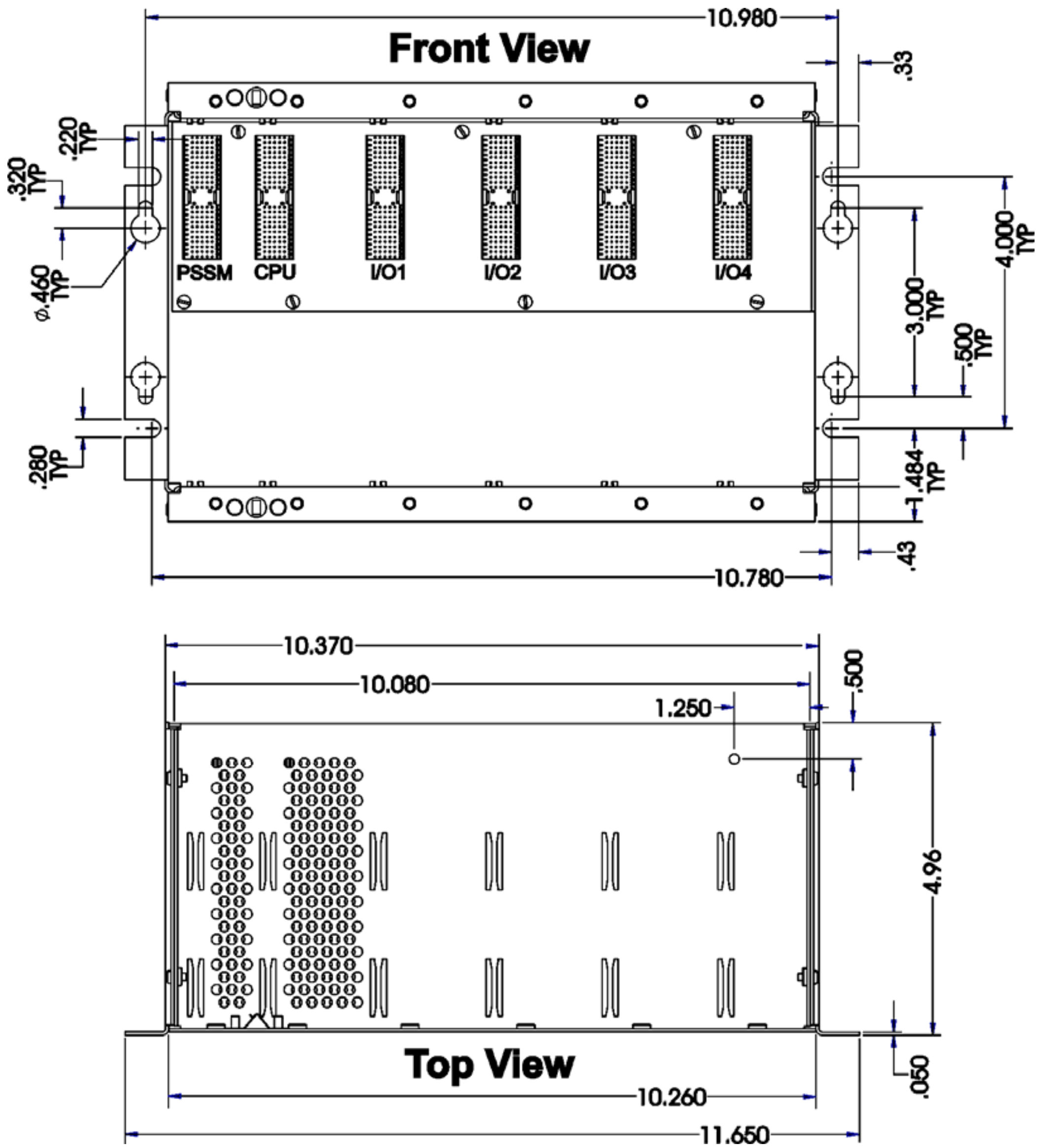



*Figure 2-2. 4-I/O Module ControlWave - Mounting Diagram*

## 2.2.4 Grounding the Housing

**⚠ Caution** **Do not install any modules in the housing until you mount and ground the housing at the designated installation site.**

Housings have a ground lug that accommodates up to a #4 AWG wire size. Once you install the housing, you must run a ground wire between the housing ground lug and a known good earth ground.

When you install the various ControlWave modules into the housing and secure them using the captive panel fasteners, this automatically connects them to chassis ground.

**Note**: After you install the PSSM in the housing, as an added precaution we recommend that you run a #14 AWG wire from the TB2-3 power connection (chassis ground) to the same known good earth ground.

Additional grounding guidelines include:

- Use stranded copper wire (#4 AWG) for the housing to earth ground, and keep the length as short as possible.
- Clamp or braze the ground wire to the ground bed conductor (typically a stranded copper AWG 0000 cable installed vertically or horizontally).
- Tin the wire ends with solder (using a high-wattage soldering iron) prior to inserting the wire into the housing ground lug.
- Run the ground wire so that any routing bend in the cable has a minimum radius of 12-inches below ground and 8-inches above ground.

## 2.3 Power Supply/Sequencer Module (PSSM)

Before we actually install the PSSM it in the housing, we're going to discuss some general information about how it works.

### 2.3.1 General Information about the PSSM

The Power Supply/Sequencer module (PSSM) takes power from an external bulk DC power supply and then provides power through the ControlWave housing/backplane to all installed modules.

The PSSM is used in the following ControlWave models:

- ControlWave Process Automation Controller
- ControlWave I/O Expansion Rack
- ControlWave Redundant Controller

The PSSM plugs into slot #1 (first slot from the left) on the ControlWave's backplane using connector J1.

The PSSM provides your ControlWave with dual power supplies for operational redundancy.

**Note:** You can optionally purchase the PSSM with only a single power supply installed, however, this configuration does not allow for redundancy within the PSSM which is discussed throughout this section.

The PSSM includes two independent power supplies. Should either power supply fail, operations automatically continue using the second supply, and you can "hot-swap" the failed power supply with a spare unit without interrupting control operations. The PSSM also supports hot swapping of I/O modules. However, you cannot replace the entire PSSM itself without first turning off power to the ControlWave.

When used as part of a redundant system, the failure of one of the two power supplies in a redundant power supply sequencer module would not force a failover to the other controller. Only the loss of both power supplies on the redundant power supply sequencer module would trigger a failover.

**Power Supply** The PSSM ships from the factory configured for a nominal input supply of 24Vdc.

**⚠ WARNING** Do not perform "hot swapping" in a Class I, Division 2 hazardous location.

**Hot Swap of I/O Modules** The PSSM supports "hot swapping" of I/O modules. This means you can insert or remove an I/O module from the chassis while power is live.

**Hot Swapping of Power Supplies** There is **no** support for "hot swapping" of the entire PSSM itself, or the CPU module, however, if you have the dual power supply version, you can hot swap a power supply **on** the PSSM. For information on hot swapping of power supplies see *Section 2.3.6.*

**Watchdog Switch** PSSMs include a watchdog metal oxide semiconductor field-effect transistor (MOSFET) switch connector. The purpose of the watchdog connector is to trigger an external alarm or annunciator if the ControlWave enters a "watchdog" condition in which the CPU cannot control your process. This occurs on power-up before the ControlWave project starts, if the unit is reset, if the ControlWave project "crashes" or if the system loses power. See *Section 2.3.7.*

**Redundancy Control Input** The same terminal block (TB3) used for watchdog control also handles a redundancy control line to a ControlWave Redundant I/O Switcher.

## 2.3.2 PSSM Installation Overview

There are several steps you need to follow when you install the PSSM.

1. Identify the carton holding the PSSM and remove it from that carton. See *Section 2.2.1*.
2. If needed, set jumpers. See *Section 2.3.3*.
3. Slide the PSSM into slot #1 of the housing.

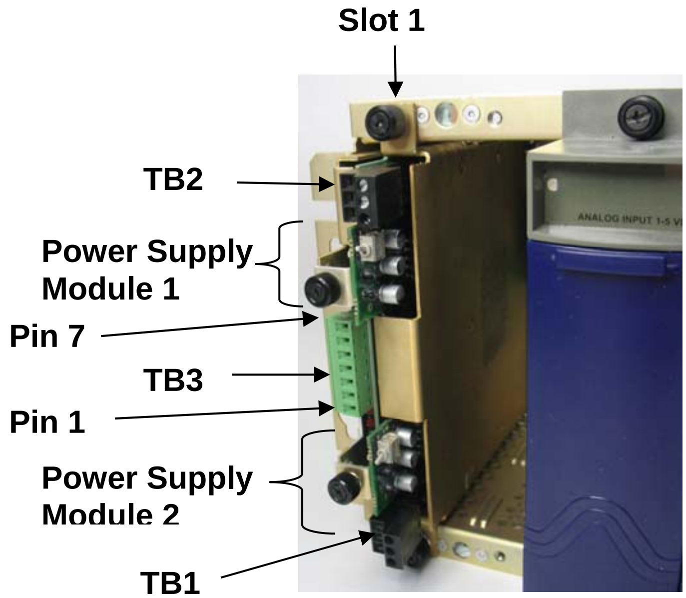



*Figure 2-3. PSSM Installed in ControlWave Slot #1 of a ControlWave Controller*

4. Tighten the captive panel fasteners to secure the PSSM in place.
5. Unplug terminal block connectors TB1 and TB2 from the PSSM and wire them to an external bulk DC power supply. See *Section 2.3.5*.
6. If you want to use the watchdog connector TB3, or use this ControlWave in a redundant system, unplug TB3 from the PSSM and wire it to an external annunciator or similar device according to instructions in *Section 2.3.7*.
7. After you configure and install the CPU module in slot #2 re-connect terminal blocks to their connectors to apply power to the unit.

## 2.3.3 Setting Jumpers

Depending upon how you are using the PSSM, you may have to change one or more jumpers from their factory default positions. See *Table 2-1* for a list of the jumpers and their functions; see *Figure 2-5* for jumper locations.

*Table 2-1. PSSM Jumpers*

| Jumper | Position | Description |
|---|---|---|
| JP1 | 1-2 | Enables the watchdog output. This is the **default**. Watchdog wiring is discussed later in this document. |
| | 2-3 | Disables the watchdog output. |
| JP2 | 1-2 | Sets the PSSM as always the on-line unit.<br>This is the **default**. Use this setting if the PSSM is **not** installed in a redundant system. |

| Jumper | Position | Description |
|---|---|---|
| | 2-3 | Specifies that the PSSM is part of a redundant system.<br>Choose this position if the PSSM is installed:<br>In a ControlWave Redundant Controller **or**<br>In a ControlWave Controller that is part of a redundant pair **or**<br>In a ControlWave I/O Expansion Rack that is part of a redundant pair. |
| JP3 | 1-2 | Enables the 12V monitor.<br>This is the **default**. When enabled, the PSSM reports a failure when voltage falls below 12V and lights the PWR Down LED to indicate the failure. |
| | 2-3 | Disables the 12V monitor.<br>When disabled, the PSSM **does not** report a failure if voltage falls below 12V. |

If you need to change the jumper positions, unscrew the protective case from the PSSM using a Phillips screwdriver (see *Figure 2-4*).

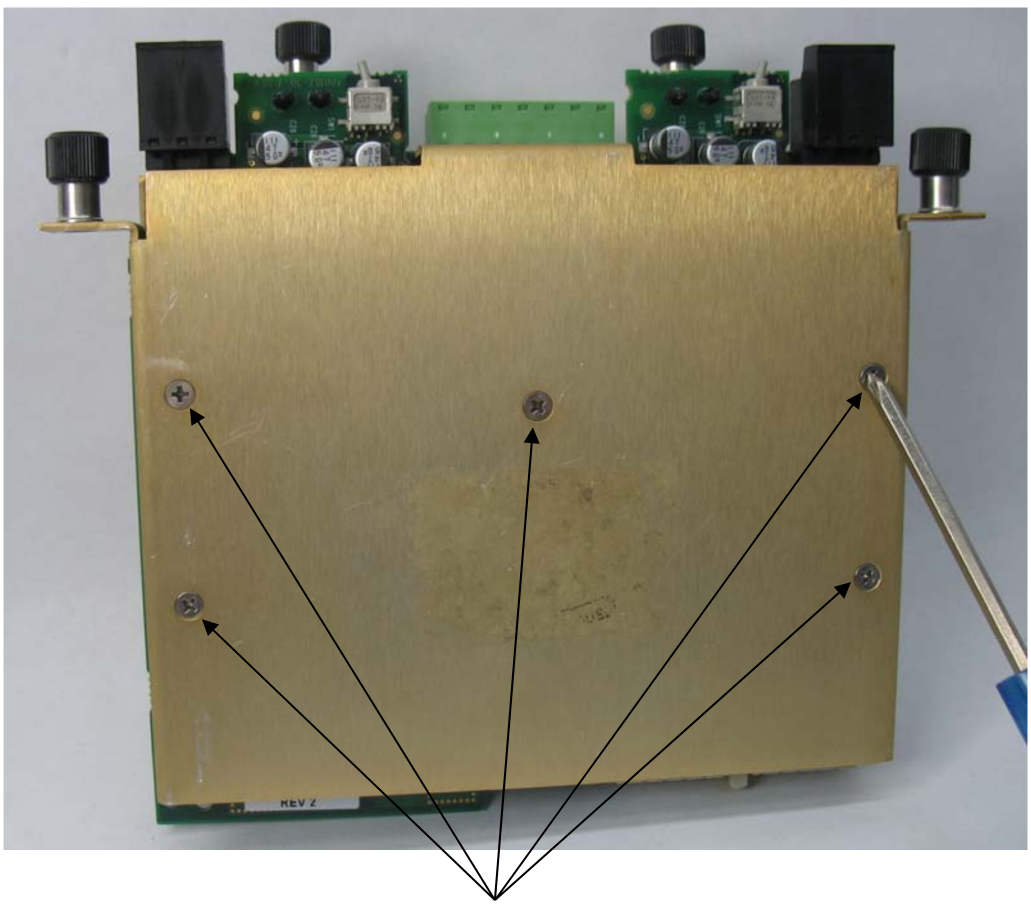



*Figure 2-4.Removing the Protective Case from the PSSM*

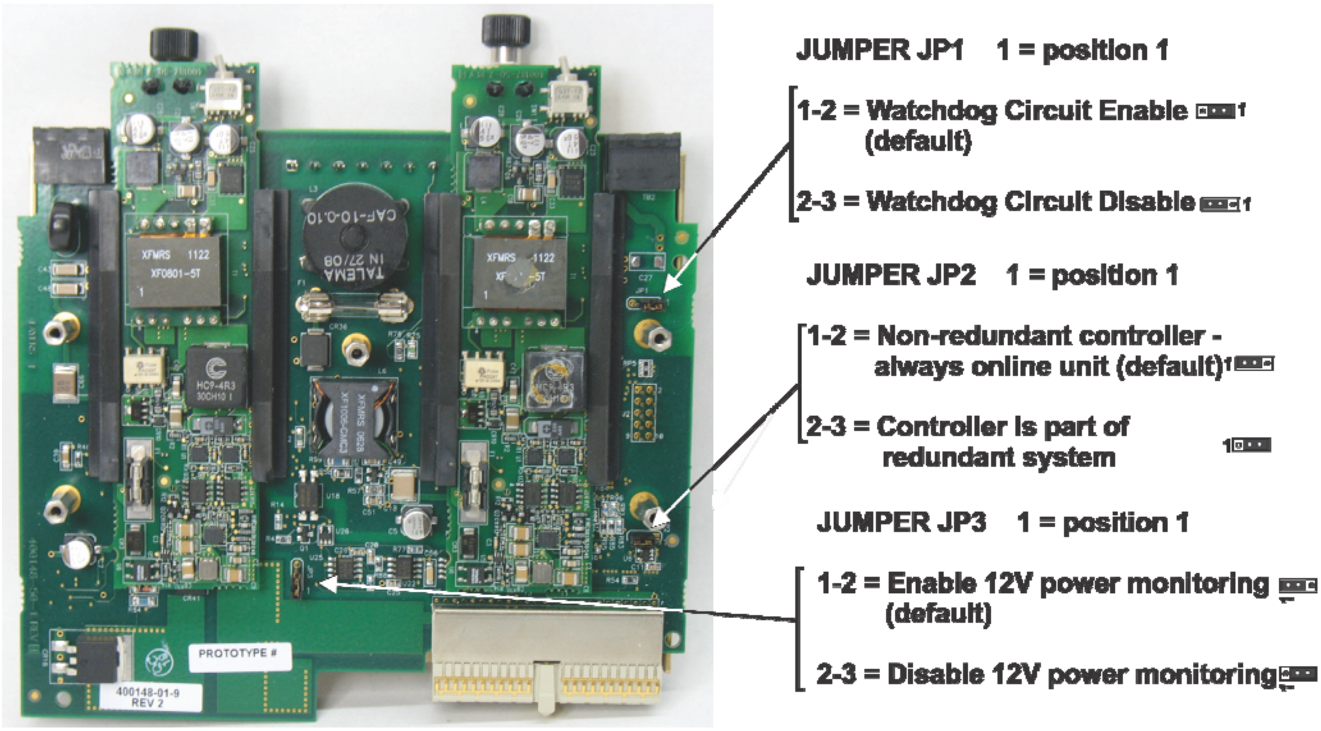



*Figure 2-5. Jumper Locations*

Make the necessary adjustments to the jumpers according to *Table 2-1*. When finished, re-attach the case by first aligning the protective case with the screw holes, then inserting and tightening each screw.

## 2.3.4 General Wiring Guidelines

- ControlWave PSSMs use compression-type terminals. TB1 and TB2 accommodate up to #14 AWG wire. The maximum wire size for TB3 is 16 AWG wire.
- When making a connection, insert the bare end of the wire (approx ¼” max) into the clamp adjacent to the screw and secure the wire.
- To prevent shorts, ensure that no bare wire is exposed. If using standard wire, tin the bare end with solder to prevent flattening and improve conductivity.
- Allow some slack in the wire while making terminal connections. Slack makes the wires more manageable and helps minimize mechanical strain on the terminal blocks.

## 2.3.5 Wiring a Bulk DC Power Supply to the PSSM

**⚠ Caution**

**At this time you can also connect power and watchdog wiring. However; for safety reasons and to prevent accidental damage to the your bulk DC power supply, do not connect the pluggable terminal block connectors TB1 and TB2 (or TB3) to the PSSM until after you install, wire, and configure the CPU module.**

**Follow the instructions in *Section 2.3.4 General Wiring Guidelines* when wiring connections.**

**Operating Range**

The ControlWave operates from +22.2 Vdc to +30.0 Vdc (with a nominal +24Vdc input source).

**One or Two Power Supplies**

You can connect one or two bulk DC power supplies (nominally +24 Vdc) to the PSSM. Use terminal blocks TB1 and TB2 to connect an external bulk power supply to the PSSM.

The external bulk 24V DC power supply you connect to **TB1-1 (+VIN)** provides system power to the ControlWave including the CPU boards, communications and I/O boards (see *Figure 2-6*). The PSSM converts, regulates, and filters the power to +5Vdc, +3.3Vdc, +12Vdc (optional) and -12Vdc (optional). +3.3 Vdc. For safety, this circuit has a 3A fuse.

The bulk DC supply you connect to terminal **TB2-1** (+VINF) powers the I/O field devices connected to the I/O modules. For safety, this circuit has a 10A fuse.

**Notes:**

- When you require two bulk power supplies, the first supply (VIN) must be rated to handle 2 amps.
- Be sure you route wires to the terminal block connectors so they do not interfere with removal/replacement of the power supply modules.
- The fuses for the PSSM **cannot** be replaced in the field.


*Figure 2-6. Wiring System Power to the PSSM*

An external power supply (22.2 to 30V) connected to **TB2** provides field power to I/O boards, and any field devices (switches, relays, etc.) powered through the I/O boards (see *Figure 2-7*).


*Figure 2-7. Wiring Field Power to the PSSM*

### Calculating the Maximum Current Required

Use the following formula to determine the maximum current required for the +24 Vdc bulk power used with a particular ControlWave:

**Max Bulk +24 Vdc Supply Current = $CPU_{max\_current}$ + $\Sigma$ I/O $Module_{max\_current}$**

where:

| | | |
|---|---|---|
| **$CPU_{max\_current}$** | refers to the maximum current required by the CPU (with or without an SCB), backplane and the PSSM. **This is 1A.** | |
| **$\Sigma$ I/O $Module_{max\_current}$** | refers to the sum of the maximum current required by each and every I/O module installed in the unit. The amount per I/O module varies as follows: | |
| | 16 AI Module | **2A per module** |
| | 8 AI Module | **1A per module** |
| | 8 AO Module | **1A per module** |
| | 16 DI Module | **1A per module** |
| | 32 DI Module | **1A per module** |
| | 16 DO Module | See table (no surge current) |
| | 32 DO Module | See table (no surge current) |
| | 6 UDI Module | See table (no surge current) |
| | 4 RTD Module | See table (no surge current) |
| | 6 LLAI Module | See table (no surge current) |

So, for example, if you have a ControlWave with a 16AI module, an 8AO module, and a 32DI module, the maximum current draw is 1A for the CPU plus 2A for the 16AI module plus 1A for the 8AO module and 1A for the 32DI module, for a total of 5A.

**Note:** This calculation covers current draw during normal operation (steady state) as well as the current draw during power-up in-rush when the unit is first powered on. Power up in-rush current can last up to 100 milliseconds and is higher than the current draw required during normal operation.

Refer to *Table 2-2* for ControlWave steady state and loop current requirements for bulk power supplies.

*Table 2-2. Steady State Current Draw for Bulk Power Supplies*

| Component(s) | System Current draw for 24Vdc Power Supply | Field Current draw for 24Vdc Power Supply | Notes |
|---|---|---|---|
| CPU (with Ethernet), PSSM and backplane | 290 mA | Not applicable | |
| CPU (with Ethernet), SCB (with Ethernet), PSSM and backplane | 400 mA | Not applicable | |
| Analog Input Module 16 points (4-20 mA) | 40.5 mA | 52.2 mA | For 24Vdc supply add 25 mA per loop |
| Analog Input Module 8 points (4-20 mA) | 36.1 mA | 29.7 mA | For 24Vdc supply add 25 mA per loop |
| Analog Output Module 8 points (4-20 mA) | 20.0 mA | 26.9 mA | For 24Vdc supply add 23.6 mA per loop |
| Analog Output Module 8 points (1-5V) | 20.0 mA | 56.8 mA | For 24Vdc supply add 26.1 mA per loop. Output at 5 mA |
| Digital Input Module 32 points | 29.2 mA | 29.7 mA | For 24Vdc supply add 4.74 mA per loop – dry contact |
| Digital Input Module 16 points | 15.8 mA | 29.7 mA | For 24Vdc supply add 4.74 mA per loop – dry contact |
| Digital Output Module 32 points | 42.6 mA | 0 mA | |
| Digital Output Module 16 points | 22.6 mA | 0 mA | |
| Universal Digital Input (UDI) – 6 points | 16.7 mA | 0 mA | |
| Isolated RTD 4 point | 26.0 mA | 0 mA | |
| Isolated Low Level Analog Input 6 points | 40.0 mA | 0 mA | |

**Note**: As an added precaution, we recommend that you run a #14 AWG wire from the TB2-3 power connection (chassis ground) to the same known good earth ground used for the housing.

## 2.3.6 Hot-swapping a Power Supply

**WARNING** **DO NOT ATTEMPT hot swapping in a Class I, Division 2 hazardous location.**

Each power supply has a Power Good indication LED (see *Chapter 5* for LED locations.) If this light goes out while the power supply is on, the power supply's output voltage is out of specification. This could occur if the supply is not properly seated in the slot or if its fuse has blown. Remove the power supply to check for these conditions. If neither condition has occurred, you may need to replace the power supply.

To remove one of the power supplies, first turn the power supply's ON/OFF switch **off** (the down position, as shown in *Figure 2-8*). Loosen the plastic screw either by hand or with a Phillips screwdriver. Grasp the bracket and gently pull the power supply straight out of the assembly.

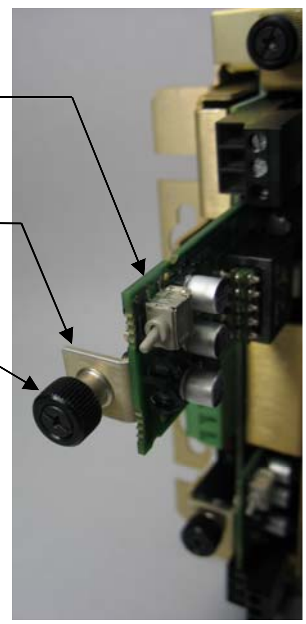



*Figure 2-8. Hot Swapping a Power Supply*

To re-insert the power supply, grasp the bracket and line up the board with the grooves in the assembly. Gently slide the card into the PSSM until it inserts into the connector. Gently tighten the screw either by hand or with a Phillips screwdriver. Now turn the On/Off switch **on** (the up position).

## 2.3.7 Wiring an External Alarm or Annunciator to the Watchdog Connector and Wiring the Redundancy Control Input (OPTIONAL)

**Caution** **At this time you can also connect power and watchdog wiring. However; for safety reasons and to prevent accidental damage to the your bulk DC power supply, do not connect the pluggable terminal block connectors TB1, TB2, or TB3 to the PSSM until after you install, wire, and configure the CPU module.**

**Follow the instructions in *Section 2.3.4 General Wiring Guidelines* when wiring connections.**

When the CPU's hardware detects improper software operation, it triggers a watchdog condition and resets the CPU. If you have enabled the watchdog output using jumper JP1, the watchdog condition triggers a failure to the redundant unit.

The circuit that drives the watchdog switch is on the secondary side of the power supply. A solid state relay actuates the watchdog hardware and is factory enabled or disabled via jumper JP1 (see *Setting Jumpers*).

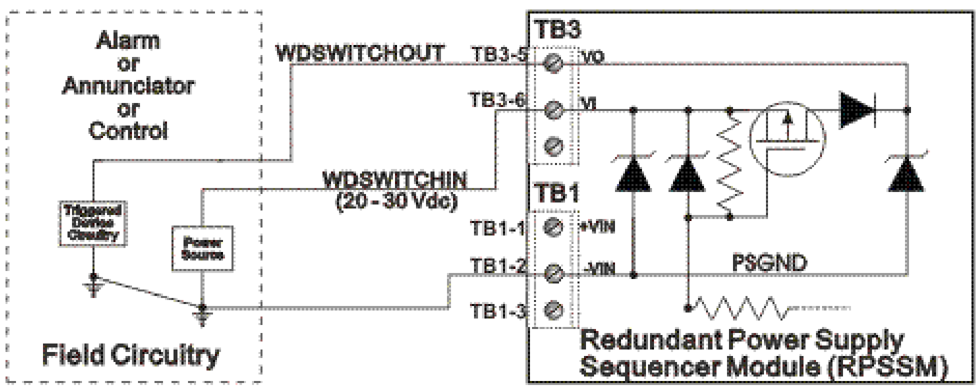



*Figure 2-9. Watchdog Switch Field Wiring*

The VI input of the terminal block (TB3-6) powers the watchdog switch. Its switched output connects to the VO output of the terminal block (TB3-5). Reference the external power source connected to the VI terminal to the return point of the input source that powers the PSSM [-VIN (TB1-2)].

PSSM connector TB3 provides watchdog switch and redundancy control connections as follows:

**Connections**

TB3-5 = VO - Watchdog switch output
TB3-6 = VI - Watchdog switch input
TB3-7 = VR - Redundant unit control input (Used with CW RED I/O)

When using a pair of ControlWave I/O expansion racks, each with a PSSM, and a ControlWave Redundant I/O and Communications Switch Unit (the redundant I/O switcher), the choice of which unit is “online” and which unit is “backup” is determined by redundancy control line wiring between the ControlWave I/O redundancy control module (IORCM) on the I/O switcher, and each I/O expansion rack (See *Figure* 2-10).

Wire terminal block connector TB3-7 on the “A” I/O expansion rack PSSM to TB2-1 on the IORCM, and TB2-2 on the IORCOM to 24V.

Similarly, wire terminal block connector TB3-7 on the “B” I/O expansion rack PSSM to TB2-3 on the IORCM, and TB2-4 on the IORCOM must to 24V.

*Figure 2-11* shows the location of the IORCM connectors on the ControlWave I/O Switcher.

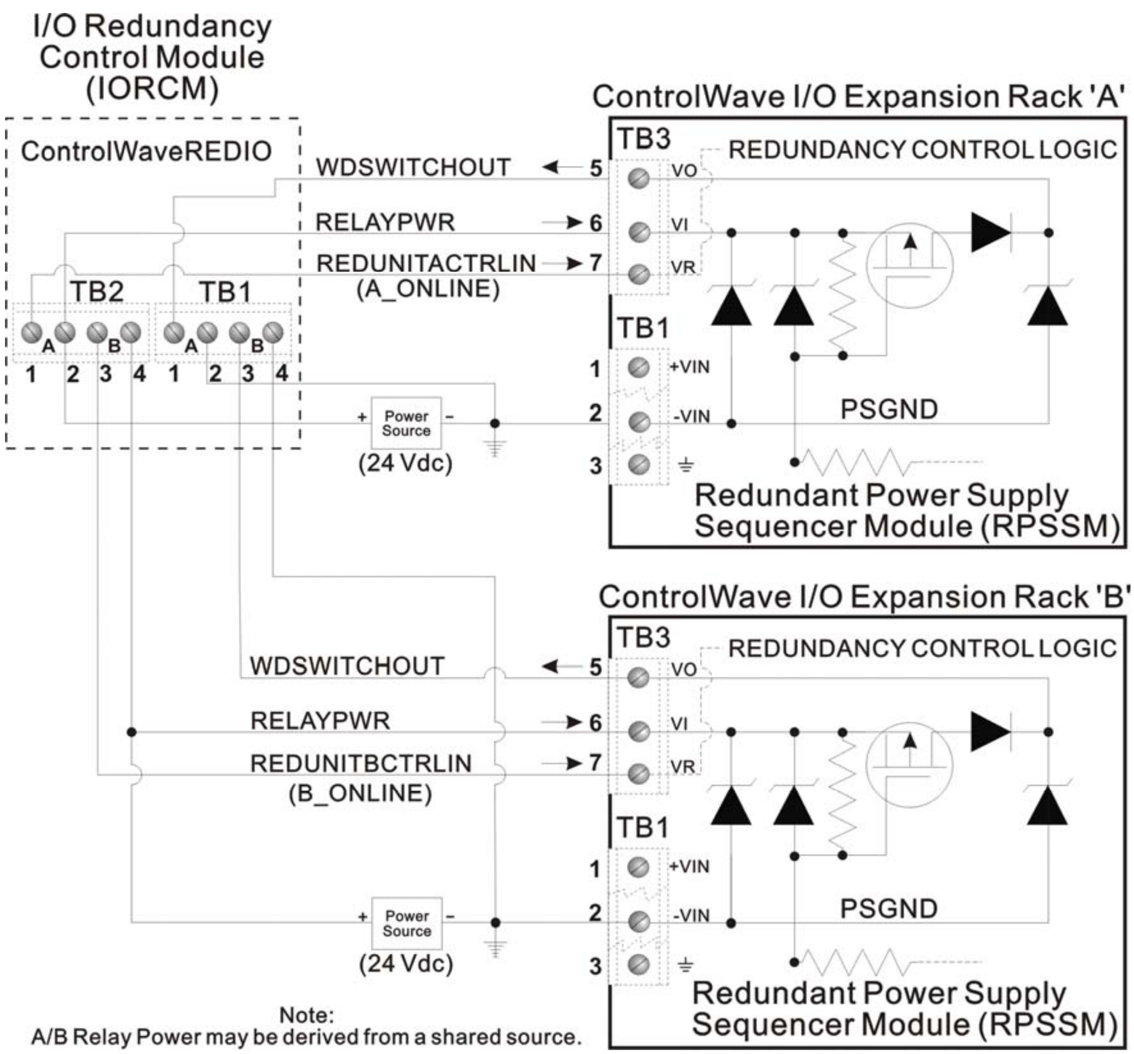



*Figure 2-10. ControlWave to ControlWave REDI/O - Redundancy Field Wiring*

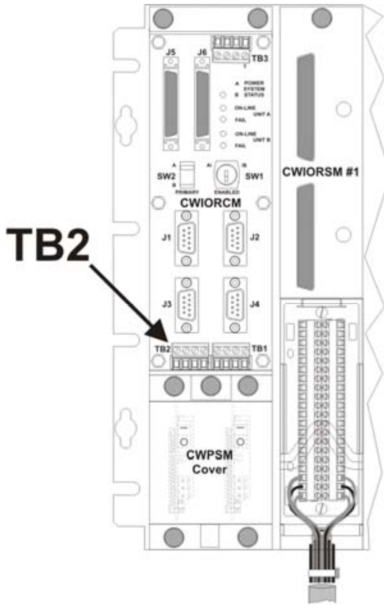



*Figure 2-11. Location of TB2 on ControlWave I/O Switcher*

## 2.3.8 Wiring Digital Inputs to indicate Power Supply Failure

Each power supply on the PSSM drives a solid state relay contact closed during normal operation. In a failure, this contact opens. You can optionally wire the contact to a digital input (either externally or internally sourced) to provide indication of a power supply failure. You must wire the contact differently depending upon whether the digital input supports internally sourced or externally sourced power. See *Table 2-3* for details.

*Table 2-3. Wiring a Digital Input to Indicate Power Supply Failure*

| Power Supply | Digital Input (Internally Sourced) | Digital Input (Externally Sourced) |
|---|---|---|
| 1 | TB3-3 SYSTEM GND<br>TB3-4 DIGITAL INPUT | TB3-3 SYSTEM PWR<br>TB3-4 DIGITAL INPUT |
| 2 | TB3-1 SYSTEM GND<br>TB3-2 DIGITAL INPUT | TB3-1 SYSTEM PWR<br>TB3-2 DIGITAL INPUT |

## 2.3.9 PSSM Specifications

*Table 2-4. PSSM Specifications*

| Redundant Power Supply Sequencer Module | |
|---|---|
| **Input Range:** | 22.2 to 30V DC (24V input supply, nominal) |
| | Shutdown occurs at 22.2 nominal for 24V input supply systems, respectively. |
| **Temperature Range:** | Operating: -40 to 70 $^{o}$ C |
| | Storage: -40 to 85 $^{o}$ C |
| **Relative Humidity:** | 15 to 95% non-condensing |
| **Vibration:** | 1G for 10-150 Hz |
| | 0.5 G for 150 Hz to 2000 Hz |
| **RFI Susceptibility** | 3V/m 80 MHz to 1000 MHz per EN50082-2 |
| **Watchdog MOSFET** | 1A |

| Power Supplies (1 or 2 on the PSSM) | |
|---|---|
| **Input Range** | 20 to 30Vdc (24V input supply, nominal) |
| **Output Voltage** | 5V ± 2%, 3.3V ± 2% |
| **Output Current** | 1A @ 3.3V, 2A @5V |
| **Efficiency** | 75% at full load |
| **Fusing** | 7x2 mm fuse 3A fast acting |

| Field Supply Power | |
|---|---|
| **VINF Input Range** | 20V to 30V |
| **Fusing** | 5x20 mm fuse 10A slow blow |

## 2.4 CPU Module

The CPU module, which controls the ControlWave and handles memory and communication functions, can only be installed in Slot #2 of the ControlWave backplane.

Identify the carton holding the CPU module and remove it from that carton. The CPU module has several different configurations, depending upon whether or not you ordered the CPU with a secondary communications board (SCB), and if you did order an SCB, which type:

- CPU with two RS-232 serial ports, and one Ethernet port. No SCB.
- CPU with two RS-232 serial ports, and one Ethernet port. SCB with one additional RS-232 port, one RS-485 port, and two additional Ethernet ports.
- CPU with two RS-232 serial ports, and one Ethernet port. SCB with one additional RS-232 and an RS-485 port.
- CPU with two RS-232 serial ports, and one Ethernet port. SCB with two RS-485 ports and two Ethernet ports.

Set DIP switches on the CPU module according to the tables on the next few pages. After you configure the DIP switches, slide the CPU module into slot #2 (the second slot from the left) of the housing.

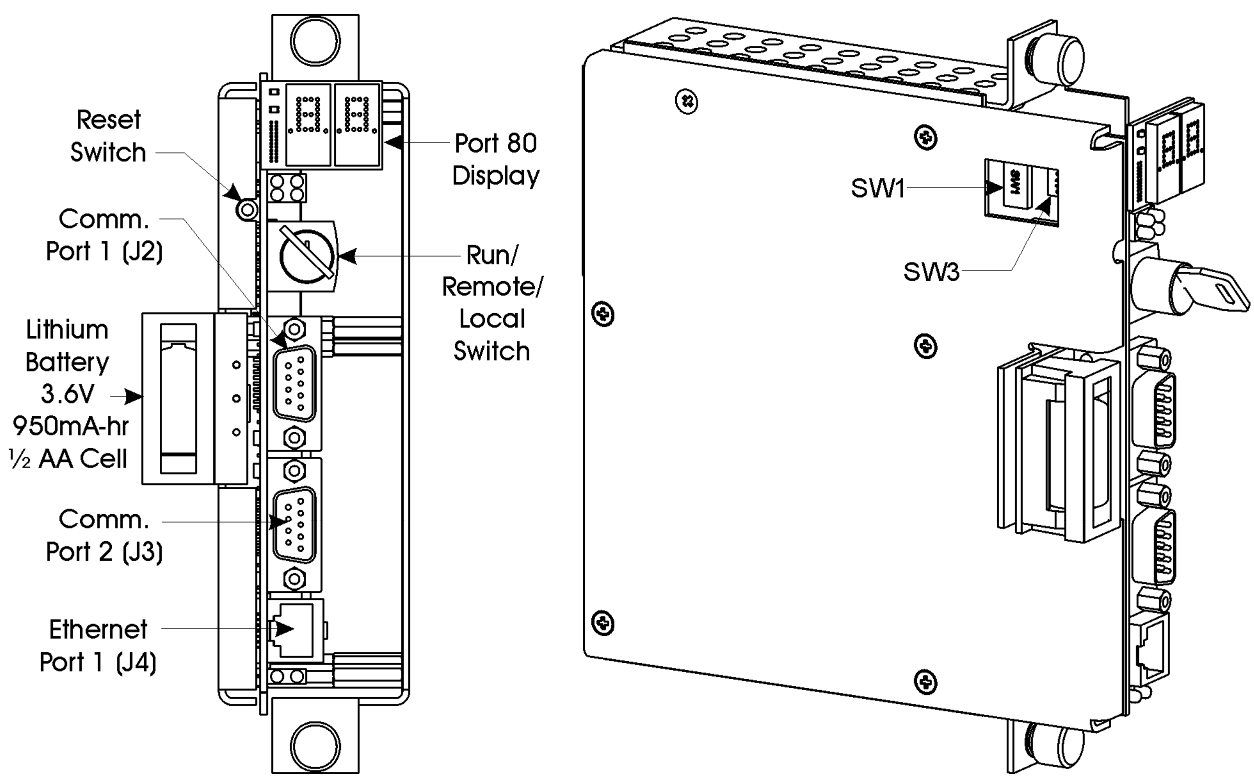



*Figure 2-12. ControlWave CPU Module (without SCB)*

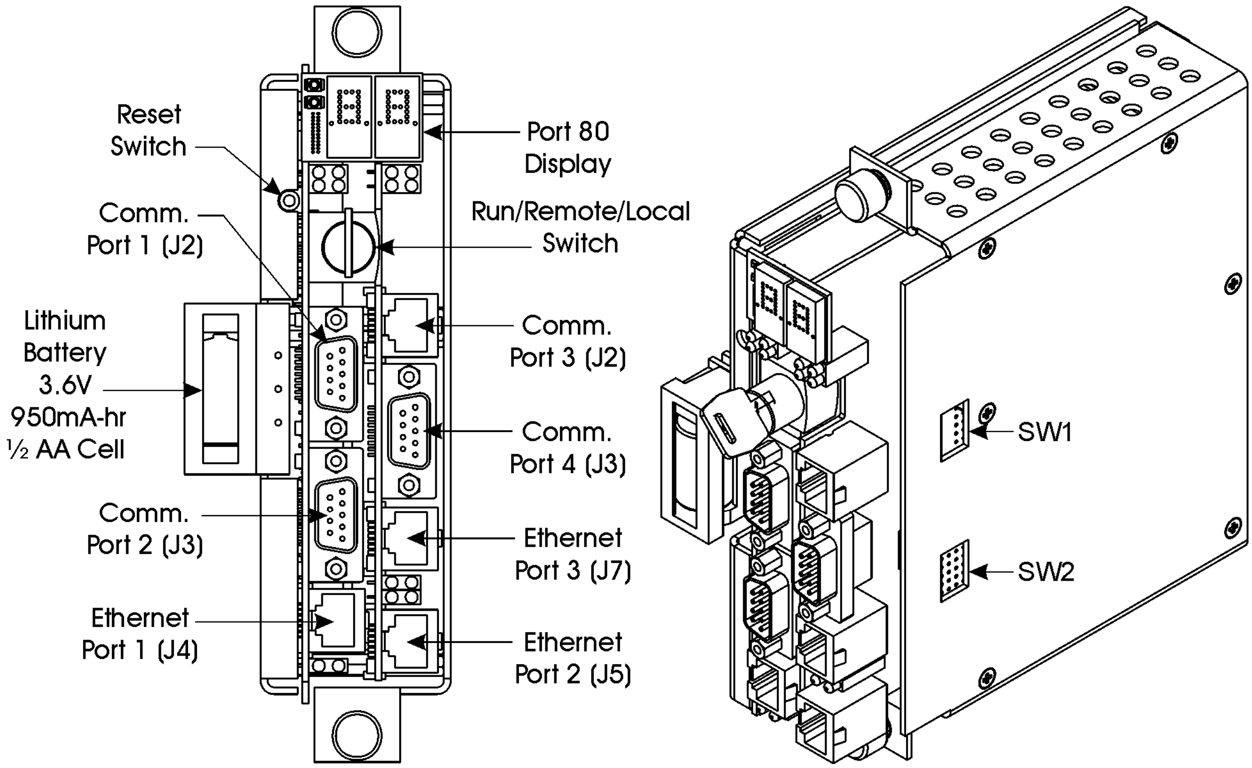



*Figure 2-13. ControlWave CPU Module (with SCB)*

### 2.4.1 Setting DIP Switches on the CPU Module

Before you install the CPU module, you must determine the settings for its DIP switches. Refer to *Figure 2-12* for the location of the DIP switch banks on the CPU board itself. If you have a secondary communications board (SCB) you must also refer to *Figure 2-13* for the location of the DIP switch banks on the SCB. Refer to *Tables 2-5* through *2-7* for DIP switch setting values.

**Note**: Examine each bank of DIP switches carefully to note the switch direction for ON or OFF.

*Table 2-5. CPU Module Switch SW1*

| SW1 Setting | Function | Mode |
|---|---|---|
| **1** | Watchdog Enable | Controls whether the system enters a watchdog state when a crash or system hangup occurs and automatically restarts. Values are:<br>**ON** (Enables watchdog circuit; **factory default**)<br>**OFF** (Disables watchdog circuit and prevents automatic restart) |
| **2** | Lock/Unlock Soft Switches | Controls the ability to modify soft switches, other configurations, and flash files. Values are:<br>**ON** (Unlocks soft switches and flash files; **factory default**).<br>**OFF** (Locks soft switches, configurations, and flash files) |

| SW1 Setting | Function | Mode |
|---|---|---|
| **3** | Use/Ignore Soft Switches | Controls the use of soft switches. Values are:<br>**ON** (Enable user-defined soft switches configured in flash memory; **factory default**)<br>**OFF** (Disable soft switch configuration and use factory defaults)<br>**Note**: Setting both switch 3 and switch 8 to **OFF** (closed) sets all serial communication ports to 9600 bps operation. All serial communication ports must be set at 9600 bps before WINDIAG can perform communication tests. |
| **4** | Core Updump (see *Section 3.6*) | Causes the ControlWave to perform a core updump, provided you have set the mode switch (SW3-3) to Recovery mode or properly sequenced the Run / Remote / Local switch on the PSSM. Values are:<br>**ON** (Disables core updump; **factory default**)<br>**OFF** (Core updump via PSSM Run/Remote/Local switch or mode switch SW3-3) |
| **5** | SRAM Control | Manages SRAM contents following a low power situation or a power outage. Values are:<br>**ON** (Retain values in SRAM during restarts; **factory default**)<br>**OFF** (Reinitialize SRAM) – Data in SRAM lost during power outage or re-start. |
| **6** | Redundancy Enable / Disable | Specifies whether this ControlWave is part of a redundant pair. Values are:<br>**ON** (Redundancy Disabled. Not part of redundant pair; **factory default**)<br>**OFF** (Redundancy Enabled. This ControlWave is one of two in a redundant pair) |
| **7** | Unit A / Unit B | Specifies whether this ControlWave is the “A” or “B” unit in a redundant pair. Values are:<br>**ON** (“A” unit in the redundant pair; **factory default**)<br>**OFF** (“B” unit in the redundant pair)<br>**Note:** If SW1-6 is **ON**, the system ignores SW1-7. |
| **8** | Enable WINDIAG | Suspends normal operation and allows diagnostic routines. Values are:<br>**ON** (Permits normal system operation, including the boot project, and disables the WINDIAG diagnostics from running; **factory default**)<br>**OFF** (Allow WINDIAG to run test; disable boot project.)<br>**Note**: Setting both switch 8 **and** switch 3 to **OFF** (closed) sets all serial communication ports to 9600 bps operation. All serial communication ports must be set at 9600 bps before WINDIAG can perform communication tests. |

*Table 2-6. CPU Module Switch SW3*

| SW3 Setting | Function | Mode |
|---|---|---|
| **1** | N/A | Not currently used. |
| **2** | System Firmware load control | Enables / disables remote system firmware upgrade via System Firmware Downloader:<br>**ON** (disables remote system firmware upgrade)<br>**OFF** (enables remote system firmware upgrade; **factory default**)<br>**Note:** Remote system firmware upgrade using System Firmware Downloader requires boot PROM version 06 (or newer) and system PROM version 4.7 (or newer). |
| **3** | Force Recovery Mode | Enables recovery mode. This allows for system firmware upgrades. Values are:<br>**ON** (enables recovery mode)<br>**OFF** (disables recovery mode). – This is the **factory default**. |
| **4** | Backup Battery Enable/Disable | Enables/disables the backup battery for SRAM and the real-time clock. Values are:<br>**ON** (enables backup battery)<br>**OFF** (disables backup battery). – This is the **factory default**.<br>**Note:** The unit ships from the factory with the backup battery disabled to conserve battery power. Set this to **ON** when you install the CPU. |

**Notes:**

- *Table 2-7* describes switch settings for ports on the SCB board. You may want to review *Section 2.4.3* before you set these switches.
- *Table 2-7* applies to the following switches:
  - SW1 on the SCB board – controls COM3
  - SW2 on the SCB board – controls COM4
- COM3 is always an RS-485 port.

*Table 2-7. SCB Port Configuration Switches (For COM3 use SW1, for COM4 use SW2)*

| SCB<br>SW1 or SW2 Switch Number | Function if this is an RS-232 Port | Function if this is an RS-485 Port |
|---|---|---|
| **1** | **ON** DTR to DSR Loopback (Use for Diagnostics only)<br>**OFF** No loopback (**factory default**) | **ON** TX+ to RX+ Loopback (Use for Diagnostics or 2-wire only)<br>**OFF** No loopback (**factory default**) |
| **2** | **ON** TXD to RXD Loopback (Use for Diagnostics only) | **ON** TX- to RX- Loopback (Use for Diagnostics or 2-wire only) |

| SCB SW1 or SW2 Switch Number | Function if this is an RS-232 Port | Function if this is an RS-485 Port |
|---|---|---|
| | **OFF** No loopback (**factory default**) | **OFF** No loopback (**factory default**) |
| **3** | Not currently used | **ON** 100 Ohm RX+ termination (end node)<br>**OFF** Not an end node (**factory default)** |
| **4** | Not currently used | **ON** 100 Ohm RX- termination (end node)<br>**OFF** Not an end node (**factory default**) |
| **5** | **ON** RTS to CTS Loopback (Use for Diagnostics only)<br>**OFF** No loopback (**factory default**) | Not currently used |
| **6** | Not currently used | **ON** (Fast slew rate enabled)<br>**OFF** (Slow slew rate enabled) (**factory default**) |
| **7** | Not currently used | **ON** RX+ bias (end node)<br>**OFF** Not an end node (**factory default**) |
| **8** | Not currently used | **ON** RX- bias (end node)<br>**OFF** Not an end node (**factory default**) |

After you set the DIP switches and insert the CPU module in slot #2 of the housing, you can connect communication ports.

### 2.4.2 Connections to RS-232 Serial Port(s)

An RS-232 port provides point-to-point, half-duplex and full-duplex communications (for a maximum of 20 feet using data quality cable).

The standard CPU module includes two RS-232 ports. If you purchased your CPU module with a secondary communication board (SCB) you may have one additional RS-232 port, depending upon the type of SCB.

**RS-232 COM Port Names and Connectors**

RS-232 COM ports are assigned names based on their location in the ControlWave. The CPU board has two RS-232 ports (COM1 and COM2). See *Table 2-8*.

*Table 2-8. RS-232 Connectors on CPU Board*

| Connector | Name | Function | Notes |
|---|---|---|---|
| J2 | COM1 | 9-pin male D-sub (RS-232) | See *Figure 2-14* & *Table 2-10* |
| J3 | COM2 | 9-pin male D-sub (RS-232) | See *Figure 2-14* & *Table 2-10* |

If you purchased an SCB board, it may include an RS-232 port. If present, the RS-232 port on the SCB is COM4.

**Note:** COM4 on the secondary communication board (SCB) can be ordered as an RS-485 port, in which case it will not function as an RS-232 port.

*Table 2-9. RS-232 Connectors on Secondary Communications Board (SCB)*

| Connector | Name | Function | Notes |
|---|---|---|---|
| J3 | COM4 | 9-pin male D-sub (RS-232) | See *Figure 2-14* & *Table 2-10* |

## RS-232 COM Port Cables

For the ControlWave, half-duplex communications use BSAP protocol or another protocol such as Modbus, while full-duplex communications use point-to-point protocol (PPP). RS-232 ports use a “null modem” cable (see *Figure 2-15*) to connect with other devices (such as a PC, a printer, another ControlWave [except the CW_10/30/35]) when the ControlWave uses the full-duplex PPP protocol.

If you don’t want to make your own cables, as described in this section, you can purchase cables.

- You can purchase a null modem cable using part number 392843-01-3.

**Note:** You can configure the ControlWave as either a master or slave node on a BSAP network.

*Figure 2-14* illustrates the CPU module’s male 9-pin D-type connector. Use the content provided in *Table 2-10* to determine pin assignments for the COM1, COM2 and COM4 ports.

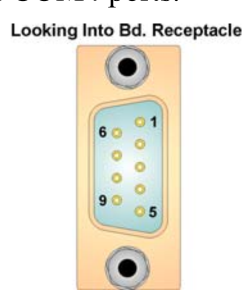



*Figure 2-14. Male DB9 9-Pin Connector*

*Table 2-10. COM1, COM2 and COM4 RS-232 Port Connector Pin Assignment*

| Pin | RS-232 Signal | RS-232 Description |
|---|---|---|
| 1 | DCD | Data Carrier Detect Input |
| 2 | RXD | Receive Data Input |
| 3 | TXD | Transmit Data Output |
| 4 | DTR | Data Terminal Ready Output |
| 5 | GND | Signal/Power Ground |
| 6 | DSR | Data Set Ready Input |
| 7 | RTS | Request to Send Output |
| 8 | CTS | Clear to Send Input |
| 9 | RI | Ring Indicator |

Use the "null modem" cable for full-duplex (PPP protocol) communications when connecting a ControlWave to a PC. (See top part of *Figure 2-15*.)

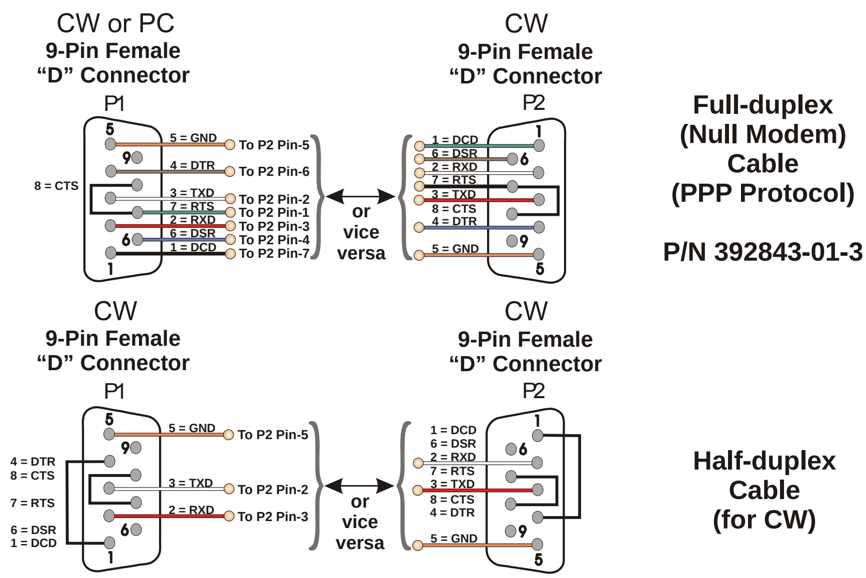



*Figure 2-15. Full-duplex and Half-duplex Cable*

Use the half-duplex cable (shown in the bottom part of *Figure 2-15*) when connecting the ControlWave to another ControlWave series unit (again, with the exception of the CW_10/30/35 units).

When communicating with a Network 3000 series RTU 3305, RTU 3310, DPC 3330, or DPC 3335 or CW_10/30/35, you must use one of the cables shown in *Figure 2-16*.

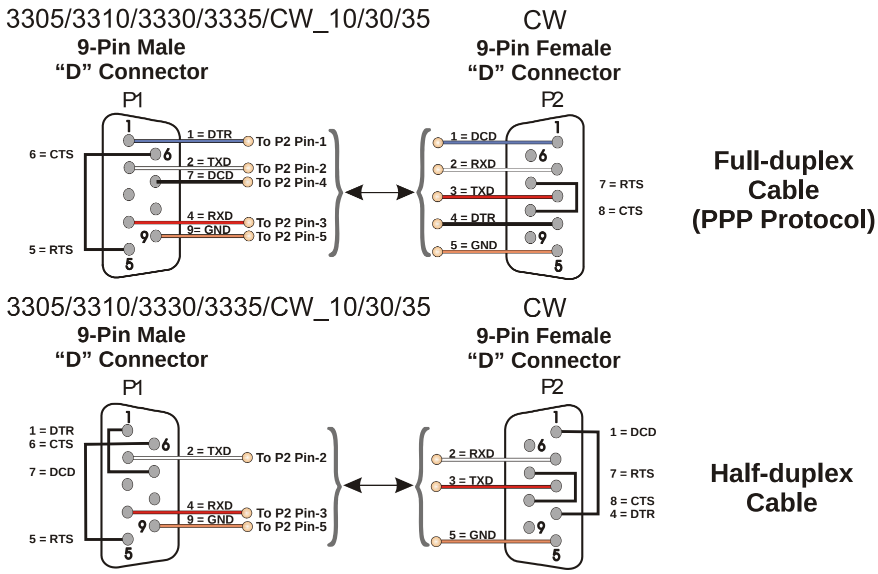



*Figure 2-16. Full-duplex and Half-duplex Cable*

To connect to a modem or radio, use the cable configuration shown in *Figure 2-17.*

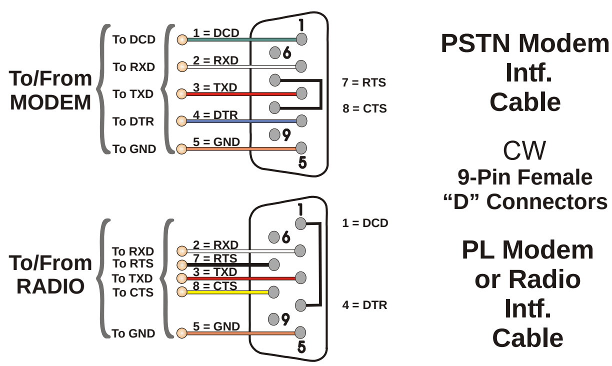



*Figure 2-17. Connecting to a Modem or Radio*

## RS-232 Cable Guidelines

Observe the following guidelines when constructing RS-232 communication cables:

- Ensure that DCD is high to transmit
- Set CTS to high to transmit.
- If the port is set for full-duplex operation, RTS is always ON.
- Ensure that DTR is always high when port is active

**Note**: Control DTR using the PORTCONTROL function block and the _P*n*_AUTO_DTR system variable in your ControlWave project. If you turn DTR off through these mechanisms, the port remains off, even though hardware is fully configured.

- When port is set for half-duplex operation, CTS must go low after RTS goes low.
- All RS-232 ports are protected by surge protectors (to ±8KV ESD).

## 2.4.3 Connections to RS-485 Serial Port(s) on the Secondary Communication Board (SCB)

The RS-485 port supports local network communications to multiple nodes up to 4000 feet away.

If you purchased your CPU module with a secondary communication board (SCB) you may have either one or two RS-485 ports.

**RS-485 COM Port Names and Connectors**

RS-485 COM ports are assigned names based on their location in the ControlWave.

- COM3 on the SCB board is always an RS-485 port.
- COM4 on the SCB board can be purchased as either an RS-232 port, or as an RS-485 port.

*Table 2-11. RS-485 Connectors on SCB*

| Connector | Name | Function | Notes |
|---|---|---|---|
| J2 | COM3 | 8-pin RJ-45 (RS-485) | See *Figure 2-18* & *Table 2-12* |
| J3 | COM4 | 9-pin male D-sub (RS-485) | See *Figure 2-14 & Table 2-13* |

**RS-485 COM Port Cables**

*Figure 2-14* illustrates the CPU module's male 9-pin D-type connector. Use the content provided in *Table 2-13* to determine pin assignments for the COM4 port on the CPU's SCB.

COM3 on the secondary communications board (SCB) is always an RS-485 port; it uses an RJ-45 connector to connect to other devices. *Figure 2-18* and *Figure 2-19* show the RJ-45 connector used for COM3 on the SCB. See *Table 2-12* for pin assignments.

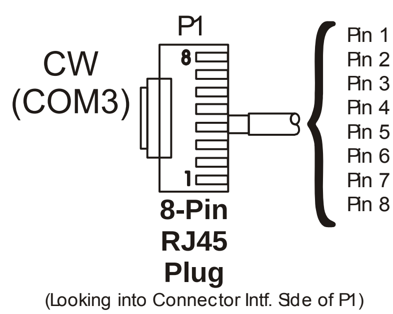



*Figure 2-18. COM3 (on SCB) RS-485 (RJ-45 connector)*

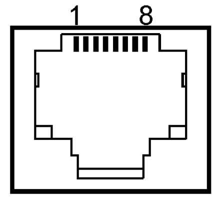



*Figure 2-19. RJ-45 Connector Associated with COM3 (SCB)*

*Table 2-12. RS-485 COM3 Port (RJ-45) Connector Pin Assignment*

| Pin | RS-485 Signal | RS-485 Description |
|---|---|---|
| 1 | | |
| 2 | RXD+ | Receive Data + Input |
| 3 | RXD- | Receive Data – Input |
| 4 | | |
| 5 | TXD- | Transmit Data – Output |
| 6 | | |
| 7 | TXD+ | Transmit Data + Output |
| 8 | ISOGND | Isolated Ground |

When COM4 is purchased as an RS-485 port, see *Table 2-13* for connector pin assignments.

*Table 2-13. RS-485 COM4 Port (Male DB9) Connector Pin Assignment*

| Pin | RS-485 Signal | RS-485 Description |
|---|---|---|
| 1 | | |
| 2 | RXD- | Receive Data - Input |
| 3 | TXD- | Transmit Data - Output |
| 4 | TXD+ | Transmit Data + Output |
| 5 | ISOGND | Isolated Ground |
| 6 | RXD+ | Receive Data + Input |
| 7 | | |
| 8 | | |
| 9 | | |

Since the RS-485 port is intended for network communications, refer to *Table 2-14* for the appropriate connections for wiring the master, first slave, and *nth* slave.

Essentially, the master and the first slave transmit and receive data on opposite lines; all slaves (from the first to the *nth*) are paralleled (daisychained) across the same lines. Wire the master node to one end of the RS-485 cable run using a 24-gauge paired conductor cable (such as a Belden 9843).

**Note:** ControlWave **only** supports half-duplex RS-485 networks.

*Table 2-14. RS-485 Network Connections*

| From Master | To First Slave | To nth Slave |
|---|---|---|
| TXD+ | RXD+ | RXD+ |
| TXD– | RXD– | RXD– |
| RXD+ | TXD+ | TXD+ |
| RXD– | TXD– | TXD– |
| ISOGND | ISOGND | ISOGND |

To ensure that the "Receive Data" lines are in a proper state during inactive transmission periods, you must maintain certain bias voltage levels at the master and most distant slave units (end nodes). These end nodes also require the insertion of 100Ω terminating resistors to properly balance the network.

You must also configure secondary communication board switches at each node to establish proper network performance. Accomplish this by configuring switches listed so that the 100Ω termination resistors and biasing networks are installed at the end nodes and are removed at all other nodes on the network. You enable receiver biasing and termination using SCB switch SW1 (for COM3) and SCB switch SW2 (for COM4). See *Table 2-7* in *Section 2.4.1 Setting DIP Switches on the CPU Module*s for information on RS-485 termination and loopback control switch settings.

## 2.4.4 Connections to Ethernet Port(s) on the CPU Module

The ControlWave can support from one to three Ethernet ports. These use a 10/100Base-T RJ-45 modular connector that provides a shielded twisted pair interface to an Ethernet hub. Two LEDs per port provide transmit and receive status indications:

*Table 2-15* shows port assignments for the Ethernet ports.

*Table 2-15. Ethernet Ports*

| Connector | Name | Function | Notes |
|---|---|---|---|
| J4 on CPU board | Ethernet Port 1 | 8-pin RJ-45 (RS-485) – Shielded Twisted Pair 10/100Base-T | |
| J5 on SCB board | Ethernet Port 2 | 8-pin RJ-45 (RS-485) – Shielded Twisted Pair 10/100Base-T | Requires SCB board |
| J7 on SCB board | Ethernet Port 3 | 8-pin RJ-45 (RS-485) – Shielded Twisted Pair 10/100Base-T | Requires SCB board |

A typical Ethernet hub provides eight 10/100Base-T RJ-45 ports (with port 8 having the capability to link either to another hub or to an Ethernet communications port). Both ends of the Ethernet twisted pair cable are equipped with modular RJ-45 connectors.

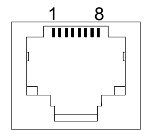



*Figure 2-20. RJ-45 Ethernet Connector*

These cables have a one-to-one wiring configuration as shown in *Figure 2-21*. *Table 2-16* provides the assignment and definitions of the 8-pin 10/100Base-T connectors.

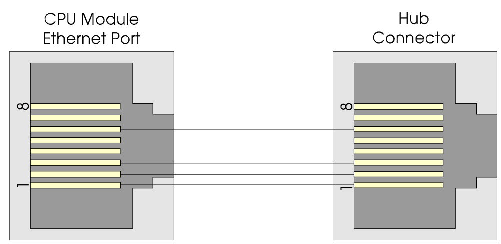



*Figure 2-21. Standard 10/100Base-T Ethernet Cable (CPU Module to Hub)*

*Table 2-16. Ethernet 10/100Base-T CPU Module Pin Assignments*

| Pin | Description |
|---|---|
| 1 | Transmit Data+ (Output) |
| 2 | Transmit Data– (Output) |
| 3 | Receive Data+ (Input) |
| 4 | Not connected |
| 5 | Not connected |
| 6 | Receive Data– (Input) |
| 7 | Not connected |
| 8 | Not connected |

**Note**: You can swap TX and RX at the hub.

You can connect two nodes in a point-to-point configuration without using a hub. However, you must configure the cable so that the TX+/- Data pins connect to the RX+/- Data pins (swapped) at the opposite ends of the cable (see *Figure 2-22*).

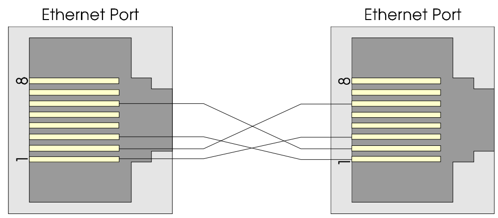



*Figure 2-22. Point-to-Point 10/100Base T Ethernet Cable*

The maximum length of one segment (CPU to hub) is 100 meters (328 feet). The use of Category 5 shielded cable is recommended.

## 2.5 Bezels

The bezel is a blue plastic cover (see *Figure 2-23*) that protects the CPU and PSSM modules. Another function of the bezel is to let you route bundled wires and cables downward between the modules and the bezel. The factory ships a version of the bezel appropriate to the options you ordered.

You should install the bezel whenever the ControlWave is operational. The bezel includes a door you can open to access the PSSM and CPU modules. If necessary, you can remove the bezel for maintenance procedures.

To install the bezel, align the snaps on the bezel with the corresponding holders on the chassis. Once you have it positioned, push gently and the bezel snaps into place.

To remove the bezel, gently grasp its sides and pull out and away from the chassis.

*Figure 2-23. Bezel Assembly*

# Chapter 3 – I/O Modules

This chapter discusses the placement and wiring for I/O modules in the ControlWave. The chapter begins with some general instructions on module installation and wiring guidelines that are common to most I/O modules. The balance of the chapter includes specific details for configuring and wiring each type of I/O module.

## In This Chapter



**Installation** Installing any I/O module in the ControlWave involves the same basic steps:

1. Remove the I/O module from the shipping carton. I/O modules include a removable terminal housing assembly. This assembly has a door that swings downward to provide access to the unit’s terminal handle you can use to remove an installed I/O module once you loosen the captive panel fasteners.

**Note:** Modules normally ship from the factory completely assembled.

2. Turn the terminal block’s quarter turn fasteners (counterclockwise) and remove the terminal housing assembly from the I/O module (see *Figure 3-1*).

3. Wire the modules according to instructions for each individual module, included later in this chapter. I/O modules support local terminations (field wiring connected directly to the I/O module’s terminal block PCB) or remote terminations (field wiring connected to a remote DIN-rail mounted terminal block assembly). See *Section 3.3.1* for information on local termination wiring and *Section 3.33.3.2* for information on remote termination wiring.

4. Align the I/O module with the assigned I/O slot and gently push the module into the chassis. When the assembly is fully seated, turn the I/O module’s captive panel fasteners (clockwise) to secure the unit

to the chassis; this establishes a low resistance path between the I/O module and chassis ground.

**5.** Install the local or remote terminal block assembly (with wiring harness) onto the I/O module (turning the quarter turn fasteners (clockwise)).

**6.** Replace the module's terminal housing assembly.

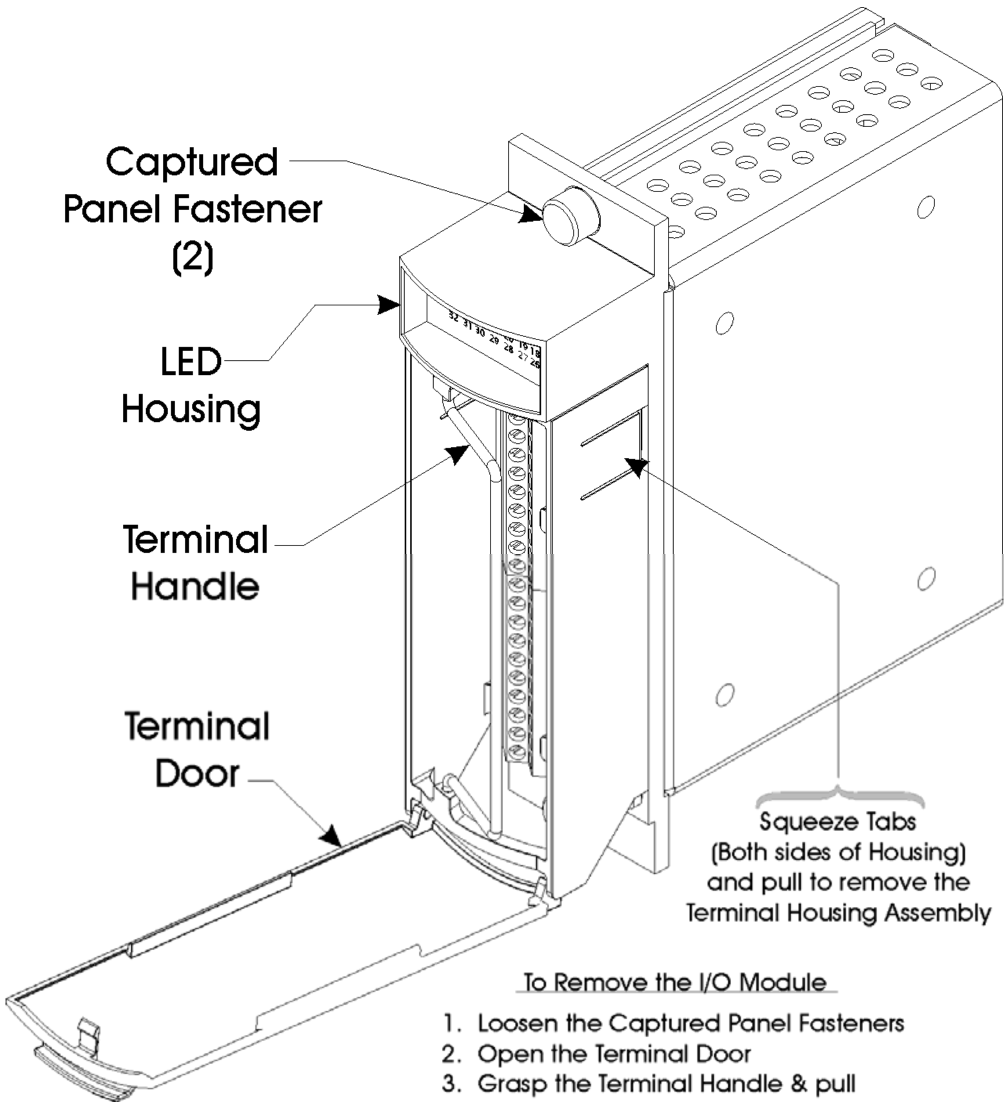



*Figure 3-1. Terminal Housing Assembly Removal*

**7.** Using a PC running the ControlWave Designer and OpenBSI software, configure the ControlWave to accept the new I/O modules and download the revised ControlWave project.

**Note:** This step is beyond the scope of this manual. Refer to the *ControlWave Designer Programmer's Handbook (D5125)* for further instructions.

**Caution**

**The ControlWave process automation controller supports "hot swapping" of I/O modules, but before any I/O modules can become operational, you must use ControlWave Designer to configure the project to accept the new I/O module, and then compile and download the revised application (project).**

**Do not install any modules in the housing until you have mounted and grounded the housing at the designated installation site.**

**To ensure safe use of this product, please review and follow the instructions in the following supplemental documentation:**

- **Supplement Guide - ControlWave Site Considerations for Equipment Installation, Grounding, and Wiring (S1400CW)**
- **ESDS Manual – Care and Handling of PC Boards and ESD Sensitive Components (S14006)**

**WARNING**

**NEVER ATTEMPT "hot swapping" in a Class I, Division 2 hazardous location.**

## 3.1 Module Placement

You can place I/O modules in the housing:

- 6-slot housing: supports up to four I/O modules in slots 3 through 6.
- 10 slot housing: supports up to eight I/O modules in slots 3 through 10.

**Note:** Interrupt driven I/O modules, such as the Universal Digital Input (UDI) **cannot** reside in slots 7 through 10 of the 10 slot housing.

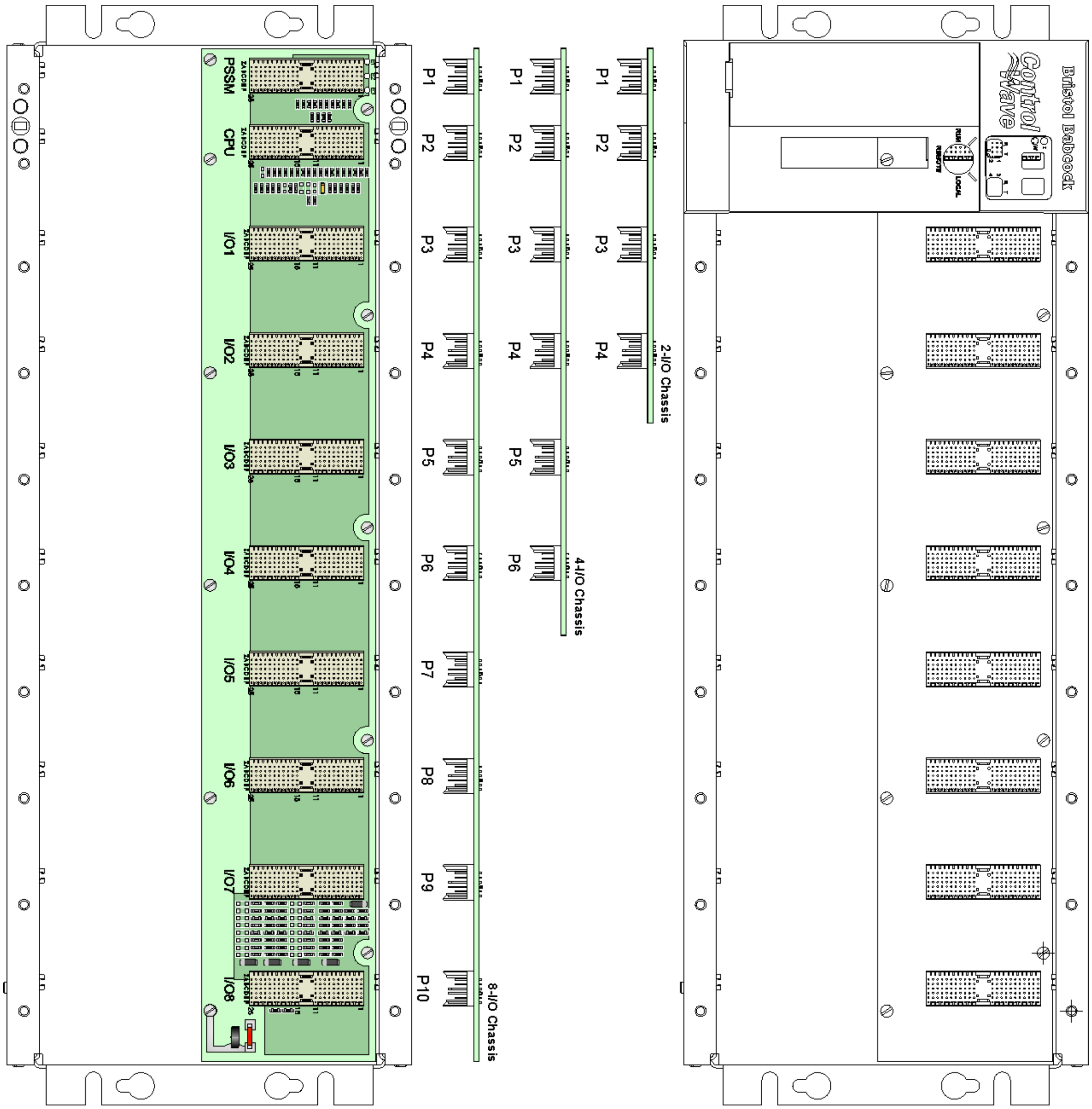



*Figure 3-2. ControlWave Chassis Slot Assignments (with/without bezel shown)*

## 3.2 Status LEDs

Most of the I/O modules include one or more light emitting diodes (LEDs) to provide diagnostic or status indications.

See *Chapter 5* for information on the different LEDs.

## 3.3 Wiring

With a few exceptions (noted in the module descriptions), I/O modules support either “local termination” (field wiring connected directly to the module’s removable terminal blocks) or “remote termination” (field wiring connected to the remote headers under the module’s cover and routed to a DIN-rail mounted terminal assembly and then to field devices).

ControlWave I/O modules use compression-type terminals that accommodate up to #14 AWG wire. Insert the wire’s bared end (approx. ¼” max) into the clamp beneath the screw and secure the wire. To prevent shorts, ensure that no bare wire is exposed. If using standard wire, tin the bare end with solder to prevent flattening and improve conductivity. Allow some slack in the wires when making terminal connections. Slack makes the wires more manageable and helps minimize mechanical strain on the terminal blocks.

### 3.3.1 Local Termination

For I/O modules equipped with local terminal blocks, install the field wiring between the I/O module’s removable terminal block connectors and field devices (see *Figure 3-3*). Use AWG 14 or smaller wire (consult with the field device manufacturer for recommendations). Leave some slack and plan for wire routing, identification, and maintenance. Route the bundled wires out through the bottom of the I/O module assembly between the terminal block and the terminal housing.

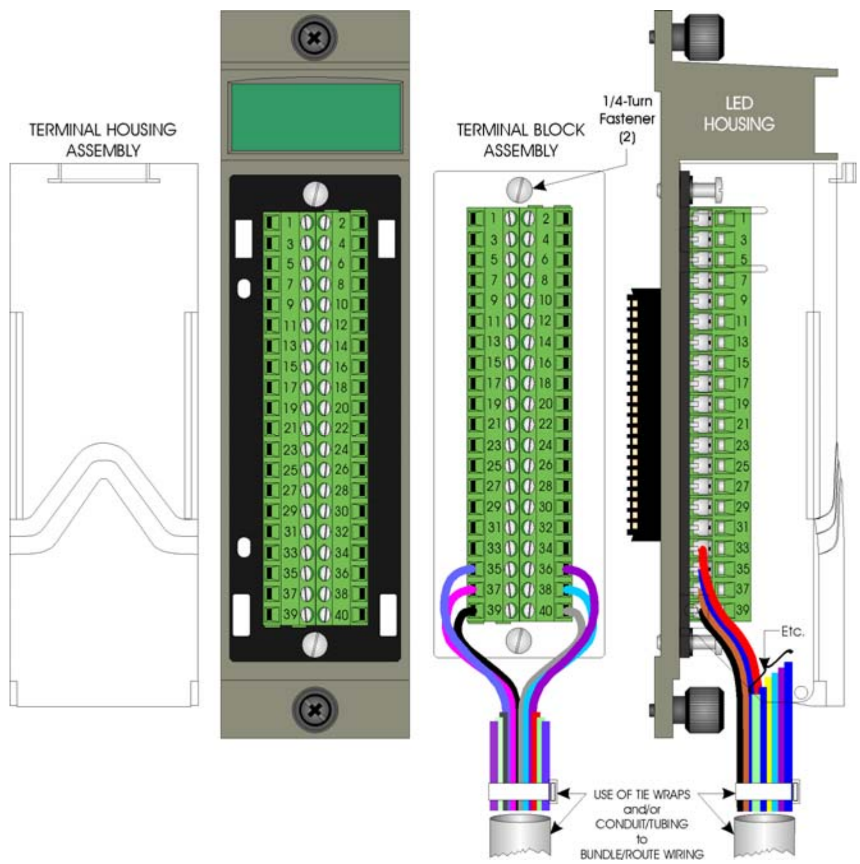



*Figure 3-3. I/O Module (Local Termination) Wire Routing*

### 3.3.2 Remote Termination

For I/O modules that support remote terminations, install cables between the module's remote headers and the remote DIN-rail mounted terminal block assemblies (see *Figure 3-4*). Install field wiring between the DIN-rail mounted terminal bock assembly and field devices (see the wiring diagrams associated with each I/O module description).

Use AWG 14 or smaller wire (consult with the field device manufacturer for recommendations) for remote terminations. Leave some slack and plan for wire routing, identification, and maintenance. Route the cables running between the I/O module and the DIN-rail mounted terminal blocks out through the bottom of the I/O module between the header block and the terminal housing assembly.

To provide access to the header block's lower ¼ turn fastener use a tie wrap to secure cables associated with connectors P3 and P4 to the lower left side of the header block assembly. Use a second tie wrap to secure cables for connectors P1 and P2 to the lower right side of the header block assembly.

### 3.3.3 Shielding and Grounding

Use twisted-pair, shielded and insulated cable for I/O signal wiring to minimize signal errors caused by electromagnetic interference (EMI), radio frequency interference (RFI), and transients. When using shielded cable, ground all shields at only one point in the appropriate system. This prevents circulating ground current loops that can cause signal errors.

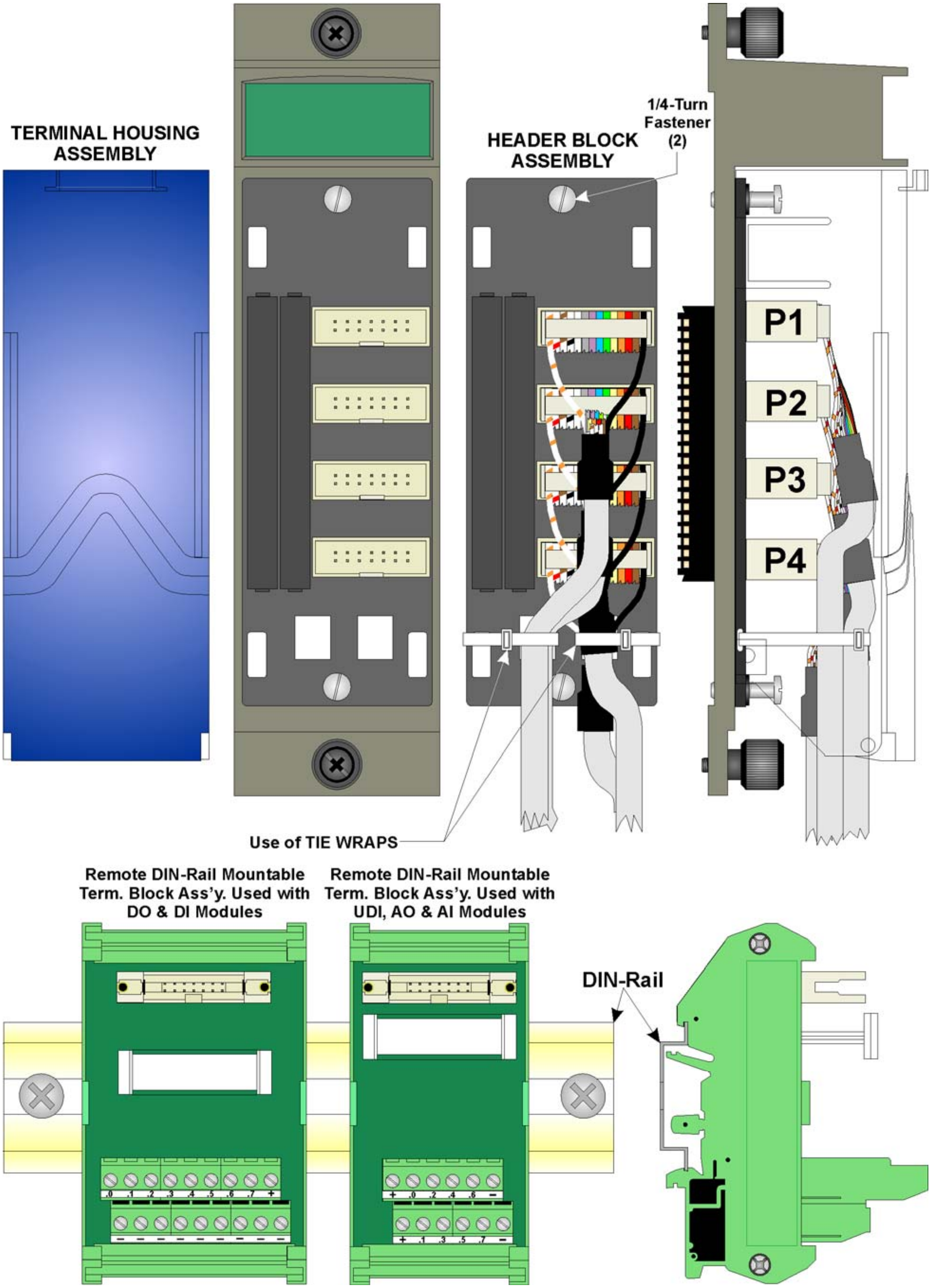



*Figure 3-4. I/O Module (Remote Termination) Wire Routing*

## 3.4 Digital Input (DI) Modules

DI modules provide 16 or 32 digital inputs. Using jumpers, you can individually configure each input as either externally sourced or internally powered using an internal +21Vdc power supply (dry contacts).

**Note:** Early versions of ControlWave DI modules required you to specify either internal or external sourcing for all DIs when you ordered the module; now you can set this yourself using jumpers on a per DI basis.

*Table 3-1 DI Module General Characteristics*

| Type | Number Supported | Characteristics |
|---|---|---|
| **Digital Inputs (DI)** | 16 or 32 | Each DI supports/ includes:<br>▪ Nominal input voltage of 24Vdc at 5 mA.<br>▪ Jumper to configure choice of either: externally sourced input - or -internally powered dry contact using internal +21 Vdc power supply.<br>▪ Nominal input current of 5 mA<br>▪ 30 ms input filtering<br>▪ Dedicated LED on module turns ON when DI is ON |

A DI module consists of a digital input printed circuit board (PCB) with either a terminal block assembly (for local termination) or a header block assembly (for remote termination). Each DI module also includes an LED board, as well as I/O assembly and mounting hardware. The DI PCB connects to the backplane using a 110-pin connector.

**Detailed Technical Specifications**

For detailed technical specifications, please see document CWPAC:DIO available on our website http://www.emersonprocess.com/remote.

**Configurations**

DI modules (general part number **396357-XX-X**) come in several different configurations. See *Table 3-2* to see the variations.

*Table 3-2 DI Module Configurations*

| Part Number | Number of DIs | Termination Connector |
|---|---|---|
| 396357-01-6 | 32 | Local |
| 396357-02-4 | 16 | Local |
| 396357-11-3: | 32 | Remote |
| 396357-12-1 | 16 | Remote |

**Isolation**

Surge suppressors and optocouplers electrically isolate the DI field circuitry from the module’s bus interface circuitry. Inputs configured for use in dry contact applications contain a +21 Vdc isolated power supply powered through an output of the hot swap circuitry which receives power originating on the backplane.

**Setting Jumpers**

You must set configuration jumpers for each DI. according to *Table 3-3*. For a 16DI module, use W1 through W16, for a 32DI module, use W1 through W32.

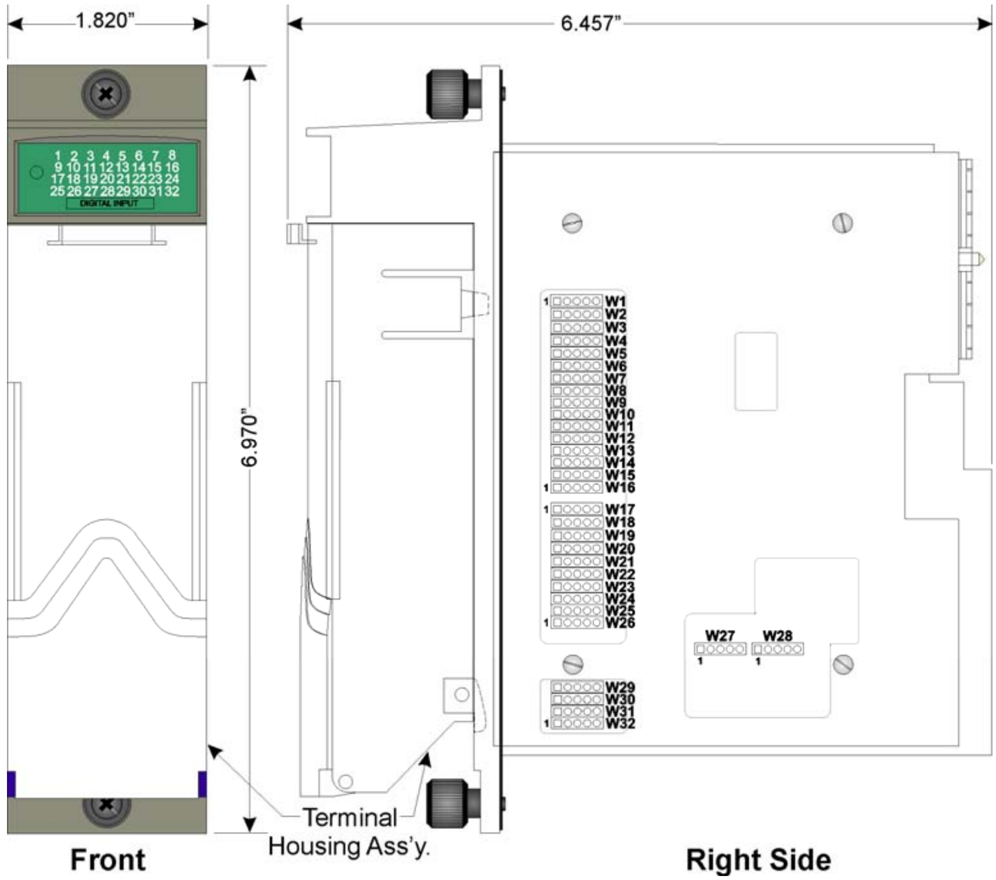



*Figure 3-5. DI Module -Right Side View - Jumper Locations*

*Table 3-3. Jumper Assignments: DI Module*

| Jumper | Purpose | Description |
|---|---|---|
| WI | Configures DI1 | Pins 2-3 & 4-5 installed = External Power DI<br>Pins 1-2 & 3-4 installed = Internal Source DI |
| W2-W32 | Configures DI2 through DI32 (respectively) | Same as W1 |

**Wiring the Module**

*Figure 3-6* shows field wiring assignments associated with locally terminated DI modules; *Figure 3-9* shows field wiring assignments associated with remotely terminated DI modules. *Figure 3-10* shows an optional remote termination module with built-in discrete relay module that supports input from 120 Vac DIs. The special remote termination module (with built-in discrete relay module) interfaces with an externally sourced DI module.

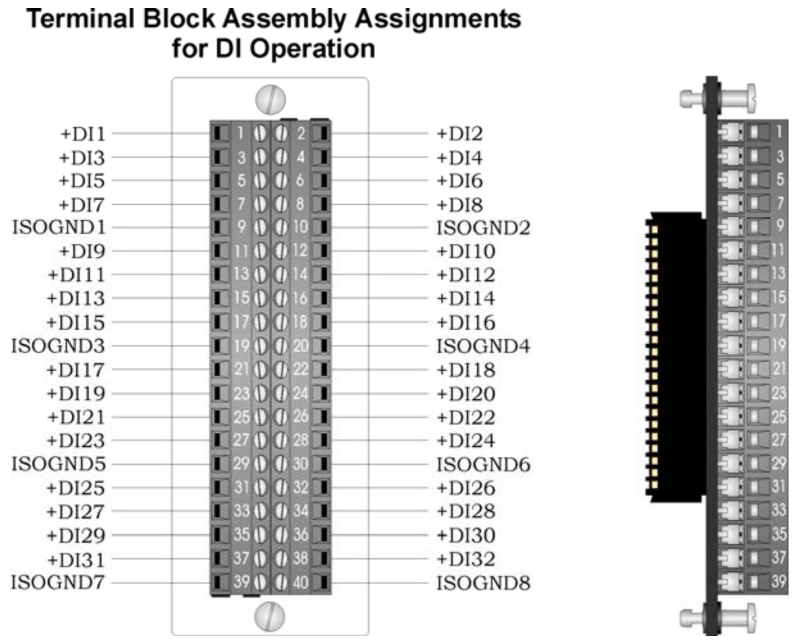



*Figure 3-6. DI Module - Local Terminal Block Assembly Assignments*

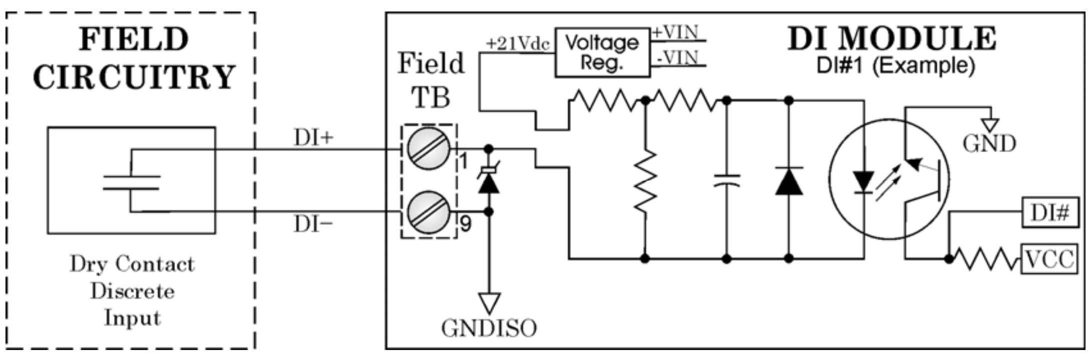



*Figure 3-7. Internally Sourced DI Module - Wiring Diagram*

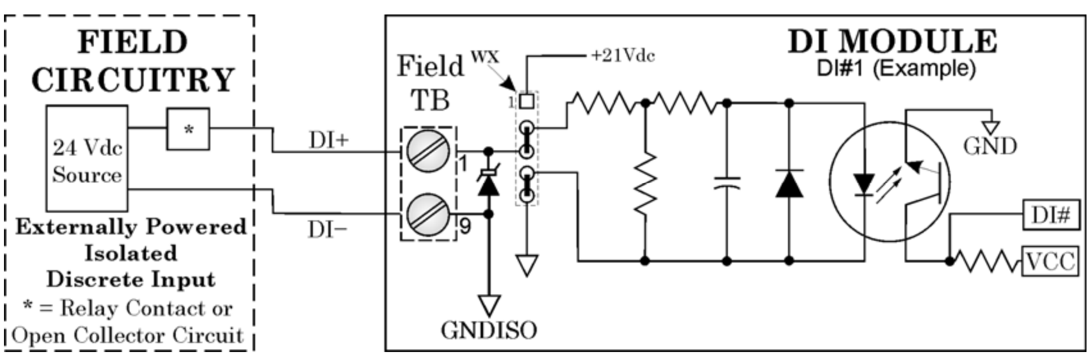
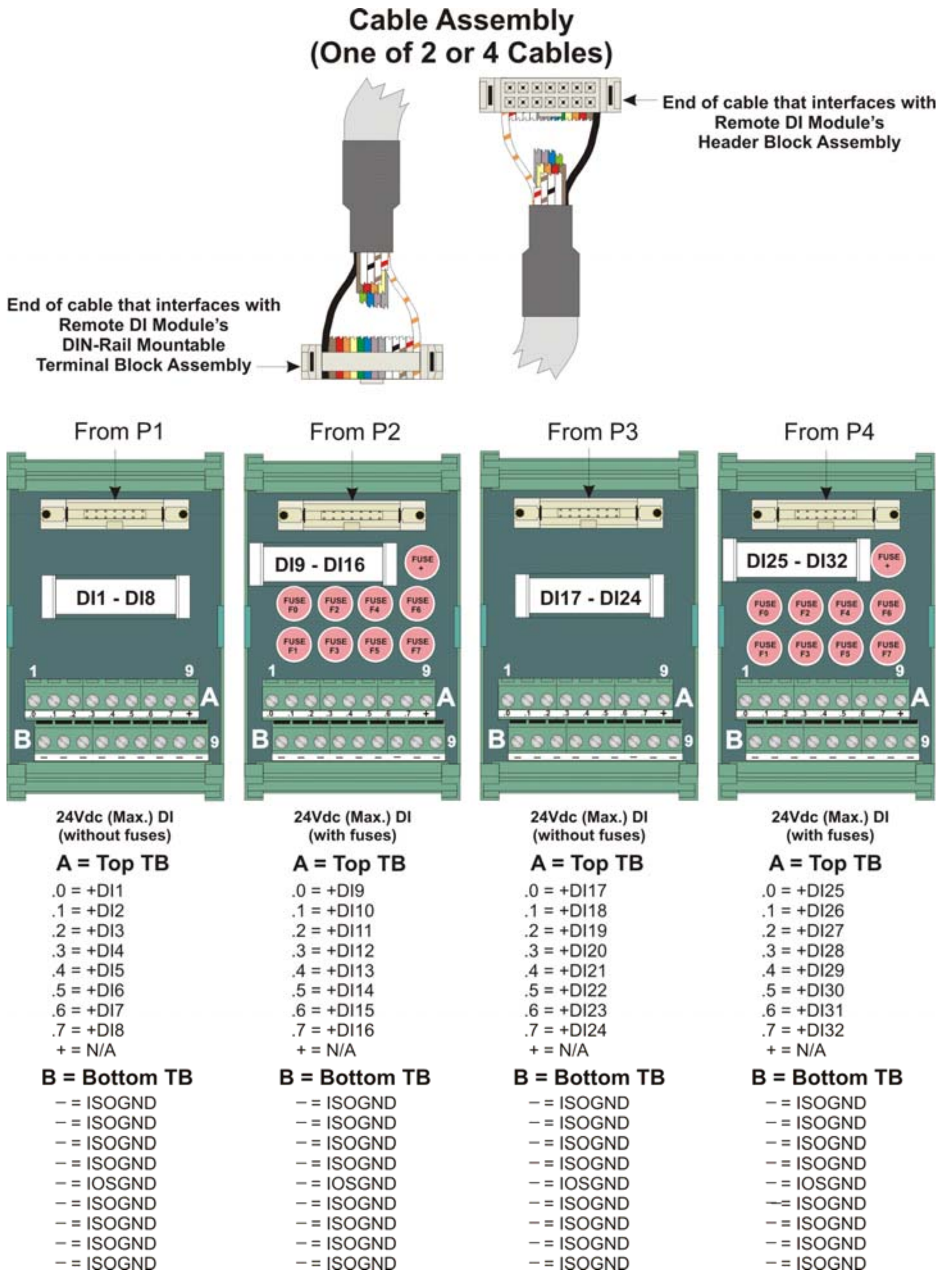



*Figure 3-8. Externally Powered DI Module - Wiring Diagram*




FUSES: F0 to F7: 1/8A, F+: 2A

*Figure 3-9. Remote DIN-Rail Mountable Terminal Block Assembly Assignments*

## Software Configuration

To use data from any ControlWave DI module you must add a **CW_DI32** board in ControlWave Designer's I/O Configurator, and then configure it. See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

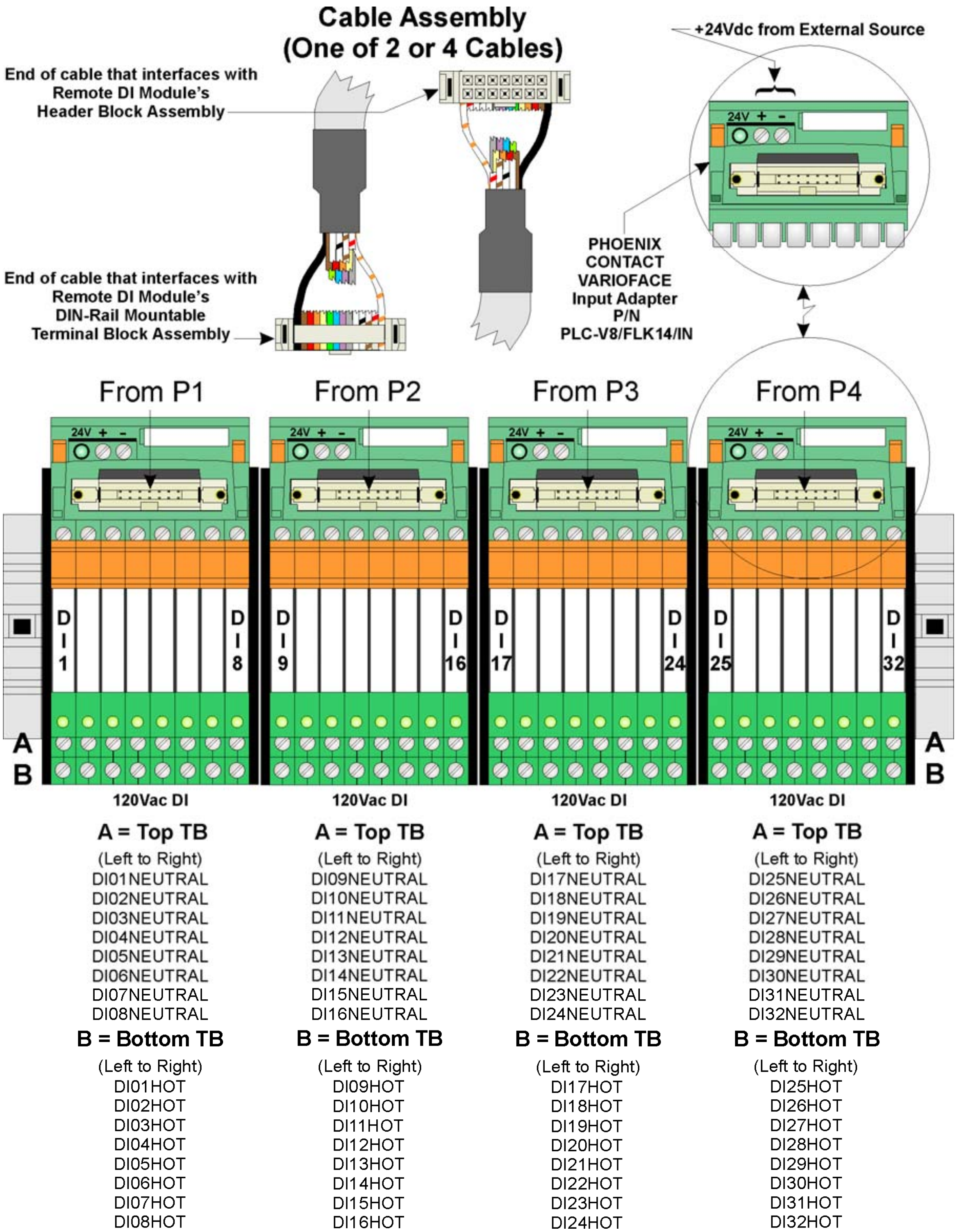



*Figure 3-10. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for Relay Isolated 120Vac DI Operation*

## 3.5 Digital Output (DO) Modules

DO modules provide 32 or 16 DOs to control signaling functions.

DO modules consist of a DO PCB with either a terminal block assembly (for local termination) or a header block assembly (for remote termination). DO modules also include an LED board, a terminal housing assembly, as well as I/O assembly and mounting hardware.

*Table 3-4 DO Module General Characteristics*

| Type | Number Supported | Characteristics |
|---|---|---|
| **Digital Outputs (DO)** | 32 or 16 | Each DO supports/ includes:<br>▪ Optically isolated open source MOSFET with surge suppression that is capable of handling 500mA at 31V.<br>▪ Maximum operating frequency of 20 Hz.<br>▪ Dedicated LED on module turns ON when DO is ON. |

**Detailed Technical Specifications**

For detailed technical specifications, please see document CWPAC:DIO available on our website http://www.emersonprocess.com/remote.

**Configurations**

The DO module (general part number **396358-XX-X**) comes in several possible configurations, see *Table 3-5*:

*Table 3-5. Isolated DO Module Configurations*

| Part Number | Number of DOs | Termination Connector | Notes |
|---|---|---|---|
| 396358-01-2 | 32 | Local | |
| 396358-02-0 | 16 | Local | |
| 396358-11-0 | 32 | Remote | |
| 396358-12-8 | 16 | Remote | |
| 396358-20-9 | 16 | Remote | DO with read-back |

**Jumper determines state of DOs on power-up**

An on-board DO load register stores output data. Jumper JP4 determines the initial state of DOs on power-up.

*Table 3-6. DO State on Power-up*

| JP4 Jumper Position | Initial DO State on Power-Up |
|---|---|
| 1-2 | Clear register – all outputs set to OFF on power-up, regardless of application initial value setting. |
| 2-3 | Hold last output – on power-up, DO that was OFF at watchdog is OFF at power-up, DO that was ON at watchdog is ON at power-up. |

**Digital Output with Readback**

Newer digital output modules with 16 outputs support read-back capability for use in redundant systems. A DO with read-back module operating in online mode monitors the DO values of its standby counterpart in order to verify that standby DO values are consistent should a failover occur. Depending upon software configuration settings; a failover can be prevented if they are inconsistent. A standard DO module used in a redundant system does not perform this monitoring; therefore the potential exists to failover to a backup DO module with failed hardware. For critical processes, the redundant DO with read-back capability is recommended.

Use the same DO module type in any redundant pair; do not install a DO with read-back module in the primary controller and a standard DO module as its redundant counterpart in the backup controller, or vice versa.

See *Software Configuration* later in this section for details on setting up DO with readback.

**Wiring the Module**

*Figure 3-11* shows field wiring assignments associated with a locally terminated DO module; *Figure 3-12* shows a wiring diagram for the DO. Field wiring assignments associated with remotely terminated DO modules. *Figure 3-13* shows field wiring assignments for a remotely terminated DO module. *Figure 3-14* shows a special remote termination module with built-in discrete relay modules.

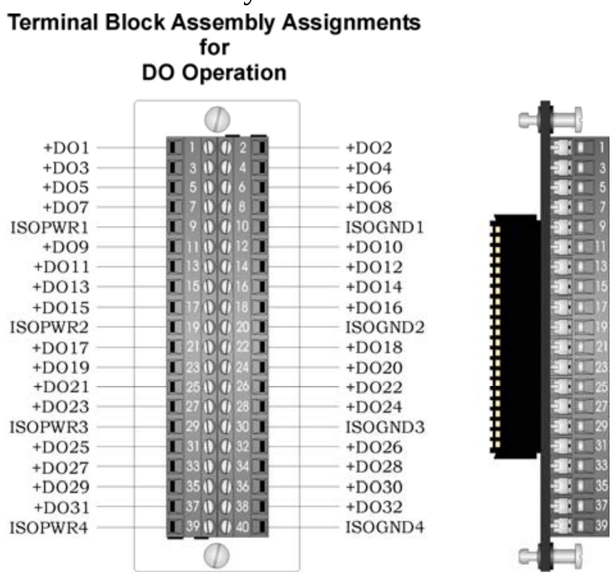



*Figure 3-11. Local Terminal Block Assembly Assignments for Open Source Isolated DO Operation*

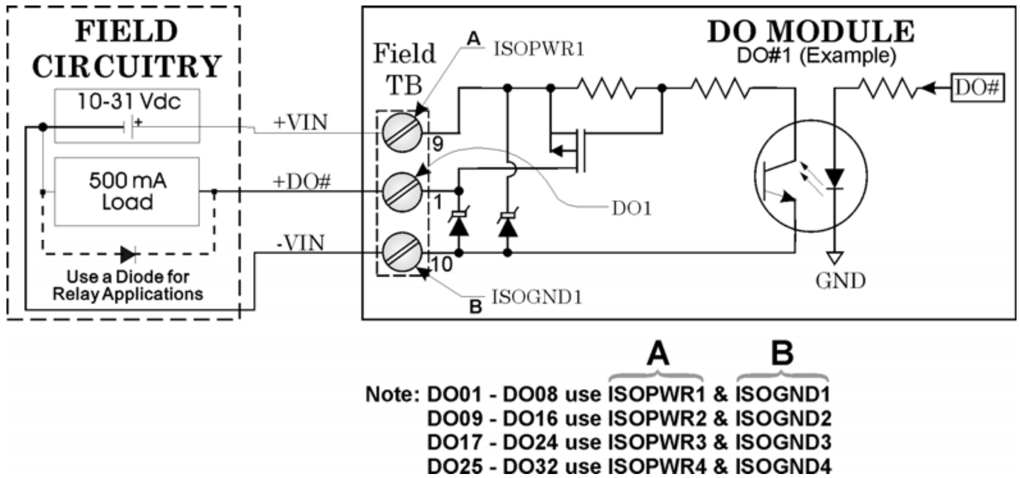
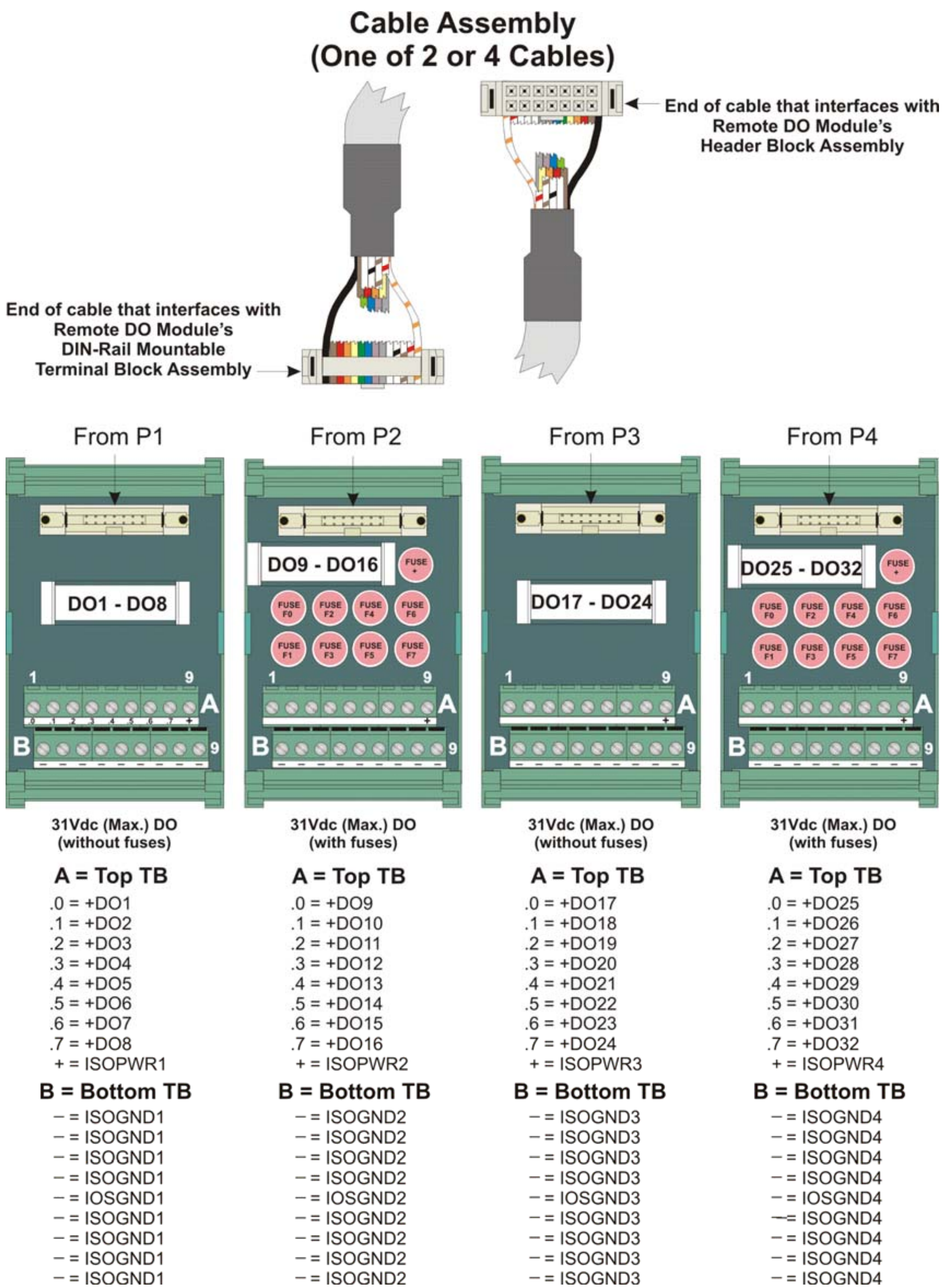



*Figure 3-12. Open Source Isolated DO Module - Wiring Diagram*




FUSES: F0 to F7: 1A, F+: 2A

*Figure 3-13. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for Open Source Isolated DO Operation*

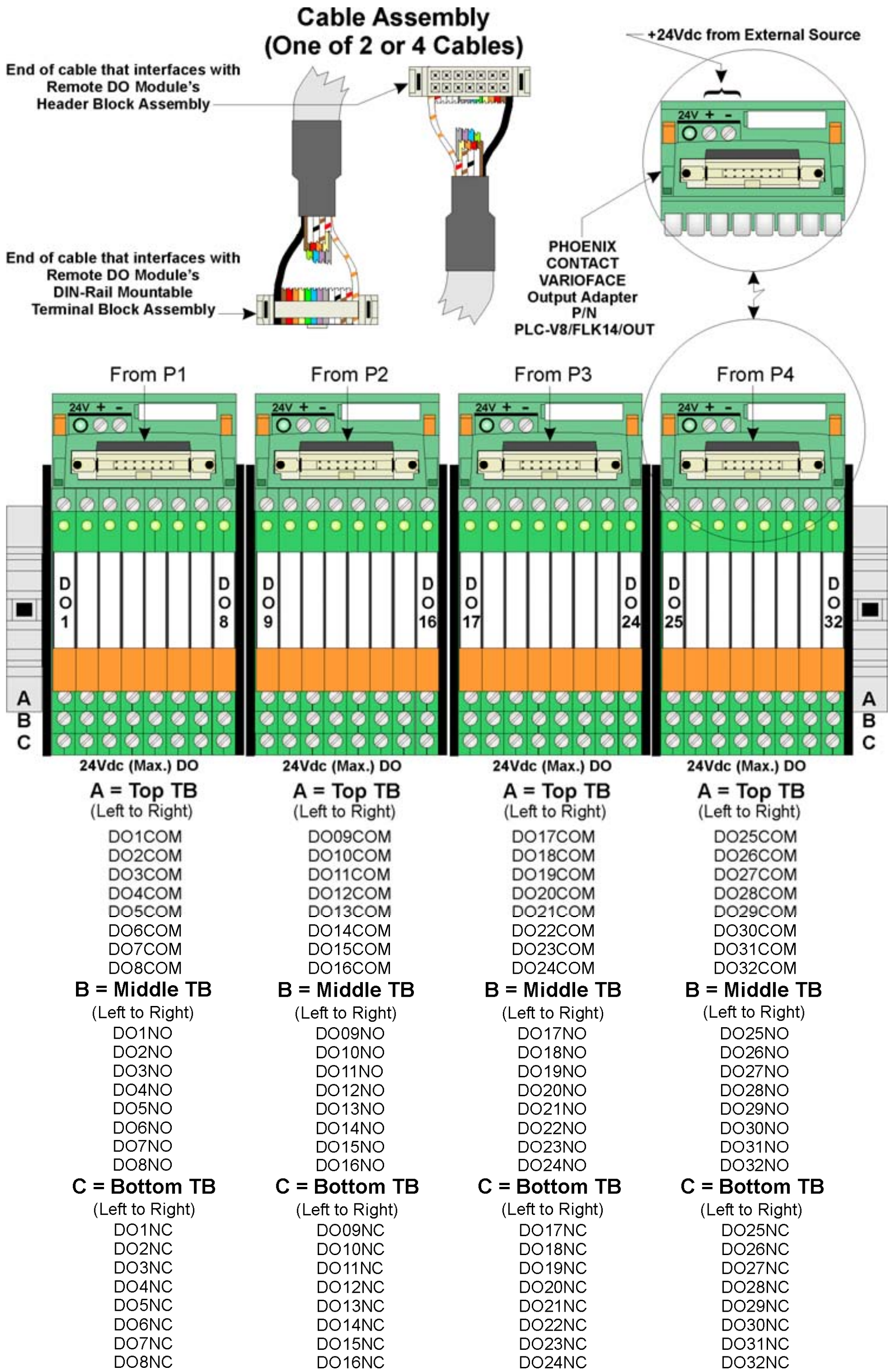



*Figure 3-14. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for Relay Isolated 24Vdc DO Operation*

## Software Configuration

To use data from any ControlWave DO module you must add a **CW_DO32** board in ControlWave Designer's I/O Configurator, and then configure it. See the *ControlWave Designer Programmer's*

*Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

**DO with Readback in a Redundant System**

Variables in the ControlWave project govern how inconsistencies between the online DO module and the standby DO module are handled in redundant systems with DO readback. Information on configuring system variables is included in the *ControlWave Designer Programmer's Handbook* (D5125).

If there is a discrepancy between the value of the online and standby DOs, the system sets a status variable to TRUE. For local I/O boards, this is a system variable that follows the format:

_RDN_IO_*n*_ERR

where *n* is the I/O slot number of the DO module in the backup unit that has a failure.

For boards residing in an I/O expansion rack, instead of a system variable, a variable mapped by the _ER_STAT virtual status board provides this indication. By default, the name of the variable follows one of two possible formats.

ERSTAT_*n*_RDN_IO_*x*_ERR

ERST_*n*_RDN_IO_*x*_ERR

where *n* is the I/O slot number of the virtual ER_STAT board, and *x* is the I/O slot number of the digital output module. See the *I/O Configurator* and *I/O Mapping* sections of the *ControlWave Designer Programmer's Handbook* (D5125) for more information. You can optionally rename these variables.

You should configure these variables as alarms so you receive notification of a failure of the backup DO module. See the ControlWave Designer online help for information on alarm configuration.

When a read-back failure occurs, the FAIL LED remains RED until the unit reboots, either through a sideload, forced redundant switchover, or power-down and restart, or you remove and replace the board (hot card replacement). Each of these operations momentarily turns the FAIL LED to GREEN (and the associated _ERR error variable to FALSE) until a new readback failure occurs, which changes the LED back to RED, and the associated _ERR error variable back to TRUE.

For boards installed locally in the controller (local I/O), another system variable (_RDN_IOERR_WARN) determines whether a failure of the standby DO (as indicated by the LED and associated _ERR error variable) should only be treated as a warning condition, which would still allow a failover to occur, or as an error which would prevent a failover to the standby.

When you set this system variable to FALSE, the system treats a DO readback failure in the associated device as an error; failover is inhibited. When you set this variable to TRUE, the system treats a DO readback failure in the associated device as a warning that does not prevent a failover, and the only reporting is via the _RDN_IO_*x*_ERR system variables and LEDs discussed, above.

For boards residing in an I/O expansion rack, instead of a system variable for this purpose, you must map a variable from the _ER_STAT virtual status board named either ERSTAT_RDN_IOERR_WARN (or ERST_RDN_IOERR_WARN). NOTE: Those are the default names, you can change them as needed.

**Note:** In the I/O Configurator, you must associate these boards with a cyclic task, and the task must not run faster than 10 milliseconds.

## 3.6 Analog Input (AI) Modules

AI modules support either 16 or eight 4–20 mA or 1–5 Vdc analog inputs.

AI modules consist of an AI PCB with either a terminal block assembly (for local termination) or a header block assembly (for remote termination). AI modules also include an LED board, a terminal housing assembly, as well as I/O assembly and mounting hardware.

*Table 3-7 Analog Input (AI) Module General Characteristics*

| Type | Number Supported | Characteristics |
|---|---|---|
| **Analog Inputs (AI)** | 16 or 8 | Each AI supports:<br>▪ Either 4–20mA internally sourced input or 1–5Vdc isolated input operation. Choice for whether the module supports 4-20mA or 1-5Vdc is set at the factory.<br>▪ 1-5Vdc AIs have a common mode range of 31Vdc.<br>▪ 4-20mA inputs reference –VF*xx* of the module.<br>▪ Analog input circuitry isolated from bus interface.<br>▪ Surge suppression and signal conditioning. |

**Cable Shields** Connect cable shields associated with AI wiring to the ControlWave housing ground. Multiple shield terminations require that you supply a copper ground bus (up to a #4 AWG wire size) and connect it to the housing's ground lug.

This ground bus must accommodate a connection to a known good earth ground (in lieu of a direct connection from the ground lug) and to all AI cable shields. Shield wires should use an appropriate terminal lug. Secure them to the copper bus using industry rugged hardware (screw/bolt, lock washer, and nuts).

**Detailed Technical Specifications** For detailed technical specifications, please see document CWPAC:AIO available on our website http://www.emersonprocess.com/remote.

**Configurations** The AI module (general part number **396352-XX-X**) has the following configurations:

*Table 3-8 Analog Input Module Configurations*

| Part Number | Number of AIs | Termination Connector | Notes |
|---|---|---|---|
| 396352-01-4 | 16 | Local | 4-20 mA |
| 396352-03-0 | 8 | Local | 4-20 mA |
| 396352-11-1 | 16 | Remote | 4-20 mA |
| 396352-13-8 | 8 | Remote | 4-20 mA |
| 396352-12-0 | 16 | Remote | 1-5 Vdc |

**Wiring the Module** *Figure 3-18* shows terminal assignments for a locally terminated AI module; *Figure 3-19* and *Figure 3-20* show terminal assignments for a 4-20mA and a 1-5Vdc remotely terminated AI, respectively.

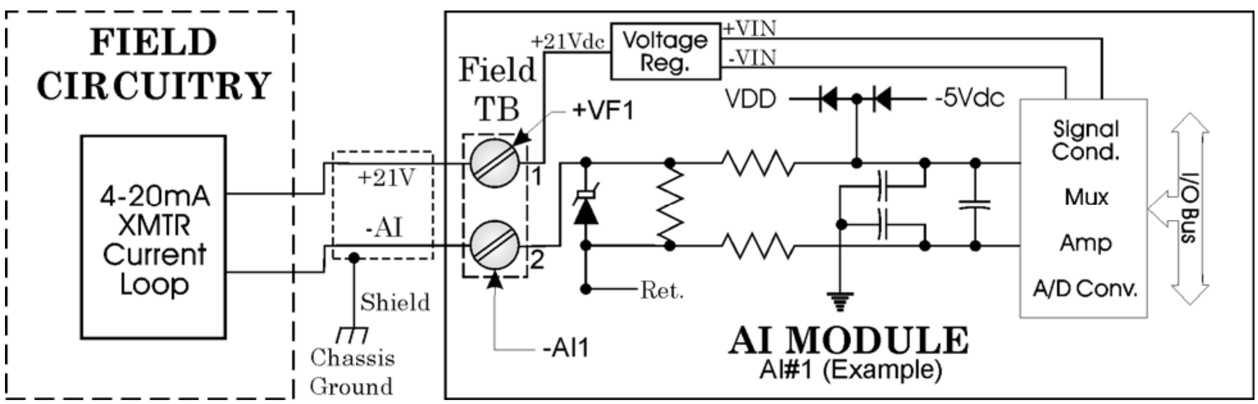



*Figure 3-15. Internally Sourced 4-20mA Current Loop AI - Wiring Diagram*

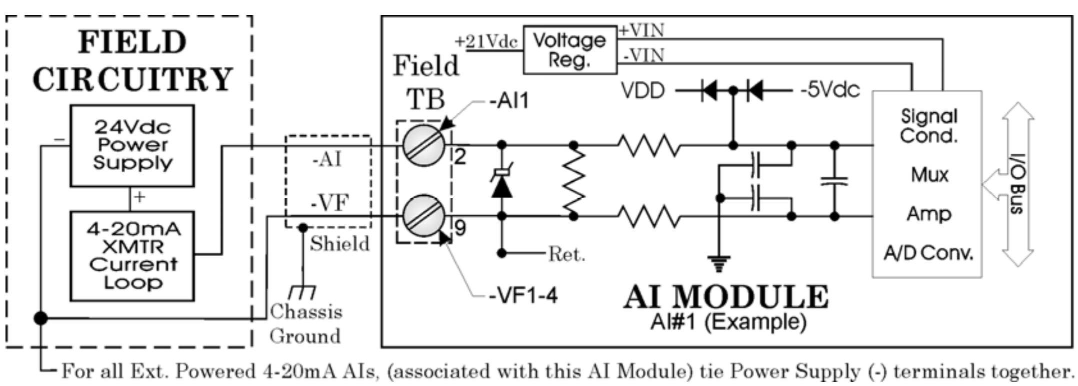



*Figure 3-16. Externally Powered 4-20mA Current Loop AI - Wiring Diagram*

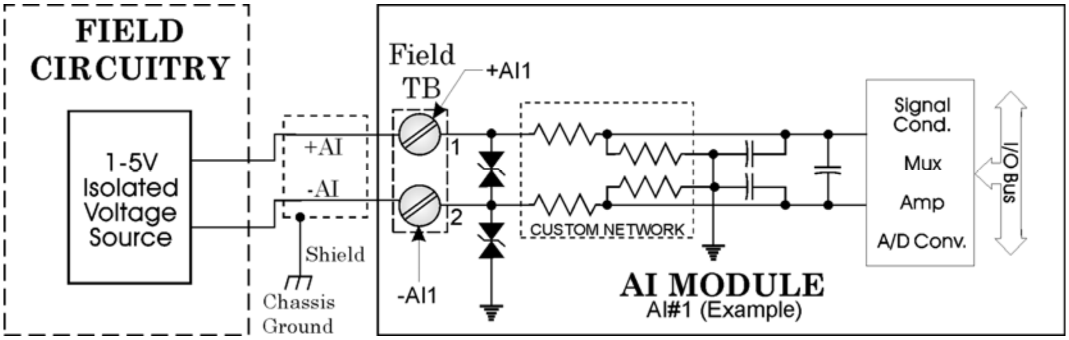



*Figure 3-17. Externally Powered Isolated 1-5 Volt AI - Wiring Diagram*

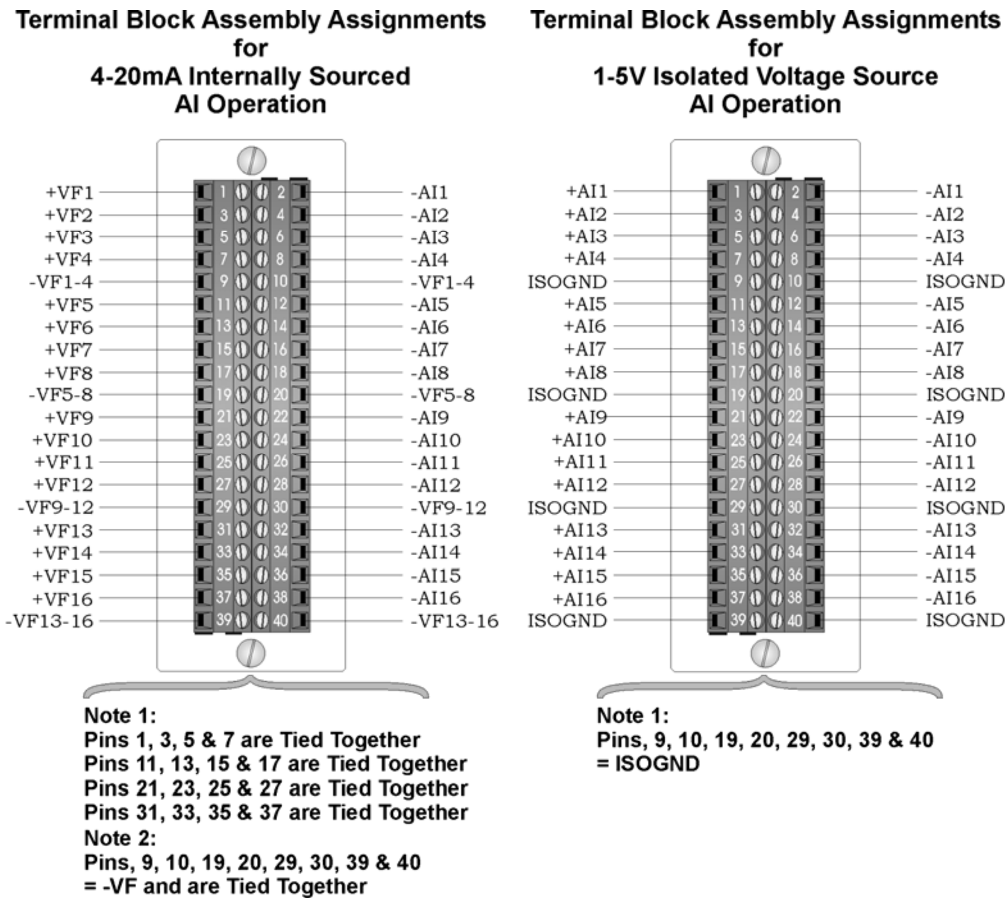



*Figure 3-18. Local AI Module Terminal Blocks Assembly Assignments*

## Software Configuration

To use data from any ControlWave analog input module you must add a **CW_AI16** board in ControlWave Designer's I/O Configurator, and then configure it. See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

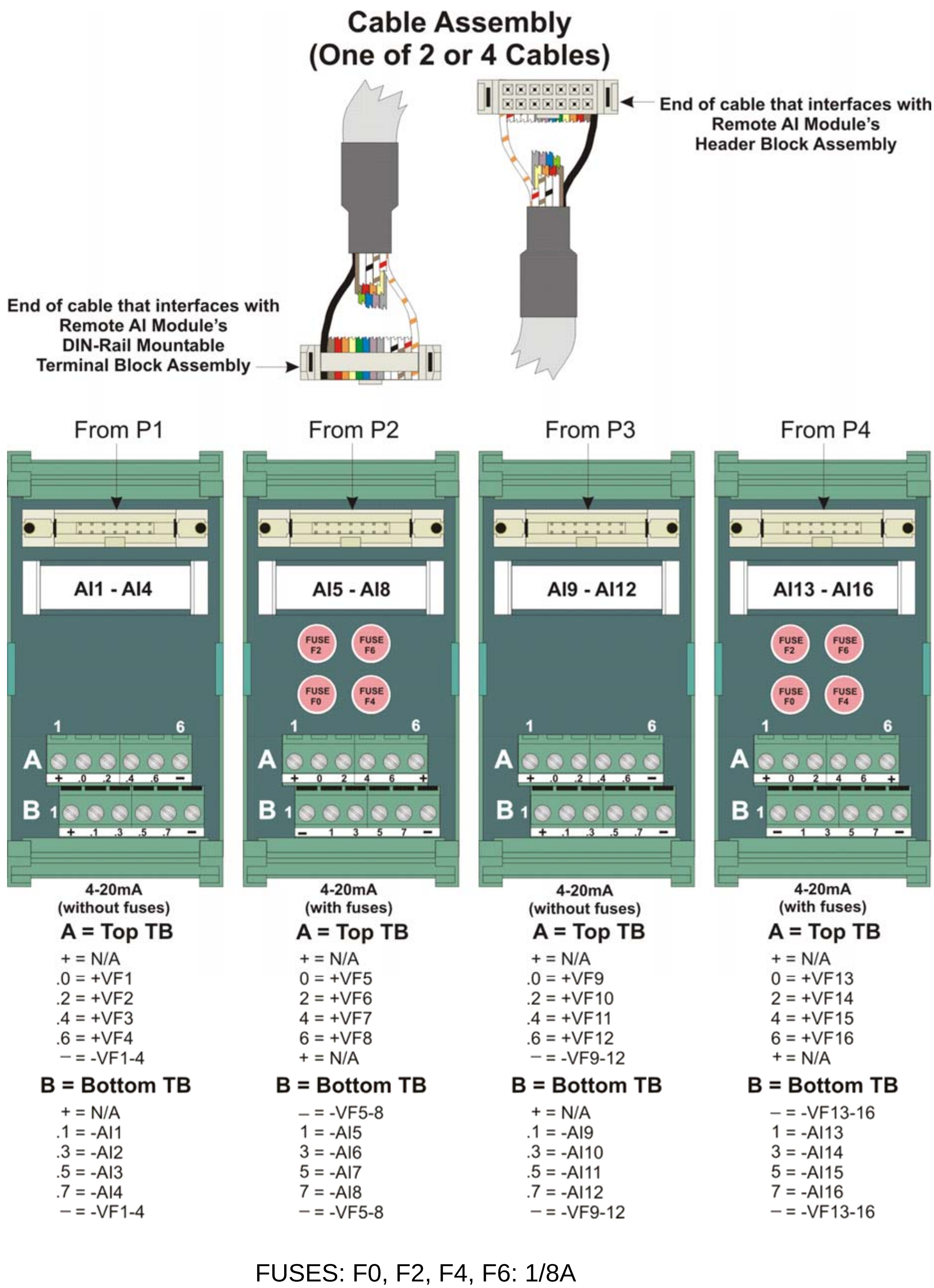
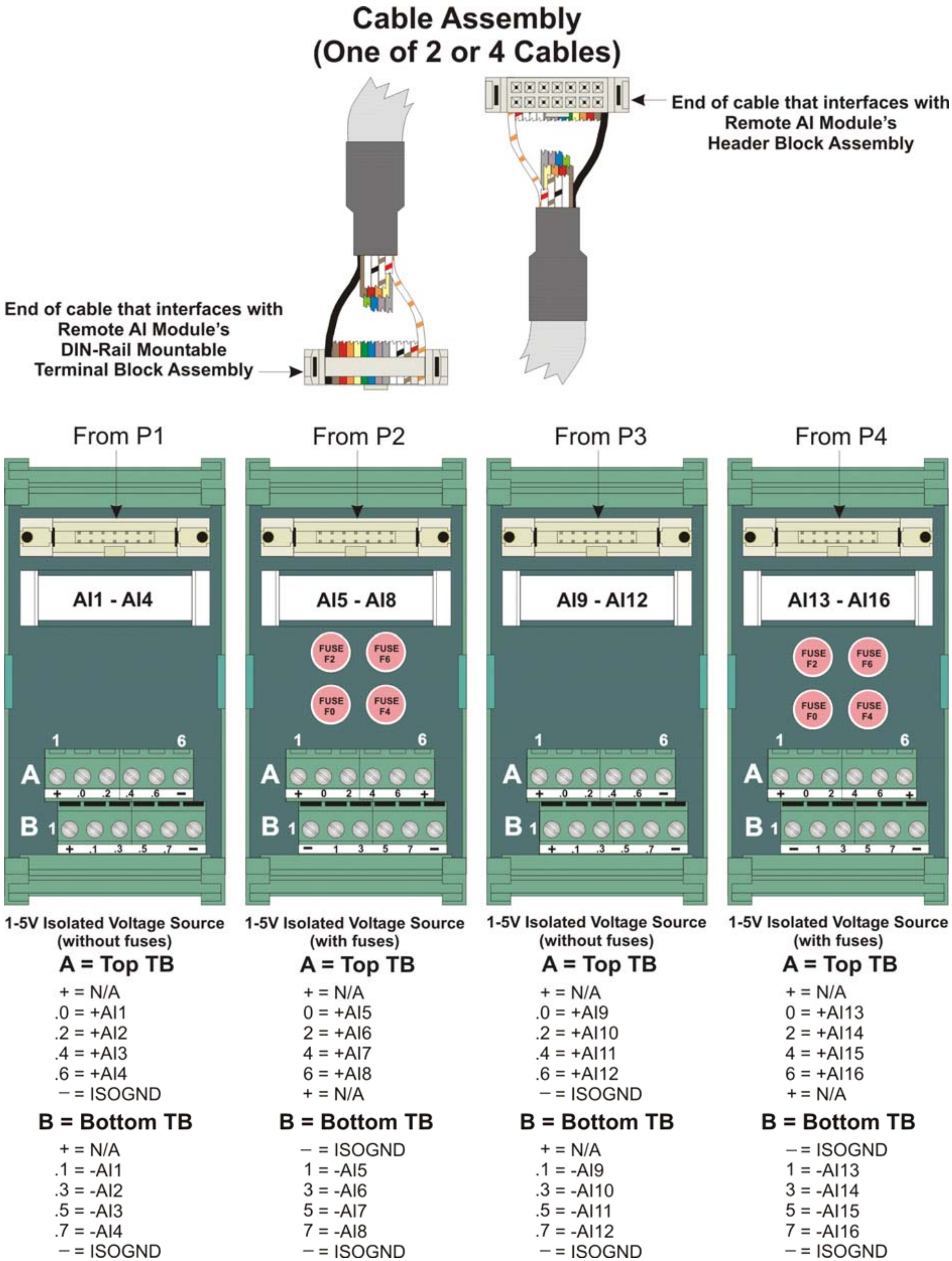



*Figure 3-19. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for 4-20 mA AI Operation*




FUSES: F0, F2, F4, F6: 1/8A

*Figure 3-20. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for 1-5V AI Operation*

## 3.7 Analog Output (AO) Modules

AO modules support eight 4–20 mA analog outputs. AO modules consist of an AO PCB (with a daughter board when configured for read-back) an LED board, a terminal housing assembly, as well as I/O assembly and mounting hardware.

*Table 3-9 Analog Output (AO) Module General Characteristics*

| Type | Number Supported | Characteristics |
|---|---|---|
| **Analog Outputs (AO)** | 8 | Each AO supports:<br>▪ 4–20mA output with a maximum external load of 650 ohms.<br>▪ Analog output circuitry isolated from bus interface<br>▪ Surge suppression |

**Analog Output with Read-back**

Analog output modules with eight outputs are available in two versions – standard AO, or AO with read-back capability for use in redundant systems. Both versions may be used in redundant systems; however, they operate differently.

An AO with read-back module operating in online mode monitors the AO values of its standby counterpart in order to verify that standby AO values are consistent should a failover occur. Depending upon software configuration settings; a failover can be prevented if they are inconsistent. A standard AO module used in a redundant system does not perform this monitoring; therefore the potential exists to failover to a backup AO module with failed hardware. For critical processes, the redundant AO with read-back capability is recommended.

Use the same AO module type in any redundant pair – i.e. do not install an AO with read-back module in the primary controller and a standard AO module as its redundant counterpart in the backup controller, or vice versa.

See *Software Configuration* later in this section for details on setting up AO with readback.

**Detailed Technical Specifications**

For detailed technical specifications, please see document CWPAC:AIO available on our website http://www.emersonprocess.com/remote.

**Configurations**

The isolated AO module (general part number **396353-XX-X**) has the following configurations:

*Table 3-10. Analog Output Module Configurations*

| Part Number | Number of AOs | Termination Connector | Notes |
|---|---|---|---|
| 396353-01-0 | 8 | local | 4-20mA |
| 396353-11-8 | 8 | remote | 4-20mA |
| 396353-20-7 | 8 | remote | 4-20mA AO Readback on this module |

**Wiring the Module** *Figure 3-21* shows field wiring assignments for a locally terminated AO module. *Figure 3-22* shows field wiring assignments for a remotely terminated AO module.

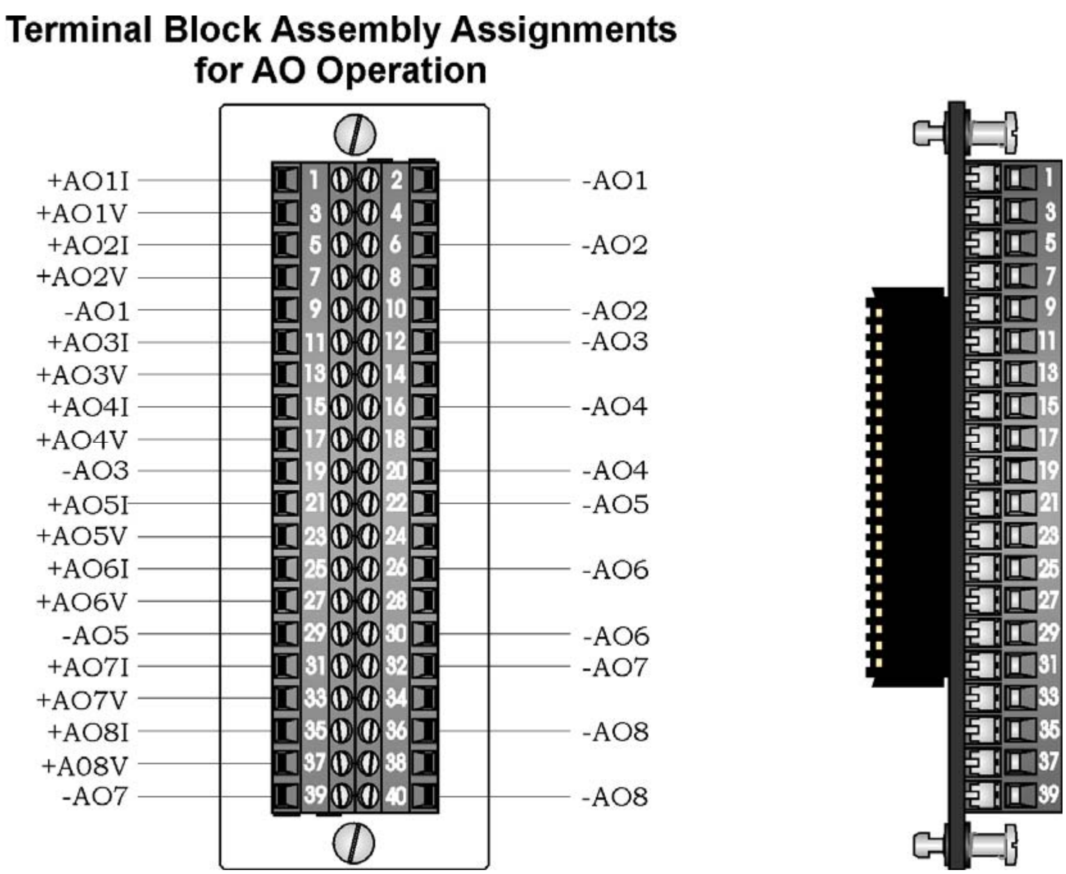
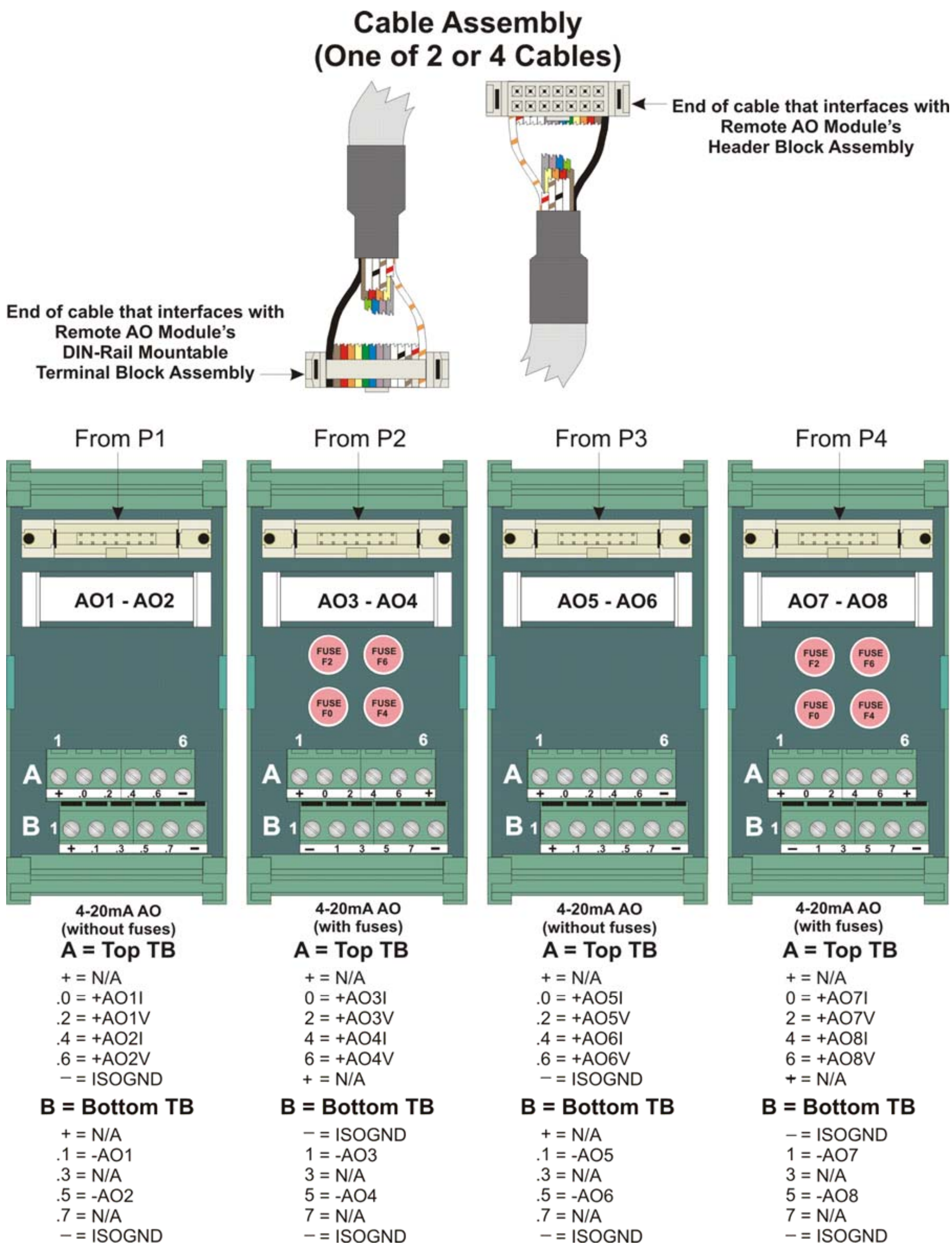



*Figure 3-21. Local AO Module Terminal Blocks Assembly Assignments*




FUSES: F0, F2, F4, F6: 1/8A

*Figure 3-22. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for AO 4-20mA Operation*

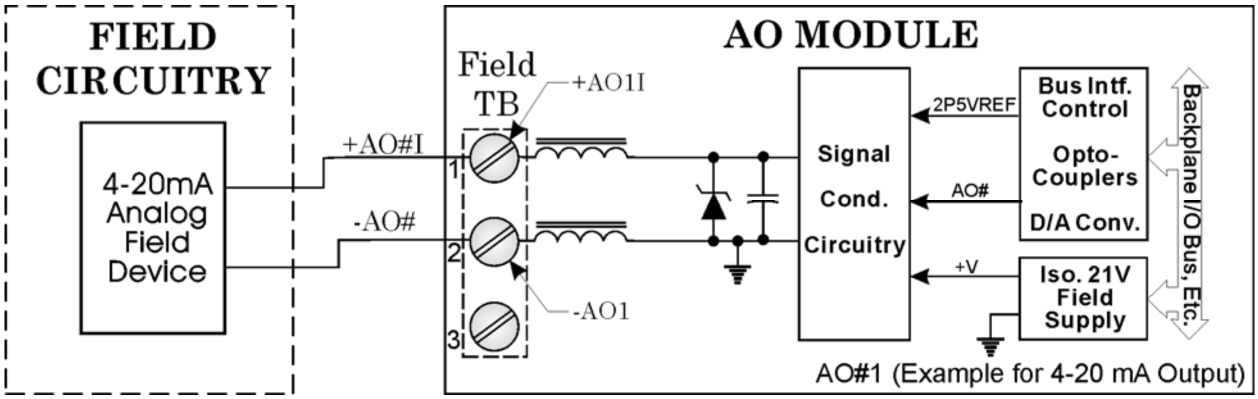



*Figure 3-23. 4-20mA Current Loop AO - Wiring Diagrams*

## Software Configuration

To use data from any ControlWave analog output module you must add a **CW_AO8** board in ControlWave Designer's I/O Configurator, and then configure it. See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

**AO with Readback in a Redundant System**

Variables in the ControlWave project govern how inconsistencies between the online AO module and the standby AO module are handled in redundant systems with AO readback. Information on configuring system variables is included in the *ControlWave Designer Programmer's Handbook* (D5125).

If there is a difference of more than 0.5% (of span) between the value of the online and standby AO values, a variable will be set TRUE. For local I/O boards, this is a system variable that follows the format:

_RDN_IO_*n*_ERR

where *n* is the I/O slot number of the AO module.

For boards residing in an I/O expansion rack, instead of a system variable, this indication is provided by a variable mapped by the _ER_STAT virtual status board. By default, the name of the variable follows one of two possible formats.

ERSTAT_*n*_RDN_IO_*x*_ERR

ERST_*n*_RDN_IO_*x*_ERR

where *n* is the I/O slot number of the virtual ER_STAT board, and *x* is the I/O slot number of the analog output module. See the *I/O Configurator* and *I/O Mapping* sections of the *ControlWave Designer*

*Programmer's Handbook* (D5125) for more information. You can optionally rename these variables.

You should configure these variables as alarms so you receive notification of a failure of the backup AO module. See the ControlWave Designer online help for information on alarm configuration.

When a read-back failure occurs, the FAIL LED remains RED until the unit is rebooted, either through a sideload, forced redundant switchover, or power-down and restart, or you remove and replace the board (hot card replacement). Each of these operations momentarily turns the FAIL LED to GREEN (and the associated _ERR error variable to FALSE) until a new readback failure occurs, which will change the LED back to RED, and the associated _ERR error variable back to TRUE.

For boards installed locally in the controller (local I/O) another system variable (_RDN_IOERR_WARN) determines whether a failure of the standby AO (as indicated by the LED and associated _ERR error variable) should only be treated as a warning condition, which would still allow a failover to occur, or as an error which would prevent a failover to the standby.

When you set this system variable to FALSE, an AO readback failure in the associated device is treated as an error; failover is inhibited. When you set this variable to TRUE, an AO readback failure in the associated device is treated as a warning that does not prevent a failover, and the only reporting is via the _RDN_IO_*x*_ERR system variables and LEDs discussed, above.

For boards residing in an I/O expansion rack, instead of a system variable for this purpose, you must have mapped a variable from the _ER_STAT virtual status board named either ERSTAT_RDN_IOERR_WARN (or ERST_RDN_IOERR_WARN). NOTE: Those are the default names, you can change them as needed.

**Note:** In the I/O Configurator, you must associate these boards with a cyclic task, and the task must not run faster than 10 milliseconds.

## 3.8 Universal Digital Input (UDI) Modules

Universal Digital Input (UDI) modules include six inputs which you can individually configure as high speed counters or polled inputs.

UDI modules consist of a UDI PCB, either a terminal board assembly for local termination or a header block assembly for remote termination, a terminal housing assembly, an LED board, as well as I/O assembly and mounting hardware.

**Note:** Because UDI modules are interrupt driven, you can only install them in the first four I/O slots.

*Table 3-11. UDI Module General Characteristics*

| Type | Number Supported | Characteristics |
|---|---|---|
| **Universal Digital Inputs (UDI)** | 6 | Each UDI supports/includes:<br>▪ Field input can be a driven signal, an open collector output, or a relay contact. Inputs handle 24V<br>▪ Jumper to configure point for debounce enable or debounce disable.<br>▪ Software configures point as a polled input with a 30 millisecond filter or as a 16-bit high speed counter (totalizer) with a 20 microsecond filter.<br>▪ Maximum input frequency of 10 KHz with a nominal input current of 5mA.<br>▪ 16 bit counter.<br>▪ Signal conditioning circuitry and bandwidth limiting circuitry. Software selectable delays for signal conditioning.<br>▪ Each input is optically isolated from the field device.<br>▪ Each input has an electrical isolation of 500Vdc to chassis and 1500Vdc to system logic.<br>▪ Surge protection. Protection from a 31dc transorb (across input and to field common) that meets ANSI/IEEE standard C37.90-1978. |

**Additional Technical Specifications**

For additional technical specifications, please see document CWPAC:UDI available on our website http://www.emersonprocess.com/remote.

**Configurations** The UDI module (general part number **396362-XX-X**) has the following configurations:

*Table 3-12. UDI Module Configurations*

| Part Number | Number of UDIs | Termination Connector |
|---|---|---|
| **396362-02-8** | 6 | local |
| **396362-12-5** | 6 | remote |

**Setting Jumpers** Each input has a jumper to enable/disable debounce. Enabling debounce activates filters that reduce spurious pulses caused by relay contact bounce. *Figure 3-24* shows the location of jumpers on the module.

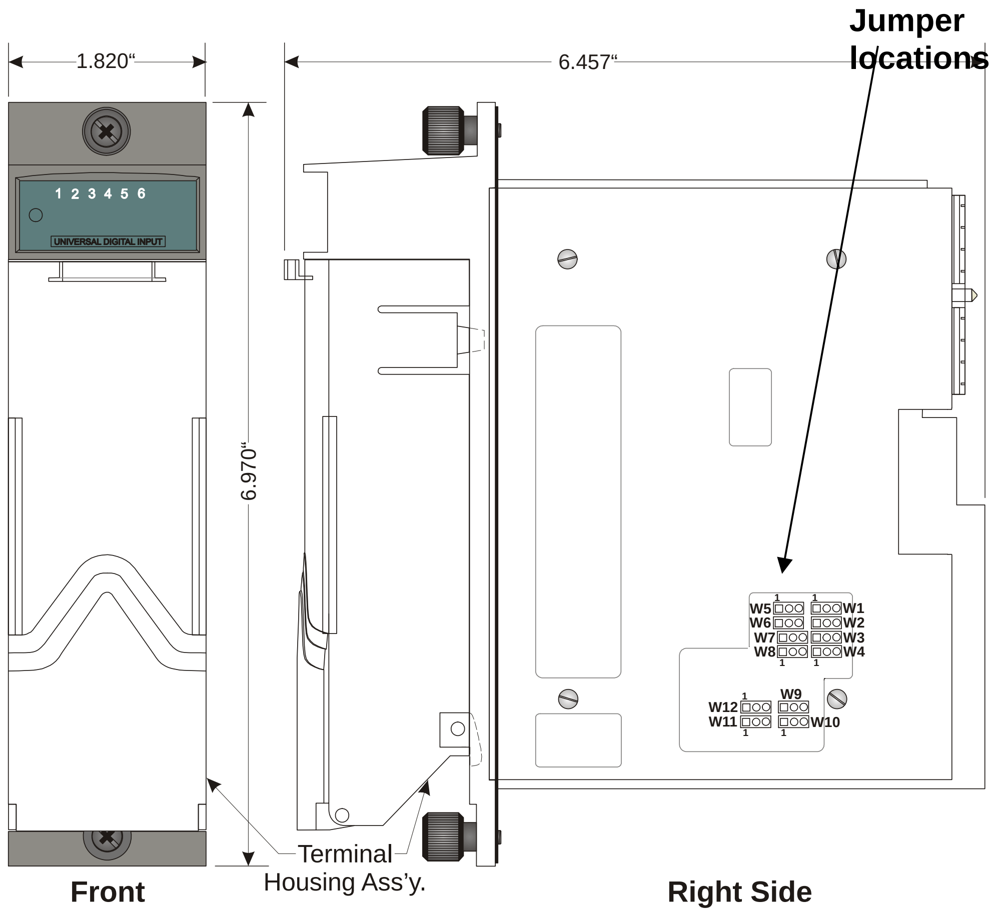



*Figure 3-24. - UDI Module -Right Side View -Jumper Locations*

*Table 3-13. Jumper Assignments: UDI Module*

| Jumper | Purpose | Description |
|---|---|---|
| W1 | Configures UDI1 | Pins 1-2 installed = Enable Debounce (Factory **default**). A change of state on **both** the SET and RST (reset) field inputs is required to accumulate counts.<br>Pins 2-3 installed = Disable Debounce. A change of state on the SET field input is required to accumulate counts. |
| W2 through W6 | Configures UDI 2 through UDI6 | Pins 1-2 installed = Enable Debounce (Factory **default**). A change of state on **both** the SET and RST (reset) field inputs is required to accumulate counts.<br>Pins 2-3 installed = Disable Debounce. A change of state on the SET field input is required to accumulate counts. |

**Wiring the Module** *Figure 3-27* shows field wiring assignments for the locally terminated UDI module. It also includes examples for relay contact and open collector applications. *Figure 3-28* shows field wiring assignments for the remotely terminated UDI module.

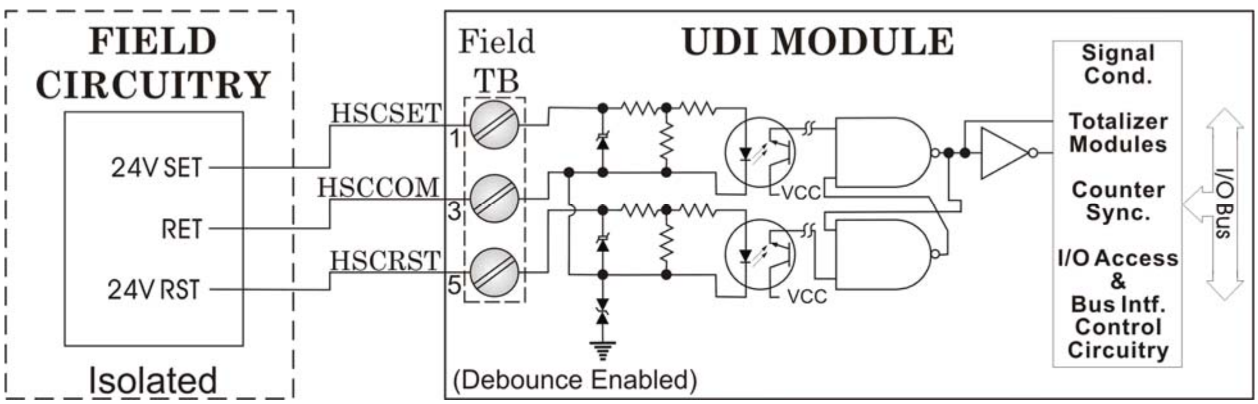



*Figure 3-25. UDI (Debounce Enabled) Wiring Diagram*

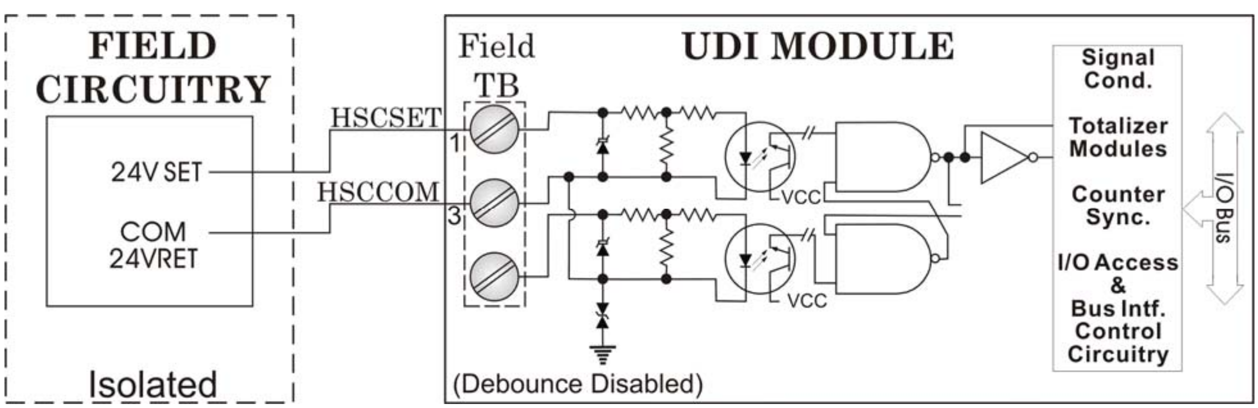



*Figure 3-26. UDI (Debounce Disabled) Wiring Diagram*

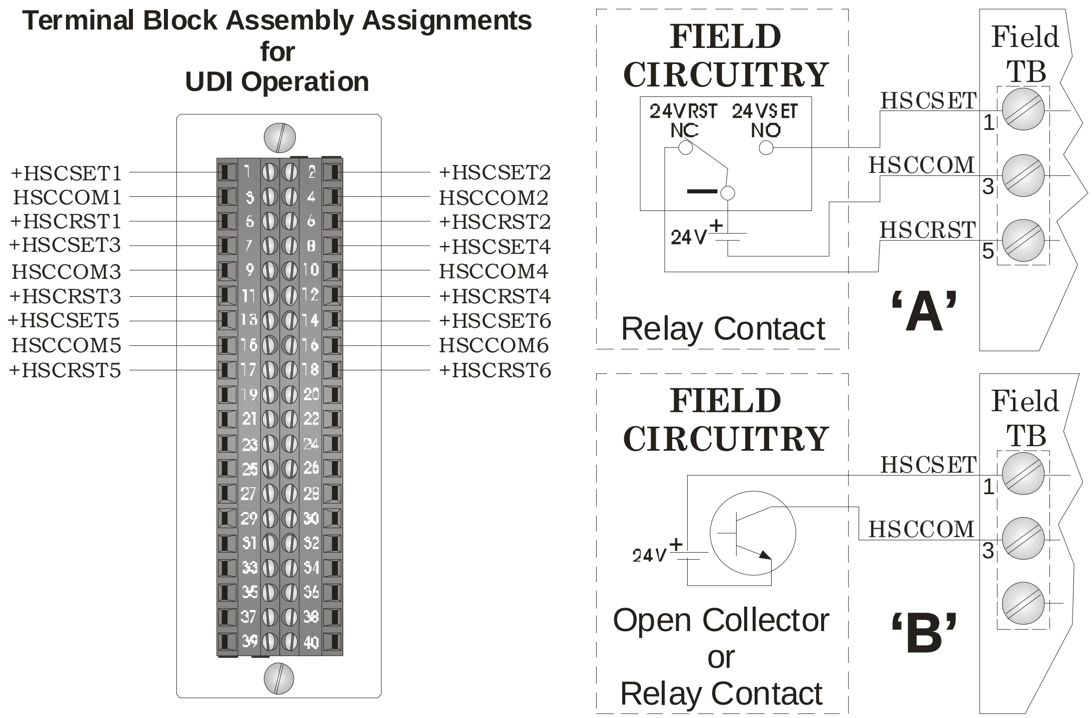
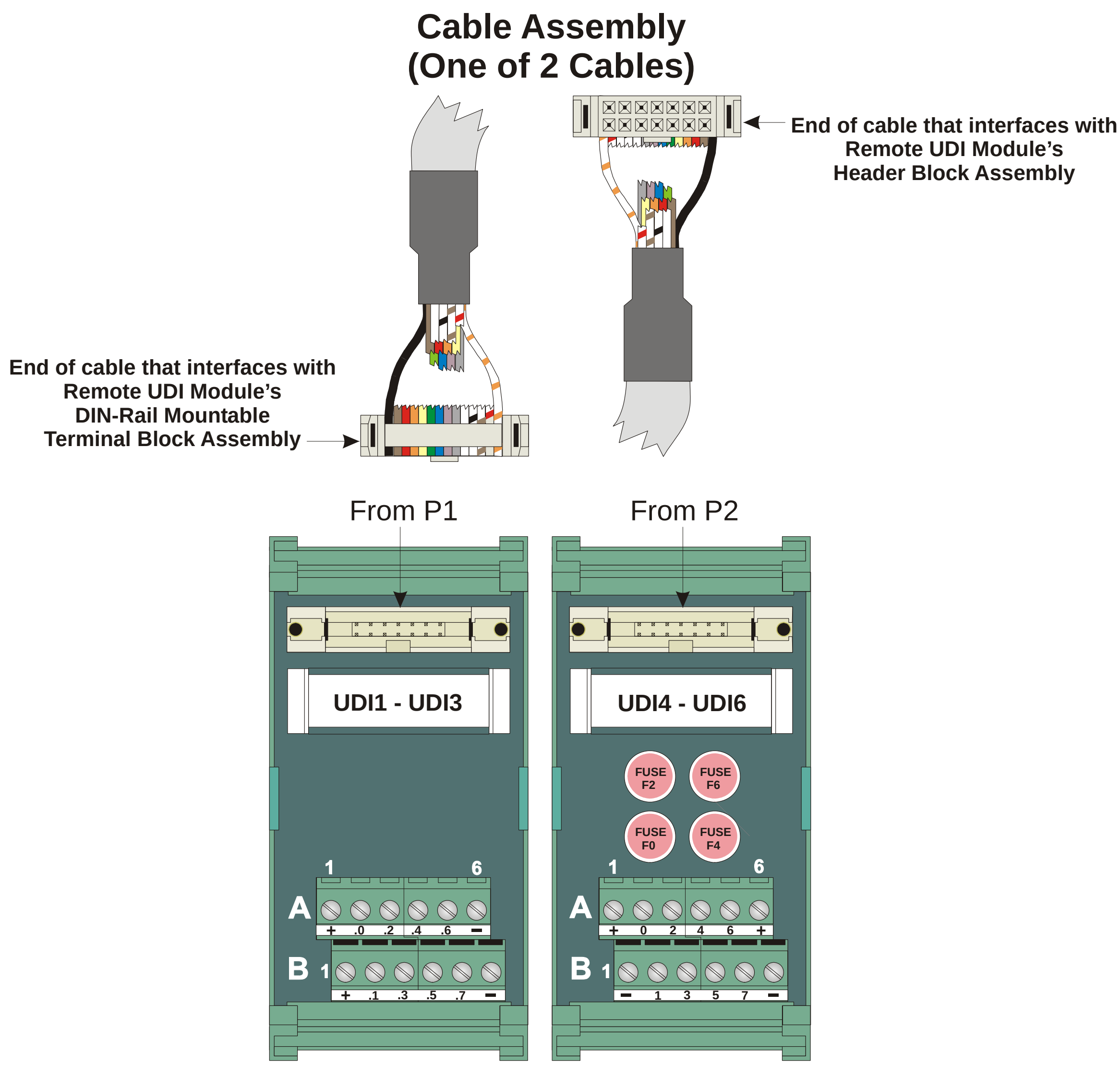



*Figure 3-27. Local UDI Terminal Block/Configuration Diagram*




**12/24V UDI (without fuses)**

**A = Top TB**

+ = N/A
.0 = UDISET1
.2 = UDIRST1
.4 = UDICOM2
.6 = UDISET3
− = UDIRST3

**B = Bottom TB**

+ = N/A
.1 = UDICOM1
.3 = UDISET2
.5 = UDIRST2
.7 = UDICOM3
− = UDIRST3

**12/24V UDI (with fuses)**

**A = Top TB**

+ = N/A
0 = UDISET4
2 = UDIRST4
4 = UDICOM5
6 = UDISET6
+ = N/A

**B = Bottom TB**

− = UDIRST6
1 = UDICOM4
3 = UDISET5
5 = UDIRST5
7 = UDICOM6
− = UDIRST6

FUSES: F0, F2, F4, F6: 1/8A

*Figure 3-28. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for UDI Operation*

## Software Configuration

To use data from a UDI module you must add a **CW_HSC12** board in ControlWave Designer's I/O Configurator, and then configure it.

The I/O Configurator is where you specify the usage for each input using the **Select Filter** list box.

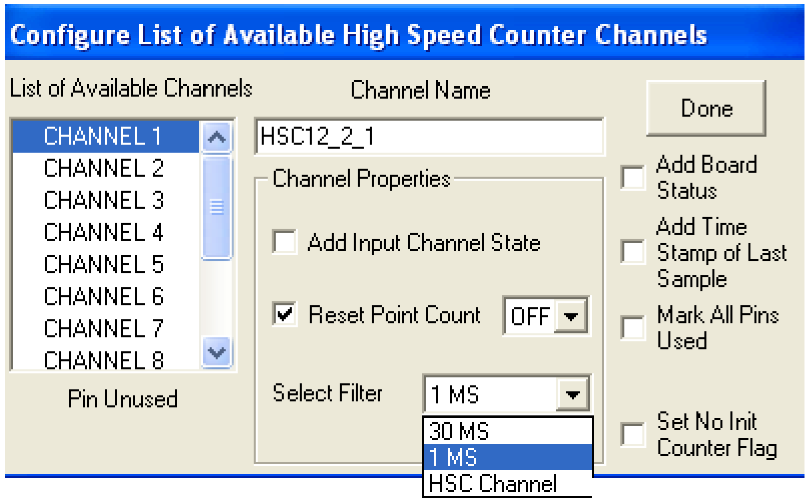



*Figure 3-29. Selecting Input Type in ControlWave Designer I/O Configurator*

Choose one of the following:

| | |
|---|---|
| **"HSC Channel"** | to select a 20 microsecond delay for 10 kHz high speed counter applications. |
| **"1 MS"** | to select a 1 millisecond delay for a low speed counter application. |
| **"30 MS"** | to select a 30 millisecond delay for a polled input. This is for general purpose inputs or contacts where contact bounce may apply. |

See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

## 3.9 Isolated Resistance Temperature Device (RTD) Input Module

RTD Input modules provide a total of four inputs. Firmware detects the RTD type (2-, 3- or 4 wire) via the installation of jumper wires on the terminal block for 2-wire and 3-wire RTDs (see *Figure 3-30).*

*Table 3-14. Isolated RTD Input Module General Characteristics*

| Type | Number Supported | Characteristics |
|---|---|---|
| **Isolated RTD Input** | 4 | Each isolated RTD input supports/includes:<br>▪ Signal conditioning circuitry<br>▪ Surge protection with a 25V transorb that meets IEEE standard 472-1978<br>▪ Current limiting for over voltage protection<br>▪ 24-bit analog to digital converter (ADC)<br>▪ Common mode range of 500V with respect to chassis<br>▪ Electrical isolation of 500Vdc (channel to channel/system bus)<br>▪ Source current to RTD limited to 330 uA |

The RTD Input Module consists of an isolated RTD input board, a terminal board assembly (for local termination) or a header block assembly (for remote termination), an LED board, a terminal housing assembly, as well as I/O assembly and mounting hardware.

**Detailed Technical Specifications**

For additional technical specifications, please see document CWPAC:TEMP available on our website http://www.emersonprocess.com/remote.

**Configuration**

The isolated RTD module (general part number **396878-XX-X**) has the following configurations

*Table 3-15. Isolated RTD Input Module Configurations*

| Part Number | Termination Connector | Notes |
|---|---|---|
| **396878-01-6** | local | |
| **396878-02-4** | remote | |

**Enabling/Disabling LEDs using jumper**

The Isolated RTD Module includes a jumper (W1) to enable/disable LEDs on the module. Normally, you should keep the LEDs enabled, but if power conservation is an issue, you could disable the LEDs.

*Table 3-16. Jumper Assignments: Non-isolated HSC Module*

| Jumper | Purpose | Description |
|---|---|---|
| W1 | Enables/disables LEDs on module | Pins 1-2 installed = Enable LEDs (Factory **default**).<br>Pins 2-3 installed = Disable LEDs |

## Wiring the Module

*Figure 3-31* shows field wiring assignments for locally terminated isolated RTD modules. *Figure 3-32* shows field wiring assignments for remotely terminated isolated RTD modules.

*Figure 3-30* provides wiring diagrams for 2-wire, 3-wire, and 4-wire RTDs to the local RTD module terminal blocks; wiring assignments, such as +RTD#_3/4W, -RTD#_4W, +RTD# and –RTD# are similar to those assigned to the Remote DIN-rail mountable terminal blocks.

**Note:** To maintain specified accuracy with a 3-wire RTD, you must match the two field wires that source and sink the RTD current within 0.01 ohms (matched in length and matched in wire type) and the ambient temperature on these wires must be the same.

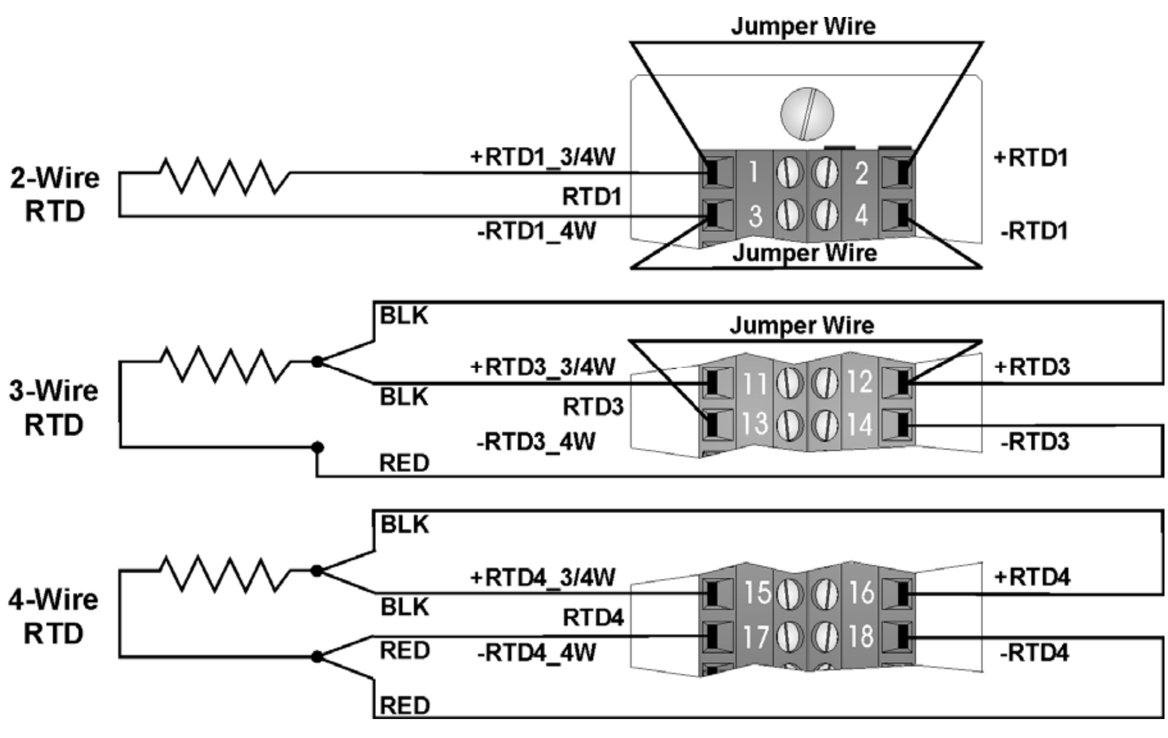



*Figure 3-30. Isolated RTD Module - 2-Wire, 3-Wire & 4-Wire Wiring Diagram*

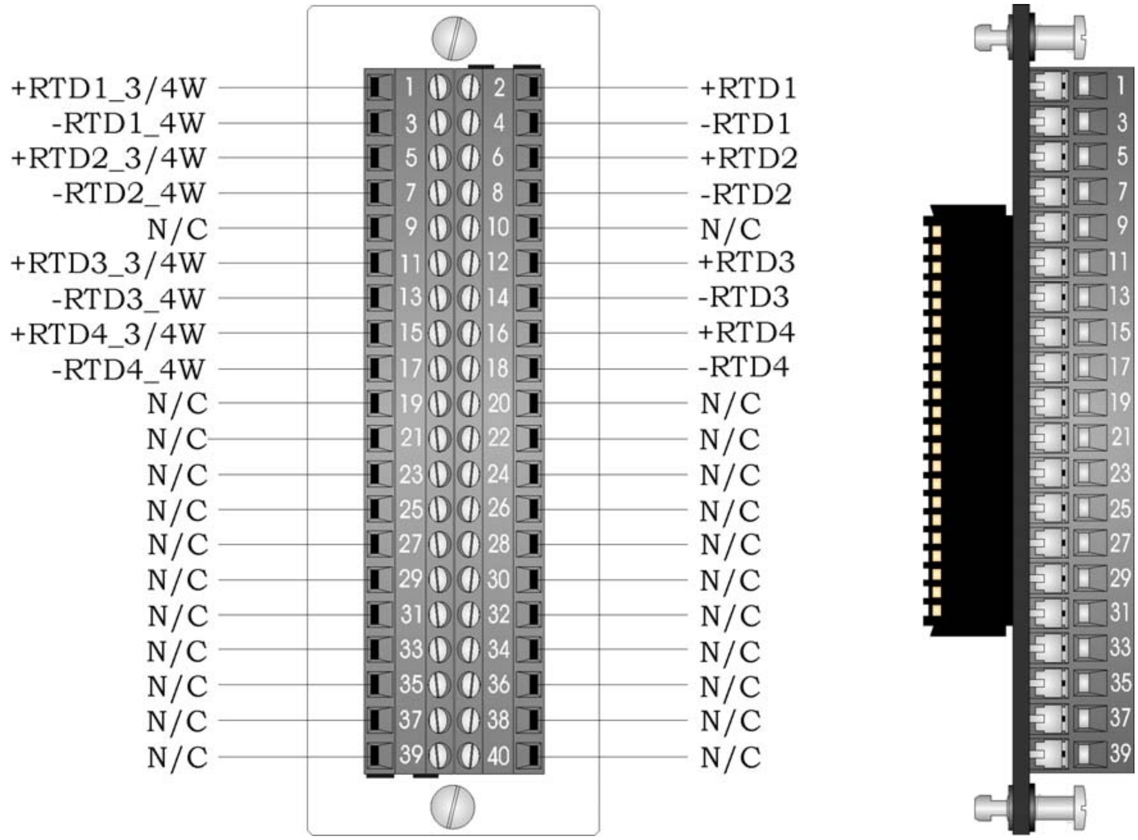
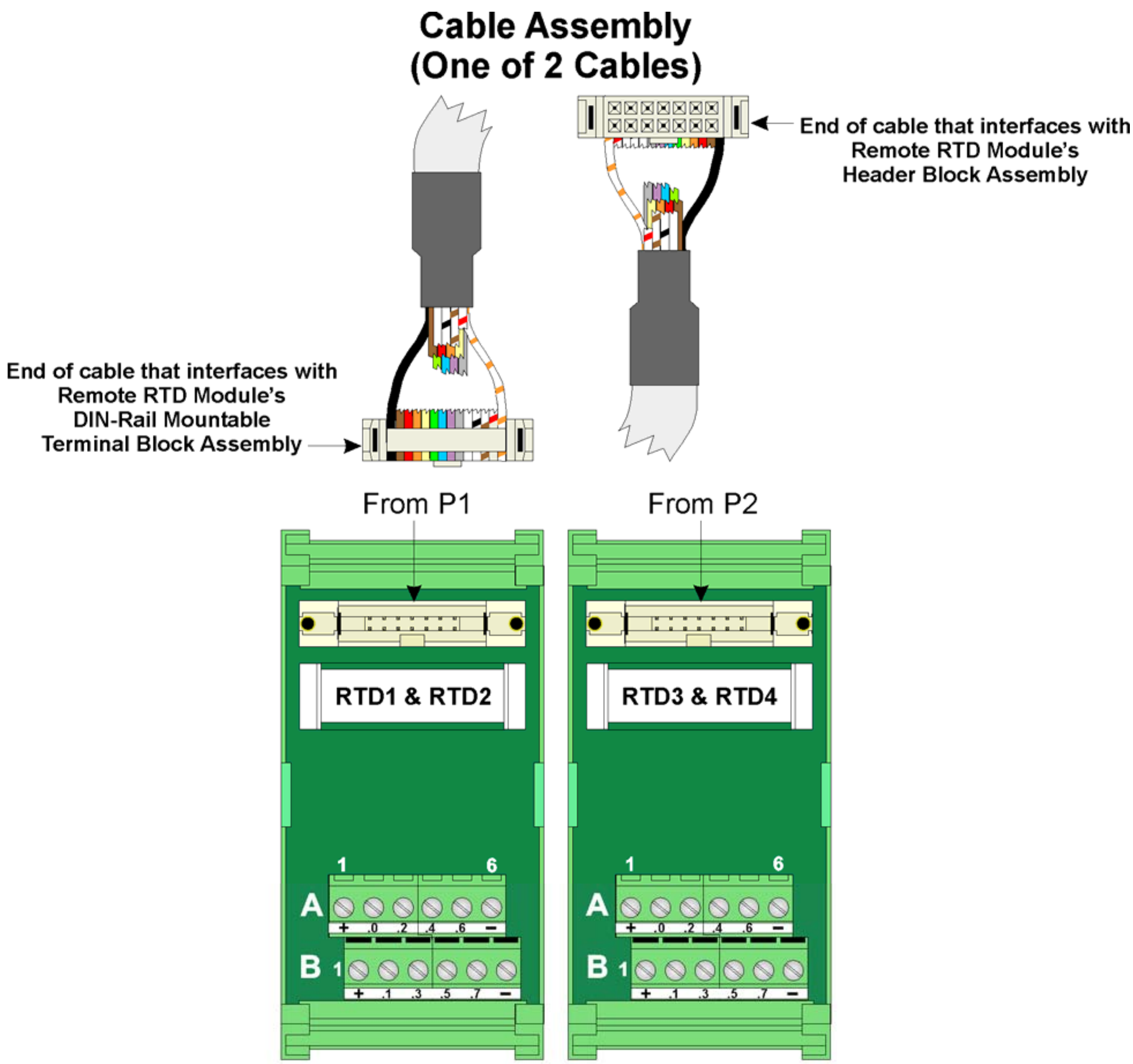



*Figure 3-31. Local Isolated RTD Module Terminal Block Assembly Assignments*

**Software Configuration**

To use data from an Isolated RTD Input module you must add a **CWM_RTD8** board in ControlWave Designer's I/O Configurator, and then configure it. See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.




| RTD AI | RTD AI |
|---|---|
| **A = Top TB** | **A = Top TB** |
| + = N/C | + = N/C |
| .0 = +RTD1_3/4W | .0 = +RTD3_3/4W |
| .2 = -RTD1_4W | .2 = -RTD3_4W |
| .4 = +RTD2_3/4W | .4 = +RTD4_3/4W |
| .6 = -RTD2_4W | .6 = -RTD4_4W |
| − = N/C | − = N/C |
| **B = Bottom TB** | **B = Bottom TB** |
| + = N/C | + = N/C |
| .1 = +RTD1 | .1 = +RTD3 |
| .3 = -RTD1 | .3 = -RTD3 |
| .5 = +RTD2 | .5 = +RTD4 |
| .7 = -RTD2 | .7 = -RTD4 |
| − = N/C | − = N/C |

*Figure 3-32. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for Isolated RTD Module Operation*

## 3.10 Isolated Thermocouple Module

Thermocouple modules (sometimes known as low level analog inputs) provide six individually isolated differential inputs for thermocouples or ±10mV inputs plus one cold junction compensation (CJC) input for temperature compensation at the terminal block.

*Table 3-17. Isolated Thermocouple Module General Characteristics*

| Type | Number Supported | Characteristics |
|---|---|---|
| **Thermocouple (TC)** | 6 | Each isolated thermocouple supports/includes:<br>▪ Signal conditioning circuitry including a 2.5V reference<br>▪ Surge suppression with a 188V Transorb that meets IEEE standard 472-1978.<br>▪ Over voltage protection<br>▪ Common mode range for each channel is 500Vdc with respect to chassis.<br>▪ 24-bit analog to digital converter (ADC) |

### Detailed Technical Specifications

For additional technical specifications, please see document CWPAC:TEMP available on our website http://www.emersonprocess.com/remote.

### Configuration

The isolated thermocouple module (general part number **396877-XX-X**) has the following configurations:

*Table 3-18. Isolated Thermocouple Module Configurations*

| Part Number | Termination Connector | Notes |
|---|---|---|
| **396877-01-0** | local | |
| **396877-02-8** | remote | |

### Enabling/Disabling LEDs using jumper

The Isolated Thermocouple Module includes a jumper (W2) to enable/disable LEDs on the module. Normally, you should keep the LEDs enabled, but if power conservation is an issue, you could disable the LEDs.

*Table 3-19. Jumper Assignments: Isolated Thermocouple Module*

| Jumper | Purpose | Description |
|---|---|---|
| W2 | Enables/disables LEDs on module | Pins 1-2 installed = Enable LEDs (Factory **default**).<br>Pins 2-3 installed = Disable LEDs |

**Wiring the Module** *Figure 3-34* shows field wiring for locally terminated isolated thermocouple modules. *Figure 3-35* shows field wiring for remotely terminated isolated thermocouple modules.

The cold junction compensation (CJC) with a built-in RTD provides thermocouple temperature compensation at the terminal block and is electrically isolated. Pins 8, 9 and 10 of the local terminal block source and sink the CJC's RTD.

*Figure 3-35* also provides diagrams showing the wiring for thermocouples and the 3-wire RTDs to a locally terminated TC module. Wiring assignments (that is, +AI#, -AI#, +CJC (Sense), -CJC (Return) & +CJC (Reference) are similar to those assigned to the remote DIN-rail mountable terminal blocks. A small CJC PCB is factory-installed to the terminal block.

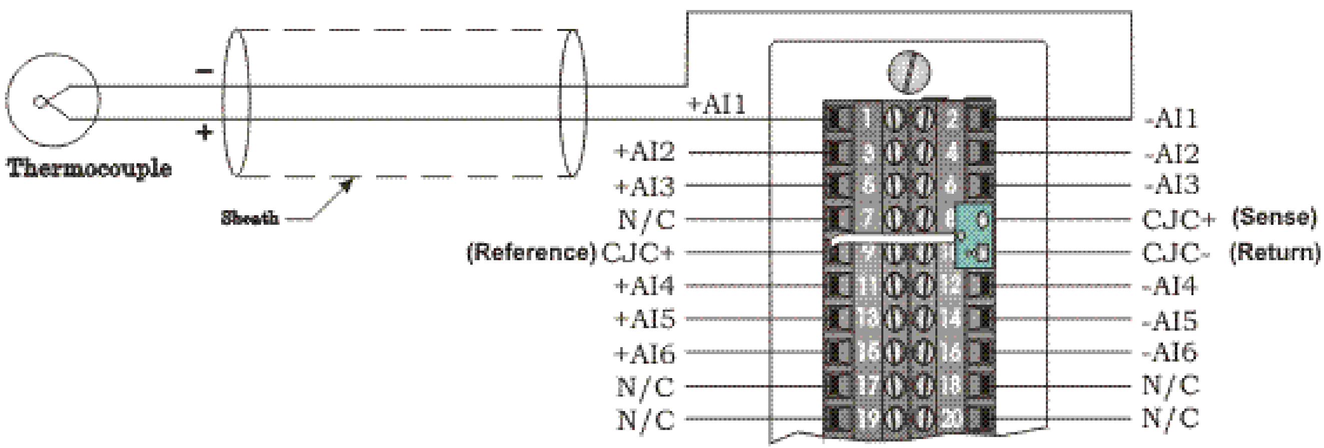



*Figure 3-33. Isolated Thermocouple Module - Wiring Diagram*

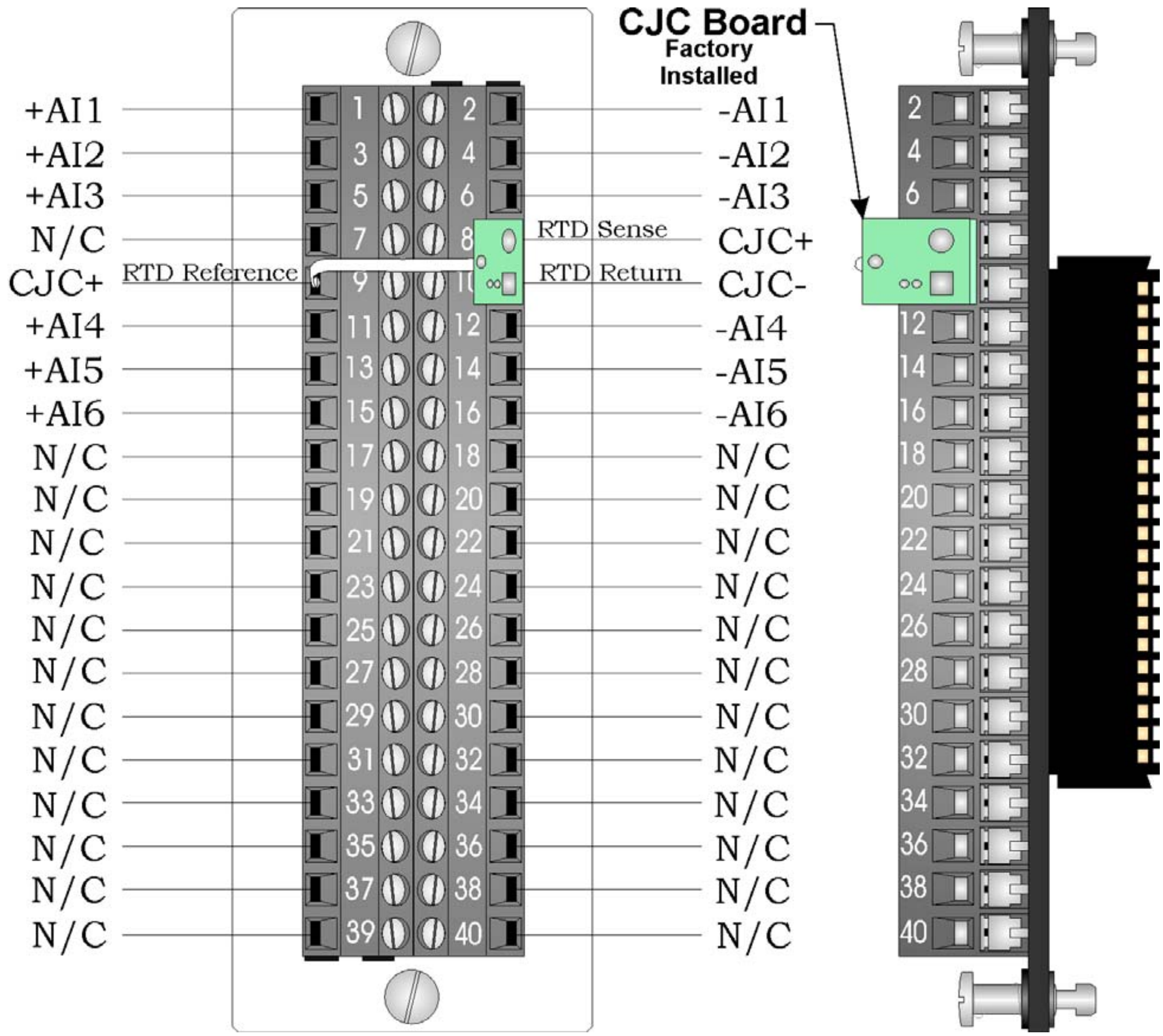



*Figure 3-34. Local Isolated Thermocouple Module Terminal Block Assembly Assignments*

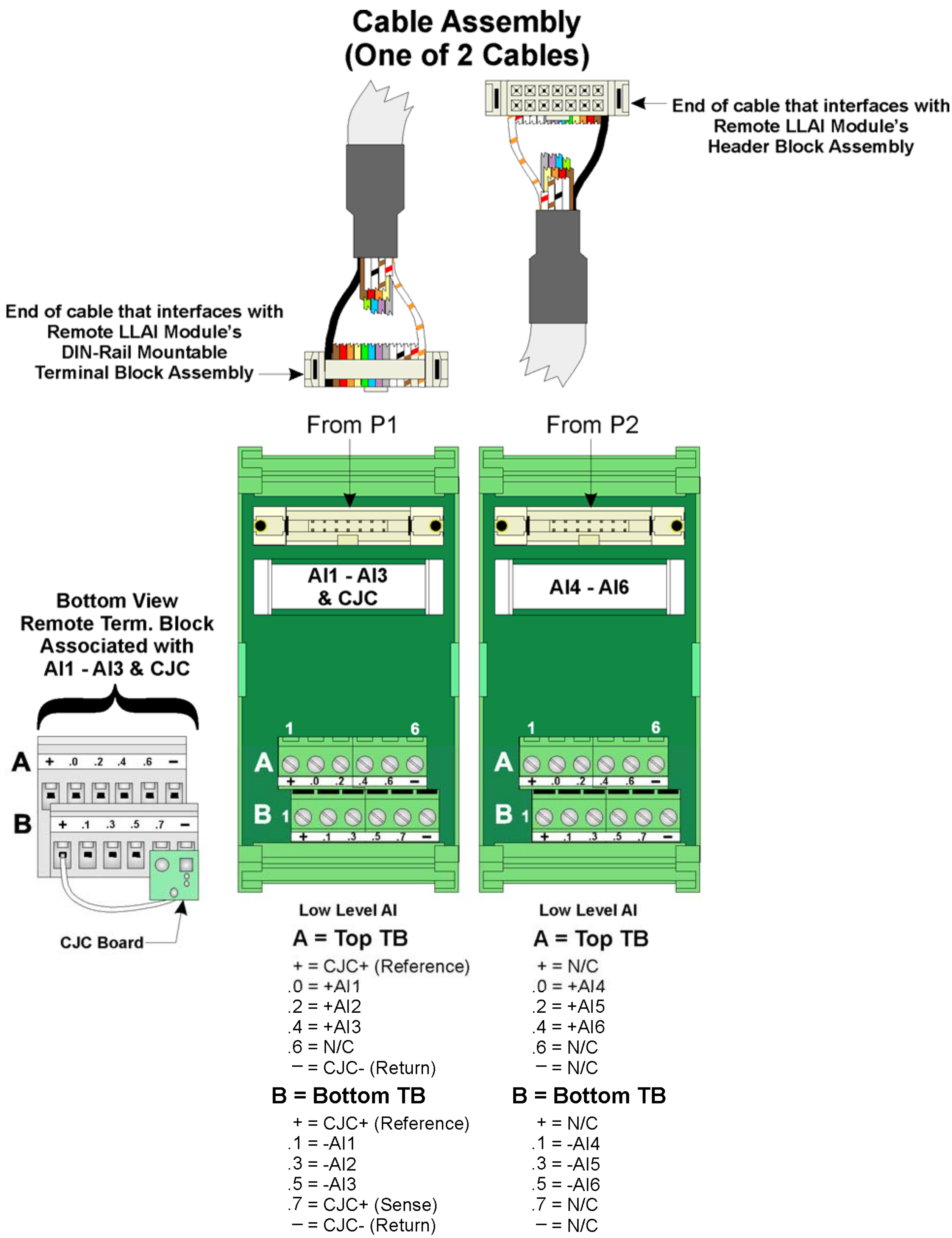



*Figure 3-35. Remote DIN-Rail Mountable Terminal Block Assembly Assignments for Isolated Thermocouple Module Operation*

**Ranges & Errors** *Table 3-20* provides the accuracy, resolution and temperature range for the various thermocouples and 10mV LLAI inputs. *Table 3-21* lists the RTD error with the CJC.

*Table 3-20. Thermocouple Module Input Accuracy and Resolution*

| Input Type | Accuracy/Range | Resolution | 25°C | –20°C to +70°C |
|---|---|---|---|---|
| B – Thermocouple | 100°C to 200°C | 2.00°C | ± 8°C | ± 16°C |
| | 200°C to 390°C | 1.00°C | ± 4°C | ± 8°C |
| | 390°C to 840°C | 0.50°C | ± 2°C | ± 4°C |
| | 840°C to 1820°C | 0.20°C | ± 1°C | ± 2°C |
| R – Thermocouple | –50°C to +50°C | 0.40°C | ± 2°C | ± 4°C |
| | +50°C to 1720°C | 0.17°C | ± 1°C | ± 2°C |
| S – Thermocouple | – 50°C to +50°C | 0.37°C | ± 2°C | ± 4°C |
| | +50°C to 1760°C | 0.18°C | ± 1°C | ± 2°C |
| C – Thermocouple | 0°C to 2315°C | 0.16°C | ± 0.75°C | ± 1.5°C |
| N – Thermocouple | – 270°C to – 260°C | 1.50°C | ± 8°C | ± 10°C |
| | – 260°C to – 250°C | 0.75°C | ± 4°C | ± 8°C |
| | – 250°C to – 230°C | 0.50°C | ± 2°C | ± 4°C |
| | – 230°C to – 150°C | 0.25°C | ± 1°C | ± 2°C |
| | – 150°C to 1300°C | 0.09°C | ± 0.500°C | ± 1°C |
| J – Thermocouple | – 210°C to 191°C | 0.08°C | ± 0.750°C | ± 1.5°C |
| | 190°C to 1200°C | 0.11°C | ± 0.500°C | ± 1°C |
| E – Thermocouple | – 270°C to – 260°C | 1.00°C | ± 3°C | ± 6°C |
| | – 260°C to – 225°C | 0.25°C | ± 1°C | ± 2°C |
| | – 225°C to – 200°C | 0.08°C | ± 0.750°C | ± 1.5°C |
| | – 200°C to 1000°C | 0.09°C | ± 0.500°C | ± 1°C |
| K – Thermocouple | – 270°C to – 261°C | 2.00°C | ± 5°C | ± 10°C |
| | – 260°C to – 246°C | 0.56°C | ± 2°C | ± 4°C |
| | – 245°C to – 180°C | 0.25°C | ± 1°C | ± 2°C |
| | – 179°C to – 145°C | 0.08°C | ± 0.750°C | ± 1.5°C |
| | – 145°C to 1372°C | 0.14°C | ± 0.500°C | ± 1°C |
| T – Thermocouple | – 270°C to – 261°C | 1.50°C | ± 4°C | ± 8°C |
| | – 260°C to – 251°C | 0.38°C | ± 2°C | ± 4°C |
| | – 250°C to – 181°C | 0.18°C | ± 1°C | ± 2°C |
| | – 180°C to – 136°C | 0.08°C | ± 0.750°C | ± 1.5°C |
| | – 135°C to – 400°C | 0.06°C | ± 0.500°C | ± 1°C |
| ± 10mV | ± 10mV | 1.2µV | ± 0.25% | ± 0.05% |

**Note:** The CJC RTD adds an additional error (see *Table 3-21*)

*Table 3-21. TC Module RTD Error with CJC at 25°C*

| Thermocouple Type | Process Temperature Range | RTD Error with CJC @ 25°C |
|---|---|---|
| B | 100°C to 1820°C | ± 0.30°C |
| R | – 50°C to +50°C | ± 0.49°C |
| | +50°C to 1720°C | ± 0.30°C |
| S | – 50°C to +50°C | ± 0.45°C |
| | +50°C to 1760°C | ± 0.30°C |

| Thermocouple Type | Process Temperature Range | RTD Error with CJC @ 25°C |
|---|---|---|
| C | 0°C to 2315°C | ± 0.30°C |
| N | – 270°C to – 261°C | ± 20.50°C |
| | – 260°C to – 251°C | ± 5.00°C |
| | – 250°C to – 231°C | ± 2.70°C |
| | – 230°C to – 189°C | ± 1.40°C |
| | – 188°C to – 70°C | ± 0.70°C |
| | – 70°C to + 25°C | ± 0.35°C |
| | +25°C to 1300°C | ± 0.30°C |
| J | – 210°C to – 111°C | ± 0.80°C |
| | – 110°C to +25°C | ± 0.40°C |
| | +25°C to 1200°C | ± 0.30°C |
| E | – 270°C to – 261°C | ± 10°C |
| | – 260°C to – 245°C | ± 3°C |
| | – 244°C to – 200°C | ± 1.50°C |
| | – 200°C to – 87°C | ± 0.75°C |
| | – 86°C to +25°C | ± 0.39°C |
| | +25°C to 100°C | ± 0.30°C |
| K | – 270°C to – 261°C | ± 15.00°C |
| | – 260°C to – 247°C | ± 4.50°C |
| | – 246°C to – 222°C | ± 2.20°C |
| | – 220°C to – 160°C | ± 1.10°C |
| | – 159°C to +25°C | ± 0.55°C |
| | +25°C to 1372°C | ± 0.30°C |
| T | – 270°C to – 261°C | ± 10.30°C |
| | – 260°C to – 243°C | ± 3.00°C |
| | – 242°C to – 196°C | ± 1.50°C |
| | – 195°C to – 61°C | ± 0.75°C |
| | – 60°C to +25°C | ± 0.375°C |
| | +25°C to 400°C | ± 0.30°C |

**Note:** Use straight-line approximation to calculate approximate error between end points.

## Software Configuration

To use data from an Isolated Thermocouple module you must add a **CW_TC12** board in ControlWave Designer’s I/O Configurator, and then configure it. See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

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# Chapter 4 – Operation

This chapter provides general operational details for using the ControlWave.

In This Chapter



## 4.1 Powering Up/Powering Down the ControlWave

Open the bezel door on the PSSM and position the power switch (or switches if you have dual supplies) to the OFF (down) position to turn the ControlWave OFF or to the ON (up) position to turn it ON.

**ON position (up) to turn ON the power supply**

**OFF position (down) to turn OFF the power supply**

*Figure 4-1. Power Switches on PSSM Setting the Operating Mode (Run/Remote/Local Switch)*

**Run/Remote/ Local Switch**

You set the CPU's Run/Remote/Local switch using a removable key. You can remove this key when the switch is in any position to prevent an unauthorized person from changing the operating mode.


*Figure 4-2. Run/Remote/Local Key Switch*

**Run** prevents you from performing any ControlWave Designer debug or program functions (start/stop, application downloads, etc.). **Remote**

and **Local** functions depend on how you configured the communication port in ControlWave Designer (serial, IP, or OpenBSI).

- **IP/OpenBSI (BSAP)**: If you configure the communication port for either of these choices in ControlWave Designer it becomes a remote port: set the Run/Remote/Local switch to **Remote** for downloads.
- **Serial**: If you configure the communication port for serial in ControlWave Designer, it becomes a local port: set the Run/Remote/Local switch to **Local** for downloads.

**Note**: Setting the Run/Remote/Local switch to **Local** enables communications through any comm port. However, if you set the switch to **Remote**, that restricts communications **only** to comm ports configured as remote comm ports.

## 4.2 Communicating with the ControlWave

You communicate to the ControlWave by connecting a cable between a port on your PC workstation and one of the ControlWave ports. See *Section 2.4* for more information on communications.

The port at the PC workstation must match the configuration of the ControlWave port.

### 4.2.1 Default Comm Port Settings

As delivered from the factory, ControlWave communication ports have default settings. *Table 4-1* details these defaults.

*Table 4-1. Default Comm Port Settings (by PCB)*

| Port | PCB | Default Configuration |
|---|---|---|
| COM1 | CPU | Ships from factory at RS-232; 115.2 Kbps using BSAP. Once the default switch is OFF, a factory default of IP Point-to-Point protocol (PPP) at 115,200 applies with an IP address of 1.1.1.1 and a mask of 255.255.255.255. |
| COM2 | CPU | RS-232; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol |
| COM3 | SCB | RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol |
| COM4 | SCB | RS-232 or RS-485 depending upon factory order; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol |

**Note**: You can re-enable the factory comm settings at any time by setting switch 3 on the CPU module's SW1 to "OFF."

**Ethernet** The ControlWave can include from one to three Ethernet ports. You can connect directly or through a network to a PC equipped with an Ethernet port.

The default IP addresses and masks for these are:

- ETH1 IP Address: 10.0.1.1 IP Mask: 255.255.255.0
- ETH2 IP Address: 10.0.2.1 IP Mask: 255.255.255.0
- ETH3 IP Address: 10.0.3.1 IP Mask: 255.255.255.0

### 4.2.2 Changing Port Settings

You change port settings (baud rate, port type, IP address, and so on) using the Flash Configuration utility.

You must establish communications with the ControlWave using NetView, LocalView, or TechView before you can run the Flash Configuration utility.

**Note:** For detailed information on using the Flash Configuration utility, see *Chapter 5* of the *OpenBSI Utilities Manual* (D5081).

**Caution** **When you change the baud rate for a port, the baud rate changes as soon as you write the flash file changes to the RTU, and do not require a reset. For this reason, you should not change baud rate for the active port on which you are communicating, or communications will immediately stop due to the baud rate mismatch between the PC port and the controller port. If this happens accidentally, you can use CPU switch settings as discussed in the notes in *Section 4.2.1* to restore defaults and re-establish communications.**

### 4.2.3 Collecting Data from the ControlWave

OpenBSI utilities such as DataView, Data Array Save/Restore and Harvester allow you to collect real time data (values of variables, array values, alarm messages) and historical data (audit records, archive files) from the ControlWave. See the *OpenBSI Utilities Manual* (D5081) for details. SCADA software such as OpenEnterprise can then present this data to an operator in the form of graphical displays and reports.

## 4.3 Creating and Downloading an Application (ControlWave Project)

Your ControlWave executes an application called a ControlWave project. You create the project using PC-based ControlWave Designer software. Instructions for creating a ControlWave project are beyond the scope of this manual. Please refer to the following sources for information:

- *Getting Started with ControlWave Designer* (D5085)
- *ControlWave Quick Setup Guide* (D5084)
- *ControlWave Designer Programmer's Handbook* (D5125)
- ControlWave Designer online help

You must connect the ControlWave to a PC running ControlWave Designer software and OpenBSI software.

**Note**: You can download an application either from ControlWave Designer or from the OpenBSI 1131 Downloader.

**1.** Set the CPU's Run/Remote/Local (key-operated) switch:

- If the PC is connected to a comm port configured as an **IP or OpenBSI Network port** set the CPU's Run/Remote/Local switch to **Remote**
- If the PC is connected to a comm port configured as a **serial port** set the CPU's Run/Remote/Local switch to **Local**

**Note**: COM1 has a factory default of 115.2 Kps (RS-232) using the Internet Point-to-Point Protocol (PPP). Do not connect COM1 to a PC unless you configure that PC's RS-232 port for PPP.

**2.** Define the project, setting communication and configuration parameters.

**3.** Download the project according to instructions in the *Downloading* section of the *ControlWave Designer Programmer's Manual* (D5125).

**4.** After the download completes successfully, restore the PSSM switch settings:

- Turn Run/Remote/Local to **Run**

## 4.4 Creating and Maintaining Backups

You should always maintain a current backup of each ControlWave project and keep it in a safe place, preferably in a location physically separate from the controller.

The reason we recommend you keep a backup files is that if a disaster occurs that damages or destroys your ControlWave hardware (flood, lightning strike, etc.) you don't want to also lose its control strategy software programs. Otherwise, when the unit is repaired or replaced, you'd have to create a new ControlWave project from scratch, which might take a lot longer than replacing a few damaged modules.

⚠ **Caution**

**Always maintain a backup copy of your ControlWave project in a safe place.**

**Anytime you modify your ControlWave project, be sure to create a new backup of the new project.**

**Notes:**

- You may find it useful to maintain more than one backup copy in case the backup media itself fails, for example, a CD-ROM becomes unreadable because it melted in the sun or a thumb drive fails because someone spilled coffee on it.
- If you don't keep more than one backup copy, it's a good idea to periodically test your backup copy to verify that the media has not failed.

### 4.4.1 Creating a Zipped Project File (*.ZWT) For Backup

**Note:** The .zwt file is a complete backup of your entire project including code, comments and graphics. It may be stored on your PC or removable storage media. It may also be downloaded and archived to ControlWave Flash memory where it may be uploaded at a later time for editing.

With your current ControlWave project open in ControlWave Designer, perform the following steps:

1. Click **File** > **Save Project As / Zip Project As.**

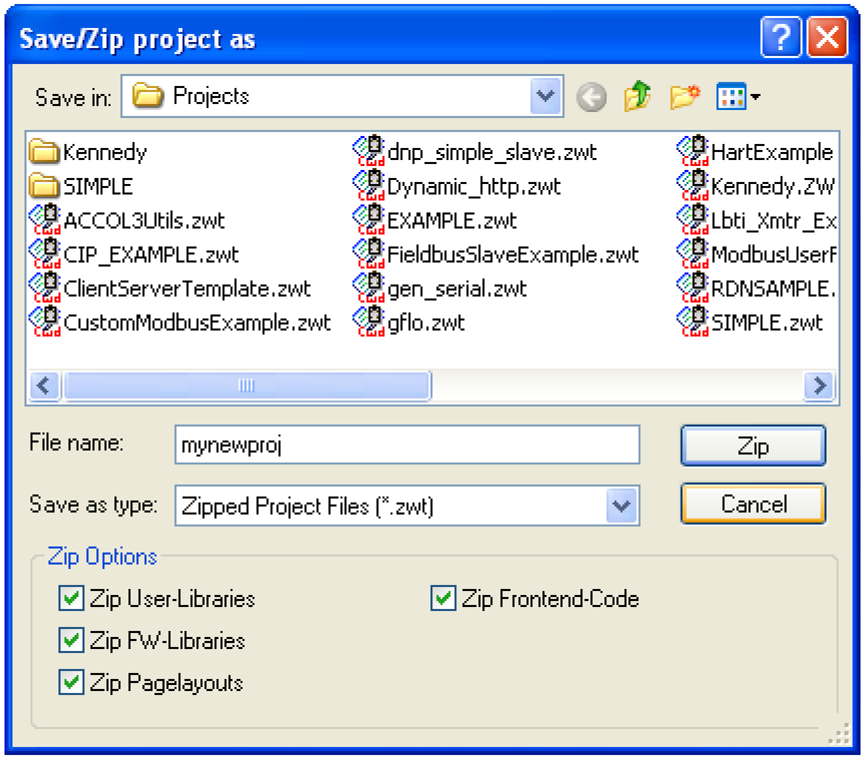



*Figure 4-3. Saving a Backup of Your Project*

**2.** In the “Save/Zip project as” dialog box, specify a project name in the **File name** field. In *Figure 4-3* we chose the name **mynewproj**.

**3.** In the **Save as type** field, choose **Zipped Project Files (*.zwt)**.

**4.** In the **Zip Options** area, select which additional files you want to include in the zwt file. Other than increasing the file size of the zwt, it doesn’t hurt to check any or all of these options.

| Zip Option | Description |
|---|---|
| **Zip User-Libraries** | If you created your own user-defined functions or function blocks, you must select this to preserve them. |
| **Zip Frontend-Code** | If you selected **Zip User-Libraries** you should also select this option to include compiled code for libraries in your zip file. Otherwise, you need to re-compile your user libraries with the project when you unzip the zwt. |
| **Zip FW-Libraries** | This includes firmware libraries, such as ACCOL3.FWL in your zwt. |
| **Zip Pagelayouts** | This includes pagelayout information for printing your project, as well as graphical elements used in 1131 languages. |

**5.** Click **Zip** and a progress bar displays the percent complete of the zipping process.

6. When the zip process completes, you'll see a message box reporting successful completion. Click **OK**.

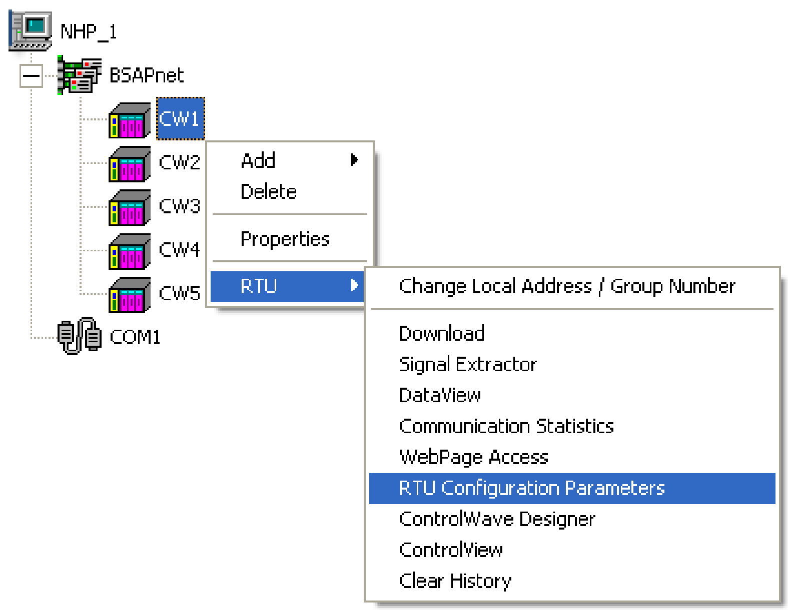
7. Copy the resulting zwt file to backup media (CD-ROM, thumb drive, etc.) If you ever need to restore the project, just open the zwt file in ControlWave Designer, load libraries as needed, then compile the project and download it into the ControlWave.

## 4.4.2 Saving Flash Configuration Parameters (*.FCP)

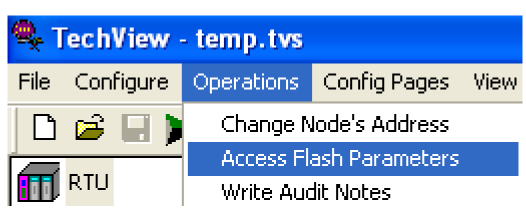
You must establish communications with the ControlWave using NetView, LocalView, or TechView before you can run the Flash Configuration utility.

**Note:** For detailed information on using the Flash Configuration utility, see *Chapter 5* of the *OpenBSI Utilities Manual* (D5081).

1. Start the Flash Configuration utility. To do this in NetView or LocalView, *right*-click on the icon for this ControlWave and choose **RTU > RTU Configuration Parameters**.




To do this in TechView, click **Operations > Access Flash Parameters** or click the Access Flash icon.




2. Depending upon how your system is configured, the Flash Configuration – Loading Options dialog box may open. If it does, choose **Load from device** and wait for the utility to

retrieve all parameters from the ControlWave, then skip to step 4, otherwise, just proceed to step 3.

**3.** Click [Read From RTU] and wait for the utility to retrieve all parameters from the ControlWave.

**4.** Click [Write To FCP] and specify a name for your FCP file, then click **Save**. When the status line indicates successful completion, your FCP file in done.

**5.** Copy the resulting FCP file to backup media (CD-ROM, thumb drive, etc.) If you ever need to restore the FCP parameters to the controller, establish communications with the unit, start the Flash Configuration utility, and load the FCP file using the **Read from FCP** button, then choose the **Write to RTU** button.

### 4.4.3 Backing up Data

You can back up certain types of data and restore it if needed. There are other types of data that you can only collect, but you cannot restore.

- If you have certain variables that represent tuning parameters (setpoints, for example) you can use tools such as the OpenBSI DataView recipe feature to save those values to a recipe file on the PC, and then restore them at a later time. See *Chapter 8* of the *OpenBSI Utilities Manual* (D5081).
- You can store the contents of read/write data arrays using the OpenBSI Data Array Save/Restore utility. See *Chapter 13* of the *OpenBSI Utilities Manual* (D5081).
- You can collect alarms, and historical data (audit records, archive files) but you cannot restore alarms or historical data.

# Chapter 5 – Service and Troubleshooting

This chapter provides general diagnostic and test information for the ControlWave.

In This Chapter



## Equipment

You need the following equipment to perform the procedures described in this chapter:

To run diagnostics software:

- PC with WINDIAG software, and either OpenBSI LocalView, NetView, or TechView for communications.
- Null modem interface cable
- Loop-back plug for RS-232 port (see *Figure 5-21*)
- Loop-back plug for RS-485 port (see *Figure 5-22*)
- Loop-back plug, 8-pin RJ-45 male (for twisted pair Ethernet) (see *Figure 5-24*)

To perform firmware upgrades:

- Null modem interface cable
- PC with the following software:
  - o OpenBSI System Firmware Downloader and either NetView, LocalView, or TechView for communications.
  - o HyperTerminal (included in Windows® XP)

**Note**: When you service a ControlWave on site, we recommend that you close down (or place under manual control) any associated processes. This precaution prevents any processes from accidentally running out of control when you conduct tests.

**Caution** **Harmful electrical potentials may still exist at the field wiring terminals even though the ControlWave power source may be turned off or disconnected. Do not attempt to unplug termination connectors or perform any wiring operations until you verify that all associated power supply sources are turned off and/or disconnected.**

**Always turn off any external supply sources for externally powered I.O circuits before you change any modules.**

## 5.1 Upgrading Firmware

The ControlWave CPU ships from the factory with system firmware already installed. If you need to upgrade the system firmware (stored in Flash memory) to acquire new functionality or restore firmware, you can use one of several methods.

**System Firmware Downloader**

Use this tool to download system firmware to an unattended remote ControlWave controller. To use this utility, you must set CPU module switch SW3-2 **OFF** (the factory default position).

**Note**: For further information and detailed use instructions, refer to *Appendix J* of the *OpenBSI Utilities Manual* (D5081).

**LocalView**

One of the standard OpenBSI utilities, LocalView requires OpenBSI version 5.1 (or newer). If you have an older version of OpenBSI, use HyperTerminal.

**Note**: For further information and detailed use instructions, refer to the Flash Mode section of *Chapter* 5 of the *OpenBSI Utilities Manual* (D5081).

**HyperTerminal**

HyperTerminal is a communications utility program included with Microsoft® Windows®.XP

**Notes:**

- If you are using a version of OpenBSI older than 5.1, or do not have OpenBSI software, you can only perform a firmware upgrade using HyperTerminal.
- While HyperTerminal is included in Microsoft® Window® XP, some newer versions of Window® do not include it.
- HyperTerminal requires *.BIN files; newer ControlWave firmware upgrade files use *.CAB files. In cases such as those, you should use the Remote System Firmware Downloader.

**1.** Connect a null modem cable between COM1 of the ControlWave and any RS-232 port on the associated PC.

**2.** Click **Start** > **Programs** > **Accessories** > **Communications** > **HyperTerminal**

**3.** If using HyperTerminal for the first time, set the communication properties (for the PC port) via the Properties Menu as follows: Bits per second: = 115200, Data bits: = 8, Parity: = None, Stop bits: = 1, and Flow control: = None and then click **OK**.

**4.** Set CPU switch SW3-3 to **ON** (Force Recovery Mode).

**5.** Apply power; to the ControlWave. The resident BIOS initializes and tests the hardware, this process is referred to as POST (Power On Self Test). Unless there is a problem, you should see the code "86" on the Port 80 display. If you see a different status code, see *Section 5.3.4.*

**6.** From the HyperTerminal Mode menu (*Figure 5-1*), press the **F** key to enter FLASH download. A message warns that the FLASH is about to be erased; press the **Y** key at the prompt. The screen displays dots as the system erases the flash memory; this could take a few minutes.

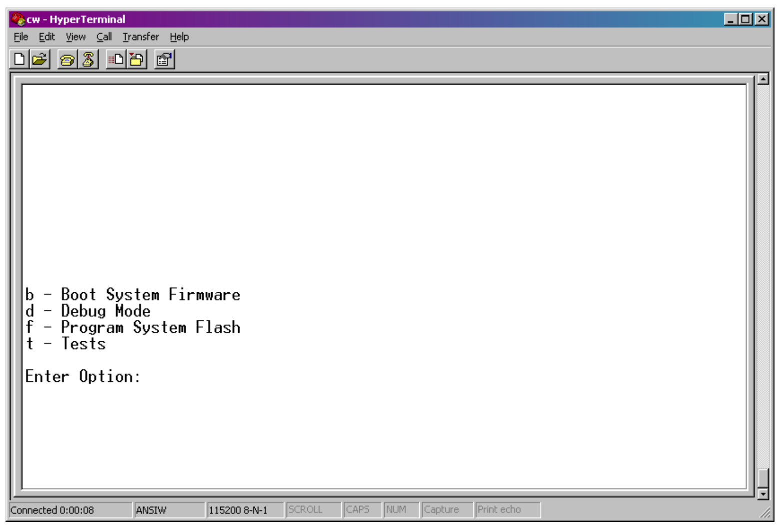



*Figure 5-1. HyperTerminal Mode Menu*

**7.** When the FLASH is ready for download, HyperTerminal repeatedly displays the letter C on the screen. In the HyperTerminal menu bar click **Transfer** > **Send File** (see *Figure 5-2*).

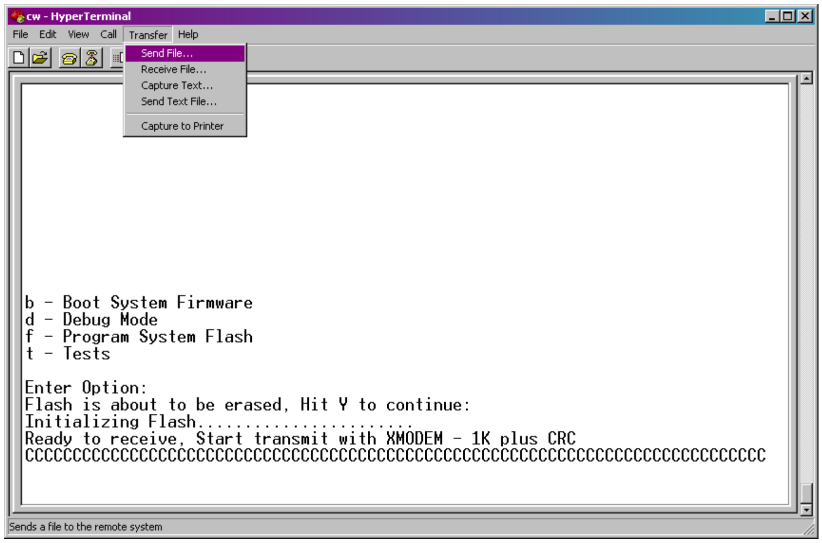



*Figure 5-2. HyperTerminal (Ready to Download)*

**8.** In the Send File dialog box (see *Figure 5-3*), select **1KXmodem** for the protocol, enter the filename of the appropriate .bin file in the format “CWP*xxxxx*.bin” (where *xxxxx* varies from release to release) and click **Send** to start the flash upgrade (see *Figure 5-4*). When you see the HyperTerminal Mode Menu again, it means the download has completed.

**9.** Exit HyperTerminal and power down the ControlWave. If desired, you can disconnect the null modem cable between the ControlWave and the PC.

**10.** Set CPU switch SW3-3 to **OFF** (Recovery Mode Disabled).

**11.** Restore power to the ControlWave.

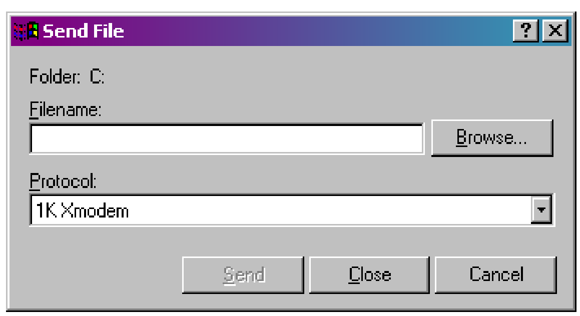



*Figure 5-3. Send File dialog box*

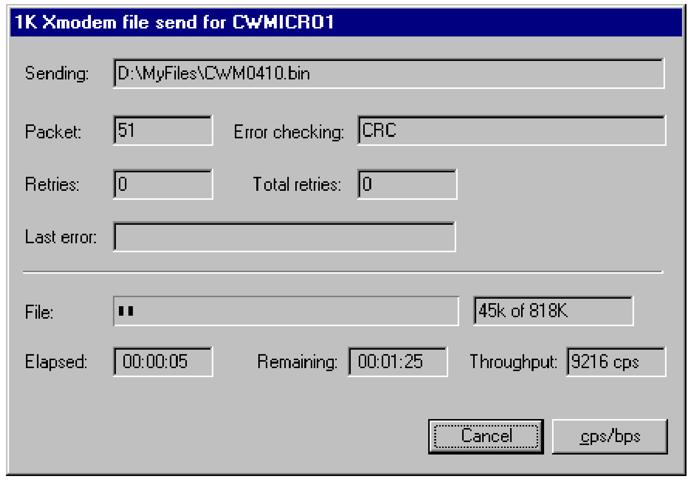



*Figure 5-4. HyperTerminal (Download in Process)*

## 5.2 Removing or Replacing Components

This section provides information on accessing ControlWave modules for testing, as well as removal/replacement procedures.

| ⚠ Caution | **Field repairs to ControlWave process automation controllers are strictly limited to the replacement of complete modules. All modules (CPU, PSSM, and I/O) are factory sealed to prevent tampering. Breaking the seal and/or replacing module components constitutes tampering and voids the product warranty. Return defective modules or housings to the factory for authorized service.** |
|---|---|

### 5.2.1 Accessing Modules for Testing

Only technically qualified personnel should test and/or replace ControlWave modules. Read completely the disassembly and test procedures described in this manual before starting. Any damage to the ControlWave resulting from improper handling or incorrect service procedures is not covered under the product warranty agreement. If you cannot properly perform these procedures, obtain authorization and then return the device to the factory for evaluation and repairs.

### 5.2.2 Removing/Replacing the Bezel

Before you can remove the CPU module or the PSSM module you must remove the bezel.

**1.** Remove any cables and or the Run/Remote/Local key from their connectors; make sure you label the cables so you can replace them later.

**2.** Grasp the sides of the bezel assembly and gently pull it off the chassis.

**3.** To replace the bezel, align the bezel’s two snaps (one near the top and one near the bottom) with the associated holes on the chassis.

(These holes are centered between the PSSM and CPU captive panel fastener holes.)

4. Press the bezel in gently until it snaps into place.
5. Reconnect the cables and reinsert the key, if necessary.

### 5.2.3 Removing/Replacing the CPU Module

Use this procedure to remove or replace the CPU module.

1. If the ControlWave is running, place any critical control processes under manual control.
2. Shut down the ControlWave by disconnecting the power.
3. Disconnect any CPU module communication cables. Label or otherwise identify them so you can easily return them to their assigned communication ports. .
4. Remove the bezel. (See *Section 5.2.2*.)
5. Loosen the two captive panel fasteners that secure the CPU module to the chassis and carefully slide it out the front of the chassis. You may need to rock the board back and forth gently to do this.
6. To replace a CPU module, the PSSM must already reside in slot 1, but power must be off. Carefully align the CPU module with the guides for slot 2 and insert the CPU module into the housing. When the module correctly seats in the backplane, turn the module’s captive panel fasteners clockwise to secure the CPU module; this establishes a low resistance path between the CPU module and chassis ground. Make sure the fasteners are tight, but don’t over-tighten them.
7. Replace any communication cables, apply power, and test the module.

### 5.2.4 Removing/Replacing the PSSM

Use this procedure to remove or replace the PSSM module.

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**Note**: For information on hot-swapping power supplies on a PSSM (assuming you have the dual power supply version) see *Section 2.3.6*.

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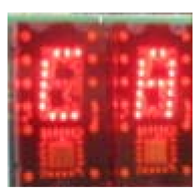
1. If the ControlWave is running, place any critical control processes under manual control.
2. Shut down the unit by turning off the power.
3. Unplug communication cables from the CPU module (be sure you label or otherwise identify them so you can reconnect them later).
4. Remove the bezel assembly (see Section 5.2.2).

5. Unplug the cables and PSSM modular connectors for power (TB1 and TB2) and watchdog (TB3).
6. Remove the CPU module. See *Section 5.2.3*. You must remove the CPU module in order to remove the PSSM.
7. Loosen the two captive panel fasteners that secure the PSSM module to the chassis and carefully slide it out the front of the chassis.
8. To replace a PSSM module, power must be off and the CPU module must be removed. Carefully align the PSSM module with the guides for slot 1 and insert the module into the housing. When the module correctly seats in the backplane, turn the module's captive panel fasteners clockwise to secure the PSSM module; this establishes a low resistance path between the PSSM module and chassis ground. Make sure the fasteners are tight, but don't over-tighten them.
9. Replace the CPU module.
10. Replace power and watchdog cables and then apply power and test the unit.

### 5.2.5 Removing/Replacing an I/O Module (Hot Swapping)

| | |
|---|---|
| ⚠ **WARNING** | **DO NOT ATTEMPT hot swapping in a Class I, Division 2 hazardous location.** |

The ControlWave process automation controller supports removal of any or all I/O modules from the housing while the application is running. This is called "hot swapping." When you initially remove or replace any I/O module, the ControlWave halts operation for 300 milliseconds before resuming operation from where it halted. During this momentary halt, the Port 80 display shows "CA" on its screen.



| | |
|---|---|
| ⚠ **Caution** | **Never try to "hot swap" more than one I/O module simultaneously. You can remove or replace multiple modules sequentially, but not at the same time.** |

1. If the ControlWave is running, place any critical control processes that use this I/O module under manual control.
2. Loosen the captive fasteners at the top and bottom of the module by turning them counter-clockwise.


*Figure 5-5. I/O Module to Be Replaced*

**3.** Open the bezel door and grasp the handle. Pull the entire module out of the chassis.

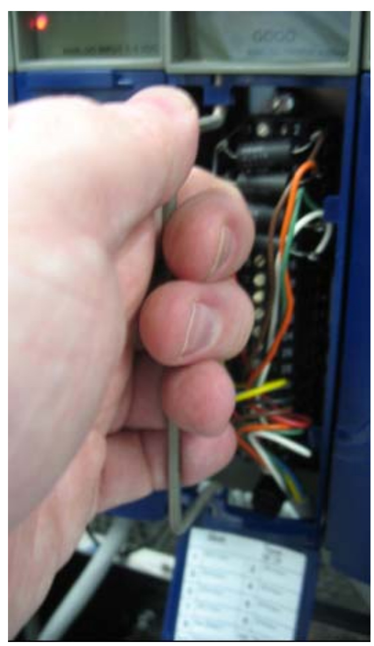


*Figure 5-6. Pulling the I/O Module Out of the Housing*

**4.** If you plan to replace this module with a new module, but want to retain all your existing I/O wiring to the terminal blocks, you need to disconnect the terminal block board from the rest of the module. To do that, loosen the screws at the top and bottom of the terminal block board. Then grab the handle and pull the terminal block board along with the terminal housing assembly off of the front of the module.

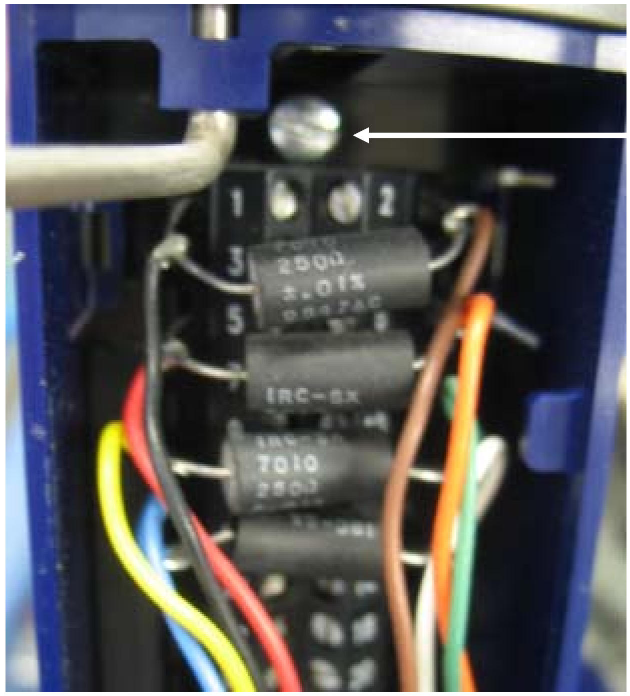



*Figure 5-7. Loosening the Top Fastener*

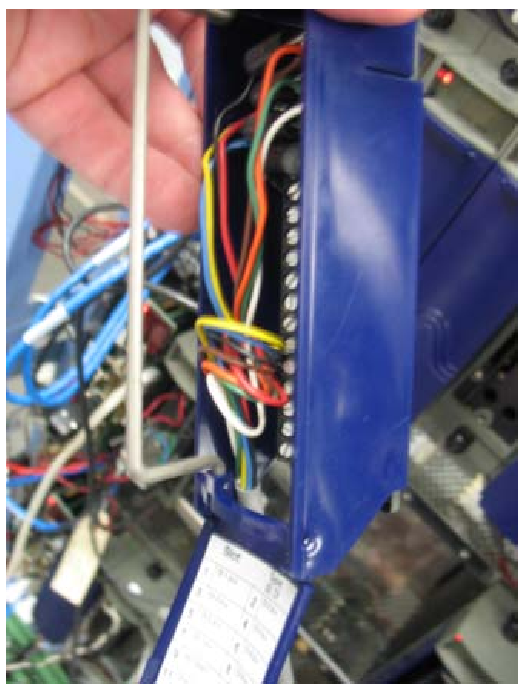


*Figure 5-8. Terminal Block Board and Terminal Housing Assembly Separated from the Rest of the Module*

**5.** Again, assuming you want to preserve your existing wiring to the terminal blocks, because you haven’t wired to the terminal blocks on the replacement module, remove the terminal block board and terminal housing assembly *from the new replacement module.*

**6.** Carefully slide the new module into the same I/O slot in the housing and tighten the top and bottom captive fasteners, but not too tight.


*Figure 5-9. New I/O Module in Place Prior to Attaching Terminal Board and Terminal Housing Assembly*

**7.** Take the terminal block board and terminal housing assembly, with all the I/O wiring, that you removed in step 4, and line up its fasteners with the holes on the module, now seated in the housing, and gently push the terminal block board and terminal housing assembly into the module and tighten the fasteners.

**8.** When the new board starts, and is functioning properly, return any processes you put into manual control to automatic control.

### 5.2.6 Removing/Replacing the Backup Battery

**Note:** For the backup battery to function, CPU switch SW3-4 must be ON. See *Section 2.4.1* for information on setting CPU module switches.

The CPU module includes a backup battery that sits in front of the PSSM module as you face the ControlWave. The battery provides backup power for the real-time clock (RTC), CMOS RAM, and the system SRAM on the CPU module. The CPU module backup battery is a 3.6V, 950 mA-hr ½ AA lithium cell battery.

**Note**: The CPU module draws power from the battery only if the module loses power. The system SRAM has a standby current draw of 50 uA maximum for each part. For a ControlWave containing 2MB of SRAM, a worst-case current draw of 110 uA allows a battery life of approximately 8,636 hours. This means you should not need to replace a battery until the ControlWave has been in service for an extended period (normally many years).

**⚠ Caution**

**You lose SRAM contents when you remove the backup battery or its assembly from the CPU module.**

**If you replace a backup battery or its assembly, wait at least one minute before re-powering the system. This enables the SRAM to completely discharge.**

**Removing / Replacing the Battery**

1. If the ControlWave is running, place any critical control processes under manual control.
2. Remove the bezel that covers the PSSM and CPU modules.
3. Grasp the battery retaining clip and gently pull it up and away from the backup battery assembly to release the top of the retaining clip.
4. Pull the retaining clip down and outward to remove it.
5. Remove the battery. Wait at least one minute for SRAM to fully de-charge.
6. Put in the replacement battery.
7. Snap the retaining clip back into place.
8. Put the bezel back in place.

## 5.3 General Troubleshooting Procedures

This section presents some procedures to troubleshoot problems with the ControlWave.

### 5.3.1 Common Communication Configuration Problems

If serial communications do not function, it is often due to one of the following issues:

- Baud rate mismatch – the baud rate at both ends of the communication line must match. If communications fail during a download of a new flash configuration profile (FCP) file, you may have changed the baud rate of the active communication line, since baud rate changes occur immediately on FCP download. You can always re-establish factory default baud rates for communication ports by powering down the unit, and then setting CPU switch SW1-3 to **OFF** and restoring power.
- Incorrect BSAP local address – this address must be an integer from 1 to 127 and must be unique on this particular BSAP communication line. You set the BSAP local address using the flash configuration utility. If this ControlWave is a BSAP slave node, and the range of addresses defined for the BSAP master port end of the communication line does not encompass the local BSAP address defined for this ControlWave, BSAP communications will not function.
- Incorrect EBSAP Group number – if you use expanded BSAP the EBSAP group number must be correct; if you are not using EBSAP, the group number must be 0.

If IP communications do not function, it is often due to incorrect IP addresses or masks. Check to see that the IP address you defined for the ControlWave is compatible with the range of IP addresses defined for the communication line on which the unit resides. Also check that the IP address of the default gateway is correct.

### 5.3.2 Checking LEDs

ControlWave modules contain light emitting diodes (LEDs) that provide operational and diagnostic functions. *Table 5-1* shows LED assignments on modules.

*Table 5-1. LED Assignments on Modules*

| Module / Board | LED Name | LED Color | Function and Location |
|---|---|---|---|
| PSSM | MC | Red | Lights when the CPU is not running, and I/O has been reset to 0. This lights momentarily when the unit first powers on **or** when the unit resets. Master Clear; ON 2msec after PWR FAIL goes low. See *Figure 5-10.* |
| PSSM | PWR DOWN | Red | ON = Bulk or regulated power has fallen below acceptable levels. See *Figure 5-10*.. |
| PSSM | PWR GOOD | Green | ON = Normal operation; all power supplies okay. See *Figure 5-10.* Each power supply on the PSSM also has its own LED which lights when power is good. If this LED does not light, remove the power supply and check the fuse. Then ensure that the board is fully inserted. |
| CPU | CR1 – WATCHDOG | Red | ON = Watchdog condition. See *Section 2.3.5* for a description of what causes a watchdog. See *Figure 5-11.* |
| CPU | CR2 – IDLE | Red | ON = CPU idle. The CPU should show idle most of the time. If this light goes OFF and stays OFF, the CPU is overloaded. See *Figure 5-11.* |
| CPU | CR3 – COMM 1 RX | Red | ON = RX (receive activity) on COMM1. See top-left of LED cluster in *Figure 5-11*. |
| CPU | CR3 – COMM 1 TX | Red | ON = TX (transmit activity) on COMM1. See top-right of LED cluster in *Figure 5-11*. |
| CPU | CR3 – COMM 2 RX | Red | ON = RX (receive activity) on COMM2. See bottom-left of LED cluster in *Figure 5-11*. |
| CPU | CR3 – COMM 2 TX | Red | ON = TX (transmit activity) on COMM2. See bottom-right of LED cluster in *Figure 5-11*. |
| CPU | CR8 – ENET Port 1 | Red/Green | ON RED = Data Collision (Left – see *Figure 5-11*.) |
| CPU | CR8 – ENET Port 1 | Red/Green | ON GREEN = Receiving data (Left – see *Figure 5-11*.) |
| CPU | CR8 – ENET Port 1 | Red/Green | ON RED = Transmitting data (Right – see *Figure 5-11*.) |
| CPU | CR8 – ENET Port 1 | Red/Green | ON GREEN = Link O.K. (Right – see *Figure 5-11*.) |
| SCB | CR2 – COMM 3 RX | Red | ON = RX (receive activity) on COMM3. See top-left of LED cluster in *Figure 5-11*. |
| SCB | CR2 – COMM 3 TX | Red | ON = TX (transmit activity) on COMM3. See top-right of LED cluster in *Figure 5-11*. |
| SCB | CR2 – COMM 4 RX | Red | ON = RX (receive activity) on COMM4. See bottom-left of LED cluster in *Figure 5-11*. |
| SCB | CR2 – COMM 4 TX | Red | ON = TX (transmit activity) on COMM4. See bottom-right of LED cluster in *Figure 5-11*. |
| SCB | CR4 – ENET Port 2 | Red/Green | ON RED = Data Collision (Left – see *Figure 5-* |

| Module / Board | LED Name | LED Color | Function and Location |
|---|---|---|---|
| | | | *11*.) |
| SCB | CR4 – ENET Port 2 | Red/Green | ON GREEN = Receiving data (Left – see *Figure 5-11*.) |
| SCB | CR4 – ENET Port 2 | Red/Green | ON RED = Transmitting data (Right – see *Figure 5-11*.) |
| SCB | CR4 – ENET Port 2 | Red/Green | ON GREEN = Link O.K. (Right – see *Figure 5-11*.) |
| SCB | CR5 – ENET Port 3 | Red/Green | ON RED = Data Collision (Left – see *Figure 5-11*.) |
| SCB | CR5 – ENET Port 3 | Red/Green | ON GREEN = Receiving data (Left – see *Figure 5-11*.) |
| SCB | CR5 – ENET Port 3 | Red/Green | ON RED = Transmitting data (Right – see *Figure 5-11*.) |
| SCB | CR5 – ENET Port 3 | Red/Green | ON GREEN = Link O.K. (Right – see *Figure 5-11*.) |
| CPU | PORT 80 DISPLAY | Red LEDs | LED Matrix displays status codes. See *Figure 5-11.* See *Table 5-3 & 5-4.* |
| AI | AI Board Status | Red/Green | ON RED = Fail state/ board not recognized<br>ON GREEN = Normal state. See *Figure 5-12* |
| AI | Range (16 LEDs – one per point) | Red | LED ON = AI over-range or AI under-range condition. See *Figure 5-12* |
| AI | Range (16 LEDs – one per point) | Green | LED ON = AI in range. See *Figure 5-12* |
| AO | AO Board status fail | Red | LED ON = AO board fail state / board not recognized. See *Figure 5-13*. |
| AO | AO Board status pass | Green | LED ON = AO board normal or O.K. state. *Figure 5-13*. |
| DI | DI Board status | Red/Green | ON RED = DI board fail state; board not recognized.<br>ON GREEN = DI board normal state. See *Figure 5-14*. |
| DI | DI board inputs (32 LEDs – 1 per point) | Red | LED ON = Input is present.<br>LED OFF = Input is not present. See *Figure 5-14*. |
| DO | DO Board status | Red/Green | ON RED = DO board fail state; board not recognized.<br>ON GREEN = DO board normal state. See *Figure 5-15.* |
| DO | DO board outputs (32 LEDs – 1 per point) | Red | LED ON = Output is ON. See *Figure 5-15.* |
| UDI | UDI Board Status Fail | Red | LED ON = UDI board fail state/board not recognized. See *Figure 5-16*. |
| UDI | UDI Board Status Pass | Green | LED ON = UDI board normal or O.K. state. See *Figure 5-16*. |
| UDI | UDI Input (12 LEDs – 1 per point) | Red | LED ON = UDI input activity.<br>LED OFF= no UDI input activity. See *Figure 5-* |

| Module / Board | LED Name | LED Color | Function and Location |
|---|---|---|---|
| | | | *16*. |
| RTD | RTD Board Status | Red/Green | ON RED = Fail state/board not recognized.<br>ON GREEN = Normal state. See *Figure 5-17*. |
| RTD | Range (8 LEDs – 1 per point) | Red | LED ON = RTD over-range or RTD under-range condition. See *Figure 5-17*. |
| RTD | Range (8 LEDs – 1 per point) | Green | LED ON = RTD in range. See *Figure 5-17*. |
| LLAI | LLAI Board Status | Red/Green | ON RED = Fail state/board not recognized.<br>ON GREEN = Normal state. See *Figure 5-18*. |
| LLAI | Range (12 LEDs – 1 per point) | Red | LED ON = LLAI over-range or LLAI under-range condition. See *Figure 5-18*. |
| LLAI | Range (12 LEDs – 1 per point) | Green | LED ON = LLAI in range. See *Figure 5-18*. |

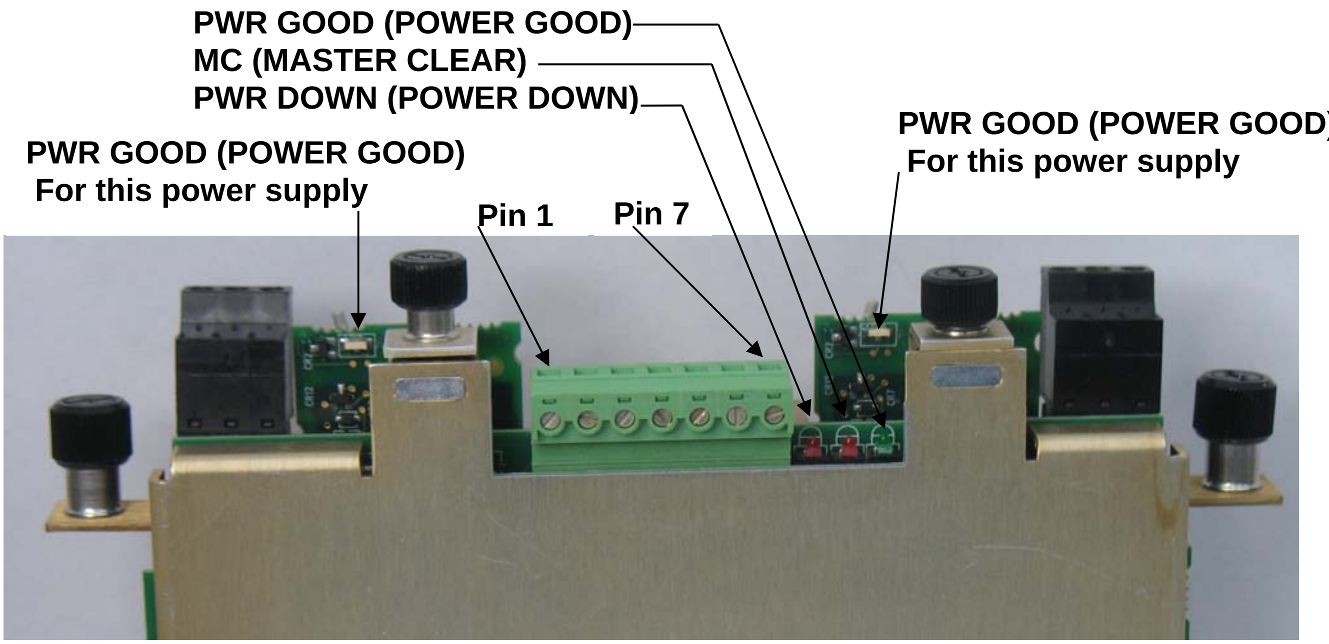



*Figure 5-10. PSSM LED Locations*

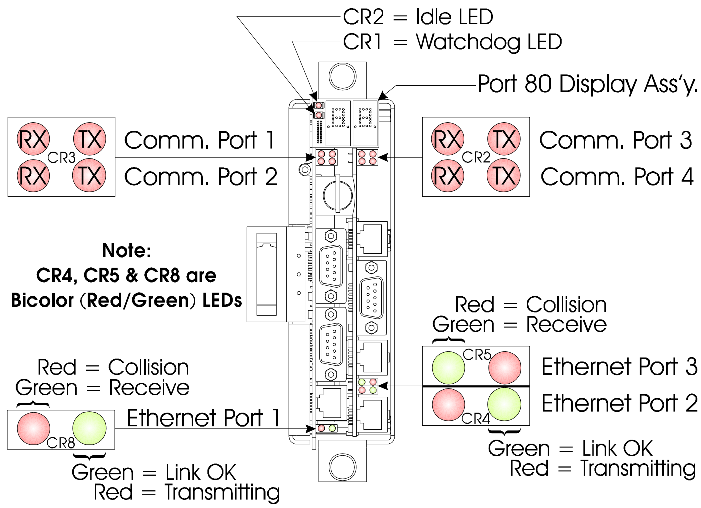



*Figure 5-11. CPU Module (CPU & SCB boards) Port & LED Designations*

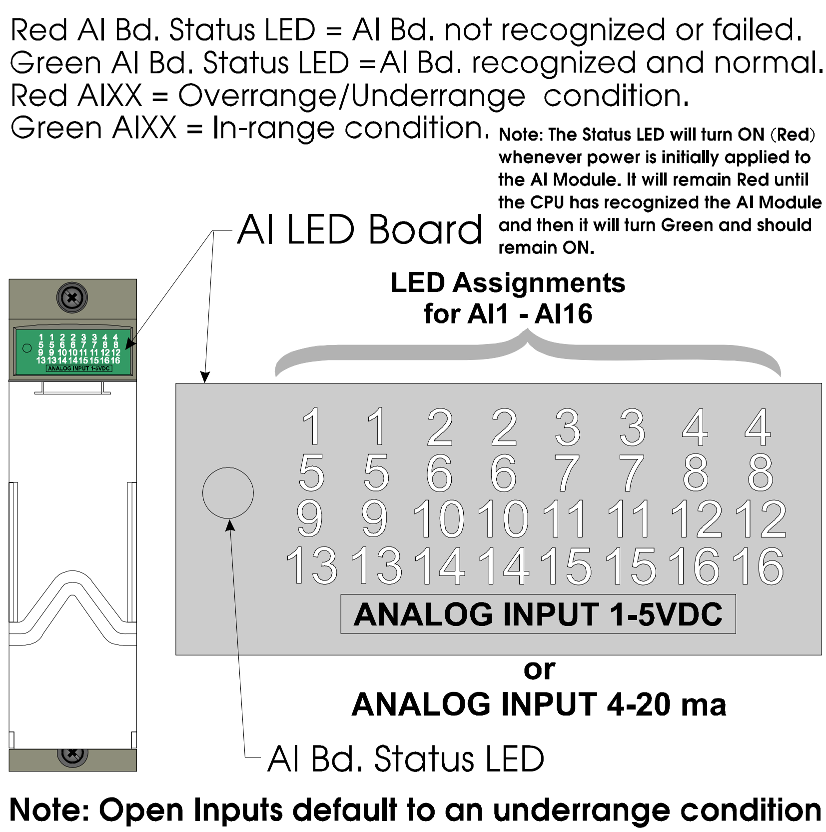



*Figure 5-12. Analog Input (AI) Module LED Designations*

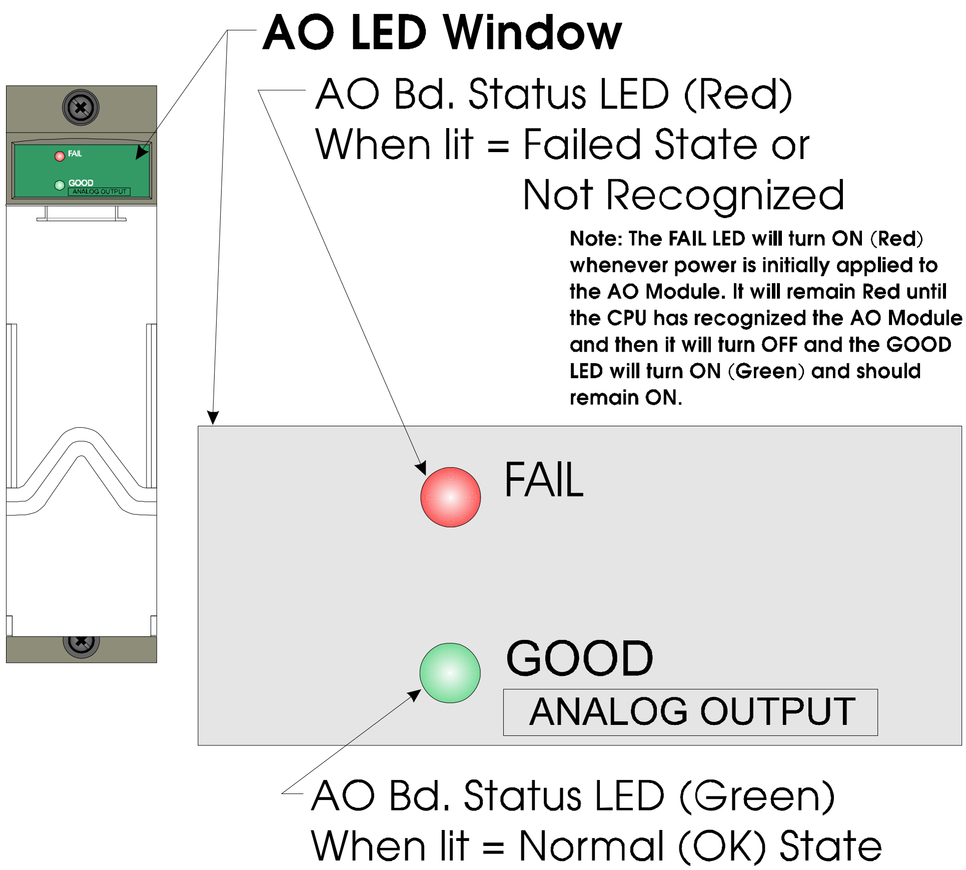



*Figure 5-13. Analog Output (AO) Module LED Designations*

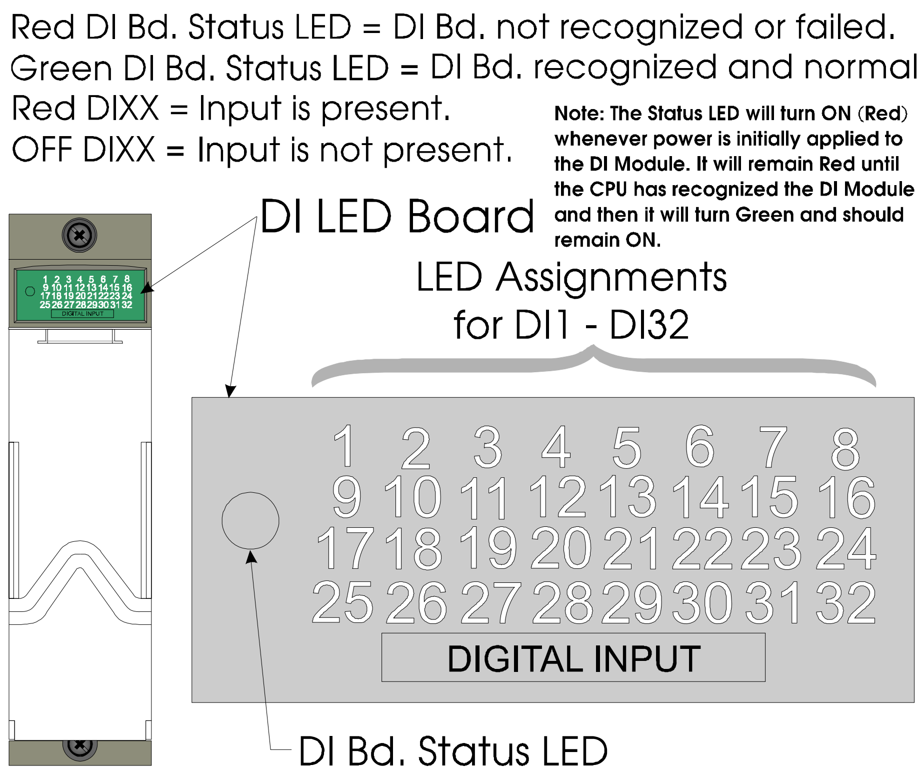



*Figure 5-14. Digital Input (DI) Module LED Designations*

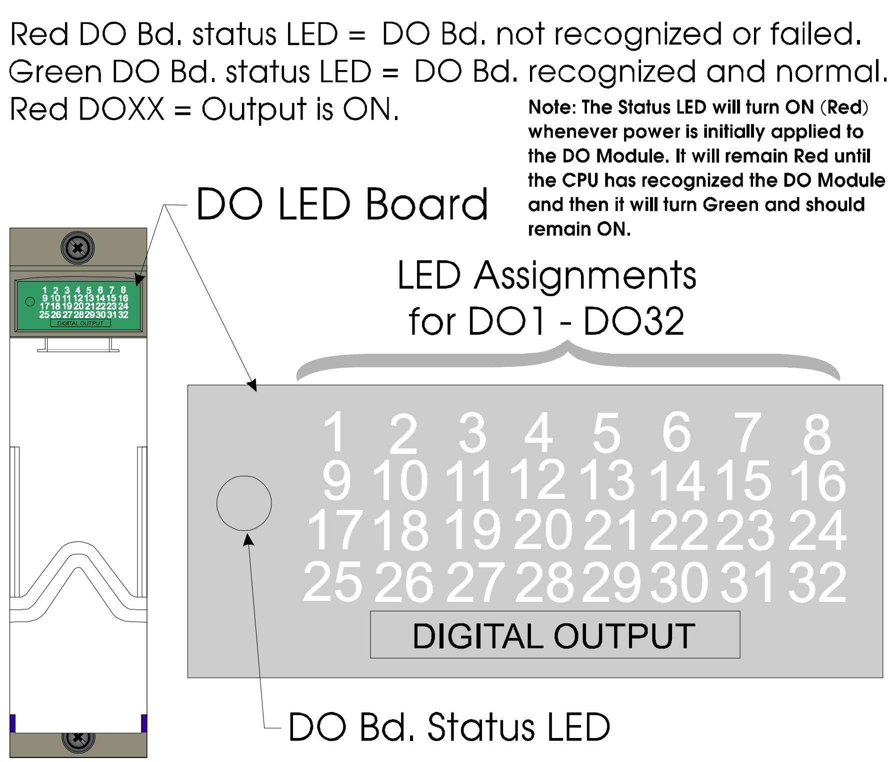



*Figure 5-15. Digital Output (DO) Module LED Designations*

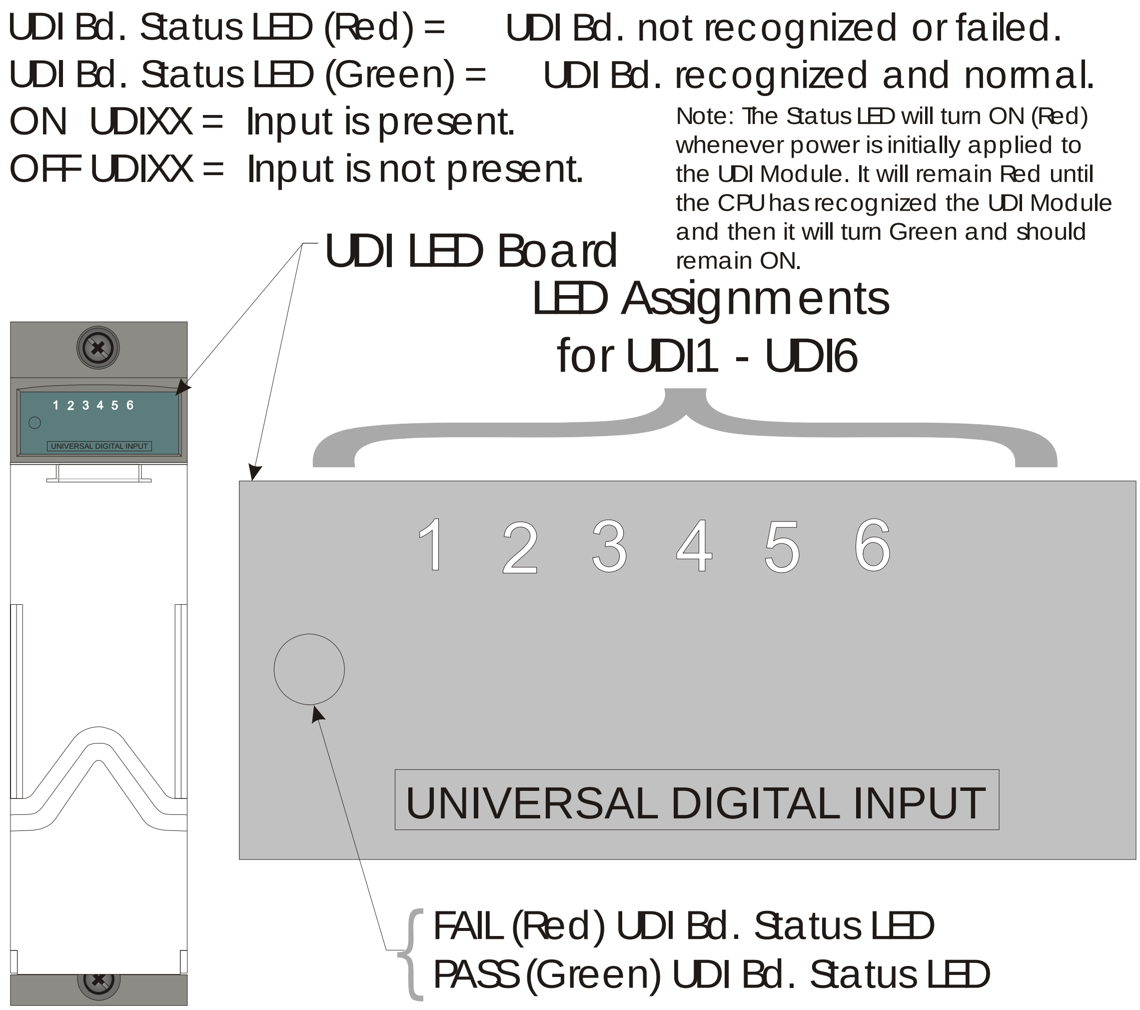



*Figure 5-16. Universal Digital Input (UDI) Module LED Designations*

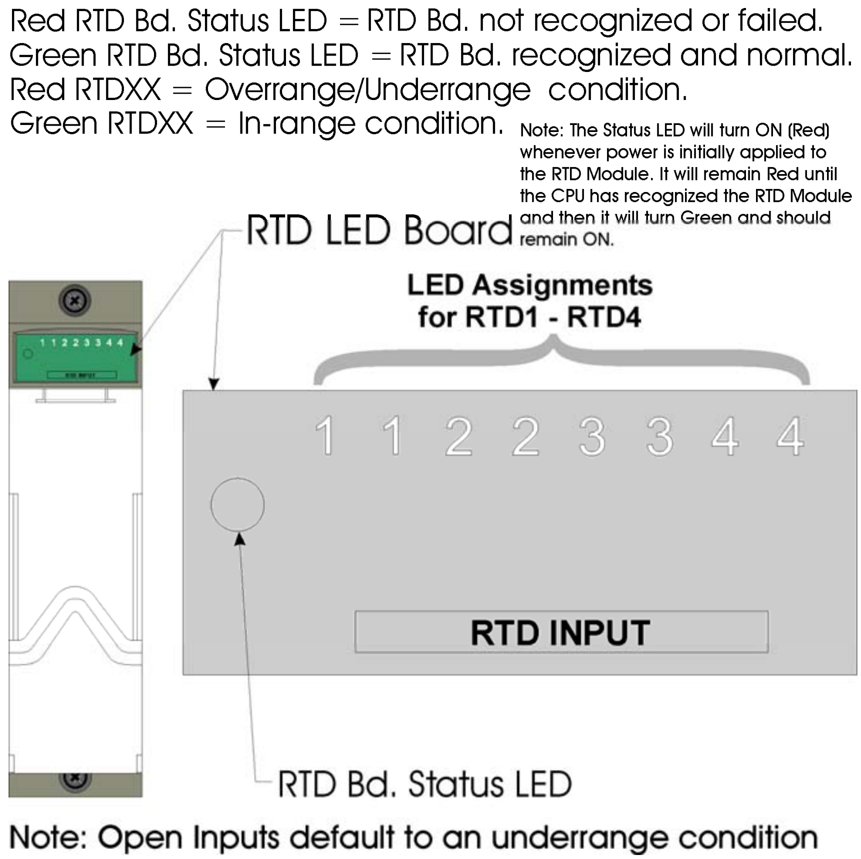



*Figure 5-17. RTD Module LED Designations*

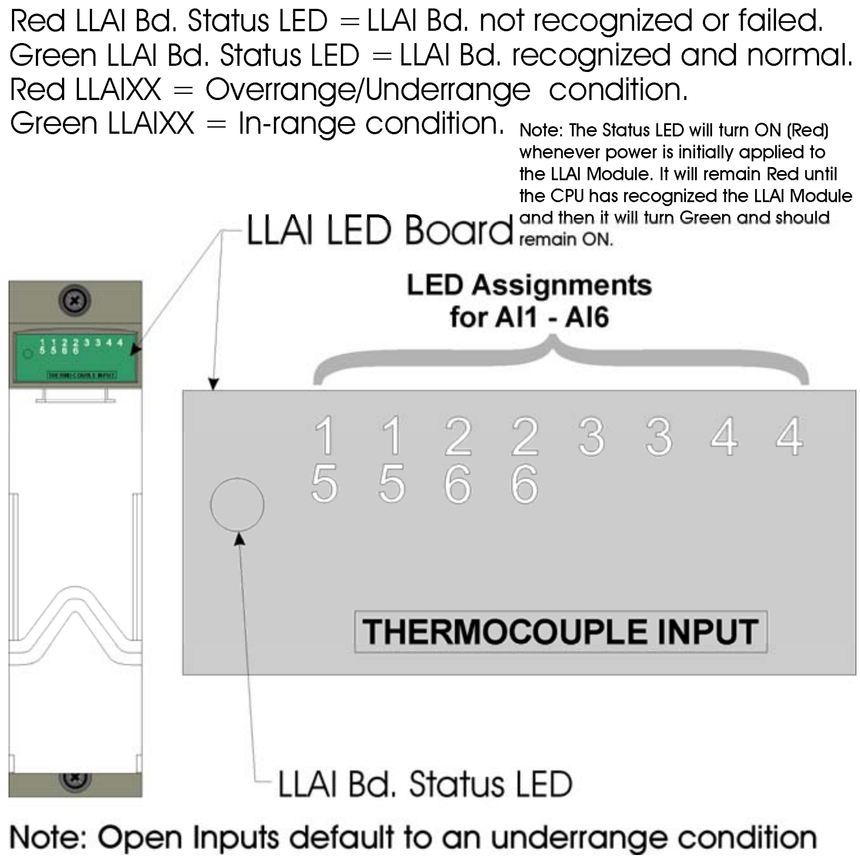



*Figure 5-18. Low Level Analog Input (LLAI) Module LED Designations*

## 5.3.3 Checking Wiring/Signals

Check I/O field wiring at the terminal blocks and at the field device. Inspect the wiring for continuity, shorts, and opens. Check I/O signals at their respective terminal blocks (see *Table 5-2*).

*Table 5-2. I/O Field Wiring - Terminal Block Reference*

| I/O Module or sub-system | Notes |
|---|---|
| Digital Input Modules | See *Section 3.4* |
| Digital Output Modules | See *Section 3.5* |
| Analog Input Modules | See *Section 3.6* |
| Analog Output Modules | See *Section 3.7* |
| Universal Digital Input (UDI) Modules | See *Section 3.8* |
| RTD Input Modules | See *Section 3.9* |
| Low Level Analog Input Modules | See *Section 3.10* |
| Watchdog Circuit | See *Section 2.3.5* |

### 5.3.4 Port 80 Display Codes

The Port 80 Display shows two different types of codes. POST codes, and run-time status codes.

**Power-On-Self-Test (POST) Codes**

When you first power up the ControlWave, or if you reset it using the reset switch, the BIOS runs a power-on-self-test (POST) to test the hardware. Normally, the POST codes pass by too quickly for you to see them, and the system enters normal run time, or if the CPU is set for force recovery mode, you see the code “86.” If there is a fault during the POST process, see *Table 5-3* for the 2-digit failure code.

*Table 5-3. Port 80 POST Status Codes*

| HEX Code | Definition |
|---|---|
| 00 | POST beginning. |
| 01 | CPU register test about to start. |
| 02 | NMIs are disabled; delay starts. |
| 03 | power-on delay finished. |
| 04 | kbd BAT done; reading kbd SYS bit. |
| 05 | disabling shadowing & cache. |
| 06 | calcing ROM cksum, wait kbd ctrllr. |
| 07 | cksum okay, kbd ctrllr free. |
| 08 | verifying BAT cmd to kbd ctrllr. |
| 09 | issuing kbd ctrllr cmd byte. |
| 0A | issuing kbd ctrllr data byte. |
| 0B | issuing pin 23, 24 blocking & unblocking. |
| 0C | issuing kbd ctrllr NOP cmd next. |
| 0D | testing CMOS RAM shutdown register. |
| 0E | checking CMOS cksum, updating DIAG byte. |
| 0F | initializing CMOS (if req’d every boot). |
| 10 | Init. CMOS status reg. for date/time. |
| 11 | disabling DMA, interrupt ctrllrs. |
| 12 | disabling Port B, disabling video display. |
| 13 | Init. board, start auto-mem detect. |
| 14 | starting timer tests. |
| 15 | testing 8254 T2, for spkr, part B. |
| 16 | testing 8254 T1, for refresh. |
| 17 | testing 8254 To, for 18.2 Hz. |
| 18 | starting memory refresh. |
| 19 | testing memory refresh. |
| 1A | testing 15usec refresh ON/OFF time. |
| 1B | testing base 64KB memory. |
| 1C | testing data lines. |
| 1D | currently loading the Boot Project. |
| 20 | testing address lines. |
| 21 | testing parity (toggling). |
| 22 | base 64KB mem read/write test. |
| 23 | system init before vector table init. |
| 24 | init vector table. |
| 25 | reading 8042 for turbo switch setting. |
| 26 | initiating turbo data. |

| HEX Code | Definition |
|---|---|
| 27 | any init after vector table init is next. |
| 28 | setting monochrome mode. |
| 29 | setting color mode. |
| 2A | toggle parity before optional video ROM. |
| 2B | init before video ROM check. |
| 2C | control passed to video ROM. |
| 2D | video ROM returned control. |
| 2E | checking for EGA/VGA adapter found. |
| 2F | no EGA/VGA found, r/w test of video. |
| 30 | looking for video retrace signal. |
| 31 | retrace failed, checking alt. Display. |
| 32 | alt found, checking video retrace signal. |
| 33 | compare switches w/actual adapter type. |
| 34 | setting display mode. |
| 35 | check ROM BIOS data area at seg 40h. |
| 36 | setting cursor for power-on msg. |
| 37 | displaying power-on message. |
| 38 | save cursor position. |
| 39 | display BIOS ident. String. |
| 3A | display “Hit <DEL> to …” msg. |
| 40 | preparing vm test. vrfy from display. |
| 41 | preparing descriptor tables. |
| 42 | enter virtual mode for memory test. |
| 43 | enable inits for diagnostics mode. |
| 44 | init data for checking wraparound at 0:0. |
| 45 | checking for wrap, find total memory size. |
| 46 | write extended memory test patterns. |
| 47 | write conventional memory test patterns. |
| 48 | finding low memory size from patterns. |
| 49 | finding high memory size from patterns. |
| 4A | check ROM BIOS data area again. |
| 4B | check for <DEL>, clear low mem for soft reset. |
| 4C | clearing ext mem for soft reset. |
| 4D | saving memory size. |
| 4E | on cold boot, display $1^{st}$ 64KB memtest. |
| 4F | on cold boot, test all of low memory. |
| 50 | adjust memsize for 1K usage. |
| 51 | system initialization in progress. |
| 52 | prepare for shutdown to real-mode. |
| 53 | saved regs & memsize, entering real-mode. |
| 54 | shutdown successful, restoring codepath. |
| 55 | disabling A20 line. |
| 56 | checking ROM BIOS data area again. |
| 57 | checking ROM BIOS data area some more. |
| 58 | clear the “Hit <DEL>” message. |
| 59 | test DMA page register. |
| 60 | verify from display memory (???). |
| 61 | test DMA0 base register. |
| 62 | test DMA1 base register. |
| 63 | checking ROM BIOS data area again. |
| 64 | checking ROM BIOS data area some more. |
| 65 | programming DMA ctrllrs 0 & 1 |
| 66 | initializing INT ctrllrs 0 & 1. |
| 67 | starting keyboard test. |
| 80 | issuing reset cmd & clring output buffer |

| HEX Code | Definition |
|---|---|
| 81 | check for stuck keys & issue test cmd. |
| 82 | initializing circular buffer. |
| 83 | check for locked keys. |
| 84 | check for memsize mismatch. |
| 85 | check for pswd or bypass setup. |
| 86 | pswd checked. Do pgming before setup. |
| 87 | call the setup module. |
| 88 | back from setup, clr screen. |
| 89 | display power-on screen message. |
| 8A | display “Wait…” message. |
| 8B | do system & video BIOS shadowing. |
| 8C | load standard setup params into BIOSDATA. |
| 8D | check and initialize mouse. |
| 8E | check floppy disks. |
| 8F | configure floppy drives. |
| 90 | check hard disks. |
| 91 | configure IDE drives. |
| 92 | checking ROM BIOS data area again. |
| 93 | checking ROM BIOS data area some more. |
| 94 | setting base & ext mem sizes. |
| 95 | memsize adjusted for 1K, verifying disp mem. |
| 96 | initialization before calling C800h. |
| 97 | call ROM BIOS extension at C800h. |
| 98 | processing after extension returns. |
| 99 | configuring timer data area, printer base addr. |
| 9A | configuring serial port base addrs. |
| 9B | initialization before coprocessor test. |
| 9C | initializing the coprocessor. |
| 9D | processing after coprocessor initialized. |
| 9E | check ext kbd, kbdID, numlock settings. |
| 9F | issue keyboard ID command next. |
| A0 | kbd ID flag reset. |
| A1 | do cache memory test. |
| A2 | display any soft errors. |
| A3 | set keyboard typematic rate. |
| A4 | program memory wait states. |
| A5 | clear screen. |
| A6 | enable parity and NMIs. |
| A7 | initialization before calling E000h. |
| A8 | call ROM BIOS extension at E000h. |
| A9 | processing after extension returns. |
| B0 | display system config. Box. |
| B1 | test low memory exhaustively. |
| B2 | test extended memory exhaustively. |
| B3 | enumerate PCI space. |

**Run Time Status Codes**

Once your ControlWave project is normally running, the Port 80 display is usually blank to conserve power. *Table 5-4* shows status codes you may see during run-time.

*Table 5-4. Port 80 Run Time Status Codes*

| HEX Code | Definition | Notes |
|---|---|---|
| 00 | No Application | |
| 01 | Application Loaded | |
| 10 | Application Loaded - BPTs Set | Break Point(s) Set |
| 11 | Application Running | Display Blank |
| 12 | Running with BPT | Break Point in Debug |
| 1D | Currently Loading the Boot Project | |
| 51 | System Initialization in Progress | |
| 86 | Recovery Mode | SW3-3 = ON; during normal runtime operation you should set SW3-3 to OFF. |
| BA | Standby (redundant systems only) | Valid Standby (can take over) |
| BC | Standby (redundant systems only) | Connected to Master |
| BD | Standby (redundant systems only) | Not Connected to Master |
| BF | Battery Fail | Check S3-4 |
| CA | Hot Card Replacement in Progress | |
| CF | Invalid Checksum Detected | Unit Stopped |
| D0 | Diagnostic Mode | SW1-8 =OFF |
| D1 | Running Diagnostic | |
| DE | User Application has failed to start | Invalid I/O Card configuration |
| F0 | NPX Error | Unit Stopped |
| F1 | Waiting for Power-down | After NMI |
| FA | CPU Bd. Switch SW1-3 Set OFF Ignore Soft Switch Configuration - Use factory defaults | Flashes for 1 second At startup |
| FC | Waiting for Alt. Watchdog Timer | Unit Stopped |
| FD | Waiting for Updump | Core Dump in process or waiting to start |
| FE | FLASH Programming Error | |
| FF | Unit Crashed | Unit Stopped |

### 5.3.5 Reset Switch

The reset switch (SW4) is a momentary button that lets you reset (stop and restart) the ControlWave while you test the unit using WINDIAG diagnostic software.

**Caution** **Never use the reset switch during normal operation.**

## 5.4 WINDIAG Diagnostic Utility

WINDIAG is a software-based diagnostic tool you use to test the performance of I/O modules, CPU memory, communication ports, and other system components. .

WINDIAG is a PC-based program, so the ControlWave must be attached to and communicating with a PC running WINDIAG. Set configuration switch SW1-8 **OFF** (closed) on the CPU module to enable the diagnostic routines.

Establish communication between the ControlWave (with/without an application loaded) and the PC with a local or network port under the following conditions:

- Turn CPU module switches SW1-3 and SW1-8 **OFF** to run the WINDIAG program. Setting SW1-8 off prevents the boot project from running and places the ControlWave in diagnostic mode. Setting SW1-3 off causes the ControlWave to ignore soft switch settings and use factory defaults; this sets all serial ports to 9600 baud in preparation for the diagnostic tests.
- Use a null modem cable to connect RS-232 ports between the ControlWave and the PC. Use an RS-485 cable to connect the RS-485 ports of the ControlWave and the PC.

**Note:** For information on port connections and cabling, please see *Chapter 2*. See *Section 4.3.1* for information on communication port defaults.

- Reserve the port running a diagnostic test for exclusive use; you cannot use that port for any other purpose during testing.

Before starting the WINDIAG program, place any critical processes the ControlWave is handling under manual control. You cannot run WINDIAG while the ControlWave is running applications. Set the CPU modules switches SW1-3 and SW1-8 to **OFF**, and perform the following steps:

**1.** Start the NetView program in OpenBSI with your current network NETDEF file. A menu displays (similar to the one in *Figure 5-19*):

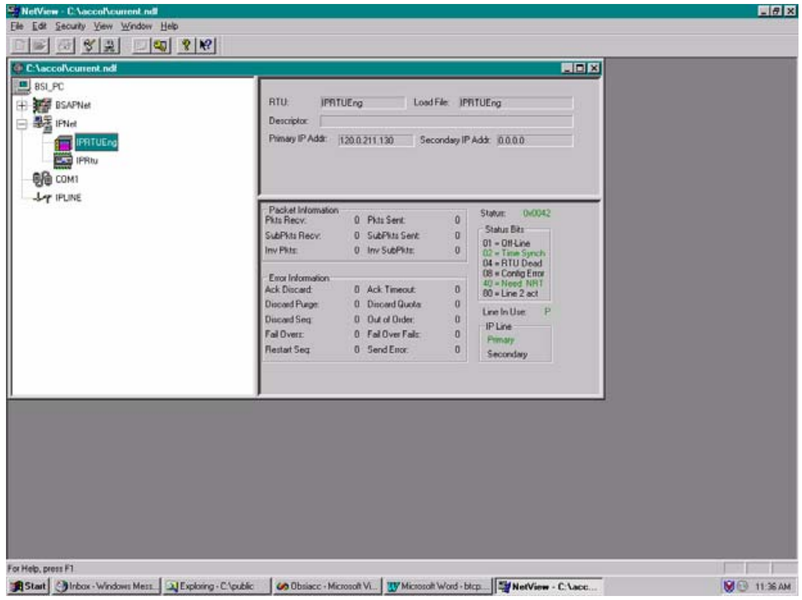



*Figure 5-19. NetView*

2. Select **Start** >**Programs** > **OpenBSI Tools** >**Common Tools** > **Diagnostics**. The Main Diagnostics menu (*Figure 5-20*) displays.

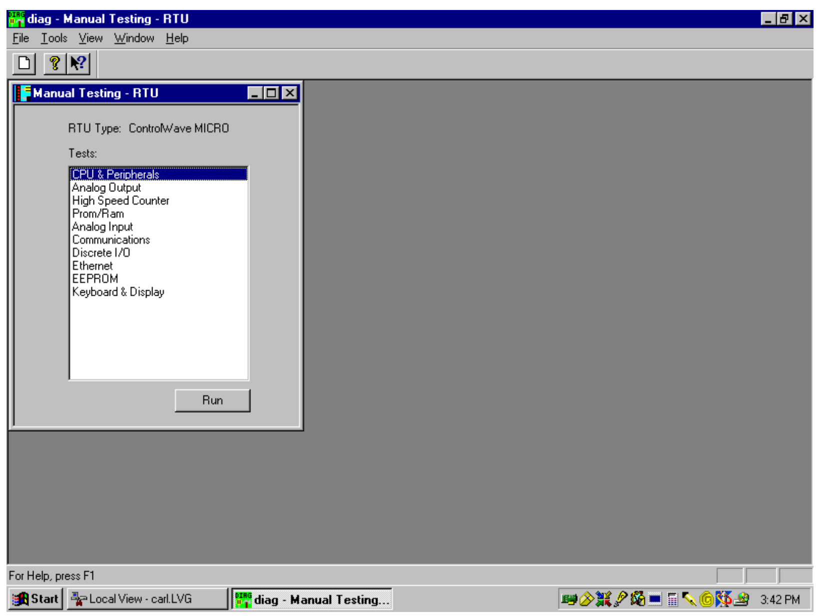



*Figure 5-20. WINDIAG Main Diagnostics Menu*

3. Select the module to be tested. Enter any prompted parameters (slot #, etc.). WINDIAG performs the diagnostics and displays pass/fail results.

4. After performing all diagnostic testing, exit WINDIAG and then exit the NetView if you don't have any other ControlWave units to test.

When you close NetView, the system asks whether you want to close OpenBSI. Select **Yes**.

**5.** Set switch SW1-8 on the CPU module to **ON** (open). The ControlWave should resume normal operation.

## 5.4.1 Available Diagnostics

Using WINDIAG, you can test all ControlWave modules with the exception of the PSSM. WINDIAG's Main Diagnostics Menu (see *Figure 5-20*) provides the following diagnostic selections:

| Option | Tests |
|---|---|
| CPU & Peripherals | Checks the CPU module (except for RAM & PROM). |
| Analog Output | Checks AOs on the Analog Output module. |
| High Speed Counter | Checks the Universal Digital Input (UDI) module. |
| Prom/Ram | Checks the CPU's RAM and PROM hardware. |
| Analog Input | Checks AIs on the Analog Input module. |
| Communications | Checks Communication ports 1 through 4. The loop-back tests require the use of a loop-back plug. |
| Discrete I/O | Checks DIs on Digital Input Module, DOs on Digital Output Modules. |
| Ethernet | Checks Ethernet Ports 1, 2, or 3. The loop-back tests require the use of a loop-back plug. |
| Low Level AI | Checks LLAI modules and RTD modules. |
| EEPROM | Checks the EEPROM. |
| Keyboard & Display | Not applicable. |

**Port Loop-back Test**

WINDIAG allows you to select the communication port (1 through 4) to test. Depending on the type of network (RS-232 or RS-485) and the port in question, a special loop-back plug is required:

- Ports 1 and 2 (RS-232) use a 9-pin female D-type loop-back plug (shown in the right side of *Figure 5-21*).

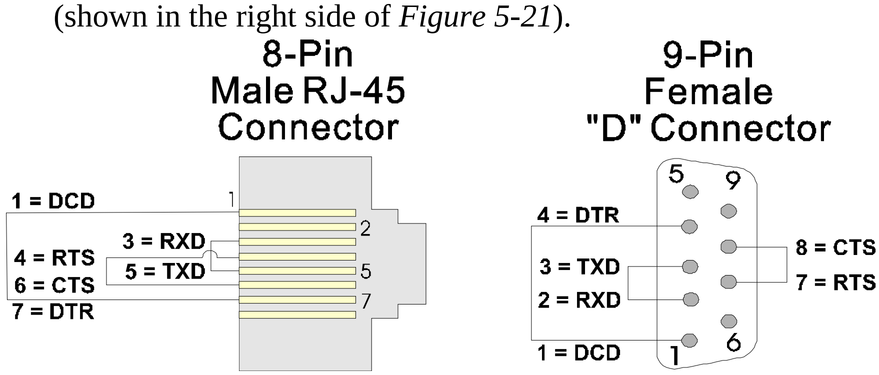



*Figure 5-21. RS-232 Loop-back Plugs*

- Port 3 (RS-232) use an 8-pin male RJ-45 loop-back plug (shown in left side of *Figure 5-21*).

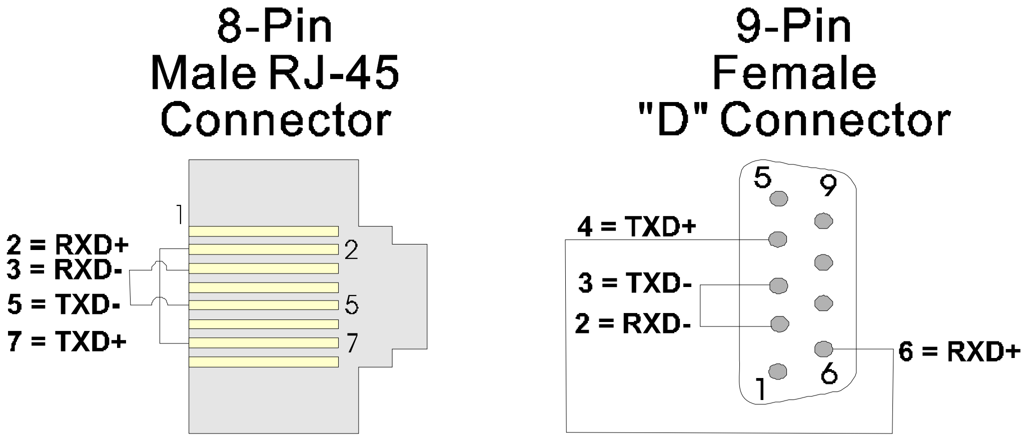



*Figure 5-22. RS-485 Loop-back Plugs*

- Port 3 (RS-485) use an 8-pin male RJ-45 loop-back plug (shown in left side of *Figure 5-22*).
- Port 4 (RS-485) use a 9-pin female D-type loop-back plug (shown in right side of *Figure 5-22*).

These tests verify the correct operation of the communication interface on ports COM1 through COM4.

**Note**: You **cannot** test a communications port while you are using it. You can only test currently unused ports. After you complete testing on all other communication ports (and verify their correct functioning), you must reconnect (using a now validated port) and test the remaining untested port.

## Test Procedure

Use this procedure to test the comm ports.

**1.** Connect an external loop-back plug to the port on the CPU or SCB port you want to test. Valid ports are:

- J2 of CPU board for COM1
- J3 of CPU board for COM2
- J2 of SCB board for COM3
- J3 of SCB board for COM4

**2.** Select **Communications** on the WINDIAG Main Diagnostics Menu. The Communications Diagnostic screen opens:

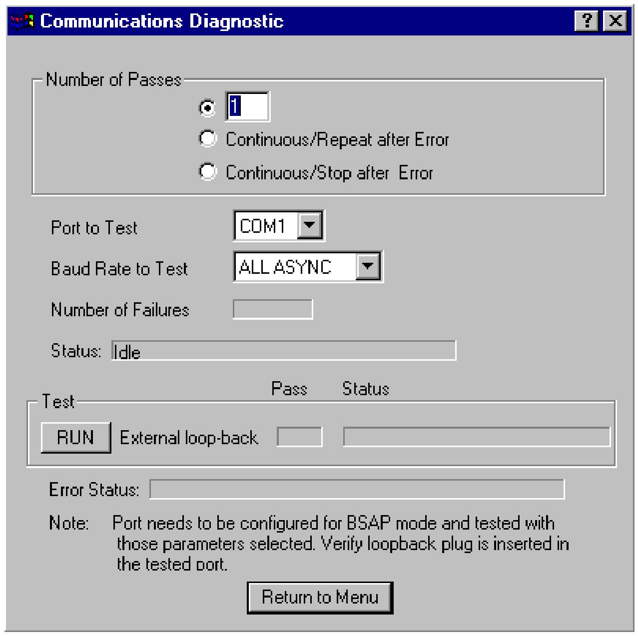



*Figure 5-23. Communications Diagnostic Menu*

**3.** Enter **5** in the Number of Passes field.

**4.** Select a port to test (click ▼ to display all available ports).

**Note**: The port you select must correlate to the port on which you placed the loop-back plug in step 1.

**5.** Select **115200** or **ALL ASYNC** as the baud rate (click ▼ to display all available rates).

**6.** Click **RUN** to start the test. At the completion of the test (which generally takes about 5 seconds), any failed results appear in the Status field to the right of the RUN button:

- TXD RXD Failure
- CTS RTS Failure

**7.** Click **Return to Menu** to display the WINDIAG Main Menu.

### Ethernet Port Loop-back Test

The **Ethernet** option on the WINDIAG Main Menu allows you to select the Ethernet communication port (1 through 3) to test.

This test configures the Ethernet port's ability to transmit and receive via the twisted pair. The text transmits frames and compares them against received frames. You need a special loop-back plug (shown in *Figure 5-24*) to perform the Ethernet loop-back test:

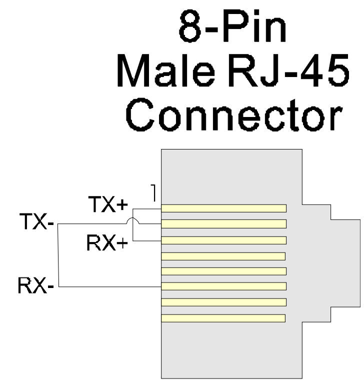



*Figure 5-24. RJ-45 Ethernet Loop-back Plug*

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**Note**: You **cannot** test a communications port while you are using it. You can only test currently unused ports. After you complete testing on all other communication ports (and verify their correct functioning), you must reconnect (using a now validated port) and test the remaining untested port.

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## Test Procedure

Use this procedure to test the Ethernet port.

**1.** Connect an external Ethernet loop-back plug (see *Figure 5-24*) to the Ethernet port on the CPU module to be tested.

**2.** Select **Ethernet** on the WINDIAG Main Diagnostics Menu. The Ethernet Diagnostic screen opens:

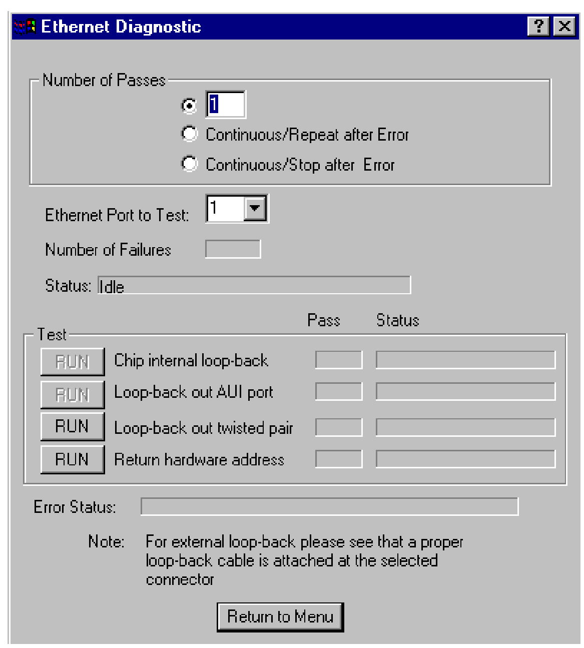


*Figure 5-25. Ethernet Diagnostic Menu*

**3.** Enter **1** in the Number of Passes field.

**4.** Enter **1, 2**, or **3** in the Ethernet Port to Test field.

**5.** Click **RUN** next to the Loop-back out twisted pair field to start the test. At the completion of the test, any failed results appear in the Status field next to the **Loop-back out twisted pair** label:

- No Hardware Present
- Loop-back Send Failed
- Loop-back Receive Failed
- Loop-back Compare Failed
- Error Information Returned

**6.** Disconnect the loop-back plug and reconnect the Ethernet cable to the ControlWave and the Ethernet hub.

**7.** Click **Return to Menu** to display the WINDIAG Main Menu.

## 5.5 Core Updump

In some cases—such as when a ControlWave fails for no apparent reason—you can upload a copy of the contents of SRAM and SDRAM to a PC for support personnel and service engineers to evaluate. This upload is called a “core updump.”

A core updump may be required if the ControlWave spontaneously enters a watchdog state that affects all system operation. This occurs when the system crashes as a result of a CPU timeout (resulting from improper software operation, a firmware glitch, and so on). In some cases, the watchdog state can recur but you cannot logically reproduce the conditions.

The CPU module’s RAM contains “crash blocks,” a firmware function provided specifically for watchdog troubleshooting. You can view and save the crash blocks by viewing the Crash Block Statistic Web Page (see the *Web_BSI Manual*, D5087). On request, you can forward crash block files to our technical support personnel. If they need additional information to evaluate the condition, the technical support group may request a core updump. Once the core updump process generates a file, you can forward that file to the support personnel for evaluation and resolution.

Use the following steps to preserve the “failed state” condition at a system crash and perform a core updump:

**1.** Set switch SW1-1 on the CPU module to **OFF** (Disable Watchdog Timer). Set switch SW1-4 to **OFF** (Enable Core Updump).

**2.** Wait for the error condition (typically FF on the Port 80 display).

**3.** Connect the ControlWave Comm Port 1 to a PC using a null modem cable.

**4.** Operate the Run/Remote/Local switch as follows:

**Note**: You must perform each step in less that one second.

**a.** Set Run/Remote/Local switch to **Run**

**b.** Set Run/Remote/Local switch to **Remote**

**c.** Set Run/Remote/Local switch to **Local**

**d.** Set Run/Remote/Local switch back to **Remote**

**e.** Set Run/Remote/Local switch back to **Local**

**5.** Start the PC's HyperTerminal program (at 115.2 kbaud) and generate a receive using the 1KX-Modem protocol. Save the resulting core updump in a file so you can forward it later to the technical support group.

By setting the CPU module switches SW1-1 and SW1-4 both off **before** the ControlWave fails, you prevent the ControlWave from automatically recovering from the failure and enable it to wait for you to take a core updump.

Once you complete the core updump, set the CPU module's switch SW1-1 to **ON** (Watchdog Enabled) and SW1-4 to **ON** (Normal Run).

With these switches set, power up the ControlWave and recommence standard operations.

When the "active" unit of a ControlWave Redundant Controller fails, it does not recover but forces the watchdog relay so the "standby" unit takes over. Once the core updump completes, set the failed unit's CPU switch SW1-1 to **ON** and SW1-4 to **ON**, if required, and then power cycle the failed unit to receive the sideload to become a valid standby unit. This applies to the ControlWave REDIO as well.

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# Appendix A – ControlWave Process Automation Controller – Special Instructions for Class I, Division 2 Hazardous Locations

1. The ControlWave Process Automation Controller is listed by Underwriters Laboratories (UL) as nonincendive and is suitable for use in Class I, Division 2, Groups A, B, C and D hazardous locations and non-hazardous locations only. Read this appendix carefully before installing a nonincendive ControlWave Process Automation Controller. In the event of a conflict between the main body of this manual and this appendix, always follow the instructions in this appendix.

2. All power and I/O wiring must be performed in accordance with Class I, Division 2 wiring methods as defined in Article 501-4 (b) of the National Electrical Code, NFPA 70, for installations within the United States, or as specified in Section 18-152 of the Canadian Electrical Code for installation in Canada.

**⚠ WARNING**

**EXPLOSION HAZARD**

**Substitution of components may impair suitability for use in Class I, Division 2 environments.**

**⚠ WARNING**

**EXPLOSION HAZARD**

**When situated in a hazardous location, turn off power before servicing / replacing the unit and before installing or removing I/O wiring.**

**⚠ WARNING**

**EXPLOSION HAZARD**

**Do NOT disconnect equipment unless the power has been switched off or the area is known to be non-hazardous.**

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# Appendix Z – Sources for Obtaining Material Safety Data Sheets

This device includes certain components or materials which may be hazardous if misused. For details on these hazards, please contact the manufacturer for the *most recent* material safety data sheet.

| Manufacturer | General Description | Emerson Part Number & Media Notes |
|---|---|---|
| Eagle Picher<br><br>http://www.eaglepicher.com | Lithium Thionyl Chloride Battery<br><br>(1/2 AA, 3.6V, 950 mAh - On-board) | 395600-01-4<br><br>Eagle Picher P/N LTC-9C |
| SAFT America<br><br>http://www.saftbatteries.com | Lithium Thionyl Chloride Battery<br><br>(1/2 AA, 3.6V, 950 mAh - On-board) | 395600-01-4<br><br>SAFT P/N LS-14250 |

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**W**

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