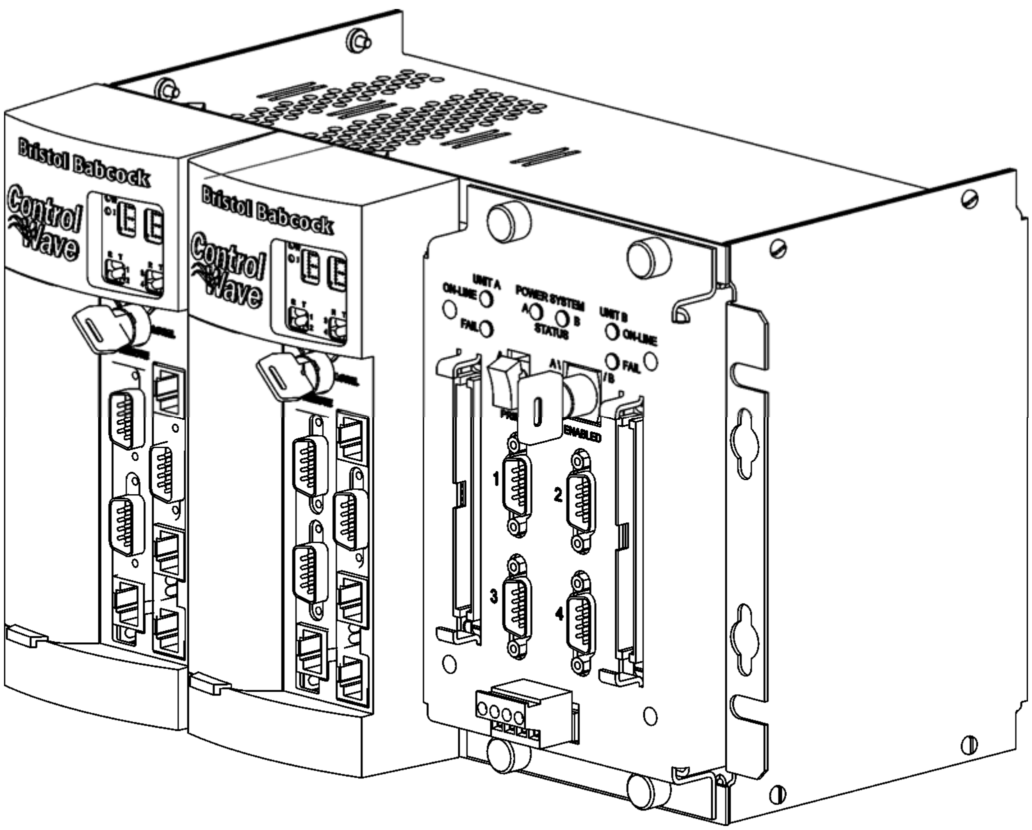
Instruction Manual
CI-ControlWaveRED
Oct., 2006

ControlWave **RED**

ControlWave Redundant Controller



ControlWave

Bristol

www.EmersonProcess.com/Bristol

EMERSON
Process Management

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 Bristol 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 in-formation is required, the purchaser is advised to contact Bristol .

RETURNED EQUIPMENT WARNING

When returning any equipment to Bristol for repairs or evaluation, please note the following: The party sending such materials is responsible to ensure that the materials returned to Bristol 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 Bristol and save Bristol harmless from any liability or damage which Bristol 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 at the back of this manual for proper care and handling of ESD-sensitive components.

Bristol 1100 Buckingham Street, Watertown, CT 06795
Telephone (860) 945-2200

WARRANTY

A. Bristol warrants that goods described herein and manufactured by Bristol are free from defects in material and workmanship for one year from the date of shipment unless otherwise agreed to by Bristol in writing.

B. Bristol warrants that goods repaired by it pursuant to the warranty are free from defects in material and workmanship for a period to the end of the original warranty or ninety (90) days from the date of delivery of repaired goods, whichever is longer.

C. Warranties on goods sold by, but not manufactured by Bristol, are expressly limited to the terms of the warranties given by the manufacturer of such goods.

D. All warranties are terminated in the event that the goods or systems or any part thereof are (i) misused, abused or otherwise damaged, (ii) repaired, altered or modified without Bristol's consent, (iii) not installed, maintained and operated in strict compliance with instructions furnished by Bristol, or (iv) worn, injured or damaged from abnormal or abusive use in service time.

E. THESE WARRANTIES ARE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED (INCLUDING WITHOUT LIMITATION WARRANTIES AS TO MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE), AND NO WARRANTIES, EXPRESS OR IMPLIED, NOR ANY REPRESENTATIONS, PROMISES, OR STATEMENTS HAVE BEEN MADE BY BRISTOL UNLESS ENDORSED HEREIN IN WRITING. FURTHER, THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION OF THE FACE HEREOF.

F. No agent of Bristol is authorized to assume any liability for it or to make any written or oral warranties beyond those set forth herein.

REMEDIES

A. Buyer's sole remedy for breach of any warranty is limited exclusively to repair or replacement without cost to Buyer of any goods or parts found by Seller to be defective if Buyer notifies Bristol in writing of the alleged defect within ten (10) days of discovery of the alleged defect and within the warranty period stated above, and if the Buyer returns such goods to Bristol's Watertown office, unless Bristol's Watertown office designates a different location, transportation prepaid, within thirty (30) days of the sending of such notification and which upon examination by Bristol proves to be defective in material and workmanship. Bristol is not responsible for any costs of removal, dismantling or reinstallation of allegedly defective or defective goods. If a Buyer does not wish to ship the product back to Bristol, the Buyer can arrange to have a Bristol service person come to the site. The Service person's transportation time and expenses will be for the account of the Buyer. However, labor for warranty work during normal working hours is not chargeable.

B. Under no circumstances will Bristol be liable for incidental or consequential damages resulting from breach of any agreement relating to items included in this quotation, from use of the information herein or from the purchase or use by Buyer, its em-ployees or other parties of goods sold under said agreement.

How to return material for Repair or Exchange

Before a product can be returned to Bristol for repair, upgrade, exchange, or to verify proper operation, form (GBU 13.01) must be completed in order to obtain a RA (Return Authorization) number and thus ensure an optimal lead time. Completing the form is very important since the information permits the Bristol Repair Dept. to effectively and efficiently process the repair order.

You can easily obtain a RA number by:

A. FAX
Completing the form (GBU 13.01) and faxing it to (860) 945-3875. A Bristol Repair Dept. representative will return call (or other requested method) with a RA number.

B. E-MAIL
Accessing the form (GBU 13.01) via the Bristol Web site (www.bristolbabcock.com) and sending it via E-Mail to brepair@bristolbabcock.com. A Bristol Repair Dept. representative will return E-Mail (or other requested method) with a RA number.

C. Mail
Mail the form (GBU 13.01) to

Bristol Inc.
Repair Dept.
1100 Buckingham Street
Watertown, CT 06795

A Bristol Repair Dept. representative will return call (or other requested method) with a RA number.

D. Phone
Calling the Bristol Repair Department at (860) 945-2442. A Bristol Repair Department representative will record a RA number on the form and complete Part I, then send the form to the Customer via fax (or other requested method) for Customer completion of Parts II & III.

A copy of the completed Repair Authorization Form with issued RA number should be included with the product being returned. This will allow us to quickly track, repair, and return your product to you.

Bristol Inc. Repair Authorization Form (off-line completion)

(Providing this information will permit Bristol Inc. to effectively and efficiently process your return. Completion is required to receive optimal lead time. Lack of information may result in increased lead times.)

Date___________________ **RA #**___________________**SH**_ **Line No.**____________

Standard Repair Practice is as follows: Variations to this is practice may be requested in the "Special Requests" section.

- Evaluate / Test / Verify Discrepancy
- Repair / Replace / etc. in accordance with this form
- Return to Customer

Please be aware of the Non warranty standard charge:

- There is a $100 minimum evaluation charge, which is applied to the repair if applicable (√ in "returned" B,C, or D of part III below)

Part I **Please complete the following information for single unit or multiple unit returns**

Address No. ________________________ **(office use only)** **Address No.** ________________________ **(office use only)**

Bill to :____ **Ship to:**____

____ ____

____ ____

Purchase Order:__________________________________ **Contact Name:**__________________________________

Phone:_________________________ **Fax:**_________________________**E-Mail:** ______________________________

Part II **Please complete Parts II & III for each unit returned**

Model No./Part No.________________________________ **Description** ______________________________________

Range/Calibration ________________________________ **S/N** ___________________

Reason for return : ☐ Failure ☐ Upgrade ☐ Verify Operation ☐ Other ______________________________

1. Describe the conditions of the failure (Frequency/Intermittent, Physical Damage, Environmental Conditions, Communication, CPU watchdog, etc.)

____

____

____

____(Attach a separate sheet if necessary)

2. Comm. interface used: ☐ Standalone ☐ RS-485 ☐ Ethernet ☐ Modem (PLM (2W or 4W) or SNW) ☐Other:_______________
3. What is the **Firmware** revision? _____________________ What is the **Software** &version? ___________________

Part III If checking "replaced" for any question below, check an alternate option if replacement is not available

A. If product is within the warranty time period but is excluded due to Bristol's warranty clause, would you like the product: ☐ repaired ☐ returned ☐ replaced ☐ scrapped?

B. If product were found to exceed the warranty period, would you like the product: ☐repaired ☐ returned ☐ replaced ☐ scrapped?

C. If product is deemed not repairable would you like your product: ☐ returned ☐ replaced ☐ scrapped?

D. If Bristol is unable to verify the discrepancy, would you like the product: ☐ returned ☐ replaced ☐ *see below?

* Continue investigating by contacting the customer to learn more about the problem experienced? The person to contact that has the most knowledge of the problem is: ______________________________ phone_____________________

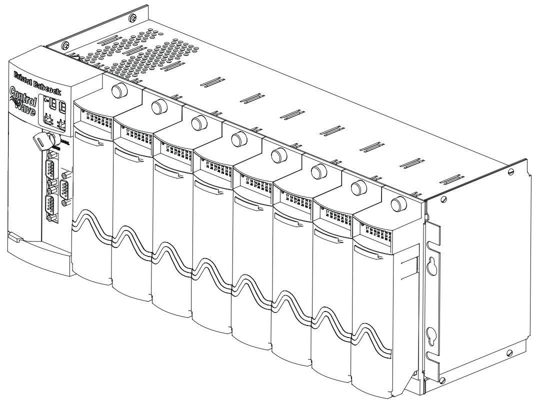
If we are unable to contact this person the backup person is: _________________________ phone_____________________

Special Requests: ____

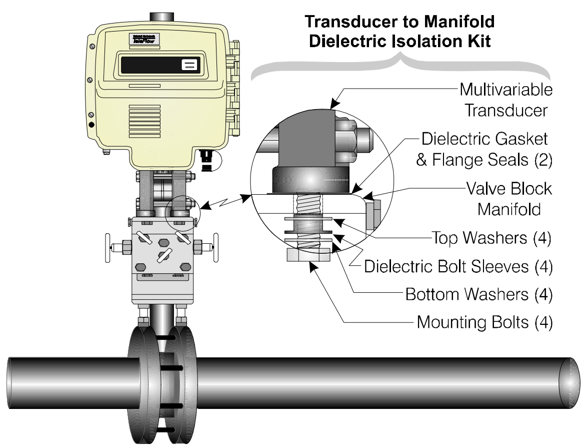
Ship prepaid to: **Bristol Inc., Repair Dept., 1100 Buckingham Street, Watertown, CT 06795**
Phone: 860-945-2442 Fax: 860-945-3875 Form GBU 13.01 Rev. B 04/11/06

Bristol
Training

GET THE MOST FROM YOUR BRISTOL BABCOCK INSTRUMENT OR SYSTEM



- Avoid Delays and problems in getting your system on-line
- Minimize installation, start-up and maintenance costs.
- Make the most effective use of our hardware and software.
- Know your system.



As you know, a well-trained staff is essential to your operation. Bristol Inc. offers a full schedule of classes conducted by full-time, professional instructors. Classes are offered throughout the year at three locations: Houston, Orlando and our Watertown, CT headquarters. By participating in our training, your personnel can learn how to install, calibrate, configure, program and maintain any and all Bristol products and realize the full potential of your system.

For information or to enroll in any class, contact our training department in Watertown at (860) 945-2343. For Houston classes, you can also contact our Houston office, at (713) 685-6200.

A Few Words About Bristol Inc.

For over 100 years, Bristol® has been providing innovative solutions for the measurement and control industry. Our product lines range from simple analog chart recorders, to sophisticated digital remote process controllers and flow computers, all the way to turnkey SCADA systems. Over the years, we have become a leading supplier to the electronic gas measurement, water purification, and wastewater treatment industries.

On off-shore oil platforms, on natural gas pipelines, and maybe even at your local water company, there are Bristol Inc. instruments, controllers, and systems running year-in and year-out to provide accurate and timely data to our customers.

Getting Additional Information

In addition to the information contained in this manual, you may receive additional assistance in using this product from the following sources:

Help Files / Release Notes

Many Bristol software products incorporate help screens. In addition, the software typically includes a 'read me' release notes file detailing new features in the product, as well as other information which was available too late for inclusion in the manual.

Contacting Bristol Inc. Directly

Bristol's world headquarters is located at 1100 Buckingham Street, Watertown, Connecticut 06795, U.S.A.

Our main phone numbers are:

(860) 945-2200
(860) 945-2213 (FAX)

Regular office hours are Monday through Friday, 8:00AM to 4:30PM Eastern Time, excluding holidays and scheduled factory shutdowns. During other hours, callers may leave messages using Bristol's voice mail system.

Telephone Support - Technical Questions

During regular business hours, Bristol's Application Support Group can provide telephone support for your technical questions.

For technical questions about TeleFlow products call (860) 945-8604.

For technical questions about **Control**Wave call (860) 945-2394 or (860) 945-2286.

For technical questions regarding Bristol's **OpenEnterprise** product, call (860) 945-3865 or e-mail: **scada@bristolbabcock.com**

For technical questions regarding **ACCOL** products, **OpenBSI Utilities**, **UOI** and all other software except for **Control**Wave and **OpenEnterprise** products, call (860) 945-2286.

For technical questions about **Network 3000** hardware, call (860) 945-2502.

You can e-mail the Application Support Group at: **bsupport@bristolbabcock.com**

The Application Support Group maintains an area on our web site for software updates and technical information. Go to: **www.bristolbabcock.com/services/techsupport/**

For assistance in interfacing Bristol hardware to radios, contact Bristol's **Communication Technology Group** in Orlando, FL at **(407) 629-9463 or (407) 629-9464**.

You can e-mail the Communication Technology Group at:
orlandoRFgroup@bristolbabcock.com

Telephone Support - Non-Technical Questions, Product Orders, etc.

Questions of a non-technical nature (product orders, literature requests, price and delivery information, etc.) should be directed to the nearest sales office (listed on the rear cover of this manual) or to your Bristol-authorized sales representative.

Please call the main Bristol Inc. number (860-945-2200) if you are unsure which office covers your particular area.

Visit our Site on the World Wide Web

For general information about Bristol Inc. and its products, please visit our site on the World Wide Web at: **www.bristolbabcock.com**

Training Courses

Bristol's Training Department offers a wide variety of courses in Bristol hardware and software at our Watertown, Connecticut headquarters, and at selected Bristol regional offices, throughout the year. Contact our Training Department at **(860) 945-2343** for course information, enrollment, pricing, and scheduling.

CI-**Control**Wave**RED**

ControlWave
Redundant Controller

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CI-ControlWaveRED

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Section 1
INTRODUCTION

1.1 GENERAL DESCRIPTION

ControlWave™ Redundant Controllers (**Control**Wave**RED**) employ a modular hardware architecture with a modern and rugged industrial design that in keeping with the rest of the line of **Control**Wave Industrial Process Automation Controllers is both simple to install and configure. **Control**Wave™ Redundant Controllers utilize dual CPUs that communicate with the same physical remote I/O. One CPU is on line, while the other functions as a "hot" backup. A CPU & Communications Redundancy Switch (CCRS) Module included in the system provides arbitration between the two processors. Should the CCRS Module detect a failure in the on-line unit, it will switch to the backup unit without interrupting control and communication functions. Each **Control**Wave**RED** CPU Module utilizes an AMD Elan SC520 microprocessor running at 100 MHz and is powered by its own Power Supply/Sequencer Module. Two Bezel Assembles are provided (one for each CPU & PSSM pair).

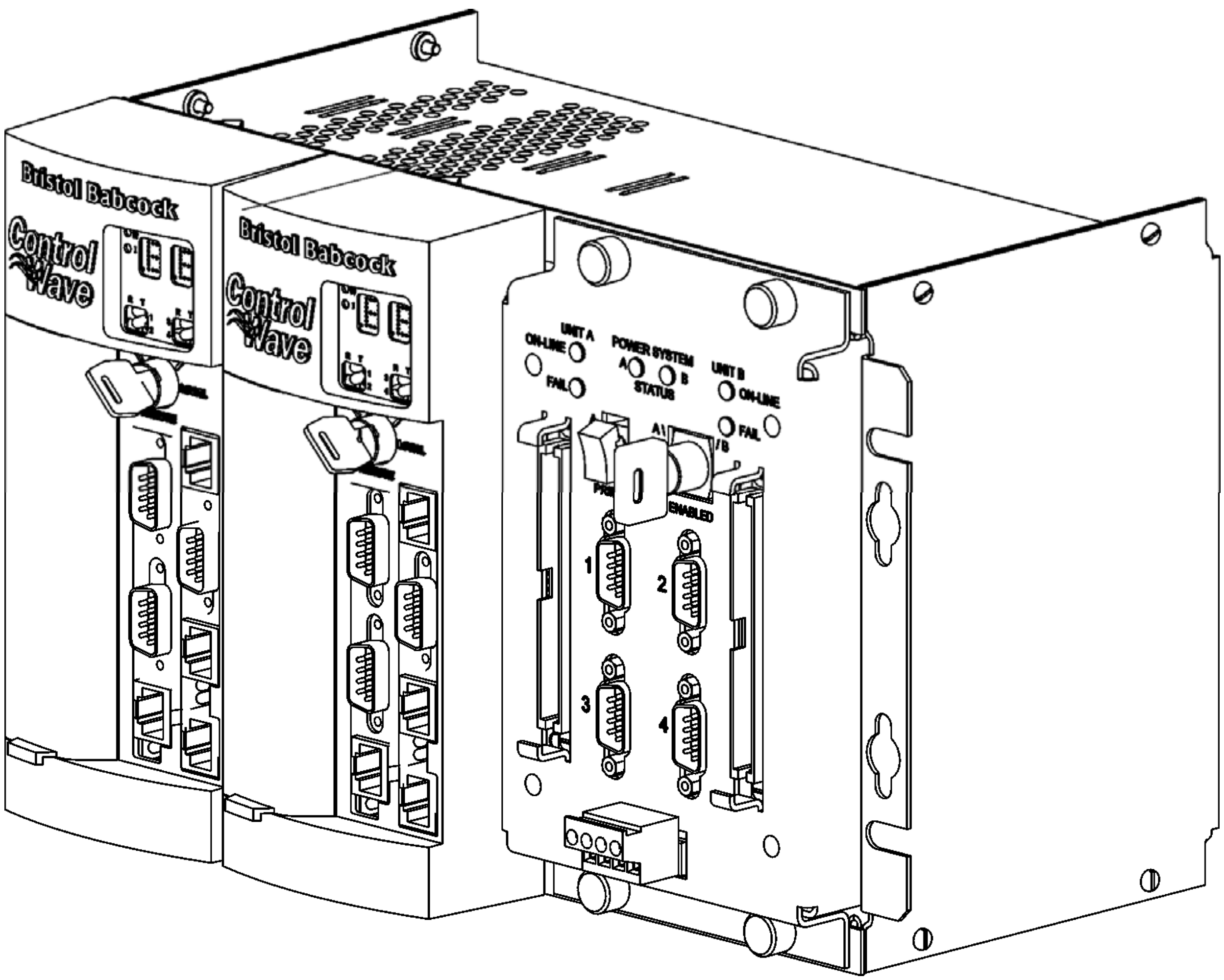


Figure 1-1 - Control Wave**RED Assembly**

At the heart of the system is the **Control**Wave**RED** CPU & Communications Redundancy Switch Module that provides for automatic or manual switching of the CPU Module that is communicating with the Remote I/O Rack or the I/O Expansion Rack being controlled. The **Control**Wave™ CPU & Communications Redundancy Switch Module (CCRSM) also provides for controlled switching of the four non-Ethernet communications ports associated with the selected or 'On-Line' CPU Module. Each CPU Module can have two, three or four RS-232 communication ports. Ports COM3 and COM4 (on the Secondary Communications Board) can be individually factory configured for either RS-232 or RS-485 operation. Port connections from the redundant CPU Modules (A & B) are routed to the front of the CPU & Communications Redundancy Switch Module by means of two cable headers and custom cabling.

ControlWave™ Redundant Controllers provide the following key features:

- Low power consumption
- Small size (supports panel-mount or 19-inch rack-mount installations)
- **Contro**lWave**RED** CPU Architecture compatible with IBM Personal Computers with a system BIOS.
  - BIOS FLASH - 512 Kbytes contained in a single IC
  - FLASH Memory - 4 Mbytes to 64 Mbytes mounted in up to 4 48-pin TSOPs
  - Memory (SRAM) - 2 Mbytes of soldered-down static RAM (SRAM) is implemented with four 512K x 8 asynchronous SRAMs that are configured as a 1M x 16-bit array. Each SRAM device operates at 3.3V and is packaged in a 32-pin TSOP. An additional 2Mbytes of SRAM may be factory installed.
  - SDRAM - 4Mbytes of on board Synchronous Dynamic RAM (SDRAM) (2 x KM416S1120DT).
  - Three 10/100Base-T Ethernet ports implemented via AMD Am79C973 Pcnet FAST *III* Controllers. The built-in transceiver provides a full-duplex implementation with a RJ-45 10/100Base-T Connector (J4).
- **Control**Wave**RED** CPU & Communications Redundancy Switch Module (CCRSM) provides for automatic switching of the CPU Module and its four associated communications ports whenever a defective CPU Module or associated PSSM is detected.
- **LED** annunciation of the On-Line CPU and Power Supply/Sequencer Modules.
- A pluggable Terminal Block on the front of the CPU & Communications Redundancy Switch Module provides dual pairs of isolated relay contacts that indicate the on-line status of the 'A' and 'B' redundant controllers.

1.2 **Control**Wave**RED** PROGRAMMING ENVIRONMENT

The **Control**Wave**RED** programming environment uses industry-standard tools and protocols to provide a flexible, adaptable approach for various process control applications in the water treatment, wastewater treatment, and industrial automation business.

The **Control**Wave**RED** programming environment consists of a set of integrated software tools which allow a user to create, test, implement, and download complex control strategies for use with Bristol Babcock's **Control**Wave and **Control**Wave**RED** Control-lers.

The tools that make up the programming environment are:

- **Control**Wave **Designer** load building package offers several different methods for generating and debugging control strategy programs including function blocks, ladder logic, structured languages, etc. The resulting process control load programs are fully compatible with **IEC 61131-3** standards. Various communication methods as offered, including TCP/IP, serial links, as well as communication to Bristol Babcock's **Open BSI** software and networks.

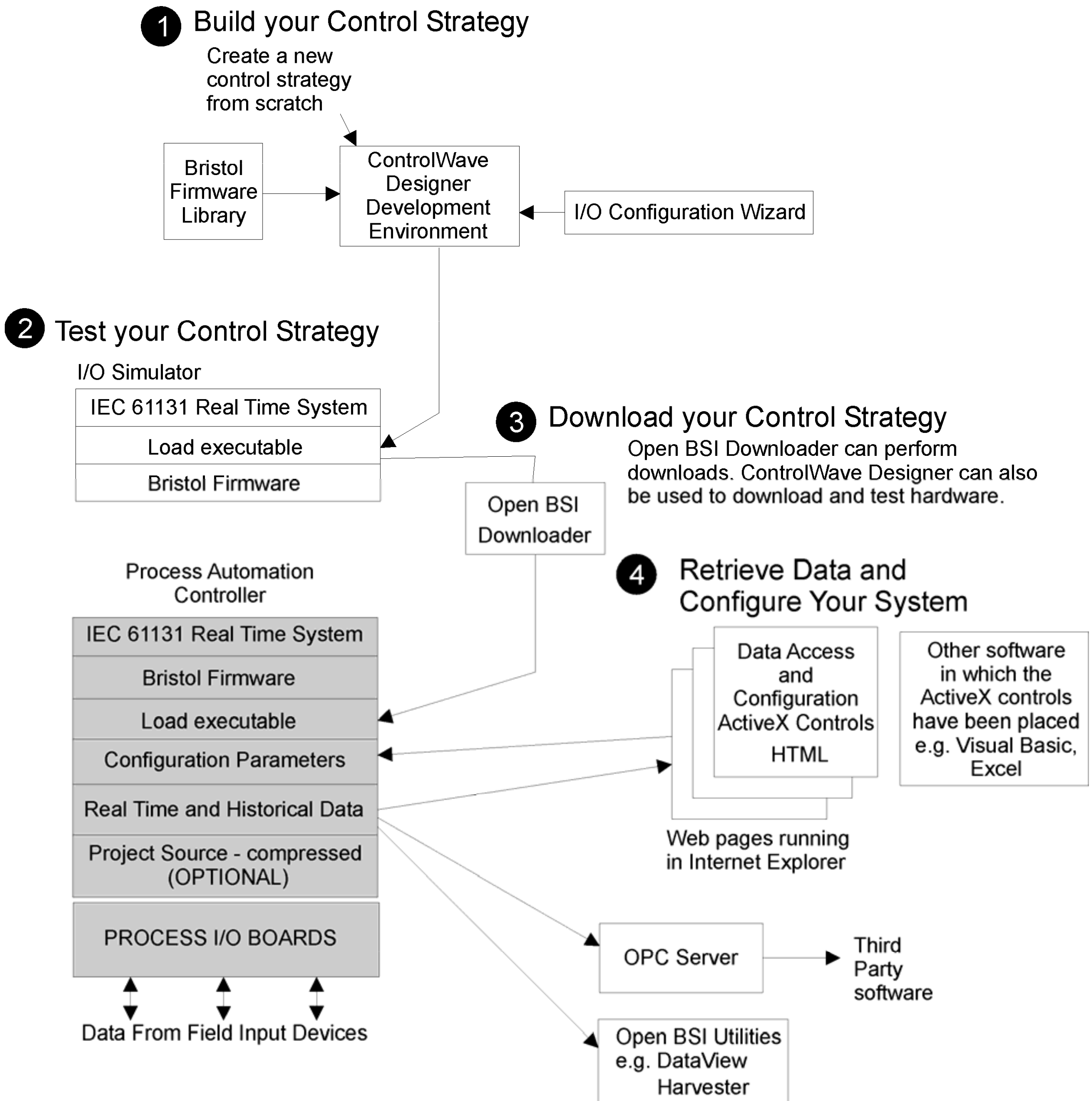


Figure 1-2 - Control Wave **- Control Strategy Software Diagram**

- The **I/O Configuration Wizard**, accessible via a menu item in **Control**Wave Designer, allows you to define **process I/O modules** in the **Control**Wave and configure the individual mapping of I/O points for digital and analog inputs and outputs.

- The **Bristol Firmware Library** (Bbifsb) which is imported into **Control**Wave Designer, includes a series of Bristol Babcock specific function blocks. These pre-programmed function blocks accomplish various tasks common to most user applications including alarming, historical data storage, as well as process control algorithms such as PID control.

- The **Bristol I/O Simulator** allows the load program generated through **Control**Wave Designer to be tested on a PC, with simulated analog and digital inputs and outputs.

The I/O Simulator utilizes the identical IEC 61131 real time system used in the **Control**Wave**RED** controller; this allows initial I/O testing and debugging to be performed in a safe, isolated environment, without the need for a running **Control**Wave**RED** controller and process I/O boards.

- The **OPC Server** (**O**bject Linking and Embedding (OLE) for **P**rocess **C**ontrol) allows real-time data access to any OPC compliant third-party software packages.

- A series of **Configuration Controls** are available for setting up various aspects of the system such as historical data storage, system security, and soft switches. Additional **Data Access Controls** are also available for retrieval of real-time data values and communication statistics. The configuration controls and the data access 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.

- **User-defined Web Pages** - If desired, user-defined web pages can be stored within a PC to provide a customized human-machine interface (HMI).

1.3 PHYSICAL DESCRIPTION

ControlWave Redundant Controllers are comprised of the following major components:

- Two CPU Modules (see Section 1.3.1) & System Batteries (see Section 1.3.1.3)
- Two Power Supply/Sequencer Modules (PSSM) (see Section 1.3.2)
- CPU & Communications Redundancy Switch Module (CCRSM) (see Section 1.3.3)
- Backplane Assembly (1.3.4)
- Chassis Assembly (see Section 1.3.5)

1.3.1 CPU Modules

Each CPU Module houses a CPU Board and optionally, a Secondary Communications Board (SCB). The CPU Board is a multilayer board that provides **Control**Wave**RED** CPU, I/O monitor/control, memory and communication functions. This board operates over an extended temperature range with long-term product reliability.

ControlWave**RED** CPU Boards are based on AMD's Elan SC520 Microcontrollers. The CPU operates at 2.5V with a system clock speed of 100 MHz. The Microcontroller is packaged in a 388-pin Plastic Ball Grid Array. The base version of the CPU Board includes two RS-232 communication ports, an Ethernet RJ-45 communication port, 2 Mbytes of Static RAM (SRAM), 4 Mbytes of Synchronous Dynamic RAM (SDRAM), 512 kbytes of BIOS in FLASH, 4 Mbytes simultaneous read/write FLASH (soldered down). Basic CPU components and features are summarized as follows:

- 2.5V Core 3.3V I/O 66/100MHz AMD Elan SC520 Processor featuring:
  Floating Point unit
  16-KB write-back cache
  Integrated PCI host bridge controller
  DRAM controller (up to 256MB supported)
  Standard PC/AT-compatible peripherals
  Three general purpose timers
  Watchdog timer
  Software timer

Synchronous serial interface
Flexible address decoding
Programmable I/O pins

- 512KB FLASH BIOS IC, 29LV040B, 90 nanosecond, 8-bit access
- 2MB SRAM, 3.3V, 512K x 8, soldered-down (factory upgradeable to 4Mbyte)
- 4MB simultaneous read/write FLASH, TSOP sites (factory upgradeable to 64Mbyte)
- Two 9 wire PC/AT compatible (RS-232) serial communications ports
- I/O Bus Interface capable of driving up to 8 slots
- 10/100Base-T Ethernet interface implemented by an AMD Pcnet Fast III Controller
- Port 80 diagnostic LED Display
- PC/104-Plus Expansion Connector
- 4Mbyte on board SDRAM - 2 x KM416S1120DT
- 3 position key-lock switch
- 3.6V, 950mA-hr Lithium ½ AA cell battery provides backup for the real-time clock, CMOS RAM & System SRAM

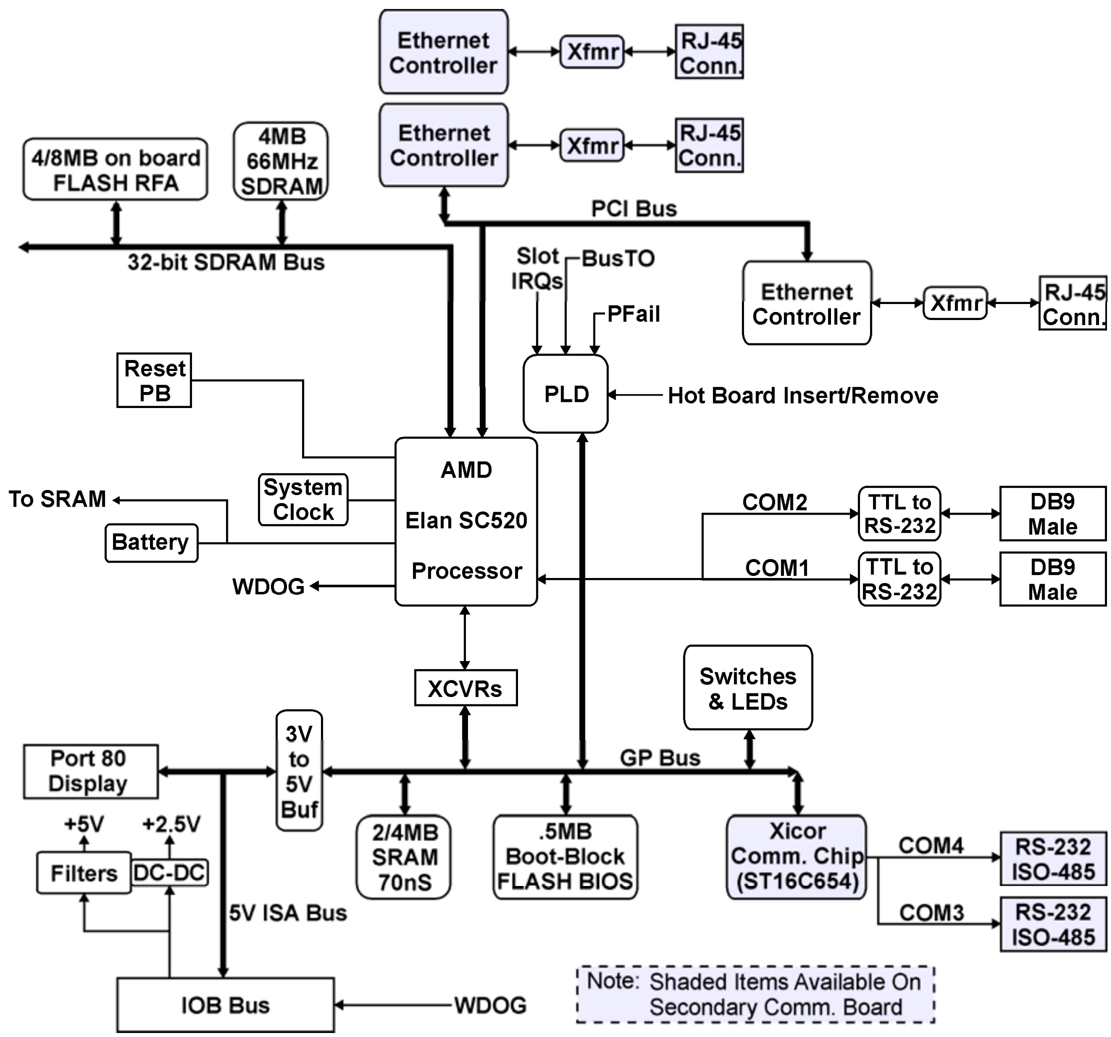


Figure 1-3 - Block Diagram of ControlWave™ CPU Board

Figure 1-3 provides the CPU Module block diagram. The shaded components of Figure 1-3 are features that are only available on Secondary Comm. Boards.

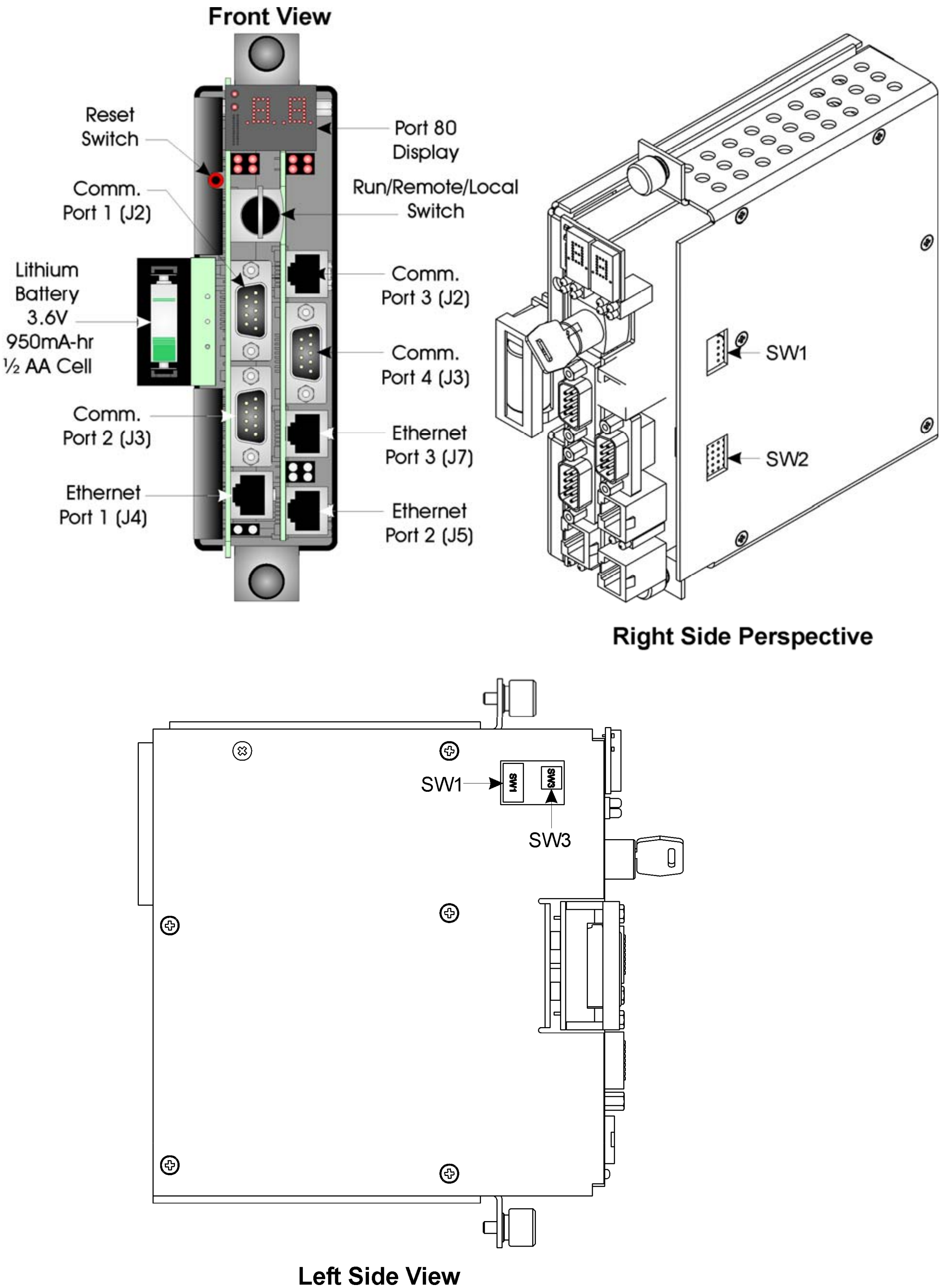


Figure 1-4 - Control Wave**RED CPU Module**

Three basic versions of the dual CPU Modules are available (Note: All CPU boards have 2 RS-232 Ports and 1 Ethernet Port):

CPU Bd. & SCB (SCB contains 2 RS-232 & 2 Ethernet Ports)
CPU Bd. & SCB (SCB contains 1 RS-232 (COM4), 1 RS-485 (COM3) & 2 Ethernet Ports)
CPU Bd. & SCB (SCB contains 2 RS-485 & 2 Ethernet Ports)

The BIOS is contained in a single 512 Kbyte uniform sector FLASH IC. This device resides on the General Purpose (GP) bus, operates at 3.3V and is configured for 8-bit access.

The CPU Board contains four 48-pin TSOP sites that accept FLASH devices ranging in density from 2 to 16 Mbytes. Units are factory configured for from 4 to 64 Mbytes of industrial simultaneous read/write (SMR) FLASH memory. The FLASH memory is a linear array of 16 Mbit parts configured for 32-bit, 16-bit or 8-bit read access (32-bit write access) and is connected to the SDRAM bus.

The base version of the CPU Module has 2Mbyte of soldered-down static RAM, implemented with four 512K x 8 asynchronous SRAMs that are configured as a 1M x 16-bit array. SRAM operate at 3.3V and are packaged in 32-pin TSOPs. An additional 2Mbyte of SRAM may be factory added to raise the board total to 4Mbyte. SRAM is placed into data retention mode (powered by a backup 3.6V lithium battery) when power is lost. The SRAM supports 16-bit or 8-bit accesses and is connected to the GP bus.

CPU Modules contain 4Mbyte of SDRAM housed in 2 KM416S1120DTs ICs (U15 & U16).

1.3.1.1 CPU Module Connectors

The CPU Modules contain up to nine (9) user accessible connectors that function as follows (see Table 1-1):

Table 1-1 - CPU Board Connector Summary

Ref.	# Pins	Function	Notes
J1	132-pin	I/OB Connector	see Figure 4-1
J2	9-pin	COM1 9-pin male D-sub	see Figure 4-2 & Table 4-2
J2	8-pin	COM3 RJ-45 (RS-232 or RS-485) *	see Figure 4-3 & Table 4-3
J3	9-pin	COM2 9-pin male D-sub	see Figure 4-2 & Table 4-2
J3	9-pin	COM4 9-pin male D-sub *	see Figure 4-2 & Table 4-2
J4	8-pin	Ethernet 10/100Base-T RJ-45 #1	see Figure 4-4 & Table 4-4
J5	8-pin	Ethernet 10/100Base-T RJ-45 #2 *	see Figure 4-4 & Table 4-4
J7	8-pin	Ethernet 10/100Base-T RJ-45 #3 *	see Figure 4-4 & Table 4-4
J10	3-pin	Battery Connector	see Figure 4-5

*** = Located on Secondary Comm. Board**

<u>CPU Board Comm. Port Connectors J2, J3 and SCB Comm. Port Connector J3</u>

The CPU Module supports up to three external 9-pin RS-232 serial ports (COM1, COM2 and COM4 (with COM4 located on the Secondary Communication Board - a PC/104 Plus expansion option). COM1, COM2 and COM4 utilize standard 9-pin male D-sub connectors and are PC/AT compatible ports. COM4 can also be factory configured for Isolated RS-485 operation instead of RS-232.

<u>CPU Module Comm. Port Connector J2 (SCB)</u>

8-pin RJ-45 connector J2 (COM3) is provided on the Secondary Communications Board and is factory set for use as an Isolated RS-485 port or is factory set for use as a RS-232 port.

This port is referenced as COM3. **Note: COM3 will be configured for RS-485 operation on SCB's configured with one RS-232 and one RS-485 port.**

Ethernet Port Connectors J4, J5 (SCB) and J7 (SCB)

Up to three Ethernet ports are supported via 8-pin RJ-45 connectors. The 10/100Base-T Ethernet interfaces are implemented using AMD Am79C973 Pcnet - FAST *III* controllers. These devices logically reside on the PCI bus and are wired for full bus-mastering capability and provide a full-duplex implementation. The Ethernet Port associated with J4, J5 (SCB) and J7 (SCB) are assigned as PCI devices 1, 2 and 3 respectively and are assigned PCI interrupts A, B and C respectively.

CPU Board I/OB Connector J1

CPU Board I/O bus connector J1 provides a 132-pin interface between Backplane PCB slot #2 (P2) or #4 (P4) and the CPU Module (CPUA or CPUB respectively).

CPU Board Battery Connector J10

CPU Board connector J10 provides a 3-pin interface to an external 3.6V Lithium Battery that is a component of the CPU Module. The 3.6V, 950mA-hr lithium ½ AA cell battery provides backup power for the real-time clock, CMOS RAM and the system's Static RAM (SRAM). Battery backup is enabled when CPU Module switch SW3-4 is set to the ON position.

1.3.1.2 CPU Module Switches

Cutouts are provided in the CPU Module to provide user access to the configuration switches. Two user configurable DIP switches are provided on the CPU Board; eight-bit DIP switch SW1 is provided for user configuration settings while four-bit DIP switch SW3 provides battery back-up and forced recovery functions. The optional Secondary Communications Board (SCB) has two eight position DIP switches (one per communications port) that provide loopback control for RS-232 ports or loopback, termination control, and receiver bias settings for isolated RS-485 ports.

The CPU Module's RUN/REMOTE/LOCAL Switch is set via a removable key. This switch can be identified by a removable key that allows the user to set the unit as follows: When set to 'RUN,' this switch prevents the user from performing any ControlWave Designer Debug/Program operations such as Start/Stop, download of application, etc. Use of the 'LOCAL' or 'REMOTE' setting depends on the type of network connection the Comm. Port in question has been configured for, via **Control**Wave Designer (Port selection can be IP, Serial or OpenBSI). If a Comm. Port has been configured for IP or OpenBSI (BSAP) communications, it is considered a remote port and the RUN/REMOTE/LOCAL Switch should be set to 'REMOTE' to receive a Debug or Program download. However, if the Comm. Port in question has been configured for Serial communications, it is considered a local port and the RUN/REMOTE/LOCAL Switch should be set to 'LOCAL' to receive a Debug/Program download.

The Reset Switch allows the user to reset (stop and restart) the unit during maintenance routines or as required.

Table 1-2 - Assignment of CPU Bd. Switch SW1 - User Configurations

Switch	Function	Setting - (ON = Factory Default)
SW1-1	Watchdog Enable	ON = Watchdog circuit is enabled OFF = Watchdog circuit is disabled
SW1-2	Lock/Unlock Soft Switches	ON = Write to Soft Switches and FLASH files OFF = Soft Switches, configurations and FLASH files are locked
SW1-3	Use/Ignore Soft Switches	ON = Use Soft Switches (configured in FLASH) OFF = Ignore Soft Switch Configuration and use factory defaults
SW1-4	Core Updump (see Section 3.6)	ON = Core Updump Disabled OFF = Core Updump via use of Run/Remote/Local Key Switch
SW1-5	SRAM Control	ON = Retain values in SRAM during restarts OFF = Force system to reinitialize SRAM
SW1-6	Redundancy Enable/Disable	ON = Redundancy Disabled OFF = Redundancy Enabled
SW1-7	Unit A/Unit B	ON = CPU assigned as 'A' CPU - OFF = CPU assigned as 'B' CPU
SW1-8	Enable WINDIAG	ON = Normal Operation (don't allow WINDIAG to run test) OFF = Disable boot project (allow WINDIAG to run test)

Table 1-3 - Assignment of CPU Bd. Switch SW3
Firmware Load Control/Recover Mode/Battery Enable

Switch	Function	Setting
SW3-1	Not Used	
SW3-2	System Firmware Load Control *	ON = Disable remote download of System Firmware OFF = Enable remote download of System Firmware
SW3-3	Force Recovery Mode	ON = Force recovery mode (via CW Console) OFF = Recovery mode disabled
SW3-4	SRAM & RTC Battery Enable	ON = Battery back-up enabled OFF = Battery back-up disabled

*** = Boot PROM version 06 or higher and System PROM version 4.7 or higher**

Table 1-4 - SCB Port Switches SW1 = COM3 & SW2 = COM4
Loopback & Termination Control

Switch#	RS-232 Function Switch ON	RS-485 Function Switch ON	Setting
1	DTR to DSR Loopback	TX+ to RX+ Loopback	ON - Only for Diagnostics
2	TXD to RXD Loopback	TX- to RX- Loopback	ON - Only for Diagnostics
3	N/A	100 Ohm RX+ Termination	ON - End Nodes Only
4	N/A	100 Ohm RX- Termination	ON - End Nodes Only
5	RTS to CTS Loopback	N/A	ON - Only for Diagnostics
6	N/A	Slow Slew Rate - ON = Fast OFF = Slow	ON/OFF - As required Factory Default = ON
7	N/A	RX+ Bias (End Node)	ON - End Nodes Only
8	N/A	RX- Bias (End Node)	ON - End Nodes Only

1.3.1.3 CPU Module System Battery

The CPU Board connects to an external battery via a three-pin connector (J10). This 3.6V, 950mA-hr lithium ½ AA cell (battery) provides backup for the real-time clock, CMOS RAM (within the microprocessor), and the System SRAM.

The system SRAM is specified to have a standby current of 50μA maximum for each part. For a system containing 2MB of System SRAM, a worst-case current draw of 210μA allows a battery life of approximately 4524 hours, while for a system containing 4MB of System SRAM a worst-case current draw of 410μA allows a battery life of 2317 hours.

A supervisory circuit is used to switch to battery power when VCC falls below VCC-10%. For maximum shelf life, the battery may be isolated from the circuit by setting switch SW3-4 (on the CPU Board) to the OFF position. If the Real-time clock looses its battery backup a ControlWave Designer system variable bit (_QUEST_DATE) is set. This bit can be used to post a message or alarm to the PC (see the 'System Variables' section of the ControlWave Designer Programmer's Handbook D5125).

1.3.1.4 CPU Module LEDs and Port 80 Display

All CPU Modules have eight (8) LEDs on the CPU Board. Units equipped with the optional Secondary Communications Board (SCB) have eight (8) additional LEDs. Additionally, all CPU Modules are provided with a Port 80 Display assembly consisting of two TI TIL311 Displays that are visible from the front of the CPU Module. The Port 80 LED Display assembly provides POST codes during system boot as well as run time status indication. During normal system operation, the Port 80 Display is powered down.

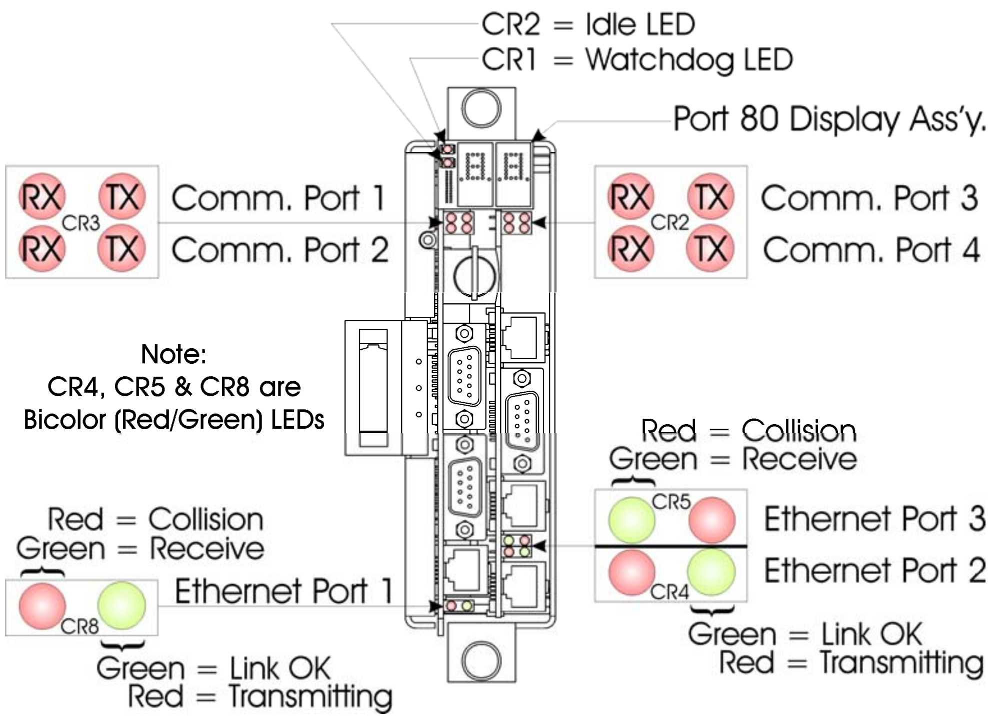


Figure 1-5 - CPU Module LEDs

1.3.1.5 CPU Module Memory Summary

A brief synopsis of CPU Module Memory is provided below.

Boot-Block FLASH BIOS

512 kbytes contained in a single IC. BIOS that runs the CPU Board is contained in this device. The BIOS is contained in a single 512 kbyte Uniform Sector FLASH (USF) IC. This device resides on the General Purpose (GP) bus, operates at 3.3V and is configured for 8-bit access.

Switch SW3-3 provides for forced update/recovery of the BIOS if SW3-3 has been set to the ON position when a reset occurs. The boot-up code passes control to the built-in Recovery Command Processor that communicates with the user via the recovery serial connection and a terminal program running on an external host computer.

FLASH Memory
4 Mbytes to 64 Mbytes simultaneous read/write (non-volatile) FLASH mounted in up to 4 48-pin TSOPs. The System Firmware and the Boot Project are stored here. The FLASH memory is a linear array of 16 Mbit parts configured for 32-bit, 16-bit or 8-bit read access (32-bit write access) and is connected to the SDRAM bus. No hardware write protection is provided for the FLASH array.

Static RAM Memory (SRAM)
2 Mbytes of soldered-down static RAM (SRAM) is implemented with four 512K x 8 asynchronous SRAMs that are configured as a 1M x 16-bit array. Each SRAM device operates at 3.3V and is packaged in a 32-pin TSOP. An additional 2Mbytes of SRAM may be factory installed. SRAM is placed into data retention mode (powered by a backup 3.6V lithium battery) when power is lost. The SRAM supports 16-bit or 8-bit accesses and is connected to the GP bus. Critical system information that must be retained during power outages or when the system has been disabled for maintenance is stored here. Data includes: Last states of all I/O, historical data, retain variables and alarm messages not yet reported.

Synchronous Dynamic RAM (SDRAM)
4 Mbytes of on board Synchronous Dynamic RAM (SDRAM) (2 x KM416S1120DT). The run application and a copy of system firmware are stored here. This allows the system to run faster than it would from the FLASH memory. SDRAM is not battery-backed.

CMOS RAM
RAM internal to the CPU Module's AMD Elan SC520 Microprocessor. This RAM data is loaded from BIOS. 10 bytes are provided for RTC alarm and calendar parameters and 114 bytes are provided as configuration parameters.

1.3.2 Power Supply/Sequencer Module

Power Supply/Sequencer Modules (PSSM) plugs into the system's Backplane Board (Connector P1 and P3) via their Compact PCI (CPCI) type keyed 132-pin connector J1. The front of the PSSM contains a system power switch, as well as two pluggable terminal blocks for external input power and watchdog MOSFET switch connections. Three LEDs, visible through the front panel, provide the following status conditions: PWRGOOD (power good: green), MC (master clear active: red) and PWRFAIL (power fail: red)

PSSMs contain a DC to DC Converter that generates isolated +5Vdc for the CPU and CCRS Modules and isolated +12Vdc for the CCRS Module. A piggy-back converter board provides isolated +3.3Vdc required for CPU logic, memory and FLASH devices.

Also contained on the PSSM is the sequencer circuit that monitors the incoming power as well as the isolated output supplies and has a reset/early power fail warning controller that interfaces with the system CPU Module. Master Clear and Power Fail signals are generated by the sequencer circuit when incoming power or the isolated supply voltages fall below specified limits. Additionally, the sequencer circuit controls an on-board watchdog MOSFET switch that will open when Master Clear is active or the CPU Module asserts the Watchdog Bad signal.

The power supply operates from bulk inputs of +10.6 to +20V or +20.7 to +30V (dc) with the nominal input supply configuration (12V or 24V) factory set by on-board jumpers. A supervisory circuit monitors the incoming power and the isolated supply voltages. The isolated supplies are shut down when the incoming voltage drops below +10.6V for a +12V system or +20.7V, for a +24V system.

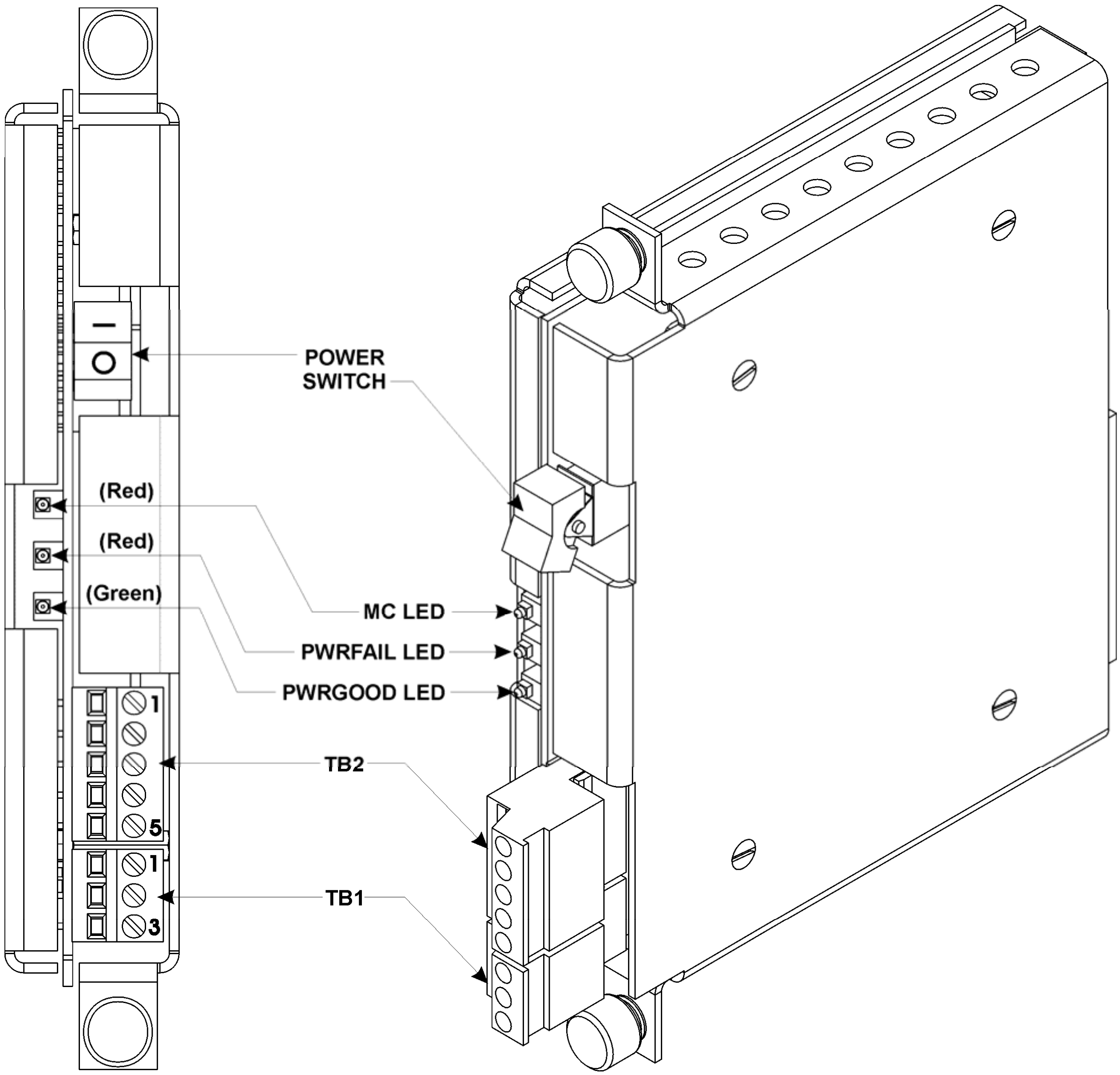


Figure 1-6 - Power Supply/Sequencer Module

The circuit that drives the watchdog MOSFET switch is on the secondary (isolated) side of the power supply. A solid state relay (SSR) actuates the watchdog hardware and is factory enabled or disabled via an on-board jumper. When either /MC or /WDOGB is active, the on-board watchdog hardware will be OFF. */WDOGB is a signal generated by the CPU Module when its hardware detects improper software operation.*

The watchdog MOSFET switch is powered via the VI input of the terminal block and its switched output is connected to the VO/NO output of the terminal block. The external power source connected to the COM terminal must be referenced to the return point of the input source that powers the PSSM (-VIN (PSGND)).

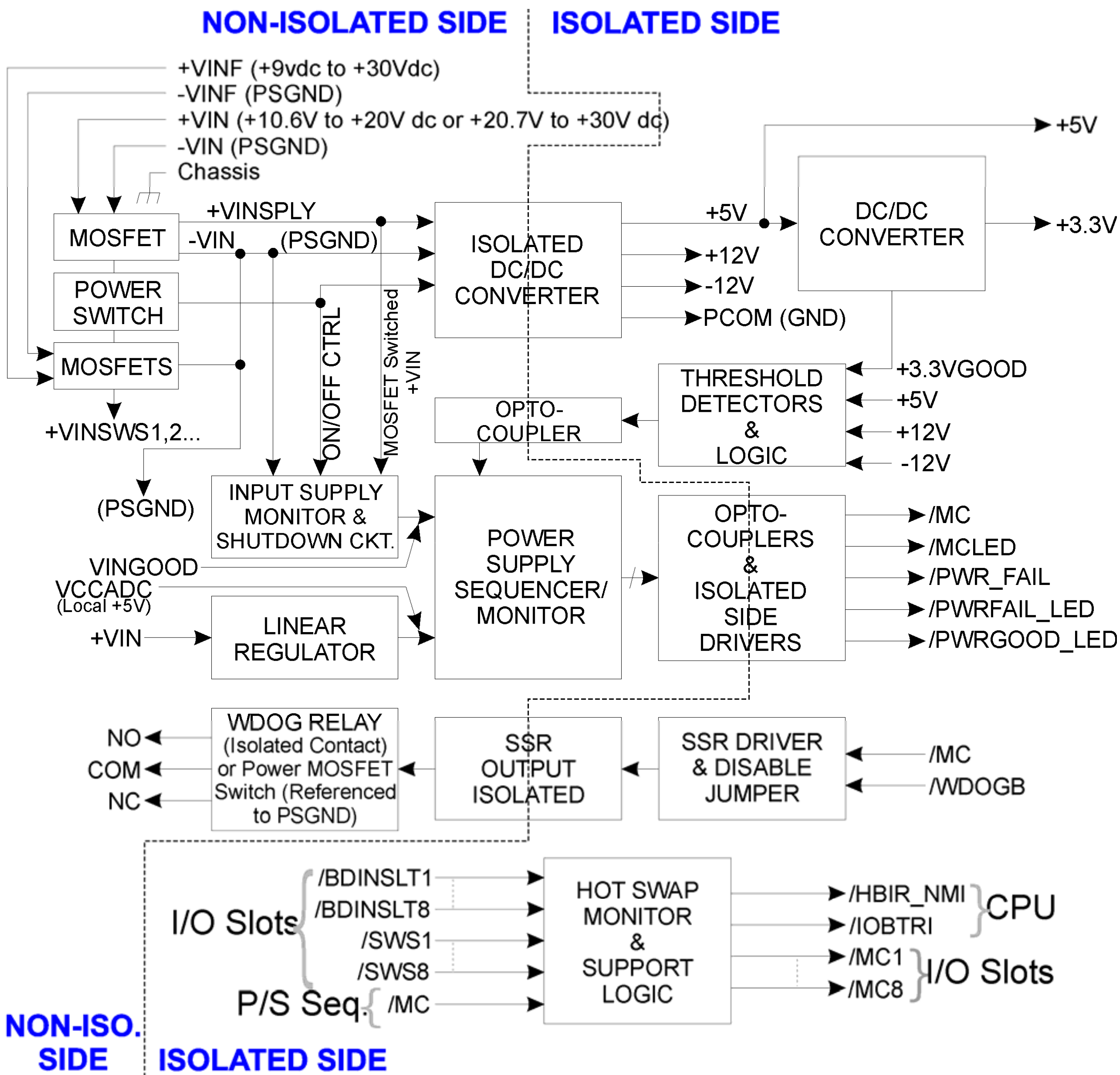


Figure 1-7 - Power Supply/Sequencer Module Block Diagram

1.3.2.1 PSSM Power Switch SW1

Switch SW1 is used to connect input power to the PSSM circuitry via Controlled Power MOSFETs when the '**I**' side of the switch has been pressed to its actuated position. This will turn the unit ON.

1.3.2.2 PSSB Board Fuse

The PSSM contains Fuse F1 that isn't field replaceable. Slow Blow Fuse F1 is rated at 3A for a +12V/24V system - protects the entire system.

1.3.2.3 PSSB Board Connectors

Connectors TB1, TB2 and J1 function as described below.

PSSB Bd. Terminal Block Connector TB1

TB1 provides 2 watchdog MOSFET switch connections:

TB1-1 = VO - Watchdog MOSFET Switch Output
TB1-2 = VI - Watchdog MOSFET Switch Input
TB1-3 = Not Used with **Control**Wave**RED**

PSSB Bd. Terminal Block Connector TB2

TB2 provides 5 input connections for bulk power:

TB2-1 = (+VIN) (+10.6V to +20V dc for +12V supply) (+20.7V to +30V dc for +24V supply)
TB2-2 = (+VINF) Field Supply - Not Used
TB2-3 = (-VIN) (1st Supply Ground)
TB2-4 = (-VINF) (2nd Supply Ground) - Not Used
TB2-5 = Chassis Ground - CHASSIS (⏚)

PSSB Bd. Connector J1

Connector J1 is a 132-pin keyed CPCI type connector that interfaces Power, Ground and Master Clear(s), power supply status (/PWR_FAIL) and watchdog status (/WDOGB) signals to Connector P1 on the Backplane Board.

1.3.2.4 PSSM LEDs

Three LEDs, visible through the front panel, will provide status conditions PWRGOOD (power good: green), MC (master clear active: red) and PWRFAIL (power fail: red). When power is first applied or when the unit is reset, the red MC LED will illuminate for a short period of time. The green PWRGOOD LED should be ON whenever the unit is running and no power problems have been detected. The red PWRFAIL LED should only be ON when power has dropped below acceptable levels.

1.3.3 **Control**Wave**RED** CPU & Comm. Redundancy Switch Module

The CPU & Communications Redundancy Switch (CCRS) Module is a system module that interfaces to a redundant pair of Power Supply/Sequencer and CPU modules via the **Control**Wave**RED** CPU & Communications Redundancy Backplane (CCRB). The CCRS Module provides either automatic or manual selection of the primary controller CPU in the case of hardware failure. The CCRS Module will also switch up to four serial communications ports to the selected primary CPU of the redundant pair. Multiple power sources within the CCRS ensure system viability. Backplane interconnects convey power, power sequencing, watchdog hardware control, primary CPU selection and respective serial communications port selection control for redundancy purposes.

CCRS Module hardware implements a front panel user interface, module/system status indicators and selected (primary) CPU communication port switching to front panel mounted 9-pin male D-type connectors. Triple replicated system logic circuitry and the multiple CCRS Module power supply circuits provide a high level of tolerance to miscellaneous hardware faults.

The CCRS Module transfers control of the process and communication from one CPU to the other CPU in the event the first CPU fails. Redundancy is recommended for plants or processes where a loss of control could result in damage or injury. The process of transferring control from one CPU to the other CPU is referred to as **fail-over**. A fail-over from one CPU to the other typically falls into one of two categories:

Hardware failures - These could occur from a variety of causes:

- loose cable
- improper configuration, e.g. board not seated properly
- power supply failure (no power for CPU)
- individual board or component breakdown

Software failures - Possible causes include:

- application program running in the CPU ‘crashes’ as indicated by ‘FF’ on the display
- all tasks are suspended for more than a user-configurable number of milliseconds
- a task watchdog occurs (this option can be user enabled/disabled)
- user-created logic for detection of a particular failure is activated, triggering a switchover via a REDUN_SWITCH function block

When redundant CPUs are used, these sorts of failures trigger a **watchdog relay**, and cause a **fail-over** from the **on-line** CPU that failed to a **standby backup** CPU. The standby CPU has been configured to be a nearly exact duplicate of the on-line CPU, so that it can assume full control over the process previously controlled by the failed CPU, and becomes the *new* on-line CPU.

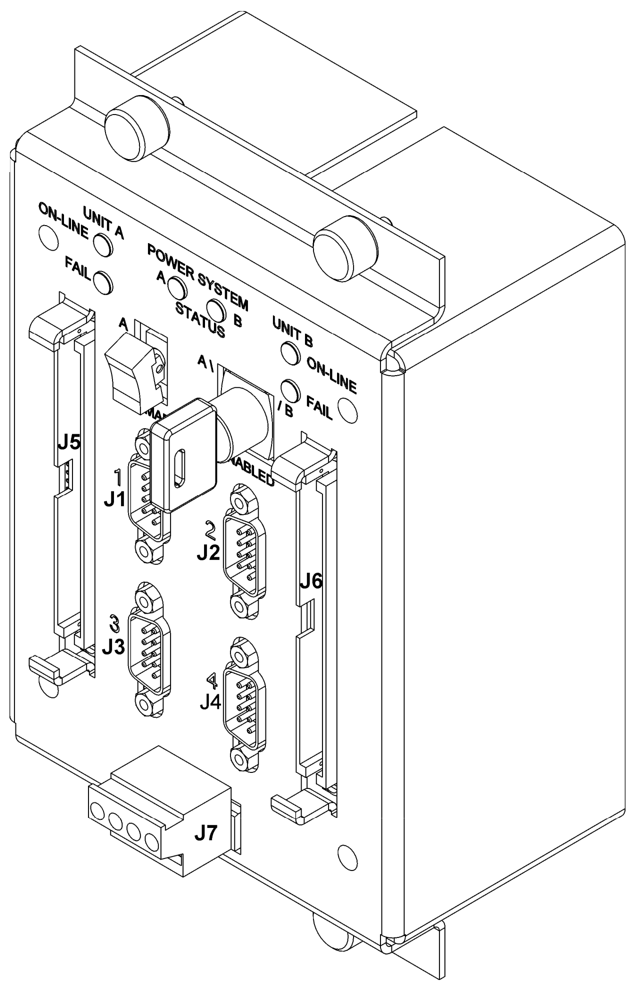


Figure 1-8 - Perspective View of CPU & Comm. Redundancy Switch Module

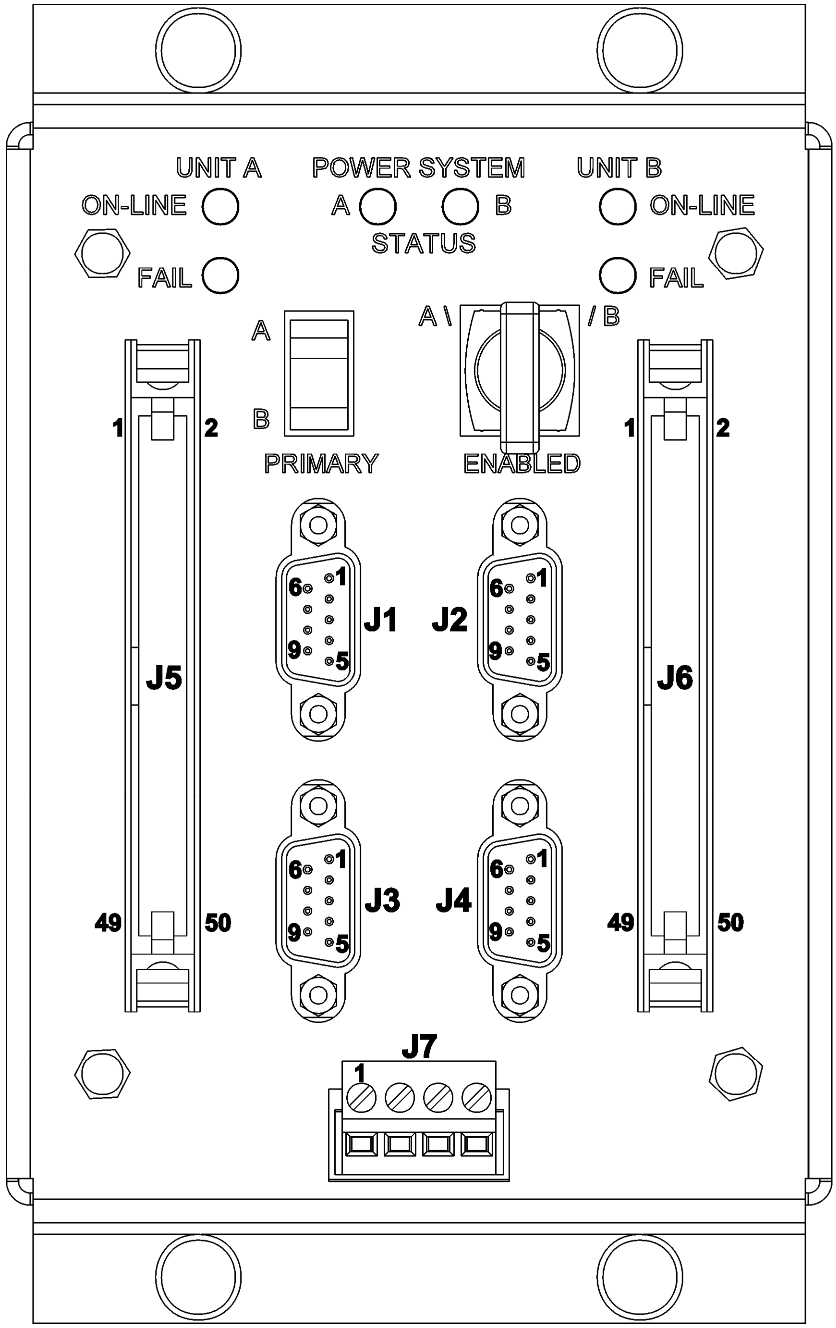


Figure 1-9 - Front View of CPU & Comm. Redundancy Switch Module

1.3.3.1 CCRS Module Switches

A/B Primary Controller Select Switch - 2-position - selects the primary controller, i.e., CPU A (**UNIT A**) or CPU B (**UNIT B**) at CCRS Module power up <u>**only**</u> if the **A/B Enabled Mode Select Switch** has been set in the automatic selection (centered) position. The selected CPU Module will be chosen as the primary system controller if the CCRS Module's logic determines it is ready for on-line duty. Otherwise, the alternate CPU will be selected if it is OK.

A/B Enable Key Switch - 3-position - used to determine whether the primary CPU selection is forced to CPU A (**UNIT A**) or CPU B (**UNIT B**) or is automatically selected (Center). Forced primary selection is useful for diagnostic purposes, where a failed CPU Module may be placed on-line for debugging.

1.3.3.2 User Accessible CCRS Module Connectors

Front of CCRS Module (see Figures 1-8 and 1-9):

Connector J1 - Switched COM1 Port - 9-pin D-Type Male RS-232 - represents COM1 of the selected CPU Module.
ConnectorJ2 - Switched COM2 Port - 9-pin D-Type Male RS-232 - represents COM2 of the selected CPU Module.
Connector J3 - Switched COM3 Port - 9-pin D-Type Male RS-232/485 - represents COM3 of the selected CPU Module.
Connector J4 - Switched COM4 Port - 9-pin D-Type Male RS-232/485 - represents COM4 of the selected CPU Module.
Connector J5 - CPU A Comm. Ports Interface Cable Header - 2 x 25 Male, Shrouded & Polarized
Connector J6 - CPU B Comm. Ports Interface Cable Header - 2 x 25 Male, Shrouded & Polarized
Connector J7 - Isolated On-Line Status Outputs - 4-pin pluggable (Screw Clamp) - Provides A & B pairs of relay driven Normally Open (NO) & Common (COM) outputs

Rear of CCRS Module:

Connector J1 - CCRS/CCRB Slot A 50-pin Ribbon Cable Header - Interface to Backplane REDSWA Connector P5.
Connector J2- CCRS/CCRB Slot B 50-pin Ribbon Cable Header - Interface to Backplane REDSWB Connector P6.

1.3.3.3 CCRS Module Status LEDs

UNIT A ON-LINE LED - Green - ON means CPUA is on line
UNIT A FAIL LED - Red - ON means CPUA has failed - If blinking means CCRS Slot A cable is not attached or is defective
UNIT B ON-LINE LED - Green - ON means CPUB is on line
UNIT B FAIL LED - Red - ON means CPUB has failed - If blinking means CCRS Slot B cable is not attached or is defective

POWER SYSTEM STATUS LEDs A & B - Red/Green
ON Green means Power is good
ON Red means Power is defective

1.3.4 **Control**Wave**RED** Backplane

The **Control**Wave**RED** Backplane provide for the interconnection of the Power Supply/Sequencer Modules (PSSMs), CPU Modules and the CPU & Communications Redundancy Switch Module (CCRSM). PSSM and CPU module slot connections are implemented with Compact PCI (CPCI) type connectors. Connections to the CPU & Communications Redundancy Switch Module are implemented via two 50-pin ribbon cable headers. The two ribbon cables connected between the Backplane and the rear of the CCRSM accommodate the interconnection of PSSMA & PSSMB provided regulated logic power, regulated relay power and Master Clear A/B signals, CPUA and CPUB provided Watch Dog A/B signals, and CCCRSM provided On-Line/BackupA and On-Line/BackupB control signals.

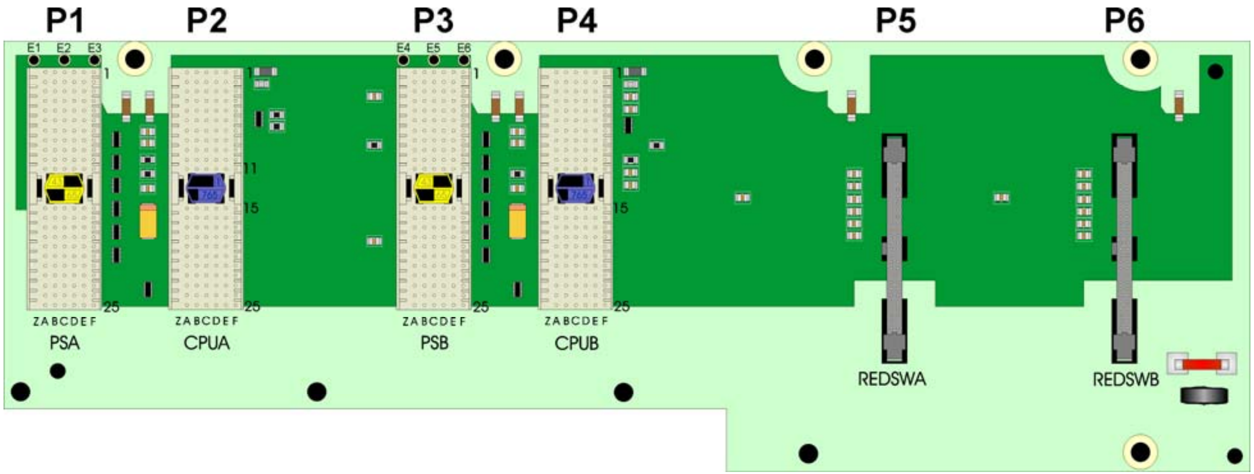


Figure 1-10 - ControlWaveRED Backplane Assembly

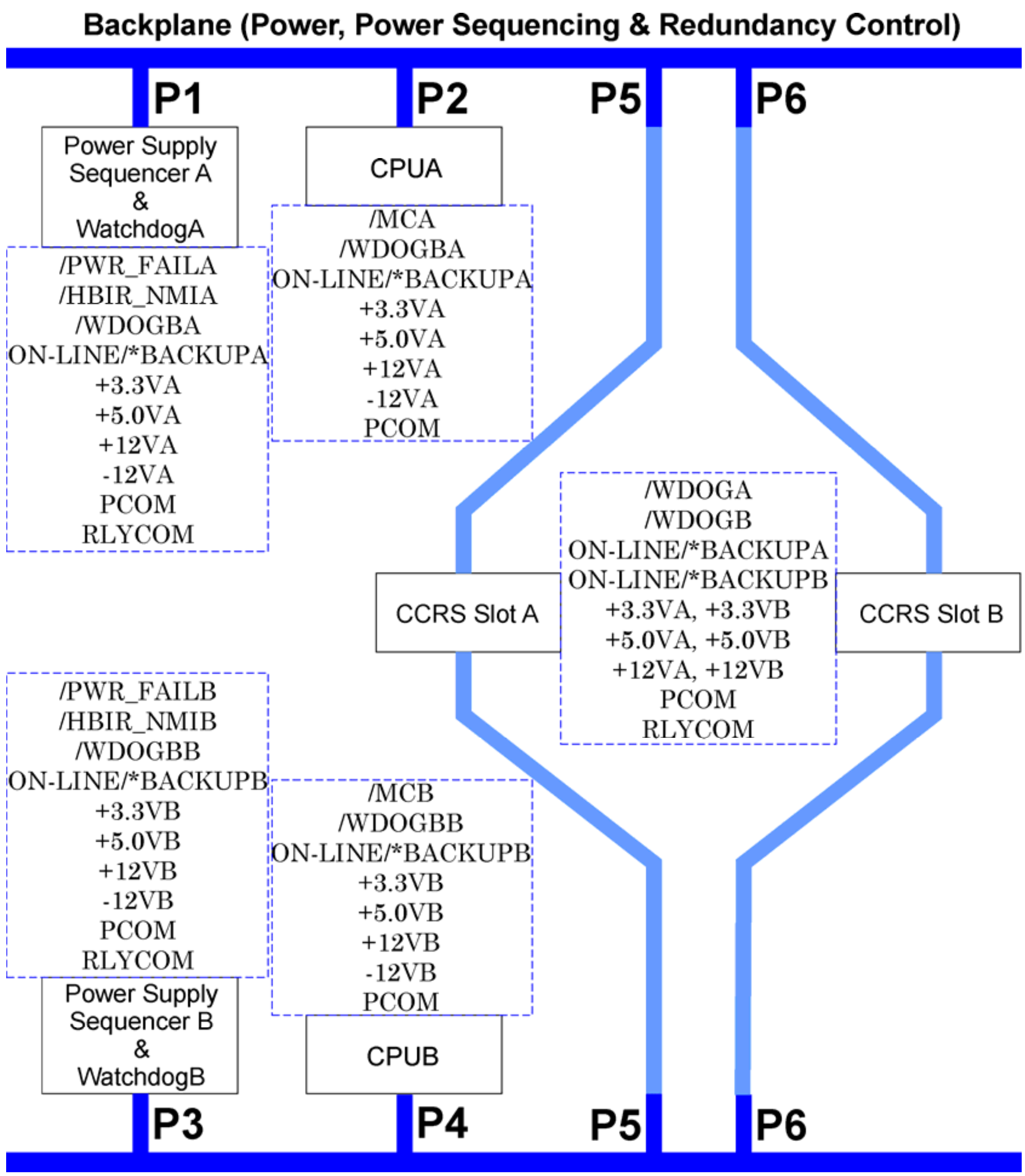


Figure 1-11 - Backplane PCB Block Diagram

Isolated power (+ 3.3V, +5V, +12V, -12V and PCOM) from the associated PSSM is connected to the CPU. The power supply monitor/sequencer circuit (within the PSSM) provides /MC and PWR_FAIL signals to the CPU thus providing properly timed early warning of low input or supply voltages followed by a CPU reset to support the WARM START CPU function. The watchdog circuitry on the PSSM is controlled by CPU signal /WDOGB.

Connectors P1 through P4 are equipped with connector coding devices. These color-coded devices are physically unique to ensure that only the correct module type can be installed. Modules are equipped with mating connector coding devices (yellow for PSSM and blue for CPU) that provide the service technician with a quick visual indication of the backplane slot(s) where the module in question can physically reside.

1.3.5 **Control**Wave**RED** Chassis

The **Control**Wave**RED** Backplane PCB and the modules that comprise the system are housed in a Stainless Steel Chassis. Any **Control**Wave**RED** Chassis can be panel/wall mounted. **Control**Wave**RED**s can also be mounted to a 19-inch equipment rack by using BBI supplied Filler Panels. **Control**Wave**RED** Chassis are factory shipped with only the CCRSM and ribbon cables installed. The Chassis assembly also contains a Ground Lug that accommodates up to a #4 AWG Ground Wire. Grounding the unit is accomplished by connecting a ground wire between the Ground Lug and a known good Earth Ground.

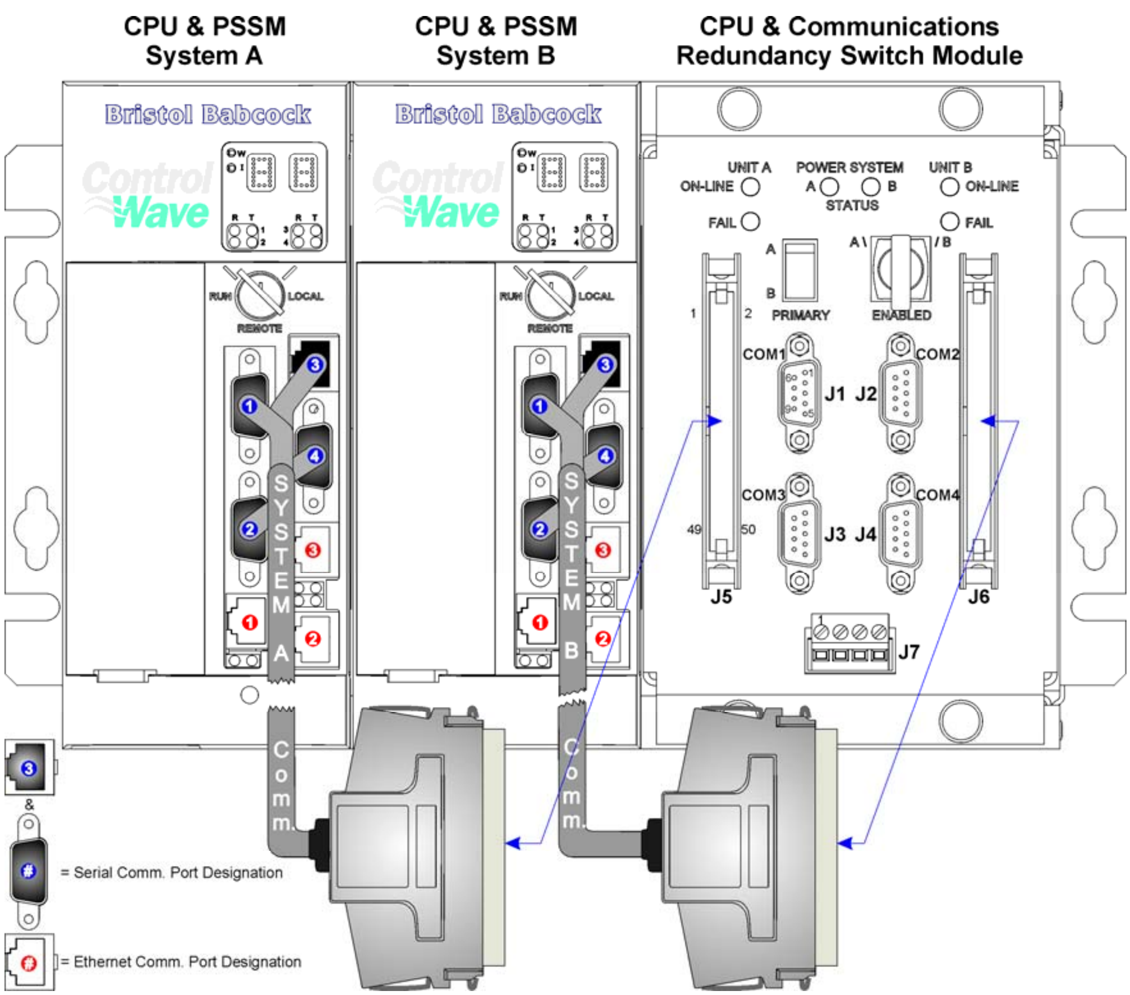


Figure 1-12 - Control Wave**RED Chassis and Comm. Cabling Diagram**

Two special communication cable assemblies provide for interconnection of CPUA's and CPUB's Comm. Ports with the CPU & Communications Redundancy Switch Module.

Section 2
INSTALLATION & OPERATION

2.1 INSTALLATION IN HAZARDOUS AREAS

ControlWave Redundant Controllers are not furnished in a closed or sealed housing. The modules that comprise the system are housed in a Stainless Steel Chassis. The Chassis can be panel or wall mounted. Mounting in a 19-inch equipment rack is possible with the use of a Bristol supplied Filler Panel. Use in Class I, Division 2, Groups A, B, C and D hazardous areas will require the selection of an appropriate enclosure that meets the NEMA Type 3X or 4X specification.

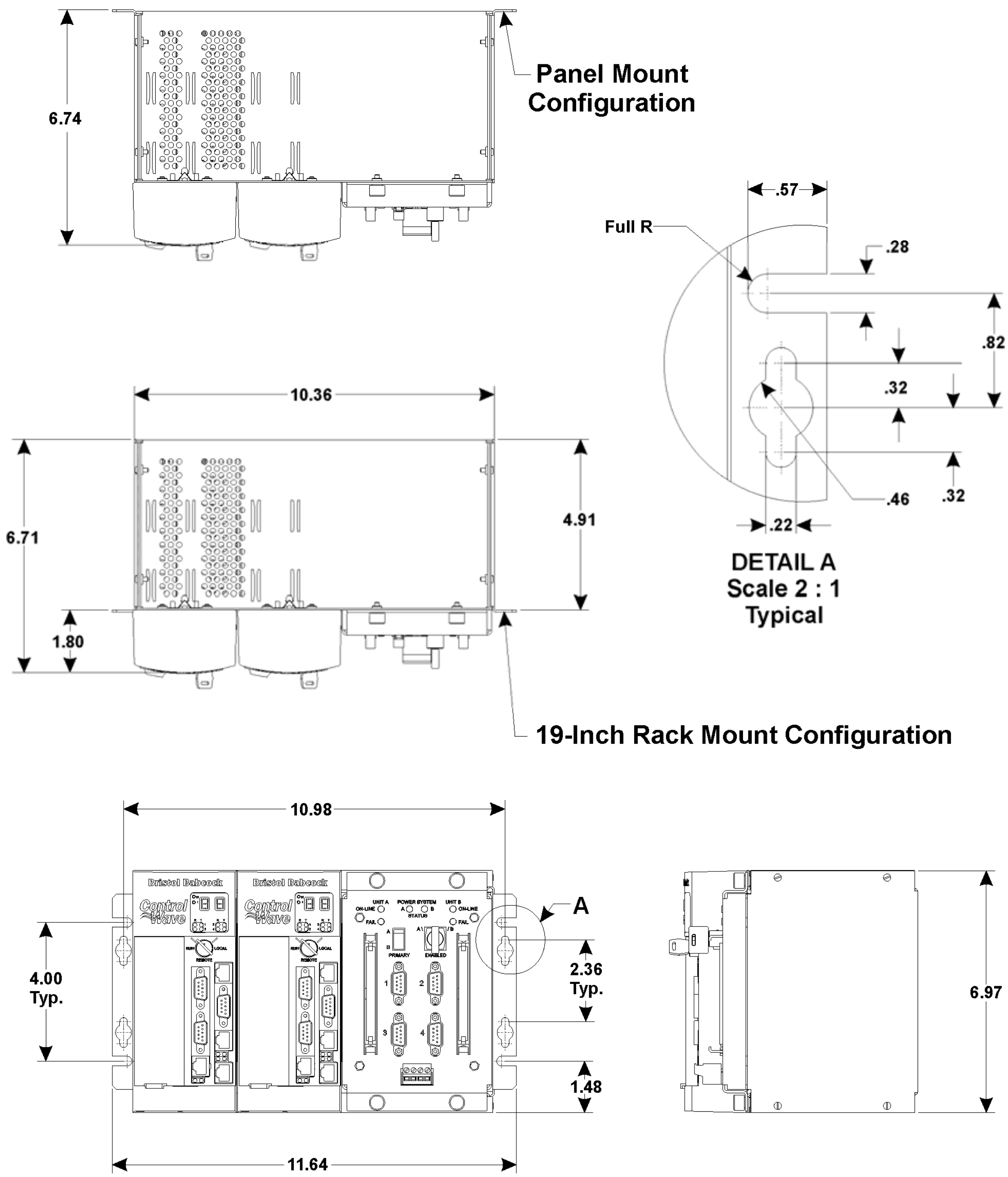


Figure 2-1 - Control Wave**RED - Mounting Diagram**

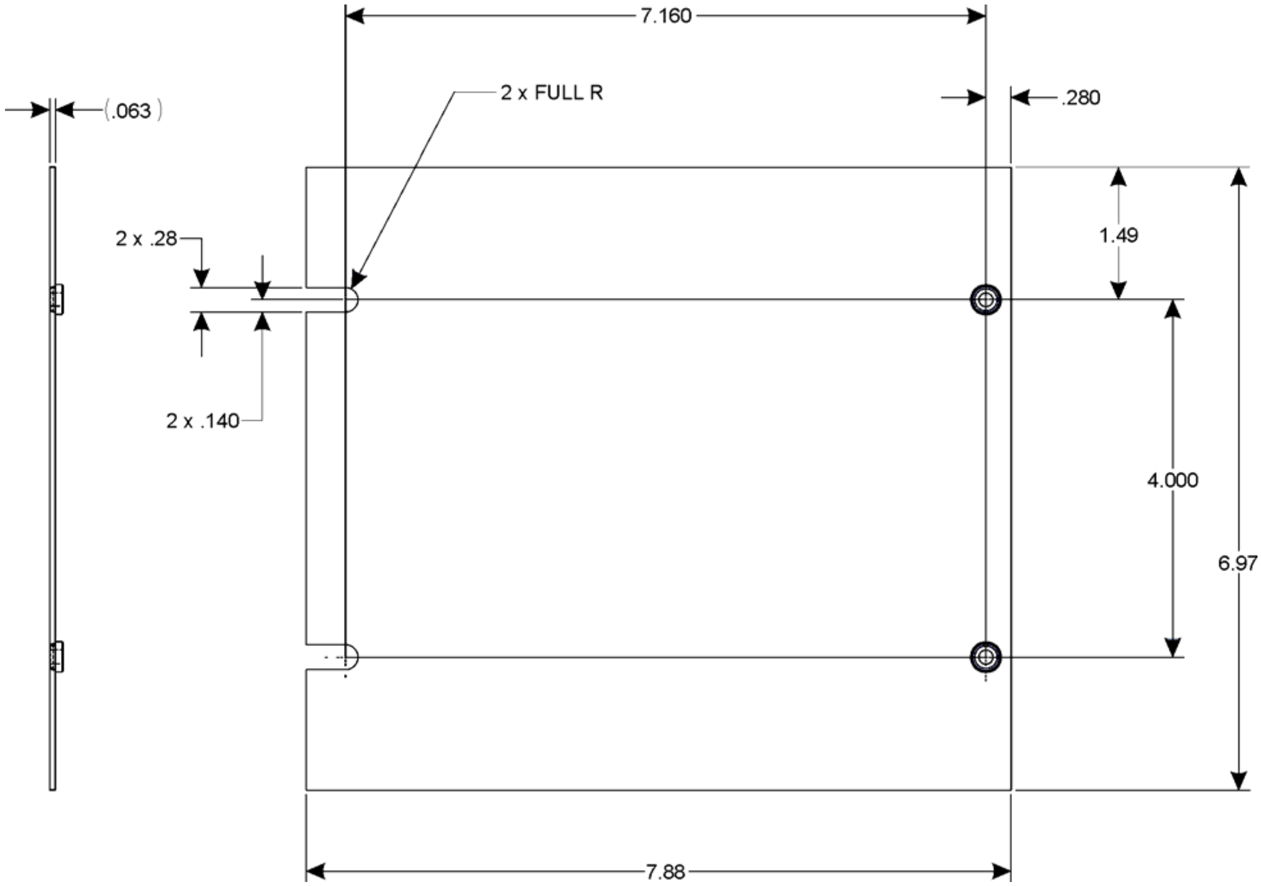


Figure 2-2 - ControlWaveRED Rack Mount Filler Panel Dimensions

2.2 ControlWaveRED INSTALLATION SITE CONSIDERATIONS

Check all clearances when choosing an installation site. Make sure that the **Control-**Wave**RED** Controller will be accessible for wiring and service. To install the **Control**Wave**RED** Chassis, see Section 2.3.1.

2.2.1 Temperature & Humidity Limits

ControlWave**RED** Controllers have been designed to operate over a -40°F to +158°F (-40°C to +70°C) temperature range (with storage at up to +185°F (+85°C)) and a 15% to 95% Non-condensing Relative Humidity range. Make sure that the ambient temperature and humidity at the measuring site remains within these limits. Operation beyond these ranges could cause output errors and erratic performance. Prolonged operation under extreme conditions could also result in failure of the unit.

2.2.2 Vibration Limits

Check the mounted enclosure, panel or equipment rack for mechanical vibrations. Make sure that the **Control**Wave**RED** Controller is not exposed to a level of vibration that exceeds those given in the specifications. The **Control**Wave**RED**'s vibration limits are 1g for 10 - 150 Hz & .5g for 150 - 2000 Hz.

2.3 **Control**Wave**RED** INSTALLATION/CONFIGURATION

ControlWave**RED** Controllers are shipped from the factory fully assembled and consisting of the following components:

Chassis Assembly - (with two CCRS interface ribbon cables) and the CCRSM.
Power Supply/Sequencer Module A
CPU Module A & Bezel - (with special Comm. cable)
Power Supply/Sequencer Module B
CPU Module B & Bezel - (with special Comm. cable)

Overview of Configuration

An overview of the eight (8) steps required to configure a **Control**Wave**RED** Controller are provided below. Also see the **Control**Wave Redundancy Setup Guide - D5123.

Step 1. Initial Hardware Installation & Configuration

This involves unpacking the **Control**Wave**RED** hardware, mounting the chassis, installing external power source wiring, wiring the Isolated On-line Status Outputs, making proper ground connections, connecting a communication cable to the PC workstation and setting CPU Module switches (to enable the backup batteries). To install and configure the **Control**Wave**RED** Controller to receive its application load follow steps 1 through 13 below:

1. Remove the Chassis from its carton and install it at its assigned work site (see Section 2.3.1).
2. Install a ground wire between the Chassis Ground Lug and a known good Earth Ground (see Section 2.3.1.1).
3. Remove CPU Module A from Chassis slot # 2 and set Switch SW3-4 ON to enable the backup battery. Replace CPU Module A into Chassis slot # 2. All other Switches are factory configured (see Section 2.3.3 for CPU Switch settings).
4. Remove CPU Module B from Chassis slot # 4 and set Switch SW3-4 ON to enable the backup battery. Replace CPU Module B into Chassis slot # 4. All other Switches are factory configured (see Section 2.3.3 for CPU Switch settings).
5. Install Watchdog MOSFET Switch wiring to each PSSM Module (see Section 2.3.4.1.3).
6. Connect Bulk DC Power to the **Control**Wave**RED**'s PSSM Modules but don't apply power at this time (see Sections 2.3.4.1 through 2.3.4.1.2).
7. Install the Bezels so that each one covers its associated PSSM and CPU Modules (see Section 2.3.6).
8. Install the special serial communications cable between the four serial communications ports on CPU Module A and connector J5 on the front (left) of the CCRSM. Install the special serial communications cable between the four serial communications ports on CPU Module B and connector J6 on the front (right) of the CCRSM.
9. Connect COMM. Port 2 of the **Control**Wave**RED**'s CCRSM to a COMM. Port of a PC (typically PC COMM. Port 1
10. Set the CCRSM's A/B Enable Key Switch to either the '**A**' or '**B**' position.
11. Set the selected CPU's RUN/REMOTE/LOCAL Switch to the LOCAL position (see Section 2.4.3).
12. Install an Ethernet cable between one of the Ethernet Ports on CPU Module A and an Ethernet Hub. Install an Ethernet cable between the same Ethernet Hub and the

Ethernet Port on CPU Module B with the same designation, i.e., Ethernet Port 1 (E1), Ethernet Port 2 (E2) or Ethernet Port 3 (E3). Or install a direct point-to-point Ethernet cable (see Figure 2-13) between CPU A and CPU B Ethernet Ports of the same designation.

13. Apply power to the **Control**Wave**RED** Controller by setting the Power Switch on both PSSM Modules to the 'I' position. After receiving the application load (see **Steps 2.** through **7.** and Section 2.4.1), you must perform **Step 8.** before the **Control**Wave**RED** Controller will be ready for on line operation. **Note: The CPU that wasn't selected (via the CCRSM's A/B Enable Key switch in step 10) will automatically receive its application load via an Ethernet side-load.**

Step 2. Software Installation on the PC Workstation

ControlWave **Designer** software must be installed on the PC workstation. This is accomplished by installing the **Control**Wave **Designer Package** from the Open BSI CD ROM.

If you will be including the **Control**Wave**RED** in an Open BSI network that requires Netview software, you should also install the **Open BSI Network Edition**.

For information on minimum system requirements and more details of the installation, see the installation procedure in Chapter 2 of the *Open BSI Utilities Manual* (document # D5081).

<u>If you have an older version of ControlWave Designer already installed:</u>

Beginning with **Control**Wave Designer Version 3.3, the copy protection key (dongle) is NOT required. Prior to installing **Control**Wave Designer 3.3 or newer, you MUST remove the hardware dongle from the parallel port of your PC workstation. Otherwise, when you subsequently start **Control**Wave Designer, it will operate only in 'DEMO' mode, and will limit the available system resources.

IMPORTANT:

When you start **Control**Wave Designer, you will be reminded to register the software. Unregistered software can only be used for a maximum of 30 days. For more information on the registration process, see Chapter 2 of the Open BSI Utilities Manual (document# D5081).

Step 3. Establish Communications using either LocalView or NetView, and Run the Flash Configuration Utility

Communications must be established with the **Control**Wave**RED** using either LocalView or NetView.

Once communications have been established, the Flash Configuration Utility must be run, in order to configure user account parameters, and to configure the **Control**Wave**RED** communication ports. An overview of this process ('Establishing Communications') is included in the *ControlWave Redundancy Setup Guide* (document # D5123). Detailed information on the Flash Configuration Utility, and LocalView is included in Chapter 5 of the *Open BSI Utilities Manual* (document # D5081). NetView is described in Chapter 6 of D5081.

Step 4. Create a Redundant Project or use the Sample Redundant Project in Control Wave **Designer**

At this point, use ControlWave Designer to create a redundant project, or use the sample redundant project provided on the Open BSI CD-ROM (RDNSAMPLE.ZWT).

For general help on creating ControlWave projects, see the *ControlWave Quick Setup Guide* (document # D5084) and the *Getting Started with ControlWave Designer Manual* (document # D5085).

For details about configuring the redundancy status variables in the project, see the *'Testing the Redundant Setup'* section of the *ControlWave Redundancy Setup Guide* (document # D5123).

NOTE:

From this point on, the order of steps may be varied, somewhat, depending upon the requirements of the user's application.

Step 5. Create Application-Specific Web Pages (OPTIONAL)

The **Control**Wave**RED** Controller supports a set of standard web pages for configuration purposes (stored on a PC). These web pages also provide access to communication statistics maintained in the controller.

Optionally, additional user-created web pages may be created to allow a customized human-machine interface. A series of ActiveX controls for data collection and configuration are provided on the Open BSI CD which can be included as part of these user-created web pages. For information on the ActiveX controls, see the *Web_BSI Manual* (document # D5087).

You can use whichever HTML creation package you want to create the pages, however, all **Control**Wave related web pages (whether standard or user-created) must be viewed within Microsoft® Internet Explorer. Web pages are stored on a PC workstation.

Step 6. Create an Open BSI Network Containing the Control Wave**RED Unit, or ADD the Control**Wave**RED unit to an Existing Open BSI Network**

In order for the **Control**Wave**RED** Controller to function as part of a Bristol network, it is necessary to include it in the Bristol network.

If no Bristol network exists:

You will need to start Open BSI's NetView software on the PC workstation in order to define a Bristol network. A series of software wizards are used to define a Network Host PC, a network, and the RTUs (controllers) belonging to the network. Finally, communication lines must be specified which handle the address assigned to the **Control**Wave**RED** Controller. Chapters 3 and 4 of the *Open BSI Utilities Manual* (document # D5081) include 'quick start' examples for performing these steps. More detailed information is included in the NetView chapter (Chapter 6) of the same manual.

If a Bristol network already exists:

You will need to add the **Control**Wave**RED** Controller to the existing network using Net-View's RTU Wizard. Chapter 6 of the *Open BSI Utilities Manual* (document # D5081) includes different sub-sections depending upon whether you are adding the unit to a BSAP network, or an IP network.

NOTE: When configuring the ControlWave Redundant Controller in NetView, it should be defined as a single RTU that has two IP addresses. See *'Communications Redundancy'* in the *'Additional Configuration'* section of the *ControlWave Redundancy Setup Guide* (document # D5123).

Step 7. Download Your Redundant Project Into the Control Wave**RED Unit**

Either **Control**Wave Designer or the Open BSI 1131 Downloader allows you to download your completed redundant project into the **ControL**WaveRED unit. Users must download the project into the boot project area of FLASH memory.

To download the application load, see Section 2.4.1.

Step 8. Final Hardware Installation & Configuration

To complete the hardware installation of the **Control**Wave**RED** Controller follow steps 1 through 6 below:

1. Shut off power at PSSM A and PSSM B.
2. Install serial communication port connections (required for the application) between the D-Type connectors on the CCRSM and the remote device, i.e., Process Automation Controller, PC, etc. (see Sections 2.3.3.2 and 2.3.3.3).
3. Install Ethernet connections to CPU Module A and CPU Module B as required for your application (see Section 2.3.3.4).
4. Install field wiring between the CCRSM's Isolated On-Line Status Output connector (J7) and the associated field device (see Section 2.3.4.2).
5. Set the RUN/REMOTE/LOCAL Switch to RUN position (see Section 2.4.3).
6. Apply power to the **Control**Wave**RED** Controller by setting the Power Switch on both PSSM Modules to the 'I' position.

2.3.1 Mounting the **Control**Wave**RED** Chassis

ControlWave**RED**s can be mounted to a panel or a wall. Mounting in a 19-inch equipment rack is possible with the use of a BBI supplied Filler Panel. Mounting hole patterns are provided in Figures 2-1 and 2-2. **Control**Wave**RED** units are factory shipped with the End Plates configured for rack mounting. A Rack Mount Extension must be added to either side to accommodate 19-inch rack mounting. When mounting one of these units to a panel or wall, it is to be positioned in accordance with the following restrictions:

- The End Plates must be removed, rotated 180° and then reinstalled to accommodate panel or wall mounting. Hole patterns and dimensions are provided in Figure 2-1.
- The unit must be positioned so that the front of the assembly is visible and the unit is accessible for service, i.e., installing an option or replacement of the Lithium Battery, or installation/removal of any module.
- **Control**Wave**RED** CPU and PSSM Modules should not be installed until the unit's Chassis has been mounted and grounded at a designated work site.

2.3.1.1 **Control**Wave**RED Grounding**

ControlWave**RED** Chassis are provided with a Ground Lug that accommodates up to a #4 AWG wire size. A ground wire must be run between the Chassis Ground Lug and a known good Earth Ground. The cases of the various **Control**Wave**RED** Modules are connected to Chassis Ground when they have been installed and secured via their Captured Panel Fasteners. As an extra added precaution, it is recommended that a #14 AWG wire be run from PSSM Power Connector TB2-5 (Chassis Ground) to the same known good Earth Ground. The following considerations are provided for the installation of **Control**-Wave**RED** system grounds:

- Chassis Ground Lug to Earth Ground wire size should be #4 AWG. It is recommended that stranded copper wire is used and that the length should be as short as possible.
- This ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a stranded copper AWG 0000 cable installed vertically or horizontally).
- The wire ends should be tinned with solder prior to insertion into the Chassis Ground Lug. *Note: Use a high wattage Soldering Iron.*
- The ground wire should be run such that any routing bend in the cable has a minimum radius of 12-inches below ground and 8-inches above ground.
- Supplement Guide S1400CW - Site Considerations for Equipment Installation, Grounding & Wiring provides additional information on grounding and Isolation.

2.3.2 Power Supply/Sequencer Module (PSSM) Configuration

Each Power Supply/Sequencer Module (PSSM) must be in place prior to the installation of its associated CPU Module, i.e., installed in slot # 1 for PSSMA or slot # 3 for PSSMB (see Figures 2-4 & 2-5). Power and Watchdog wiring can be performed at this time, however; for safety reasons and to prevent accidental damage to the user's bulk DC Power Supply(s), it is recommended that pluggable Terminal Block connectors TB1 and TB2 (associated with each PSSM) are not connected to the PSSMs until the CPU Modules have been wired, and hardware configured. Section 2.3.4.1.3 provides details on Watchdog Connector TB1 wiring and Section 2.3.4.1.2 provides details on DC Power Connector TB2 wiring.

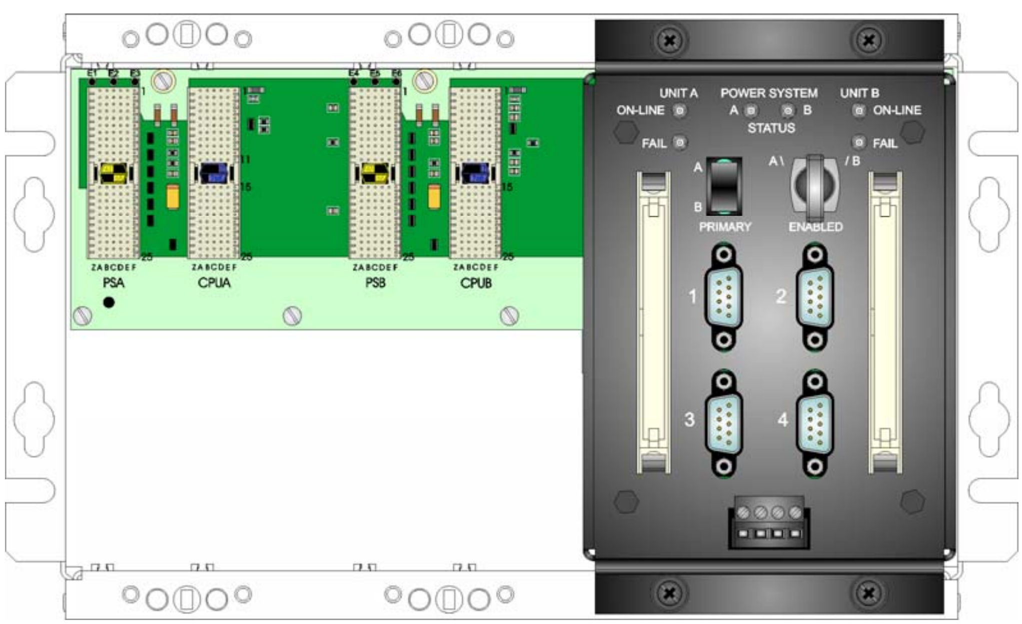


Figure 2-3 - Control Wave**RED Prior to Installation of PSSMs**

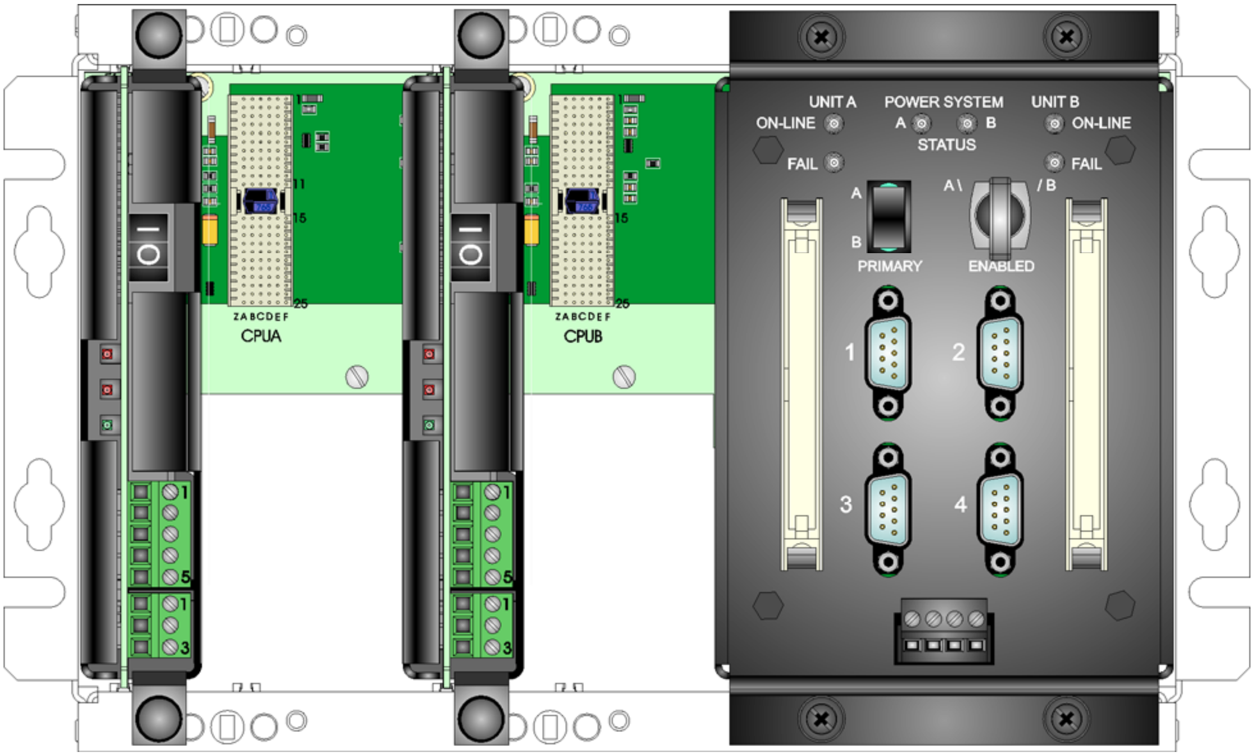


Figure 2-4 - PSSMs Installed in ControlWaveRED Slots #1 and #3

Figure 2-5 - PSSMs & CPUMs Installed in ControlWaveRED Slots #1 through #4

2.3.3 CPU Module Configuration

To configure the CPU Modules, DIP Switches must be set (see Section 2.3.3.1) and Communication Ports must be wired (see Sections 2.3.3.2 through 2.3.3.4). The CPU Modules reside in slot # 2 and slot # 4 (see Figure 2-5).

2.3.3.1 CPU Module Switch Configuration

ControlWave CPU Module DIP Switches are factory configured for redundancy operation with System A assigned to the PSSMA and CPUA (installed in slots # 1 & 2 respectively) and with System B assigned to the PSSMB and CPUB (installed in slots # 3 & 4 respectively). CPUs leave the factory with the backup battery disabled. Set Switch SW3-4 (on both CPUs) to the ON position to enable the backup battery. Tables 2-1 and 2-2 provide an overview of switch settings.

Table 2-1 - CPU Bd. Switch SW1 - User Configurations

Switch	Function	Setting - (Bold = Factory Default)
SW1-1	Watchdog Enable	**ON = Watchdog circuit is enabled** OFF = Watchdog circuit is disabled
SW1-2	Lock/Unlock Soft Switches	**ON = Write to Soft Switches and FLASH files** OFF = Soft Switches, configurations and FLASH files are locked
SW1-3	Use/Ignore Soft Switches	**ON = Use Soft Switches (configured in FLASH)** OFF = Ignore Soft Switch Configuration and use factory defaults
SW1-4	Core Updump See Section 3.6	**ON = Core Updump Disabled** OFF = Core Updump Enabled (use Run/Remote/Local Switch)
SW1-5	SRAM Control	**ON = Retain values in SRAM during restarts** OFF = Force system to reinitialize SRAM
SW1-6	Redundancy Enable/Disable	ON = Redundancy Disabled **OFF = Redundancy Enabled**
SW1-7	Unit A/Unit B	**ON** = CPU assigned as 'A' CPU - **OFF** = CPU assigned as 'B' CPU
SW1-8	Enable WINDIAG	**ON = Normal Operation (don't allow WINDIAG to run test)** OFF = Disable boot project (allow WINDIAG to run test)

SW1-1 set OFF will disable the system from entering a watchdog state when a crash or system hangup occurs. Setting SW1-1 OFF prevents the system from automatically restarting. - **Factory Set ON**

SW1-2 set OFF prevents changing the Soft Switches, other configurations and FLASH files, i.e., these items are locked. To change Soft Switch, configuration and FLASH files SW1-2 must be set to the ON position (see Section 2.4.7). - **Factory Set ON**

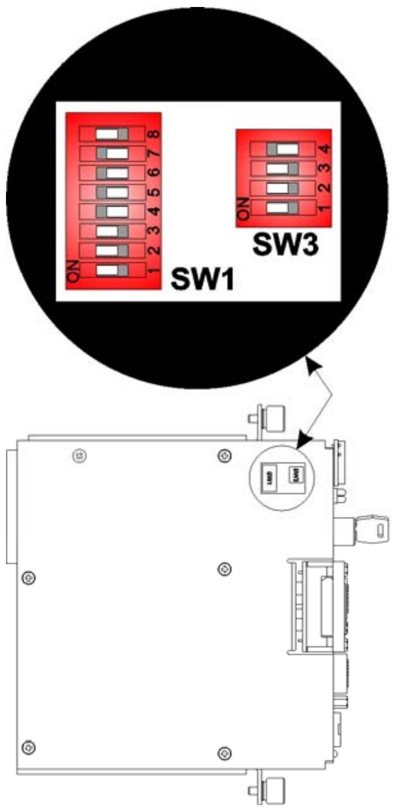
SW1-3 set OFF forces the use of Soft Switches as set per factory default (see Section 2.4.7). For use of user defined Soft Switches, SW1-3 must be set to the ON position. *Note: If both SW1-3 and SW1-8 are set OFF (closed), communication ports COM1 through COM4 will be set to 9600 bps operation.* - **Factory Set ON**

SW1-4 set OFF and used in conjunction with a properly sequenced Run/Remote/Local Switch will cause the **Control**Wave**RED** CPU to perform a Core Updump (**see Section 3.6**). - **Factory Set ON**

SW1-5 set OFF forces the **Control**Wave**RED** CPU to reinitialize SRAM when the unit recovers from a low power or power outage condition. When set ON, the contents of SRAMS will be retained and utilized when the system restarts. - **Factory Set ON**

SW1-6 set ON will disable the redundancy feature of the **Control**Wave**RED** but will allow the CPU to run as the forced application controller. Set SW1-6 to the OFF position for normal operation. When it is necessary to run a non-redundant application (because of a defective CCRS Module or the other redundant system's PSSM or CPU, or while troubleshooting, etc.) place SW1-6 to the ON position. - **Factory Set OFF**

SW1-7 set OFF will assign the CPU to System 'B.' Place SW1-7 to the ON position when it is desired to utilize the CPU in System 'A.' *Note: System 'A' CPU must reside in Slot #2 and System 'B' CPU must reside in Slot #4.* - **Factory Set - CPUA ON - CPUB OFF**



NOTE:

If the Battery is removed when power is off, Switch SW3-4 should be set OFF for over a minute or power should remain off for at least one minute.

- or -

SW1-5 MUST be set OFF for the next Boot.

Figure 2-6 - CPU Module Switches SW1 & SW3

SW1-8 set OFF prevents the 'Boot Project' from running and places the unit into diagnostic mode. SW1-8 must be set OFF to run the WINDIAG program resident on the local PC (see Section 3.5). When SW1-8 has been set ON, diagnostics are disabled. SW1-8 must be set to the ON position for normal system operation, i.e. for the Boot project to run. *Note: If both SW1-3 and SW1-8 are set OFF (closed), communication ports COM1 through COM4 will be set to 9600 bps operation.* - **Factory Set ON**

Table 2-2 - CPU Bd. Switch SW3
Firmware Load Control/Recovery Mode/Protect/Battery Enable

Switch	Function	Setting
SW3-1	Not Used	
SW3-2	System Firmware Load Control *	ON = Disable remote download of System Firmware OFF = Enable remote download of System Firmware
SW3-3	Force Recovery Mode	ON = Force recovery mode (via CW Console) OFF = Recovery mode disabled
SW3-4	SRAM & RTC Battery Enable	ON = Battery back-up enabled OFF = Battery back-up disabled

*** = Boot PROM version 06 or higher and System PROM version 4.7 or higher**

Table 2-5 in Section 2.3.3.3 provides SCB Port Switches SW1 (COM3) and SW4 (COM4) RS-232 & RS-485 communication port settings.

2.3.3.2 Communication Ports

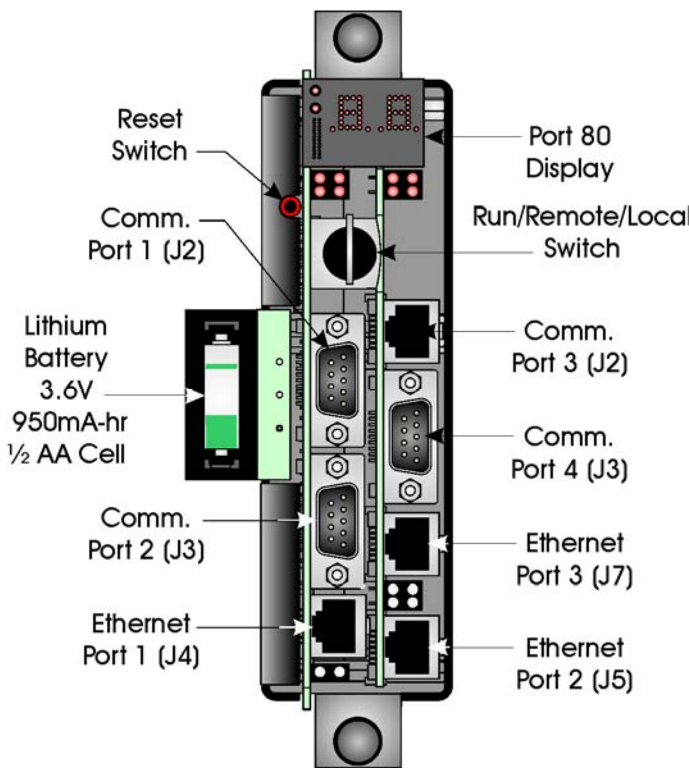
A **Control**Wave**RED** Controller can be configured as a Master node on either a MODBUS network or a BSAP network. Up to seven communication ports are contained on the **Control**Wave**RED** CPU Module and are designated as follows:

COM1 - Port 1: CPU Bd. J2, PC/AT 9-Pin Male D-Sub - RS-232
COM2 - Port 2: CPU Bd. J3, PC/AT 9-Pin Male D-Sub - RS-232
COM3 - Port 3: SCB Bd. J2, 8-Pin RJ-45 - RS-232/RS-485
COM4 - Port 4: SCB Bd. J3, PC/AT 9-Pin Male D-Sub - RS-232/RS-485
Ethernet Port 1: CPU Bd. J4, 8-Pin RJ-45 - Twisted Pair 10/100Base-T
Ethernet Port 2: SCB Bd. J5, 8-Pin RJ-45 - Twisted Pair 10/100Base-T
Ethernet Port 3: SCB Bd. J7, 8-Pin RJ-45 - Twisted Pair 10/100Base-T

Communication Ports 1 through 4 support asynchronous operation. Communication Ports COM1 and COM2 support RS-232 operation while COM3 and COM4 are individually factory configured per order for RS-232 or RS-485 operation. RS-232 and RS-485 Ports are protected to ±8KV ESD (Contact). Ethernet and RS-485 Ports are isolated to 500Vdc.

Any of the four non-Ethernet communication ports can be configured for local communications, i.e., connected to a PC loaded with **Control**Wave Designer and OpenBSI software.

Each CPU Module contains four serial communications ports that are connected to the CPU & Comm. Redundancy Switch Module via a special communications cable (see Figure 2-8).



Note: Comm. Port 3 will be configured for RS-485 operation on SCB's configured with one RS-232 and one RS-485 port.

Figure 2-7 - CPU Module Component Identification Diagram

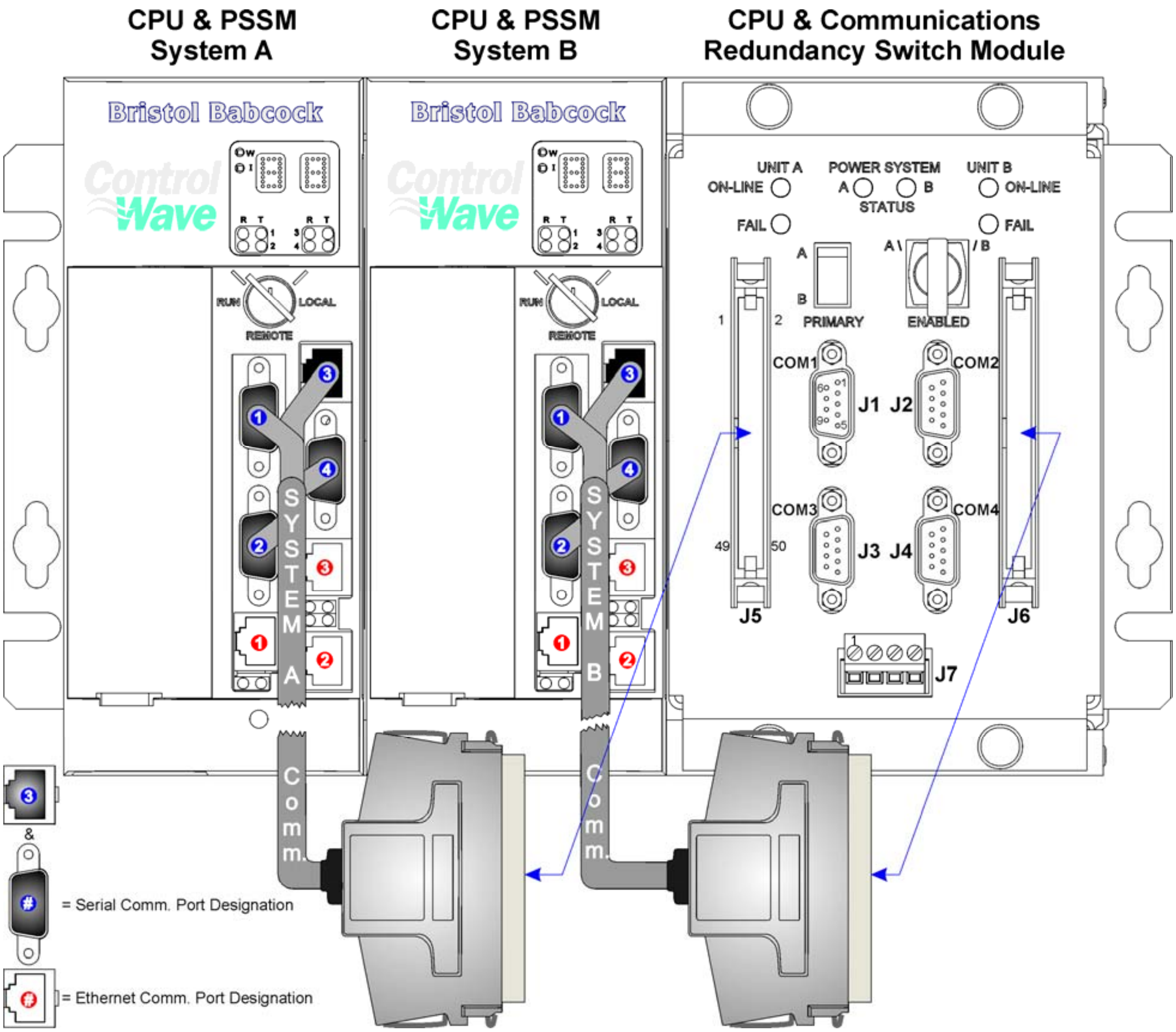


Figure 2-8 - Redundant Communication Cables Connection Diagram

The connections for the CCRSM 9-pin, RS-232/485 interfaces are shown in Figure 2-9, while the corresponding pin labels are provided in Table 2-3.

2.3.3.3 RS-232 & RS-485 Interfaces

Communications ports (COM1 & COM2) support RS-232 communications only. RS-232 or RS-485 communications can be provided by communications ports COM3 and COM4. These connectors are summarized below. **Note: All four serial communications ports on the CCRSM use PC/AT 9-Pin Male D-Sub connectors.**

CPU Bd. J2 - 9-Pin Male D-Sub - RS-232 - COM1 - CCRSM J1 (Port 1)
CPU Bd. J3 - 9-Pin Male D-Sub - RS-232 - COM2 - CCRSM J2 (Port 2)
SCB Bd. J2 - 8-Pin RJ-45 - RS-232/RS-485 - COM3 - CCRSM J3 (Port 3)
SCB Bd. J3 - 9-Pin Male D-Sub - RS-232/RS-485 - COM4 - CCRSM J4 (Port 4)

RS-232 Ports
An RS-232 interface supports point to point half-duplex and full-duplex communications (20 feet maximum, using data quality cable). Half-duplex communications supported by the **Control**Wave**RED** utilize MODBUS or BSAP protocol, while full-duplex is supported by the Point to Point (PPP) protocol. **Control**Wave**RED** RS-232 ports utilize the “null modem”

cable (Figure 2-9A) to interconnect with other devices such as a PC, printer, a **Control**Wave unit, a **Control**Wave I/O Expansion Rack, a **Control**Wave**LP**, etc. when the **Control**Wave**RED** is communicating using the full-duplex PPP protocol. The half-duplex cable shown in Figure 2-9A is utilized when the **Control**Wave**RED** Controller is connected to a **Control**Wave**LP**, a **Control**Wave I/O Expansion Rack, a **Control**Wave, etc. The "null modem" cable may be used for full-duplex communications (PPP protocol) when a **Control**Wave**RED** Controller is connected to a PC. If communicating with a Bristol series 3305, 3310, 3330 or 3335 RTU/DPC, one of the cables shown in Figure 2-9B must be used. Refer to Figure 2-9C to connect a **Control**Wave**RED** to either a modem or radio.

An illustration of the CPU and CCRSM's male 9-pin D-type connectors is provided in Figure 2-10. Table 2-3 provides the connector pin assignments for CCRSM ports 1 through 4. The connector pin assignments for CPU Module Communications Port 3 is provided in Chapter 4 (see Figure 4-3 and Table 4-3).

Note: The following facts regarding **Control**Wave**RED** RS-232 serial communications ports should be observed when constructing communications cables:

- DCD must be high to transmit
- CTS must be high to transmit
- When port is set for full-duplex operation - RTS is always ON
- DTR is always high (when port is active)
- When port is set for half-duplex operation - CTS must go low after RTS goes low

RS-485 Ports

ControlWave Controllers can use an RS-485 configured port for local network communications to multiple nodes up to 4000 feet away. Since this interface is intended for network communications, Table 2-4 provides the appropriate connections for wiring the master, 1st 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 (daisy chained) across the same lines. The master node should be wired to one end of the RS-485 cable run. A 24-gauge paired conductor cable, such as Belden 9843 should be used. *Note: Only half-duplex RS-485 networks are supported.*

Table 2-3 - CCRSM: COM1 through COM4 Connector Pin Assignment

Pin #	Signal RS-232	Description: RS-232 Signals	Signal RS-485	Description: RS-485 Signals
1	DCD	Data Carrier Detect Input		N/A
2	RXD	Receive Data Input	RXD-	Receive Data - Input
3	TXD	Transmit Data Output	TXD-	Transmit Data - Output
4	DTR	Data Terminal Ready Output	TXD+	Transmit Data + Input
5	GND	Signal/Power Ground	ISOGND	Isolated Ground
6	DSR	Data Set Ready Input	RXD+	Receive Data + Output
7	RTS	Request To Send Output		N/A
8	CTS	Clear To Send Input		N/A
9	RI	Ring Indicator *		N/A

Note: RS-485 Signals in Table 2-3 are only available on COM3 & COM4. *** RI signal**
is not available on COM3.

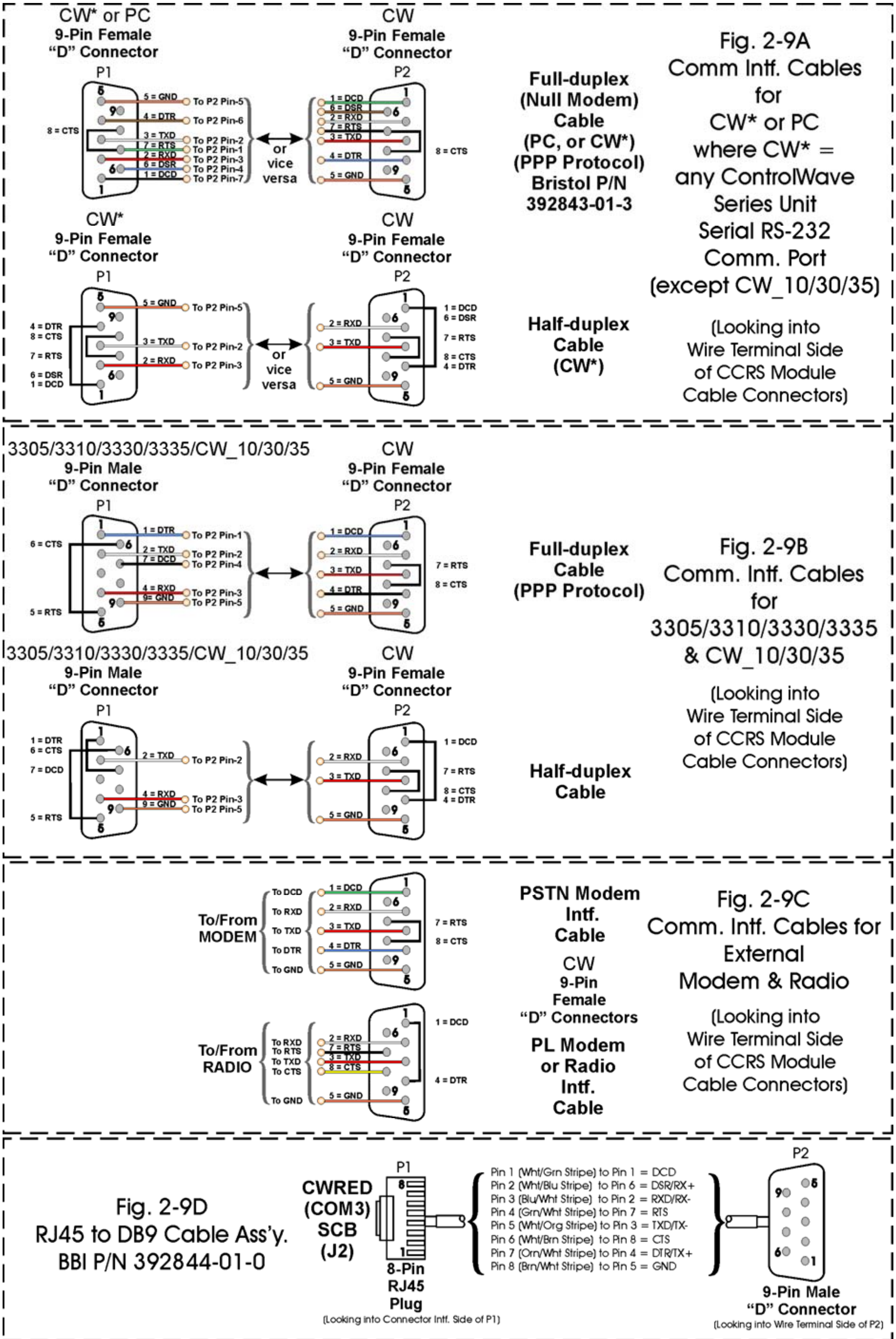


Figure 2-9 - Communication Port RS-232 Cables Wiring Diagrams

Looking into CPU/CCRS Module Receptacle

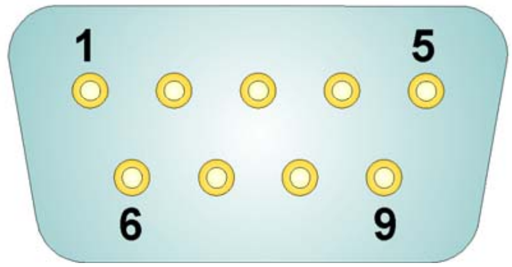


Figure 2-10 - Male DB9 9-Pin Connector (CPUM: COM1, COM2 & COM4)
(CCRSM: COM1 - COM4)

Table 2-4 - RS-485 Network Connections
(see Tables 2-3 & 4-3 for **Control**Wave RS-485 Port Pin # Assignments)

From Master	To 1st Slave	To nth Slave
TXD+	RXD+	RXD+
TXD-	RXD-	RXD-
RXD+	TXD+	TXD+
RXD-	TXD-	TXD-
ISOGND	ISOGND	ISOGND

Note: Pins 1, 2, 3, 4 & 9 of Bristol Series 3305, 3310, 3330, 3335 & 3340 RTU/DPC RS-485 Comm. Ports are assigned as follows: 1 = TXD+, 2 = TXD-, 3 = RXD+, 4 = RXD- & 9 = ISOGND.

To ensure that the “Receive Data” lines are in a proper state during inactive transmission periods, certain bias voltage levels must be maintained at the master and most distant slave units (end nodes). These end nodes also require the insertion of 100-Ohm terminating resistors to properly balance the network. Secondary Communication Board switches must be configured at each node to establish proper network performance. This is accomplished by configuring SCB Switch SW1 (Comm. Port 3) and/or SCB Switch SW2 (Comm. Port 4) so that the 100-Ohm termination resistors and biasing networks are installed at the end nodes and are removed at all other nodes on the network (see Table 2-5).

Table 2-5 - SCB Port Switches SW1 = COM3, SW2 = COM4
Loopback & Termination Control

Switch	RS-232 Function Switch ON	RS-485 Function Switch ON	Setting
1	DTR to DSR Loopback	TX+ to RX+ Loopback	ON - Only for Diagnostics
2	TXD to RXD Loopback	TX- to RX- Loopback	ON - Only for Diagnostics
3	N/A	100 Ohm RX+ Termination	ON - End Nodes Only
4	N/A	100 Ohm RX- Termination	ON - End Nodes Only
5	RTS to CTS Loopback	N/A	ON - Only for Diagnostics
6	N/A	Slow Slew Rate - ON = Fast OFF = Slow	ON/OFF - As required Factory Default = ON
7	N/A	RX+ Bias (End Node)	ON - End Nodes Only
8	N/A	RX- Bias (End Node)	ON - End Nodes Only

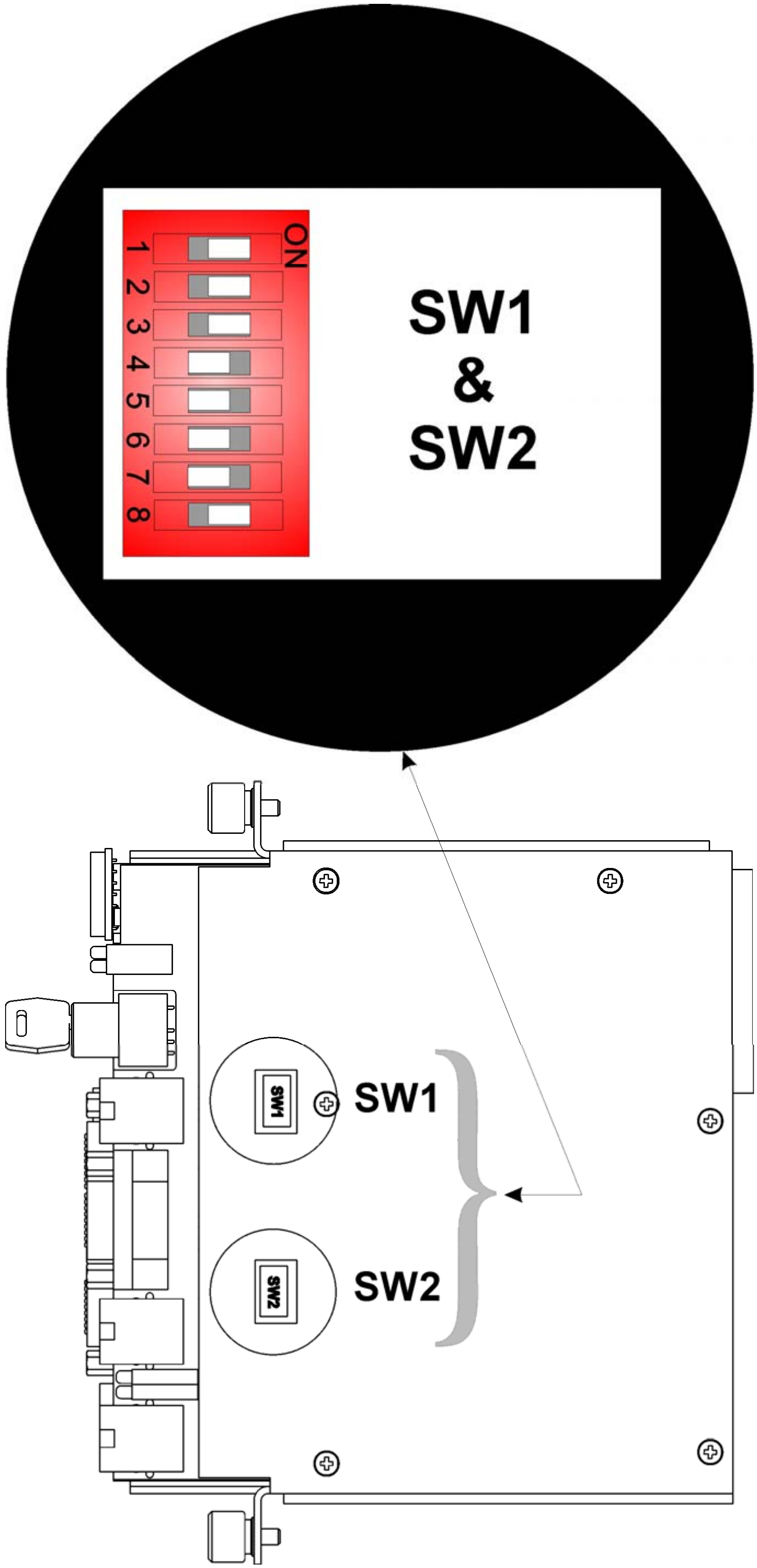


Figure 2-11 - Secondary Comm. Bd. Switches SW1 (COM3) & SW2 (COM4)

2.3.3.4 Ethernet Ports

ControlWave**RED** CPU Modules can contain from one to three Ethernet Ports. Each Port utilizes a 10/100Base-T RJ-45 modular connector that typically provides a shielded twisted pair interface to an Ethernet Hub. Each CPU will have a user selected Ethernet Port which, in addition to standard process communications will accommodate redundant CPU "Side Load" communications. ***Note: A dedicated, point-to-point Ethernet communications line may be used for redundant "Side Load" communications in lieu of a standard Ethernet connection.*** It is via this Side Load communication scheme that the secondary CPU monitors the Primary CPU's activity. **Control**Wave**RED** Ethernet Port assignment is provided below.

Ethernet Port 1: CPU Bd. J4, 8-Pin RJ-45 - Shielded Twisted Pair 10/100Base-T
Ethernet Port 2: SCB Bd. J5, 8-Pin RJ-45 - Shielded Twisted Pair 10/100Base-T
Ethernet Port 3: SCB Bd. J7, 8-Pin RJ-45 - Shielded Twisted Pair 10/100Base-T

A typical Ethernet Hub provides eight (8) 10/100Base-T RJ-45 Ports (with Port 8 having the capability to link to another Hub or to an Ethernet communications port). Both ends of the twisted pair Ethernet cable are equipped with modular RJ-45 connectors. These cables have a one-to-one wiring configuration as shown in Figure 2-14. Table 2-6 provides the assignment and definitions of the 8-pin 10/100Base-T connectors.

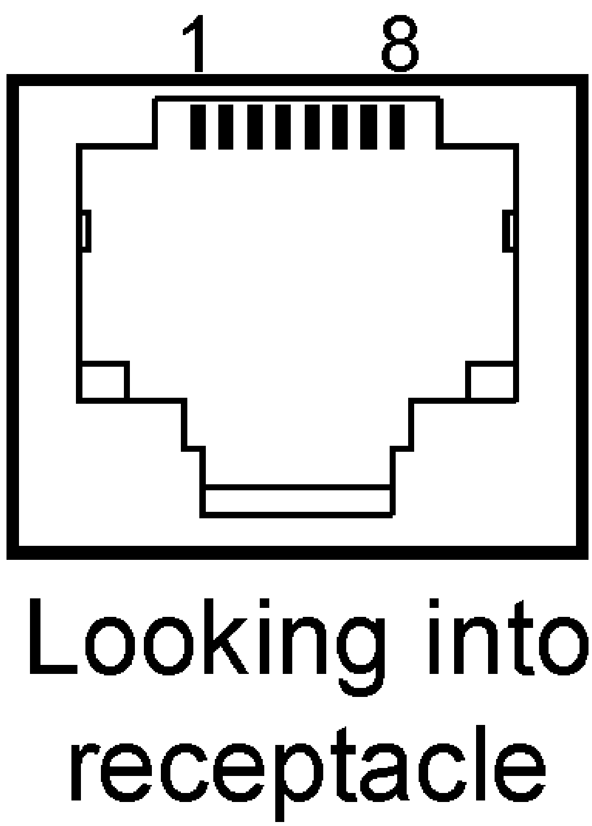


Figure 2-12 - RJ-45 Connector (Ethernet Ports) J2 (CPU), J5 & J7 (SCB)

It is possible to connect two nodes in a point-to-point configuration without the use of a Hub. However, the cable used must be configured such that the TX+/- Data pins are connected to the RX+/- Data pins (swapped) at the opposite ends of the cable (see Figure 2-13).

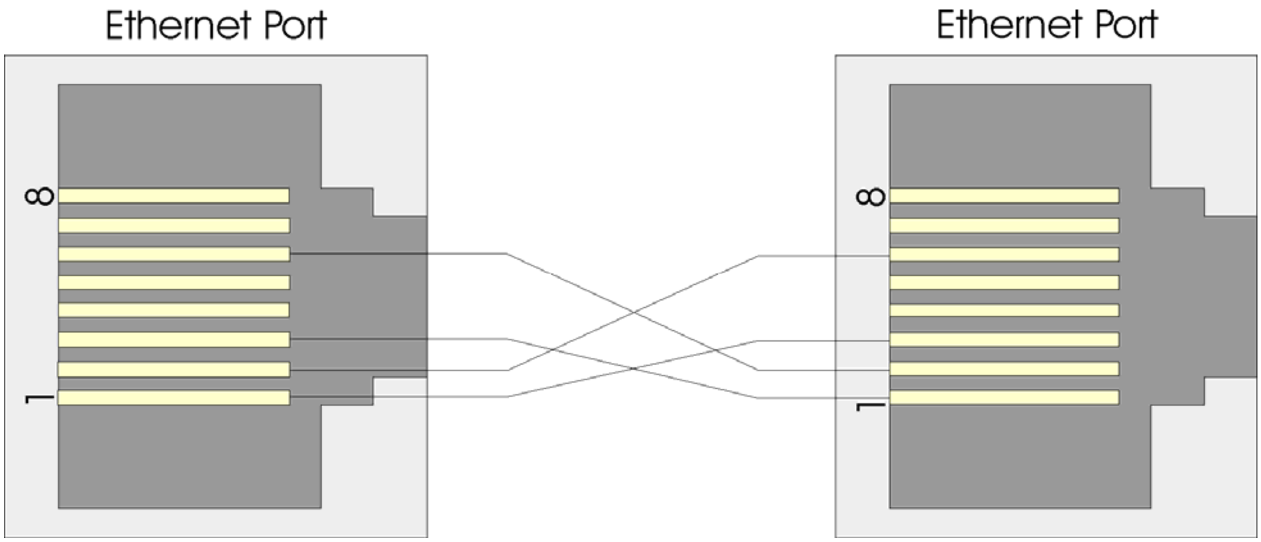


Figure 2-13 - Point-to-Point 10/100Base-T Ethernet Cable

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

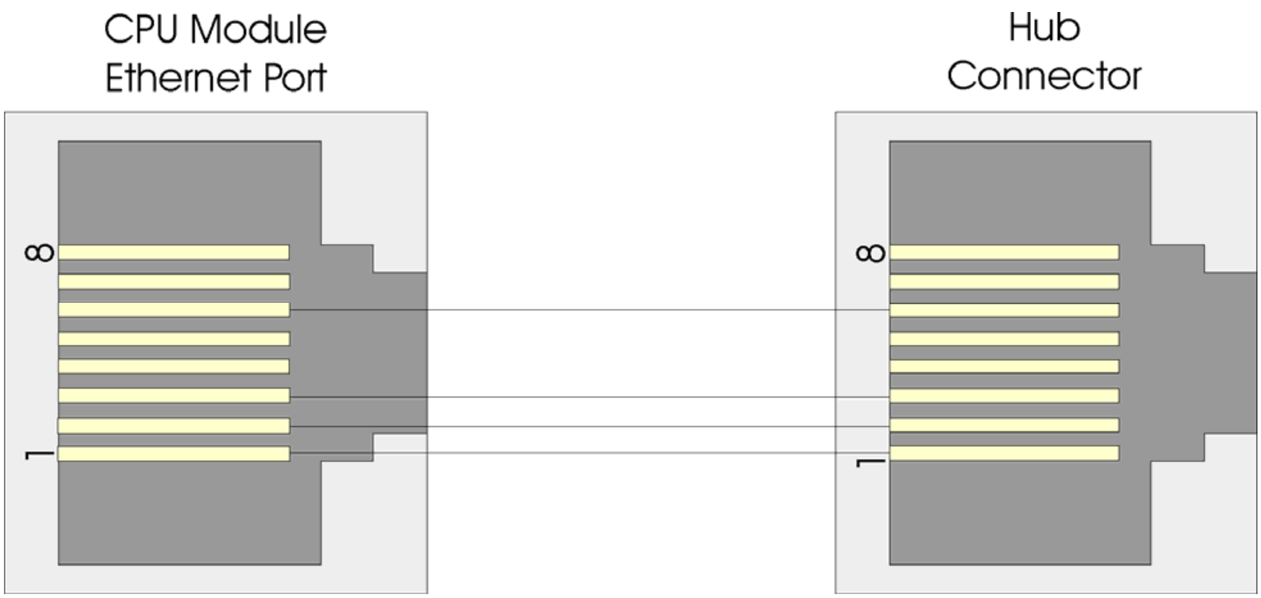


Figure 2-14 - Standard 10/100Base-T Ethernet Cable (CPU Module to Hub)

Table 2-6 - Ethernet 10/100Base-T CPU Module Pin Assignments

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

***Note: TX & RX are swapped at Hub's*.**

2.3.4 Wire Connections

ControlWave**RED** Controllers utilize compression-type terminals that accommodate up to #14 AWG wire. A connection is made by inserting the wire's bared end (1/4" max) into the clamp beneath the screw and securing the screw. The wire should be inserted fully so that no bare wires are exposed to cause shorts. If using stranded wire, tin the bare end with solder to prevent flattening and improve conductivity.

2.3.4.1 Power Supply Wiring

ControlWave**RED** PSSMs utilize compression-type terminals that accommodate up to #14 AWG wire. Allow some slack in the wires when making terminal connections. The slack makes the connections more manageable and minimizes mechanical strain on the terminal blocks.

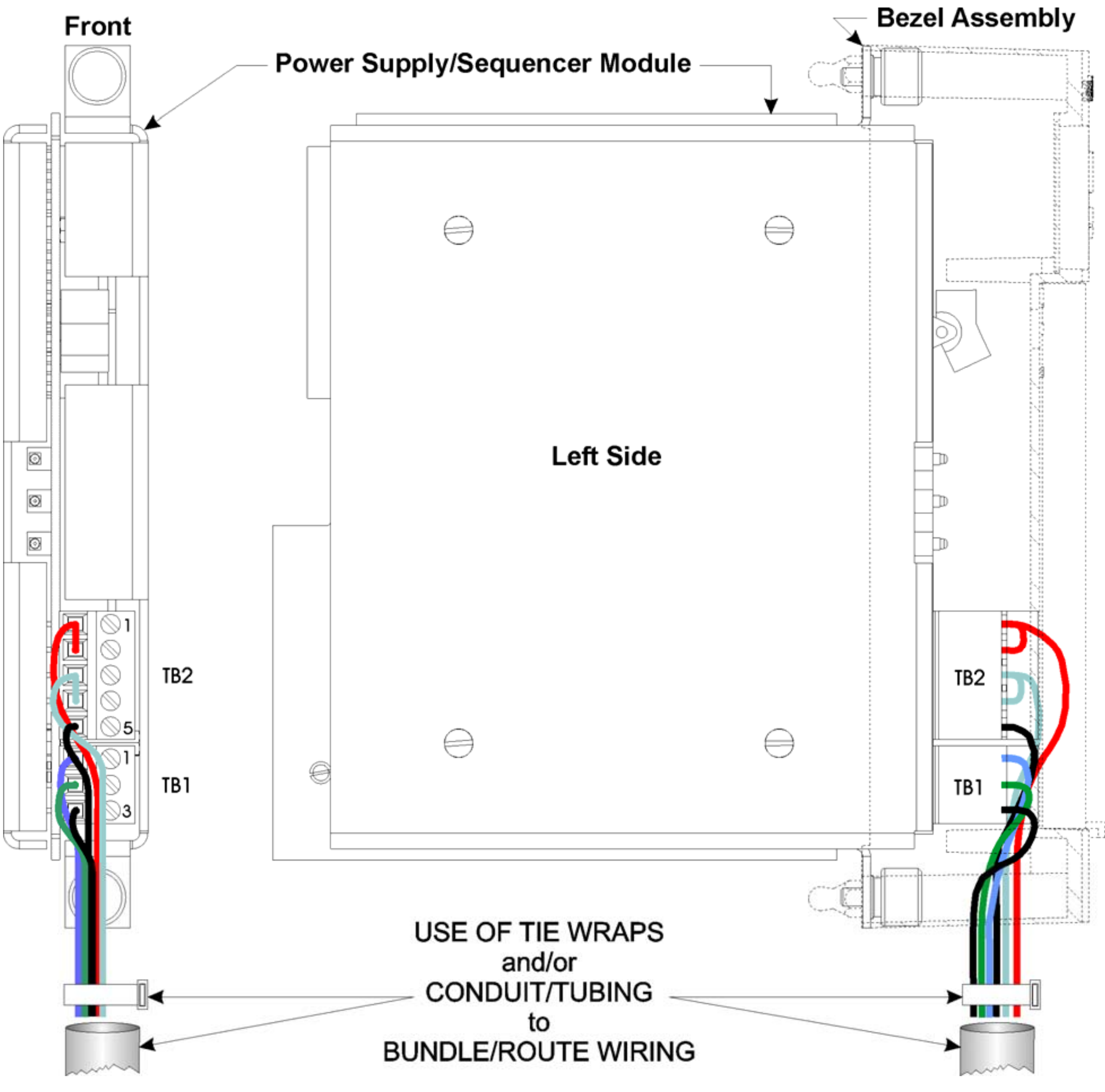


Figure 2-15 - PSSM Wire Routing Diagram

2.3.4.1.1 Bulk Power Supply Current Requirements

ControlWave**RED** Controllers are equipped with either a 12Vdc or 24Vdc Power Supply Sequencer Module (PSSM). The maximum current required for the +12Vdc or +24Vdc bulk power supply used with a particular **Control**Wave**RED** Controller are provided as follows:

Bulk +12/24Vdc Supply Current = Current of CPU + PSSM + Backplane + CCRSM

This summation will accommodate steady state as well as power up in-rush current draw.

Note: When two bulk power supplies are required, the first supply (VIN) (see Fig. 2-16) must be rated to handle 2 Amps.

Table 2-7 and 2-8 provide detailed steady state current requirements for each **Control**Wave**RED** module.

Table 2-7 - Power Requirements for Bulk 12Vdc Power Supply

COMPONENTS	SYSTEM	NOTES
CPU/SCB, CHASSIS, PSSM	A = 1050mA	CPU w/Ethernet SCB w/Ethernet
CCRSM	B = 140mA	

Table 2-8 - Power Requirements for Bulk 24Vdc Power Supply

COMPONENTS	SYSTEM	NOTES
CPU/SCB, CHASSIS, PSSM	A = 650mA	CPU w/Ethernet SCB w/Ethernet
CCRSM	B = 40mA	

2.3.4.1.2 Power Wiring

DC Power is interconnected to the PSSM via Connector TB2. One Bulk DC Power Supply can be connected to each **Control**Wave**RED** PSSM or both can share the same supply. The Bulk DC supply (nominally +12Vdc or +24Vdc) connected to TB2-1 (+VIN) is converted, regulated and filtered by the PSSM to produce +5Vdc, +3.3Vdc, +12Vdc and -12Vdc (optional). This PSSM circuit is fused at 3A and is referred to as the LOGIC Supply since these voltages are used for CPU, communications and I/O logic.

The operating range of the LOGIC Supply is +10.6 to +20.0 Vdc (nominal +12Vdc input source) or +20.7 to +30.0 Vdc (nominal +24Vdc input source).

PSSM Connector TB2 provides 5 input connections for bulk power as follows:

TB2-1 = (+VIN) (+10.6V to +20V dc for +12V supply) (+20.7V to +30V dc for +24V supply)
TB2-2 = (+VINF) Not Used
TB2-3 = (-VIN) (1st Supply Ground)
TB2-4 = (-VINF) (2nd Supply Ground) - Not Used
TB2-5 = Chassis Ground - CHASSIS (⏚)

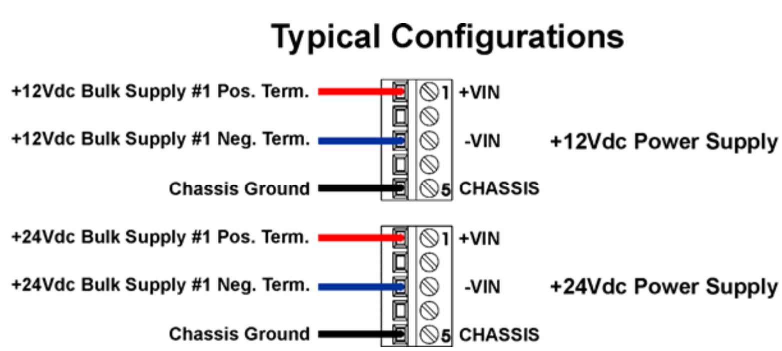


Figure 2-16 - PSSM TB2 Typical Wiring Schemes

2.3.4.1.3 Watchdog MOSFET Switch Wiring (see Figures 2-15, 2-16 & 2-17)

The circuit that drives the Watchdog MOSFET switch is on the secondary side of the power supply. A solid state relay (SSR) actuates the watchdog hardware and is factory enabled or disabled via an on-board jumper. When either the Master Clear or Watchdog Bad signal are active, the on-board watchdog hardware will be OFF. *Watchdog Bad is a signal generated by the CPU Module when its hardware detects improper software operation.*

The watchdog MOSFET switch is powered via the VI input of the terminal block (TB1-2) and its switched output is connected to the VO output of the terminal block (TB1-1). The external power source connected to the VI terminal must be referenced to the return point of the input source that powers the PSSM [-VIN or PSGND (TB2-3)].

PSSM Connector TB1 provides 3 Watchdog MOSFET switch connections as follows:

<u>**MOSFET Connections:**</u> (see Figures 2-15 & 2-17)
TB1-1 = VO - Watchdog MOSFET Switch Output
TB1-2 = VI - Watchdog MOSFET Switch Input
TB1-3 = Not Used with **Control**Wave**RED**

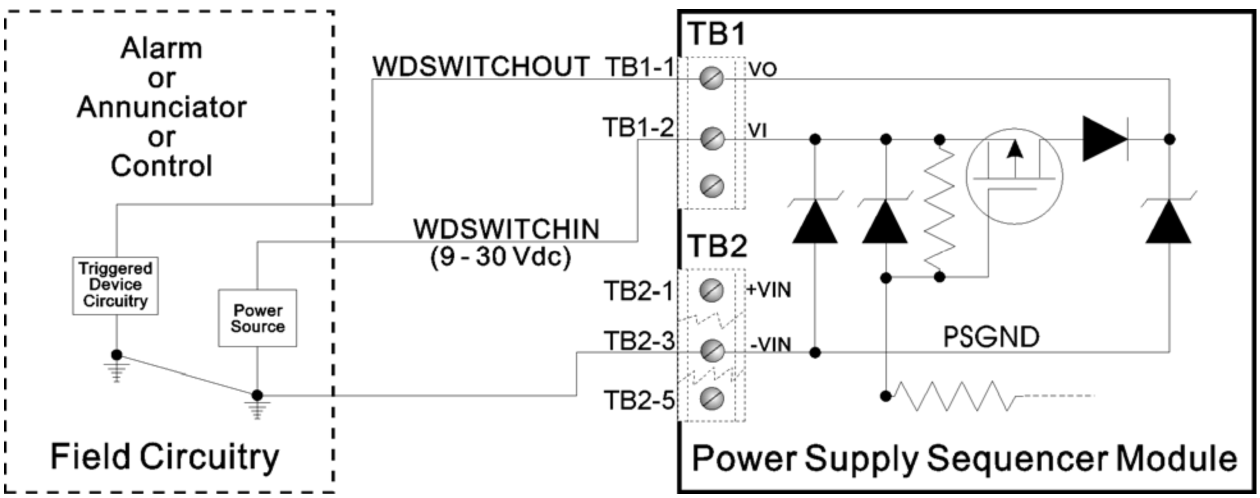


Figure 2-17 - Watchdog MOSFET Switch Field Wiring

2.3.4.2 CCRS Module Isolated On-Line Status Output Wiring

CCRSMs utilize compression-type terminals that accommodate up to #14 AWG wire. Allow some slack in the wires when making terminal connections. The slack makes the connections more manageable and minimizes mechanical strain on the terminal blocks.

CCRSMs are provided with isolated relay circuitry that provides output status signals representing the redundancy control states of CPU Module A & B. These isolated on-line status outputs provide an on-line (ONLINE) and a common (COM) lead point that can handle up to 30Vdc (max) from a field powered device. **The isolated relay switch associated with the CPU Module that is on-line will be closed while the relay switch associated with the standby CPU Module will be open.**

CCRS Module Terminal Block Connector J7 provides isolated on-line status output connections as follows:

<u>**Isolated On-Line Status Output Connections:**</u> (see Figure 2-18)

J7-1 = A_ONLINE - Switch Output (associated with CPU Module A)
J7-2 = A_ONLINE - Common connection (associated with CPU Module A)
J7-3 = B_ONLINE - Switch Output (associated with CPU Module B)
J7-4 = B_ONLINE - Common connection (associated with CPU Module B)

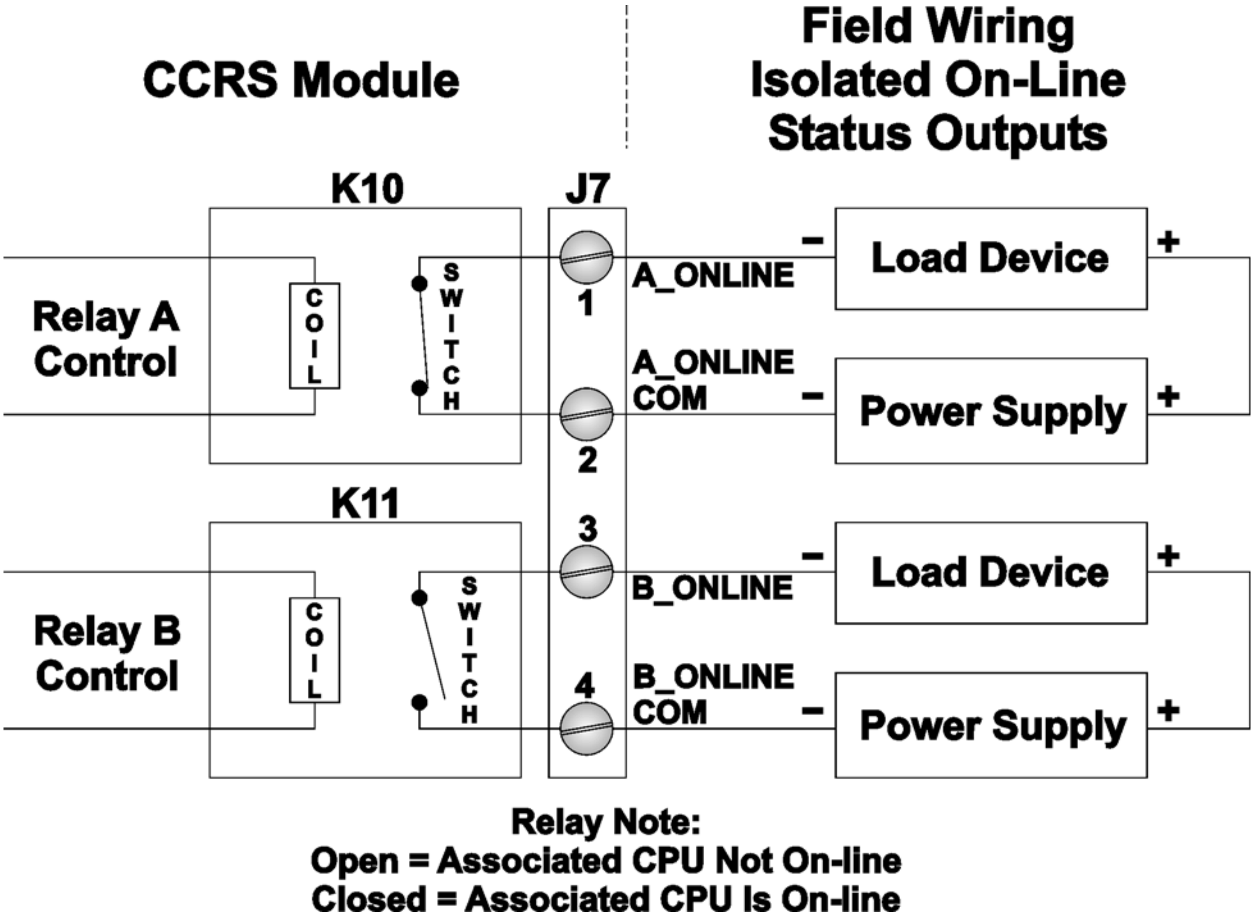


Figure 2-18 - CCRS Module - Isolated On-Line Status Outputs - Field Wiring

2.3.5 Installation of the Lithium Backup Battery (see Figures 2-5 & 2-19)

The 3.6V Lithium backup battery located on the CPU Module connects to CPU Board connector J10. This 950mA-hr lithium ½ AA cell battery is provided with a three-wire connector (2-wires used). The battery provides backup for the real-time clock, CMOS RAM and the system SRAM. A supervisory circuit is used to switch to battery power when VCC falls below VCC - 10%. The Battery PCB provides a regulated +2.5Vdc to the CPU Module.

The system SRAM has a standby current draw of 50uA maximum for each part. For a unit containing 2MB of SRAM, a worst-case current draw of 210uA allows a battery life of approximately 4524 hours, while for a unit containing 4MB of SRAM, a worst-case current draw of 410uA results in a battery life of approximately 2317 hours.

CPU Board Switch SW3-4 must be set to the ON position to enable the battery. For maximum shelf life, the battery may be isolated from the circuit by moving CPU Board Switch SW3-4 to the OFF position.

The CPU Module is shipped with the Lithium backup battery installed. To remove the Lithium backup battery, the Battery Retaining Clip must be removed from the Battery Holder Assembly (see Figure 2-19). Once the replacement battery has been installed into the Battery Holder Assembly on the Battery Backup PCB Assembly, the Battery Retaining Clip can be easily snapped back into place.

Note:
If the lithium battery is removed when power is off, CPU Switch SW3-4 should be set OFF for over a minute or power should remain off for at least a minute.

- or -

CPU Switch SW1-5 MUST be set OFF for the next Boot.

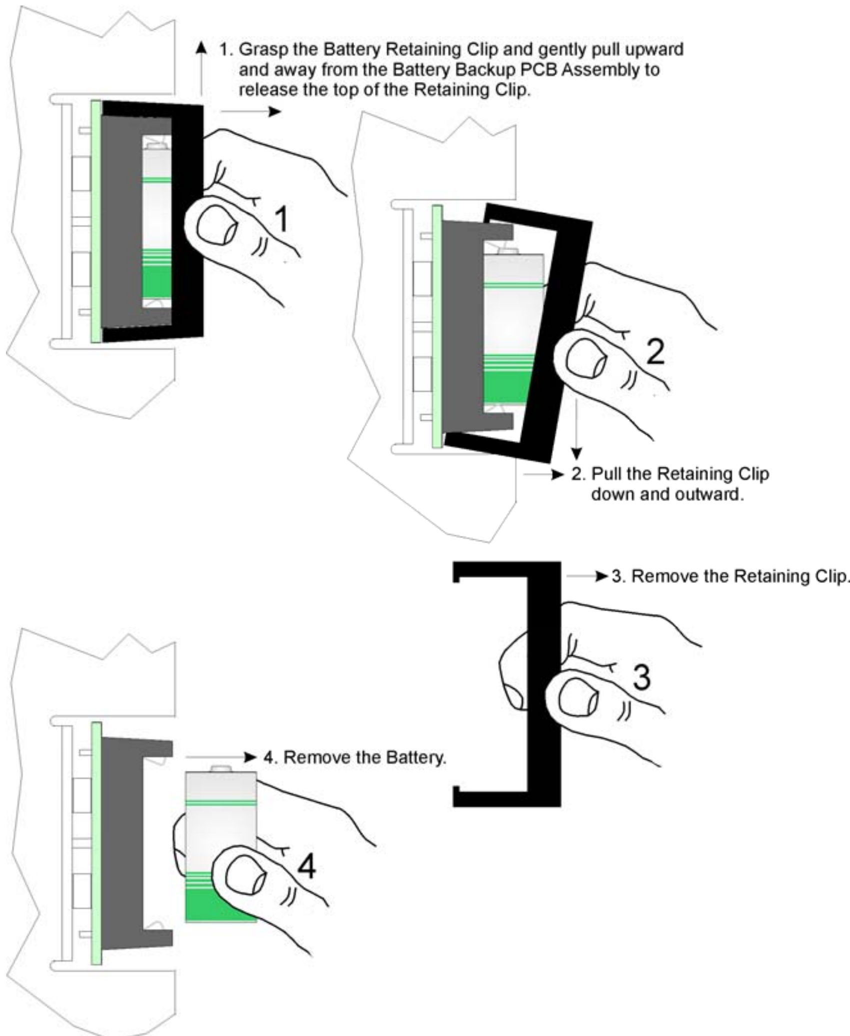


Figure 2-19 - Lithium Backup Battery Removal Diagram

2.3.6 Installation of the Bezel Assembly (see Figures 2-1, 2-5 & 2-20)

Each Bezel Assembly covers the front of a PSSM and CPU Module and provides the following functions:

- It can be removed or its Terminal Door opened to access the PSSM and CPU modules.
- Bundled wires and cables are routed downward between the modules and the Bezel.

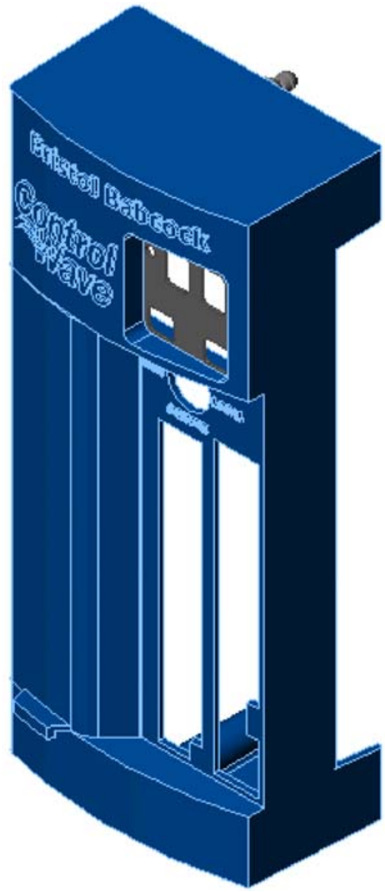


Figure 2-20 - Bezel Assembly

The appropriate Bezel Assembly is shipped with the CPU Module and should be installed whenever the unit is operational (except during service). The Bezel is secured to the Chassis by two snaps. To remove the Bezel assembly, gently grasp its sides and pull out and away from the Chassis.

Installation of the Bezel Assembly requires that its snaps be aligned with their mating holders on the Chassis. Once the Bezel has been properly positioned on the Chassis, a slight push should snap it into place.

2.4 OPERATIONAL DETAILS

ControlWave**RED** Process Automation Controllers are shipped from the factory with firmware that allows the unit to be configured in conjunction with an IEC 61131 application program. This section provides information as follows:

- Steps required to download the application load and place the unit into 'Run' mode.
- Steps required to download system firmware.
- Operation of the CPU Module's Reset Switch
- Operation of the CPU Module's RUN/REMOTE/LOCAL Switch
- Operation of the CCRS Module's A/B Primary Controller Select Switch
- Operation of the CCRS Module's A/B Enable Key Switch
- Soft Switch Configurations and Communication Ports

Operational details on **Control**Wave**RED** LEDs, the PORT 80 Display and use of the BBI WINDIAG program for fault isolation are provided in Chapter 3.

2.4.1 Downloading the Redundant Project

A **Control**Wave**RED** Controller must receive its configured redundant project before it can be placed into operation. This will require connection of one of the **Control**Wave**RED** unit's CPU Modules (via the CCRSM's A/B Enable Key Switch) to a PC running Windows 98™/Windows NT™ (4.0 or higher) and equipped with **Control**Wave Designer software & OpenBSI software. Configuration of the redundant project load must be performed by an individual familiar with the various programming tools. The following software user documentation is referenced:

Getting Started with **Control**Wave Designer Manual - D5085
ControlWave Designer Reference Manual - D5088
Open BSI Utilities Manual - D5081
Web_BSI Manual - D5087
ControlWave Redundant Setup Guide - D5123

This download can be initiated, i.e., from **Control**Wave Designer, or from the OpenBSI 1131 Downloader for **Control**Wave Nodes.

1. Set the selected CPU's RUN/REMOTE/LOCAL Switch (Key Operated) as follows:
   - If the PC is connected to a **Control**Wave**RED**'s Comm. Port that has been configured as an IP or OpenBSI Network Port, set the CPU's RUN/REMOTE/LOCAL Switch to the 'REMOTE' position.
   - If the PC is connected to a **Control**Wave**RED**'s Comm. Port that has been configured as a Serial Port, set the CPU's RUN/REMOTE/LOCAL Switch to the 'LOCAL' position.

   Note: From the factory, COM1 defaults to 115.2 kbd (RS-232) using the Internet Point to Point Protocol (PPP). Don't connect COM1 to a PC unless the PC's RS-232 port in question has been configured for PPP.

2. Once the **Control**Wave**RED** redundant project has been defined and communications and configuration parameters have been set, perform the download into the boot project area (see 'Testing the Redundant Setup' in Document # D5123).

3. After the download has been completed set the CPU's RUN/REMOTE/LOCAL Switch to the RUN position and the CCRSM's A/B Enable Key Switch to its center (Auto Selection) position.

2.4.2 Upgrading **Control**Wave Firmware

ControlWave Process Automation Controller CPUs ship from the factory with system firmware already installed. If an upgrade of the system firmware is required, use one of the procedures below to download the new or replacement firmware from the PC.

Upgrade of system firmware via LocalView FLASH Mode requires OpenBSI 5.1 (or newer). If you have an older version of OpenBSI, FLASH upgrades are to be performed via HyperTerminal. Connect of one of the **Control**Wave**RED** unit's CPU Modules (via the CCRSM's A/B Enable Key Switch) to a PC running Windows™ 2000 (Service Pack 3 or newer) or Windows™ XP Professional.
You will need a binary (*.BIN) system firmware file, and that file should be defined in the Flash Master File (FLASH.MST). A sample Flash Master File is shown, below:
cwp0410.bin   Firmware - Release 04.1

Upgrade of an unattended **Control**Wave **RED** can be accomplished from a remote PC. This capability is introduced in Section 2.4.2.3.

2.4.2.1 Using LocalView to Upgrade **Control**Wave Firmware

NOTE

Both Control Wave **CPUs must be set to Recovery Mode ENABLE (ON) prior to performing the FLASH upgrade, then set to Recovery Mode DISABLE (OFF) after the upgrade. This is accomplished via CPU Switch SW3-3. Also set Switch SW1-3 (OFF) on both CPUs to ignore soft switch configuration and use factory defaults; set SW1-3 on both CPUs (ON) after the upgrade.**

A null modem cable (see Figure 2-9) must be connected to **Control**Wave CPU Port COM1 (via J1 of the CPU & Communications Redundancy Switch Module) and to any RS-232 port on the associated PC. The PC's RS-232 port used for this purpose must be set to run at 115.2 Kbaud.

Set the A\ENABLED/B Switch on the CPU & Communications Redundancy Switch Module to the 'A'; or the 'B' position. Apply power to the ControlWaveRED by turning both PSSM's ON/OFF Switch to the ON ('I') position. The resident BIOS will initialize and test the hardware, this process is referred to as POST (Power On Self Test).

A status of the POST progress is displayed on the Port 80 display. Unless there is a problem these codes will scroll at a fast rate and won't be discernable. Successful completion is indicated with an 86 on the Port 80 display.

Follow the procedure below to upgrade the Firmware in both CPUs. If not already running, apply power to the associated PC.

Start LocalView, Choose FLASH, Enter A Name, Click on [Create]

Start LocalView by clicking on: **Start → Programs → OpenBSI Tools → LocalView**. The New View Mode dialog box will appear (see Figure 2-21).

"Mode"
Choose 'Flash' for the mode.

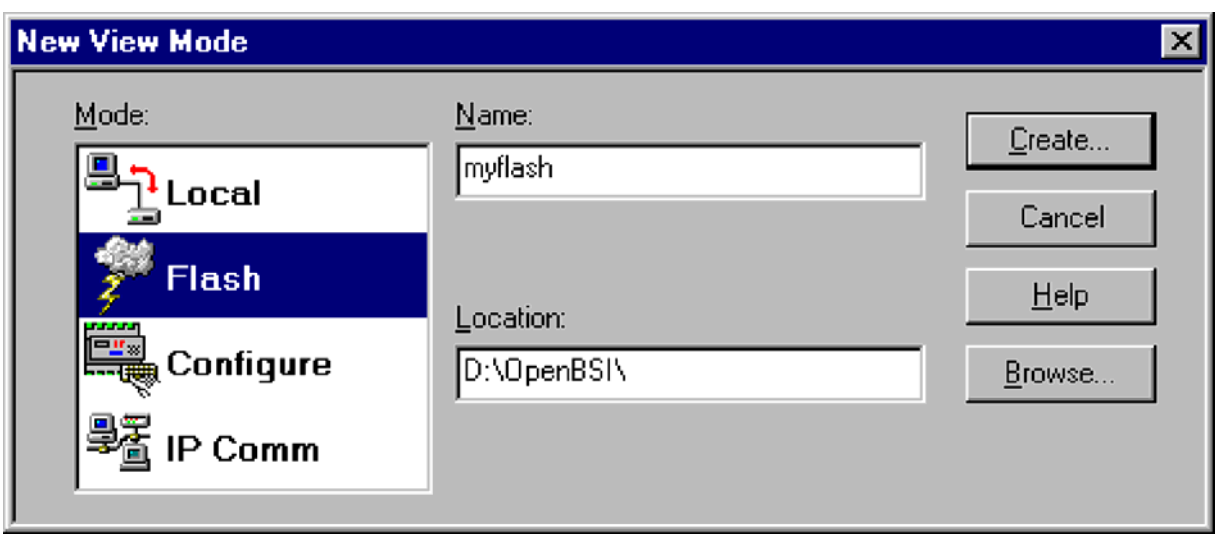


Figure 2-21 - Local View - New View Mode Menu

"Name"

Enter a name for the View Mode File in the **"Name"** field.

"Location"

If you want to store the View Mode File in a directory other than that shown in the **"Location"** field, enter the new location there, or use the **[Browse]** push button to find the directory.

When the **"Mode"**, **"Name"**, and **"Location"** have been specified, click on the **[Create]** push button to activate the Communication Setup Wizard (see Figure 2-22).

Step 1 - Communication Setup

Complete the fields in the Communication Setup Wizard as described, below.

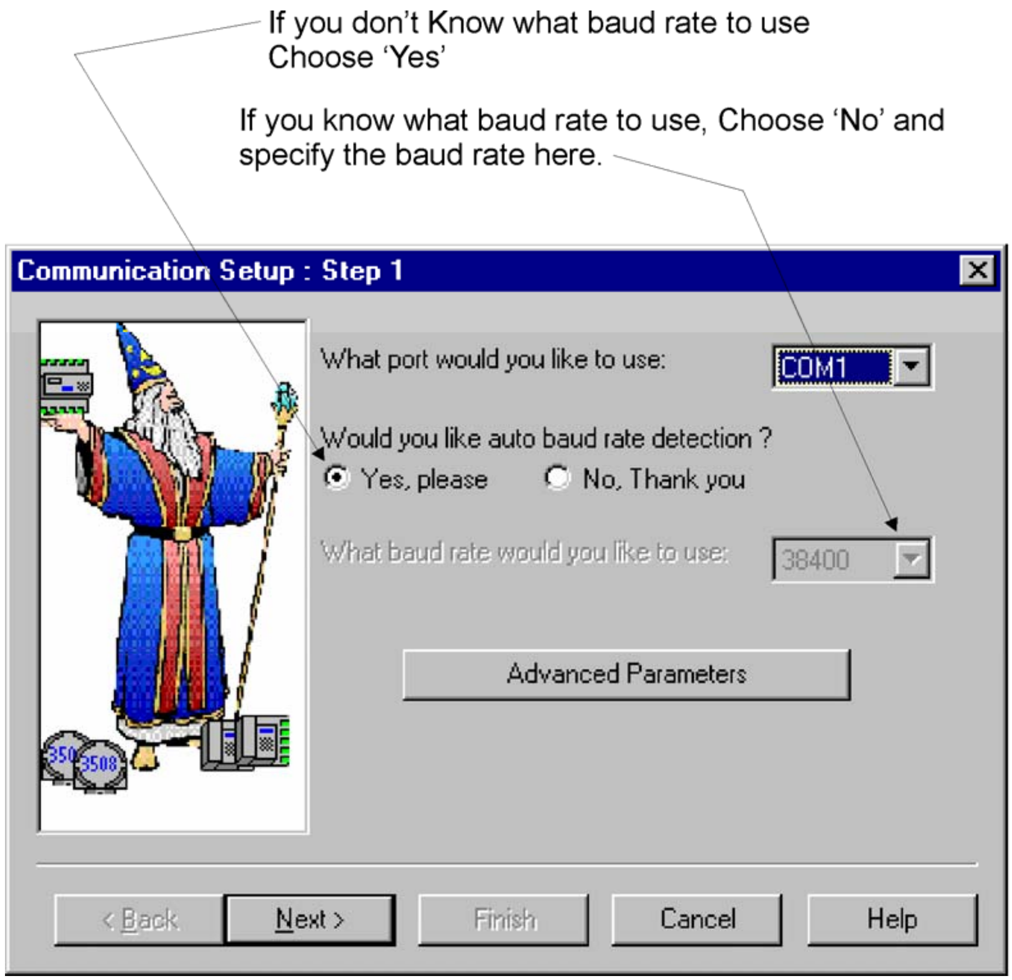


Figure 2-22 - Communication Setup: Step 1 Menu

"What port would you like to use?"

Specify the PC port you would like to use; this would be the port on the PC which will be connected to the serial cable, e.g. COM1:, COM2:, etc.

"Would you like to use auto baud rate detection?" / "What baud rate would you like to use?"

If you know which baud rate to use, answer no for auto baud detection, and specify the baud rate. If you do not know which baud rate to use, choose auto baud detection.

[Advanced Parameters]

See the *'Advanced Communication Parameters Dialog Box'* section, later in this chapter for details on this.

Click on the **[Next]** pushbutton to activate the next wizard (see Figure 2-23).

Step 2 - Flash RTU Setup

In the Flash RTU Setup Wizard (see Figure 2-23), complete the fields as described, below:

"What is the type of the RTU?"

Use the list box to select the type of controller you are connected to. In this case, you should only choose from among the ControlWave-series options:

Select this option:	For this type of unit:
ControlWave	**Control**Wave Process Automation Controller or **Control**Wave Redundant Controller

"What is the local address of the RTU that you would like to connect to?"

Select the BSAP local address of the **Control**Wave unit (from 1 to 127) using the list box provided.

"If you are flashing a redundant pair, specify the time to wait before start downloading:?"

Enter the time (from 1 to 30 seconds) in the time box (if no time is entered, default = 0). Allow enough time for both processors to settle down (Hex Code 86 should be displayed on both Port 80 Displays).

Click on the **[Next]** push button to activate the Flash Data Setup Wizard.

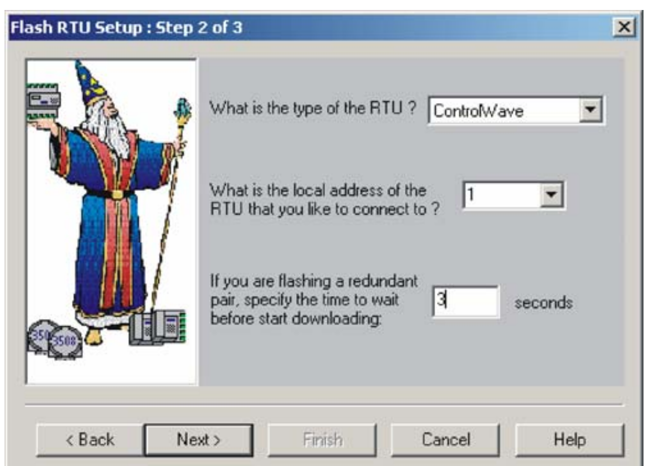


Figure 2-23 - Flash RTU Setup Menu

Step 3 - Flash Data Setup

Complete the fields in the Flash Data Setup Wizard (see Figure 2-24), as described, below:

"Please enter the name of the binary file to Flash"

To upgrade system firmware, you must specify the path and name of a binary (*.BIN) file on your hard disk containing the firmware. Normally, the contents of the various available BIN files are described in a Flash Master File (see box at bottom of the dialog box). If you have specified a Flash Master File, double-click on the description of the binary file you want to download to the RTU. Its path and name will be copied into this field. (If you do NOT have a Flash Master File, type the path and name of the binary file directly into this field.)

"Location of Flash Master File"

Specifies the location of the Flash Master File (FLASH.MST). The contents of the FLASH Master File will be displayed in the box at the bottom of the dialog box, and may be used to select binary files for FLASH downloading. (See above). If necessary, you can use the **[Browse]** push button to locate the FLASH Master File.

Figure 2-24 - Flash Data Setup Menu

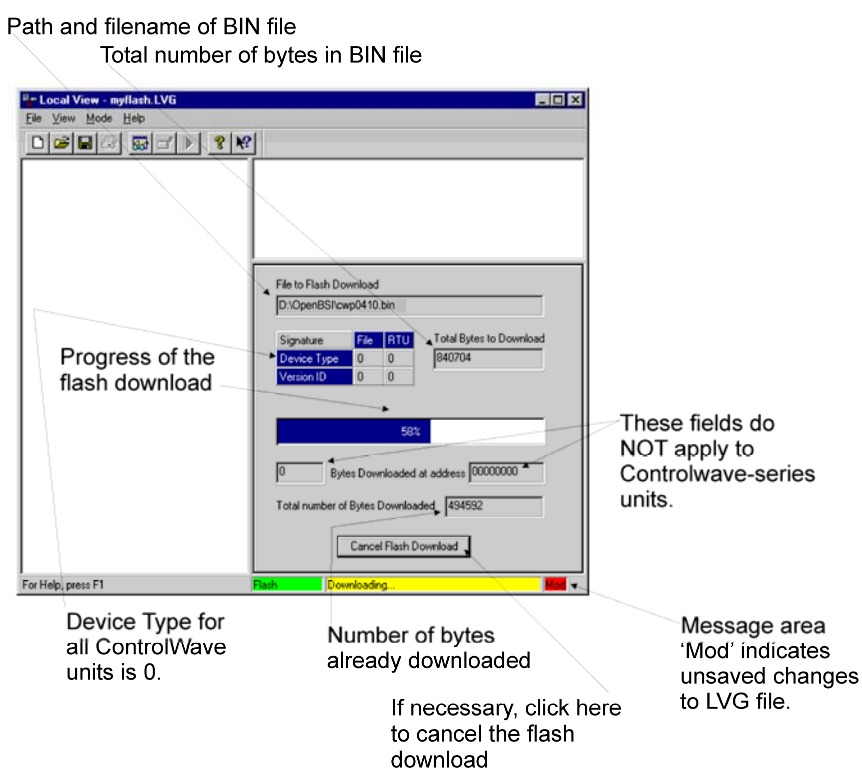


Figure 2-25 - Local View Downloading System Firmware Menu

Click on **[Finish]** to install the specified BIN file in FLASH memory at the RTU.

Once the Flash download has begun, you will NOT be allowed to shut down LocalView, unless you cancel the download, or it has been completed.

The progress of the Flash download will be displayed in the window. Any mismatch in file versions, or if the type of .BIN file does not match the type of RTU, the download will be aborted.

<u>Advanced Communication Parameters Dialog Box</u>

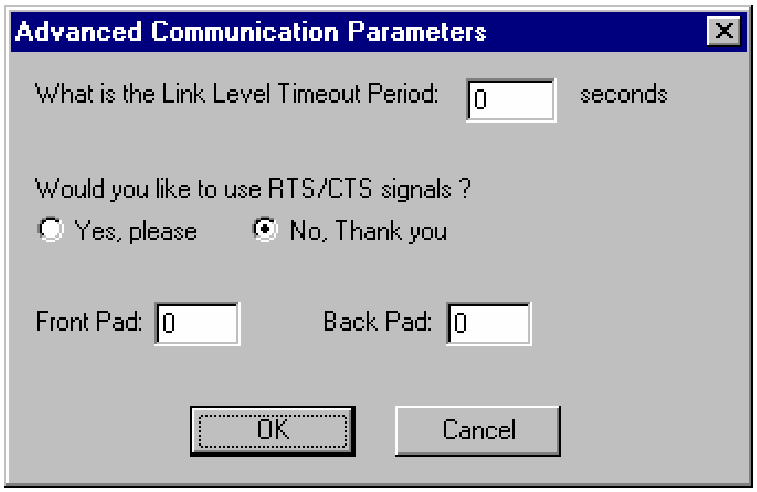


Figure 2-26 - Local View Advanced Communication Parameters Menu

“What is the Link Level Timeout Period”

This defines the maximum amount of time (in seconds) that Open BSI will wait to receive a response to any one data link transaction. If 0 is entered as the link timeout period, the system will use a default timeout calculated based on the baud rate of the line.

"Would you like to use RTS/CTS signals?"

If your communication line uses Ready to Send (RTS) / Clear to Send (CTS) signals (not to be confused with ControlWave variables used for this purpose), click on 'Yes'.

"Front Pad", "Back Pad"

These fields specify the number of null characters to insert at the beginning (front) or ending (back) of a message. Null characters may be useful in situations where there may be a momentary delay, which could cause the start of a message to be missed, for example, while a radio link is being activated. To determine the delay caused by null packing, perform the following calculation:

seconds of delay = (number of null characters x 10) / baud rate

2.4.2.2 Using HyperTerminal to Upgrade **Control**Wave Firmware

A null modem cable (see Figure 2-9) must be connected to **Control**Wave CPU Port COM1 (via J1 of the CPU & Communications Redundancy Switch Module) and to any RS-232 port on the associated PC. The PC’s RS-232 port used for this purpose must be set to run at 115.2 Kbaud. On both CPUs, set CPU Switch SW3 position 3 to ON (ON = Force Recovery).

Set the A\ENABLED/B Switch on the CPU & Communications Redundancy Switch Module to the 'A'; or the 'B' position and apply power to the **Control**Wave**RED**. After both Port 80 Displays stabilize with a Status Code of 86, follow the procedure below to upgrade the Firmware in both CPUs. If not already running, apply power to the associated PC.

1. Apply power to the ControlWaveRED by turning both PSSM's ON/OFF Switch to the ON ('I') position. The resident BIOS will initialize and test the hardware, this process is referred to as POST (Power On Self Test).

   A status of the POST progress is displayed on the Port 80 display. Unless there is a problem these codes will scroll at a fast rate and won't be discernable. Successful completion is indicated with an 86 on the Port 80 display and with the cold start menu being displayed on the PC's screen. Detection of a fault will be indicated by a 2-digit code on the Port 80 display. Refer to Section 3.4.4 for POST Status Code definition.

2. If not already running, apply power to the associated PC.

3. Start the HyperTerminal program on the PC. Note: HyperTerminal is a Windows 95 (or newer) application utility program. If using HyperTerminal for the first time, set the communications properties (for the PC Port being utilized) 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. From the HyperTerminal Recovery Mode menu (Figure 2-27), press the 'F' key, to enter FLASH download. A message will be displayed warning that the FLASH is about to be erased; press the 'Y' key at the prompt. The screen will display dots as the flash devices are being erased; this could take a few minutes.

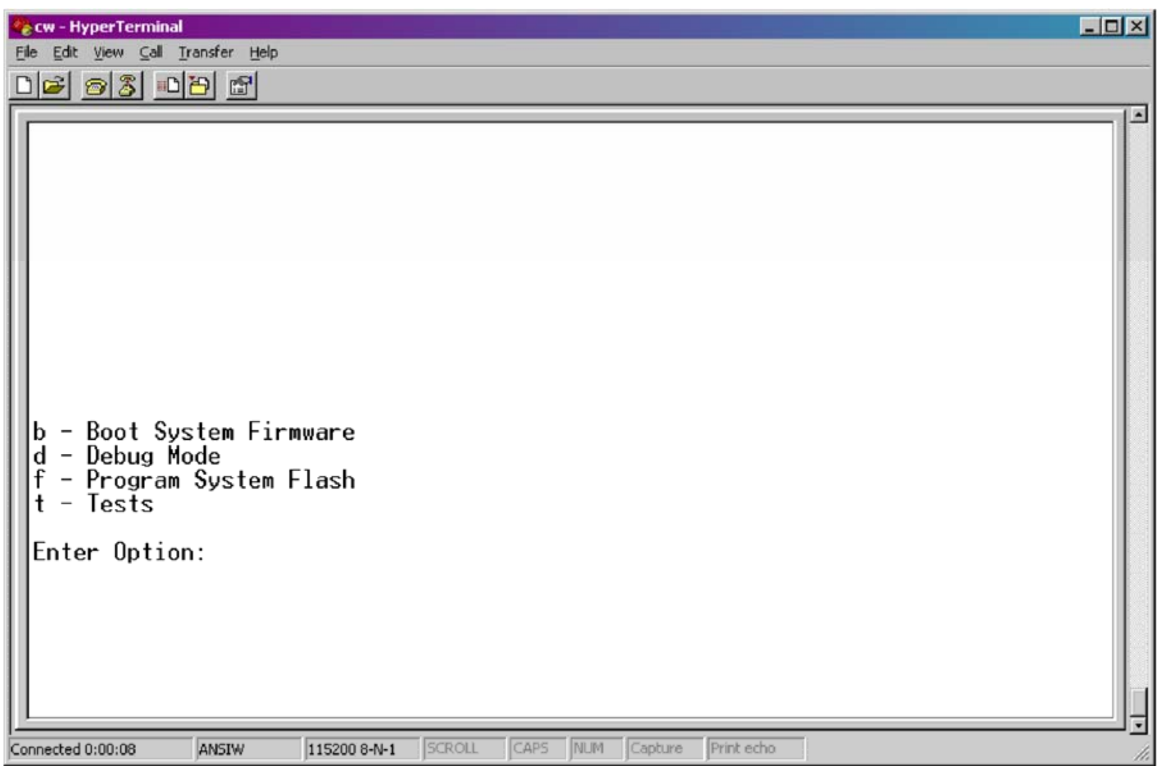


Figure 2-27 - HyperTerminal Recovery Mode Menu

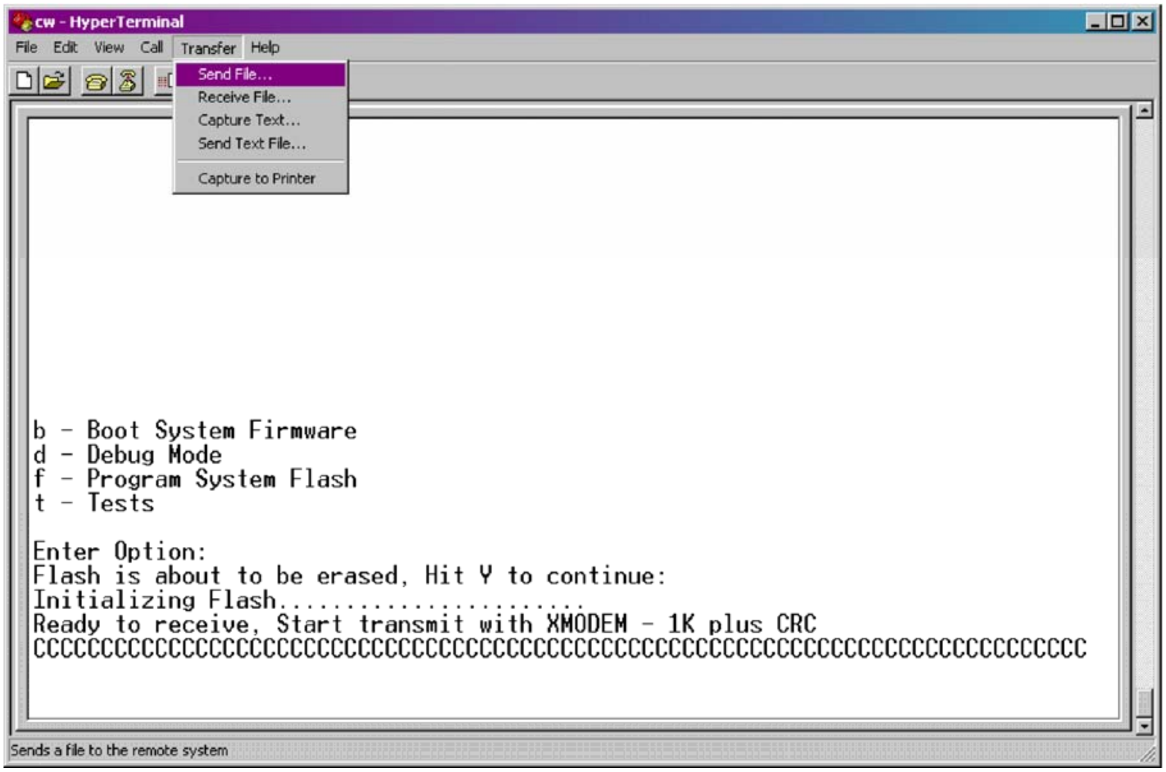


Figure 2-28 - HyperTerminal FLASH Download Menu
(Ready to Download) - (Transfer/Send File Selected)

5. When the FLASH is ready for download the letter C will be displayed on the screen. In the HyperTerminal command bar click on Transfer and then Send File…(see Figure 2-28). In the Send File Dialog Box (see Figure 2-29), 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). Click on the Send button to start the download (see Figures 2-29 and 2-30). When the HyperTerminal Recovery Mode Menu of Figure 2-27 appears, the download has completed.

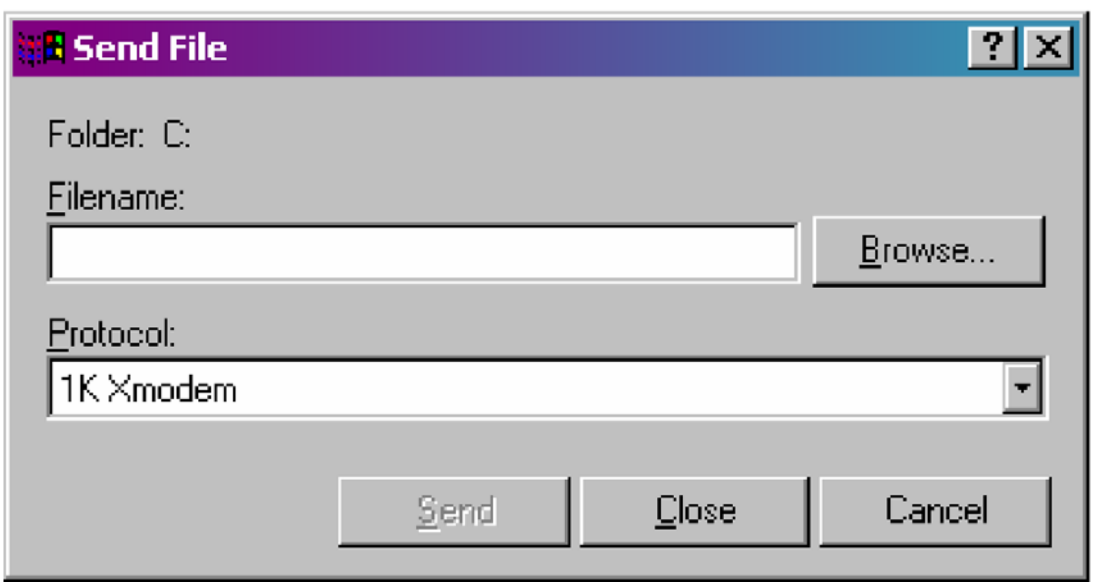


Figure 2-29 - HyperTerminal Flash Download
(Send File Dialog Box - Enter Filename)

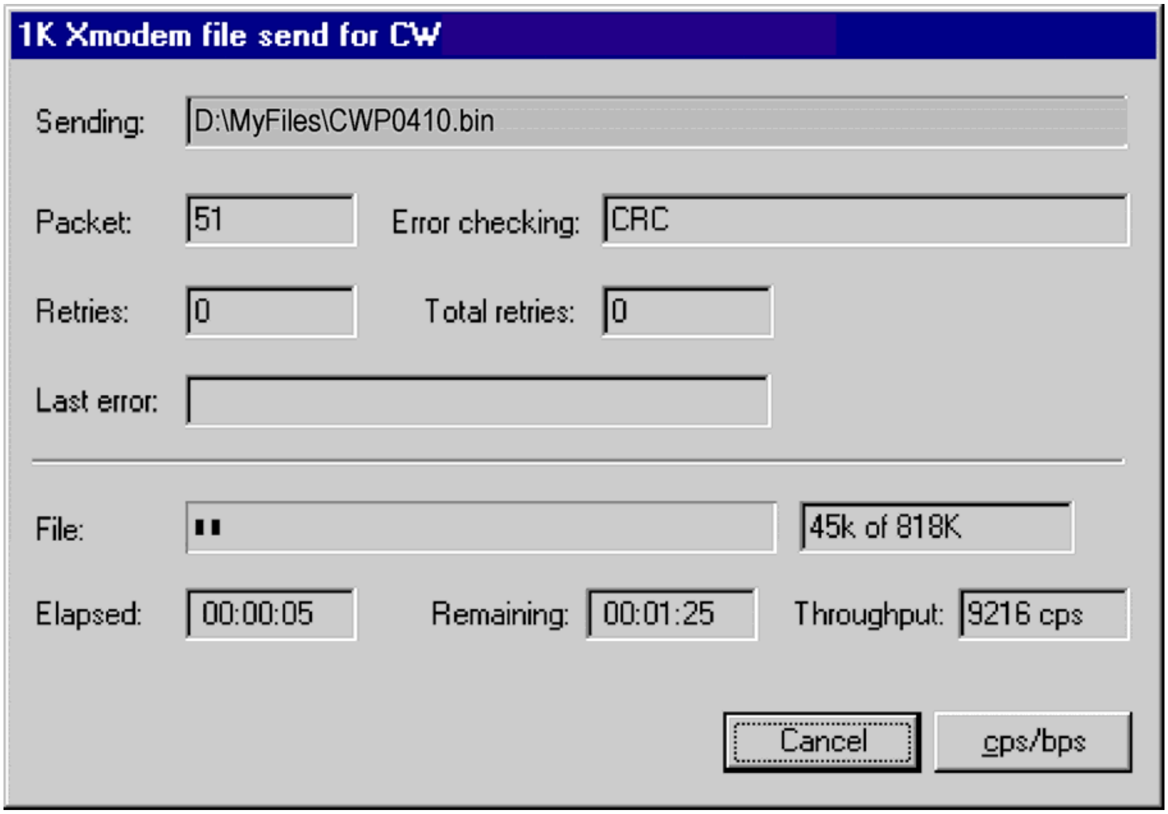


Figure 2-30 - HyperTerminal FLASH Download (Download in Process)

6. Close the HyperTerminal program. The null modem cable connected between the **Control**Wave**RED** and the PC can be removed if desired.

7. On both CPUs, set Switch SW3 position 3 to OFF (OFF = Recovery Mode Disabled). Switch Power OFF and then ON again via both PSSM's ON/OFF Switch.

   Once the **Control**Wave is running its application load, status codes posted to the Port 80 Display have a different meaning than the Port 80 POST Status Codes (see Section 3.4.4 for POST Status Codes). The PORT 80 Display is disabled during normal running operation to save power. These Port 80 Running Status (Hex) Codes are listed in Table 2-11.

Table 2-9 - PORT 80 - Running 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
BA	Standby - Valid Standby (can take over)	Watchdog LED OFF
BC	Standby - Connected to Master	Watchdog LED ON
BD	Standby - Not connected to Master	Watchdog LED ON
BF	Battery Fail (flashed at startup)	Check S3-4
CA	Hot Card Replacement in Progress	

Table 2-9 - PORT 80 - Running Status Codes (Continued)

Hex Code	Definition	Notes
CF	Invalid Firmware Checksum Detected	Unit Stopped
D0	Diagnostic Mode	SW1-8 =OFF
D1	Running Diagnostic	
DE	User Application has failed to start	Invalid I/O Driver
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

*** Not an actual Running Status Code - SW3-3 should be OFF**

Note: If the STANDBY CPU's Port 80 Display is not posting a Running Status Code of 'BA' when the ONLINE CPU goes off line (looses power, is shut off, etc.) it won't switch over to become the online unit.

2.4.2.3 Remote Upgrade of ControlWave Firmware

It is possible to download system firmware into an unattended remote **Control**Wave **RED.** This function can only be accomplished if CPU Board Switch SW3-2 (associated with the unit in question) is set in the OFF position (factory default). The procedure for performing a remote download of system firmware is discussed in Appendix J of the Open BSI Utilities Manual (document D5081). **Note: Remote upgrade of Control**Wave **RED Firmware requires Boot PROM version 4.7 or higher and System PROM version 4.7 or higher.**

2.4.3 Operation of the RUN/REMOTE/LOCAL Switch

The CPU Module's RUN/REMOTE/LOCAL Switch is set via a removable key. The CPU Module's RUN/REMOTE/LOCAL Switch can be identified by a removable key that allows the user to set the unit as follows: When set to 'RUN,' this switch prevents the user from performing any **Control**Wave Designer Debug/Program operations such as Start/Stop, download of application, etc. Use of the 'LOCAL' or 'REMOTE' setting depends on the type of network connection the Comm. Port in question has been configured for (Port selection can be IP, Serial or OpenBSI). If a Comm. Port has been configured for IP or OpenBSI (BSAP) communications, it is considered a remote port and the RUN/REMOTE/LOCAL Switch should be set to 'REMOTE' to receive a download. However; if the Comm. Port in question has been configured for Serial communications, it is considered a local port and the RUN/REMOTE/LOCAL Switch should be set to 'LOCAL' to receive a download. *Note: When the RUN/REMOTE/LOCAL Switch has been set to the 'LOCAL' position, communications via any ControlWave Comm. Port is possible, i.e., via either a local or remote Comm. Port. However; when the RUN/REMOTE/LOCAL Switch has been set to the 'REMOTE' position, only communications with a Comm. Port that has been configured as a remote Comm. Port is possible.*

The key used to set the RUN/REMOTE/LOCAL Switch may be removed or inserted while the RUN/REMOTE/LOCAL Switch is in any position.

2.4.4 Operation of The Reset Switch

The CPU Module's Reset Switch is a momentary button that allows the operator to reset (stop and restart) the CPU Module in question when the unit is being tested via WINDIAG. ***Never use this switch during normal operation.***

2.4.5 Operation of the CCRSM A/B Primary Controller Select Switch

The CCRSM A/B Primary Controller Select Switch is a two position toggle switch that is used to select the primary controller, i.e., CPU A (**UNIT A**) or CPU B (**UNIT B**) at CCRS Module power up **only** if the A/B Enabled Mode Select Switch has been set in the automatic selection (centered) position. The selected CPU Module will be chosen as the primary system controller if the CCRSM's logic determines it is ready for on-line duty. Otherwise, the alternate CPU will be selected if it is OK.

2.4.6 Operation of the CCRSM A/B Enable Key Switch

The A/B Enable Key Switch has three positions and is used to determine whether the primary CPU selection is forced to CPU A (**UNIT A**) or CPU B (**UNIT B**) or is automatically selected (Center). Forced primary selection is useful for diagnostic purposes, where a failed CPU Module may be placed on-line for debugging.

2.4.7 Soft Switch Configuration and Communication Ports

Firmware defined soft switches that control many default settings for various system operating parameters such as BSAP Local Address, EBSAP Group Number, four (4) communication port parameters, etc., can be viewed and, if desired, changed via 'Configuration Web Pages' in Microsoft Internet Explorer via the Flash Configuration Utility. When connecting the **Control**Wave**RED** to the PC (local or network) for the first time you should be aware of the communication port default parameter settings provided below (see Figures 2-5 through 2-9). *Note: Communication port factory defaults can be enabled anytime by setting CPU Board Switch SW1-3 to the OFF position.*

COM1: From the factory, COM1 (originating on the CPU Bd.) defaults to 115.2 kbps (RS-232) using the Internet Point to Point Protocol (PPP). *Note: **Control**Wave Port COM1 will be configured for RS-232 operation (at 9600 bps) by setting CPU Switches SW1-3 and SW1-8 OFF. This will prevent the boot project from running and places the unit into diagnostic mode.* To test COM1 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. Connection to a PC requires the use of an RS-232 "Null Modem" cable (see Figure 2-9).

COM2: From the factory, COM2 (originating on the CPU Bd.) defaults to 9600 bps, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM2 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. It is recommended that an RS-232 "Null Modem" cable be connected between COM2 and the PC (typically COM1) (see Figure 2-9).

COM3: When factory set for RS-232 or RS-485 operation, COM3 (originating on the SCB) defaults to 9600 bps, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. This port utilizes an RJ-45 female connector (see Figures 2-7, 2-9D and 4-3 and Table 4-3). To test COM3 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. Connection to a PC depends on the type of communications port jack utilized by the PC.

If the PC is equipped with an RS-232 Port that utilizes an RJ-45 jack, use either a special "Null Modem" cable equipped with RJ-45 male plugs and wired like the null modem cable of Figure 2-9A, or use Bristol "Null Modem" cable P/N 392843-01-3 connected to two Bristol "RJ45 to DB9 Adapter" cables P/N 392844-01-0 (see Figures 2-9A & 2-9D), to interconnect the PC to COM3.

If the PC's RS-232 Port utilizes the standard 9-pin D-type male connector, the use of the Bristol "Null Modem" cable P/N 392843-01-3 (see Figure 2-9A) and one Bristol "RJ45 to DB9 Adapter" cable P/N 392844-01-0 (see Figure2-9D) will be required. This RS-232 network, consisting of two cables, connects to COM3 of the **Control**Wave with an 8-pin RJ-45 male connector and to the PC (typically COM1) with a 9-pin D-type female connector.

If RS-485 communications is required an RS-485 cable can be assembled using the connections provided in Table 2-4.

COM4: When factory set for RS-232 or RS-485 operation, COM4 (originating on the SCB) defaults to 9600 bps, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM4 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. In lieu of the use of COM2, an RS-232 "Null Modem" cable (see Figure 2-9) can be connected between COM4 and the PC (typically COM1) or an RS-485 cable (see Tables 2-3 & 2-4) can be connected between COM4 and the PC's RS-485 Port.

Others: Any of the three optional Ethernet Ports can be connected directly or via a network to a PC equipped with an Ethernet Port (see Figures 2-7, 2-8 and 2-12 through 2-14). If not configured with an address, the **Control**Wave**RED** uses DHCP (by default) to obtain an IP address.

Section 3
SERVICE

3.1 SERVICE INTRODUCTION

This section provides general, diagnostic and test information for the **Control**Wave**RED** Controller.

The service procedures described herein will require the following equipment:

1. PC with null modem interface cable & Bristol Software
2. Loop-back plug, 9-pin female D-Sub (for RS-232) (see Figure 3-9)
3. Loop-back plug, 9-pin female D-Sub (for RS-485) (see Figure 3-11)
4. Loop-back plug, 8-pin RJ-45 male (for RS-232) (see Figure 3-9)
5. Loop-back plug, 8-pin RJ-45 male (for RS-485) (see Figure 3-11)
6. Loop-back plug, 8-pin RJ-45 male (for twisted pair Ethernet) (see Figure 3-12)
7. Ohmmeter or Continuity Tester (see Section 3.8.9)

The following test equipment can be used to test the Power Supply/Sequencer Module (PSSM):

1. DMM (Digital Multimeter): 5-1/2 digit resolution
2. Variable DC Supply: Variable to 30Vdc @ 2.5A (with vernier adjustment)

When **Control**Wave**RED** Controllers are serviced on site, it is recommended that any associated processes be closed down or placed under manual control. This precaution will prevent any processes from accidentally running out of control when tests are conducted.

Warning

*Harmful electrical potentials may still be present at the field wiring terminals even though the **Control**Wave**RED**'s power source may be turned off or disconnected. Do not attempt to unplug termination connectors or perform any wiring operations until all the associated supply sources are turned off and/or disconnected.*

Warning

Always turn off the any external supply sources used for externally powered I/O circuits, before changing any modules.

3.2 COMPONENT REMOVAL/REPLACEMENT PROCEDURES

This section provides information on accessing **Control**Wave**RED** modules for testing, installation and removal procedures.

3.2.1 Accessing Modules For Testing

Testing and replacement of **Control**Wave**RED** Controller modules should only be performed by technically qualified persons. Familiarity with the disassembly and test procedures described in this manual are required before starting. Any damage to the **Control**Wave**RED** Controller resulting from improper handling or incorrect service procedures will not be covered under the product warranty agreement. If these procedures cannot be performed properly, the unit should be returned to Bristol (with prior authorization from Bristol Inc.) for factory evaluation and repairs. All Modules (PSSM, CPU & CCRSM) are factory sealed to prevent tampering; if the seal is broken by other than Bristol Babcock personnel, the warranty is void.

3.2.2 Removal/Replacement of a Bezel Assembly

Before a CPU Module can be removed, the associated Bezel Assembly (that covers the PSSM and the CPUM) must be removed from the Chassis.

1. Set the CCRSM's A/B Enabled Mode Select Switch to either the 'A' or 'B' position as required, to force the other CPU to take control. Remove the Comm. Cable from the four Comm. Ports on the CPU Module. Grasp the sides of the Bezel Assembly and gently pull it off the Chassis.
2. To replace the Bezel Assembly, align the Bezel's two snaps (one near the top and one near the bottom) with their receptacles on the Chassis (centered between the PSSM's and CPUM's Captured Panel Fastener holes).

3.2.3 Removal/Replacement of a CPU Module (CPUM)

1. Remove the applicable Bezel Assembly (see section 3.2.2).
2. If the entire unit is to be serviced, place any critical control processes under manual control. Shut down the PSSM unit (associated with the applicable CPUM) by setting the PSSM's Power Switch to the 'O' position.
3. Loosen the two Captured Panel Fasteners that secure the CPU Module to the Chassis and then carefully slide the CPU Module out of the front of the Chassis.
4. To replace the CPU Module, the Power Supply/Sequencer Module must be installed (see Section 3.2.5). Carefully align the CPU Module with **Control**Wave**RED** Slot 2 or slot 4 (as required) and insert the unit into the Chassis. When the assembly is fully seated (CPU Module Connector J1 has mated with Backplane Connector P2/P4), turn the module's Captured Panel Fasteners (clockwise) to secure CPU Module to the Chassis thus establishing a low resistance path between the CPU Module and Chassis Ground. Make sure that the module's Captured Panel Fasteners are snug but don't over-tighten them.

3.2.4 Replacing a Failed CPU while the other CPU Remains On-line

If you have a **Control**Wave Redundant Controller fully installed and running a plant or process, and one of its CPU Modules fails, you can use the following procedure to replace the failed board, while still allowing the other CPU Module to control the plant/process.

WARNING

If performing this procedure in a Class 1 Div 2 hazardous environment, be sure to turn OFF the power to the Power Supply Sequencing Module (PSSM) of the affected unit, prior to removing a failed PSSM or CPU Module. (See steps 1 to 3 of this procedure.)

In addition, any time a maintenance procedure such as this is performed on a controller connected to a 'live' plant or process, adequate safeguards must be taken to ensure that manual backup systems are available and ready should the control system fail during the maintenance procedure.

1. First, check to see that a power problem is not the actual cause of the failure of this particular CPU. To do this, check the POWER SYSTEM STATUS LEDS (A and B) on the CCRS (see Figure 3-6). They must both be lit GREEN. In addition, the two LEDs labeled 'FAIL' must NOT be blinking. If this is NOT the case, check cable connections between the CCRS Module and the Communications Redundancy Backplane (CCRB).

   Finally, open the bezel door of each Power Supply Sequencer Module (PSSM), and verify that the PWRGOOD LED is lit, and that the MC and PWRFAIL LEDs are NOT lit.

   If all of these LED checks indicate there are no power problems, continue with step 2 of this procedure, otherwise, stop and correct the power problems first, and see if they solve the failed CPU problem.

2. Take the A/B Enabled key switch on the CCRS out of automatic mode, and switch it to the currently on-line operating CPU (A or B), in other words:

   - If the 'A' CPU failed, turn the key switch to 'B'.

   - If the 'B' CPU failed, turn the key switch to 'A'.

   This will allow control of the process/plant to be maintained during the repair procedure.

3. Power OFF the failed unit. (The power switch is located underneath the bezel door on the Power Supply Sequencer Module (PSSM)).

4. Save the current **Control**Wave configuration parameters and soft switch settings of the on-line CPU in a file on your PC. If, by chance, you already have this information saved, you can skip to Step 5, otherwise continue with this step. There are two ways to do this: You can save the information in a Flash Configuration Profile (*.FCP) file, or you can save the information in your NETDEF file. *For this procedure, we will cover the FCP method only, because using the NETDEF method has certain variations depending upon how you are communicating with the* ***Control****Wave.*

   <u>Saving Configuration Parameters and Soft Switch Settings into an FCP File:</u>

   a. Plug a cable from your PC/laptop into a configured serial port on-the CCRS panel and establish communications with the on-line CPU using either NetView or LocalView. Start the Flash Configuration Utility (see Figure 3-1).

   b. Sign on, and leave the Flash Configuration Utility running.

   c. Click on **[Load From RTU]**. This loads the current flash configuration and soft switch settings into the Flash Configuration Utility. Click on **[Close]** after the transfer is complete.

   d. To save the current flash configuration and soft switch settings to an (*.FCP) file on your PC, click on the **[Write Profile]** button, then specify the path and name you want to use for this *.FCP file. Next, click on **[Save]**.

e. If practical to do so, leave the Flash Configuration Utility running, because it will be needed later in step 12.

f. Disconnect the cable from the serial port on the CCRS.

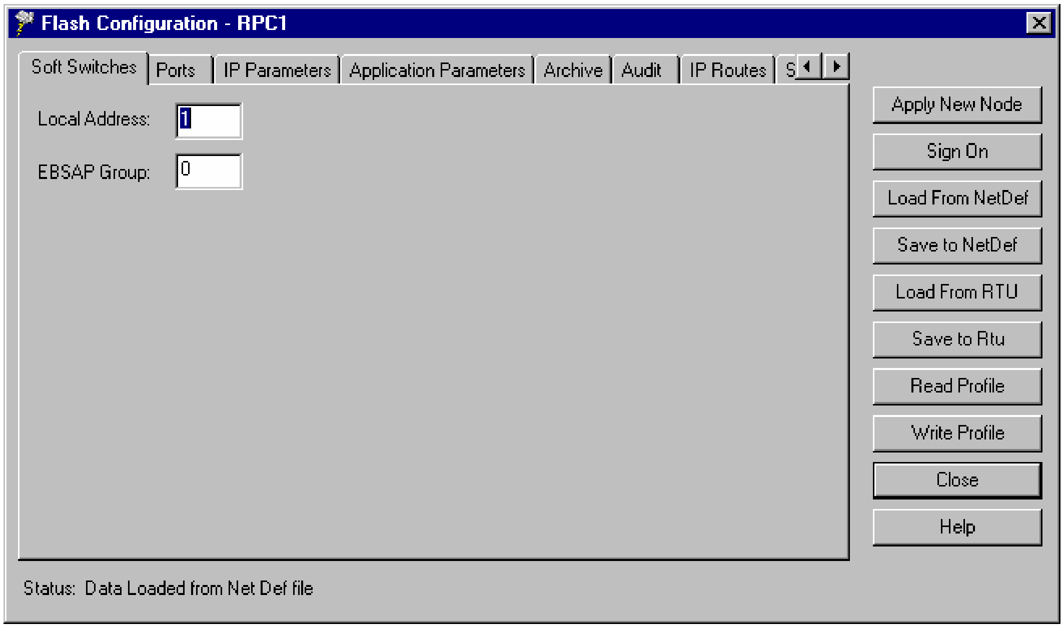


Figure 3-1 - FLASH Configuration Utility Menu

5. Disconnect the four Serial Comm. cables and any Ethernet cables from the failed CPU Module. For details on these cables, see Sections 2.3.3.3 & 2.3.3.4.

6. Remove the Bezel Assembly of the failed CPU Module (See Section 3.2.2 for information on removing the Bezel Assembly)

7. Remove the *failed* CPU Module and set it aside (See Section 3.2.3 for information on removing the CPU Module).

8. Unpack the *new* (spare) CPU Module, and set its switches to match *exactly* those on the *failed* CPU Module, *except* for the following changes:

   - Disable redundant operation by setting switch SW1-6 to ON.

   - Disable the boot project from running by setting switch SW1-8 to OFF. (This puts this CPU in diagnostic mode.)

9. Insert the new CPU Module in the slot where the failed Module had been, but do NOT put in the bezel assembly at this time.

10. Connect the cable from your PC *locally* into serial port COM2 of the *new* CPU Module (do NOT connect through the CCRS).

11. Apply power to the CPU Module. It should come up with an indication of “D0“ on the display, indicating that it is in diagnostic mode.

12. On the PC, start the Flash Configuration Utility (if not already running) and sign on. (Since this is a new CPU, you must use ‘SYSTEM’ and ‘666666’ to sign on).

13. Click on **[Read Profile]** and select whichever Flash Configuration Profile (*.FCP) file contains the flash parameters and soft switch settings for this **Control**Wave (the file you saved in Step 4), then click on **[Open]**. A status message should appear saying 'Flash configuration profile has been read successfully'.

14. Click on **[Save to RTU]**, and the contents of the FCP file will be copied to the new CPU board, effectively setting the configuration parameters and soft switches.

15. Click on **[Close]** at the end of the transfer.

16. You will be asked whether or not you want to save these parameters to the NETDEF file. This is optional. If you are in NetView, you can do this. If you choose this option while in LocalView, the parameters will NOT be permanently saved unless you are in 'Configure' mode. Answer **[Yes]** or **[No]** as desired.

17. You will see a message box warning you that certain parameters are only activated when the unit is powered OFF and back ON. Click on **[OK]**. Then click on **[Close]** to exit the Flash Configuration Utility.

18. Turn power to the newly installed CPU Module OFF.

19. Disconnect the serial cable from the newly installed CPU Module.

20. Remove the newly installed CPU Module again.

21. Change switches on the CPU Module as follows:

    - Re-enable redundant operations by setting switch SW1-6 to OFF.

    - Re-enable the boot project by setting switch SW1-8 to ON. (This disables diagnostic mode.)

22. Now that the switches are set properly, put the CPU Module back in its slot, and install the Bezel Assembly.

23. Re-connect the four Serial Communication cables and any Ethernet cables, which were removed in step 5, to the CPU Module.

24. Apply power to the new CPU. The new parameters will be activated, and the on-line CPU will perform a side-load to update the new CPU Module. If the update is successful, 'BA' will appear on the display of the newly installed CPU Module.

25. Turn the A/B Enabled key switch to the center position. This puts the controller back into automatic mode. The unit can now operate redundantly again.

Variations on Steps 4 and 13 of this Procedure - Saving Flash Configuration Parameters in the NETDEF File

In the procedure, above, we used the Flash Configuration Profile (FCP) file to save flash configuration parameters and soft switch settings. Instead, we could have saved this information in the NETDEF file for this network. This method, however, varies depending upon whether you are communicating via LocalView or NetView.

If communicating via NetView:

If communicating via NetView, this method is straightforward, since you will already have chosen a NETDEF file in order to communicate.

In the Flash Configuration Utility, choose **[Load From RTU]** to call up the flash parameters and soft switch settings from the on-line **Control**Wave.

Click on **[Close]** at the conclusion of the transfer, then click on **[Save to NetDef]** and all of this information will be saved in your current NETDEF file.

Later, in Step 13, when configuring the new CPU Module, choose **[Load From NetDef]** to call the information up, instead of **[Read Profile]**.

If communicating via LocalView

If communicating via LocalView, in order to make use of the actual NETDEF file, you MUST choose 'Configure Mode' when starting LocalView. Otherwise, LocalView will use its own temporary NETDEF file, which will automatically disappear on program exit. For full details on using LocalView in 'Configure Mode' please refer to Chapter 5 of the Open BSI Utilities Manual (document# D5081).

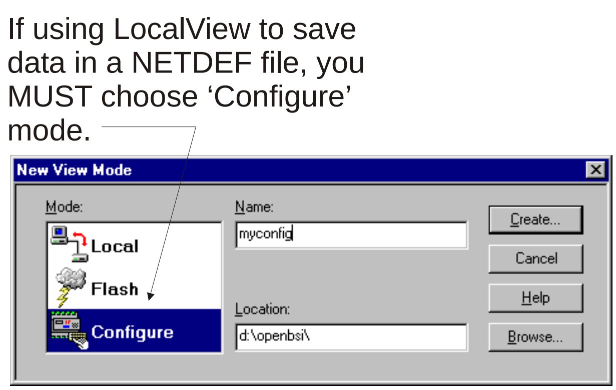


Figure 3-2 - Choosing 'Configure Mode' when Starting LocalView

In addition, when setting up LocalView communications, you must check the **"Use an existing configuration (.NDF) file**" box, then use the **[Browse]** button to locate the NETDEF file containing this **Control**Wave controller. Finally, choose the node name of the controller from the list box (see Figure 3-3).

The remaining portions of this method are similar to using NetView:

In the Flash Configuration Utility, choose **[Load From RTU]** to call up the flash parameters and soft switch settings from the on-line **Control**Wave. Click on **[Close]** at the end of the transfer, then click on **[Save to NetDef]** and all of this information will be saved in the NETDEF file you selected.

Later, in Step 13, when configuring the new CPU Module, choose **[Load From File]** to call the information up, instead of **[Read Profile]**.

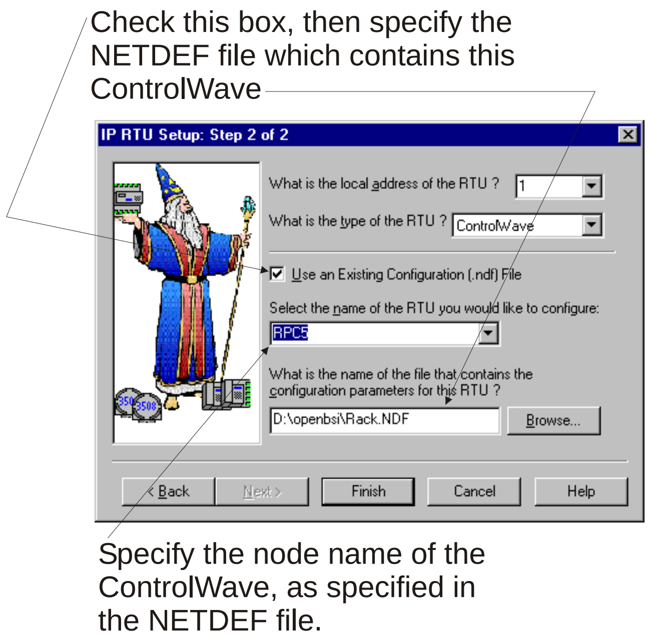


Figure 3-3 - Selecting 'Use an existing configuration (.ndf) File' (on IP RTU Setup Menu - Step 2 of 2)

3.2.5 Removal/Replacement of a Power Supply/Sequencer Module (PSSM)

1 Remove the applicable Bezel Assembly (see Section 3.2.2).
2 Remove the associated CPU Module (see Section 3.2.3 or 3.2.4).
3. Unplug the PSSM's modular connectors TB1 (Power) and TB2 (Watchdog).
4. Loosen the two Captured Panel Fasteners that secure the PSSM to the Chassis and then carefully slide the PPSM out of the front of the Chassis.
5. To replace the PSSM, the CPU Module must be removed. Carefully align the PSSM with **Control**Wave**RED** Slot 1 or Slot 3 (as required) and insert the unit into the Chassis. When the assembly is fully seated (PSSM Connector J1 has mated with Backplane Connector P1/P3), turn the module's Captured Panel Fasteners (clockwise) to secure the Power Supply/Sequencer Module to the Chassis thus establishing a low resistance path between the PSSM and Chassis Ground. Make sure that the module's Captured Panel Fasteners are snug but don't over-tighten them.
6. Replace the CPU Module (see Section 3.2.3 or 3.2.4) and apply power.

3.2.6 Removal/Replacement of a CCRS Module (CCRSM)

1. Place any critical control processes under manual control. Shut down both PSSM units by setting their Power Switches to the 'O' position.
2. Disconnect the Comm. Cable Assemblies from CCRSM connectors J5 and J6.
3. Loosen the four Captured Panel Fasteners that secure the CCRSM to the Chassis and then carefully slide the CCRSM out of the front of the Chassis.
4. Remove the ribbon cables from connectors P5 (Slot A) and P6 (Slot B) on the Backplane Board. Carefully eject both Cable End Connectors by simultaneously actuating both Eject Tabs on the Cable Headers.
5. To replace the CCRS Module, follow steps 4 through 2 in reverse order and then apply power to both PSSMs.

3.3 TROUBLESHOOTING TIPS

3.3.1 Power Supply/Sequencer Module (PSSM) Voltage Checks

Only one bulk power source can be connected to a PSSM. Both PSSMs may share the same power source or they may be discretely powered (see Figure 3-4):

TB2-1 = (+VIN) (+10.6V to +20V dc for +12V supply) (+20.7V to +30V dc for +24V supply)
TB2-2 = (+VINF) Field Supply Input - Not Used
TB2-3 = (-VIN) (1st Supply Ground)
TB2-4 = (-VINF) (2nd Supply Ground) Internally connected to TB2-3 - Not Used
TB2-5 = Chassis Ground - CHASSIS (⏚)

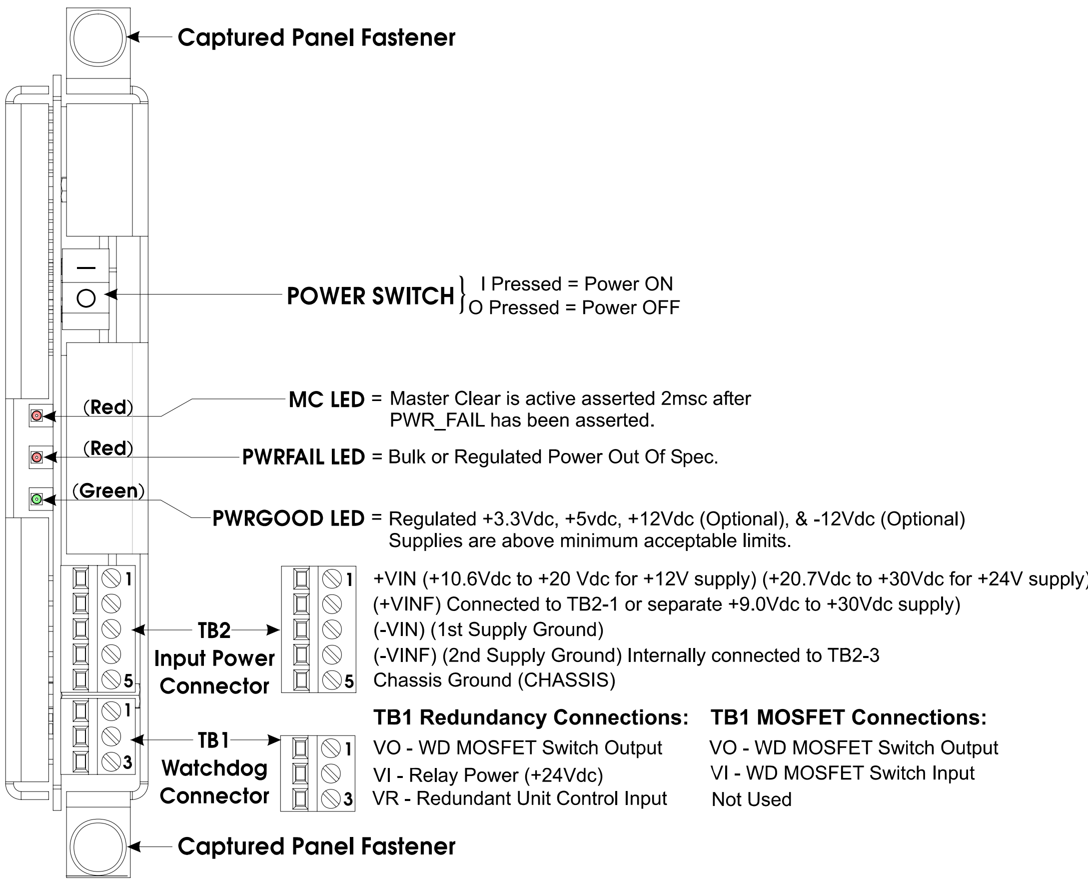


Figure 3-4 - Power Supply/Sequencer Module's TB1, TB2 & LED Designations

Bulk supply voltages can be checked at TB2 using a voltmeter or multimeter. PPSM's are factory configured for use with a nominal 12Vdc or 24Vdc bulk power supply. The maximum and minimum input power switchpoints can be tested with the use of a Variable dc Power Supply connected between TB2-1 (+) and TB2-3 (-). By increasing the input voltage (starting at +10.6Vdc or +20.7Vdc) for +12V or +24V units respectively, you can determine the point at which the unit will turn on, i.e., the point at which the green PWRGOOD LED on the PSSM comes ON (Vt+). By decreasing the input voltage (starting at +20Vdc or +30Vdc) for +12V and +24V units respectively, you can determine the point at which the unit turns off, i.e., the point at which the green PWRGOOD LED on the PSSM goes OFF (Vt-). If the value of the bulk power supply's +12Vdc or +24Vdc output approaches the value of Vt+ or Vt- it should be replaced by one with the correct +12V or +24V output.

3.3.2 LED Checks

All **Control**Wave**RED** Modules contain light emitting diodes (LEDs) that provide operational and diagnostic functions. A brief synopsis of the individual module LEDs is provided as follows:

PSSM: 3 LEDs: 1 MC LED, 1 PWRFAIL LED & 1 PWRGOOD LED
CPUM: 2 LEDs per Comm. Port = 4; 2 LEDs per Ethernet Port = 2
1 Idle LED, 1 Watchdog LED & the Port 80 LED Display Assembly
SCB: 2 LEDs per Comm. Port = 4; 2 LEDs Per Ethernet Port = 4
CCRSM: 6 LEDs: 1 UNIT A ON-LINE LED, 1 UNIT A FAIL LED, 1 UNIT B ON-LINE LED , 1 UNIT B FAIL LED, 1 POWER SYSTEM STATUS A LED & 1 POWER SYSTEM STATUS B LED

ControlWave**RED** Module LED designations and functions are provided in Table 3-1.

Table 3-1 - LED Assignment

Module	LED Name	LED Color	Function
PSSM	MC	Red	ON 2msec after PWR_FAIL goes low *
PSSM	PWRFAIL	Red	ON = Bulk or Regulated Power out of Specs. *
PSSM	PWRGOOD	Green	ON = Normal operation - all supplies O.K. *
CPUM	CR1 - WATCHDOG	Red	ON = Watchdog Condition - OFF = Normal
CPUM	CR2 - IDLE	Red	ON = CPU Idle
CPUM	CR3 - COMM 1 RX	Red	ON = RX Activity (Top-Left - see Fig 3-5)
CPUM	CR3 - COMM 1 TX	Red	ON = TX Activity (Top-Right -see Fig 3-5)
CPUM	CR3 - COMM 2 RX	Red	ON = RX Activity (Bottom-Left - see Fig 3-5)
CPUM	CR3 - COMM 2 TX	Red	ON = TX Activity (Bottom-Right -see Fig 3-5)
CPUM	CR8 - ENET Port 1	Red/Green	ON Red = Data Collision (Left - see Fig 3-5)
CPUM	CR8 - ENET Port 1	Red/Green	ON Green = Receiving Data (Left -see Fig 3-5)
CPUM	CR8 - ENET Port 1	Red/Green	ON Red = Transmitting Data (Right - see Fig 3-5)
CPUM	CR8 - ENET Port 1	Red/Green	ON Green = Link O.K. (Right -see Fig 3-5)
SCB	CR2 - COMM 3 RX	Red	ON = RX Activity (Top-Left - see Fig 3-5)
SCB	CR2 - COMM 3 TX	Red	ON = TX Activity (Top-Right -see Fig 3-5)
SCB	CR2 - COMM 4 RX	Red	ON = RX Activity (Bottom-Left - see Fig 3-5)
SCB	CR2 - COMM 4 TX	Red	ON = TX Activity (Bottom-Right -see Fig 3-5)
SCB	CR4 - ENET Port 2	Red/Green	ON Red = Data Collision (Left - see Fig 3-5
SCB	CR4 - ENET Port 2	Red/Green	ON Green = Receiving Data (Left -see Fig 3-5)
SCB	CR4 - ENET Port 2	Red/Green	ON Red = Transmitting Data (Right - see Fig 3-5)
SCB	CR4 - ENET Port 2	Red/Green	ON Green = Link O.K. (Right -see Fig 3-5)
SCB	CR5 - ENET Port 3	Red/Green	ON Red = Data Collision (Left - see Fig 3-5)
SCB	CR5 - ENET Port 3	Red/Green	ON Green = Receiving Data (Left -see Fig 3-5)
SCB	CR5 - ENET Port 3	Red/Green	ON Red = Transmitting Data (Right - see Fig 3-5
SCB	CR5 - ENET Port 3	Red/Green	ON Green = Link O.K. (Right) (see Fig 3-5)
CPUM	PORT 80 DISPLAY	Red	LED Matrix Status Codes (see Fig 3-5) **
CCRSM	UNIT A ON-LINE	Green	ON = CPUA is on line
CCRSM	UNIT A FAIL	Red	ON = CPUA has failed Blinking Red = System A Backplane Cable is not attached or has failed.
CCRSM	UNIT B ON-LINE	Green	ON = CPUB is on line

Table 3-1 - LED Assignment (Continued)

Module	LED Name	LED Color	Function
CCRSM	UNIT B FAIL	Red	ON = CPUB has failed Blinking Red = System B Backplane Cable is not attached or has failed.
CCRSM	POWER SYSTEM A STATUS	Red/Green	ON Green = All 3.3Vdc Pwr. Sources, i.e., V1, V2 & V3 are O.K. ON Red = One or more of the Pwr. Sources V1, V2 and V3 are defective
CCRSM	POWER SYSTEM B STATUS	Red/Green	ON Green = +12VA and +12VB are good and remaining logic 3.3V Pwr. Source V4 is O.K. ON Red = Pwr. Source V4 is defective or +12VA or +12VB is defective.

* = see Figure 3-4, ** = see Sections 2.4.2 & 3.4.4

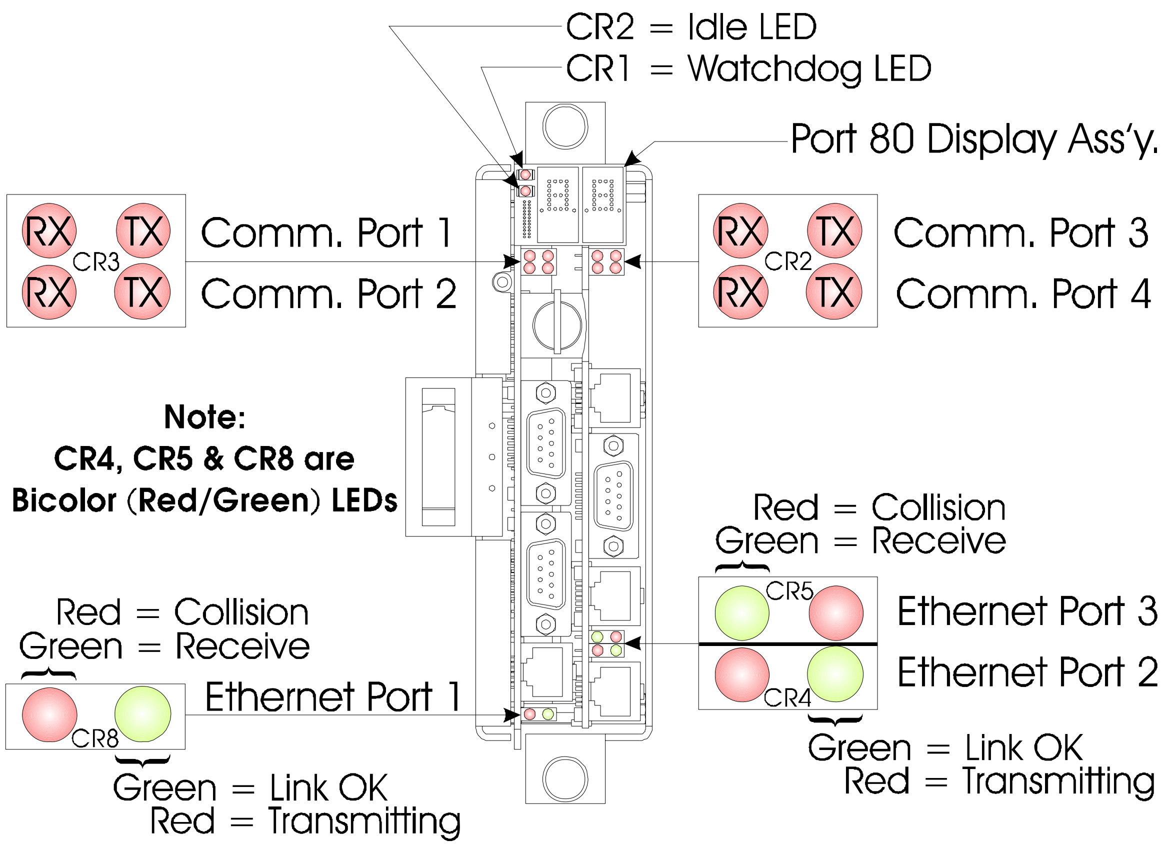


Figure 3-5 - CPU Module Port & LED Designations

3.3.3 Wiring/Signal Checks

Check I/O Field Wires at the Card Edge Terminal Blocks and at the field device. Check wiring for continuity, shorts & opens. Check I/O signals at their respective Terminal Blocks (see Table 3-2).

Table 3-2 - I/O Field Wiring - Terminal Block Reference List

I/O Subsystem	Figures	Notes
Watchdog Ckt.	2-16 & 2-17	See Section 2.3.4.1.3
On-Line Status	2-18	See Section 2.3.4.2

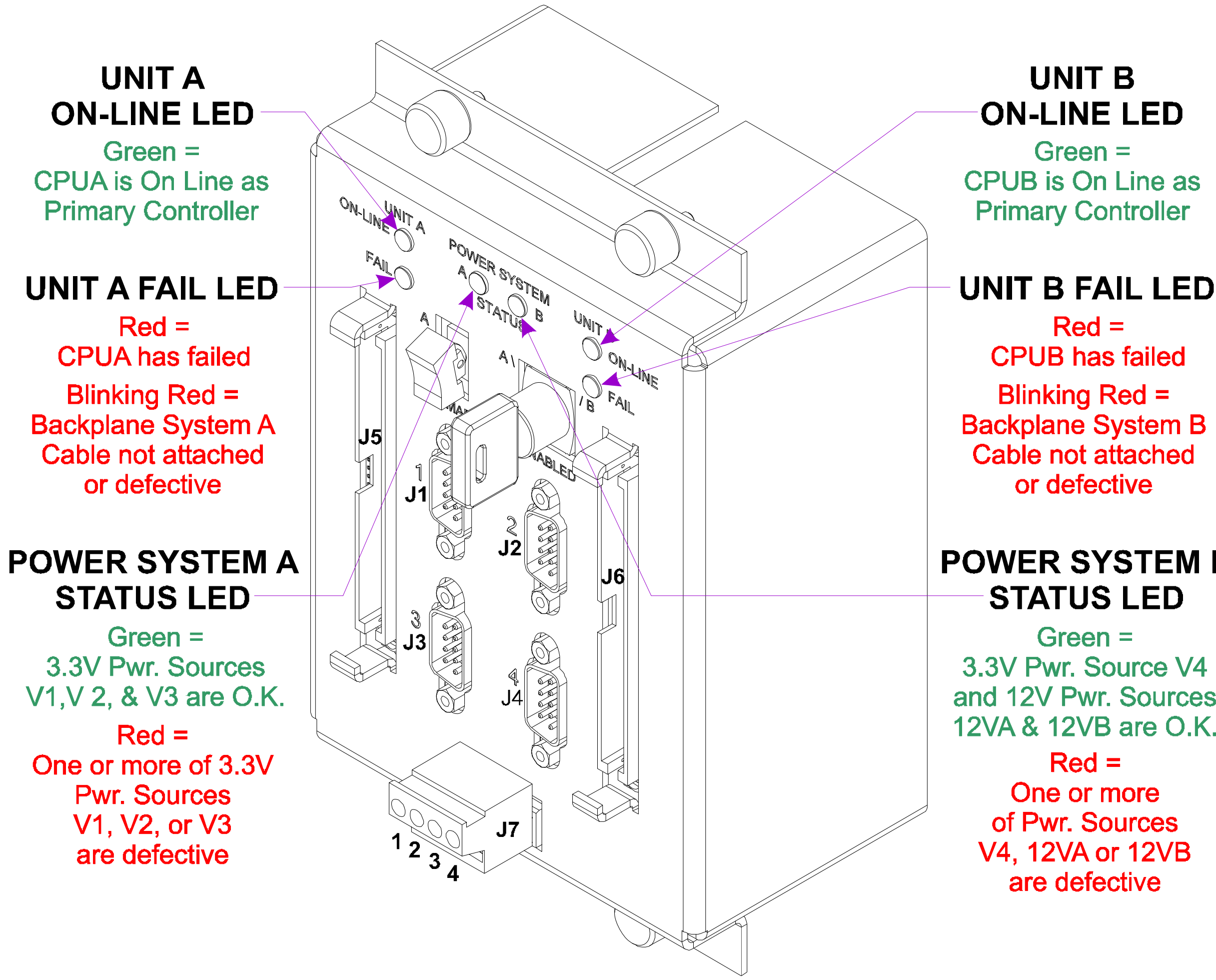


Figure 3-6 - CCRS Module LED Designations

3.4 GENERAL SERVICE NOTES

Certain questions or situations frequently arise when servicing the Bristol Controllers. Some items of interest are provided in Sections 3.4.1 through 3.4.4.

3.4.1 Extent of Field Repairs

Field repairs to **Control**Wave**RED**s are strictly limited to the replacement of complete modules. **Control**Wave**RED** Modules are sealed and employ a tamper indicator. Disassembly of a **Control**Wave**RED** Module constitutes tampering and will violate the warranty. Defective **Control**Wave**RED** Chassis or Modules must be returned to Bristol Babcock for authorized service.

3.4.2 Disconnecting RAM Battery

ControlWave**RED** CPU Lithium RAM batteries can be replaced while power is on. If the RAM battery is disconnected when the power is off, the unit will still execute its FLASH-based application load (Boot Project) upon power-up, but all of the current process data will be lost. Upon power-up, the unit will act as though it had just been booted and it will revert back to the initial values specified in its application load. The battery may be disabled by setting CPU Switch SW3 position 4 to the OFF position.

Note:
If the lithium battery is removed when power is off, CPU Switch SW3-4 should be set OFF for over a minute or power should remain off for at least a minute.

- or -

CPU Switch SW1-5 MUST be set OFF for the next Boot.

3.4.3 Maintaining Backup Files

It is essential to maintain a backup disk of each application load file to guard against an accidental loss of process configuration data. Without a backup record, it will be necessary to reconfigure the entire application load; that can be a very time consuming procedure. Always play it safe and keep backup copies of your operating system loads. A copy of the application load can be loaded into **Control**Wave**RED** FLASH memory or saved to a PC's Hard Drive as a ZIP file.

3.4.4 Port 80 Display POST Checks

At start-up, by applying power or by depressing the momentary contact (RESET) switch (SW4), the resident BIOS will initiate and test the hardware; this process is referred to as POST, i.e., Power On Self Test.

The status of the POST progress (typically too fast to discern) is posted to the CPU Module's Port 80 Display. Successful POST completion is indicated with an 86 on the port 80 Display if the unit is in Recovery Mode. Detection of a fault will be indicated by a 2-digit code on the Port 80 Display (see Table 3-3). **Note: See Table 2-9 for Running Status Codes.**

Table 3-3 - 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.

Table 3-3 - Port 80 POST Status Codes (Continued)

Hex Code	Definition
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.
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 1st 64KB memtest.
4F	on cold boot, test all of low memory.
50	adjust memsize for 1K usage.

Table 3-3 - Port 80 POST Status Codes (Continued)

Hex Code	Definition
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
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.

Table 3-3 - Port 80 POST Status Codes (Continued)

Hex Code	Definition
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.

Note: Once the unit is running its application load, status codes posted to the Port 80 Display have a different meaning than the Port 80 POST Status Codes. The PORT 80 Display on the ONLINE unit is disabled during normal running operation while that of the STANDBY unit should display Hex Code 'BA' (Backup Available). Port 80 Running Status (Hex) Codes are listed in Table 2-9. Once the system is running its application load the STANDBY CPU's Port 80 Display must be posting a Running Status Code of 'BA' when the ONLINE CPU goes off line (looses power, is shut off, etc.), or it won't switch over to become the ONLINE unit.

3.5 WINDIAG DIAGNOSTICS

Bristol's WINDIAG software is a diagnostic tool used for testing **Control**Wave**RED** CPU memory, communications ports, etc., for proper performance. The **Control**Wave**RED** must be communicating with a PC equipped with Bristol's WINDIAG program. CPU Module configuration switch SW1-8 must be set to the OFF (Closed) position to enable diagnostics. Communication between the **Control**Wave**RED** (with/without application loaded) and the PC can be made via a Local or Network Port with the following restrictions:

- CPU Board Switch SW1-8 must be OFF (closed) to run the WINDIAG program. Setting SW1-8 OFF will prevent the 'Boot Project' from running and will place the unit into diagnostic mode.
- Any **Control**Wave**RED** communication port can be connected to the PC provided their port speeds match. Most PCs have a COM1 port (typically RS-232 and defaulted to 9600 bps operation).
- The **Control**Wave**RED** communication port to be tested using the WINDIAG program must be configured for 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. This can be accomplished via user defined Soft Switches, or for ports COM2, COM3 and COM4, by setting CPU Board Switch SW1-3 OFF (closed).
- Communication port COM1 is only forced to 9600 bps operation when CPU Switches SW1-3 and SW1-8 have both been set OFF (closed). COM1 can also be set to 9600 bps operation via user defined Soft Switches.
- Setting CPU Board Switches SW1-3 and SW1-8 OFF (closed) prevents the 'Boot Project' from running, places the unit into diagnostic mode and forces communication ports COM1 through COM4 to operate at 9600 baud.

COM1: From the factory, COM1 (originating on the CPU Bd.) defaults to 115.2 kbd (RS-232) using the Internet Point to Point Protocol (PPP). *Note: **Control**Wave**RED** Port*

COM1 will be configured for RS-232 operation (at 9600 bps) by setting CPU switches SW1-3 and SW1-8 OFF (closed). This will prevent the boot project from running and places the unit into diagnostic mode. To test COM1 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. Connection to a PC requires the use of an RS-232 “Null Modem” cable (see Figure 2-9).

COM2: From the factory, COM2 (originating on the CPU Bd.) defaults to 9600 bps, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM2using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. It is recommended that an RS-232 “Null Modem” cable be connected between COM2 and the PC (typically COM1) (see Figure 2-9).

COM3: When factory set for RS-232 or RS-485 operation, COM3 (originating on the SCB) defaults to 9600 bps, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. This port utilizes an RJ-45 female connector (see Figures 2-7 through 2-9D and Table 2-4). To test COM3using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. Connection to a PC depends on the type of communications port jack utilized by the PC.

If the PC is equipped with an RS-232 Port that utilizes an RJ-45 jack, use either a special “Null Modem” cable equipped with RJ-45 male plugs and wired like the null modem cable of Figure 9A, or use Bristol “Null Modem” cable P/N 392843-01-3 connected to two Bristol “RJ45 to DB9 Adapter” cables P/N 392844-01-0 (see Figures 2-9A & 2-9D), to interconnect the PC to COM3.

If the PC’s RS-232 Port utilizes the standard 9-pin D-type male connector, the use of the Bristol “Null Modem” cable P/N 392843-01-3 (see Figure 2-9A) and one Bristol “RJ45 to DB9 Adapter” cable P/N 392844-01-0 (see Figure2-9D) will be required. This RS-232 network, consisting of two cables, connects to COM3 of the **Control**Wave**RED** with an 8-pin RJ-45 male connector and to the PC (typically COM1) with a 9-pin D-type female connector.

If RS-485 communications is required, an RS-485 cable can be assembled using the connections provided in Table 2-5.

COM4: When factory set for RS-232 or RS-485 operation, COM4 (originating on the SCB) defaults to 9600 bps, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM4 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW1-8 must be set to the OFF position. In lieu of the use of COM2, either an RS-232 “Null Modem” cable (see Figure 2-9) can be connected between COM4 and the PC (typically COM1) or an RS-485 cable (see Tables 2-3 & 2-4) can be connected between COM4 and the PC’s RS-485 Port.

Others: Any of the three optional Ethernet Ports can be connected directly or via a network to a PC equipped with an Ethernet Port (see Figures 1-5 and 2-12 through 2-14). If not configured with an address, the **Control**Wave**RED** uses DHCP (by default) to obtain an IP address.

To use the WINDIAG program place any critical process (associated with the **Control**Wave**RED** unit in question) under manual control. WINDIAG cannot be run while the **Control**Wave**RED** application is running. Set the CPU Modules Switches SW1-3 and SW1-8 to the OFF (closed) position. Perform steps 1 through 6 below.

1. Start the OpenBSI NetView Program. A menu similar to Figure 3-7 will appear.
2. To start the WINDIAG program, go to the Start Program's menu, select OpenBSI Tools, then select Utilities Programs and then select Diagnostics.

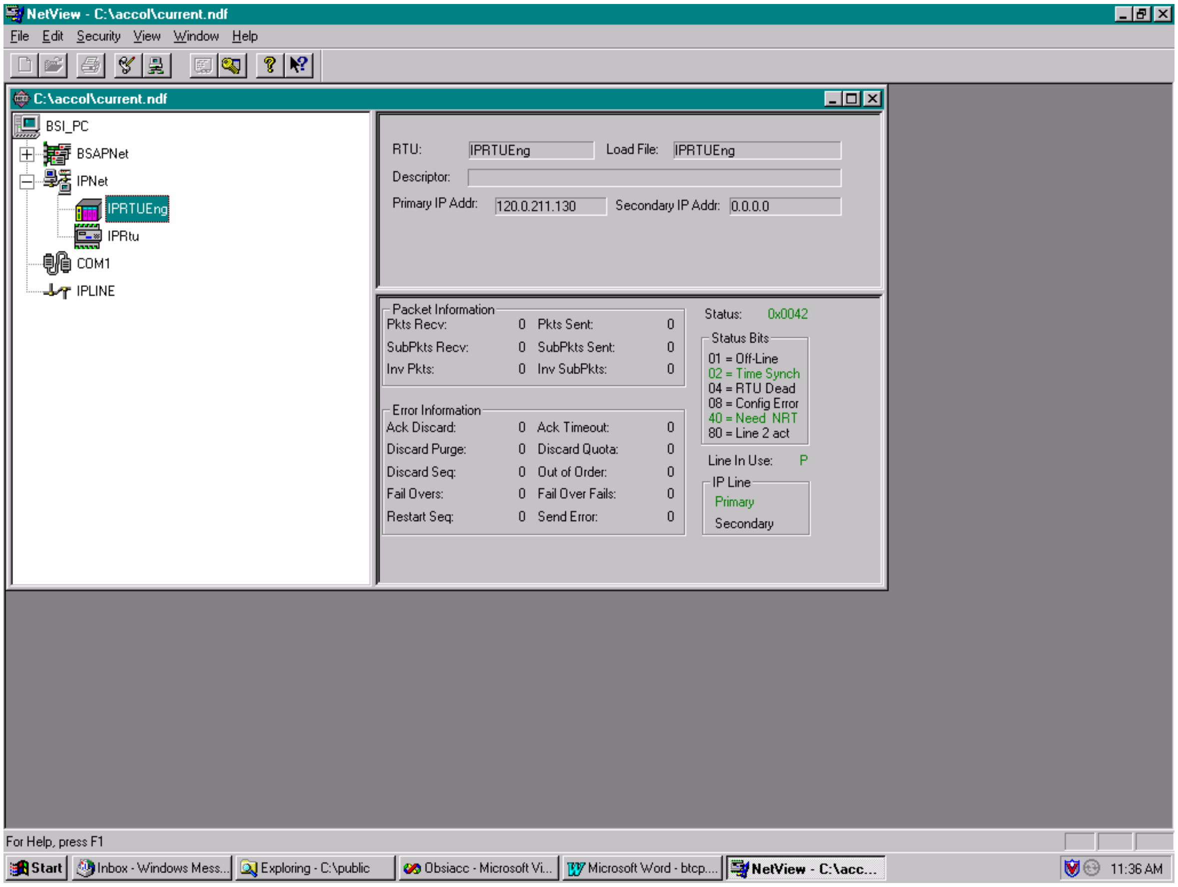


Figure 3-7 - Netview Startup Menu - Example with Multiple Networks

3. Once WINDIAG has been entered, the Main Diagnostics Menu of Figure 3-8 will appear.
4. Select the module to be tested. Enter any prompted parameters. WINDIAG will perform the diagnostics and display pass/fail results.
5. After all diagnostic testing has been performed, exit the WINDIAG program and then exit the Netview Program if there aren't any other units to be tested.
   When you close the Netview program you will be prompted as to whether or not you want to close the OpenBSI program; select Yes.
6. Set the **Control**Wave**RED** CPU Switch SW1-8 to the ON (Open) position. The **Control**Wave**RED** should resume normal operation.

3.5.1 Diagnostics Using WINDIAG

All Controllers Modules except the Power Supply/Sequencer Module can be tested using the WINDIAG program. From WINDIAG's Main Diagnostics Menu (see Figure 3-8) the following diagnostic tests can be performed:

CPU & Peripherals Diagnostic:	Checks the CPU Module (except for RAM & PROM).
PROM/RAM Diagnostic:	Checks the CPU's RAM and PROM hardware.
Communications Diagnostic:	Checks Comm. Ports 1 through 4 - The External loop-back tests require the use of a loop-back plug.
Ethernet Diagnostics:	Checks Ethernet Ports 1 through 3 - The Loop-back Out Twisted Pair tests require the use of a loop-back plug.

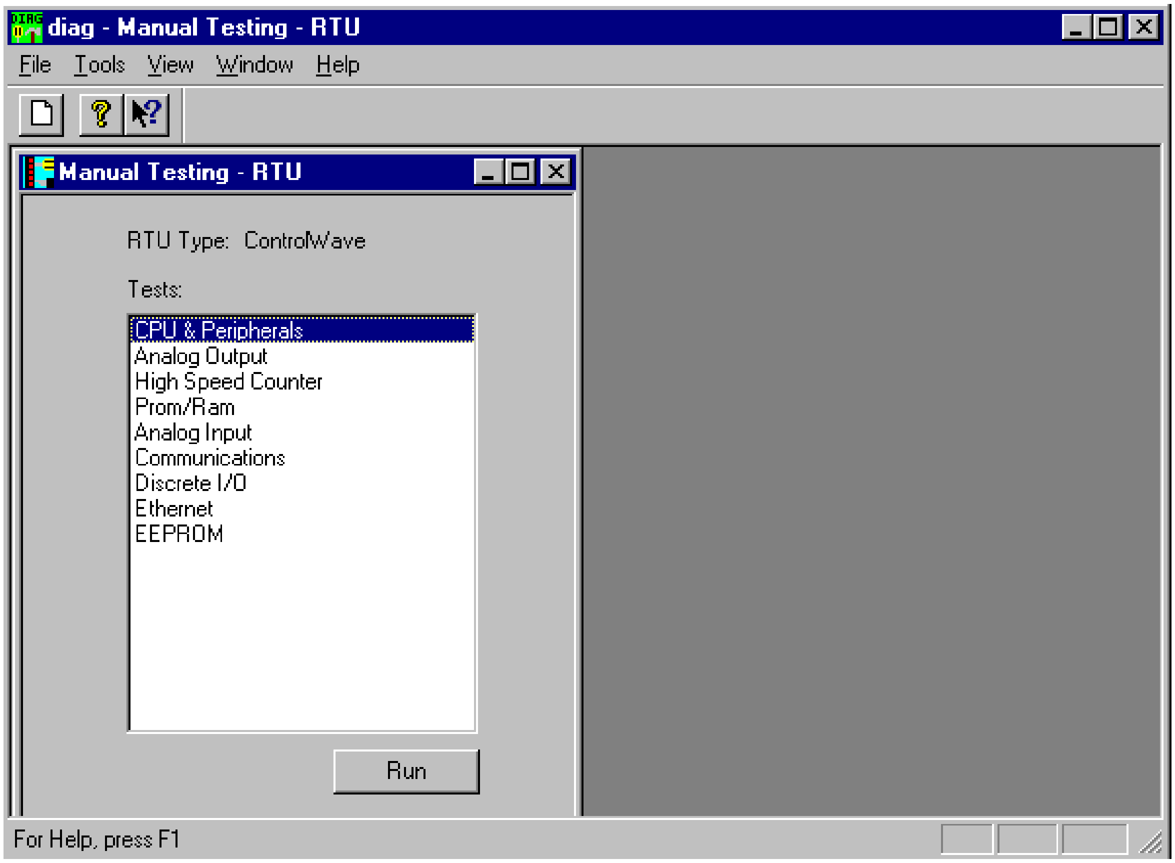


Figure 3-8 - WINDIAG Main Diagnostics Menu

3.5.1.1 Communications Diagnostic Port Loop-back Test

WINDIAG's Communications Diagnostic Menu (see Figure 3-10) provides for selection of the communication port to be tested (1 through 4). Depending on the type of network (RS-232 or RS-485) and the port in question, a special loop-back plug is required as follows:

Ports 1, 2 & 4 set-up for RS-232 use a 9-pin female D-type loop-back plug (see Fig. 3-9).
Port 4 set-up for RS-485 use a 9-pin female D-type loop-back plug (see Fig. 3-11).
Port 3 set-up for RS-232 use an 8-pin male RJ-45 loop-back plug (see Fig. 3-9).
Port 3 set-up for RS-485 use an 8-pin male RJ-45 loop-back plug (see Fig. 3-11).

This group of tests verifies the correct operation of the Communication Interface. COM1, COM2, COM3 and COM4 can be tested with this diagnostic. The **Control**Wave**RED** communication port that is connected to the PC (local or network and used for running these tests) can't be tested until diagnostics have been established via one of the other ports, i.e., to test all **Control**Wave**RED** communication ports (via WINDIAG), communications with the PC will have to be established twice (each time via a different port). It should be noted that the **Control**Wave**RED** communication port that is connected to the PC (RS-232, RS-485 or Ethernet) must be good for WINDIAG to run the Communications Diagnostics.

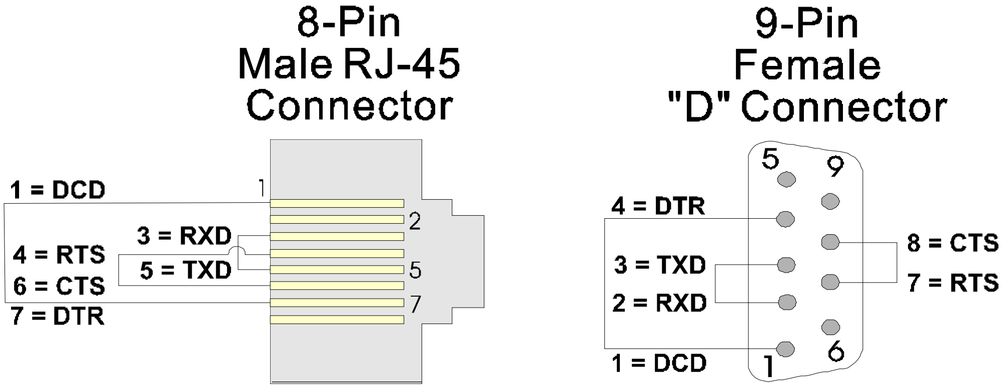


Figure 3-9 - RS-232 Loop-back Plugs

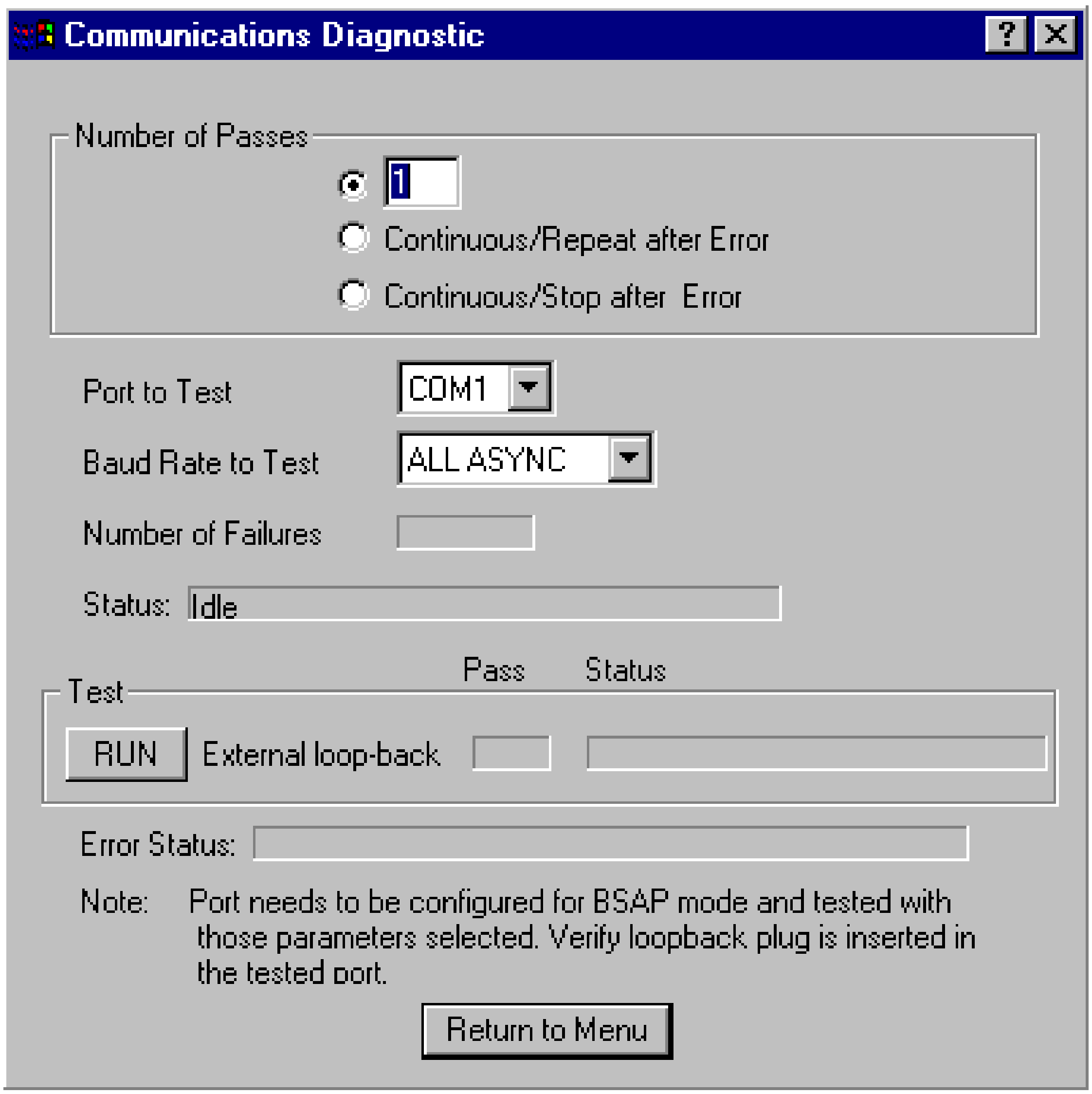


Figure 3-10 - WINDIAG's Communications Diagnostic Menu

3.5.1.2 COM 1, 2, 3, 4 External Loop-back Test Procedure

1. Connect an external loop-back plug to the CPU Port to be tested, i.e., J2 of CPU for Port 1, J3 of CPU for Port 2, J2 of SCB for Port 3, or J3 of SCB for Port 4 (see Figures 3-9 through 3-11).

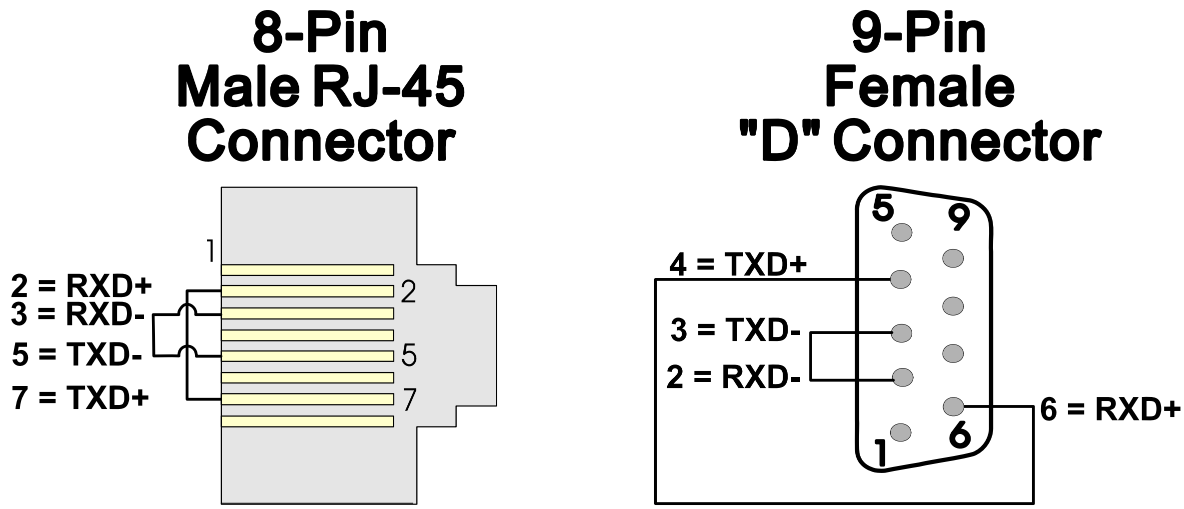


Figure 3-11 - RS-485 Loop-back Plugs

2. Type "1," "2," "3," or "4" for the port to test.

3. Set baud rate to test to 115200 baud or ALL ASYNC and the number of passes to 5.

4. Click on RUN button next to External loop-back.

- Test responses:
  a) Success - All sections of test passed
  b) Failure - TXD RXD Failure
  - CTS RTS Failure
- Execution time < 5 sec.

3.5.1.3 Ethernet Diagnostic Port Loop-back Test

WINDIAG's Ethernet Diagnostic Menu (see Figure 3-13) provides for selection of the Ethernet communication port to be tested (1 through 3). A special loop-back plug is required to perform the Ethernet loop-back test (see Figure 3-12).

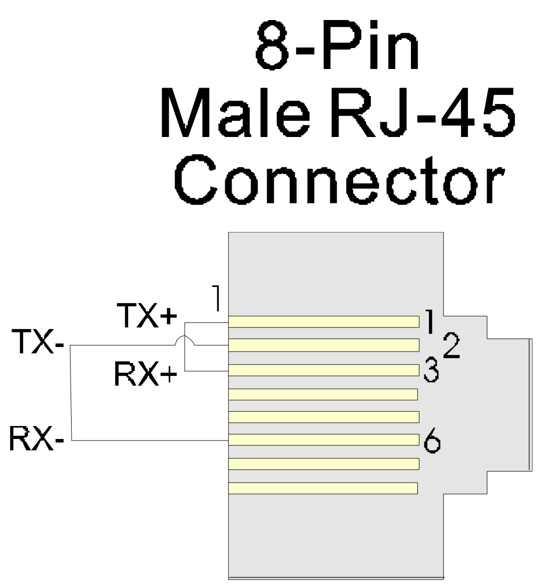


Figure 3-12 - RJ-45 Ethernet Loop-back Plug

If a **Control**Wave**RED** Ethernet port is connected to the PC (and used for running these tests), it can't be tested until diagnostics have been established via one of the other ports, i.e., to test all **Control**Wave**RED** communication ports (via WINDIAG), communications with the PC will have to be established twice (each time via a different port. It should be noted that the **Control**Wave**RED** communication port that is connected to the PC (RS-232, RS-485 or Ethernet) must be good for WINDIAG to run the Communications Diag-nostics.

This test configures the Ethernet to transmit and receive via the twisted pair port. Test frames are transmitted and compared against received frames.

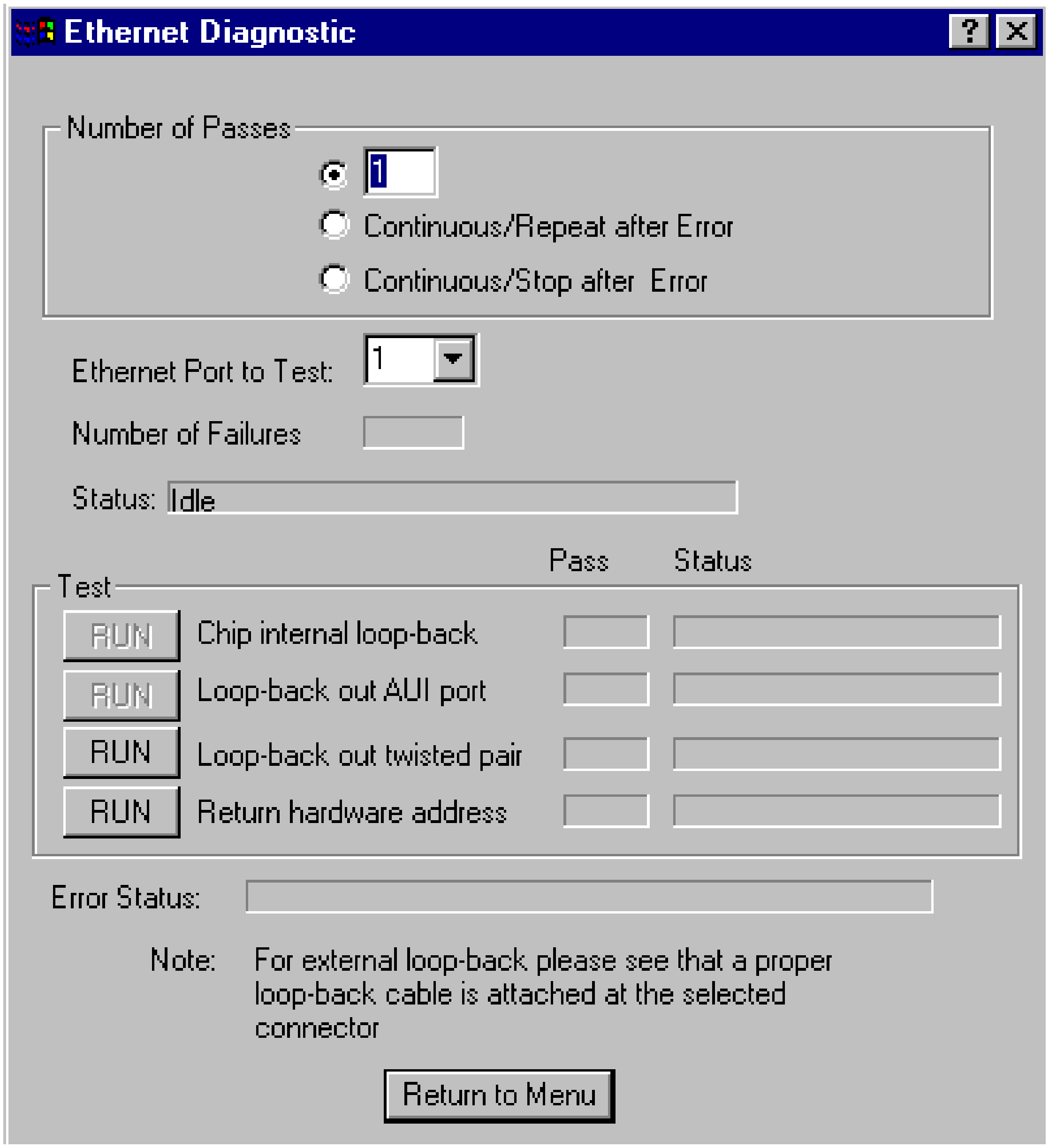


Figure 3-13 - WINDIAG's Ethernet Diagnostic Menu

3.5.1.4 Ethernet Port 1, 2 & 3 External Loop-back Test Procedure

1. Connect an external RJ-45 Ethernet loop-back plug (see Figure 3-16) into the Ethernet Port to be tested, i.e., J4 of CPU for Port 1, J5 of SCB for Port 2, or J7 of SCB for Port 3.
2. Type "1," "2," or "3" for the port to test.
3. Click on the "RUN" button next to the Loop-back out twisted pair test.

4. Click on RUN button next to External loop-back.

- Test responses:
  a) Success - All sections of test passed
  b) Xmit Error
  c) Rx Error
  d) Buffer Compare Failure

3.6 CORE UPDUMP

In some cases a copy of the contents of SRAM and SDRAM can be uploaded to a PC for evaluation by Bristol, Inc. engineers; this may be the case when the unit fails for no apparent reason. This upload is referred to as a 'Core Updump.' A Core Updump may be required if the **Control**Wave**RED** Controller repeatedly enters a 'Watchdog State' thus ill effecting system operation. A Watchdog State is entered when the system crashes, i.e., a CPU timeout occurs due to improper software operation, a firmware glitch, etc. In some cases the Watchdog State may reoccur but may not be logically reproduced.

'Crash Blocks' (a function of firmware provided for watchdog troubleshooting) are stored in CPU RAM. The user can view and save the 'Crash Blocks' by viewing the Crash Block Statistic Web Page (see Chapter 4 of the Open BSI Technician's Toolkit - D5087). Crash Block files should be forwarded to Bristol for evaluation. If additional information is required to evaluate the condition, a Core Updump may be requested by Bristol. Once the file generated by the Core Updump has been forwarded to Bristol, it will be evaluated and the results will be provided to the user.

Follow the five steps below to preserve the 'failed state' when the unit 'crashes,' i.e., enters a Watchdog State and to perform a Core Updump.

1. Set CPU Module Switch SW1-1 OFF (Disable Watchdog Timer). If SW1-4 is ON, set it OFF (Enable Core Updump).
2. Wait for the error condition (typically FF on Port 80 Display).
3. Connect the **Control**Wave**RED**'s Comm Port 1(on the CPU & Communications Redundancy Switch Module) to a PC using a Null Modem Cable (see Figure 2-9).
4. Operate the CPU Module's RUN/REMOTE/LOCAL Switch as follows:
   Note: Perform each step in less than 1 second.

   Turn RUN/REMOTE/LOCAL Switch to RUN
   Turn RUN/REMOTE/LOCAL Switch to REMOTE
   Turn RUN/REMOTE/LOCAL Switch to LOCAL
   Turn RUN/REMOTE/LOCAL Switch to REMOTE
   Turn RUN/REMOTE/LOCAL Switch to LOCAL
5. Start the PC's HyperTerminal Program (at 115.2kbaud) and generate a receive using the 1KX-Modem protocol. Save the resulting Core Updump in a file to be forwarded to Bristol for evaluation.

When the 'active unit' of a **Control**Wave**RED** has failed, it will not recover but forces the Watchdog Relay so that the 'standby unit' takes over. Once the Core Updump has completed, set the failed unit's CPU Switch SW1-1 ON (Watchdog Circuit Enabled) and SW1-4 ON (Normal Run Mode), if required and then power cycle the failed **Control**Wave unit to receive the "side load," and to become a valid standby unit.

3.7 TROUBLESHOOTING REDUNDANCY PROBLEMS

There are several conditions, which can prevent the redundancy set-up from functioning. Some relate to configuration errors in the redundancy set-up itself, others relate to conditions, which cause the Standby to not be ready to take over if a failure occurs.

Some of the possible conditions that prevent redundancy from working include:

- A/B unit DIP switches set improperly. These need to be set to opposite values; i.e. one CPU must be the "A" unit, and the other must be the "B" unit; you must never have two "A" units or two "B" units.

- Switch settings must be correct. See Section 2.3.3.1 earlier in this manual, for details.

- Insufficient memory available in the backup unit.

- Mismatch between the "A" and "B" unit (or between boot project in the standby unit and executing project in the on-line unit) with respect to Port configuration parameters, historical parameters, soft switch parameters, IP routing parameters, or application parameters. Any time an update is made to Flash parameters in the on-line unit, the same changes should be saved to the backup, or a mismatch will exist the next time the units are booted. NOTE: It is possible to configure system variables, which allow certain mismatches to exist, without preventing redundant operation (errors are treated as warnings.) See the **[Ignore]** button in the 'Redundancy' page of the System Variable Wizard.

- A mismatch in Historical configuration or data (audit/ archive) can result in the standby unit, never being ready to take over for the on-line unit. This would be indicated by the on-line unit operating correctly, but the standby unit continuously cycling through the sequence 'BD', 'BC', 'BA', 'BD'. To correct this problem, the procedure, shown below, must be followed:

PROCEDURE FOR CORRECTING HISTORICAL CONFIGURATION/DATA MIS-MATCHES

Indication: Standby unit never stays at 'BA', it continually cycles through 'BD', 'BC', 'BA' and back to 'BD'.

Note: For this procedure, we are assuming "A" is the on-line unit, and "B" is the standby; if the converse is true, reverse the letters.

Note: The sequence shown herein is critical; the steps must be performed in the order shown.

Step #	Unit A – Online Unit	Unit B – Standby Unit
1.	• Power OFF this unit.	
2.		• Power OFF this unit.
3.		• Power ON this unit (it should now go on-line).
4.		• Start the Flash Configuration Utility (from within LocalView/NetView). • On the 'Archives' page, remove all of the archive files.

Step #	Unit A – Online Unit	Unit B – Standby Unit
		• On the 'Audit' page, set the number of alarms and events both to 0. • Then choose **[Save to Rtu]**. DO NOT save changes to the NETDEF file. • Exit the Flash Configuration utility.
5.		• Power OFF this unit.
6.	• Power ON this unit.	
7.	• Start the Flash Configuration Utility. • Choose **[Load From RTU]**. • Power OFF this unit, but leave the Flash Configuration Utility running.	
8.		• Power ON this unit. It should go on-line, with a clear historical system.
9.		• Choose **[Save to Rtu]**. This effectively transfers the historical configuration, but not the data.
10.		• Power OFF this unit.
11.	• Verify that the "B" unit is OFF. (See Step 10.) • Power ON the "A" unit.	
12.		• Power ON this unit, it will receive a side-load of all data from the on-line unit. • 'BA' (without repeated cycles of 'BD', 'BC') indicates success.

3.8 **Control**Wave**RED FUNCTIONAL TESTS**

Tests provided herein allow the user to verify the proper functionality of the **Control**Wave **RED**. **Note: The Control**Wave**RED must be running a valid redundant Control-**Wave **project.**

- Basic Reset and Supervisory Power-Up Test (Sections 3.8.1)
- Redundant Power Source and Supervisory Power-Up Tests (Section 3.8.2)
- Watchdog Mechanism Power-Up Tests (Section 3.8.3)
- Primary CPU Selection on Power-Up Tests (Section 3.8.4)
- Tests of Switchover from 'Dead' Primary Selected Unit on Power-Up (Section 3.8.5)
- Forced Primary CPU Selection on Power-Up Tests (Section 3.8.6)
- Normal Power-Up and Switchover Tests (Section 3.8.7)
- Normal Power-Up and Forced Switchover Tests (Section 3.8.8)
- On-Line Relay Functional Tests (Section 3.8.9)
- Communication Ports Functional Tests (Section 3.8.10)

3.8.1 Basic Reset and Supervisory Power-Up Tests

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF
Turn External Supply Power ON
A & B Power System Status LED's should initially be RED
After approximately 1 second, both Power System Status LED's should change to GREEN

3.8.2 Redundant Power Source & Supervisory Power-Up Tests

Initial conditions: Resume from last test; Both Power System Status LED's should be GREEN
Turn PSSM A OFF
A Power System Status LED should change to RED
Turn PSSM A ON
A Power System Status LED should change to GREEN
Turn PSSM B OFF
B Power System Status LED should change to RED
Turn PSSM B ON
B Power System Status LED should change to GREEN

3.8.3 Watchdog Mechanism Power-Up Tests

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON
A & B Fail LED's should initially be RED
After both CPU's go through self-test, the primary CPU should go on-line (On-Line LED = GREEN), and the backup unit should be side loaded from the primary (Display = BD -> BC -> BA); both A & B Fail LED's should go OFF
Turn PSSM A OFF; If CPU A was previously on-line, then CPU B should go on-line when PSSM A is turned off; If CPU B was previously on-line, it will remain on-line
A Fail LED should change to RED; B Fail LED should remain off
Turn PSSM A ON
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should change to OFF; B Fail LED should remain off
Turn PSSM B OFF; CPU A should go on-line
B Fail LED should change to RED; A Fail LED should remain off
Turn PSSM B ON
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should change to OFF; A Fail LED should remain off

3.8.4 Primary CPU Selection on Power-Up Tests

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = A; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = GREEN, B On-Line LED = OFF
After CPU A completes self-test, the A Fail LED should go OFF
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = B; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = OFF, B On-Line LED = ON
After CPU B completes self-test, B Fail LED should go OFF
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (A CPU Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF

3.8.5 Tests of Switchover from "Dead" Primary Selected Unit on Power-Up

Initial conditions: PSSM A switch = OFF; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = A; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = ON, B On-Line LED = OFF
A Fail LED remains RED as PSSM A is off
CPU B should complete self-test, but cannot be side loaded from the primary CPU (A) because A is powered down; CPU B should display BD; B Fail LED should remain RED
After a time delay of 13 seconds, the CCRS will attempt to bring CPU B on-line:
B On-Line LED should change to ON & A On-Line LED should change to OFF
CPU B should run its self-test; After B completes self-test, B Fail LED should go OFF (CPU B is now on-line); A Fail LED should remain RED & A On-Line LED should remain OFF
Restore CPU A
Turn PSSM A ON
Initially: A Fail LED = RED; A On-Line LED should remain OFF
After CPU A completes self-test, it should be side loaded from the primary CPU (B);

(CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF

Initial conditions: PSSM A switch = ON; PSSM B switch = OFF; Ext Supply Pwr = OFF; A/B Primary Switch = B; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = OFF, B On-Line LED = ON
B Fail LED remains RED as PSSM B is off
CPU A should complete self-test, but cannot be side loaded from the primary CPU (B) because B is powered down; CPU A should display BD; A Fail LED should remain RED
After a time delay of 13 seconds, the CCRS will attempt to bring CPU A on-line:
A On-Line LED should change to ON & B On-Line LED should change to OFF
CPU A should run its self-test; After A completes self-test, A Fail LED should go OFF (CPU A is now on-line); B Fail LED should remain RED & B On-Line LED should remain OFF
Restore CPU B
Turn PSSM B ON
Initially: B Fail LED = RED; B On-Line LED should remain OFF
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF

3.8.6 Forced Primary CPU Selection on Power-Up Tests

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = A; A/B Enabled Switch = B (right position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = OFF, B On-Line LED = ON
After CPU B completes self-test, B Fail LED should go OFF
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF
Turn PSSM B OFF
B Fail LED should go ON and B On-Line LED should remain ON
Turn PSSM B ON
After CPU B completes self-test, B Fail LED should go OFF
B On-Line LED should remain ON

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = B; A/B Enabled Switch = A (left position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = ON, B On-Line LED = OFF
After CPU A completes self-test, A Fail LED should go OFF
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF
Turn PSSM A OFF
A Fail LED should go ON and A On-Line LED should remain ON
Turn PSSM A ON
After CPU A completes self-test, A Fail LED should go OFF
A On-Line LED should remain ON

3.8.7 Normal Power-Up & Switchover Tests

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = A; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = GREEN, B On-Line LED = OFF
After CPU A completes self-test, the A Fail LED should go OFF
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF
Turn PSSM A OFF
B On-Line LED should change to GREEN, A On-Line LED should change to OFF & A Fail LED should change to RED
Turn PSSM A ON
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF
Turn PSSM B OFF
A On-Line LED should change to GREEN, B On-Line LED should change to OFF & B Fail LED should change to RED
Turn PSSM B ON
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = B; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON

Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = OFF, B On-Line LED = GREEN
After CPU B completes self-test, the B Fail LED should go OFF
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF
Turn PSSM B OFF
A On-Line LED should change to GREEN, B On-Line LED should change to OFF & B Fail LED should change to RED
Turn PSSM B ON
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF
Turn PSSM A OFF
B On-Line LED should change to GREEN, A On-Line LED should change to OFF & A Fail LED should change to RED
Turn PSSM A ON
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF

3.8.8 Normal Power-Up & Forced Switchover Tests

Initial conditions: **PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF;** **A/B Primary Switch = A; A/B Enabled Switch = AUTO (center position)**
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = GREEN, B On-Line LED = OFF
After CPU A completes self-test, the A Fail LED should go OFF
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF
Change A/B Enabled Switch to B (right position): Force Switchover to B
B On-Line LED should change to GREEN, A On-Line LED should change to OFF & A Fail LED should change to RED
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF
Change A/B Enabled Switch to A (left position): Force Switchover to A
A On-Line LED should change to GREEN, B On-Line LED should change to OFF & B Fail LED should change to RED
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = B; A/B Enabled Switch = AUTO (center position)
Turn External Supply Power ON
Initially: A Fail LED = RED, B Fail LED = RED; A On-Line LED = OFF, B On-Line LED = GREEN
After CPU B completes self-test, the B Fail LED should go OFF
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF
Change A/B Enabled Switch to A (left position): Force Switchover to A
A On-Line LED should change to GREEN, B On-Line LED should change to OFF & B Fail LED should change to RED
After CPU B completes self-test, it should be side loaded from the primary CPU (A); (CPU B Display = BD -> BC -> BA)
B Fail LED should go OFF and B On-Line LED should remain OFF
Change A/B Enabled Switch to B (right position): Force Switchover to B
B On-Line LED should change to GREEN, A On-Line LED should change to OFF & A Fail LED should change to RED
After CPU A completes self-test, it should be side loaded from the primary CPU (B); (CPU A Display = BD -> BC -> BA)
A Fail LED should go OFF and A On-Line LED should remain OFF

3.8.9 On-Line Relay Functional Tests

The CCRS Module has two sets of isolated relay contacts that indicate (by being closed) which of the pair of CPU modules is currently on-line. Terminal block plug J7 on the CCRS panel gives access to the relay contacts for test using the following procedure. Refer to Figure 3.3 for connector and pin identification. An ohmmeter or continuity indicator may be used to check relay status.

Initial conditions: PSSM A switch = ON; PSSM B switch = ON; Ext Supply Pwr = OFF; A/B Primary Switch = A; A/B Enabled Switch = A (left position)
Check continuity between J7-1 & J7-2; there should be continuity indicating CPU A is on-line
Check continuity between J7-3 & J7-4; there should be no continuity indicating CPU B is not on-line
Turn External Supply Power ON
A On-Line LED should be ON
Check continuity between J7-1 & J7-2; there should be continuity indicating CPU A is on-line
Check continuity between J7-3 & J7-4; there should be no continuity indicating CPU B is not on-line
Change A/B Enabled Switch to B (right position): Force Switchover to B
B On-Line LED should be ON
Check continuity between J7-1 & J7-2; there should be no continuity indicating CPU A

is not on-line
Check continuity between J7-3 & J7-4; there should be continuity indicating CPU B is on-line

3.8.10 CCRS Assembly Communication Ports Functional Tests

3.8.10.1 Configuration for Port Tests

CPU modules A and B must be configured to run diagnostics prior to using the following procedure (see Section 3.5). SW1-8 on each must be set to the “OFF” position to enable diagnostics.

An RS232 cable must be connected between CCRS port COM1 (J1) and the PC configured with ControlWave diagnostics (WINDIAG) and Open BSI Tools. Successful interaction between the diagnostic tools and the testing of remaining ports COM2 → COM4 will serve as test validation of COM1 switching through the CCRS. Refer to Sections 3.5.1.1 & 3.5.1.2 for required setup. (Note: PC connection to CCRS COM1 is preferable in the tests described here).

Ports COM1 and COM 2 are always RS232 level, while COM3 and COM4 may be either RS232 or RS485 dependent on the hardware assembly chosen. In the tests that follow, utilize the appropriate loopback plugs and CCRS –> CPU cables based on the type of port to be tested.

The CCRS module will switch the communication ports of the CPU currently on-line to the set of connectors on its front panel. During first pass testing, the CCRS A/B Enabled switch should be placed in the “A” position to force CPU A on-line and to run the serial com diagnostics via interaction with the Open BSI Tools. When ports COM2, 3 and 4 have been successfully tested, the switch should be moved to the “B” position and all tests should be repeated for on-line CPU B.

3.8.10.2 Communication Port Switching Tests

Reference Section 2.3 and Figure 2-8
Establish communication between Open BSI Tools (NetView or LocalView) and the selected CCRS CPU on port COM1
Bring up diagnostics (WINDIAG) and select the Communications Diagnostic test
Select the port to be tested (B = COM2, C = COM3, D = COM4), the number of passes (enter “25”) and the Baud Rate (select 38.4 Kbps). Place the required loopback plug on the port under test and click on the “RUN” button in the diagnostic window. If the port paths are properly switched and all hardware is functional, the status display will contain the message “Success” and the diagnostic should run for 25 passes before the status message displays “Idle”.
Repeat the tests for all ports
Repeat all of the above after the alternate CPU is placed on-line with the A/B Enabled switch

Section 4
SPECIFICATIONS

4.1 CPU, MEMORY & PROGRAM INTERFACE

Processors: AMD Elan SC520 microcontroller, 100MHz

Memory: 4Mbyte of system FLASH
2/4Mbtye of on-board static RAM
4Mbyte of SDRAM (2 x KM416S1120DT) -
512Kbytes Uniform Sector FLASH IC BIOS.

Real Time Clock: Contained in SC520 - generates a 1-second timer pulse for use by the application software.

Connectors: (see Table 4-1 and referenced Tables)

Table 4-1 - CPU Module User Accessible Connector Summary

Ref.	# Pins	Function	Notes
J1	132-pin	I/OB Connector	see Figure 4-1
J2	9-pin	COM1 9-pin male D-sub	see Figure 4-2 & Table 4-2
J2	8-pin	COM3 RJ-45 (RS-232 or RS-485) *	see Figure 4-3 & Table 4-3
J3	9-pin	COM2 9-pin male D-sub	see Figure 4-2 & Table 4-2
J3	9-pin	COM4 9-pin male D-sub *	see Figure 4-2 & Table 4-2
J4	8-pin	Ethernet 10/100Base-T RJ-45 #1	see Figure 4-4 & Table 4-4
J5	8-pin	Ethernet 10/100Base-T RJ-45 #2 *	see Figure 4-4 & Table 4-4
J7	8-pin	Ethernet 10/100Base-T RJ-45 #3 *	see Figure 4-4 & Table 4-4
J10	3-pin	Battery Connector	see Figure 4-5

*** = located on Secondary Comm. Board**

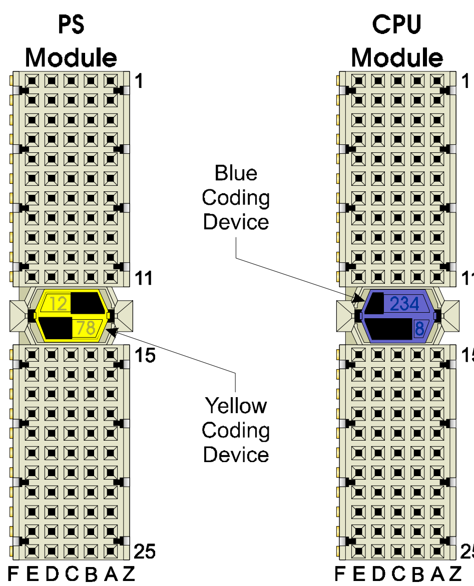


Figure 4-1 - Power Supply Bd. & CPU Bd. Backplane Connectors

Looking into Board Connectors

Looking into CPU or CCRS Module D-Type Comm. Port Receptacle

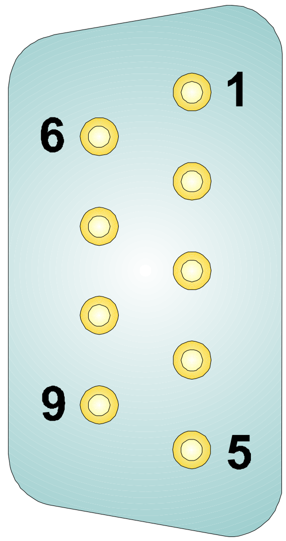


Figure 4-2 - DB9 9-Pin Connector Port Pin Assignments
CPU Module Comm. Ports COM1, COM2 & COM4
CCRS Module Comm. Ports COM1, COM2, COM3 & COM4

Table 4-2 - COM1, COM2 & COM4 (SCB) Connector Pin Assignment

Pin #	Signal RS-232	Description: RS-232 Signals	Signal RS-485	Description: COM4 ONLY RS-485 Signals
1	DCD	Data Carrier Detect Input		N/A
2	RXD	Receive Data Input	RXD-	Receive Data - Input
3	TXD	Transmit Data Output	TXD-	Transmit Data - Output
4	DTR	Data Terminal Ready Output	TXD+	Transmit Data + Output
5	GND	Signal/Power Ground	ISOGND	Isolated Ground
6	DSR	Data Set Ready Input	RXD+	Receive Data + Input
7	RTS	Request To Send Output		N/A
8	CTS	Clear To Send Input		N/A
9	RI	Ring Indicator Input		N/A

Table 4-3 - SCB Connectors J2 (COM3) Pin Assignment

Pin #	Signal RS-232	Description: RS-232 Signals	Signal RS-485	Description: RS-485 Signals
1	DCD	Data Carrier Detect Input		N/A
2	DSR	Data Set Ready Input	RXD+	Receive Data + Input
3	RXD	Receive Data Input	RXD-	Receive Data - Input
4	RTS	Request To Send Output		N/A
5	TXD	Transmit Data Output	TXD-	Transmit Data - Output
6	CTS	Clear To Send Input		N/A
7	DTR	Data Terminal Ready Output	TXD+	Transmit Data + Output
8	GND	Signal/Power Ground	ISOGND	Isolated Ground

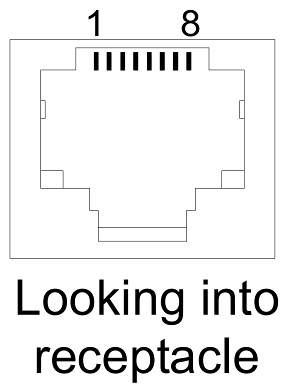


Figure 4-3 - RJ45 Connector J2 (SCB) Associated with COM3 (SCB)

Table 4-4 - Ethernet 10/100Base-T RJ-45 Connector Pin Assignment (CPU #1) & (SCB #2 & #3)

Pin #	Signal Nmae	Description: Ethernet Signals
1	TXO+	Transmit Data + Output
2	TXO-	Transmit Data - Output
3	RXI+	Receive Data + Input
6	RXI-	Receive Data - Input
4, 5, 7 & 8	N/C	N/A

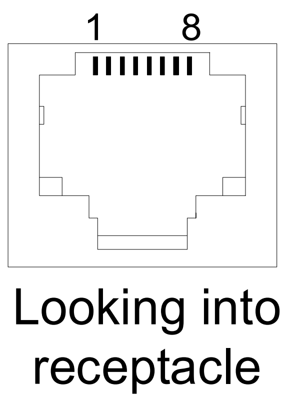


Figure 4-4 - RJ45 Ethernet Connector J4, J5 (SCB) & J7 (SCB)
J4 = Ethernet 1, J5 = Ethernet 2 & J7 = Ethernet 3

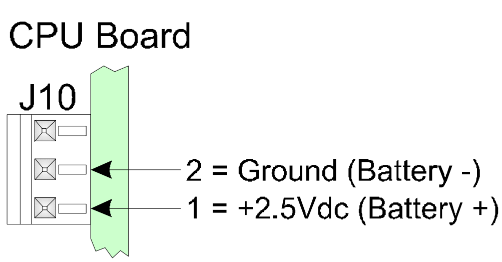


Figure 4-5 - Connector J10 - CPU Battery Header

4.1.1 CPU Module Communication Ports

Connector/Port: J2 - 9-Pin D-Type - COM1 (RS-232)
J2 - 8-Pin RJ-45 - COM3 (RS-232 or RS-485) (on SCB)
J3 - 9-Pin D-Type - COM2 (RS-232)

	J3 - 9-Pin D-Type COM4 (RS-232) (on SCB) J4 - 8-Pin RJ-45 - #1 -Ethernet 10/100Base-T J5 - 8-Pin RJ-45 - #2 -Ethernet 10/100Base-T (on SCB) J7 - 8-Pin RJ-45 - #3 - Ethernet 10/100Base-T (on SCB)
Baud Rate:	300 to 115K (bps) for RS-232 or RS-485 10/100M (bps) for Ethernet

4.2 POWER SUPPLY/SEQUENCER MODULE

4.2.1 Input/Output Power Specs.

Note: Voltages are dc unless otherwise specified.

Operating Range:	TB2-1 (+VIN) LOGIC (dc) Supply +10.6V to +20.0V (+12V Input Supply) (Shutdown occurs at +10.6V nominal) +20.7V to +30.0V (+24V Input Supply) (Shutdown occurs at +20.7V nominal)
Output Voltages:	Isolated +3.3V, +5V, +12V & -12V (optional)
Output Current:	*Typical (±12V Supplies Not Used)* 1.5A (Max.) @ +5V 1A (Max.) @ +3.3V 0A @ ±12V *with 0A @ +3.3V* 2A (Max.) @ +5V 200mA (Max.) @ +12V 200mA (Max.) @ -12V
Output Ripple:	*With +5V @ 1A, +12V & -12V @ 200mA* +5V Output: 50mV, 110mVpp @ 30V input +12V Output: 40mVpp @ 20V input -12V Output: 50mVpp @ 24V input *With +5V @ 300mA, ±12V supplies OFF* +5V Output: 50mV, 280mVpp
Input Current:	*With Supply Loading of 5V @ 1.25A, +3.3V @ 1.0A, +12V & -12V @ 0mA* Vin @ +12V - Iin Max. 1.62A Vin @ +24V - Iin Max. 0.80A
Fusing:	3A Slow Blow 5x20mm Fuse - LOGIC Supply
Electrical Isolation:	500Vdc Primary to Secondary
Surge Suppression:	500Vdc MOV, -VIN (PSGND) to CHASSIS 32V Transient Suppressor from +VIN to -VIN (PSGND) Meets ANSI/IEEE C37.90-1978
Terminations:	Pluggable, maximum wire size is 14 gauge

Shutdown:	+12V PSSM: Max. ON Switchpoint = 11.11V Min. OFF Switchpoint = 10.52V +24V System: Max. ON Switchpoint = 22.05V Min. OFF Switchpoint = 20.49V
Power Switch:	MOSFET Driven by Switch connected to Gate

4.2.2 Power Supply Sequencer Specs.

Signals Monitored:	Switched Input Supply Voltage (+VINSWS) Isolated Output Voltages (+3.3V, +5V, +12V & -12V)
Sequencer Switchpoints For Master Clear & Power Fail	<u>+12V Input Supply System</u> Input Power. Max. ON = +11.02V Input Power Min. OFF = +10.78V <u>+24V Input Supply System</u> Input Power. Max. ON = +21.87V Input Power Min. OFF = +21.09V +5V Max. ON Switchpoint = +4.85V +5V Min. OFF Switchpoint = +4.75V ±12V Max. ON Switchpoint = ±11.52V ±12V Min. OFF Switchpoint = ±11.38V
Sequencer Output Signals:	/MC, /PWR_FAIL - Timing on power down: /MC active 2msec after /PWR_FAIL asserted. /MC, /PWR_FAIL - Timing on power up: /MC, /PWR_FAIL active for 100msec after all monitored voltage levels reach nominally good values.
Watchdog Sequencer:	Input Signals: /MC & /WDOGB Enable/ Disable: Via CPU Module Switch SW1-1 Watchdog MOSFET Switch populated: Voltage applied to VI terminal TB1-2 switched to VO terminal (TB1-1) unless either /MC or /WDOGB is asserted; applied voltage is referenced to -VIN (PSGND) at TB2-3

4.2.3 Power Supply Connectors (see Table 4-5 and referenced Tables)

Table 4-5 - PSSM Connector Summary

Ref.	# Pins	Function	Notes
J1	132-pin	Backplane Connector	see Figure 4-1
TB1	3-pin	Watchdog Term. Block	see Figure 4-6 & Table 4-6
TB2	5-pin	Input Power Term. Block	see Figure 4-6 & Table 4-6

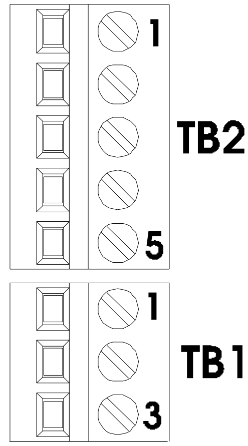


Figure 4-6 - Power Supply/Sequencer Module Connectors TB1 & TB2

Table 4-6 - Power Supply Terminal Blocks

TERM. #	NAME	FUNCTION
TB1-1	VO	VO MOSFET Watchdog Switch Output
TB1-2	VI	VI MOSFET Watchdog Switch Input
TB1-3	N/A	Not used
TB2-1	+VIN	+10.6V to +30V (dc) Input
TB2-2	+VINF	Field Device Power - Not Used
TB2-3	-VIN	1st Supply Common
TB2-4	-VINF	2nd Supply Common (Field Device Power) - Not Used
TB2-5	CHASSIS	Chassis Ground

4.3 BACKPLANE PCB

Slots: 2 CPU & 2 Power Supply (Modules) & the CCRS Module
2 Ribbon Cable Headers for Interconnect with CCRSM

Power: +3.3V, +5V, +12V, -12V (optional), PCOM

Connectors: 132-pin CPCI style connectors for CPUs and PSSMs; two unique keying configurations prevent module insertion into improper slot locations. Two 50-pin Cable Headers accommodate the CCRSM (see Figure 4-7 & Table 4-7)

Table 4-7 - Backplane PCB Connector Assignment

Number	Function	Reference
P1	PSSM A Interface	See Figures 4-1 & 4-7
P2	CPU Module A Interface	See Figures 4-1 & 4-7
P3	PSSM B Interface	See Figures 4-1 & 4-7
P4	CPU Module B Interface	See Figures 4-1 & 4-7
P5	REDSWA Ribbon Cable Intf. to CCRSM rear connector J1	See Figure 4-7 & Table 4-11
P6	REDSWB Ribbon Cable Intf. to CCRSM rear connector J2	See Figure 4-7 & Table 4-12

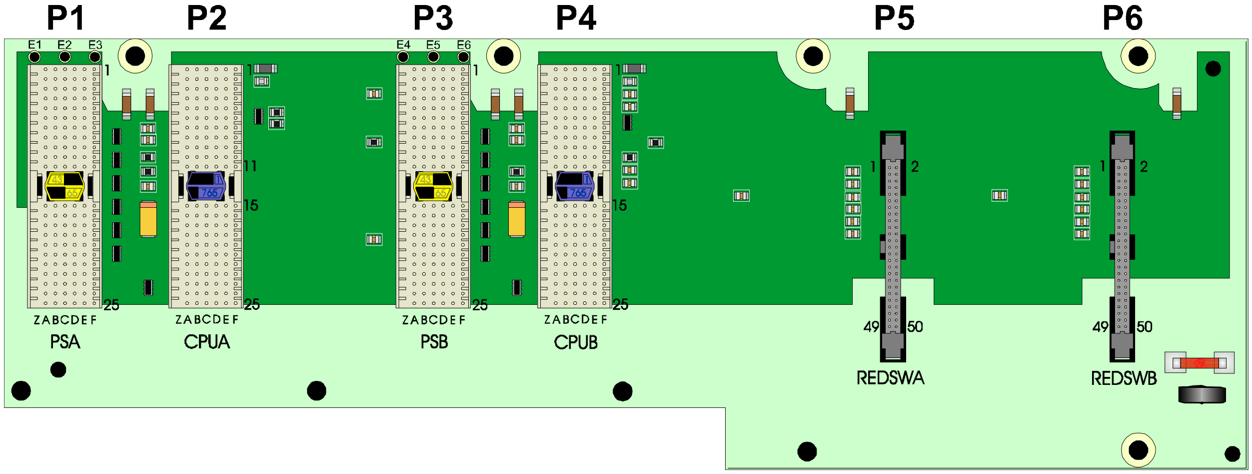


Figure 4-7 - Backplane PCB Connector Assignment

4.4 CCRS MODULE SPECIFICATIONS

Electrical Isolation:	500Vdc from all isolated logic signals to CHASSIS GND
Connectors:	(see Table 4-8 and referenced Tables)

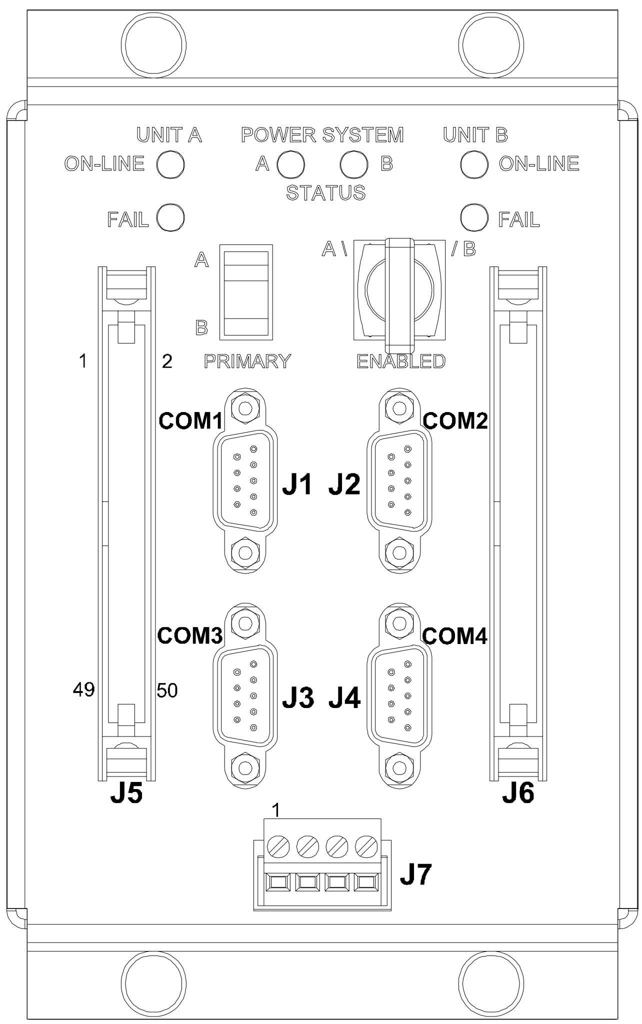


Figure 4-8 – CCRS Module Connector Assignment

Table 4-8 - CCRS Module User Accessible Connector Summary

Front of CCRS Module

Ref.	# Pins	Function	Notes
J1	9-pin	COM1 9-pin male D-sub (RS-232)	see Figs. 4-2 & 4-8 & Table 4-2
J2	9-pin	COM2 9-pin male D-sub (RS-232)	see Figs. 4-2 & 4-8 & Table 4-2
J3	9-pin	COM3 9-pin male D-sub (RS-232 or RS-485)	see Figs. 4-2 & 4-8 & Table 4-2
J4	9-pin	COM4 9-pin male D-sub (RS-232 or RS-485)	see Figs. 4-2 & 4-8 & Table 4-2
J5	50-pin	Header for System A CPU Comm. Ports	see Figure 4-8 & Table 4-9
J6	50-pin	Header for System B CPU Comm. Ports	see Figure 4-8 & Table 4-10
J7	4-pin	A & B On-Line Status Outputs	see Figure 4-8 & Table 4-13

Rear of CCRS Module

Ref.	# Pins	Function	Notes
J1	50-pin	CCRSM to Backplane Slot P5 (REDSWA) via Ribbon Cable	see Table 4-11
J2	50-pin	CCRSM to Backplane Slot P6 (REDSWB) via Ribbon Cable	see Table 4-12

Table 4-9 - CCRS Module Connector J5 Pin Assignment

Pin #	Signal Name	Pin #	Signal Name
1	RXD1A	2	DCD1A
3	DSR1A	4	CTS1A
5	RI1A	6	GND
7	GND	8	TXD1A
9	DTR1A	10	RTS1A
11	N/C	12	N/C
13	RXD2A	14	DCD2A
15	DSR2A	16	CTS2A
17	RI2A	18	GND
19	GND	20	TXD2A
21	DTR2A	22	RTS2A
23	N/C	24	N/C
25	N/C	26	N/C
27	RXD3A (RX3A-)	28	DCD3A
29	DSR3A (RX3A+)	30	CTS3A
31	N/C	32	GND (ISOGND3A)
33	GND (ISOGND3A)	34	TXD3A (TX3A-)
35	DTR3A (TX3A+)	36	RTS3A
37	N/C	38	N/C
39	N/C	40	N/C
41	RXD4A (RX4A-)	42	DCD4A
43	DSR4A (RX4A+)	44	CTS4A
45	RI4A	46	GND (ISOGND4A)
47	GND (ISOGND4A)	48	TXD4A (TX4A-)
49	DTR4A (TX4A+)	50	RTS4A

Table 4-10 - CCRS Module Connector J6 Pin Assignment

Pin #	Signal Name	Pin #	Signal Name
1	RXD1B	2	DCD1B
3	DSR1B	4	CTS1B
5	RI1A	6	GND
7	GND	8	TXD1B

Table 4-10 - CCRS Module Connector J6 Pin Assignment (Continued)

Pin #	Signal Name	Pin #	Signal Name
9	DTR1B	10	RTS1B
11	N/C	12	N/C
13	RXD2B	14	DCD2B
15	DSR2B	16	CTS2B
17	RI2B	18	GND
19	GND	20	TXD2B
21	DTR2B	22	RTS2B
23	N/C	24	N/C
25	N/C	26	N/C
27	RXD3B (RX3B-)	28	DCD3B
29	DSR3B (RX3B+)	30	CTS3B
31	N/C	32	GND (ISOGND3B)
33	GND (ISOGND3B)	34	TXD3B (TX3B-)
35	DTR3B (TX3B+)	36	RTS3B
37	N/C	38	N/C
39	N/C	40	N/C
41	RXD4B (RX4B-)	42	DCD4B
43	DSR4B (RX4B+)	44	CTS4B
45	RI4B	46	GND (ISOGND4B)
47	GND (ISOGND4B)	48	TXD4B (TX4B-)
49	DTR4B (TX4B+)	50	RTS4B

Table 4-11 - CCRS Module Backplane Interconnect Cable Header J1 & Backplane Cable Header P5 Pin Assignment

Pin #	Signal Name	Pin #	Signal Name
1	+3.3VA	2	PCOM
3	+3.3VB	4	PCOM
5	N/C	6	PCOM
7	N/C	8	PCOM
9	+5VA	10	PCOM
11	+5VA	12	PCOM
13	+5VA	14	PCOM
15	+5VB	16	PCOM
17	+5VB	18	PCOM
19	+5VB	20	PCOM
21	N/C	22	PCOM
23	N/C	24	PCOM
25	N/C	26	PCOM
27	/WDOGBA	28	PCOM
29	/WDOGBB	30	PCOM
31	ON-LINE/*BACKUPA	32	PCOM
33	ON-LINE/*BACKUPB	34	CBL_PRESENTA (PCOM)
35	N/C	36	N/C
37	N/C	38	N/C
39	N/C	40	N/C
41	N/C	42	N/C
43	+12VA	44	RLYCOM (PCOM)
45	+12VA	46	RLYCOM (PCOM)
47	+12VB	48	RLYCOM (PCOM)
49	+12VB	50	RLYCOM (PCOM)

Table 4-12 - CCRS Module Backplane Interconnect Cable Header J2 & Backplane Cable Header P6 Pin Assignment Pin Assignment

Pin #	Signal Name	Pin #	Signal Name
1	+3.3VA	2	PCOM
3	+3.3VB	4	PCOM
5	N/C	6	PCOM
7	N/C	8	PCOM
9	+5VA	10	PCOM
11	+5VA	12	PCOM
13	+5VA	14	PCOM
15	+5VB	16	PCOM
17	+5VB	18	PCOM
19	+5VB	20	PCOM
21	N/C	22	PCOM
23	N/C	24	PCOM
25	N/C	26	PCOM
27	/WDOGBA	28	PCOM
29	/WDOGBB	30	PCOM
31	ON-LINE/*BACKUPA	32	PCOM
33	ON-LINE/*BACKUPB	34	CBL_PRESENTB (PCOM)
35	N/C	36	N/C
37	N/C	38	N/C
39	N/C	40	N/C
41	N/C	42	N/C
43	+12VA	44	RLYCOM (PCOM)
45	+12VA	46	RLYCOM (PCOM)
47	+12VB	48	RLYCOM (PCOM)
49	+12VB	50	RLYCOM (PCOM)

Table 4-13- CCRS Module Isolated On-Line Status Outputs Connector J7 Pin Assignment

Pin #	Signal	Description
1	A_ONLINE	A ONLINE RELAY (Switched Contact)
2	A_ONLINE_COM	A ONLINE RELAY (COM Contact)
3	B_ONLINE	B ONLINE RELAY (Switched Contact)
4	B_ONLINE_COM	B ONLINE RELAY (COM Contact)

4.4.1 CCRS Module Communication Ports

Connector/Port: J1 - 9-Pin D-Type - COM1 (RS-232)
J2 - 9-Pin D-Type - COM2 (RS-232)
J3 - 9-Pin D-Type - COM3 (RS-232 or RS-485)
J4 - 9-Pin D-Type - COM4 (RS-232 or RS-485)

Baud Rate: 300 to 115K (bps) for RS-232 or RS-485

Status Indication: 6 LEDs (2 of which are dual color)

4.5 ENVIRONMENTAL SPECIFICATIONS

Temperature: <u>Operating</u>: -40 to +158 °F (-40 to +70 °C)
<u>Storage</u>: -40 to +185 °F (-40 to +85 °C)

Relative Humidity: 15-95% Non-condensing

Vibration:	1g for 10 - 150 Hz .5g for 150 - 2000 Hz
Shock:	30g (11 msec duration) 50g (11 msec duration)
RFI Susceptibility:	In conformity with the following standards: ENV 50140 Radio-frequency electromagnetic field, Amplitude modulated ENV 50204 Radio-frequency electromagnetic field, Pulse modulated

4.6 DIMENSIONS

Dimensions & Installation:	see Figure 4-9
Filler Panel Dimensions:	see Figure 4-10

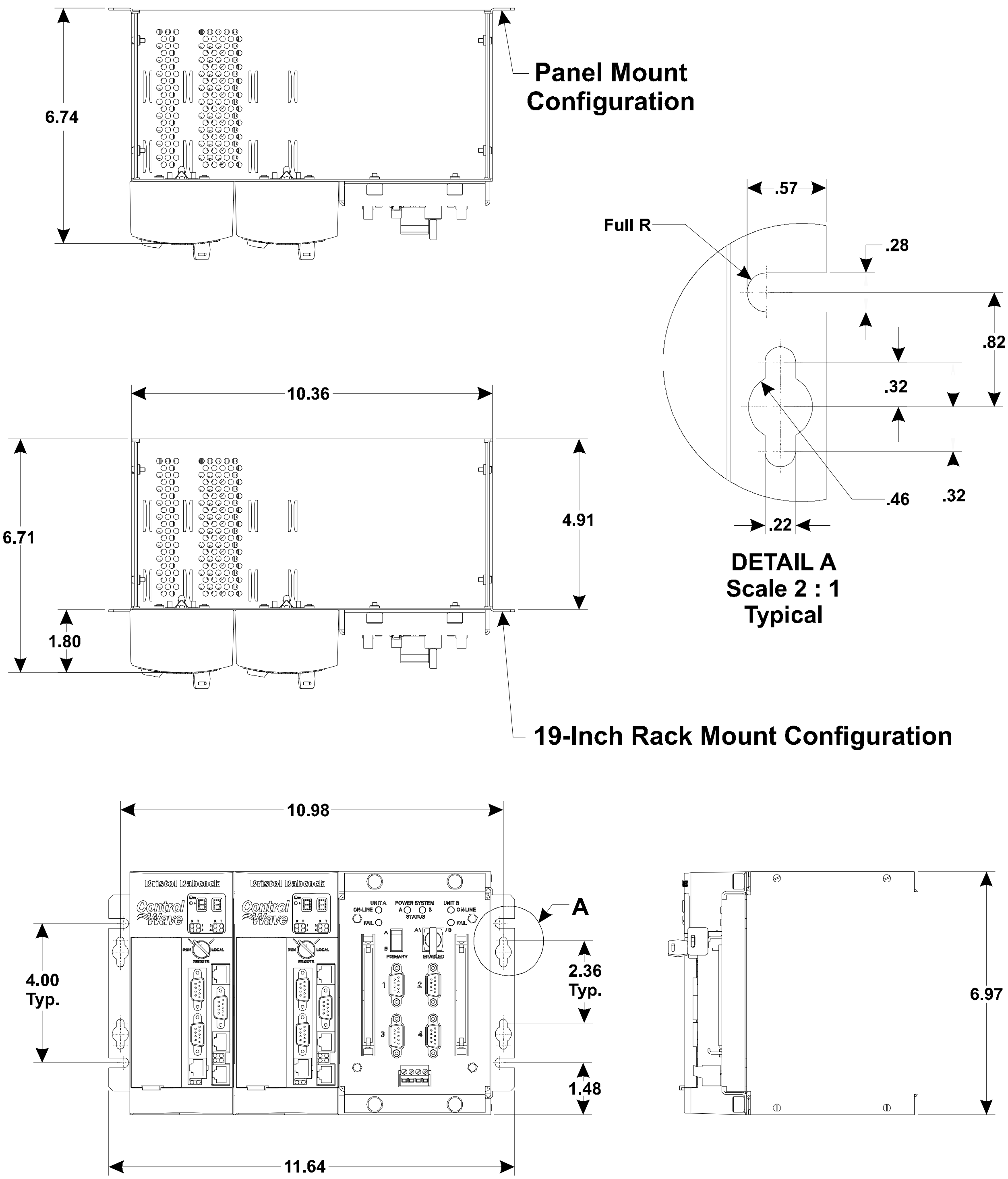


Figure 4-9 - ControlWaveRED Dimension & Installation Drawing

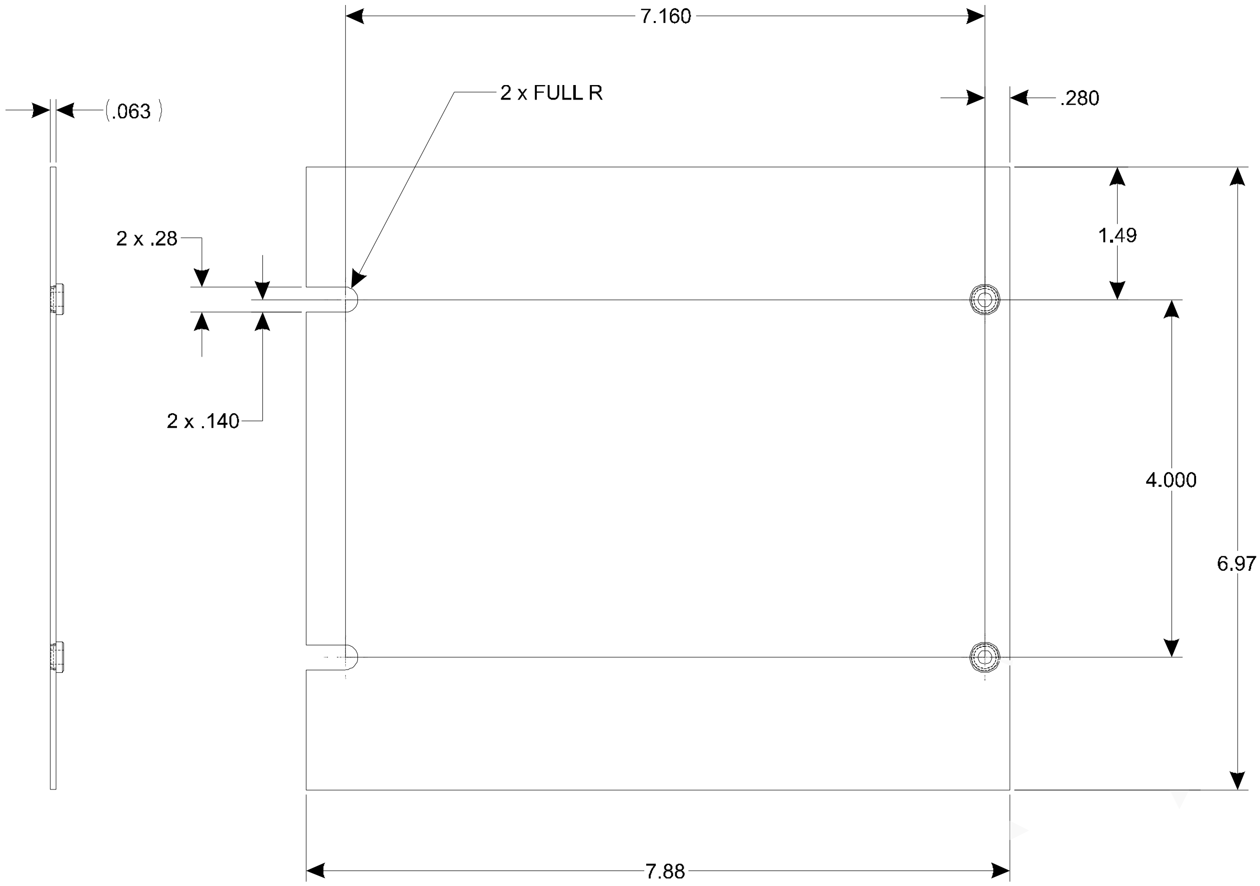


Figure 4-10 - Control Wave**RED Rack Mount Filler Panel Dimensions**

ControlWave**RED Process Automation Controller**
Special Instructions for Class I, Division 2 Hazardous Locations

1. The Bristol **Control**Wave Redundant CPU & Communications Switch 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 document carefully before installing a nonincendive Bristol **Control**Wave**RED** Process Automation Controller. In the event of a conflict between the **Control**Wave**RED** Customer Instruction Manual (CI-**Control**-Wave**RED**) and this document, always follow the instructions in this document.

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.

3. **WARNING: EXPLOSION HAZARD - Substitution of components may impair suitability for use in Class I, Division 2 environments.**

4. **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.**

5. **WARNING: EXPLOSION HAZARD - Do Not disconnect equipment unless the power has been switched off or the area is known to be nonhazardous.**

ControlWaveRED Process Application Controller
Material Safety Data Sheets

Material Safety Data Sheets are provided herein to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. This standard must be consulted for specific requirements.

Material Safety Data Sheets are provided in the order listed in Table Z-1 below.

TABLE Z-1 MSDS for ControlWaveRED Instruction Manual CI-ControlWaveRED

Manufacturer	General Description	Bristol Babcock Part Number or Media Notes
Eagle Pitcher	Lithium Thionyl Chloride Battery (1/2 AA, 3.6V, 950 mAh - On-board)	395600-01-4 Eagle Pitcher P/N LTC-9C
SAFT America	Lithium Thionyl Chloride Battery (1/2 AA, 3.6V, 950 mAh - On-board)	395600-01-4 SAFT P/N LS-14250 MSDS Not provided herein.

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard.
29 CFR 1910.1200 Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 12 18-0072

Identity *(As Used on Label and List)*
CAREFREE or HE Rechargeable Battery

Note: *Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that*

Section I

Manufacturer's Name: Eagle-Picher Industries, Inc.	Emergency Telephone Number: 417-659-9635 800-424-9300 (CHEMTREC)
Address (Number, Street, City State, and Zip Code): P.O. Box 130, 14212 Bethel Road, Seneca, MO 64865	Telephone Number for Information: 417-659-9635
	Date Prepared: 12 Sept. 02
	Signature of Preparer (optional)

Section II - Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))		OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Lead	CAS #7439-92-1	0.050 mg/m^3	0.15 mg/m^3		50%
Lead Oxides	CAS #1314-41-6 - 1317-36-8	0.050 mg/m^3	0.15 mg/m^3		25%
38% Sulfuric Acid, 1.28 s.g.	CAS #7664-93-9	1.0 mg/m^3	1.0 mg/m^3		18%

GROUND SHIPMENTS: NOT REGULATED PER 49 CFR 173.159 (d)

AIR SHIPMENTS: Not Regulated Per IATA, Special Provisions 4.4, A67

OCEAN SHIPMENTS: Not Regulated

THIS PRODUCT IS AN ARTICLE UNDER OSHA

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O=1)	N/A
Vapor Pressure (mm Hg.)	N/A	Melting Point	N/A
Vapor Density (Air=1)	N/A	Evaporation Rate (Butyl Acetate=1)	N/A

Solubility in Water
N/A

Appearance in Odor
N/A

Section IV - Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
Direct Flame to Battery Case	UL-94HB, 94V-O on FR UNITS	N/A	N/A

Extinguishing Media
Water, Foam, Dry

Special Fire Fighting Procedures
N/A

Unusual Fire and Explosion Hazards
Keep lighted cigarettes, sparks and flames away. Explosion can result from improper charging and ignition of charging gases. Explosion can result if charged in gas tight enclosures.

Section V - Reactivity Data

Stability			Conditions to Avoid
	Unstable		
	Stable	XX	

Incompatibility (Materials to Avoid)

Solvents may dissolve battery case material.

Hazardous Decomposition or Byproducts

Severe overcharge and overheating may cause sulfur oxide fumes.

Hazardous Polymerization			Conditions to Avoid
	May Occur		
	Will Not Occur	XX	

Section VI - Health Hazard Data

Routes(s) of Entry	Inhalation?	Skin?	Ingestion?
Eyes	Yes	Yes	Yes

Health Hazards (Acute and Chronic)

Severe burns and eye damage from sulfuric acid electrolyte.

Illness from sulfur oxide fumes

Contains lead which is known to cause birth defects or other reproductive harm.

Carcinogenicity	NTP?	IARC Monographs?	OSHA Regulated?
NA	No	No	No

Signs and Symptoms of Exposure

Irritation and Acid Burns

Pungent odor and respiratory irritation

Medical Conditions

Generally Aggravated by Exposure

N/A

Emergency and First Aid Procedures

For sulfur oxide fumes, disconnect batteries, evacuate and ventilate.

External, flush areas contaminated by sulfuric acid electrolyte with water.

Internal, drink large quantities of water or milk, followed by milk of magnesia, beaten eggs, or vegetable oil

Section VII - Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled

Avoid contact with sulfuric acid electrolyte from battery. Flush with water.

Neutralize with solution of baking soda in water.

Waste Disposal Method

Unlawful to dispose in landfill. Do not incinerate, puncture, disassemble or mutilate

Dispose with automotive battery scrap in accordance with local and federal regulations.

Precautions to be taken in Handling and Storing

Batteries with released electrolyte shall be sealed in polyethylene bags.

Keep batteries away from children

Other Precautions

Do not crack battery cases. Do not overcharge. Do not short circuit battery terminals.

Keep lighted cigarettes, sparks and flames away from charging batteries.

Section VIII - Control Measures

Respiratory Protection (*Specific Type)*

N/A

Ventilation		
	Local Exhaust	Specific
	Mechanical *(General)*	Other Natural convection

Protective Gloves	Eye Protection
Use rubber gloves if case is cracked	Recommended

Other Protective Clothing or Equipment

N/A

Work/Hygienic Practices

N/A

Supplement Guide - S1400CW

Issue: 04/05

ControlWave™

SITE CONSIDERATIONS
For
EQUIPMENT INSTALLATION,
GROUNDING
&
WIRING

A Guide for the Protection of
Site Equipment & Personnel
In the Installation of
ControlWave
Process Automation Controllers

Bristol Babcock

NOTICE

Copyright Notice

Request for Additional Instructions

Additional copies of instruction manuals may be ordered from the address below per attention of the Sales Order Processing Department. List the instruction book numbers or give complete model number, serial or software version number. Furnish a return address that includes the name of the person who will receive the material. Billing for extra copies will be according to current pricing schedules.

Supplement Guide S1400CW
SITE CONSIDERATIONS FOR EQUIPMENT INSTALLATION, GROUNDING & WIRING

TABLE OF CONTENTS

Supplement Guide S1400CW
SITE CONSIDERATIONS FOR EQUIPMENT INSTALLATION, GROUNDING & WIRING

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Section 5 - WIRING TECHNIQUES (Continued)

REFERENCE DOCUMENTS

1. IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems - ANSI/IEEE Std 142-1982
2. IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise inputs to Controllers from External Sources - IEE Std 518-1982
3. Lightning Strike Protect; Roy B. Carpenter, Jr. & Mark N. Drabkin, Ph.D.; Lightning Eliminators & Consultant, Inc., 6687 Arapahoe Road, Boulder Colorado
4. Lightning Protection Manual for Rural Electric Systems, NRECA Research Project 82-5, Washington DC, 1983
5. Grounding for the Control of EMI; Hugh W. Denny; Don White Consultants, Inc., 1983, 1st Edition
6. Fundamentals of EGM - Electrical Installations; Michael D. Price; NorAm Gas Transmission, 525 Milam Street, Shreveport, Louisiana 71151
7. TeleFlow Modem Grounding Kit 621495-01-8 Installation Instructions - PIP-3530MGKI; Bristol Babcock, Watertown, CT 06795

Section 1 - Overview

1.1 INTRODUCTION

This document provides information pertaining to the installation of **Control**Wave systems; more specifically, information covering reasons, theory and techniques for protecting your personnel and equipment from electrical damage. Your instrument system affects the quality of service provided by your company and many aspects of its operational safety. Loss of instruments means lost production and profits as well as increased expenses.

Information contained in this document is for educational purposes. Bristol Babcock makes no warranties or guarantees on the effectiveness or the safety of techniques described herein. Where the safety of installations and personnel is concerned, refer to the National Electrical Code Rules and rules of local regulatory agencies.

1.2 MAJOR TOPICS

Topics are covered in seven sections designed to pinpoint major areas of concern for the protection of site equipment and personnel. The following overview is provided for each of the major sections.

- **Section 2 - Protection**
  This section provides the reasons for protecting instrument systems. An overview of the definition of quality and what we are trying to accomplish in the protection of site installations and how to satisfy the defined requirements is presented. Additionally, this section provides considerations for the protection of personnel and equipment.

- **Section 3 - Grounding & Isolation**
  Information pertaining to what constitutes a good earth ground, how to test and establish such grounds, as well as when and how to connect equipment to earth grounds is provided

- **Section 4 - Lightning Arresters & Surge Protectors**
  Some interesting information dealing with Lightning strikes and strokes is presented in technical and statistical form along with a discussion of how to determine the likelihood of a lightning strike. Protecting equipment and personnel during the installation of radios and antenna is discussed in a review of the dangers to equipment and personnel when working with antennas. Reasons for the use of lightning arresters and surge protectors are presented along with overviews of how each device protects site equipment.

- **Section 5 - Wiring Techniques**
  Installation of Power and "Measurement & Control" wiring is discussed. Information on obscure problems, circulating ground and power loops, bad relays, etc. is presented. Good wire preparation and connection techniques along with problems to avoid are discussed. This sections list the ten rules of instrument wiring.

Section 2 - Protection

2.1 PROTECTING INSTRUMENT SYSTEMS

Electrical instrumentation is susceptible to damage from a variety of natural and man made phenomena. In addition to wind, rain and fire, the most common types of system and equipment damaging phenomena are lightning, power faults, communication surges & noise and other electrical interference's caused by devices such as radios, welders, switching gear, automobiles, etc. Additionally there are problems induced by geophysical electrical potential & noise plus things that are often beyond our wildest imagination.

2.1.1 Quality Is Conformance To Requirements

A quality instrumentation system is one that works reliably, safely and as purported by the equipment manufacturer (and in some cases by the system integrator) as a result of good equipment design and well defined and followed installation practices. If we except the general definition of quality to be, "quality is conformance to requirements," we must also except the premise that a condition of "quality" can't exist where requirements for such an end have not been evolved. In other words, you can't have quality unless you have requirements that have been followed. By understanding the requirements for a safe, sound and reliable instrumentation system, and by following good installation practices (as associated with the personnel and equipment in question), the operational integrity of the equipment and system will be enhanced.

Understanding what is required to properly install BBI equipment in various environments, safely, and in accordance with good grounding, isolating and equipment protection practices goes a long way toward maintaining a system which is healthy to the owner and customer alike. Properly installed equipment is easier to maintain and operate, and is more efficient and as such more profitable to our customers. Following good installation practices will minimize injury, equipment failure and the customer frustrations that accompany failing and poorly operating equipment (of even the finest design). Additionally, personnel involved in the installation of a piece of equipment add to or subtract from the reliability of a system by a degree which is commensurate with their technical prowess, i.e., their understanding of the equipment, site conditions and the requirements for a quality installation.

2.2 PROTECTING EQUIPMENT & PERSONNEL

ControlWave installations must be performed in accordance with National Electrical Code Rules, electrical rules set by local regulatory agencies, and depending on the customer environment (gas, water, etc), other national, state and local agencies such as the American Water Works Association (AWWA). Additionally, installation at various customer sites may be performed in conjunction with a "safety manager" or utility personnel with HAZMAT (hazardous material) training on materials present (or potentially present) as required by OSHA, the customer, etc.

2.2.1 Considerations For The Protection of Personnel

Always evaluate the site environment as if your life depended on it. Make sure that you understand the physical nature of the location where you will be working. Table 2-1 provides a general guideline for evaluating an installation site.

Table 2-1 - Installation Site Safety Evaluation Guide

#	Guide
1	Indoor or outdoor – Dress Appropriately
2	If outdoor, what kind of environment, terrain, etc. Watch out for local varmint (bees, spiders, snakes, etc.)
3	If indoor or outdoor – determine if there are any pieces of dangerous equipment or any processes which might be a risk to your safety
4	If in a tunnel, bunker, etc. watch out for a build up of toxic or flammable gases. Make sure the air is good. Watch out for local varmint (bees, spiders, snakes, etc.)
5	Hazardous or Non-Hazardous Environment – Wear appropriate safety equipment and perform all necessary safety measures.
6	Before installing any equipment or power or ground wiring, make sure that there are no lethal (life threatening) voltages between the site where the instrument will be installed and other equipment, pipes, cabinets, etc. or to earth itself.
7	Never assume that adjacent or peripheral equipment has been properly installed and grounded. Determine if this equipment and the **Control**Wave unit in question can be touched simultaneously without hazard to personnel and/or equipment?
8	Before embarking to remote locations where there are few or no human inhabitants ask a few simple questions like, should I bring water, food, hygienic materials, first aid kit, etc? Be Prepared!
9	Observe the work habits of those around you – for your own safety!

Some of the items that a service person should consider before ever going on site can be ascertained by simply asking questions of the appropriate individual. Obviously other safety considerations can only be established at the installation site.

2.2.2 Considerations For The Protection of Equipment

Always evaluate the site installation/service environment and equipment. Understand the various physical interfaces you will be dealing with such as equipment mounting and supporting, **Control**Wave analog and digital circuits, power circuits, communication circuits and various electrical grounds. Table 2-2 provides a general guideline for evaluating the equipment protection requirements of an installation site.

Table 2-2 - Equipment Protection Site Safety Evaluation Guide

#	Guide	Reference Section
1	Environment - Class I, Division 2 - Nonincendive Environment - Class I, Division 1 - Intrinsically Safe Other - Safe or unrated area	See Appendix A of CI Manual See Appendix B of CI Manual
2	Earth Ground - Established by mechanical/electrical or (both) or not at all.	See Section 3
3	Is the area prone to lightning strikes?	See Section 4
4	Are there surge suppressors installed or to be installed?	See Section 4
5	Are there overhead or underground power or communication cables in the immediate area?	See Section 2.3

Table 2-2 - Equipment Protection Site Safety Evaluation Guide (Continued)

#	Guide	Reference Section
6	Is there an antenna in the immediate area?	See Section 4.1.2
7	How close is other equipment? Can someone safely touch this equipment and a **Control**Wave simultaneously?	See Section 2.3
8	Determine equipment ground requirements. How will the **Control**Wave and its related wiring be grounded? Consider Earth Ground, Circuit Ground, Conduit Ground, Site Grounds!	See Section 3
9	Are there any obviously faulty or questionable power or ground circuits?	See Section 2.3

2.3 OTHER SITE SAFETY CONSIDERATIONS

Overhead or underground power or communication cables must be identified prior to installing a new unit. Accidentally cutting, shorting or simply just contacting power, ground, communication or process control I/O wiring can have potentially devastating effects on site equipment, the process system and or personnel.

Don't assume that it is safe to touch adjacent equipment, machinery, pipes, cabinets or even the earth itself. Adjacent equipment may not have been properly wired or grounded, may be defective or may have one or more loose system grounds. Measure between the case of a questionable piece of equipment and its earth ground for voltage. If a voltage is present, something is wrong.

AC powered equipment with a conductive case should have the case grounded. If you don't see a chassis ground wire, don't assume that it is safe to touch this equipment. If you notice that equipment has been grounded to pipes, conduit, structural steel, etc., you should be leery. ***Note: AWWA's policy on grounding of electric circuits on water pipes states, "The American Water Works Association (AWWA) opposes the grounding of electrical systems to pipe systems conveying water to the customer's premises…."***

Be sure that the voltage between any two points in the instrument system is less than the stand-off voltage. Exceeding the stand-off voltage will cause damage to the instrument and will cause the instrument to fail.

Section 3 - Grounding & Isolation

3.1 POWER & GROUND SYSTEMS

ControlWaves utilize DC power systems. AC power supplies are not provided with **Control**Wave units. **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/EFC**, **Control**Wave**RED**, **Control**Wave**REDIO** and **Control**Wave I/O Expansion Racks are provided with a Ground Lug that accommodates up to a #4 AWG size wire for establishing a connection to Earth Ground. In the case of the **Control**Wave**LP**, a Chassis Ground termination terminal (TB2, Pin-3), that accepts up to a #14 AWG size wire, is provided on the unit's Power Supply/Sequencer Board.

3.2 IMPORTANCE OF GOOD GROUNDS

ControlWave units (see above) are utilized in instrument and control systems that must operate continually and within their stated accuracy over long periods of time with minimum attention. Failures resulting from an improperly grounded system can become costly in terms of lost time and disrupted processes. A properly grounded system will help prevent electrical shock hazards resulting from contact with live metal surfaces, provide additional protection of equipment from lightning strikes and power surges, minimize the effects of electrical noise and power transients, and reduce signal errors caused by ground wiring loops. Conversely, an improperly grounded system may exhibit a host of problems that appear to have no relation-ship to grounding. It is essential that the reader (service technician) have a good under-standing of this subject to prevent needless troubleshooting procedures.

WARNING

*This device must be installed in accordance with the National Electrical Code (NEC) ANSI/NEPA-70. Installation in hazardous locations must also comply with Article 500 of the code. For information on the usage of **Control**Wave units in Class I, Division 2, Groups C & D Hazardous and Nonhazardous locations, see appendix A of the applicable Customer Instruction (CI) manual. For information on the usage of **Control**Wave units in Class I, Division 1, Groups C & D Hazardous locations, see appendix B of the applicable Customer Instruction (CI) manual.*

3.3 EARTH GROUND CONNECTIONS

To properly ground a **Control**Wave unit, the units Chassis Ground (post or terminal) must ultimately be connected to a known good Earth Ground. Observe recommendations provided in topics Establishing a Good Earth Ground and Ground Wire Considerations.

3.3.1 Establishing a Good Earth Ground

A common misconception of a ground is that it consists of nothing more than a metal pipe driven into the soil. While such a ground may function for some applications, it will often not be suitable for a complex system of sophisticated electronic equipment. Conditions such as soil type, composition and moisture will all have a bearing on ground reliability.

A basic ground consists of a 3/4-inch diameter rod with a minimum 8-foot length driven into conductive earth to a depth of about 7-feet as shown in Figure 3-1. Number 3 or 4 AWG solid copper wire should be used for the ground wire. The end of the wire should be clean, free of any coating and fastened to the rod with a clamp. This ground connection should be covered or coated to protect it from the weather and the environment.

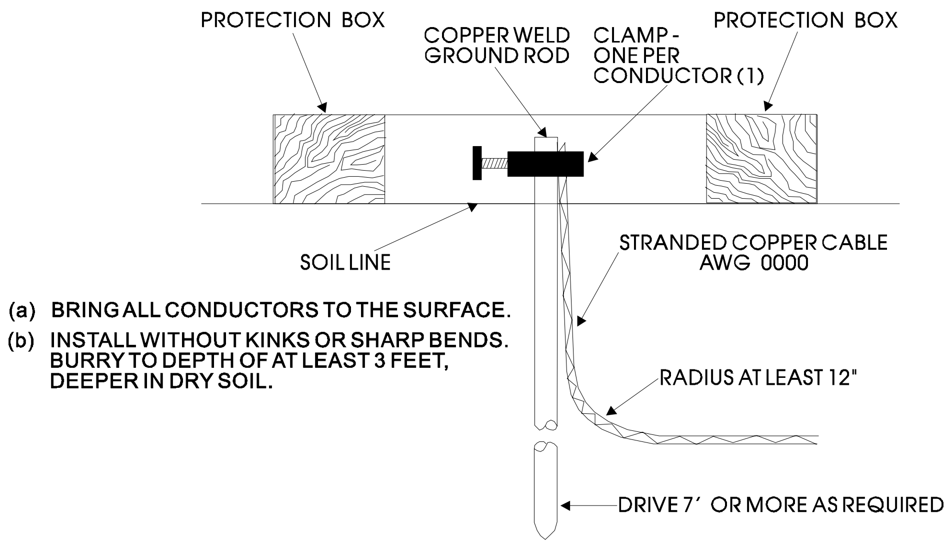


Figure 3-1 - Basic Ground Rod Installation

3.3.1.1 Soil Conditions

Before installing a ground rod, the soil type and moisture content should be analyzed. Ideally, the soil should be moist and moderately packed throughout to the depth of the ground rod. However, some soils will exhibit less than ideal conditions and will require extra attention.

Soil types can be placed into two general categories with respect to establishing and maintaining a good earth ground, i.e., ‘Good Soil’ and ‘Poor Soil.’

To be a good conductor, soil must contain some moisture and free ions (from salts in the soil). In very rainy areas, the salts may be washed out of the soil. In very sandy or arid area the soil may be to dry and/or salt free to a good conductor. If salt is lacking add rock salt (NaCl); if the soil is dry add calcium chloride ($CaCl_2$).

3.3.1.2 Soil Types:

Good	Poor
Damp Loam	Back Fill
Salty Soil or Sand	Dry Soil
Farm Land	Sand Washed by a Lot of Rain
	Dry Sand (Desert)
	Rocky Soil

Ground Beds must always be tested for conductivity prior to being placed into service. A brief description of ground bed testing in ‘Good Soil’ and ‘Poor Soil’ is provided herein. Details on this test are described in the National Electrical Code Handbook. Once a reliable ground has been established, it should be tested on a regular basis to preserve system integrity.

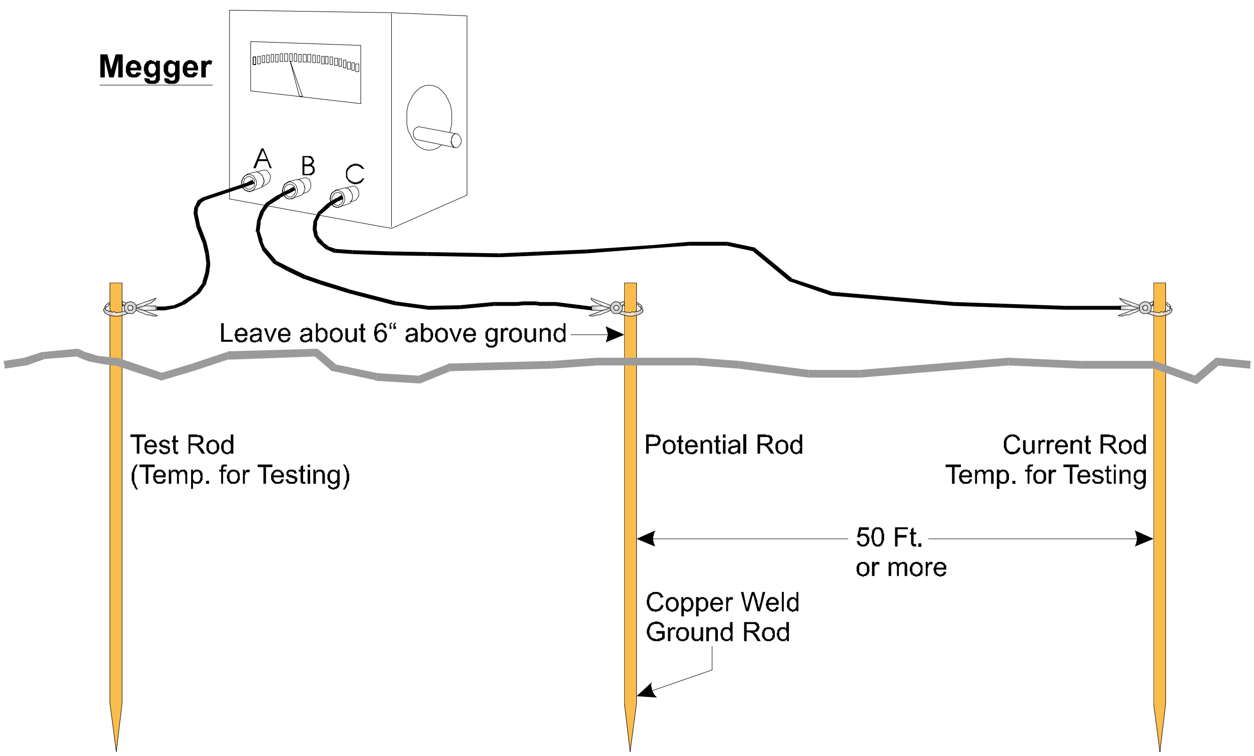


Figure 3-2 - Basic Ground Bed Soil Test Setup

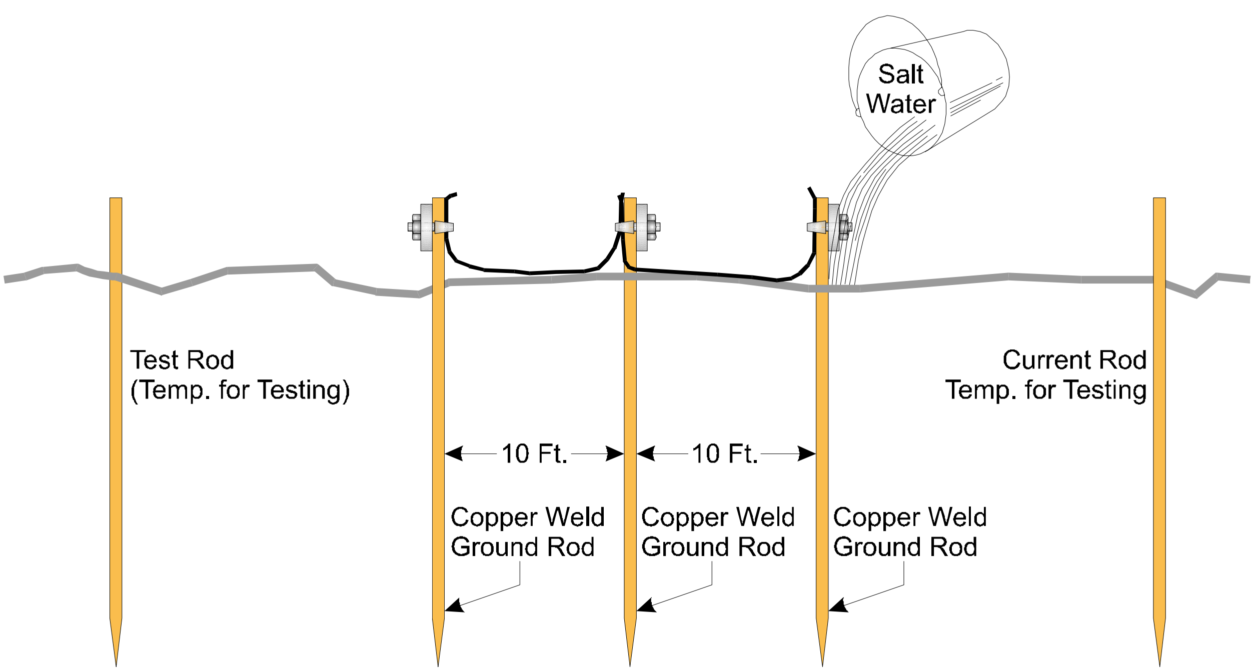


Figure 3-3 - Basic Ground Bed Soil Test Setup with Additional Ground Rods

Figure 3-2 shows the test setup for ‘Good Soil’ conditions. If the Megger* reads less than 5 ohms, the ground is good. The lower the resistance, the better the earth ground. If the

Megger reads more than 10 ohms, the ground is considered 'poor.' If a poor ground is indicated, one or more additional ground rods connected 10 feet from the main ground rod should be driven into the soil and interconnected via bare AWG 0000 copper wire and 1" x ¼-20 cable clamps as illustrated in Figure 3-3). *** Note: Megger is a Trademark of the Biddle Instrument Co. (now owned by AVO International). Other devices that may be used to test ground resistance are "Viboground"; Associated Research, Inc., "Groundmeter"; Industrial Instruments, Inc., and "Ground-ohmer"; Herman H. Sticht Co., Inc.**

If the Megger still reads more than 10 ohms, mix a generous amount of cooking salt, ice cream salt or rock salt with water and then pour about 2.5 to 5 gallons of this solution around each rod (including the test rods). Wait 15 minutes and re-test the soil. If the test fails, the soil is poor and a 'Poor Soil Ground Bed' will have to be constructed.

Figure 3-4 shows a typical Poor Soil Ground Bed Electrode. A Poor Soil Ground Bed will typically consists of four or more 10-foot long electrodes stacked vertically and separated by earth. Figure 3-5 shows the construction of a Poor Soil Ground Bed. For some poor soil sites, the ground bed will be constructed of many layers of 'Capacitive Couplings' as illustrated. In extremely poor soil sites one or more 3' by 3' copper plates (12 gauge or 1/16" thick) will have to be buried in place of the electrodes.

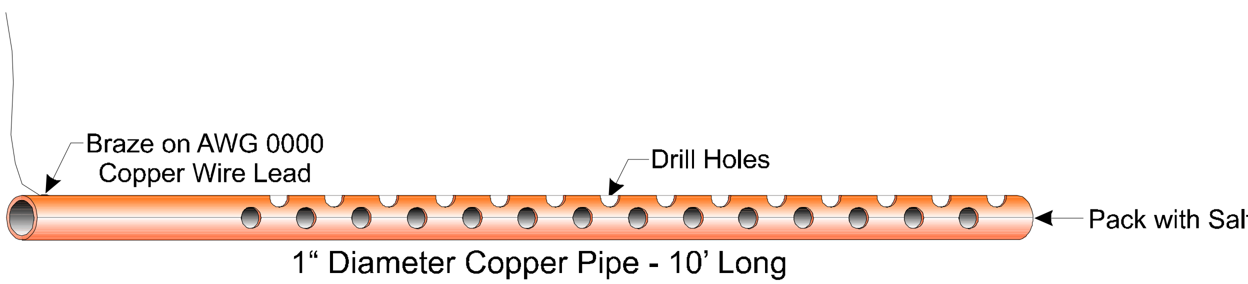


Figure 3-4 - Ground Electrode Construction for Poor Soil Conditions

3.3.1.3 Dry, Sandy or Rocky Soil

Very dry soil will not provide enough free ions for good conductance and a single ground rod will not be effective. A buried counterpoise or copper screen is recommended for these situations. It will be necessary to keep the soil moist through regular applications of water.

Sandy soil, either wet or dry, may have had its soluble salts leached out by rain water, thereby reducing conductivity of the ground. High currents from lightning strikes could also melt sand and cause glass to form around the ground rod, rendering it ineffective. A buried counterpoise or copper screen is preferred for these installations along with regular applications of salt water.

Rocky soil can pose many grounding problems. A counterpoise or copper plate will probably be required. Constructing a trench at the grounding site and mixing the fill with a hygroscopic salt such as calcium chloride may help for a time. Soaking the trench with water on a regular basis will maintain conductivity.

Units with phone modems require the use of a lightning arrester. The lightning arrester must be situated at the point where the communication line enters the building.

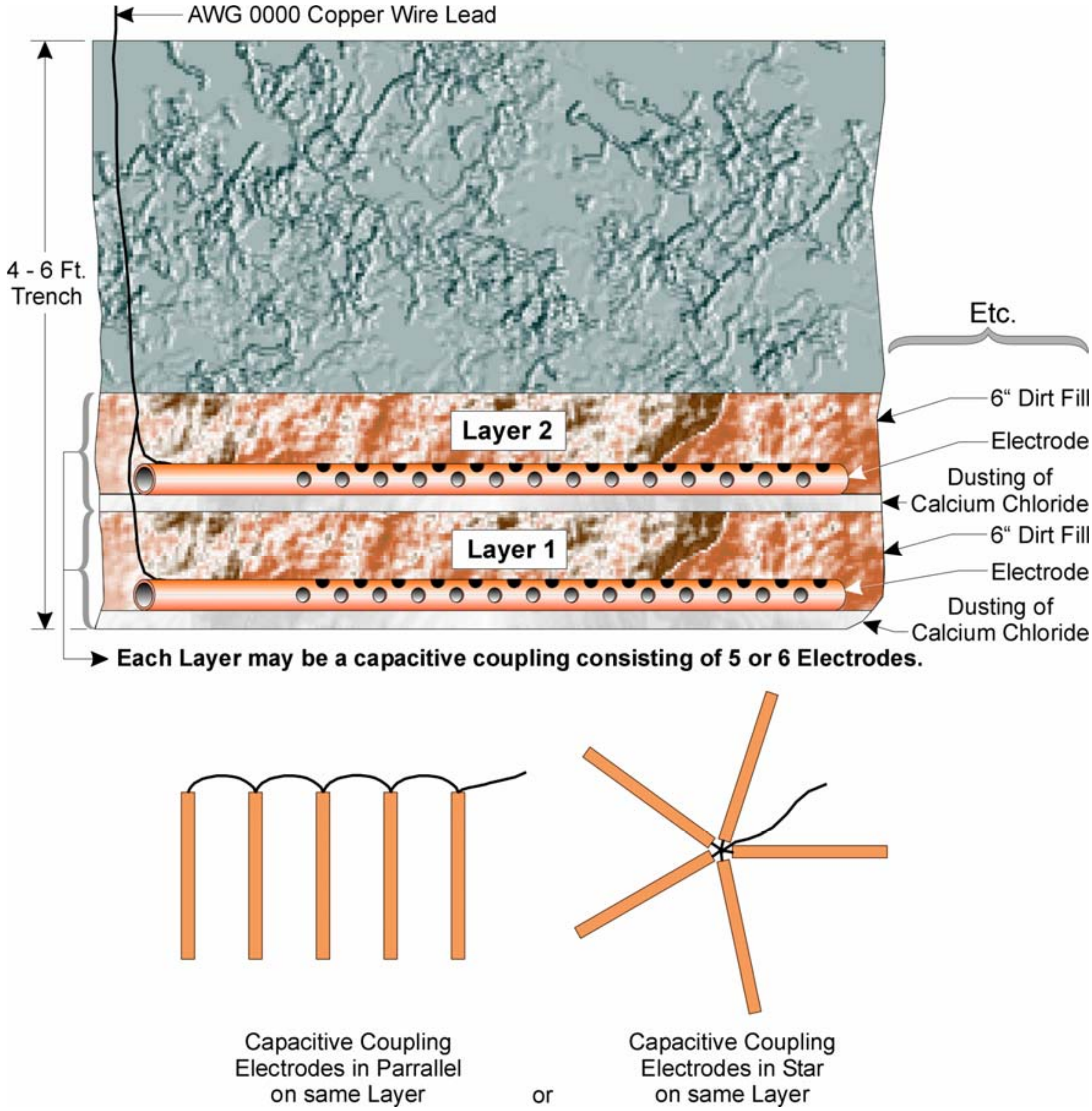


Figure 3-5 - Poor Soil Ground Bed Construction Diagram

3.3.2 Ground Wire Considerations

ControlWave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control-**Wave**RED**, **Control**Wave **REDIO** & **Control**Wave I/O Expansion Rack

ControlWave Chassis are provided with a Ground Lug that accommodates up to a #4 AWG wire size. A ground wire must be run between the Chassis Ground Lug and a known good Earth Ground. The cases of the various **Control**Wave Modules are connected to Chassis Ground when they have been installed and secured via their two Captured Panel Fasteners. As an extra added precaution, it is recommended that a #14 AWG wire be run from PSSM Power Connector TB2-5 (Chassis Ground) (PSSM Connector TB1-3 for **Control**Wave **MICRO** unit) (SCM Connector TB1-3 for **Control**Wave **EFM**) to the same known good Earth Ground.

ControlWave**LP** Process Automation Controller

A #14 AWG ground wire must be run from the **Control**Wave**LP**'s PSSB Terminal TB2-3 (Chassis Ground) to a known good Earth Ground. In lieu of a direct connection to Earth

Ground, it is recommended that the unit's Chassis Ground Terminal be connected to a conductive mounting panel or plate, a user supplied Ground Lug or a user supplied Ground Bus. The panel, lug or bus in turn must be connected to a known good Earth Ground via a #4 AWG wire.

General Considerations
The following considerations are provided for the installation of **Control**Wave system grounds:

- Size of ground wire (running to Earth Ground should be #4 AWG. It is recommended that stranded copper wire is used for this application and that the length should be as short as possible.
- This ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a stranded copper AWG 0000 cable installed vertically or horizontally).
- The wire ends should be tinned with solder prior to installation.
- The ground wire should be run such that any routing bend in the cable has a minimum radius of 12-inches below ground and 8-inches above ground.

The units Earth Ground Cable should be clamped to an exposed Ground Rod or to an AWG 0000 stranded copper Ground Cable that in turn should be connected to either an Earth Ground Rod or Earth Ground Bed. Both ends of the units Earth Ground Cable must be free of any coating such as paint or insulated covering as well as any oxidation. The connecting point of the Ground Rod or AWG 0000 Ground Cable must also be free of any coating and free of oxidation. Once the ground connection has been established (at either the Ground Rod or Ground Cable) it should be covered or coated to protect it from the environment.

3.3.3 Other Grounding Considerations

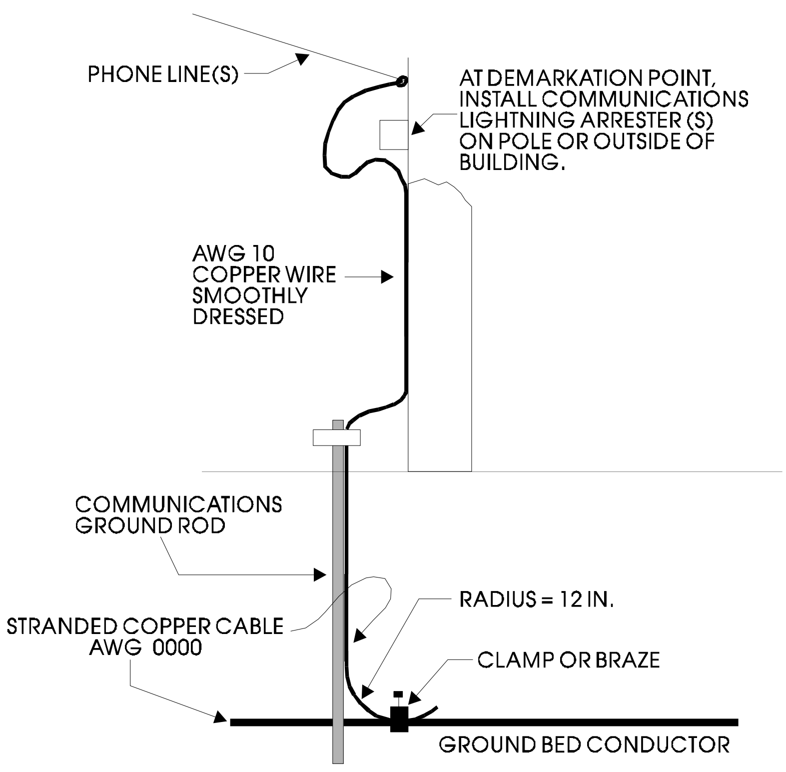


Figure 3-6 - Grounding of Phone Line

For applications employing equipment that communicates over telephone lines, a lightning arrester **Must Be** provided. For indoor equipment the lightning arrester must be installed at the point where the communication line enters the building as shown in Figure 3-6. The ground terminal of this arrester must connect to a ground rod and/or a buried ground bed.

Gas lines also require special grounding considerations. If a gas meter run includes a thermocouple or RTD sensor installed in a thermowell, the well (not the sensor) must be connected to a gas discharge-type lightning arrester as shown in Figure 3-7. A copper braid, brazed to the thermal well, is dressed into a smooth curve and connected to the arrester as shown. The curve is necessary to minimize arcing caused by lightning strikes or high static surges. The path from the lightning arrester to the ground bed should also be smooth and free from sharp bends for the same reason.

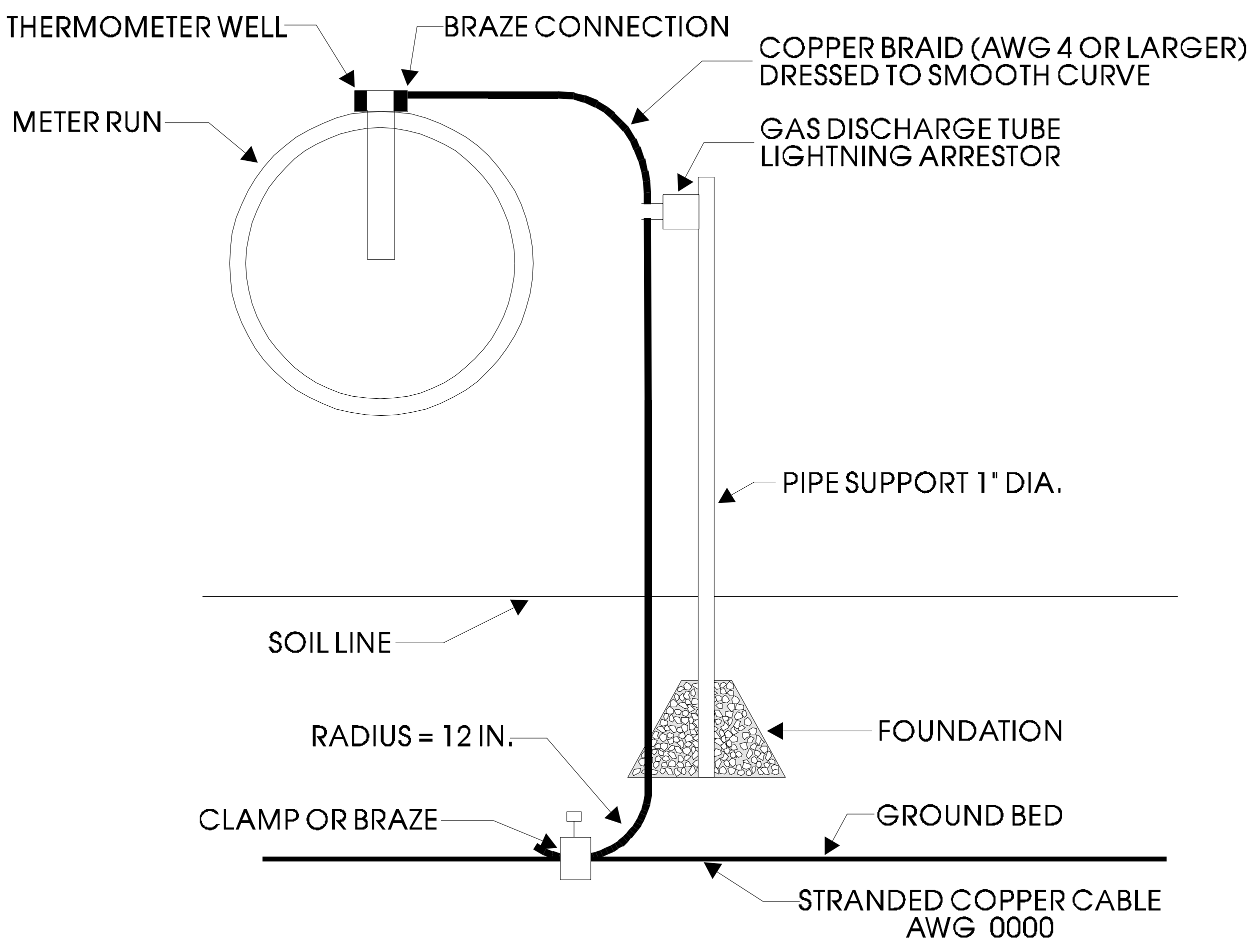


Figure 3-7 - Grounding of Thermometer Well in Gas Line

3.4 ISOLATING EQUIPMENT FROM THE PIPELINE

3.4.1 Meter Runs Without Cathodic Protection

ControlWave **EFM/GFC/XFC**'s may be mounted directly on the pipeline or remotely on a vertical stand-alone two-inch pipe (see Figure 3-8). The Earth Ground Cable is to run between the **Control**Wave **EFM/GFC/XFC**'s Ground Lug and Earth Ground (Rod or Bed) even though the **Control**Wave **EFM/GFC/XFC**'s Multivariable Transducer may be grounded to the pipeline. If any pressure transmitters or pulse transducers are remotely mounted, connect their chassis grounds to the pipeline or earth ground.

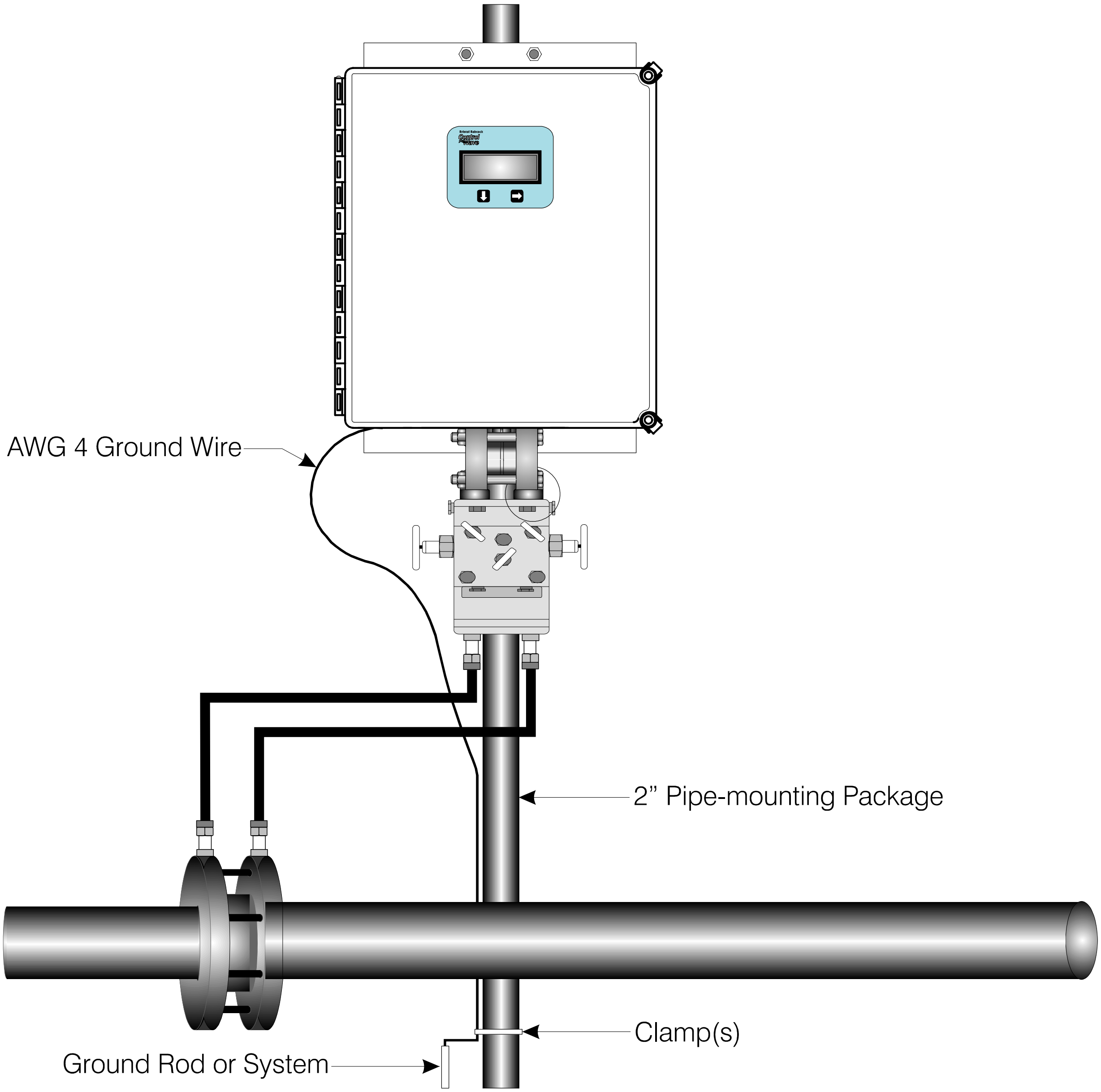


Figure 3-8 - Control Wave **EFM (Installation is similar to GFC/XFC)**
Remote Installation without Cathodic Protection

3.4.2 Meter Runs With Cathodic Protection

Dielectric isolators are available from Bristol Babcock and are always recommended as an *added measure* in isolating the **Control**Wave **EFM/GFC/XFC** from the pipeline even though the **Control**Wave **EFM/GFC/XFC** does provide 500V galvanic isolation from the pipeline and should not be affected by cathodic protection or other EMF on the pipeline. **Control**Wave **EFM/GFC/XFC** may be mounted directly on the pipeline (see Figure 3-9) or remotely on a vertical stand-alone two-inch stand-pipe (see Figure 3-10). It is recommended that isolation fitting always be used in remotely mounted meter systems. An isolation fittings or gasket should be installed between the following connections:

- all conductive tubing that runs between the pipeline and mounting valve manifold and/or the units multivariable pressure transducer
- all conductive connections or tubing runs between the **Control**Wave **EFM/GFC** and turbine meter, pulse transducer, or any input other device that is mounted on the pipeline
- any Temperature Transducer, Pressure Transmitter, etc. and their mount/interface to the pipeline

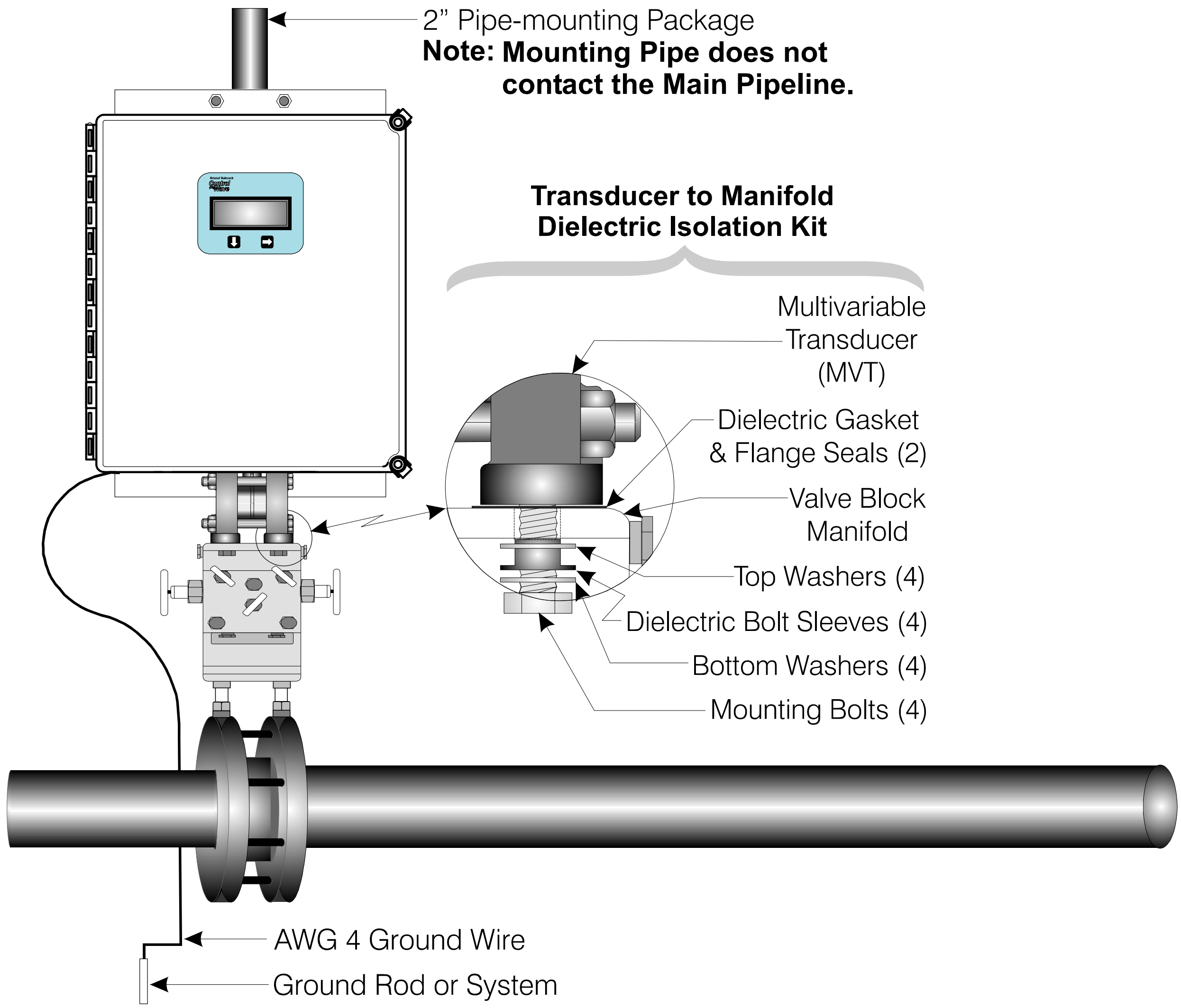


Figure 3-9 - Control Wave **EFM (Installation is similar to EFM/GFC/XFC) Direct Mount Installation (with Cathodic Protection)**

The ground conductor connects between the **Control**Wave **EFM/GFC/XFC**'s Ground Lug and a known good earth ground. Connect the cases of Temperature Transducers, Pressure Transmitters, etc., to the known good earth ground. If the mounting 2-inch pipe is in continuity with the pipeline it will have to be electrically isolated from the **Control**Wave **EFM/GFC/XFC**. Use a strong heat-shrink material such as RAYCHEM WCSM 68/22 EU 3140. This black tubing will easily slip over the 2-inch pipe and then after uniform heating (e.g., with a rose-bud torch) it electrically insulates and increases the strength of the pipe stand.

See BBI Specification Summary F1670SS-0a for information on PGI Direct Mount Systems and Manifolds.

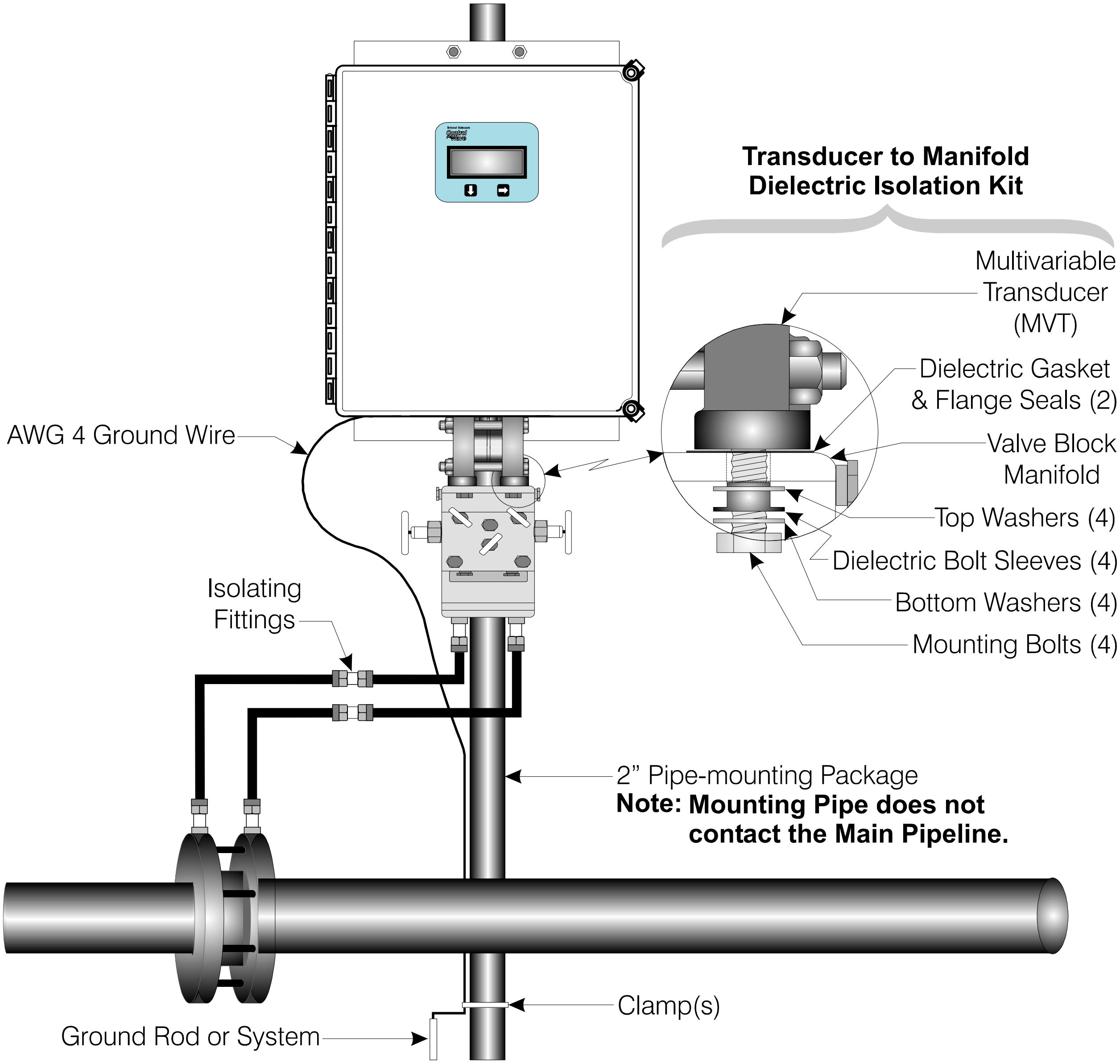


Figure 3-10 – ControlWave EFM (Installation is similar to GFC/XFC) Remote Installation (with Cathodic Protection)

Section 4 - Lightning Arresters & Surge Protectors

4.1 STROKES & STRIKES

Lightning takes the form of a pulse that typically has a 2 µS rise and a 10 µS to 40 µS decay to a 50% level. The IEEE standard is an 8 µS by 20 µS waveform. The peak current will average 18 KA for the first impulse and about half of that for the second and third impulses. Three strokes (impulses) is the average per lightning strike. The number of visible flashes that may be seen is not necessarily the number of electrical strokes.

A lightning strike acts like a constant current source. Once ionization occurs, the air becomes a luminous conductive plasma reaching up to 60,000° F. The resistance of a struck object is of little consequence except for the power dissipation on the object ($I^2 \times R$). Fifty percent of all lightning strikes will have a first impulse of at least 18 KA, ten percent will exceed the 60 KA level, and only about one percent will exceed 120 KA.

4.1.1 Chance of Being Struck by Lightning

The map of Figure 4-1 shows the average annual number of thunderstorm days (Isokeraunic level) for the various regions within the continental U.S.A. This map is not representative of the severity of the storm or the number of lightning strikes since it does not take into account more than one lightning strike in a thunderstorm day. The Isokeraunic or Isoceraunic number provides a meteorological indication of the frequency of thunderstorm activity; the higher the Isokeraunic number the greater the lightning strike activity for a given area. These levels vary across the world from a low of 1 to a high of 300. Within the United States the Isokeraunic level varies from a low of 1 to a high of 100.

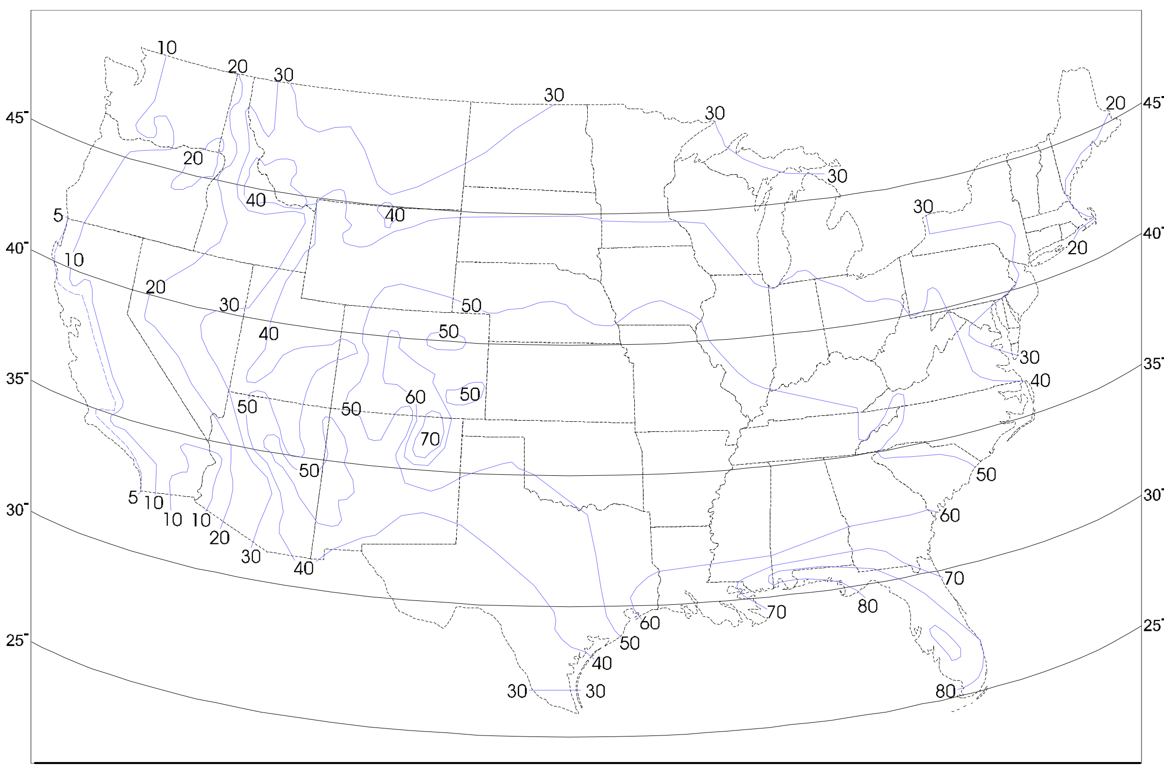


Figure 4-1 - Average Thunderstorm Days of the Year (for Continental USA)

Thunderstorms are cloud formations that produce lightning strikes (or strokes). Across the United States there is an average of 30 thunderstorm days per year. Any given storm may produce from one to several strokes. Data on the subject indicates that for an average area within the United States there can be eight to eleven strokes to each square mile per year. The risk of stroke activity is increased for various areas such central Florida where up to 38 strokes to each square mile per year are likely to occur.

To determine the probability of a given structure (tower, building, etc.) (within your location) being struck, perform the following computation:

1. Using the map of Figure 4-1 (or a comparable meteorological map for your local), find the Isokeraunic level (I) for your area. Then using Chart 1, find "A" for your area.
2. Refer to Figure 4-1 to find the latitude. Then using Chart 2, find "B" for your latitude (Lat.°).
3. Multiply "A" x "B" to get "C".
4. To calculate the number of lightning strikes per year that are likely to strike a given object (tower, mast, etc.), use the equation that follows (where "C" was calculated in step 3 and "H" is equal to the height of the object.

   Strikes Per Year = $(\text{"C"} \times H^2) \div (.57 \times 10^6)$

Chart 1

I	"A"
5	8
10	26
20	85
30	169
40	275
50	402
60	548
70	712
80	893
90	1069
100	1306

Chart 2

LAT.°	"B"
25	.170
30	.200
35	.236
40	.280
45	.325

Note for these charts:
I = Thunderstorm Days Per Year (Isokeraunic Number)
A= Stroke activity for associated Isokeraunic Area
B= Height/Stroke coefficient for associated latitude

For Example: On Long Island, New York (Isokeraunic number 20), Chart 1 gives "A" to equal 85. The latitude is approximately 40°. Referring to Chart 2, "B" is found to be equal to .28. "C" for this example is equal to 23.80. Using the equation for strikes per year, it is determined that a 100-foot tower has .4 chances per year of being struck by lightning. Assuming that no other structures are nearby, the tower will more than likely be struck by lightning at least once in three years.

Note: The Isokeraunic activity numbers connoted as I, "A" and "B" in Charts 1 and 2 above are provided for the continental United States. Isokeraunic data for various countries is available from various federal or state Civil Engineering or Meterorelogical organizations. This information is typically available from manufacturers of lightning strike protection equipment (such as Lightning Arresters).

Since **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control-**Wave**LP** and **Control**Wave**EXP** units are dc operated systems that are isolated from AC grids, they are typically immune to lightning strikes to power lines or power equipment (except for inductive flashover due to close installation proximity). However, once a radio or modem has been interfaced to a **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control**Wave**LP**, or **Control**Wave**EXP** the possibility of damage due to a lightning strike on power or telephone lines or to a radio antenna or the antenna's tower must be considered. It is recommended that the additional lightning protection considerations listed below be followed for units installed in areas with a high possibility or history of stroke activity.

Units interfaced to a modem: In series with the phone line (as far away as possible from the equipment) - for indoor installations the lightning arrester should typically be located at the point where the line enters the structure.

Units interfaced to a radio: Mount antenna discharge unit (lightning arrester) as close as possible to where the lead in wire enters the structure. See Antenna Caution below.

4.1.2 Antenna Caution

Each year hundreds of people are killed, mutilated, or receive severe permanent injuries when attempting to install or remove an antenna or antenna lead. In many cases, the victim was aware of the danger of electrocution but failed to take adequate steps to avoid the hazard. For your safety, and for proper installation maintenance, please **read** and **follow** the safety precautions that follow - **they may save your life**.

- When installing or servicing an antenna:
  DO NOT use a metal ladder. DO NOT step onto or touch an antenna mast while power is applied to an associated radio unless the radio is a low power (low current) type.
  DO NOT work on a wet or windy day, especially during a thunderstorm or when there is lightning or thunder in your area. Dress properly; shoes with rubber soles and heels, rubber gloves, long sleeve shirt or jacket.
- The safe distance from power lines should be at least twice the height of the antenna and mast combination.
- Antenna Grounding per National Electrical Code Instructions:
  A. Use AWG 10 or 8 aluminum or AWG 1 copper-clad steel or bronze wire, or larger as ground wires for both the mast and lead-in. Securely clamp the wire to the bottom of the mast.
  B. Secure lead-in wire from antenna to antenna discharge (lightning arrester) unit and the mast ground wire to the structure (building, shed, etc.) with stand-off insulators spaced from 4 feet (1.22 meters) to 6 feet (1.83 meters) apart.
  C. Mount antenna discharge unit as close as possible to where the lead-in wire enters the structure.
  D. The hole drilled through the wall for the lead-in wire should be just large enough to accommodate the cable. Before drilling this hole, make sure there are no wires or pipes, etc. in the wall.
  E. Push the cable through the hole and form a rain drip loop close to where the wire enters the exterior of the structure.
  F. Caulk around the lead-in wire (where it enters the structure) to keep out drafts.
  G. Install lightning arresters (antenna discharge units). The grounding conductor should be run in as straight a line as practicable from the antenna mast and/or the antenna discharge units to grounding electrode(s).
  H. Only connect the antenna cable to the radio after the mast has been properly grounded and the lead-in cable has been properly connected to lightning arresters which in turn have each been properly connected to a known good earth ground.

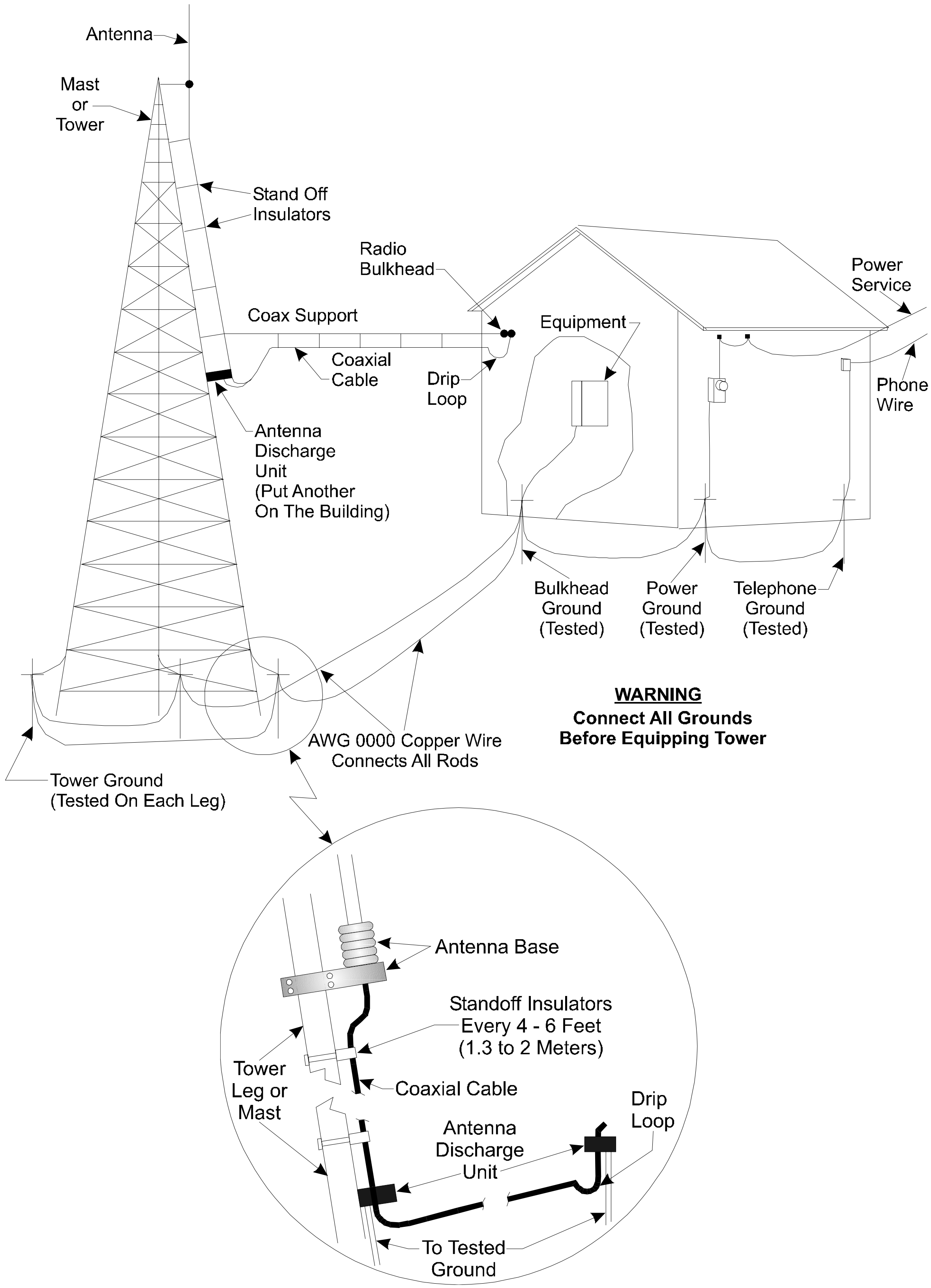


Figure 4-2 - Radio Antenna Field Installation Site Grounding Diagram

For all systems it is best to have all communication equipment input/output grounds tied together. In the case of **Control**Wave units, this is accomplished via the unit's Chassis Ground (Typically at a ground lug, ground bus or ground plate). However additional communication equipment lightning arresters and surge suppressors should be tied to the same system ground. System ground consists of the tower leg grounds utility ground and bulkhead-equipment ground-stakes that are tied together via bare copper wire.

4.1.3 Ground Propagation

As in any medium, a dynamic pulse, like R.F., will take time to propagate. This propagation time will cause a differential step voltage to exist in time between any two ground rods that are of different radial distances from the strike. With a ground rod tied to a struck tower, the impulse will propagate its step voltage outwardly from this rod in ever-expanding circles, like a pebble thrown into a pond. If the equipment house has a separate ground rod and the power company and/or telephone company grounds are also separate, the dynamic step voltage will cause currents to flow to equalize these separate ground voltages. Then if the coax cable (associated with a radio) is the only path linking the equipment chassis with the tower ground, the surge can destroy circuitry.

4.1.4 Tying it all Together

To prevent this disaster from occurring, a grounding system must be formed which interconnects all grounds together. This will equalize and distribute the surge charge to all grounds, and at the same time, it will make for a lower surge impedance ground system. This interconnection can be done as a grid, where each ground has a separate line to each other ground, or by using a "rat Race" ring which forms a closed loop (not necessarily a perfect circle) which surrounds the equipment house completely.

By making this interconnection, it will be necessary to use proper I/O protectors for the equipment. Of course, these should be a requirement regardless of whether this grounding technique is used. I/O protectors are used for power lines (even those these don't feed into a **Control**Wave unit), telephone lines, and also to minimize EMI pick-up from a strike. Ideally it is best to place all I/O protectors on a common panel that has a low inductance path to the ground system. The **Control**Wave units would then have a single ground point from its Chassis Ground Terminal/Ground Lug to this panel. In lieu of this, the **Control**Wave unit in question should be tied to a ground rod that in turn is connected to the Earth/System Ground created for the site.

Your protected equipment connected to a common single ground system, will now be just like a bird sitting on a high tension wire. When lightning strikes, even with a 50 ohm surge impedance ground system, the entire system consisting of equipment, ground system, building, etc., will all rise together to the one million volt peak level (for example) and will all decay back down together. So long as there is no voltage differential (taken care of by protectors and ground interconnections, there will be no current flow through the equipment and therefore no resulting equipment damage.

4.1.5 Impulse Protection Summary

- Use more than one ground rod.
- Place multi-ground stakes more than their length apart.
- Tie Power, Telco, Tower, Bulkhead and equipment ground together.
- Make all ground interconnect runs that are above ground with minimum radius bends of eight inches and run them away from other conductors and use large solid wire or a solid strap.

- Watch out for dissimilar metals connections and coat accordingly.
- Use bare wire radials together where possible with ground stakes to reduce ground system impedance.
- Use I/O protectors (Phone line, Radio) with a low inductance path to the ground system.
- Ground the Coaxial Cable Shield (or use an impulse suppressor) at the bottom of the tower just above the tower leg ground connection.

4.2 USE OF LIGHTNING ARRESTERS & SURGE PROTECTORS

Units equipped with radios or modems use lightning arresters and surge protectors to protect equipment from lightning strikes, power surges and from damaging currents that have been induced onto communication lines.

The first line of defense is the Lightning Arrester. These devices typically use gas discharge bulbs that can shunt high currents and voltages to earth ground when they fire. The high current, high voltage gas discharge bulb has a relatively slow response time and only fire when their gas has been ionized by high voltage.

The second line of defense is the Surge Protector, which is made of solid state devices, fires very quickly and conducts low voltages and currents to ground. Surge protectors are built into BBI 9600 bps modems.

Lightning Arresters are applied to circuits as follows:

- Equipment or circuits that can be exposed to lightning strikes, falling power lines, high ground currents caused by power system faults, by operational problems on electric railways, etc.

- Equipment installed in dry, windy areas, such as the Great Plains and the Southwest Desert in the United States. Wind and wind blown dust can cause high voltages (static) to appear on overhead wires, fences, and metal buildings.

Note: Lightning Arresters may explode if lightning strike is very close. Mount lightning arresters where flying parts won't cause injury to equipment or personnel.

Section 5 - Wiring Techniques

5.1 OVERVIEW

This section provides information pertaining to good wiring practices. Installation of Power and “Measurement & Control” wiring is discussed. Information on obscure problems, circulating ground and power loops, bad relays, etc. is presented. Good wire preparation and connection techniques along with problems to avoid are discussed.

5.2 INSTRUMENT WIRING

Each of the rules listed below is briefly discussed; the emphasis herein is placed on the avoidance of problems as well as equipment safety.

Rule 1 - Never utilize common returns.

Rule 2 - Use twisted shielded pairs (with overall insulation) on all Signal/Control circuits.

Rule 3 - Ground cable shields at one end only.

Rule 4 - Use known good earth grounds (Rod, Bed, System) and test them periodically,

Rule 5 - Earth connections must utilize smoothly dressed large wire.

Rule 6 - Perform all work neatly and professionally.

Rule 7 - Route high power conductors away from signal wiring according to NEC Rules.

Rule 8 - Use appropriately sized wires as required by the load.

Rule 9 - Use lightning arresters and surge protectors.

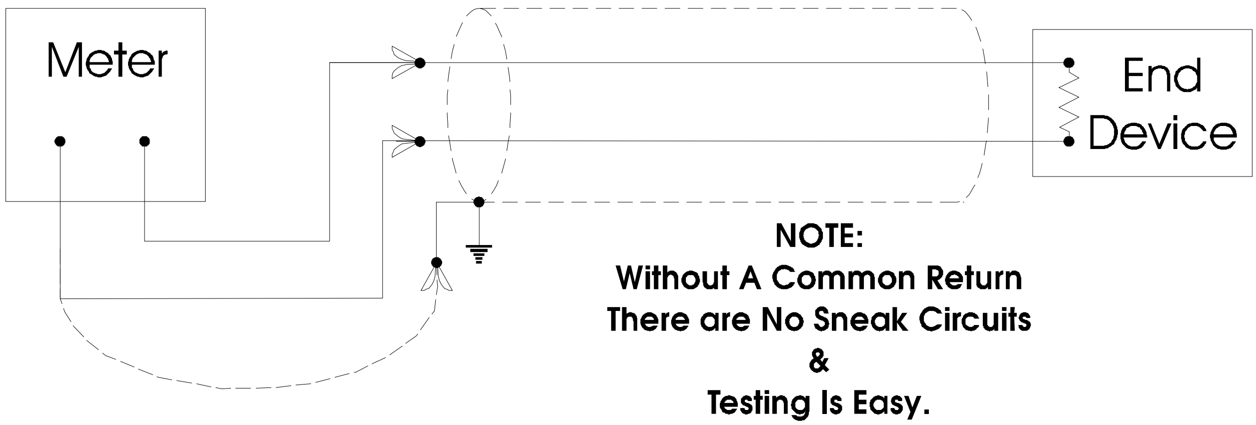
Rule 10 - Make sure all wiring connections are secure.

5.2.1 Common Returns

Use of common returns on I/O wiring is one of the most common causes of obscure and difficult to troubleshoot control signal problems. Since all wires and connections have distributed resistance, inductance and capacitance, the chances of a achieving a balanced system when common returns are present is very remote. Balanced systems (or circuits) are only achieved when all currents and voltages developed in association with each of the common returns are equal. In a balanced system (or circuit) there are no noise or measurment errors introduced due to by “sneak circuits.”

The illustration of Figure 5-1 shows the difference between testing an I/O circuit that is discrete and has no sneak circuits and one that utilizes common returns. Common sense tells us that it is tough to mix up connections to a twisted shielded pair (with overall vinyl covering) to every end device. Do yourself a favor; to make start up easier, DON’T USE COMMON RETURNS!

Field Wired Circuit Without A Common Return



Field Wired Circuit With A Common Return

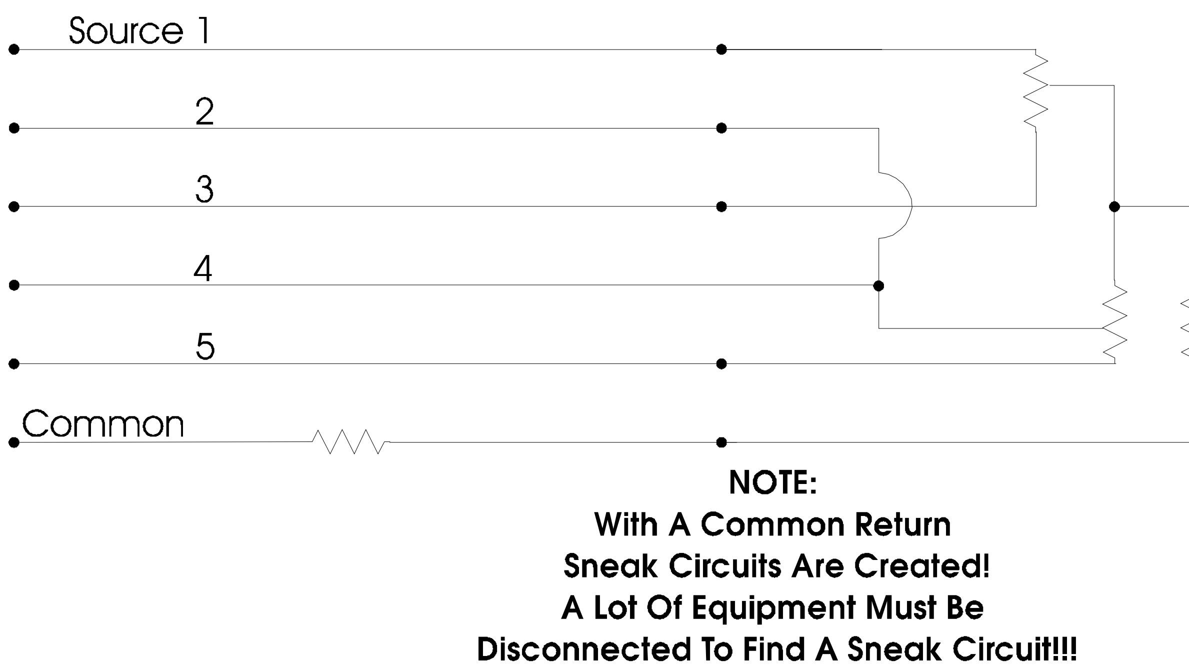


Figure 5-1 - Field Wired Circuits With & Without A Common Return

5.2.2 Use of Twisted Shielded Pair Wiring (with Overall Insulation)

For all field I/O wiring the use of twisted shielded pairs with overall insulation is highly recommended. This type of cable provides discrete insulation for each of the wires and an additional overall insulated covering that provides greater E.M.I. immunity and protection to the shield as well.

5.2.3 Grounding of Cable Shields

DO NOT connect the cable shield to more than one ground point; it should only be grounded at one end. Cable shields that are grounded at more than one point or at both ends may have a tendency to induce circulating currents or sneak circuits that raise havoc with I/O signals. This will occur when the ground systems associated with multipoint connections to a cable shield have a high resistance or impedance between them and a ground induced voltage is developed (for what ever reason, i.e., man made error or nature produced phenomena).

5.2.4 Use of Known Good Earth Grounds

ControlWave units should only have one connection to earth ground. For **Control**Wave and **Control**Wave **MICRO** Process Automation Controllers, **Control**Wave **MICRO**, **Control**Wave **EFM** Electronic Flow Meters, **Control**Wave **GFC/XFC** Gas Flow Computers and **Control**Wave I/O Expansion Racks, this connection is provided via the Ground Lug that is situated on the bottom of the unit. **Control**Wave**LP**s require the installation of a ground lug, ground bus or ground plate/panel. Since **Control**Wave units are DC-based systems, grounding does not take into account AC power grounding considerations. Earth grounding the unit is absolutely necessary when the unit is equipped with a radio or modem. Additionally these units should be connected to earth ground when they are installed in areas that have frequent lightning strikes or are located near or used in conjunction with equipment that is likely to be struck by lightning or if struck by lightning may cause equipment or associated system failure. Earth Grounds must be tested and must be known to be good before connecting the **Control**Wave. Earth grounds must be periodically tested and maintained (see Section 4).

5.2.5 Earth Ground Wires

Earth connections must utilize smoothly dressed large wire. Use AWG 3 or 4 stranded copper wire with as short a length as possible. Exercise care when trimming the insulation from the wire ends. Twists the strands tightly, trim off any frizzes and tin the ends with solder. The earth ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a standard AWG 0000 copper cable. The earth ground wire should be run such that any routing bend in the cable is a minimum 8-inch radius above ground or a minimum 12-inch radius below ground.

5.2.6 Working Neatly & Professionally

Take pride in your work and observe all site and maintenance safety precautions. After properly trimming the stranded pair wire ends, twist them in the same direction as their manufacturer did and then tin them with solder. Install the tinned wire end into it's connector and then secure the associated connector's clamping screw. Remember to check these connections for tightness from time to time. If solid copper wire is used (in conjunction with the DC Power System or for Earth Ground) make sure that the conductor is not nicked when trimming off the insulation. Nicked conductors are potential disasters waiting to happen. Neatly trim shields and whenever possible, coat them to protect them and prevent shorts and water entry.

Remember loose connections, bad connections, intermittent connections, corroded connections, etc., are hard to find, waste time, create system problems and confusion in addition to being costly.

5.2.7 High Power Conductors and Signal Wiring

When routing wires, keep high power conductors away from signal conductors. Space wires appropriately to vent high voltage inductance. Refer to the National Electrical Code Handbook for regulatory and technical requirements.

5.2.8 Use of Proper Wire Size

ControlWaves utilize compression-type terminals that accommodate up to #14 AWG gauge wire. A connection is made by inserting the bared end (1/4 inch max.) into the clamp beneath the screw and securing the screw.

Allow some slack in the wires when making terminal connections. Slack makes the connections more manageable and minimizes mechanical strain on the PCB connectors. Provide external strain relief (utilizing Tie Wrap, etc.) to prevent the loose of slack at the **Control**Wave.

Be careful to use wire that is appropriately sized for the load. Refer to equipment manufacturer's Specs. and the National Electrical Code Handbook for information on wire size and wire resistance. After installing the field wiring, test each load to determine if the correct voltage or current is present at the load. If you know the resistance of the field wires (Circular Mills x Length) you should be able to calculate the load voltage. Conversely, if you know the minimum load voltage and current, you should be able to derive the maximum voltage loss that is allowable due to line resistance and then the correct wire size.

Referring to Figure 5-2, a relay that is picked by 100 mA, with a loop supply voltage of 24V and a total line resistance of 20 ohms, the load voltage (voltage across the relay) should be:

$V_L = V_S - (V_C + V_C)$ where $V_C + V_C = (R_C + R_C)\ I$

$22 = 24 - 2$ where $2V = (20\ \Omega) \times 0.1\ A$

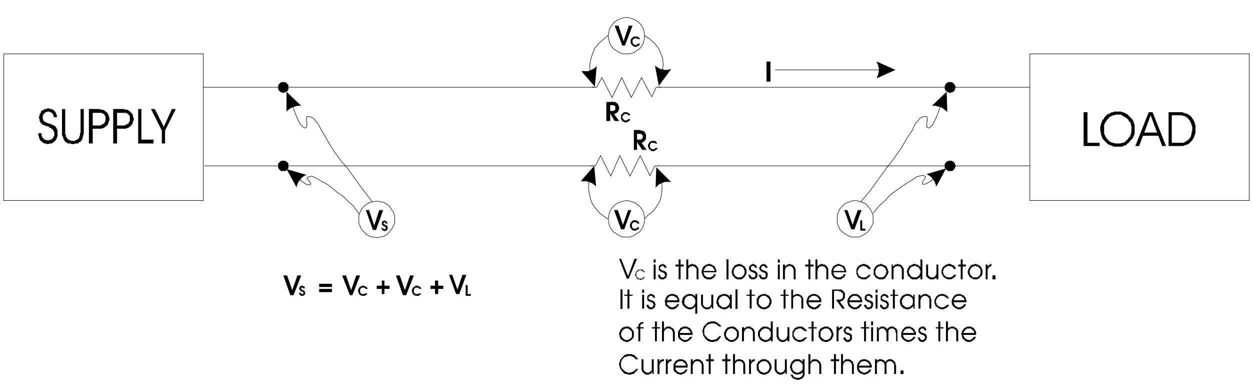


Figure 5-2 - Calculating Load Voltage due to Line Resistance

5.2.9 Lightning Arresters & Surge Protectors

Use lightning arresters in association with any radio or modem equipped unit. BBI 9600 bps modems are equipped with surge protection circuitry. Lightning arresters or Antenna

Discharge Units should be placed on the base of the antenna and at the point where the antenna lead (typically coax) enters the site equipment building. When a modem is used, a lightning arrester should be placed at the point where the phone line enters the site equipment building. If you use a modem (manufactured by other than BBI) it is recommended that you also install a surge suppressors or lightning arrester on the phone line as close to the modem as possible. *Any unit interfaced to a radio or modem must be connected to a known good earth ground.*

5.2.10 Secure Wiring Connections

Make sure that all wiring connections are secure. In time wires that were once round will become flattened due to the pressure applied by screw compression type terminals and site vibrations. After a while these compression screws have a tendency to become loose. Part of a good maintenance routine should be to check and tighten all screws associated with wiring terminal connections. Avoid nicking the wire(s) when stripping insulation. Remember, nicked conductors will lead to future problems. Also remember to provide some cabling slack and strain relief.

If installing stranded or braided wiring that has not been tinned, be sure to tightly twist the end (in the same direction as manufactured) and then trim off any frizzed wires.

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DOCUMENT NUMBER: S1400CW
TITLE: *ControlWave™ SITE CONSIDERATIONS For EQUIPMENT INSTALLATION, GROUNDING & WIRING*
ISSUE DATE: APR., 2005
COMMENT/COMPLAINT:

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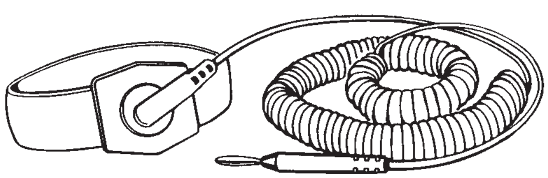
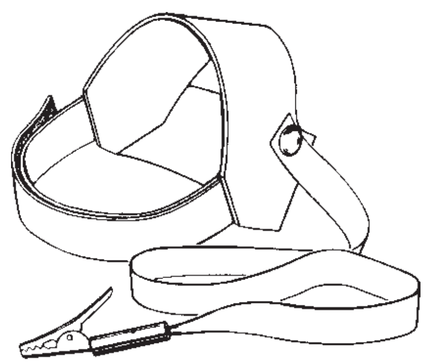
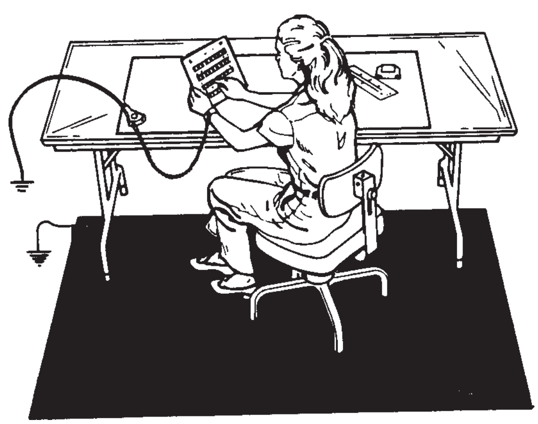
ESDS Manual
S14006
4/15/92

CARE AND HANDLING OF PC BOARDS AND ESD-SENSITIVE COMPONENTS







BRISTOL BABCOCK

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TOOLS AND MATERIALS REQUIRED

1. Tools

Anti-Static Field kit. It is recommended that an anti-static field kit be kept on any site where solid-state printed circuit boards and other ESD-sensitive components are handled. These kits are designed to remove any existing static charge and to prevent the build-up of a static charge that could damage a PC board or ESD-sensitive components. The typical anti-static field kit consists of the following components:

1. A work surface (10mm conductive plastic sheet with a female snap fastener in one corner for ground cord attachment).
2. A 15-foot long ground cord for grounding the work surface.
3. Wrist strap (available in two sizes, large and small, for proper fit and comfort) with a female snap fastener for ground cord attachment.
4. A coiled ground cord with a practical extension length of 10 feet for attachment to the wrist strap.

Toothbrush (any standard one will do)

2. Materials

- Inhibitor (Texwipe Gold Mist ; Chemtronics Gold Guard, or equivalent)
- Cleaner (Chemtronics Electro-Wash; Freon TF, or equivalent)
- Wiping cloth (Kimberly-Clark Kim Wipes, or equivalent)

ESD-SENSITIVE COMPONENT HANDLING PROCEDURE

1. Introduction

Microelectronic devices such as PC boards, chips and other components are electro-static-sensitive. Electrostatic discharge (ESD) of as few as 110 volts can damage or disrupt the functioning of such devices. Imagine the damage possible from the 35,000 volts (or more) that you can generate on a dry winter day by simply walking across a carpet. In fact, you can generate as much as 6,000 volts just working at a bench.

There are two kinds of damage that can be caused by the static charge. The more severe kind results in complete failure of the PC board or component. This kind of damage is relatively simple, although often expensive, to remedy by replacing the affected item(s). The second kind of damage results in a degradation or weakening which does not result in an outright failure of the component. This kind of damage is difficult to detect and often results in faulty performance, intermittent failures, and service calls.

Minimize the risk of ESD-sensitive component damage by preventing static build-up and by promptly removing any existing charge. Grounding is effective, if the carrier of the static charge is **conductive** such as a human body. To protect components from **nonconductive** carriers of static charges such as plastic boxes, place the component in static-shielding bags.

This manual contains general rules to be followed while handling ESD-sensitive components. Use of the anti-static field kit to properly ground the human body as well as the work surface is also discussed.

Table 1

Typical Electrostatic Voltages

	Electrostatic Voltages	
Means of Static Generation	10-20 Percent Relative Humidity	65-90 Percent Relative Humidity
Walking across carpet	35,000	1,500
Walking over vinyl floor	12,000	250
Worker at bench	6,000	100
Vinyl envelopes for work instructions	7,000	600
Poly bag picked up from bench	20,000	1,200
Work chair padded with poly foam	18,000	1,500

2. General Rules

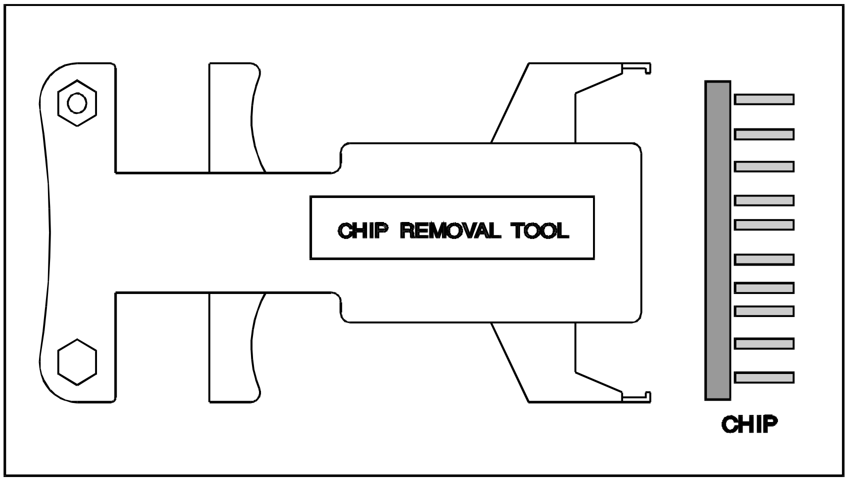
(1) ESD-sensitive components shall **only** be removed from their static-shielding bags by a person who is properly grounded.

(2) When taken out of their static-shielding bags, ESD-sensitive components shall **never** be placed over, or on, a surface which has not been properly grounded.

(3) ESD-sensitive components shall be handled in such a way that the body does not come in contact with the conductor paths and board components. Handle ESD-sensitive components in such a way that they will not suffer damage from physical abuse or from electric shock.

(4) EPROMS/PROMS shall be kept in anti-static tubes until they are ready to use and shall be removed **only** by a person who is properly grounded.

(5) When inserting and removing EPROMS/PROMS from PC boards, use a chip removal tool similar to the one shown in the figure following. Remember, all work should be performed on a properly grounded surface by a properly-grounded person.



Typical Chip Removal Tool

(6) It is important to note when inserting EPROMS/PROMS, that the index notch on the PROM must be matched with the index notch on the socket. Before pushing the chip into the socket, make sure all the pins are aligned with the respective socket-holes. Take special care not to crush any of the pins as this could destroy the chip.

(7) Power the system down before removing or inserting comb connectors/plugs or removing and reinstalling PC boards or ESD-sensitive components from card files or mounting hardware. Follow the power-down procedure applicable to the system being serviced.

(8) Handle all defective boards or components with the same care as new components. This helps eliminate damage caused by mishandling. Do not strip used PC boards for parts. Ship defective boards promptly to Bristol Babcock in a static-shielding bag placed *inside* static-shielding foam and a box to avoid damage during shipment.

CAUTION

Don't place ESD-sensitive components and paperwork in the same bag.

The static caused by sliding the paper into the bag could develop a charge and damage the component(s).

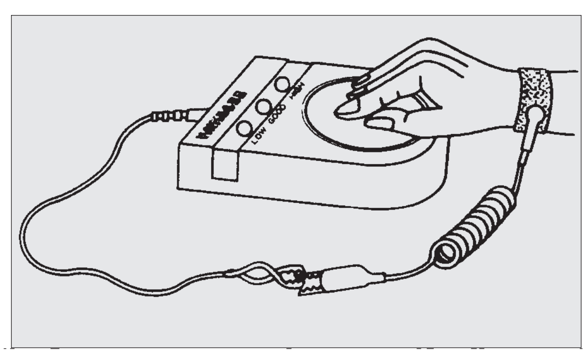
(9) Include a note, which describes the malfunction, in a *separate* bag along with each component being shipped. The repair facility will service the component and promptly return it to the field.

3. Protecting ESD-Sensitive Components

(1) As stated previously, it is recommended that an electrically-conductive anti-static field kit be kept on any site where ESD-sensitive components are handled. A recommended ESD-protective workplace arrangement is shown on page 7. The anti-static safety kit serves to protect the equipment as well as the worker. As a safety feature, a resistor (usually of the one-megohm, 1/2-watt, current-limiting type) has been installed in the molded caps of the wrist strap cord and the ground cord. This resistor limits current should a worker accidently come in contact with a power source. Do not remove the molded caps from grounded cords. If a cord is damaged, replace it immediately.

(2) Be sure to position the work surface so that it does **not** touch grounded conductive objects. The protective resistor is there to limit the current which can flow through the strap. When the work surface touches a grounded conductive object, a short is created which draws the current flow and defeats the purpose of the current-limiting resistor.

(3) Check resistivity of wrist strap periodically using a commercially-available system tester similar to the one shown in the figure below:



Note: If a system checker is not available, use an ohmmeter connected to the cable ends to measure its resistance. The ohmmeter reading should be **1 megohm +/- 15%**. Be sure that the calibration date of the ohmmeter has not expired. If the ohmmeter reading exceeds **1 megohm by +/- 15%**, replace the ground cord with a new one.

4. Static-safe Field Procedure

(1) On reaching the work location, unfold and lay out the work surface on a convenient surface (table or floor). Omit this step if the table or floor has a built-in ESD-safe work surface.

(2) Attach the ground cord to the work surface via the snap fasteners and attach the other end of the ground cord to a reliable ground using an alligator clip.

(3) Note which boards or components are to be inserted or replaced.

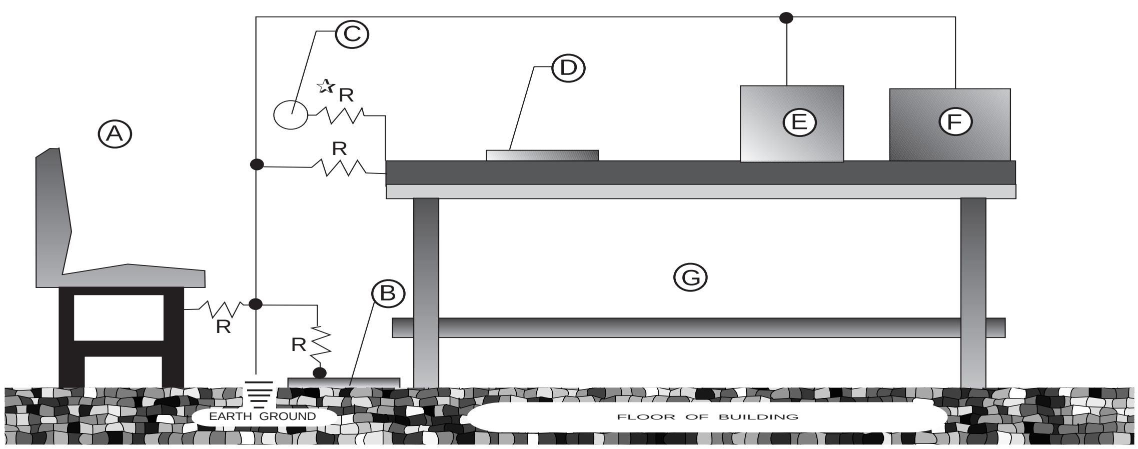
(4) Power-down the system following the recommended power-down procedure.

(5) Slip on a known-good wristband, which should fit snugly; an extremely loose fit is not desirable.

(6) Snap the ground cord to the wristband. Attach the other end of the ground cord to a reliable ground using the alligator clip.

(7) The components can now be handled following the general rules as described in the instruction manual for the component.

(8) Place the component in a static-shielding bag before the ground cord is disconnected. This assures protection from electrostatic charge in case the work surface is located beyond the reach of the extended ground cord.



LEGEND

A - Chair with ground (optional)

B - ESD protective floor mat (optional)

C - Wrist strap

D - ESD protective trays, etc.

E - Ionizer

F - Other electrical equipment

G - Workbench with ESD protective table top

☆ NOTE: ALL RESISTORS 1M Ω +/-10% 1/2W

(9) If a component is to undergo on-site testing, it may be safely placed on the grounded work surface for that purpose.

(10) After all component work is accomplished, remove the wrist straps and ground wire and place in the pouch of the work surface for future use.

5. Cleaning And Lubricating

The following procedure should be performed periodically for all PC boards and when a PC board is being replaced.

CAUTION

Many PC board connectors are covered with a very fine gold-plate.

Do not use any abrasive cleaning substance or object such as a pencil eraser to clean connectors.

Use only the approved cleaner/lubricants specified in the procedure following.

WARNING

Aerosol cans and products are extremely combustible.

Contact with a live circuit, or extreme heat can cause an explosion.

Turn OFF all power and find an isolated, and ventilated area to use any aerosol products specified in this procedure.

(1) Turn the main line power **OFF**. Blow or vacuum out the component. This should remove potential sources of dust or dirt contamination during the remainder of this procedure.

(2) Clean PC board connectors as follows:

a. Review the static-safe field procedure detailed earlier.

b. Following the ESD-sensitive component handling procedures, remove the connectors from the boards and remove the PC boards from their holders.

c. Use cleaner to remove excessive dust build-up from comb connectors and other connectors. This cleaner is especially useful for removing dust.

d. Liberally spray all PC board contacts with Inhibitor. The inhibitor:

- Provides a long lasting lubricant and leaves a protective film to guard against corrosion
- Improves performance and reliability
- Extends the life of the contacts
- Is nonconductive, and is safe for use on most plastics

e. Clean the comb contacts using a **lint-free** wiping cloth.

f. Lightly mist all comb contacts again with Inhibitor.

NOTE: Do not use so much Inhibitor that it drips.

g. Repeat the above procedure for the other PC boards from the device.

(3) Cleaning PC edge connectors

a. Use cleaner to remove excessive dust build-up from connectors. This cleaner is especially useful for removing dust.

b. Liberally spray the outboard connector with Inhibitor.

c. Lightly brush the outboard connector with a soft, non-metallic, bristle brush such as a toothbrush.

d. Spray the connector liberally to flush out any contaminants.

e. Remove any excess spray by shaking the connector or wiping with either a toothbrush, or a **lint-free** wiping cloth.

6. Completion

(1) Replace any parts that were removed.

(2) Make sure that the component cover is secure.

(3) Return the system to **normal** operation.

(4) Check that the component operates normally.

ControlWave RED (Redundant Controller)

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