Instruction Manual
Doc Number CI-ControlWave EFM
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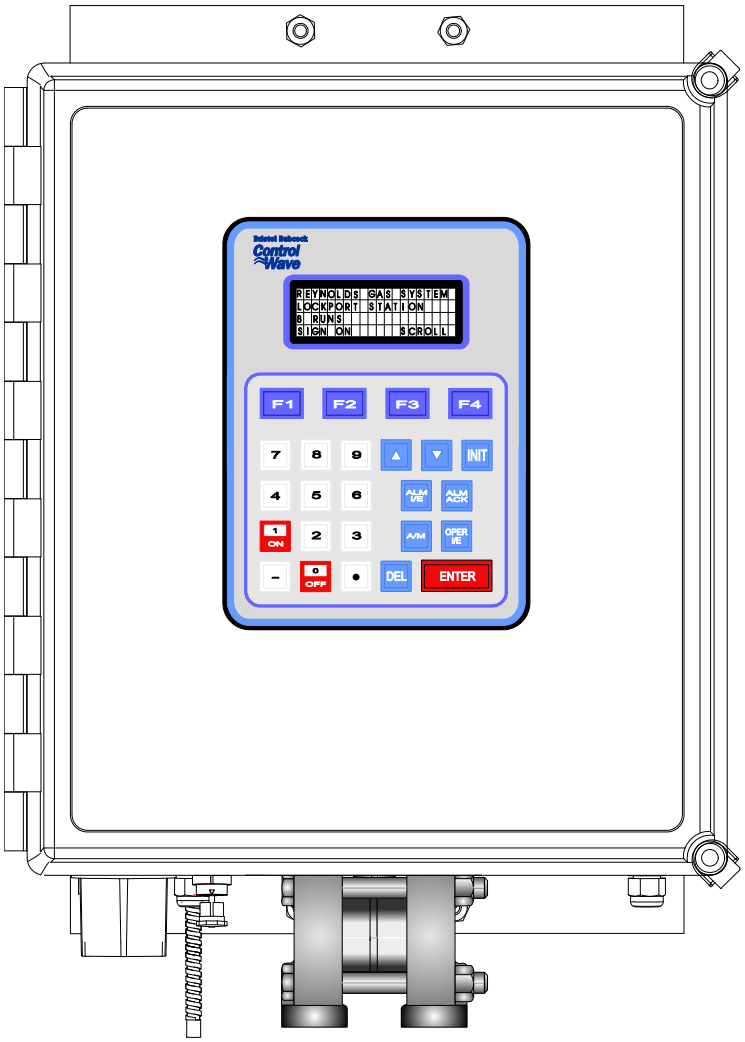
ControlWave® EFM (Electronic Flow Meter)



Remote Automation Solutions
www.EmersonProcess.com/Remote

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IMPORTANT! READ INSTRUCTIONS BEFORE STARTING!

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

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

EQUIPMENT APPLICATION WARNING

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

RETURNED EQUIPMENT WARNING

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

ELECTRICAL GROUNDING

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

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

EQUIPMENT DAMAGE FROM ELECTROSTATIC DISCHARGE VOLTAGE

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

Contents

Chapter 1 – Introduction

This manual focuses on the hardware aspects of the ControlWave® Electronic Flow Meter (EFM) (called the "ControlWave EFM" or "EFM" throughout the rest of this manual). For information about the software used with the EFM, refer to *Getting Started with ControlWave Designer* (D5085), the *ControlWave Designer Programmer's Handbook* (D5125), and the online help in ControlWave Designer. For information on the flow measurement application used in the ControlWave EFM, see the *ControlWave Flow Measurement Applications Guide* (D5137).

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

In This Chapter

The ControlWave EFM measures differential pressure, static pressure, and temperature and computes flow for both volume and energy for up to four meter runs in accordance with API (American Petroleum Institute) and AGA (American Gas Association) standards.

Features ControlWave EFMs have the following key features:

- Exceptional performance and low power consumption through use of the ARM microprocessor
- Two CPU options (33 MHz or 150 MHz)
- Two RS-232 and one RS-485 asynchronous serial communication ports
- Optional Ethernet port (150 MHz CPU only)
- Optional Expansion Communication modules (ECOMs) with optional built-in modem and/or radio
- Wide operating temperature range: (–40 to +70°C) (–40 to 158°F)
- Variety of I/O modules (including mixed I/O)
- RTD input
- Lithium coin cell battery (located on the CPU module) provides battery backup for the real-time clock and the system's static RAM (SRAM)
- Keypad /. Display for operator interaction.

- Nonincendive Class I, Division 2 (Groups C and D) Hazardous Location approvals

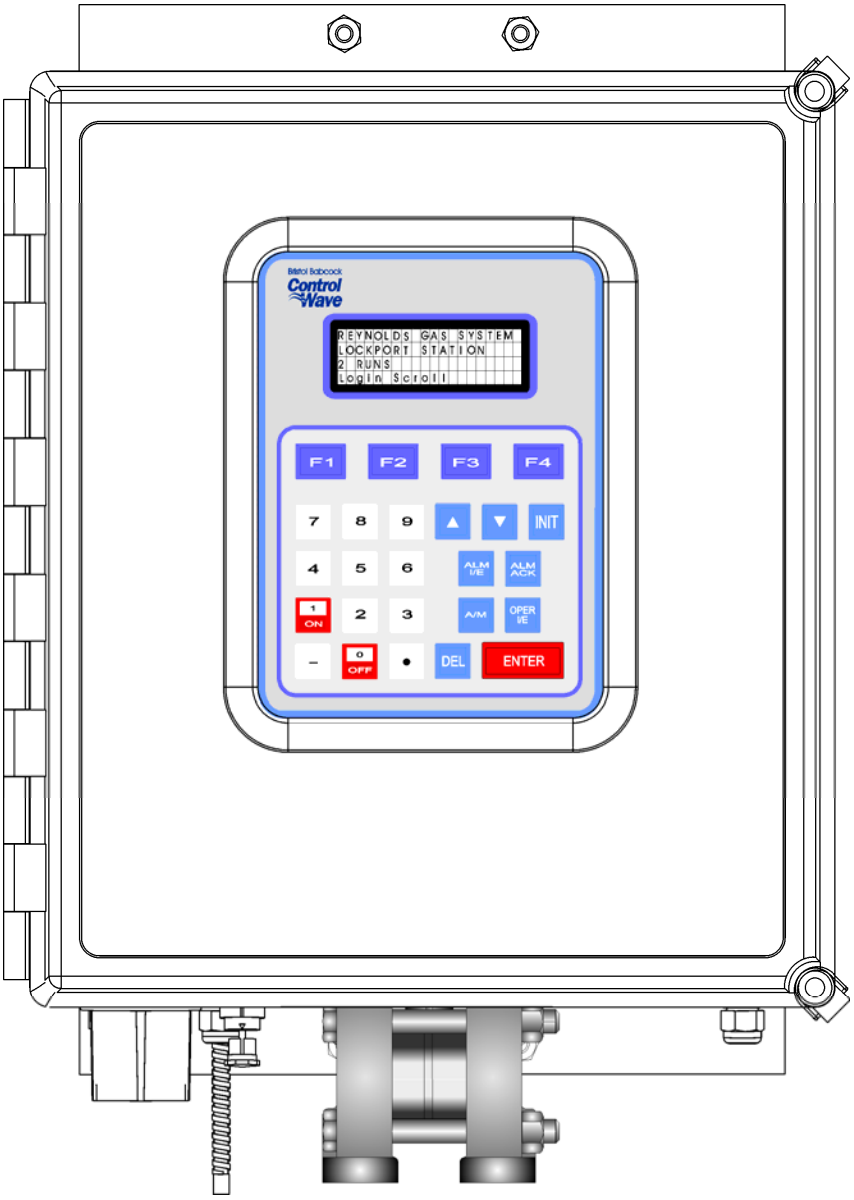


Figure 1-1. ControlWave EFM Enclosure (shown with 25-Button Display/Keypad Assembly and local circular port)

1.1 Scope of the Manual

This manual contains the following chapters:

Chapter 1 Introduction	Provides an overview of the hardware and general specifications for the ControlWave EFM.
Chapter 2 Installation	Provides information on mounting the housing, wiring power, configuring the CPU module and optional Expanded Communications module (ECOM), and related peripherals such as the

	optional keypad.
Chapter 3 I/O Modules	Provides general information and wiring diagrams for the I/O modules.
Chapter 4 Operation	Provides information on day-to-day operation of the ControlWave EFM.
Chapter 5 Service and Troubleshooting	Provides information on service and troubleshooting procedures.

1.2 Physical Description

ControlWave EFMs are furnished in a NEMA 3X rated Hoffman® enclosure. The flow computer hardware comprises a backplane board (mounted in a housing), a system controller module (SCM) and a CPU module. Optional expansion communication module(s) may reside in slots 3 and 4 of the housing in lieu of I/O modules. The CPU module includes the communication ports and the system memory.

All system modules plug into the backplane (either 4-slot or 8-slot). Each I/O module provides the circuitry and field interface hardware necessary to interconnect the assigned field I/O circuits. Non-isolated power is generated and regulated by the system controller module (SCM) that provides +3.3Vdc for all logic and bulk power for I/O field circuits from either a bulk 6Vdc or bulk 12Vdc source.

1.3 Housings and Enclosure

The ControlWave EFM housings are open-faced gold-irridite aluminum which (whether base or expansion) are gold irridite-plated aluminum. They house the printed circuit board (PCB) backplane and all ControlWave EFM modules. The housing mounts to a fabrication panel on the inner rear wall of the enclosure.

Two housings are available:

- 4-slot backplane supports one system controller module (SCM), one CPU, and two I/O modules.
- 8-slot base housing supports one SCM, one CPU, and up to six I/O modules. The 8-slot housing does not allow use of the internal battery/solar panel option.
- You can substitute one or two expansion communication modules (ECOMs) for I/O modules in slots 3 and 4.

The ControlWave EFM sits in a standard NEMA 3X Hoffman® enclosure, which also houses the multivariable transducer, battery, and communication equipment such as a radio or modem. The enclosure consists of two pieces, the body and the front cover. A continuous gasket seals the unit when you close the cover. A hinge on the left side (facing the front of the unit) if formed by molded channels on the front cover and the body that capture a stainless steel pin. Two latches on

the enclosure's right side secure the cover when you close it.

A weatherproof communication connector, either a 9-pin male D-type connector or a circular 3-pin connector (the local port) mounts to the bottom of the enclosure and connects internally to RS-232 communication port 1 for local communications.

The front cover includes a liquid crystal display (LCD) and keypad for local operator access.

1.4 CPU Module

The CPU (central processing unit) module houses the multi-layer PCB, which contains the CPU, I/O monitor/control, memory, and communication functions.

The CPU module includes:

- Sharp LH7A400 System-on-Chip ARM microprocessor with 32-bit ARM9TDMI Reduced Instruction Set Computer (RISC) core, operating at 1.8V with a system clock speed of 33 MHz or 150 MHz.
- two RS-232 communication ports,
- one RS-485 communication port
- one 10/100baseT Ethernet ports (150 MHz units only)
- 2 MB of battery backed Static RAM (SRAM),
- 64MB of Synchronous Dynamic RAM (SDRAM),
- 512KB boot/downloader Flash,
- 16MB simultaneous read/write Flash memory
- transmit (TX) and receive (RX) LEDs for each communication port
- configuration DIP switches (described in *Chapter 2*.)

CPU Module Configurations

The CPU module has two basic configurations, both of which have an on-board backup battery and different combinations of communications ports:

Table 1-1. CPU Module Configurations

Number of RS-232 Ports	Number of RS-485 Ports	Number of Ethernet Ports	See Figure
2	1	0	left side of *Figure 1-2*
2	1	1	right side of *Figure 1-2*

Note: Do not confuse the CPU module (which has communication components) with the Expansion Communication module (ECOM), which **does not** have a CPU component or a battery backup but **does** have additional communication components.

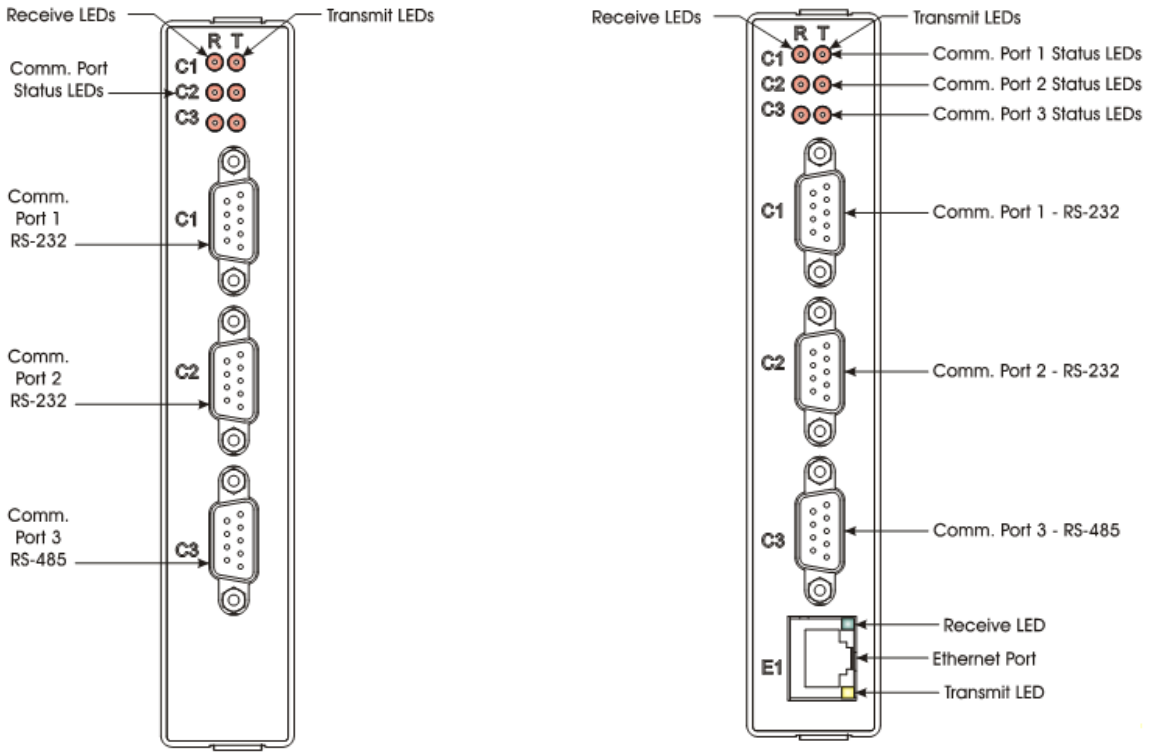


Figure 1-2. 33MHz CPU Module with Three Serial Ports (left), 150 MHz CPU Module with Three Serial Ports and One Ethernet Port (right)

CPU Backup Battery CPU modules have a coin cell socket that accepts a lithium battery. This battery provides backup power for the real-time clock and the system's Static RAM (SRAM).

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

Boot/Downloader FLASH

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

FLASH Memory

The CPU module contains 16 MB of FLASH memory. The FLASH memory holds the system firmware and the boot project. Optionally FLASH memory also stores the zipped ControlWave project (*.zwt), user files, and historical data (audit/archive files).The FLASH does not support hardware write protection.

System Memory (SRAM)

The CPU module has 2 MB of static random access memory (SRAM). During power loss periods, SRAM enters data retention mode (powered by a lithium backup battery). Critical system information that must be

retained during power outages or when the system has been disabled for maintenance is stored here. This includes the last states of all I/O points, audit/archive historical data (if not stored in FLASH), the values of any variables marked RETAIN, the values of any variables assigned to the static memory area, and any pending alarm messages not yet reported.

SDRAM

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

1.5 System Controller Module (SCM)

The System Controller Module (SCM) takes power from an external bulk DC power supply (or an optional solar panel and lead acid battery combination) and then provides +3.3Vdc power and GND through the ControlWave EFM housing/backplane to all installed modules. The SCM also supplies switched field power to I/O module slots.

Power Options

The SCM operates with a nominal input of either 6V or 12V received from a bulk supply connected to a pluggable terminal block, or from a 30 or 40 watt solar panel connected to a rechargeable lead acid battery.

If your EFM includes options such as the 21V power supply for external transmitters, a case-mounted radio/modem, or a digital to relay I/O board, you need a power distribution board as well.

1.6 Expansion Communications Modules

Expansion Comm. Modules provide two additional serial communications ports and optionally the choice of a piggy-backed dial-line modem or piggy-backed 900 MHz Spread Spectrum radio (or both). The top port (labeled C1) supports RS-232 operation while the second one (labeled C2) supports RS-485 operation. You can optionally order the RS-485 port with isolation to 500Vdc. You can install up to two expansion communication modules in backplane slots 3 and 4.

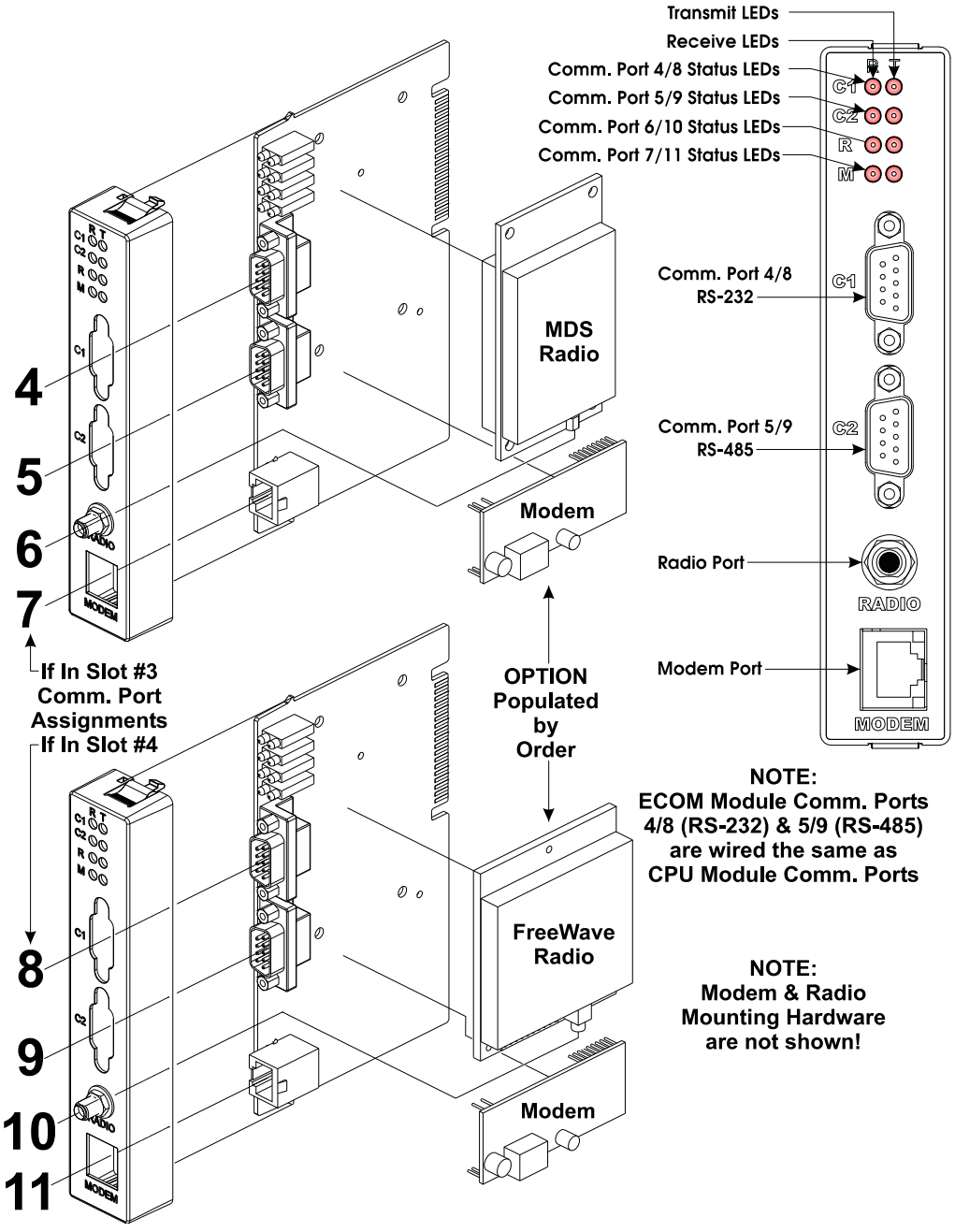


Figure 1-3. Expansion Communications (ECOM) Module

1.7 I/O Modules

The ControlWave EFM supports factory-configured I/O modules including analog I/O, analog input, digital I/O, high speed counter and mixed I/O.

Refer to *Chapter 3* for information on specific I/O modules. *Figure 1-4* shows a typical I/O module housing.

Configuration jumpers on I/O modules accommodate individual field I/O user configuration. Terminations are pluggable and accept a maximum wire size of #14 AWG. All I/O modules have surge protection that meets C37.90-1978 and IEC 801-5 specifications. Each I/O module connects to the backplane using a 36-pin male card-edge connector. With the exception of the mixed I/O module, all I/O modules are provided with two 10-point terminal block assemblies (for local termination) or two 14-pin mass Termination headers (for remote termination). Mixed I/O modules have two 10-point terminal blocks for local termination only.

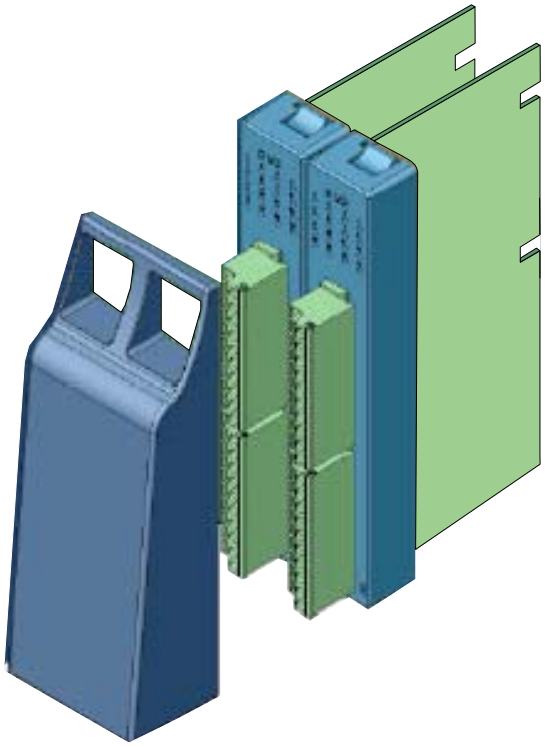


Figure 1-4. Two ControlWave EFM I/O Modules (with Bezel)

1.8 Software Tools

The ControlWave programming environment consists of a set of integrated software tools which allow you to create, test, implement, and download complex control strategies for use with the ControlWave. *Figure 1-5* graphically presents the programming environment.

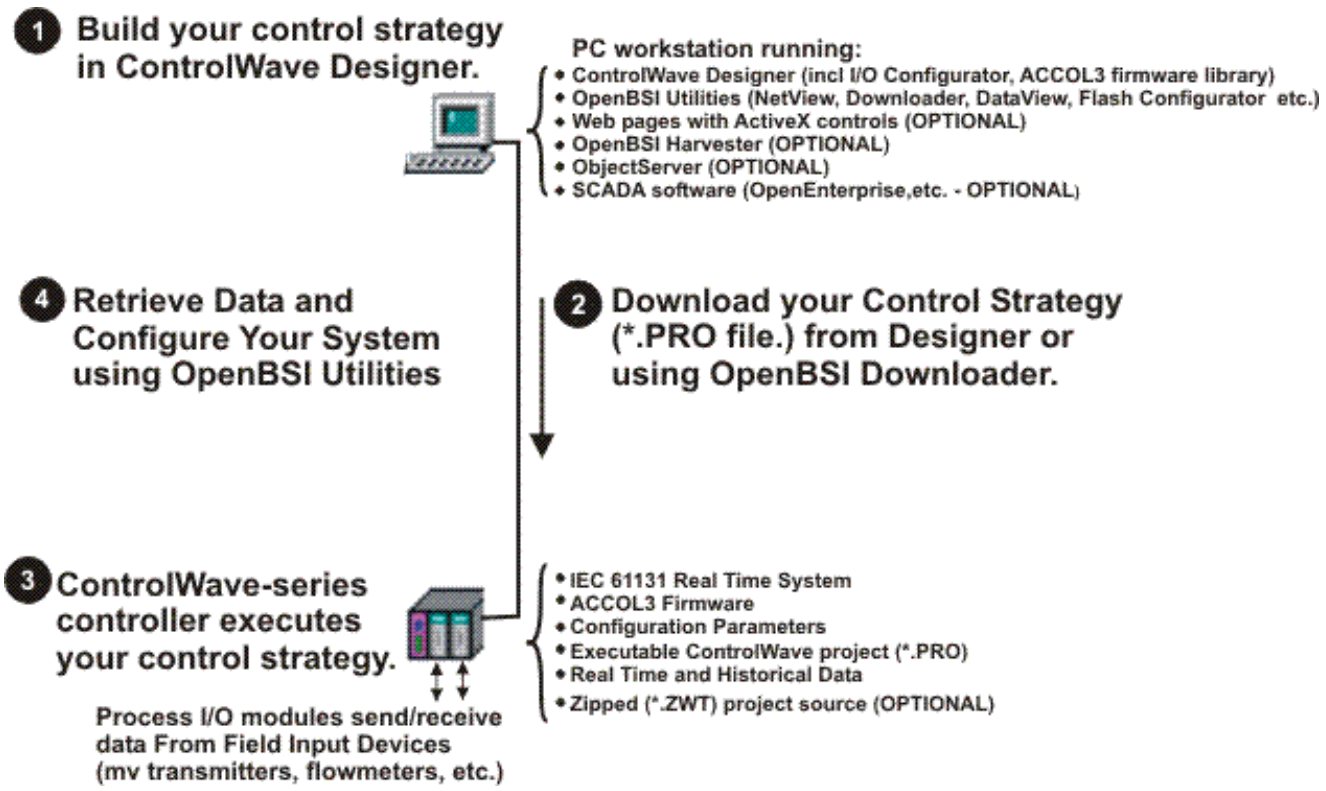


Figure 1-5. ControlWave Programming Environment

The tools which make up the programming environment include:

- **ControlWave Designer** is your load-building package. It offers several different methods for you to create control strategy programs that run in your ControlWave. You can use pre-made function blocks, ladder logic, or structured languages. The resulting process control strategy programs (called **projects**) are fully compatible with **IEC 61131** standards. For information on ControlWave Designer, see the *Getting Started with ControlWave Designer* manual (document D5085), and the *ControlWave Designer Programmer's Handbook* (document D5125).
- The **I/O Configurator**, accessible via a menu item in ControlWave Designer, allows you to define process I/O modules in the ControlWave and configure the individual mapping of I/O points for digital and analog inputs and outputs. For information on the I/O Configurator see the *ControlWave Designer Programmer's Handbook* (document D5125).
- The **ACCOL3 Firmware Library,** available within ControlWave Designer, includes a series of ControlWave-specific function blocks. These pre-programmed function blocks let you accomplish various tasks common to most user applications including alarming, historical data storage, as well as process control algorithms such as PID control. For information on individual function blocks, see the online help within ControlWave Designer.

- **OpenBSI Utilities** provides a set of programs that allow you to configure a communication network of ControlWave controllers, download files to the controllers, and collect data from the network. OpenBSI also exports data from the network to a SCADA/host package, such as **OpenEnterprise**. For information on configuring OpenBSI communications, see the *OpenBSI Utilities Manual* (document D5081).
- **OpenBSI Harvester** is a special add-on package that allows scheduled data collections from large networks. For information on the Harvester, see the *OpenBSI Harvester Manual* (document D5120).
- A series of **web page controls** are available for retrieval of real-time data values and communication statistics. These controls utilize ActiveX technology and are called through a set of fixed web pages, compatible with Microsoft® Internet Explorer. Alternatively, developers can place the controls in third-party ActiveX compatible containers such as Visual BASIC or Microsoft® Excel. For information on the ActiveX controls, see the *Web_BSI Manual* (document D5087).
- **User-defined web pages** - If desired, you can use the ActiveX web controls in your own user-defined web pages you can store at the PC to provide a customized human-machine interface (HMI).
- **Flash Configuration Utility** – Parameters such as the BSAP local address, IP address, etc. are set using the Flash Configuration Utility, accessible via OpenBSI LocalView, NetView, or TechView. For information on the Flash Configuration Utility, see *Chapter 5* of the *OpenBSI Utilities Manual* (document D5081).

Communication Protocols

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

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

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

1.9 Overview of the Gas Flow Measurement Application

Note: For detailed information on the gas flow measurement application and web pages refer to the *ControlWave Flow Measurement Applications Guide* (D5137).

You can purchase the ControlWave EFM with a pre-programmed flow measurement application already loaded.

The ControlWave standard gas flow measurement application collects static pressure, differential pressure and temperature data and computes flow, energy, and volume for a station.

A **station** typically refers to a single flow computer and all its associated meter runs. Each **meter run** refers to measurement of natural gas through a single pipeline. The ControlWave EFM supports up to four meter runs. Meter runs can use orifice, turbine, or ultrasonic meters.

The application includes an auto-selector, PID/flow pressure control algorithm per run or per station.

If you have the optional expansion communication module, you can interface to a chromatograph to provide energy throughput as well as composition information.

The application also supports a nomination function.

1.9.1 Data Acquisition – Static Pressure, Differential Pressure, Temperature Variables

The application requires these process inputs for orifice measurement:

- static pressure (SP) collected once per second
- differential pressure (DP) collected once per second
- flowing temperature (T) collected once per second

The application requires these process inputs for measurement using a positive displacement (PD), turbine, or ultrasonic meter:

- static pressure (SP) collected once per second
- frequency input collected once per second
- flowing temperature (T) collected once per second

The application also collects self-test and compensation variables at intervals of four seconds or less.

Pressure data can come from any of the following sources:

- Analog pressure transmitters connected to analog input points on a process I/O module in the ControlWave flow computer.
- Built-in multivariable transducer.
- External multivariable transmitters (Bristol or Rosemount) using BSAP or Modbus communications through an RS-485 communication port.

1.9.2 Flow and Volume Calculations

Flow and volume calculations conform to American Petroleum Institute (API) and American Gas Association (AGA) standards.

Supported flow calculations include:

- AGA3-1985/NX-19

- AGA3-1992 with selectable AGA8 Gross or AGA8 Detail
- AGA7/NX-19
- AGA7 with selectable AGA8 Gross or AGA8 Detail
- Auto-adjust AGA7/NX-19
- Auto-adjust AGA7 with selectable AGA8 Gross or AGA8 Detail

The application performs a complete flow calculation using the process variables every second. Each calculation includes instantaneous rate according to API 14.3, compressibility according to AGA 8 Detail or Gross method, and updates of all volumes, totals, and archive averages.

1.9.3 Flow Rate and Flow Time Calculations (AGA3)

For orifice flow measurement, the application compares the differential pressure value to a low flow cutoff value every second. If the differential pressure falls below the low flow cutoff value, flow is considered to be zero for that second. Hourly and daily flow time is defined to be the number of seconds for which the differential pressure exceeded the cutoff value for the period.

The values for static and differential pressure and temperature are used as inputs to the flow equations. You can select API 14.3 (AGA3, 1992) and AGA8 calculations, with compressibility calculations according to AGA Report No. 8, 1992 (with 1993 errata). The application supports both the detail method and the two gross methods of characterization described in AGA 8. Users may also select the AGA3, 1995 and NX-19 flow equations to calculate the rate of flow.

1.9.4 Flow Rate and Flow Time Calculations (AGA7)

When using PD meters, turbine meters or ultrasonic meters, the application calculates flow rate by applying the correction factor computed by the AGA7 calculations to the frequency of the input pulses. When the frequency drops below 1 Hz, the application sets the flow rate estimate to zero; however, volume calculations still accumulate. The flow time recorded is the time for which the flow rate is non-zero.

1.9.5 Extension Calculation and Analog Averaging

For orifice meters, the application calculates the flow extension every second. The extension is the square root of the product of the absolute upstream static pressure times the differential pressure. This extension is used in the flow rate calculation. When there is no flow, the application reports the arithmetic averages of static pressure and temperature. This allows you to monitor static pressure and temperature during shut-in periods.

1.9.6 Energy Calculation

The application offers the option of using a fixed volumetric heating value or calculating the energy content of the gas according to AGA Report No. 5.

1.9.7 Volume and Energy Integration

The application integrates and accumulates volume and energy at the end of every calculation cycle. The application calculates the volume for a cycle by multiplying the calculated rate by the flow time for that cycle. The application calculates the energy for a cycle by multiplying the volume at base conditions by the heating value.

1.9.8 Downstream Pressure Tap

The multivariable transducer typically measures static pressure from an integral tap on the upstream, high-pressure leg of the differential pressure connection. The transducer can also measure static pressure at the downstream pressure tap, with the measurement taken from the low-pressure side to the high-pressure side. In this installation, the differential signal from the transducer is negative. If, while using the integral smart multivariable transmitter (MVT) or an external MVT, you select the downstream tap location during MVT configuration, the MVT firmware changes the sign of the differential pressure to provide a positive DP value.

1.9.9 Historical Data Storage (Audit Records/ Archive Files)

The ControlWave supports two distinct types of historical data storage – audit records and archive files.

Where feasible, both forms of archive data conform to the requirements of the API Chapter 21. Specifically, the averages of the process variables stored in the data archive are for flowing periods, appropriate to their usage in the equations, and any gas-related parameter designated an event that is changed by an operator either remotely or locally causes an entry in the audit log.

Audit Records (Alarms and Events)

The audit system maintains a history of alarms and certain events that have an impact on the calculated and reported gas flow rates and volumes.

The application stores the most recent 500 alarms and the most recent 500 events. As new alarms/events arrive, they overwrite the oldest entries. Internally, the ControlWave stores alarms and events separately to prevent recurring alarms from overwriting configuration audit data events. The application reports alarms and events in the same log.

The following circumstances generate an audit record:

- Any operator change to a configuration variable
- Any change in the state of an alarm variable
- A system restart
- Certain other system events

You can view audit records on-screen in the audit log.

See *Appendix K* of the *OpenBSI Utilities Manual* (D5081) for help on interpreting audit records.

Archive Files (Averages, totals, and other values)

Archive files store the value of process variables and other calculated variables at specified intervals along with the date and time of each entry. This includes flow rates, volumes and other calculated values. When archive files fill up, new values overwrite the oldest entries in the files.

The application displays archive file data in hourly, data, and periodic logs you can view on screen.

Log Breaks

You can configure the application to support the "breaking" of a log period when an operator-changes a parameter. When this occurs, the log period in process closes out to make a log, and a new log begins.

Note: To prevent the system from creating several very short logs due to a series of successive configuration changes, log breaks don't occur if a log contains less than 60 seconds (flowing or otherwise) of data. This means that is a user enters 15 configuration changes over a two minute period, the log breaks only twice. By default the log break feature is disabled.

Hourly Historical Data Log

Each meter run maintains an hourly data log that holds one record for every contract hour. Hourly logs hold 840 entries or 35 days; this ensures that the previous period of hourly data is always resident in flash memory.

The hourly data log stores the following items:

- corrected volume
- uncorrected volume
- accumulated energy
- average static pressure
- average temperature
- average differential pressure
- average specific gravity
- average heating value
- flow time

- uncorrected count

ControlWave EFM maintains an hourly historical log for each of up to four runs.

Daily Historical Data Log

Each meter run maintains a daily data log that holds one record for every contract gas day. You can change the contract hour so the contract gas day starts at some time other than midnight. The daily log holds 62 entries; this ensures that the previous calendar month of daily data is always resident in flash memory.

The daily data log stores the following items:

- corrected volume
- uncorrected volume
- accumulated energy
- average static pressure
- average temperature
- average differential pressure
- average specific gravity
- average heating value
- flow time
- uncorrected count

ControlWave EFM maintains a daily historical log for each of up to four runs.

Periodic Historical Data Log

Each meter run maintains a periodic data log that holds one record for every log interval. Each log interval is 15 minutes. The periodic historical data log holds 1440 records, or four days of 15 minute data.

The periodic historical data log stores the following items:

- flowing differential pressure
- flowing static pressure
- flowing temperature
- frequency

ControlWave EFM maintains a daily historical log for each of up to four runs.

1.9.10 Run Switching

If you use multiple meter runs in the application, you can configure run switching. Run switching (also known as meter run staging or tube switching) allows changes to the number of meter runs currently active to meet the gas flow demand for the station.

1.9.11 Sampler and Odorizer

Samplers are external devices which measure the quality of the gas stream. Because natural gas is odorless and colorless, devices called odorizers inject an additive to the gas stream that allows people to detect the presence of natural gas in the event of a gas leak.

1.9.12 Flow Rate Control – DCC (Jog Control) Using PID

To configure the EFM to perform flow rate control you wire the two discrete outputs to the open and close inputs of a controller. The EFM uses a proportional/integral/derivative (PID) algorithm to cause the measured rate of flow to match a user-entered setpoint. When the flow rate falls below the setpoint, the open output is pulsed. When the flow rate rises above the setpoint, the close output is pulsed. The PID equation calculates the duration of the open or close pulse; the minimum pulse duration is 1.0 seconds. The user changeable parameters are:

- Flow setpoint in MSCFH
- Deadband in % of setpoint
- Proportion gain
- Integral time in repeats/minute
- Derivative time in seconds
- Valve travel time (full close to full open)
- Process control limiting
- Pressure override limits

The flow control algorithm runs once per second.

1.9.13 Pulse Output for External Totalizer or Sampler

When you configure the EFM to provide a pulse output based on volume, the operator provides a control volume and pulse duration. After each calculation cycle, the application compares an internal volume accumulator to the control volume. If the accumulator exceeds the control volume then a pulse is output and the accumulator is reduced by the volume represented by the pulse. You can use the pulse output to drive an external totalizer, odorizer, gas sampler, or similar device.

1.9.14 Nominations

Nominations allow you to configure the EFM to allocate precise amounts of gas flow (called nomination values) during specific time periods, called nomination periods. When the nomination value is reached, the system performs an action (such as opening or closing a valve). Prior to reaching the nomination value, the application compares the volume/energy to a configured alarm level and generates an alarm when the volume/energy meets or exceeds that alarm level.

Chapter 2 – Installation

This chapter discusses the physical configuration of the ControlWave EFM, considerations for installation, and instructions for setting switches and jumpers on the CPU, SCM, and ECOM modules.

In This Chapter

2.1 Site Considerations

When choosing an installation site, check all clearances. Ensure that the ControlWave EFM front cover (hinged on the left side) can be opened for wiring and service and that the LCD/keypad is visible and accessible to the on-site operator.

⚠ Caution

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

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

Specifications for Temperature, Humidity and Vibration

See document 1660DS-5i available on our website for detailed technical specifications for temperature, humidity, and vibration for the ControlWave EFM. This document is available on our website at www.emersonprocess.com/remote.

- Ensure that the ambient temperature and humidity at the installation site remains within these specifications. Operation beyond the specified ranges could cause output errors and erratic performance. Prolonged operation under extreme conditions could also result in failure of the unit.
- Check the mounted enclosure, panel, or equipment rack for mechanical vibrations. Make sure that the ControlWave EFM is not exposed to a level of vibration that exceeds that provided in the technical specifications.

2.1.1 Class I, Div 2 Installation Considerations

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

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

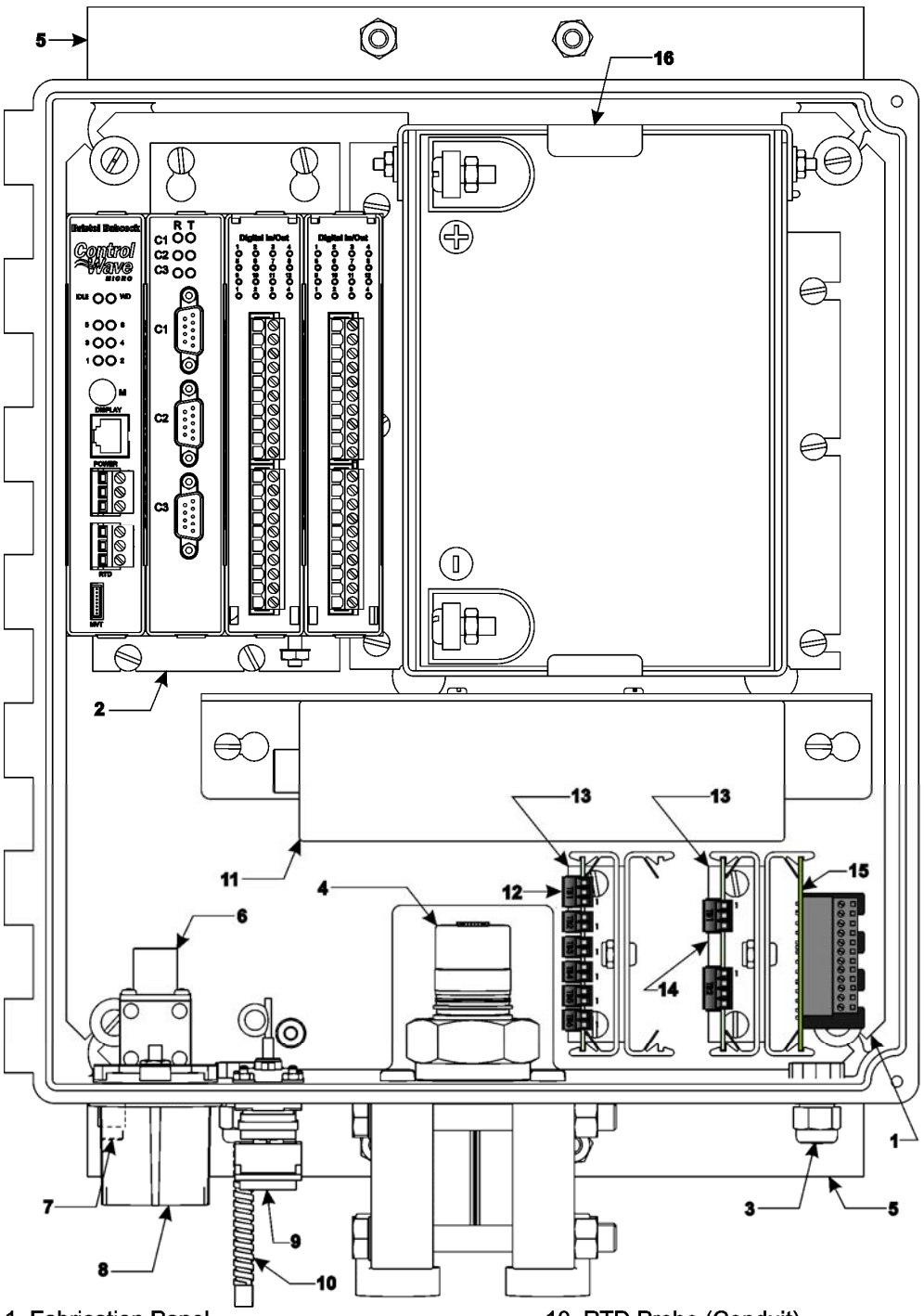
⚠ WARNING

EXPLOSION HAZARD

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

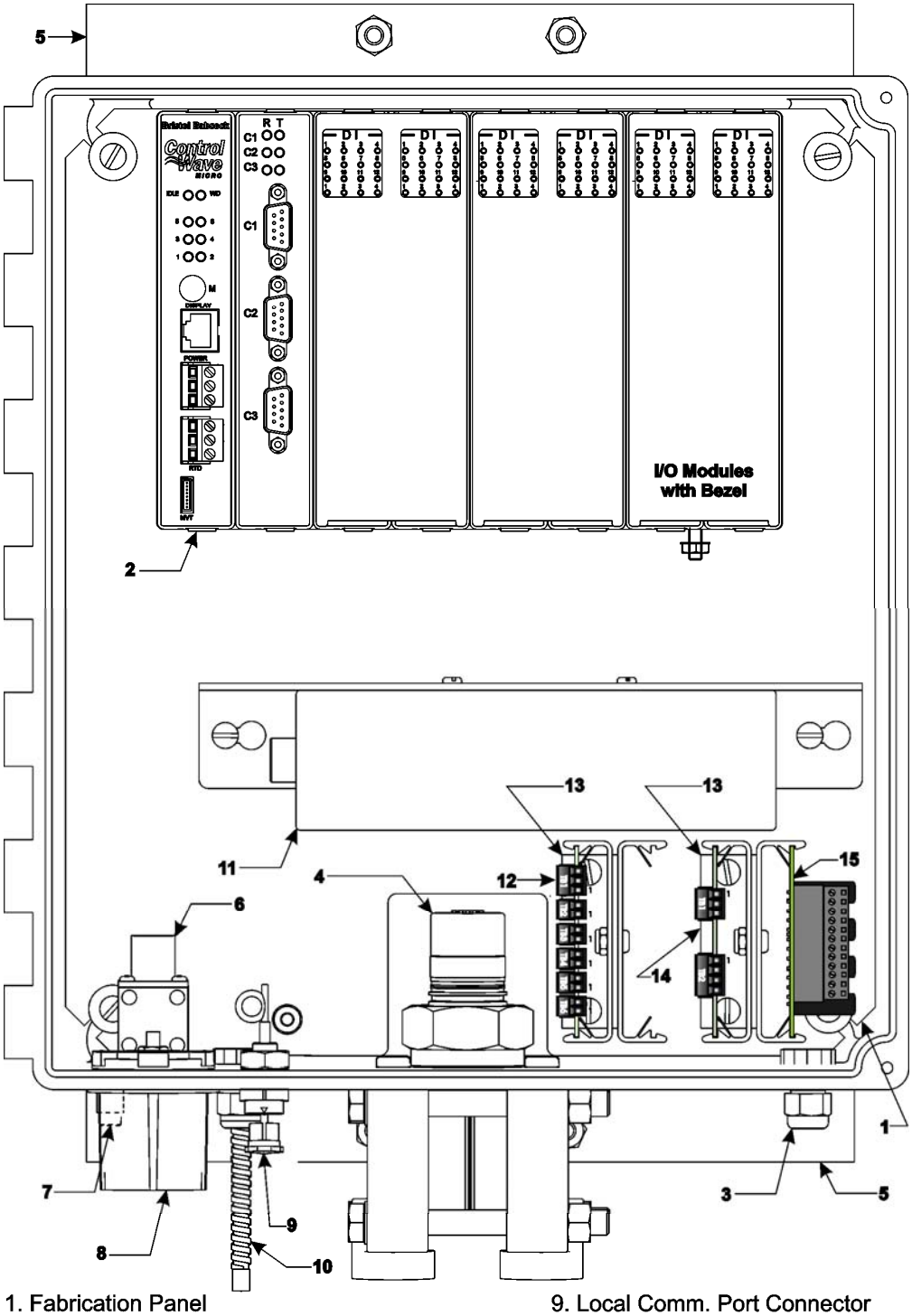
When the ControlWave EFM is situated in a hazardous location, turn off power before servicing or replacing the unit and before installing or removing I/O wiring.

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



1. Fabrication Panel
2. ControlWave MICRO EFM 4-Slot Base Assembly (from Left to Right - SCM, CPU & 2 I/O Modules)
3. .5" Liquit Tight Conduit Fitting
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug
8. 1" NPT Conduit Hub
9. Local Comm. Port Connector
10. RTD Probe (Conduit)
11. External Radio (MDS - Transnet)
12. Power Distribution Board
13. Dual PCB Mounting Bracket (with Snap Tracks))(Qty. 2)
14. 21V Power Supply Board
15. Digital to Relay I/O Board
16. Rechargeable, Sealed Lead-Acid Battery (Secured by Battery Mounting Bracket)

Figure 2-1. 4-Slot ControlWave EFM (Internal View) Component Identification Diagram (Shown with D-Type Local Port)



1. Fabrication Panel
2. ControlWave MICRO EFM 8-Slot Base Assembly (from Left to Right - SCM, CPU & 6 I/O Modules)
3. .5" Liquid Tight Conduit Fitting
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug (Behind Item #8)
8. 1" NPT Conduit Hub
9. Local Comm. Port Connector
10. RTD Probe (Conduit)
11. External Radio (MDS - Transnet)
12. Power Distribution Board
13. Dual PCB Mounting Bracket (with Snap Tracks))(Qty. 2)
14. 21V Power Supply Board
15. Digital to Relay I/O Board

Figure 2-2. 8-Slot ControlWave EFM (Internal View) Component Identification Diagram (Shown with Circular Local Port)

2.2 Installation Overview

Installing a ControlWave EFM involves several general steps:

1. Unpack, mount and ground the unit. (See *Section 2.3* and *Section 2.4*.)
2. Remove the System Controller Module (SCM) and configure jumpers and mode switch as needed, then re-install it in chassis slot 1. (See *Section 2.5*.)
3. Remove the CPU, enable the backup battery jumper and set switches as needed then re-install it in chassis slot 2. (See *Section* 2.9.)
4. Configure/connect the communication port to a PC or other devices. (See *Section* 2.9.3 to *Section 2.10.3*.
5. Install I/O wiring to each I/O module, connect a cable to a Bristol 3808 transmitter (if required). (See *Chapter 3*).
6. Install the bezels to protect the I/O modules (see *Section 2.11*.)
7. If required, install the RTD probe (see *Section 3.7*.)
8. Install the rechargeable lead acid battery and solar panel (if provided). (See *Section 2.6*.)
9. Connect DC power wiring and apply power. (See *Section 2.5.6*.)
10. Install PC-based software (ControlWave Designer and/or OpenBSI/TechView)
11. Establish communications
12. Create an application-specific control strategy (ControlWave project).
13. Create application-specific web pages (optional)
14. Add the ControlWave EFM to an OpenBSI network
15. Download the application-specific ControlWave project into the ControlWave EFM.

Notes:

- If you purchased the ControlWave EFM with the standard application already loaded, you do not need to create an application, or web pages, and the application is already downloaded for you. ControlWave Designer would only be necessary if you also purchased application source code and wanted to edit it.
- Steps 10 through 15 require that you install and use ControlWave Designer software on your PC. This manual focuses on hardware installation and preparation. Software installation and configuration is beyond the scope of this manual.

2.3 Unpacking Components

Packaging

The ControlWave EFM ships from the factory fully assembled with all components installed except for the unit's solar panel and battery (if provided); these items ship separately.

If you ever need to re-install modules into the housing, follow these guidelines:

Notes:

- Do **not** install modules in the housing until you mount and ground the housing at the designated installation site.
- The SCM module must reside in slot #1 of the housing.
- The CPU module must reside in slot #2 of the housing.
- The first ECOM module (if you have one) must reside in slot #3 of the housing (the first I/O slot); a second ECOM module (if you have one) must reside in slot #4 of the housing (the second I/O slot).

Housing

The housing (or chassis) for the ControlWave EFM is an open-faced gold irridite coated aluminum assembly. The eight slot housing has six I/O slots; the four slot housing has two I/O slots. You can substitute one or two expansion communication modules for I/O modules in the first two I/O slots.

Keyed cutouts in the housing's rear wall permit wall or panel mounting. The housing is mounted to the fabricated panel on the inner rear wall of the enclosure and has the following components:

- Built-in guides on the top and bottom of the housing permit easy installation and removal of modules
- Built-in ground lug (on bottom of unit)
- Backplane provides seating and electrical interface to all modules.
- Internal mounting brackets support the various system components in the enclosure such as the battery and ControlWave EFM base assembly. The battery and EFM base assembly mount to the fabrication panel which secures to the inner rear wall of the enclosure. If you have a radio/modem it mounts using the radio/modem mounting bracket beneath the battery mounting bracket on units with a 4-slot chassis.

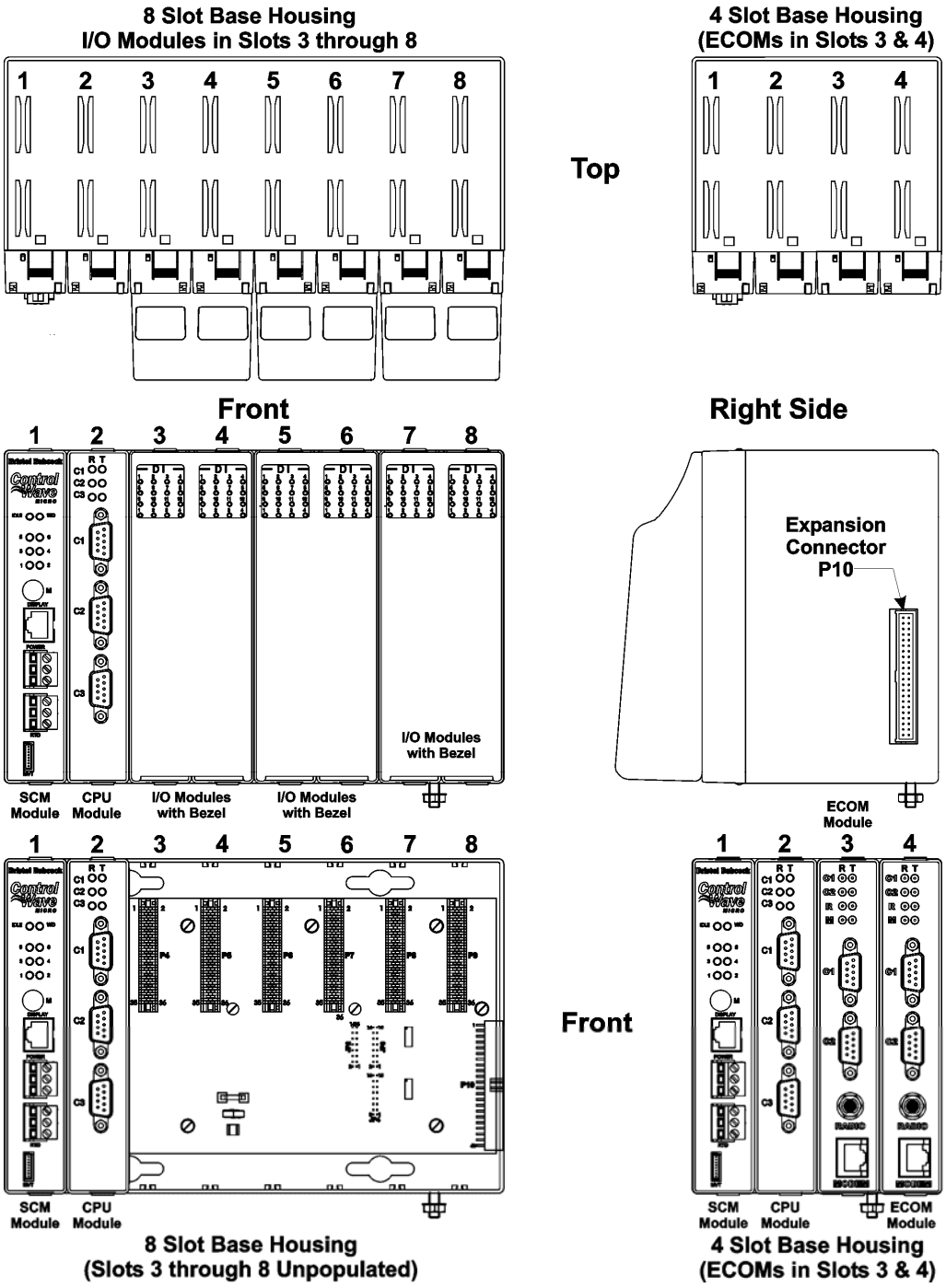
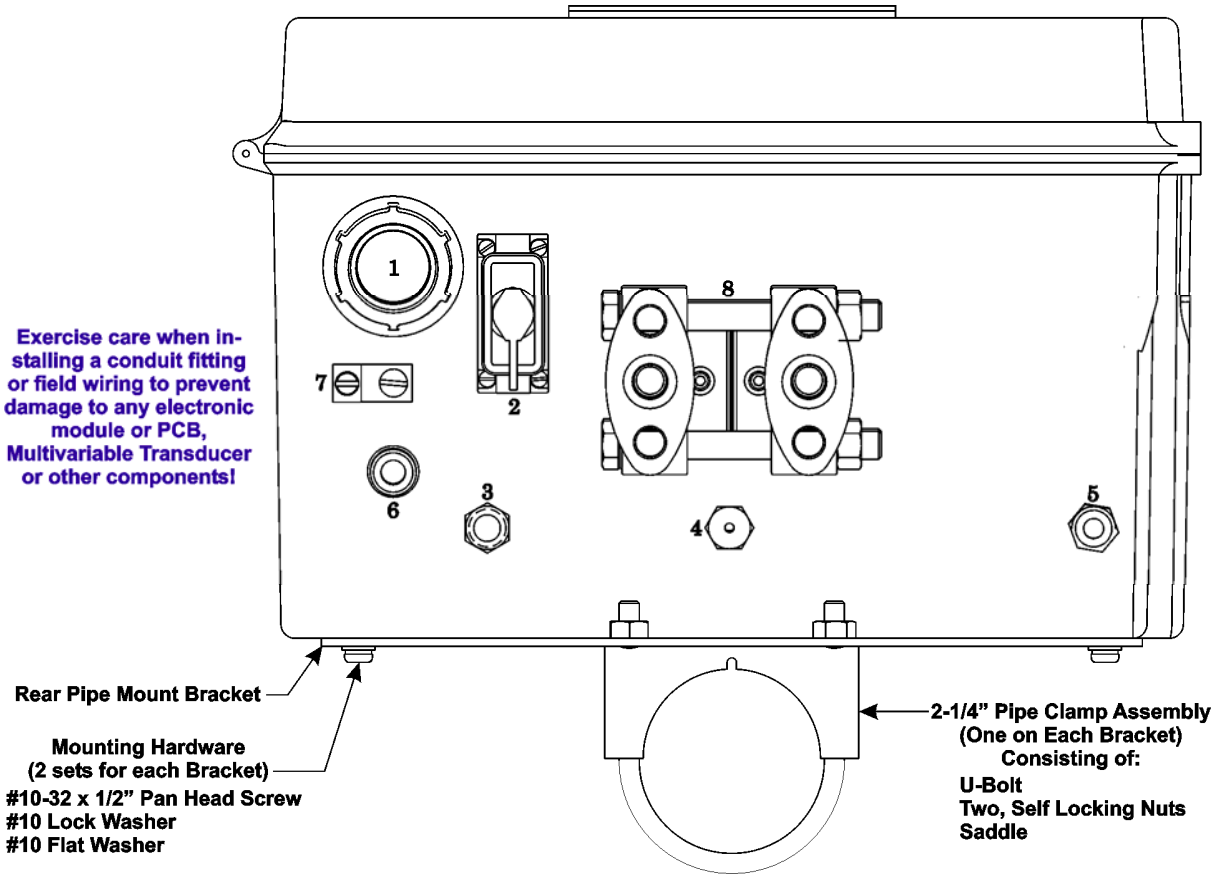


Figure 2-3. 8/4-Slot ControlWave EFM Housing - The 4-Slot Chassis is shown with ECOMs in Slots 3 & 4)

2.4 Mounting the EFM Housing

- You must position the ControlWave EFM vertically with the transducer (MVT) at its base. Make sure clearances are adequate so that you can open the door, and ensure the front of the assembly is visible and accessible for service, installation, and for operator access to the LCD display/keypad.

- You can mount the unit to a wall, or to a vertical 2 inch pipe clamped at the rear of the unit with two clamps and four bolts. You must anchor the pipe in cement deep enough to conform to local building codes associated with frost considerations.
- If your unit requires a solar panel, make sure there is sufficient clearance. You can mount the solar panel to the same 2" pipe that secures the unit.
- You mount the MVT to a process manifold which then mounts to the main (meter run) directly or via two pipes. (See *Figure 2-9*, *Figure 2-10*, and *Figure 2-11*).
- Only connect power wiring after the unit is mounted and properly grounded.
- I/O, power, RTD, antenna and communication port cabling enters the bottom of the unit through conduit or special function fittings.



(1) 1" NPT Conduit Hub
(2) Local Port D-Type Jack Male D-Type Jack or Circular Female Jack
(3) RTD Cable Assembly or Sealing Plug
(4) Battery Ventilation Assembly
(5) 5" Liquid Tight Conduit Fitting or Plug
(6) Ant. Cable Fitting, Polyphaser,
(7) Solderless Ground Lug
(8) Multivariable Transducer

Figure 2-4. ControlWave EFM Bottom View

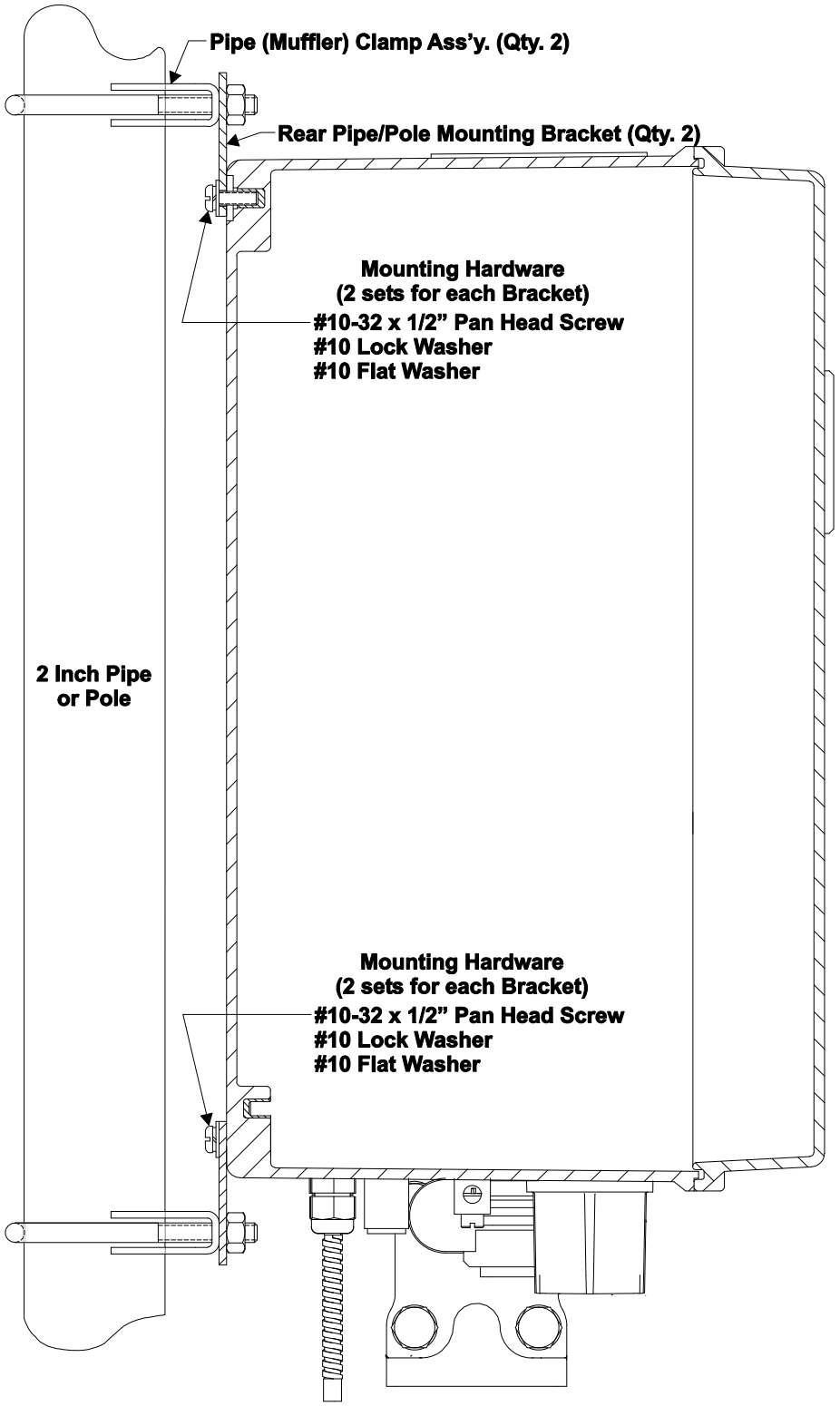


Figure 2-5. Side View of ControlWave EFM Mounted to a 2" Pipe

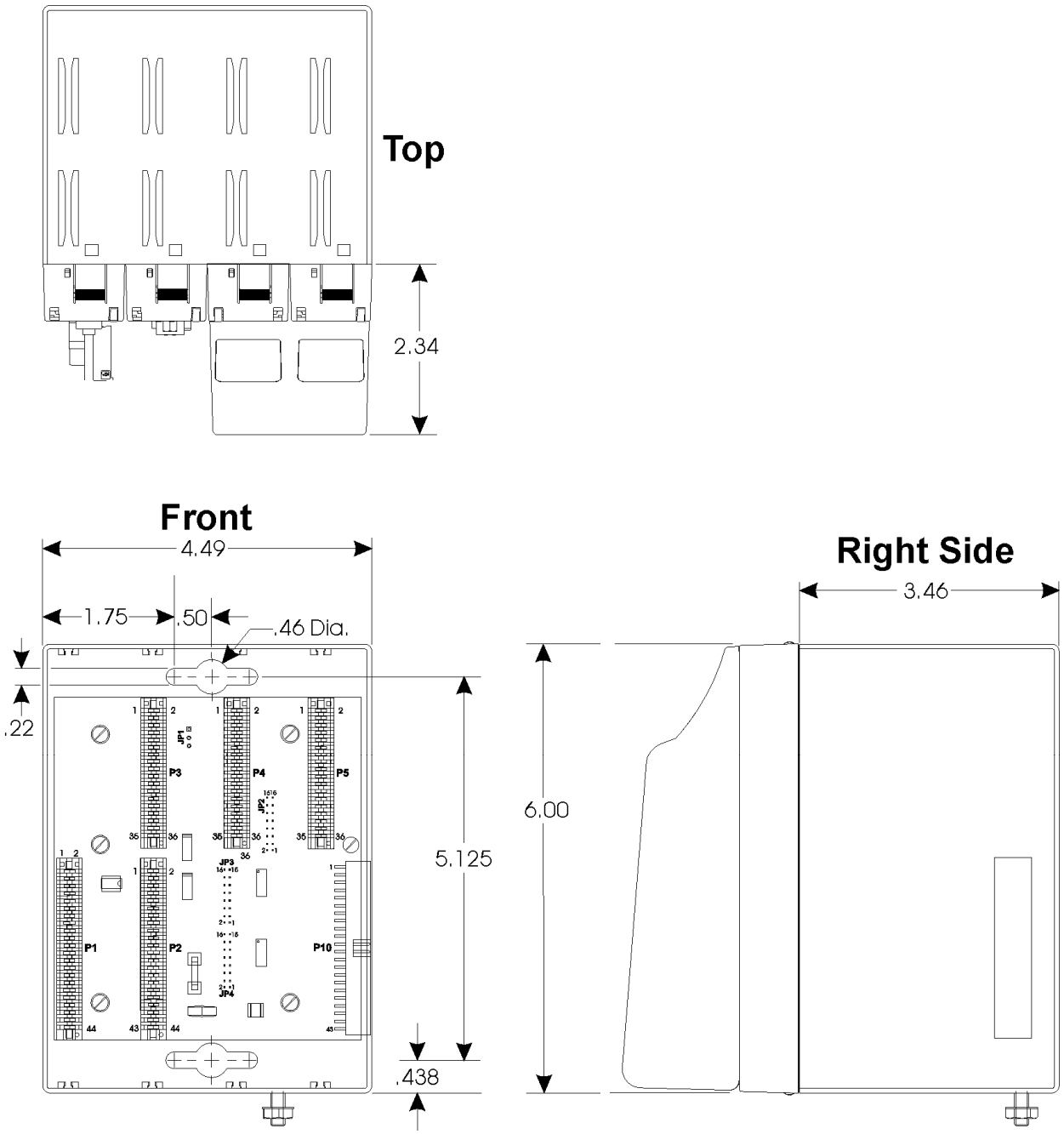


Figure 2-6. 4-Slot ControlWave EFM

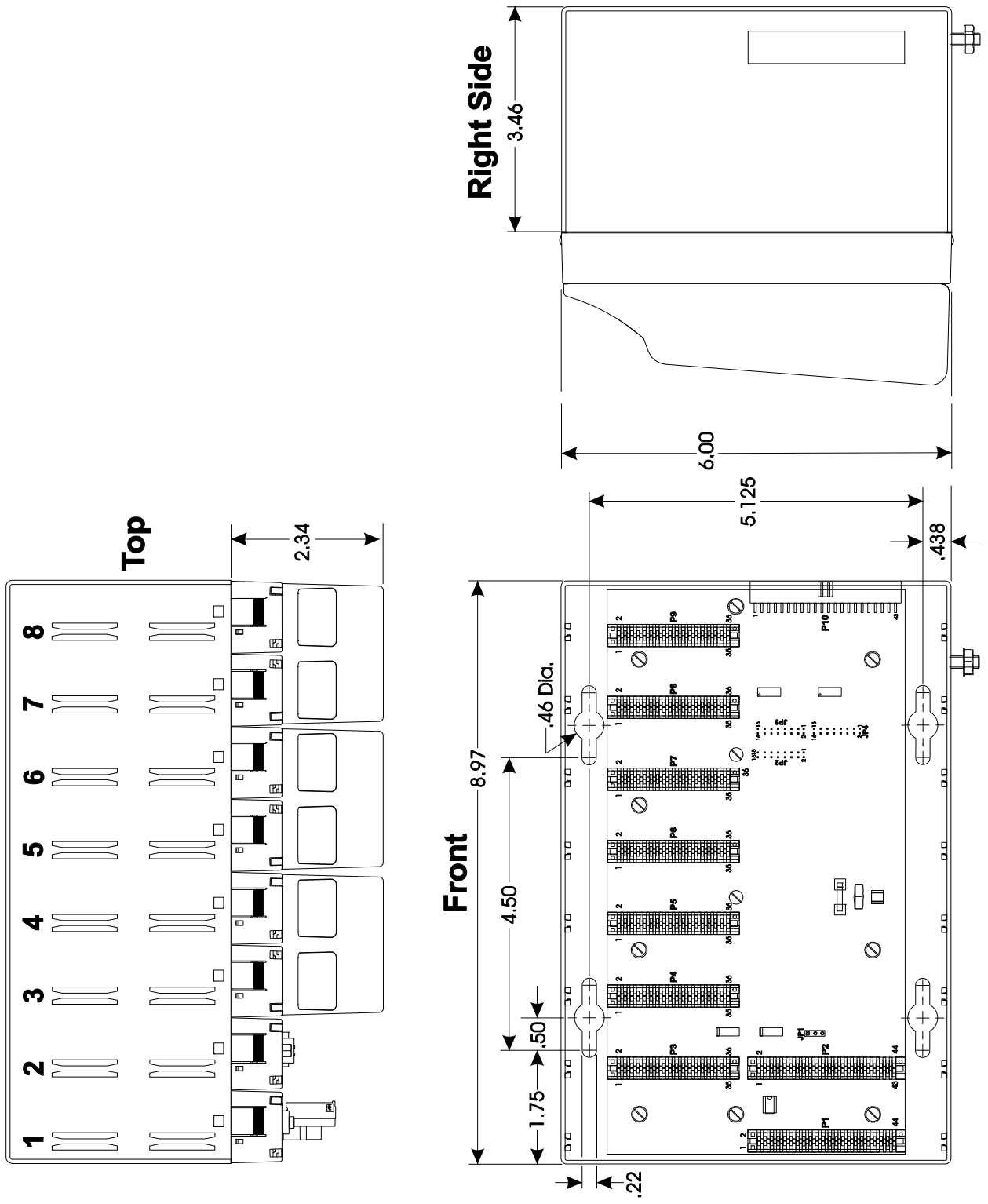


Figure 2-7. 8-Slot ControlWave EFM - Base Chassis Assembly Dimensions

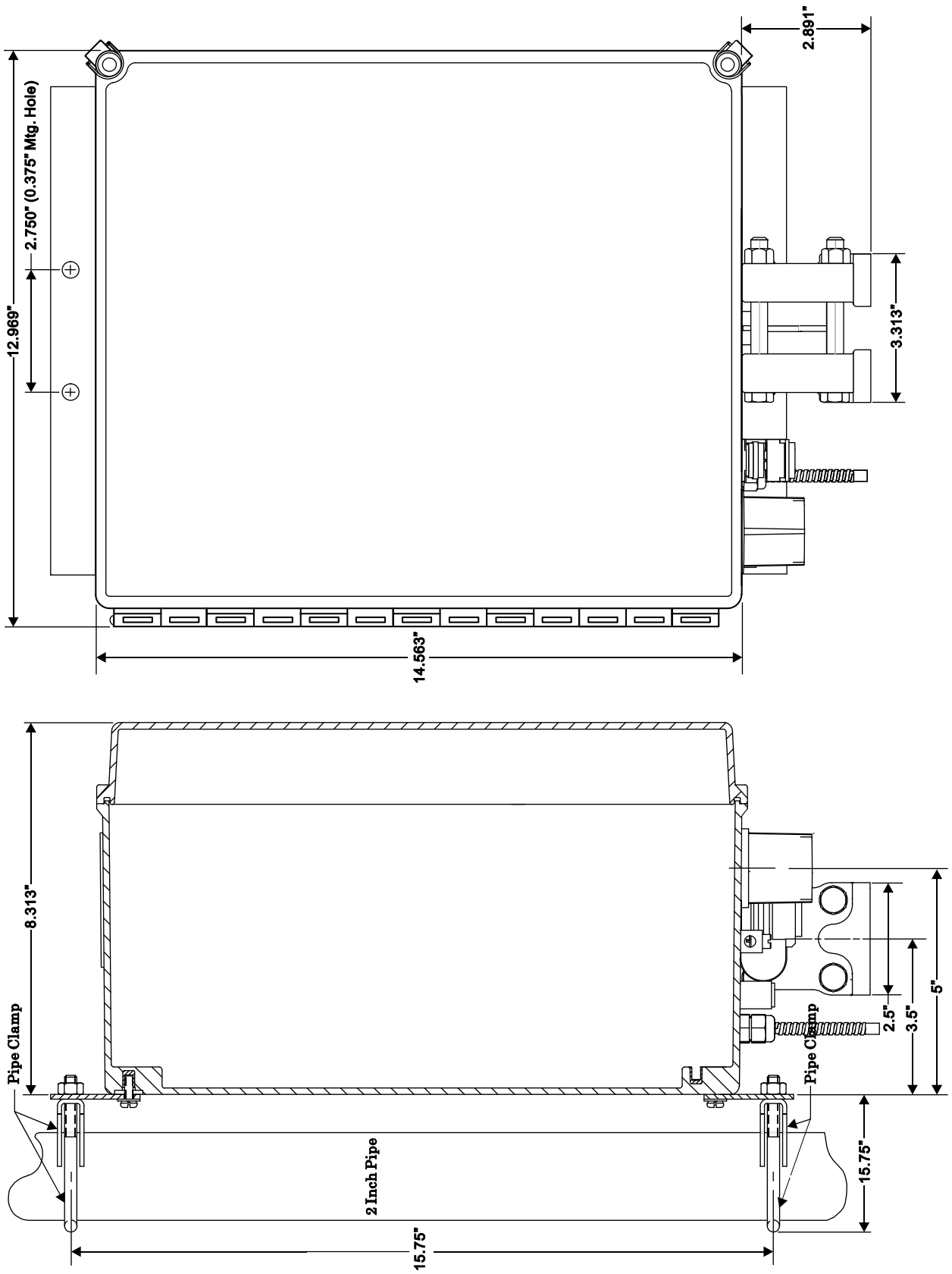


Figure 2-8. ControlWave EFM NEMA 3X Enclosure Dimensions

2.4.1 Grounding the Housing

The ControlWave EFM enclosure includes a ground lug. Once you have installed the unit, run a ground wire (#4 AWG max wire size) between the ground lug (see *Figure 2-4*) and a known good earth ground. As an added precaution, run a #14 AWG wire from SCM power connector TB1-3 (chassis ground) to the same known good earth ground. For more information on grounding see the *ControlWave Grounding Supplement* (S1400CW):

Additional grounding guidelines include:

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

2.4.2 Connecting to the Multi-Variable Transducer (MVT)

The ControlWave EFM's multivariable transducer (MVT) secures to the bottom of the enclosure. The MVT pressure assembly connects to the process manifold either directly or by tubing. Within the body of the transducer, metal diaphragms are exposed to the gas. Solid-state strain gauge sensors in the neck of the transducer measure the pressure applied to the diaphragms and produce proportional electrical signals.

The neck of the transducer extends into the bottom of the enclosure, with the body of the transducer outside the enclosure. The MVT cable connector is factory mated with System Controller module connector P2.

The MVT provides connection ports on the process flange as the standard arrangement. Optional manifold blocks may also be specified.

Figure 2-9 details MVT process flange and optional manifold block connector mounting dimensions.

Standard Process Flange for MVT – Two process flanges containing the connection ports are assembled to the transmitter. Port designations (L and H) are stamped on the body of the flanges. Ports accept ¼-18 NPT pipe connections to 2-1/8 in. centers for connection to orifice taps or a standard three-valve manifold. These process flange connections are illustrated at the top of *Figure 2-9*.

Four bolts and nuts hold the two process flange assemblies in place. When you remove the bolts, you can reposition the flanges so that the connections can emanate from the front, rear or bottom of the transducer. Take care not to damage the sensor module assembly during this procedure. Once you position the flange, tighten the bolts in an alternating sequence to about 20-30 foot-pounds of torque.

Optional Process Manifold Blocks – Process manifold blocks may be installed on the transducers to permit the use of connector assemblies having different connection centers. The manifold blocks, which are oval in appearance, mate with the transmitter's process flange. The blocks may be installed in several positions to achieve different connection centers as shown in *Figure 2-9*.

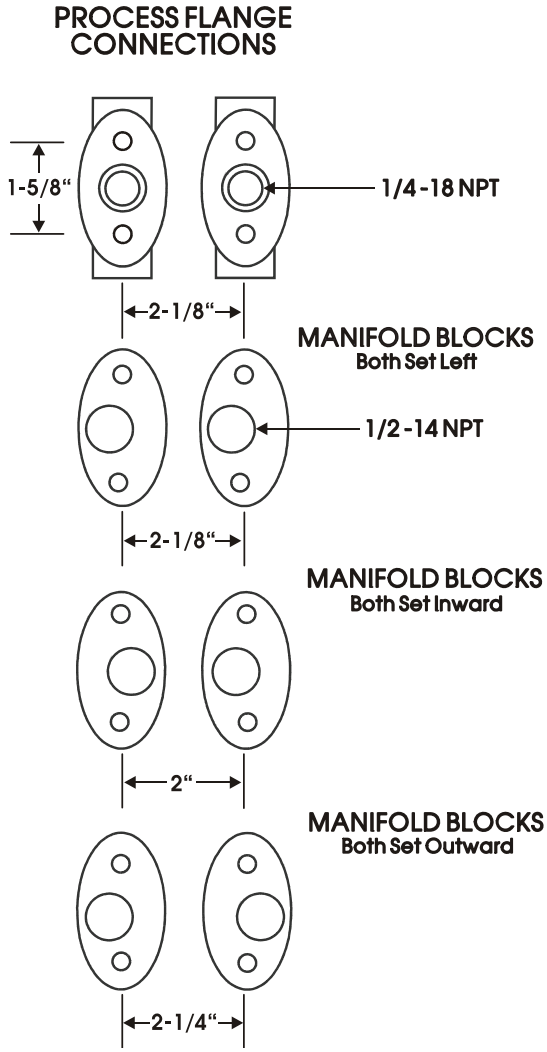


Figure 2-9. Process Flange and Optional Manifold Block Connectors

2.4.3 Process Pipeline Connection (Meter Runs without Cathodic Protection)

You can mount the ControlWave EFM directly on the pipeline or remotely on a vertical stand-alone two-inch pipe or on a wall. The Earth ground cable must run between the EFM's ground lug and Earth ground (rod or bed) even though the ControlWave EFM's multivariable transducer (MVT) 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.

Note: For installation of the unit without cathodic protection, a direct mount installation is similar to *Figure 2-10* and a remote installation is similar to *Figure 2-11*. The main difference is that **without cathodic protection**, whether you're mounting directly or remotely, **you do not use** the transducer to manifold dielectric isolation kit.

2.4.4 Process Pipeline Connection (Meter Runs with Cathodic Protection)

You can mount the ControlWave EFM directly on the pipeline (using a manifold block) or remotely on a vertical stand-alone two-inch pipe or on a wall.

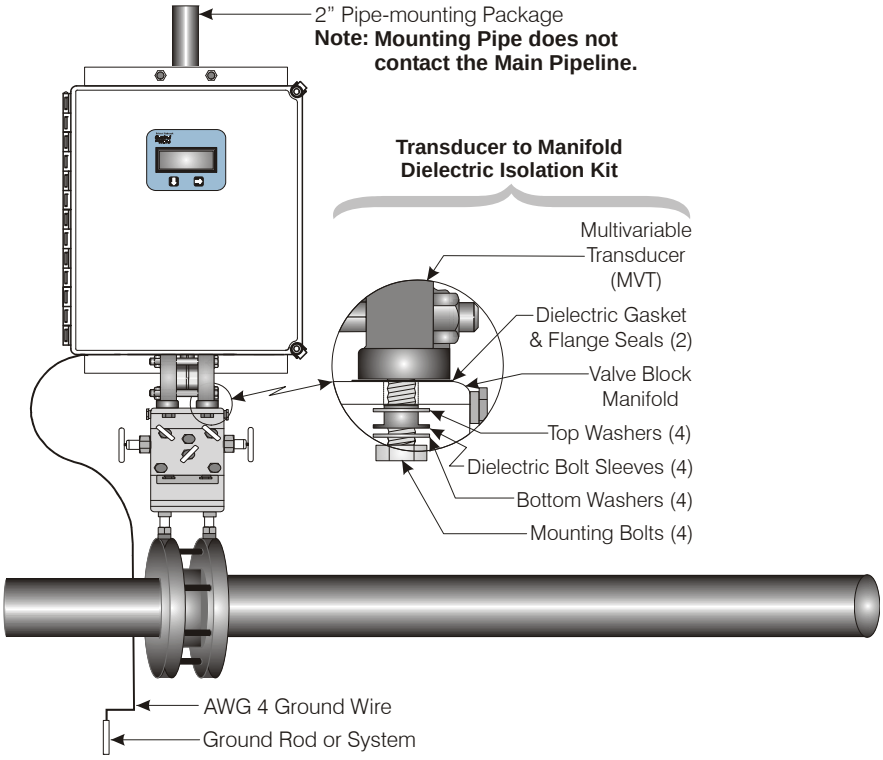


Figure 2-10. ControlWave EFM Direct Mount Installation with Cathodic Protection

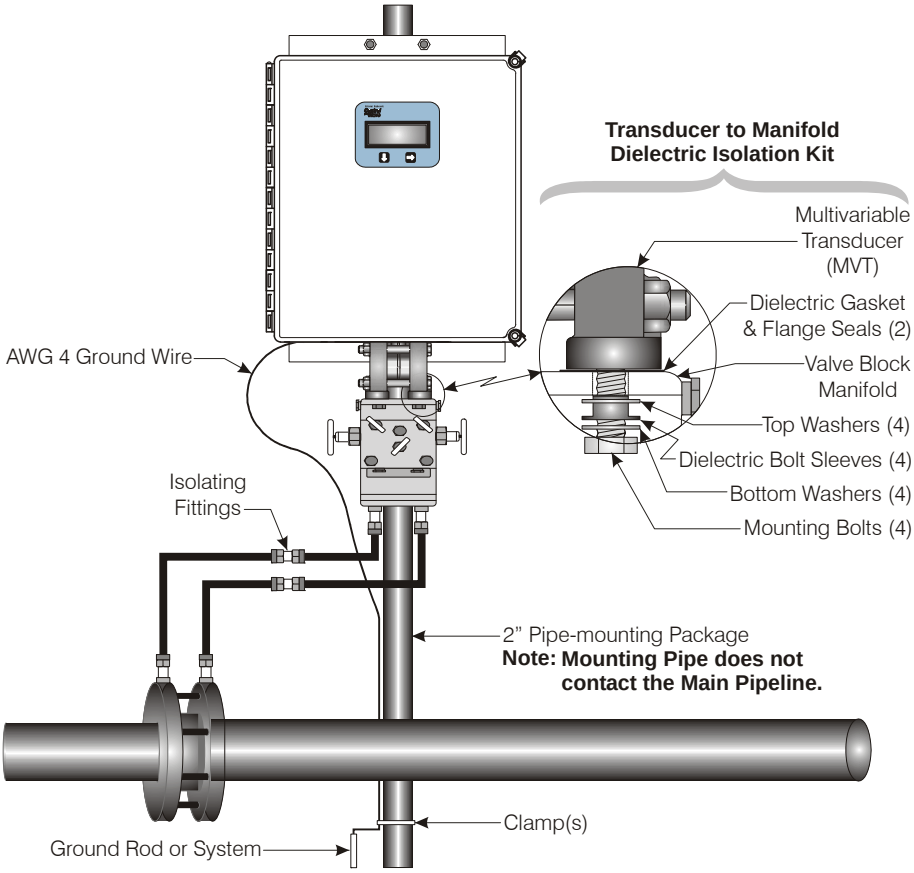


Figure 2-11. ControlWave EFM Remote Installation with Cathodic Protection

Dielectric isolators are available and are always recommended as an added measure in isolating the ControlWave EFM from the pipeline even though the enclosure does provide some galvanic isolation from the pipeline and should not be affected by the cathodic protection or other EMF on the pipeline.

It is recommended that isolation fitting always be used in remotely mounted meter systems.

Install isolation fittings or gaskets between the following connections:

- All conductive tubing that runs between the pipeline and mounting valve manifold and/or the unit's multivariable transducer (MVT).
- All conductive connections or tubing runs between the ControlWave EFM and a turbine meter, pulse transducer, or any other I/O device that is mounted on the pipeline.
- Any temperature transducer, pressure transmitter, etc. and their mount/interface to the pipeline.

In remote installations, the ground conductor connects between the ControlWave EFM's chassis ground lug and a known earth ground. Connect the cases of temperature transducers, pressure transmitters, etc. to the known good earth ground. If the mounting 2-inch pipe (when used) is in continuity with the pipeline you must electrically isolate it

from the EFM. Use a strong heat-shrink material such as RAYCHEM WCSM 68/22 EU 3140. This black tubing easily slips over the 2-inch pipe and then after uniform heating (with a rosebud torch) it electrically insulates and increases the strength of the pipe stand. See F1670SS-0a for information on PGI direct mount systems and manifolds.

2.5 System Controller Module (SCM)

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

2.5.1 General Information about the SCM

DC power from a bulk DC supply (nominally +6 Vdc or +12 Vdc) connects to the System Controller Module (SCM) on connector TB1. The SCM converts, regulates, and filters the power to provide +3.3 Vdc to modules in the backplane.

The SCM plugs into slot #1 (first slot from the left) on the ControlWave EFM's backplane using connector P1, a 44-pin female non-keyed header (see *Figure 2-12*).

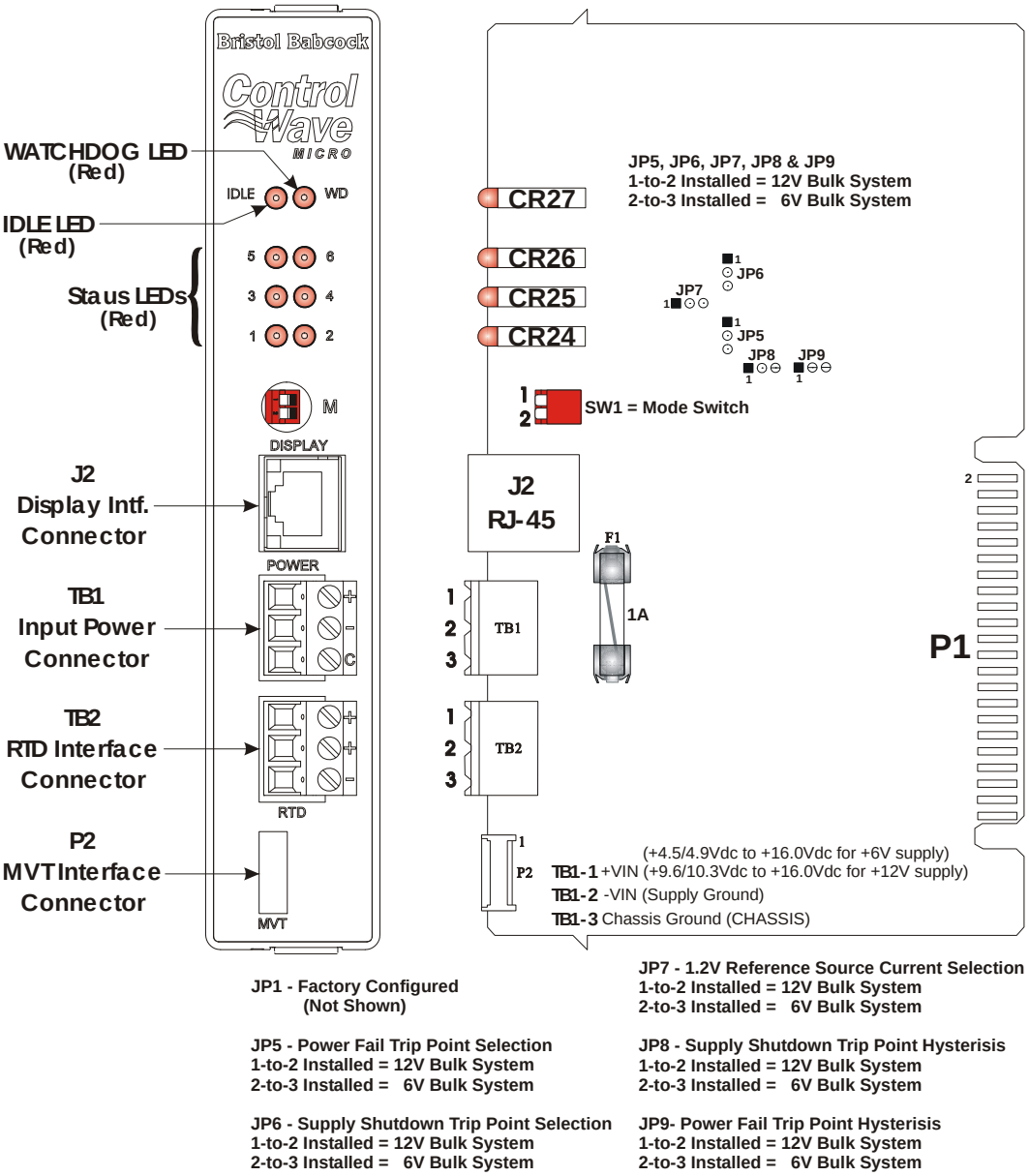


Figure 2-12. System Controller Module Component Identification Diagram

Another connector (TB2-future) provides an RTD connection, and an RJ-45 connector provides the interface to the display/keypad.

Two red LEDs on the SCM's front panel enable you to monitor the status of the watchdog (WD) and Idle (IDLE) circuits.

Note: The Idle LED is usually on, indicating when the CPU has free time at the end of its execution cycle. If the LED is off, it indicates the CPU has no free time and may be overloading.

Six additional LEDs provide system status codes (see *Chapter 5)*.

Board Fuse

The SCM is fused to protect the entire system using a 5x20mm slow blow fuse F1 rated at 1 Amp.

2.5.2 SCM Installation Overview

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

1. Identify the carton holding the SCM and remove it from that carton. See *Section 2.3.*
2. Set jumpers on the SCM based on whether your external DC bulk power supply provides +12V or +6V. See *Section 2.5.3.*
3. If your SCM includes a mode switch (SW1) set it according to *Section 2.5.4.*
4. Slide the SCM into slot #1 of the housing.
5. Unplug terminal block connector TB1 from the SCM and wire it to an external bulk DC power supply. See *Section 2.5.6.*
6. If you want to use the RTD connector TB2, unplug it from the SCM and wire it to an RTD according to instructions in *Section 3.7.*
7. After you configure and install the CPU module in slot #2 re-connect terminal blocks to their connectors to apply power to the unit.

2.5.3 Setting Jumpers on the SCM

The SCM has five jumpers (JP5, JP6, JP7, JP8, JP9) which you set based on whether your bulk DC power supply will provide +12V or +6V. See *Figure 2-12* to locate the jumpers on your version of the SCM.

- **JP5, JP6, JP7, JP8 and JP9**: Three-position bulk power system selection Jumper:
  - 1-to-2 Installed = Choose this to select +12V Bulk System
  - 2-to-3 Installed = Choose this to select +6V Bulk System

2.5.4 Setting Mode Switch SW1 on the SCM

The SCM has a DIP switch that controls whether the SCM operates in Local Mode or Recovery Mode.

Local Mode is the normal operating mode for the ControlWave EFM, and is the factory default. We recommend you use the factory default unless you have a reason to use Recovery Mode.

Only use Recovery Mode during system firmware upgrades or core updumps. See *Chapter 5* for more information on these subjects.

Table 2-1 lists the SW1 settings:

Table 2-1. SCM Switch SW1

Switch position	Mode
Both switches set to right (Open) **or** both switches set to left (Closed)	Activates Recovery mode, used for firmware upgrades or core updumps.
Upper switch (SW-1) set to right (Open) and lower switch (SW-2) set to left (Closed)	Activates Local mode, used for normal operation. (This is the **factory default**)

Note: Only the SCM SW1 switch settings listed in the table have been tested.

2.5.5 General Wiring Guidelines

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

2.5.6 Wiring a Bulk DC Power Supply to the SCM

Caution

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

Follow the instructions in *Section 2.5.5 General Wiring Guidelines* when wiring connections.

You can connect one bulk DC power supply (nominally either +12 Vdc or +6 Vdc) to the SCM using connector TB1.

Use the following formula to determine the maximum current required:

Bulk + 6/12 Vdc Supply Current = CPU + Sum of all ECOM modules and I/O modules, optional boards and optional case-mounted modem/radio

Notes:

- This summation accommodates steady state current draw.
- *Table 2-2* provides detailed steady state power current requirements for each ControlWave EFM base assembly module. Current consumption in this table is based on the standard EFM application (ControlWave project).
- In the case of a case-mounted modem or radio, the unit's manufacturer
- Power requirements for the optional digital to relay I/O board, 21V power supply board, and the battery charger power manager board are provided in the ControlWave EFM product data sheet.

Refer to *Table 2-2* for ControlWave EFM bulk power requirements.

Table 2-2. Bulk Power Requirements

Component	Bulk 12 Vdc Power Supply	Bulk 6 Vdc Power Supply
CPU + SCM and backplane	8.6 mA	14 mA
Non-isolated AI/AO Module	2.8 mA + (47.2 mA – VEXT)	5.6 mA + (47.2 mA – VEXT)
Non-isolated DI/O Module	12 mA	24 mA
Non-isolated HSC Module	5 mA	10 mA
Non-isolated Mixed I/O module (with optional AO board)	16.67 mA + (24.3 mA – VEXT)	34 mA + (24.3 mA – VEXT)
ECOM without modem/radio	22 mA	45 mA
ECOM with MultiTech modem	56 mA	112 mA
ECOM with MDS radio	277 mA	555 mA
ECOM with modem & MDS radio	311 mA	622 mA
ECOM with FreeWave radio	272 mA	545 mA
ECOM with modem and FreeWave radio	306 mA	612 mA

Terminal Block Connector TB1

Unplug removable connector TB1 from the SCM and wire DC power to the connector. We recommend you do **not** plug the connector back into the SCM until the CPU module is already installed in the housing.

TB1 provides three input connections for bulk DC power:

- TB1-1: (+VIN) (+4.5V/4.9V to +16V dc for +6V supply) (+9.6/10.3V to +16V dc for +12V supply)
- TB1-2 = (-VIN) (Supply Ground)
- TB1-3 = Chassis Ground - CHASSIS (⏚)

Figure 2-13 shows the typical wiring at the SCM's TB1 block.

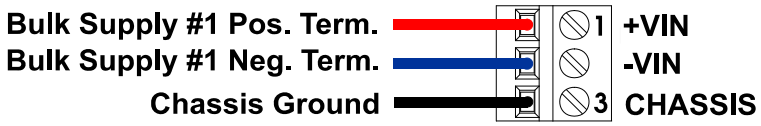


Figure 2-13. SCM TB1 Wiring

Note: As an added precaution, we recommend that you run a #14 AWG wire from the TB1-3 power connection (Ground) to the same known good earth ground used for the base housing.

2.6 Using a Solar Panel and Lead Acid Battery to Power the EFM

Instead of an external bulk DC power supply, you can use a solar panel and rechargeable lead acid battery combination to power the EFM.

You can order this option with a 30W/40W solar panel with a built-in regulator and a 12V, 33AH lead acid battery.

2.6.1 Mounting the Solar Panel

You can mount the solar panel to a 2" to 2-3/8" pipe using muffler (pipe) clamps. You secure the pipe clamps using four ¼-20 nuts and washers. See *Figure 2-14*.

Allow sufficient clearance so that you can swivel the solar panel for optimum alignment with the sun, and so you can adjust the tilt angle for maximum performance to accommodate the latitude of the installation site. Solar panel wires enter the unit through a liquid tight conduit fitting on the bottom of the enclosure.

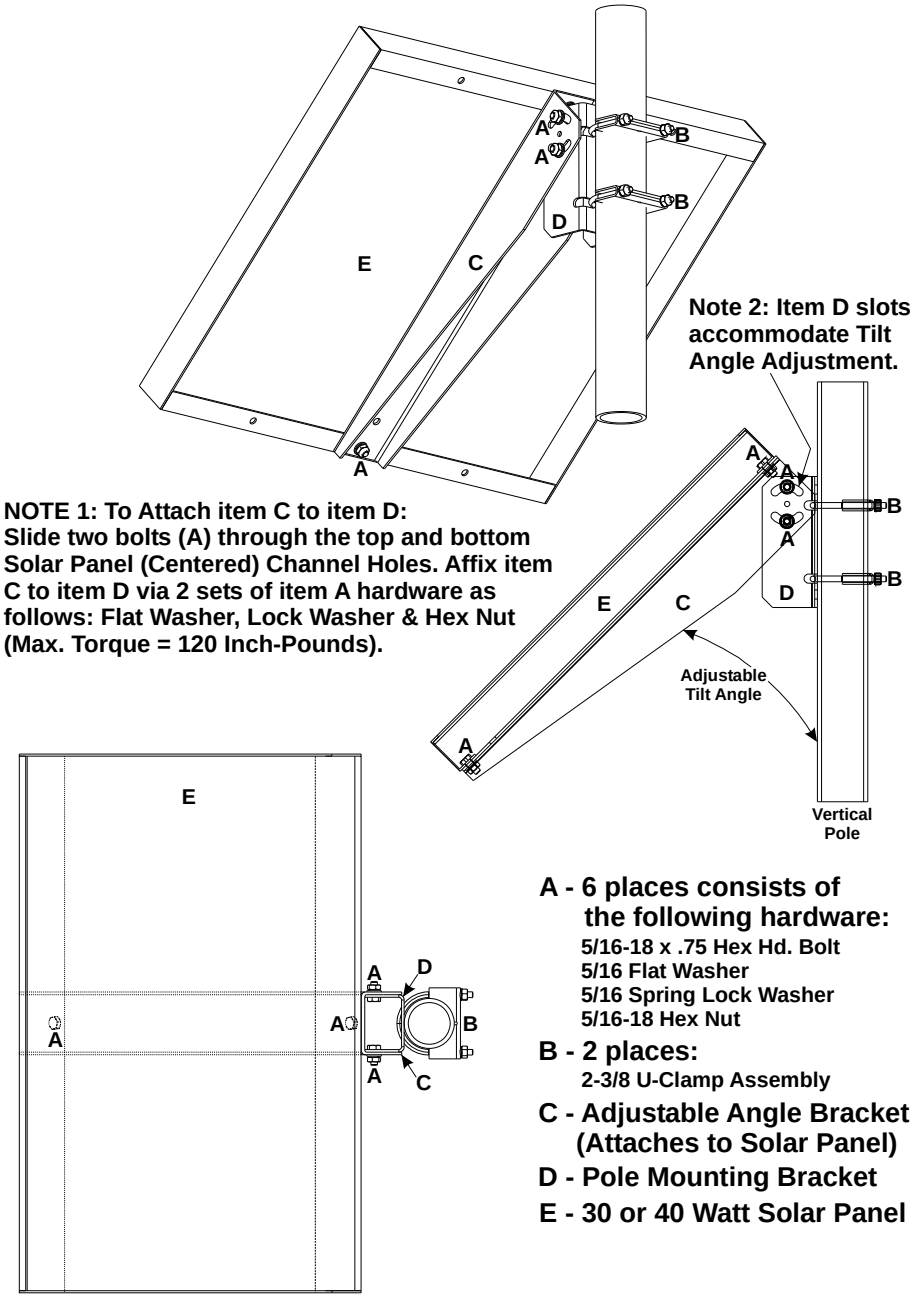


Figure 2-14. 30/40 Watt Solar Panel Mounting Diagram

Swivel and Tilt Angle

You must swivel the solar panel for optimum alignment with the sun. In the northern hemisphere, face the panel due south (not magnetic south). In the southern hemisphere, face the panel due north (not magnetic north).

30/40 watt solar panel systems have adjustable tilt angles. Adjust the tilt angle for maximum performance to accommodate the latitude of your installation site. *Table 2-3* shows the angle (from horizontal) at which you should install the solar panel to maximize annual energy output. At most latitudes, performance can be improved by less of an angle during the summer and more of an angle during winter.

Table 2-3. Solar Panel Tilt Angle

Latitude	**Tilt Angle**
0-4°	10° from Horizontal
5-20°	Add 5° to the Local Latitude
21-45°	Add 10° to the Local Latitude
46-65°	Add 15° to the Local Latitude
66-75°	80° from Horizontal

Connecting the Solar Panel to the Lead Acid Battery

Internally, you connect the solar panel wires directly to the rechargeable lead acid battery:

PWR (red wire) terminal
GND (black wire) terminal

See *Section 2.6.2* for more information on these connections.

2.6.2 Installing the Lead Acid Battery and Solar Panel Harness

Remove the rechargeable sealed lead-acid battery from its shipping carton and install it on its mounting bracket within the enclosure as illustrated in *Figure 2-15*.

1. Remove connector TB1 from the system controller module (SCM) and remove the battery/power harness from the battery charger/power manager board.
2. Remove the lead-acid battery from its shipping carton.
3. Install the lead-acid battery (on end) as illustrated in *Figure 2-15*.

Note: Before you install it, make sure the lead-acid battery is fully charged.

4. Route the solar panel power wiring harness into the enclosure through the solar power conduit fitting (see Item 5 of *Figure 2-4*).
5. Connect the solar panel harness to the internal battery (red = positive & black = negative).
6. Secure the battery using the battery clamp.
7. When you are ready to apply power, connect the battery power harness to either the power distribution board (if present) or to TB1 on the SCM.

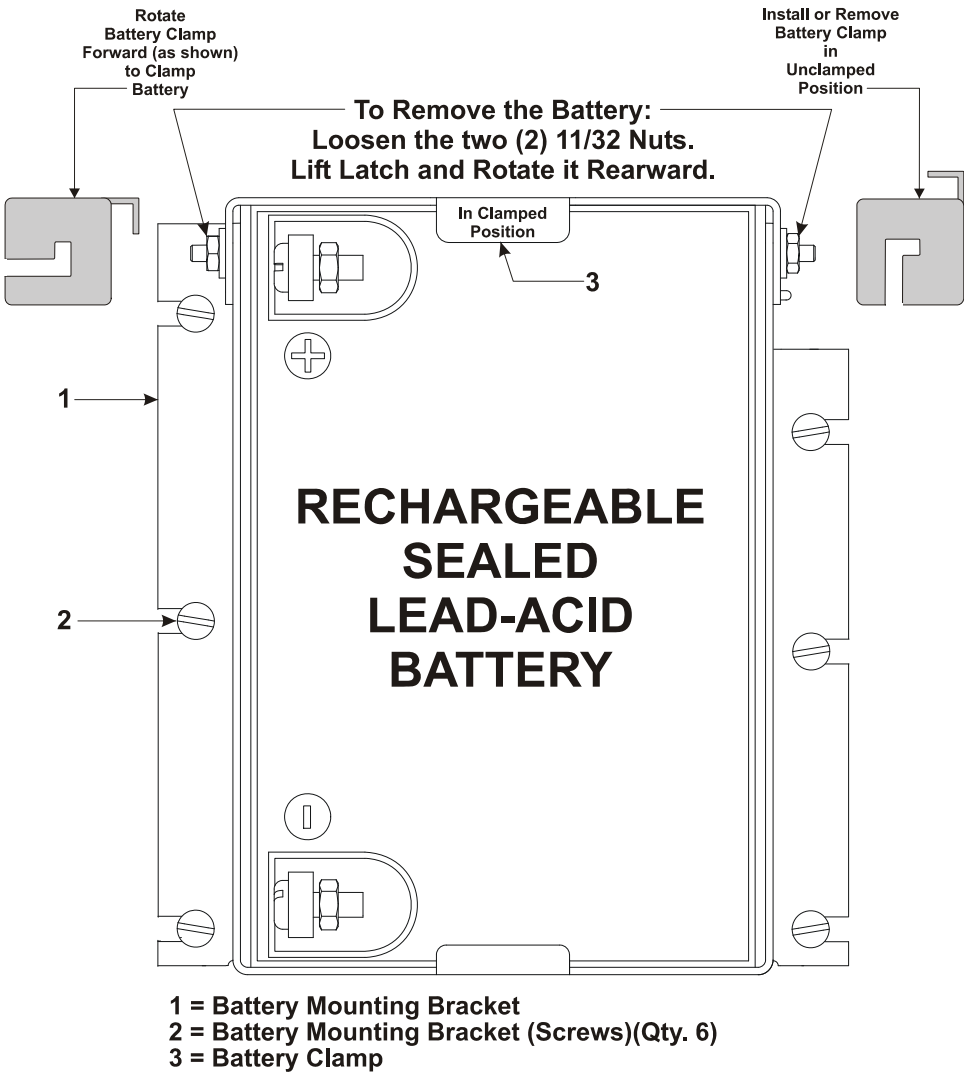


Figure 2-15. Enclosure with Sealed Lead-acid Battery Installed

2.7 Power Distribution Board (Optional)

If your ControlWave EFM includes any of the following optional components, it also requires the power distribution board.

- 21V Power Supply Board for external transmitters
- Digital to Relay I/O Board
- Case-mounted radio or modem

The power distribution board, as well as the 21V power supply board and the digital to relay I/O board mount inside the enclosure using a Snap Track and dual PCB mounting bracket.

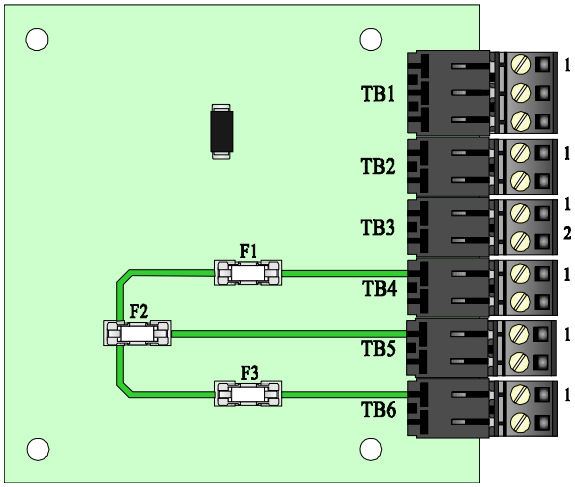


Figure 2-16. Power Distribution Board

Power distribution boards include six terminal block connectors:

TB1 Primary Power Input: (three-conductor) (from user supplied bulk power source)

- TB1-1 = Power+ (Pos. input)
- TB1-2 = Power– (Neg. input)
- TB1-3 = Chassis (GND)

TB2 - Main Power Output 1: (two-conductor) (to SCM Power Connector TB1)

- TB2-1 = PWR1+ to TB1-1 on SCM (+VIN)
- TB2-2 = PWR1– to TB1-2 on SCM (–VIN)

TB3 - Main Power Output 2: (two-conductor) (to 21V PS Board Connector TB1)

- TB3-1 = PWR2+ to TB1-1 on 21VPS (+VIN)
- TB3-2 = PWR2– to TB1-2 on 21VPS (GND)

TB4 - Fused Power Output 1: (two-conductor) (to Digital to Relay I/O Board Connector J1)

- TB4-1 = FPWR1+ to J1-10 on D-to-R I/O Bd. (PWR+)

- TB4-2 = FPWR1– to J1-9 on D-to-R I/O Bd. (PWR GND)

TB5 - Fused Power Output 2: (two-conductor) (to External Modem/Radio Pwr. Connector)

- TB5-1 = FPWR2+ to Radio/Modem Power+
- TB5-2 = FPWR2– to Radio/Modem Power– (PWR GND)

TB6 - Fused Power Output 3: (two-conductor) (optional use - similar to TB5)

- TB6-1 = FPWR3+ to Radio/Modem Power+
- TB6-2 = FPWR3– to Radio/Modem Power– (PWR GND)

Note: Fuse F1 is rated at 1.5A and protects the solar panel regulator circuitry. Fuse F3 is rated at .5A and protects fused power output 1. F1 and F3 are provided for Class I, Div. 1 hazardous location use only, which does not apply to the ControlWave EFM.

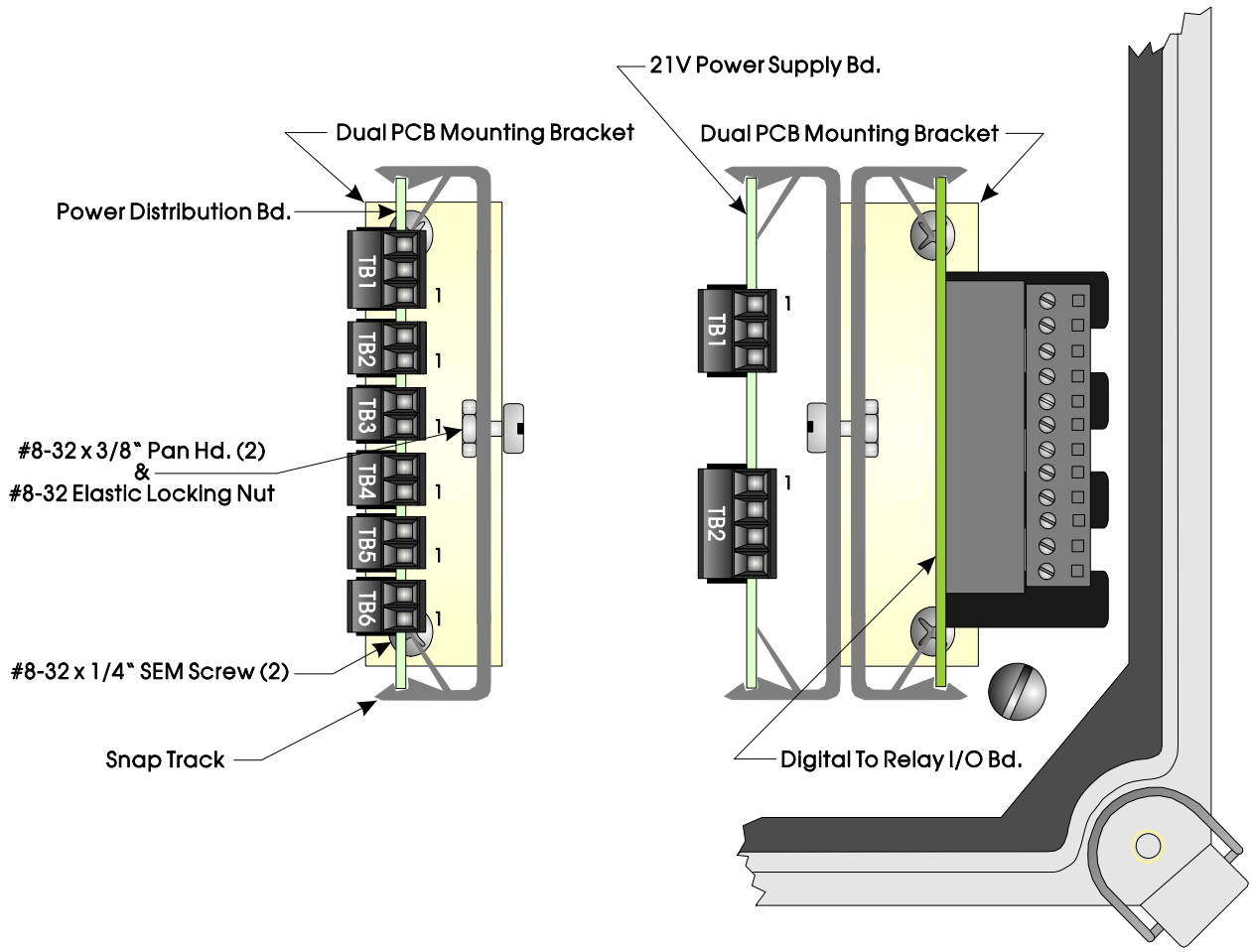


Figure 2-17. Power Distribution Board and Other Options - Snap Track Mounting

2.8 21V Power Supply (Optional)

The 21V power supply is typically used to provide power to temperature and pressure transmitters (such as the Bristol 3508) that require higher than +12V but lower than +21.4V (± .8V) to operate.

The 21V power supply has two terminal blocks that accommodate power connections between the EFM and the remote transmitters. TB1 is a three-position terminal block that provides input power from the power distribution board (see Section 2.7). Four-position terminal block (TB2) provides +21V power and ground to the remote transmitters. See *Table 2-4* and *Figure 2-18* for details on these connections.

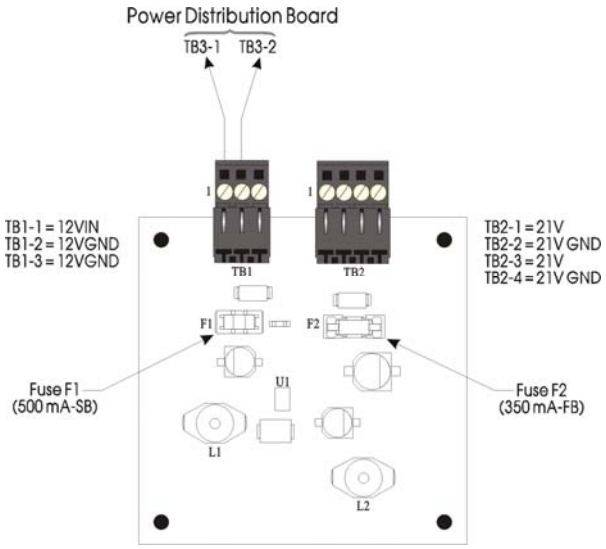


Figure 2-18. 21V Power Supply Board

Table 2-4 - 21V Power Supply Board Terminal Designations

21VPS TB#	21VPS TB Name	Connection to Power Dist. Bd.	Connection to XMTR
TB1-1	+12VIN	TB3-1	N/A
TB1-2	12VGND	TB3-2	N/A
TB1-3	CHASSISGND	N/A	N/A
TB2-1	+21V	N/A	XMTR1+
TB2-2	21VGND	N/A	XMTR1-
TB2-3	+21V	N/A	XMTR2+
TB2-4	21VGND	N/A	XMTR2-

2.9 CPU Module

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

Note: Do not confuse the CPU module (which has communication components) with the Expansion Communication module (ECOM), which **does not** have a CPU component or a battery backup but **does** have additional communication components.

Identify the carton holding the CPU module and remove it from that carton. The CPU module has two basic configurations, each of which have on-board communications components:

- CPU with two RS-232 serial ports, and one RS-485 serial port (see *Figure 2-19*)
- CPU with two RS-232 serial ports, one RS-485 serial port, and one Ethernet port (see *Figure 2-20*). The Ethernet option is only available for 150 MHz CPU.

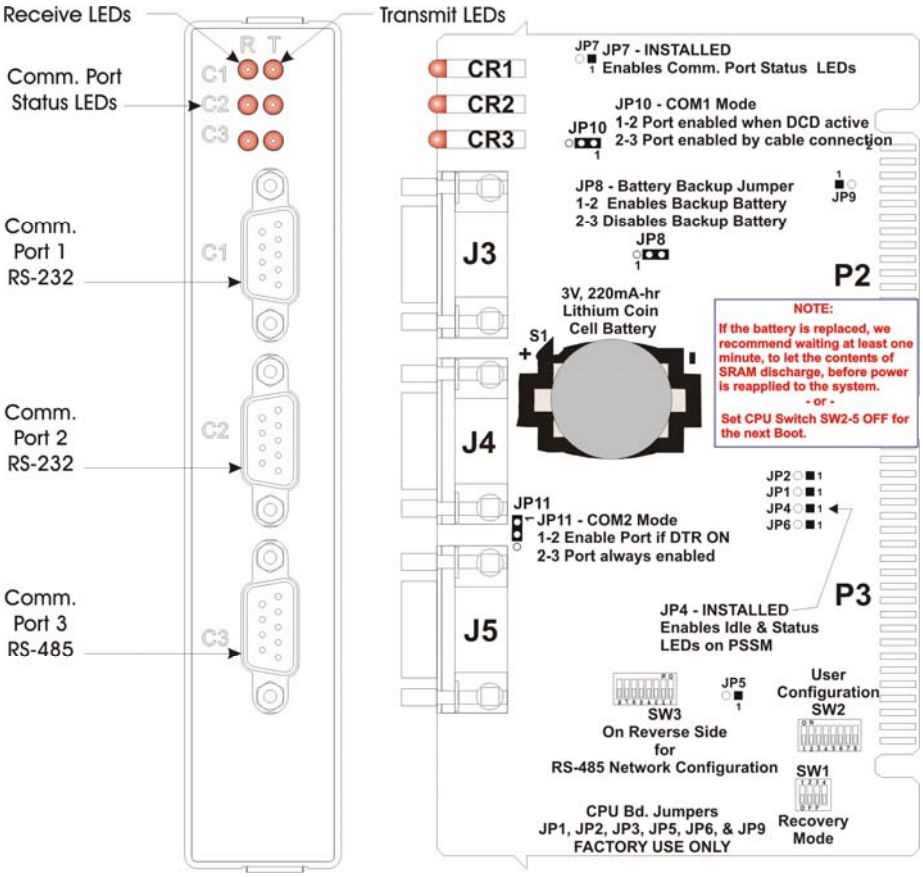


Figure 2-19. CPU Module with Three Serial Ports

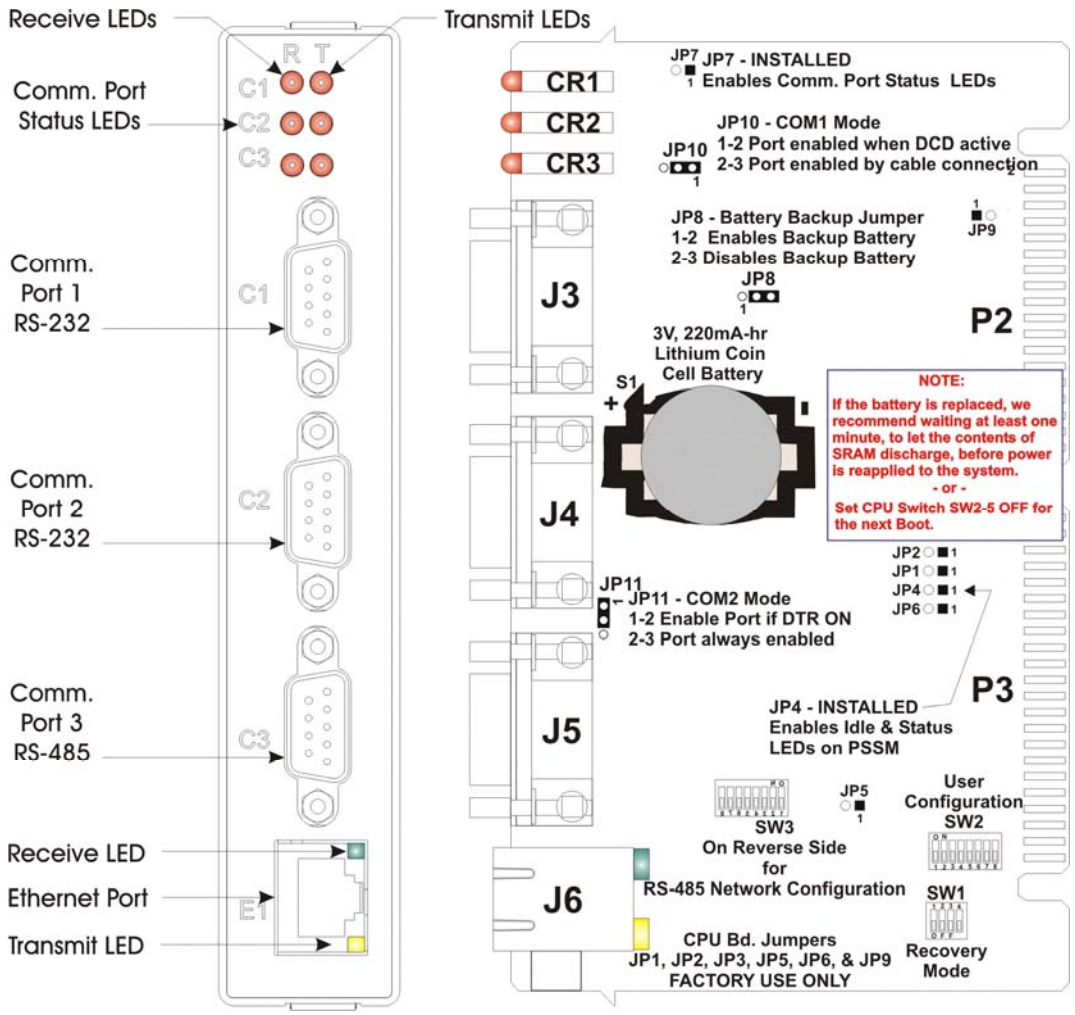


Figure 2-20. CPU Module with Three Serial Ports and One Ethernet Port

2.9.1 Setting Jumpers on the CPU Module

Each CPU module contains a number of jumpers (labeled with JP*n*) when *n* in the jumper number. See *Figure 2-19* or *Figure 2-20* to locate the jumpers.

Note: When present, jumpers 1, 2, 3, 5, 6, and 9 (**JP1, JP2**, **JP3**, **JP5**, **JP6,** and **JP9**) are reserved for factory use only. **Do not alter these jumpers from their factory settings**.

- Jumper 4 (**JP4**) enables the Idle and Status LEDs on the SCM. It comes enabled from the factory. (We recommend you leave these LEDs enabled during initial installation and setup. If power conservation is an issue, you can disable these LEDs by removing the jumper.)
- Jumper 7 (**JP7**) enables the Communication Port Status LEDs on the CPU module. It comes enabled from the factory. We recommend you leave these LEDs enabled during initial installation and setup. If

power conservation is an issue, you can disable these LEDs by removing the jumper.

Note: For maximum shelf life, the CPU module ships from the factory with the installed lithium backup battery disabled. You must enable it when you install the CPU module by placing JP8 on pins 1-2.

- Jumper 8 (**JP8**) enables/disables the lithium backup battery on the CPU module.
  - Pins 1-2: Enables the CPU module's backup battery.
  - Pins 2-3: Disables the CPU module's backup battery (**Factory default**)
- Jumper 10 (**JP10**) specifies how COM1 is enabled.
  - Pins 1-2: Enables COM1 whenever DCD is active. (**Factory default**)
  - Pins 2-3: Enables COM1 whenever you connect a cable to the port.
- Jumper 11 (**JP11**) when present, specifies how COM2 is enabled.
  - Pins 1-2: Enables COM2 whenever DTR is ON. (**Factory default**)
  - Pins 2-3: Port is always enabled. This setting can be used to control external radios that feature DTR sleep modes.

2.9.2 Setting DIP Switches on the CPU Module

Before you install the CPU module, you must determine the settings for three banks of DIP switches. Refer to *Figure 2-19* or *Figure 2-20* for the location of the DIP switch banks on each CPU module. Refer to *Tables 2-5* through *2-7* for DIP switch setting values.

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

Table 2-5. CPU Module Switch SW1

SW1 Setting	Function	Mode
1	N/A	Not currently used.
2	N/A	Not currently used.
3	Force Recovery Mode	Enables recovery mode. Values are: **ON** (enables recovery mode) **OFF** (disables recovery mode). – This is the **factory default**.
4	N/A	Not currently used.

Table 2-6. CPU Module Switch SW2

SW2 Setting	Function	Mode
1	Watchdog Enable	Controls whether the system enters a watchdog state when a crash or system hangup occurs and automatically restarts. Values are: **ON** (Enables watchdog circuit; **factory default**) **OFF** (Disables watchdog circuit and prevents automatic restart)
2	Lock/Unlock Soft Switches	Controls the ability to modify soft switches, other configurations, and flash files. Values are: **ON** (Unlocks soft switches and flash files; **factory default**). **OFF** (Locks soft switches, configurations, and flash files)
3	Use/Ignore Soft Switches	Controls the use of soft switches. Values are: **ON** (Enable user-defined soft switches configured in flash memory; **factory default**) **OFF** (Disable soft switch configuration and use factory defaults) **Note**: Setting both switch 3 and switch 8 to **OFF** (closed) sets all serial communication ports to 9600 bps operation. All serial communication ports must be set at 9600 bps before WINDIAG can perform communication tests.
4	Core Updump	Causes the ControlWave EFM to perform a core updump, provided you have set the SCM mode switch to Recovery mode. Values are: **ON** (Disables core updump; **factory default**) **OFF** (Core updump via SCM mode switch SW1)
5	SRAM Control	Manages SRAM contents following a low power situation or a power outage. Values are: **ON** (Retain values in SRAM during restarts; **factory default**) **OFF** (Reinitialize SRAM) – Data in SRAM lost during power outage or re-start.
6	System Firmware	Allows a remote download of system firmware (on units equipped with boot PROM version 4.7 or higher and system PROM version 4.7 and higher). Values are: **ON** (Enable remote download of system firmware; **factory default**) **OFF** (Disable remote download of system firmware)
7	N/A	Not currently used.
8	Enable WINDIAG	Suspends normal operation and allows diagnostic routines. Values are: **ON** (Permits normal system operation, including the boot project, and disables the WINDIAG diagnostics from running; **factory default**) **OFF** (Allow WINDIAG to run test; disable boot project and normal system operation.) **Note**: Setting both switch 8 **and** switch 3 to **OFF** (closed) sets all communication ports to 9600 bps operation. All serial communication ports must be set at 9600 bps before WINDIAG can perform communication tests.

Notes:

- *Table 2-7* describes switch settings for the RS-485 port. You may want to review *Section 2.9.4 Connections to RS-485 Serial Port(s)* before you set these switches.
- *Table 2-7* applies to the following switches:
  - SW3 on CPU Module – controls COM3
  - SW1 on Type 1 ECOM Module – controls COM5/COM9
  - SW1 on Type 2 ECOM Module – controls COM6/COM10
  - SW2 on Type 2 ECOM Module – controls COM7/COM11

Table 2-7. RS-485 Configuration Switch

SW3 Setting	Function	Mode
1	TX+ to RX+ Loopback	**ON** (only for diagnostics *or 2-wire*)
2	TX- to RX- Loopback	**ON** (only for diagnostics *or 2-wire*)
3	100 Ohm RX+ Termination	**ON** (End nodes only)
4	100 Ohm RX- Termination	**ON** (End nodes only)
5	N/A	Not currently used
6	Slew Rate (ISO485 Only)	**ON** (Slow rate enabled) **OFF** (Fast rate enabled) **Note**: On CPU module, not currently used.
7	RX+ Bias (End Node)	**ON** (End nodes only)
8	RX- Bias (End Node)	**ON** (End nodes only)

After you configure the jumpers and DIP switches, slide the CPU module into slot #2 (the second slot from the left) of the housing (see *Figure 2-6* or *Figure 2-7*).

2.9.3 Connections to RS-232 Serial Port(s) on CPU or ECOM Modules

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

Your CPU module includes two RS-232 ports.

If you require additional RS-232 ports, you can purchase an optional expansion communication module that can include either one (ECOM Type 1) or two (ECOM Type 2) RS-232 ports. The ControlWave EFM can support up to two expansion communication modules, for a total of up to four additional RS-232 ports beyond those on the CPU module. Expansion communication modules reside in slot #3 and slot #4.

RS-232 COM Port Names and Connectors

RS-232 COM ports are assigned names based on their location in the ControlWave EFM.

- The CPU module RS-232 ports are COM1 and COM2.

Table 2-8. RS-232 Connectors on CPU

Connector	Name	# Pins	Function	Notes
J3	COM1	9-pin	9-pin male D-sub (RS-232). Also supports circular 3-pin female connector *(local port)* at the bottom of the enclosure.	See *Figure 2-19*, *Figure 2-20*, *Figure 2-21* & *Table 2-8*
J4	COM2	9-pin	9-pin male D-sub (RS-232)	See *Figure 2-19*, *Figure 2-20* *Figure 2-21* & *Table 2-8*

- If you have an ECOM module with one RS-232 port, this is COM4 if the module is in slot #3 or COM8 if the module is in slot #4.
- If you have an ECOM module with two RS-232 ports, those ports are COM4 and COM5, respectively, if the ECOM module is in slot #3, or COM8 and COM9, respectively, if the ECOM module is in slot #4.

Table 2-9. RS-232 Connectors on Expansion Communications Modules

Connector	Name	# Pins	Function	Notes
J4	COM4 (when in slot 3) COM8 (when in slot 4)	9-pin	9-pin male D-sub (RS-232)	See *Figure 2-21, Figure 2-31, Figure 2-32* & *Table 2-10*
J5	COM5 (when in slot 3) COM9 (when in slot 4)	9-pin	9-pin male D-sub (RS-232)	See *Figure 2-21, Figure 2-32* & *Table 2-10* Only available on ECOM Type 2 models.

RS-232 COM Port Cables

For the ControlWave EFM, half-duplex communications use Modbus or BSAP protocol, while full-duplex communications use point-to-point protocol (PPP). RS-232 ports use a "null modem" cable (see *Figure 2-22*) to connect with other devices (such as a PC, a printer, another ControlWave [except the CW_10/30/35]) when the ControlWave EFM uses the full-duplex PPP protocol.

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

Figure 2-21 illustrates the CPU module's male 9-pin D-type connector. Use the content provided in *Table 2-8* to determine pin assignments for the COM1 and COM2 ports and the expansion communication ports COM4/5 and COM8/9.

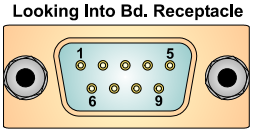


Figure 2-21. Male DB9 9-Pin Connector

Table 2-10. RS-232 Port Connector Pin Assignment

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

Use the "null modem" cable for full-duplex (PPP protocol) communications when connecting a ControlWave EFM to a PC. (See top part of *Figure 2-22*.)

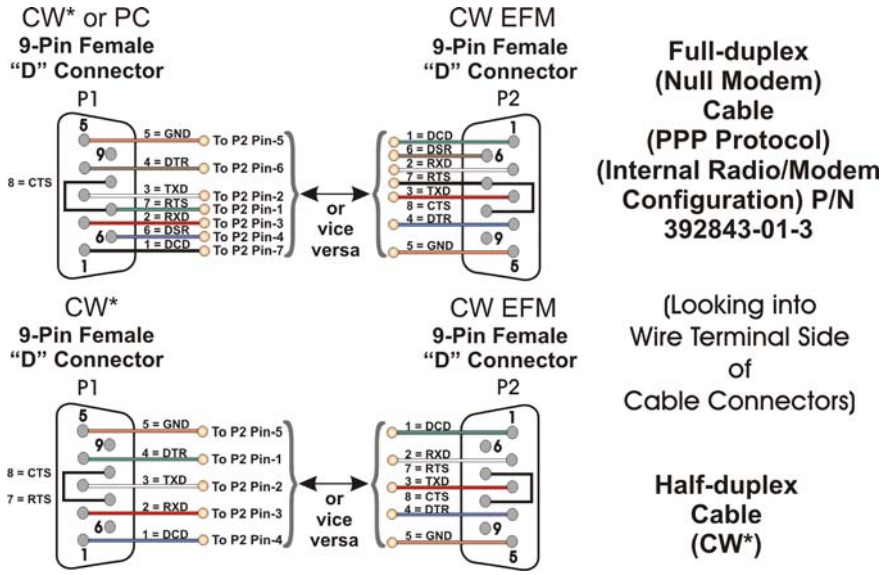


Figure 2-22. Full-duplex and Half-duplex Cable

Use the half-duplex cable (shown in the bottom part of *Figure 2-22*) when connecting the ControlWave EFM to another ControlWave series unit (again, with the exception of the CW_10/30/35).

When communicating with a Network 3000 series RTU 3305, RTU 3310, DPC 3330, or DPC 3335 or CW_10/30/35, you must use one of the cables shown in *Figure 2-23*.

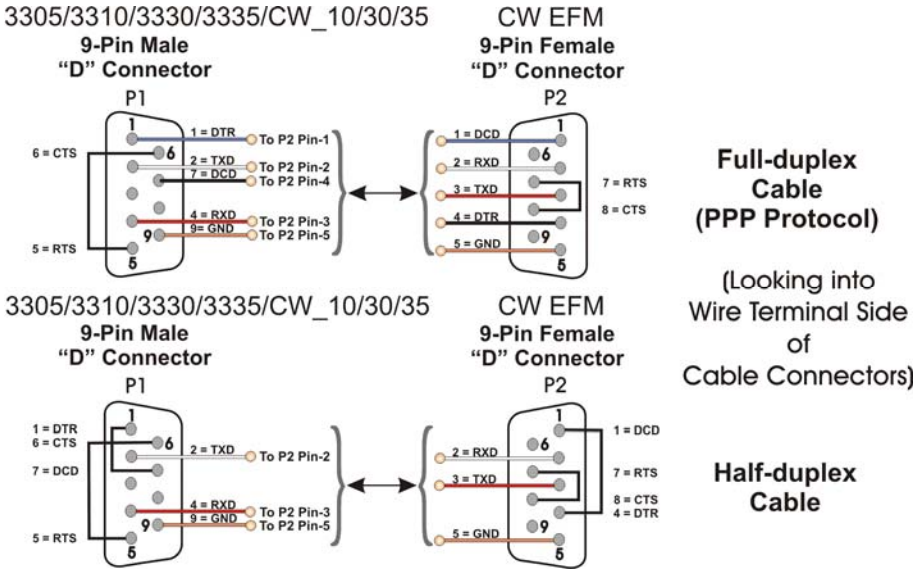


Figure 2-23. Full-duplex and Half-duplex Cable

When connecting the ControlWave EFM to an external (case-mounted) modem or radio, use the cable shown in

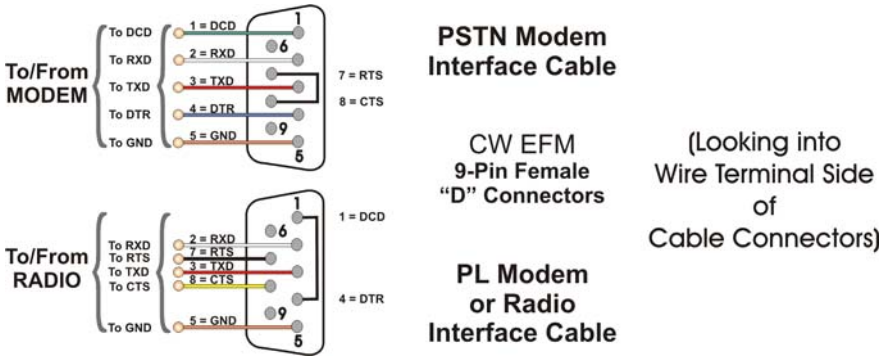


Figure 2-24. Communication Interface Cable for Connection to Case-Mounted (External) Radio or Modem

When interfacing to the COM3 port of a ControlWave, or the COM5 or COM6 port a ControlWaveEXP unit, use the cable presented in *Figure 2-25* along with the cable shown in *Figure 2-22* or *Figure 2-23*.

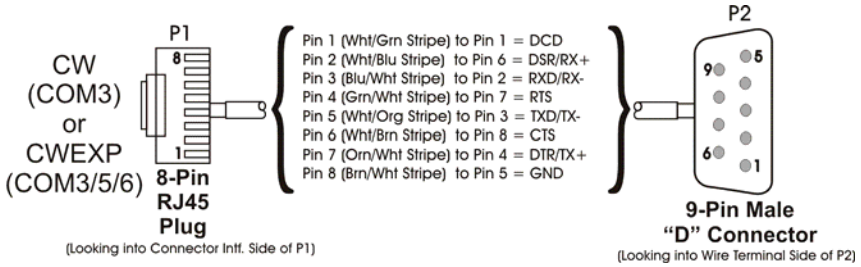


Figure 2-25. Full-duplex and Half-duplex Cable

If you use the local port circular connector see *Figure 2-26*, *Figure 2-27* and *Table 2-11*.

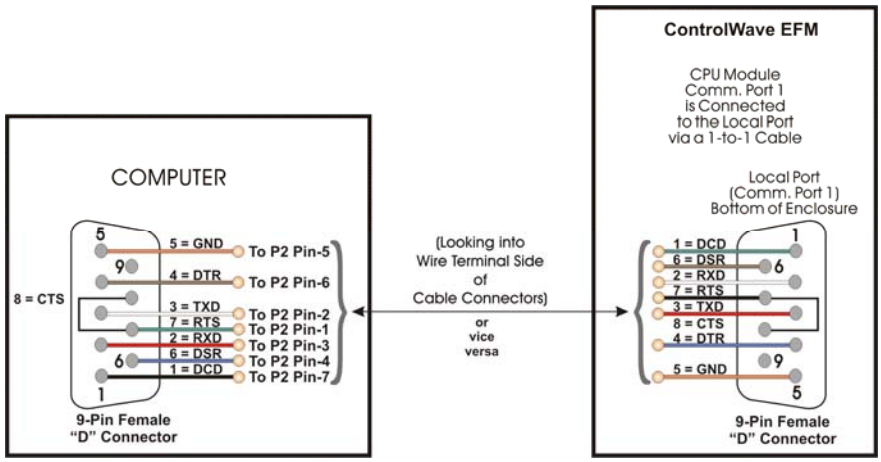


Figure 2-26. PC Connected to ControlWave EFM via D-Type Local Port (use Null Modem Cable P/N 392843-01-3)

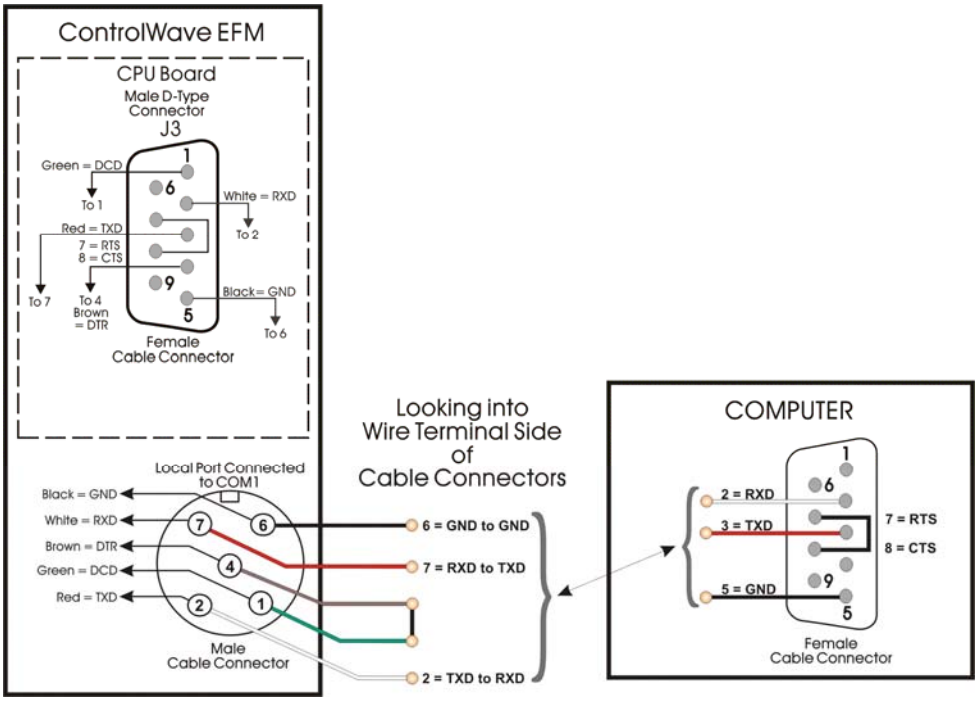


Figure 2-27. PC Connected to ControlWave EFM via Circular Local Port (use Cable P/N 395402-01-8 [10 foot cable] or P/N 395402-02-6 [25 foot cable])

Table 2-11. RS-232 Port (COM1) Connector Pin Assignment (COM1 Connectors – Circular Local Port & D-Type "C1" Connector on CPU)

COM1 Pin	RS-232 Signal	RS-232 Description	Wire Color	Local Port RS-232 Pin
1	DCD	Data Carrier Detect Input	Green	1
2	RXD	Receive Data Input	White	7
3	TXD	Transmit Data Output	Red	2
4	DTR	Data Terminal Ready Output	Brown	4
5	GND	Signal/Power Ground	Black	6
6	DSR	Data Set Ready Input		
7*	RTS	Request to Send Output		
8*	CTS	Clear to Send Input		

* RTS connected to CTS

RS-232 Cable Guidelines

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

- Ensure that DCD is high to transmit (except when dialing a modem)

- Verify that each RS-232 transceiver has one active receiver while disabled (in power down mode); connect the DCD signal to the active receiver.
- Set CTS to high to transmit.
- If the port is set for full-duplex operation, RTS is always ON.
- Ensure that DTR is always high when port is active; DTR enables RS-232 transceivers.

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

- When port is set for half-duplex operation, CTS must go low after RTS goes low.
- All RS-232 comm ports support RTS, DTR, CTS, DCD, and DSR control signals.
- All RS-232 comm port I/O signals are protected by surge protectors.

2.9.4 Connections to RS-485 Serial Port(s) on CPU or ECOM Modules

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

Your CPU module includes one RS-485 port.

If you require additional RS-485 ports, you can purchase an optional expansion communication module that includes one or two RS-485 ports. The ControlWave EFM can support up to two expansion communication modules, for a total of up to four additional RS-485 ports beyond the one on the CPU module. Expansion communication modules reside in slot #3 and slot #4.

RS-485 COM Port Names and Connectors

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

- The CPU module's RS-485 port is COM3.
- If you have a Type 1 ECOM module in slot #3, its RS-485 port is COM5. If you have a Type 1 ECOM module in slot #4, its RS-485 port is COM9.
- If you have a Type 2 ECOM module in slot #3, its RS-485 ports are COM6 and COM7. If you have a Type 2 ECOM module in slot #4, its RS-485 ports are COM10 and COM11.

Table 2-12 provides the connector assignments for CPU port COM3; *Table 2-13* shows the assignments for ECOM1 port COM5/9; and *Table 2-14* shows assignments for ECOM2 ports COM6/10 and 7/11.

Table 2-12. RS-485 Connectors on CPU

Connector	Name	# Pins	Function	Notes
J5	COM3	9-pin	9-pin male D-sub (RS-485)	See *Figure 2-19* and *Figure 2-20.*

Table 2-13. RS-485 Connectors on Type 1 Expansion Communications Modules

Connector	Name	# Pins	Function	Notes
J5	COM5 (when in slot 3) COM9 (when in slot 4)	9-pin	9-pin male D-sub (RS-485)	See *Figure 2-31* & *Table 2-14* Only available on ECOM Type 2 models.

Table 2-14. RS-485 Connectors on Type 2 Expansion Communications Modules

Connector	Name	# Pins	Function	Notes
J6	COM6 (when in slot 3) COM10 (when in slot 4)	9-pin	9-pin male D-sub (RS-485)	See *Figure 2-32* & *Table 2-14*
J7	COM7 (when in slot 3) COM11 (when in slot 4)	9-pin	9-pin male D-sub (RS-485)	See *Figure 2-32* & *Table 2-14*

RS-485 COM Port Cables

Figure 2-21 illustrates the CPU module's male 9-pin D-type connector. Use the content provided in *Table 2-15* to determine pin assignments for the COM3 port on the CPU (CPU switch SW3), and COM5/9, COM6/10, and COM7/11 expansion communication ports (ECOM switches SW1 and SW2).

Table 2-15. RS-485 Port Connector Pin Assignment

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

Since the RS-485 port is intended for network communications, refer to *Table 2-16* for the appropriate connections for wiring the master, first slave, and *nth* slave.

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

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

Table 2-16. RS-485 Network Connections

From Master	To First Slave	To nth Slave
TXD+	RXD+	RXD+
TXD–	RXD–	RXD–
RXD+	TXD+	TXD+
RXD–	TXD–	TXD–
GND/ISOGND	GND/ISOGND	GND/ISOGND

ISOGND with isolated RS-485 ports only.

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

You must also configure switches at each node to establish proper network performance. Accomplish this by configuring switches listed so that the 100Ω termination resistors and biasing networks are installed at the end nodes and are removed at all other nodes on the network. You enable receiver biasing and termination (as well as 2-wire or 4-wire selection) using an 8-position DIP switch located on the CPU and ECOM modules. See *Table 2-5* in *Section 2.9.2 Setting DIP Switches on the CPU Module*s for information on RS-485 termination and loopback control switch settings.

2.9.5 Connections to Ethernet Port on the CPU Module

Caution

The RJ45 Ethernet port is located on the CPU module (150 MHz version only). The SCM also has one RJ45 port for the optional Display/Keypad. Never connect Ethernet to the Display/Keypad port or damage to the SCM will result.

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

Port assignments are:

- Ethernet Port 1: CPU Bd. J6, 8-Pin RJ-45 - Shielded Twisted Pair 10/100Base-T
- Ethernet Port 2: CPU Bd. J5, 8-Pin RJ-45 - Shielded Twisted Pair 10/100Base-T

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

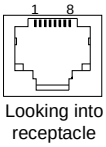


Figure 2-28. RJ-45 Ethernet Connector

These cables have a one-to-one wiring configuration as shown in *Figure 2-29*. *Table 2-17* provides the assignment and definitions of the 8-pin 10/100Base-T connectors.

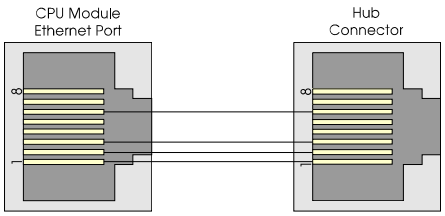


Figure 2-29. Standard 10/100Base-T Ethernet Cable (CPU Module to Hub)

Table 2-17. Ethernet 10/100Base-T CPU Module Pin Assignments

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

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

You can connect two nodes in a point-to-point configuration without using a hub. However, you must configure the cable so that the TX+/- Data pins connect to the RX+/- Data pins (swapped) at the opposite ends of the cable (see *Figure 2-30*).

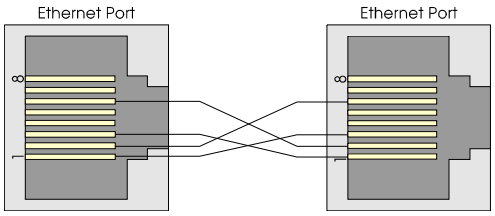


Figure 2-30. Point-to-Point 10/100Base T Ethernet Cable

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

2.10 Expanded Communications Module (ECOM)

ControlWave EFM can support up to two optional expanded communications modules (ECOMs) which you can install **only** in slots #3 or #4 (in place of I/O modules). ECOMSs **do not** have a CPU component.

Two Types of ECOM Modules

There are two types of ECOM module:

- Type 1 Expansion Communications Module (ECOM1) with one RS-232 port, one RS-485 serial port, and an optional modem port (see *Figure 2-31*)
- Type 2 Expansion Communications Module (ECOM2) with two RS-232 serial ports and two RS-485 serial ports (see *Figure 2-32*)

Identify the carton holding the ECOM module(s) and remove the module from that carton.

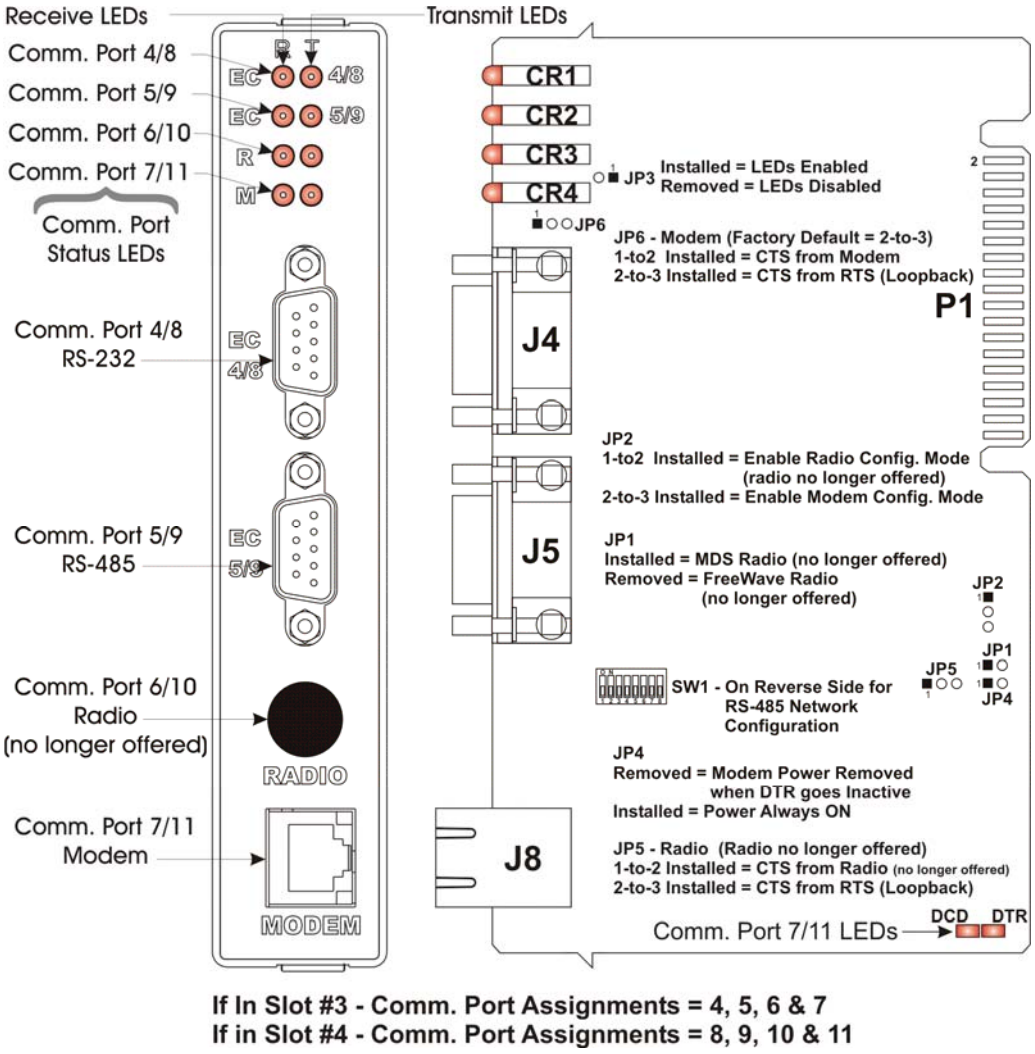


Figure 2-31. Type 1 ECOM with Two Serial Ports and a Modem

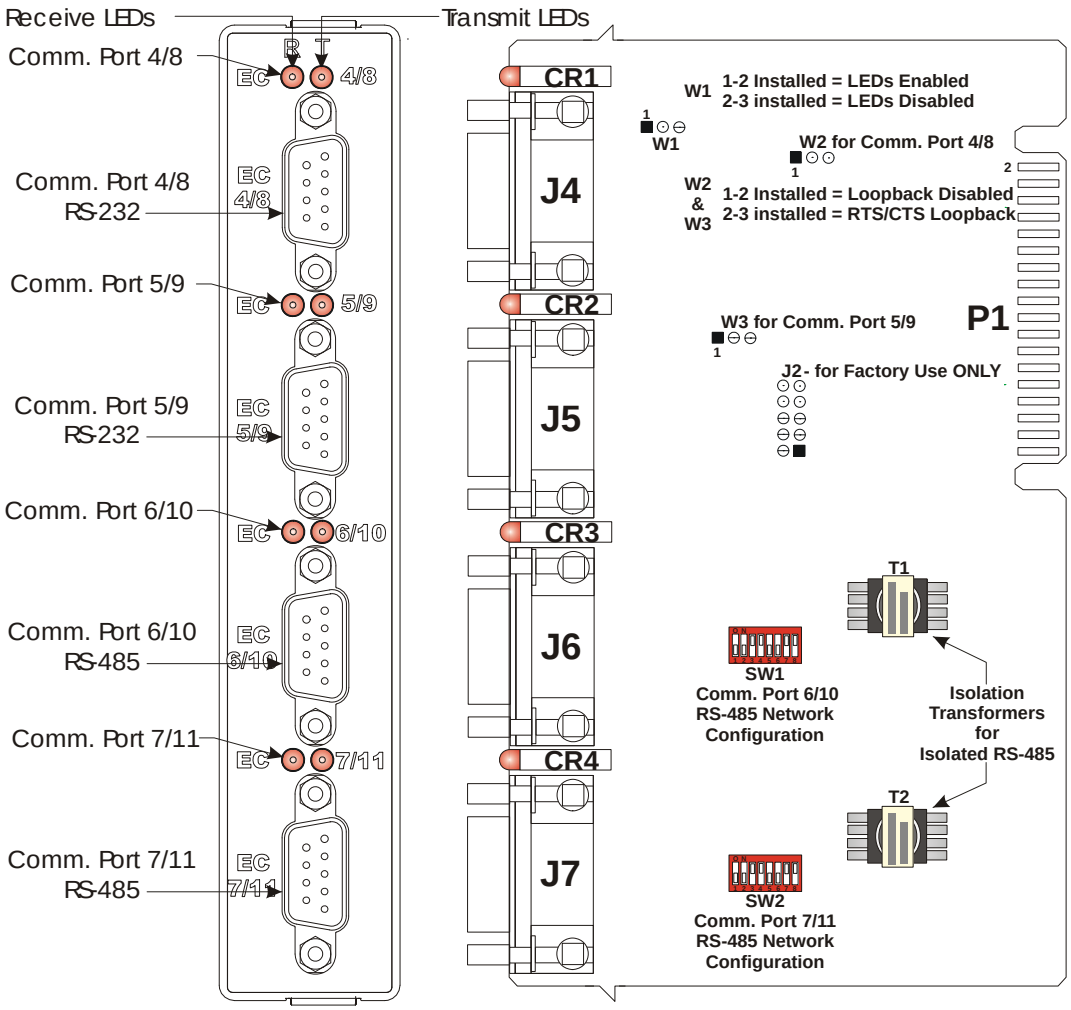


Figure 2-32. Type 2 ECOM with Two RS-232 and Two RS-485 Ports

Detailed Technical Specifications

For detailed technical specifications, please see document CWMICRO:COM available on our website http://www.emersonprocess.com/remote/D301673X012.pdf.

2.10.1 RS-232 Ports

Type 1 ECOMs include one RS-232 port. Type 2 ECOMs include two RS-232 ports. For information on connecting to these ports, including cabling information, see *Section 2.9.3.*

2.10.2 RS-485 Ports

Type 1 ECOMs include one RS-485 port. Type 2 ECOMs include two RS-485 ports. For information on connecting to these ports, including cabling information, see *Section 2.9.4.*

When connecting a ControlWave EFM to an external (case-mounted) modem, use the cable configuration in *Figure 2-33*.

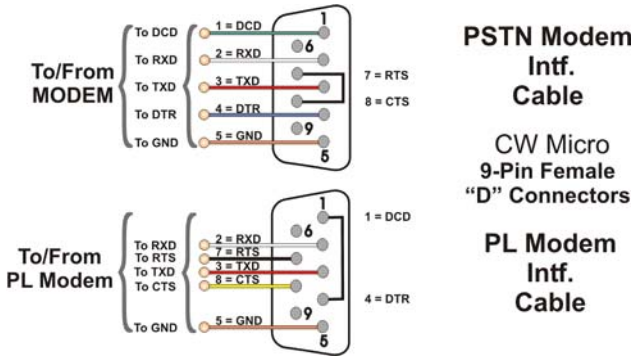


Figure 2-33. Full-duplex and Half-duplex Cable

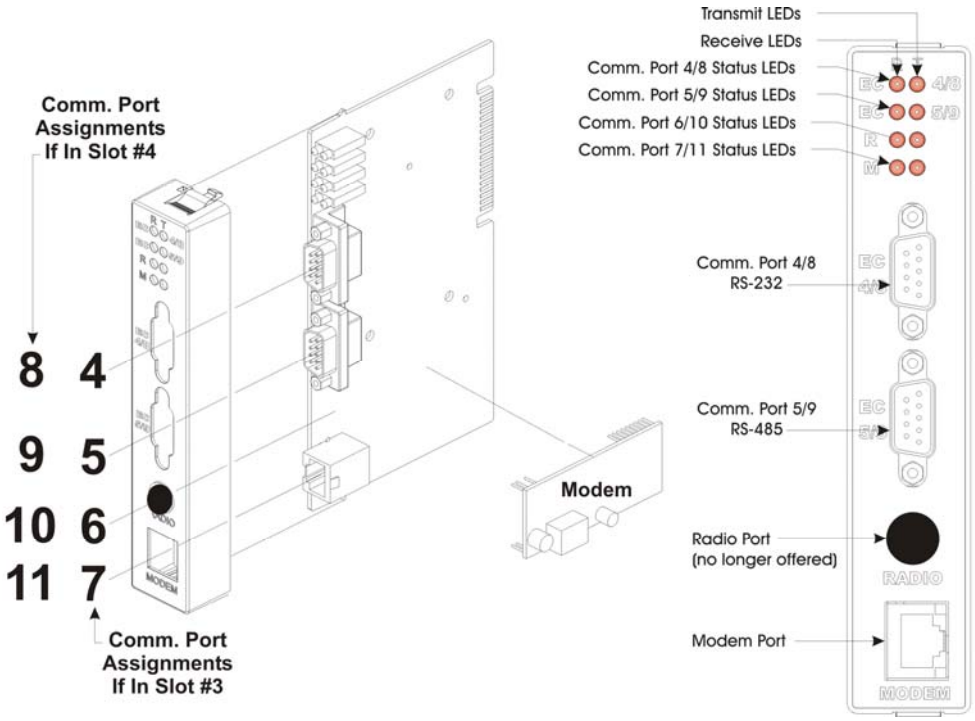


Figure 2-34. ECOM Modem Installation

2.10.3 Modem Port (Type 1 ECOM only)

You can mount an optional 56Kb PSTN Hayes-type modem on a Type 1 ECOM (see *Figure 2-34*).

The ControlWave EFM then assigns the modem COM7 (if in slot #3) or COM11 (if in slot #4).

You can configure the MultiTech model MT9234SMI modem module for publicly switched telephone network (PSTN) operation. You can

also clock DTE/DCE serial data into (transmit) or out of (receive) the modem at rates up to 115.2 kHz.

The factory supplies the modem pre-installed or in kit form with all required hardware. You install it on the ECOM1 module and then use the Ports page in the Flash Configuration utility (in NetView, LocalView, or TechView) to assign ports. Configure a profile for the modem using AT commands submitted using a terminal emulation program (such as HyperTerminal). Users typically use AT commands only when checking the modem's active or stored profile or when reconfiguring a modem (to turn auto answer on or off, etc.).

Prior to shipment from the factory, the MultiTech modems are pre-configured using the following steps:

1. Connect pin Enable modem setup by setting jumper JP2 on the ECOM to 2-3.
2. Connect via HyperTerminal (Parameters = 9600, 8, N, 1, None) to ECOM port C1 using the null modem cable (see *Figure 2-22*).
3. Send Factory Default = **AT&F0**
4. Disable Flow Control = **AT&K0**
5. Set baud rate using AT Command: **AT$SB9600,** or whatever baud rate you require.
6. Write to Memory. = **AT&W**
7. Disable setup mode. Park JP2 (no connection)

Note: You can reconfigure the modem using AT commands and a terminal program (like HyperTerminal). Connect pins 2 and 3 of JP2 with a suitcase jumper, and use a null modem cable (see *Figure 2-22*) to connect the PC to the modem (COM4 or COM8).

PSTN Connections

Figure 2-35 shows a publicly switched telephone network (PSTN) using a single master and three remote ControlWave EFMs (equivalent to EFMs for this application) each equipped with a PSTN modem. This application requires only one remote connection.

Use a cable with standard telephone connectors (RJ11s) on each end. Plug one end of the cable into the RJ11 connector jack on the ECOM and the end into a RJ11 wall jack. The telephone company provides the necessary subscriber loops at its central system along with the phone numbers for each destination.

Caution **Connect only one modem on each drop. If you attempt to parallel two or more modems across a single drop, an impedance mismatch occurs, adversely affecting the signal. Modems cannot provide reliable communications under these conditions.**

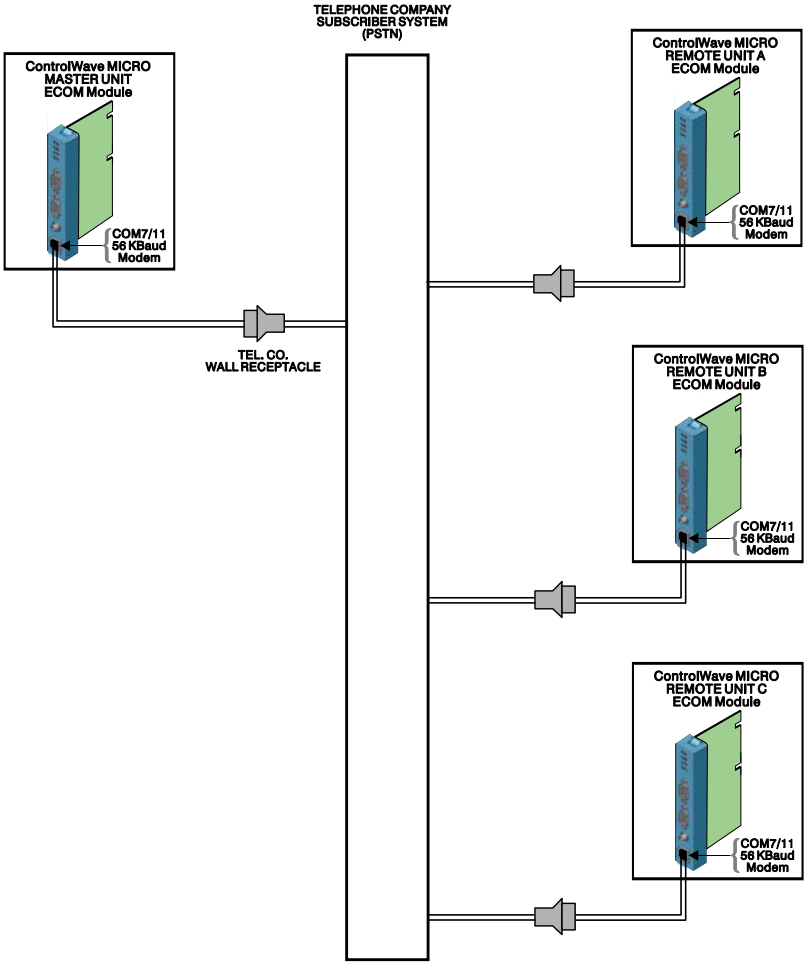


Figure 2-35. PTSN Field Connections for ControlWave Micros (and EFMs)

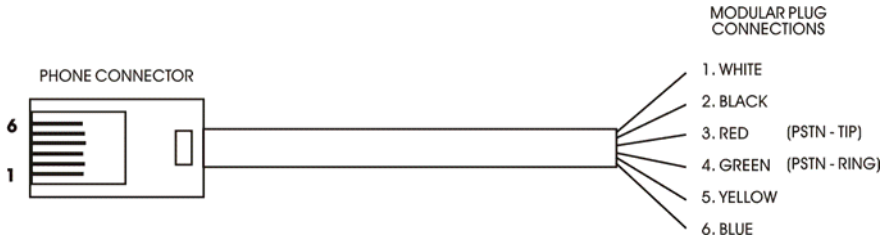


Figure 2-36. Phone Cord Wiring

The 56K PSTN modem is FCC-approved for use with public telephone lines. However, before you place a modem in operation, check the following items to make sure you meet all FCC requirements:

- Connections to party line service are subject to state tariffs.
- Connections to telephone company-provided coin service (central office implemented systems) are prohibited.
- The equipment compliance information is summarized as follows:
  - Complies with Part 68 FCC Rules.
  - Contains device with FCC Registration Number: AU7-USA-25814-M5-E

- Ringer Equivalence Number (REN): 0.3B

Note: The sum of all the RENs on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be usable on a given line.

- Make any direct connections to PSTN lines through standard plugs and jacks as specified in the FCC rules. The PSTN line connector plugs into J1 on the modem. Notify your telephone company that the jack (connector) required for your device is one of the following:
  - USOC: RJ11C **or**
  - USOC: RJ11W

Note: The jack provided on the Modem (J1) is a 6-pin TELCO RJ-11. The connections to the modem are pin 3 PSTN-Tip, and pin 4 PSTN-Ring.

- After the telephone company has installed the above jack, connect the modem to your equipment by inserting the appropriate equipment interface RJ11 plug into the modem and wall connector.

2.11 Bezels

Bezels are blue plastic covers (see *Figure 2-37*) that protect an adjacent pair of I/O modules and provide an easy way for you to route wiring. The factory provides bezels with each order. Install bezels over I/O modules whenever the ControlWave EFM is operational; remove the bezels for maintenance procedures.

Bezels attach to the module covers of two adjacent I/O modules. Hooks on the bezels (see *Figure 2-37*) attach to notches in the upper and lower portions of the module covers. Align the hooks on the bezel with the notches on the I/O module covers and slide the bezel down. To remove the bezel, grasp its sides and gently squeeze them, and pull up and then away from the I/O modules.

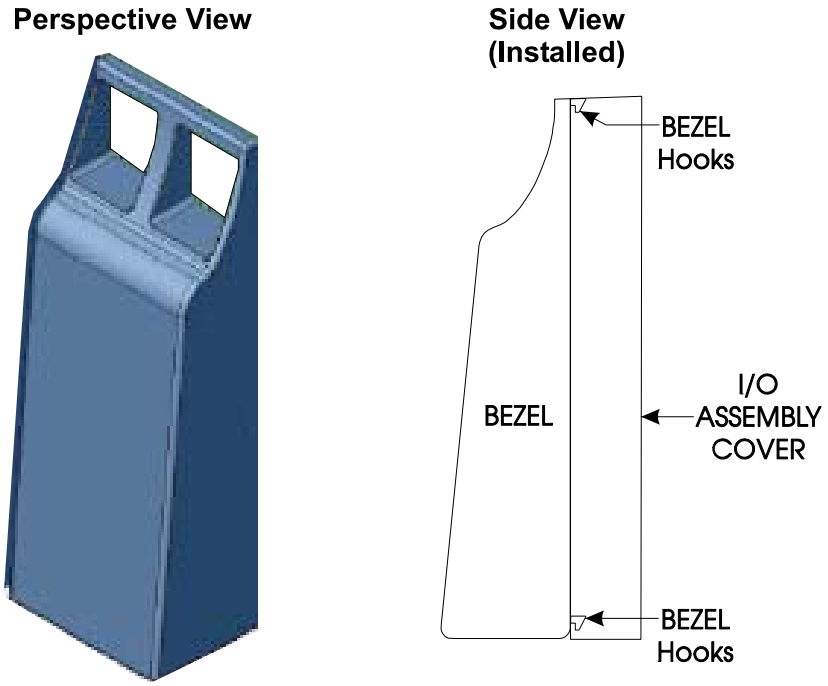


Figure 2-37. Bezel Assembly

2.12 Case Mounted Radio/Modem

An alternative to using a Type 1 ECOM module with an integrated modem/radio is to order a case-mounted modem/radio. In this configuration, the ControlWave EFM ships from the factory with a user selected radio or modem installed within the enclosure (beneath the battery mounting bracket) or as a radio-ready unit, in other words, ready for field installation of a factory-supplied radio. The installer must ensure that the remote antenna (associated with a case mounted radio) is properly installed and connected.

- See the *ControlWave Radio-Ready Installation Guide* (D5138) for information on installing factory-supplied radios in the field.
- See the *ControlWave PSTN Modem Installation Guide* (D301734X012) for information on installing the 9600 bps PSTN modem.

2.13 Optional Display/Keypads

The ControlWave EFM supports two optional display/keypads:

- A 2-button keypad (shown in the left of *Figure 2-38*)
- A 25-button keypad (shown in the right *Figure 2-38*)

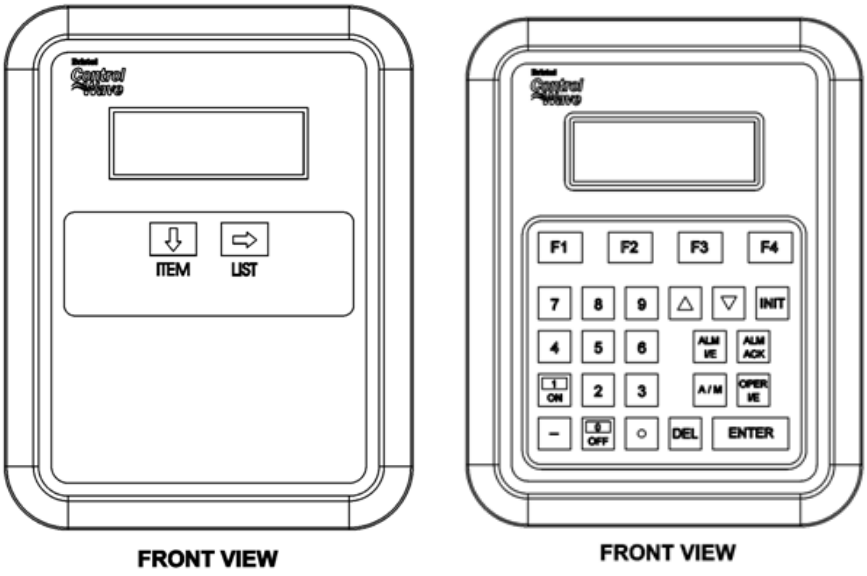


Figure 2-38. Optional 2-Button and 25-Button Keypads

Both keypads use the same 4-line by 20-character LCD displays. You connect the keypad to the ControlWave EFM using a cable, one end of which has an RJ-45 jack (connected into the RJ-45 equipped with two plugs). This cable connects between the RJ-45 display jack (J2) on the SCM module and RJ-45 jack (J1) on the remote Display/Keypad assembly. A potentiometer, provided on the keypad, allows you to set the contrast of the LCD display.

Note: For further information on the installation and use of the optional keypads, refer to the *ControlWave Display/Keypad Manual (D5135)*.

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Chapter 3 – I/O Modules

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

In This Chapter

Installation

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

1. Remove the I/O module and associated I/O module cover from the shipping carton. The cover snaps on or off to provide access to the unit's I/O connectors.

Notes:

- I/O modules for the ControlWave EFM use local termination where field wiring connects directly to the I/O module's removable terminal blocks**.**
- You can use the ControlWave Loop Power Supply to provide regulated and isolated 24Vdc field power for externally powered non-isolated I/O. See *PIP-ControlWaveLS.*
- Modules normally ship from the factory completely assembled.

2. When installing wiring in conjunction with the I/O modules, install the field wiring between the I/O module's removable terminal blocks and field devices. (See *Section 3.2 Wiring*.)
3. Align the I/O module with its intended slot on the base housing and slide the module into the housing. Make sure the module I/O module cover snaps into the appropriate securing notches on the housing.
4. Plug the local cable assemblies into the appropriate I/O module connectors

5. After installing and wiring two I/O modules into adjacent slots in the housing, cover the modules with a protective bezel. The bezels snap on and off for maintenance.
6. Using a PC running the ControlWave Designer and OpenBSI software, configure the ControlWave EFM to accept the new I/O modules and download the revised ControlWave project.

Note: This step is beyond the scope of this manual and is only required if you are not using the base flow measurement application which has I/O already defined. Refer to the *ControlWave Designer Programmer's Handbook* (D5125) for further instructions.

Caution

Power down the ControlWave EFM before you install or remove any I/O module. Shut down any processes the ControlWave EFM may be managing (or switch them over manually or handle with another controller). Perform any hardware configuration (wiring, jumper configuration, and installation) only when the ControlWave EFM is powered down.

Before any I/O modules can become operational, you must use ControlWave Designer to configure and then download the application (project). The exception to this is if the application is already configured for you.

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

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

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

3.1 Module Placement

You can place I/O modules in the housing:

- 4-slot housing: supports up to two I/O modules in slots 3 and 4.
- 8-slot housing: supports up to six I/O modules in slots 3 through 8.
- Optionally you can install an expansion communication module in slot 3, slot 4, or both, instead of an I/O module.

Note: Some modules have placement restrictions. Note these in the individual descriptions.

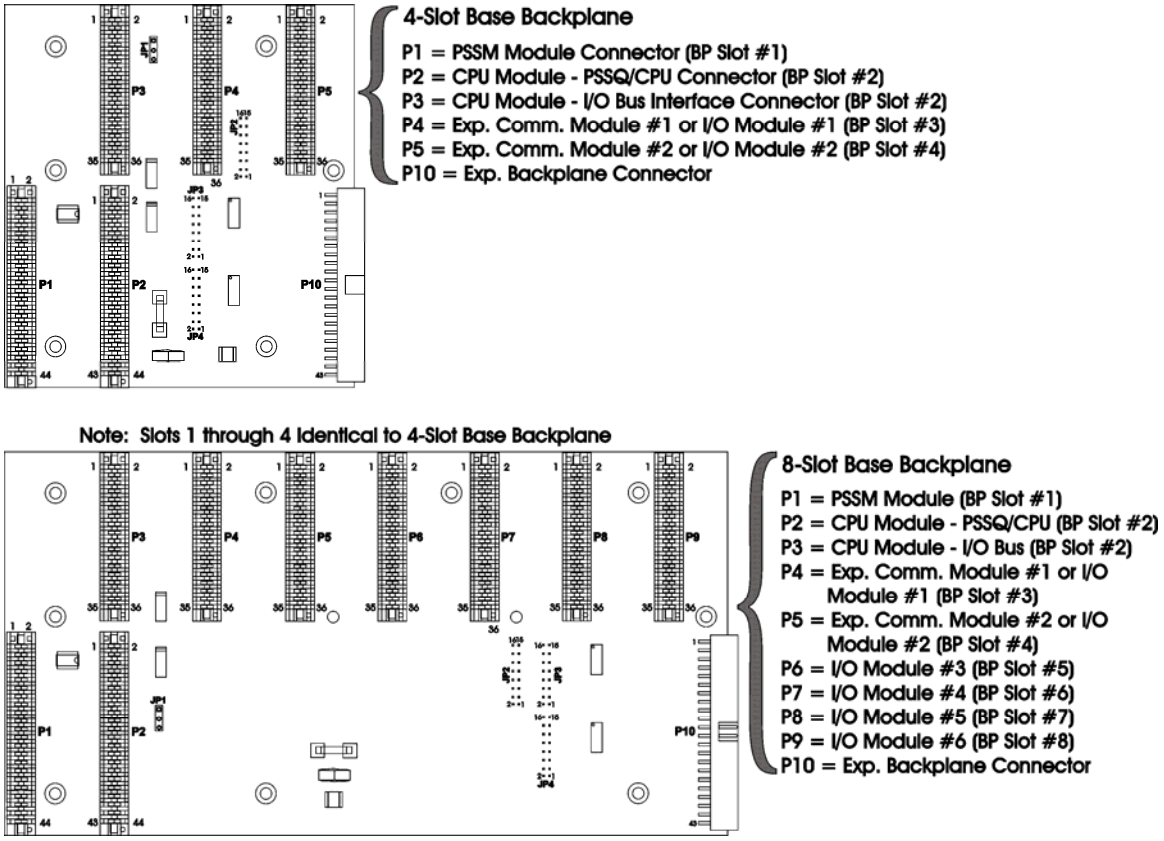


Figure 3-1. ControlWave EFM Slot Assignments

3.2 Wiring

I/O modules support local termination where field wiring connects directly to the module's removable terminal blocks.

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

3.2.1 Local Termination

For I/O modules equipped with local terminal blocks, install the field wiring between the I/O module's removable terminal block connectors and field devices (see *Figure 3-1*). Use AWG 14 or smaller wire (consult with the field device manufacturer for recommendations). Leave some slack and plan for wire routing, identification, and maintenance. Route the bundled wires out through the bottom of the I/O

module assembly between the terminal block and the terminal housing. All I/O wiring should be routed in/out of the enclosure through the 1" NPT conduit hub.

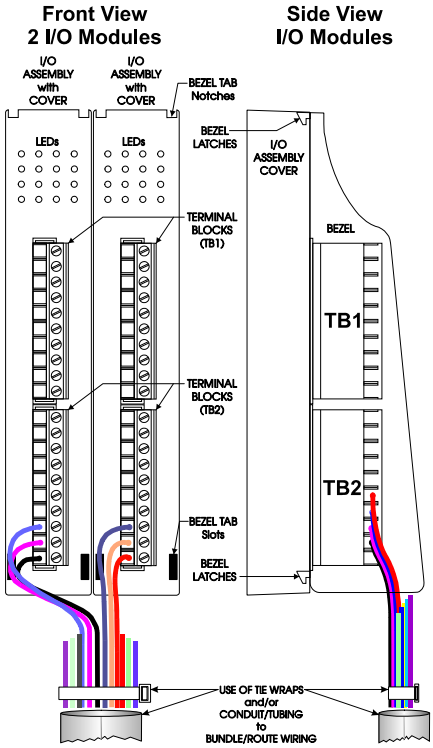


Figure 3-2. Module Wiring: Local Termination

3.2.2 Shielding and Grounding

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

3.3 Non-isolated Digital Input/Output (DI/O) Module

Non-isolated DI/O modules consist of a digital input/output PCB with two 10-point terminal block assemblies for local termination. The DI/O module also includes 14 configuration jumpers, an LED board with 16 status LEDs (one for each point), and a cover assembly. The DI/O module connects with the backplane using a 36-pin gold-plated card-edge connector.

Non-isolated DI/O modules contain field interface circuitry for up to 12 digital inputs and four digital outputs.

Table 3-1. Non-Isolated DI/DO Module General Characteristics

Type	Number Supported	Characteristics
Digital Inputs (DI)	12	Each DI supports/ includes: ▪ Internally sourced DI operation for dry contacts pulled internally to 3.3Vdc when field input is open. ▪ Surge suppressor ▪ Signal conditioning ▪ Filter time of 15 ms ▪ Jumper to configure source current for either 2 mA or 60 uA ▪ Dedicated LED on module turns ON when DI is ON.
Digital Outputs (DO)	4	Each DO supports/ includes: ▪ Open drain MOSFET provides 100mA at 30Vdc to an externally powered device. ▪ Surge suppressor ▪ Current sink to ground of DI/DO module ▪ Dedicated LED on module turns ON when DO is ON.

Detailed Technical Specifications

For detailed technical specifications, please see our website http://www.emersonprocess.com/remote.

Setting Jumpers

DI/O modules provide 12 individually field configurable DIs and 4 non-configurable externally powered DOs.

Using configuration jumpers W1 through W12, you can set each DI individually to provide either a 2 mA or 60 uA source current. *Table 3-2* details jumper settings.

Table 3-2. Jumper Assignments: Non-isolated DI/O Module

Jumper	Purpose	Description
W1-W12	Configures DI1 through DI12 (respectively)	Pins 1-2 installed = 2mA Source Current Pins 2-3 installed = 60uA Source Current
W13	Enables LEDs	Pins 1-2 installed = allows manual enabling of LEDs

Jumper	Purpose	Description
		Pins 2-3 installed = allows software enabling of LEDs
W14	Programs Serial EEPROM	**Reserved for factory use only**

Wiring the Module

Figure 3-3 shows the terminal block assignments for the locally terminated DI/O module.

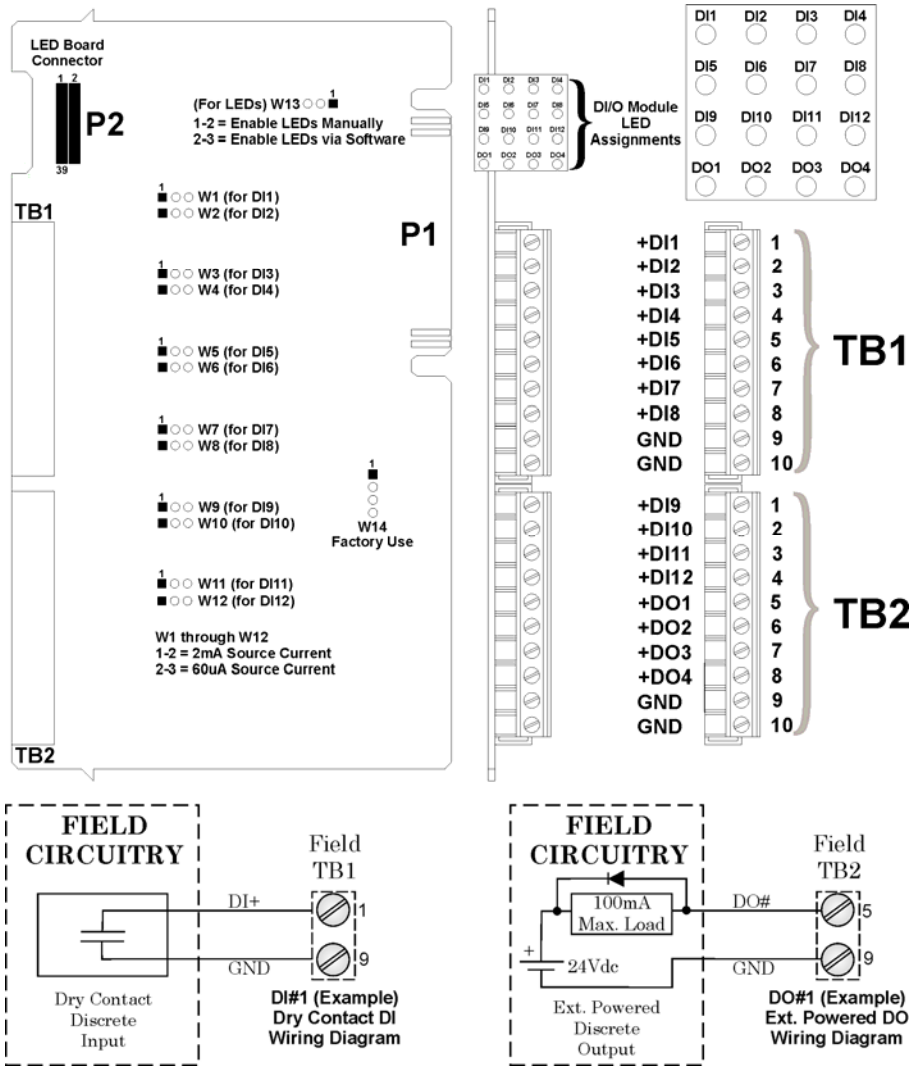


Figure 3-3. Non-isolated DI/O Module (Local Termination)

Software Configuration

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

3.4 Non-isolated Analog Input/Output & Analog Input Module

Non-isolated Analog Input/Output (AI/O) modules support six externally sourced 4–20mA or 1–5 Vdc single-ended analog inputs and optionally, two independently configurable 4–20 mA or 1–5 Vdc analog outputs. **Non-isolated Analog Input (AI) modules are identical to AI/O modules but have a depopulated AO section.**

AI/O modules consist of an AI/O PCB with two 10-point terminal block assemblies for local termination, 12 configuration jumpers, and a cover assembly. The AI/O module connects with the backplane using a 36-pin gold-plated card-edge connector.

Table 3-3. Non-Isolated AI/O and AI Module General Characteristics

Type	Number Supported	Characteristics
Analog Inputs (AI)	6 on AI/O Module 6 on AI Module	Each AI supports/includes: ▪ Jumper to configure input for either 4–20mA or 1–5 Vdc ▪ Signal conditioning that provides 2 Hz low pass filter ▪ Transorb for surge suppression ▪ Analog to Digital converter
Analog Outputs (AO)	2 on AI/O Module None on AI Module	Each AO supports/includes: ▪ Jumper to configure output for either 4–20mA or 1–5 Vdc ▪ maximum external load to the 4–20mA output of either 250 ohms with an external 11V power source or 650 ohms with an external 24V power source. ▪ maximum external load current to the 1–5 Vdc output is 5 mA with an external 11-30 V power source. ▪ AO operation requires an 11–30Vdc power source connected to the VEXT terminal of the AI/O module.

Detailed Technical Specifications

For detailed technical specifications, please see our website http://www.emersonprocess.com/remote.

Configurations

Each non-isolated **AI/O** module (general part number **396568-01-7**) consists of a PCB with six AIs, 2 AOs, and comes with a module cover.

Each non-isolated **AI** module (general part number **396569-01-3**) consists of a PCB with six AIs and comes with a module cover.

Cable Shields

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

to the housing's ground lug.

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

Setting Jumpers

AI/O and AI modules have jumpers you can use to configure each of the six AIs. You can individually configure AIs for 1–5 Vdc or 4–20 mA operation. See *Table 3-4*.

Table 3-4. Jumper Assignments: Non-isolated AI/O and AI Module

Jumper	Purpose	Description
JP1-JP6	Configures AI1 through AI6 (respectively)	Pins 1-2 installed = 4-20 mA AI Pins 2-3 installed = 1-5 V AI
JP7[1]	AO1 Field Output	Pins 1-2 installed = 4-20 mA AO Pins 2-3 installed = 1-5 V AO
JP8[1]	AO2 Field Output	Pins 1-2 installed = 4-20 mA AO Pins 2-3 installed = 1-5 V AO
JP9[1]	AO1 Output Type	Pins 1-2 installed = 1-5 V AO Pins 2-3 installed = 4-20 mA AO
JP10[1]	AO2 Output Type	Pins 1-2 installed = 1-5 V AO Pins 2-3 installed = 4-20 mA AO
JP1	Configures ISP Connector	**Reserved for factory use only**
W1	Programs Serial EEPROM	**Reserved for factory use only**

1 Configuration for JP7 and JP9 must match (that is, both 1-5 V or 4-20mA)
Configuration for JP8 and JP10 must match (that is, both 1-5 V or 4-20mA)

Wiring the Module

Figure 3-4 shows field wiring assignments associated with the locally terminated AI/O and AI modules.

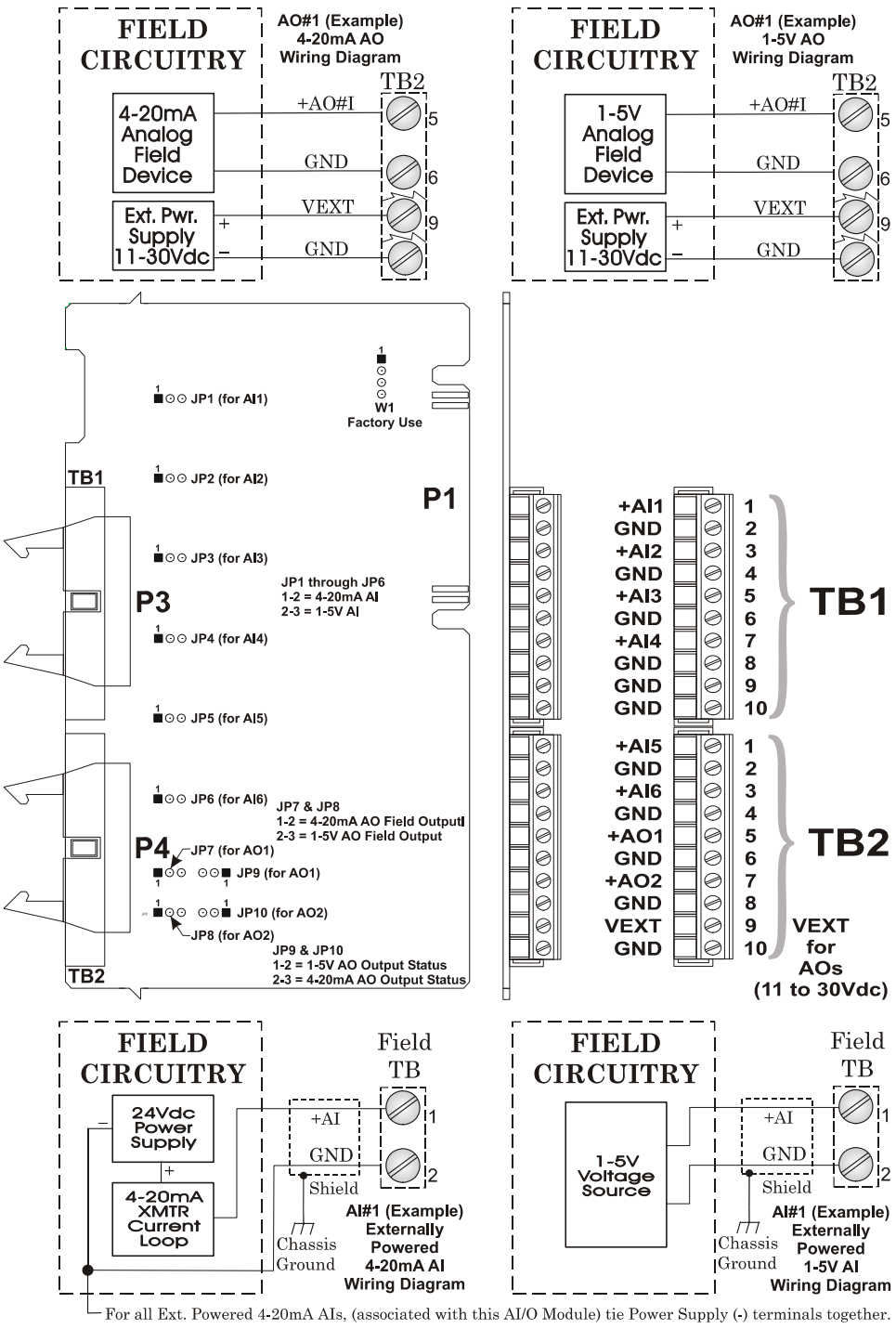


Figure 3-4. Non-isolated AI/O and AI Module Configuration (Local Termination)

Software Configuration

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

3.5 Non-isolated High Speed Counter (HSC) Input Module

Non-isolated High Speed Counter (HSC) Input modules provide up to four inputs. You can individually configure HSC module inputs for either a 10 KHz (high speed) or 300 Hz (low speed) input, and as a 16-bit high speed counter

HSC modules consist of a HSC PCB with two 10-point terminal block assemblies for local termination, 14 configuration jumpers, an LED daughter board with four status LEDs (one for each point), and a cover assembly. The HSC PCM connects with the backplane using a 36-pin gold-plated card-edge connector.

Table 3-5. High Speed Counter Module General Characteristics

Type	Number Supported	Characteristics
High Speed Counter Inputs (HSC)	4	Each HSC supports/includes: ▪ Jumper to configure point as either a low speed input (300 Hz) or a high speed input (10 KHz). ▪ Jumper to configure HSC current. ▪ Bandwidth limiting ▪ Surge suppression ▪ Field inputs can be driven by signals or relay contacts. ▪ LED status indicator

Detailed Technical Specifications

For detailed technical specifications, please see our website http://www.emersonprocess.com/remote.

Setting Jumpers

HSC modules support up to four HSC inputs. Configure the HSC jumpers (W1 through W14) according to *Table 3-6*.

Table 3-6. Jumper Assignments: Non-isolated HSC Module

Jumper	Purpose	Description
W1 – W4	Configures HSC1 through HSC4 (respectively)	Pins 1-2 installed = Enables 300 Hz (low speed input) Pins 2-3 installed = Enables 10 KHz (high speed input)
W5	Programs Serial EEPROM	**Reserved for factory use only**
W6	Enables LEDs	Pins 1-2 installed = Enables LEDs manually Pins 2-3 installed = Enables LEDs via software
W7 & W8	Controls HSC1 Current	Pins 1-2 installed = Enables additional 2 mA load Pins 2-3 installed = Enables 200 uA source; no 2 mA load
W9 & W10	Controls HSC2 Current	Pins 1-2 installed = Enables additional 2 mA load Pins 2-3 installed = Enables 200 uA source; no 2 mA load
W11 & W12	Control HSC3 Current	Pins 1-2 installed = Enables additional 2 mA load Pins 2-3 installed = Enables 200 uA source; no 2 mA load
W13 & W14	Controls HSC4 Current	Pins 1-2 installed = Enables additional 2 mA load Pins 2-3 installed = Enables 200 uA source; no 2 mA load

Wiring the Module

Figure 3-5 shows field wiring assignments for the locally terminated HSC module.

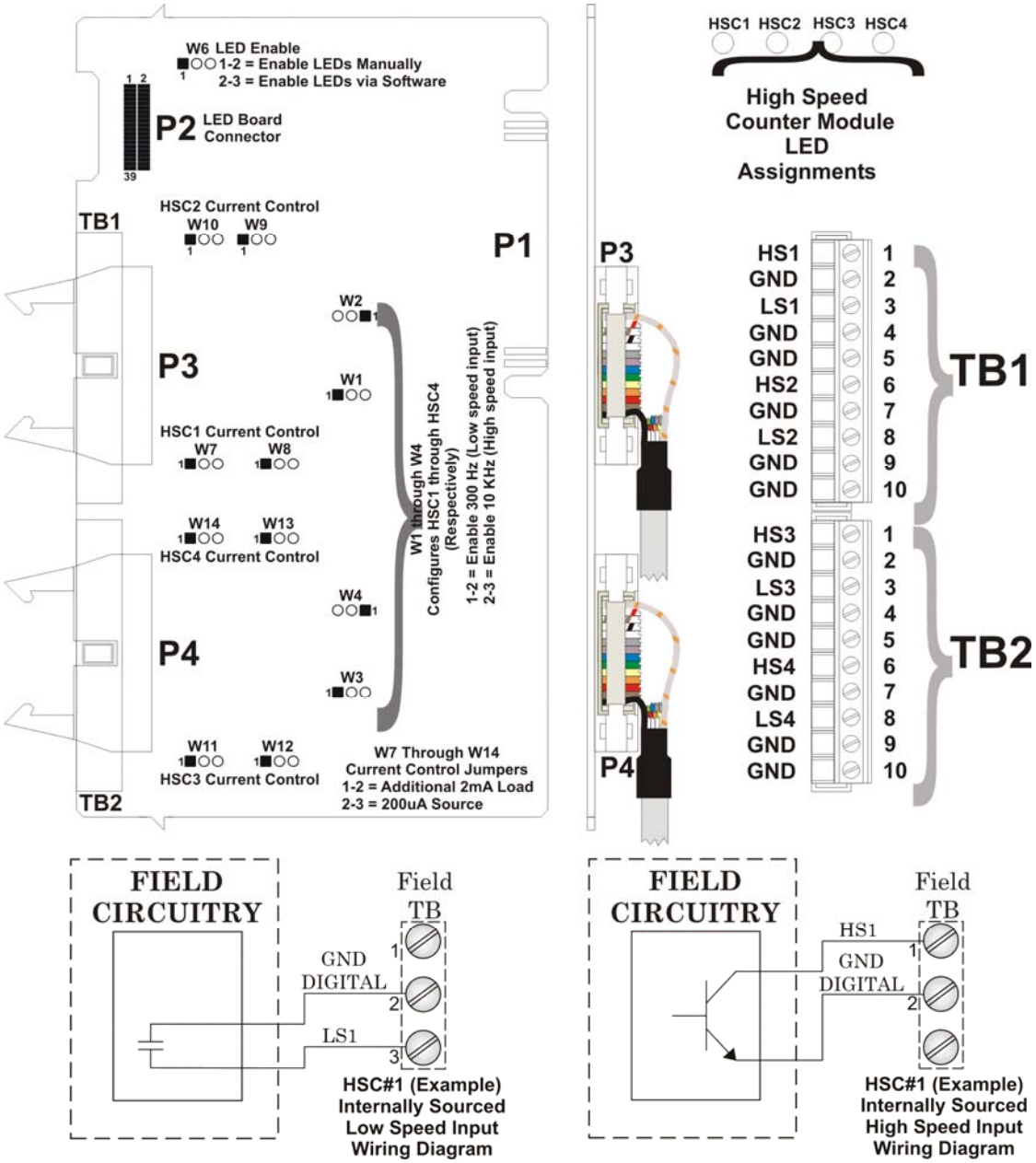


Figure 3-5. Non-isolated HSC Module (Local Termination)

Software Configuration

To use data from a high speed counter module you must add a **CWM_HSC4** board in ControlWave Designer's I/O Configurator, and then configure it. See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

3.6 Non-isolated Mixed I/O (MI/O) Module

Non-isolated Mixed I/O (MI/O) modules provide up to six individually field configurable DI/Os, four AIs, two HSC Inputs and, optionally, one AO.

MI/O modules consist of an MI/O PCB with two 10-point terminal block assemblies (TB1 and TB2) for local termination, 28 configuration jumpers, and a module cover. The MI/O PCB connects to the backplane using a 36-pin gold-plated card-edge connector.

Note: Unless otherwise noted, I/O circuitry is identical to circuitry used on corresponding I/O modules in earlier sections of this chapter.

The high speed counters support surge suppression, bandwidth limiting, and 20 µs (50 kHz) filtering. You can individually field configure the HSC inputs to enable/disable contact debounce circuitry and for 2 mA or 200µA (low power) operation. The maximum frequency of an HSC input signal is 15 kHz.

Detailed Technical Specifications

For detailed technical specifications, please see our website http://www.emersonprocess.com/remote.

Optional AO

Optionally, certain configurations of MI/O modules can also support one externally powered (VEXT = 11–30 Vdc) analog output.

AO circuitry consists of a 12-bit resolution Digital-to-Analog Converter (DAC).

Configurations

The non-isolated Mixed I/O (MI/O) module (general part number **396630-XX-X**) has the following configurations:

Table 3-7. Mixed I/O Module Configurations

Part Number	I/O Included	Termination Connector	Notes
396897-01-0	4AI, 2HSC, 6DI/DO	local	includes LED daughterboard
396897-02-9	4AI, 2HSC, 6DI/DO & 1AO (on daughterboard)	local	includes LED daughterboard

Setting Jumpers

MI/O modules have 28 jumpers you can use to configure each input or output. See *Table 3-8.* See *Figure 3-7* for jumper locations.

Table 3-8. Jumper Assignments: Non-isolated MI/O Module

Jumper	Purpose	Description
W1[1]	Configures optional AO for voltage or current output	Pins 1-2 installed = Sets AO for current output Pins 2-3 installed = Sets AO for voltage output
W2	Configures optional AO for voltage or current output	Pins 1-2 installed = Sets AO for voltage output Pins 2-3 installed = Sets AO for current output
W3	Enables DI/DO status LEDs	Pins 1-2 installed = Enables LEDs manually Pins 2-3 installed = Enables LEDs via software
W4	Enables HSC status LEDs	Pins 1-2 installed = Enables LEDs manually Pins 2-3 installed = Enables LEDs via software
W5 & W6	Controls HSC1 Current	Pins 1-2 installed = Permits additional 2 mA load Pins 2-3 installed = Permits 200 uA source; no 2 ma load
W7 & W8	Controls HSC2 Current	Pins 1-2 installed = Permits additional 2 mA load Pins 2-3 installed = Permits 200 uA source; no 2 ma load
W9 & W10	Configures HSC1 and HSC2 debounce (respectively)	Pins 1-2 installed = Enables HSC debounce Pins 2-3 installed = Disabled HSC debounce
W11-W16	Configures DI1 through DI6 current (respectively)	Pins 1-2 installed = Sets 2 mA source current Pins 2-3 installed = Sets 60 uA source current
W17-W22	Select DI/O1 through DI/O6 points (respectively)	Pins 1-2 installed = Sets digital input operation Pins 2-3 installed = Sets digital output operation
W23-W26	Configures AI1 through AI4 (respectively)	Pins 1-2 installed = 4–20 mA AI (250Ω resistor in) Pins 2-3 installed = 1–5 Vdc AI
W27[2]	Selects AO Voltage	Pins 1-2 installed = N/A Pins 2-3 installed = External Field Voltage (TB2-9)
W28	Enables HSC Circuitry	Pins 1-2 installed = Enable (power) HSC circuit Pins 2-3 installed = Disable HSC circuit

1 W1 jumper located on optional AO daughterboard.
2 Set W27 **always** to pins 2-3.

Wiring the Module

Figure 3-6 shows field wiring assignments for a locally terminated MI/O module. See *Figure 3-7* for jumper locations and terminal blocks.

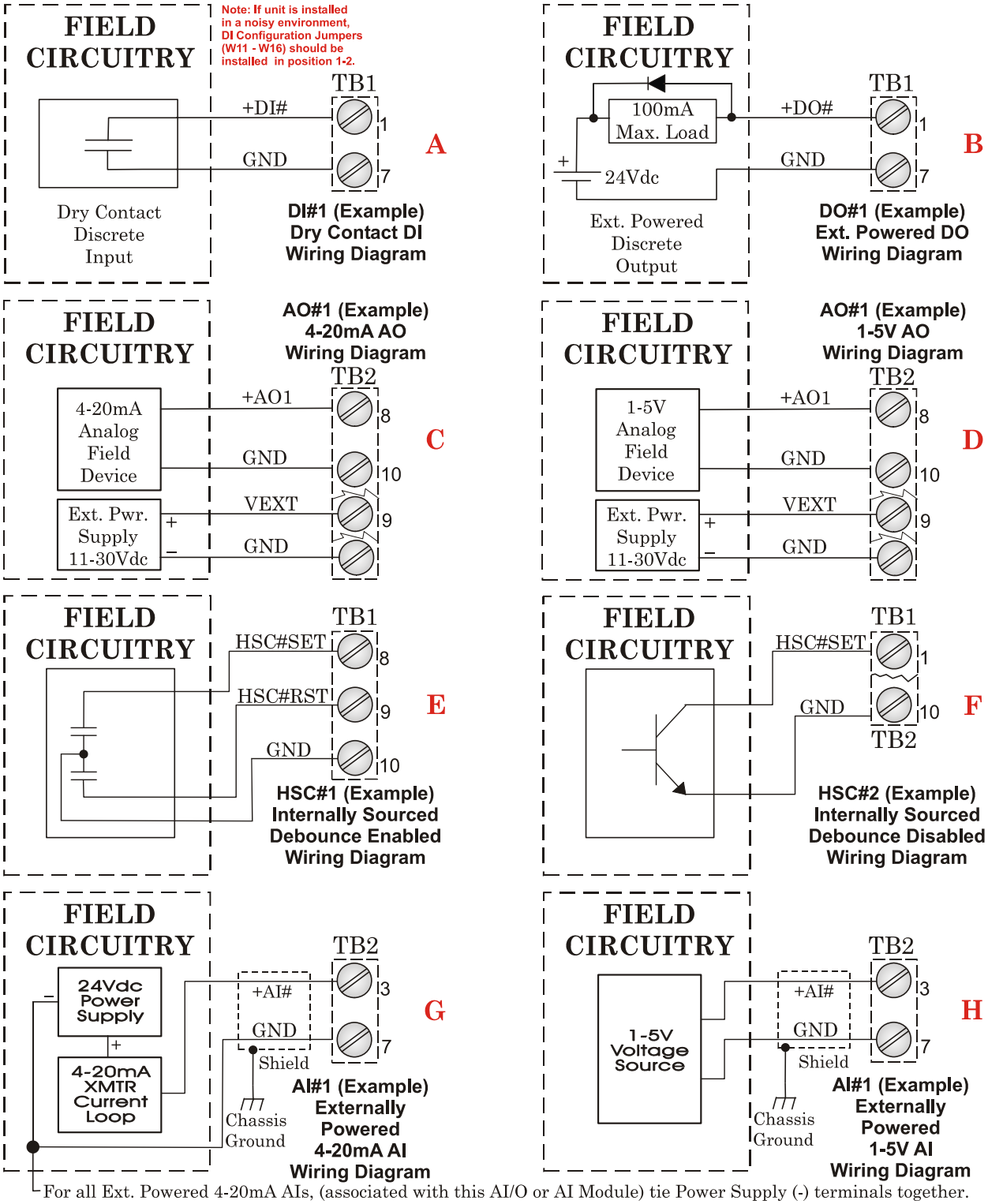


Figure 3-6. Mixed I/O Module Wiring Diagram

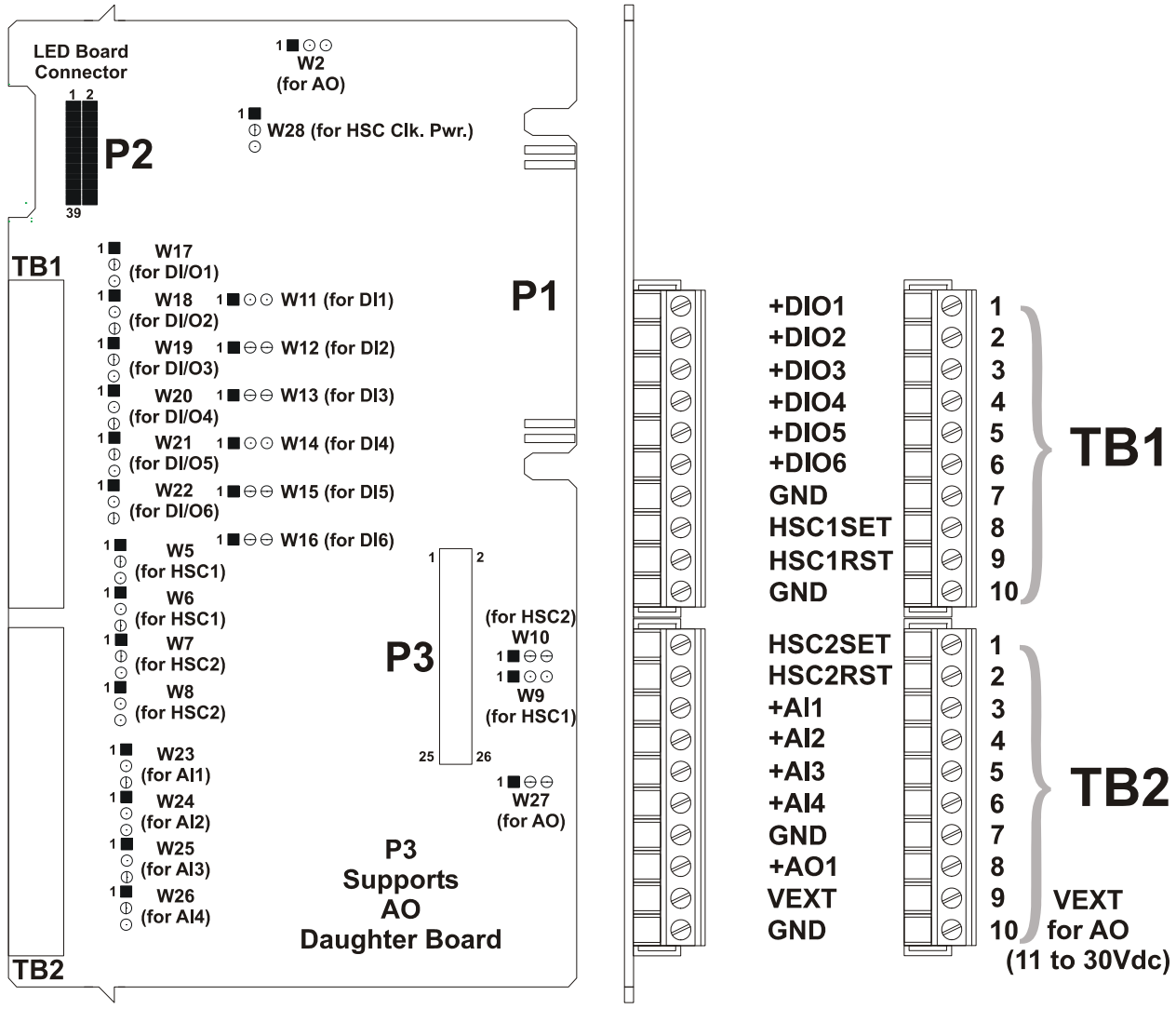


Figure 3-7. Non Isolated Mixed I/O Module Configuration Diagram

Software Configuration

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

3.7 Resistance Temperature Device (RTD) Inputs on SCM

System controller module connector TB2 provides connection to a 3-wire 100 ohm platinum bulb RTD (using the DIN 43760 curve).

Wire the RTD according to *Table 3-9*, *Figure 3-8* and *Figure 3-9*. In this configuration, the return lead connects to the RTD- terminal and the two junction leads (Sense and Excitation) connect to the RTD+ and RTD EXC terminals.

Caution

Never ground the RTD cable shield at both ends or allow it to come in contact with metallic/conductive conduit because multiple ground paths can cause RTD input errors.

Table 3-9. RTD Connections to System Controller Module Connector TB2

TB2 Pin	Signal	Function
1	RTD EXC	Excitation
2	RTD+	Sense
3	RTD-	Return

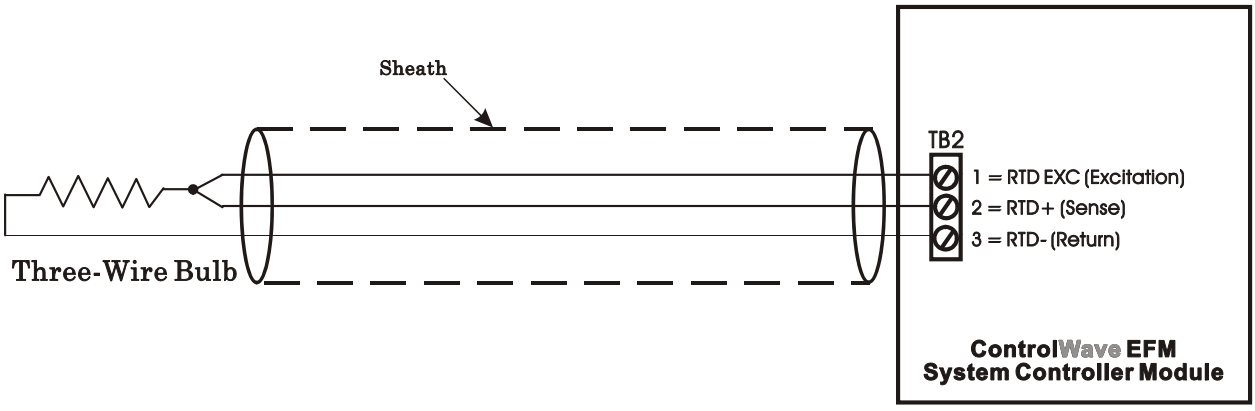


Figure 3-8. 3-Wire RTD Temperature Input Wiring

Installing the RTD Probe

To install the RTD probe, screw the fitting body into the thermowell with a 7/8” open-end wrench. While you apply pressure against the sheath to force the tip of the RTD probe into the bottom of the thermowell (so that the probe tip is in contact with the bottom of the thermowell), tighten the 9/16” nut using an open-end wrench against the 7/8” fitting body.

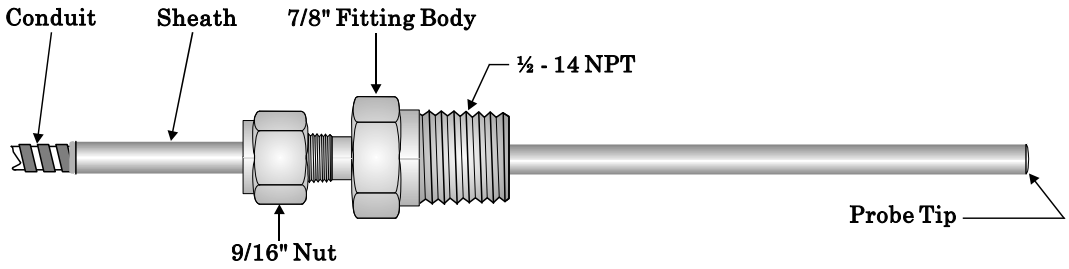


Figure 3-9. RTD Probe Installation/Removal Diagram

Software Configuration

To use data from the RTD your ControlWave project must include a **CWM_ECPU** which you set up using ControlWave Designer’s I/O Configurator. See the *ControlWave Designer Programmer's Handbook* (D5125) for more information. That same manual includes an *I/O Mapping* section that describes, for advanced users, the I/O map for this module.

3.8 Digital to Relay I/O Board Option

Digital to relay I/O boards accept up to two discrete input signals from an open drain MOSFET device and convert them to Form C relay output signals using solid state relay (SSR) logic. The minimum current load will be 100mA. *Figure 3-10* provides a component view of the Digital to Relay I/O Board.

Each ControlWave EFM discrete output is converted to a Form C relay output signal which can be configured for opposite or identical state conditions, i.e., both Normally Open (NO) or Normally Closed (NC) or one Normally open with the other Normally Closed.

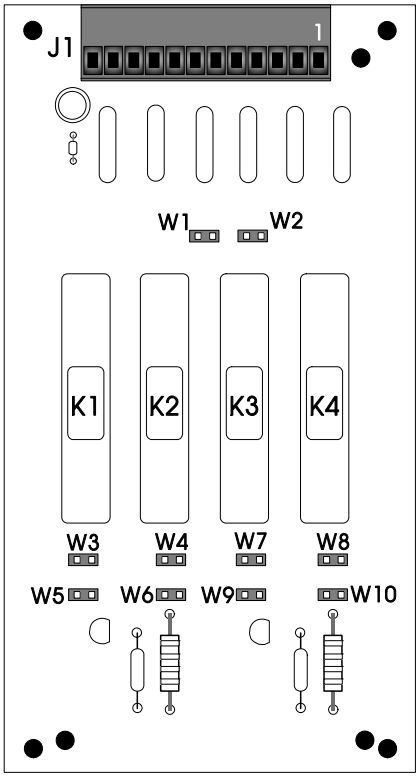


Figure 3-10. Digital to Relay I/O Board

Digital to Relay I/O Board Jumper Settings

The Digital to Relay I/O Board contains ten (10) Jumpers which allow you to configure contacts for Normally Open/Normally Closed states. You can configure contacts associated with each of the Form C Relays for identical or opposite states.

Note: Jumper Pairs W3/W5, W4/W6, W7/W9 and W8/W10 must be set in opposite states.

You can optionally tie the commons associated with each form C relay (R0COM and R1COM) to the ControlWave EFM power ground or to a floating ground. Jumper W1 is associated with Outputs R0A and R0B and W2 is associated with outputs R1A and R1B. When you install jumper W1, it ties the common (C) associated with outputs R0A and R0B to ControlWave EFM power ground; when jumper W1 is not installed, the common is floating. When you install jumper W2 it ties the common (C) associated with outputs R1A and R1B to ControlWave EFM power ground; when jumper W2 is not installed, the common will be floating.

Table 3-10 provides the relationship between Jumper settings and Form C Relay Outputs.

Table 3-10 Jumper Settings versus Form C Relay Output States

Jumpers W3/W5	R0A State	Jumpers W4/W6	R0B State	Jumpers W7/W9	R1A State	Jumpers W7/W9	R1B State
IN/OUT	NO	IN/OUT	NO	IN/OUT	NO	IN/OUT	NO
OUT/IN	NC	OUT/IN	NC	OUT/IN	NC	OUT/IN	NC

NO = Normally Open; NC = Normally Closed

Table 3-11 - Digital to Relay I/O Board Connections to J1/P1

J1 Pin	Signal	Function	Wiring Connections
1	R1B	Relay 1 Output B	To field
2	R1A	Relay 1 Output A	To field
3	R1COM	Relay 1 Common	To field (see W2)
4	Chassis GND	Chassis Ground	Chassis ground lug
5	R0COM	Relay 0 Common	To field (jumper W1)
6	R0B	Relay 0 Output B	To field
7	R0A	Relay 0 Output A	To field
8			
9	Power GND	Power ground	Power distribution board TB4 pin 2 (black wire)
10	Power – DC	Power – 6/12 V dc	Power distribution board TB4 pin 1 (red wire)
11	DOut0	Discrete Output 0	DI/O module TB 2-5 through TB 2-8 or mixed I/O module TB1-1 through TB1-6 (yellow wire)
12	DOut1	Discrete Output 1	DI/O module TB 2-6 through TB 2-8 or mixed I/O module TB1-2 through TB1-6 (orange wire)

The DI/DO module *(Section 3.3)* and the mixed I/O module *(Section 3.6)* provide independent firmware controlled open drain outputs, which can be used for control or signaling functions (DI/DO Modules provide up to four DO while the mixed I/O module provides up to 6 DO). Each output is wired to the source terminal of an N Channel MOSFET capable of switching up to 16 Volts at up to 100mA. When closed, the FET shorts the output to ground with resistance of .5 Ohms or less. These outputs are protected by 16V Transorbs.

⚠ Caution **Since these outputs are not isolated, exercise care to ensure that the load current does not affect operation of the ControlWave EFM or related devices**

You can wire two of these outputs to field circuitry via the Digital to Relay I/O Board option (see *Figure 3-11*). *Table 3-11* provides the wiring connections for the DI/O module or the mixed I/O module and the Digital to Relay I/O Board.

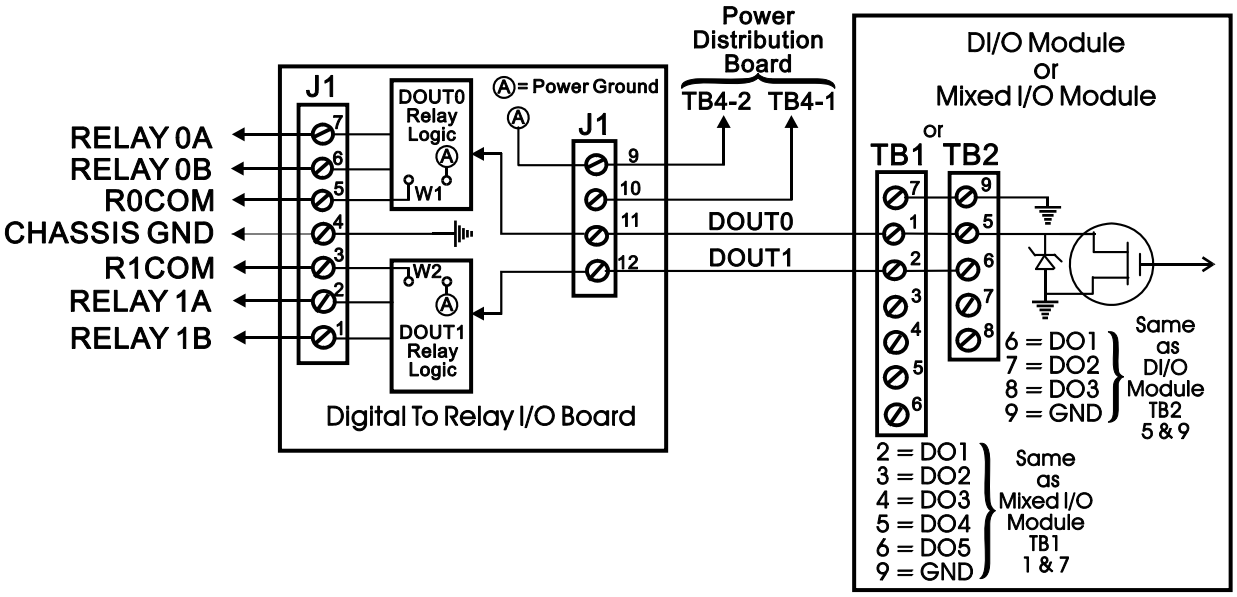


Figure 3-11. Digital to Relay I/O Board Wiring Diagram

3.9 Connections to a Bristol Model 3808 Transmitter

You can connect a Bristol 3808 transmitter (digital) to the ControlWave EFM through either an RS-232 or RS-485 port. Communication schemes and cable lengths determine the type of communication port you need to use. In general RS-232 communications require that you place the 3808 transmitter within 25 feet of the ControlWave EFM (local communications). You can use RS-485 communications to reach transmitters up to 4000 feet away (remote communications).

Figure 3-12 details RS-232 wiring connections required between the ControlWave EFM and the 3808 transmitter.

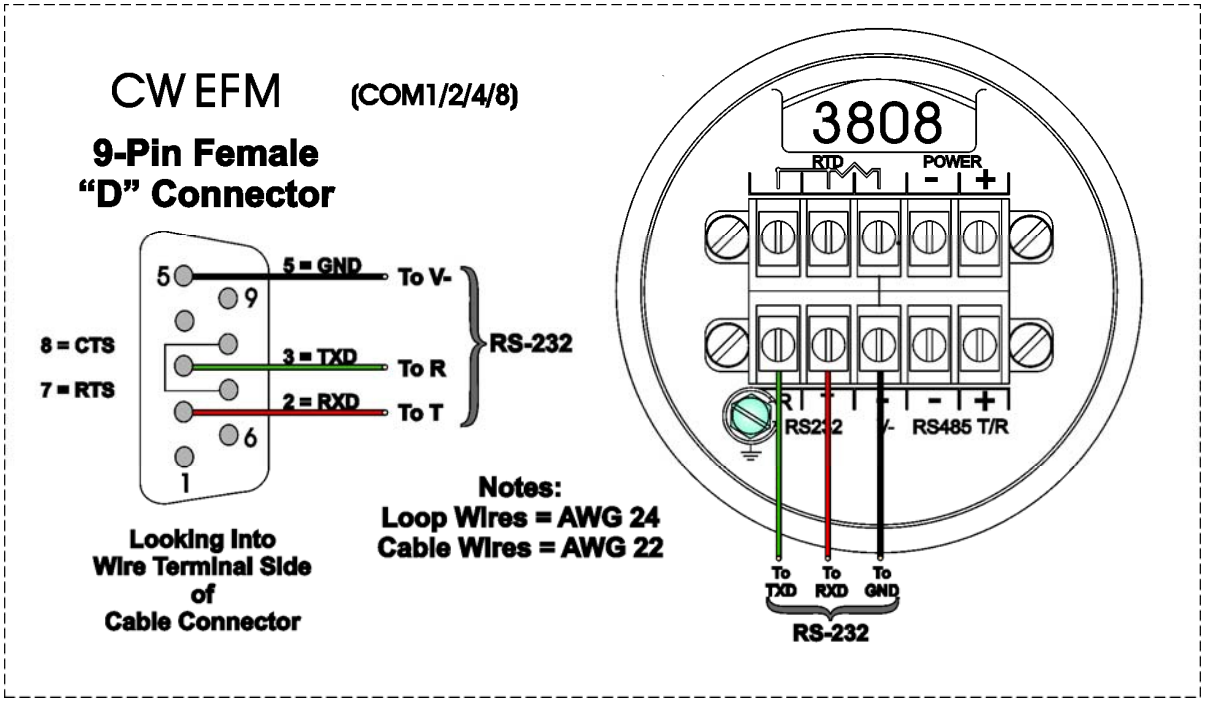


Figure 3-12. 3808 Transmitter to ControlWave EFM RS-232 Comm. Cable Diagram

Figure 3-13 details RS-485 wiring connections required between the ControlWave EFM and the 3808 transmitter.

Note: For loopback and termination control use switch SW3 on the CPU module to configure COM3. Use switch SW1 on the ECOM module to configure COM5 or COM9.

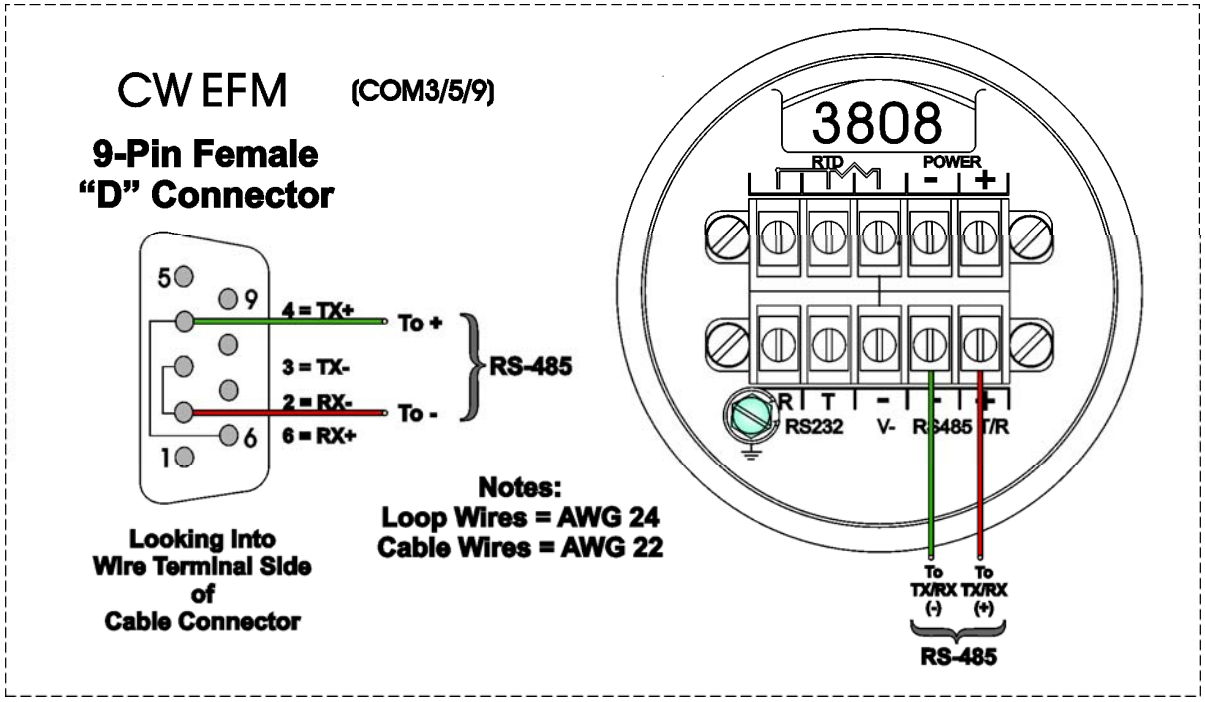


Figure 3-13. 3808 Transmitter to ControlWave EFM RS-485 Comm. Cable

You can connect up to eight (8) Bristol 3808 transmitters to a ControlWave EFM using a half-duplex RS-485 network. See *Figure 3-14* for an illustration of this type of network.

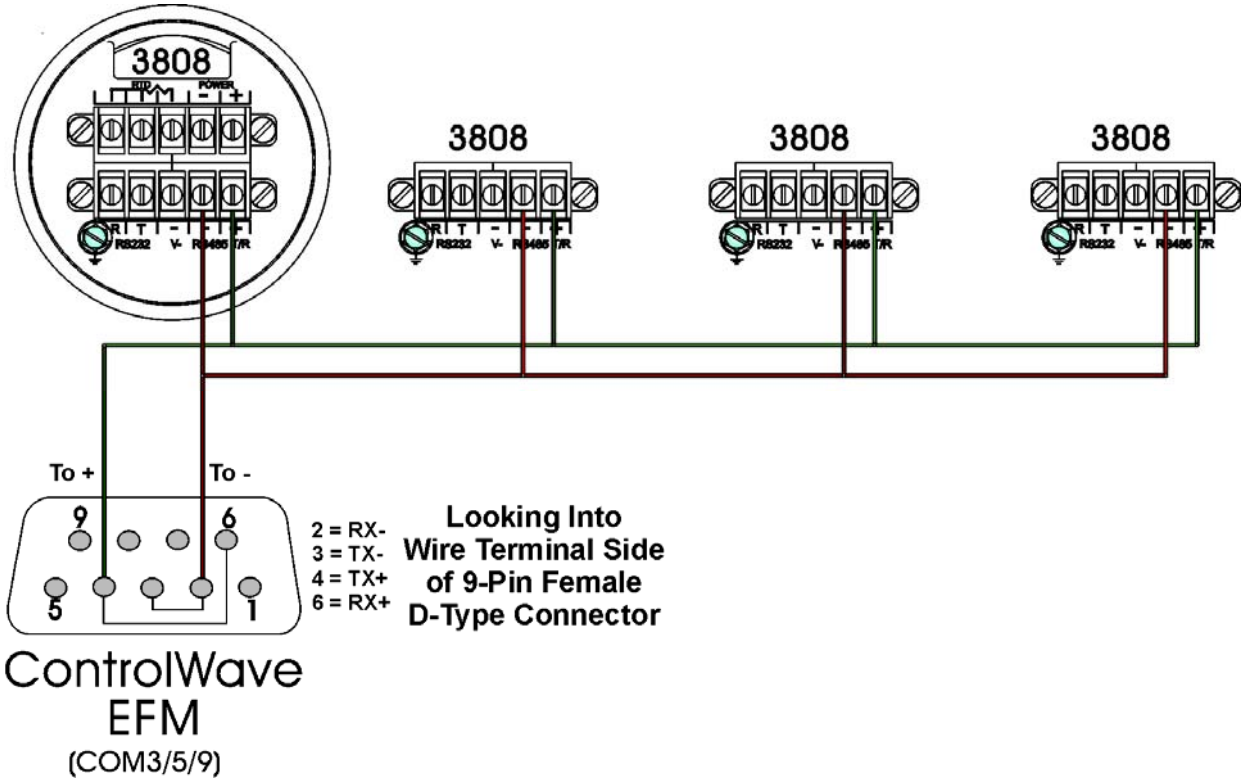


Figure 3-14. ControlWave EFM to 3808s - RS-485 Network Diagram

Chapter 4 – Operation

This chapter provides general operational details for using the ControlWave EFM.

In This Chapter

WARNING

EXPLOSION HAZARD

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

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

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

4.1 Powering Up/Powering Down the ControlWave EFM

The ControlWave EFM receives power from either an external bulk power or a rechargeable lead acid battery and solar panel combination. Power connects to connector TB1 on the SCM. *Chapter 2* includes instructions for wiring power supply to the ControlWave EFM.

To apply power to the ControlWave EFM, plug the power supply into connector TB1 on the SCM.

To remove power from the ControlWave EFM, unplug the power supply from connector TB1 on the SCM.

Mode Switch

The mode switch (SW1) is a two-position piano type DIP switch that allows you to configure the mode for firmware upgrades, core updumps, or normal running operations (see *Figure 4-1*).

- Set both DIP switches to either the Open position (to the right) or the Closed position (to the left) to place the ControlWave EFM in

Recovery mode. Use Recovery mode for a firmware upgrade or a core updump (see *Chapter 5*).

- Set SW1-1 (the upper DIP switch) to the Open (right) position and SW1-2 (the lower DIP switch) to the Closed (left) position to place the ControlWave EFM in **Local** mode, which is used for normal running operations.

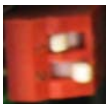


Figure 4-1. Mode Switch

4.2 Communicating with the ControlWave EFM

You communicate to the ControlWave EFM by connecting a cable between a port on your PC workstation and one of the ControlWave EFM ports.

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

4.2.1 Default Comm Port

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

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

Port	PCB	Default Configuration
COM1	CPU	Ships from factory at RS-232; 115.2 Kbps using BSAP. Once the default switch is OFF, a factory default of IP Point-to-Point protocol (PPP) at 115,200 applies.
COM2	CPU	RS-232; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM3	CPU	RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM4	ECOM Type 1 or Type 2	RS-232; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM5	ECOM Type 1	RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
	ECOM Type 2	RS-232; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM6	ECOM Type 1	Not applicable
	ECOM Type 2	RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM7	ECOM Type 1	Not applicable
	ECOM Type 2	RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol

Port	PCB	Default Configuration
COM8	ECOM Type 1 or Type 2	RS-232; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM9	ECOM Type 1	RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
	ECOM Type 2	RS-232; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM10	ECOM Type 1	Radio port
	ECOM Type 2	RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol
COM11	ECOM Type 1	Modem port
	ECOM Type 2	RS-485; 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol

Notes:

- You can re-enable the factory default comm. settings at any time by setting switch SW2-3 on the CPU module to "OFF."
- If you set both SW2-3 and SW2-8 to "OFF" all serial ports (including COM1) become 9600 baud/BSAP. This is used for diagnostics mode.
- For information on communication cables see *Chapter2*.

Ethernet

Using an optional Ethernet port (located on the CPU module), you can connect either directly or through a network to a PC equipped with an Ethernet port.

The Ethernet port is only available for the 150 MHz CPU. If the Ethernet port is present, the factory pre-configures its initial IP address and mask, as follows:

ETH1 IP Address: 10.0.1.1 IP Mask: 255.255.255.0

Because each unit that ships from the factory has this address initially pre-programmed, you should only use this address for "bench" testing and configuration. You must change this address before putting the ControlWave unit on an actual network, since an address conflict would exist as soon as you place the second ControlWave unit online.

4.2.2 Changing Port Settings

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

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

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

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

4.2.3 Collecting Data from the ControlWave EFM

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

4.3 Creating and Downloading an Application (ControlWave Project)

Your ControlWave executes an application called a ControlWave project. Certain standard projects are available for purchase, or you can purchase PC-based ControlWave Designer software and create your own project. Instructions for creating a ControlWave project are beyond the scope of this manual. Please refer to the following sources for information:

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

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

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

- Set the SCM's Mode switch to local mode (that is, SW1-1 to Open [right] and SW1-2 to Closed [left]).

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

1. Define the EFM project, setting communication and configuration parameters.

2. Download the project according to instructions in the *Downloading* section of the *ControlWave Designer Programmer's Manual* (D5125).
3. After the download completes successfully, leave Mode switch (SW1) in **local mode**.

4.4 Creating and Maintaining Backups

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

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

Caution

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

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

Notes:

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

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

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

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

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

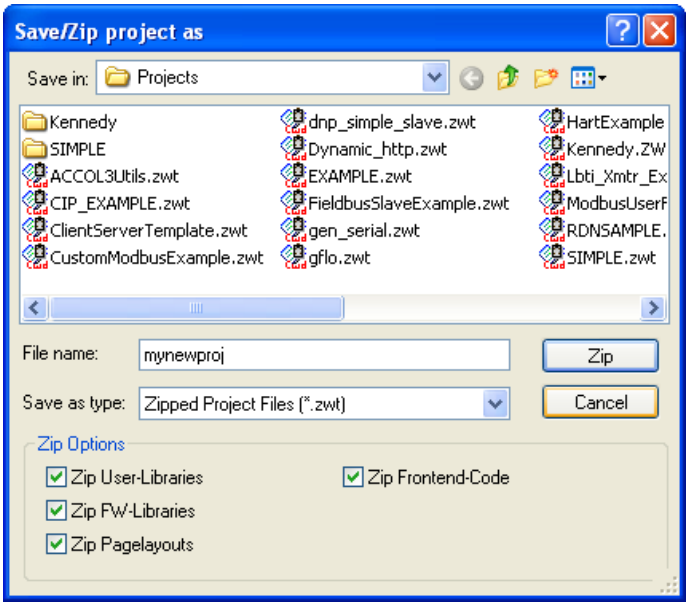


Figure 4-2. Saving a Backup of Your Project

2. In the "Save/Zip project as" dialog box, specify a project name in the **File name** field. In *Figure 4-2* we chose the name **mynewproj**.
3. In the **Save as type** field, choose **Zipped Project Files (*.zwt)**.
4. In the **Zip Options** area, select which additional files you want to include in the zwt file. Other than increasing the file size of the zwt, it doesn't hurt to check any or all of these options.

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

5. Click **Zip** and a progress bar displays the percent complete of the zipping process.
6. When the zip process completes, you'll see a message box reporting successful completion. Click **OK**.

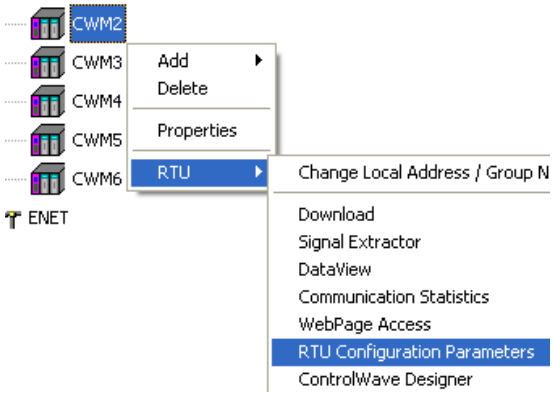
7. Copy the resulting zwt file to backup media (CD-ROM, thumb drive, etc.) If you ever need to restore the project, just open the zwt file in ControlWave Designer, load libraries as needed, then compile the project and download it into the ControlWave.

4.4.2 Saving Flash Configuration Parameters (*.FCP)

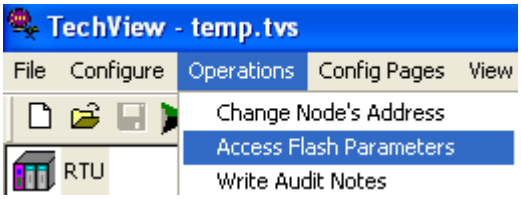
You must establish communications with the ControlWave using NetView, LocalView, or TechView before you can run the Flash Configuration utility.

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

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



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



2. Depending upon how your system is configured, the Flash Configuration – Loading Options dialog box may open. If it does, choose **Load from device** and wait for the utility to retrieve all parameters from the ControlWave, then skip to step 4, otherwise, just proceed to step 3.

3. Click 

and wait for the utility to retrieve all parameters from the ControlWave.

4. Click 

and specify a name for your FCP file, then click **Save**. When the status line indicates successful completion, your FCP file in done.

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

4.4.3 Backing up Data

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

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

Chapter 5 – Service and Troubleshooting

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

In This Chapter

Equipment

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

To run diagnostics software:

- PC with WINDIAG software, and either OpenBSI LocalView, NetView, or TechView for communications.
- Null modem interface cable
- Loop-back plug, 9-pin female D-Sub (for RS-232) (see *Figure 5-12*)
- Loop-back plug, 9-pin female D-Sub (for RS-485) (see *Figure 5-13*)
- Loop-back plug, 8-pin RJ-45 male (for twisted pair Ethernet) (see *Figure 5-15*)

To perform firmware upgrades:

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

To replace the SRAM backup battery:

- Depending on the type of battery holder, either a small flat head screwdriver, or tweezers/needle nose pliers.

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

Caution

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

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

WARNING

EXPLOSION HAZARD

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

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

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

See Appendix A for details on Class I Division 2 usage of this device.

5.1 Upgrading Firmware

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

System Firmware Downloader

Use this tool to download system firmware to an unattended remote ControlWave EFM. To use this utility, you must set CPU module switch SW2-6 **ON** (the factory default position).

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

LocalView

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

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

HyperTerminal

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

Notes:

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

1. Connect a null modem cable between COM1 of the ControlWave EFM and any RS-232 port on the associated PC.
2. Click **Start** > **Programs** > **Accessories** > **Communications** > **HyperTerminal**
3. If using HyperTerminal for the first time, set the communication properties (for the PC port) via the Properties Menu as follows: Bits per second: = 115200, Data bits: = 8, Parity: = None, Stop bits: = 1, and Flow control: = None and then click **OK**.
4. Either set the SCM's mode switch (SW1) for Recovery Mode, that is, set both switches in the **OPEN** or **CLOSED** position or set CPU Switch SW1-3 **ON** (ON = Force Recovery).
5. Apply power; to the ControlWave EFM. The resident BIOS initializes and tests the hardware, this process is referred to as POST (Power On Self Test). Unless there is a problem, SCM status LEDS show status code 10 (LED #5 ON). If you see a different status code, see *Section 5.3.1*
6. From the HyperTerminal Mode menu (*Figure 5-1*), press the **F** key to enter FLASH download. A message warns that the FLASH is about to be erased; press the **Y** key at the prompt. The screen displays dots as the system erases the flash memory; this could take a few minutes.

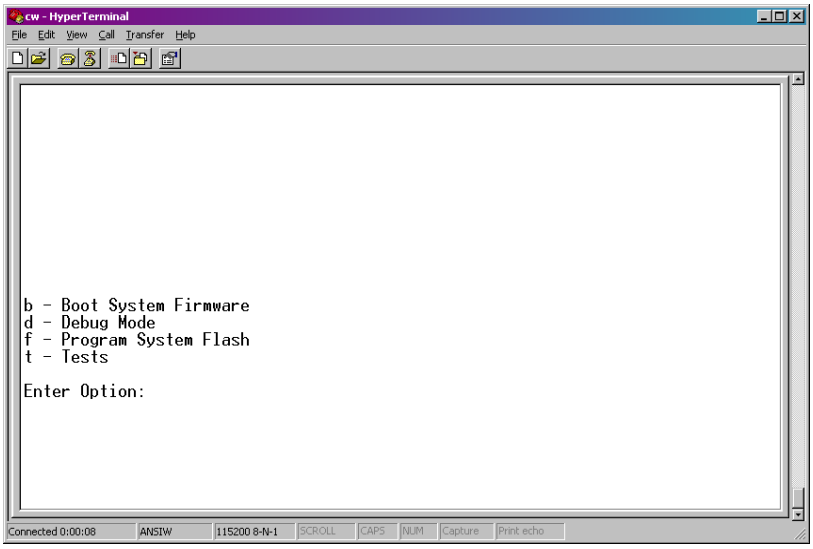


Figure 5-1. HyperTerminal Mode Menu

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

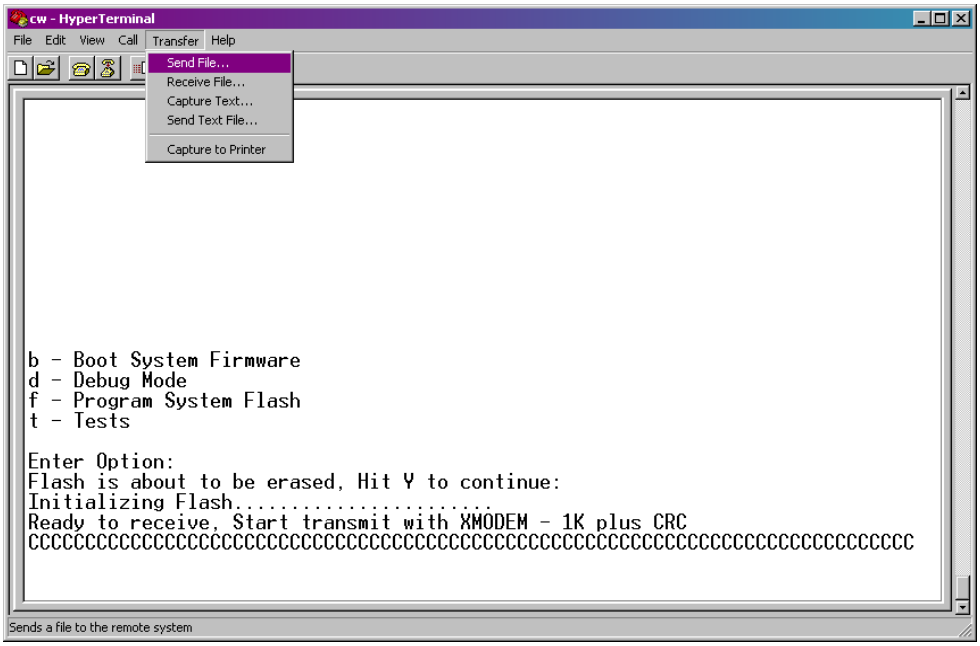


Figure 5-2. HyperTerminal (Ready to Download)

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

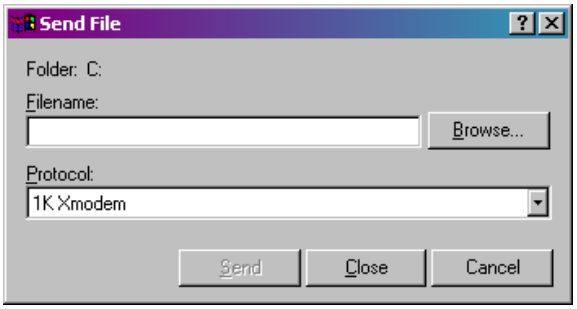


Figure 5-3. Send File dialog box

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

10. Set the SCM's mode switch (SW1) for Local Mode, i.e., SW1-1 in the **OPEN** (**Right**) position and SW1-2 in the **CLOSED** (**Left**) position or if CPU Module Switch SW1-3 was set for Recovery Mode, set it to the **OFF** position (OFF = Recovery Mode Disabled).

11. Restore power to the ControlWave EFM.

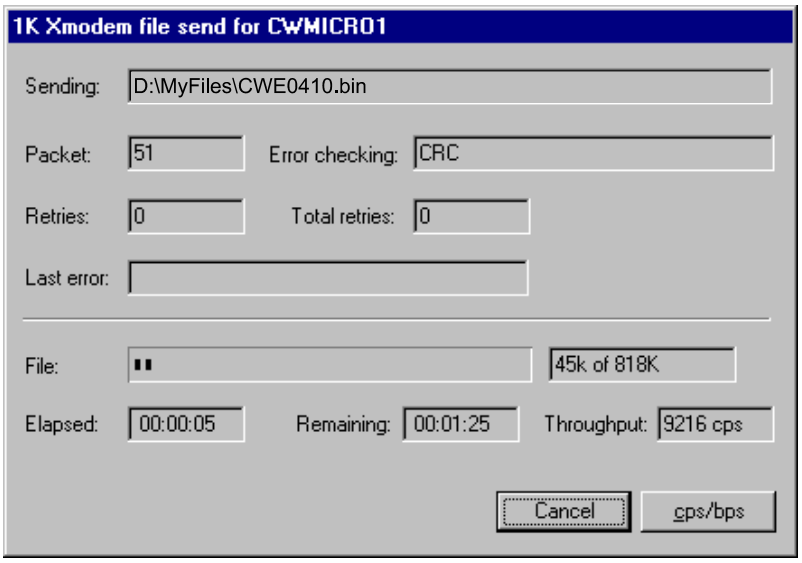


Figure 5-4. HyperTerminal (Download in Process)

5.2 Removing or Replacing Components

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

Caution **Field repairs to ControlWave EFMs are strictly limited to the replacement of complete modules. Replacing module components constitutes tampering and violates the product warranty. Return defective modules or housings to the factory for authorized service.**

5.2.1 Accessing Modules for Testing

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

5.2.2 Removing/Replacing the Bezel

1. Grasp the sides of the bezel assembly and gently lift it up and then off its associated I/O module covers.
2. To replace the bezel, align the latches (left and right, top and bottom) with the associated notches in the I/O module cover. Press the bezel in so that the notches capture its latches and slide it downward until it securely seats.

5.2.3 Removing/Replacing the CPU Module

Use this procedure to remove or replace the CPU module.

1. If the EFM is running, place any critical control processes under manual control.
2. Shut down the EFM by disconnecting power from the system controller module (SCM).
3. Disconnect any CPU module communication cables. Label or otherwise identify them so you can easily return them to their assigned communication ports. .
4. Press down on the cover's built-in top latch (with one hand) and up on the cover's built-in bottom latch (with the other hand).
5. Carefully slide the CPU module out of the front of the housing. If any binding occurs, gently rock the module up and down to free it.
6. To replace a CPU module, power must be off. Carefully align the CPU module with the guides for slot 2 in the EFM and insert the module into the housing. When the module correctly seats, its cover should latch to the housing.

7. Replace any communication cables, apply power, and test the module.

5.2.4 Removing/Replacing the SCM

Use this procedure to remove or replace the System Controller Module (SCM).

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Unplug the SCM's modular connectors.
3. Press down on the cover's built-in top latch (with one hand) and up on the cover's built-in bottom latch (with the other hand).
4. Carefully slide the SCM out of the front of the housing. If binding occurs, gently rock the module up and down to free it.
5. To replace an SCM, power must be off. Carefully align the SCM with the guides for slot 1 in the EFM and insert the module into the housing. When the module correctly seats, its cover should latch to the housing.
6. Replace power and watchdog cables and then apply power and test the unit.

5.2.5 Removing/Replacing an I/O Module

Use this procedure to remove or replace an I/O module.

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Remove the applicable bezel (see *Section 5.2.2*).
3. Unplug local termination cable headers from I/O module connectors TB1 and TB2 and set the cables aside. Label or otherwise identify these cables so you can easily return them to their assigned connectors.
4. Press down on the cover's built-in top latch (with one hand) and up on the cover's built-in bottom latch (with the other hand).
5. Carefully slide the I/O module out of the front of the housing. If binding occurs, gently rock the I/O module up and down to free it.
6. To replace an I/O module, power must be off. Carefully align the I/O module with the applicable I/O slot and insert the unit into the housing. When the module correctly seats, its cover should latch to the housing.
7. Connect local termination cables to I/O module connectors.

8. Apply power and test the unit.

5.2.6 Removal/Replacement of an Expansion Communication Module

Use this procedure to remove or replace an expansion communication (ECOM) module.

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Disconnect any ECOM module communication cables. Label or otherwise identify them so you can easily return them to their assigned communication ports. .
3. Press down on the cover's built-in top latch (with one hand) and up on the cover's built-in bottom latch (with the other hand).
4. Carefully slide the ECOM module out of the front of the housing. If binding occurs, gently rock the ECOM module up and down to free it.
5. To replace an ECOM module, power must be off. Carefully align the ECOM module with the appropriate slot (3 or 4) and insert the unit into the housing. When the module correctly seats, its cover should latch to the housing.
6. Connect communication cables to ECOM module connectors.
7. Apply power and test the unit.

5.2.7 Removal/Replacement of the Rechargeable Lead-acid Battery

Use this procedure to remove or replace the rechargeable lead acid battery.

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Disconnect the power cables from the battery terminals (remove screw and nut on each terminal).
3. Loosen the two 11/32" nuts on the ends of the battery clamp. Lift the battery clamp and rotate it rearward.
4. Carefully lift up and remove the rechargeable lead-acid battery.

Note: Make sure your replacement lead acid battery is fully charged before you install it.

5. To replace the battery, align the unit so that the negative battery terminal is oriented to the top and right as illustrated in Figure 2-15 and place the battery into the battery mounting bracket (battery clamp must be in the released position.
6. Raise the battery clamp and rotate it forward until you can lower it to secure the rechargeable lead-acid battery. Tighten the two 11/32" nuts on the ends of the battery clamp.
7. Replace the power cables to the battery terminals (black/NEG, Red/POS).
8. Apply power and test the unit.

5.2.8 Removal/Replacement of a Power Distribution Board

Use this procedure to remove or replace the optional power distribution board.

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Unplug wiring harnesses from power distribution board connectors TB1 through TB6. Label or otherwise identify them so you can easily re-connect them later.
3. Slide the power distribution board toward the front of the unit and remove it from its snap track holder.
4. To replace the power distribution board, slide it into its snap track holder. Replace wiring harness connectors TB1 through TB6.
5. Apply power and test the unit.

5.2.9 Removal/Replacement of a 21V Power Supply Board

Use this procedure to remove or replace the optional 21V power supply board.

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Unplug wiring harnesses from 21V power supply board connectors TB1 and TB2.
3. Slide the 21V power supply board toward the front of the unit and remove it from its snap track holder.
4. To replace the 21V power supply board, slide it into its snap track holder. Replace wiring harness connectors TB1 and TB2.
5. Apply power and test the unit.

5.2.10 Removal/Replacement of a Digital to Relay I/O Board

Use this procedure to remove or replace the optional digital to relay I/O board.

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Unplug wiring harnesses from digital to relay I/O board connector J1.
3. Slide the digital to relay I/O board toward the front of the unit and remove it from its snap track holder.
4. To replace the digital to relay I/O board, slide it into its snap track holder. Replace wiring harness connector J1/P1.
5. Apply power and test the unit.

5.2.11 Removal/Replacement of a Case-Mounted Radio/Modem

Use this procedure to remove or replace a case-mounted radio or modem.

1. If the EFM is running, place any critical control processes under manual control and shut down the unit by disconnecting power from the SCM.
2. Remove the removable lead-acid battery (if present) (see *Section 5.2.7*).
3. Disconnect (unplug) all connectors (power and interface) from the radio/modem.
4. Remove the mounting screws from the bottom (inside) of the battery mounting bracket and remove the radio/modem (with mounting plate if present).
5. Replace the radio/modem in the reverse order from which it was removed.
6. Apply power and test the unit.

5.2.12 Removing/Replacing the Backup Battery

Note: The CPU module draws power from the battery only if the module loses power. For a ControlWave EFM containing 2MB of SRAM, a worst-case current draw of 42 uA allows a battery life of approximately 5238 hours. This means you should not need to replace a battery until the ControlWave EFM has been in service for an extended period (normally many years).

The CPU module accommodates a lithium coin cell backup battery housed in a coin-cell socket (S1). A supervisory circuit on the CPU switches to battery power when the regulated 3.3 Vdc falls out of specification. The battery then provides backup power for the real-time clock (RTC) and the system SRAM on the CPU module.

Caution

You lose SRAM contents when you remove the backup battery.

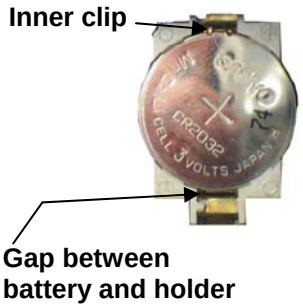
If you replace a backup battery, wait at least one minute before re-powering the system. This enables the SRAM to completely discharge.

After you install the new battery, ensure that you have placed jumper JP8 on pins 1-2 (to enable the battery).

The procedure for replacing the battery varies slightly depending upon the type of battery holder – snap type or clip type.

Removing / Replacing the Battery – Snap Type Holder

Battery Part Numbers:
CR2032
DL2032



1. If the EFM is running, place any critical control processes under manual control.
2. Remove power from the ControlWave EFM.
3. Remove the CPU module from the housing.
4. To remove the lithium battery, insert the tip of a small flat head screw driver into the gap between the battery and the holder. (The gap is on the side of the holder that doesn't have the inner clip against the battery.) Gently push the screwdriver at an angle underneath the battery and it will pop out of the holder.
5. To install the replacement battery, press one side of the battery against the inner clip of the holder then press the battery down into the slot so it snaps in.
6. Replace the CPU module in slot 2 of the housing.
7. Re-connect power to the ControlWave EFM.
8. Once the battery has been replaced, the unit executes its Flash-based application ("boot project") at power-up, but all of the current process data is lost. At power-up, the EFM acts as though it had just been booted and reverts back to the initial values specified in its application.

Removing / Replacing the Battery – Clip Type Holder

Battery Part Numbers:

BR2330, BR2335, BR2335-B

1. If the EFM is running, place any critical control processes under manual control.
2. Remove power from the ControlWave EFM.
3. Remove the CPU module from the housing.
4. To remove the lithium battery, gently pry up the tab holding the battery in the coin cell socket and remove the battery with a pair of tweezers or needle-nosed pliers. Install the replacement battery.
5. Replace the CPU module in slot 2 of the housing.
6. Re-connect power to the ControlWave EFM.
7. Once the battery has been replaced, the unit executes its Flash-based application ("boot project") at power-up, but all of the current process data is lost. At power-up, the EFM acts as though it had just been booted and reverts back to the initial values specified in its application.

5.2.13 Enabling / Disabling the Backup Battery

For maximum shelf life, the CPU module ships from the factory with the installed lithium backup battery disabled. You must enable it when you install the CPU module.

Enabling

To enable the battery, install jumper JP8 on pins 1-2.

Disabling

For maximum shelf life, you can isolate the battery from the circuit by placing jumper JP8 on pins 2-3.

5.3 General Troubleshooting Procedures

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

5.3.1 Checking LEDs

Most EFM modules contain light emitting diodes (LEDs) that provide operational and diagnostic functions.

Table 5-1 shows LED assignments on EFM modules.

Table 5-1. LED Assignments on Modules

Module	LED Name	LED Color	Function
SCM	IDLE	Red	ON = Idle
SCM	WD	Red	ON = Watchdog condition OFF = Normal

Module	LED Name	LED Color	Function
SCM	6 STATUS	Red	See *Table 5-2* and *Figure 5-5*
CPU	C1 RX (Comm 1)	Red	ON = RX activity (top left; see *Figure 5-6*)
CPU	C1 TX (Comm 1)	Red	ON = TX activity (top right; see *Figure 5-6*)
CPU	C2 RX (Comm 2)	Red	ON = RX activity (middle left; see *Figure 5-6*)
CPU	C2 TX (Comm 2)	Red	ON = TX activity (middle right; see *Figure 5-6*)
CPU	C3 RX (Comm 3)	Red	ON = RX activity (bottom left; see *Figure 5-6*)
CPU	C3 TX (Comm 3)	Red	ON = TX activity (bottom right; see *Figure 5-6*)
CPU	ENET Port 1	Green	ON = RX activity (top; see *Figure 5-6)*
CPU	ENET Port 1	Yellow	ON = TX activity (bottom; see *Figure 5-6*)
ECOM1	EC 4/8 RX (Comm 4)	Red	ON = RX activity (top left; see *Figure 5-7*)
ECOM1	EC 4/8 TX (Comm 4)	Red	ON = TX activity (top right; see *Figure 5-7*)
ECOM1	EC 5/9 RX (Comm 5)	Red	ON = RX activity (2nd from top left; see *Figure 5-7*)
ECOM1	EC 5/9 TX (Comm 5)	Red	ON = RX activity (2nd from top right; see *Figure 5-7*
ECOM1	Radio RX (Comm6)[1]	Red	ON = RX activity (3rd from top left; see *Figure 5-7*) (Note: Radio no longer offered- ignore - always ON)
ECOM1	Radio TX (Comm6)[1]	Red	ON = TX activity (3rd from top right; see *Figure 5-7*) Note: Radio no longer offered (always OFF)
ECOM1	Modem RX (Comm7)[1]	Red	ON = RX activity (bottom left;; see *Figure 5-7*)
ECOM1	Modem TX (Comm7)[1]	Red	ON = TX activity (bottom right; see *Figure 5-7)*
ECOM2	EC4/8 RX (Comm 4/8) [1]	Red	ON = RX activity (top left; see *Figure 5-8*)
ECOM2	EC4/8 TX (Comm 4/8) [1]	Red	ON = TX activity (top right; see *Figure 5-8*)
ECOM2	EC5/9 RX (Comm 5/9) [1]	Red	ON = RX activity (2nd from top left; see *Figure 5-8*)
ECOM2	EC5/9 TX (Comm 5/9) [1]	Red	ON = TX activity (2nd from top right; see *Figure 5-8*
ECOM2	EC6/10 RX (Comm 6/10) [1]	Red	ON = RX activity (3rd from top left; see *Figure 5-8*)
ECOM2	EC6/10 TX (Comm 6/10) [1]	Red	ON = TX activity (3rd from top right; see *Figure 5-8*)
ECOM2	EC7/11 RX (Comm 7/11) [1]	Red	ON = RX activity (bottom left;; see *Figure 5-8*)
ECOM2	EC7/11 TX (Comm 7/11) [1]	Red	ON = TX activity (bottom right; see *Figure 5-8*)
DI/OM	INPUT (12 LEDs,1 per point)	Red	LED ON = Input is present LED OFF = Input not present (see *Figure 5-9*)
DI/OM	OUTPUT (4 LEDs,1 per point)	Red	LED ON = Output is ON (see *Figure 5-9*)
HSCM	INPUT (4 LEDs, 1 per point)	Red	LED ON = Input activity on input is present LED OFF = No activity on input (see *Figure 5-9*)

[1]Radio or modem with Type 1 comm board only

SCM System Status LED Codes

As the EFM runs its application, status codes post to the six LEDs on the SCM. *Table 5-2* provides activity descriptions of the LEDs; *Figure 5-5* shows what the LEDs look like for each hex code.

Table 5-2. System Status LED Codes on SCM

Status in Hex	LED 6	ED 5	LED 4	LED 3	LED 2	LED 1	Activity Indicator
00	0	0	0	0	0	0	Application Running
01	0	0	0	0	0	1	Unit in Diagnostic Mode
03	0	0	0	0	1	1	Unit Running Diagnostics
04	0	0	0	1	0	0	Flash XSUM Error
05	0	0	0	1	0	1	Error Initializing Application Device
07	0	0	0	1	1	1	Flash Programming Error
08	0	0	1	0	0	0	Using Factory Defaults (flashed at start)
09	0	0	1	0	0	1	Battery Failure Detected (flashed at startup)
0A	0	0	1	0	1	0	Currently Loading the Boot Project
0B	0	0	1	0	1	1	System Initialization in Progress
10	0	1	0	0	0	0	Waiting in Recovery Mode
11	0	1	0	0	0	1	Error Testing SDRAM
12	0	1	0	0	1	0	Error Testing SRAM
20	1	0	0	0	0	0	Application Loaded
28	1	0	1	0	0	0	Stopped at Break Point
30	1	1	0	0	0	0	No Application Loaded
38	1	1	1	0	0	0	Running with Break Points
3B	1	1	1	0	1	1	Waiting for a Power-down (after NMI)
3E	1	1	1	1	1	0	Waiting for Updump to be Performed
3F	1	1	1	1	1	1	Unit Crashed (Watchdog Disabled)

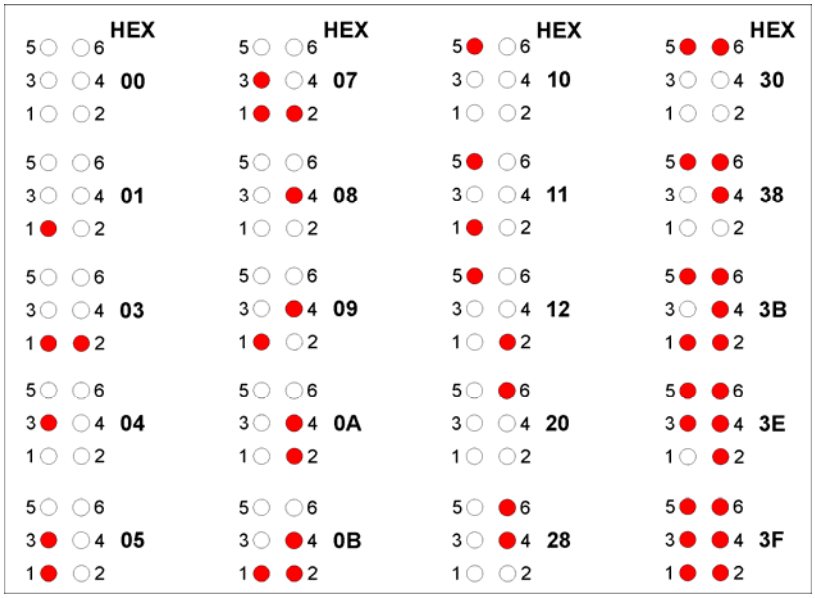


Figure 5-5. SCM Status LED Hexadecimal Codes

CPU Module LEDs

The CPU module has six comm port activity LEDs on the CPU board. Units equipped with an Ethernet port have two additional LEDs located on the Ethernet RJ-45 connector. *Table 5-3* details assignments for the LEDs on the CPU module.

An ON LED indicates an associated transmit (TX) or receive (RX) activity.

Table 5-3. CPU Module LEDs

LED Ref	LED Function
C1	Transmit (TX) COM1
C1	Receive (RX) COM2
C2	Transmit (TX) COM2
C2	Receive (RX) COM2
C3	Transmit (TX) COM3
C3	Receive (RX) COM3
E1 – Bottom	Ethernet Link Transmit (TX)
E1 – Top	Ethernet Link Receive (RX)

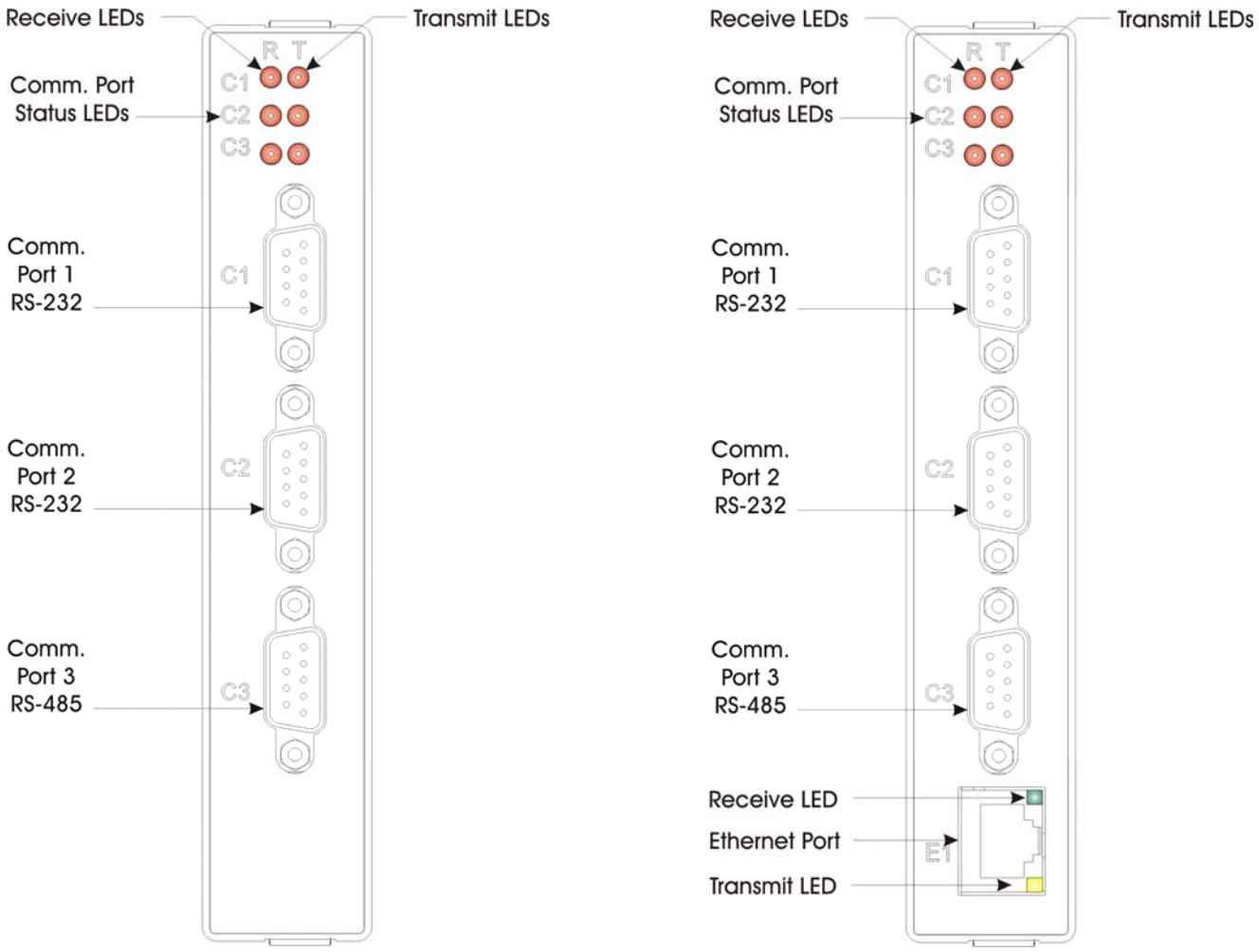


Figure 5-6. CPU Module Comm Connectors and LEDs

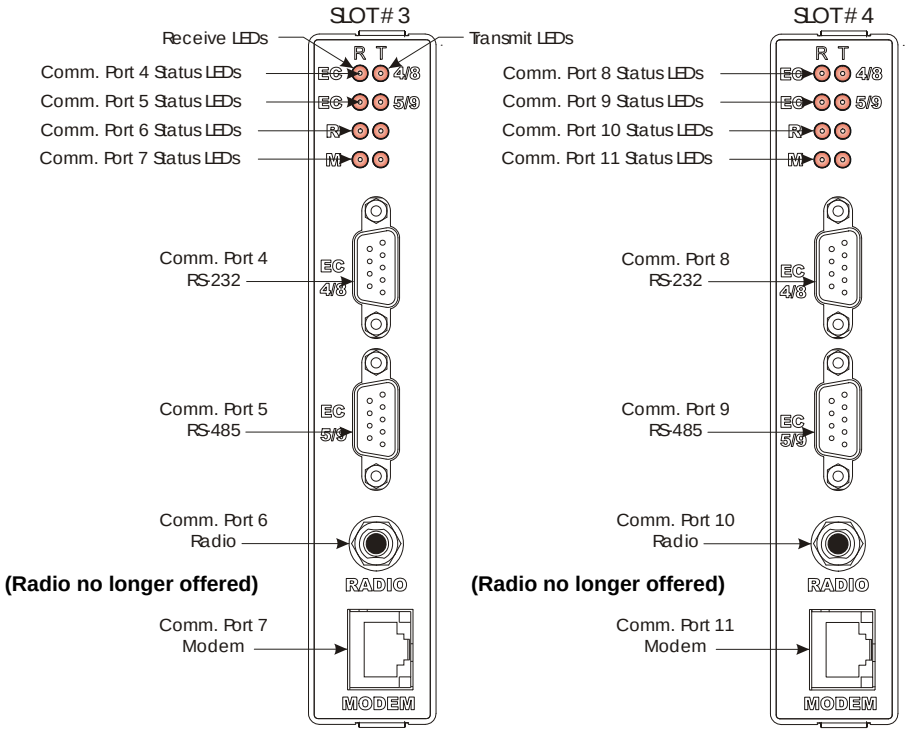


Figure 5-7. Type 1 Expansion Comm Module Comm Connectors and LEDs

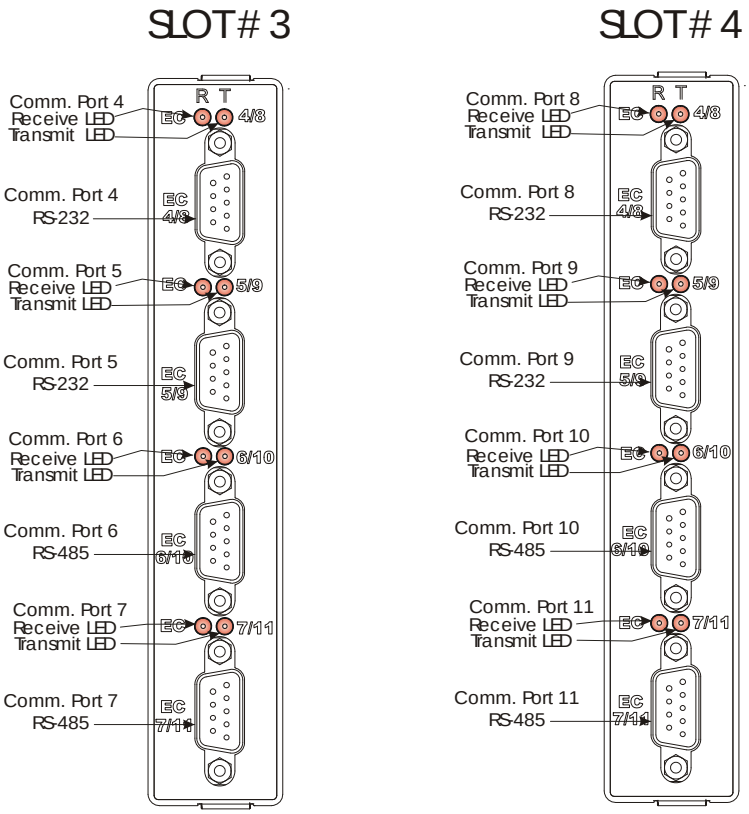


Figure 5-8. Type 2 Expansion Comm Module Comm Connectors and LEDs

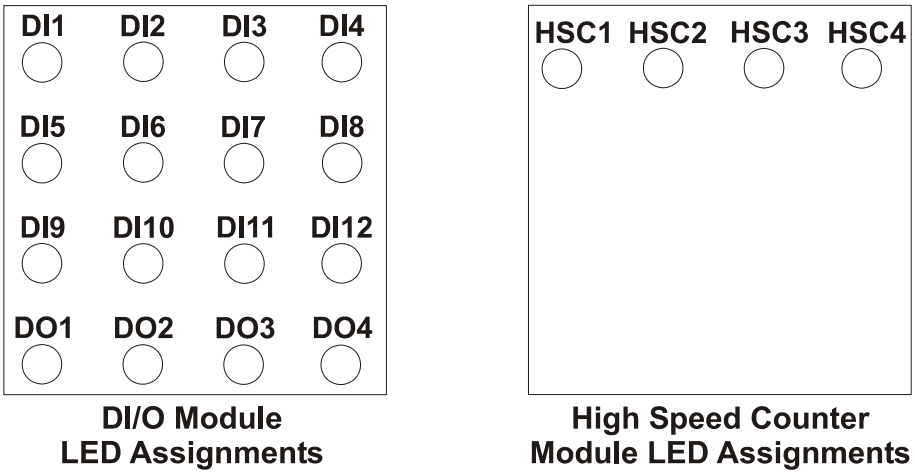


Figure 5-9. I/O Module LEDs

5.3.2 Checking Wiring/Signals

Check I/O field wiring at the terminal blocks and at the field device. Inspect the wiring for continuity, shorts, and opens. Check I/O signals at their respective terminal blocks (see *Figure 3-2* for wiring diagrams).

5.3.3 Calibration Checks

To calibrate the MVT and the RTD, use TechView software. See the *TechView User's Guide* (D5131) for more information.

5.3.4 Common Communication Configuration Problems

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

- Baud rate mismatch – the baud rate at both ends of the communication line must match. If communications fail during a download of a new flash configuration profile (FCP) file, you may have changed the baud rate of the active communication line, since baud rate changes occur immediately on FCP download. You can always re-establish factory default baud rates for communication ports by powering down the unit, and then setting CPU switch SW2-3 to **OFF** and restoring power.
- Incorrect BSAP local address – this address must be an integer from 1 to 127 and must be unique on this particular BSAP communication line. You set the BSAP local address using the flash configuration utility. If this ControlWave EFM is a BSAP slave node, and the range of addresses defined for the BSAP master port end of the communication line does not encompass the local BSAP address defined for this ControlWave EFM, BSAP communications will not function.

- Incorrect EBSAP Group number – if you use expanded BSAP the EBSAP group number must be correct; if you are not using EBSAP, the group number must be 0.

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

5.4 WINDIAG Diagnostic Utility

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

WINDIAG is a PC-based program, so the EFM must be attached to and communicating with a PC running WINDIAG. Set configuration switch SW2-8 **OFF** (closed) on the CPU module to enable the diagnostic routines.

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

- Turn CPU module switch SW2-8 **OFF** to run the WINDIAG program. Setting this switch off prevents the boot project from running and places the EFM in diagnostic mode.
- Use a null modem cable to connect RS-232 ports between the EFM and the PC; use an RS-485 cable (see *Section 2.4.4*) to connect the RS-485 ports of the EFM and the PC.
- Reserve the port running a diagnostic test for exclusive use; you cannot use that port for any other purpose during testing.
- Connect any EFM communication port to the PC provided their port speeds match. Most PCs have a COM1 port (typically RS-232 and defaulted to 9600 bps operation).
- Configure the EFM communication port to be tested using WINDIAG for 9600 baud, 8-bits, no parity, 1 stop bit, and BSAP/ControlWave Designer protocol operation. Communication port COM1 is only forced to 9600 bps operation when you have set switch SW2-3 on the CPU module to **OFF**.

Table 5-4. COM Port Defaults for Diagnostics

Port	Module	Default Configuation
COM1	CPU	RS-232: 115.2 kbd using IP PPP protocol To run diagnostics, set RS-232 to 9600 baud by setting CPU switches SW2-3 and SW2-8 **OFF**.
COM2	CPU	RS-232: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.

Port	Module	Default Configuation
COM3	CPU	RS-485: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM4	ECOM Types 1 or 2	RS-232: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM5	ECOM Type 1	RS-485: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
	ECOM Type 2	RS-232: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM6	ECOM Type 1	Not applicable
	ECOM Type 2	RS-485: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM7	ECOM Type 1	Not applicable
	ECOM Type 2	RS-485: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM8	ECOM Types 1 or 2	RS-232: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM9	ECOM Type 1	RS-485: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
	ECOM Type 2	RS-232: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM10	ECOM Type 1	Radio port
	ECOM Type 2	RS-485: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.
COM11	ECOM Type 1	Modem port
	ECOM Type 2	RS-485: 9600 baud, 8 bits, no parity, 1 stop bit, BSAP or ControlWave Designer protocol.

You can connect an optional Ethernet port (situated on the CPU module) directly or via a network to a PC equipped with an Ethernet port (see *Section 2.9.5*).

Before starting the WINDIAG program, place any critical processes the EFM is handling under manual control. You cannot run WINDIAG while the EFM is running applications. Set the CPU modules switches SW2-3 and SW2-8 to **OFF**, and perform the following steps:

1. Start the NetView program in OpenBSI with your current network NETDEF file. A menu displays (similar to the one in *Figure 5-10*):

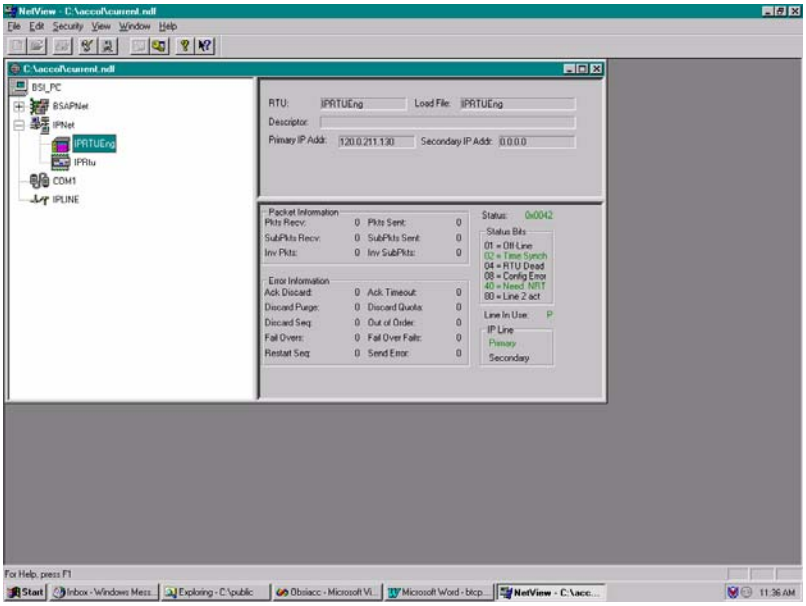


Figure 5-10. NetView

2. Select **Start** >**Programs > OpenBSI Tools** >**Common Tools** > **Diagnostics**. The Main Diagnostics menu (*Figure 5-11*) displays.

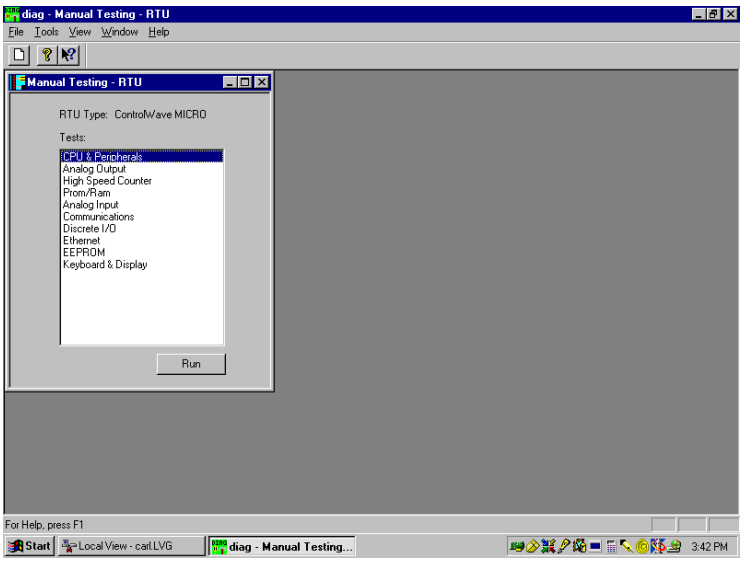


Figure 5-11. WINDIAG Main Diagnostics Menu

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

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

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

5. Set switch SW2-8 on the CPU module to **ON** (open). The EFM should resume normal operation.

5.4.1 Available Diagnostics

Using WINDIAG, you can test all EFM modules with the exception of the SCM. WINDIAG's Main Diagnostics Menu (see *Figure 5-11*) provides the following diagnostic selections:

Option	Tests
CPU & Peripherals	Checks the CPU module (except for RAM & PROM).
Analog Output	Checks AOs on AI/O, AO, or Mixed I/O modules.
High Speed Counter	Checks HSCs on HSC or Mixed I/O modules.
Prom/Ram	Checks the CPU's RAM and PROM hardware.
Analog Input	Checks AIs on AI/O, AI, or Mixed I/O modules.
Communications	Checks Communication ports 1 through 9 (but not COM6 or COM7). The External loop-back tests require the use of a loop-back plug.
Discrete I/O	Checks DIs on DI, DI/O, or Mixed I/O modules and/or checks DOs on DO, DI/O, or Mixed I/O modules.
Ethernet	Checks Ethernet Port 1. The Loop-back Out Twisted Pair tests require the use of a loop-back plug.

Port Loop-back Test

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

- RS-232 ports use a 9-pin female D-type loop-back plug (shown in *Figure 5-12*).

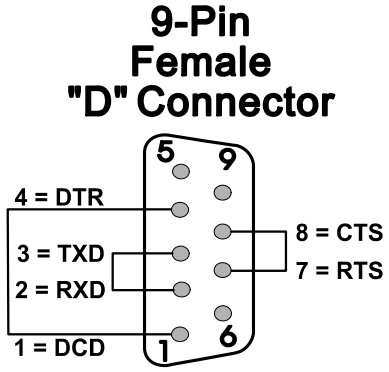


Figure 5-12. RS-232 Loop-back Plug

- RS-485 ports use a 9-pin female D-type loop-back plug (shown in *Figure 5-13*).

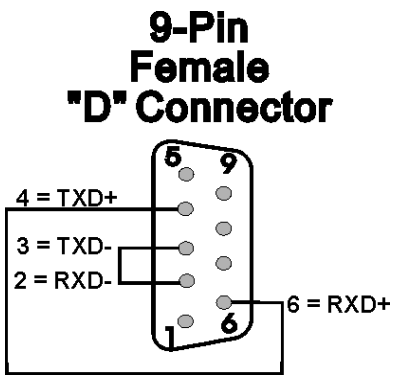


Figure 5-13. RS-485 Loop-back Plug

These tests verify the correct operation of the serial ports.

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

Test Procedure

Use this procedure to test the comm ports.

1. Connect an external loop-back plug to the port on the CPU, ECOM1, or ECOM2 module to be tested. Valid ports are:

- J3 of CPU module for COM1
- J4 of CPU module for COM2
- J5 of CPU module for COM3
- J4 of ECOM1 module for COM4/8
- J5 of ECOM1 module for COM5/9
- J4 of ECOM2 module for COM4/8
- J5 of ECOM2 module for COM5/9
- J6 of ECOM2 module for COM6/10
- J7 of ECOM2 module for COM7/11

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

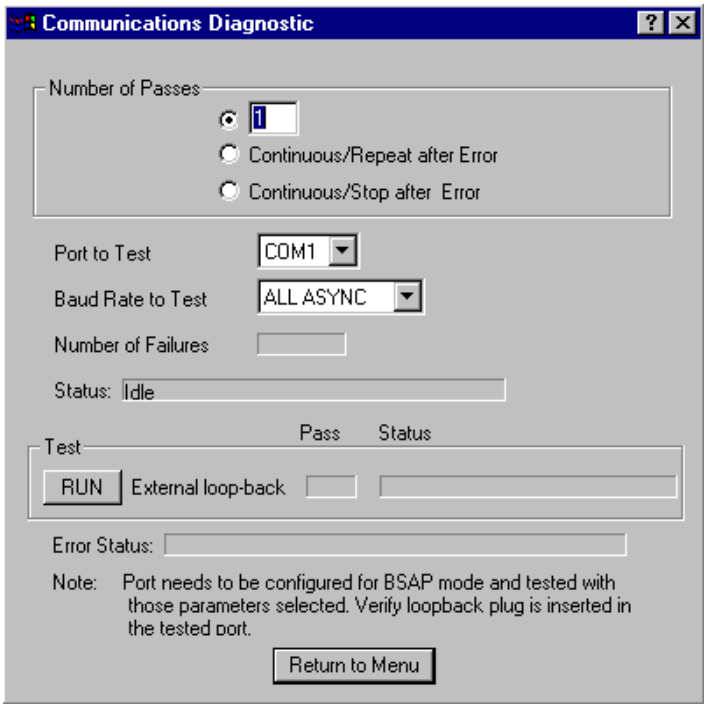


Figure 5-14. Communications Diagnostic Menu

3. Enter **5** in the Number of Passes field.
4. Select a port to test (click ▼ to display all available ports).

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

5. Select **115200** or **ALL ASYNC** as the baud rate (click ▼ to display all available rates).
6. Click **RUN** to start the test. At the completion of the test (which generally takes about 5 seconds), any failed results appear in the Status field to the right of the RUN button:
   - TXD RXD Failure
   - CTS RTS Failure
7. Click **Return to Menu** to display the WINDIAG Main Menu.

Ethernet Port Loop-back Test

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

This test configures the Ethernet port's ability to transmit and receive via the twisted pair. The text transmits frames and compares them against received frames. You need a special loop-back plug (shown in *Figure 5-15*) to perform the Ethernet loop-back test:

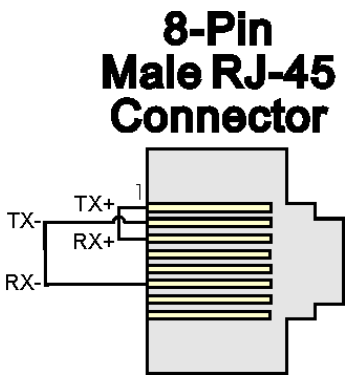


Figure 5-15. RJ-45 Ethernet Loop-back Plug

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

Test Procedure

Use this procedure to test the Ethernet port.

1. Connect an external Ethernet loop-back plug (see *Figure 5-15*) to the Ethernet port on the CPU module to be tested.
2. Select **Ethernet** on the WINDIAG Main Diagnostics Menu. The Ethernet Diagnostic screen opens:

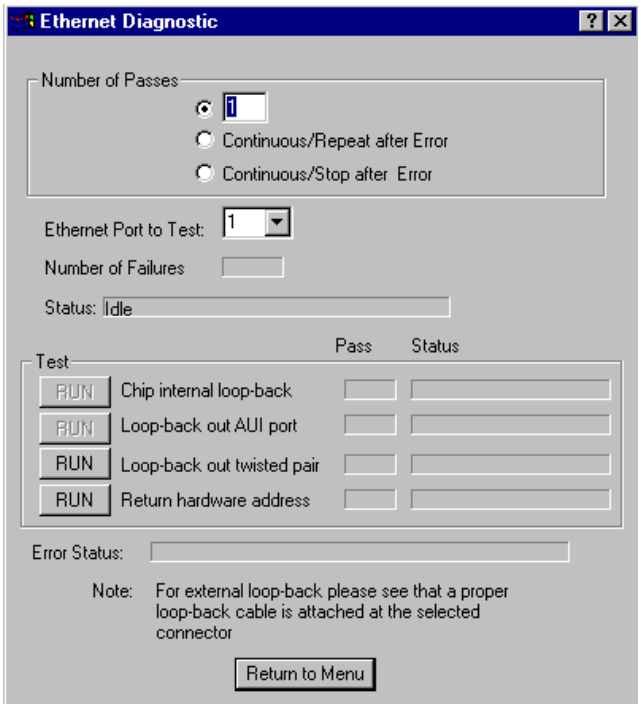


Figure 5-16. Ethernet Diagnostic Menu

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

4. Enter **1** in the Ethernet Port to Test field.
5. Click **RUN** next to the Loop-back out twisted pair field to start the test. At the completion of the test, any failed results appear in the Status field next to the **Loop-back out twisted pair** label:
   - No Hardware Present
   - Loop-back Send Failed
   - Loop-back Receive Failed
   - Loop-back Compare Failed
   - Error Information Returned
6. Disconnect the loop-back plug and reconnect the Ethernet cable to the EFM and the Ethernet hub.
7. Click **Return to Menu** to display the WINDIAG Main Menu.

5.5 Core Updump

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

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

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

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

1. Set switch SW2-1 on the CPU module to **OFF** (Disable Watchdog Timer). If switch SW2-4 is **ON**, set it to **OFF** (Enable Core Updump).

   Note: The factory default setting for switch SW2-4 is **OFF**.

2. Wait for the error condition (typically 3F on the SCM's status LEDs).

3. Connect the ControlWave EFM's Comm Port 1 to a PC using a null modem cable.
4. If the SCM's mode switch has a Run/Remote/Local switch, set it as follows. Set **both** SW1-1 and SW1-2 to the right (open) operation or both to the left (closed).
5. Start the PC's HyperTerminal program (at 115.2 kbaud) and generate a receive using the 1KX-Modem protocol. Save the resulting core updump in a file so you can forward it later to the technical support group.

By setting the CPU module switches SW2-1 and SW2-4 both off **before** the EFM fails, you prevent the EFM from automatically recovering from the failure and enable it to wait for you to take a core updump.

Once you complete the core updump, set the CPU module's switch SW2-1 to **ON** (Watchdog Enabled) and SW2-4 to **OFF** (Core Updump Disabled).

Additionally, for the SCM mode switch, set switch SW1-1 to open (right) and SW1-2 to closed (left).

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

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Appendix A – ControlWave EFM Electronic Flow Meter – Special Instructions for Class I, Division 2 Hazardous Locations

1. The ControlWave Electronic Flow Meter (EFM) is listed by Underwriters Laboratories (UL) as nonincendive and is suitable for use in Class I, Division 2, Groups C and D hazardous locations or non-hazardous locations only. Read this appendix carefully before installing a nonincendive ControlWave Electronic Flow Meter (EFM). In the event of a conflict between the ControlWave EFM Instruction Manual (*CI-ControlWave EFM*) and this appendix, always follow the instructions in this appendix
2. The ControlWave Electronic Flow Meter (EFM) includes both nonincendive and unrated field circuits. Unless a circuit is specifically identified in this appendix as nonincendive, the circuit is unrated. Unrated circuits must be wired using Div. 2 wiring methods as specified in article *501-4(b)* of the *National Electrical Code (NEC), NFPA 70* for installations in the United States, or as specified in *Section 18-152* of the *Canadian Electrical Code* for installation in Canada.
3. The local communications port terminates in a D-Type connector on the bottom of the ControlWave Electronic Flow Meter (EFM) enclosure. The wiring on this connector is unrated. No connections may be made to this port unless the user ensures that the area is known to be nonhazardous. Connections to this port are temporary, and must be short in duration to ensure that flammable concentrations do not accumulate while it is in use.
4. The optional power system (solar panel and battery) approved for use with the nonincendive ControlWave Electronic Flow Meter (EFM) are described in the model specification. The connection to the solar panel is approved as a nonincendive circuit so that Division 2 wiring methods are not required. The nominal panel voltage must match the nominal battery voltage (12V).
5. An RTD is normally supplied with the ControlWave EFM. Connection to the RTD is approved as a nonincendive circuit, so that Division 2 wiring methods are not required.
6. Signal connectors available for customer wiring are listed in *Table A1*. I/O connections are unrated and must be wired using Div. 2 wiring methods.

7. The UL listed nonincendive ControlWave EFM may include radio/modem communications (listed on the model spec.) that is used in conjunction with a 30W Solar Panel and 12V, 33AH Lead Acid Battery System. Connection to the radio or modem is approved as a nonincendive circuit, so that Division 2 wiring methods are not required.
8. The UL listed nonincendive ControlWave EFM may include a Digital to Relay I/O Board (option). No field wiring connections/removals should be made at the Digital to Relay I/O Board unless the area is known to be nonhazardous. Digital to Relay I/O Board I/O circuitry is unrated an must be wired using Div. 2 wiring methods.
9. The UL listed nonincendive ControlWave EFM may include a 21V Power Supply Board (option). No field wiring connections/removals should be made at the 21V Power Supply Board unless the area is known to be nonhazardous. 21V Power Supply Board Transmitter Interface circuitry is unrated and must be wired using Div. 2 wiring methods.

WARNING #1

EXPLOSION HAZARD

Do NOT disconnect Solar Power from the Battery or any other power connections within the ControlWave EFM enclosure (including connectors TB1 through TB6 on the Power Distribution Board, connector TB1 on the System Controller Module, any power connections to optional items such as radio, modem, Digital to Relay I/O Board, 21V Power Supply Board, or cabling to the Display/Keypad) unless the area is known to be nonhazardous.

WARNING #2

EXPLOSION HAZARD

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

WARNING #3

EXPLOSION HAZARD

The area must be known to be nonhazardous before servicing/replacing the unit and before installing or removing I/O wiring.

WARNING #4

EXPLOSION HAZARD

Do NOT disconnect equipment unless power has been disconnected and the area is known to be non-hazardous.

Table A-1. Module/Board Customer Wiring Connectors

Module/Item	Connector	Wiring Notes
CPU Module	J3 – COM1, 9-pin Male D-sub	Factory connected to local comm. port. Refer to item 3 of this appendix.
CPU Module	J4 – COM2, 9-pin Male D-sub RS-232 J5 – COM3, 9-pin Male D-sub RS-485	Remote comm. port: For radio or external network comm. Refer to model spec. and item 6 of this appendix. When used for network comm., use Div 2 wiring methods. If COM2 is used in conjunction with a radio/modem refer to item 7 of this appendix.
SCM Module	J2 – Display interface RJ-45 female	Factory Wired.*
SCM Module	P2 – MVT interface	Factory Wired.*
SCM Module	TB1 – Input power	Typically factory wired *
SCM Module	TB2 – RTD Interface	Field wired – refer to Item 5 of this appendix.
Exp. Comm. Module 1	J4 – COM4, 9-pin Male D-sub RS-232 J5 – COM5, 9-pin Male D-sub RS-485	Remote Comm. Port: For radio or external Network Comm. Refer to model spec. and item 6 of this appendix. When used for Network Comm., use Div. 2 wiring methods. If COM4 is used in conjunction with a radio/modem refer to item 7 of this appendix.
Exp. Comm. Module 1	J8 – COM7, RJ11 female	Modular connection to phone company equipment.
Exp. Comm. Module 2	J4 – COM8, 9-pin Male D-sub RS-232 J5 – COM9, 9-pin Male D-sub RS-485	Remote Comm. Port: For radio or external Network Comm. Refer to model spec. and item 6 of this appendix. When used for Network Comm., use Div. 2 wiring methods. If COM8 is used in conjunction with a radio/modem refer to item 7 of this appendix.
Exp. Comm. Module 2	J8 – COM11, RJ11 female	Modular connection to phone company equipment. Refer to the warning #2, #3, #4, and item 7 of this appendix.
Analog I/O Module	TB1/TB2 – 10-pin terminal blocks	Field I/O wiring connectors are unrated; use Div. 2 wiring methods.*
Digital I/O Module	TB1/TB2 – 10-pin terminal blocks	Field I/O wiring connectors are unrated; use Div. 2 wiring methods.*
HSC Input Module	TB1/TB2 – 10-pin terminal blocks	Field I/O wiring connectors are unrated; use Div. 2 wiring methods.*
Mixed I/O Module	TB1/TB2 – 10-pin terminal blocks	Field I/O wiring connectors are unrated; use Div. 2 wiring methods.*
Digital to Relay I/O Board	J1 10-pin in-line connector	Field I/O wiring connector is unrated; use Div. 2 wiring methods. Refer to item 8 of this appendix.*
Power Distribution Board (See warning #1 of this appendix)	TB1 – 3-pin terminal block TB2 – 2-pin terminal block TB3 – 2-pin terminal block TB4 – 2-pin terminal block	Primary Power Input – User wired * Main Power Out 1 – Factory wired * Main Power Out 2 – Factory wired * Fused Power Out 1 – Factory wired *

Module/Item	Connector	Wiring Notes
	TB5 – 2-pin terminal block TB6 – 2pin terminal block	Fused Power Out 2 – Factory wired * Fused Power Out 3 – Factory wired *
21V Power Supply Board (See warning #1 and item 9 of this appendix)	TB1 – 3-pin terminal block TB2 – 4-pin terminal block	12V power input – Factory wired * 21V Transmitter Power – Field wired TB2 is unrated, use Div. 2 wiring methods.
Enclosure bottom	Local Port circular connector	Local comm. port – Factory wired. Refer to item 3 of this appendix. *

Note: ***** These wires should only be installed/removed when the item (PCB) in question is installed / removed or when checking wiring continuity. The area must be known to be nonhazardous before servicing / replacing the unit and before installing or removing PCBs, connectors, or individual I/O or power wires. Refer to warnings #2, #3, #4 of this appendix. All input 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.

Appendix D – Modem Installation

D2.1 Modem Installation & Configuration

D2.1.1 Installing an Internal MultiTech Modem (MT9234SMI)

To install a Model MT9234SMI Modem onto an ECOM Module, perform the following steps:

Remove the ECOM Module from the controller (see *Figure D1*).

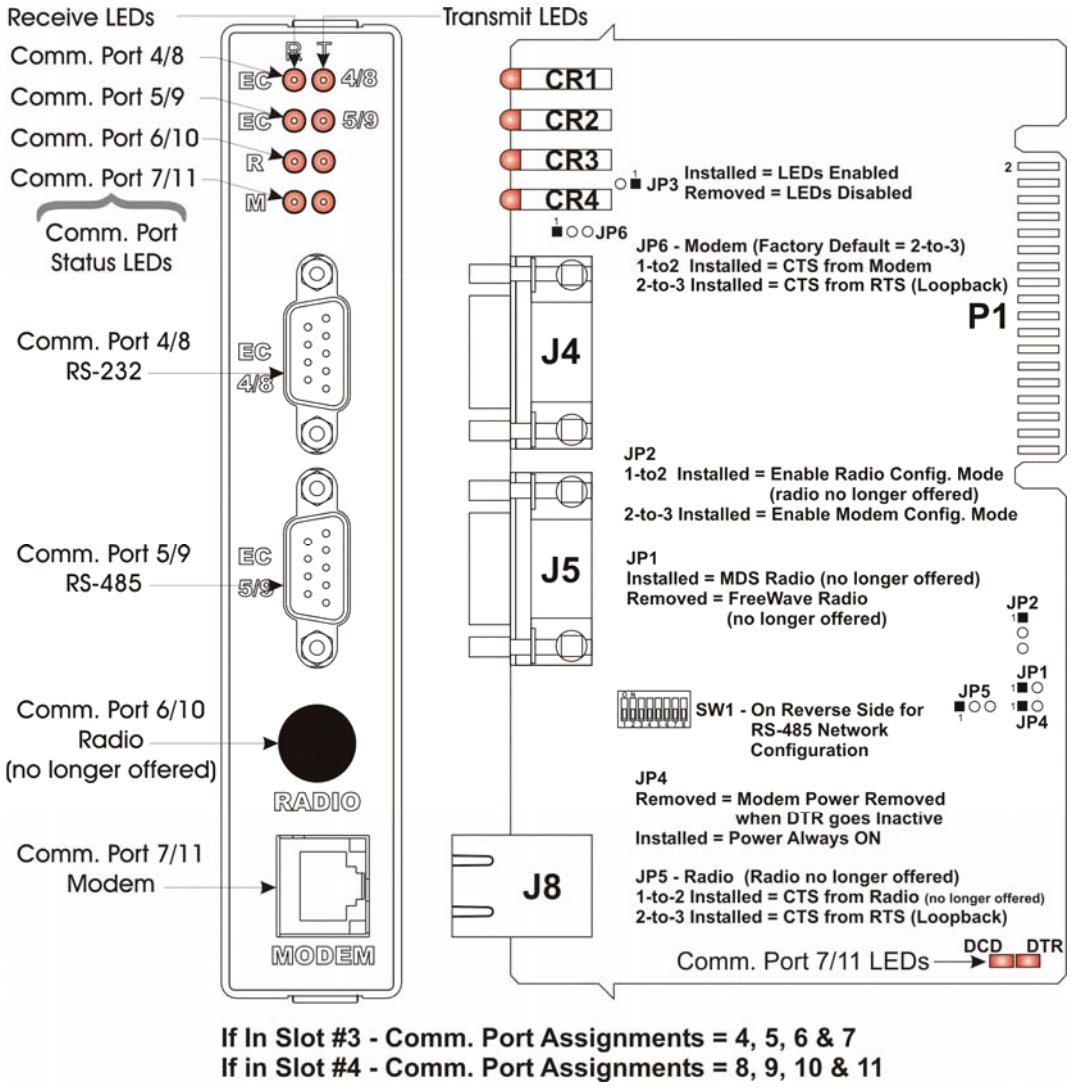

Figure D1. Expansion Comm. Module Component Identification Diagram

1. Unplug the antenna cable from the RF Connector on any installed radio module. Grasp the ECOM Module with one hand. Squeeze both sides of the cover panel (just below the unit's top) and pull up and away to release the cover panel and EMI Gasket from the PCB (see *Figure D2).*

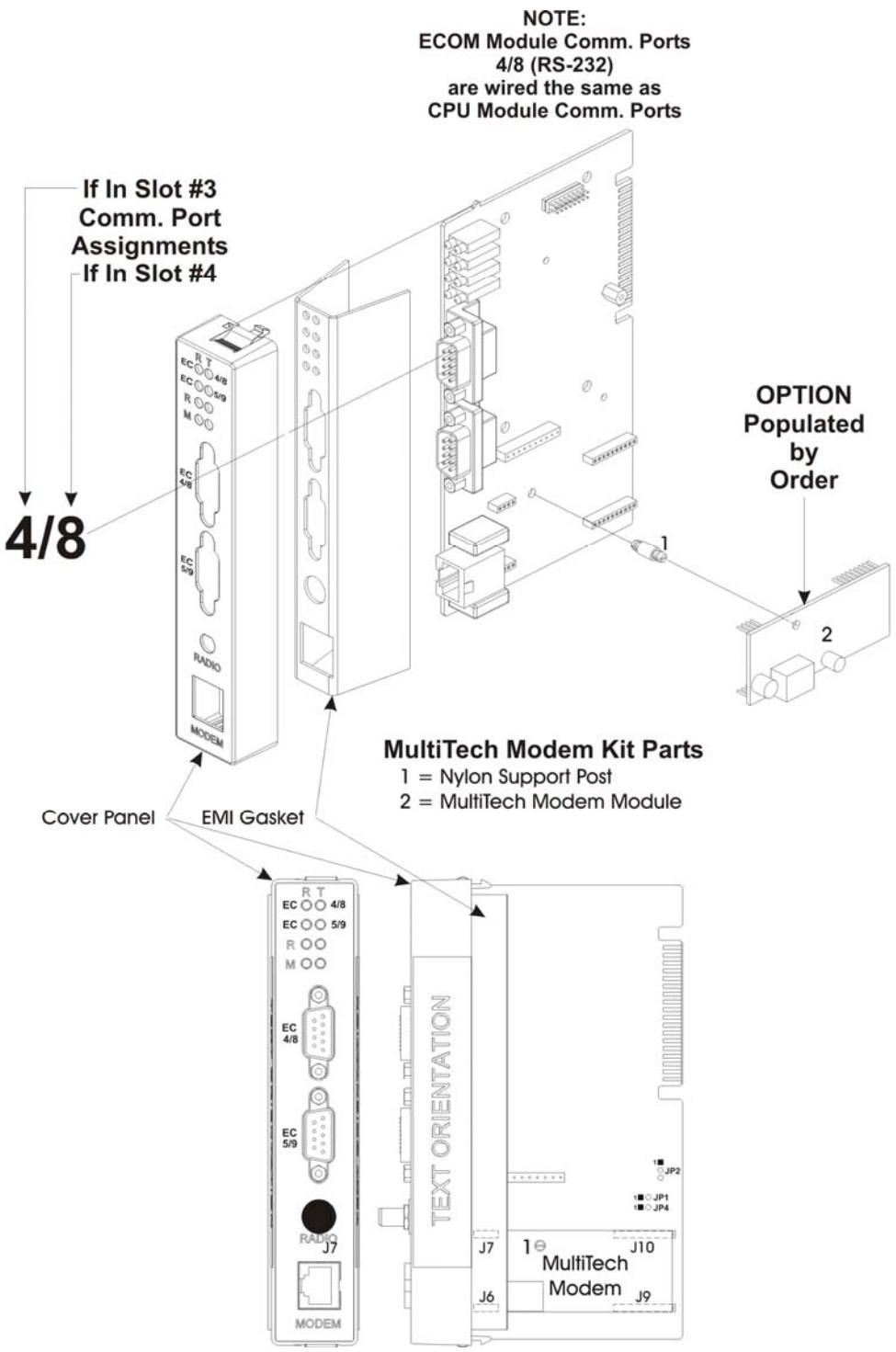

Figure D2. MultiTech Modem Installation Diagram

Note: If necessary, you can use a small screwdriver to pry the cover panel from the PCB.

2. Install the nylon support post included in the kit onto the ECOM Module.

3. Mount the MultiTech Modem to the ECOM Module making sure that the interface connectors (J6, J7, J9 & J10 on the ECOM Module) align.
4. Plug the antenna cable(s) (if present - removed in Step 2) into the appropriate RF connector of an installed radio module(s).
5. Snap the cover panel onto the ECOM Module PCB and insert the ECOM Module into the appropriate backplane slot, i.e., Slot 3 or 4.
6. Apply power and test the unit.

D2.1.2 Configuring the MultiTech Modem (MT9234SMI)

To configure a model MT9234SMI Modem (installed on an ECOM Module), perform the following steps:

1. If required, remove the ECOM Module from the controller (see *Figure D1*).
2. Place the modem into configuration mode by setting ECOM Module jumper JP2 onto pins 2 and 3. This enables configuration of the modem through Comm. Port 4 for modem on ECOM1 or through COMM. Port 8 for modem on ECOM2.
3. Connect a full duplex ControlWave null modem cable (see *Figure D3*) between a PC and Comm. Port 4 (ECOM1) to configure modem on ECOM1 or Comm. Port 8 (ECOM2) to configure modem on ECOM2.

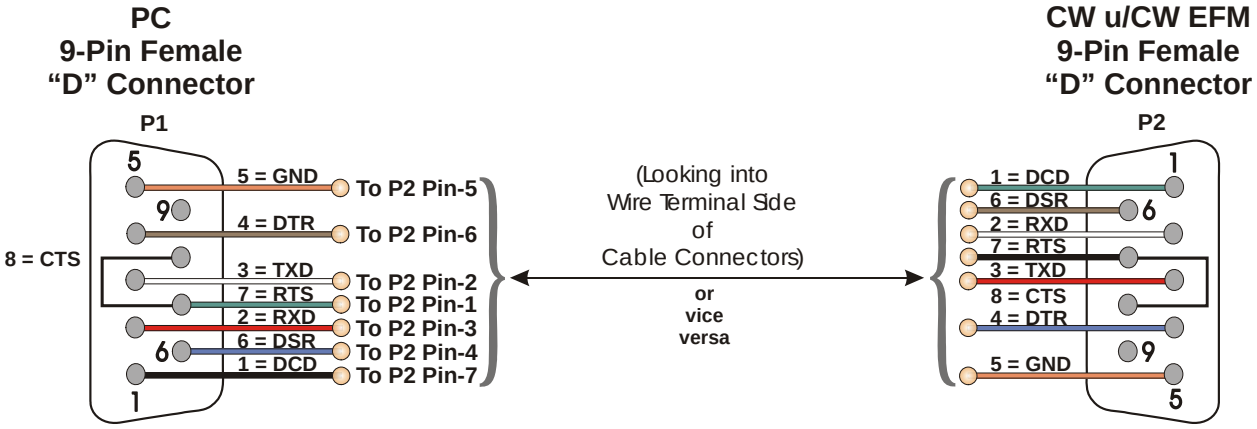

Figure D2. Internal Modem Configuration P/N 392843-01-3 Full-duplex Null Modem Cable Diagram

4. Open HyperTerminal on the PC and set the PC communication port settings as follows:

- Bits per second: 9600
- Data bits: 8
- Parity: None
- Stop bit: 1
- Flow Control: None
- Send Factory Default AT&F0.
- Disable Flow Control AT&K0.
- Set baud rate using AT Command for example:
  AT$SB9600,
  (Modify for whatever baud rate you require.)
- Write to memory AT&W.

5. Set ECOM Module configuration jumper JP2 into a storage position.

Appendix Z – Sources for Obtaining Material Safety Data Sheets

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

Manufacturer	General Description	Emerson Part Number & Media Notes
DURACELL (DL 2032) http://www.duracell.com PANASONIC (CR 2032) http://www.panasonic.com ENERGIZER (CR 2032) http://www.energizer.com SANYO (CR 2032) VARTA (CR 2032) http://www.varta-microbattery.com	LITHIUM MANGANESE DIOXIDE COIN CELL BATTERY	W15020X0012
B.B. Battery Co., Ltd. (BP33-12) http://www.bb-battery.com/	12V – 33AH/20 HR SEALED LEAD ACID BATTERY	395407-03-6

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