Instruction Manual
Doc Number CI-ControlWave XFC
Part Number D301396X012
November 2013

ControlWave® XFC
(Explosion-Proof Gas Flow Computer)

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 explains how to install and configure the Model 3820 EX ControlWave Explosion-Proof Gas Flow Computer (hereafter referred to as the "ControlWave XFC").

Chapter 1 details the structure of the manual, and discusses the basic features of the ControlWave XFC.

In This Chapter

1.1 Scope of this Manual

This manual contains the following chapters:

Chapter 1 Introduction	Describes the basic features and functions of the ControlWave XFC.
Chapter 2 Installation	Describes how to install the ControlWave XFC.
Chapter 3 Service	Describes certain activities for servicing the ControlWave XFC.
Chapter 4 Specifications	Describes the operational specifications and physical dimensions of the ControlWave XFC.

1.2 Overview

The primary function of the ControlWave Explosion-Proof Gas Flow Computer (XFC) is to measure the flow of natural gas in accordance with API (American Petroleum Institute) and AGA (American Gas Association) standards.

It is compatible with the TeleFlow-series in software and networking solutions for SCADA and EFM (Electronic Flow Meter) data editing/management, and is similar in all operations.

You can integrate the ControlWave XFC with Bristol Model 3808 MVT low-power transmitters for explosion-proof installations.

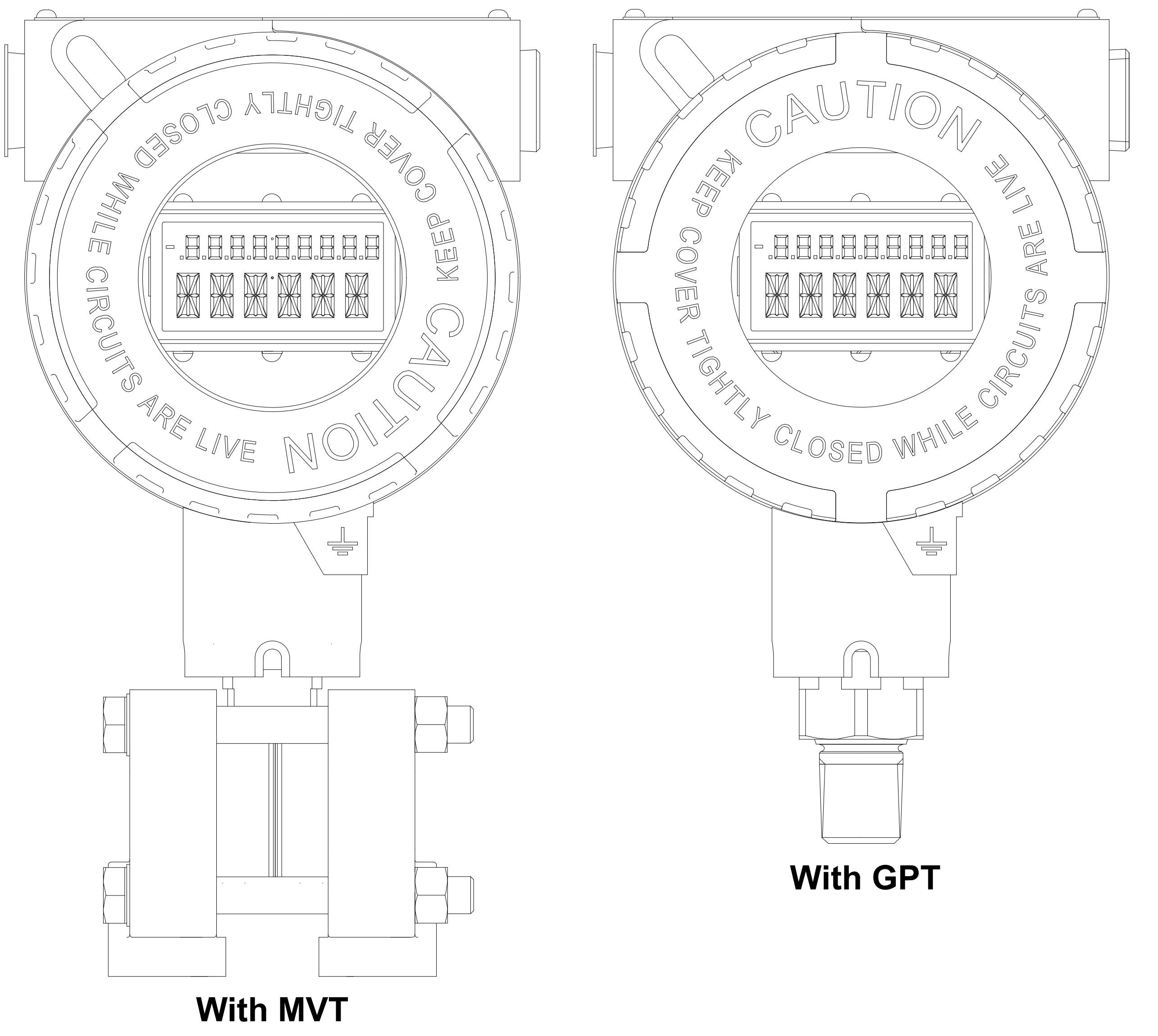


Figure 1-1. 3820-EX - ControlWave XFC Models

The major components of the ControlWave XFC are described in the sections that follow:

1.3 Explosion-Proof Housing

ControlWave XFCs are housed in an explosion-proof enclosure (case). The housing consists of the main body and two threaded covers.

The ControlWave XFC can be operated in an unprotected outdoor environment (see the product data sheet for details on temperature, humidity, and vibration limits.)

The front cover provides a viewing window for the LCD display. Access to the terminal plate is gained by removing the rear cover.

Four ¾-inch conduit fittings allow for ease of installation.

The ControlWave XFC has approval for Explosion Proof Class I, Division 1, Groups C & D locations (see *Appendix B*). It also has approval for Non-Incendive Class I Division 2 Groups A, B, C& D hazardous locations (see *Appendix A*).

A data plate containing product identification and certification information is screwed to the top of the housing.

1.4 CPU Board Assembly

The multilayer CPU board provides processing, I/O monitor/control, memory and communication functions.

A System-on-Chip Advanced RISC Machine (ARM) microprocessor with 32-bit ARM9TDMI Reduced Instruction Set Computer (RISC) is the core of the CPU board.

In addition to the microprocessor and control logic, the CPU board includes memory, a serial real time clock, an LCD display, and a switch bank for system configuration.

1.4.1 Memory

The CPU board includes three types of memory: Boot FLASH, Static RAM, and FLASH.

Boot Flash (512K)

Boot/download code is contained in a single 512 Kbyte FLASH chip on the CPU board. User-configured soft switch parameters, audit/archive configuration information, and communication port configuration data are also stored in Boot FLASH.

Static RAM (2MB)

The running control strategy program (ControlWave project) executes wihin 2MB battery-backed static RAM on the CPU board. Although you can download the ControlWave project directly into SRAM, it is strongly recommended that you download it into FLASH memory as the **bootproject**. This allows the system to automatically copy the project from FLASH into SRAM, when it is needed.

Static RAM also holds the last state of all I/O values, pending alarm messages, and optionally, audit/archive data.

Retain variables, which are values of any variables you need to preserve during power outages or when the system has been disabled for maintenance, also reside in static RAM.

⚠ Caution **Only retain variables are maintained during power outages, restarts, etc. All data in SRAM (including retain variables) is lost if, during a power failure or restart, there is also a failure of the backup battery, or if the user clears SRAM using the SRAM control switch.**

FLASH Memory (8MB)

The CPU board includes 8MB of simultaneous read/write FLASH memory.

System firmware is stored and executed from within FLASH memory. Historical data (audit/archive) is also typically stored in FLASH.

When you download your ControlWave project into the unit, you should always store it in FLASH as the bootproject. If no ControlWave project is already running, or if the system is restarted, the system automatically copies the project from FLASH into SRAM for execution.

The contents of FLASH memory remain intact during a system restart or power failure.

1.4.2 LCD Display

The CPU board includes a liquid crystal display (LCD) that enables an on-site operator with the ability to look sequentially at current values of process variables. In normal operation, the integral two-line LCD display stays on after the unit is configured and placed in service. The LCD display contains an upper row consisting of a ± LCD character and nine 7-segment LCD characters, and a bottom row consisting of six 14-segment LCD characters. Variable values controlled by the application post to the upper characters and variable names post to the lower characters. Variable names may include units up to 20 characters in length which scroll across the bottom row.

You control the messages appearing in the LCD display using the DISPLAY function block, in the ControlWave project.

1.5 I/O and Communications

The ControlWave XFC sends and receives data through its communication ports and input/output I/O assembly.

1.5.1 Communications

The ControlWave XFC communicates using either **BSAP**, or the serial IP Point-to-Point Protocol **PPP**. Alternatively, third-party protocols may be used such as Allen-Bradley DF1, CIP, DNP3, HART, or MODBUS; see the ControlWave Designer online help for a list of supported protocols.

Three serial communication ports are provided.

Each of these ports allows local communication with a PC running OpenBSI or ControlWave Designer.

You can change the factory default settings for these ports using the Flash Configuration Utility.

1.5.2 I/O Board Assembly

The I/O board assembly ships from the factory mounted against the **terminal plate**. This board contains a microcontroller that handles the following functions:

- Multivariable transducer (MVT) or Gage Pressure Transducer (GPT) interface.
- Analog to digital circuitry that monitors an external RTD and the unit's power source.

Optional Process I/O circuitry consists of the following:

- Two Discrete Inputs (DI), four Discrete Inputs / Discrete Outputs (DI/DO), two High Speed Counters (HSC)

  -or-
- Two Discrete Inputs (DI), four Discrete Inputs / Discrete Outputs (DI/DO), two High Speed Counters (HSC), three optional 1-5V Analog Inputs (AI). one optional 4-20mA Analog Output (AO)

Multivariable or Gage Pressure Transducer

The ControlWave XFC supports **either** a:

- Multivariable Transducer (MVT) for differential pressure (DP) or gage pressure (GP) measurements.

  or a
- Gage Pressure Transducer (GPT) for gage pressure (GP) measurement.

The multivariable transducer (MVT) pressure assembly is connected to the process manifold either directly or by tubing while the gage pressure transducer (GPT) **MUST ONLY** be connected via tubing. In 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 MVT/GPT transducer extends into the bottom of the enclosure, with the body of the transducer outside the enclosure. The MVT/GPT cable connector is factory mated with the I/O board assembly.

RTD Probe

A 100-ohm platinum bulb (using the DIN 437600 curve) is optionally available. Factory-supplied RTDs are provided with three wires; the return lead connects to the RTD- terminal while the two junction leads (sense and excitation) connect to the RTD+ terminals. RTDs must be used and connected based on the area classification. In Class I Div I installations use sealed fittings. See *Appendix B* for more information.

1.6 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 XFC. *Figure 1-2* graphically presents the programming environment.

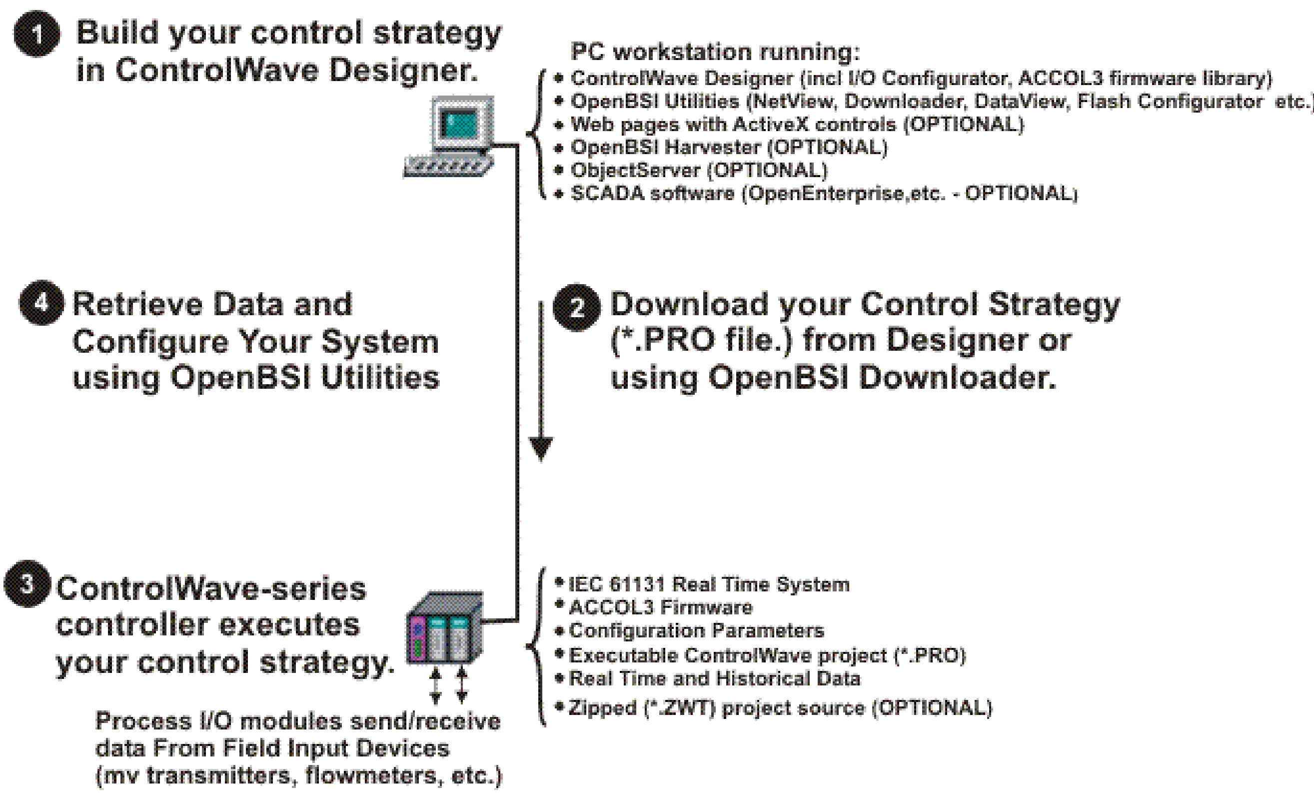


Figure 1-2. ControlWave Programming Environment

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 unit. 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 in the ControlWave and configure the individual mapping of I/O points for discrete 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. (See the *ControlWave Flow Measurement Applications Guide* D5137) 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 other protocols including: Modbus, Allen-Bradley DF1, CIP, DNP3, and Hex Repeater. See the ControlWave Designer online help for details and restrictions.

1.7 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 XFC 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.

1.7.1 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.

1.7.2 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.

1.7.3 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.

1.7.4 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.

1.7.5 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.

1.7.6 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.

1.7.7 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.

1.7.8 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.

1.7.9 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 the *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.

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

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 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

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

1.7.10 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.

1.7.11 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.

1.7.12 Chromatograph Interface

If you use a chromatograph to measure gas component information you can integrate this into the application. You can also specify fixed gas component percentages to use if the chromatograph fails.

1.7.13 Nominations

Nominations allow you to configure the ControlWave flow computer to allocate precise amounts of gas flow during specific time periods, called nomination periods.

Chapter 2 – Installation

Chapter 2 explains how to install the ControlWave Explosion-Proof Gas Flow Computer (XFC) and make connections for power, I/O and communications.

In This Chapter

2.1 Before You Begin

Several things need to be considered before you begin the installation:

2.1.1 Installation in Hazardous Areas

Each ControlWave explosion-proof gas flow computer (XFC) is furnished in an explosion-proof case designed to operate in Class I, Division 1 explosion-proof environments (Groups C & D) and in a nonincendive Class I Division 2 Groups (A, B, C & D) hazardous location. (See *Appendix A* and *Appendix B*).

2.1.2 Site Location Considerations

Check all clearances when choosing an installation site. Make sure you can open the ControlWave XFC for wiring and service.

Make sure the LCD display is visible and accessible to the on-site operator.

Only install the XFC in a location that meets the temperature, humidity and vibration specifications listed in product data sheet 1660DS-7E on the Emerson Remote Automation Solutions website. Use of the XFC in a location that exceeds those specifications could result in failure of the XFC.

2.1.3 General Wiring Guidelines

- ControlWave XFC pluggable terminal blocks 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 screw.
- 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.

2.1.4 Reviewing Supplemental Safety Instructions

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

Supplemental Guide – ControlWave Site Considerations for Equipment Installation, Grounding, and Wiring **(S1400CW)**

ESDS Manual – Care and Handling of PC Boards and ESD Sensitive Components **(S14006)**

2.2 Installation Overview

Installing a ControlWave XFC involves several general steps:

⚠ WARNING **EXPLOSION HAZARD – Never perform installation while in a hazardous area.**

1. Unpacking, assembling, and configuring the hardware. This includes the following tasks.

a) Mount the enclosure on site. (See *Section 2.3.2*)

b) Unscrew the front cover and enable the backup battery using the jumper. If necessary, set CPU switches, then screw the front cover back on.

d) Connect a communication cable from one of the serial ports (typically COM1) to a laptop PC.

e) Unscrew the rear cover and connect the I/O wiring to the terminal plate assembly. (See *Section 3.3*)

f) If used, connect a communication cable between one of the ports and a Bristol 3808 transmitter.

f) Install a ground wire between the enclosure’s ground lug (or ground screw on the terminal plate assembly) and a known good Earth ground.

h) Connect the RTD probe (if required). (See *Section 3.3.7*)

i) Wire DC power to the unit then screw the rear wiring cover back on.

j) Turn on power. (See *Section 4.1*)

2. Install PC-based software (TechView).

3. Establish communications to perform calibration activities or view data using the standard flow measurement application menus.

Note: Steps 2 through 3 require that you install and use OpenBSI TechView software to perform calibration and that you use the standard menus. This manual focuses on hardware installation and preparation. Software installation and configuration is beyond the scope of this manual. Refer to the *TechView User's Guide* (D5131) and the *ControlWave Flow Measurement Applications Guide (*D5137) for more information. If you are **not** using the flow measurement application and plan to create your own application, refer to the *Getting Started with ControlWave Designer Manual* (D5085) and the *ControlWave Designer Programmer's Handbook* (D5125).

2.3 Hardware Installation on Site

This section discusses hardware installation of the ControlWave XFC at its field location.

⚠ WARNING **Make sure the pipes, tubing, and fittings used at the installation site are adequate for the pressure measured.**

Notes:

- We recommend you pre-configure the group number and local address of the ControlWave XFC in a lab environment using TechView and the Flash Configuration utility. This allows you to avoid doing extra configuration at the field site.
- You will need a small thin screw driver, a 3mm hex wrench, in addition to other basic tools, to complete the installation.

2.3.1 Unpacking the Unit

The ControlWave XFC ships from the factory with all integral components wired and mounted. Remove the ControlWave XFC from its carton.

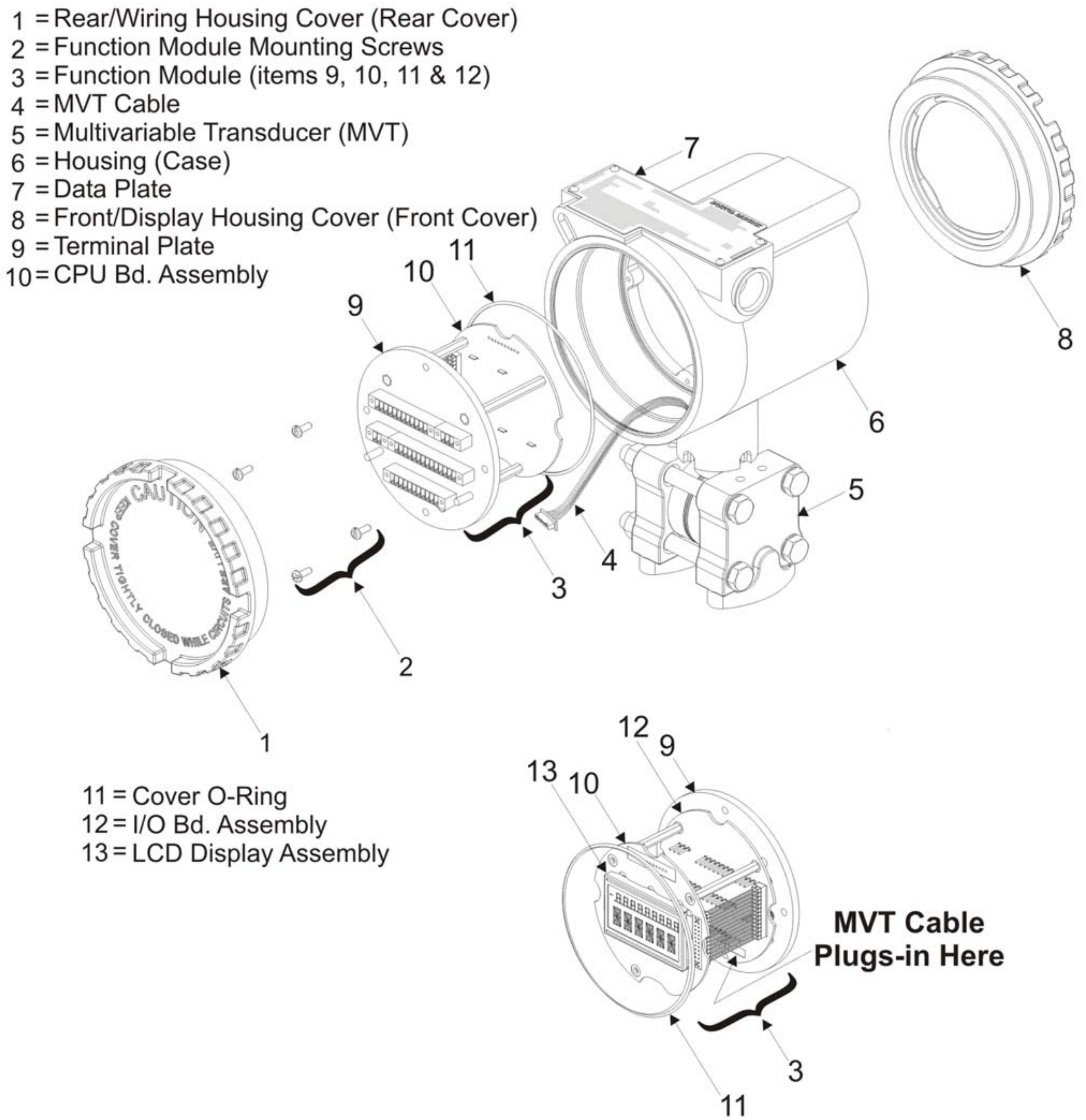


Figure 2-1. ControlWave XFC (with MVT) (Isometric Views) Component Identification Diagram

Note: Internally, circuit boards are stood-off and mate to the terminal plate via an assembly called the "function module." The function module secures to the inside of the XFC via four screws.

2.3.2 Mounting the Unit and Connecting the MVT or GPT

You can order the ControlWave XFC with either a multi-variable transducer (MVT) or a gage pressure transducer (GPT). In 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 to the bottom of the enclosure, with the body of the transducer outside the enclosure. The MVT/GPT cable connector is factory-mated with the I/O board assembly connector P1.

When mounting one of these units, position it in accordance with the following restrictions:

- Position the unit vertically with the transducer (MVT or GPT) at its base. Only units equipped with a multivariable transducer (*Figure 2-2*) may be mounted directly to the "Main" (meter run) utilizing a process manifold or they can be mounted remotely to a vertical or horizontal 2" pipe (via a pipe clamp, bracket, and adapter blocks) and connected to the process manifold using tubing. Units equipped with a gage pressure transducer can **ONLY** be mounted to a vertical or horizontal 2" pipe (via a pipe clamp, bracket, and adapter blocks) – see *Figure 2-3* and connected to the process manifold using tubing. If used, you must anchor the two inch pipe in cement (deep enough to conform to local building codes associated with frost considerations).

Note: Units equipped with a gage pressure transducer **CANNOT** be mounted directly to the process main (meter run). Units with the GPT may only be connected via tubing.

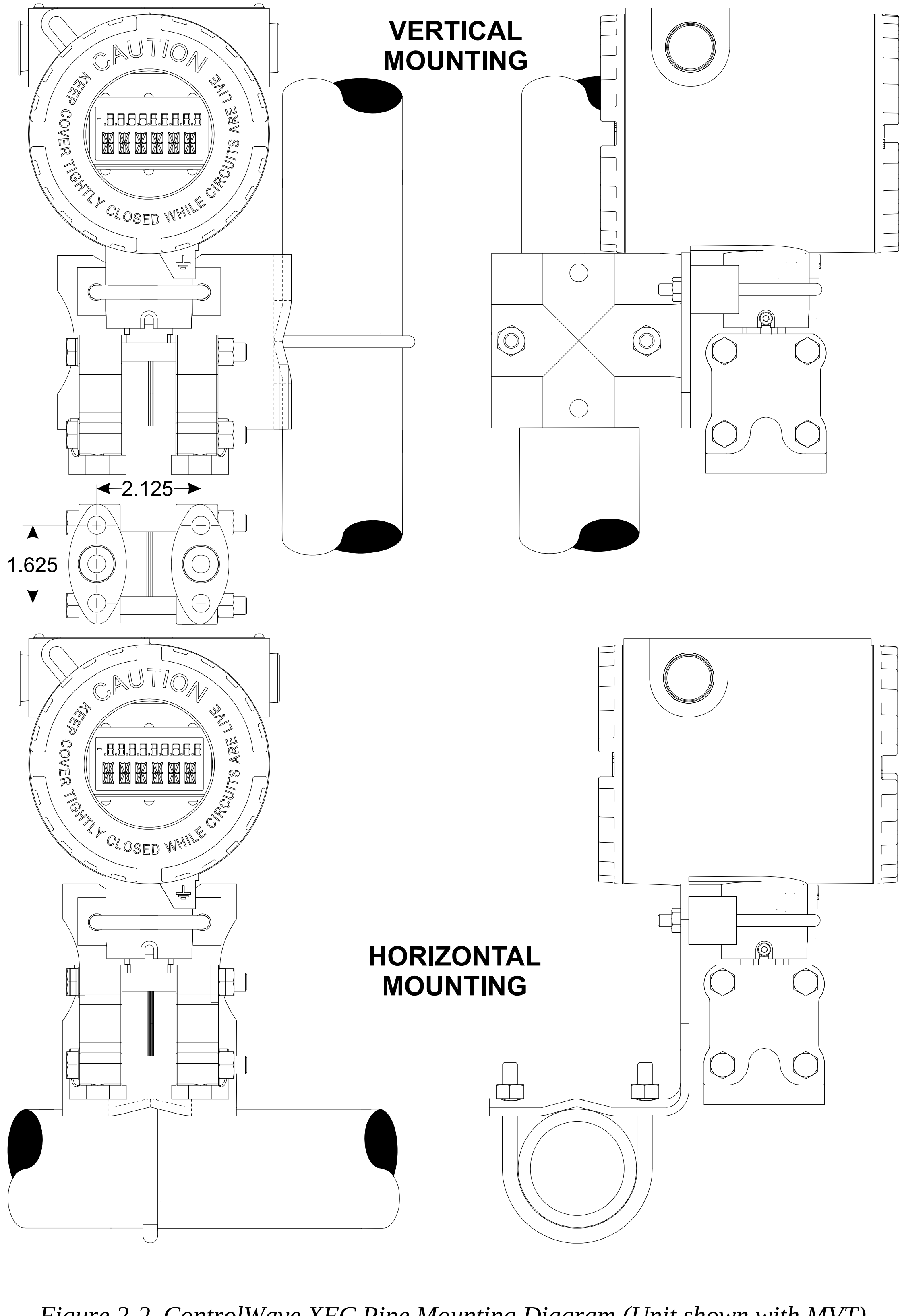


Figure 2-2. ControlWave XFC Pipe Mounting Diagram (Unit shown with MVT)

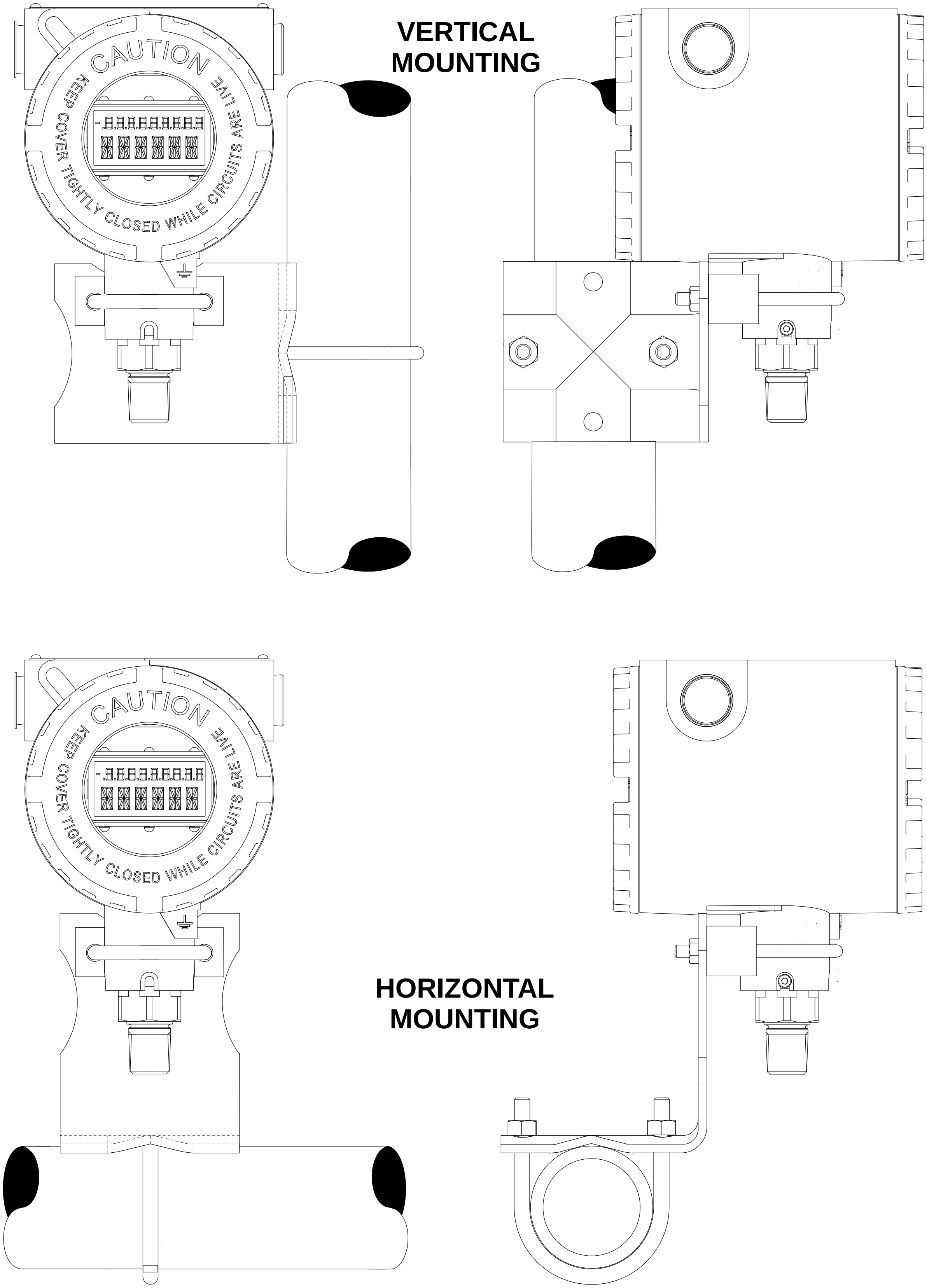


Figure 2-3. ControlWave XFC Pipe Mounting Diagram (Unit shown with GPT)

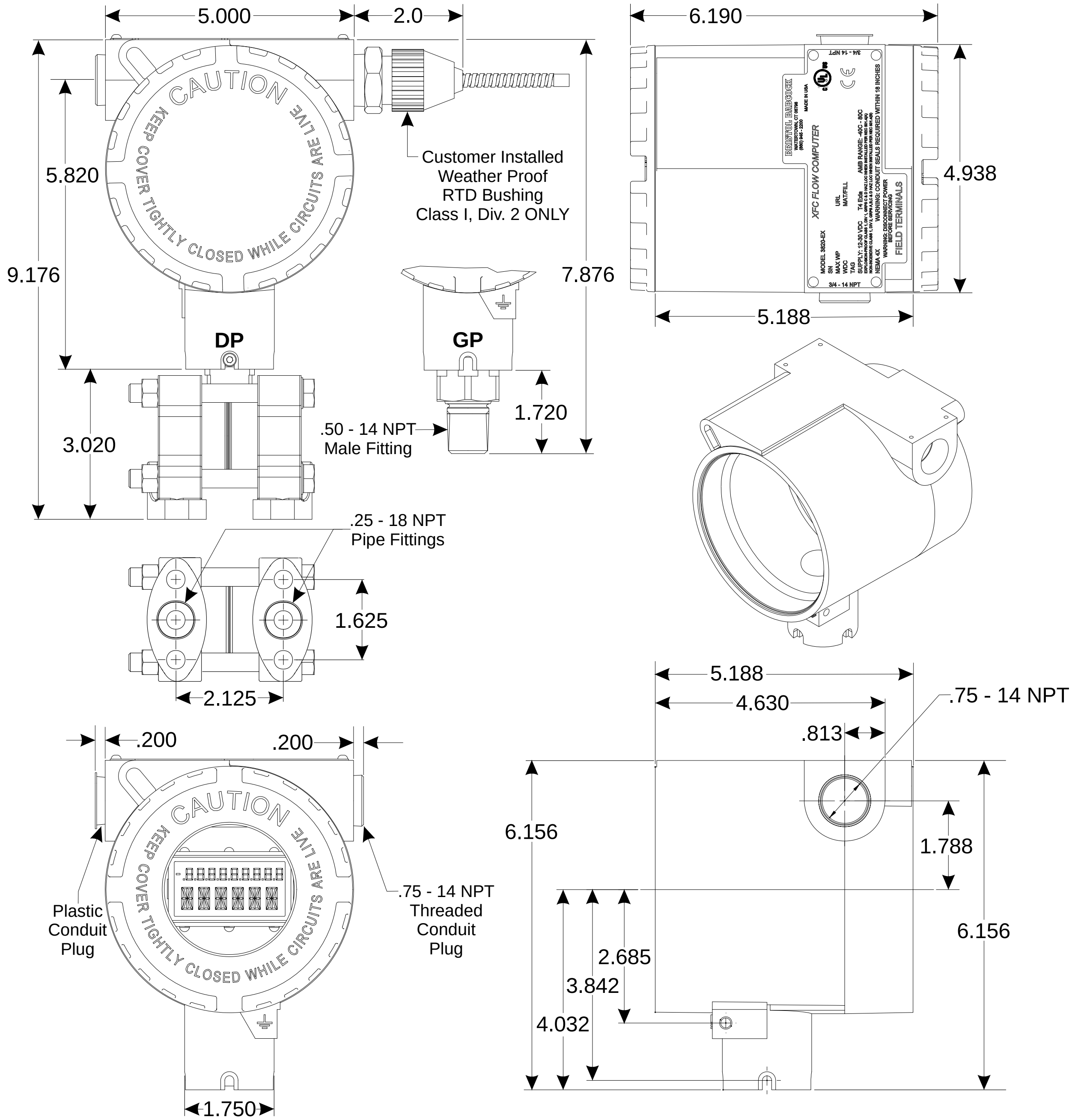


Figure 2-4. ControlWave XFC Dimensions Drawing

Bolt the multivariable transmitter (MVT) to a process manifold that you connect to the main (meter run) directly or via two pipes (see *Figure 2-5, Figure 2-6, Figure 2-7*, and *Figure 2-8*).

- Position the unit so that the front of the assembly is visible and the unit is accessible for service (i.e. battery replacement, wiring connections, etc.) The LCD display must be visible and accessible for the onsite operator.
- Do not connect power wiring to its source until the unit has been mounted and grounded at its designated work site.

- Route I/O wiring, external power wiring, RTD cabling, local communication port, and network (RS-232 and RS-485) communication port cabling so it enters the top of the unit through ¾ - 14 NPT conduit fittings. You can also route I/O wiring through the right side of the unit (when facing the front). This requires that you remove the hole plug and replace it with a ¾" – 14 NPT conduit fitting.
- If you use a bendable RTD, use a weather proof conduit fitting for installation in Class I, Division 1 explosion-proof environments (Groups C & D).

Connecting to a Multivariable Transducer (MVT)

Your ControlWave XFC may have an optional multivariable transducer (MVT) secured to the bottom of the unit. *Figure 2-5* details MVT process flange and optional manifold block connector mounting dimensions.

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

- **Standard Process Flange for MVT –** Two process flanges containing the connection ports are assembled to the differential transmitter. Port designations (L and H) are stamped on the body between 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 2-5*.
- 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 transmitter. 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 transmitters 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 2-5*.

Connecting to a Gage Pressure Transducer (GPT)

You can secure an optional gage pressure transducer (GPT) to the bottom of the enclosure instead of the MVT. Gage pressure transducers are equipped with a ½-14 NPT male pipe fitting.

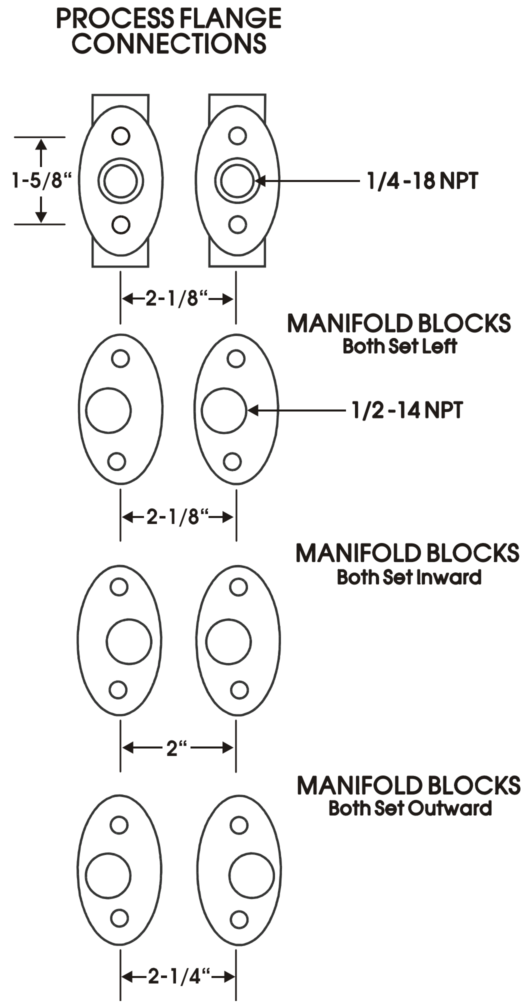


Figure 2-5. Process Flange and Optional Manifold Block Connectors

Case Rotation

Once mounted, you can rotate the case (XFC housing) up to 180° in either direction, i.e., clockwise or counterclockwise. You must not rotate the case from its shipped position any more than 180° clockwise or counterclockwise.

Caution **If you rotate the ControlWave XFC case (housing) more than 180° from its shipped position, you may damage the unit.**

To rotate the case, remove the setscrew that locks the MVT to the XFC with a 3mm hex wrench. Once the case has been turned to the desired position, be sure to replace and tighten the set-screw (see *Figure 2-6*).

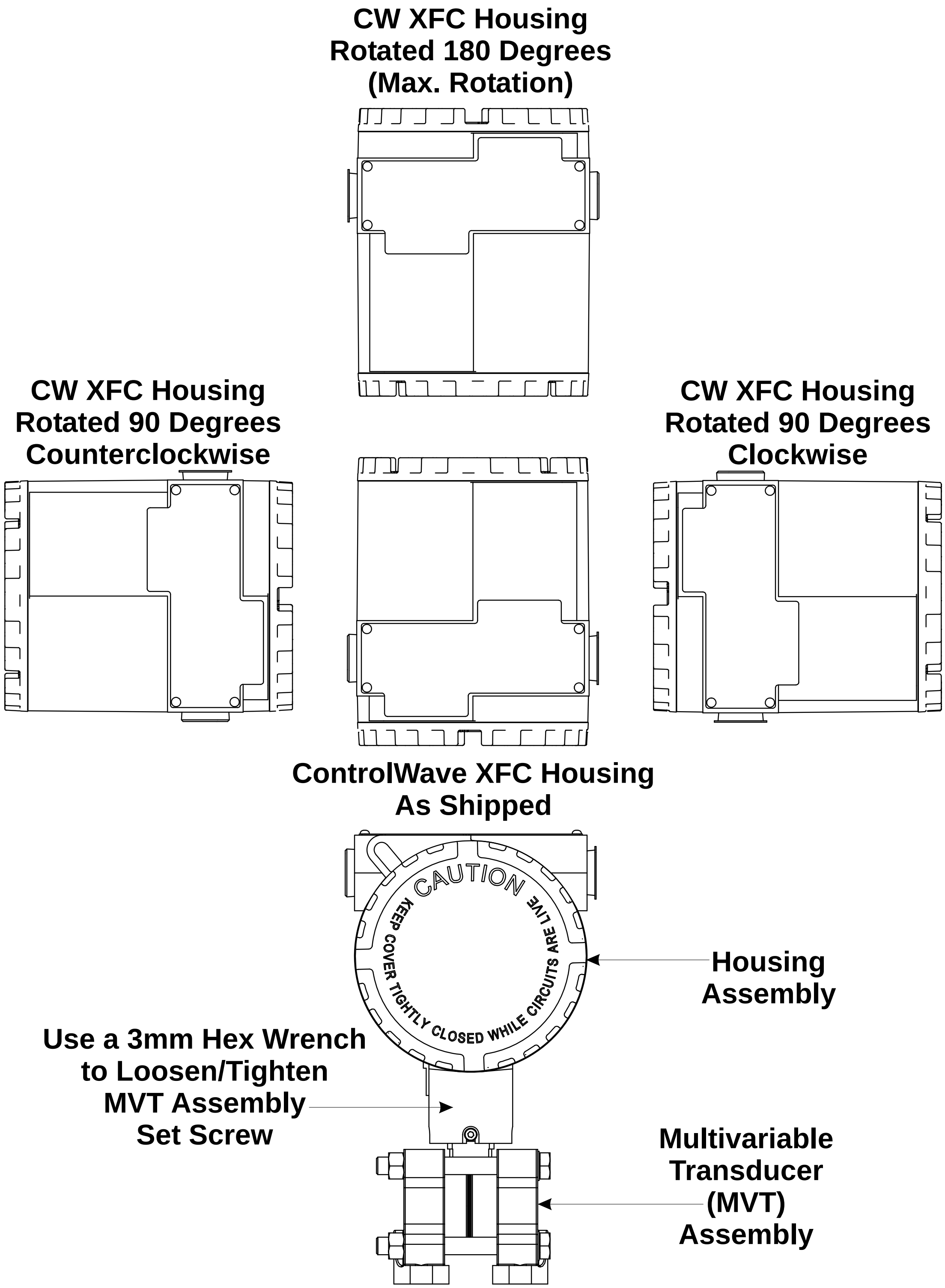


Figure 2-6. ControlWave XFC Housing Assembly Rotation Diagram

Process Pipeline Connection (Meter Runs without Cathodic Protection)

Units equipped with an optional MVT may be mounted directly on the pipeline or remotely on a vertical or horizontal stand-alone two-inch pipe or on a wall or panel. Units equipped with optional gage pressure transducers (GPT) may **only** be mounted remotely, that is, on a vertical or horizontal stand-alone two-inch pipe or on a wall or panel. The Earth ground must run between the XFC's ground lug and Earth ground (rod or bed) even though the ControlWave XFC units equipped with a MVT or GPT 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.

Mount the ControlWave XFC on a stand-alone vertical/horizontal 2-inch pipe or on a wall or panel. Connect the ground conductor between the ControlWave XFC chassis ground lug and a known good Earth ground. Connect the cases of temperature transducers, pressure transmitters, etc., to the known good Earth ground. If the unit is mounted to a 2-inch pipe in continuity with the pipeline, you may have to electrically isolate the 2-inch pipe from the ControlWave XFC. 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 rose bud torch, it electrically insulates and increases the strength of the pipe stand. See specification summary F1670SS-0a for information on PGI direct mount systems and manifolds.

Note: Remote installation of a unit, without cathodic protection, is similar to that of *Figure 2-7* except that it does not require the transducer to manifold dielectric isolation kit.

Process Pipeline Connection (Meter Runs with Cathodic Protection)

Dielectric isolators are available and are always recommended as an *added measure* in isolating the ControlWave XFC 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. ControlWave XFCs equipped with an MVT may be mounted directly on the pipeline or remotely on a vertical/horizontal stand-alone two-inch pipe or on a wall or panel (see *Figure 2-8*). ControlWave XFCs equipped with a GPT can only be mounted on a vertical/horizontal stand-alone two-inch pipe or on a wall or panel. 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 XFC gas flow computer 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.

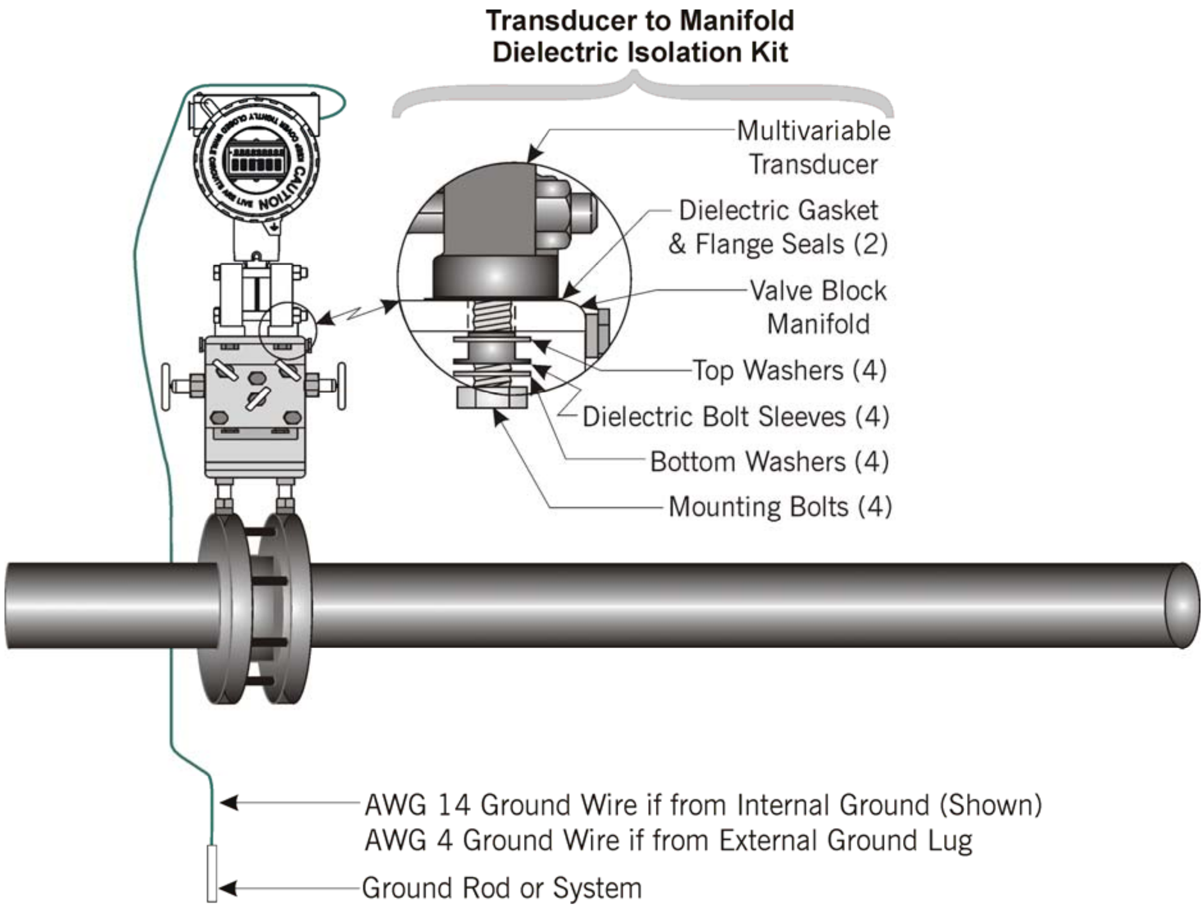


Figure 2-7. ControlWave XFC Direct Mount Installation with Cathodic Protection

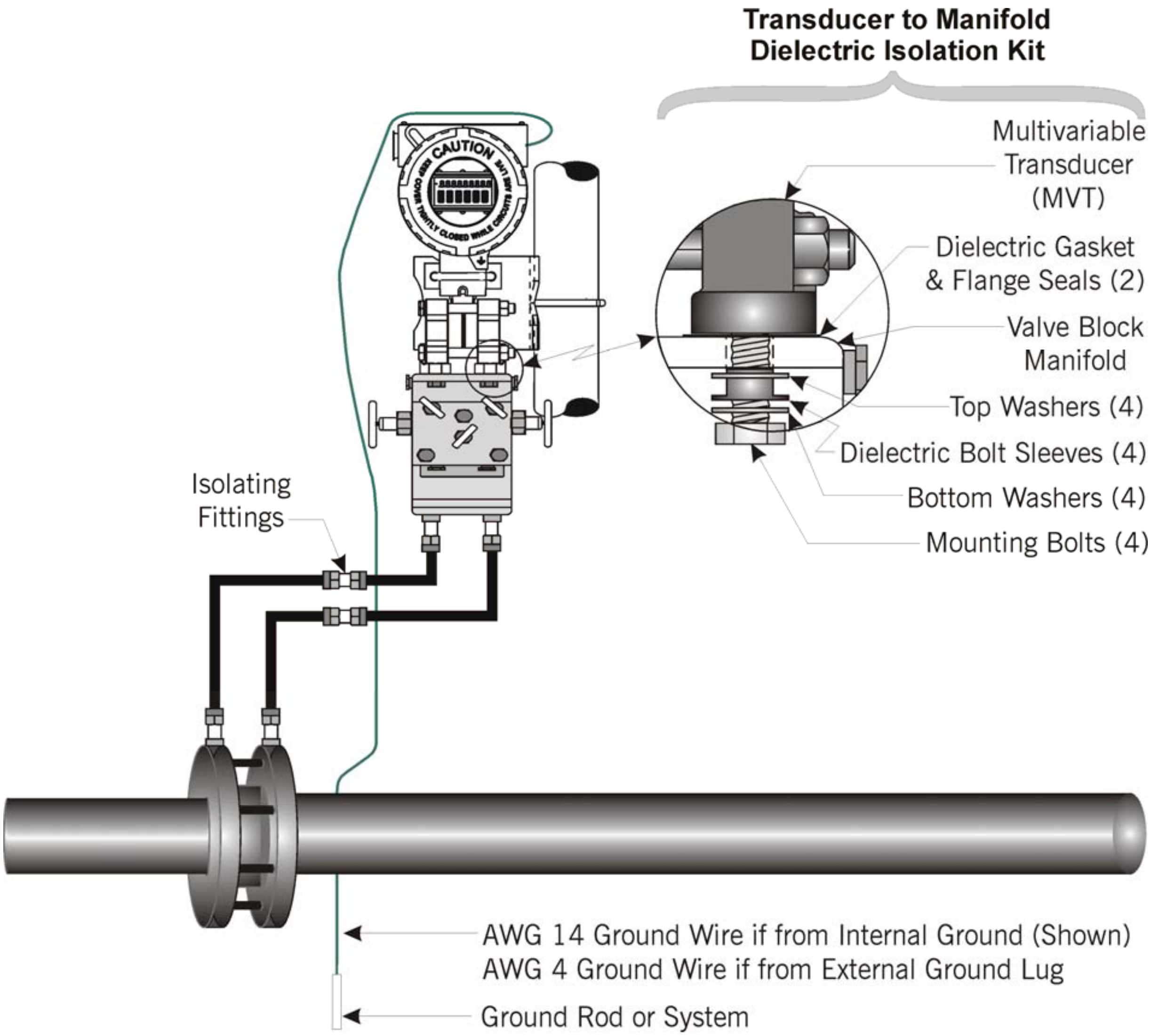


Figure 2-8. ControlWave XFC Remote Installation (with Cathodic Protection)

2.4 Setting CPU Switches and Jumpers

Before you begin, unscrew the front windowed cover.

Lithium Backup Battery Jumper JP1

The CPU board is equipped with a coin-cell socket (BT1) that accommodates a 3.0V, 255 mA-hr lithium coin cell battery. In a power failure or system restart, this battery provides backup power for the real-time clock (RTC) and the SRAM.

CPU boards are shipped with the lithium backup battery installed, but with the battery disabled, via jumper JP1, to allow for maximum shelf life, prior to installing the ControlWave XFC. When disabled, jumper JP1 is removed and stored on either of its pins.

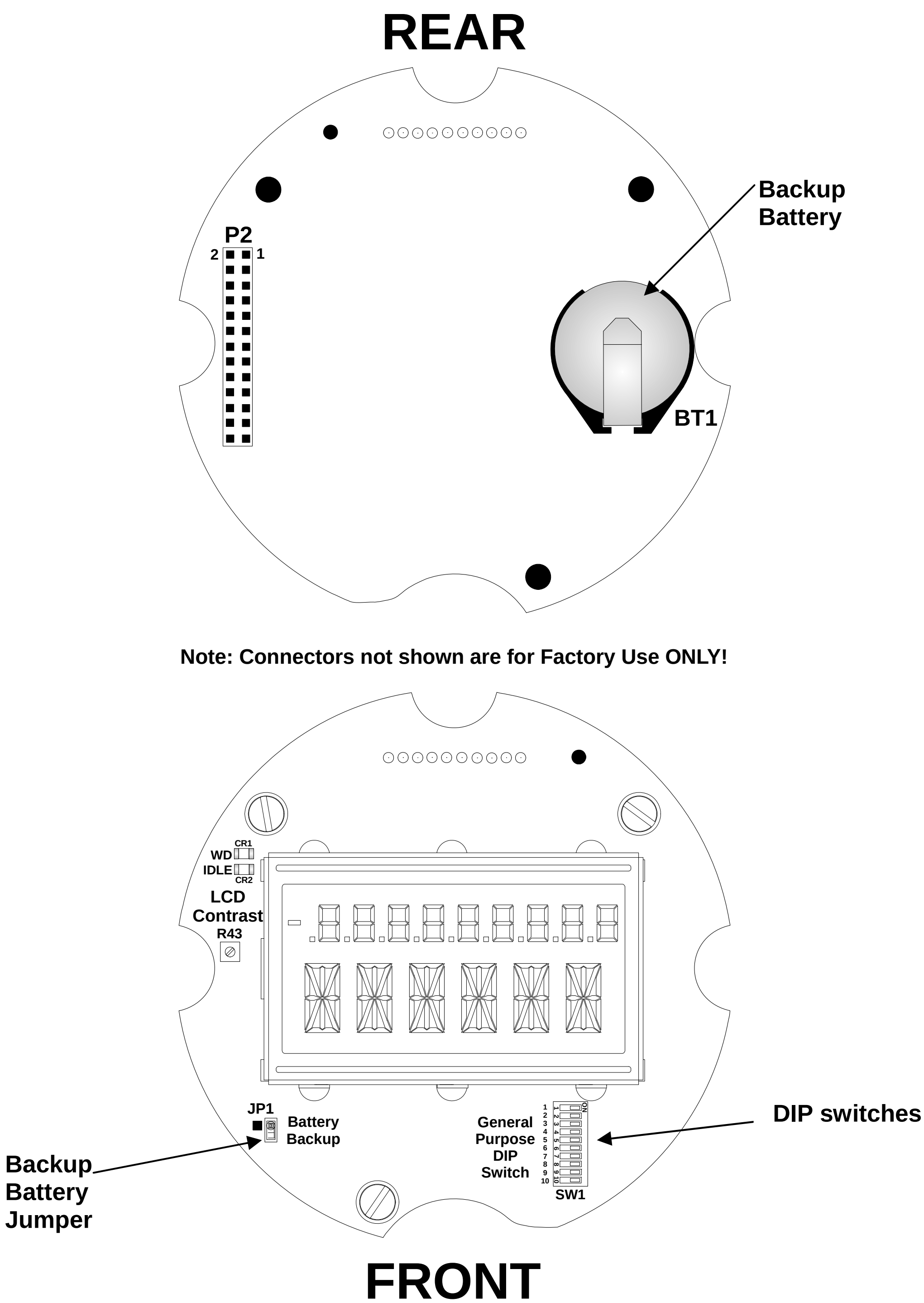


Figure 2-9. CPU Module Component Identification Diagram

Therefore, when you install the ControlWave XFC, you must enable the backup battery by placing jumper JP1 on its jumper posts (see *Figure 2-9*).

- JP1 installed on both posts = battery **enabled**
- JP1 removed or on only one post = battery **disabled**

Because current is only drawn from the lithium backup battery if the unit loses power, this should support many years of operation without the need to replace the lithium backup battery.

Note: If the backup battery is working properly, the _BAT_OK system variable is set ON; if the battery fails, this is OFF. The Ram Backup Battery Status shows on the Station Summary page in the standard measurement application. If the real-time clock loses its battery backup, the ControlWave system variable _QUEST_DATE turns ON. You can monitor this to generate an alarm. See the *System Variables* section of the *ControlWave Designer Programmer's Handbook* (D5125) for more information. See the *ControlWave Flow Measurement Applications Guide* (D5137) for information on the standard measurement application.

Setting CPU DIP switches

In most cases, leave the CPU switch bank switches in their factory default positions.

Review *Table 2-1* and, if needed, change switches from their default settings. Otherwise, leave them at their defaults.

Table 2-1. CPU Switch Bank SW1

Switch Number	Function	Setting (BOLD =Factory default)		Notes
SW1-1	Enable / Disable Watchdog circuit	**ON** OFF	Watchdog circuit is enabled Watchdog circuit is disabled	The Watchdog circuit allows the system to automatically attempt a restart after a system crash or hang.
SW1-2	Unlock / Lock soft switches	**ON** OFF	Unlock soft switches and flash files for writing Lock soft switches and flash files to prevent writing	
SW1-3	Use / Ignore soft switches	**ON** OFF	Use soft switches Ignore soft switches and use factory defaults	For use of user defined soft switches, SW1-3 must be set to the ON position. Note: If both SW1-3 and SW1-8 are set OFF (closed), all communication ports will be set to 9600 bps operation.
SW1-4	Core Updump Disable / Enable	ON **OFF**	Disable core updump Enable core updump	Performing a core updump causes the contents of SRAM to Used in conjunction with SW1-9 and SW1-10

Switch Number	Function	Setting (BOLD =Factory default)	Notes
SW1-5	SRAM Control	**ON** Retain values preserved in SRAM and used during restart. OFF Reinitialize SRAM – clear all values when the unit recovers from a low power or power outage condition.	Note: If the battery is removed from the CPU board (due to replacement) when the CPU board has been removed, power should not be applied before one minute has passed unless SW1-5 on the CPU has been set OFF.
SW1-6	Remote system firmware download Enable / Disable	**ON** Enable remote system firmware download OFF Disable remote system firmware download	In ordain order to use remote system firmware download, the XFC must have boot and system PROM versions 4.7 and newer.
SW1-7	RESERVED FOR FUTURE USE	Leave at ON	
SW1-8	Disable/Enable WINDIAG	**ON** Normal operation. Allow bootproject to run; disable WINDIAG OFF Disable bootproject; allow WINDIAG to run	SW1-8 set OFF prevents the 'Boot Project' from running and places the unit into diagnostic mode. SW1-8 must be set OFF to run WINDIAG program. When SW1-8 has been set ON, diagnostics is disabled. SW1-8 must be set to the ON position for normal system operation, i.e. for the Boot project to run. Note: If both SW1-3 and SW1-8 are set OFF (closed), all communication ports will be set to 9600 bps operation.
SW1-9	Recovery Mode	ON Enable Recovery Mode **OFF Disable Recovery Mode** (See description for SW-10 for more information)	Recovery Mode is used to allow upgrades of the unit's system firmware and for core updumps. (See *Chapter 3* for more information.)
SW1-10	Force updump or allow normal operation	Default = OFF – meaning varies based on SW1-9 position. (See description)	SW1-9 & SW1-10 are multiplexed to provide operator control of Local Mode or Recovery Mode. Local Mode is used for normal operation. When both SW1-9 and SW1-10 are set ON or OFF, or with SW1-9 set ON and SW1-10

Switch Number	Function	Setting (BOLD =Factory default)	Notes
			set OFF, Recovery Mode is enabled. Local Mode is enabled when SW1-9 is OFF and SW1-10 is ON.

Replace the front cover
When finished with jumper and switch settings, screw the windowed front cover back onto the unit.

2.5 Making Communication Wiring Connections

You configure a ControlWave XFC as a slave node of a data concentrator in the network.

Alternatively, you can configure the ControlWave XFC as a master or slave node on either a BSAP network or a MODBUS network. You can also use Point-to-Point Internet protocol (PPP). Other third-party protocols (Allen-Bradley DF1, CIP, DNP3, and HART) are also supported; see the ControlWave Designer online help for an up-to-date list. A variety of communication schemes are available. Three communication ports are available and are accessible on the I/O board assembly terminal plate.

Note: All serial ports are located on terminal block J2.

Table 2-2 describes these communication ports:

Table 2-2. Serial Communication Ports

Serial Port	Type	Usage	Factory Defaults
COM1 Local Port	3-pin RS-232 Half Duplex Labeled: LOCAL	BSAP MODBUS Other third-party protocols	115.2K baud BSAP If unit in Diagnostic mode, defaults to 9600 baud, BSAP.
COM2 Network Port	7-pin RS-232 Full Duplex Half Duplex Labeled: NETWORK	For the standard Well head application, COM2 is reserved for the radio.	9600 baud BSAP slave
COM3 RS485 Port	3-wire RS-485 Half Duplex Labeled: RS-485	BSAP MODBUS Other third-party protocols	9600 baud BSAP master (intended for use with Bristol 3808 MVT transmitters)

2.5.1 Connections to RS-232 Serial Port(s) COM1 or COM2

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

COM1 and COM2 have different connector pin assignments. See the tables below for connector pin assignments.

Table 2-3. COM1 Connector Pin Assignment

Pin	RS-232 Signal	RS-232 Description
5	RXD	Receive Data Input
6	TXD	Transmit Data Output
7	GND	Power Ground

Table 2-4. COM2 Connector Pin Assignment

Pin	RS-232 Signal	RS-232 Description
8	TXD	Transmit Data Output
9	RXD	Receive Data Input
10	RTS	Request to Send Output
11	CTS	Clear to Send Input
12	DTR	Data Terminal Ready Output
13	DCD	Data Carrier Detect Input
14	GND	Power Ground

RS-232 COM1/COM2 Port Cables

For the ControlWave XFC, 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 2-11*) to connect with other devices (such as a PC, a printer, another ControlWave [except the CW_10/30/35]) when the ControlWave XFC uses the full-duplex PPP protocol.

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

Use the “null modem” cable for full-duplex (PPP protocol) communications when connecting a ControlWave XFC to a PC. (See top part of *Figure 2-10*.)

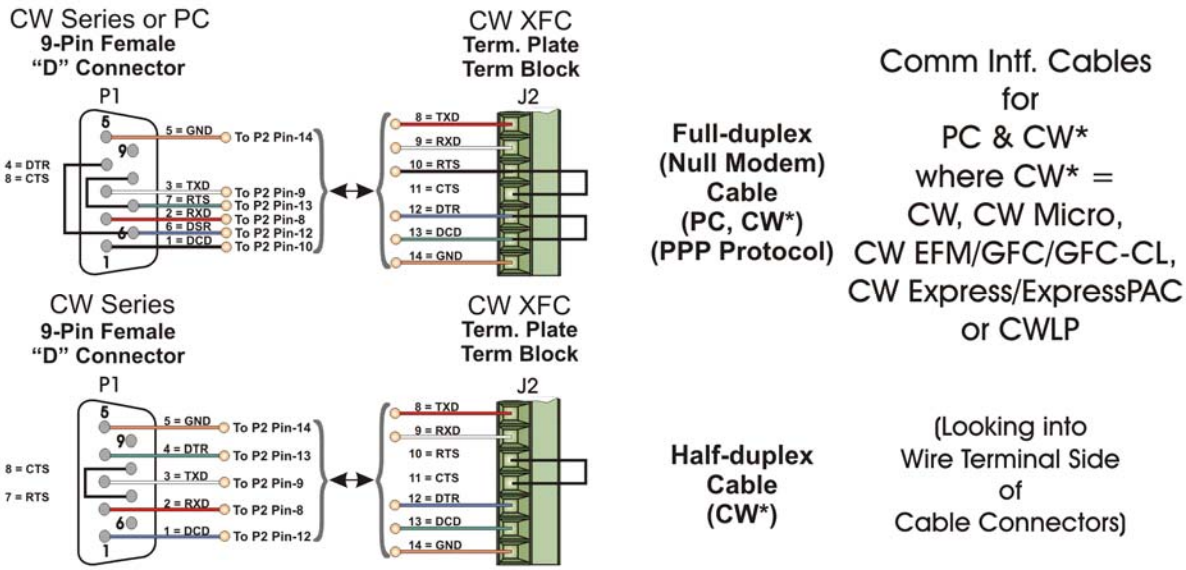


Figure 2-10. Full-duplex and Half-duplex Cable

Use the half-duplex cable (shown in the bottom part of *Figure 2-10*) when connecting the ControlWave XFC 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 2-11*.

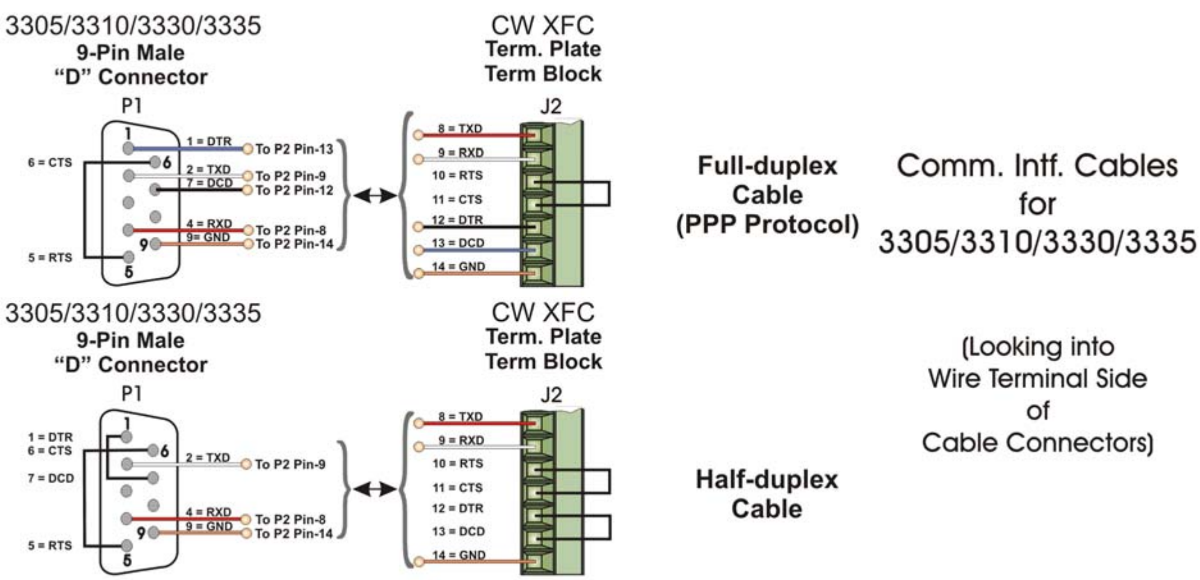


Figure 2-11. Cables for Connection to 33XX including CW_10, CW_30, CW_35

To connect the local serial port (COM1) to a PC or a Bristol 3808 transmitter, refer to the cable shown in *Figure 2-12*:

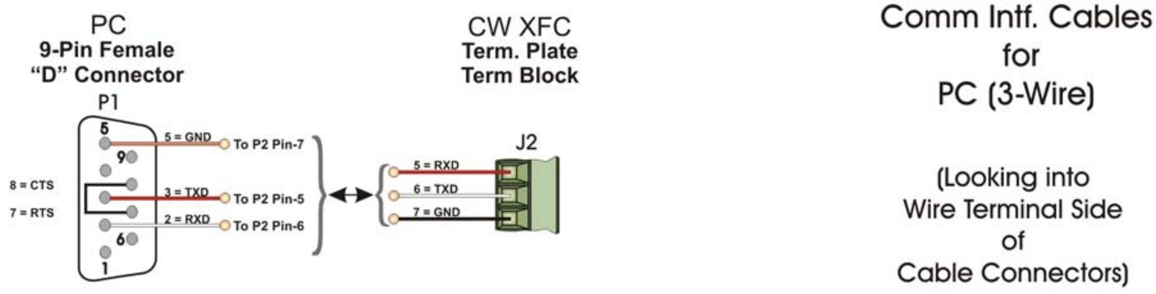


Figure 2-12. Cable for Connecting COM1 to a 3808 or a PC

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, and DCD control signals.
- All RS-232 comm port I/O signals are protected by surge protectors.

2.5.2 Connections to the COM3 (RS-485) Serial Port

COM3 supports local network communications to multiple nodes up to 4000 feet away.

Table 2-5. COM3 Connector Pin Assignment

Pin	RS-485 Signal	RS-485 Description
1	GND	Power ground
2	TR-	Transmit/Receive Data –I/O
3	TR+	Transmit/Receive Data +I/O

Since the RS-485 port is intended for network communications, refer to *Table 2-10* 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). No termination resisters are required; operating at 19,2000 baud supports a 4000 foot network. You can use the +V and ground terminal provided on either side of the RS-485 port to power the 3808 transmitters.

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

Table 2-6. RS-485 Network Connections

From Master	To First Slave	To nth Slave
TR+	TR+	TR+
TR–	TR–	TR–
GND	GND	GND

Note: When wiring to four-wire RS-485 ports, connect TR+ to TXD+ and RXD+ and connect TR= to TXD- and RXD=.

2.6 Wiring Power

The ControlWave XFC requires an external bulk power supply.

Power Supply Current and Voltage Requirements

The ControlWave XFC operates with a voltage range of 6-30Vdc, however if you use the analog output option, you require a minimum of 12V. The maximum current required by the XFC is 5 mA plus 4 mA for each active communication port (regardless of the bulk supply voltage) plus any current (up to 20 mA) used to supply the analog output. This current consumption is based on the standard flow measurement application.

2.6.1 Wiring the Connection

⚠ **Caution**

For safety reasons and to prevent accidental damage to your bulk DC power supply, do not connect the power until after you install, wire, ground, and configure the entire unit.

Follow the instructions in *Section 2.1.3 General Wiring Guidelines* when wiring connections.

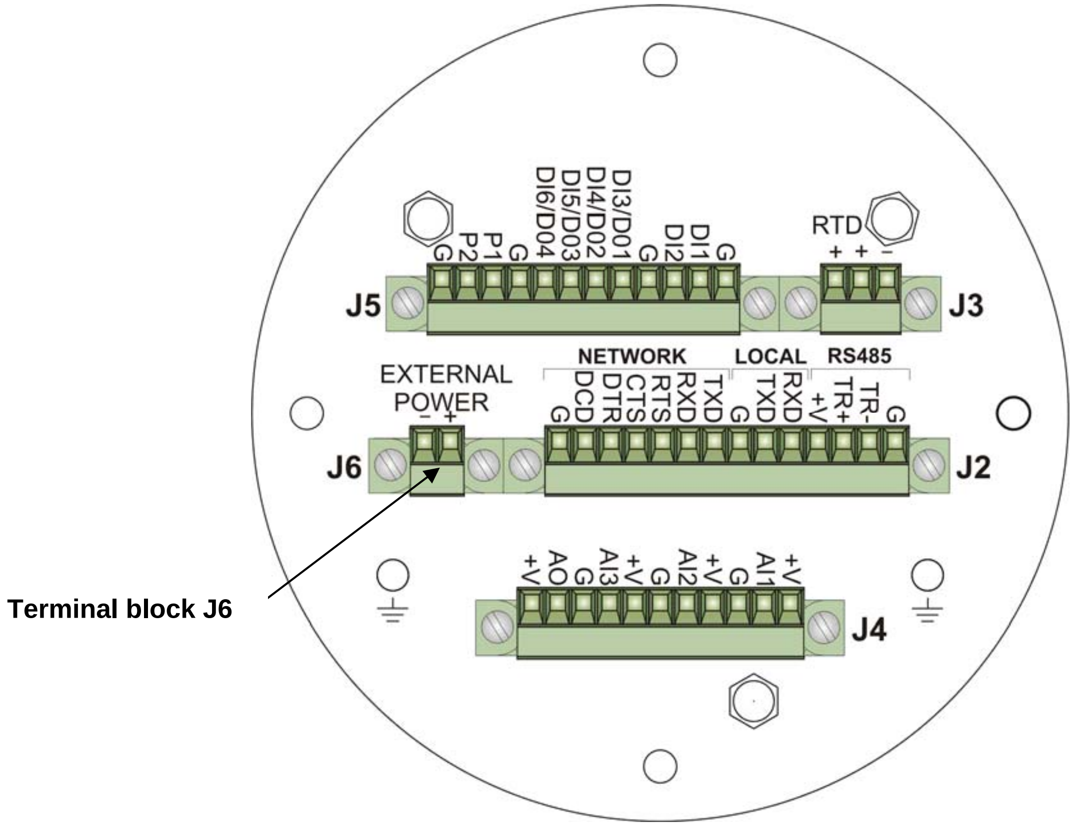


Figure 2-13. ControlWave XFC Terminal Plate

Connect the bulk DC supply to the XFC at terminal block J6 on the terminal plate.

There are two input connections for bulk power:

- J6-1 = (+VIN) (+6.0 Vdc to +30.0 Vdc)
- J6-2 = (-VIN) (supply ground)

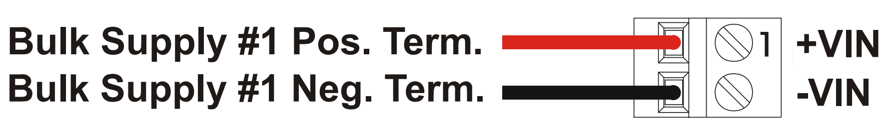


Figure 2-14. Terminal Plate Connector (J6) - Primary Power Wiring

2.6.2 Grounding the Housing

The ControlWave XFC enclosure optionally includes a ground lug. Once you have installed the unit, run a ground wire (#4 AWG max wire size) between the ground lug and a 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.

Chapter 3 – I/O Configuration and Wiring

This chapter discusses setting I/O configuration switches and jumpers and wiring I/O connections to the ControlWave XFC.

In This Chapter

3.1 I/O Wiring

The ControlWave XFC has a terminal plate for I/O connections. You access the terminal plate by removing the rear cover of the unit. The ControlWave XFC uses card edge terminal blocks to accommodate field wiring. You route the wires into the enclosure/chassis through a ¾" inch conduit fitting.

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

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
err

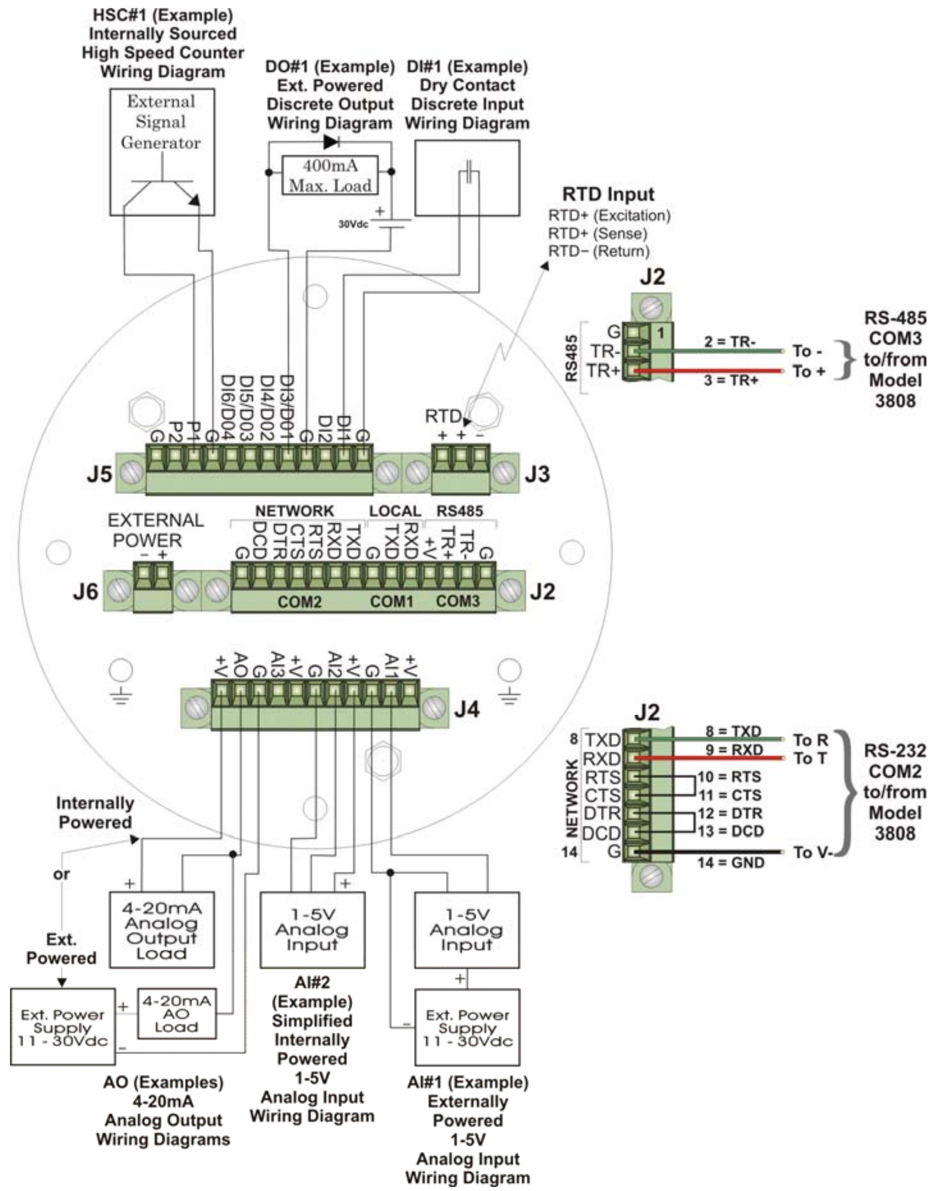


Figure 3-1. ControlWave XFC - Terminal Plate Field I/O Wiring Diagrams

3.1.1 Non-Isolated Discrete Inputs (DI) on J5

Terminal block connector J5 provides interface to two dedicated non-isolated discrete inputs DIs – DI1 through DI2.

Table 3-1. Non-Isolated DI General Characteristics

Type	Number Supported	Characteristics
Discrete Inputs (DI)	2	▪ Supports dry contact inputs pulled internally to 3.6 Vdc when field input is open. ▪ Source current of either 60 µA from the 3.6V supply. ▪ 15 ms input filtering.

Wiring

See *Figure 3-1* for wiring diagrams.

Software Configuration

To use data from these DIs you must include a **CWM_RTU** board in your ControlWave project using 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 board.

Note: If you are using the standard flow measurement application, the software configuration has already been done for you.

3.1.2 Non-Isolated Discrete Inputs/ Discrete Outputs (DI/DO) on J5

DI/O circuitry is wired through 12-point terminal block (J5) that is located on the terminal plate of the I/O board assembly.

In addition to the two non-configurable discrete inputs (DI) described in *Section 3.1.1*, there are four individually user-selectable points that are configurable as either discrete inputs (DI) or externally powered discrete outputs (DO).

Surge suppression and signal conditioning is provided for each DI. Each DI provides a 60uA source current from 3.6 Vdc. For the individually selectable DI/DOs, circuitry provides internally-sourced DI operation for dry contacts pulled internally to 3.6 Vdc when the field input is open.

Table 3-2. Non-Isolated DI/O General Characteristics

Type	Number Supported	Characteristics
Discrete Outputs (DO)	Up to 4 (DO1 through DO4) in lieu of usage of DI3 to DI6	▪ Sink current to digital ground, up to 400 mA each at 16 Vdc from an externally powered device ▪ Surge protection
Discrete Inputs (DI)	Up to 4 (DI3 through DI6) in lieu of usage of DO1 to DO4	▪ Provides a 60 µA source current from 3.6 Vdc. Dry contacts pulled internally to 3.6 Vdc when the field input is open. ▪ Surge protection and signal conditioning

Wiring

See *Figure 3-1* for wiring diagrams.

⚠ Caution

Never physically wire a point as a DI and then attempt to drive the DO. The DO will override the incoming DI value.

Software Configuration

To use data from these DI/DO points you must include a **CWM_RTU** board in your ControlWave project using ControlWave Designer's I/O Configurator, and then configure it. For the user-selectable DI/DO points, you choose, in software, whether a point is a DI or DO by configuring variables for digital pins of the CWM_RTU board, in ControlWave Designer's I/O Configurator. When selecting DI usage for DI3/DO1, DI4/DO2, DI5/DO3 or DI6/DO4, use pins 3, 4, 5, and 6, respectively. When selecting DO usage for those points, use pins 13, 14, 15, and 16, respectively.

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 board.

Note: If you are using the standard flow measurement application, the software configuration has already been done for you.

3.1.3 Non-Isolated Analog Inputs (AI) on J4

Terminal block connector J4 provides interface to three single-ended analog inputs (AIs).

Table 3-3. Non-Isolated AI General Characteristics

Type	Number Supported	Characteristics
Analog Inputs (AI)	3	▪ 2 Hz low pass filter for each AI. ▪ Surge Suppression. ▪ Supports 1 to 5 V devices. ▪ Field power source can be the ControlWave XFC's V+ ≈ Input power - .6Vdc (and doesn't exceed 15 Vdc) or an external 11 to 30 Vdc power source.

Wiring

Each AI includes three terminals (+V, AI# and GND). See *Figure 3-1* for wiring diagrams.

Notes:

- You must connect cable shields associated with AI wiring to the ControlWave XFC chassis ground post on the terminal plate (#14 AWG maximum wire size). The terminal plate includes two ground posts.
- Multiple shield terminations require you to supply a copper ground bus. You must connect the ground bus to the ControlWave XFC chassis ground lug using up to a #4 AWG wire size. The ground bus must accommodate a connection to a known good Earth ground (in lieu of a direct connection from a terminal plate ground post) and to all AI cable shields.
- Use an appropriate terminal lug for shield wires and secure them to the copper bus using industry rugged hardware (screw/bolt, lock washer and nuts).

Software Configuration

To use data from these AIs you must include a **CWM_RTU** board in your ControlWave project using 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 board.

Note: If you are using the standard flow measurement application, the software configuration has already been done for you.

3.1.4 Non-Isolated Analog Output (AO) on J4

Terminal block connector J4 provides interface to a single analog output (AO).

Table 3-4. Non-Isolated AO General Characteristics

Type	Number Supported	Characteristics
Analog Output (AO)	1	▪ Supports 4-20mA sink operation. ▪ Field power source for the 4 to 20 mA device can be from the ControlWave XFC +V supply or an external 11 to 30 Vdc power source grounded to the AO ground terminal. The +V source tracks the unregulated supply voltage to 15V is is current limited to approximately 80 mA. ▪ Maximum external load you can connect to the 4-20mA output is 450 ohms (with an external 11V power source) or 1000 ohms (with an external 24V power source).

Wiring

See *Figure 3-1* for wiring diagrams.

Software Configuration

To use data from this AO you must include a **CWM_RTU** board in your ControlWave project using 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 board.

Note: If you are using the standard flow measurement application, the software configuration has already been done for you.

3.1.5 Non-Isolated High Speed Counter (HSC) on J5

Terminal block connector J5 provides interface to two externally sourced single-ended high speed counter inputs (HSC1 and HSC2). They may also be used as discrete inputs by monitoring the state of the input.

Table 3-5. Non-Isolated High Speed Counters General Characteristics

Type	Number Supported	Characteristics
High Speed Counter / Discrete Inputs	2	▪ Software-selectable signal conditioning circuitry provides either 15 µs or 1 ms filtering. ▪ All input circuits have surge suppression and bandwidth limiting. ▪ All input circuits have surge suppression. HSC inputs support externally-generated, internally-sourced input signals. Values of HSC inputs may also be monitored, providing (DI) functionality. ▪ High speed counter inputs are sourced from V+ with a source current of 54 µA. ▪ Two-wire HSC inputs are internally sourced and don't support contact debounce circuitry. ▪ Maximum frequency of an input signal is10kHz.

Wiring

See *Figure 3-1* for wiring diagrams.

Software Configuration

To use data from these high speed counter inputs you must include a **CWM_RTU** board in your ControlWave project using 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 board.

You can toggle between the 15 µs or 1 ms filtering through a variable in the ControlWave project associated with the CWM_RTU board. The variable follows the format MIX_1_*x*_HSC_SEL where *x* is the counter channel (either 1 or 2). Setting the variable to TRUE activates the 1 ms filtering.

Note: If you are using the standard flow measurement application, the software configuration has already been done for you.

3.1.6 Resistance Temperature Device (RTD) Inputs on CPU/System Controller Board

Terminal block connector J3 provides connection to a 3-wire 100 ohm platinum bulb RTD (using the DIN 43760 curve).

Wire the RTD according to *Table 3-9* and *Figure 3-4* and *Figure 3-5*. 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 3-6. RTD Connections to Terminal Block Connector J3

J3 Pin	Signal	Function	Wire Color
1	RTD -	Return	White
2	RTD+	Sense	Red
3	RTD EXC	Excitation	Red

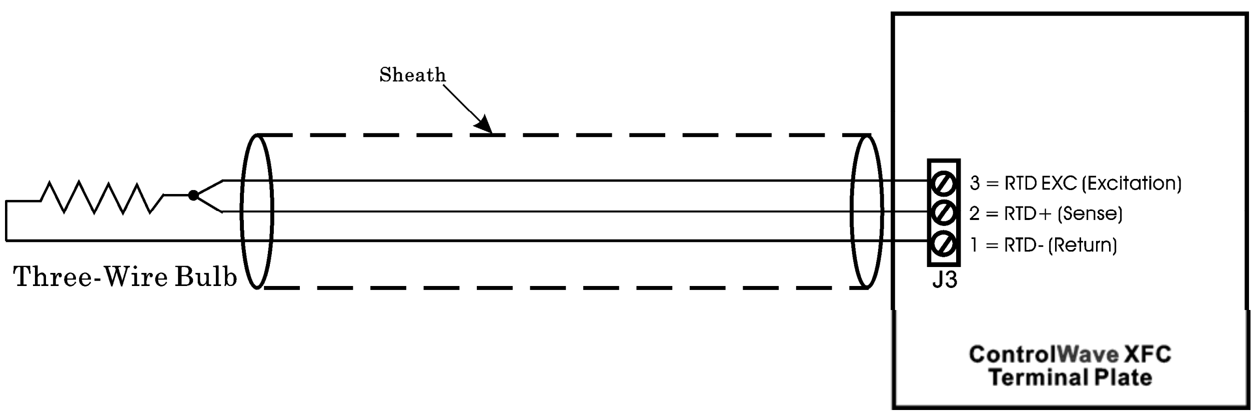


Figure 3-2. 3-Wire RTD Temperature Input Wiring

⚠ WARNING

EXPLOSION HAZARD:

Always use an RTD connection head and conduit for Division 1 installations.

Never use a bendable RTD for a Division 1 installation. Only use a bendable RTD (supplied with a plastic bushing) for division 2 installations, as this renders the housing non-explosion proof.

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. See *Figure* 3-3.

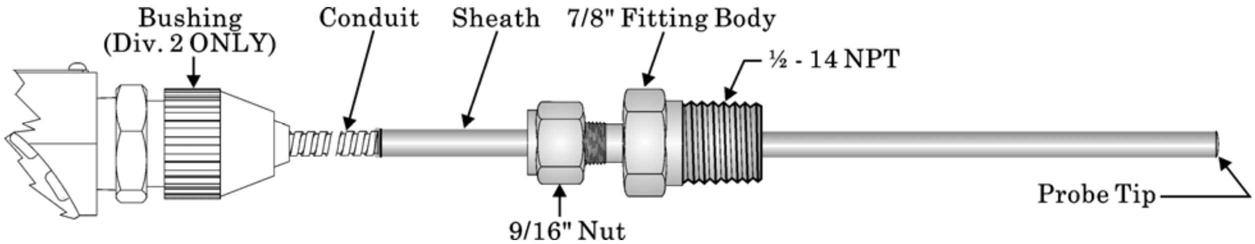


Figure 3-3. RTD Probe Installation/Removal Diagram

Software Configuration

To use data from the RTD you must include a **CWM_RTU** board in your ControlWave project using 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.

Note: If you are using the standard flow measurement application, the software configuration has already been done for you.

3.1.7 Connections to a Bristol Model 3808 Transmitter

You can connect a Bristol 3808 transmitter (digital) to the ControlWave XFC 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 XFC (local communications). You can use RS-485 communications to reach transmitters up to 4000 feet away (remote communications).

Figure 3-4 details RS-232 wiring connections required between the ControlWave XFC and the 3808 transmitter.

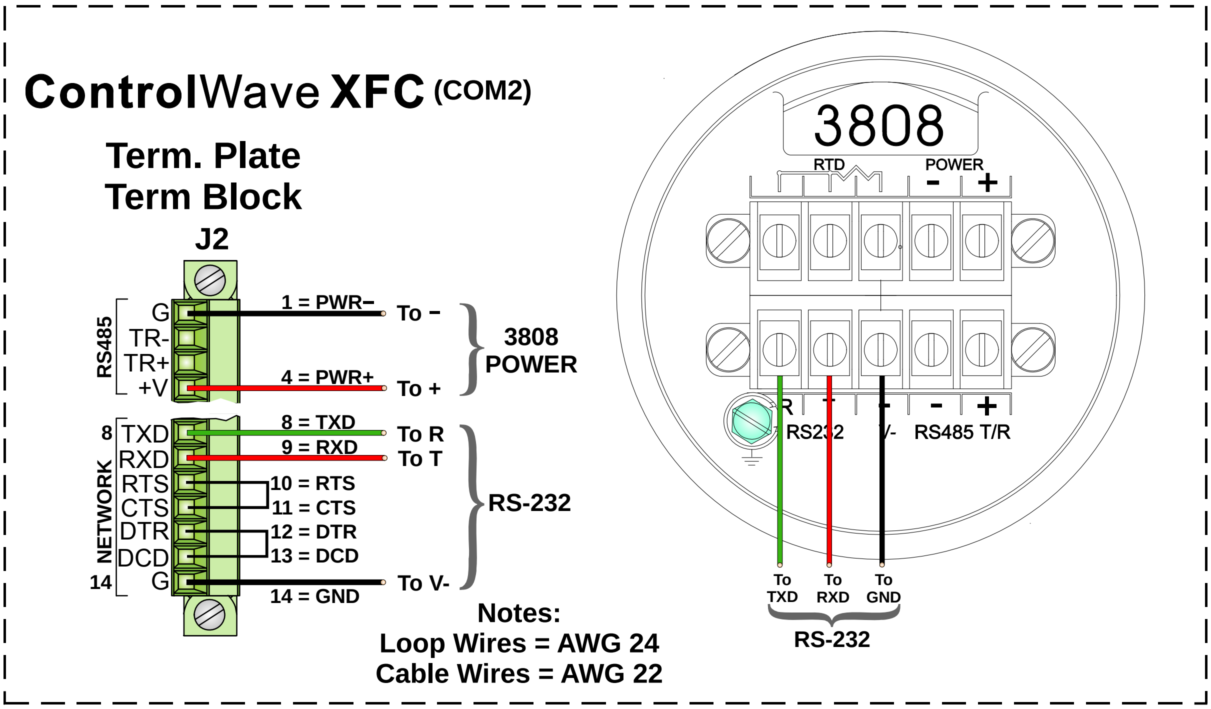


Figure 3-4. 3808 Transmitter to ControlWave XFC RS-232 Comm. Cable Diagram

Figure 3-5 details RS-485 wiring connections required between the ControlWave XFC and the 3808 transmitter.

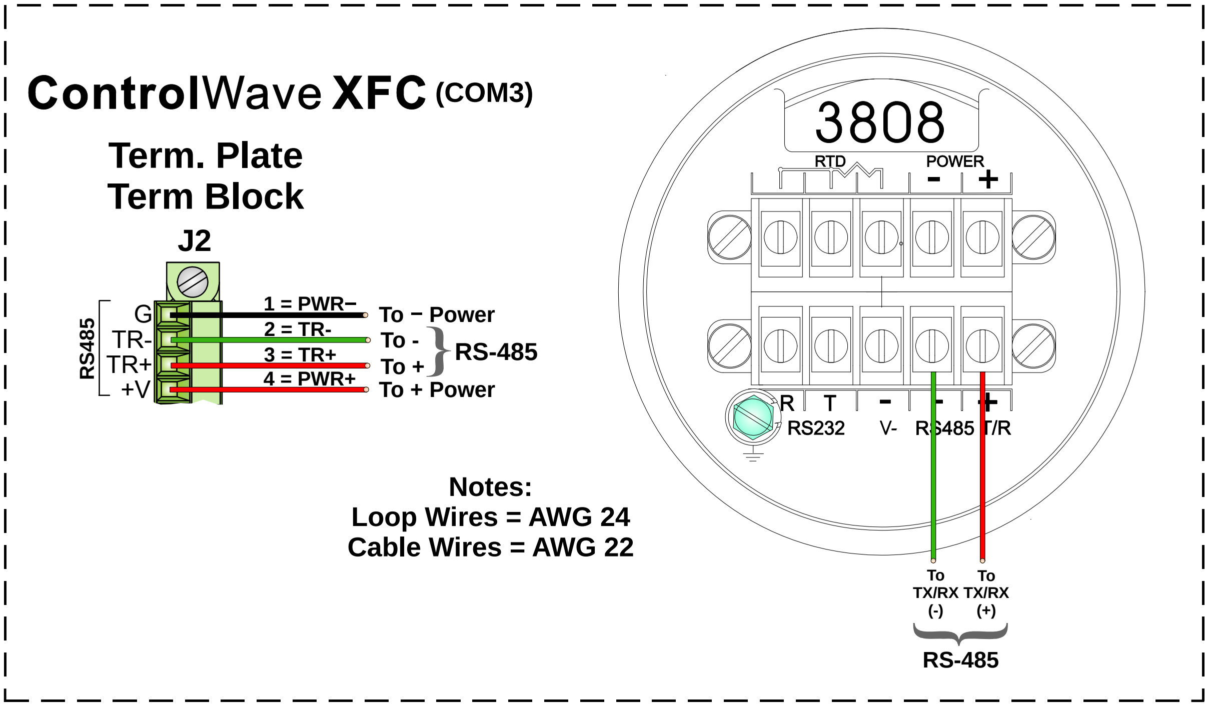


Figure 3-5. 3808 Transmitter to ControlWave XFC RS-485 Comm. Cable

You can connect up to two 3808 transmitters to a ControlWave XFC using a half-duplex RS-485 network. See *Figure 3-6* for an illustration of this type of network.

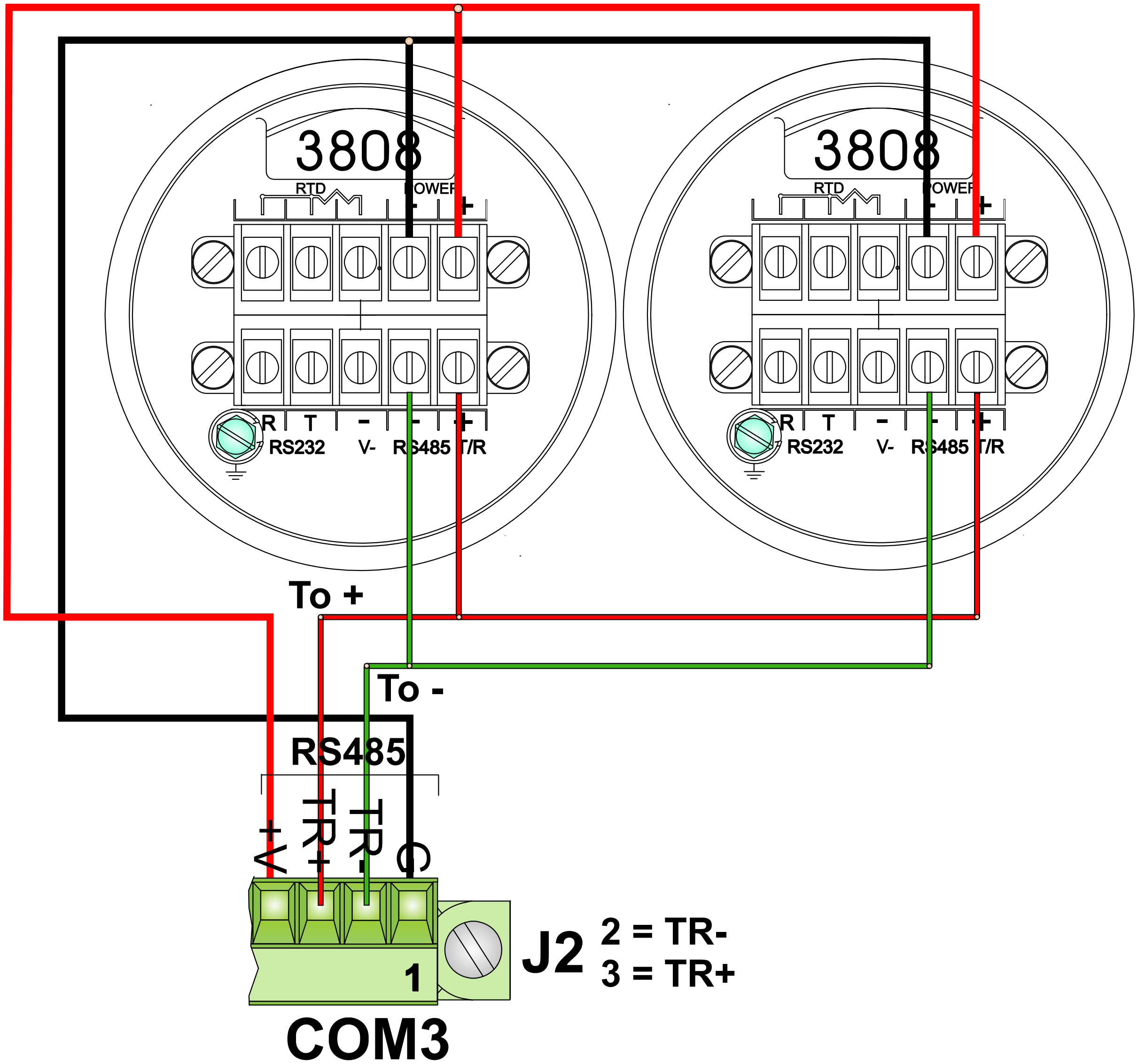


Figure 3-6. ControlWave XFC to 3808s - RS-485 Network Diagram

Chapter 4 – Operation

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

In This Chapter

4.1 Powering Up/Powering Down the ControlWave XFC

Caution

For safety reasons and to prevent accidental damage to your bulk DC power supply, do not connect the power until after you install, wire, ground, and configure the entire unit.

Follow the instructions in *Section 2.1.3 General Wiring Guidelines* when wiring connections.

WARNING

EXPLOSION HAZARD

The area must be non-hazardous in order to connect or disconnect equipment. Never remove the explosion proof covers if the circuit is live.

The ControlWave XFC receives power from an external bulk power supply wired to connector J6 on the terminal plate. *Chapter 2* includes instructions for wiring power to the ControlWave XFC..

Power Up

To apply power to the ControlWave XFC, remove the rear cover of the unit and plug in connector J6 on the terminal plate. If your ControlWave project resides in flash memory, the project will load into SRAM and begin execution. Depending upon the setting of the SRAM control switch, retain variable values may load as well. Replace the rear cover.

Caution

When you disconnect power from the ControlWave XFC, your running control strategy is erased from SRAM, as is any process data not stored in retention mode. When configured for retention and the backup battery remains good, SRAM stores the last states of all I/O points, audit/archive data not residing in FLASH, the values of all variables marked RETAIN, the values of variables stored in the static memory area, and any pending unreported alarm messages.

Power Down To apply power to the ControlWave XFC, remove the rear cover of the unit and unplug connector J6 on the terminal plate. Replace the rear cover..

4.2 Communicating with the ControlWave XFC

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

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

4.2.1 Default Comm Port Settings

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

Table 4-1. Default Comm Port Settings

Port	PCB	Default Configuration
COM1	CPU	RS-232; 115.2 Kbps, 8-bits, no parity, 1 stop bit using BSAP or ControlWave Designer protocol.
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. Intended for use with Bristol 3808 transmitters. You use jumpers W12 through W16 to configure COM3 for either RS-232 or RS-485

Note: You can re-enable the factory communication settings at any time by setting CPU module switch SW2-3 to **OFF**.

4.2.2 Changing Port Settings

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

You must establish communications with the ControlWave device 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 factory defaults and re-establish communications.

4.2.3 Collecting Data from the ControlWave XFC

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)

Most XFC users purchase the ControlWave gas flow measurement application (ControlWave project) which ships pre-installed in the XFC when it leaves the factory.

You can, however, create your own project using PC-based ControlWave Designer software. Instructions for creating a ControlWave project are beyond the scope of this manual. Please refer to the following sources for information:

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

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

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

1. Connect a serial cable between your PC and COM1 of the ControlWave XFC.

2. Define the ControlWave project in ControlWave Designer, and set communication and configuration parameters.

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

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 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.**

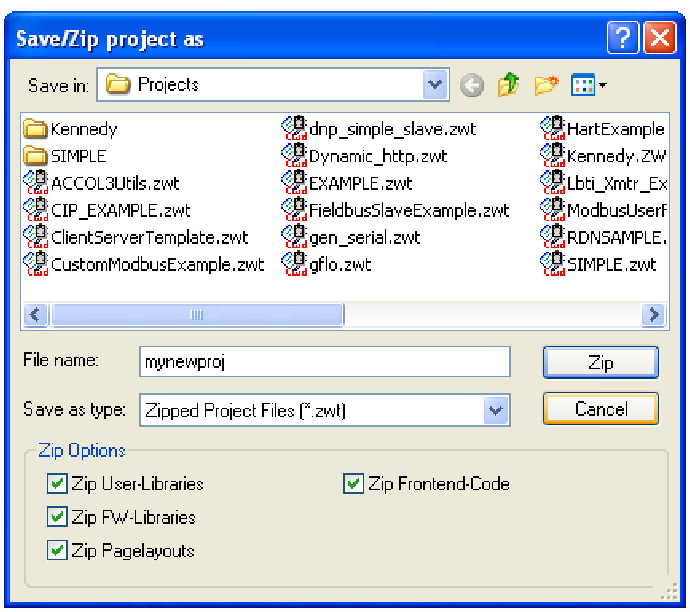


Figure 4-1. Saving a Backup of Your Project

2. In the “Save/Zip project as” dialog box, specify a project name in the **File name** field. In *Figure 4-1* 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.

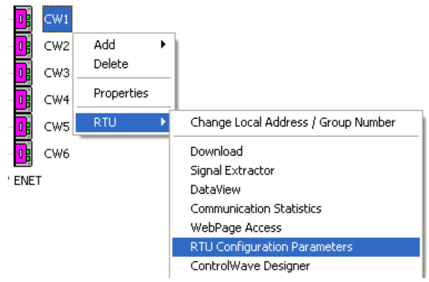
5. Click **Zip** and a progress bar displays the percent complete of the zipping process.
6. When the zip process completes, you’ll see a message box reporting successful completion. Click **OK**.
7. Copy the resulting zwt file to backup media (CD-ROM, thumb drive, etc.) If you ever need to restore the 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)

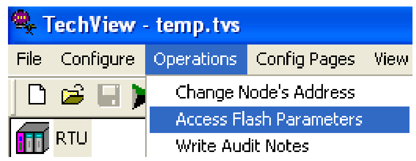
You must establish communications with the ControlWave XFC using NetView, LocalView, or TechView before you can run the Flash Configuration utility.

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 XFC, 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 XFC as well as some common maintenance procedures.

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 (See *Figure 5-7*.)

To perform firmware upgrades:

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

To replace the SRAM backup battery:

- Tweezers or needle-nose pliers

Miscellaneous other equipment:

- Needle-nose pliers
- Screw drivers
- Anti-seize compound (when replacing GPT/MVT)

Note: When you service a ControlWave XFC 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.

WARNING **EXPLOSION HAZARD**

Never open the covers for service in a hazardous location if the circuit is live. 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. See Appendix B for details on Class I Division 1 usage of this device.

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

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

5.1 Upgrading Firmware

The ControlWave XFC 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 XFC. To use this utility, you must set CPU board switch SW1-6 **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 Window® do not include it.
- The screens shown here may appear different depending upon the version of HyperTerminal you use.
- 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 special 3-wire communication cable between COM1 of the ControlWave XFC and any RS-232 port on the associated PC. (See *Figure 2-12*.)
2. Click **Start** > **Programs** > **Accessories** > **Communications** > **HyperTerminal**
3. If using HyperTerminal for the first time, set the communication properties (for the PC port) via the Properties Menu as follows: Bits per second: = 115200, Data bits: = 8, Parity: = None, Stop bits: = 1, and Flow control: = None and then click **OK**.
4. Set CPU board switches 1-9 and 1-10 to enable recovery mode. When both SW1-9 and SW1-10 are set ON or OFF, or with SW1-9 set ON and SW1-10 set OFF, recovery mode is enabled.
5. Apply power; to the ControlWave XFC. The resident BIOS initializes and tests the hardware, this process is referred to as POST (Power On Self Test). Unless there is a problem, the LCD display should show RECOV. 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.

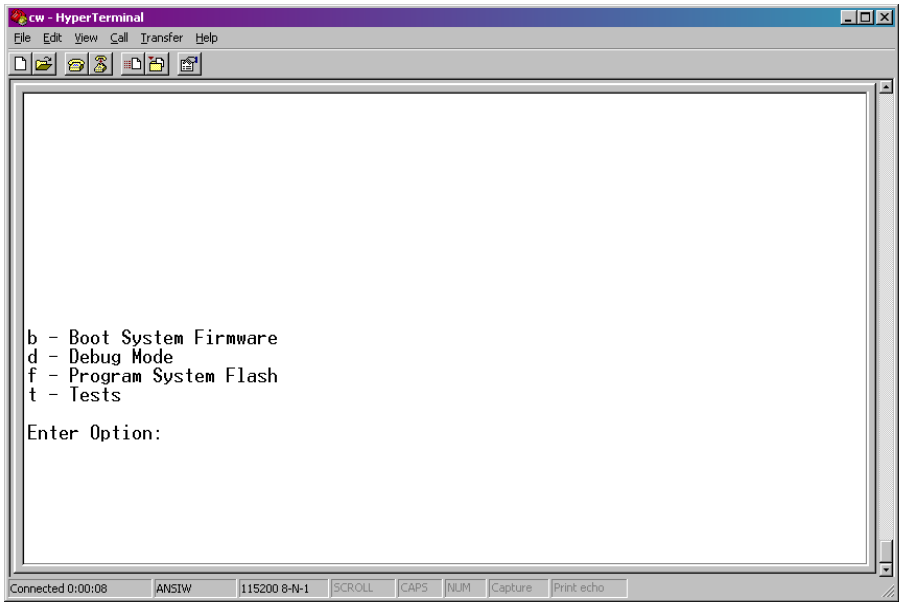


Figure 5-1. HyperTerminal Mode Menu

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*).

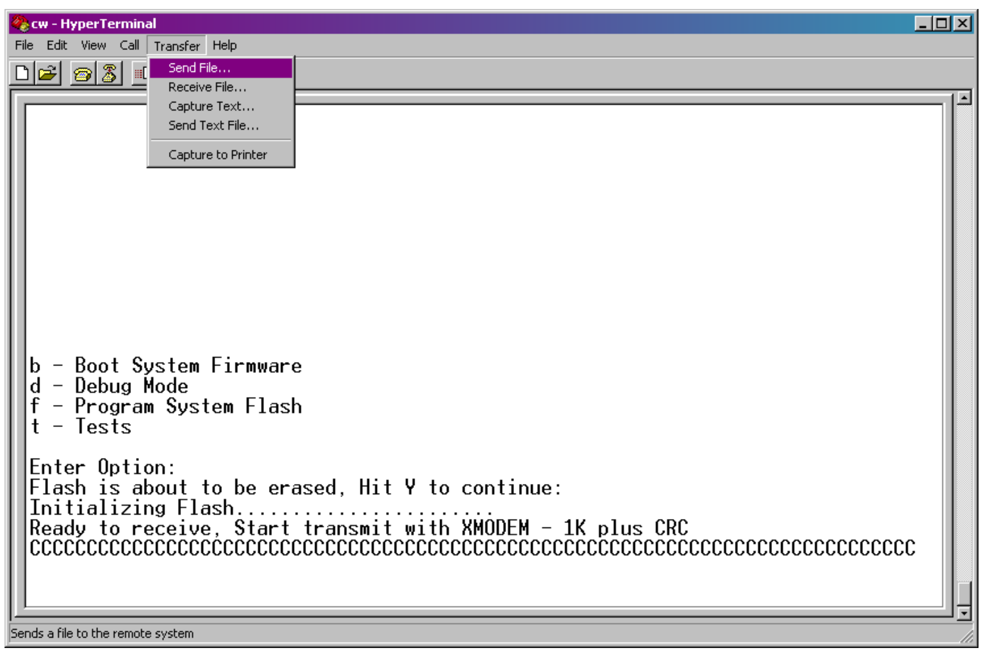


Figure 5-2. HyperTerminal (Ready to Download)

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 "CWX*xxxxx*.bin" where *xxxxx* varies from release to release) and click **Send** to start the flash upgrade (see *Figure 5-*

4). When you see the HyperTerminal Mode Menu again, it means the download has completed.

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

10. Return switches SW1-9 to OFF and SW1-10 to ON to resume normal operation. (Recovery Mode Disabled).

11. Restore power to the ControlWave XFC.

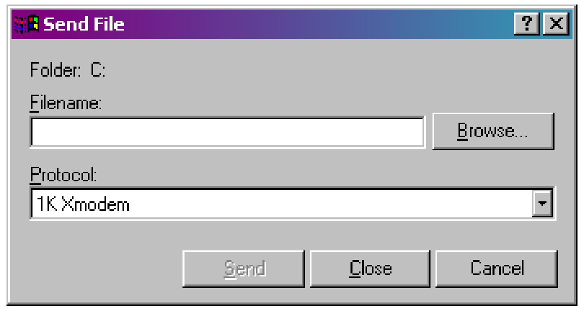


Figure 5-3. Send File dialog box

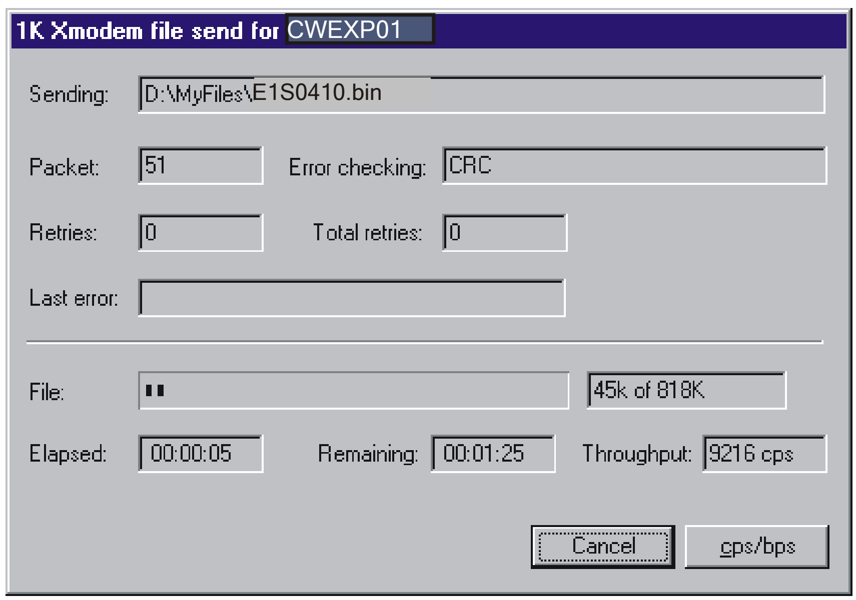


Figure 5-4. HyperTerminal (Download in Progress)

5.2 Removing or Replacing Components

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

Note: Internally, circuit boards are stood-off and mate to the terminal plate via an assembly called the "function module." The function module secures to the inside of the XFC via four screws. To replace a printed circuit board, you must first remove the four screws that secure the function module. Once you remove the function module you can access the individual circuit boards for removal / replacement.

WARNING

EXPLOSION HAZARD

Never open the covers for service in a hazardous location if the circuit is live. 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.

Always turn off any external supply sources used for externally powered I/O circuits before changing any printed circuit boards.

See Appendix A for details on Class I Division 2 usage of this device.
See Appendix B for details on Class I Division 1 usage of this device.

Caution

Field repairs to the ControlWave XFC are strictly limited to the replacement of complete boards. Replacing board components constitutes tampering and violates the product warranty. Return defective boards or housings to the factory for authorized service.

Observe proper grounding practices for control of electrostatic discharge (ESD). See document S14006 for details.

5.2.1 Accessing Modules for Testing

Only technically qualified personnel should test and/or replace ControlWave XFC components. Read completely the disassembly and test procedures described in this manual before starting. Any damage to the ControlWave XFC 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.

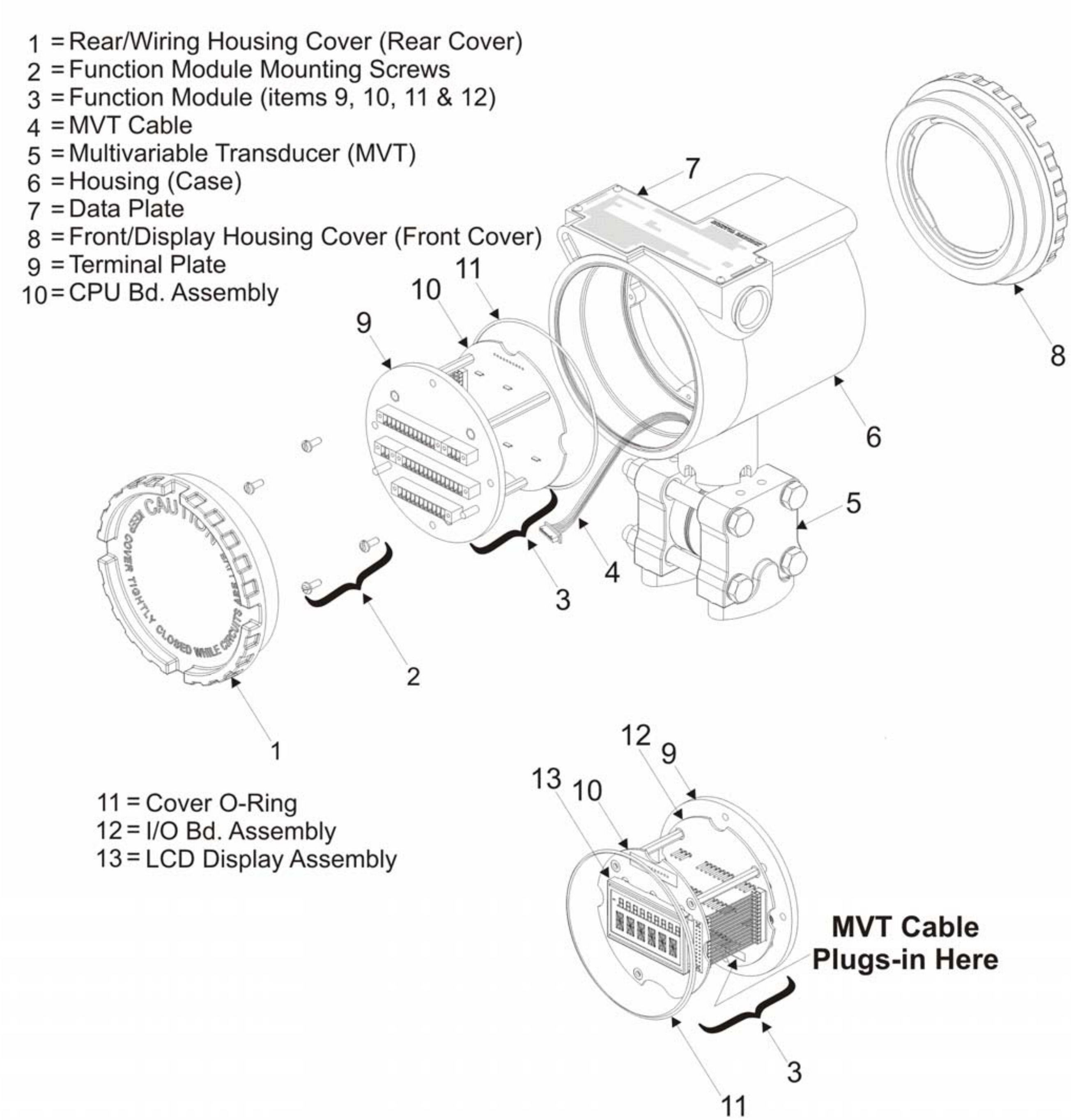


Figure 5-5. ControlWave XFC (with MVT) (Isometric Views) Component Identification Diagram

5.2.2 Removing/Replacing the Function Module

Use this procedure to remove or replace the function module.

1. If the ControlWave XFC is running, place any critical control processes under manual control.
2. Remove the rear cover and disconnect power at the terminal

plate (terminal block connector TB6).

3. Unplug terminal block communication cable connector J2, RTD connector J3, and I/O wiring connectors J4 and J5. Push the wires and plugs into the conduit so the terminal plate can clear the housing when you remove the function module.

4. Remove the four screws that secure the function module to the case and carefully move the function module far enough so you can disconnect the MVT interface cable. Disconnect the MVT interface cable from connector P1 near the bottom of the I/O board.

Note: It may be helpful to remove the rear cover and use a free hand to help guide the MVT cable under the CPU board.

5. Remove the function module.

6. To replace the function module, you must first plug the MVT interface cable into connector P1 near the bottom of the I/O board. Next, align the replacement function module with the case so that the terminal plate connector (J4) is positioned at the bottom, and insert the unit into the case.

7. Replace the four screws removed in step 4 and re-connect the cables disconnected in steps 2 and 3. Replace the rear cover.

5.2.3 Removing/Replacing the MVT or GPT Transducer

1. If the ControlWave XFC is running, place any critical control processes under manual control.

2. Remove the rear cover and shut down the ControlWave XFC by disconnecting the power at the terminal plate (terminal block connector TB6). Disconnect all I/O connections, including RTD wiring from the terminal plate.

3. Remove the ControlWave XFC from its installation site and take it to a repair area that supports proper ESD (electrostatic discharge) control.

4. Disconnect the MVT/GPT interface cable from the I/O board. This requires removal of the function module. See *Section 5.2.2*.

5. Loosen the Allen screw that secures the MVT or GPT to the case, and then unscrew and remove the MVT/GPT.

6. To install a replacement MVT/GPT, reverse steps 5 through 2. Make sure the MVT/GPT O-ring seal is in place and apply anti-seize compound as required. When you install an MVT/GPT at the bottom of the enclosure, screw it in all the way and then back off approximately one turn and orient the flange for the desired high and low settings.

5.2.4 Removing/Replacing the Backup Battery

Note: The CPU board includes a 3.0V 255mA-hr lithium coin cell battery. The battery provides backup for the SRAM and real time clock (RTC) but it does **NOT** preserve the running control strategy (ControlWave project). The 2MB of SRAM has a standby current of 25 µA at maximum temperature of 70^{o}C (plus 2:µA for the real-time clock). For a system containing 2MB of SRAM, and 70^{o}C maximum temperature, a worst-case current draw of 27µA allows a battery life of approximately 9400 hours. If the same system is used at a 25^{o}C maximum temperature, the SRAM standby current draw would be only 6 µA (plus 2 µA for the real time clock for a total of 8 µA) allowing a battery life of more than 31,000 hours. Because current is only drawn from the lithium backup battery if the unit loses power, this should support many years of operation without the need to replace the lithium backup battery.

Note: If the backup battery is working properly, the _BAT_OK system variable is set ON; if the battery fails, this is OFF. The Ram Backup Battery Status shows on the Station Summary page in the standard measurement application. If the real-time clock loses its battery backup, the ControlWave system variable _QUEST_DATE turns ON. You can monitor this to generate an alarm. See the *System Variables* section of the *ControlWave Designer Programmer's Handbook* (D5125) for more information. See the *ControlWave Flow Measurement Applications Guide* (D5137) for information on the standard measurement application.

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 JP1 on both posts (to enable the battery).

Removing / Replacing the Backup Battery

1. If the ControlWave XFC is running, place any critical control processes under manual control.
2. Remove the rear cover and shut down the unit by disconnecting power at the terminal plate (connector TB6).
3. Remove the four screws that secure the function module to the case and carefully move the function module far enough to allow you to access the backup battery.
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. Align the function module with the case so that terminal plate connector J4 is positioned at the bottom and insert the function module into the case. Replace the four screws removed in step 3.
6. Re-connect power at connector TB6. Replace the rear cover.
7. Once the battery has been replaced and power is restored, 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 ControlWave XFC acts as though it had just been booted and reverts back to the initial values specified in its application.

5.2.5 Enabling / Disabling the Backup Battery

For maximum shelf life, the CPU board ships from the factory with the installed lithium backup battery disabled. You must enable it when you install the ControlWave XFC. See *Figure 2-9* for the location of the backup battery jumper.

Enabling To enable the battery, install jumper JP1 on both posts.

Disabling To disable the battery, remove JP1 or store it on only one post.

5.3 General Troubleshooting Procedures

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

5.3.1 Checking LEDs

The ControlWave XFC includes two red light emitting diodes (LEDs) that provide operational and diagnostic functions.

Table 5-1. LEDs

LED	Color	Description
WD (CR1 right)	RED	ON = Watchdog condition – program crash; OFF = Normal operation
IDLE (CR1 left)	RED	ON = CPU Idle. To save power, the idle LED should be on for only 2 seconds every minute.

5.3.2 Checking LCD Status Codes

The following codes may appear on the LCD display:

Table 5-2. LCD Display Status Codes

LCD Display	Indication Definition
Blank	Application Running
DIAG	Unit in Diagnostic Mode
R DIAG	Unit Running Diagnostics
FWXSUM	Flash XSUM Error
DEVERR	Error Initializing Application Device
FLASH	Flash Programming Error
FACT	Using Factory Defaults *
BATT	Battery Failure Detected *
STRTUP	Currently Loading the Boot Project
INIT	System Initialization in Progress
RECOV	Waiting in Recovery Mode
RAMERR	Error Testing SRAM
STOP	Application Loaded
HALT	Stopped at a Break Point
NO APP	No Application Loaded
BREAKP	Running with Break Points
POWERD	Waiting for Power-down (after NMI)
UPDUMP	Waiting for Updump to be Performed
NOTRUN	Unit Crashed (Watchdog Disabled)

* flashed on screen during startup

5.3.3 Wiring/Signal Checks

- Check I/O field wires at the card edge terminal blocks and at the field device.
- Check wiring for continuity, shorts and opens.
- Check I/O signals at their respective terminal blocks.

5.4 WINDIAG Diagnostic Utility

Caution **The ControlWave XFC cannot execute your control strategy while it runs diagnostic routines; place any critical processes controlled by the ControlWave XFC under manual control before starting this procedure.**

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

WINDIAG is a PC-based program, so the ControlWave XFC must be attached to and communicating with a PC running WINDIAG. Establish communication between the ControlWave XFC (with/without an application loaded) and the PC with a local or network port under the following conditions:

- Set CPU module switches SW1-3 to **OFF** and SW1-8 to **OFF**. Turning these switches off sets all serial ports on the ControlWave XFC to 9600 baud in preparation for diagnostic testing and prevents the boot project from running and also places the ControlWave XFC in diagnostic mode.
- Connect any ControlWave XFC serial communication port to the PC provided their port speeds match. Use a null modem cable to connect RS-232 ports between the ControlWave XFC and the PC; use an RS-485 cable to connect the RS-485 port of the ControlWave XFC and the PC. See *Chapter 2* for information on cables.
- Reserve the port running a diagnostic test for exclusive use; you cannot use that port for any other purpose during testing.

Follow these steps:

1. Start OpenBSI communications using NetView, TechView, or LocalView, and select the RTU you want to test.
2. Select **Start** >**Programs** > **OpenBSI Tools** >**Common Tools** > **Diagnostics**. The Diagnostics window opens.
3. Click **File > Single RTU** to open the main diagnostics menu.

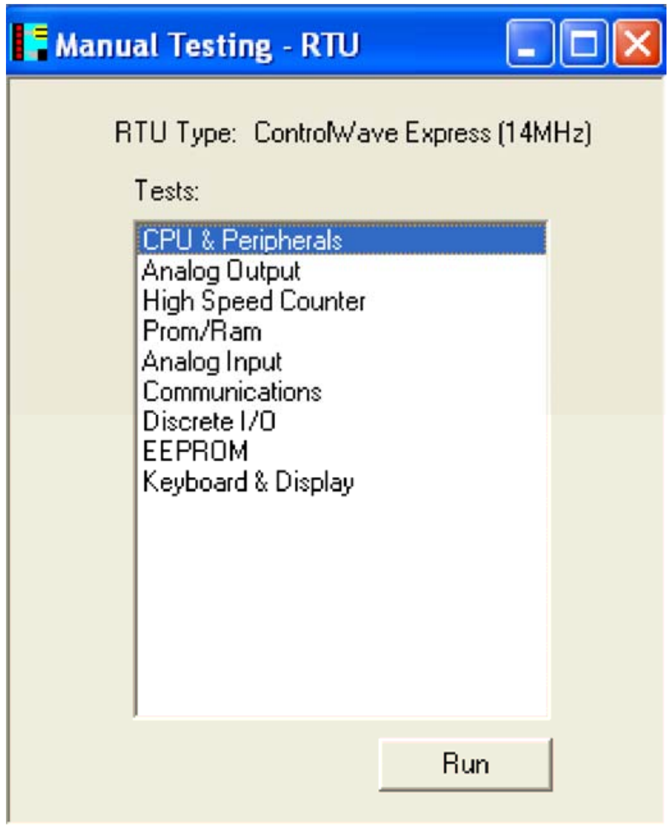


Figure 5-6. WINDIAG Main Diagnostics Menu

4. Select the component to be tested. See *Section 5.4.1* for a description of the tests. Enter any prompted parameters (slot #, etc.). WINDIAG performs the diagnostics and displays pass/fail results.

After performing all diagnostic testing, exit WINDIAG.

5. Set switches SW1-3 and SW1-8 on the CPU module to **ON**. The ControlWave XFC should resume normal operation.

5.4.1 Available Diagnostics

WINDIAG's Main Diagnostics Menu (see *Figure 5-6*) provides the following diagnostic selections:

Option	Tests
CPU & Peripherals	Checks the CPU except for SRAM and FLASH.
Analog Output	Checks AOs.
High Speed Counter	Checks HSCs.
Prom/Ram	Checks the SRAM and FLASH memory.
Analog Input	Checks AIs.
Communications	Checks serial communication ports COM1, COM2, and COM3. The RS-232 external loop-back tests require loop-back wires.
Discrete I/O	Checks DIs and DOs.

Option	Tests
Keyboard & Display	Checks the display hardware.

Port Loop-back Test

WINDIAG allows you to select the communication port 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:

- Port 1 - RS-232 uses a single loop-back wire. See *Figure 5-7.*
- Port 2 - RS-232 uses three loop-back wires. See *Figure 5-7.*
- Port 3 - RS-485 requires no loop-back wiring.

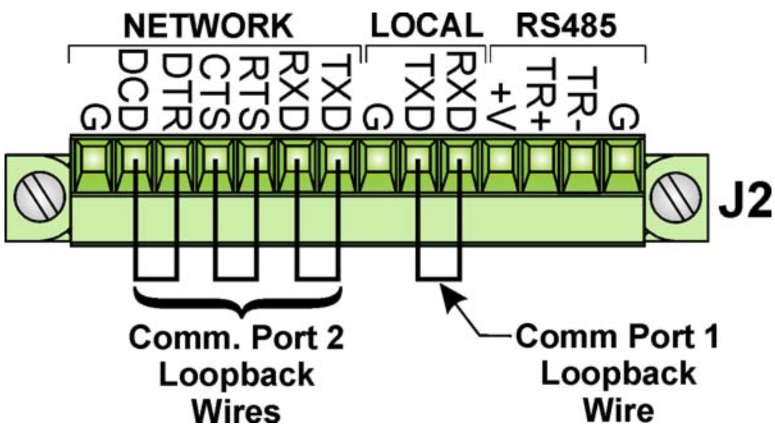


Figure 5-7. COM1 & COM2 RS-232 Loop-back Plug/Wires

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 communication ports.

1. Connect external loop-back wires to the port you want to test. **Note: The RS-485 port does not require loop-back wires.**
2. Select **Communications** on the WINDIAG Main Diagnostics Menu. The Communications Diagnostic screen opens:

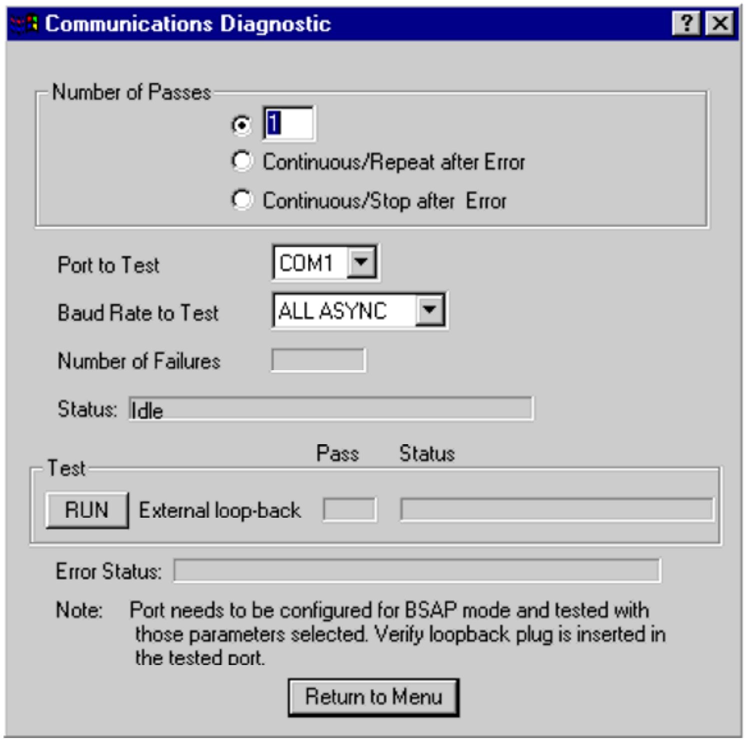


Figure 5-8. Communications Diagnostic Menu

3. Choose the port you want to test (**COM1**, **COM2**, or **COM3)**

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

4. Set baud rate at **115200** or **ALL SYNC** for ports COM1 or COM2 and **38400** for COM3.

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

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: For example:

- TXD RXD Failure
- CTS RTS Failure
- If you see "Success" then all sections of the test passed.

5.5 Core Updump

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

A core updump may be required if the ControlWave XFC 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'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 CPU switch SW1-1 to **OFF** (Disable Watchdog Timer). Set switch SW1-4 to **OFF** (Enable Core Updump).

   Note: The factory default setting for switch SW1-4 is **OFF**.

2. Connect the ControlWave XFC's Comm Port 1 to a PC using a special 3-wire cable. (See *Figure 2-12* for the cable diagram.)
3. Set CPU switches SW1-9 and SW1-10 so **both are ON** or set them so **both are OFF**. Alternatively, set **SW1-9 ON AND SW1-10 OFF**. Any of these configurations enable recovery mode.
4. Start the PC's HyperTerminal program (at 115.2 kbaud) and generate a file 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/System Controller board switches SW1-1 and SW1-4 both off **before** the ControlWave XFC fails you prevent the XFC 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 switch SW1-1 to **ON** (Watchdog Enabled) and SW1-4 to **ON** (Core Updump Disabled).

Additionally, set switch SW1-9 to **OFF** and SW1-10 to **ON**.

With these switches set, power up the ControlWave XFC and begin regular operations.

5.6 Calibration Checks

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

Appendix A – Special Instructions for Class I Division 2 Hazardous Locations

- The ControlWave XFC Gas Flow Computer (XFC Model 3820-EX) is listed by Underwriters Laboratories (UL) as nonincendive and is suitable for use in Class I, Division 2, Groups A, B, C and D hazardous locations or nonhazardous locations only. Read this appendix carefully before installing a nonincendive ControlWave XFC (Model 3820-EX) Gas Flow Computer. Refer to the other chapters of this manual for general information. In the event of a conflict between the other chapters of this manual, and this appendix, always follow the instructions in this appendix.
- The ControlWave XFC (Model 3820-EX) Gas Flow Computer 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 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.
- All communication ports terminate on a terminal block (J2) on the terminal plate within the enclosure. Wiring to this connector (J2) is unrated. No connections may be made to communication ports unless the user ensures the area is known to be nonhazardous. Connections to the “local port” are temporary and must be in short duration to ensure that flammable concentrations do not accumulate while it is in use.
- A bendable RTD may be supplied with the ControlWave XFC. Connection to the RTD is approved as a nonincendive circuit so that Division 2 wiring methods are not required.
- Signal connectors available for customer wiring are listed in *Table A-1*. I/O connections are unrated and must be wired using Division 2 wiring methods.

⚠ WARNING	**EXPLOSION HAZARD – Do NOT disconnect power connections within the ControlWave XFC enclosure (J6) unless the area is known to be non-hazardous.**

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

⚠ WARNING	**EXPLOSION HAZARD – The area must be known to be non-hazardous before servicing/replacing the unit and before installing or removing I/O wiring.**

⚠ WARNING	**EXPLOSION HAZARD – Do NOT disconnect equipment unless power has been disconnected and the area is known to be non-hazardous.**

Table A-1 Terminal Plate Connector

Customer Wiring Connectors

Connector	Wiring Notes
J2: Pins 1 through 4 RS-485 Communication Port and power connections for Model 3808 transmitter	RS-485 communication port connectors: For external Network Communications. Refer to Model Spec. and paragraph 3 of this appendix. *****
J2: Pins 5 through 7 RS-232 Local communications port	RS-232 communication port connectors: For temporary external network communications. Refer to model spec. and paragraph 3 of this appendix. *****
J2: Pins 8 through 14 RS-232 Network communications port	RS-232 communication port: For external network communications. Refer to model spec. and paragraph 3 of this appendix. Use Division 2 wiring methods. *****
J3: Pins 1 through 3 RTD interface	Field wired: Refer to paragraph 4 of this appendix.
J4: Pins 1 though 11 AI/O Interface and Field Power	Analog input/output field wiring and unit supplied (15Vdc) field power: Field I/O wiring connector is unrated, use Division 2 wiring methods.*
J5: Pins 1 through 9 DI/O interface	Discrete input/output field wiring: Field I/O wiring connector is unrated, use Division 2 wiring methods. *****
J5: Pins 9 through 12 HSC interface	High speed counter input field wiring: Field I/O wiring connector is unrated, use Division 2 wiring methods. *
J6: Pins 1 and 2 Input power	Power interface: Power connector is unrated, use Division 2 wiring methods. *****

***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 on page 1 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 B – Special Instructions for Class I Division 1 Hazardous Locations

- The ControlWave Explosion-Proof Flow Computer (XFC Model 3820-EX) is listed by Underwriters Laboratories (UL) as explosion proof and is suitable for use in Class I, Division 1, Groups C and D hazardous locations or nonhazardous locations. Read this appendix carefully before installing an explosion-proof ControlWave XFC (Model 3820-EX) Explosion-Proof Gas Flow Computer. Refer to the other chapters of this manual for general information. In the event of a conflict between the other chapters of this manual, and this appendix, always follow the instructions in this appendix.

- The ControlWave XFC (Model 3820-EX) Explosion-Proof Gas Flow Computer 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 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.

⚠ **WARNING**	**Though the ControlWave XFC (Model 3820-EX) has a local port for local interrogation, it should not be accessed with the cover removed in a Class I Division 1 area unless it has first been verified that no flammable concentrations exist in that area. The local port may be wired through a conduit, using seals, to an unclassified or Division 2 area.**

- All communication ports terminate on a terminal block (J2) on the terminal plate within the enclosure. Wiring to this connector (J2) is unrated. No connections may be made to communication ports unless the user ensures that the area is known to be nonhazardous. Connections to the "Local Port" are temporary and must be short in duration to ensure that flammable concentrations do not accumulate while it is in use.

- An RTD may be supplied with the ControlWave XFC. Connection to the RTD is approved as a nonincendive circuit. **NOTE: A bendable RTD (with a plastic bushing, as utilized in Division 2 installations) may not be used in a Division 1 area as it renders the area non-explosion-proof. Use an RTD connection head and explosion-proof conduit for Division 1 installations.**

- Signal connectors available for customer wiring are listed in Table B-1. I/O connections are unrated and must be wired using 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.

⚠ **WARNING**	**EXPLOSION HAZARD – Do NOT disconnect power connections within the ControlWave XFC enclosure (J6) unless the area is known to be non-hazardous.**

⚠ **WARNING**	**EXPLOSION HAZARD – Substitution of components may impair suitability for use in Class I, Division 1 environments.**

⚠ **WARNING**	**EXPLOSION HAZARD – The area must be known to be non-hazardous before servicing/replacing the unit and before installing or removing I/O wiring.**

⚠ **WARNING**	**EXPLOSION HAZARD – Do NOT disconnect equipment unless power has been disconnected and the area is known to be non-hazardous.**

Table B-1 Terminal Plate Customer Wiring Connectors

Connector	Wiring Notes
J2: Pins 1 through 4 RS-485 Communication Port and power connections for Model 3808 transmitter	RS-485 communication port connectors: For external Network Communications. Refer to Model Spec. and paragraphs 3 and 5 of this appendix.
J2: Pins 5 through 7 RS-232 Local communications port	RS-232 communication port connectors: For temporary external network communications. Refer to model spec. and paragraphs 3 and 5 of this appendix. *****
J2: Pins 8 through 14 RS-232 Network communications port	RS-232 communication port: For external network communications. Refer to model spec. and paragraphs 3 and 5 of this appendix. *****
J3: Pins 1 through 3 RTD interface	Field wired: Refer to paragraph 4 of this appendix.
J4: Pins 1 through 11 AI/O interface and field power	Analog input/output field wiring and unit supplied (15Vdc) field power: Field I/O wiring connector is unrated, refer to paragraph 5 of this appendix.*
J5: Pins 1 through 9 DI/O interface	Discrete input/output field wiring: Field I/O wiring connector is unrated. Refer to paragraph 5 of this appendix. *****
J5: Pins 9 through 12 HSC interface	High speed counter input field wiring: Field I/O wiring connector is unrated. Refer to paragraph 5 of this appendix.*
J6: Pins 1 and 2 Input power	Power interface: Power connector is unrated. Refer to paragraph 5 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 on page 1 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 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**
DURACELL http://www.duracell.com	3V lithium manganese dioxide battery P/N: DL 2450	395620-01-5
DOW CORNING http://www1.dowcorning.com	Silicone 200(R) Fluid, 100 CST Pressure transducer media fill	

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V

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Headquarters:
Emerson Process Management
Remote Automation Solutions
6005 Rogerdale Road
Houston, TX 77072 U.S.A.
T +1 281 879 2699 | F +1 281 988 4445
www.EmersonProcess.com/Remote

Europe:
Emerson Process Management
Remote Automation Solutions
Unit 8, Waterfront Business Park
Dudley Road, Brierly Hill
Dudley UK DY5 1LX
T +44 1384 487200 | F +44 1384 487258
www.EmersonProcess.com/Remote

North American/Latin America:
Emerson Process Management
Remote Automation Solutions
6005 Rogerdale Road
Houston TX USA 77072
T +1 281 879 2699 | F +1 281 988 4445
www.EmersonProcess.com/Remote

Middle East/Africa:
Emerson Process Management
Remote Automation Solutions
Emerson FZE
P.O. Box 17033
Jebel Ali Free Zone – South 2
Dubai U.A.E.
T +971 4 8118100 | F +971 4 8865465
www.EmersonProcess.com/Remote

Asia-Pacific:
Emerson Process Management
Remote Automation Solutions
1 Pandan Crescent
Singapore 128461
T +65 6777 8211| F +65 6777 0947
www.EmersonProcess.com/Remote