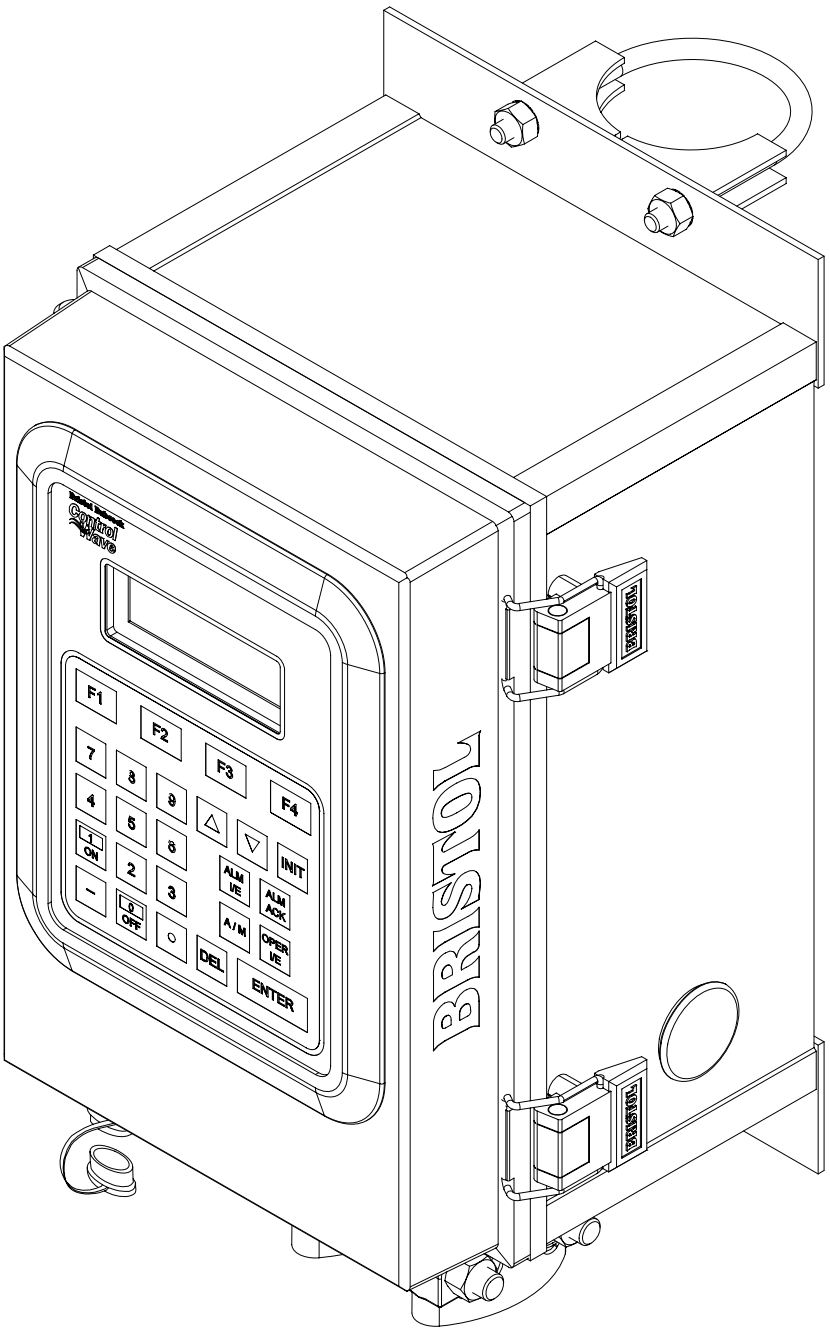
ControlWave GFC Classic (Gas Flow Computer)



ControlWave

IMPORTANT! READ INSTRUCTIONS BEFORE STARTING!

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

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

EQUIPMENT APPLICATION WARNING

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

RETURNED EQUIPMENT WARNING

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

ELECTRICAL GROUNDING

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

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

EQUIPMENT DAMAGE FROM ELECTROSTATIC DISCHARGE VOLTAGE

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

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

WARRANTY

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

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

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

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

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

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

REMEDIES

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

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

How to return material for Repair or Exchange

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

You can easily obtain a RA number by:

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

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

C. Mail
Mail the form (GBU 13.01) to

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

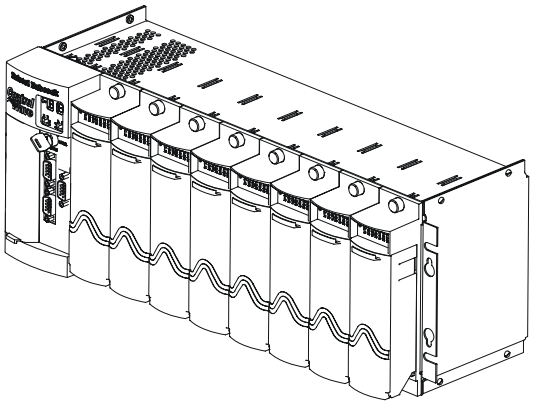
A Bristol Repair Dept. representative will return call (or other requested method) with a RA number.

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

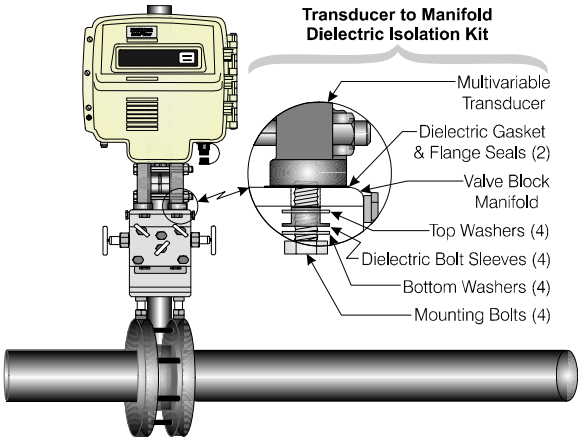
A copy of the completed Repair Authorization Form with issued RA number should be included with the product being returned. This will allow us to quickly track, repair, and return your product to you.

Bristol
Training

GET THE MOST FROM YOUR BRISTOL BABCOCK INSTRUMENT OR SYSTEM



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



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

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

A Few Words About Bristol Inc.

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

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

Getting Additional Information

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

Help Files / Release Notes

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

Contacting Bristol Inc. Directly

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

Our main phone numbers are:

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

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

Telephone Support - Technical Questions

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

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

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

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

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

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

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

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

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

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

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

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

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

Visit our Site on the World Wide Web

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

Training Courses

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

CI-ControlWave GFC-CL

ControlWave **GFC CLASSIC**
Gas Flow Computer

INSTALLATION FORWARD

NOTE for all Control Wave **GFC-CL Installers:**

READ THIS SECTION FIRST!

This manual has been designed for the following audience:

- Customer Site Engineers, who must plan for the installation and implementation of the C**ontrol**Wave **GFC-CL**.
- Instructors who must become familiar with and teach Field Engineers/Technicians on the installation, operation and repair of **Control**Wave **GFC-CL**.
- Field Engineers/Technicians who must install and service the **Control**Wave **GFC-CL**.

Installation of the C**ontrol**Wave **GFC-CL** Gas Flow Computer is provided in two formats as follows:

Section 2 - <u>Installation & Operation</u> provides a detailed overview of the installation and operation of the C**ontrol**Wave **GFC-CL**. Section 2 provides all the information required for instructors who are training individuals unfamiliar with the **Control**Wave **GFC-CL**. It is also intended to support anyone who needs to learn how to install and operate the **Control**-Wave **GFC-CL** for the first time.

Appendix C - <u>Hardware Installation Guide</u> is intended for individuals who are already familiar with the **Control**Wave **GFC-CL** but need the configuration information in a concise format. Field Engineers/Technicians who have previously installed one or more **Control**-Wave **GFC-CL** will find the necessary installation information logically sequenced for their convenience.

NOTE:

A Windows driven diagnostic tool referred to as WINDIAG is provided on the OpenBSI Software CDROM. WINDIAG is documented in instruction manual D4041A – <u>Window Diagnostics for Bristol Controllers</u>. Bristol's WINDIAG program provides menu driven diagnostics that have been designed to assist a technician or Process Engineer in troubleshooting the various ControlWave GFC-CL circuits. A brief overview is provided in Section 3.5 of this manual. For more detailed descriptions of Control Wave **GFC-CL Windows Diagnostics than those provided herein, see Document D4041A – Chapters 1 and 7C.**

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APPENDICES/SUPPLEMENTAL INSTRUCTION

REFERENCED Bristol CUSTOMER INSTRUCTION MANUALS

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REFERENCED Bristol CUSTOMER INSTRUCTION MANUALS (Continued)

REFERENCED OEM MANUALS

Expansion Comm. Module Piggy-back Modem/Radio OEM Manuals

MDS Transnet Radio wired to Polyphaser - Spread Spectrum Data Transceiver
MDS document MDS 05-3946A01, Rev. A April, 2003 (PDF = 3946A-TNET_OEM-web.pdf)

Internal FreeWave Radio (wired to Polyphaser) - Spread Spectrum Data Transceiver
FreeWave Spread Spectrum Wireless Data Transceiver User Manual - V5.0R (model FGR09CSU) Contact the FreeWave Tech Support group @ 303-444-3862 or at www.freewave.com to request the latest copy of the user manual.

MultiTech Systems wired to Surge Suppressor - Modem Module MT3334SMI & MT5634SMI
MultiTech Systems Developer Guide PN S000181C, version C 6/24/02 (PDF = S000181C.pdf)

External Modem/Radio OEM Manuals

MDS Transnet 900 - Spread Spectrum Data Transceiver
MDS TransNET 900 Spread Spectrum Data Transceiver Installation & Operation Guide – MDS Doc. MDS 05-2708A01, Rev. C, Feb., 2004 (PDF = 2708C-TransNET-web.pdf) for MDS TransNet 900

MDS 4710A – Remote Data Transceiver (Radio)
MDS 4710/9710 Series 400MHz/900 MHz Remote Data Transceiver Installation and Operation Guide – MDS Doc. 05-3305A01, Rev. B, Sept. 2000
(PDF = 3305B-710AC.pdf) for model MDS 4710A

MDS 4710B – Data Transceiver (Radio)
MDS 4710B/9710B Data Transceiver Installation and Operation Guide – MDS Doc. 05-3316A01, Rev. E, Sept. 2000
(PDF = 3316E-x710B.pdf) for model MDS 4710B

MDS 9810 – Spread Spectrum Data Transceiver (Radio)
MDS 9810/24810 900 MHz/2.4GHz Spread Spectrum Transceivers Installation and Operation Guide – MDS Doc. 05-3301A01, Rev. B, April 2000
(PDF = 3301B-x810.pdf) for model MDS 9810

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Gas Flow Computer

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External Modem/Radio OEM Manuals (Continued)

Section 1
ControlWave GFC-CL INTRODUCTION

1.1 GENERAL DESCRIPTION

ControlWave **GFC-CL** gas flow computers have been designed to perform as the ideal platform for remote site automation, measurement and data management in the oil and gas industry. **Control**Wave **GFC-CL**s measure differential pressure, static pressure and temperature for a single run and compute flow for both volume and energy. In addition to operation in an unprotected outdoor environment, the **Control**Wave **GFC-CL** gas flow computer provides the following key features.

Hardware/Packaging Features:

- 32-bit ARM9 processor (LH7A400) provides exceptional performance and low power consumption
- Wide operating temperature range: (-40 to +70°C) (-40 to 158°F)
- Two Board Platform: (CPU/System Controller Bd. and Battery Charger & I/O Bd.)
- Battery backup for the real-time clock and the system's SRAM is provided by a 3.0V, 300mA-hr lithium coin cell battery located on the CPU Module
- Very low power consumption - minimizes costs of solar panel/battery power systems, which are also integrated into the package
- Integral Multivariable Transducer (MVT) with "smart" performance (for DP or GP measurement) or Gage Pressure Transducer (for GP measurement)
- Three serial communications ports (One RS-232, One RS-485 and One RS-232/485)
- Four line alphanumeric display (with dual-button Keypad or 25-button Keypad)
- Standard I/O includes: 2 Digital Inputs (DI), 2 High Speed Counter Inputs (HSC), and 2 Digital Outputs (DO)
- Optional I/O includes: 3 Analog Inputs (AI) and 1 Analog Output (AO)
- RTD input
- Nonincendive Class I, Div. 2, Groups C & D Hazardous Locations (see Appendix A)
- Broad selection of modem and wireless communications are instrument package options
- Cost effective for small RTU/Process Controller applications

Firmware/Software Features

- Preprogrammed to meet API 21.1 requirements for a two-run metering station (with networking via BSAP or Modbus)
- Functions as a Process Controller or Remote Terminal Unit (RTU)
- Standard Application Program supports the following Flow calculations:
  - Calculates AGA3-1995/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
  - Instromet Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Daniel Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
- WebBSI Web pages are preconfigured for all user operations.
- Additional, standard application programs will be introduced on a continual basis.
- Using our ControlWave Designer IEC 61131-3 Programming Environment, any user or third party can modify the standard application or create a completely customized program – full support from Bristol Babcock is available, every step of the way.
- **Control**Wave **GFC-CL**s are compatible with Bristol Babcock's TeleFlow-series in software and networking solutions for SCADA and EFM (Electronic Flow Meter) data editing/management, and are similar in all operations.

ControlWave **GFC-CL** gas flow computers are furnished in a NEMA 3R rated enclosure. The gas flow computer hardware is comprised of a CPU/System Controller Board (mounted on the inside of the Instrument Front Cover), a Battery Charger & Input/Output Board (mounted on edge within the enclosure) and either a Multivariable Transducer (MVT) or a Gage Pressure Transducer (GPT) (mounted on the bottom of the enclosure). Sharp's LH7A400 System-on-Chip Advanced RISC Machine (ARM) microprocessor with 32-bit ARM9TDMI Reduced Instruction Set Computer (RISC) is the core of the CPU/System Controller Board. In addition to the microprocessor and control logic, the CPU/System Controller Board includes one fixed RS-232 Communication Port (COM1), one fixed RS-485 Communication Port (COM3), 1 configurable (RS-232/RS-485) Communication Port (COM2), 2MB of battery backed Static RAM (SRAM), 512kB Boot/Downloader FLASH, 8MB simultaneous read/write FLASH, SPI I/O Bus Connector, Serial Real Time Clock, Power Supply Sequencer, and Display/Keypad Interface. In addition to Idle, Watchdog, Power Good, DCD, DTR and the various Comm. Port LEDs, there are six status LEDs located on the CPU/System Controller Board that will display run time status information

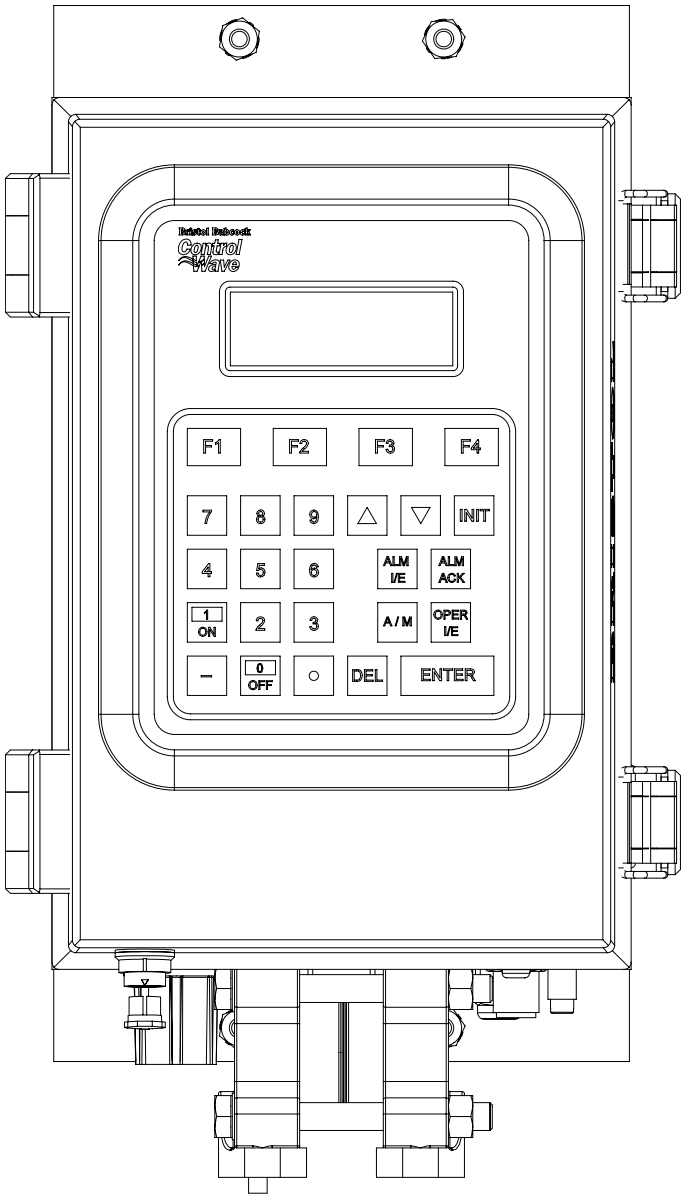
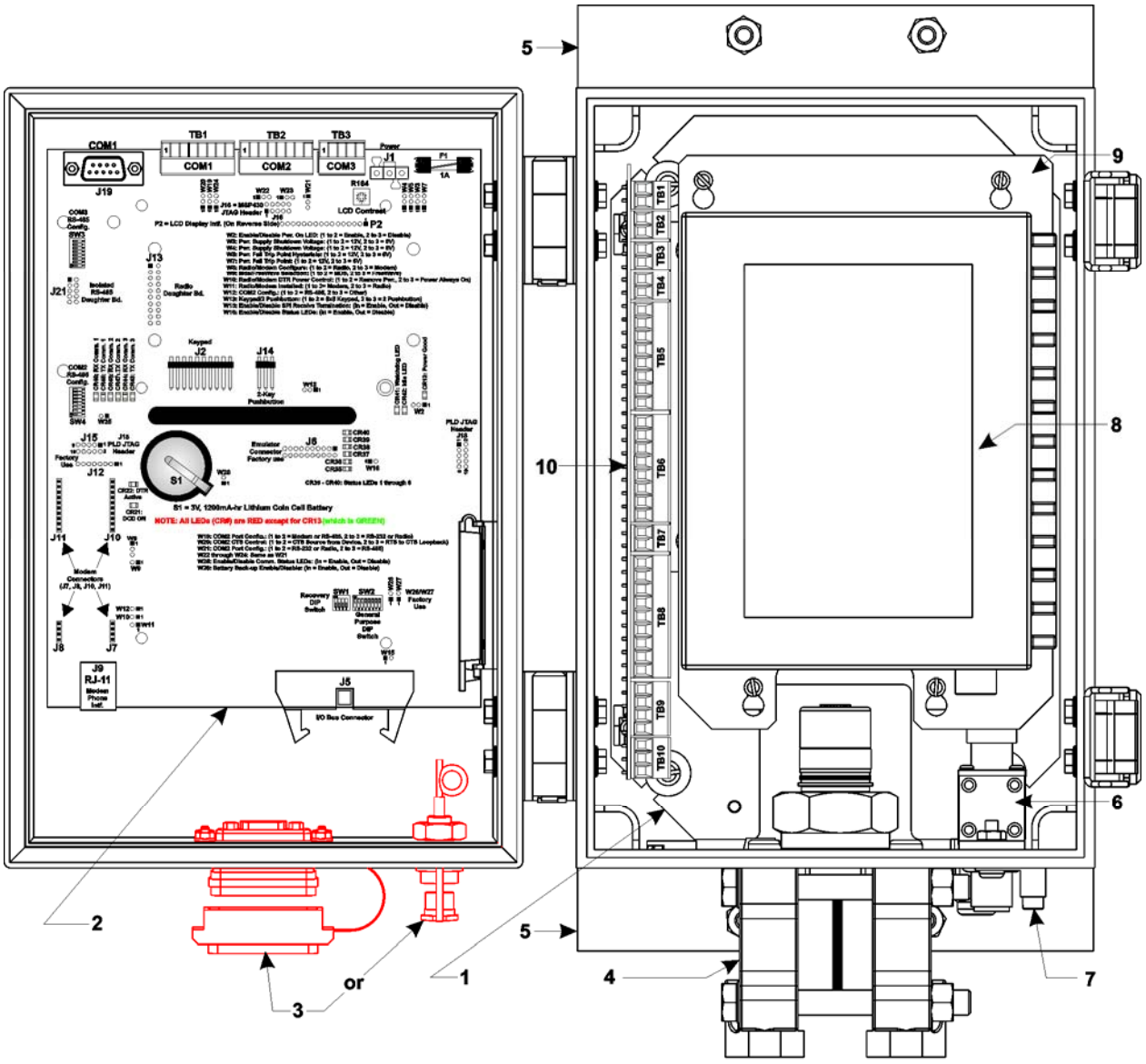


Figure 1-1 - Control Wave **GFC-CL Enclosure (MVT Equipped) (with 25-Button Display/Keypad Assembly)**



1. Fabrication Panel
2. CPU/System Controller Board
3. Local Comm. Port Connector & Cover
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug
8. External Radio (MDS - Transnet)
9. Radio/Modem Mounting Bracket
10. Battery Charger & I/O Board

Note: Item 3
Left = D-Type Connector
Right = Circular Connector
(One Provided)

Figure 1-2A - MVT Equipped ControlWave GFC-CL (with MDS - Transnet Radio) (Internal View) Component Identification Diagram

Battery Charger & I/O Boards provide the circuitry and field interface hardware necessary to interconnect the assigned field I/O circuits. Non-isolated power is generated and regulated by the CPU/System Controller Board (C/SCB) that provides +3.3Vdc for all logic and bulk power for I/O field circuits from either a bulk 6Vdc or bulk 12Vdc source. +1.8Vdc, used by the ARM microprocessor, is generated on the CPU Module (derived from the regulated 3.3Vdc logic power).

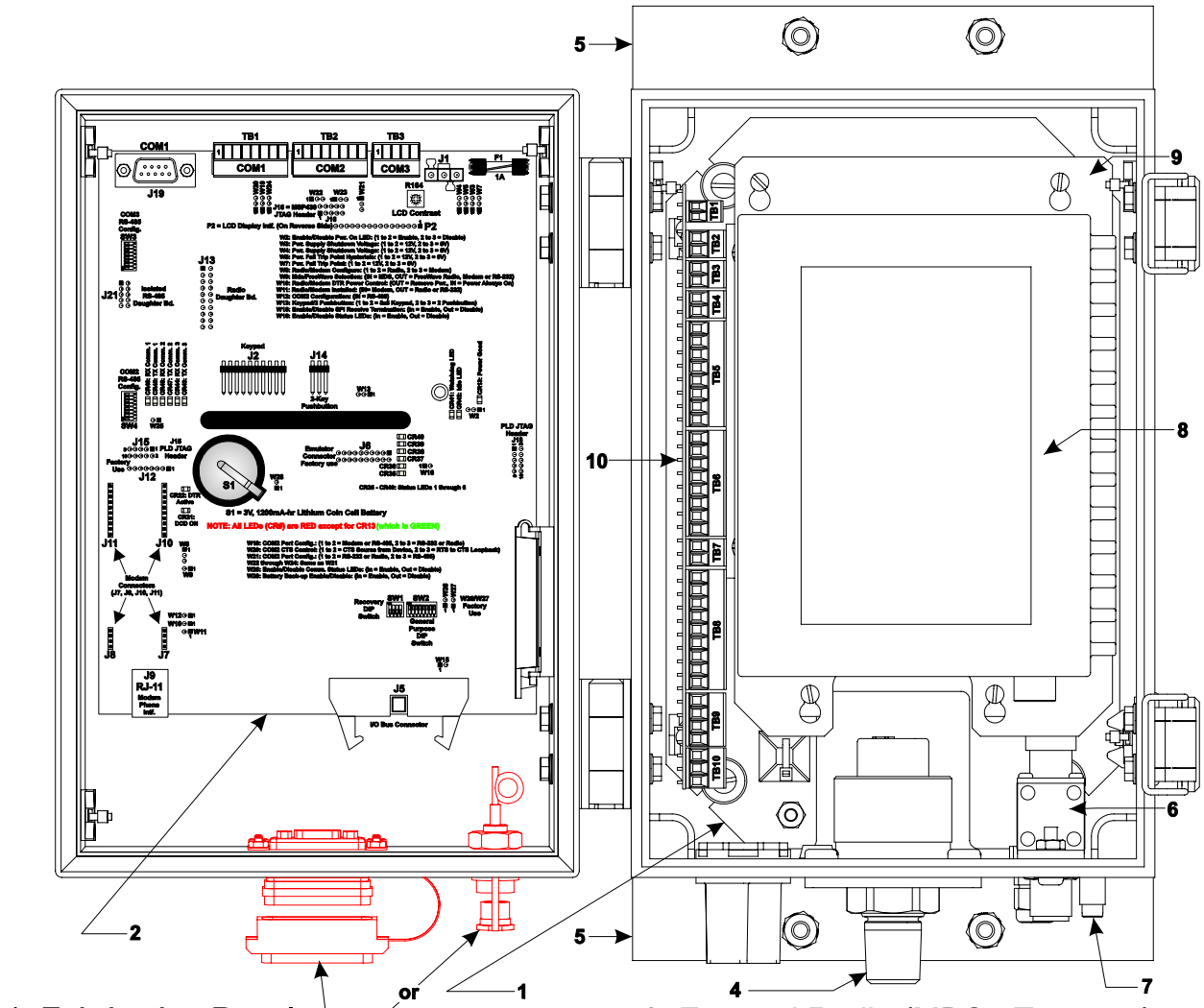


Figure 1-2B – GPT Equipped ControlWave GFC-CL (with MDS - Transnet Radio) (Internal View) Component Identification Diagram

Note: When equipped with a Gage Pressure Transducer, a GPT Adapter Plate is mounted to the bottom of the enclosure.

1.2 ControlWave PROGRAMMING ENVIRONMENT

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

ControlWave **GFC-CL** units provide an ideal platform for remote site automation, measurement, and data management in the oil and gas industry.

The control strategy file created and downloaded into the controller is referred to as a **Control**Wave **project**. The **Control**Wave **GFC-CL** ships from Bristol with a standard **Control**Wave project, pre-configured for gas flow measurement, already loaded and ready to run.

The **Control**Wave programming environment consists of a set of integrated software tools which allow a user to modify the standard gas flow measurement project to fit the needs of their own particular application, as well as to create, test, implement, and download a different **Control**Wave project, if desired.

The tools that make up the programming environment are:

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

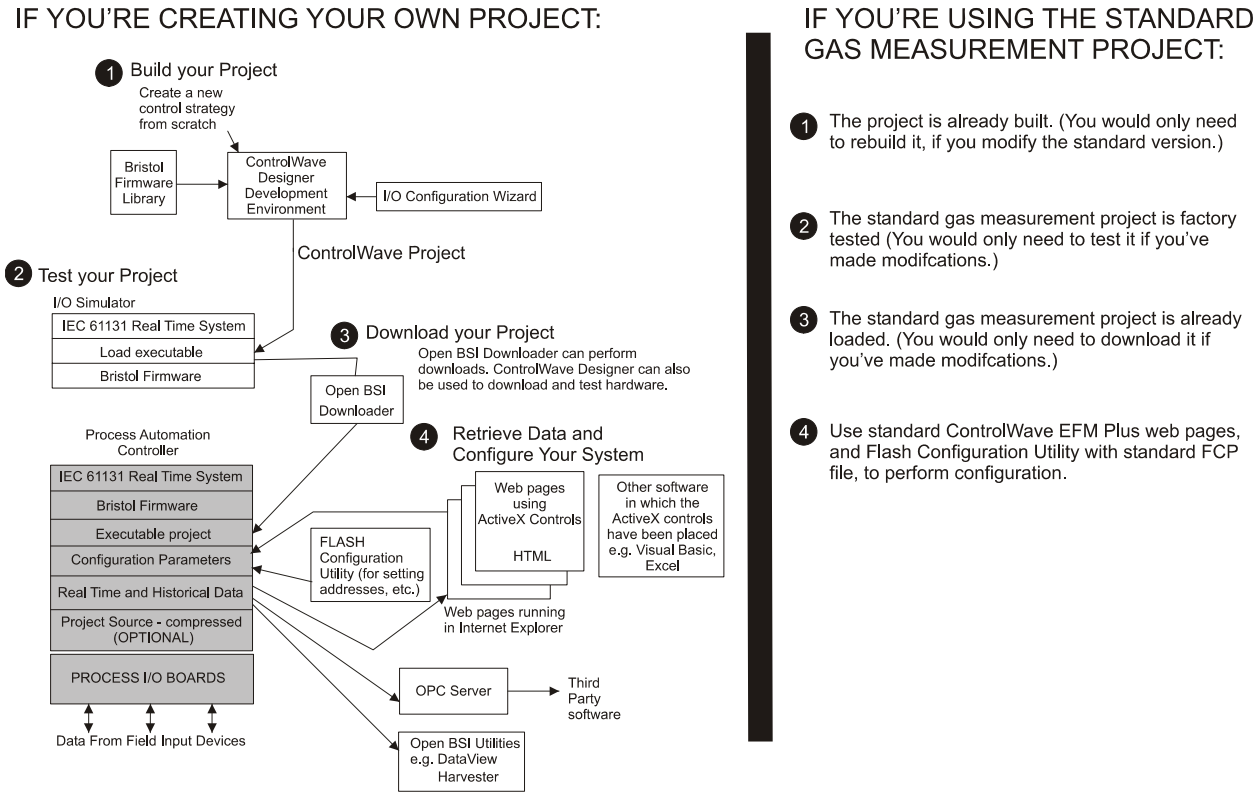


Figure 1-3 - Control Wave **- Control Strategy Software Diagram**

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

- The **ACCOL3 Firmware Library** which is imported into **Control**Wave Designer, includes a series of Bristol Babcock specific function blocks. These pre-programmed function blocks accomplish various tasks common to most user applications including alarming, historical data storage, as well as process control algorithms such as PID control.

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

- A set of **Control**Wave **GFC-CL** web pages is provided to set configuration parameters for the standard gas flow measurement project, running in the unit. These web pages use Bristol **ActiveX controls** for retrieval of real-time data values and communication statistics from the unit. The ActiveX controls are compatible with Microsoft® Internet Explorer. Alternatively, developers can place the ActiveX controls in third-party ActiveX compatible containers such as Visual BASIC or Microsoft® Excel.

- **User-defined Web Pages** – Users can place the *same* ActiveX controls into their own web pages to provide a customized human-machine interface (HMI) to the **Control-**Wave **GFC-CL**.

- **Flash Configuration Utility** – Parameters such as the BSAP local address, IP address, etc. are set using the Flash Configuration Utility, accessible via Open BSI LocalView or NetView. The **Control**Wave **GFC-CL** ships with a standard Flash Configuration Profile (FCP) file, with default configuration parameters already set.

1.3 PHYSICAL DESCRIPTION

ControlWave **GFC-CL** gas flow computers are comprised of the following major components:

- Enclosure with Local Communications Port (RS-232) and LCD Display (Section 1.3.1)
- CPU/System Controller Board (Section 1.3.2)
- Battery Charger & I/O Board (Section 1.3.3)
- Internal Mounting Brackets (Section 1.3.5)

ControlWave **GFC-CL**s can be factory configured with the following options:

- Multivariable Transducer (MVT) or Gage Pressure Transducer (GPT) (Section 1.3.4)
- RTD Probe (Section 1.3.3.3.4)
- Radio/Modem (Section 1.3.6)

1.3.1 Enclosure

ControlWave **GFC-CL**s are housed in a standard NEMA 3R rated fiberglass enclosure. External dimensions (excluding added hardware and Cover Latches) are approximately 11.73" high, by 9.08" wide, by 7.44" deep (without mounting brackets). When present, the Multivariable Transducer adds 2.80" or the Gage Pressure Transducer adds approximately 1.60" to the height of the unit. The enclosure consists of two pieces, the body and the Instrument Front Cover. A continuous gasket seals the unit when the Instrument Front Cover is closed. A hinge on the left side (facing the front of the unit) is formed by molded channels on the Instrument Front Cover and the body that capture a stainless steel pin. Two latches on the enclosure's right side secure the Instrument Front Cover when it is closed.

A weatherproof communication connector (the Local Port) is mounted to the bottom of the Instrument Front Cover and is connected internally to RS-232 Comm. Port 1. The Local Port provides connection for a local communications device, typically a PC. Communications rate is configurable 300 to 115.2 KB (115.2 KB - default).

Enclosures are provided with either a 2-button 4 X 20 LCD display or a 4 X 20 LCD display supported by a 25-button keypad. In normal operation, the display stays off after the unit has been configured and placed into service. The operator may activate the display at any time by pressing the appropriate front panel button.

1.3.2 CPU/System Controller Board

The multilayer CPU/System Controller Board provides **Control**Wave **GFC-CL** CPU, I/O monitor/control, memory and communication functions. **Control**Wave **GFC-CL** CPU/System Controller Boards operate over an extended temperature range with long-term product reliability.

ControlWave **GFC-CL** CPU/System Controller Boards are based on a 32-bit ARM9TDMI RISC Core Processor. The CPU/System Controller Board is specified to operate with an input voltage range from 4.5 to 16.0 Vdc and with a system clock speed of 14 MHz. The Microcontroller is packaged in a 256-pin Plastic Ball Grid Array. In addition to the microprocessor and control logic, the CPU Board includes one fixed RS-232 communication Port (COM1), one fixed RS-485 communication port (COM3) and a communication port that can be configured for RS-232 (default), RS-485 (4-wire) or modem/radio operation. CPU Memory consists of 2MB of battery backed Static RAM (SRAM), 512kB Boot/Downloader FLASH and 8MB simultaneous read/write FLASH. Interface to field I/O is provided through an I/O Bus Connector.

CPU/System Controller Boards are provided backup power via a coin cell socket that accepts a 3.0V, 300mA-hr lithium battery. This 3.0V battery provides backup power for the real-time clock and the system's Static RAM (SRAM). Backup power is enabled when Configuration Jumper W28 (adjacent to the battery) is installed.

If the 3.3Vdc that powers the unit goes out of specification, a supervisory circuit on the CPU/System Controller Board switches the battery voltage to the VBAT3.3 hardware signal (used by the CPU's SRAM and RTC). This supervisory circuit also generates a BATTERYGOOD signal when the battery voltage is above 2.2V.

The system SRAM is specified to have a standby current of 20µA maximum for each part (plus 2uA for the RTC). For a system containing 2MB of System SRAM, a worst-case current draw of 42µA allows a battery life of approximately 7142 hours.

The power supply operates from +4.5/+4.9 to +16Vdc or +9.6/10.3 to +16Vdc with the nominal input supply configuration (+6V or +12V) user configured via on-board jumpers. A supervisory circuit monitors the incoming power and the supply voltages. The isolated supplies are shut down when the incoming voltage drops below +4.5V for a +6V system or +9.6V, for a +12V system.

A supervisory circuit is used to switch to battery power when VCC falls out of specification. For maximum shelf life, the battery may be isolated from the circuit by removing the Backup Battery Jumper W28 from position 1 to 2 and then storing it on either pin. If the Real-time clock looses its battery backup a ControlWave Designer system variable bit (_QUEST_DATE) is set. This bit can be used to post a message or alarm to the PC (see the 'Systems Variables' section of the ControlWave Designer Programmer's Handbook D5125).

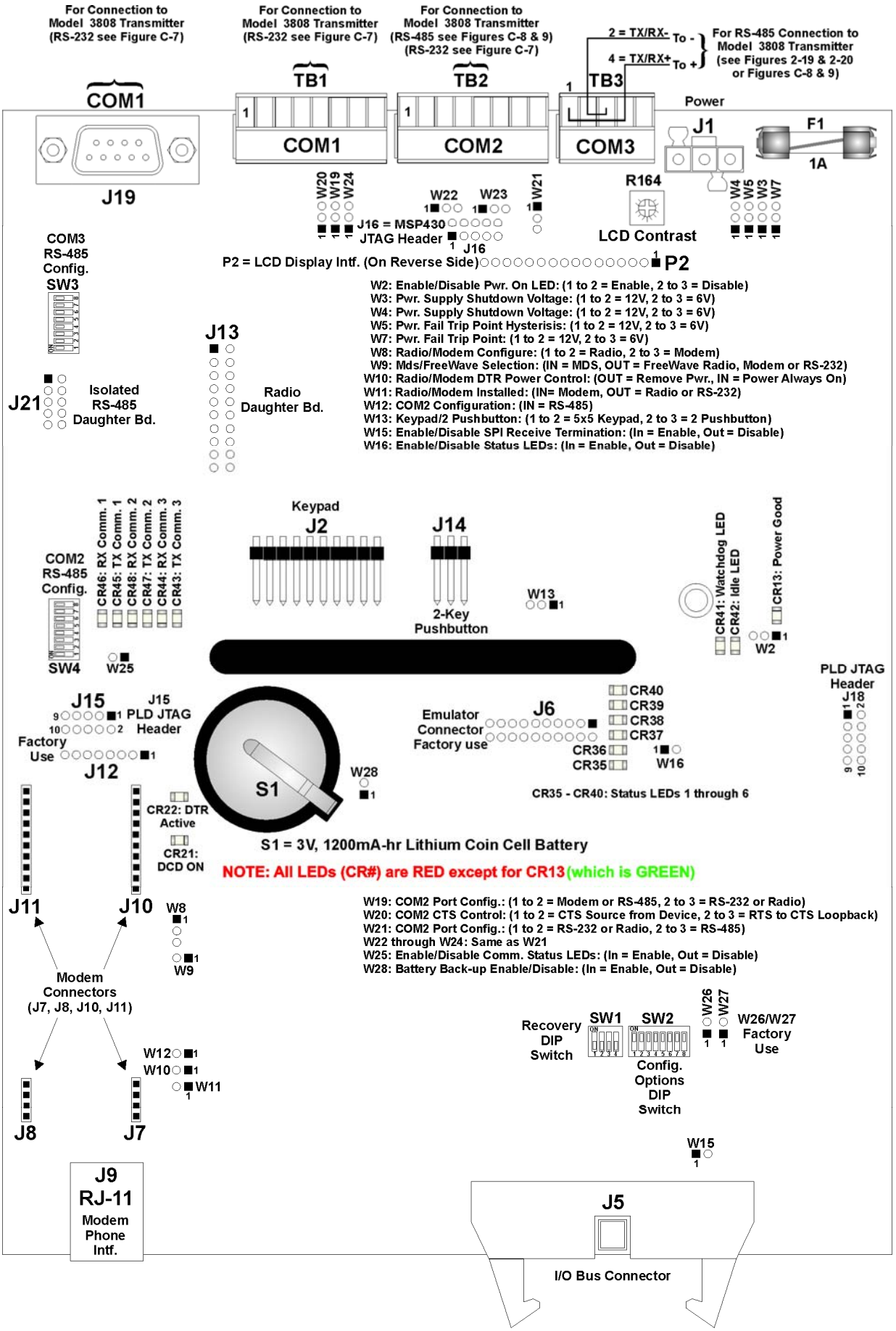


Figure 1-4 - ControlWave GFC-CL CPU/System Controller Board

Basic CPU components and features are summarized as follows:

- LH7A400 System-on-Chip 32-bit ARM9TDMI RISC Core microprocessor
- 512KB FLASH Boot/Downloader, 29LV040B, 90 nS, 8-bit access
- 2MB SRAM, 3.3V, 512K x 32, with Battery Back-up
- 8MB simultaneous read/write FLASH, TSOP site
- 3 serial Comm. ports (COM1 & COM2 with modem control)
- SPI I/O Bus Interface, three separate chip selects
- Spread Spectrum clock for lower EMI
- Serial Real Time Clock with battery backup
- 8-Position general-purpose switch bank plus a 4-Position recovery switch bank
- Coin cell socket accepts a 3.0V, 300mA-hr lithium battery
- Six Status LEDs, 6 Comm. Port LEDs plus DTR Active, DCD On, Watchdog, Idle and Power Good LEDs
- 5.4V to 16V Power Supply with Fail Safe Sequencer
- Display/Keypad Interface
- Optional Modules: Isolated RS-485 Module, Modem Module & Radio Module

1.3.2.1 CPU/System Controller Board Connectors

The CPU/System Controller Boards are equipped with up to twenty-one (21) connectors that function as follows (see Table 1-1):

Table 1-1 - CPU/System Controller Board Connector Summary

Ref.	# Pins	Function	Notes
P2	16-pin	Display Intf.	Reverse Side of Board
P3	76-pin	Factory Debug	Not shown or user accessible
J1	3-Pin	Power	Top Edge - see Figure 1-4
J2	10-Pin	25-Button Keypad Intf.	
J5	26-pin	IOBUS	Intf. to Battery Charger & I/O Bd.
J6	20-pin	Emulator Connector	Factory Use
J7	4-pin	Modem connector	Piggy-back Modem
J8	4-pin	Modem connector	Piggy-back Modem
J9	6-pin	Modem/Phone Line connector	Tip & Ring used (Bottom Edge)
J10	10-pin	Modem connector	Piggy-back Modem
J11	10-pin	Modem connector	Piggy-back Modem
J12	8-pin	Modem Signal Debug	Not user accessible
J13	20-pin	Radio Daughter Board	
J14	3-pin	2-Key Pushbutton	
J15	10-pin	PLD JTAG Header	Not user accessible
J18	10-pin	PLD JTAG Header	Not user accessible
J19	9-pin	9-pin Male D-type (COM1 - RS-232)	Top Edge
J21	10-pin	Isolated RS-485 Daughter Board	N/A
TB1	8-pin	Term. Block (COM1 - RS-232)	see Table 2-3A or 4-2
TB2	8-pin	Term. Block (COM2 - RS-232/485)	see Table 2-3A or 4-2
TB3	5-pin	Term. Block (COM3 - RS-485)	see Table 2-3B or 4-3

CPU/System Controller Board Serial Comm. Port Connectors (see Section 1.5.5)
The CPU Module supports up to three serial communication ports (COM1, COM2 & COM3). COM1 is supported by two connectors; J19 – (Male 9-pin D-Type) and TB1 (-8-pin Term Block). COM2 utilizes an 8-pin Terminal Block and COM3 utilizes a 5-pin Terminal Block. COM1 supports RS-232 communications, COM3 supports RS-485 communications and COM2 can be configured to support RS-232 or RS-485 communications. RS-232 ports

are protected with LCDA12C devices to ±4KV ESD. RS-485 ports are protected with LCDA12C and LCDA05 devices to ±4KV ESD.

1.3.2.2 CPU Memory

Boot/downloader FLASH
Boot/download code is contained in a single 512Kbytes uniform sector FLASH IC. This device resides on the local bus, operates at 3.3V and is configured for 8-bit access. 4-Position DIP-Switch SW1's position 3 allows start-up menu options to be displayed or boot-up from system FLASH. If SW1-3 is closed when a reset occurs, the boot-up code will cause a recovery menu to be sent out the COM1 serial port to a terminal program running on an external host computer. *Note: Recovery Mode will also be initiated if CPU/System Controller Board Switch SW1 positions 1 and 2 are both set **ON** or **OFF** during a reset.*

FLASH Memory
The base version of the CPU Module has 8Mbytes of 3.3V, simultaneous read/write (DL) FLASH memory. Each CPU Board contains one 48-pin TSOP site that will each accept 4 or 8 Mbytes of 3.3V, (DL) FLASH IC, for a total of 4 or 8 Mbytes of memory. FLASH memory is 16-bits wide. System Firmware and the Boot Project are stored here. No hardware write protection is provided for the FLASH array.

System Memory (SRAM)
The base version of the CPU Module has 2Mbytes of soldered-down static RAM, implemented with one 1M x 16 asynchronous SRAM that is configured as a 1M x 16-bit array. All random access memory retained data is stored in SRAM. During power loss periods, SRAM is placed into data retention mode (powered by a 3.0V lithium battery). SRAMs operate at 3.3V and are packaged in 44-pin TSOPs. Critical system information that must be retained during power outages or when the system has been disabled for maintenance is stored here. Data includes: Last states of all I/O, historical data, retain variables and pending alarm messages not yet reported. The SRAM supports 16-bit accesses.

1.3.2.3 CPU/System Controller Board Configuration Jumpers

ControlWave **GFC-CL** CPU/System Controller Board are provided with 21 User Configuration Jumpers that function as follows:

- W2 - Power On LED Enable/Disable Jumper
  1 to 2 = Enable Power On LED
  2 to 3 = Disable Power On LED

- W3 - Power Supply Shut-down Selection
  1 to 2 = 12V Power Supply Shut-down
  2 to 3 = 6V Power Supply Shut-down

- W4 - Power Supply Shut-down Selection
  1 to 2 = 12V Power Supply Shut-down
  2 to 3 = 6V Power Supply Shut-down

- W5 - Power Fail Trip Point Hysterisis Selection
  1 to 2 = 12V Power Fail Trip Point Hysterisis
  2 to 3 = 6V Power Fail Trip Point Hysterisis

- W7 - Power Fail Trip Point Selection
  1 to 2 = 12V Power Fail Trip Point
  2 to 3 = 6V Power Fail Trip Point

- W8 - Radio/Modem Configuration Selection (**Store Config. Jumper when not in use**)
  1 to 2 = Configure Radio
  2 to 3 = Configure Modem

- W9 - Radio Selection
  IN = MDS Radio
  OUT = FreeWave Radio or Modem or RS-232

- W10 - Radio/Modem DTR Control Selection
  IN = Power Always ON to Radio/Modem
  OUT = Remove Power to Radio/Modem with DTR

- W11 - Radio/Modem Installation Selection
  IN = Modem Installed
  OUT = Radio Installed or RS-232 Operation

- W12 - COM2 Configuration Selection
  IN = COM2 is RS-485
  OUT = COM2 is RS-232 or Radio or Modem

- W13 - Keypad/2-Button Display Selection
  1 to 2 = 5x5 Keypad/Display
  2 to 3 = 2-Button Display

- W15 - Enable/Disable SPI Receive Termination
  IN = Enable SPI Receive Termination
  OUT = Disable SPI Receive Termination

- W16 - Status LED Enable/Disable Selection
  IN = Enable Status LEDs
  OUT = Disable Status LEDs

- W19 - COM2 RS-232/RS-485 Modem/Radio Selection
  1 to 2 = COM2 set for Modem or RS-485
  2 to 3 = COM2 set for Radio or RS-232

- W20 - COM2 CTS Use Selection
  1 to 2 = COM2 CTS Source is from Device
  2 to 3 = COM2 RTS to CTS Loopback

- W21 - COM2 RS-232/Radio or RS-485 Selection
  1 to 2 = COM2 set for RS-232 or Radio
  2 to 3 = COM2 set for RS-485

- W22 - COM2 RS-232/Radio or RS-485 Selection
  1 to 2 = COM2 set for RS-232 or Radio
  2 to 3 = COM2 set for RS-485

- W23 - COM2 RS-232/Radio or RS-485 Selection
  1 to 2 = COM2 set for RS-232 or Radio
  2 to 3 = COM2 set for RS-485

- W24 - COM2 RS-232/Radio or RS-485 Selection
  1 to 2 = COM2 set for RS-232 or Radio
  2 to 3 = COM2 set for RS-485

- W25 - Enable/Disable Comm. Status LED Selection
  IN = Enable Comm. Status LEDS
  OUT = Disable Comm. Status LEDs

- W28 - Enable/Disable Battery Back-up Selection
  IN = Enable Battery Back-up
  OUT = Disable Battery Back-up

1.3.2.4 CPU/System Controller Board Configuration Switches

Four user configurable DIP-Switches are provided on the CPU/System Controller Board; eight-bit DIP-Switch SW2 is provided for user configuration settings while four-bit DIP-Switch SW1 provides forced recovery functions. Eight-bit DIP-Switch SW3 provides loopback, termination control, and receiver bias settings for the RS-485 port (COM3). Eight-bit DIP-Switch SW4 provides loopback, termination control, and receiver bias set-tings for COM2 when configured for RS-485 port operation (via jumpers W19 & W21).

Table 1-2 - CPU/System Controller Bd. Switch SW2 Assignments
Note: Except for SW2-4, ON = Factory Default

SW#	Function	Setting - (ON = Factory Default)
SW2-1	Watchdog Enable	ON = Watchdog circuit is enabled OFF = Watchdog circuit is disabled
SW2-2	Lock/Unlock Soft Switches	ON = Write to Soft Switches and FLASH files OFF = Soft Switches, configurations and FLASH files are locked
SW2-3	Use/Ignore Soft Switches	ON = Use Soft Switches (configured in FLASH) OFF = Ignore Soft Switch Configuration and use factory defaults
SW2-4	Core Updump See Section 3.6	ON = Core Updump Disabled OFF = Core Updump Enabled via Mode Switch (SW1)
SW2-5	SRAM Control	ON = Retain values in SRAM during restarts OFF = Force system to reinitialize SRAM
SW2-6	System Firmware Load Control *	ON = Enable remote download of System Firmware OFF = Disable remote download of System Firmware
SW2-7	N/A	
SW2-8	Enable WINDIAG	ON = Normal Operation (don't allow WINDIAG to run test) OFF = Disable boot project (allow WINDIAG to run test)

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

Table 1-3 - CPU/System Controller Bd. SW1 Assignments
Recovery Mode/Local Mode Control

SWITCH	Function	Setting
SW1-1/2	Recovery/Local Mode *	Both ON or OFF = Recovery Mode SW1 OFF & SW2 ON = Local Mode
SW1-3	Force Recovery Mode	ON = Force Recovery Mode (via CW Console) OFF = Recovery Mode disabled

*** = Note: Only the Switch SW1 settings listed in this table, have been tested (SW1-4 = N/A).**

Table 1-4 - CPU/System Controller Bd. Switch SW3/SW4 Assignments
RS-485 Loopback & Termination Control (COM3 = SW3 & COM2 = SW4)

SWITCH #	RS-485 Function Switch ON	Setting
SW3/4-1	TX+ to RX+ Loopback/2-Wire	ON – 2-Wire Operation or Loopback Enabled OFF – 4-Wire Operation & Loopback Disabled
SW3/4-2	TX– to RX– Loopback/2-Wire	ON – 2-Wire Operation or Looback Enabled OFF – 4-Wire Operation & Loopback Disabled
SW3/4-3	100 Ohm RX+ Termination	ON – End Nodes Only
SW3/4-4	100 Ohm RX– Termination	ON – End Nodes Only
SW3-6 (see Note 2)	Slew Rate ISO485 ONLY	ON – Slow Rate Enabled OFF – Fast Rate Enabled
SW3/4-7	RX+ Bias (End Nodes/Node)	ON – 4-Wire = Both End Nodes 2-Wire = One End Node Only OFF = No Bias
SW3/4-8	RX– Bias (End Nodes/Node)	ON – 4-Wire = Both End Nodes 2-Wire = One End Node Only OFF – No Bias

1.3.2.5 CPU/System Controller Board LEDs

ControlWave **GFC-CL** CPU/System Controller Boards are equipped with 17 LEDs. Table 1-5 provides CPU/System Controller Board LED assignments.

Table 1-5 - Assignment of CPU Module LEDs

LED Ref.	Function	Color	LED Ref.	Function	Color
CR13	Power Good	Green	CR41	Watchdog	Red
CR21	DCD ON (Modem)	Red	CR42	Idle	Red
CR22	DTR Active (Modem)	Red	CR43	TX COM3	Red
CR35	Status	Red	CR44	RX COM3	Red
CR36	Status	Red	CR45	TX COM1	Red
CR37	Status	Red	CR46	RX COM1	Red
CR38	Status	Red	CR47	TX COM2	Red
CR39	Status	Red	CR48	RX COM2	Red
CR40	Status	Red			

Two red LEDs provide for the following status conditions when lit: WD (CR41 - Indicates a Watchdog condition has been detected) & IDLE (CR42 - Indicates that the CPU has free time at the end of its execution cycle. Normally, it should be ON most of the time. When the Idle LED is OFF, it indicates that the CPU has no free time, and may be overloaded). The green Power Good LED (CR13) is on when power is within specification. Six status LEDs provide run time status codes.

1.3.3 Battery Charger and I/O Board

The Battery Charger and I/O Board mounts vertically on edge against the inner left side of the enclosure. Interface to the CPU/System Controller Board is provided via a 26-pin ribbon cable. In addition to solar panel charging circuitry, the Battery Charger and I/O Board contains an MSP430 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

- Process I/O circuitry consisting of the following:
    - Three 1-5V or 4 to 20mA Analog Inputs (Optional)
    - Two Discrete Inputs and Outputs
    - Two High Speed Counters
    - One Analog Output (1-5V or 4 to 20mA) (Optional)

An on-board solar charger is capable of charging a 7AH battery (6V or 12V) (with the charging cycle controlled by the MSP430 Microcontroller. An internal feature of the MSP430 that measures the IC temperature is used to calculate the maximum battery voltage for the charging cycle. Charging circuitry provides failsafe control that can override the MSP430 output when the battery voltage exceeds the maximum specified voltage. When the MSP430 has lost control of the system (due to Master Clear being active or a Watchdog State, the battery will be charged to a voltage allowable at 60°C (140°F).

A backup battery connector (TB3) accommodates uninterrupted power while the internal battery is being charged. Charging circuitry does not support or control the backup battery circuit. Primary Battery (TB2) and Backup Battery (TB3) inputs are diode or'd with the resulting output supplying power to the CPU/System Controller, the on board 24V supply (for AI's and AO's), and the field power for HSC devices.

1.3.3.1 Battery Charger and I/O Board Connectors

Battery Charger and I/O Boards are equipped with up to thirteen (13) connectors that function as follows (see Table 1-6):

Table 1-6 - Battery Charger and I/O Board Connector Summary

Ref.	# Pins	Function	Notes
P1	3-Pin	Power	Top Edge (Rear)
P2	8-Pin	MVT or GPT Transducer Interface	See Figure 1-5 & Section 3.2.6
P3	26-pin	IOBUS	Intf. to Cpu/System Controller Bd.
TB1	2-pin	Solar Power	see Section 2.3.9.3
TB2	2-pin	Primary Power	see Section 2.3.9.2
TB3	2-pin	Backup Battery Power	see Section 2.3.9-
TB4	2-pin	Auxiliary Power	Powers External Radio/Modem (see Section 2.3.9
TB5	8-pin	Discrete Inputs and Discrete Outputs	see Section 2.3.4.4
TB6	8-pin	High Speed Counter Inputs	see Section 2.3.4.7
TB7	2-pin	N/A	N/A
TB8	9-pin	Analog Inputs	see Section 2.3.4.5s
TB9	4-pin	Analog Outputs	see Section 2.3.4.6
TB10	3-pin	RTD Input	see Section 2.3.5s

1.3.3.2 Battery Charger and I/O Board Configuration Jumpers

ControlWave **GFC-CL** Battery Charger and I/O Boards are provided with 14 User Configuration Jumpers that function as follows:

- JP1 - AI1 Input Type (1-5V or 4-20mA)
  1 to 2 = 4-20mA Analog Input
  2 to 3 = 1-5V Analog Input

- JP2 - AI2 Input Type (1-5V or 4-20mA)
  1 to 2 = 4-20mA Analog Input
  2 to 3 = 1-5V Analog Input

- JP3 - AI3 Input Type (1-5V or 4-20mA)
  1 to 2 = 4-20mA Analog Input
  2 to 3 = 1-5V Analog Input

- JP4 - AO Output Source (1-5V or 4-20mA)
  1 to 2 = 4-20mA Analog Output
  2 to 3 = 1-5V Analog Output

- JP5 - AO Configuration Status (1-5V or 4-20mA)
  1 to 2 = 4-20mA Analog Output
  2 to 3 = 1-5V Analog Output

- JP6 - AO Power Source
  1 to 2 = Internal 24V Supply
  2 to 3 = +V External

- JP7 - HSC1 Debounce Enable/Disable
  1 to 2 = Debounce Enabled
  2 to 3 = Debounce Disabled

- JP8 - HSC2 Debounce Enable/Disable
  1 to 2 = Debounce Enabled
  2 to 3 = Debounce Disabled

- JP9 - System Power for +24V Supply Selection
  1 to 2 = System Power ON
  2 to 3 = System Power Open (OFF)

- JP10 - AI Field Power Configuration
  1 to 2 = Output of JP6
  2 to 3 = System Power through Polyfuse

- JP11 - HSC2/NAMUR Output Feed to One shot
  1 to 2 = +HSC2 (Factory Default)
  2 to 3 = NAMUR

- JP12 - NAMUR Field Connected to Daughter Bd.
  1 = NAMUR Power Source
  2 = GND
  3 = NAMUR Signal

- JP13 - NAMUR Daughter Board Power Connection & Output
  1 = 3.3V
  2 = GND
  3 = NAMUR - HSC

- JP14 - Bypass Intrinsically Safe (IS) Fuse (F5) – (for NI versions)
  Installed = Bypass IS Fuse (F5)

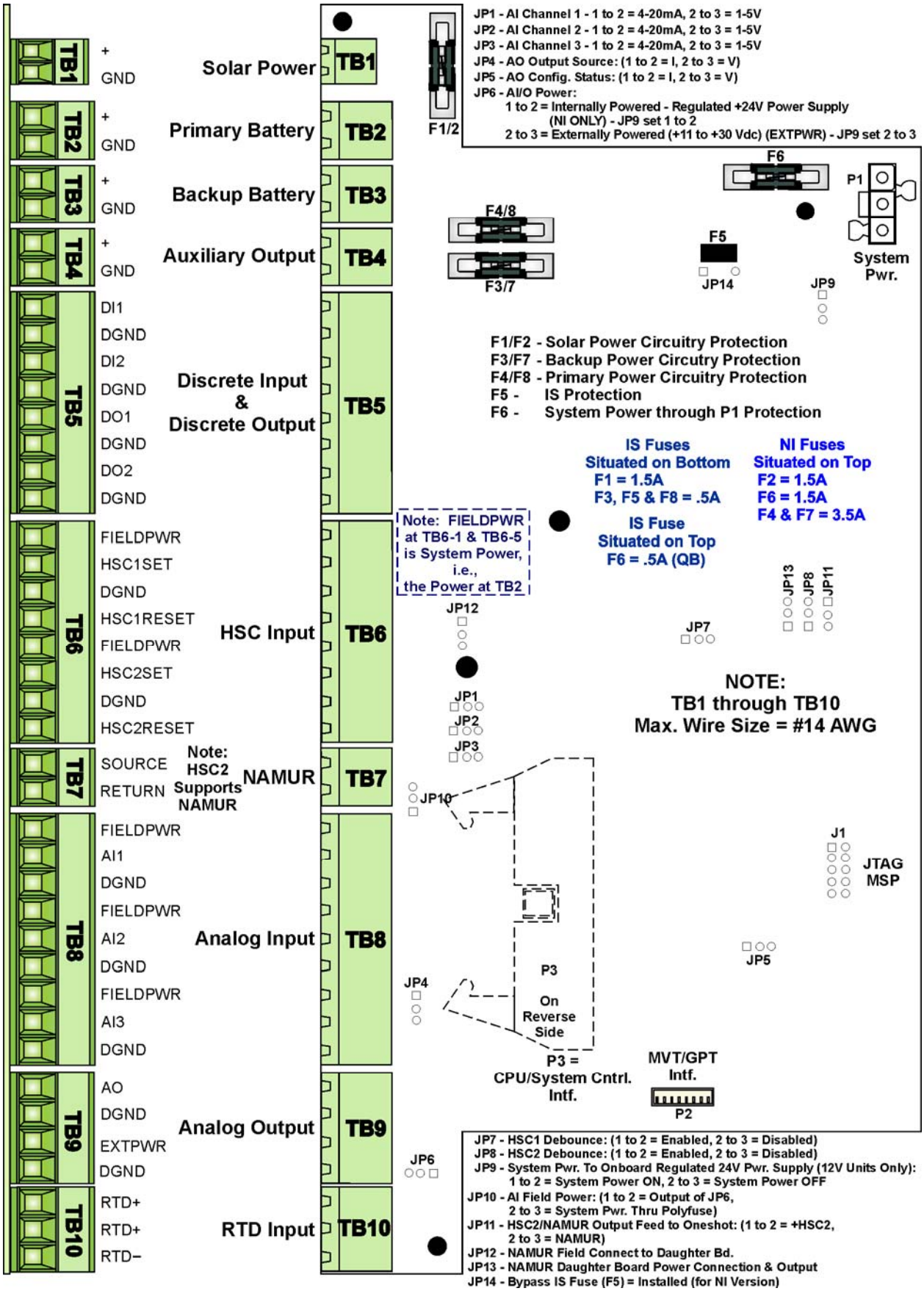


Figure 1-5 - ControlWave GFC-CL Battery Charger & I/O Board

1.3.3.3 Battery Charger and I/O Board Field I/Os

Field I/O Wiring is supported by card edge Terminal Block Connectors as follows:

Non-isolated Analog Input/Output Connector (Section 1.3.3.3.1)
Non-isolated Digital Input/Output Connector (Section 1.3.3.3.2)
Non-isolated High Speed Counter Input Connector (Section 1.3.3.3.3)
Optional RTD Input Connector - Section 1.3.3.4

1.3.3.3.1 Non-isolated Analog I/O (also see Sections 2.3.4.5 through 2.3.4.6.1)

Edge connectors TB8 and TB9 provide interface to three single ended Analog Inputs and 1 Analog Output (respectively). Three field terminals (on TB8) are assigned for each Analog Input. AI field power is applied to each Analog Input (controlled via jumpers JP10 and JP6) can be supplied by the system battery, an external power source, or in the case of a 12V system, from a **Control**Wave **GFC-CL** produced 24V field power supply. Each AI/O channel can be individually configured for 4 to 20mA or 1-5V operation.

AIs are supplied with a two hertz low pass filter and surge suppression (via 30Vdc Transorbs for NI versions and 16Vdc Transorbs for IS versions).

Analog Output circuitry consists of a 12-bit resolution Digital to Analog Converter, a V to I circuit and a V to V circuit. 4 to 20mA or 1-5V operation is jumper configured via JP4 and JP5.

1.3.3.3.2 Non-isolated Digital I/O (also see Section 2.3.4.4)

Edge connector TB5 provides interface to 2 Digital Inputs and 2 Digital Outputs. All Digital Inputs support dry contact inputs that are pulled internally to 3.3 Vdc when the field input is open. Source current will be 60uA from the 3.3V supply. 15 millisecond input filtering protects against contact bounce.

Digital Outputs have a 16V or 30V operating range and are driven by Open Drain FETs that provide 100 mA (Max.) at 16Vdc for the 6V system or 100mA (Max.) at 30Vdc for the 12V system. The maximum output frequency is 20 Hz. Transorbs (16Vdc for IS versions & 30Vdc for NI versions) provide surge suppression between each signal and ground.

1.3.3.3.3 Non-isolated High Speed Counter Inputs (also see Sections 2.3.4.7)

Edge connector TB6 provides the interface to two externally sourced single ended High Speed Counter Inputs (HSCI) with selectable debounce circuitry (JP7 for HSC1 & JP8 for HSC2). Signal conditioning circuitry provides 20 microsecond filtering. All Input circuits have surge suppression. HSC inputs can be operated as internally sourced dry contact or externally generated internally sourced input signals.

High Speed Counter inputs are sourced from 3.3Vdc with a source current of 200uA and a maximum input frequency of 10kHz.

1.3.3.3.4 Optional RTD Input Probe (also see Section 2.3.5)

Edge Connector TB10 provides connection to a 100-ohm platinum bulb (using the DIN 43760 curve). The common three-wire configuration is accommodated. In this con-

figuration, the return lead connects to the RTD- terminal while the two junction leads (Sense and Excitation) connect to the RTD+ terminals.

1.3.3.4 Battery Charger and I/O Board Input Power Connections

Four 2-position Terminal Blocks are provided for input power wiring as follows:

- TB1 - Solar Power: Power from a 1W - 6V, 5W - 6V or 5W - 12V Solar Panel
- TB2 - Primary Power: Power from an internal BBI supplied battery or an external 6V or 12V supply (see Model Specification for list of batteries)
- TB3 - External User supplied battery (6V or 12V). TB3 is diode or'd with TB2, but is not supported by a charging circuit.
- TB4 - Auxiliary Power Output for the optional BBI supplied external radio/modem

Power may be provided by a rechargeable 6/12V Lead Acid Battery (used in conjunction with a Solar Panel), a rechargeable Lithium Battery, or power may be externally supplied.

Solar panels mount to a 2" pipe and can be swiveled for optimum alignment with the sun and their tilt angle is adjustable for maximum performance to accommodate the latitude of the installation site. Solar panel wires enter the unit through a liquid tight conduit fitting on the bottom of the enclosure and are connected to TB1.

Internally the solar panel wires connect to the rechargeable battery via connector TB1 - PWR (red wire) and GND (black wire) terminals.

1.3.4 Multivariable or Gage Pressure Transducer

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 System Controller Module connector P2.

1.3.5 Internal Mounting Brackets

Internal mounting brackets that support the various system components, such as the Battery, **Control**Wave **GFC-CL** Battery Charger and I/O Board, and the optional external radio/modem option, are mounted on the 'Fabrication Panel,' which in turn is secured to the inner rear wall of the enclosure. A BBI supplied external radio or modem will mount in front of the battery via a Battery Cover/Radio/Modem Mounting Bracket.

1.3.6 Radio/Modem

In lieu of an internal modem/radio an external modem or spread spectrum radio may be factory installed within the enclosure. A listing of modem and radios is provided in the Table Of Contents under the topic REFERENCED OEM MANUALS.

1.4 FIELD WIRING

ControlWave **GFC-CL** gas flow computers support connection to external field devices through its field wiring terminals on the Battery Charger and I/O Board. Connections to the following types of external devices may be made:

- RTD
- Analog Inputs (AIs)
- Digital Inputs (DIs)
- Digital Outputs (DOs)
- Relays
- Pulse Inputs (HSCs)
- Analog Outputs (AOs)
- Battery/Power Supply/Solar Panel
- Communications (RS-232, RS-485 and Ethernet)

1.5 FUNCTIONS

ControlWave **GFC-CL** can come with or without a base application program that satisfies API 21.1 requirements for a meter station using up to two meter runs. Using **Control**-Wave Designer, the user can readily modify this load to add or subtract functions, increase the number of runs, etc. An overview of the base application load is provided below.

- Uses pre-configured web pages for user readings, configuration and maintenance. Web pages can be modified and new pages configured to work with a modified application load
- Application load is object oriented
- Standard configuration is a two-run station
- Each run can be orifice, turbine or ultrasonic meter type
- Flow calculations include the following:
- 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
- Includes run switching
- Includes an auto-selector, PID flow/pressure control algorithm per run or per station
- Interfaces to a chromatograph and provides energy throughput as well as composition information (requires the optional Expansion Communications Module)
- Resides on a BSAP SCADA network
- Supports samplers and odorizers
- Provides audit trail and archives
- Includes a nominations function
- Allows the user to select engineering units, including English and metric

The primary function of the **Control**Wave **GFC-CL** is to measure the flow of natural gas in accordance with API (American Petroleum Institute) and AGA (American Gas Association) standards. Items below implement and supplement the primary function:

- Data acquisition (see Section 1.5.1)
- Flow calculations (see Section 1.5.2)
- Data archives (see Section 1.5.3)
- Audit trail archives (see Section 1.5.3.4)
- Local display (see Section 1.5.4)
- Communications (see Section 1.5.5)
- Control outputs (see Section 1.5.6)

- Status inputs (see Section 1.5.6)
- Self test and diagnostics (see Section 1.5.7)

1.5.1 Data Acquisition

The process inputs used by the **Control**Wave **GFC-CL** are static pressure, differential pressure, and temperature for orifice measurement, or static pressure, temperature, and frequency input for positive displacement (PD), turbine, or ultrasonic meters. Static pressure and differential pressure may be obtained from the Multivariable Transducer connected to the **Control**Wave **GFC-CL** Battery Charger & I/O Board. Static pressure may also be obtained from a Gage Pressure Transducer (in lieu of a MVT) when the unit is so equipped. Inputs may also be derived from external smart Multivariable Transmitters using either the BSAP or MODBUS protocols. Alternatively, the inputs may be obtained via the local I/O Modules using analog transmitters. The standard **Control**Wave **GFC-CL** application program allows any combination of inputs to be selected, for up to two runs of measurement.

Regardless of the operating mode or the calculation interval, the **Control**Wave **GFC-CL** acquires samples as follows:

a. Differential pressure once per second
b. Static pressure once per second
c. Flowing temperature once per second
d. All self-test and compensation values at intervals of 4 seconds or less

1.5.2 Flow and Volume Calculations

The **Control**Wave **GFC-CL** 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. The user can select AGA3/NX-19 (1985), AGA3/AGA8, AGA7/NX-19 or AGA7/AGA8.

1.5.2.1 Flow Rate and Flow Time Calculations (AGA3)

For orifice flow measurement, the differential pressure value is compared to a flow cutoff value every second. If the differential pressure is less than the 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, temperature, and flow extensions are used as inputs to the flow equations. Users may select API 14.3 (AGA3, 1992) and AGA8 calculations, with compressibility being calculated according to AGA Report No. 8, 1992 (with 1993 errata). Both the DETAIL method and the two GROSS methods of characterization described in AGA8 are supported. Users may also select the AGA3, 1995 and NX-19 flow equations to calculate the rate of flow.

1.5.2.2 Flow Rate Calculations and Flow Time Accumulations (AGA7)

When using PD meters, turbine meters or ultrasonic meters, the flow rate is calculated 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 flow rate estimate is set to zero;

however, volume calculations are still accumulated. The flow time recorded is the time for which the flow rate is non-zero.

1.5.2.3 Extension Calculation and Analog Averaging

For orifice meters, a flow extension is calculated 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, arithmetic averages of static pressure and temperature are reported. This allows monitoring of static pressure and temperature during shut-in periods.

1.5.2.3.1 Energy Calculation

The **Control**Wave **GFC-CL** offers the option of using a fixed volumetric heating value or calculating the energy content of the gas according to AGA Report No. 5.

1.5.2.3.2 Volume and Energy Integration

Volume and energy are each integrated and accumulated at the end of every calculation cycle. The volume for a cycle is the calculated rate multiplied by the flow time for that cycle. The energy for a cycle is calculated by multiplying the volume at BASE conditions by the heating value.

1.5.2.4 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. Static pressure can be measured 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, the user selects the downstream tap location during MVT configuration, the MVT firmware changes the sign of the differential pressure to provide a positive DP value.

1.5.3 Archives

The **Control**Wave **GFC-CL** stores two distinct types of archive data. The first type is Audit Trail data, which is a recording of the various events and alarms that have an impact on the calculated and reported rates and volumes. The second type is historical data, which includes records of rates and volumes and other signals over time. When an archive log becomes full, new entries replace the oldest entries in the log.

Where feasible, both forms of archive data conform to the requirements of the API Chapter 21 (the Committee on Gas Measurement's GFC document). 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.

The **Control**Wave **GFC-CL** supports the "breaking" of a log period when an operator-entered parameter is changed. When this occurs, the log period in process is closed out, a log is made, and a new log is begun. This feature is disabled by default and may be enabled by the operator. *Note: To prevent several very short logs from being created due to a series of successive configuration changes, the* **Control**Wave **GFC-CL** *will not create a log which*

contains less than 60 seconds (flowing or otherwise) of data. Therefore if a user enters 15 configuration changes over a 2minute period, the log will only be broken twice.

1.5.3.1 Hourly Historical Data Log

The Hourly Data Log 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 **Control**Wave **GFC-CL** FLASH memory.

The following items are stored in the Hourly Data Log:

- Corrected Volume
- Uncorrected Volume
- Accumulated Energy
- Average Static Pressure
- Average Temperature
- Average Differential Pressure
- Average Specific Gravity
- Average Heating Value
- Flow Time
- Uncorrected Count

Each log entry also contains the date and time. The **Control**Wave **GFC-CL** has a Hourly Historical Log for each of four runs.

1.5.3.2 Daily Historical Data Log

The Daily Data Log holds one record for every contract day. The contract hour may be changed by the user. The daily log holds 62 entries; this ensures that the previous calendar month of daily data is always resident in **Control**Wave **GFC-CL** FLASH memory.

The following items are stored in the Daily Data Log.

- Corrected Volume
- Uncorrected Volume
- Accumulated Energy
- Average Static Pressure
- Average Temperature
- Average Differential Pressure
- Average Specific Gravity
- Average Heating Value
- Flow Time
- Uncorrected Count

Each log entry also contains the date and time. The **Control**Wave **GFC-CL** has a Daily Historical Log for each of the two runs.

1.5.3.3 Periodic Historical Data Log

The periodic data log holds one record for every log interval. Log interval is 15 minutes. The Periodic Historical Data Log holds 1440 records, or four days of 15 minute data.

The following items are stored in the Periodic Historical Data Log:

- Flowing Differential Pressure
- Flowing Static Pressure
- Flowing Temperature
- Frequency

Each log entry also contains the date and time. The **Control**Wave **GFC-CL** has a Periodic Historical Data Log for each of four runs.

1.5.3.4 Alarm and Event Storage

The **Control**Wave **GFC-CL** keeps an Audit Trail Buffer capable of storing the most recent 500 Alarms and the most recent 500 Events. Internally, these buffers are maintained separately to prevent recurring alarms from overwriting configuration audit data. Externally, they are reported to the user as a single entity. Both operate in a circular fashion with new entries overwriting the oldest entry when the buffer is full.

The following circumstances cause an entry to be made in the Audit Trail Buffer:

- Any operator change to a **Control**Wave **GFC-CL** configuration variable
- Any change in the state of a **Control**Wave **GFC-CL** alarm signal
- A system restart
- Certain other system events

1.5.4 LCD Display

In normal operation, the display stays off after the unit is configured and placed in service. The operator may activate the display at any time by pressing the appropriate front panel button (depending on the keyboard type). When activated, the display scrolls through a list of current values. The list defaults to an appropriate set of values.

1.5.5 Communications

A **Control**Wave **GFC-CL** can be configured as a Master or Slave node on either a MODBUS network or a BSAP network. Up to three serial communication ports are contained on the **Control**Wave **GFC-CL** CPU/System Controller Board. RS-232 Communication Port COM1 is supported by three connectors as follows: J19 (9-pin D-Type Male connector) and TB1 (8-pin Terminal Block) are situated on the CPU/System Controller Board while the Local Port connector associated with COM1 is situated externally on the bottom of the Instrument Front Cover. ***Note: The Local Port is factory wired to COM1 via an internal harness that is plugged into TB1 on the CPU/System Controller Board.*** Communication ports situated on the CPU/System Controller Board are designated as follows:

CPU/System Controller Board:

COM1 - Port 1: J19 - 9-Pin Male D-Sub - RS-232)
COM1 - Port 1: TB1 - 8-Pin Term. Block - RS-232 (Factory connected to the Local Port)
COM2 - Port 2: TB2 - 8-Pin Term Block - RS-232/RS-485 (Configured via W12, W19, W20 W21 (SW4 is used when COM2 is set for RS-485 operation) (COM2 supports an Internal or External Modem or Radio option)
COM3 - Port 3: TB3 - 4-Pin Term Block - RS-485 (Configured via SW3)

Communication Ports COM1, COM2 & COM3 support serial asynchronous operation. Communication Port COM1 supports RS-232 operation while COM3 supports RS-485

operation. Communication Ports COM2 may be user configured for either RS-232 or RS-485 operation. Additionally, the CPU/System Controller Board may optionally contain a 56Kbaud PSTN Modem or a Spread Spectrum Modem (Radio). Any serial communication port can be configured for local communications, i.e., connected to a PC loaded with **Control**Wave Designer and OpenBSI software.

RS-232 Ports
An RS-232 interface supports Point to Point, half-duplex and full-duplex communications (20 feet maximum, using data quality cable). Half-duplex communications supported by the **Control**Wave **GFC-CL** utilize MODBUS or BSAP protocol, while full-duplex is supported by the Point to Point (PPP) protocol. **Control**Wave **GFC-CL** RS-232 ports utilize the "null modem" cable (Figure 2-11A) to interconnect with other devices such as a PC, printer, another **Control**Wave **GFC-CL**, **Control**Wave **GFC**, **Express**, **ExpressPAC**, **MICRO**, **EFM**, or **Control**Wave unit, a **Control**Wave I/O Expansion Rack or a **Control**Wave**LP** unit when the **Control-**Wave **GFC-CL** is communicating using the full-duplex PPP protocol.

RS-485 Ports
ControlWave **GFC-CL** can use an RS-485 communication port for network communications to multiple nodes up to 4000 feet away. Essentially, the master and the first slave transmit and receive data on opposite lines; all slaves (from the first to the "nth") are paralleled (daisy chained) across the same lines. The master node should be wired to one end of the RS-485 cable run. A 24-gauge paired conductor cable, such as Belden 9843 should be used. *Note: Only half-duplex RS-485 networks are supported.*

Comm. Port Defaults
From the factory COM1 defaults to 115.2 kbd using the BSAP Protocol. The remaining serial communication ports, i.e., COM2 and COM3 default as follows:

COM2 – BSAP Slave @ 9600 Baud
COM3 – BSAP Master @ 9600 Baud (for use with Bristol Babcock 3808 MVT Transmitters)

1.5.5.1 BSAP Message Support

The **Control**Wave **GFC-CL** supports the same subset of BSAP messages as the other **Control**Wave products.

1.5.6 Discrete and Analog I/O GFC Functionality

ControlWave **GFC-CL** gas flow computers are equipped with a variety of Inputs and Outputs (see Sections 1.3.3.1 through 1.3.3.4). While using the standard application program, inputs and outputs required for measurement and control are mapped to the application using the configuration Web pages. Analog Alarm limits for variables required by the standard application program are defined via the configuration Web pages. Discrete Input alarms associated with the standard application program can be enabled or disabled on a per point basis via the configuration Web pages. Control algorithms (flow control, sampler control, odorant control, etc.) are selected via the configuration Web pages.

1.5.6.1 Flow Rate Control - DDC (jog control) using PID

When the user configures the **Control**Wave **GFC-CL** to perform flow rate control, the two digital output signals are wired to the Open and Close inputs of a controller. The **Control**-Wave **GFC-CL** uses a Proportional/Integral/Derivative (PID) algorithm to cause the

measured rate of flow to match a user-entered setpoint. When the flow rate is below the setpoint, the Open output is pulsed. When the flow rate is above the setpoint, the Close output is pulsed. The PID equation calculates the duration of the Open or Close pulse. The minimum pulse duration is 1.0 seconds. The user changeable parameters are:

- Flow Setpoint in MSCFH
- Deadband in % of setpoint
- Proportional Gain
- Integral Time in repeats/minute
- Derivative Time in seconds
- Valve Travel Time (full close to full open)
- Process Control Limiting
- Pressure Override Limits

The flow control algorithm runs once per second.

1.5.6.2 Pulse Output for External Totalizer or Sampler

When the **Control**Wave **GFC-CL** is configured to provide a pulse output based on volume, the operator provides a control volume and a pulse duration. After each calculation cycle, an internal volume accumulator is compared to the control volume. If the accumulator exceeds the control volume then a pulse is output and the accumulator is reduced by the volume represented by the pulse. The pulse output may be used to drive an external totalizer, odorizer, gas sampler, or similar device.

1.5.6.3 Nominations

The nomination function allows a user to establish a time period over which an accumulation count of volume or energy that is delivered during the period is monitored and compared to a configured 'nomination' value. When the nomination value is reached, the system will perform an action (such as opening or closing a valve). Prior to nomination being reached, the volume/energy will be compared to a configured alarm level and an alarm will be generated when the volume/energy reaches or exceeds the defined (specified) level.

1.5.7 Self Test & Diagnostics

The **Control**Wave **GFC-CL** periodically runs a series of diagnostics to verify the operational status of various system components. The tests include transducer parameters, main and backup battery voltages, software sanity checks, and other indications of system health. An appropriate alarm is generated if any test fails.

Bristol's WINDIAG program provides menu driven diagnostics that have been designed to assist a technician or Process Engineer in troubleshooting the various **Control**Wave **GFC-CL** circuits (see Document D4041A).

Section 1A
PRODUCT FEATURES & OVERVIEW

1A.1 PRODUCT OVERVIEW

ControlWave® products have been designed and integrated as a highly adaptable, high performance Distributed Open Controller family with exceptional networking capability that provides a complete Process Automation Management Solution. **Control**Wave **GFC-CL** gas flow computers have been designed with an emphasis on providing high performance with low power consumption, scalability and modularity. **Control**Wave **GFC-CL** Housings support to 2 main circuit boards, i.e., the CPU/System Controller Board and the Battery Charger and I/O Board.

ControlWave **GFC-CL** gas flow computers have been designed as an ideal platform for remote site automation, measurement and data management within the oil & gas industry. **Control**Wave **GFC-CL** units are extremely effective in Flow Computer, Process Controller or Remote Terminal Unit capacities as follows:

- API 21.1 EFM/Flow Computer application

ControlWave **GFC-CL** units offer a cost effective and competitive match to all industry meters used in Electronic Flow Measurement and Flow Computer installations.

- For orifice and other differential meters, the **Control**Wave **GFC-CL** has been designed to integrate a DP/P/T, smart Multivariable Transducer with excellent performance over the full range of operating pressure and temperature conditions.
- For static pressure meters, the **Control**Wave **GFC-CL** has been designed to integrate a Gage Pressure Transducer with excellent performance over the full range of operating pressure and temperature conditions.
- For linear meters, such as turbine and ultrasonic meters, the **Control**Wave **GFC-CL** doesn't overlook the importance of pressure and temperature corrections and utilizes smart P/T circuitry to provide high accuracy over the full range of operating conditions.

- Process Controller or Remote Terminal Unit (RTU) applications

Process Controller and RTU applications don't suffer performance limitations of flow computers with expanded hardware. User configurable I/O provides AI/O, DI/O and HSC functionality. An optional piggy-back mounted radio or modem or an external Spread Spectrum Modem/Radio may be mounted within the enclosure.

1A.1.1 Hardware Features

- Wide operating temperature range (-40 to 70°C)
- Nonincendive Class I, Div. 2 Hazardous Location approval & CE approval
- ARM9 Processor provides exceptional performance and low power consumption
- Standard three serial communication ports (One RS-232, One RS-232/485 & One RS-485)
- I/O siutuated on one circuit board provides cost effective I/O for small RTU applications

1A.1.2 Firmware and Software Features

- Standard application load for up to two run, API 21.1 EFM operation
- Additional application loads (e.g. well automation with plunger lift control) are also available
- Full user programming environment, **Control**Wave Designer with ACCOL III, is available for modification of existing loads as well as creation of custom loads
- Full suite of function blocks for flow calculations, audit trail, historical archive/data management, communication, and process control is included.
- File management, including video images
- Fully supported by a complete HMI and network communication software suite: Bristol's OpenBSI

1A.2 PRODUCT FAMILY COMPATIBILITY

Not only is **Control**Wave **GFC-CL** scalable, it is also compatible with Bristol Babcock's **Control**Wave family. **Control**Wave **GFC-CL** is fully software-compatible with the original **Control**Wave, which provides greater I/O capacity.

1A.2.1 Open Standards for Programming, Network Config. and Communication

Only **Control**Wave brings the perfect combination of industry standards to minimize learning, engineering and implementation costs.

By adhering to such industry standards as Ethernet, TCP/IP, Microsoft Windows®, COM/DCOM, FTP, OLE and ActiveX, **Control**Wave is able to achieve the highest degree of openness in control system architecture and bring the optimal process efficiency and productivity needed to ensure a successful system implementation.

1A.2.2 **Control**Wave **Designer with ACCOL III**

To minimize your engineering and development time, we have adopted the international standard for PLC programming, IEC 61131-3. **Control**Wave Designer is a fully IEC 61131-3 compliant programming environment for the **Control**Wave family of products. **Control**Wave Designer includes all five IEC 61131-3 process languages for batch, continuous and discrete control. Function Block Diagram, Structured Text Sequential Function Chart, Ladder Logic Diagram and Instruction List.

ControlWave **Designer** includes an extensive library of more than 200 basic IEC 61131-3 functions and function blocks common to many IEC 61131-3 based products. These include:

- Flip-flops, Counters & Timers
- Ladder diagram functions – coils and contacts, etc.
- Numerical, Arithmetic & Boolean functions – Sine, Cosine, Add, Sub, Square Root, And, Or, etc.
- Selection & Comparison – Min, Max, Greater than, Equal, Less than, etc.
- Type conversions – Integer to Real, Boolean to Word, etc.

1A.2.3 ACCOL III

In addition to the basic functions and function blocks, **Control**Wave Designer brings the benefit of over twenty years of SCADA and plant control experience in Bristol Babcock's ACCOL III function block library. ACCOL III includes over sixty function blocks valuable

for use in oil & gas, water & waste and process measurement & control applications. Further, ACCOL III is designed to take full advantage of the significant features offered by **Control**Wave.

Briefly, this library includes function blocks for:

- Average, Compare, Totalize
- Scheduling & Sequencing
- PID & Lead/Lag
- AGA gas flow and liquids calculations
- File handling

In addition, **Control**Wave ensures data integrity, in the event of a communication interruption, by storing critical time-stamped alarm and historical data in the controller memory. This data is then securely retrieved when communication is restored.

1A.3 STANDARD APPLICATION PROGRAM

ControlWave **GFC-CL** can come with or without a base, application program that satisfies API 21.1 requirements for a meter station using up to four meter runs. Using **Control**Wave Designer, the user can readily modify this load to add or subtract functions, increase the number of runs, etc.

Overview of the base, application load:

- Uses pre-configured web pages for user readings, configuration and maintenance-web pages can be modified and new pages configured to work with a modified application load
- Application load is object oriented
- Standard configuration is a four-run station
- Each run can be orifice, turbine or ultrasonic meter type
- Flow calculations include the following:
  - 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
  - Instromet Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Daniel Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Includes run switching
  - Includes an auto-selector, PID flow/pressure control algorithm per run or per station
  - Interfaces to a chromatograph and provides energy throughput as well as composition information
  - Resides on a BSAP SCADA network
  - Supports samplers and odorizers
  - Provides audit trail and archives
  - Includes a nominations function
  - Allows the user to select engineering units, including English and metric

1A.3.1 OpenBSI - Simply Creative

OpenBSI (**O**pen **B**ristol **S**ystem **I**nterface) is a set of network setup, communication diagnostic, and data viewing utilities that provide access to both **Control**Wave and Network 3000 controllers and RTUs. OpenBSI is the only product available in the industry to bring such unique functionality and ease of use to the network level. At the core is the communication interface, written as a Windows communication server API through which other client applications communicate with the Bristol networks. OpenBSI supports both serial BSAP protocol and Ethernet Internet Protocol communication to **Control**Wave and Network 3000 RTUs and controllers.

1A.3.2 OpenBSI Utilities

Above this communication layer are a group of applications known as OpenBSI Utilities. These client utilities communicate through the server to collect and manage data gathered from the network, generate files based on collected historical data, collect alarms, and monitor and control OpenBSI communications.

- Communication engine for PC applications
- Supports **Control**Wave and Network 3000 serial and IP protocols
- RS 232, Dial-line, cellular, radio, CDPD, satellite, and Ethernet connections
- Provides on-line download & signal variable changes
- Allows network configuration through NetView
- PC and Network communication diagnostics
- OPC Server for interfacing to most HMI software
- Harvester collects historical data on request or scheduled basis

NetView is the basic configuration and application interface for all network operations. NetView uses a tree structure for network graphical display in the Windows Explorer style. Network nodes can be added on-line by simply dragging the node Icon into the tree. This invokes a configuration Wizard simplifying network setup. Through the NetView Wizard, the necessary network parameters are entered for node and IP address, alarm and message routing, and network communication media. Once configured, selecting any node allows direct access to the common OpenBSI utilities to reprogram, download a new application to the node, review communication statistics, view real-time data through DataViewer, and edit controller/RTU properties.

Local Configuration Wizard allows local communication with any attached C**ontrol-**Wave controller or RTU to download system flashware upgrades, configure cold download parameters, and configure IP and soft-switch parameters.

DataView is an on-line utility used to collect and display several types of process data, including signal values, data array values, signal lists, and audit trail information.

Operators have the ability to alter signal values. Multiple DataView windows may be open simultaneously.

1A.3.3 Real-time ActiveX Controls

One of the many benefits OpenBSI brings to you is our use of open standards such as ActiveX Controls. ActiveX is another of the Microsoft standards, which allow plug and play with any ActiveX container, using Microsoft ActiveX container technology such as Visual Basic, HTML web pages, and Microsoft Excel.

The set of available ActiveX Controls provides the basic functions necessary to communicate and collect data from **Control**Waves.

1A.3.3.1 ActiveX Controls

- Security - 56-bit encryption - allows the user to sign on to the RTU
- Signal Value - displays signal values in various formats
- Comm. Statistics - works with a standard page that displays the RTU's communication statistics
- Configuration Info - works with a standard page that displays and allows the user to change RTU Configuration information
- Historical - Collect and view historical archive and audit files

The IP compliant **Control**Wave opens the door for owner controlled access via web pages. Any generic web page builder can be employed to create user defined pages to access **Control**Wave. The web pages are populated with these pre-configured ActiveX controls and are stored at the PC.

1A.3.3.2 Required Software

Microsoft Internet Explorer
Bristol Babcock ActiveX controls
OpenBSI LocalView or NetView

1A.3.4 Historical Data Collection

High Historical Data Integrity
The **Control**Wave Historical Data Collection system offers exceptional historical data integrity by providing time-stamped historical data storage in **Control**Wave flash memory. The historical data is collected, through OpenBSI, on a scheduled or demand basis and converted to .CSV and ODBC compliant file formats for use in spreadsheets and reports. If data is missed due to a communication failure, it is collected when the communication is reestablished and the PC historical database is back-filled with the missing data. This distributed historical database architecture provides the greatest data reliability and integrity during communication or PC failure.

Another important historical feature is the Audit storage and collection system. The Audit Trail is a file stored in **Control**Wave flash memory containing significant events and time-stamped alarms. The alarms stored in the Audit system provide a historical archive in addition to the real-time alarm reporting system.

This file is also collected through OpenBSI and presented as a text file in the PC. This functionality is extremely useful in providing an event trail during communication or PC downtime or other system problem.

- Archive Collection - collection and storage to disk of the **Control**Wave archive data
- Audit Collection - collection and storage to disk of the **Control**Wave audit data.
- Exports data files to third party, CSV & ODBC applications
- DDE compliant for use with other popular Windows applications

1A.3.5 OPC Server

With industry demand for open standards, **Control**Wave answers the call by embracing technologies that open the door for maximizing your efficiency and productivity. The OPC standard was developed by the OPC Foundation comprised of hardware and software suppliers from the process control community. OPC allows the engineer to select best in class hardware and software with confidence in their interoperability. Our OpenBSI OPC Server was among the first to comply with the OPC Foundation alarm and event server specification.

- OPC Data Access 1.0a & 2.0 compatible
- Windows NT, 2000 & XP
- Compatible with both **Control**Wave and Network 3000 systems
- 32 bit multi-threading, multi-processor design
- Automatic database builder
- Integrated real-time data monitor
- Supports OPC Browse interface
- Supports both serial communications and IP Ethernet connections
- Supports COM/DCOM & OLE Automation
- Primary and Background polling scheme
- OPC Alarm & Event Server support

1A.4 **Control**Wave **OPEN NETWORK CONNECTIVITY**

By embracing the open system network technologies available through TCP/IP, Ethernet, OPC, and Microsoft DNA, as well as pseudo standards such as Modbus and Open Modbus, **Control**Wave can provide a total Process Automation Management Solution for in-plant LAN based networks and Wide Area Network SCADA systems.

With the exceptional connectivity provided by the **Control**Wave network, access to real-time data and operating conditions, historical data, maintenance and performance data are all available to the global network. **Control**Wave provides the needed information to the plant floor technician, operator, engineer, supervisor and corporate management, even external customers.

1A.4.1 Communication Protocols

Like all Bristol products, C**ontrol**Wave supports BSAP (Bristol Standard Asynchronous Protocol), Modbus, DF1, DNP 3 (serial) and serial ASCII as standard functions. These protocols are implemented in Flashware so no additional hardware is required to use any one or a combination of all protocols.

1A.4.1.1 BSAP Protocol

BSAP - All Bristol Network 3000 and **Control**Wave RTU and controller products support BSAP protocol. BSAP is widely accepted as providing exceptional data integrity and greatly simplifies communication between controllers. BSAP is provided with interfaces for Master/Slave, vertical networks and Client/Server, horizontal networks. In either case, variable lists are created in each controller that are easily passed from server to client or slave to master.

BSAP meets the definition of an industry-standard, open architecture protocol because if conforms to ISO standards 2629, 1745 and 2111, it is not proprietary in that Bristol does not charge a license fee and makes the protocol and documentation available to anyone.

While BSAP is an open protocol, the added functionality of the messages provides much more capability than is found in other networks.

- Global time-synchronization
- Time-stamped Alarm reporting
- Historical archive data transfer
- Audit file transfer
- On-line program editing
- Diagnostics
- Communication statistics

1A.4.1.2 Modbus Protocol

Modbus - Modbus is often considered a de-facto standard protocol because broad usage as either the primary or a secondary offering in many measurement and control related products. Even with its common use, Modbus protocol actually has many variations. Consider Modbus RTU and Modbus ASCII, Master & Slave, Serial and TCP/IP Open Modbus. In addition there are consideration regarding supported function codes, floating point values and byte order. Bristol Babcock supports the following:

- Modbus serial and TCP/IP Open Modbus (Ethernet)
- Master and Slave
- Modbus RTU and ASCII
- Modes 1 - 7, 8, 15 & 16
- Integer and IEEE 4 byte floating point

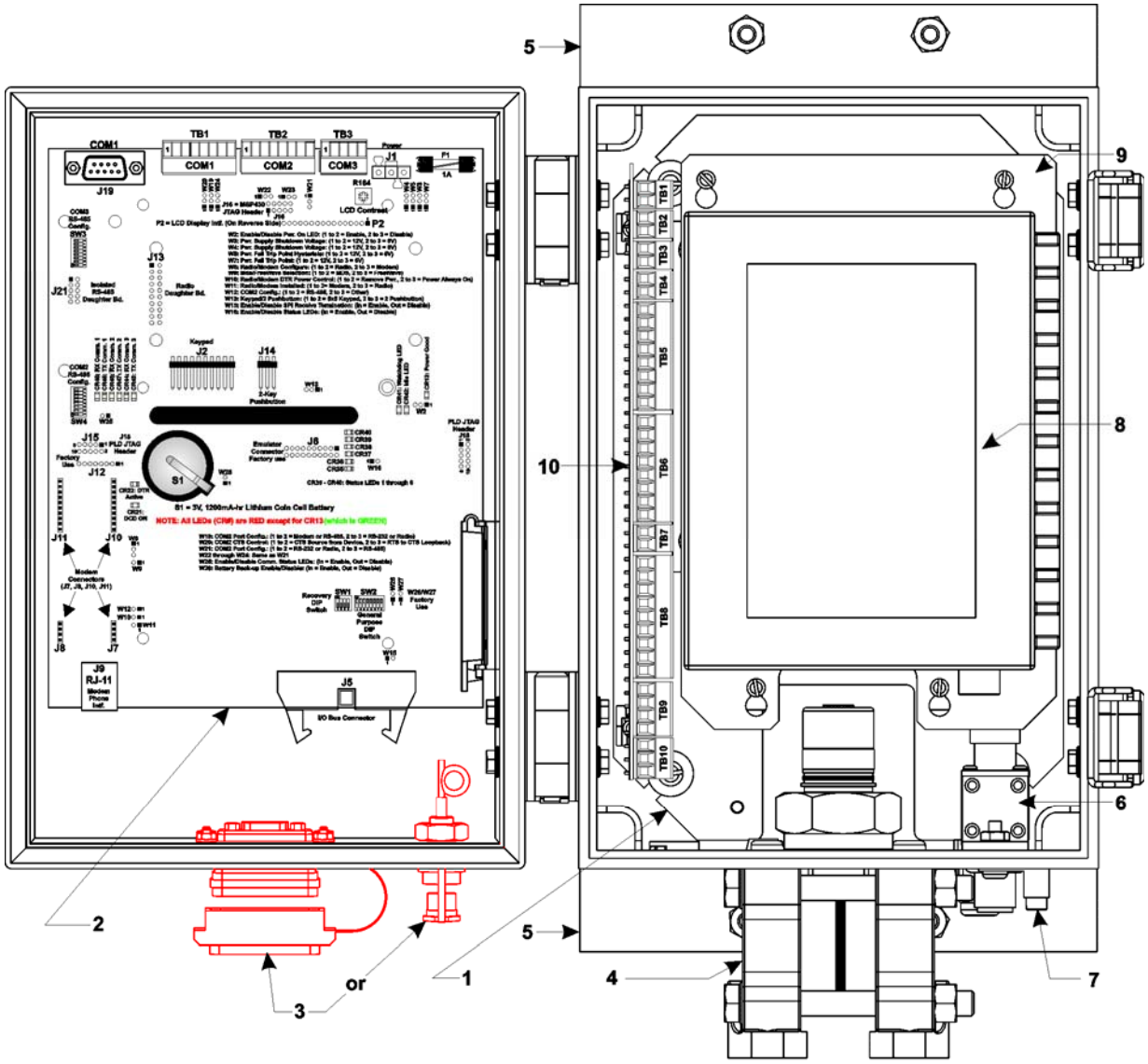
1A.4.1.3 Generic Serial Interface

The Generic Serial Interface is a user programmable Master and Slave protocol used to send and receive messages typically with third party serial ASCII devices. This protocol can be used to interface with such devices and message boards, card readers and many measurement devices.

Section 2
INSTALLATION & OPERATION

2.1 INSTALLATION IN HAZARDOUS AREAS

Each **Control**Wave **GFC-CL** gas flow computer is furnished in an enclosure designed to meet the NEMA Type 3R specifications and to operate in a Class I, Division 2, Groups C & D environment with a nonincendive rating (see Appendix A).



1. Fabrication Panel
2. CPU/System Controller Board
3. Local Comm. Port Connector & Cover
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug
8. External Radio (MDS - Transnet)
9. Radio/Modem Mounting Bracket
10. Battery Charger & I/O Board

Note: Item 3
Left = D-Type Connector
Right = Circular Connector
(One Provided)

Figure 2-1A - MVT Equipped Control Wave **GFC-CL (with MDS - Transnet Radio)**

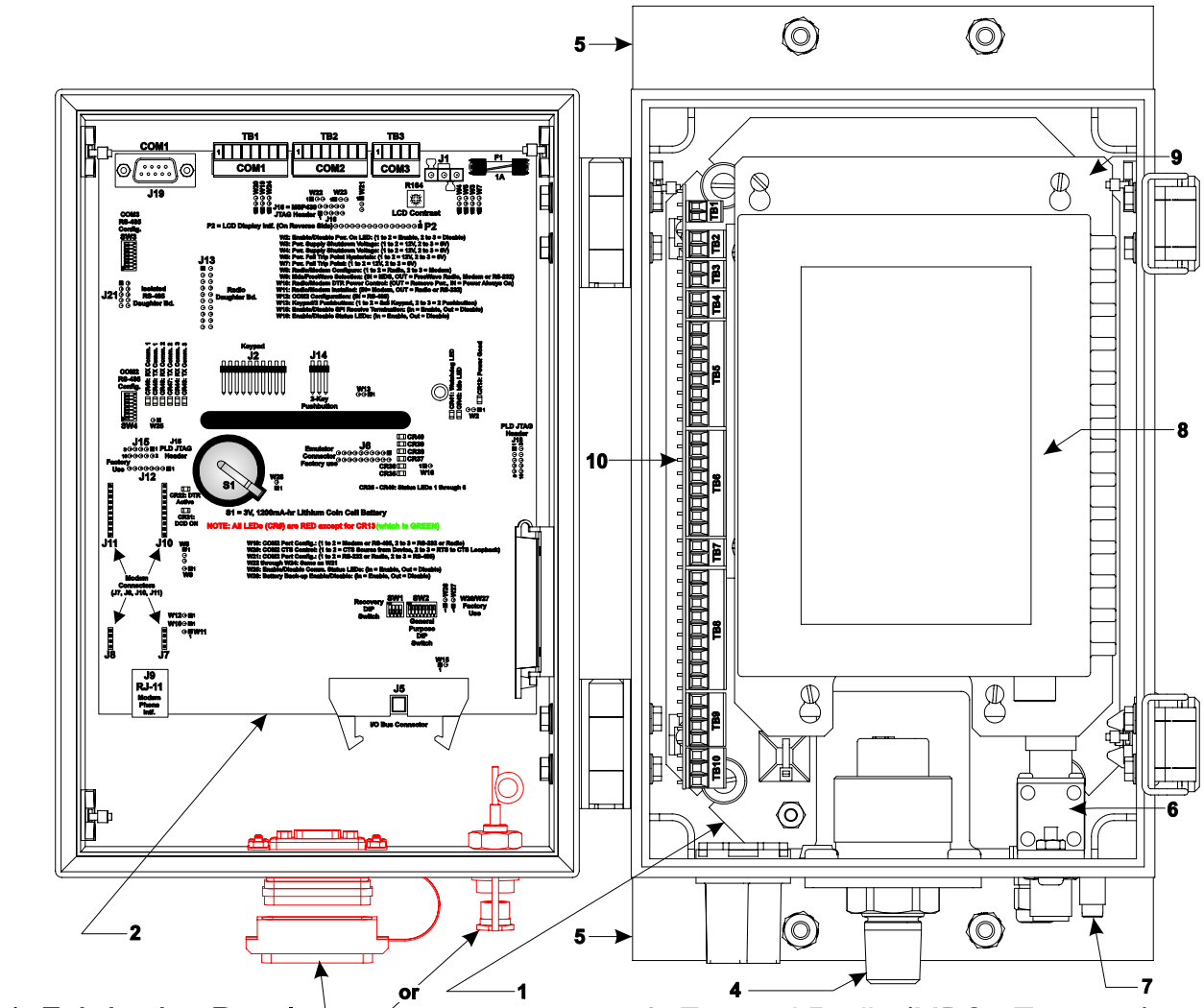


Figure 2-1B - GPT Equipped ControlWave GFC-CL (with MDS - Transnet Radio)

Dimensional drawings of the NEMA Enclosures are provided at the end of Chapter 4.

2.2 SITE LOCATION CONSIDERATIONS

Check all clearances when choosing an installation site. Make sure that the **Control**Wave **GFC-CL** Instrument Front Cover (hinged on the left side) can be opened for wiring and service. Make sure that the LCD/Keypad is visible and accessible to the on-site operator. There should also be clearance for the optional Solar Panel (if required). The enclosed unit measures 11.73" in height by 9.08" in width by 7.44" in depth (without the mounting brackets). A Gage Pressure Transducer adds approximately 1.60" to the height of the unit while a Multivariable Transducer adds 2.80" to the height of the unit.

Information on mounting the **Control**Wave **GFC-CL** assembly at an installation site is provided in Section 2.3.1 Mounting the **Control**Wave **GFC-CL** Enclosure.

2.2.1 Temperature & Humidity Limits

ControlWave **GFC-CL** gas flow computers have been designed to operate over a -40°F to +158°F (-40°C to +70°C) temperature range (with storage at up to +185°F (+85°C)) and a 0% to 95% Relative Humidity range. Make sure that the ambient temperature and humidity at the measuring site remains within these limits. Operation beyond these ranges could cause output errors and erratic performance. Prolonged operation under extreme conditions could also result in failure of the unit.

2.2.2 Vibration Limits

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

2.3 **Control**Wave **GFC-CL INSTALLATION/CONIGURATION**

ControlWave **GFC-CL** gas flow computers are shipped from the factory with all components (wired and mounted) except for the unit's Solar Panel and Battery; these items are shipped separately.

Overview of Configuration

An overview of the seven main configuration steps are provided herein.

Step 1. Hardware Configuration

This involves unpacking the **Control**Wave **GFC-CL** hardware, mounting the enclosure, wiring I/O terminations, connecting any permanent communication cables, making proper ground connections, connecting a communication cable to a PC workstation, setting switches and setting jumpers. To install and configure the **Control**Wave **GFC-CL**, follow Hardware Configuration steps 1 through 10 below:

1. Remove the unit from its carton and install it at the assigned work site (see Section 2.3.1). Dimensions are provided in Section 4.6 of this manual.
2. Remove the Battery Charger and I/O Board Assembly and after configuring its jumpers, install it into the **Control**Wave **GFC-CL** Enclosure (see Section 2.3.2).
3. Make sure that the Lithium Backup Battery has been enabled, i.e., Backup Battery Jumper W28 on the CPU/System Controller Assembly (on the inside of the Instrument Front Cover) should be installed (on its jumper posts). Configure the CPU/System Controller Board DIP-Switches and Jumpers (see Section 2.3.8).
4. Configure/Connect appropriate communication port(s) (see Section 2.3.3.2). Connect COMM. Port 1 (Local Port) or 2 of the **Control**Wave **GFC-CL** (depending on CPU/System Controller Board Switch SW2 settings - see Section 2.3.3.1) to a Communication Port of a PC (typically PC COMM. Port 1). *Note: Also see Section 2.4.4.*
5. Install I/O wiring to the Battery Charger and I/O Board (see Section 2.3.4). Install a communications cable to a Model 3808 Transmitter if required (see Section 2.3.6).

6. Install a ground wire between the Enclosure's Ground Lug and a known good Earth Ground (see Section 2.3.7.5).
7. If required, install the RTD Probe (see Section 2.3.5).
8. Install the Rechargeable Battery and Solar Panel (if provided) (see Sections (2.3.7 through 2.3.7.3.2).
9. Connect DC Power wiring to the **Control**Wave **GFC-CL** Battery Charger and I/O Board (see Sections 2.3.7.1 & 2.3.7.2).
10. Apply power to the **Control**Wave **GFC-CL**. Now continue with Steps 2 through 7 below (and Section 2.4.1) and the **Control**Wave **GFC-CL** will be ready for on line operation.

Step 2. Software Installation on the PC Workstation

ControlWave **Designer** software will have to be installed on the PC if the **Control**Wave **GFC-CL** is being utilized in an application other than that supported by the standard load. This is accomplished by installing the **Control**Wave **Designer Package** from the Open BSI CD ROM.

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

If you have an older version of ControlWave Designer already installed:

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

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

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

Communications must be established with the **Control**Wave **GFC-CL** using either LocalView or NetView.

The **Control**Wave **GFC-CL** ships from the factory with a default Flash configuration. Most users will need to edit this configuration to set the IP address (if using PPP), BSAP local address, user accounts, and port parameters. This can be done in one of two ways:

- Either open the supplied Flash Configuration Profile (FCP) file and modify it, directly in the Flash Configuration Utility, or in a text editor,
- Or retrieve existing Flash Parameters directly from the unit, and edit them in the Flash Configuration Utility.

Detailed information on the Flash Configuration Utility, and LocalView is included in Chapter 5 of the *Open BSI Utilities Manual* (document # D5081). NetView is described in Chapter 6 of that same manual.

Step 4. Modification of the Application-Specific Control Strategy (OPTIONAL)

ControlWave **GFC-CL** gas flow computers are shipped with the GFC program already loaded. However, you can create your own application-specific control strategy using **Control**Wave Designer. This involves opening a new project using the 'CWMicro' template, defining I/O points using the I/O Configurator, and creating a program using one or more of the five supported IEC 61131 languages (FBD, ST, SFC, LD, or IL). Some of these languages are text based, others use graphical diagrams. The choice is up to you, depending upon your particular application.

The ***Control****Wave* ***MICRO*** *Quick Setup Guide* (document # D5124) includes a simple LD example. Additional examples are included in the manual, *Getting Started with* ***Control****Wave Designer* (document # D5085). More detailed information about **Control**Wave Designer and IEC 61131 is included in the ***Control****Wave Designer Reference Manual* (document # D5088).

The ACCOL3 Firmware Library, which is automatically accessible through the template referenced above, includes a series of function blocks which perform a variety of process control and communication functions. These can be included within your program to perform various duties including PID control, alarming, calculations, etc. Detailed information about each function block is included in the **Control**Wave Designer on-line help files.

On the variables declaration page(s) in **Control**Wave Designer, you will need to mark any variable you want to make accessible to external programs, such as Open BSI's DataView utility, as **"PDD"**. Similarly, any variables which should be collected into a database, or exported using the OLE for Process Control (OPC) Server must be marked as **"OPC."** Variables marked as OPC can be built into a text file by the **OpenBSI Signal Extractor.** The text file can then be used in the creation of a database for human machine interface (HMI) software such as OpenEnterprise or Iconics' Genesis. These HMI software packages require that the **"Datatype conversion enable"** option be selected when generating the file using Signal Extractor. Information about the OpenBSI Signal Extractor is included in Chapter 12 of the *Open BSI Utilities Manual* (document # D5081).

Once the program has been created, it is assigned to an executable task. The entire project is then saved and compiled.

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

NOTE: If you modify the standard GFC-CL program, you may need to modify the standard web pages associated with it. (See Step 5, below).

Step 5. Use Standard Web Pages Provided to Select Options in the Standard Control Strategy or Create Your Own Application-Specific Web Pages

The **Control**Wave **GFC-CL** has a standard set of web pages for configuration purposes (stored on a PC) that lets you enter parameters, and configuration options for the standard GFC program (see Step 4, above). If you modify the standard GFC program, you may need to modify the standard web pages. If you create your own application program (instead of

using the standard one), you may create your own web pages using Bristol ActiveX controls discussed in the *Web_BSI Manual* (document # D5087).

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

Step 6. Create an Open BSI Network Containing the ControlWave GFC-CL, or ADD the Control Wave **GFC-CL to an Existing Open BSI Network**

In order for the **Control**Wave **GFC-CL** unit to function as part of a Bristol network, it is necessary to include it in the Bristol network.

If no Bristol network exists:

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

If a Bristol network already exists:

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

Step 7. If applicable, download new or modified control strategy (OPTIONAL)

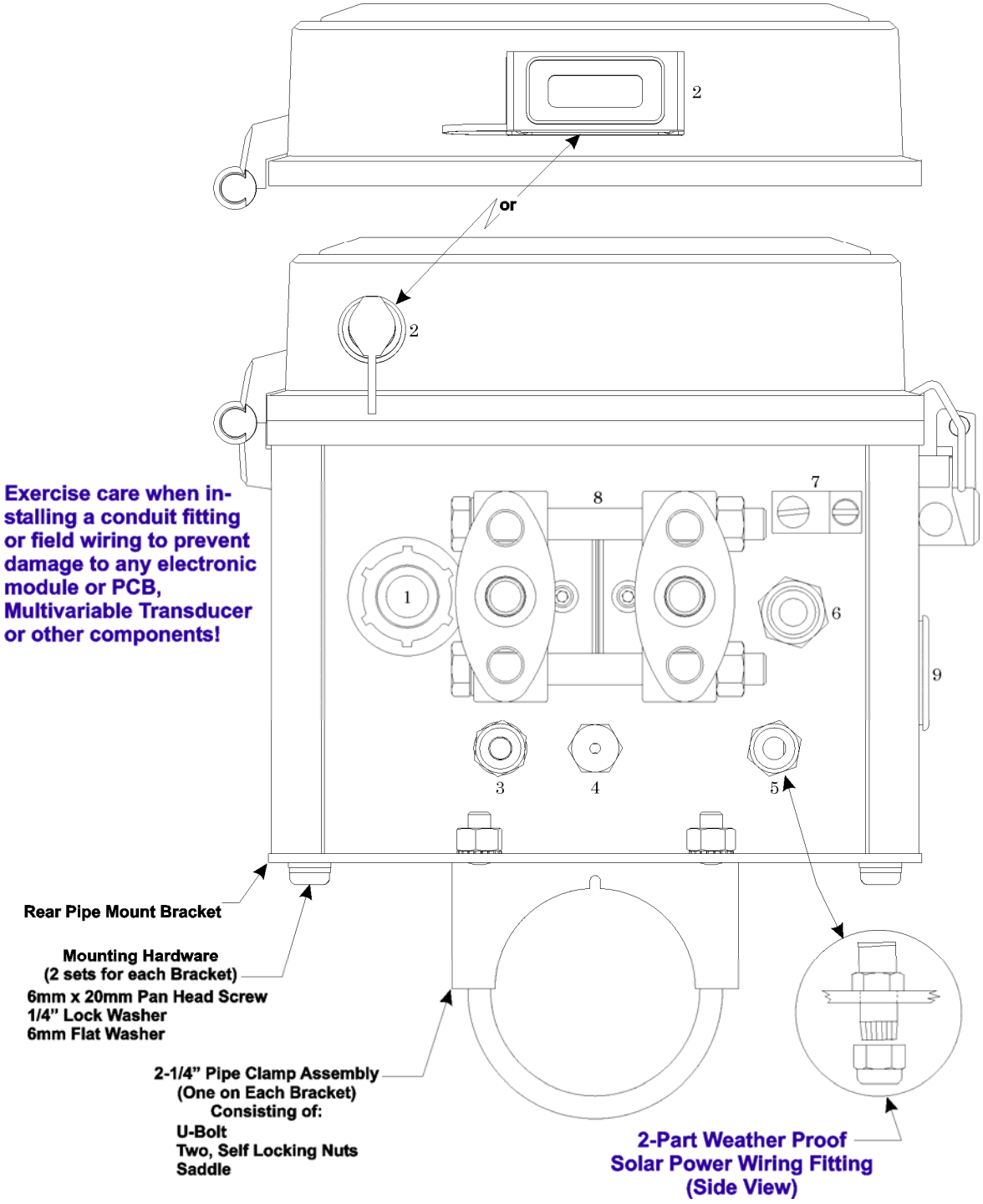
If you modified the standard GFC program, or substituted your own program, compile and download the new or modified program into the unit, using either ControlWave Designer, or the Open BSI 1131 Downloader. In this case, you download the control strategy into the BOOT project area of FLASH memory; this ensures that if the **Control**Wave **GFC-CL** is reset, or if there has been a failure of the backup battery, the control strategy can be restarted from the beginning, i.e. from the BOOT project in FLASH memory. To download the project, see Section 2.4.1.

2.3.1 Mounting the Control**Wave GFC-CL Enclosure**

When mounting one of these units, it is to be positioned in accordance with the following restrictions:

- The unit is to be positioned vertically with the Transducer (MVT or GPT) at its base. Only units equipped with a Multivariable Transducer may be mounted directly to the 'Main' (meter run) (utilizing a Process Manifold – see Figure 2-5) or they can be mounted remotely to a panel or wall or to a vertical 2" pipe (clamed at the rear of the unit via two clamps and four bolts – see Figures 2-3 and 2-6). Units equipped with a Gage Pressure Transducer can ONLY be mounted remotely to a panel or wall or to a vertical 2" pipe (clamed at the rear of the unit via two clamps and four bolts – see Figure 2-3). If used, the 2" pipe is to be anchored in cement (deep enough to conform to local building codes associated with frost considerations). The basic unit measures 11.73" in height by 9.08" in width by 7.44"in depth (without the mounting brackets). A

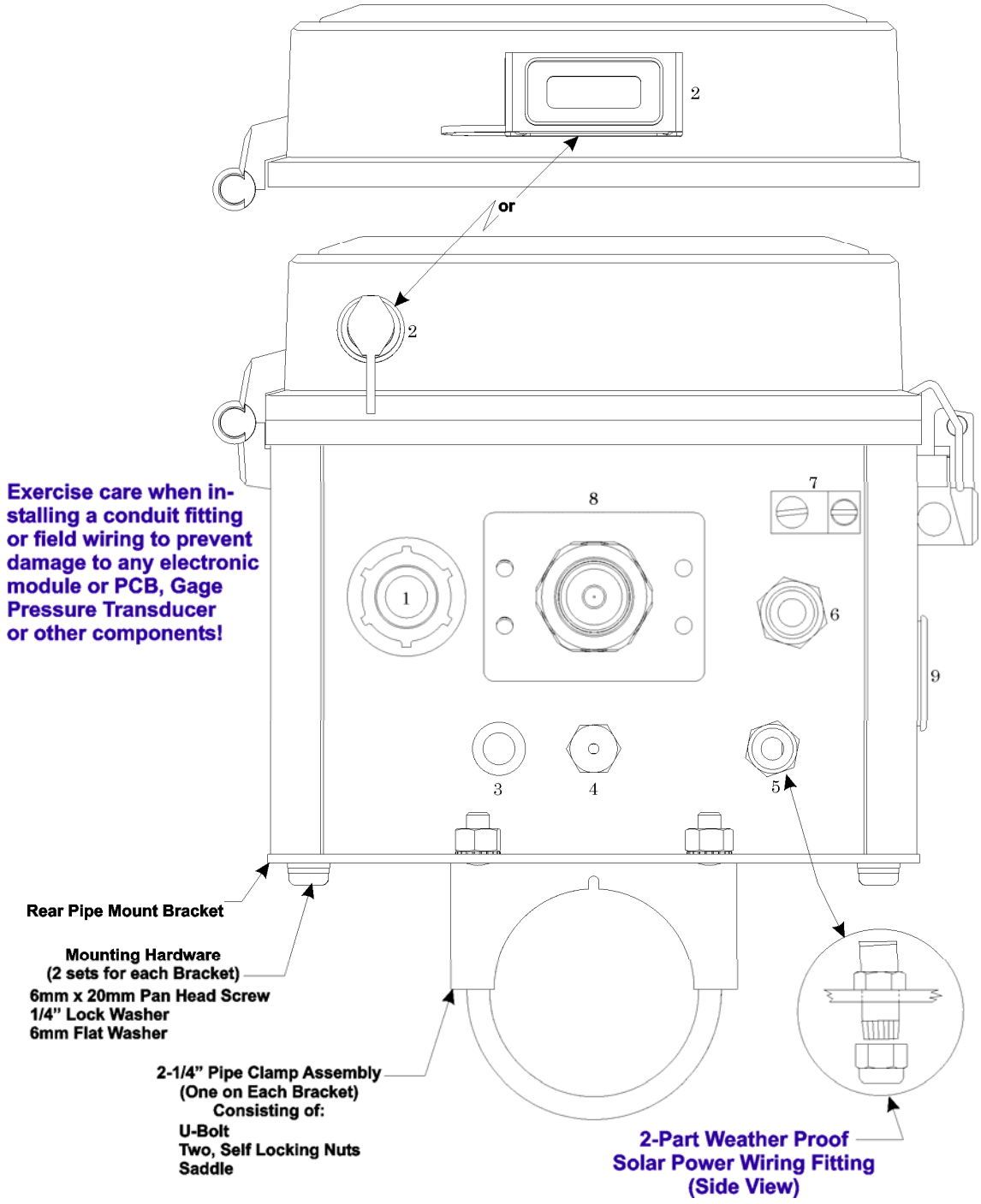
GPT Transducer adds approximately 1.60" to the height of the unit while a Multivariable Transducer adds 2.80" to the unit's height. **Note: Units equipped with a Gage Pressure Transducer CANNOT be directly mounted to the 'Main' (meter run).**



(1) .5" Conduit Fitting - I/O wires
(2) Local Port Connector
(3) RTD Cable Assembly or Sealing Plug
(4) Battery Ventilation Assembly
(5) Solar Pwr. Cable, Ext. Pwr. Cable, or Plug
(6) Ant. Cable, Polyphaser, or Plug
(7) Solderless Ground Lug
(8) Multivariable Transducer
(9) .880" hole for .75" Conduit Fitting (Plugged)

Figure 2-2A - ControlWave GFC-CL Bottom View (Shown with MVT)

- The Multivariable Transducer (MVT) is bolted to a process manifold which in-turn is connected to the main (meter run) directly or via two pipes (see Figures 2-5 - 2-7).
- The unit must be positioned so that the front of the assembly is visible and the unit is accessible for service, i.e., installing an option or replacement of the Lithium Battery, or installation/removal of any **Control**Wave **GFC-CL** Module.



(1) .5" Conduit Fitting - I/O wires
(2) Local Port Connector
(3) RTD Cable Assembly or Sealing Plug
(4) Battery Ventilation Assembly
(6) Solar Pwr. Cable, Ext. Pwr. Cable, or Plug
(6) Ant. Cable, Polyphaser, or Plug
(8) Solderless Ground Lug
(8) Gage Pressure Transducer
(9) .880" hole for .75" Conduit Fitting (Plugged)

Figure 2-2B - Control Wave **GFC-CL Bottom View (Shown with GPT)**

- Make certain that the LCD Display/Keypad is accessible and visible to the on-site operator.
- There should be clearance for the optional Solar Panel (if required) (the Solar Panel may be mounted to the same 2" pipe that secures the unit.
- Power wiring should not be installed until the unit has been mounted and grounded at a designated work site.
- I/O wiring, external power wiring, RTD cabling, local comm. port, antenna cable, and network (RS-232 and RS-485) comm. port cabling enter the bottom of the unit though conduit or special function fittings. I/O wiring may be routed through the left side of the unit (right when facing the front) in lieu of the bottom. This requires that the left side hole plug be removed and replaced with a 1/2" Conduit Fitting (swapped out from the bottom of the unit).

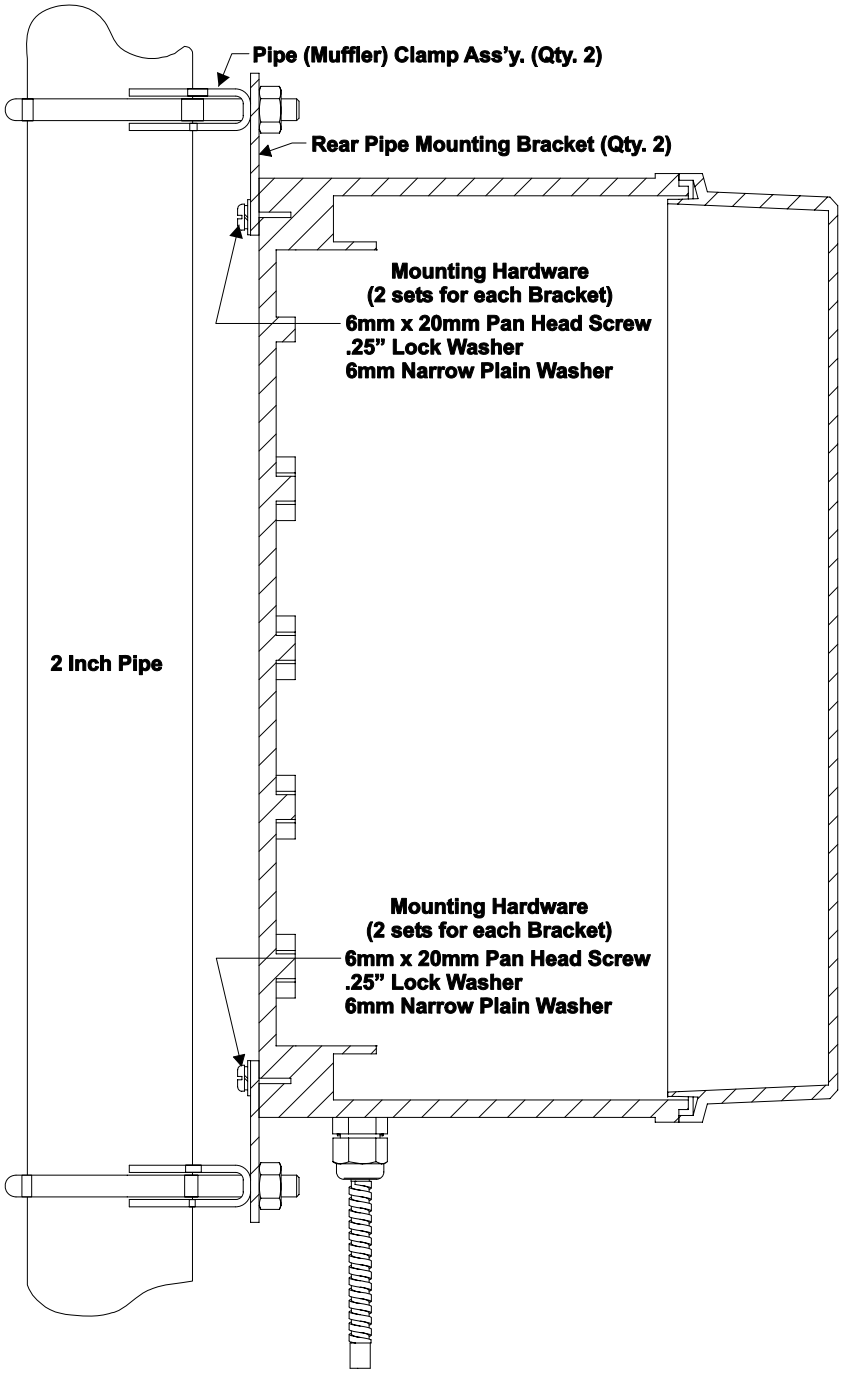


Figure 2-3 - Side View of ControlWave GFC-CL Mounted to a 2" Pipe

2.3.1.1 Connection to the Multivariable Transducer (MVT)

One optional Multivariable Transducer (MVT) (secured to the bottom of the enclosure) can be provided with each **Control**Wave **GFC-CL**. 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. Both arrangements are described as follows:

Standard Process Flange. Two process flanges containing the connection ports are assembled to the transmitter. Port designations (L and H) are stamped on the body of the flanges. Ports accept 1/4-18 NPT pipe connections on 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.

The two process flange assemblies are held in place by four bolts and nuts. When the bolts are removed, the flanges can be repositioned so that the connections can emanate from the front, rear or bottom of the transmitter. Care should be taken not to damage the sensor module assembly during this procedure. Once the flange has been positioned, the bolts should be tightened in an alternating sequence to about 20-30 foot-pounds of torque.

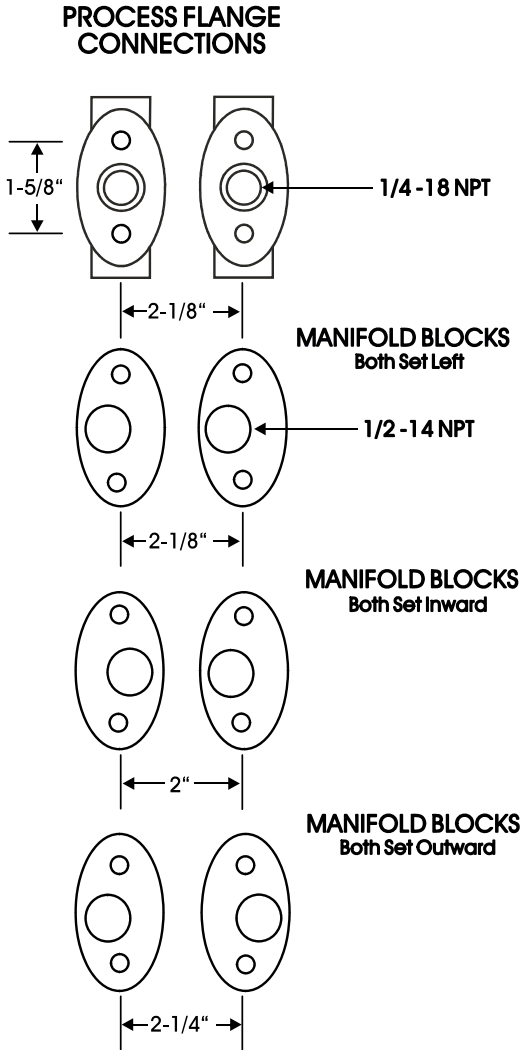


Figure 2-4 - Process Flange and Optional Manifold Block Connectors

Optional Process Manifold Blocks: Process manifold blocks may be installed on the transmitter 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 2-4.

MVT Interface Cable: An interface, connected to the top of the MVT, is factory connected to Connector P2 near the bottom of the Battery Charger & I/O Board. This cable is keyed to simplify installation.

2.3.1.2 Connection to a Gage Pressure Transducer (GPT)

One optional Gage Pressure Transducer (GPT) (secured to the bottom of the enclosure) can be provided with each **Control**Wave **GFC-CL**. Gage Pressure Transducers are equipped with a 1/2-14 NPT male pipe fitting (see Figure 2-3B & 4-5B).

2.3.1.3 Process Pipeline Connection (Meter Runs without Cathodic Protection)

ControlWave **GFC-CL**s equipped with an optional Multivariable Transducer (MVT) may be mounted directly on the pipeline or remotely on a vertical stand-alone two-inch pipe or on a wall or panel. **Control**Wave **GFC-CL**s equipped with an optional Gage Pressure Transducer (GPT) may ONLY be mounted remotely, i.e., on a vertical stand-alone two-inch pipe or on a wall or panel. The Earth Ground Cable is to run between the **Control**Wave **GFC-CL**'s Ground Lug and Earth Ground (Rod or Bed) even though **Control**Wave **GFC-CL** units equipped with a MVT or GPT Transducer may be grounded to the pipeline. If any pressure transmitters or pulse transducers are remotely mounted, connect their chassis grounds to the pipeline or earth ground.

2.3.1.4 Process Pipeline Connection (Meter Runs with Cathodic Protection)

Dielectric isolators are available from Bristol Babcock and are always recommended as an *added measure* in isolating the **Control**Wave **GFC-CL** from the pipeline even though the enclosure does provide some galvanic isolation from the pipeline and should not be affected by cathodic protection or other EMF on the pipeline. **Control**Wave **GFC-CL**s equipped with an MVT may be mounted directly on the pipeline (utilizing a manifold block) (see Figure 2-5) or remotely on a vertical stand-alone two-inch pipe (see Figure 2-6). Units equipped with a GPT may only be remotely mounted, i.e., on a vertical 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. An isolation fittings or gasket should be installed between the following connections:

- all conductive tubing that runs between the pipeline and mounting valve manifold and/or the units Multivariable Transducer (MVT)
- all conductive connections or tubing runs between the **Control**Wave **GFC-CL** 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.

Mount the **Control**Wave **GFC-CL**'s enclosure on a stand-alone vertical 2-inch pipe or on a wall or panel or in the case of units equipped with a MVT directly to the pipeline (utilizing a Manifold Bock). The ground conductor connects between the **Control**Wave **GFC-CL**'s 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 mounting

2-inch pipe (when used) is in continuity with the pipeline it may have to be electrically isolated from the ControlWave GFC. Use a strong heat-shrink material such as RAYCHEM WCSM 68/22 EU 3140. This black tubing will easily slip over the 2-inch pipe and then after uniform heating (e.g., with a rose-bud torch) it electrically insulates and increases the strength of the pipe stand. See BBI Specification Summary F1670SS-0a for information on PGI Direct Mount Systems and Manifolds.

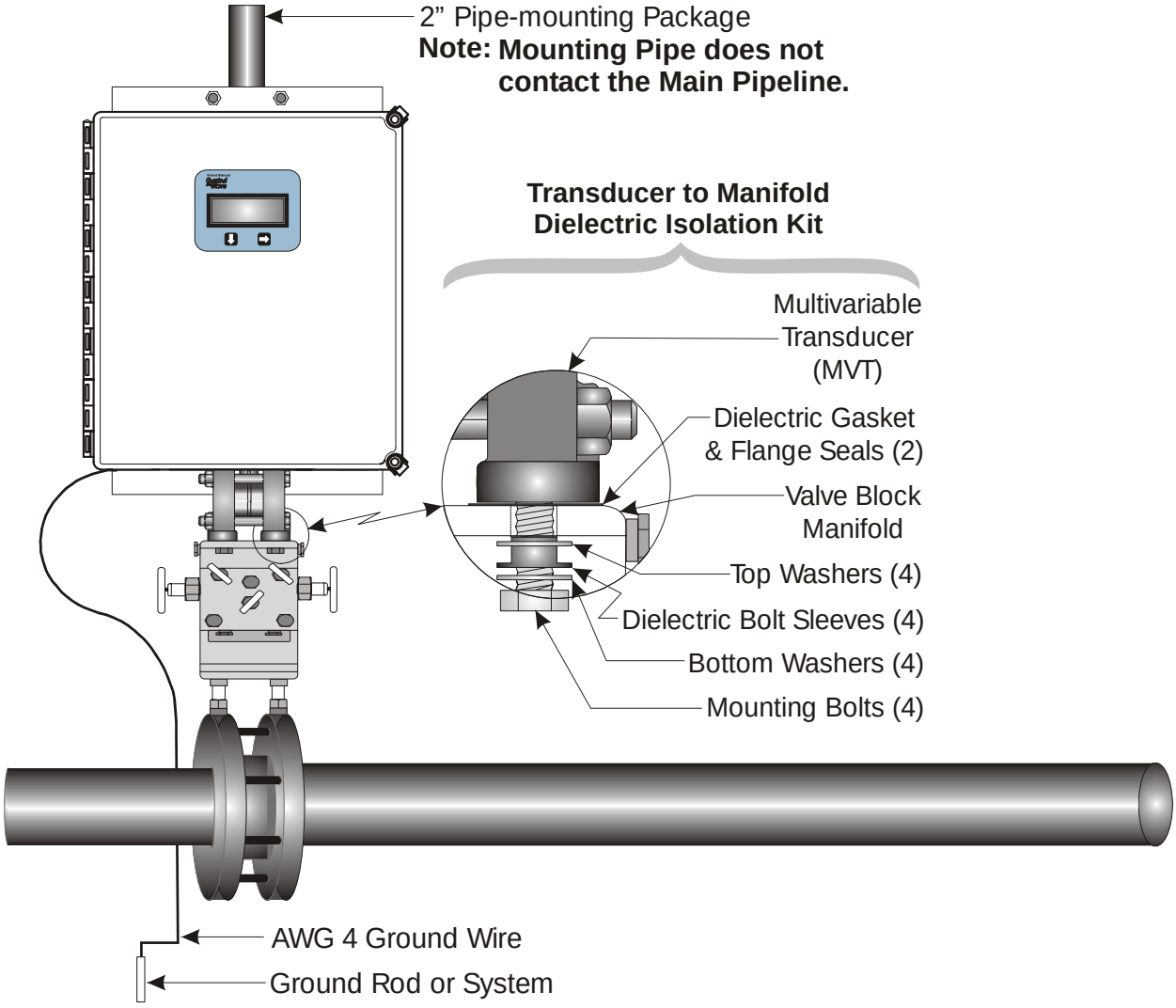


Figure 2-5 - ControlWave EFM (Similar to GFC-CL)
Direct Mount Installation (with Cathodic Protection)

Note: Installation of unit, without Cathodic protection, is similar to that of Figure 2-5 or 2-6 except it doesn't utilize the Transducer to Manifold Dielectric Isolation Kit.

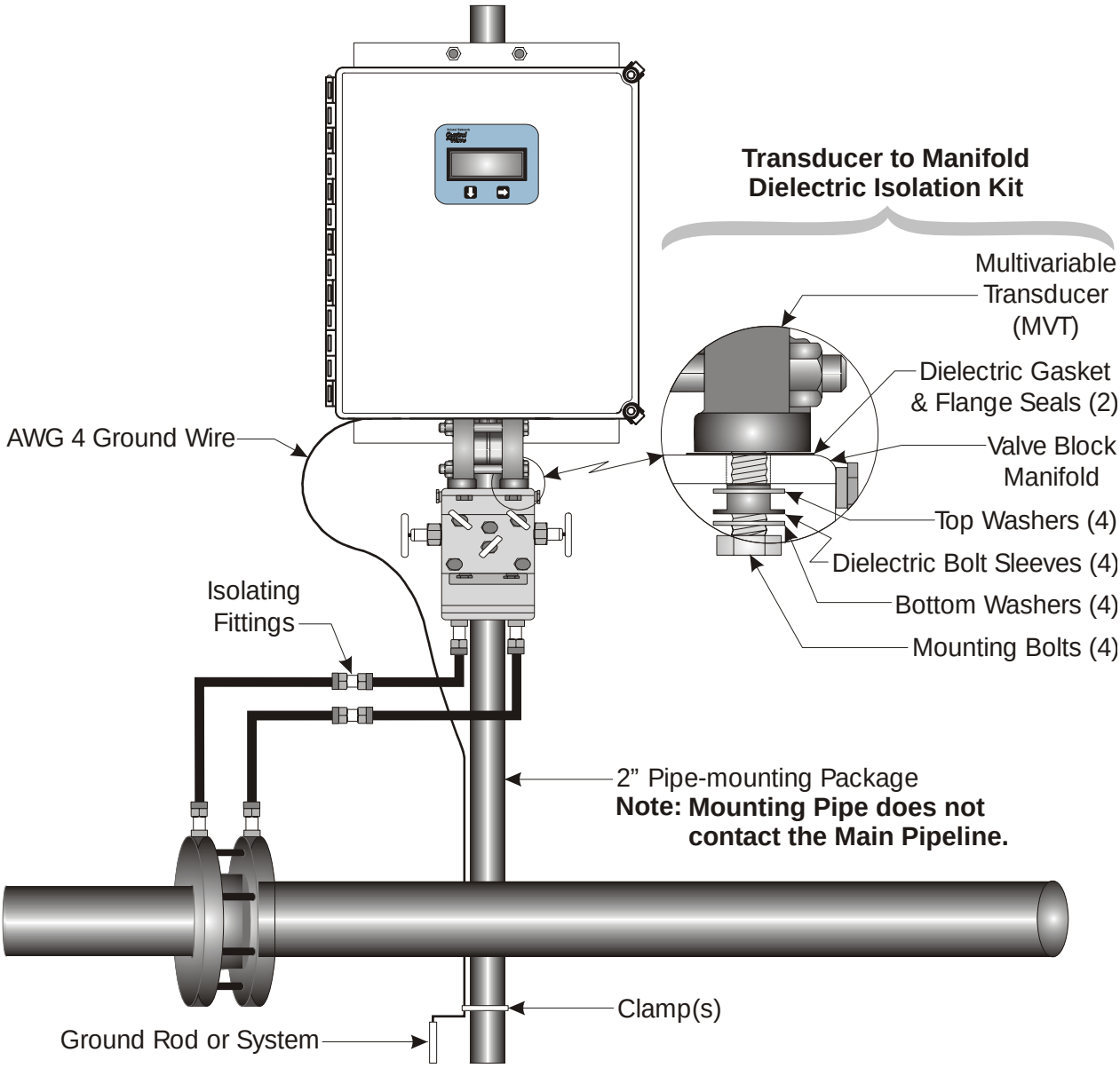


Figure 2-6 - ControlWave EFM (Similar to GFC-CL)
Remote Installation (with Cathodic Protection)

2.3.2 Battery Charger and I/O Board Configuration

Battery Charger and I/O Board jumpers must be set to configure field I/Os, the system power (+24V or EXTPWR) used in conjunction with the Analog Output, and to install/remove the intrinsically safe (IS) Fuse (F5) (see Figure 2-7).

For safety reasons and to prevent accidental damage to a user supplied external bulk DC Power Supply, it is recommended that the pluggable Power Terminal Blocks TB1, TB2 and TB3 on the Battery Charger and I/O Board be disconnected until the entire unit has been wired, and hardware configured. Sections 2.3.7.1 & 2.3.7.2 provide details on DC Power Connector wiring.

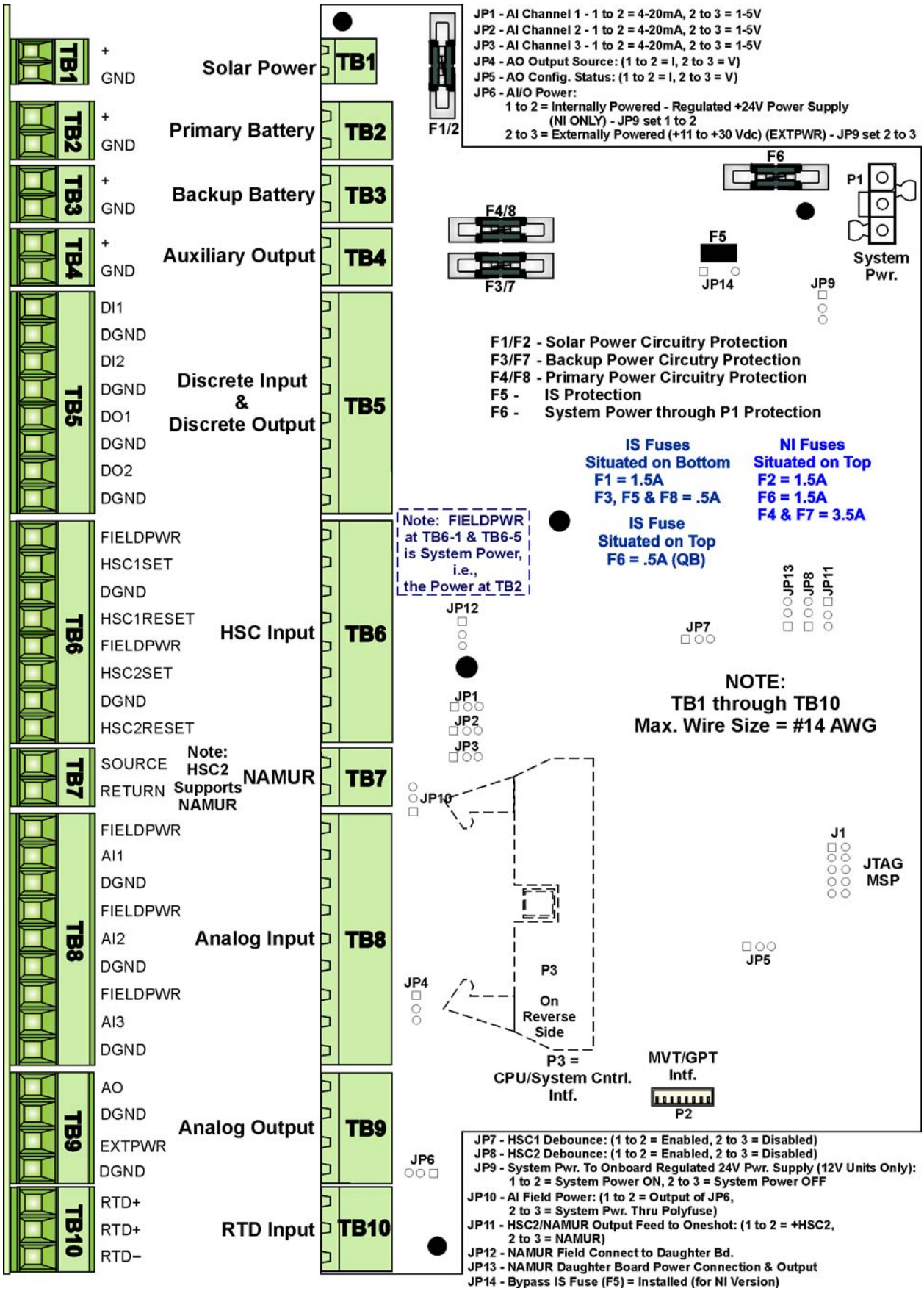


Figure 2-7 - Battery Charger & I/O Board Component Identification Diagram

2.3.3 CPU/System Controller Board Configuration

To configure the CPU/System Controller Board, Jumpers must be set (see Figure 2-8), DIP-Switches must be set (see Section 2.3.3.1) and Communication Ports must be wired (see Sections 2.3.3.2 through 2.3.3.3). The CPU/system Controller Board is situated on the inside of the Instrument Front Cover (see Figure 2-1).

2.3.3.1 CPU/System Controller Board Switch Configuration

ControlWave **GFC-CL** CPU/System Controller Board DIP-Switches must be set for the desired performance options. Tables 2-1, 2-2 and 2-5 provide an overview of switch settings.

SW2-1 set OFF will disable the system from entering a watchdog state when a crash or system hangup occurs. Setting SW2-1 OFF prevents the system from automatically restarting.

SW2-2 set OFF prevents changing the Soft Switches, other configurations and FLASH files, i.e., these items are locked. To change Soft Switch, configuration and FLASH files SW2-2 must be set to the ON position (see Section 2.4.4).

Table 2-1 – CPU/System Controller Bd. Switch SW2 - User Configurations
Note: Except for SW2-4, ON = Factory Default

SW#	Function	Setting - (ON = Factory Default)
SW2-1	Watchdog Enable	ON = Watchdog circuit is Enabled OFF = Watchdog circuit is Disabled
SW2-2	Lock/Unlock Soft Switches	ON = Write to Soft Switches and FLASH files OFF = Soft Switches, configurations and FLASH files are locked
SW2-3	Use/Ignore Soft Switches	ON = Use Soft Switches (configured in FLASH) OFF = Ignore Soft Switch Configuration and use factory defaults
SW2-4	Core Updump See Section 3.6	ON = Core Updump Disabled OFF = Core Updump Enabled via Mode Switch (SW1)
SW2-5	SRAM Control	ON = Retain values in SRAM during restarts OFF = Force system to reinitialize SRAM
SW2-6	System Firmware Load Control *	ON = Enable remote download of System Firmware OFF = Disable remote download of System Firmware
SW2-7	N/A	
SW2-8	Enable WINDIAG	ON = Normal Operation (don't allow WINDIAG to run test) OFF = Disable boot project (allow WINDIAG to run test)

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

SW2-3 set OFF forces the use of Soft Switches as set per factory default (see Section 2.4.4). For use of user defined Soft Switches, SW2-3 must be set to the ON position. *Note: If both SW2-3 and SW2-8 are set OFF (closed), all communication ports will be set to 9600 bps operation.*

SW2-4 set OFF and used in conjunction with Mode Switch (SW1) will cause the **Control**Wave **GFC-CL** to perform a Core Updump (see Section 3.6).

SW2-5 set OFF forces the **Control**Wave **GFC-CL** to reinitialize SRAM when the unit recovers from a low power or power outage condition. When set ON, the contents of SRAM will be retained and utilized when the system restarts. **Note: If the Battery is removed from the CPU Module (CPU removed) CPU should not be installed (and power applied) before one minute has passed unless SW2-5 on the CPU has been set OFF.**

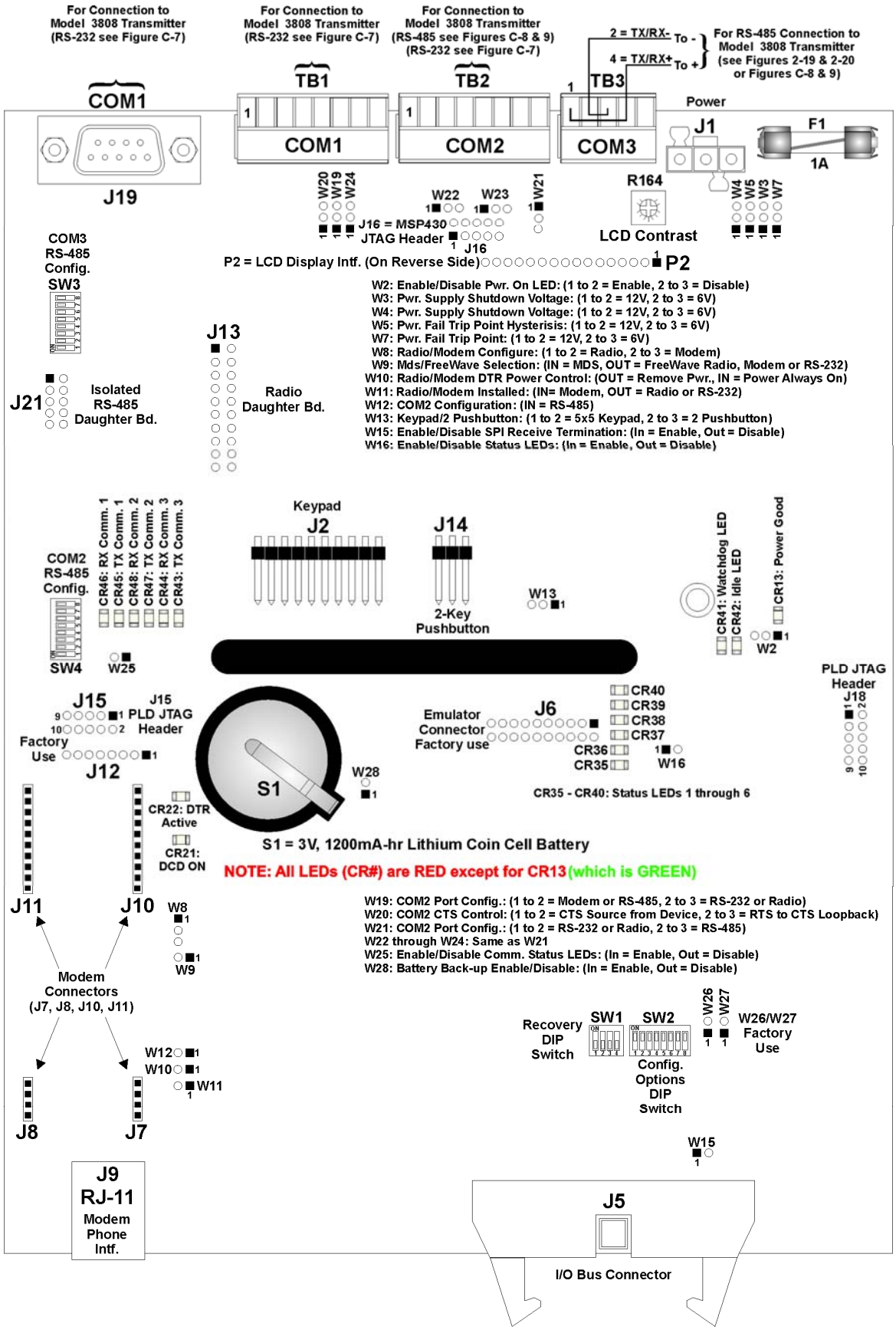


Figure 2-8 - CPU/System Controller Board Component Identification Diagram

SW2-6 set ON will enable the user to perform a remote download of System Firmware (on units equipped with Boot PROM version 4.7 or higher and System PROM version 4.7 or higher).

SW2-8 set OFF prevents the 'Boot Project' from running and places the unit into diagnostic mode. SW2-8 must be set OFF to run the WINDIAG program resident on the local PC (**see Section 3.5**). When SW2-8 has been set ON, diagnostics is disabled. SW2-8 must be set to the ON position for normal system operation, i.e. for the Boot project to run. *Note: If both SW2-3 and SW2-8 are set OFF (closed), all communication ports will be set to 9600 bps operation.*

Table 2-5 in Section 2.3.3.3 provides CPU/System Controller Board Switch SW3 (COM3) and SW4 (COM2) RS-485 communication port settings.

Table 2-2 - CPU/System Controller Bd. Switch SW1
Recovery Mode/Local Mode Control

SWITCH	Function	Setting
SW1-1/2	Recovery/Local Mode *	Both ON or OFF = Recovery Mode SW1 OFF & SW2 ON = Local Mode
SW1-3	Force Recovery Mode *	ON = Force Recovery Mode (via CW Console) OFF = Recovery Mode disabled
SW1-4	Not Used	N/A

*** = Note: Only the Switch SW1 settings listed in this table, have been tested.**

2.3.3.2 Communication Ports

A **Control**Wave **GFC-CL** can be configured as a Master or Slave node on either a MODBUS network or a BSAP network. A variety of communication schemes are available. An optional 56K PSTN Modem and Spread Spectrum Modem (Radio) can be piggy-back mounted on the CPU/System Controller Board. Three communication ports are contained on the standard CPU/System Controller Board. These communication ports are designated as follows:

CPU/System Controller Board:
COM1 - Port 1: J19 (9-Pin Male D-Sub), TB1 (8-Pin Term Block) - RS-232 (TB1 is factory connected to the Local Port)
COM2 - Port 2: TB2 (8-Pin Term. Block) RS-232/RS-485 - RS-485 Configured by SW4 (COM2 supports an Internal or External Modem or Radio option)
COM3 - Port 3: TB3 (5-Pin Term. Block) RS-485 - Configured by SW3

COM1 is also available as the Local Port. This is accomplished via either a 9-pin D-Type male connector or a circular 5-pin female connector. The Local Port is located on the bottom of the Instrument Front Cover.

Communication Ports COM1, COM2 and COM3 support serial asynchronous operation as listed above. Any communication port (COM1, COM2 or COM3) can be configured for local communications, i.e., connected to a PC loaded with **Control**Wave Designer and OpenBSI software.

Diagram of RS-232/485 interfaces and connectors are shown in Figures 2-9 through 2-11B. Hardware connector pin wiring assignments are provided in Tables 2-3A and 2-3B.

2.3.3.3 RS-232 & RS-485 Interfaces

ControlWave **GFC-CL** RS-232 & RS-485 communication schemes are discussed herein.

RS-232 Ports
An RS-232 interface supports Point to Point, half-duplex and full-duplex communications (20 feet maximum, using data quality cable). Half-duplex communications supported by the **Control**Wave **GFC-CL** utilize MODBUS or BSAP protocol, while full-duplex is supported by the Point to Point (PPP) protocol. **Control**Wave **GFC-CL** RS-232 ports utilize a "null modem" cable (Figure 2-10A - Top) to interconnect with other devices such as a PC, printer, another **Control**Wave series unit, when the **Control**Wave **GFC-CL** is communicating using the full-duplex PPP protocol. A half-duplex cable (Figures 2-10A - Bottom) is utilized when the **Control**Wave **GFC-CL** is connected to any **Control**Wave series or to another **Control**Wave **GFC-C**. If communicating with a Bristol series 3305, 3310, 3330 or 3335 RTU/DPC, one of the cables shown in Figure 2-10B must be used. Refer to Figure 2-10C to connect **Control**Wave **GFC-CL** serial RS-232 port COM2 to either an external modem or external radio. When interfacing to Port COM3 of a **Control**Wave unit, or to COM5 or COM6 of a **Control**Wave**EXP**, the cable of Figure 2-10D must be used along with the one of Figure 2-10A or 2-10B.

Illustrations of the Local Communication Port cable connections (Communication Port 1) are provided in Figures 2-11A and 2-11B.

An illustration of the CPU/System Controller Module's male 9-pin D-type connectors is provided in Figure 2-9. Table 2-3A provides the connector pin assignments for ports COM1 and COM2 while Table 2-3B provides connector pin assignments for ports COM3.

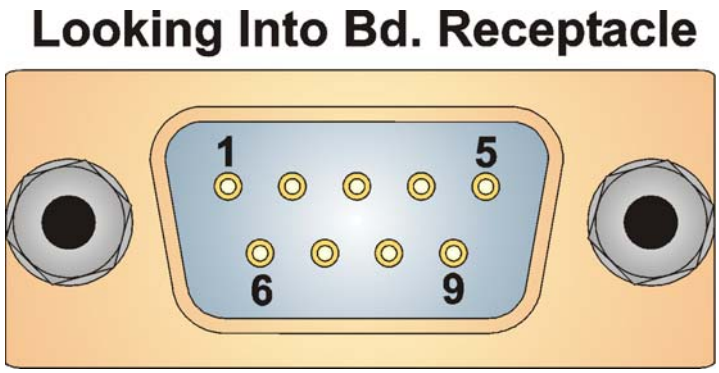


Figure 2-9 - Male DB9 9-Pin Connector Associated with COM1

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

- DCD must be high to transmit (except when dialing a modem)
- Each RS-232 transceiver has one active receiver while in power down mode (disabled); the DCD signal is connected to the active receiver.
- CTS must be high to transmit.
- When port is set for full-duplex operation - RTS is always ON.
- DTR is always high (when port is active); DTR enables RS-232 Transceivers.
- When port is set for half-duplex operation - CTS must go low after RTS goes low.
- All RS-232 Comm. ports support RTS, DTR, CTS, DCD and DSR control signals.
- All RS-232 Comm. port I/O signals are protected by LCDA12C surge protectors to ±4KV ESD.

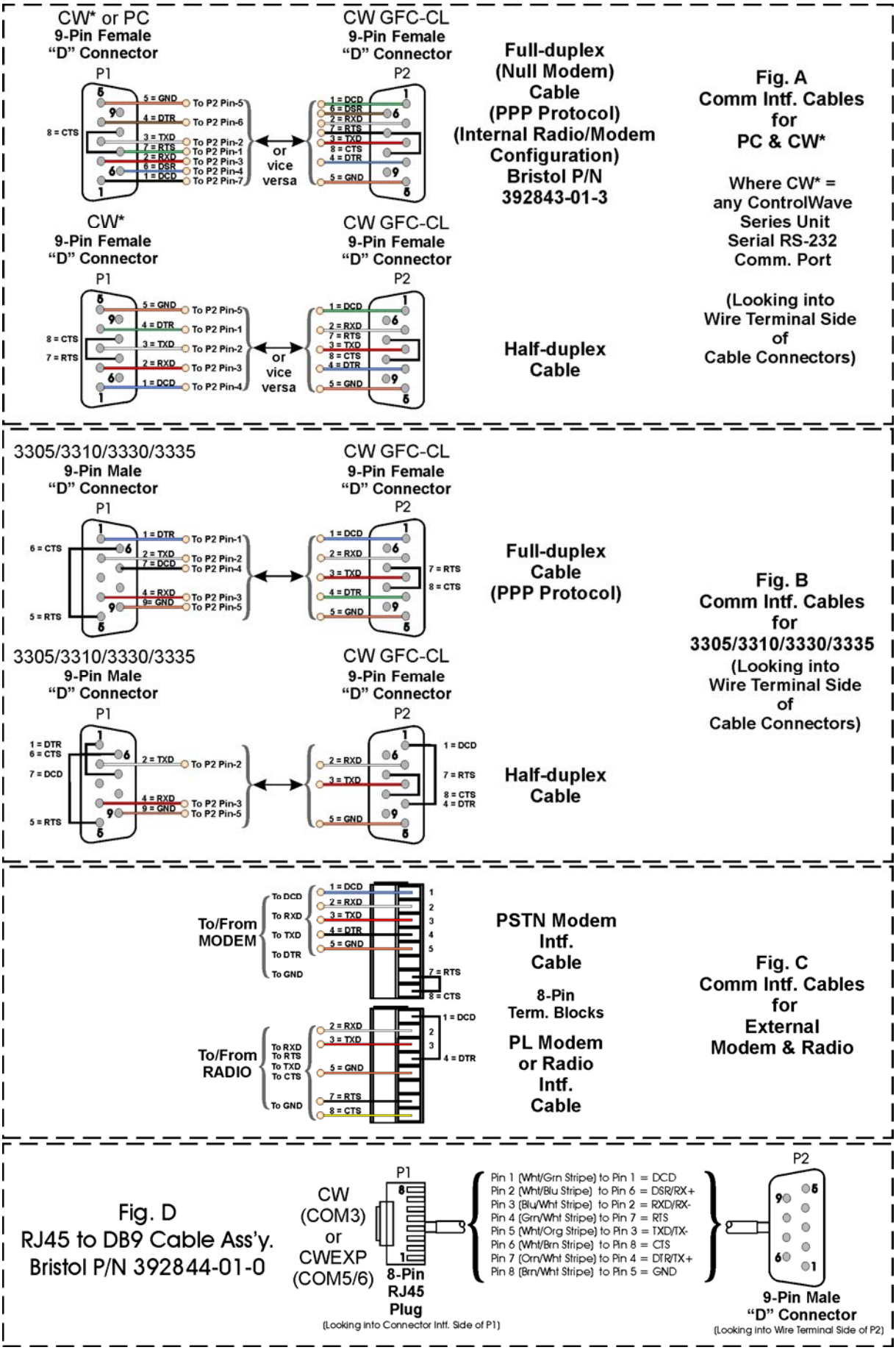


Figure 2-10 - Communication Ports – CPU Board RS-232 Cable Wiring Diagram

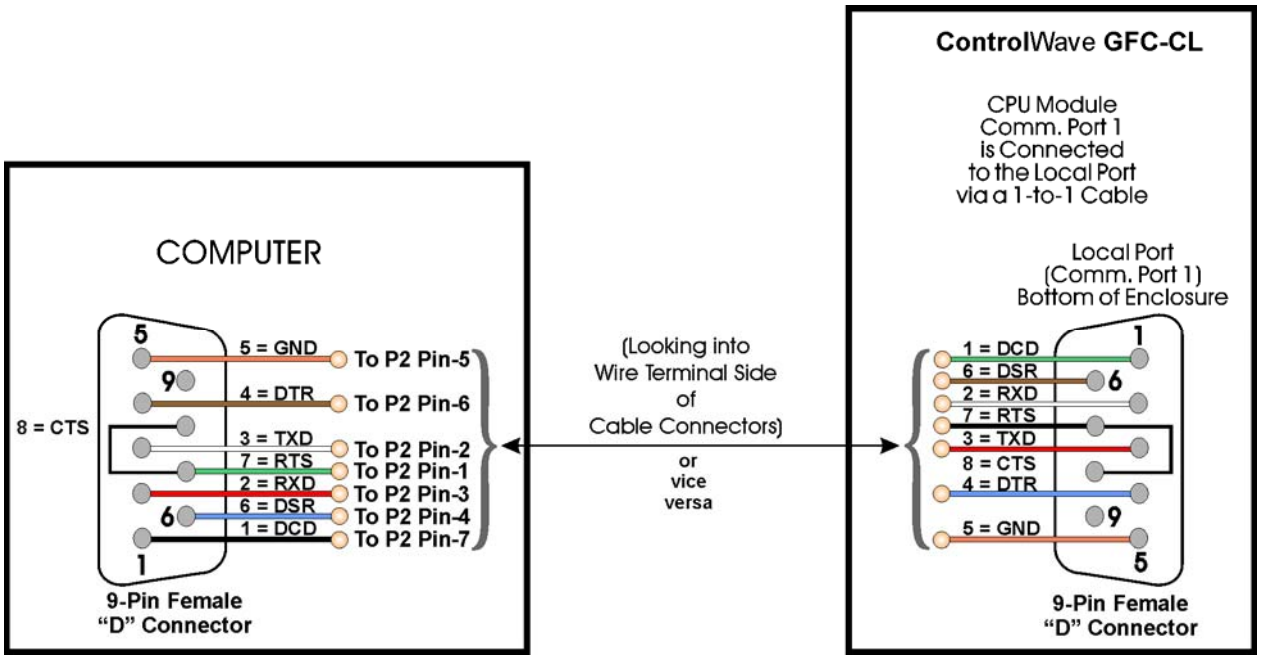


Figure 2-11A - PC Connected to CW GFC-CL via Local Port (D-Type Version)
(Use Null Modem Cable - Bristol Part Number 392843-01-3)

Table 2-3A1 - RS-232 Ports (COM1 & 2) and RS-485 Ports (COM2) Connector Pin Assignments (All COM1 Connectors, i.e., D-Type Local Port, J19 & TB1 and COM2 Connector TB2)

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

Table 2-3A2 - RS-232 Port (COM1) Connector Pin Assignments (COM1 Connectors, i.e., Circular Type Local Port & TB1)

Pin #	Signal RS-232	Description: RS-232 Signals	Local Port RS-232 Pin #
1	DCD	Data Carrier Detect Input	
2	RXD	Receive Data Input	7 (WHT Wire)
3	TXD	Transmit Data Output	2 (RED Wire)
4	DTR	Data Terminal Ready Output	
5	GND	Power Ground	6 (BLK Wire)
6	DSR	Data Set Ready Input	
7	RTS	Request To Send Output	*
8	CTS	Clear To Send Input	*

* RTS connected to CTS at TB1 of CPU for Local Port Comm. Cable

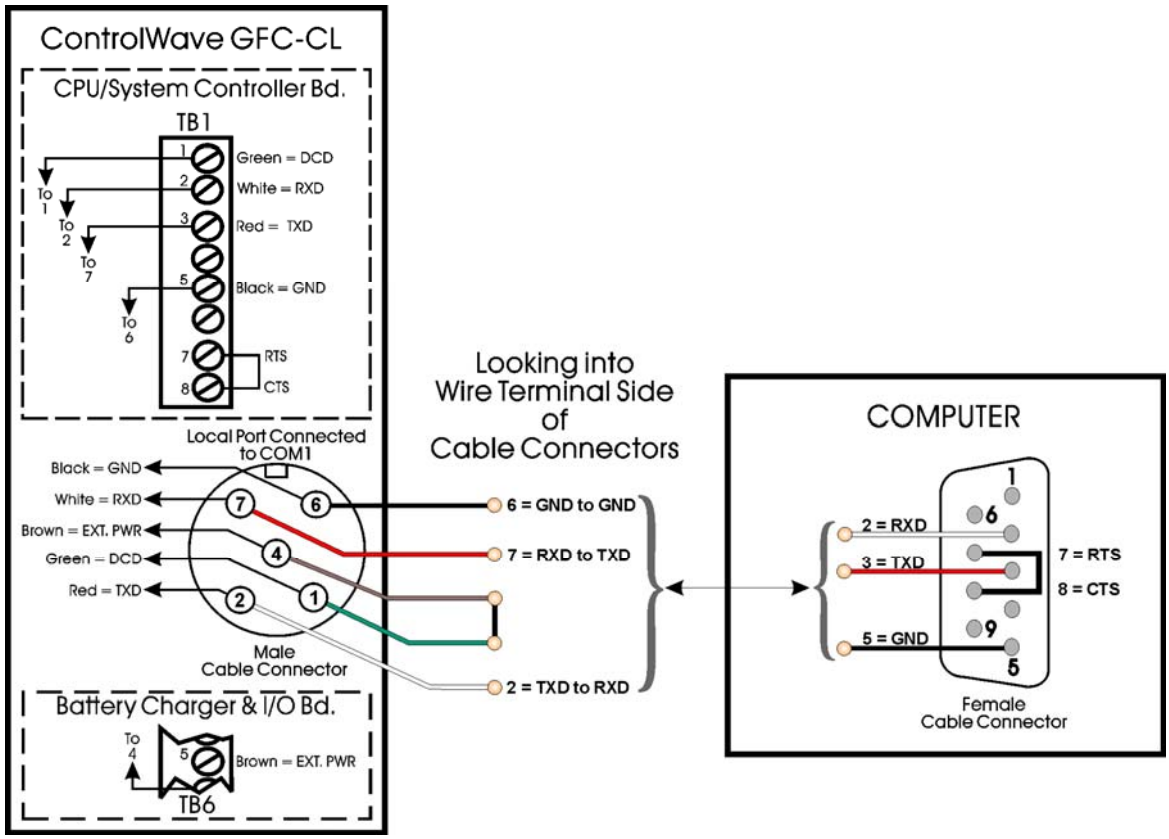


Figure 2-11B - PC Connected to ControlWave GFC-CL via Local Port (Circular Port Version)
Bristol Cable Part Number 395402-01-8 = 10 Foot Comm. Cable
Bristol Cable Part Number 395402-02-6 = 25 Foot Comm. Cable

Table 2-3B - RS-485 Port (COM3)
Connector Pin Assignments (TB3)

Pin #	Signal RS-485	Description: RS-485 Signals
1	RXD+	Receive Data + Input
2	RXD–	Receive Date – Input
3	TXD–	Transmit Data – Output
4	TXD+	Transmit Data + Output
5	Power Ground	Ground

RS-485 Ports

ControlWave **GFC-CL** can use an RS-485 communication port for local network communications to multiple nodes up to 4000 feet away. Since this interface is intended for network communications, Table 2-4 provides the appropriate connections for wiring the master, 1st slave, and nth slave. Essentially, the master and the first slave transmit and receive data on opposite lines; all slaves (from the first to the "nth") are paralleled (daisy chained) across the same lines. The master node should be wired to one end of the RS-485 cable run. A 24-gauge paired conductor cable, such as Belden 9843 should be used. *Note: Only half-duplex RS-485 networks are supported.*

Receiver biasing and termination as well as 2-wire or 4-wire selection are enabled by eight-position DIP-Switches situated on the CPU/System Controller Board as follows: COM3: Switch SW3, COM2: Switch SW4.

Table 2-3A provides the connector pin assignments for CPU/System Controller Board port COM2. Table 2-3B provides connector pin assignments for CPU/System Controller Board port COM3. Table 2-5 provides the RS-485 termination and loopback control Switch Settings for the RS-485 Ports.

To ensure that the "Receive Data" lines are in a proper state during inactive transmission periods, certain bias voltage levels must be maintained at the master and most distant slave units (end nodes). These end nodes also require the insertion of 100-Ohm terminating resistors to properly balance the network. Secondary Communication Board switches must be configured at each node to establish proper network performance. This is accomplished by configuring CPU/System Controller Bd. Switch SW3 (COM3) and/or Switch SW4 (COM2) so that the 100-Ohm termination resistors and biasing networks are installed at the end nodes and are removed at all other nodes on the network (see Table 2-5).

Table 2-4 - RS-485 Network Connections
(see Table 2-3A/B **Control**Wave **GFC-CL** RS-485 Port Pin # Assignments)

From Master	To 1st Slave	To nth Slave
TXD+	RXD+	RXD+
TXD–	RXD–	RXD–
RXD+	TXD+	TXD+
RXD–	TXD–	TXD–
GND/ISOGND*	GND/ISOGND*	GND/ISOGND*

* ISOGND with Isolated RS-485 Ports Only!

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

Table 2-5 - CPU/System Controller Bd. Switch SW3/SW4 Assignments
RS-485 Loopback & Termination Control (SW3 for COM3 – SW4 for COM2)

SWITCH #	RS-485 Function Switch ON	Setting
SW3/4-1	TX+ to RX+ Loopback/2-Wire	ON – 2-Wire Operation or Loopback Enabled OFF – 4-Wire Operation & Loopback Disabled
SW3/4-2	TX– to RX– Loopback/2-Wire	ON – 2-Wire Operation or Looback Enabled OFF – 4-Wire Operation & Loopback Disabled
SW3/4-3	100 Ohm RX+ Termination	ON – End Nodes Only
SW3/4-4	100 Ohm RX– Termination	ON – End Nodes Only
SW3-6 (see Note 2)	Slew Rate ISO485 ONLY	ON – Slow Rate Enabled OFF – Fast Rate Enabled
SW3/4-7	RX+ Bias (End Nodes/Node)	ON – 4-Wire = Both End Nodes 2-Wire = One End Node Only OFF = No Bias
SW3/4-8	RX– Bias (End Nodes/Node)	ON – 4-Wire = Both End Nodes 2-Wire = One End Node Only OFF – No Bias

Note 1: Closed = Switch set ON Note 2: Switch SW3-6 (COM3) = N/A

2.3.3.4 Piggy-back Spread Spectrum Modem (Radio) Port (see Appendix D)

An optional Spread Spectrum Modem (Radio) is available on the CPU/System Controller Board and is assigned as COM2. There are two unique radios offered. These radios will only communicate with their own brand of radio, i.e., FreeWave radios are not compatible with

MDS Transnet radios. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the radio at a rate up to 115.2kHz. These radios are supplied in kit form with all the hardware required for user installation onto a CPU/System Controller Board. Figure 2-13 shows both versions of radios mounted on CPU/System Controller Board. A Radio is user installed onto the CPU/System Controller Board (see Figure 2-12) and its associated Port is setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView.

FreeWave® Spread Spectrum Wireless Data Transceiver:
Operates in the 902 to 928 MHz range (20 miles).

Microwave Data System Inc. MDS TransNET OEM™ Spread Spectrum Data Transceiver:
Operates in the 902 to 928 MHz range (20 miles).

Installation steps 1 - 3 below support user installation and configuration of a Radio.

1. Mount the radio (Spread Spectrum Modem) onto the Radio Carrier Board and then mount this combined assembly onto the CPU/System Controller Board. Install the L-shaped Bracket onto the lower right corner of the CPU/System Controller Board. Install one end of the internal coaxial RF cable supplied with the radio in question onto the radio's RF SMA Connector. Connect the other end of the internal coaxial RF cable to the L-shaped Bracket.
2. Install the user supplied coaxial RF cable between the unit's RF antenna cable or Polyphaser and the remote antenna.
3. For **FreeWave Radio**: Follow the Tuning Transceiver Performance" section of the FreeWave Technologies Inc. FreeWave Spread Spectrum Wireless Data Transceiver User Manual to configure the radio.

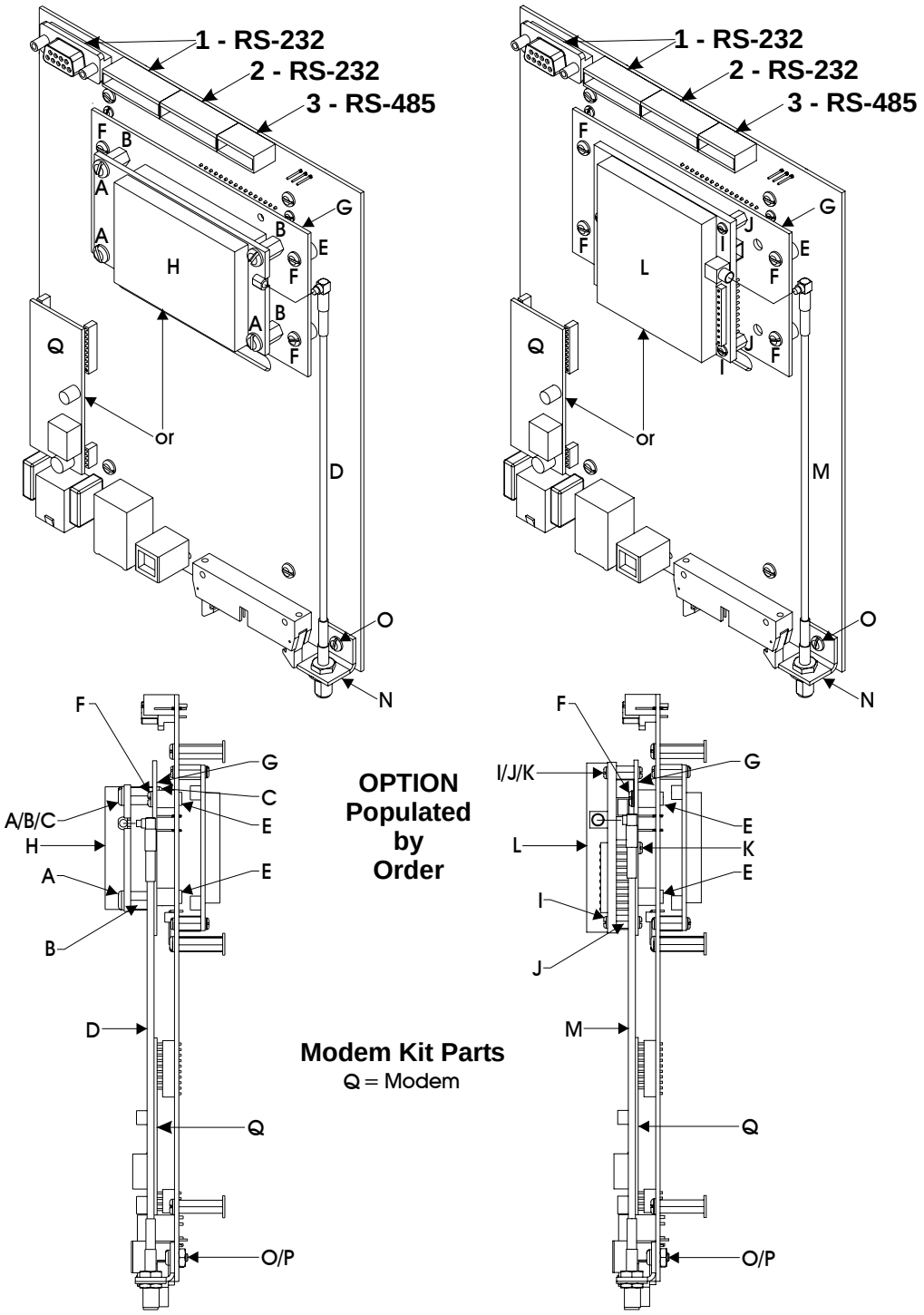
   For **MDS Radio**: Refer to section 3.3 "Initial Power-Up & Configuration" within the MDS TransNet OEM Integration Guide and if necessary for more information on connecting a PC terminal and preparing it for use, refer to section 9.0 "PROGRAMMING REFERENCE."

Note:

Whenever setting any Jumper or connecting/removing a communication cable to/from a PC, power should be turned OFF. To invoke the setup program, connect the radio (via COM1) to a terminal program (such as HyperTerminal) via a null modem cable (see Figure 2-11), put the radio into setup mode and set the parameters for the terminal to those of Table 2-6. The setup program is invoked by connecting Pins 1 and 2 of CPU/System Controller Board Jumper Post W8.

Table 2-6 - Radio Setup Menu Terminal Settings

PARAMETERS	SETTINGS	PARAMETERS	SETTINGS
Baud Rate	19,200	Parity Check	None/Off
Data Rate	8	Carrier Detect	None/Off
Parity	None	Flow Control	Xon/Xoff
Stop Bits	1		



MDS (Transnet) Radio Kit/Option Parts

A = 6-32 x .250 Pan Head Screw (Qty. 4)
B = 6-32 x .313 F/F Standoff (Qty. 4)
C = 6-32 x .188 Pan Head Screw (Qty. 4)
D = Transnet Radio Cable (with Nut and Washer)
E = Swaged Standoff (Qty. 4)
F = 4-40 x .250 Pan Head Screw (Qty. 4)
G = Radio Carrier Board
H = MDS Transnet Radio Module
N = L-shaped Bracket
O = Screw
P = Nut

FreeWave Radio Kit/Option Parts

E = Swaged Standoff (Qty. 4)
F = 4-40 x .250 Pan Head Screw (Qty. 4)
G = Radio Carrier Board
I = 2-56 x 1/4 Pan Head Screw (Qty. 3)
J = 2-56 x .250 F/F Standoff (Qty. 3)
K = 2-56 x .188 Pan Head Screw (Qty. 3)
L = FreeWave Radio Module
M = FreeWave Radio Cable (with Nut & Washer)
N = L-shaped Bracket
O = Screw
P = Nut

Figure 2-12 - CPU/System Controller Board Radio/Modem Installation Diagram

2.3.3.5 Piggy-back 56K PSTN Modem Port (see Appendix D)

An optional 56K PSTN Hayes type Modem can be mounted piggy-back on the CPU/System Controller Board and is assigned to COM2. The Model MT5634SMI Modem module is manufactured by MultiTech System and can be user configured for PSTN operation. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the modem at a rate up to 115.2kHz.

Modems are supplied in kit form with all the hardware required for user installation onto a CPU/System Controller Board. Figure 2-12 shows the modem mounted on the CPU/System Controller Board.

A Modem is installed onto the CPU/System Controller Board (see Figure 2-12) and its associated Port is setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView. A Terminal Emulation program such as HyperTerminal is used to profile the modem via AT commands. Users typically use AT commands only when checking the modem's active or stored profile or when reconfiguring a modem, e.g., to turn auto answer on or off, etc.

The following 7 steps should be taken to configure a MultiTech Modem (this should have been done during factory installation):

- Enable modem setup by setting CPU/System Controller Board jumpers as follows: W8 to 2-3, W11 Installed, W19 to 1 to 2, and for DTR Power Control as follows: W10 Installed = Power Always On
- Connect via HyperTerminal (Parameters = 9600, 8, N, 1, & None) to port COM1 (J19 on the CPU/System Controller Board or the Local Port) using the null modem cable (see Figure 2-11A or 2-12).
- Send Factory Default = AT&W1 ATZ
- Disable Flow Control = AT&K0
- Set Baud using AT Command: AT$SB9600**,** or whatever baud rate you require.
- Write to Memory = AT&W0
- Disable setup mode. Park Jumper W8 (no connection)

After completing the seven configuration steps (if required) use WebBSI to select the "Radio/Modem Control Mode" on the **Radio & Modem Control Configuration** Web page.

Note:

Whenever setting any Jumper or connecting/removing a communication cable to/from a PC, power should be turned OFF. The modem can be reconfigured via AT commands using a terminal program (such as HyperTerminal). Connect Pins 2 and 3 of CPU/System Controller Board Jumper Post W8 via a Suitcase Jumper. Connect the modem (via port COM1) to the PC via a null modem cable (see Figure 2-11).

Publicly Switched Telephone Network (PSTN) Hookup

A PSTN using a master and three remote Process Automation Controllers (each equipped with a PSTN modem) is shown in Figure 2-13. A connection to the PSTN is made using a cable having standard telephone connectors at each end. One end of the cable plugs into CPU/System Controller Board RJ11 connector jack (J9) while the other end plugs into a telephone company RJ11 wall jack. The telephone company provides the necessary subscriber loops at its central system along with the phone numbers for each destination.

Warning

Only one modem should be connected to each drop. If an attempt is made to parallel two or more modems across a single drop, an impedance mismatch will occur and the quality of the signal will be adversely affected. Modems will not provide reliable communications under these conditions.

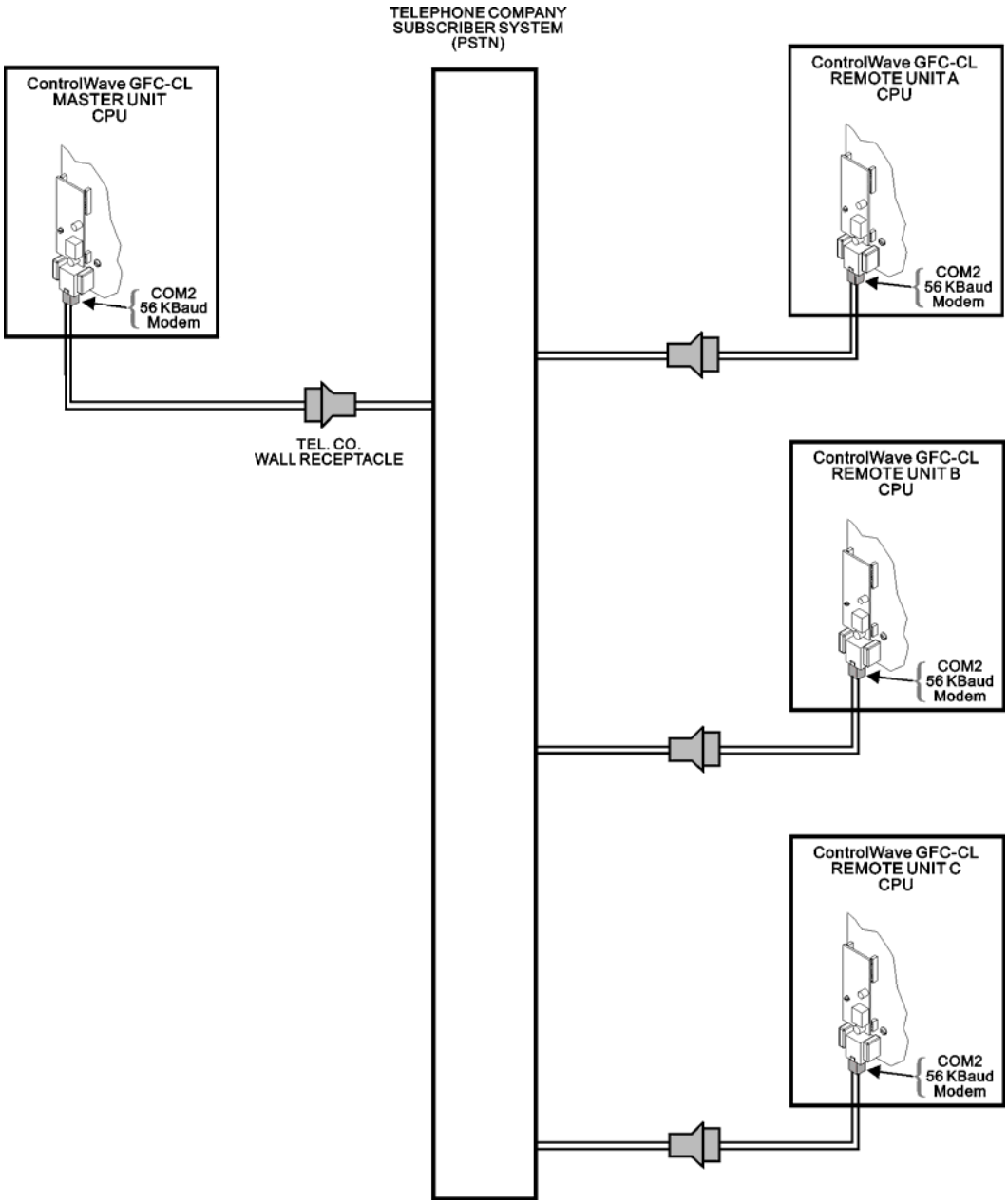


Figure 2-13 - Field Connections for ControlWave GFC-CL on Basic PSTN

An application consisting of a single master and a single remote requires only one of the remote connections shown in Figure 2-13.

The 56K PSTN Modem is FCC-approved for use with public telephone lines. Before placing a modem in operation, the following items should be checked to insure that all FCC requirements are met:

- Connections to party line service is subject to state tariffs.
- Connection to telephone company provided coin service (central office implemented systems) is prohibited.

- The equipment compliance information is summarized as follows:
  Complies with Part 68 FCC Rules.
  Contains device with FCC Registration Number: AU7-USA-25814-M5-E
  Ringer Equivalence Number (REN): 0.3B

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

- Any direct connections to PSTN lines must be made through standard plugs and jacks as specified in the FCC rules. The PSTN line connector plugs into J1 on the modem. Notify your telephone company that the jack (connector) required for your device is one of the following: *Note: The Jack provided on the Modem (J1) is a 6-Pin TLECO RJ-11.* The connections to the modem are Pin 3 PSTN-Tip, and Pin 4 PSTN-Ring.

  USOC: RJ11C or USOC: RJ11W

- After the telephone company has installed the above jack, connect the modem to your equipment by inserting the appropriate equipment interface cable (plugs) into the modem jack and the wall jack.

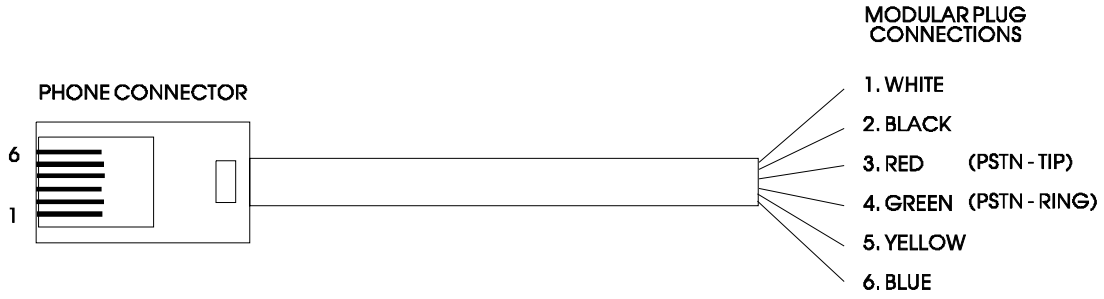


Figure 2-14 - Wiring for Phone Cord Connector

2.3.3.6 Radio Ready and External (Case Mounted) Modem or Radio

A wide selection of modems and radios are offered. The **Control**Wave **GFC-CL** is factory shipped with a user selected radio or modem installed within the enclosure (in front of the Battery Mounting Bracket) or as a radio ready unit, i.e., ready for field installation of a Bristol supplied radio. The installer must ensure that the remote antenna (associated with a case mounted radio) is properly installed and connected.

Information on operating and configuring a Bristol supplied radio or modem is contained in documentation authored by the unit's manufacturer. A list of reference manuals is provided in the Table of Contents under the topic REFERENCED OEM MANUAS.

2.3.4 I/O Wiring

ControlWave **GFC-CL**s are provided with Card Edge Terminal Blocks that accommodate field wiring. Wiring is routed into the enclosure through a 1/2" Conduit Fitting.

2.3.4.1 I/O Wire Connections

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

Allow some slack in the wires when making terminal connections. The slack makes the connections more manageable and minimizes mechanical strain on the terminal blocks.

2.3.4.2 Shielding and Grounding

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

2.3.4.3 Non-isolated Discrete Input/Output Connector Block TB5 (see Figure 2-15)

ControlWave **GFC-CL** Battery Charger and I/O Boards contain field interface circuitry for up to 2 Discrete (Digital) Inputs and 2 Discrete (Digital) Outputs. Surge Suppression and signal conditioning is provided for each DI. DO circuits consist of an open drain MOSFETs and Surge Suppression. DI/O circuitry utilizes an 8-point Terminal Block Assembly.

DI/O circuitry provides internally sourced DI operation for Dry Contacts pulled internally to 3.3Vdc when the field input is open. Each DI is protected with a surge suppressor. DI filtering is 15 milliseconds. DO circuitry utilizes open drain MOSFETs and surge suppressors. The DOs sink current to digital ground.

2.3.4.3.1 Discrete Input/Output Configurations

Terminal Block TB5 supports two non-configurable DIs and 2 non-configurable externally powered DOs. Each DI provides a 60uA source current from 3.3Vdc. Open drain MOSFETs associated with each DO provide up to 100mA each @ 16Vdc for a 6V system or 100mA @ 30Vdc for a 12V system to an externally powered device. Field wiring assignments are provided in Figure 2-15.

2.3.4.4 Non-isolated Analog Input Connector Block TB8 (see Figure 2-15)

Battery Charger and I/O Boards contain field interface circuitry for up to three (3) Analog Inputs that are individually configurable for 4-20mA or 1 to 5V operation. Field power source can be from the battery powered **Control**Wave **GFC-CL**, an external power source, or in the case of a 12V version, from the 24V field source.

Each AI signal is channeled through signal conditioning circuitry (that provides a 2 Hertz low pass filter), a transorb for surge suppression, multiplexer, and an A to D Converter (ADC).

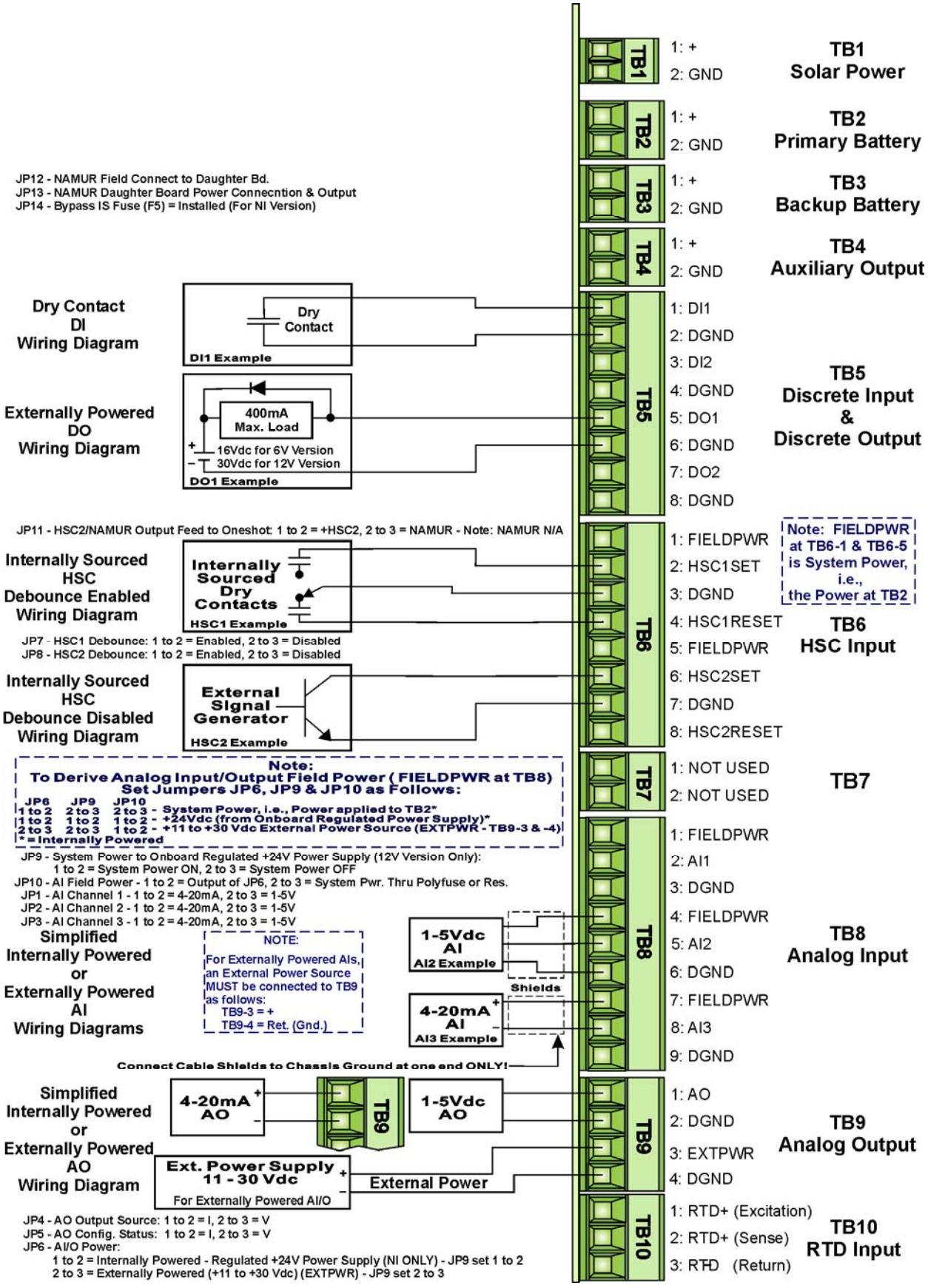


Figure 2-15 - Battery Charger and I/O Board Field I/O Wiring Diagrams

2.3.4.4.1 Analog Input Configurations

AI circuits are provided with Configuration Jumpers that accommodate configuration of each of the three Analog Inputs. Analog Input can be individually configured for 1-5V or 4-20mA operation. Field wiring assignments are provided in Figure 2-15.

Note:
Cable shields associated with AI wiring should be connected to the Control Wave **GFC-CL's Chassis Ground. Multiple shield terminations will require a user supplied copper ground bus. This ground bus must be connected to the Control**Wave **GFC-CL's Chassis Ground Lug (using up to a #4 AWG wire size) and must accommodate connection to a known good Earth Ground (in lieu of a direct connection from the Ground Lug) and to all AI cable shields. Shield wires should use an appropriate Terminal Lug and should be secured to the copper bus via industry rugged hardware (screw/bolt, lock washer and nuts).**

Table 2-7 - Analog Input Circuitry Jumper Assignments

Jumper	Purpose	Notes
JP1 - JP3	Configures AI1 through AI3 (respectively)	Pins 1-2 installed = 4-20mA AI Pins 2-3 installed = 1-5V AI
JP6	AO/AI Power	Pins 1-2 installed = +24V Supply Pins 2-3 installed = +V External
JP10	AI Field Power	Pins 1-2 installed = Output of JP6 Pins 2-3 installed = System Power through Polyfuse

2.3.4.5 Non-isolated Analog Output Connector Block TB9 (see Figure 2-15)

Battery Charger and I/O Boards contain field interface circuitry for up to one Analog Output that is configurable for 4-20mA or 1 to 5V operation. Field power source can be from the battery powered **Control**Wave **GFC-CL**, an external power source, or in the case of a 12V version, from the 24V field source. The Analog Output circuit consists of a 12-bit resolution Digital to Analog Converter (DAC), a V to I circuit, and a V to V circuit. A jumper is used to set the status of the output mode, i.e., current or voltage. The 12-bit DAC dives the V to I circuitry. A scaling circuit within the V to I circuit drives the V to V circuitry. Analog Output circuitry is not populated on 6V versions of the **Control**Wave **GFC-CL**.

2.3.4.5.1 Analog Output Configurations

The Analog Output circuit utilizes three Configuration Jumpers that accommodate 1-5V or 4-20mA AO operation and AO Power selection, i.e., internal (24Vdc) or external power (11 - 30Vdc). The maximum external load that can be connected to the 4-20mA output is 250 ohms (with an external 11V power source) or 650 ohms (with an external 24V power Source). The maximum external load current for the 1-5V output is 5mA (with an external 11 to 30 V power source). AO operation requires either an 11 to 30Vdc power source connected to the EXTPWR terminal of the AO circuit Terminal Block (TB9-3) or the unit supplied 24Vdc supply.

Table 2-8 - Analog Output Circuitry Jumper Assignments

Jumper	Purpose	Notes
JP4 JP5	AO1 Field Output Source AO1 Output Status	Pins 1-2 installed = 4-20 mA AO Pins 2-3 installed = 1-5V AO
JP6	AO/AI Power	Pins 1-2 installed = +24V Supply Pins 2-3 installed = +V External

2.3.4.6 Non-isolated High Speed Counter Input Connector TB6 (see Figure 2-15)

Non-isolated High Speed Counter Input (HSC) circuitry supports a total of 2 inputs provided with surge suppression bandwidth limiting and 20 microsecond (50kHz) filtering. In addition, HSCI circuitry contains conditioning circuitry consisting of a debounce circuit followed by a one shot pulse circuit that generates a 65 microsecond ±10% pulse and limits the maximum frequency of an input signal to 15kHz. HSC inputs may be individually field configured with contact debounce circuitry enabled or disabled. When debounce circuitry is enabled, spurious pulses caused by relay contact bounce do not affect the count. HSC circuitry is supported by an 8-point Terminal Block Assembly (for local termination) and 3 Configuration Jumpers.

Field inputs can be driven signals, or relay contacts. Each HSC input is configured as a 16-bit high-speed counter.

2.3.4.6.1 High Speed Counter Configurations

A total of 2 HSC inputs with surge protection are provided. HSC Configuration Jumpers must be set per Table 2-9.

Table 2-9 - Non Isolated High Speed Counter Module Jumper Assignments

Jumper	Purpose	Notes
JP7 JP8	Configures HSC1 Configures HSC2	Pins 1-2 installed = Enables HSC Debounce Pins 2-3 installed = Disabled HSC Debounce
JP11	HSC2/NAMUR Output Feed	Pins 1-2 installed = +HSC2 (Default) Pins 2-3 installed = NAMUR – N/A

2.3.5 RTD Wiring

A 3-wire RTD may be provided with the **Control**Wave **GFC-CL**. Connector TB2 on the System Controller Module accommodates a removable three-wire Terminal Block (TB10). This connector accommodates a 100-ohm platinum bulb using the DIN 43760 curve. **Control**Wave **GFC-CL**'s utilize the common three-wire con-figuration. In this configuration, the Return lead connects to RTD- and the two junction leads (Sense and Excitation), connect to RTD+ and RTD EXC. Connection between the RTD and System Controller Module is wired as follows:

Table 2-10 - RTD Connections to System Controller Connector TB2

TB10 Pin	Signal	Function
1	RTD EXC	Excitation
2	RTD+	Sense
3	RTD-	Return

Never ground the RTD Cable Shield at both ends or allow it to come in contact with conductive conduit as multiple ground paths could cause RTD input errors.

To install the RTD Probe, screw the Fitting Body into the thermowell with a 7/8"open-end wrench. While applying 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 thermowell), tighten the Nut (9/16" open-end wrench) against the 7/8" Fitting Body (see Figure 2-17).

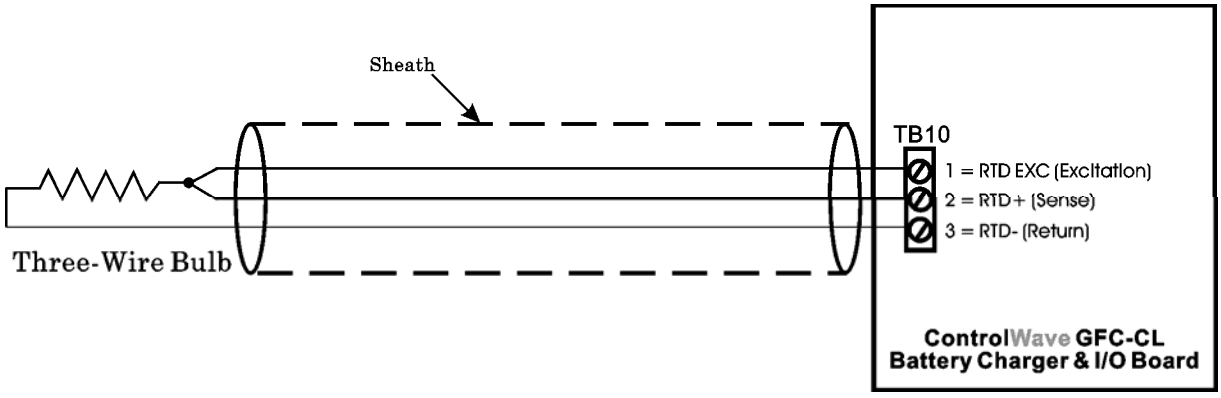


Figure 2-16 - 3-Wire RTD Temperature Input Wiring

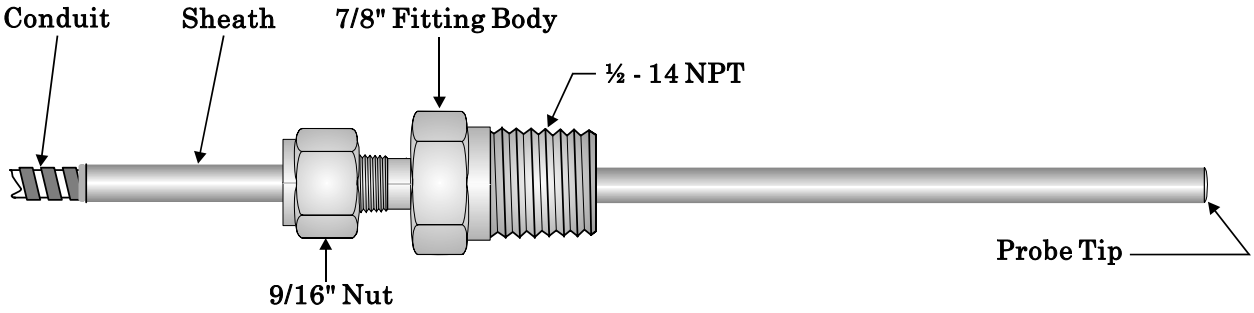


Figure 2-17 - RTD Probe Installation/Removal Diagram

2.3.6 Connection to a Model 3808 Transmitter

A Model 3808 Transmitter (Digital) can be interfaced to a **Control**Wave **GFC-CL** via either an RS-232 or an RS-485 communication scheme. Communication schemes and cable lengths are determined the type of communication port utilized. In general RS-232 communications are utilized when the Model 3808 Transmitter is situated within 25 feet of the **Control**Wave **GFC-CL**, i.e., for local communications. Communications can be achieved with transmitters up to 4000 feet away (remote communications) via the RS-485 scheme.

Figures 2-18 and 2-19 detail the RS-232 and RS-485 wiring connections required between the **Control**Wave **GFC-CL** and the Model 3808 Transmitter.

Up to two (2) Model 3808 Transmitters can be connected to a **Control**Wave **GFC-CL** via a half duplex RS-485 Network. An illustration of this network is provided in Figure 2-20.

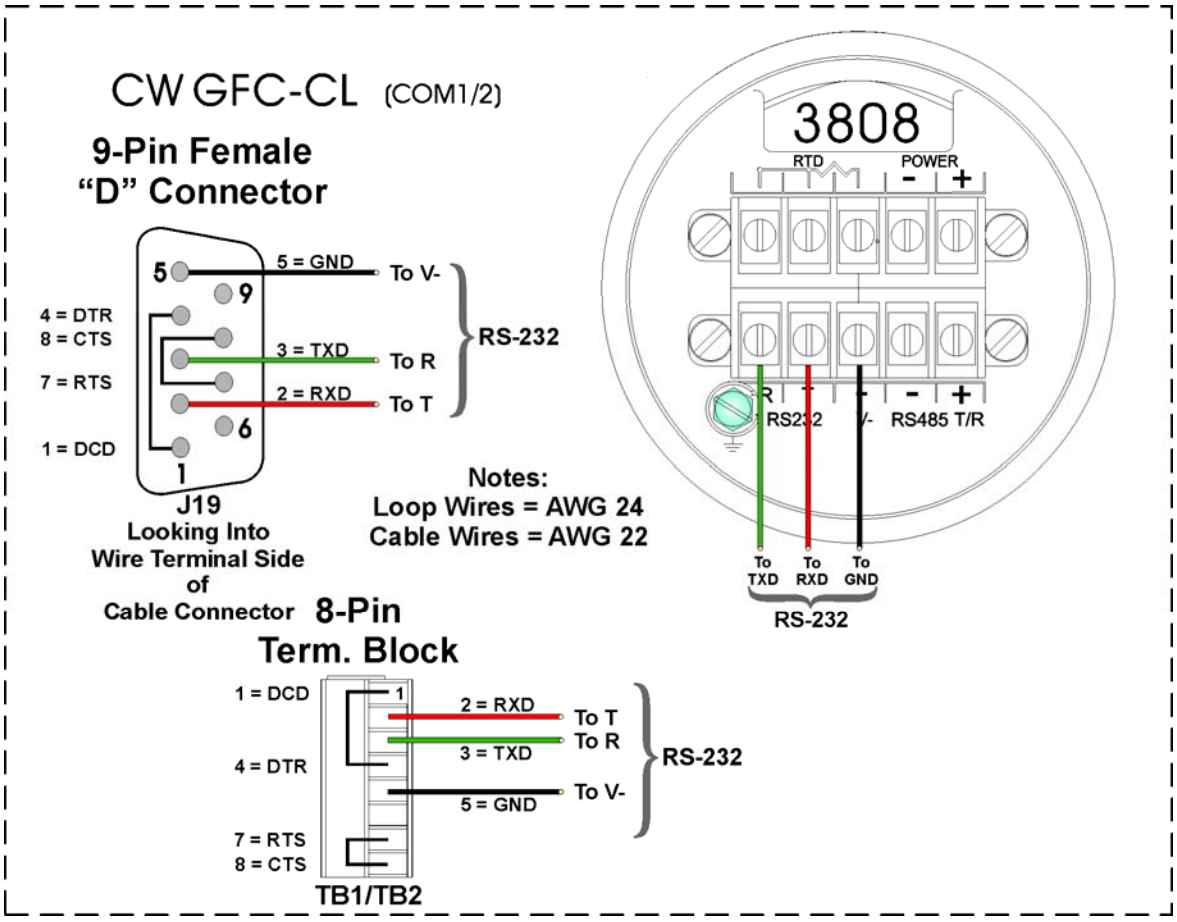
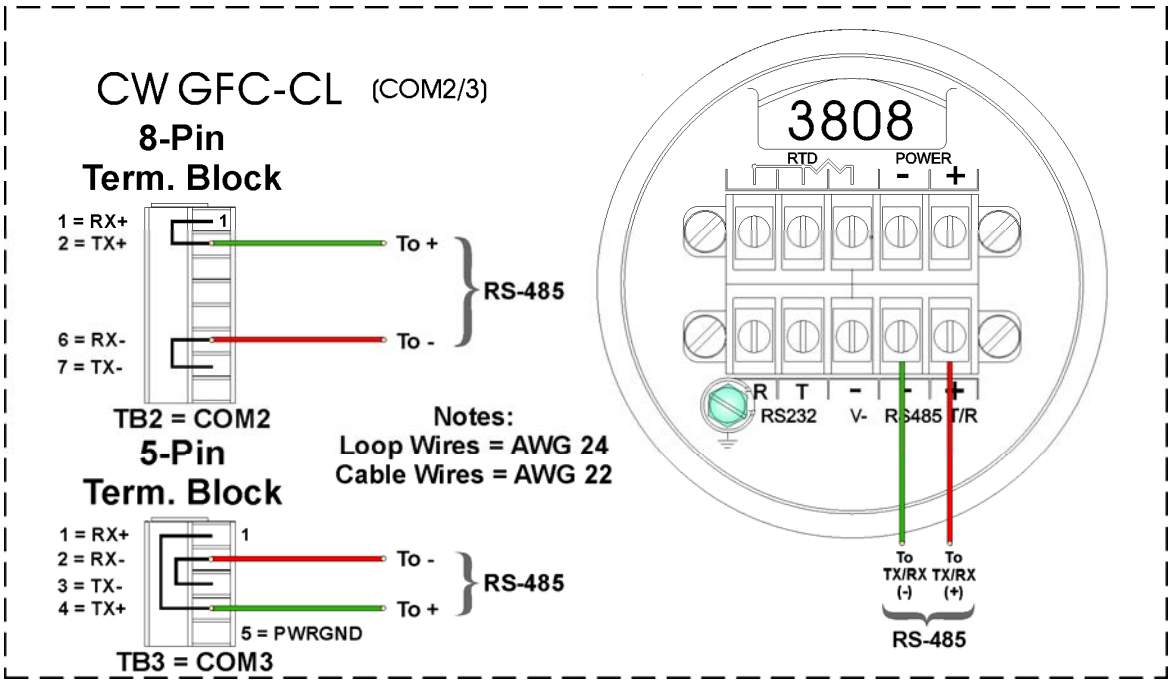


Figure 2-18 - Model 3808 Transmitter to ControlWave GFC-CL RS-232 Comm. Cable Diagram



Note: For Loopback & Termination Control:
Use SW3/SW4 on CPU/System Controller Board to configure COM3/COM4.

Figure 2-19 - Model 3808 Transmitter to CW GFC-CL RS-485 Comm. Cable

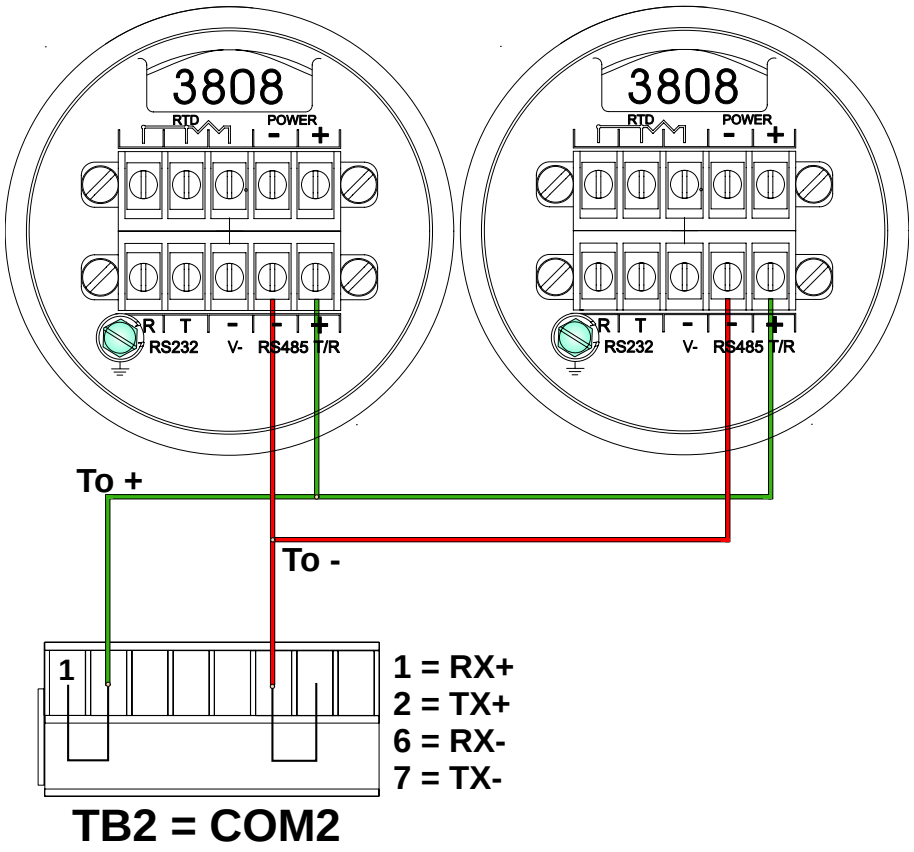


Figure 2-20 - ControlWave GFC-CL to 3808s - RS-485 Network Diagram

2.3.7 Power Wiring & Distribution

Primary Power is applied to Connector TB2 of the Battery Charger and I/O Board (TB2-1 = + & TB2-2 = GND) (GND = -) and may be provided as follows:

- Bristol supplied 6V Lithium Battery
- Bristol supplied 12V Lithium Battery Pack (Dual Lithium Batteries)
- Bristol supplied 6V/7AH Lead Acid Battery – used with a 1W, 6V Solar Panel System
- Bristol supplied 6V/7AH Lead Acid Battery – used with a 5W, 6V Solar Panel System
- Bristol supplied 12V/7AH Lead Acid Battery – used with a 5W, 12V Solar Panel System
- External (User Supplied) Power Supply (+4.5/+4.9 to +16Vdc or +9.6/10.3 to +16Vdc

Three other power interface connectors are provided on the Battery Charger and I/O Board and (in all cases (Pin-1 = + & Pin-2 = GND) (GND = -) function as follows:

- TB1 - Solar Power (1W - 6V, 5W - 6V or 5W - 12V) (TB2-1 = + & TB2-2 = -)
- TB3 - Backup Battery (External User Supplied 6V or 12V) (Diode Or'd with TB2)
- TB4 - Auxiliary Output Power - for External Radio/Modem.

ControlWave **GFC-CL** Terminal Blocks utilize compression-type terminals that accommodate up to #14 AWG wire. A connection is made by inserting the wire's bared end (1/4" max) into the clamp adjacent to the screw and then securing the screw. The wire should be inserted fully so that no bare wires are exposed to cause shorts. If using standard wire, tin the bare end with solder to prevent flattening and improve conductivity. Allow some slack in the wires when making connections. The slack makes the connections more manageable and helps to minimize mechanical strain on the terminal blocks.

Note: Fuses F1 and F3 are provided for Class I, Div. 1 Hazardous Location use Only (see Figure 2-7).

2.3.7.1 Bulk Power Supply Current Requirements

ControlWave **GFC-CL** gas flow computers are equipped with a CPU/System Controller Board that accepts either 6Vdc or 12Vdc Bulk Power input. The maximum current required for a particular **Control**Wave **GFC-CL** can be estimated as follows:

Bulk +6/12Vdc Supply Current = CPU/System Controller Board (with options) + Battery Charger and I/O Board + LCD Display Keypad + Optional External Modem/Radio

This summation will accommodate steady state current draw. Table 2-11 provides detailed steady state power current requirements for each **Control**Wave **GFC-CL** configuration. Note: In the case of an external modem/radio, the unit's manufacturer provides power consumption specifications.

Table 2-11 - Control Wave **GFC-CL Base Assembly Power Requirements**

COMPONENTS	BULK 12Vdc Supply	BULK 6Vdc Supply
CPU + Battery Charger and I/O + LCD with 2/25-Button Keypad	W/O Field Supply & with AO Output Under range 5mA	6.2mA
CPU + Battery Charger and I/O + LCD with 2/25-Button Keypad	With Field Supply - Field Supply Efficiency Varies from 40% @ 5mA Load to 80% @ 100mA Load 30mA Total Current (5ma Load on Field Supply) 250mA Total Current (100mA Load on Field Supply)	6.2mA
RS-485 Comm Port is ON	1mA	2mA
Optional Piggy-back 56K Modem	34mA	67mA
Optional Piggy-back MDS Radio	289mA	577mA
Optional Piggy-back FreeWave Radio	250mA	500mA
Optional External Modem/Radio	See Manufacturer's Spec.	See Manufacturer's Spec.

Note: Current consumption provided in Table 2-11 is based on the standard Gas Flow Computer application load. For 3808 power consumption refer to CI-3808.

2.3.7.2 Power Wiring

DC Power is interconnected to the CPU/System Controller Board (J1) via a wiring harness that originates on the Power Supply and I.O Board (P1). One Bulk DC supply can be connected to the **Control**Wave **GFC-CL** CPU/System Controller Board. The Bulk DC supply (nominally +6Vdc or +12Vdc) connected to TB2-1 (Power Supply and I/O Board) and is converted, regulated and filtered by the CPU/System Controller Board to produce +3.3Vdc. This CPU/System Controller Bd. circuit is fused at 1A (F1). The operating range of the units +4.5/4.9Vdc to +16.0Vdc (nominal +6Vdc input source) or +9.6/10.3Vdc to +16.0Vdc (nominal +12Vdc input source).

Power Supply and I/O Board Connector TB2 provides 2 input connections for bulk power:

TB2-1 = (+VIN) (+4.5/4.9V to +8V dc for +6V bulk) (+9.6/10.3V to +16V dc for +12V bulk)
TB2-2 = (-VIN) (Supply Ground)

Figure 2-21 - Battery Charger and I/O Board (TB2) Primary Power Wiring

2.3.7.3 Mounting an Optional Solar Panel

Solar Panels (used to charge the rechargeable lead acid batteries) are to be mounted to a 2" to 2-3/8" pipe as illustrated in Figures 2-22 and 2-23. Muffler (Pipe) Clamps, utilized for this purpose, are secured via four 1/4-20 nuts and washers.

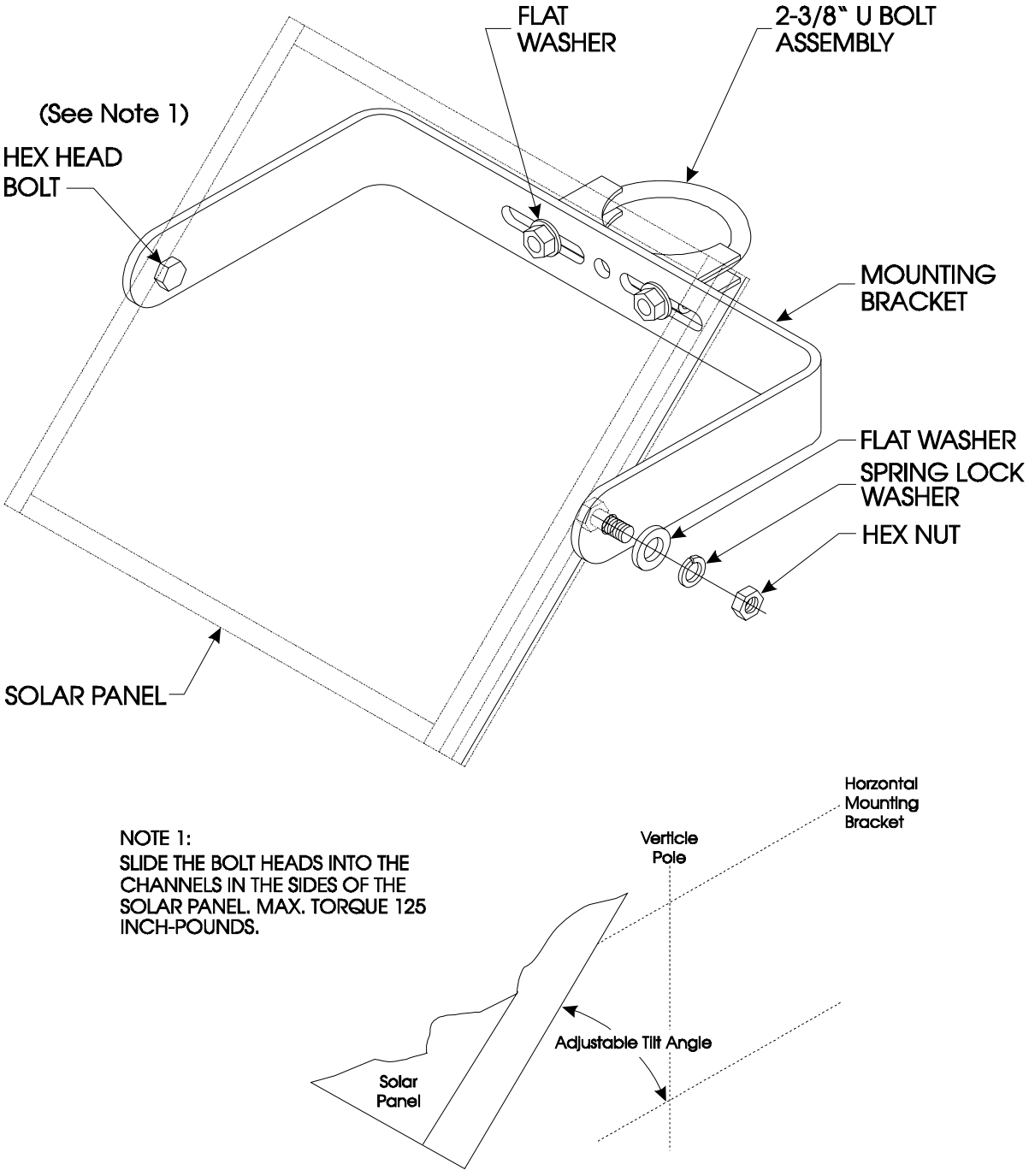


Figure 2-22 - 5 Watt Solar Panel Mounting Diagram

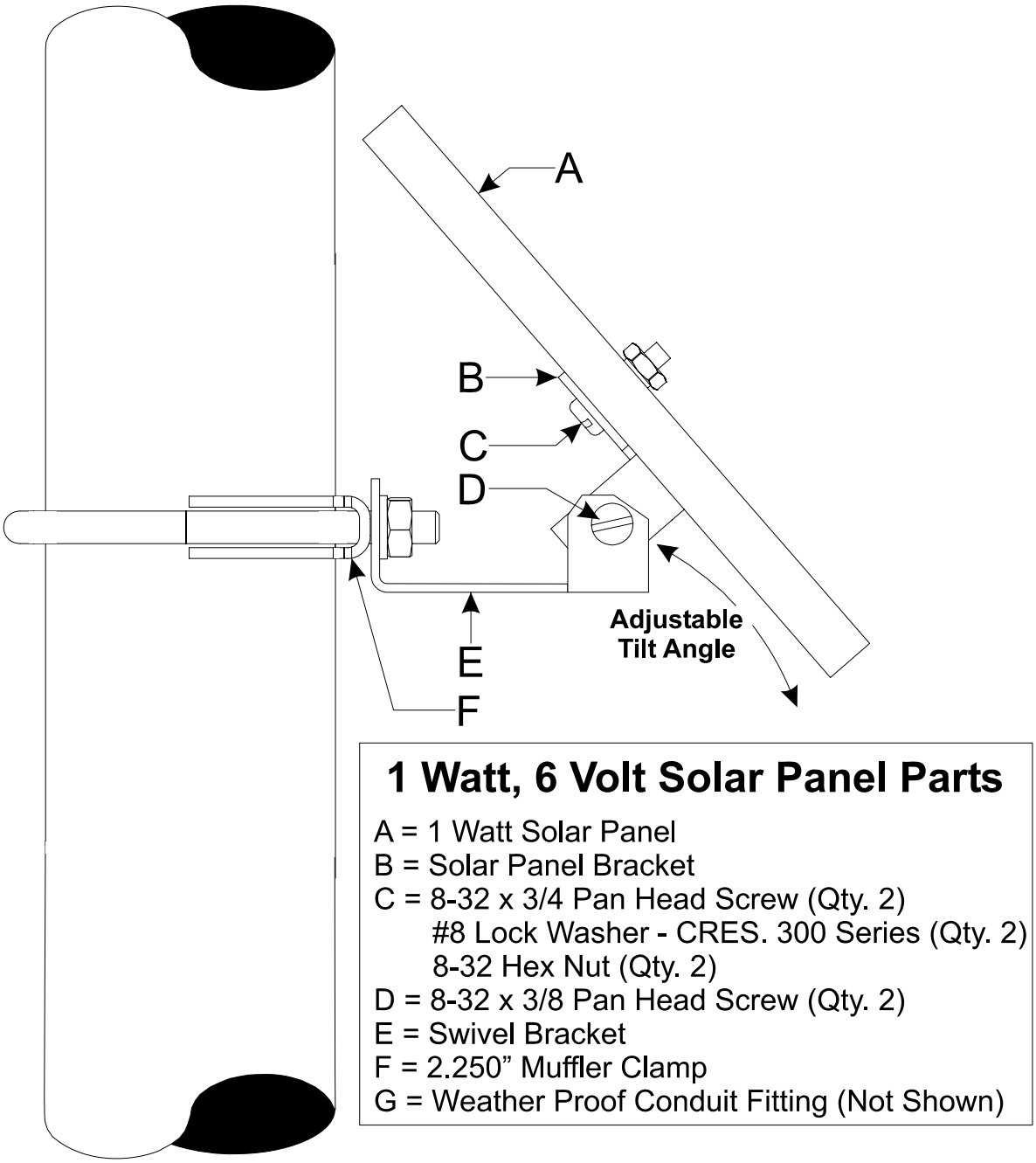


Figure 2-23 - 1 Watt Solar Panel Mounting Diagram

2.3.7.3.1 Swivel (Directional Facing)

Solar Panels used in the Northern Hemisphere should face due south (not magnetic south) while those used in the southern hemisphere should face due north (not magnetic north).

2.3.7.3.2 Tilt Angle

1 and 5 Watt Solar Panel Systems (see Figures 2-22 & 2-23) have adjustable tilt angles. Table 2-12 shows the angle (from horizontal) at which the Solar Panel should be installed in order to maximize annual energy output. At most latitudes, performance can be improved by less of an angle during the summer and more of an angle during the winter.

Table 2-12 - Solar Panel Tilt Angle for Solar Panels

LATITUDE	INSTALLATION ANGLE
0-4°	10° from Horizontal
5-20°	Add 5° to the Local Latitude
21-45°	Add 10° to the Local Latitude
46-65°	Add 15° to the Local Latitude
66-75°	80° from Horizontal

2.3.7.4 ControlWave GFC-CL System Grounding

ControlWave **GFC-CL** Enclosures are provided with a Ground Lug that accommodates up to a #4 AWG wire size. A ground wire must be run between the Enclosure's Ground Lug (see Figure 2-2) and a known good Earth Ground. The following considerations are provided for the installation of **Control**Wave **GFC-CL** system grounds (see S1400CW):

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

2.3.8 Operation of the Lithium Backup Coin-cell Battery

CPU/System Controller Boards are equipped with a Coin-cell Socket (S1) that accommodates a 3.0V, 300 mA-hr lithium coin cell. A supervisory circuit on the CPU/System Controller Board is used to switch to battery power when the regulated 3.3Vdc VCC falls out of specification. The CPU/System Controller Board switches the battery voltage to the VBAT3.3 hardware signal, which provides backup power for the real-time clock (RTC) and the system SRAM on the CPU Module.

The system SRAM has a standby current draw of 20uA maximum for each part. For a unit containing 2MB of SRAM, a worst-case current draw of 42uA allows a battery life of approximately 7142 hours.

Jumper W28 on the CPU/System Controller Board must be installed to enable the battery. For maximum shelf life, the battery may be isolated from the circuit by removing Jumper W28. W28's suitcase jumper can be stored on either of its pins.

CPU/System Controller Boards are shipped with the Lithium backup battery installed. To remove the backup battery, pry up the Battery Securing Tab on the Coin-cell Battery Socket and then remove the battery using a pair of tweezers or needle-nose pliers. Install the replacement battery. Note: This step will not be required until units have been in operation for an extended period of time (normally many years) as the battery life is approximately 7142 hours of backup service. (Power is drawn from the battery when the unit looses power).

NOTE:
If the Lithium backup battery is disconnected or removed when power is off the contents of SRAM (on the CPU/System Controller Board) will not be retained.

Once a Lithium backup battery has been removed, don't install a replacement battery for at least one minute unless SW2-5 on the CPU/System Controller Board has been set OFF.

2.4 OPERATIONAL DETAILS

ControlWave **GFC-CL**s are shipped from the factory with firmware that allows the unit to be configured in conjunction with an IEC 61131, application program. This section provides information as follows:

- Steps required to download the application load and place the unit into 'Run' mode.
- Steps required to download system firmware.
- Operation of the CPU/System Controller Board's Mode Switch (SW1)
- Soft Switch Configurations and Communication Ports

Operational details on **Control**Wave **GFC-CL** LEDs and use of the Bristol WINDIAG program for fault isolation are provided in Chapter 3.

2.4.1 Downloading the Application Load

Any **Control**Wave **GFC-CL** must have a configured application load before it can be placed into operation. For units not shipped with the 'Standard Load,' this will require connection of the **Control**Wave **GFC-CL** to a PC running Windows NT (4.0 or higher), Windows 2000 or Windows XP Professional and equipped with **Control**Wave Designer software & OpenBSI software. Configuration of the application load must be performed by an individual familiar with the various programming tools. The following software user documentation is referenced:

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

An application load download can be initiated, i.e., from **Control**Wave Designer, or from the OpenBSI 1131 Downloader for **Control**Wave **GFC-CL** Nodes.

1. Make sure that the CPU/System Controller Board's Mode Switch (SW1) is set in 'Local Mode,' i.e., SW1-1 set to the **OFF** position and SW1-2 set to the **ON** position.

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

2. Once the **Control**Wave **GFC-CL** project has been defined, communications and configuration parameters have been set, perform the download according to either '**Control**Wave Designer' (see D5088 - chapter 11) or 'The Open BSI 1131 Downloader' (see D5081 - Chapter 7).

3. After the download has been completed leave the CPU/System Controller Board's Mode Switch (SW1) in the 'Local Mode' position.

2.4.2 Upgrading ControlWave GFC-CL Firmware

The **Control**Wave **GFC-CL** CPU ships from the factory with system firmware already installed. If an upgrade of the system firmware is required, use one of the procedures below to download the new or replacement firmware from the PC.

Upgrade of system firmware via LocalView FLASH Mode requires OpenBSI 5.1 (or newer). If you have an older version of OpenBSI, FLASH upgrades are to be performed via HyperTerminal. You will need a binary (*.BIN) system firmware file that is read as follows: cwi0440.bin (where cwi is the product code and 0440 is the release #). Upgrade of an unattended **Control**Wave **GFC-CL** can be accomplished from a remote PC. This capability is introduced in Section 2.4.2.3.

2.4.2.1 Using LocalView to Upgrade ControlWave GFC-CL Firmware

NOTE

Your Control Wave **GFC-CL must be set to Recovery Mode ENABLE (ON) prior to performing the FLASH upgrade, then set to Recovery Mode DISABLE (OFF) after the upgrade. On Control**Wave **GFC-CLs this is accomplished via the CPU/System Controller Board's Mode Switch SW1. Set SW1-3 to the ON position for Recovery Mode. After setting SW1-3 to the ON position, turn power OFF and then ON again.**

A null modem cable (see Figures 2-10A & 2-11A) must be connected to COM1 of the **Control**Wave **GFC-CL** and to any RS-232 port on the associated PC. The PC's RS-232 port used for this purpose must be set to run at 115.2 Kbaud. **Control**Wave **GFC-CL** CPU Switch SW1, position, 3 must be set ON.

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

Start LocalView by clicking on: **Start → Programs → OpenBSI Tools → LocalView**. The New View Mode dialog box will appear (see Figure 2-24).

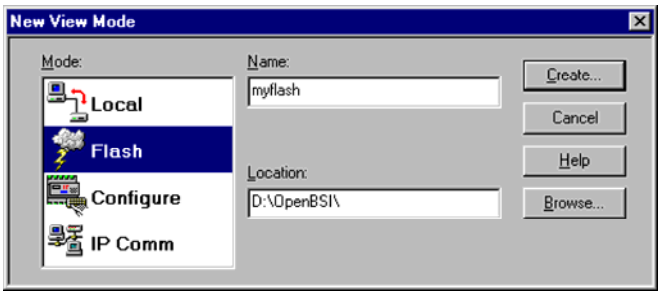


Figure 2-24 - Local View - New View Mode Menu

"Mode"
Choose 'Flash' for the mode.

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

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

When the **"Mode"**, **"Name"**, and **"Location"** have been specified, click on the **[Create]** push button to activate the Communication Setup Wizard.

Step 1 - Communication Setup

Choose the communication port you want in the **What port would you like to use:** field. Click on the **[Next]** pushbutton to activate the next wizard.

Figure 2-25 - Communication Setup: Step 1 Menu

Step 2 - Flash RTU Setup

In the Flash RTU Setup Wizard, you need not set the RTU type or local address, since these are unused in this mode. Click on the **[Next]** push button to activate the Flash Data Setup Wizard.

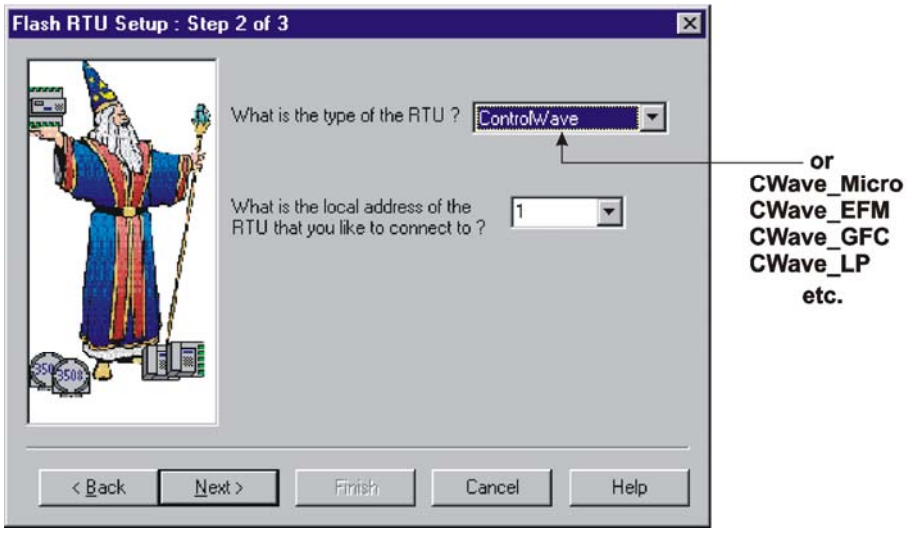


Figure 2-26 - Flash RTU Setup Menu

Step 3 - Flash Data Setup

Complete the following fields in the Flash Data Setup Wizard:

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

To upgrade system firmware, you must specify the path and name of a binary (*.BIN) file on your hard disk containing the firmware.

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

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

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

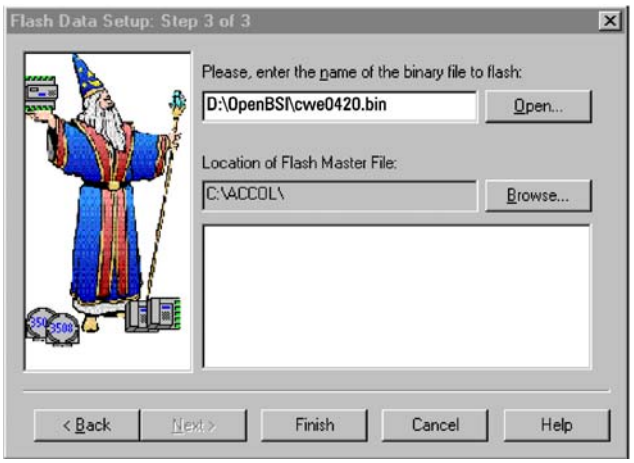


Figure 2-27 - Flash Data Setup Menu (Note: Substitute \cwi0420.bin for cwe04...)

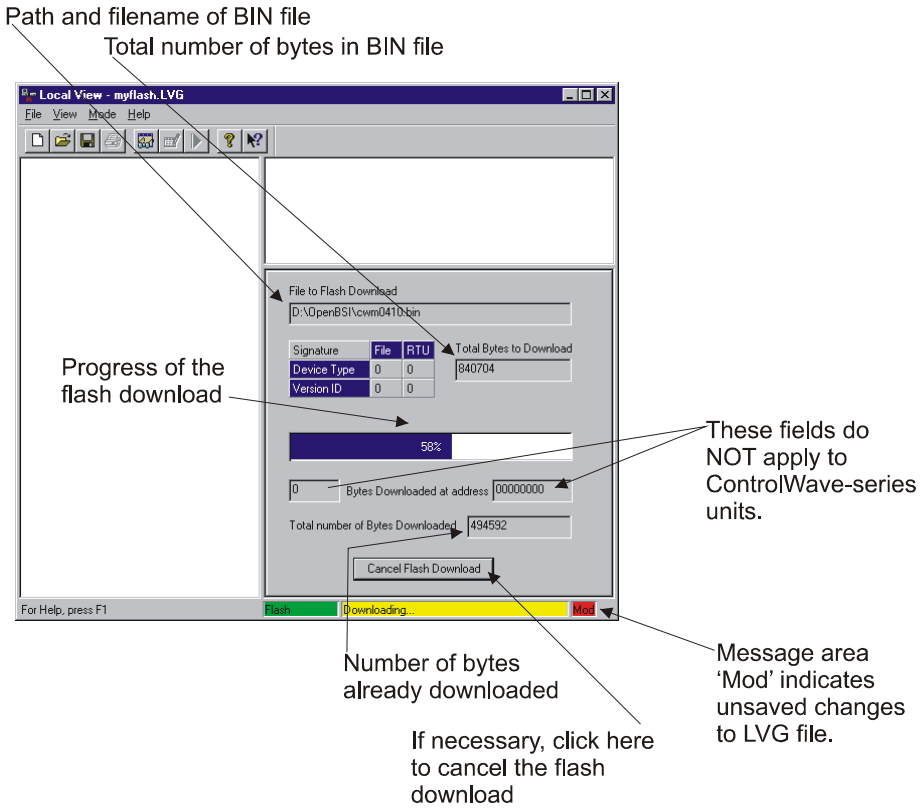


Figure 2-28 - Local View Downloading System Firmware Menu

Once the download has completed, set SW1-3 to the OFF position and then turn power OFF and then ON again.

2.4.2.2 Using HyperTerminal to Upgrade ControlWave GFC-CL Firmware

A null modem cable (see Figures 2-10A & 2-11A) must be connected to COM1 of the **Control**Wave **GFC-CL** and to any RS-232 port on the associated PC. The PC's RS-232 port used for this purpose must be set to run at 115.2 Kbaud. **Control**Wave **GFC-CL** CPU/System Controller Board Switch SW1, position, 3 must be set to the **ON** position.

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

2. Start the HyperTerminal program on the PC. Note: HyperTerminal is a Windows 95 (or newer) application utility program. If using HyperTerminal for the first time, set the communications properties (for the PC Port being utilized) via the Properties Menu as follows: Bits per second: = 115200, Data bits: = 8, Parity: = None, Stop bits: = 1, and Flow control: = None and then click OK.

3. Set the CPU/System Controller Board's Mode Switch (SW1) for 'Recovery Mode,' i.e., set CPU/System Controller Board Switch SW1-3 to the ON position.

4. Apply power to the **Control**Wave **GFC-CL**. The resident BIOS will initialize and test the hardware, this process is referred to as POST (Power On Self Test).

   Unless there is a problem status code 10 (Status LED #5 ON) will be posted to the CPU/System Controller Board's Status LEDs. Detection of a fault during POST will be posted on the Status LEDs. When the Power On Self Test has completed, a system status code will be posted to the Status LEDs (see Table 2-13 and Figure 2-33).

   From the HyperTerminal Recovery Mode menu (Figure 2-29), press the 'F' key to enter FLASH download. A message will be displayed warning that the FLASH is about to be erased; press the 'Y' key at the prompt. The screen will display dots as the flash devices are being erased; this could take a few minutes.

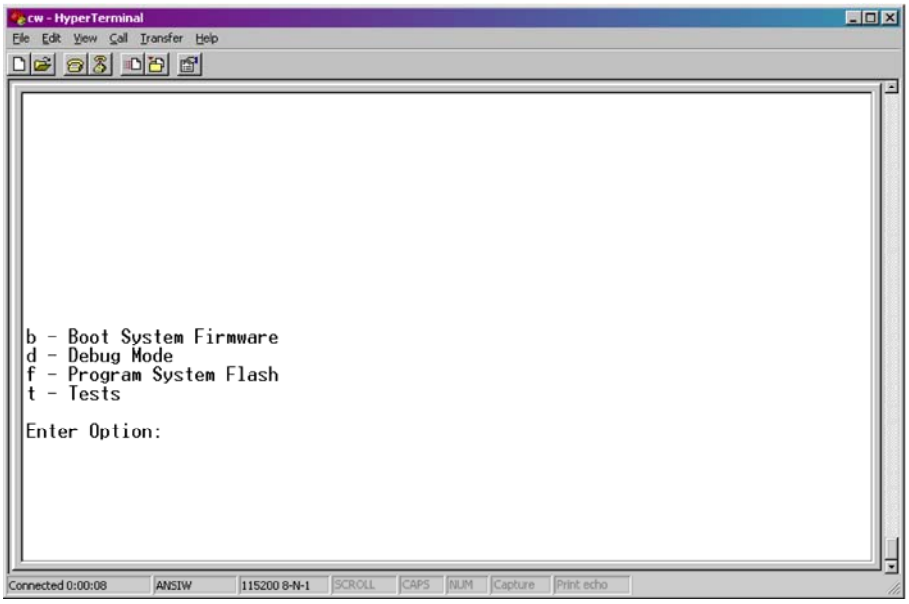


Figure 2-29 - HyperTerminal Recovery Mode Menu

5. When the FLASH is ready for download the letter C will be displayed on the screen. In the HyperTerminal command bar click on Transfer and then Send File (see Figure 2-30). In the Send File Dialog Box (see Figure 2-31), select "1KXmodem" for the protocol, enter the filename of the appropriate .bin file in the format "CWI*xxxxx*.bin" (where *xxxxx* varies from release to release). Click on the Send button to start the download (see Figure 2-31). When the HyperTerminal Recovery Mode Menu of Figure 2-29 appears, the download has completed.

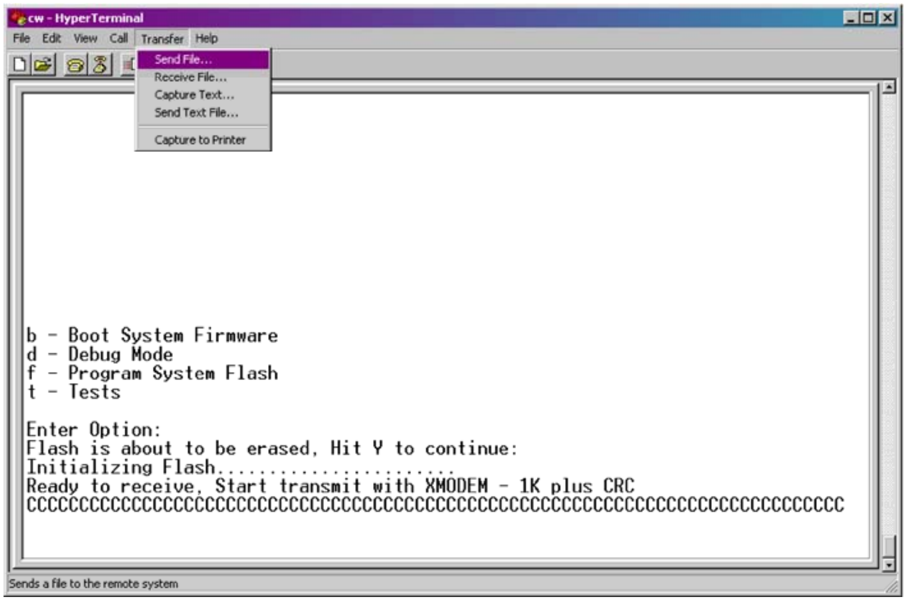


Figure 2-30 - HyperTerminal FLASH Download Menu (Ready to Download) - (Transfer/Send File Selected)

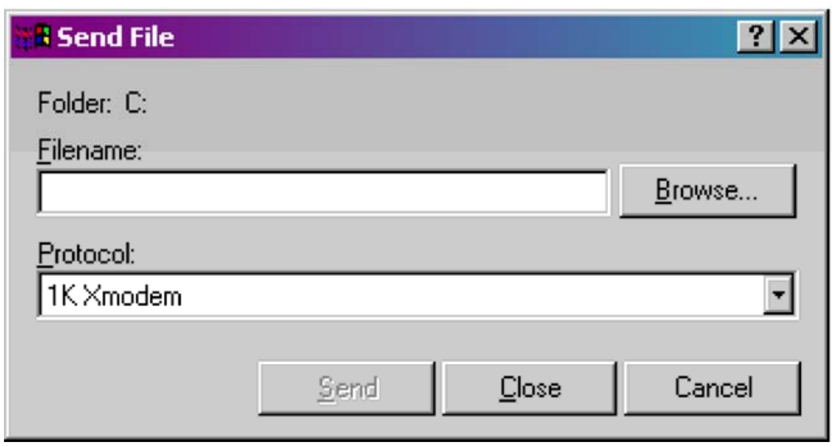


Figure 2-31 – HyperTerminal Flash Download (Send File Dialog Box)

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

7. Set the CPU/System Controller Board's Mode Switch (SW1) for 'Local Mode,' i.e., set SW1-3 OFF. Then switch power OFF/ON.

Once the **Control**Wave **GFC-CL** is running its application load, status codes are posted to the six Status LEDs on the CPU/System Controller Board and to the LCD Display Assembly. These Status LED (Hex) Codes are listed in Table 2-13 (see Figure 2-33).

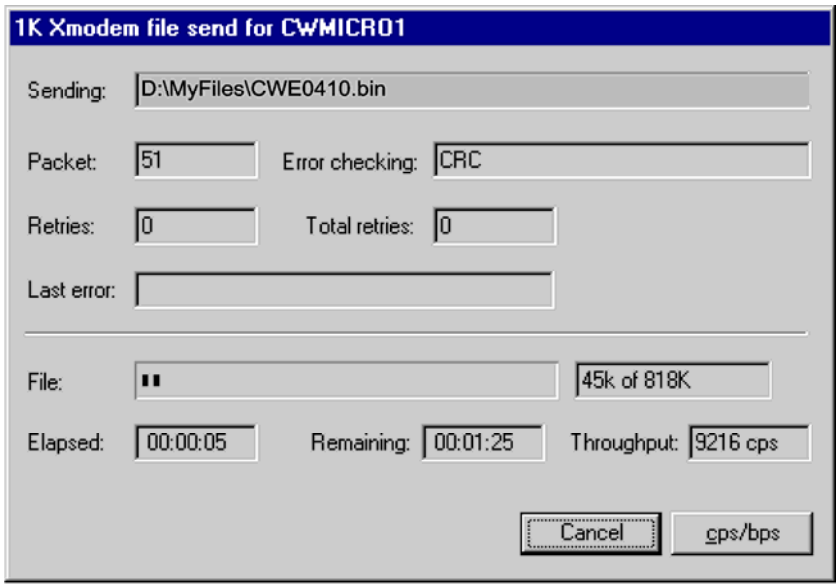


Figure 2-32 - HyperTerminal FLASH Download (Download in Process)
(Note: Substitute \cwi0420.bin for cwe04...)

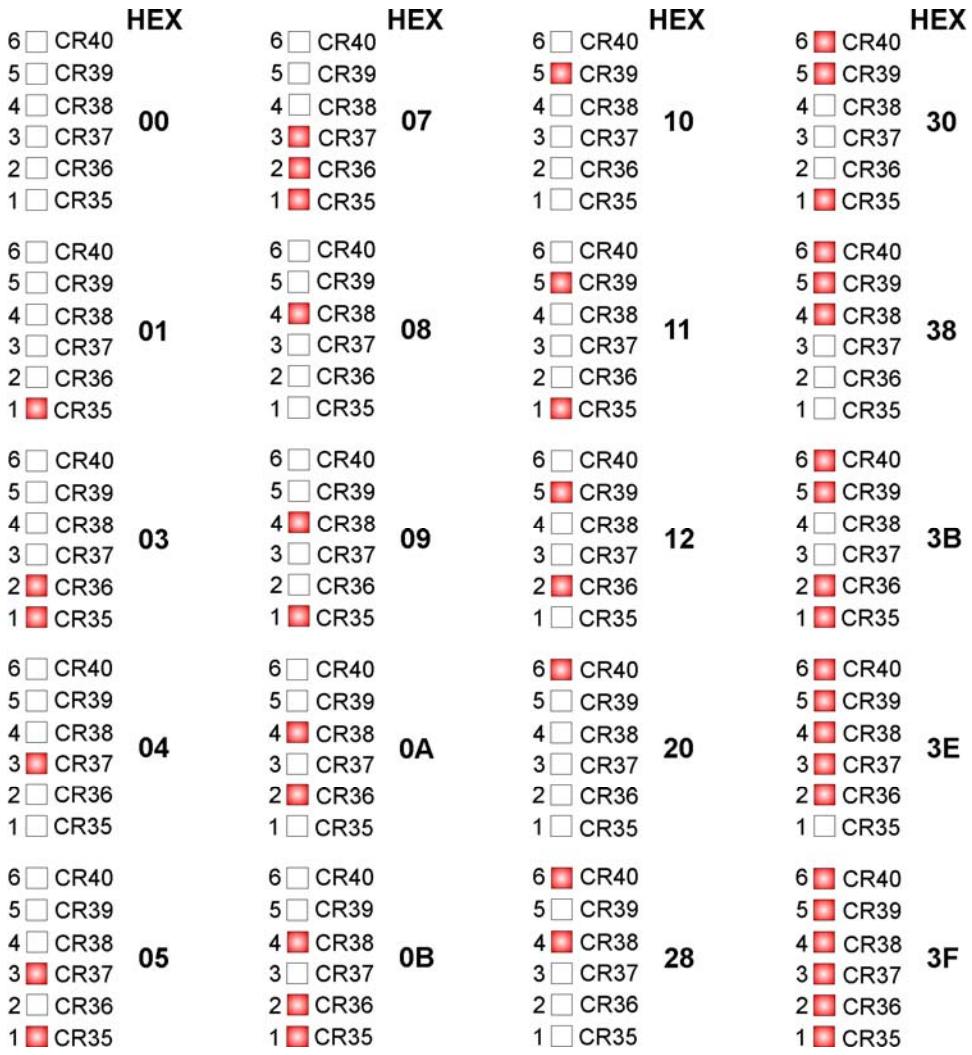


Figure 2-33 – CPU/System Controller Bd. Status LED Hexi-decimal Codes
(See Table 2-13 for Definitions)

Table 2-13 - System Status Codes on LCD Display & LEDs on CPU/System Cntrl. Bd.

LED 6 CR40	LED 5 CR39	LED 4 CR38	LED 3 CR37	LED 2 CR36	LED 1 CR35	Status In Hex	LCD Disp.	Indication Definition
0	0	0	0	0	0	00	Blank	Application Running
0	0	0	0	0	1	01	DIAG	Unit in Diagnostic Mode
0	0	0	0	1	1	03	R DIAG	Unit Running Diagnostics
0	0	0	1	0	0	04	FWXSUM	Flash XSUM Error
0	0	0	1	0	1	05	DEVERR	Error Initializing Application Device
0	0	0	1	1	1	07	FLASH	Flash Programming Error
0	0	1	0	0	0	08	FACT	Using Factory Defaults *
0	0	1	0	0	1	09	BATT	Battery Failure Detected *
0	0	1	0	1	0	0A	STRTUP	Currently Loading the Boot Project
0	0	1	0	1	1	0B	INIT	System Initialization in Progress
0	1	0	0	0	0	10	RECOV	Waiting in Recovery Mode
0	1	0	0	1	0	12	RAMERR	Error Testing SRAM
1	0	0	0	0	0	20	STOP	Application Loaded
1	0	1	0	0	0	28	HALT	Stopped at a Break Point
1	1	0	0	0	0	30	NO APP	No Application Loaded
1	1	1	0	0	0	38	BREAKP	Running with Break Points
1	1	1	0	1	1	3B	POWERD	Waiting for Power-down (after NMI)
1	1	1	1	1	0	3E	UPDUMP	Waiting for Updump to be Performed
1	1	1	1	1	1	3F	NOTRUN	Unit Crashed (Watchdog Disabled)

*** = Flashed at startup**

2.4.2.3 Remote Upgrade of ControlWave GFC-CL Firmware

It is possible to download system firmware into an unattended remote **Control**Wave **GFC-CL.** This function can only be accomplished if CPU Board Switch SW2-6 (associated with the unit in question) is set in the ON position (factory default). The procedure for performing a remote download of system firmware is discussed in Appendix J of the Open BSI Utilities Manual (document D5081). **Note: Remote upgrade of Control**Wave **GFC_CL Firmware requires Boot PROM version 4.7 or higher and System PROM version 4.7 or higher.**

2.4.3 Operation of the Mode Switch

The CPU/System Controller Board's Mode Switch (SW1) is a four position DIP-Switch; functions are listed in Table 2-14.

Table 2-14 - CPU/System Controller Bd. Mode Switch SW1 Assignments Recovery Mode/Local Mode Control

SWITCH	Function	Setting
SW1-1/2	Recovery/Local Mode *	Both ON or OFF = Recovery Mode SW1 OFF & SW2 ON = Local Mode
SW1-3	Force Recovery Mode *	ON = Force Recovery Mode (via CW Console) OFF = Recovery Mode disabled
SW1-4	Not Used	N/A

*** = Note: Only the Switch SW1 settings listed in this table, have been tested.**

Recovery Mode: Recovery Mode is used for either a firmware upgrade (see Section 2.4.2) or a core updump (see Section 3.6).

Local Mode: Local Mode should be selected for normal running operations.

2.4.4 Soft Switch Configuration and Communication Ports

Firmware defined soft switches that control many default settings for various system operating parameters such as BSAP Local Address, EBSAP Group Number, three (3) communication port parameters, etc., can be viewed and, if desired, changed via the Flash Configuration Utility, which is accessible from LocalView or NetView. When connecting the **Control**Wave **GFC-CL** to the PC (local or network) for the first time you should be aware of the communication port default parameter settings provided below (see Figures 2-8 through 2-13). *Note: Communication port factory defaults can be enabled anytime by setting CPU Board Switch SW2-3 to the OFF position. CPU Switch SW2-8 must be set OFF to run the WINDIAG program.*

COM1: From the factory, RS-232 Communications Port COM1 defaults to 115.2 kbd (RS-232) using the BSAP Protocol. *Note: By setting CPU Switch SW2-8 OFF, the boot project will be prevented from running and the unit will be placed into diagnostic mode.* To test COM1 using the WINDIAG program, it must not otherwise be in use. Connection to a PC requires the use of an RS-232 "Null Modem" cable (see Figure 2-12).

COM2: From the factory, RS-232 Communications Port COM2 on the CPU Board defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM2 using the WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.*

COM3: RS-485 Communications Port COM3 on the CPU Board defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM3 using the WINDIAG program, it must not otherwise be in use *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.* In lieu of the use of an RS-232 Port, an RS-485 cable (see Tables 2-3 & 2-5) can be connected between COM3 and the PC's RS-485 Port.

2.4.5 Optional Display/Keypad Assemblies

Two Display/Keypad Assemblies are offered; one with a dual-button Keypad (see Figure 2-34) and one with a 25-button Keypad (see Figure 2-35). Both Display/Keypad Assemblies utilize identical 4 x 20 LCD Displays. Each Display/Keypad Assembly employs a unique microcontroller based Display/Keypad Interface Circuitry (situated on the CPU/System Controller Board) that drive the 4 x 20 LCD Display and interfaces the Keypad. Interface to the Display Assembly is accomplished via a 16-pin connector (Plug on CPU/System Controller Board and Jack on rear of Display Ass'y.). Interface between the CPU/System Controller Board and the applicable keypad is accomplished via a ribbon cable that plugs into CPU/System Controller Board Connector Jack J2 (in the case of the 25-button Keypad) or Connector Jack J14 (in the case of the Dual-button Keypad). A potentiometer (R164) used to set the contrast of the LCD Display is provided on the CPU/System Controller Board.

Figure 2-36 provides mounting hardware information for the Dual-button Display/Keypad Assembly. Operation of the Dual-button Display/Keypad Assembly is discussed in section 2.4.5.1.

Figure 2-37 provides mounting hardware information for the 25-button Display/Keypad Assembly. Information on configuring the 'Display Function Block' (required to configure the Display associated with the 25-button Display/Keypad Assembly) is provided in ControlWave Designer's On-Line Help.

Note: Operation of the 25-button Display/Keypad Assembly is discussed in Appendix E.

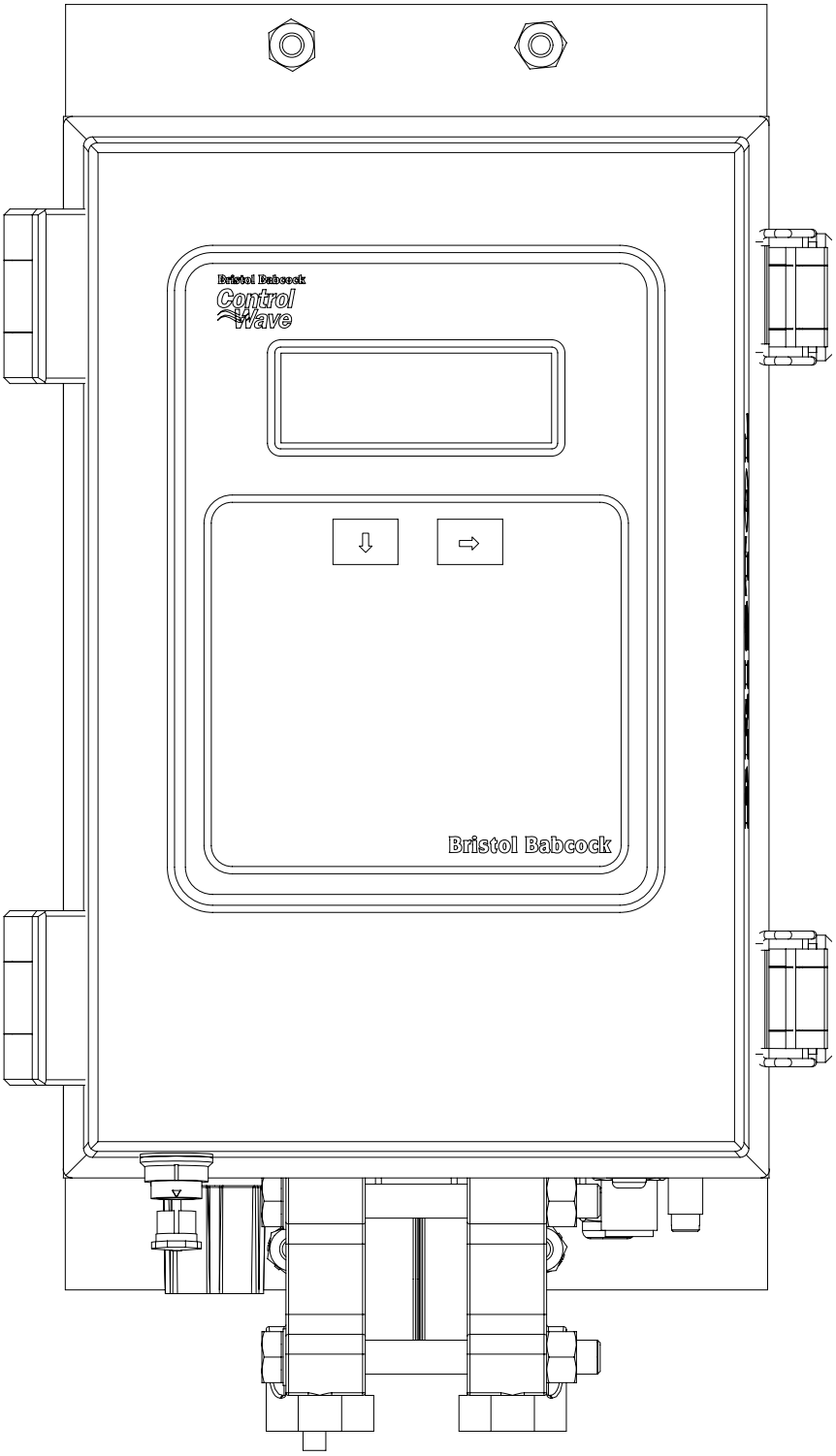


Figure 2-34 - ControlWave GFC-CL
(with Dual-Button Display/Keypad Assembly)

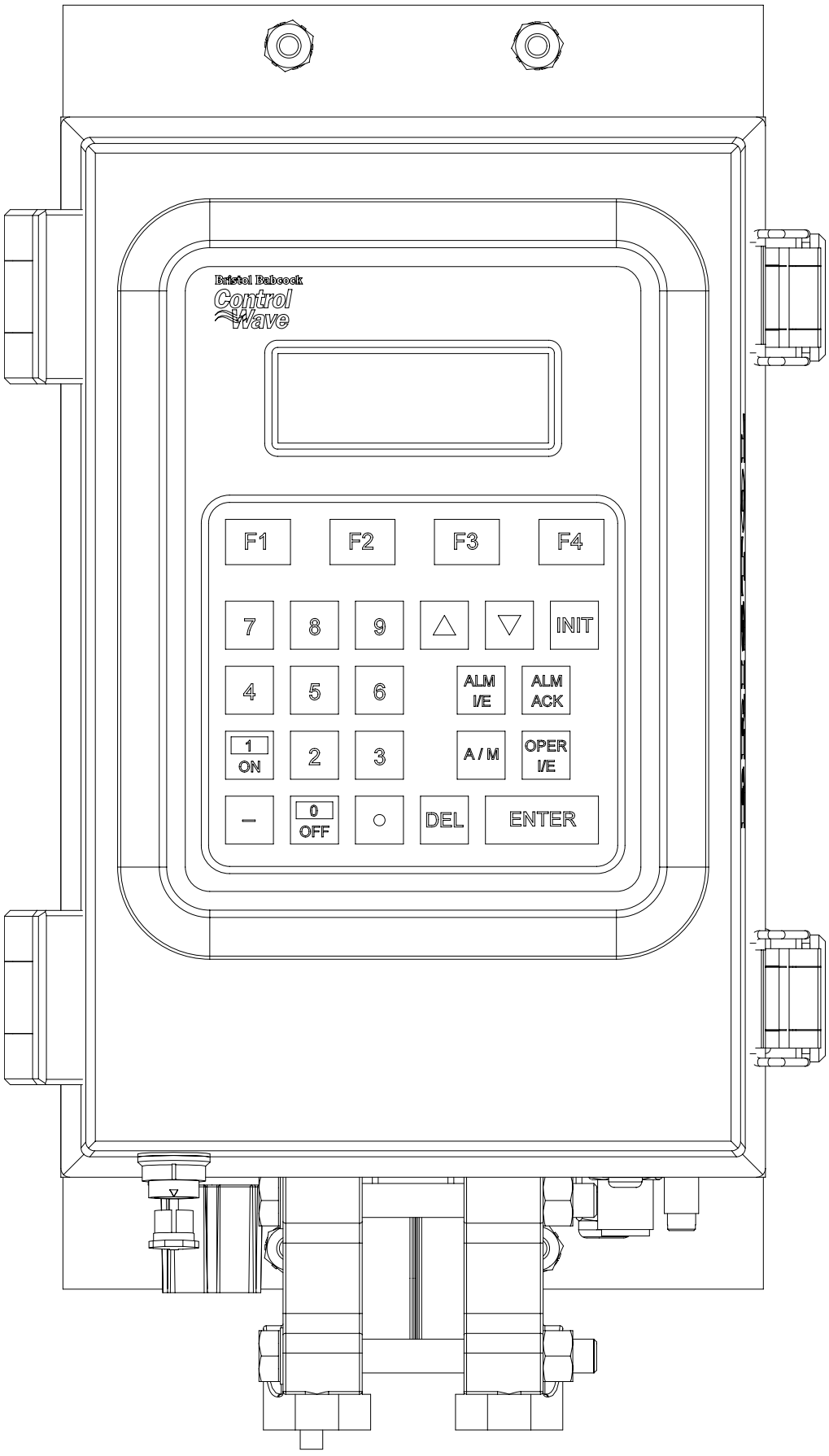
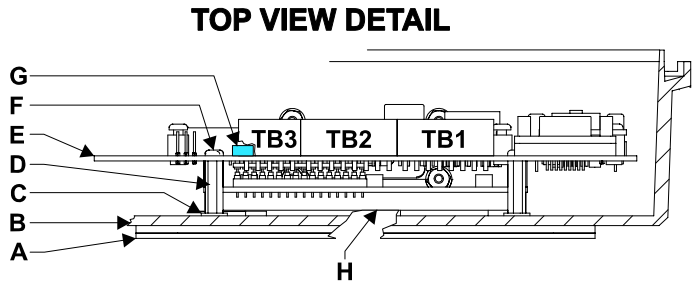
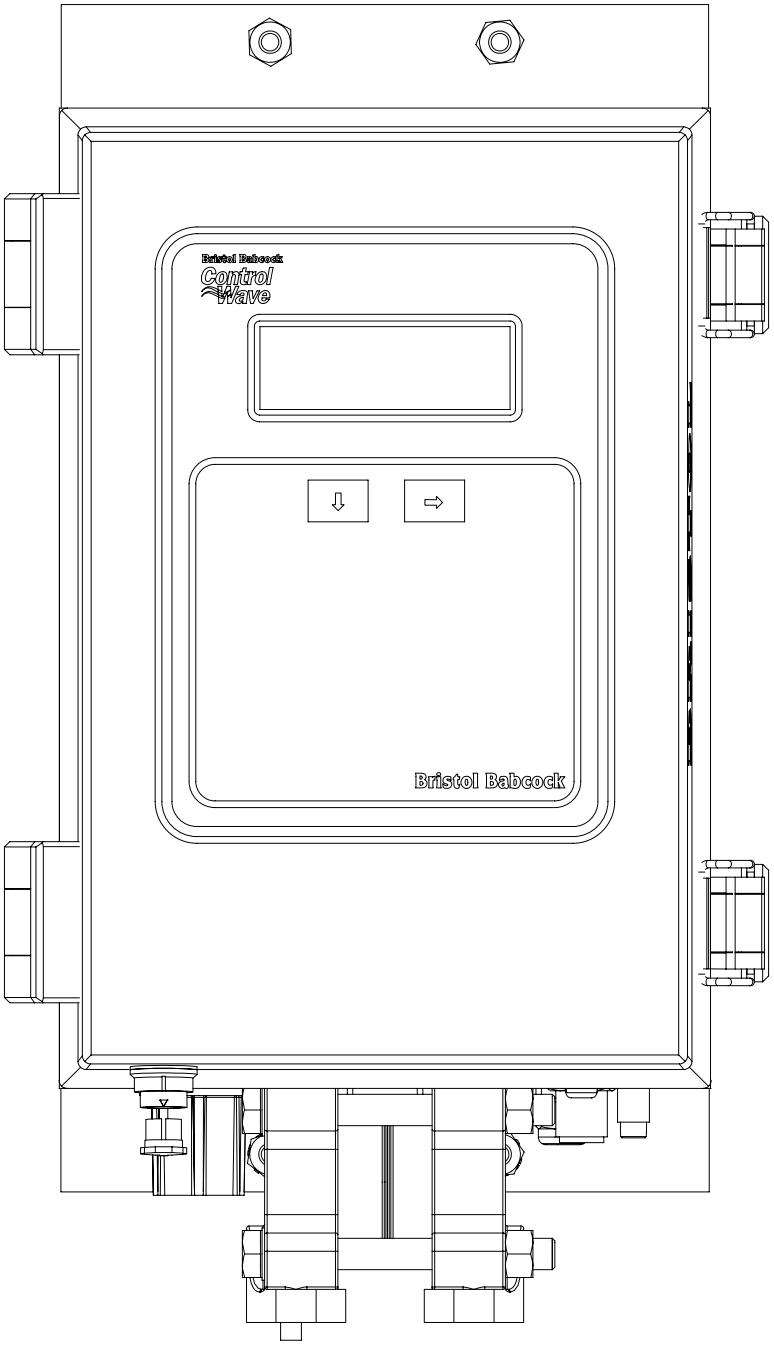


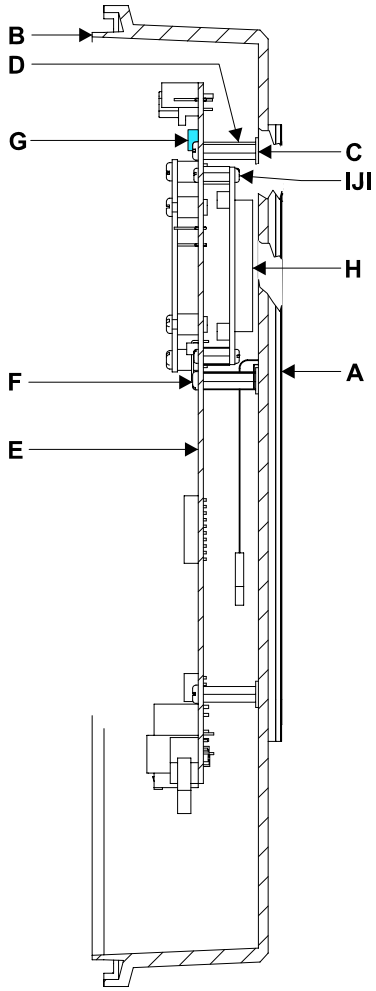
Figure 2-35 - Control Wave **GFC-CL**
(with 25-button Display/Keypad Assembly)



A = Display/Keypad Front Plate
B = Front Cover
C = Washer (Qty. 6)
D = .563" F/F Standoff (Qty. 6)
E = CPU/System Controller Board
F = Screw (Qty. 6)
G = Brightness Adj. Potentiometer
H = Display Sub-Ass'y.
I = Screw (Qty. 8)
J = F/F Standoff (Qty. 4)



FRONT VIEWS ControlWave GFC



RIGHT SIDE VIEW DETAIL

Figure 2-36 - Dual-button Display/Keypad Assembly Installation Drawing

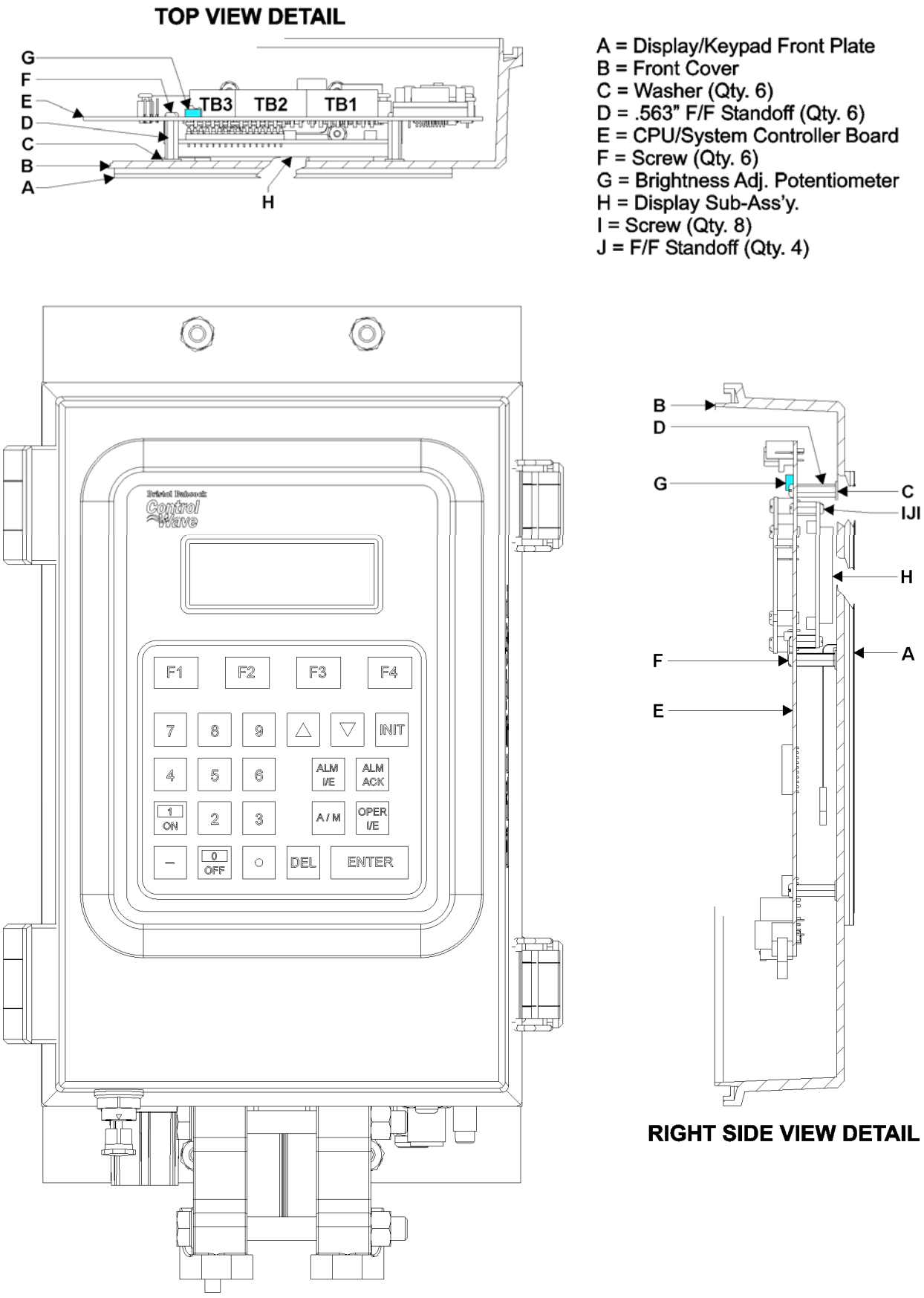


Figure 2-37 - 25-Button Display/Keypad Assembly Installation Drawing

2.4.5.1 Operation of the Dual-button Display/Keypad Assembly

The Display will have a timeout of 20 minutes. If there has been no keypad activity for this time the display will "logout," i.e., the display will be turned off and scrolling stopped until a key press occurs. When a key press occurs after a timeout the display will return to the opening screen.

If a shorter timeout of the display is needed for power savings, another timeout may be implemented. The processor connected to the display will control the timeout. When the timeout occurs the display will be blanked, but communications between the **Control**Wave **GFC-CL** CPU and display processor will still occur. The display processor will ignore posting the messages to the screen when in the low power mode. When a key is pressed the display processor will return to displaying information to the display.

Displays are organized into screens as follows:

Opening Screen: User defined strings

List Selection Screen: List Name
List Number
<Blank Line>
<Blank Line>

The List Selection screen is entered from the main opening screen by pressing the right arrow. Once here the operator can select which list is to be viewed. The operator can traverse though different list numbers by pressing the down arrow key. When the list to be scrolled is shown on the display, pressing the right arrow key will bring the operator to the Display Element screen.

Display Element Screen: <Blank Line>
<Blank Line>
Variable Name
Variable Name

The Display Element screen is entered from the list selection screen by pressing the right arrow. Once here the operator can view the variables in the list. Once entered the first element of the list is displayed and then next element will be displayed after the scroll timeout occurs. The scrolling will continue displaying the next element in the list and then wrapping around to the beginning of the list. The down arrow key will toggle the display through hold and scroll mode. Pressing the right arrow key will bring the operator to the list selection screen.

Display/Keypad Assemblies are supported by **Automatic Mode** and **Manual Mode**.

Automatic Mode
In Automatic mode a set of screens (based on the application load) are displayed. The application programmer provides strings for the opening screen. From there the firmware is responsible for displaying the screens and responding to key presses. Screens are fixed and start off with an opening screen, which displays user information passed into the function block. Users can view a list to select which list is to be scrolled. Once the list to be scrolled has been selected, the user can scroll through the list by pressing the down arrow key. List elements will be displayed automatically, scrolling at a predetermined rate (determined by

iiScrollTime). The user may pause on a variable by pressing the right arrow key. Pressing the right arrow key again will cause the list to start scrolling again.

The essence of Automatic mode is that the user can supply inputs into the function that will determine which list can be displayed, but cannot change the menu or display. The user is allowed to select a list and to start/stop scrolling.

Manual Mode

In Manual Mode the programmer is responsible for creating each screen and displaying the next desired screen, based on key inputs. The programmer has access to all lines of the display and can provide any string that he/she desires to display. Special formats that must be adhered to that allow the programmer to display what they want on the screen are provided in the description of iaScrnSruct in the ACCOL 3 Display function block within ControlWave Designer's On-Line Help. It should be noted that currently, Manual Mode does not support reading Keypad keypresses. **Note: Manual Mode operation requires ControlWave Firmware 4.50 or newer.**

Section 3
SERVICE

3.1 SERVICE INTRODUCTION

This section provides general, diagnostic and test information for the **Control**Wave **GFC-CL**.

The service procedures described herein will require the following equipment:

1. PC with null modem interface cable & Bristol's WINDIAG Software
2. Loop-back plugs/wires (for RS-232 and RS-485) (see Figure 3-9)

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

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

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

Warning

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

Warning

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

3.2 COMPONENT REMOVAL/REPLACEMENT PROCEDURES

This section provides information on accessing **Control**Wave **GFC-CL** components for testing, as well as removal/replacement procedures.

3.2.1 Accessing Components For Testing

Testing and replacement of **Control**Wave **GFC-CL** components should only be performed by technically qualified persons. Familiarity with the disassembly and test procedures described in this manual are required before starting. Any damage to the **Control**Wave **GFC-CL** resulting from improper handling or incorrect service procedures will not be covered under the product warranty agreement. If these procedures cannot be performed properly, the unit should be returned to Bristol (with prior authorization from Bristol Inc.) for factory evaluation and repairs.

3.2.2 Removal/Replacement of the CPU/System Controller Board

1. Open the Instrument Front Cover.
2. If the **Control**Wave **GFC-CL** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the Battery Charger & I/O Board Assembly at TB1, TB2 and TB3.
3. Disconnect all CPU/System Controller Board communication cables, making sure they are identified so they can be returned to their assigned Comm. Ports.
4. Disconnect the I/O Bus cable from connector J5.
5. Disconnect the Power cable from connector J1.
6. Disconnect the Keypad cable from connector J2 or the 2-Key Pushbutton cable from connector J14.
7. While securing the CPU/System Controller Board, remove the six screws that secure it to the six mounting standoffs. Carefully slide the Keypad/2-Key Pushbutton cable through the board's slotted cutout area and remove the CPU/System Controller Board assembly from the Instrument Front Cover.
8. If the CPU/System Controller Board is to be replaced, remove any optional piggy-back mounted printed circuit boards.
9. To replace a CPU/System Controller Board, power must be off. Install the appropriate optional hardware and the LCD Display/Keypad hardware. Open the Instrument Front Cover. Carefully slide the Keypad/2-Key Pushbutton cable through the board's slotted cutout area (rear to front). Align the CPU/System Controller Board with its six mounting standoffs and install the six mounting screws.
10. Replace all cables removed in steps 3 through 6. Apply power and test the unit.

3.2.3 Removal/Replacement of a Primary Battery System

1. If the **Control**Wave **GFC-CL** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the Battery Charger & I/O Board Assembly at TB1, TB2 and TB3.
2. Loosen the four screws that secure the Radio/Modem Mounting Bracket to the Battery Mounting Bracket.
3. Slide Radio/Modem Mounting Bracket toward the top of the unit and remove it. If a Radio or Modem is installed, carefully set the Radio/Modem Mounting Bracket to one side.
4. Carefully remove the Primary Battery System (with cables attached).
5. To replace the Primary Battery System, follow steps 4 through 2 in reverse order. Replace Power cables (TB1, TB2 and TB3) and test the unit. **Note: Make sure the Primary Battery is fully charged before installing it.**

3.2.4 Removal/Replacement of the Battery Charger & I/O Board

1. Open the Instrument Front Cover.
2. If the **Control**Wave **GFC-CL** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the Battery Charger & I/O Board Assembly at TB1, TB2 and TB3.
3. Unplug all Card Edge field wiring Terminal Blocks in use, i.e., TB4 through TB10.
4. Remove the Primary Battery System (see Section 3.2.3)
5. Slide the Battery Charger & I/O Board forward until you can remove the large screw that secures the System Ground Cable to it. Remove the large System Ground Cable Screw.
6. Continue to slide the Battery Charger & I/O Board forward until the CPU/System Controller Interface cable can be removed from connector P3 on its rear (left side).

7. Unplug the MVT Interface cable from P2.
8. Remove the Battery Charger & I/O Board and unplug the System Power cable from connector P1.
9. To replace the Battery Charger & I/O Board, follow steps 8 through 2 in reverse order.
10. Replace Power cables (TB1, TB2 and TB3) and test the unit.

3.2.5 Removal/Replacement of an External Radio/Spread Spectrum Modem

1. If the **Control**Wave **GFC-CL** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the Battery Charger & I/O Board Assembly at TB1, TB2 and TB3.
2. Disconnect (unplug) all connectors (power and interface) from the Radio/Modem.
3. Disconnect the antenna cable from the Radio/Modem.
3. Loosen the four screws that secure the Radio/Modem Mounting Bracket to the Battery Mounting Bracket.
4. Slide Radio/Modem Mounting Bracket toward the top of the unit and remove it with the Radio or Modem installed.
5. Remove the mounting screws from the bottom (inside) of the Radio/Modem Mounting Bracket and remove the Radio/Modem.
6. Replace the Radio/Modem in the reverse order from which it was removed.
7. Replace Power cables (TB1, TB2 and TB3) and test the unit.

3.2.6 Removal/Replacement of the MVT or GPT Transducer

1. If the **Control**Wave **GFC-CL** is running, place any critical control processes under manual control.
2. Shut down the unit by disconnecting power to the Battery Charger & I/O Board Assembly at TB1, TB2 and TB3. Remove the **Control**Wave **GFC-CL** from its installation site and take it to a depot repair area that supports proper ESD control.
3. Disconnect the MVT/GPT Interface Cable from the Battery Charger & I/O Board Assembly.
4. Remove the large Mounting Collar (Nut) from the neck of the MVT/GPT; then unscrew the four screws (from within the enclosure) that secure the MVT to the GPT Mounting Plate to the bottom of the enclosure and remove the MVT/GPT Transducer.
5. To install a replacement MVT'GPT, follow steps 4 through 1 in reverse order. Make sure the MVT/GPT O-Ring Seal is in place and apply anti-sieze compound as required. When installing a MVT into the bottom of the enclosure, orient the Flange for the desired High and Low settings.

3.3 TROUBLESHOOTING TIPS

3.3.1 Battery Charger & I/O Board Voltage Checks

One bulk power source or an internal battery (Primary Power System) can be connected to the Battery Charger & I/O Board Assembly. Connector TB2 provides 2 input terminal connections for bulk power (see Figure 3-3):

TB2-1 = (+VIN) (+4.5/4.9V to +8Vdc for +6V supply) (+9.6/10.3V to +16Vdc for +12V supply)
TB2-2 = Chassis Ground - CHASSIS

Bulk supply voltages can be checked at TB2 using a voltmeter or multimeter. Battery Charger & I/O Board Assemblies are factory configured for use with a nominal 6Vdc or 12Vdc bulk power supply. The maximum and minimum input power switch-points can be tested with the use of a Variable dc Power Supply connected between TB2-1 (+) and TB2-2 (-). By increasing the input voltage (starting at less than +4.5Vdc or less than +9.6Vdc) for +6V or +12V units respectively, you can determine the point at which the unit will turn on, i.e., the point at which the green PWRGOOD LED on the CPU/System Controller Board comes ON (Vt+). By decreasing the input voltage (starting at 8Vdc or +16Vdc), you can determine the point at which the unit turns off, i.e., the point at which the PWRGOOD LED on the CPU/System Controller Board goes OFF (Vt-). If the value of the Primary Power System (battery) or bulk power supply's +6Vdc or +12Vdc output approaches the value of Vt+ or Vt- it should be replaced by a battery/power supply with the correct +6V or +12V output.

3.3.2 LED Checks

ControlWave **GFC-CL** CPU/System Controller Boards contain light emitting diodes (LEDs) that provide operational and diagnostic functions. With the exception of the Ethernet Port transmit and receive LEDs (green and yellow respectively) and the Power Good LED (CR13) which is green all LEDs are red.

A brief synopsis of the individual CPU/System Controller Board LEDs (CR#) is provided as follows:

CR13 Power Good
CR21 DCD ON
CR22 DTR Active
CR35 Status LED 1 (see Table 3-1 and Figures 3-1 & 3-2)
CR36 Status LED 2 (see Table 3-1 and Figures 3-1 & 3-2)
CR37 Status LED 3 (see Table 3-1 and Figures 3-1 & 3-2)
CR38 Status LED 4 (see Table 3-1 and Figures 3-1 & 3-2)
CR39 Status LED 5 (see Table 3-1 and Figures 3-1 & 3-3)
CR40 Status LED 6 (see Table 3-1 and Figures 3-1 & 3-2)
CR41 Watchdog LED - ON = Watchdog Condition - OFF = Normal Operation
CR42 Idle LED - ON = Idle
CR43 Comm. Port 3 - TX - ON = Transmit Activity
CR44 Comm. Port 3 - RX - ON = Transmit Activity
CR45 Comm. Port 1 - TX - ON = Transmit Activity
CR46 Comm. Port 1 - RX - ON = Transmit Activity
CR47 Comm. Port 2 - TX - ON = Transmit Activity
CR48 Comm. Port 2 - RX - ON = Transmit Activity

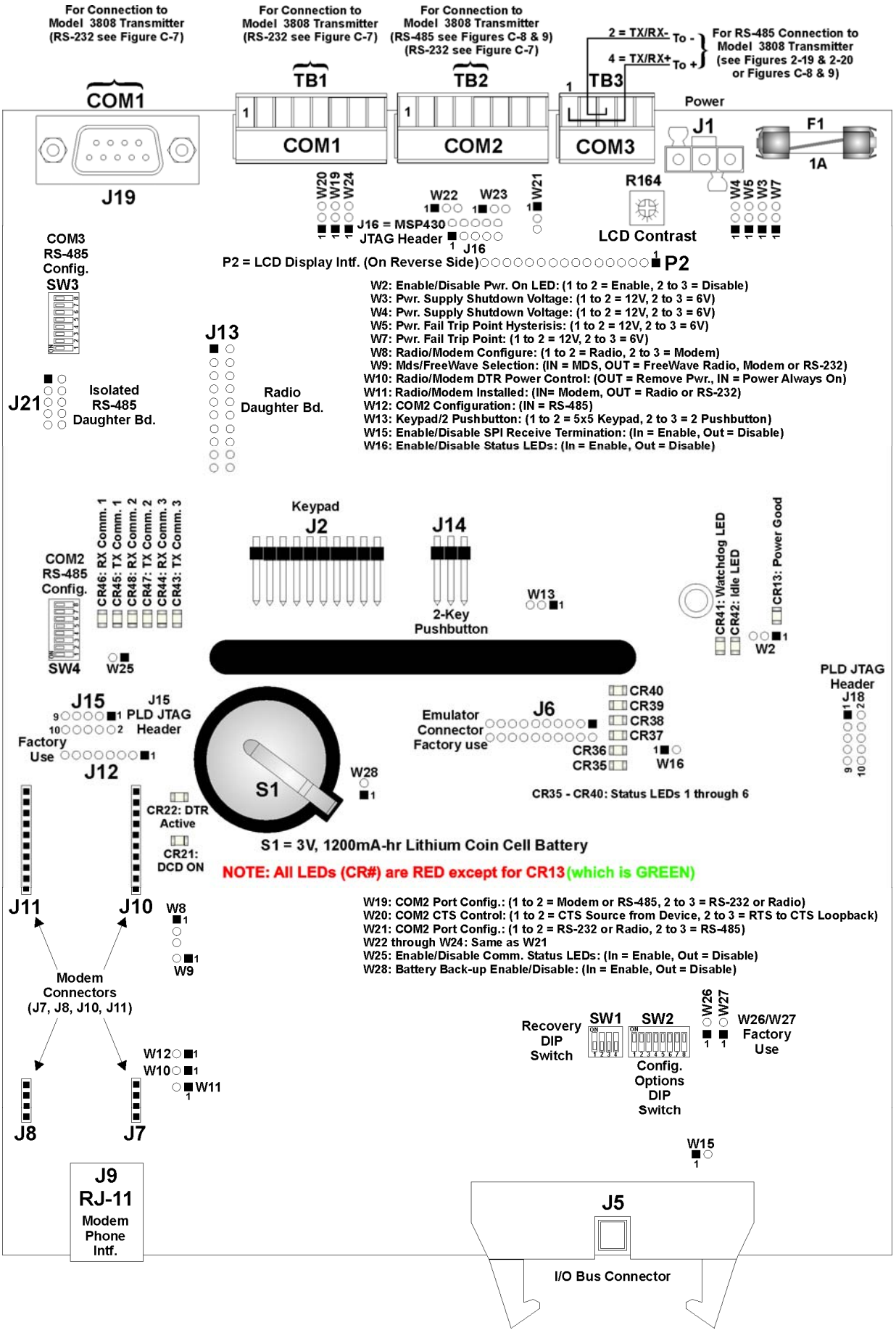


Figure 3-1 - CPU/System Controller Board Component Identification Diagram

Table 3-1 - System Status Codes LCD Display & LEDs on CPU/System Cntrl. Bd.

LED 6 CR40	LED 5 CR39	LED 4 CR38	LED 3 CR37	LED 2 CR36	LED 1 CR35	Status In Hex	LCD Disp.	Indication Definition
0	0	0	0	0	0	00	Blank	Application Running
0	0	0	0	0	1	01	DIAG	Unit in Diagnostic Mode
0	0	0	0	1	1	03	R DIAG	Unit Running Diagnostics
0	0	0	1	0	0	04	FWXSUM	Flash XSUM Error
0	0	0	1	0	1	05	DEVERR	Error Initializing Application Device
0	0	0	1	1	1	07	FLASH	Flash Programming Error
0	0	1	0	0	0	08	FACT	Using Factory Defaults *
0	0	1	0	0	1	09	BATT	Battery Failure Detected *
0	0	1	0	1	0	0A	STRTUP	Currently Loading Boot Project
0	0	1	0	1	1	0B	INIT	System Initialization in Progress
0	1	0	0	0	0	10	RECOV	Waiting in Recovery Mode
0	1	0	0	1	0	12	RAMERR	Error Testing SRAM
1	0	0	0	0	0	20	STOP	Application Loaded
1	0	1	0	0	0	28	HALT	Stopped at a Break Point
1	1	0	0	0	0	30	NO APP	No Application Loaded
1	1	1	0	0	0	38	BREAKP	Running with Break Points
1	1	1	0	1	1	3B	POWERD	Waiting for Power-down (after NMI)
1	1	1	1	1	0	3E	UPDUMP	Waiting for Updump to be Performed
1	1	1	1	1	1	3F	NOTRUN	Unit Crashed (Watchdog Disabled)

*** = Flashed at startup**

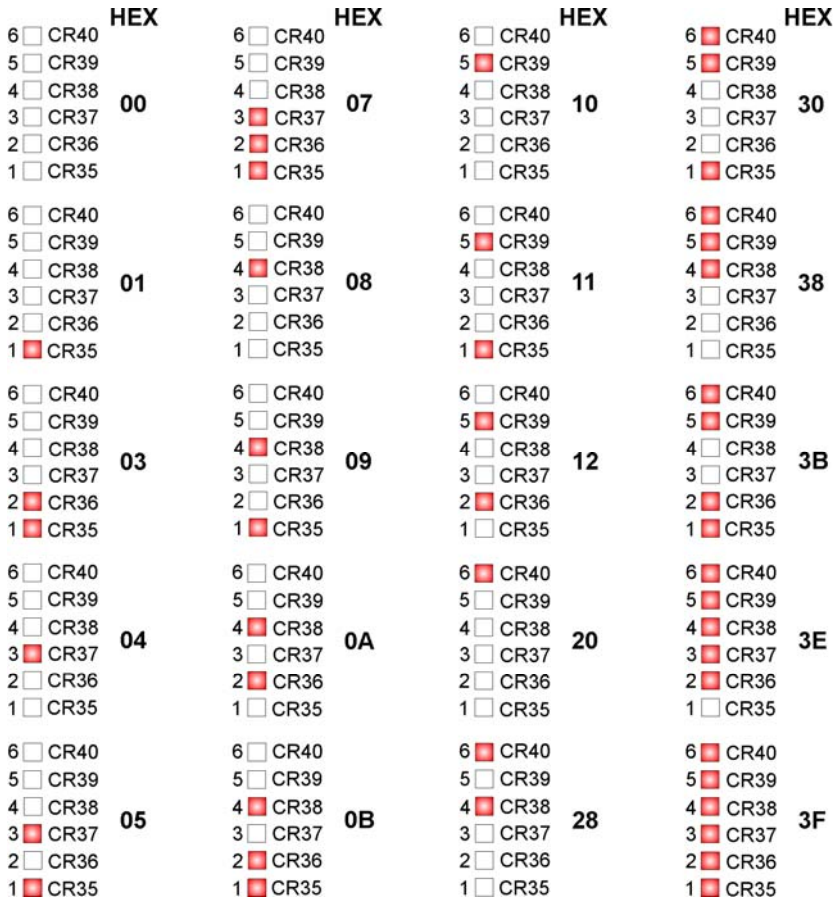


Figure 3-2 - CPU/System Controller Board Status LED Hexi-decimal Codes (See Table 3-1 for Definitions)

3.3.3 Wiring/Signal Checks

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

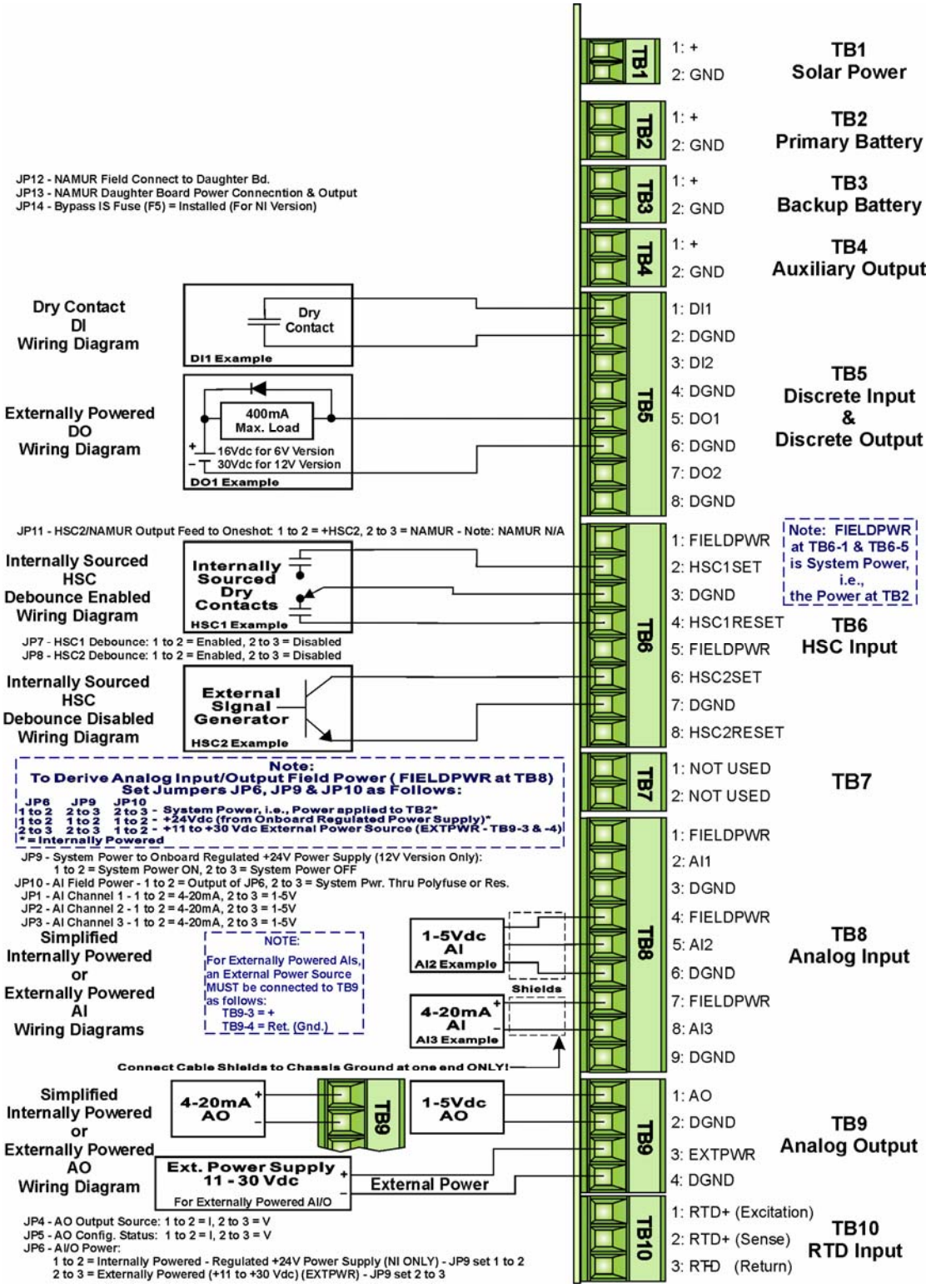


Figure 3-3 - Battery Charger & I/O Board Field Wiring Diagram

(Note: See Figure 2-7 for Battery Charger & I/O Board Component Identification)

3.4 GENERAL SERVICE NOTES

Certain questions or situations frequently arise when servicing the **Control**Wave **GFC-CL**. Some items of interest are provided in Sections 3.4.1 through 3.4.4.

3.4.1 Extent of Field Repairs

Field repairs to a **Control**Wave **GFC-CL** are strictly limited to the replacement of complete modules. Component replacement on a **Control**Wave **GFC-CL** Module constitutes tampering and will violate the warranty. Defective **Control**Wave **GFC-CL** components (printed circuit boards, LCD Displays, Multivariable Transducer (MVT, etc.) must be returned to Bristol for authorized service.

3.4.2 Disconnecting RAM Battery

The **Control**Wave **GFC-CL**'s Lithium RAM battery cannot be replaced while power is on. Once the RAM battery has been replaced, the unit will still execute its FLASH-based application load (Boot Project) upon power-up, but all of the current process data will have been lost. Upon power-up, the unit will act as though it had just been booted and it will revert back to the initial values specified in its application load. The battery may be disabled by removing the CPU/System Controller Board's Battery Backup Board Jumper, W28.

3.4.3 Maintaining Backup Files

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

3.5 WINDIAG DIAGNOSTICS

Bristol Babcock's WINDIAG program provides menu driven diagnostics that have been designed to assist a technician or Process Engineer in troubleshooting the various Control Wave **GFC-CL circuits. For more detailed descriptions of Control**Wave **GFC-CL Windows Diagnostics than those provided herein see Document D4041A – Chapters 1 & 7C.**

Bristol's WINDIAG Software is a diagnostic tool used for testing **Control**Wave **GFC-CL** electronics including, I/O circuitry, CPU memory, communications ports, etc., for proper performance. The **Control**Wave **GFC-CL** must be communicating with a PC equipped with the WINDIAG program. CPU/System Controller Board configuration switch SW2-8 must be set to the OFF (Closed) position to enable diagnostics. Communication between the **Control**Wave **GFC-CL** (with/without application loaded) and the PC can be made via a Local or Network Port with the following restrictions:

- CPU/System Controller Board Switch SW2-8 must be OFF to run the WINDIAG program. Setting SW2-8 OFF will prevent the 'Boot Project' from running and will place the unit into diagnostic mode.

- Any **Control**Wave **GFC-CL** communication port can be connected to the PC (Process Engineer's Interface) provided their port speeds and configuration match, e.g., baud

rate, parity, stop bits, protocol, etc. This can be accomplished via user defined Soft Switches.

- Setting CPU/System Controller Board Switch SW2-3 OFF will force ports COM2 and COM3 to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation.

- Communication port COM1 is only forced to 9600 bps operation when CPU/System Controller Board Switches SW2-3 and SW2-8 have both been set OFF. COM1 can also be set to 9600 bps operation via user defined Soft Switches.

- Setting CPU/System Controller Board Switches SW2-3 and SW2-8 OFF prevents the 'Boot Project' from running, places the unit into diagnostic mode and forces communication ports COM1, COM2 and COM3 to operate at 9600 baud.

COM1: From the factory, RS-232 Communications Port COM1 defaults to 115.2 kbd (RS-232) using the BSAP Protocol. *Note: Port COM1 will be configured for RS-232 operation (at 9600 baud) by setting CPU/System Controller Board Switches SW2-3 and SW2-8 OFF. This will prevent the boot project from running and places the unit into diagnostic mode. CPU/System Controller Board Switch SW2-8 must be set OFF to run the WINDIAG program.* Connection to a PC requires the use of an RS-232 "Null Modem" cable (see Figure 2-11 or 2-12).

Communication Port COM1 has three (3) physical locations. Only one of these connectors can be connected to a PC or other devise. Com1 connectors are identified as follows:

A 9-pin male D-type connecter (J19) on the CPU/System Controller Board.

An 8-position Terminal Block (TB1) on the CPU/System Controller Board. From the factory, a wiring harness connects TB1 to the Local Port (situated on the bottom of the Instrument Cover.

Either a 9-pin male D-type connecter or a 3-pin circular connector situated on the bottom of the Instrument Cover.

COM2: From the factory, RS-232/RS-485 Communications Port COM2 (8-position Terminal Block TB2) on the CPU/System Controller Board defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation (RS-232).

Note: COM2 is assigned to either an optional Radio/Spread Spectrum Modem or a 56K PSTN Modem (mounted piggy-back on the CPU/System Controller Board). If one of these options is present, connector TB2 should not be used. In lieu of one of the piggy-back mounted communication options, an external Radio/Spread Spectrum Modem may be mounted inside the unit on the Radio Mounting Bracket. An external Radio/Spread Spectrum Modem is interfaced to COM2 via connector TB2 on the CPU/System Controller Board.

COM3: RS-485 Communications Port COM3 on the CPU/System Controller Board (5-position Terminal Block TB3) defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. In lieu of the use of an RS-232

Port, an RS-485 cable (see Tables 2-3 & 2-5) can be connected between COM3 and a PC's RS-485 Port.

To use the WINDIAG program place any critical process (associated with the **Control**Wave **GFC-CL** unit in question) under manual control. WINDIAG cannot be run while the **Control**Wave **GFC-CL** application is running. Set the CPU/System Controller Board Switch SW2-8 to the OFF position. Perform steps 1 through 6 below.

1. Start the OpenBSI NetView Program. A menu similar to Figure 3-4 will appear.

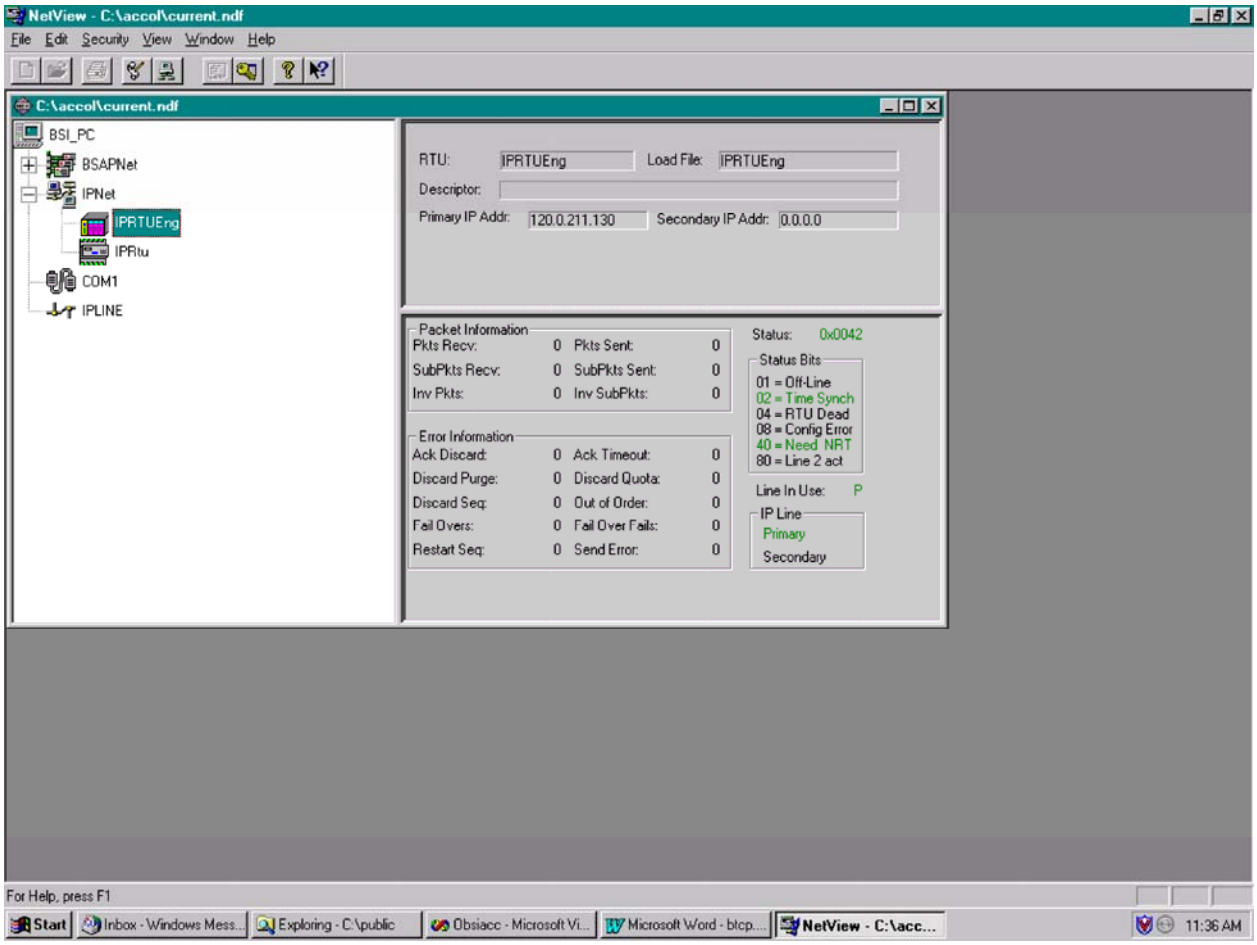


Figure 3-4 - Netview Startup Menu - Example with Multiple Networks

2. To start the WINDIAG program, go to the Start Program's menu, select OpenBSI Tools, then select Utilities Programs and then select Diagnostics.

3. Once WINDIAG has been entered, the Main Diagnostics Menu of Figure 3-5 will appear.

4. Select the module to be tested. Enter any prompted parameters (slot #, etc.). WINDIAG will perform the diagnostics and display pass/fail results.

5. After all diagnostic testing has been performed, exit the WINDIAG program and then exit the Netview Program if there aren't any other **Control**Wave **GFC-CL** units to be tested.

When you close the Netview program you will be prompted as to whether or not you want to close the OpenBSI program; select Yes.

6. Set **Control**Wave **GFC-CL** CPU/System Controller Board Switch SW2-8 to the ON (Open) position. The **Control**Wave **GFC-CL** should resume normal operation.

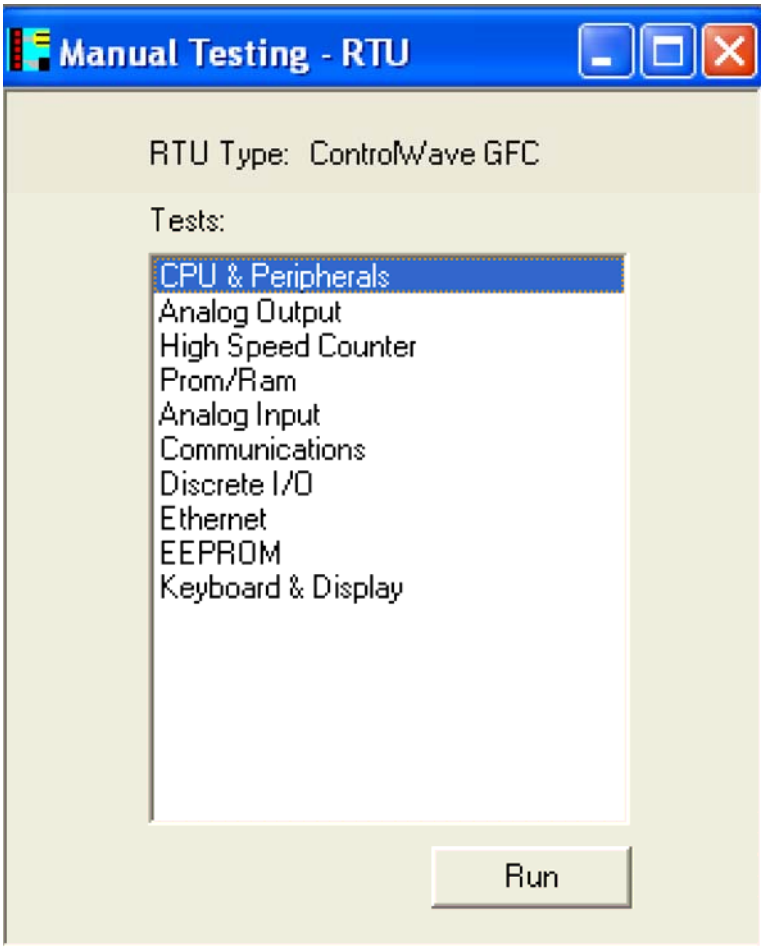


Figure 3-5 - WINDIAG Main Diagnostics Menu

3.5.1 Diagnostics Using WINDIAG

ControlWave **GFC-CL** electronics can be tested using the WINDIAG program. From WINDIAG's Main Diagnostics Menu (see Figure 3-5) the following diagnostic tests can be performed:

CPU & Peripherals Diagnostic:	Checks the CPU/System Controller Board [except for RAM & PROM (FLASH)].
PROM/RAM Diagnostic:	Checks the CPU/System Controller Board's RAM and PROM (FLASH) hardware.
Communications Diagnostic:	Checks Comm. Ports 1, 2 and 3 - The External loop-back tests require the use of a loop-back plug.
Analog Output Diagnostic:	Checks AOs on the Battery Charger & I/O Board.
Analog Input Diagnostic:	Checks AIs on the Battery Charger & I/O Board.
Discrete I/O Diagnostic:	Checks DIs or DOs on the Battery Charger & I/O Bd.
High Speed Counter Diagnostic:	Checks HSCs on the Battery Charger & I/O Board.
Keyboard & Display Diagnostics	Checks Keyboard/Keypad & Display hardware

3.5.1.1 Communications Diagnostic Port Loop-back Test

WINDIAG's Communications Diagnostic Menu (see Figure 3-8) provides for selection of the communication port to be tested. Depending on the type of network (RS-232 or RS-485) and the port in question, a special loop-back plug is required as follows:

Port 1 - RS-232 use a 9-pin female D-type loop-back plug or loop-back wires (see Fig. 3-6).
Port 2 - RS-232 use loop-back wires (see Figure 3-6).
Port 2 - RS-485 use loop-back wires (see Figure 3-7)
Port 3 - RS-485 use loop-back wires (see Figure 3-7).

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

3.5.1.2 Serial Comm. Port External Loop-back Test Procedure

Connect an external loop-back plug or loop-back wires to the Communications Port to be tested (see Figures 3-6 and 3-7).

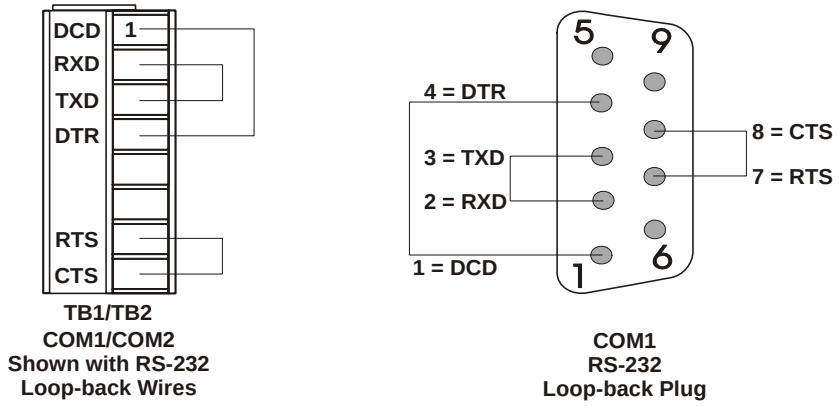


Figure 3-6 - RS-232 Loop-back Plug/Wires

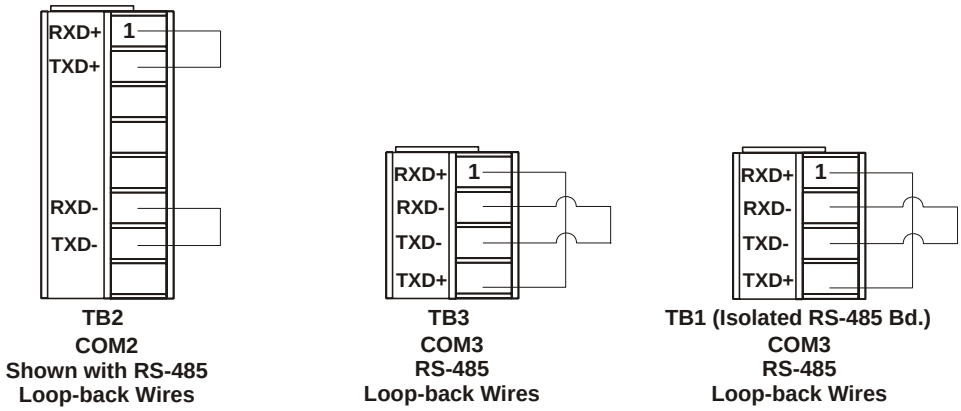


Figure 3-7 - RS-485 Loop-back Wires (Note TB1 N/A)

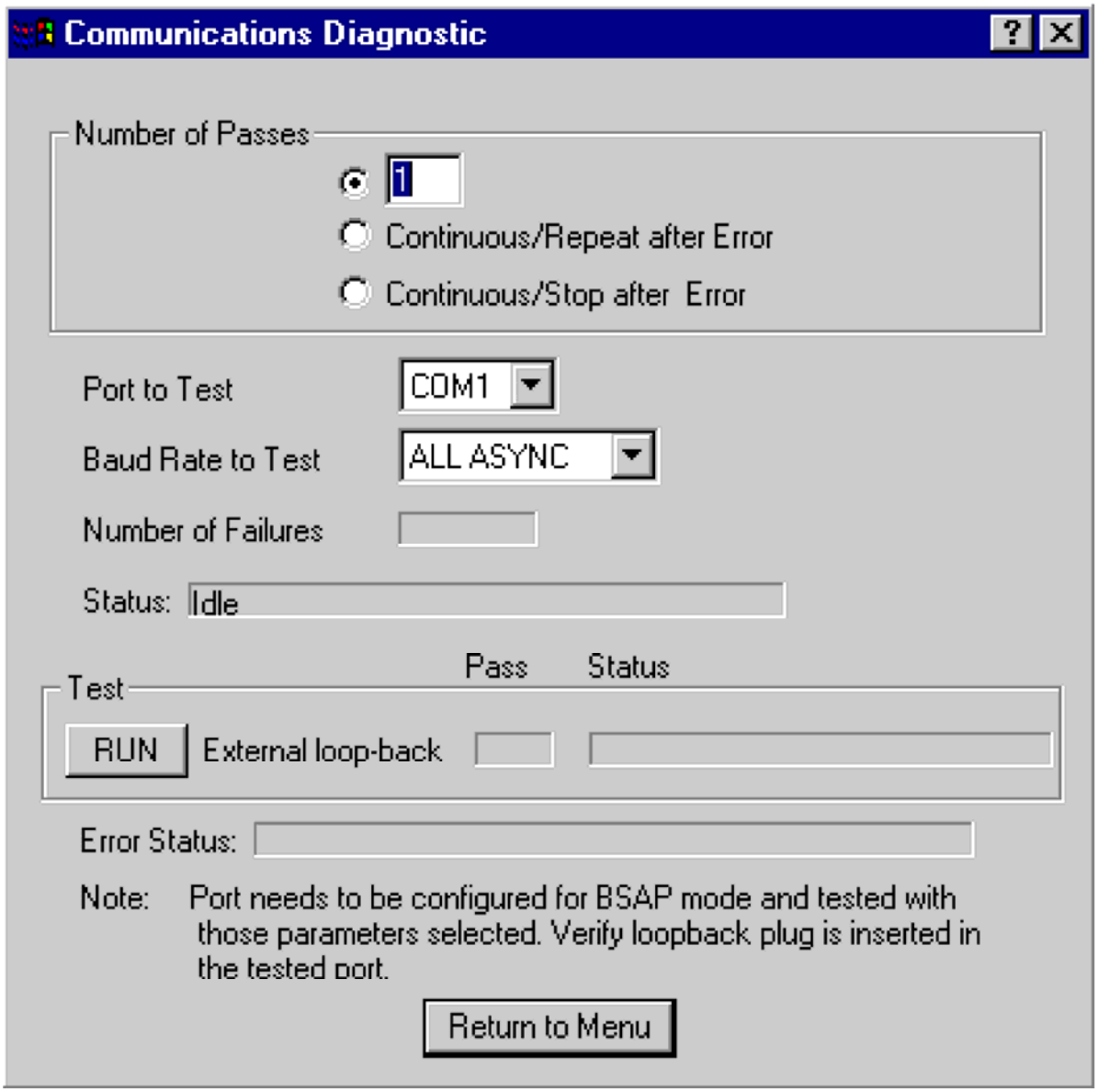


Figure 3-8 - WINDIAG's Communications Diagnostic Menu

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

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

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

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

3.6 CORE UPDUMP

In some cases a copy of the contents of SRAM and SDRAM can be uploaded to a PC for evaluation by Bristol Babcock Inc. (BBI) engineers. This upload is referred to as a 'Core

Updump.' A Core Updump may be required if the **Control**Wave **GFC-CL** electronic flow meter repeatedly enters a 'Watchdog State' thus ill effecting system operation. A Watchdog State is entered when the system crashes, i.e., a CPU timeout occurs due to improper software operation, a firmware glitch, etc. In some cases the Watchdog State may reoccur but may not be logically reproduced.

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

Follow the five steps below to perform a Core Updump.

1. Set CPU/System Controller Board Switch SW2-1 OFF (Disable Watchdog Timer). If Switch SW2-4 is ON, set it to OFF (Enable Core Updump). **Note: The factory default setting for SW2-4 is OFF.**

2. Wait for the error condition (typically 3F on SCM Status LEDs).

3. Connect **Control**Wave **GFC-CL** Comm. Port 1 to a PC using a Null Modem Cable (see Figures 2-11 and 2-12).

4. Set CPU/System Controller Board Switch (SW1- Recovery) so that SW1-1 and SW1-2 are both in either the **UP** (ON) position or the **DOWN** (OFF) position.

5. Start the PC's HyperTerminal Program (at 115.2kbaud) and generate a file using the 1KX-Modem protocol. Save the resulting Core Updump in a file to be forwarded to BBI for evaluation.

When the Core Updump has been completed, set the CPU/System Controller Board's Recovery Switch as follows: SW1-1 is in the **DOWN** position & SW1-2 is in the **UP** position. Enable the Watchdog Timer by setting CPU/System Controller Board' SW2-1 ON.

3.7 CALIBRATION CHECKS

Calibration of the MVT/GPT and the RTD are performed using OpenBSI's TechView Program (see document # D5131 – TechView User's Guide).

Section 4
SPECIFICATIONS

4.1 CPU, MEMORY & PROGRAM INTERFACE

Processor: Sharp's LH7A400 32-bit System-on-Chip with 32-bit ARM9TDMI RISC Core

Memory: 8 Mbytes of simultaneous read/write FLASH
2 Mbyte of on-board SRAM
512 Kbytes FLASH Boot/Downloader

Real Time Clock: A Semtech SH3000 support IC provides a full BCD clock calendar with programmable periodic/wakeup interrupt and a programmable clock generator with adjustable spectrum spreading.

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

Table 4-1 - CPU/System Controller Board Connector Summary

Ref.	# Pins	Function	Notes
P2	16-pin	Display Intf.	Reverse Side of Board
P3	76-pin	Factory Debug	Not shown or user accessible
J1	3-Pin	Power	Top Edge - see Figure 1-5
J2	10-Pin	25-Button Keypad Intf.	
J5	26-pin	IOBUS	Intf. to Battery Charger & I/O Bd.
J6	20-pin	Emulator Connector	Factory Use
J7	4-pin	Modem connector	Piggy-back Modem
J8	4-pin	Modem connector	Piggy-back Modem
J9	6-pin	Modem/Phone Line connector	Tip & Ring used (Bottom Edge)
J10	10-pin	Modem connector	Piggy-back Modem
J11	10-pin	Modem connector	Piggy-back Modem
J12	8-pin	Modem Signal Debug	Not user accessible
J13	20-pin	Radio Daughter Board	
J14	3-pin	2-Key Pushbutton	
J15	10-pin	PLD JTAG Header	Not user accessible
J18	10-pin	PLD JTAG Header	Not user accessible
J19	9-pin	9-pin Male D-type (COM1 - RS-232)	Top Edge
J21	10-pin	Isolated RS-485 Daughter Board	N/A
TB1	8-pin	Term. Block (COM1 - RS-232)	see Table 2-x or 4-x
TB2	8-pin	Term. Block (COM2 - RS-232/485)	see Table 2-x or 4-x
TB3	5-pin	Term. Block (COM3 - RS-485)	see Table 2-x or 4-x

4.2 COMMUNICATION PORTS

Connector/Port: CPU/System Controller Board
J19 - 9-Pin D-Type - COM1 (RS-232)
TB1 - 8-Pos. Term. Block - COM1 (RS-232)
TB2 - 8-Pos. Term. Block - COM2 (RS-232/RS-485)
TB3 - 5-Pos. Term. Block - COM3 (RS-485)
J9 - 6-Pin RJ-45 - COM2 - PSTN Modem*

Bottom of Front Cover (one or the other)
9-Pin D-Type - COM1 (RS-232)
3-Pin Circular - COM1 (RS-232)

Baud Rate: 300 to 115Kbps for RS-232 or RS-485
Up to 56Kbps for Modem

Table 4-2A - RS-232 Ports (COM1 & 2) and RS-485 Port (COM2) Connector Pin Assignments (All COM1 Connectors, i.e., J19 & TB1 and COM2 Connector TB2 – Located on CPU/System Controller Bd.)

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

Table 4-2B - RS-232 Port (COM1) Connector Pin Assignments (Local Port on Bottom of Front Cover & TB1 on CPU/System Controller Bd)

TB1 Pin #	Signal RS-232	Description: RS-232 Signals	Local Port RS-232 Pin #
2	RXD	Receive Data Input	7 (WHT Wire)
3	TXD	Transmit Data Output	2 (RED Wire)
5	GND	Power Ground	6 (BLK Wire)

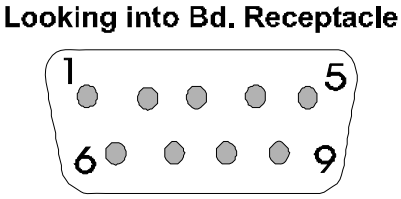


Figure 4-1A - DB9 9-Pin Connectors Associated with COM1 Located on CPU/System Controller Bd. or Bottom of Front Cover (Local Port)

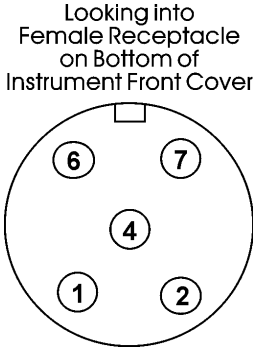


Figure 4-1B - Circular Local Port Connector Associated with COM1 Located on Bottom of Instrument Front Cover

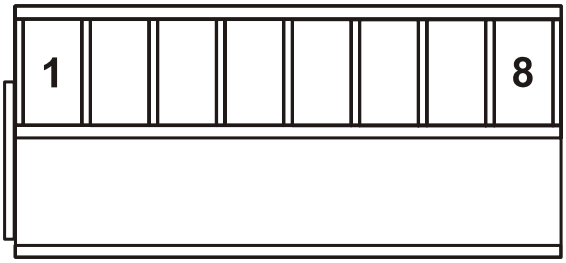


Figure 4-2 - 8-Position Terminal Block TB1 & TB2 Associated with COM1 & COM2 Located on CPU/System Controller Board

Table 4-3 - RS-485 Port (COM3) Connector Pin Assignments
TB3 - Located on CPU/System Controller Board

Pin #	Signal RS-485	Description: RS-485 Signals
1	RXD+-	Receive Data + Input
2	RXD-	Receive Date - Input
3	TXD–	Transmit Data – Output
4	TXD+	Transmit Data + Output
5	Power Ground	Ground

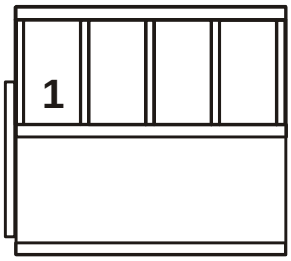


Figure 4-3 - 5-Position Terminal Block Associated with COM3
TB3 Located on CPU/System Controller Board

4.3 CPU/SYSTEM CONTROLLER BOARD

4.3.1 Input Power Specs.

Note: Voltages are dc unless otherwise specified.

Operating Range:	+4.5/4.9V to +16.0V (+6V Input Supply) (Shutdown occurs at +4.72/4.33V nominal) +9.6/10.3V to +16.0V (+12V Input Supply) (Shutdown occurs at +10.29/9.56V nominal)
Output Voltages:	+3.3Vdc ±1%
Output Current:	1A Max. @ 3.3Vdc
Output Ripple P/P:	+3.3V Output: 10mV
Fusing:	1A Slow Blow 5x20mm Fuse
Electrical Isolation:	None

Surge Suppression: 16V Transorb to DGND and Chassis
Meets ANSI/IEEE C37.90-1978

Terminations: Pluggable, maximum wire size is 16 gauge

Shutdown: +6V System:
Max. ON Switchpoint = 4.90V
Min. OFF Switchpoint = 4.33V

+12V System:
Max. ON Switchpoint = 10.3V
Min. OFF Switchpoint = 9.28V

4.3.2 Power Supply Sequencer Specs.

Signals Monitored: Input Power

Sequencer Switchpoints: +3.3V Max. ON Switchpoint = +3.15V
+3.3V Min. OFF Switchpoint = +3.00V
+1.8V Max. ON Switchpoint = +1.72V
+1.8V Min. OFF Switchpoint = +1.64V

Sequencer Output Signals: PFDLYCLK Timing on power down 2msec after POWER-FAIL
VIN100M timing on power Up 1200msec delay for Good Power
POWERGOOD incoming power, 3.3V & 1.8V in Spec.

4.4 BATTERY CHARGER & I/O BOARD SPECIFICATIONS

4.4.1 External Power Monitor Specs.

Input Signal: Input power after fuse, before Diode

Input Range: 0 to 8Vdc (6V System), 0 to 16Vdc (12V System)

Resolution: 12 Bit

Accuracy: Calibrated: ±0.65% @ +25°C (+77°F)
Calibrated: ±0.91% over -40 to +85°C (-6.2 to +185°F)

4.4.2 Battery Charger & I/O Board Connectors (see Figure 4-4, Tables 4-4 & 4-5)

Table 4-4 – Battery Charger & I/O Board User Connector Summary

Ref.	# Pins	Function
P1	3-pin	System Power Intf. Connector
P2	8-pin	MVT Interface Connector
P3	26-pin	CPU/System Controller Intf. Connector
TB1	2-pin	Solar Power Terminal Block
TB2	2-pin	Primary Battery Terminal Block
TB3	2-pin	Backup Battery Terminal Block
TB4	2-pin	Auxiliary Power Terminal Block
TB5	8-pin	DI & DO Terminal Block

Table 4-4 – Battery Charger & I/O Board User Connector Summary (Continued)

Ref.	# Pins	Function
TB6	8-pin	HSC Terminal Block
TB7	2-pin	NAMUR Terminal Block (N/A)
TB8	9-pin	AI Terminal Block
TB9	4-pin	AO Terminal Block
TB10	3-pin	RTD Interface Terminal Block

Table 4-5 - System Controller Module Input Power Terminal Block Assignments

TERM. #	NAME	FUNCTION
TB1-1	+VIN	+6Vdc or +12Vdc (nominal) Input
TB1-2	-VIN	Supply Common (Ground)

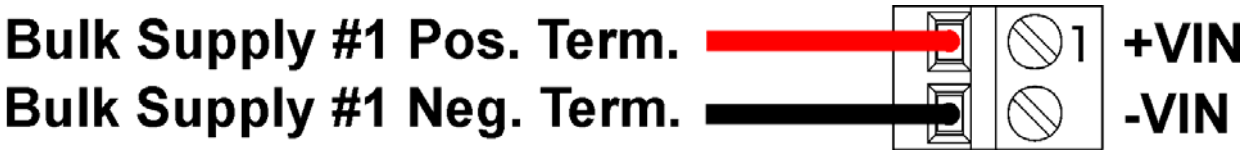


Figure 4-4 - Battery Charger & I/O Board (TB2) (Primary Power Connector)

4.4.3 Non-isolated Digital Input/Output Circuitry Specs.

Non-isolated Digital Inputs

Number of Inputs:	2 DI - Internally Sourced (Dry Contact) operation
Input Filtering:	15 milliseconds
Input Current:	60uA nominal
'0' State Voltage:	below 1.5V
'1' State Voltage:	above 1.5V
Bus Access:	SPI
Electrical Isolation:	None
Surge Suppression:	Transorb between signal and ground (16V for 6V Version, 31V for 12V Version) Meets ANSI/IEEE C37.90-1978
Status Indication:	None

Non-isolated Digital Outputs

Number of Outputs:	2 DO
Output Configuration:	Open Drain (Externally Powered)
Maximum Load Current:	100mA each @ 16/30Vdc (6/12V System)

Bus Access:	SPI
Electrical Isolation:	None
Surge Suppression:	Transorb between signal and ground (16V for 6V Version, 31V for 12V Version) Meets ANSI/IEEE C37.90-1978

General DI/DO Circuitry Specs.

Terminations:	Pluggable, max wire size is 14 gauge for local terminations - Two 14-pin mass termination headers are provided for remote terminations.

4.4.4 Non-isolated Analog Input/Output Circuitry Specs.

Non-isolated Analog Inputs

Number of Inputs:	3 Single Ended Inputs (1-5V or 4-20mA) individually jumper configurable
Input Type:	(Externally Powered) Voltage Input: 1-5 Vdc (Externally Powered) Current Loop: 4-20mA
Input Impedance:	1 Meg ohm for 1-5V inputs 250 ohm for 4-20mA inputs

Non-isolated Analog Outputs

Number of Outputs:	1 AO (1-5V or 4-20mA) individually jumper configurable
4-20mA Output Compliance:	250 ohm load with 11V External Power Source 650 ohm load with 24V External Power Source
1-5V Output:	5mA maximum output current into external load with external voltage range of 11 to 30 Vdc
Internal Power for AI/O	24Vdc

General AI/AO Circuitry Specs.

Accuracy:	Analog Input 0.1% of Span @ +25°C (+77°F) 0.2% of Span @ -40°C to +70°C (-40°F to 158°F) Analog Output Current Output: 0.1% of Span @ +25°C (+77°F) 0.2% of Span @ -20°C to +70°C (-4°F to 158°F) 0.3% of Span @ -40°C to +70°C (-40°F to 158°F)

Voltage Output Compliance (I_{load}max = 5mA):
(see Note[1] & Note[2])
0.1% of Span + X @ +25ºC (+77ºF)
0.2% of Span + X @ -20ºC to +70ºC (-4ºF to +158ºF)
0.3% of Span + X @ -40ºC to +70ºC (-40ºF to 158ºF)
where X = [(2.5 ohms x I_{load})/4.4V x 100]
Note[1]: Does not include error due to inductors
Note[2]: 2.5 ohm uncompensated series resistance with Inductors

Terminations: Pluggable - Max. wire size is 14 gauge

Data Transfer: SPI

4.4.5 Non-isolated High Speed Counter Input Circuitry Specs.

Number of Inputs: 2 HSC Inputs per Module

Input Configuration: Internally Sourced Dry Contact, individually Jumper selectable Debounce Circuitry

Input Frequency: 10kHz Max.

Input filtering: 20 microseconds

Signal Conditioning: Debounce circuit for contact closures and bandwidth limiting

'1' State Voltage: below 1.5V
'0' State Voltage: above 1.5V

Bus Access: SPI

Electrical isolation: None

Surge Suppression: Transorb between signal and ground (16V for 6V Version, 31V for 12V Version)
Meets ANSI/IEEE C37.90-1978

Terminations: Pluggable, max wire size is 14 gauge for local terminations - Two 14-pin mass termination headers are provided for remote terminations

Status Indication: None

Power Consumption: Additional Current per Input
200uA per HSCSET or HSCRST Input (ON State)

4.5 ENVIRONMENTAL SPECIFICATIONS

Temperature: Operating: -40 to +158 °F (-40 to +70 °C)
Storage: -40 to +158 °F (-40 to +70 °C)

Relative Humidity:	0-95% Non-condensing
Vibration:	2g for 10 - 150 Hz 1g for 150 - 2000 Hz
RFI Susceptibility:	In conformity with the following standards: IEC 1000-4-3 (Level 2): 3V/meter - 80MHz to 1000MHz
ESD:	Field connected circuits meet the requirements of IEC 1000-4-2 for ESD withstand capability up to 4KV

4.6 DIMENSIONS

NEMA 3R Enclosure	**Control**Wave **GFC-CL** with MVT (see Figure 4-5) **Control**Wave **GFC-CL** with GPT (see Figure 4-6)

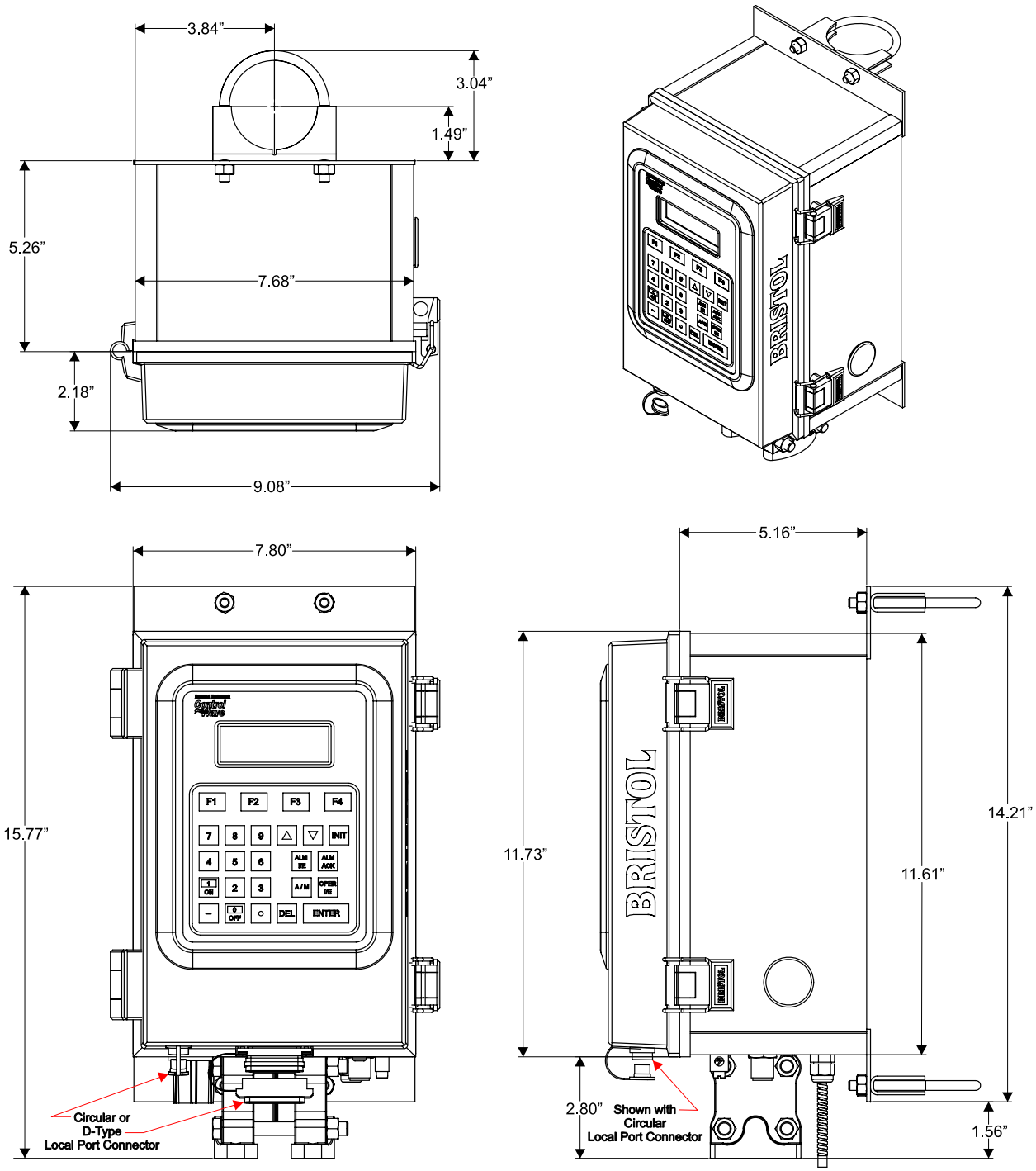


Figure 4-5 - ControlWave GFC-CL (with MVT) - NEMA 3R Enclosure Dimensions

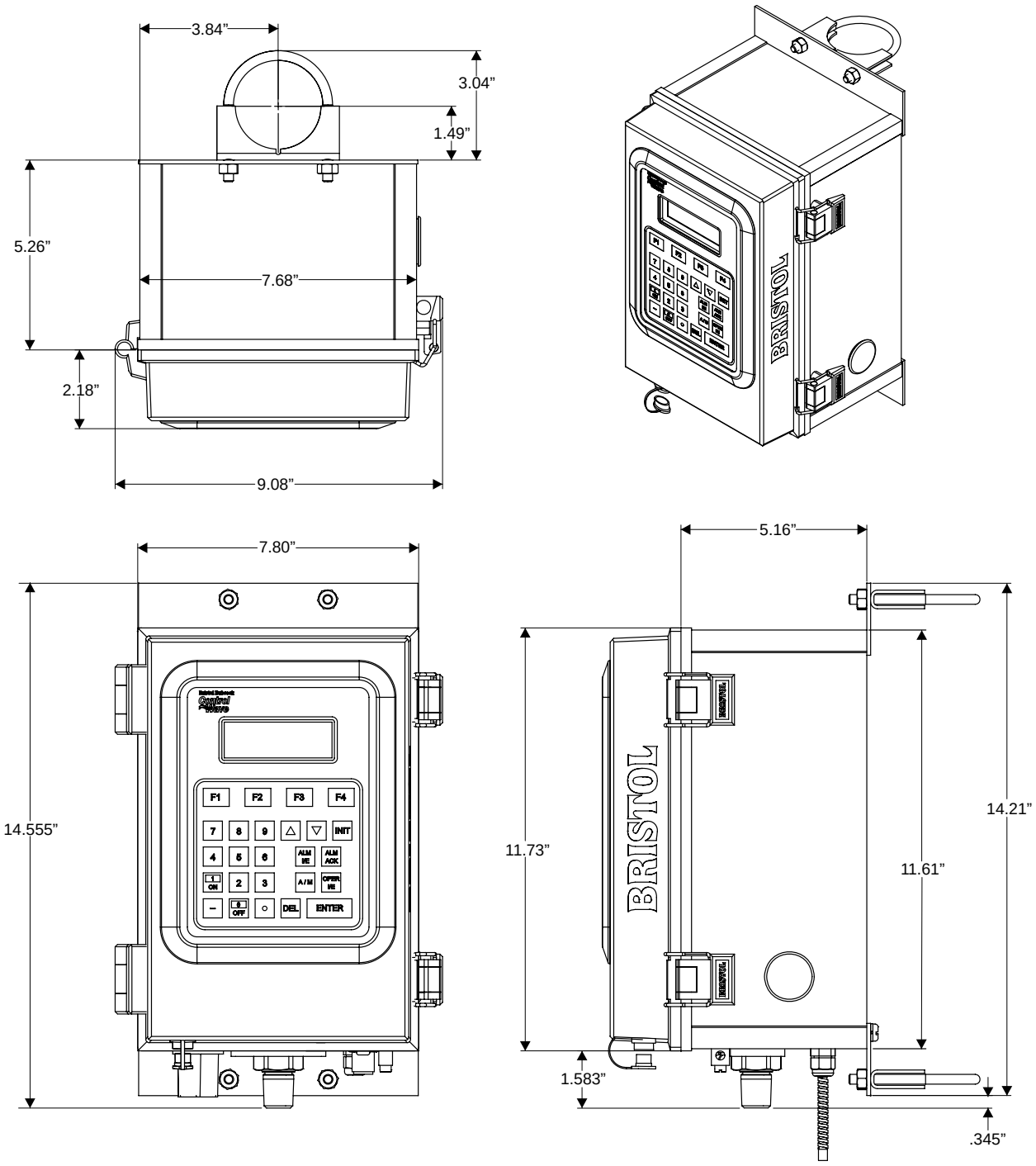


Figure 4-6 - Control Wave **GFC-CL (with GPT) - NEMA 3R Enclosure Dimensions**

ControlWave **GFC-CL**
Special Instructions for Class I, Division 2 Hazardous Locations

1. Bristol's **Control**Wave **GFC-CL** Gas Flow Computer is listed by Underwriters Laboratories (UL) as nonincendive and is suitable for use in Class I, Division 2, Group C and D hazardous locations or nonhazardous locations only. Read this document carefully before installing a nonincendive **Control**Wave **GFC-CL** Gas Flow Computer. Refer to the **Control**Wave **GFC-CL** Gas Flow Computer User's Manual for general information. In the event of a conflict between the **Control**Wave **GFC-CL** Gas Flow Computer User's Manual and this document, always follow the instructions in this document.
2. The **Control**Wave **GFC-CL** Gas Flow Computer includes both nonincendive and unrated field circuits. Unless a circuit is specifically identified in this document as nonincendive, the circuit is unrated. Unrated circuits must be wired using Div. 2 wiring methods as specified in article 501-4(b) of the National Electrical Code (NEC), NFPA 70 for installations in the United States, or as specified in Section 18-152 of the Canadian Electrical Code for installation in Canada.
3. The local communications port terminates in either a D-Type connector or a circular 3-pin connector on the bottom of the **Control**Wave **GFC-CL** Gas Flow Computer instrument front cover. The wiring on this connector is unrated. No connections may be made to this port unless the user ensures that the area is known to be nonhazardous. Connections to this port are temporary, and must be short in duration to ensure that flammable concentrations do not accumulate while it is in use.
4. The optional power system (solar panel and battery) approved for use with the nonincendive **Control**-Wave **GFC-CL** Gas Flow Computer are described in the Model Specification. The connection to the solar panel is approved as a nonincendive circuit so that Division 2 wiring methods are not required. The nominal panel voltage must match the nominal battery voltage (6V or 12V).
5. **WARNING: EXPLOSION HAZARD - Do Not disconnect Solar Power from the Battery or any other power connections within the Control**Wave **GFC-CL Enclosure (including connectors TB1 through TB4 and connector P1 on The Battery Charger & I/O Board, or connector J1 on the CPU/System Controller Board, any power connections to optional items such as radio/modem, or cabling to the Display/Keypad unless the area is known to be nonhazardous.**
6. **WARNING: EXPLOSION HAZARD - Substitution of major components may impair suitability for use in Class I, Division 2 environments.**
7. **WARNING: EXPLOSION HAZARD - The area must be known to be nonhazardous before servicing/replacing the unit and before installing or removing I/O wiring.**
8. **WARNING: EXPLOSION HAZARD - Do Not disconnect equipment unless power has been disconnected and the area is known to be nonhazardous.**
9. An RTD is normally supplied with the **Control**Wave **GFC-CL**. Connection to the RTD is approved as a nonincendive circuit, so that Division 2 wiring methods are not required.
10. Signal connectors available for customer wiring are listed in Table A1. I/O Connections are unrated and must be wired using Div. 2 wiring methods.
11. The UL listed nonincendive **Control**Wave **GFC-CL** may include radio/modem communications (listed on Model Spec.) that is used in conjunction with a 5W, 12V, 7AH Lead Acid Battery System. Connection to the radio or modem is approved as a nonincendive circuit, so that Division 2 wiring methods are not required.

Table A1 -Module/Board Connector Customer Wiring Connectors

Module/Item	Connector	Wiring Notes
CPU/System Controller Board	J19: COM1, 9-pin Male D-sub TB1: COM1, 8-pin Term. Block	RS-232 Comm. Port Connectors: For external Network Comm. Refer to Model Spec. and ¶ 10 of this document.
CPU/System Controller Board	TB2: COM2, 8-pin Term Block RS-232/RS-485 TB3: COM3, 5-pin Term Block	Remote Comm. Port: For Radio or external Network Comm. Refer to Model Spec. and ¶ 10 of this document. When used for Network Comm., use Div. 2 wiring methods. If COM2 is used in conjunction with a radio/modem refer to ¶ 11 of this document. If COM3 is used in conjunction with a modem refer to ¶ 11 of this document.
CPU/System Controller Board	J2: 25-Button Display Intf. 10-pin Inline Male Connector	Factory Wired - *
CPU/System Controller Board	J14: 2-Button Display Intf. 3-pin Inline Male Connector	Factory Wired - *
CPU/System Cntrl. Bd.	J9: RJ11 Female Connector	Modular connection to Phone Co. equipment.

Table A1 -Module/Board Connector Customer Wiring Connectors (Continued)

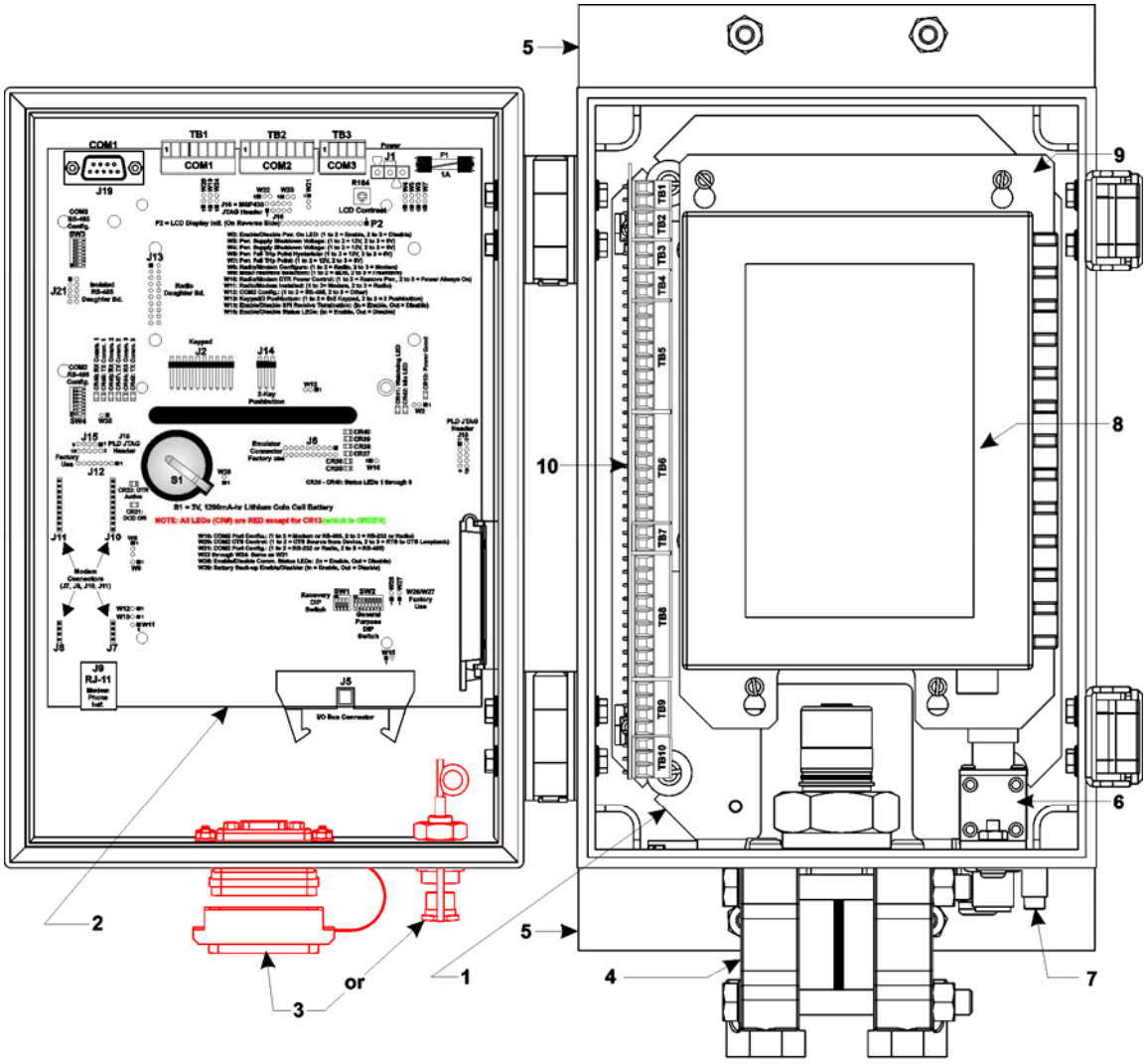
Module/Item	Connector	Wiring Notes
CPU/System Cntrl. Bd.	J20: RJ45 Female Connector	Modular connection Ethernet 10/100BaseT
CPU/System Cntrl. Bd.	J5: I/O Bus Cable Connector	I/O Interface Bus - Factory Wired
CPU/System Cntrl. Bd.	J1: 3-pin Molex Male Connector	Power Interface - Factory Wired
Battery Charger & I/O Board	P1: 3-pin Molex Male Connector	Power Interface - Factory Wired - *
Battery Charger & I/O Board	P2: MVT Interface	Factory Wired - *
Battery Charger & I/O Board	TB1: 2-pin Term. Block TB2: 2-pin Term. Block TB3: 2-pin Term. Block TB4: 2-pin Term. Block	Solar Power: User Wired - * Primary Power: Factory/User Wired - * Backup Battery: User Wired - * Auxiliary Output: Factory Wired - *
Battery Charger & I/O Board	TB5: 8-pin Term. Block DI & DI Interface	Discrete Input/ Output Field Wiring: Field I/O wiring connector is unrated, use Div. 2 wiring methods. *
Battery Charger & I/O Board	TB6: 8-pin Term. Block HSC Interface	High Speed Counter Field Wiring: Field Input wiring connector is unrated, use Div. 2 wiring methods. *
Battery Charger & I/O Board	TB7: 2-pin Term. Block	N/A: No Connection Permitted
Battery Charger & I/O Board	TB8: 9-pin Term. Block AI Interface	Analog Input Field Wiring: Field Input wiring connector is unrated, use Div. 2 wiring methods. *
Battery Charger & I/O Board	TB9: 4-pin Term. Block AO Interface	Analog Output Field Wiring: Field Output wiring connector is unrated, use Div. 2 wiring methods. *
Battery Charger & I/O Board	TB10: 3-pin Term. Block RTD Interface	Field Wired: Refer to 9 of this document
Front Cover Bottom	Local Port 9-pin Male D-sub Connector (Early Version) or Local Port 3-pin Female Circular Connector (Present Version)	Local Comm. Port - Factory Wired. Refer to ¶ 3 of this document. *

*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 ¶ 6, 7 & 8 of this document. 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 C
HARDWARE INSTALLATION GUIDE

Hardware Configuration

There are seven (7) main steps required to configure a **Control**Wave **GFC-CL**. This appendix provides an overview of these steps with an emphasis on the installation and configuration of the hardware. This appendix is intended for users who have already installed at least one **Control**Wave **GFC-CL**.



1. Fabrication Panel
2. CPU/System Controller Board
3. Local Comm. Port Connector & Cover
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug
8. External Radio (MDS - Transnet)
9. Radio/Modem Mounting Bracket
10. Battery Charger & I/O Board

Note: Item 3
Left = D-Type Connector
Right = Circular Connector
(One Provided)

Figure C-1A - Control Wave **GFC-CL (with MVT & MDS - Transnet Radio) (Internal View) Component Identification Diagram**

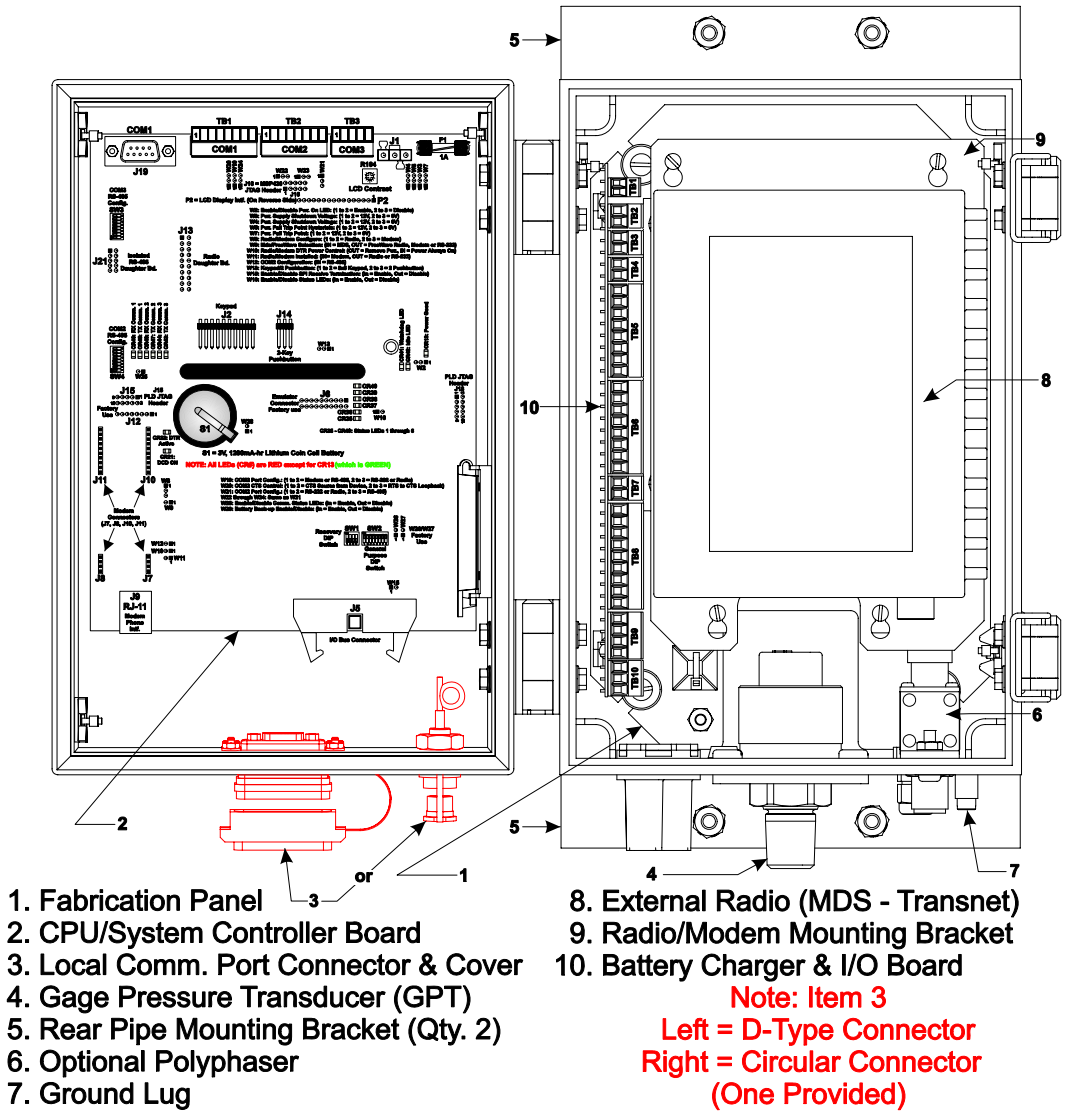


Figure C-1B - ControlWave GFC-CL (with GPT & MDS - Transnet Radio) (Internal View) Component Identification Diagram

Step 1. Hardware Configuration

This involves unpacking the **Control**Wave **GFC-CL** hardware, mounting the enclosure, wiring I/O terminations, connecting any permanent communication cables, making proper ground connections, connecting a communications cable to a PC work-station, setting switches and setting jumpers. To install and configure the **Control**Wave **GFC-CL**, follow Hardware Configuration steps 1 through 10 below:

1. Remove the unit from its carton and install it at the assigned work site (see Section 2.3.1 and associated subsections). Dimensions are provided in Section 4.6 of this manual.

2. Remove the Battery Charger & I/O Board Assembly and after configuring its configuration jumpers, install it into **Control**Wave **GFC-CL** Enclosure (see Figure C-2).

3. Make sure that the Lithium Backup Battery has been enabled, i.e., Backup Battery Jumper W28 on the CPU/System Controller Board (on the inside of the Instrument Front Cover) should be installed (on its jumper posts). Configure the CPU/System

Controller Board's DIP Switches and Jumpers. Tables C-1 through C-3 provides overviews of the Switch Settings (see Figure C-2).

Table C-1 - CPU/System Controller Bd. Switch SW1
Recovery Mode/Local Mode Control

SWITCH	Function	Setting
SW1-1/2	Recovery/Local Mode *	Both UP or DOWN = Recovery Mode SW1 DOWN & SW2 UP = Local Mode
SW1-3	Force Recovery Mode *	ON = Force Recovery Mode (via CW Console) OFF = Recovery Mode disabled
SW1-4	Not Used	N/A

*** = Note: Only the Switch SW1 settings listed in this table, have been tested.**

Table C-2 - CPU/System Controller Bd. Switch SW2 - User Configurations
Note: Except for SW2-4, ON = Factory Default

SW#	Function	Setting - (ON = Factory Default)
SW2-1	Watchdog Enable	ON = Watchdog circuit is Enabled OFF = Watchdog circuit is Disabled
SW2-2	Lock/Unlock Soft Switches	ON = Write to Soft Switches and FLASH files OFF = Soft Switches, configurations and FLASH files are locked
SW2-3	Use/Ignore Soft Switches	ON = Use Soft Switches (configured in FLASH) OFF = Ignore Soft Switch Configuration and use factory defaults
SW2-4	Core Updump See Section 3.6	ON = Core Updump Disabled OFF = Core Updump Enabled via Mode Switch (SW1)
SW2-5	SRAM Control	ON = Retain values in SRAM during restarts OFF = Force system to reinitialize SRAM
SW2-6	System Firmware Load Control *	ON = Enable remote download of System Firmware OFF = Disable remote download of System Firmware
SW2-7	N/A	
SW2-8	Enable WINDIAG	ON = Normal Operation (don't allow WINDIAG to run test) OFF = Disable boot project (allow WINDIAG to run test)

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

Table C-3 - CPU/System Controller Bd. Switch SW3/SW4 Assignments
RS-485 Loopback & Termination Control (SW3 for COM3 – SW4 for COM2)

SWITCH #	RS-485 Function Switch ON	Setting
SW3/4-1	TX+ to RX+ Loopback/2-Wire	ON – 2-Wire Operation or Loopback Enabled OFF – 4-Wire Operation & Loopback Disabled
SW3/4-2	TX– to RX– Loopback/2-Wire	ON – 2-Wire Operation or Looback Enabled OFF – 4-Wire Operation & Loopback Disabled
SW3/4-3	100 Ohm RX+ Termination	ON – End Nodes Only
SW3/4-4	100 Ohm RX– Termination	ON – End Nodes Only
SW3-6 (see Note 2)	Slew Rate ISO485 ONLY	ON – Slow Rate Enabled OFF – Fast Rate Enabled
SW3/4-7	RX+ Bias (End Nodes/Node)	ON – 4-Wire = Both End Nodes 2-Wire = One End Node Only OFF = No Bias
SW3/4-8	RX– Bias (End Nodes/Node)	ON – 4-Wire = Both End Nodes 2-Wire = One End Node Only OFF – No Bias

Note 1: Closed = Switch set ON Note 2: Switch SW3-6 (COM3) = N/A

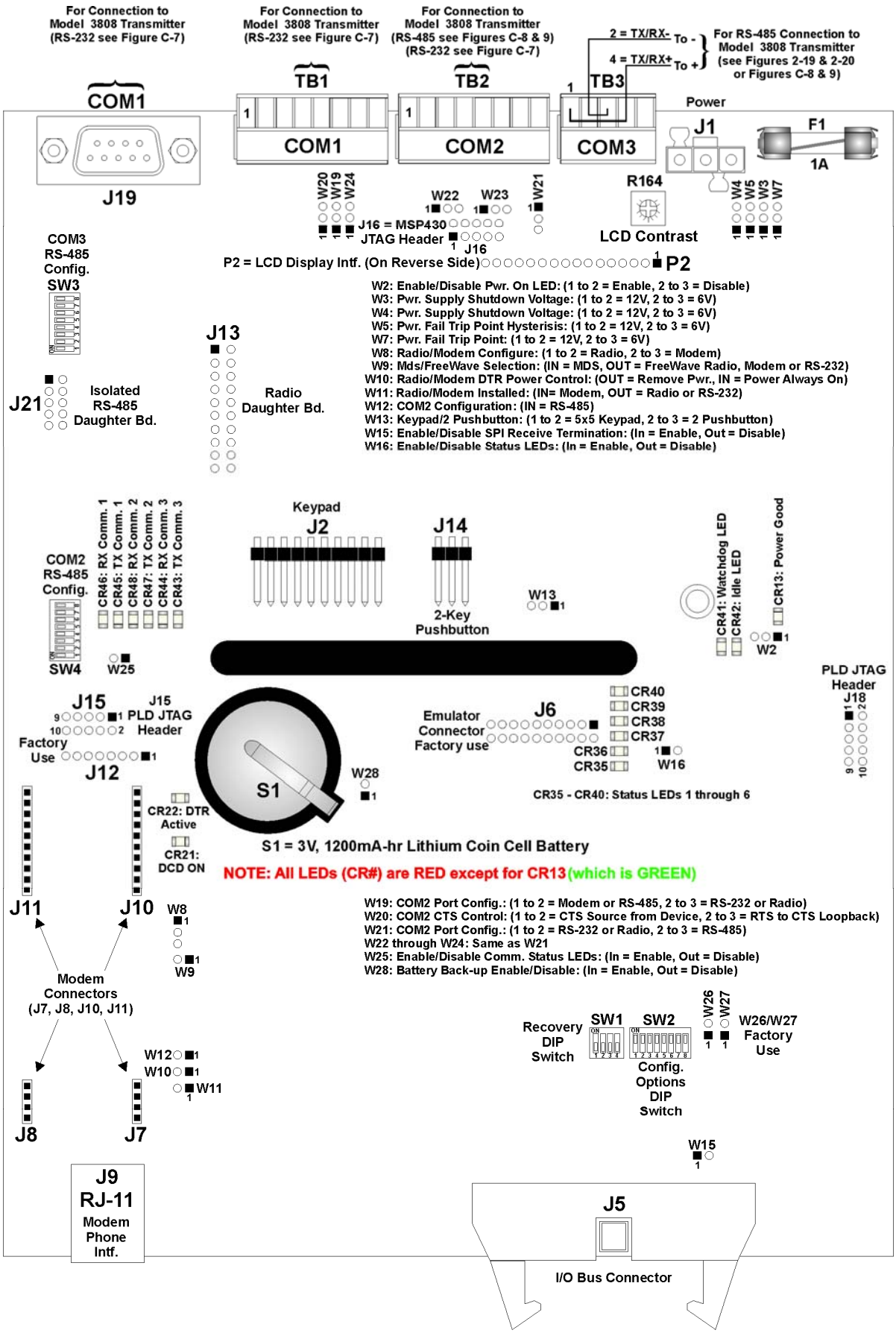


Figure C-2 - ControlWave GFC-CL CPU/System Controller Board Component Identification Diagram

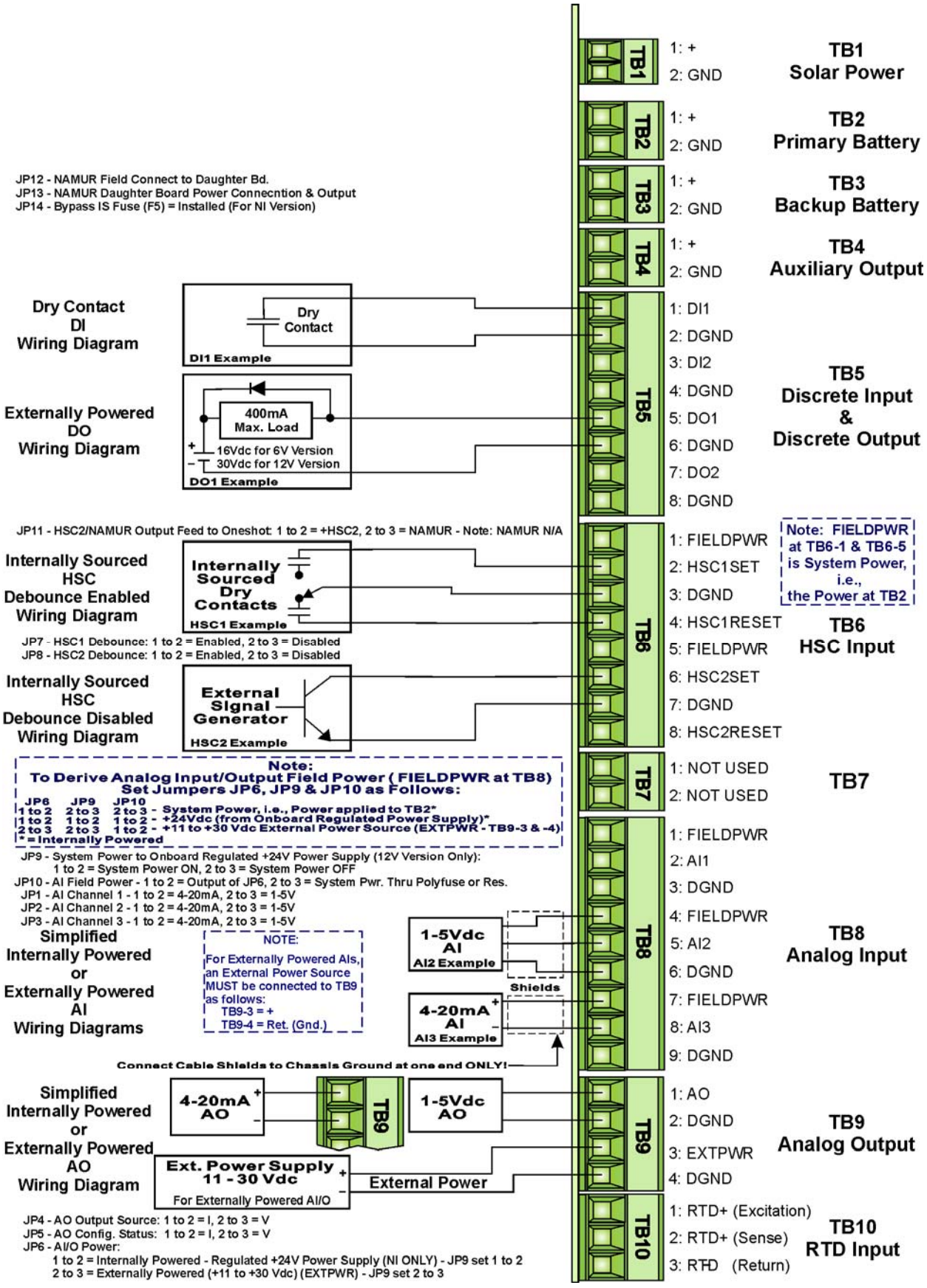


Figure C-3 - Battery Charger & I/O Board Component Identification Diagram

Step 1. Hardware Configuration (Continued)

4. Configure/Connect appropriate communication port(s) (see Sections 2.3.3.2). Connect COMM. Port 1 or 2 of the **Control**Wave **GFC-CL** (depending on CPU/System Controller Board's Switch SW2 settings - see Tables C-2 & C-3 and Figures C-4A through C-5) to a Communication Port of a PC (typically PC COMM. Port 1). *Note: Also see Section 2.4.4.*

   A **Control**Wave **GFC-CL** can be configured as a Master or Slave node on either a MODBUS network or a BSAP network. A variety of communication schemes are available. An optional 56K PSTN Modem and Spread Spectrum Modem (Radio) can be piggy-back mounted on the CPU/System Controller Board. Three communication ports are contained on the standard CPU/System Controller Board. These communication ports are designated as follows:

   CPU/System Controller Board:
   COM1 - Port 1: J19 (9-Pin Male D-Sub), TB1 (8-Pin Term Block) - RS-232 (TB1 is factory connected to the Local Port)
   COM2 - Port 2: TB2 (8-Pin Term. Block) RS-232/RS-485 - RS-485 Configured by SW4 (COM2 supports an Internal or External Modem or Radio option)
   COM3 - Port 3: TB3 (5-Pin Term. Block) RS-485 - Configured by SW3

   COM1 is also available as the Local Port. This is accomplished via a 9-pin D-Type male connector (on earlier models) or a circular 3-pin female connector (on currently manufactured models). The Local Port is located on the bottom of the Instrument Front Cover.

   Communication Ports COM1, COM2 and COM3 support serial asynchronous operation as listed above. Any communication port (COM1, COM2 or COM3) can be configured for local communications, i.e., connected to a PC loaded with **Control**Wave Designer and OpenBSI software. The pin labels for the various RS-232/485 interface connectors are provided in Tables C-4A1 through C-4B.

   RS-232 & RS-485 Interfaces

   ControlWave **GFC-CL** RS-232 & RS-485 Comm. schemes are discussed herein.

   RS-232 Ports
   An RS-232 interface supports Point to Point, half-duplex and full-duplex communications (20 feet maximum, using data quality cable). Half-duplex communications supported by the **Control**Wave **GFC-CL** utilize MODBUS or BSAP protocol, while full-duplex is supported by the Point to Point (PPP) protocol. **Control**Wave **GFC-CL** RS-232 ports utilize a "null modem" cable (Figure C-5 - Top) to interconnect with other devices such as a PC, printer, another **Control**Wave series unit when the **Control**Wave **GFC-CL** is communicating using the full-duplex PPP protocol. A half-duplex cable (Figures C-5A - Bottom) can be utilized when the **Control**Wave **GFC-CL** is connected to another **Control**Wave series unit. If communicating with a Bristol series 3305, 3310, 3330 or 3335 RTU/DPC, one of the cables shown in Figure C-5B must be used. Refer to Figure C-5C to connect **Control**Wave **GFC-CL** serial RS-232 port COM2 to either an external modem or external radio. When interfacing to Port COM3 of a **Control**Wave unit, or to COM5 or COM6 of a **Control**Wave**EXP**, the cable of Figure C-5D must be used along with the one of Figure C-5A.

Step 1. Hardware Configuration (Continued)

Tables C-4A1 through C-4B provides the connector pin assignments for ports COM1, COM2, COM3.

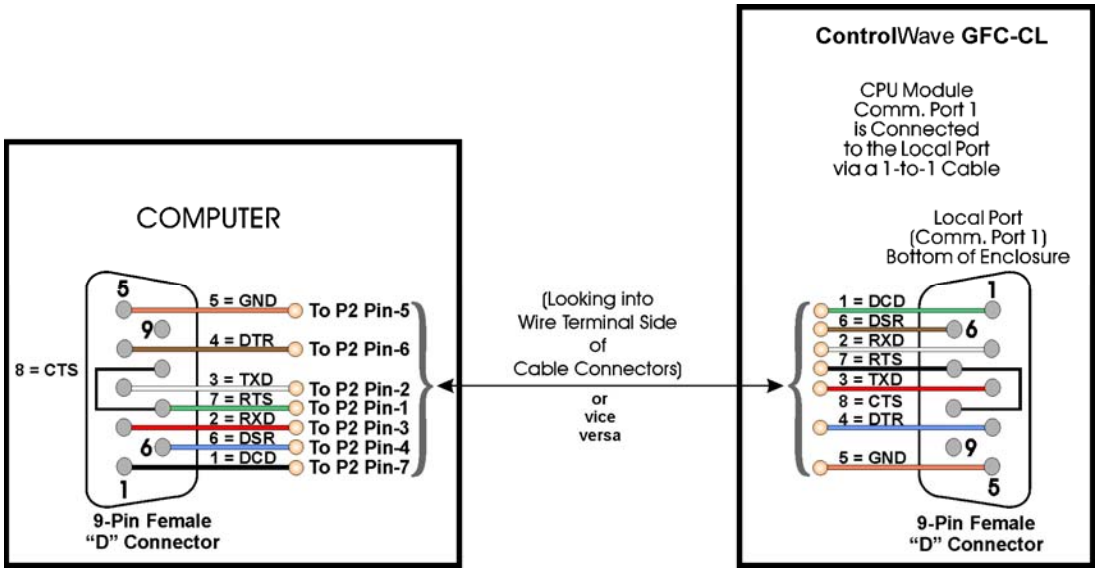


Figure C-4A - PC Connected to ControlWave GFC-CL Local Port
(D-Type Connector Version)
(Use Null Modem Cable - Bristol Part Number 392843-01-3)

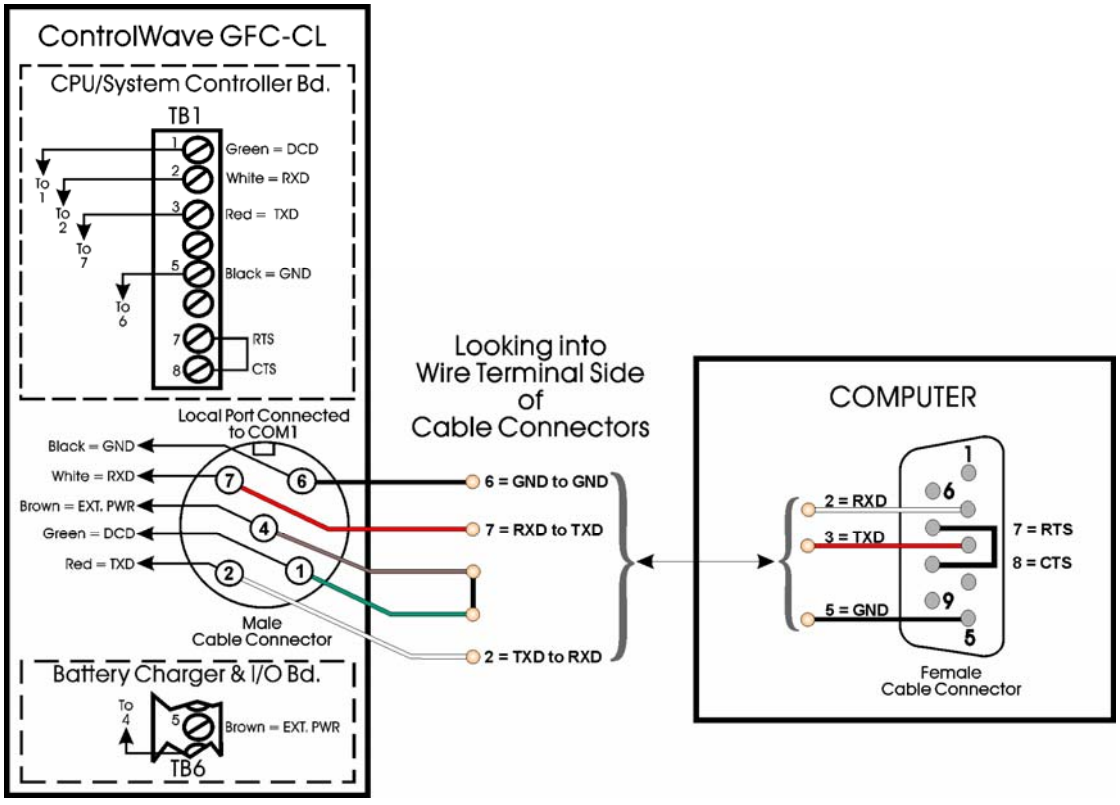


Figure C-4B - PC Connected to ControlWave GFC-CL Local Port
(Circular Port Version)
Bristol Part Number 395402-01-8 = 10 Foot Comm. Cable
Bristol Part Number 395402-02-6 = 25 Foot Comm. Cable

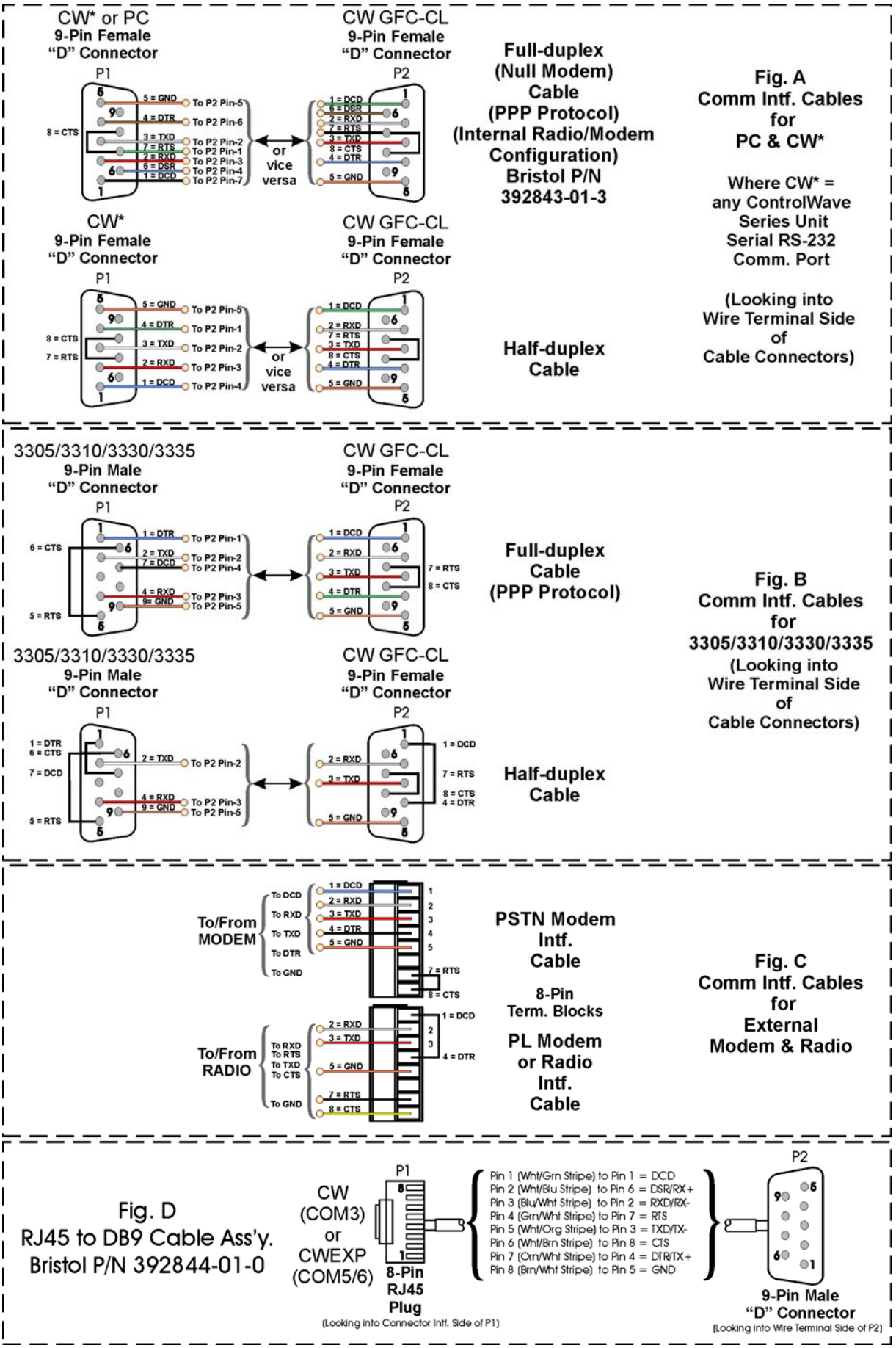


Figure C-5 - Communication Port RS-232 Cable Wiring Diagram

Step 1. Hardware Configuration (Continued)

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

- DCD must be high to transmit (except when dialing a modem)
- Each RS-232 transceiver has one active receiver while in powerdown mode (disabled); the DCD signal is connected to the active receiver.
- CTS must be high to transmit.
- When port is set for full-duplex operation - RTS is always ON.
- DTR is always high (when port is active); DTR enables RS-232 Transceivers.
- When port is set for half-duplex operation - CTS must go low after RTS goes low.
- All RS-232 Comm. ports support RTS, DTR, CTS, DCD and DSR control signals.
- All RS-232 Comm. port I/O signals are protected by LCDA12C surge protectors to ±4KV ESD.

Table C-4A1 - RS-232 Ports (COM1 & 2) and RS-485 Ports (COM2) Connector Pin Assignments (All COM1 Connectors, i.e., Local Port, J19 & TB1 and COM2 Connector TB2)

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

Table C-4A2 - RS-232 Port (COM1) Connector Pin Assignments (COM1 Connectors, i.e., Circular Local Port & TB1)

Pin #	Signal RS-232	Description: RS-232 Signals	Local Port RS-232 Pin #
1	DCD	Data Carrier Detect Input	
2	RXD	Receive Data Input	7 (WHT Wire)
3	TXD	Transmit Data Output	2 (RED Wire)
4	DTR	Data Terminal Ready Output	
5	GND	Power Ground	6 (BLK Wire)
6	DSR	Data Set Ready Input	
7	RTS	Request To Send Output	*
8	CTS	Clear To Send Input	*

* RTS connected to CTS at TB1 of CPU for Local Port Comm. Cable

RS-485 Ports

Control**Wave GFC-CL** can use an RS-485 communication port for local network communications to multiple nodes up to 4000 feet away. Since this interface is intended for network communications, Table C-5 provides the appropriate connections for wiring the master, 1st slave, and nth slave. Essentially, the master and the first slave transmit and receive data on opposite lines; all slaves (from the first to the "nth") are paralleled (daisy chained) across the same lines. The master node should be wired to one end of the RS-485

cable run. A 24-gauge paired conductor cable, such as Belden 9843 should be used. *Note: Only half-duplex RS-485 networks are supported*

Step 1. Hardware Configuration (Continued)

Table C-4B - RS-485 Port (COM3)
Connector Pin Assignments (TB3)

Pin #	Signal RS-485	Description: RS-485 Signals
1	RXD+	Receive Data + Input
2	RXD–	Receive Date – Input
3	TXD–	Transmit Data – Output
4	TXD+	Transmit Data + Output
5	Power Ground	Ground

Receiver biasing and termination as well as 2-wire or 4-wire selection are enabled by eight-position DIP-Switches situated on the CPU/System Controller Board as follows: COM3: Switch SW3, COM2: Switch SW4.

Table C-4A1 provides the connector pin assignments for CPU/System Controller Board port COM2. Table C-4B provides connector pin assignments for CPU/System Controller Board port COM3. Table C-3 provides the RS-485 termination and loopback control Switch Settings for the RS-485 Ports.

To ensure that the "Receive Data" lines are in a proper state during inactive transmission periods, certain bias voltage levels must be maintained at the master and most distant slave units (end nodes). These end nodes also require the insertion of 100-Ohm terminating resistors to properly balance the network. Secondary Communication Board switches must be configured at each node to establish proper network performance. This is accomplished by configuring CPU/System Controller Bd. Switch SW3 (COM3) and/or Switch SW4 (COM2) so that the 100-Ohm termination resistors and biasing networks are installed at the end nodes and are removed at all other nodes on the network (see Table C-5).

Table C-5 - RS-485 Network Connections
(see Table C-4A/B **Control**Wave **GFC** RS-485 Port Pin # Assignments)

From Master	To 1st Slave	To nth Slave
TXD+	RXD+	RXD+
TXD–	RXD–	RXD–
RXD+	TXD+	TXD+
RXD–	TXD–	TXD–
GND/ISOGND*	GND/ISOGND*	GND/ISOGND*

* ISOGND with Isolated RS-485 Ports Only!

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

Spread Spectrum Modem Port

An optional Spread Spectrum Modem (Radio) is available on the CPU/System Controller Board and is assigned as COM2. There are two unique radios offered. These radios will only communicate with their own brand of radio, i.e., FreeWave radios are not compatible with

MDS radios. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the radio at a rate up to 115.2kHz.

Step 1. Hardware Configuration (Continued)

These radios are supplied in kit form with all the hardware required for user installation onto a CPU/System Controller Board. A Radio is user installed onto the CPU/System Controller Board (see Figure C-6) and its associated Ports is setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView.

FreeWave® Spread Spectrum Wireless Data Transceiver:
Operates in the 902 to 928 MHz range (20 miles).

Microwave Data System Inc. MDS TransNET OEM™ Spread Spectrum Data Transceiver:
Operates in the 902 to 928 MHz range (20 miles).

Installation steps below support user installation and configuration of a Spread Spectrum Modem.

- Mount the radio (Spread Spectrum Modem) onto the Radio Carrier Board and then mount this combined assembly onto the CPU/System Controller Board. Install the L-shaped Bracket onto the lower right corner of the CPU/System Controller Board. Install one end of the internal coaxial RF cable supplied with the radio in question onto the radio's RF SMA Connector. Connect the other end of the internal coaxial RF cable to the L-shaped Bracket.

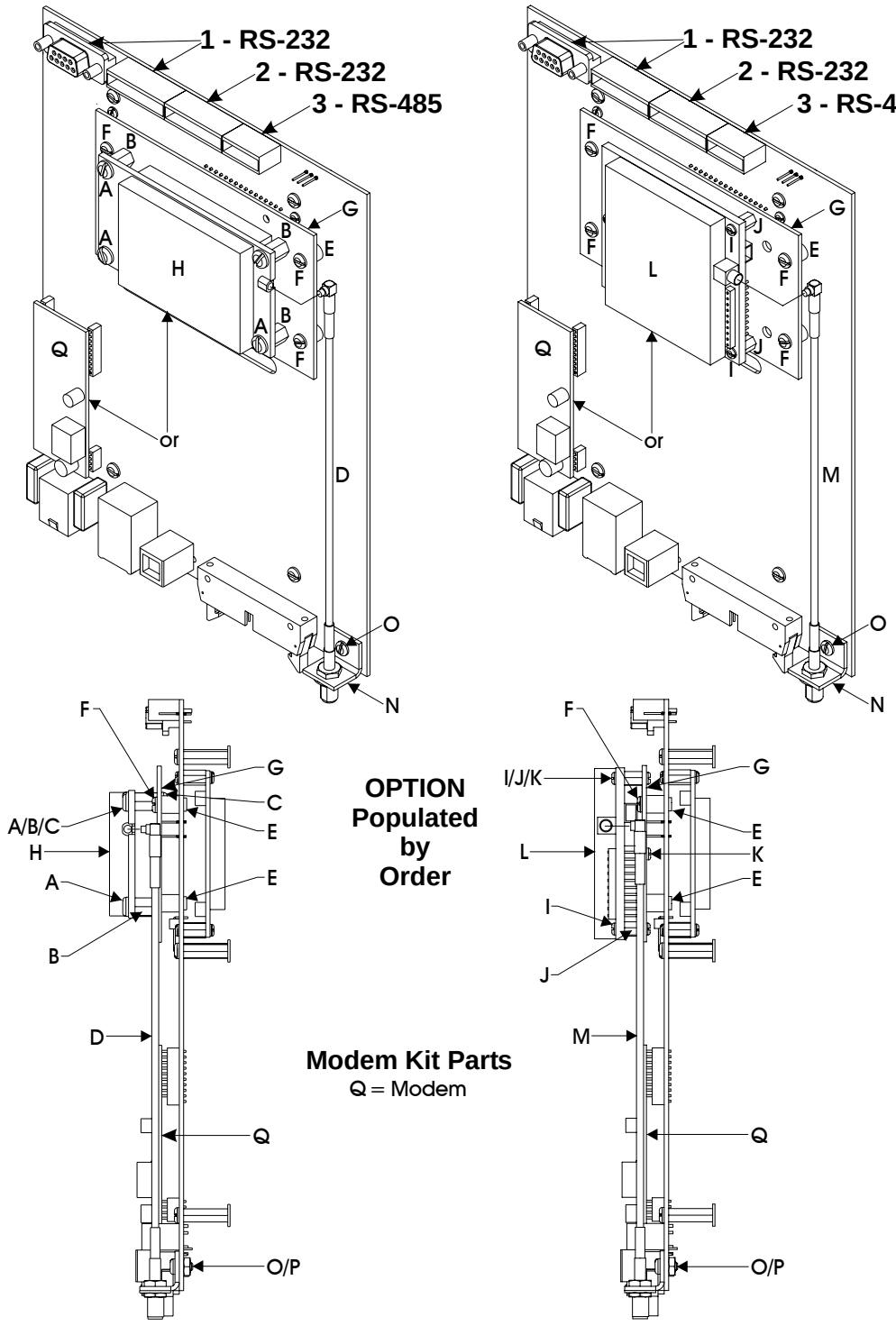
- Install the user supplied coaxial RF cable between the unit's RF antenna cable or Polyphaser and the remote antenna.

- For **FreeWave Radio**: Follow the Tuning Transceiver Performance" section of the FreeWave Technologies Inc. FreeWave Spread Spectrum Wireless Data Transceiver User Manual to configure the radio.

  For **MDS Radio**: Refer to section 3.3 "Initial Power-Up & Configuration" within the MDS TransNet OEM Integration Guide and if necessary for more information on connecting a PC terminal and preparing it for use, refer to section 9.0 "PROGRAMMING REFERENCE."

Note:

Whenever setting any Jumper or connecting/removing a communication cable to/from a PC, power should be turned OFF. To invoke the setup program, connect the radio (via COM1) to a terminal program (such as Hyperterminal) via a null modem cable (see Figure C-5), put the radio into setup mode and set the parameters for the terminal to those of Table C-6 below. The setup program is invoked by connecting Pins 1 and 2 of CPU/System Controller Board Jumper Post W8.



MDS (Transnet) Radio Kit/Option Parts

A = 6-32 x .250 Pan Head Screw (Qty. 4)
B = 6-32 x .313 F/F Standoff (Qty. 4)
C = 6-32 x .188 Pan Head Screw (Qty. 4)
D = Transnet Radio Cable (with Nut and Washer)
E = Swaged Standoff (Qty. 4)
F = 4-40 x .250 Pan Head Screw (Qty. 4)
G = Radio Carrier Board
H = MDS Transnet Radio Module
N = L-shaped Bracket
O = Screw
P = Nut

FreeWave Radio Kit/Option Parts

E = Swaged Standoff (Qty. 4)
F = 4-40 x .250 Pan Head Screw (Qty. 4)
G = Radio Carrier Board
I = 2-56 x 1/4 Pan Head Screw (Qty. 3)
J = 2-56 x .250 F/F Standoff (Qty. 3)
K = 2-56 x .188 Pan Head Screw (Qty. 3)
L = FreeWave Radio Module
M = FreeWave Radio Cable (with Nut & Washer)
N = L-shaped Bracket
O = Screw
P = Nut

Figure C-6 - CPU/System Controller Board Radio/Modem Installation Diagram

Step 1. Hardware Configuration (Continued)

Table C-6 - Radio Setup Menu Terminal Settings

PARAMETERS	SETTINGS
Baud Rate	19,200
Data Rate	8
Parity	None
Stop Bits	1
Parity Check	None/Off
Carrier Detect	None/Off
Flow Control	Xon/Xoff

56K PSTN Modem Port

An optional 56K PSTN Hayes type Modem can be mounted piggy-back on the CPU/System Controller Board and is assigned to COM2. The Model MT5634SMI Modem module is manufactured by MultiTech System and can be user configured for PSTN operation. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the modem at a rate up to 115.2kHz.

Modems are supplied in kit form with all the hardware required for user installation onto an Expansion Communications Module. Figure C-6 shows the modem mounted on the CPU/System Controller Board.

A Modems is user installed onto the CPU/System Controller Board and its associated Port is setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView. A Terminal Emulation program such as Hyperterminal is used to profile the modem via AT commands. Users typically use AT commands only when checking the modem's active or stored profile or when reconfiguring a modem, e.g., to turn auto answer on or off, etc.

For additional installation information see section 2.3.3.5 of this manual.

Step 1. Hardware Configuration (Continued)

5. Install I/O wiring to the Battery Charger & I/O Board Assembly (if required see Section 2.3.4) (see Figure C-3). Install a communications cable between the **Control**Wave **GFC-CL a**nd a Model 3808 Transmitter (Network of Transmitters) if required (see Figures C-7 through C-9).

6. Install a ground wire between the Chassis Ground Lug and a known good Earth Ground (also see Supplement Guide S1400CW).

   ControlWave **GFC-CL** Enclosures are provided with a Ground Lug that accommodates up to a #4 AWG wire size. A ground wire must be run between the Chassis Ground Lug and a known good Earth Ground. The following considerations are provided for the installation of **Control**Wave **GFC-CL** system grounds.

   - Chassis Ground Lug to Earth Ground wire size should be #4 AWG. It is recommended that stranded copper wire is used and that the length should be as short as possible.

Step 1. Hardware Configuration (Continued)

- This ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a stranded copper AWG 0000 cable installed vertically or horizontally).

- The wire ends should be tinned with solder prior to insertion into the Chassis Ground Lug. *Note: Use a high wattage Soldering Iron.*

- The ground wire should be run such that any routing bend in the cable has a minimum radius of 12-inches below ground and 8-inches above ground

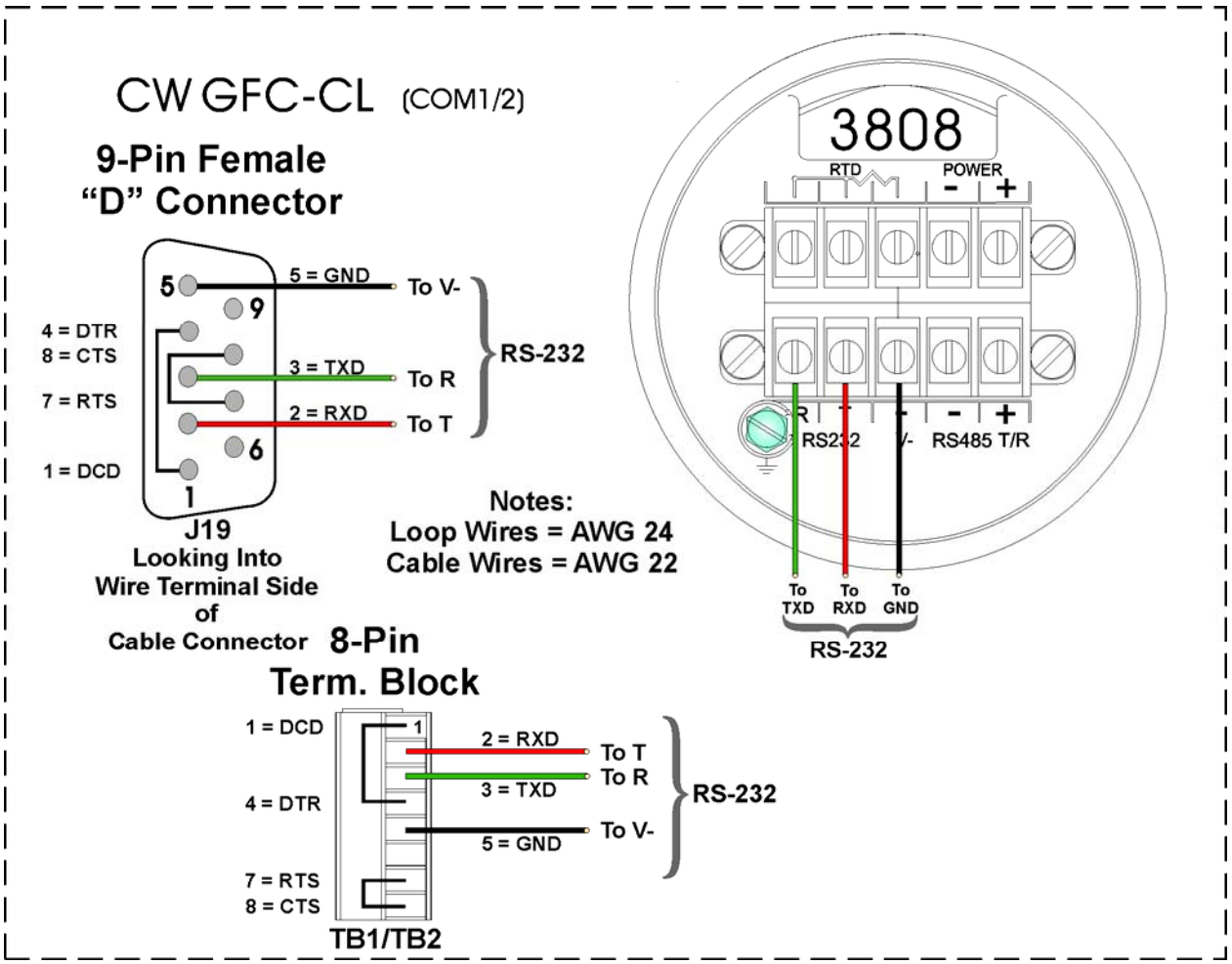
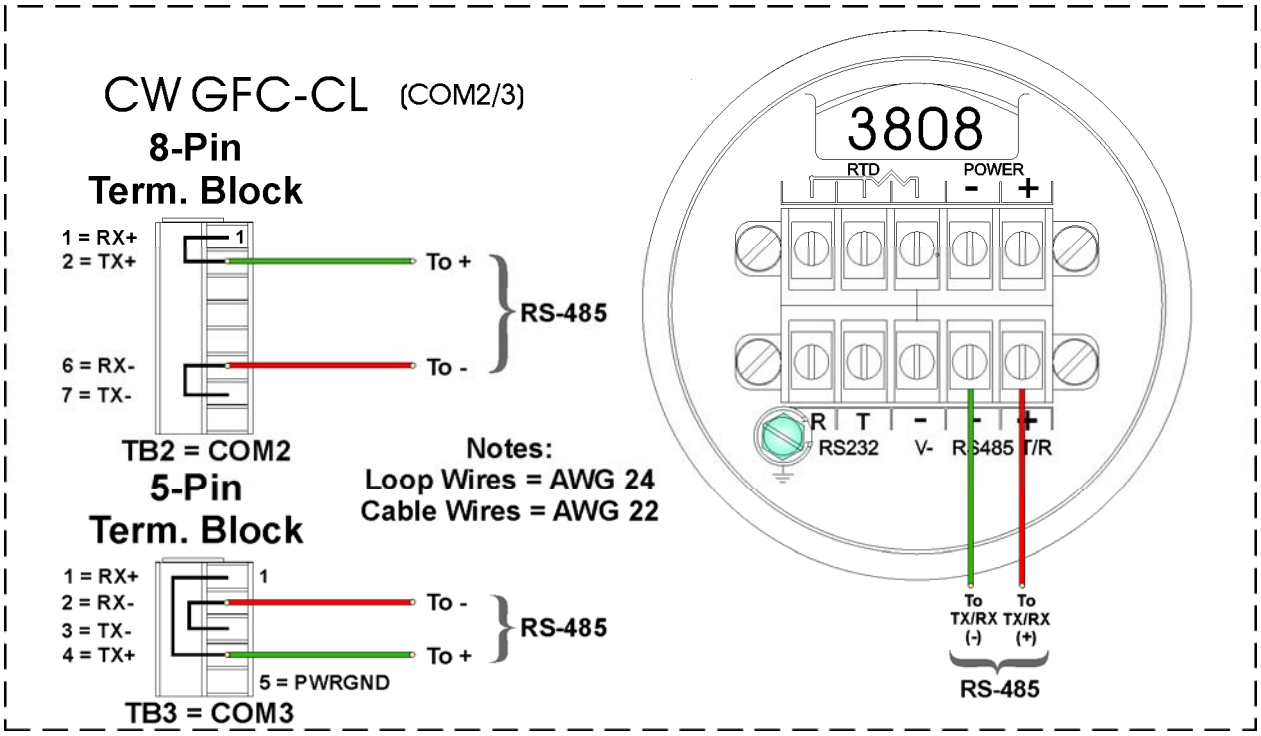


Figure C-7 - Model 3808 Transmitter to Control Wave **GFC-CL**
RS-232 Comm. Cable Diagram

Figures C-7 and C-8 detail the RS-232 and RS-485 wiring connections required between the **Control**Wave **GFC-CL** and the Model 3808 Transmitter.

Up to two (2) Model 3808 Transmitters can be connected to a **Control**Wave **GFC-CL** via a half duplex RS-485 Network. An illustration of this network is provided in Figure C-9



Note: For Loopback & Termination Control:
Use SW3/SW4 on CPU/System Controller Board to configure COM3/COM4.

Figure C-8 - Model 3808 Transmitter to CW GFC-CL - RS-485 Comm. Cables

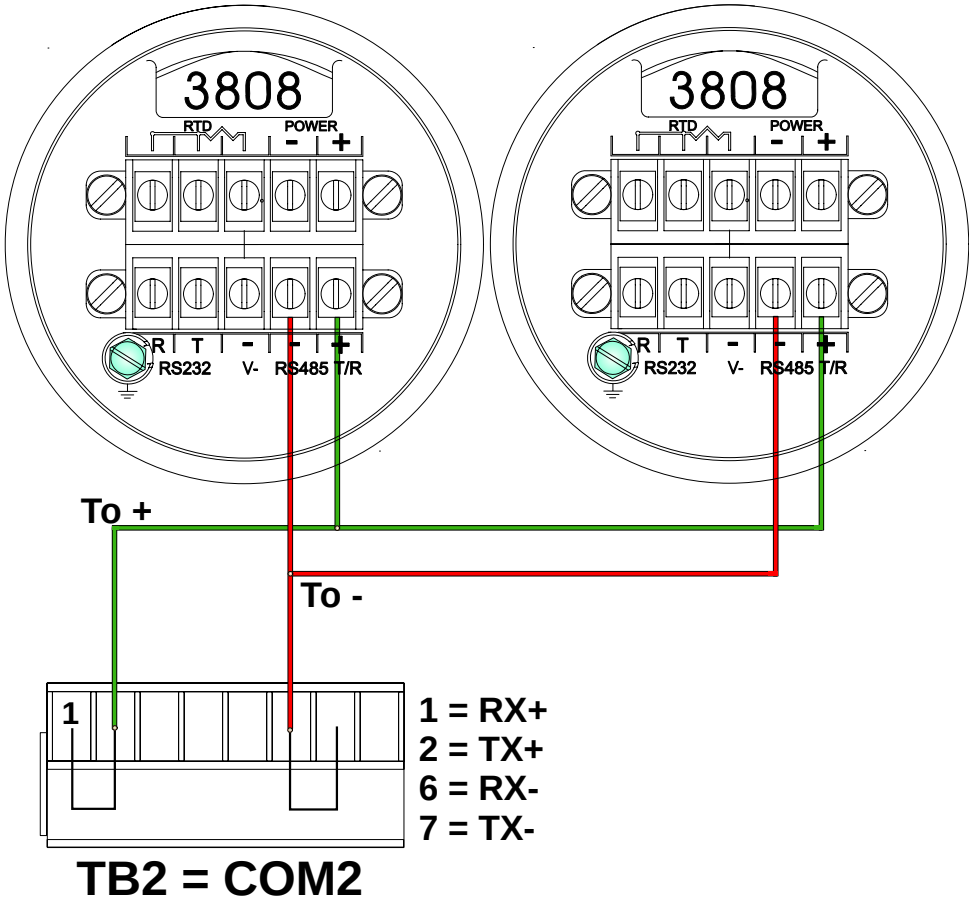


Figure C-9 - ControlWave GFC-CL to 3808s - RS-485 Network Diagram

Step 1. Hardware Configuration (Continued)

7. Install RTD (wiring and Probe) (see Section 2.3.5 of this manual).

8. Install the Rechargeable Battery and Solar Panel (if provided) (see Sections 2.3.8 and 2.3.7.3).

9. Connect DC Power wiring to the **Control**Wave **GFC-CL** Battery Charger & I/O Board assembly (see Section 2.3.7.1 and 2.3.7.2).

   SCM Connector TB1 provides 2 input connections for bulk power as follows:

   TB1-1 = (+VIN) (+4.5/4.9V to +8V dc for +6V bulk) (+9.6/10.3V to +16.0V dc for +12V)
   TB1-2 = Chassis Ground - CHASSIS

10. Apply power to the **Control**Wave **GFC-CL**. Continue with Steps 2 through 7 below (and Section 2.4.1) and the **Control**Wave **GFC-CL** will be ready for on line operation.

Step 2. Software Installation on the PC Workstation

ControlWave **Designer** software will have to be installed on the PC if the **Control**Wave **GFC-CL** is being utilized in an application other than that supported by the standard load. This is accomplished by installing the **Control**Wave **Designer Package** from the Open BSI CD ROM.

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

If you have an older version of ControlWave Designer already installed:

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

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

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

Communications must be established with the **Control**Wave **GFC-CL** using either LocalView or NetView.

The **Control**Wave **GFC-CL** ships from the factory with a default Flash configuration. Most users will need to edit this configuration to set the IP address (if using PPP), BSAP local address, user accounts, and port parameters. This can be done in one of two ways:

- Either open the supplied Flash Configuration Profile (FCP) file and modify it, directly in the Flash Configuration Utility, or in a text editor,

- Or retrieve existing Flash Parameters directly from the unit, and edit them in the Flash Configuration Utility.

Detailed information on the Flash Configuration Utility, and LocalView is included in Chapter 5 of the *Open BSI Utilities Manual* (document # D5081). NetView is described in Chapter 6 of that same manual.

Step 4. Modification of the Application-Specific Control Strategy (OPTIONAL)

ControlWave **GFC-CL** gas flow computers are shipped with the GFC program already loaded. However, you can create your own application-specific control strategy using **Control**Wave Designer. This involves opening a new project using the 'CWMicro' template, defining I/O points using the I/O Configurator, and creating a program using one or more of the five supported IEC 61131 languages (FBD, ST, SFC, LD, or IL). Some of these languages are text based, others use graphical diagrams. The choice is up to you, depending upon your particular application.

The ***Control****Wave* ***MICRO*** *Quick Setup Guide* (document # D5124) includes a simple LD example. Additional examples are included in the manual, *Getting Started with* ***Control****Wave Designer* (document # D5085). More detailed information about **Control**Wave Designer and IEC 61131 is included in the ***Control****Wave Designer Reference Manual* (document # D5088).

The ACCOL3 Firmware Library, which is automatically accessible through the template referenced above, includes a series of function blocks which perform a variety of process control and communication functions. These can be included within your program to perform various duties including PID control, alarming, calculations, etc. Detailed information about each function block is included in the **Control**Wave Designer on-line help files.

On the variables declaration page(s) in **Control**Wave Designer, you will need to mark any variable you want to make accessible to external programs, such as Open BSI's DataView utility, as **"PDD"**. Similarly, any variables which should be collected into a database, or exported using the OLE for Process Control (OPC) Server must be marked as **"OPC."** Variables marked as OPC can be built into a text file by the **OpenBSI Signal Extractor.** The text file can then be used in the creation of a database for human machine interface (HMI) software such as OpenEnterprise or Iconics' Genesis. These HMI software packages require that the **"Datatype conversion enable"** option be selected when generating the file using Signal Extractor. Information about the OpenBSI Signal Extractor is included in Chapter 12 of the *Open BSI Utilities Manual* (document # D5081).

Once the program has been created, it is assigned to an executable task. The entire project is then saved and compiled.

NOTE: From this point on, the order of steps may be varied, somewhat, depending upon the requirements of the user's application. If you modify the standard GFC-CL program, you may need to modify the standard web pages associated with it. (See Step 5, below).

Step 5. Use Standard Web Pages Provided to Select Options in the Standard Control Strategy or Create Your Own Application-Specific Web Pages

The **Control**Wave **GFC-CL** has a standard set of web pages for configuration purposes (stored on a PC) that lets you enter parameters, and configuration options for the standard GFC program (see Step 4, above). If you modify the standard **GFC-CL** program, you may need to modify the standard web pages. If you create your own application program (instead of using the standard one), you may create your own web pages using Bristol Babcock ActiveX controls discussed in the *Web_BSI Manual* (document # D5087).

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

Step 6. Create an Open BSI Network Containing the Control Wave **GFC-CL, or ADD the Control**Wave **GFC-CL to an Existing Open BSI Network**

In order for the **Control**Wave **GFC-CL** unit to function as part of a Bristol network, it is necessary to include it in the Bristol network.

If no Bristol network exists:

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

If a Bristol network already exists:

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

Step 7. If applicable, download new or modified control strategy (OPTIONAL)

If you modified the standard GFC program, or substituted your own program, compile and download the new or modified program into the unit, using either ControlWave Designer, or the Open BSI 1131 Downloader. In this case, you download the control strategy into the BOOT project area of FLASH memory; this ensures that if the **Control**Wave **GFC-CL** is reset, or if there has been a failure of the backup battery, the control strategy can be restarted from the beginning, i.e. from the BOOT project in FLASH memory. To download the project, see Section 2.4.1. To download the application load, see Section titled Downloading the Application Load.

Downloading the Application Load

Any **Control**Wave **GFC-CL** must have a configured application load before it can be placed into operation. For units not shipped with the 'Standard Load,' this will require connection of the **Control**Wave **GFC-CL** to a PC running Windows NT (4.0 or higher), Windows 2000 or Windows XP Professional and equipped with **Control**Wave Designer software & OpenBSI

software. Configuration of the application load must be performed by an individual familiar with the various programming tools. The following software user documentation is referenced:

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

An application load download can be initiated, i.e., from **Control**Wave Designer, or from the OpenBSI 1131 Downloader for **Control**Wave **GFC-CL** Nodes.

1. Make sure that the CPU/System Controller Board's Mode Switch (SW2) is set in 'Local Mode,' i.e., SW1-1 in the **DOWN** position and SW1-2 in the **UP** position.

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

2. Once the **Control**Wave **GFC-CL** project has been defined, communications and configuration parameters have been set perform the download according to either '**Control**Wave Designer' (see D5088 - chapter 11) or 'The Open BSI 1131 Downloader' (see D5081 - Chapter 7).

3. After the download has been completed leave the CPU/System Controller Board's Mode Switch (SW1) set in 'Local Mode,' i.e., SW1-1 in the **DOWN** position and SW1-2 in the **UP** position.

LED Checks

ControlWave **GFC-CL** CPU/System Controller Boards contain light emitting diodes (LEDs) that provide operational and diagnostic functions. With the exception of the Power Good LED (CR13) which is green, all LEDs are red. A brief synopsis of the individual CPU/System Controller Board LEDs (CR#) is provided as follows:

CR13 Power Good
CR21 DCD ON
CR22 DTR Active
CR35 Status LED 1 (see Table 3-7 and Figure 3-10)
CR36 Status LED 2 (see Table 3-7 and Figure 3-10)
CR37 Status LED 3 (see Table 3-7 and Figure 3-10)
CR38 Status LED 4 (see Table 3-7 and Figure 3-10)
CR39 Status LED 5 (see Table 3-7 and Figure 3-10)
CR40 Status LED 6 (see Table 3-7 and Figure 3-10)
CR41 Watchdog LED - ON = Watchdog Condition - OFF = Normal Operation
CR42 Idle LED - ON = Idle
CR43 Comm. Port 3 - TX - ON = Transmit Activity
CR44 Comm. Port 3 - RX - ON = Transmit Activity
CR45 Comm. Port 1 - TX - ON = Transmit Activity
CR46 Comm. Port 1 - RX - ON = Transmit Activity
CR47 Comm. Port 2 - TX - ON = Transmit Activity
CR48 Comm. Port 2 - RX - ON = Transmit Activity

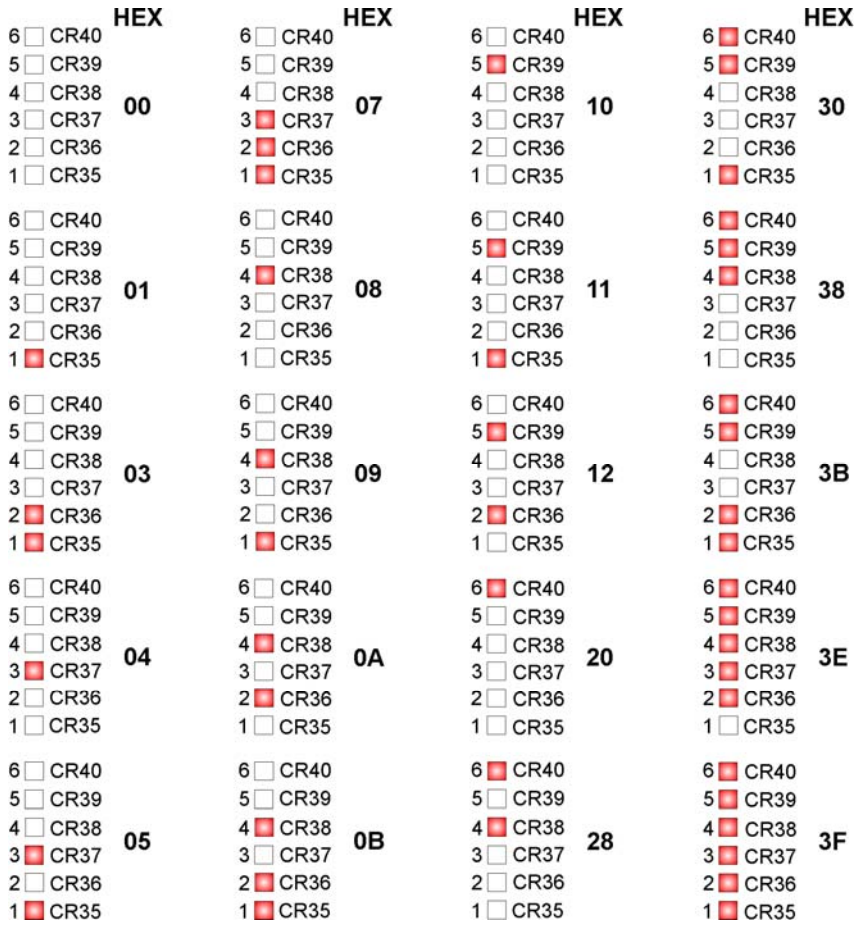


Figure C-10 - SCM Status LED Hexi-decimal Codes

Table C-7
System Status Codes on LCD Display and LEDs on CPU/System Controller Board

LED 6 CR40	LED 5 CR39	LED 4 CR38	LED 3 CR37	LED 2 CR36	LED 1 CR35	Status In Hex	LCD Disp.	Indication Definition
0	0	0	0	0	0	00	Blank	Application Running
0	0	0	0	0	1	01	DIAG	Unit in Diagnostic Mode
0	0	0	0	1	1	03	R DIAG	Unit Running Diagnostics
0	0	0	1	0	0	04	FWXSUM	Flash XSUM Error
0	0	0	1	0	1	05	DEVERR	Error Initializing Application Device
0	0	0	1	1	1	07	FLASH	Flash Programming Error
0	0	1	0	0	0	08	FACT	Using Factory Defaults *
0	0	1	0	0	1	09	BATT	Battery Failure Detected *
0	0	1	0	1	0	0A	STRTUP	Currently Loading the Boot Project
0	0	1	0	1	1	0B	INIT	System Initialization in Progress
0	1	0	0	0	0	10	RECOV	Waiting in Recovery Mode
0	1	0	0	1	0	12	RAMERR	Error Testing SRAM
1	0	0	0	0	0	20	STOP	Application Loaded
1	0	1	0	0	0	28	HALT	Stopped at a Break Point
1	1	0	0	0	0	30	NO APP	No Application Loaded
1	1	1	0	0	0	38	BREAKP	Running with Break Points
1	1	1	0	1	1	3B	POWERD	Waiting for Power-down (after NMI)
1	1	1	1	1	0	3E	UPDUMP	Waiting for Updump to be Performed
1	1	1	1	1	1	3F	NOTRUN	Unit Crashed (Watchdog Disabled)

*** = Flashed at startup**

Appendix D
PIGGY-BACK RADIO/MODEM INSTALLATION GUIDE

D1.1 RADIO INSTALLATION & CONFIGURATION

D1.1.1 Installing an Internal FreeWave Radio (FGR09CSU)

FreeWave Radio Model GR09SCU is provided (for user installation) in a kit consisting of the following components:

- 2-56 x .188" Pan Head Screw (Nylon) (Qty. 3) - Fig. D1 Reference = K
- 2-56 x .250" F/F Standoff (Nylon) (Qty. 3) - Fig. D1 Reference = J
- 2-56 x .250" Pan Head Screw (Qty. 3) - Fig. D1 Reference = I
- 4-40 x .250" Pan Head Screw (Qty. 4) - Fig. D1 Reference = F
- Swaged Standoff (Qty 4) - Built into CPU/System Controller Bd. - Fig. D1 Reference = E
- Radio Carrier Board - Fig. D1 Reference = G
- FreeWave Radio Module - Fig. D1 Reference = L
- FreeWave Radio Cable - Fig. D1 Reference = M
- FreeWave Radio Cable Mounting Hardware - Fig. D1 Reference: N = L-shaped Bracket, O = Screw and P = Nut

To install a Model FGR09SCU Radio onto a CPU/System Controller Board, perform the following eight (8) steps (referring to Figure D-1):

1. Install the three (3) 2-56 x .250 F/F standoffs (item J) onto the front of the Radio Carrier Board (Item G). These standoffs are secured via three (3) 2-56 x .188 Pan Head Screws (item K) that pass through the rear of the Radio Carrier Board.

2. Align the FreeWave Radio Assembly (item L) with the Radio Carrier Board (item G). Press the two assemblies together and secure them via three (3) 2-56 x .250 Pan Head Screws (item I).

3. Align the Radio Carrier Board (with FreeWave Radio installed) with the four (4) built-in Swaged Standoffs (item E) on the CPU/System Controller Board and secure this assembly via four (4) 4-40 x .250 Pan Head Screws (item F).

4. Secure the L-shaped Antenna Cable Bracket (item N) to the lower right corner of the front of the CPU/System Controller Board via the remaining screw (item O) and nut (item P)

5. Plug the radio end of the Antenna Cable (item M) into the FreeWave Radio's RF Connector.

6. Install the antenna end of the Antenna Cable (item M) through the L-shaped Bracket (item N - installed in step 4). Secure the Antenna Cable to the Cover Panel via the Antenna Cable's washer and nut.

7. Set the CPU/System Controller Board Radio/Modem Jumpers as follows:

W8: set Jumper to storage position, i.e., parked (no connection)
W9: set Jumper to storage position, i.e., parked (no connection)
W10: set Jumper for DTR Power Control
Removed = Remove Power with DTR OFF
Installed = Power Always ON
W11: set Jumper to storage position, i.e., parked (no connection)
W12: set Jumper to storage position, i.e., parked (no connection)
W19: set Jumper onto posts 2 to 3
W21: set Jumper onto posts 1 to 2
W22: set Jumper onto posts 1 to 2
W23: set Jumper onto posts 1 to 2
W24: set Jumper onto posts 1 to 2

8. Apply power and test the unit.

D1.1.2 FreeWave Radio (FGR09CSU) Configuration Guidelines

To configure a Model FGR09SCU Radio (installed on a CPU/System Controller Board), perform the following seven (7) steps:

1. Place the radio into configuration mode by setting CPU/System Controller Board Jumper W8 onto pins 1 and 2. This will enable configuration of the radio through Comm. Port 1.

2. Connect a Modem Cable (see Figures D2A & D2B) between a PC and the Local Port, i.e., Comm. Port 1.

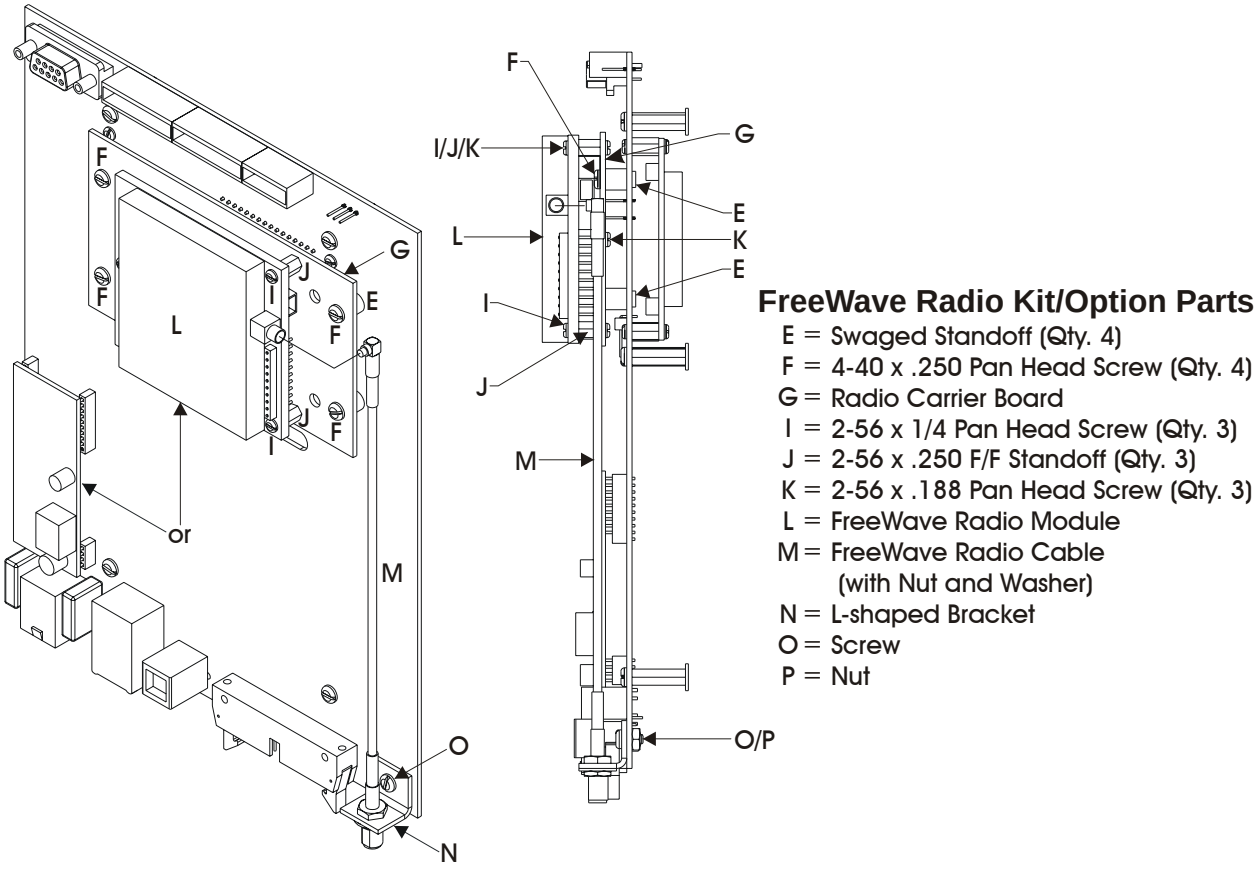


Figure D1 - FreeWave Radio Installation Diagram

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

Bits per second:	19200
Data bits:	8
Parity:	None
Stop bit:	1
Parity Check:	None/Off
Carrier Detect:	None/Off
Flow Control:	Xon/Xoff

4. Cycle power to the **Control**Wave **GFC-CL**. The FreeWave configuration menu will appear in Hyperterminal.

5. In the configuration menu, set the radio as a multipoint slave. Go to the edit book and type in the serial number of the Master Radio to which you want to communicate. Make sure the Baud Rate matches that of the Master Radio. Once settings have been implemented, press the Esc Key to exit the configuration menu.

6. Set CPU/System Controller Board Configuration Jumper W8 into a storage position, i.e., parked (no connection). Apply power and test the unit.

7. Using HyperTerminal at the Master Radio, inter configuration mode and set the radio as a multipoint master. Using the edit book (in configuration mode) make sure that no serial number is set. Verify that the baud rate matches that of the Slave Radio.

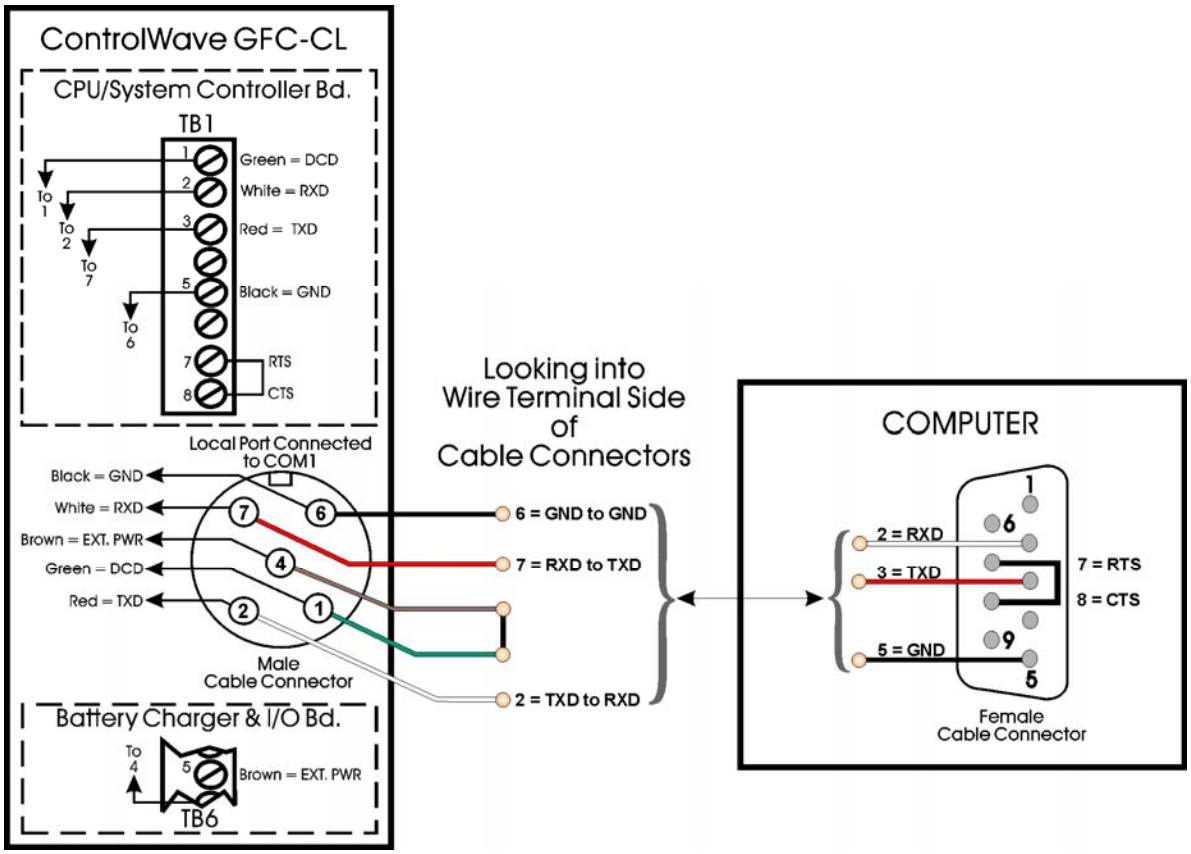


Figure D2A - PC Connected to Control Wave **GFC-CL via Circular Local Port**
Bristol Cable Part Number 395402-01-8 = 10 Foot Comm. Cable
Bristol Cable Part Number 395402-02-6 = 25 Foot Comm. Cable

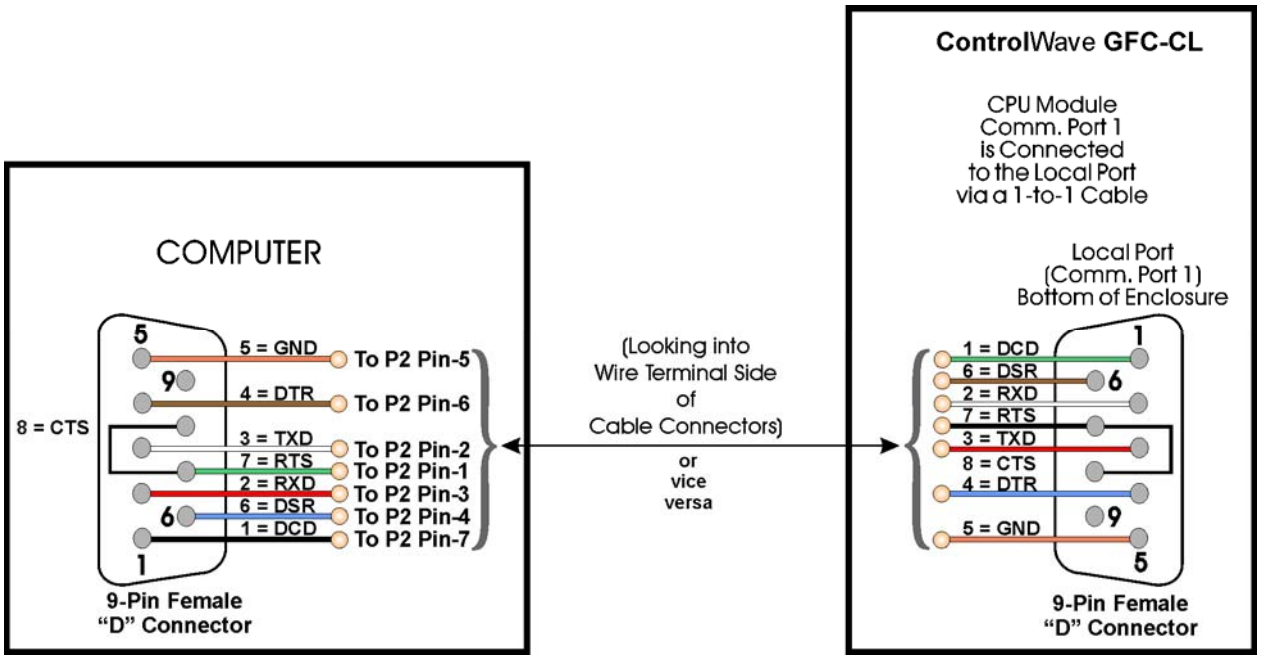


Figure D2B - (Internal Radio/Modem Configuration) Bristol P/N 392843-01-3 Full-duplex Null Modem Cable Diagram

D1.1.3 Installing an Internal MDS Transnet OEM Radio

MDS Transnet OEM Radio is provided (for user installation) in a kit consisting of the following components:

- 6-32 x .250" Pan Head Screw (Qty. 4) - Fig. D3 Reference = A
- 6-32 x .313" F/F Standoff (Qty. 4) - Fig. D3 Reference = B
- 6-32 x .188" Pan Head Screw (Qty. 4) - Fig. D3 Reference = C
- Transnet Radio Cable (with Nut and Washer- Fig. D3 Reference = D
- Swaged Standoff (Qty 4) - Built into CPU/System Controller Bd. - Fig. D3 Reference = E
- 4-40 x .250" Pan Head Screw (Qty. 4) - Fig. D3 Reference = F
- Radio Carrier Board - Fig. D3 Reference = G
- MDS Transnet Radio Module - Fig. D3 Reference = H
- MDS Transnet Radio Cable Mounting Hardware - Fig. D3 Reference: N = L-shaped Bracket, O = Screw and P = Nut

To install a Transnet OEM Radio onto a CPU/System Controller Board, perform the following eight (8) steps (referring to Figure D-3):

1. Install the four (4) 6-32 x .313 F/F standoffs (item B) onto the front of the Radio Carrier Board (Item G). These standoffs are secured via four (4) 6-32 x .188 Pan Head Screws (item C) that pass through the rear of the Radio Carrier Board.

2. Align the MDS Transnet OEM Radio Assembly (item H) with the Radio Carrier Board (item G). Press the two assemblies together and secure them via four (4) 6-32 x .250 Pan Head Screws (item A).

3. Align the Radio Carrier (with MDS Transnet OEM Radio installed) with the four (4) built-in Swaged Standoffs (item E) on the CPU/System Controller Board and secure this assembly via four (4) 4-40 x .250 Pan Head Screws (item F).

4. Secure the L-shaped Antenna Cable Bracket (item N) to the lower right corner of the front of the CPU/System Controller Board via the remaining screw (item O) and nut (item P)

5. Plug the radio end of the Antenna Cable (item D) into the MDS Transnet OEM Radio's RF Connector.

6. Install the antenna end of the Antenna Cable (item D) through the L-shaped Bracket (item N - installed in step 4). Secure the Antenna Cable to the Cover Panel via the Antenna Cable's washer and nut.

7. Set the CPU/System Controller Board Radio/Modem Jumpers as follows:

   W8: set Jumper to storage position, i.e., parked (no connection)
   W9: set Jumper to storage position, i.e., parked (no connection)
   W10: set Jumper for DTR Power Control
   Removed = Remove Power with DTR OFF
   Installed = Power Always ON
   W11: set Jumper to storage position, i.e., parked (no connection)
   W12: set Jumper to storage position, i.e., parked (no connection)
   W19: set Jumper onto posts 2 to 3
   W21: set Jumper onto posts 1 to 2
   W22: set Jumper onto posts 1 to 2
   W23: set Jumper onto posts 1 to 2
   W24: set Jumper onto posts 1 to 2

8. Apply power and test the unit.

D1.1.4 MDS Transnet OEM Radio Configuration Guidelines

To configure a MDS Transnet OEM Radio (installed on a CPU/System Controller Board), perform the following seven (7) steps:

1. Place the radio into configuration mode by setting CPU/System Controller Board Jumper W8 onto pins 1 and 2. This will enable configuration of the radio through Comm. Port 1.

2. Connect a Modem Cable (see Figures D2A & D2B) between a PC and the Local Port, i.e., Comm. Port 1.

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

Bits per second:	19200
Data bits:	8
Parity:	None
Stop bit:	1
Parity Check:	None/Off
Carrier Detect:	None/Off
Flow Control:	Xon/Xoff

4. Cycle power to the **Control**Wave **GFC-CL**. After hitting the escape (Esc) key and then the carriage return twice (at approximately half second intervals), the right arrow (>) will appear.

5. In the configuration menu, set the radio mode using either the MODE M (master) or MODE R (remote) command. ***Note: There can be only one Master radio per network.*** Go to the edit book and type in the serial number of the network's Master Radio. Set a unique Network Address (1 - 65000) using the ADDR command. ***Note: All radios on the network must have the same Network Address.*** Make sure the Baud Rate of any Remote Radio matches that of the Master Radio. Set the radio's data interface parameters (bps: 1200 – 114200 bps), Data Bits: (8). Parity (N), Stop bits: (1). Once settings have been implemented, press the Esc Key to exit the configuration menu.

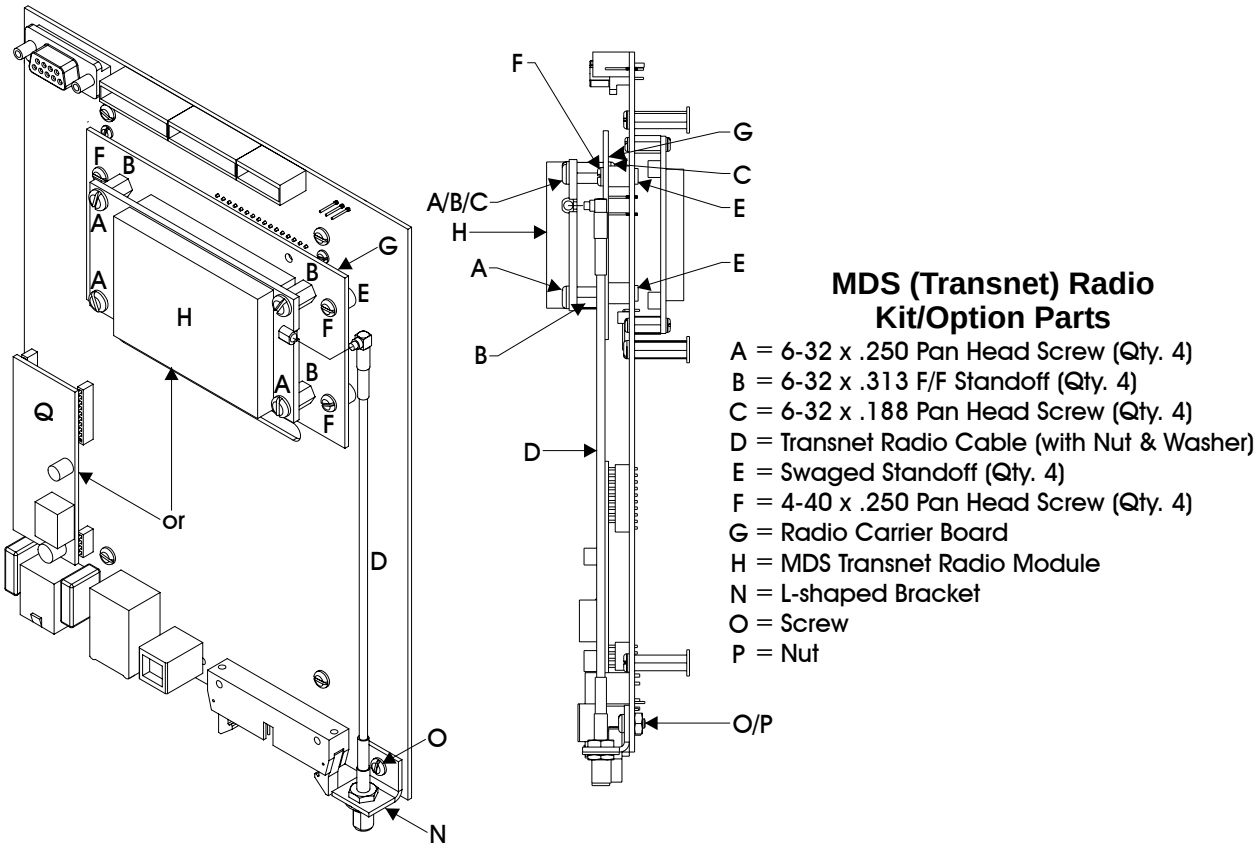


Figure D3 - MDS Transnet OEM Radio Installation Diagram

6. Set CPU/System Controller Board Configuration Jumper W8 into a storage position, i.e., parked (no connection).

7. Apply power and test the unit.

D2.1 MODEM INSTALLATION & CONFIGURATION

D2.1.1 Installing an Internal MultiTech Modem (MT5634SMI)

MultiTech Modem Model MT5634SMI is provided (for user installation) in a kit consisting of the following components:

- MultiTech Modem Module - Fig. D4 Reference = Q

To install a Model MT5634SMI Modem onto a CPU/System Controller Board, perform the following three (3) steps (referring to Figure D4):

1. Mount the MultiTech Modem (item Q) to the CPU/System Controller Board making sure that the interface connectors (J7, J8, J10 & J11) align with those on the rear of the modem.

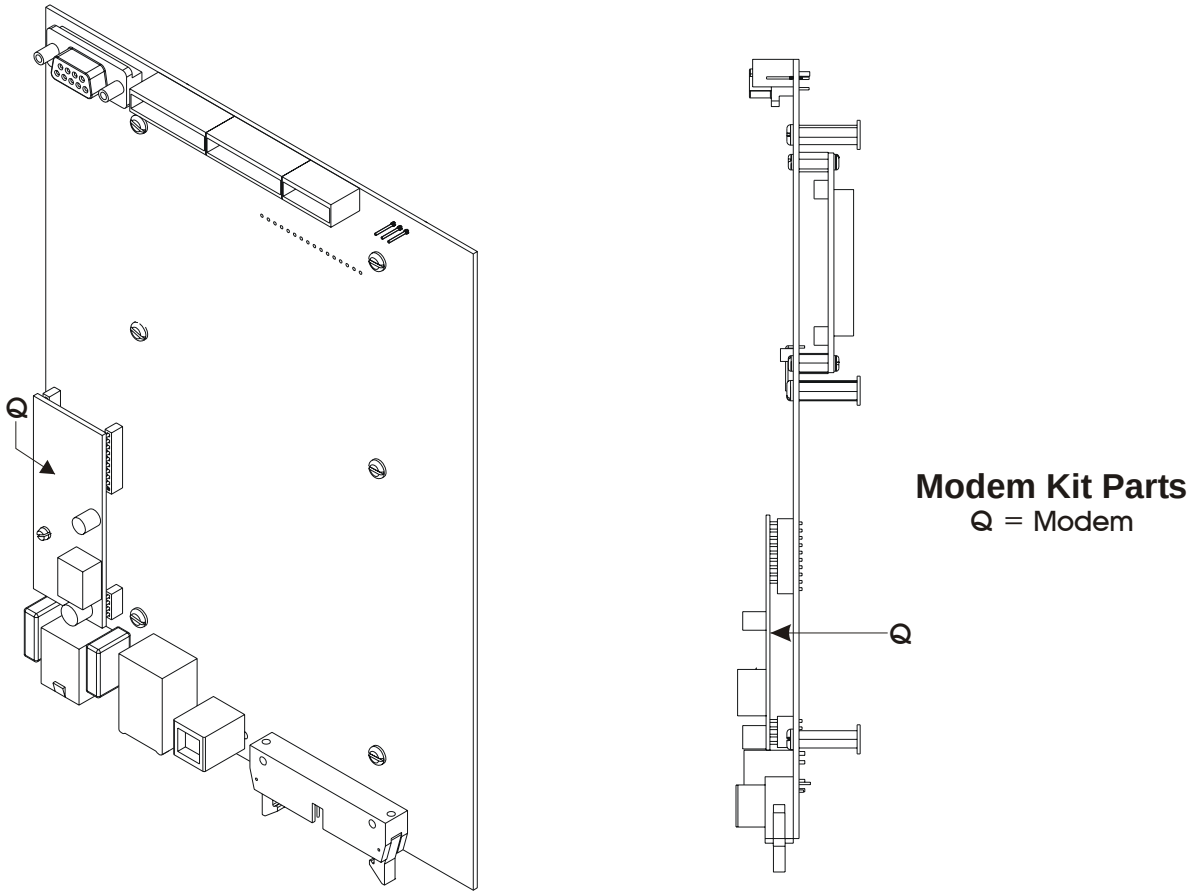


Figure D4 - MultiTech Modem Installation Diagram

2. Set the CPU/System Controller Board Radio/Modem Jumpers as follows:
   W8: set Jumper to storage position, i.e., parked (no connection)
   W9: set Jumper to storage position, i.e., parked (no connection)
   W10: set Jumper for DTR Power Control
   Removed = Remove Power with DTR OFF
   Installed = Power Always ON
   W11: Install Jumper
   W12: set Jumper to storage position, i.e., parked (no connection)
   W19: set Jumper onto posts 1 to 2
   W21: set Jumper onto posts 1 to 2
   W22: set Jumper onto posts 1 to 2
   W23: set Jumper onto posts 1 to 2
   W24: set Jumper onto posts 1 to 2

3. Apply power and test the unit

D2.1.2 Configuring the MultiTech Modem (MT5634SMI)

To configure a Model MT5634SMI Modem (installed on a CPU/System Controller Board), perform the following seven (7) steps (this should have been done during factory installation):

1. Place the modem into configuration mode by setting CPU/System Controller Board Jumper W8 onto pins 2 and 3. This will enable configuration of the modem through Comm. Port 1.

2. Connect a Modem Cable (see Figures D2A & D2B) between a PC and the Local Port, i.e., Comm. Port 1.

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

Bits per second:	9600
Data bits:	8
Parity:	None
Stop bit:	1
Flow Control:	None

3. Send Factory Default = AT&W1 ATZ.

4. Disable Flow Control = AT&K0.

5. Set baud rate using AT Command: AT$SB9600, or whatever baud rate you require.

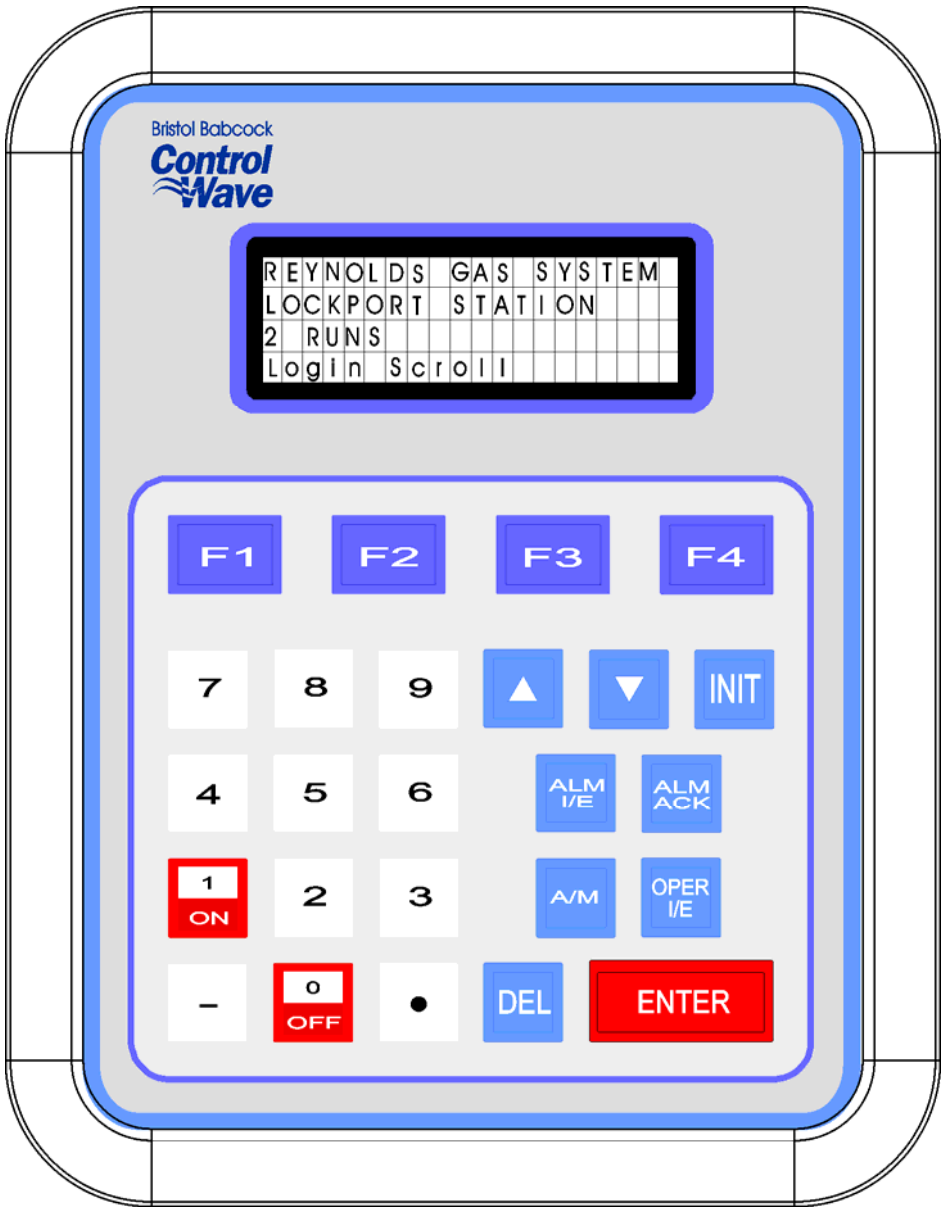
6. Write to memory = AT&W0.

7. Set CPU/System Controller Board Configuration Jumper W8 into a storage position, i.e., parked (no connection).

After completing the seven configuration steps (if required) use WebBSI to select the "Radio/Modem Control Mode" on the **Radio & Modem Control Configuration** Web page.

ControlWave GFC-CL DISPLAY/KEYPAD ASSEMBLY - GUIDE

Appendix E



ControlWave

APPENDIX E

ControlWave GFC-CL Display/Keypad Assembly Guide

TABLE OF CONTENTS

NOTE:

The Dual-button Display/Keypad Assembly is discussed at the end of Chapter 2 (see Section 2.4.5.1).

Appendix E
DISPLAY/KEYPAD ASSEMBLY GUIDE

E1.1 OVERVIEW

Bristol Display/Keypad assemblies provide a built-in, local, user interface for the **Control**Wave **GFC-CL** These assemblies allow an operator or engineer to view and modify variable values and associated status information, via an ACCOL3 Function Block. Variables can include inputs, process variables, calculated variables, constants, setpoints, tuning parameters and outputs used in a measurement or control application. Status bits include alarm state, alarm acknowledge, control, manual, and questionable data.

Setting up the Display/Keypad is a simple matter of configuring a Display Function Block in the ControlWave Designer project.

The Display/Keypad is comprised of a four line by twenty character liquid crystal display, with adjustable LCD Contrast, and a 25 button membrane key matrix. Each key has a microswitch for positive tactile feedback. This means that as you firmly depress the keys, you will feel it click as it engages. In the case of the **Control**Wave **GFC-CL**, the Display/Keypad is located in the Instrument Front Cover and is installed at the factory.

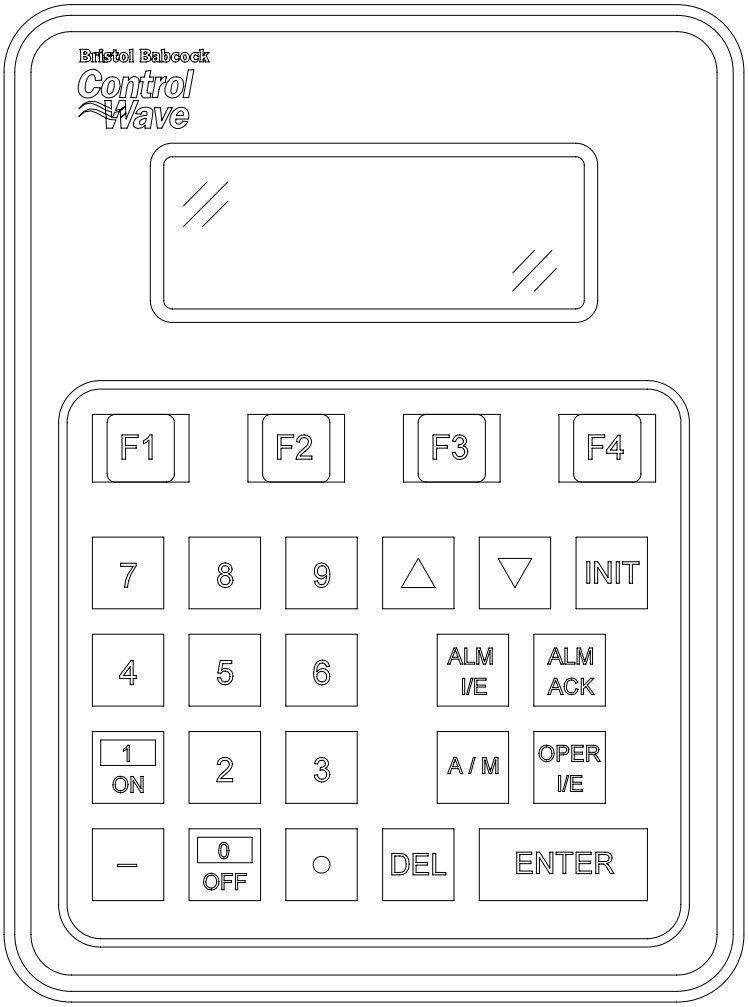


Figure 1 - Display/Keypad Assembly – 25 Button Keypad & 4 X 20 Display

Display/Keypad Assemblies are supported by **Automatic Mode and Manual Mode**.

Automatic Mode
In Automatic Mode a set of screens (based on the application load) are displayed. The application programmer provides strings for the opening screen. From there the firmware is responsible for displaying the screens and responding to key presses. Screens are fixed and start off with an opening screen, which displays user information passed into the function block. Users can view a list to select which list is to be scrolled. Once the list to be scrolled has been selected, the user can scroll through the list by pressing the down arrow key. List elements will be displayed automatically, scrolling at a predetermined rate (determined by iiScrollTime). The user may pause on a variable by pressing the right arrow key. Pressing the right arrow key again will cause the list to start scrolling again.

The essence of Automatic Mode is that the user can supply inputs into the function that will determine which list can be displayed, but cannot change the menu or display. The user is allowed to select a list and to start/stop scrolling.

Manual Mode
In Manual Mode the programmer is responsible for creating each screen and displaying the next desired screen, based on key inputs. The programmer has access to all lines of the display and can provide any string that he/she desires to display. Special formats that must be adhered to that allow the programmer to display what they want on the screen are provided in the description of iaScrnSruct in the ACCOL 3 Display function block within ControlWave Designer's On-Line Help. It should be noted that currently, Manual Mode does not support reading Keypad keypresses. **Note: Manual Mode operation requires ControlWave Firmware 4.50 or newer.**

If you're setting up the keypad, follow the configuration instructions provided in Section E3 of this appendix.

If your keypad has already been set up, Section E4 will tell you how to use the keypad and interpret the display.

E2.1 DISPLAY FUNCTION BLOCK DESCRIPTION

Keypad and display control/configuration are handled by the DISPLAY Function Block. This function block allows an operator to view/change variable data or to be allowed to scroll through lists of variable data based upon their login privileges.

In order for the keypad and display to operate, the ControlWave Designer project must include a properly configured DISPLAY Function Block. Use ControlWave Designer to configure this function block and assign the parameters according to the four steps covered in Section 3.

E2.1.1 DISPLAY Function Block Parameters

Referring to Figure 2, various DISPLAY Function Block Parameters are available. For information on configuring the Display Function Block, please reference on-line help in ControlWave Designer.

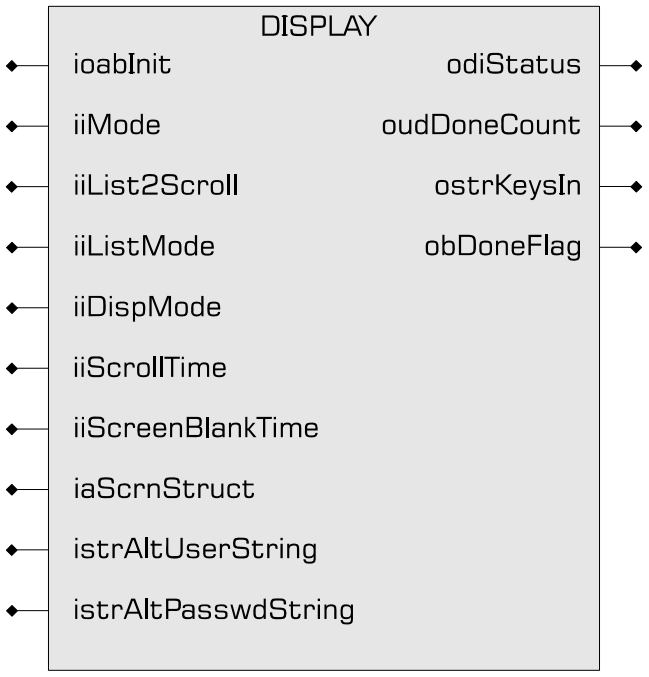


Figure 2 - ACCOL3 DISPLAY Function Block Parameters

E3.1 PREPARING THE ControlWave PROJECT

In order for the keypad and display to operate, the ControlWave Designer project must include a properly configured Display Function Block. Once the Keypad is operating, a user who has signed on with a password can scroll through the names of variable lists and choose a list to read or change. Use Up Arrow and Down Arrow keys to select the Username and use the numeric keys to enter your password. The steps that follow describe how to configure this function block.

Step 1: Creating the Identifier Display

The Identifier Display is the first display to appear when the Display Function Block is initialized and begins to execute. This display will look similar to Figure 3. Each of the first three lines of the display contains the text value of a string variable. These string variables are created utilizing iaScrnStruct parameters of the Display Function Block (See Figure 2) and your computer keyboard. Since this is the first display that the user will see, you may want the display to contain general information such as the node name of the controller or the process that the controller is monitoring.

The bottom line on the display is called the legend line. It shows which function keys are currently active and their purpose. Function keys are those keys on the Keypad that are marked ([F1] through [F4]). Function key assignments are preconfigured and cannot be changed. Using function keys is described in Section 4, Using the Keypad.

The legend line in Figure 3 shows that the user has two choices: to Log-in (using [F1]) or scroll (using [F2]).

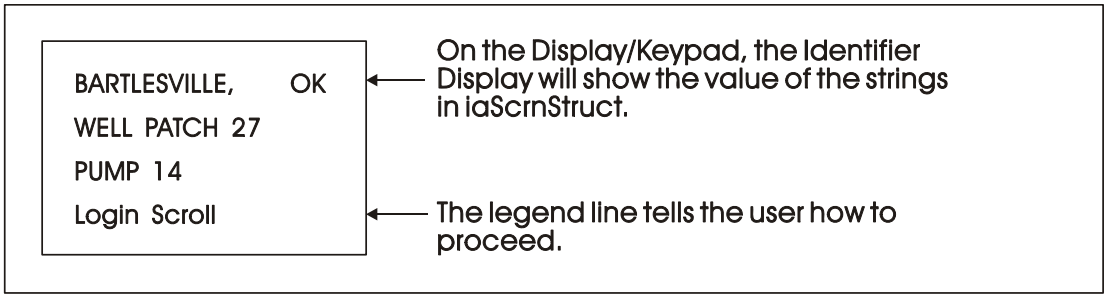


Figure 3 - Creating the Identifier Message

Step 2: Defining a Scroll List

Once the Keypad is operating properly, you can automatically scroll through a list of variables created via DISPLAY Function Block Parameters iiList2Scroll and iiListMode. Scrolling can be done without entering a password. The variables in the list are displayed one at a time and in the same order in which they were entered in the variable list.

Later, we'll discuss other variable lists that can be accessed with the keypad. To distinguish this list from others, let's call this variable list the Scroll List.

Enter the number of a variable list to be scrolled. This variable list becomes the Scroll List. The Scroll List can contain different types of variables (that is, logical, analog and string). You can create a specific scroll variable list or use any list in the ControlWave Project.

Each variable in the Scroll List will be displayed for the number of seconds defined by the iiScrollTime parameter. If you don't specify a time for this parameter, the hold time will be two seconds. If you signed-on and then started scrolling you will be signed-off in 20 minutes if no keys are pressed. If you don't want to automatically stop scrolling after 20 minutes, sign-off (INIT key) before starting scrolling.

Step 3: Assigning Passwords

A valid RTU username/password combination must be entered to go beyond the initial displays. Passwords can be any combination of numbers up to 16 digits in length, from 0000000000000000 to 9999999999999999. If none are specified, the default values are system for User-name and 666666 for Password (read/write access).

Step 4: Status Information

Enter a variable name on the odiStatus terminal.

See On Line Help in ControlWave Designer for Status Values.

The next section describes how to use the Keypad to access variable information.

E4.1 USING THE KEYPAD

The Identifier Display is the starting point from which you can go to other displays. It shows an identification message and the words Login and Scroll at the bottom of the screen (see Note 1). The identification message may contain the name of the controller, the plant equipment it is monitoring, or the variables you can expect to see when you use this display.

Note 1 : If your display shows something else, press the [F4] key until you see the words Login and Scroll on the bottom line.

If your screen is blank, turn the brightness screw clockwise. This screw is located to the left of the Keypad (looking at the rear of the 25-Button Display/Keypad Assembly (see Figure 17). If no letters appear, the controller has not been programmed properly to operate the keypad.

The words Login and Scroll at the bottom of the screen are on the legend line. It tells you which function keys (that is, key [F1] through [F4]) are active and their purpose at that time.

Up to four legends can appear on the legend line. The legend on the far left corresponds to the function of the [F1] key. The assignment for the [F4] key is on the far right. Keys [F2] and [F3] are described to the left and right of center. When no legend appears, that function key is not active at that time. For example, in Figure 4 only [F1] and [F2] are active.

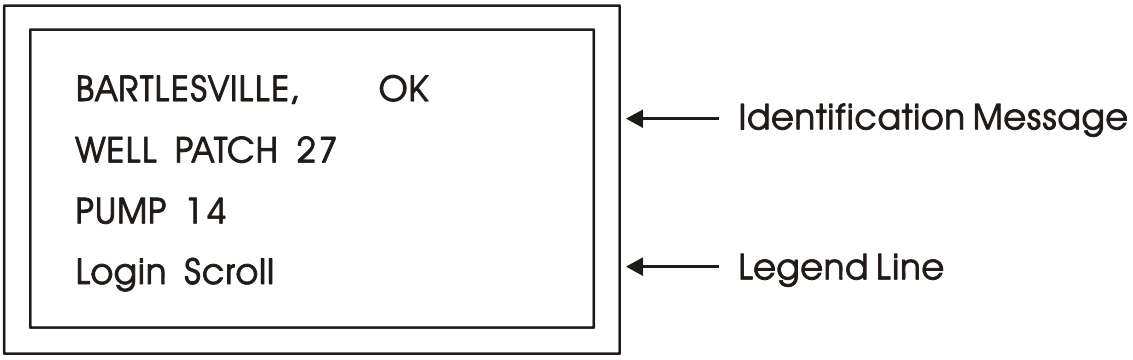


Figure 4 - The Identifier Display

From the Identifier Display, you have two choices. Pressing [F1] will allow you to sign-on if you have a password. By pressing [F2] you can activate automatic scrolling through a list of variables.

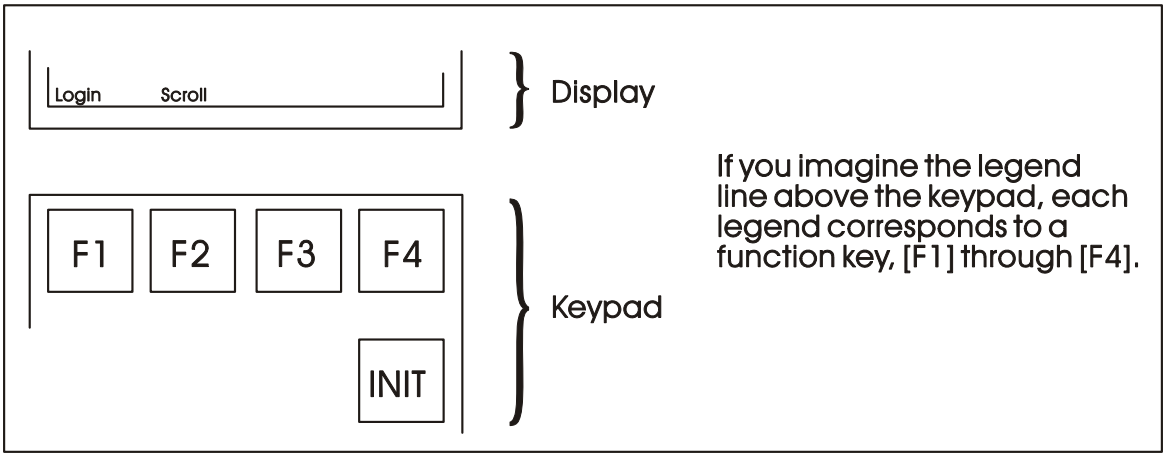


Figure 5 - Identifier Display Legends and Corresponding Keypad Alignment for 25 Button Membrane Key Matrix Keypad System

E4.1.1 Scrolling

To begin automatic scrolling, press [F2] from the Identifier Display (Figure 4). Variable information will appear on the screen and remain there for 1 to 30 seconds (default = 2). The

variable name appears on the first line. The variable value appears on the second line and status information appears on the third line. An example is shown in Figure 6.

When all variables in the list have been displayed, they will be shown again in the same order. This is called Single Variable Mode.

Pressing Mlti [F2] activates Multiple Variable Mode. Multiple Variable Mode displays up to three (3) variables and their values on the screen simultaneously. Pressing Sngl [F2] terminates Multiple Variable Mode and returns you to Single Variable Mode.

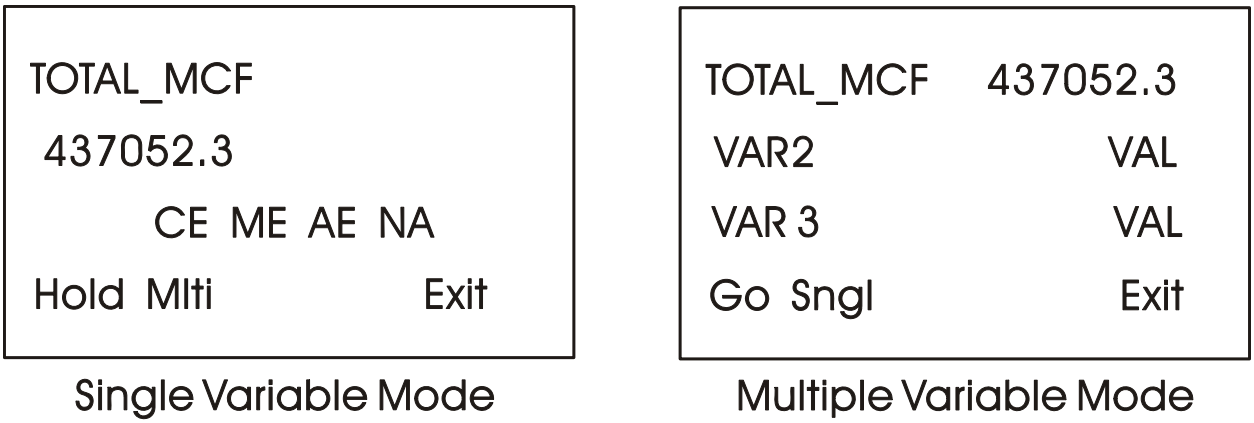


Figure 6 - Scrolling

Press HOLD [F1] to halt scrolling. Changing variable values will continue to be displayed.

Press GO [F1] to resume scrolling.

Press EXIT [F4] to return to the Identifier Display (Figure 4).

E4.1.2 Signing-On

To access the List Menu, you must first sign-on with a proper password. From the Identifier Display (Figure 4), press [F1]. The screen will look like Figure 7A or 7C. If the display looks like Figure 7C:

> Someone else has already signed on. Go to the paragraph below that starts "Once you have successfully signed on,…".

If the display looks like Figure 7A:

> Select the Username (default = system) by using the Up and Down Arrow Keys. If the Username system is displayed and no other Username is available (i.e., no others have been assigned), press [ENTER].
>
> Enter a password using the 0 to 9 keys. For security, asterisks will appear as you enter the digits. If you make a mistake, press [F1] and try again or use the delete key to delete the previously pressed key action. The default password is 666666 (used when a password is not known or no password has been assigned). After typing the password, press [ENTER].
>
> If your password is not recognized, the asterisks will be erased after you press [ENTER]. Check your password and try again.

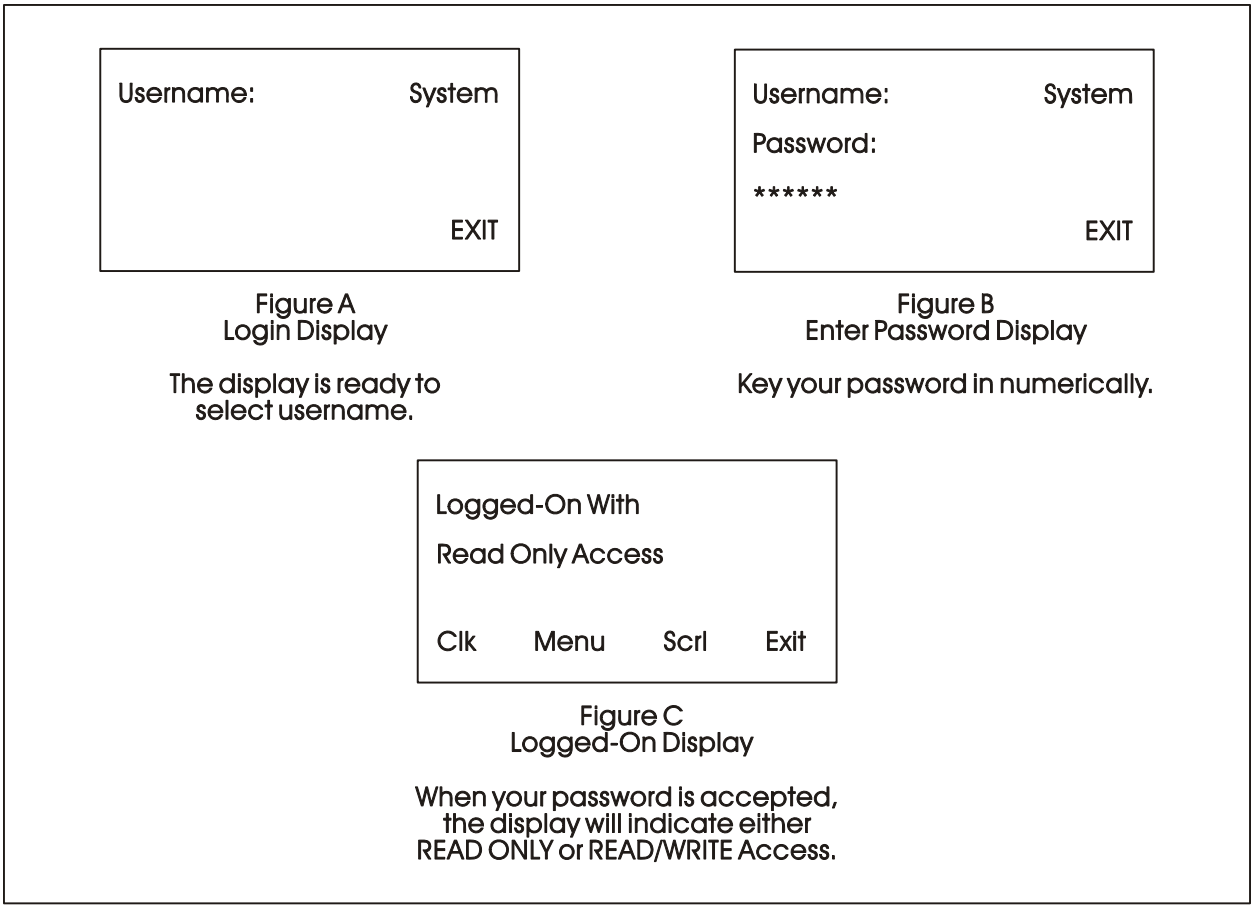


Figure 7 - Logging On

Once the correct password has been entered, the display will look like Figure 7C.

When the second line shows READ/WRITE, you can read and write variable parameters. When it shows READ ONLY you cannot change variable parameters. You are only permitted to read variable information. If your display shows READ ONLY and you want to change variable values, sign-off (press the [INIT] key) and log on with a username and password that provides Read/Write privileges.

Once you have successfully signed on, the legend line will show that you have four options. You can view and change the time and date of the local clock, access more variable lists, Scroll, or return to the Identifier Display. Use function keys F1 through F4 to select the next menu (F1 = Clock, F2 = Menu, F3 = Scroll list & F4 = Exit). Let's start by setting the local clock.

E4.1.3 Using the Clock Functions

From the Logged-On Display (Figure 7C), press [F1]. The screen will show the present date and time and will look like Figure 8. Follow the instructions below to change the time or date. When you're finished, press [F4] to exit.

Today's date is shown in the first line in the format month/day/year.

The current time is shown in the form of hours:minutes:seconds.

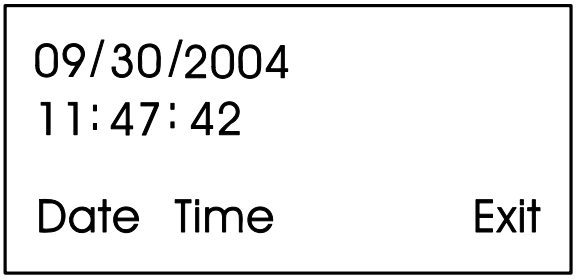


Figure 8 - Clock Display

E4.1.3.1 Changing the Time

From the display shown in Figure 8, press Time [F2]. Colons (:) will appear on the third line. Enter the new time there and press [ENTER]. Valid times range from 00:00:00 to 23:59:59. Invalid entries will be ignored. The display will be updated to show the new time.

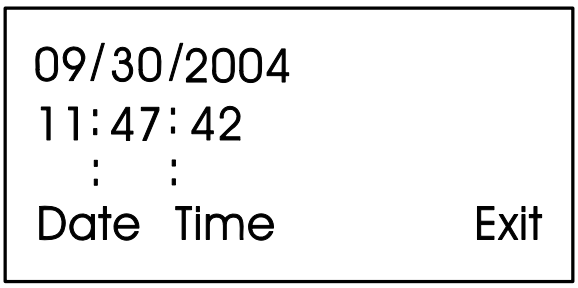


Figure 9 - Time Set Display

If you make a mistake while entering the new time, use [DEL] to backspace and delete one character at a time.

E4.1.3.2 Changing the Date

From the clock display (Figure 8, press [F1]. Slash marks (/) will appear on the third line. Enter the new date there and press [ENTER].

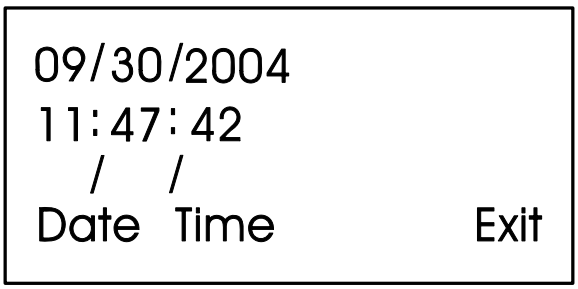


Figure 10 - Date Set Display

If you make a mistake while entering the new date, use [DEL] to back space and delete one character at a time. Press [F4] to return to the Logged-On Display (Figure 7C).

E4.1.4 Choosing a Variable List from the List Menu

The List Menu is another area where variable information can be seen. As explained earlier in this section, your first opportunity to read variable information is by choosing the

SCROLL function from the Initial Display. The variable name and value are presented from the Scroll List. This function is available to all users even without signing-on.

The List Menu will show other groups of variable which you can choose to read. This information will be more detailed than the Scroll List.

To get to the List Menu, choose MENU (press [F2]) from the Logged-On Display (Figure 7C).

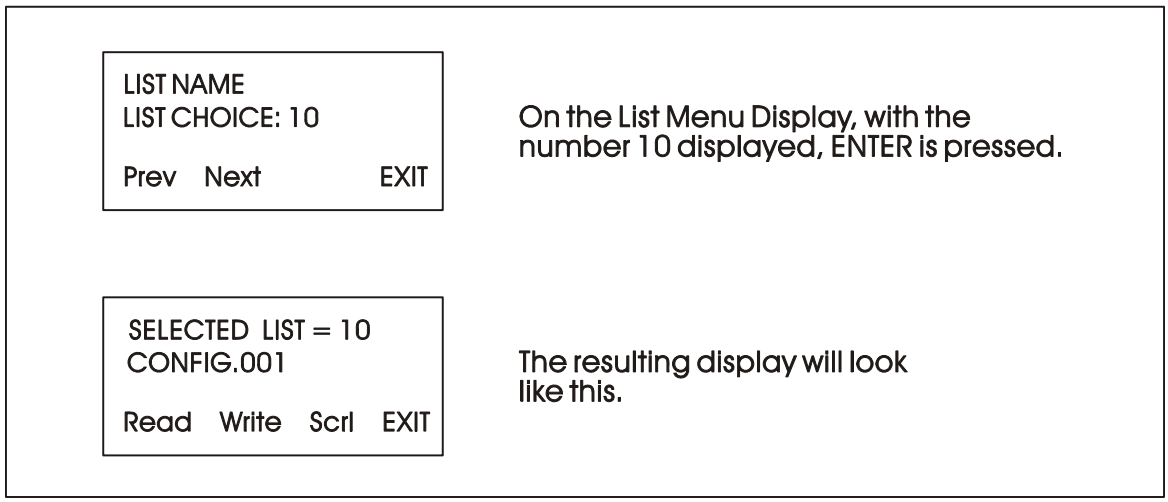


Figure 11 - Using the List Menu Display

The first variable list number in the menu will appear on the second line.

Press PREV (F1) and NEXT (F2) to see the other variable lists that are available in the List Menu. You can also use the Up and Down Arrow Keys to scroll through the various lists. To move directly to a list, enter the list number, then press [ENTER].

E4.1.5 Moving Through a Variable List

After READ (F1) or WRITE (F2) has been pressed, the display will show the first variable in the list. An example is shown in Figure 12. Each time NEXT (F2) is pressed; the display will show the next variable in the list. PREV (F1) will show the previous variable. You can also use the Up and Down Arrow Keys to move through a list.

Automatic wraparound occurs in either direction. When you reach the end of the list, [F1] will display the first variable again. At the top of the list, [F2] will display the last variable.

E4.1.6 Changing Variable Parameters

From Figure 11, you can change variable parameters by pressing F2 [Write]. Then follow the directions summarized below (see Note 2).

Note 2: If your display does not contain the legend Write in the legend line, your password will only allow you to read variables. If you want to change variable values at this time, you must first log-off and then log-on using the correct password. See your Systems Engineer for the correct password.

Before making any changes, first check the signal inhibit status field (See Figure 12). When the display shows ME (manual enable) you can change variable parameters. When it shows MI (manual inhibit), you cannot alter the parameters of this variable. If the field indicates MI, press the OPER I/E key to change it to ME.

To change an analog value:

Press CHNG (F3) to clear the third line. Use the number keys 0 through 9 to enter the new value. The minus sign and period are also permitted. Press [ENTER].

If you make a mistake, press CHNG (F3) and enter the number again or use the [DEL] key to erase a character.

Another way to enter new values is by using the arrow up and arrow down keys (located below the [F3] key and left of the [INIT] key). These keys will raise and lower the value by 1% of the displayed amount.

To change the status of a logical variable:

Press CHNG (F3), then use either the down and up arrow keys or the [0/OFF] and [1/ON] keys to change the state of a logical variable. If the [0/OFF] and [1/ON] keys are used, you must also press [ENTER].

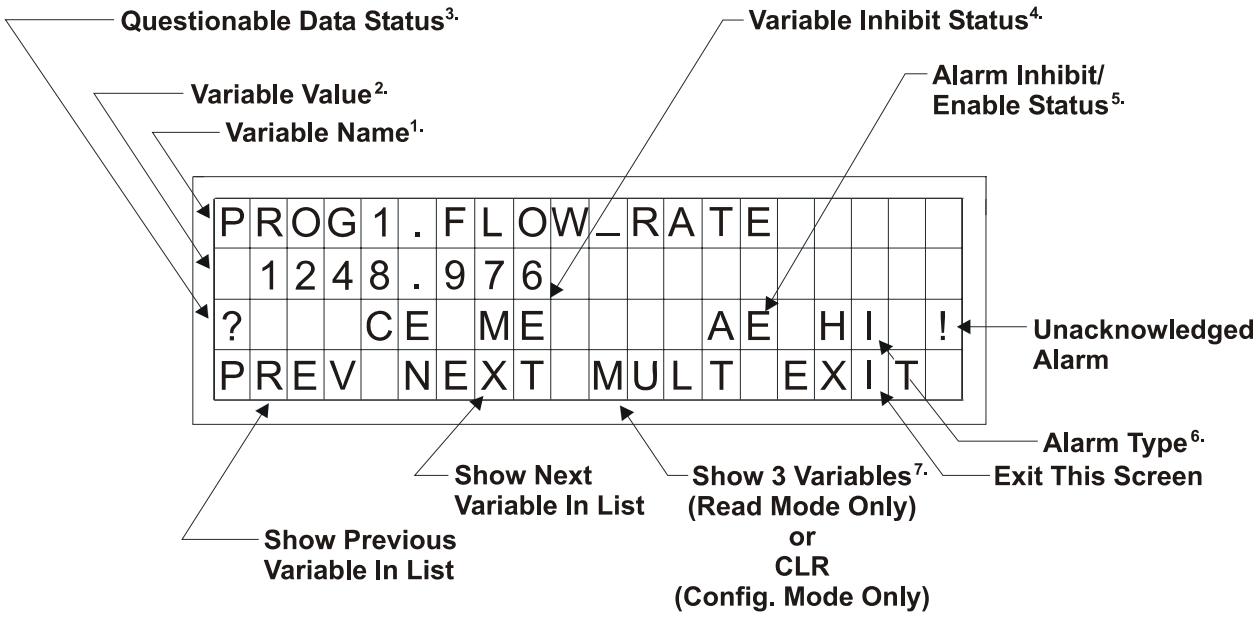


Figure 12 - Interpreting Variable Information

To acknowledge an alarm:

Press [ALM ACK].

To change the alarm enable/inhibit status for alarm variables:

Press [ALM I/E] key. (Note: This will only inhibit alarm reporting, and not alarm level detection.)

Notes for Figure 12

1. Variable Name (Example 1: @GV.FLOW_RATE) (Example 2: @GV.TOTAL_FLOW_RATE)

2. Value - analog value, string value, or logical value. Values which cannot fit in this field will be shown as asterisks.

   Analog values are displayed in floating point format, for example, 0.0125, 99.627, and 1287.66. When the value cannot be shown in floating point format, scientific format is used (1.287668E+10 or 1.25E-02 for example).

3. Questionable Data Status - for analog variables, column 1 will be clear if the status is valid. It will display a question mark if the status is questionable.

4. Variable Inhibit Status

   CE (Control Enable) means this variable can be updated by the ControlWave project.
   CI (Control Inhibit) means the variable cannot be updated by the ControlWave project.
   ME (Manual Enable) means the variable can be changed manually.
   MI (Manual Inhibit) means the variable cannot be changed manually.

5. Alarm Enable (for alarm variables only)

   AE - variable is alarm enabled (changes will be reported).
   AI - variable is alarm inhibited (changes will not be reported).

6. Alarm State

For Analog Variables:		For Logical Variables:	
HH	- high-high alarm	TA	- true alarm
HI	- high alarm	FA	- false alarm
LO	- low alarm	CA	- change-of-state alarm
LL	- low-low alarm		

   ! - alarm is unacknowledged

Notes for Figure 12 (Continued)

7 Multiple Signal Display

In Read Mode, pressing MULT (F3) will display the variable name extension, value, and units for three variables at one time. These variables include the variable displayed when NEXT (F2) was pressed and the next two variables in the list. Press SNGL [F3] to return to viewing one variable at a time (see Figure 12A).

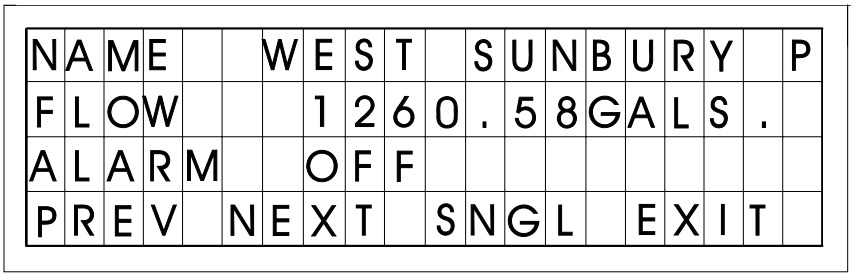


Figure 12A - Example of MULT Display in READ Mode

Variables are shown below as they would appear in SNGL mode.

1) String
SITE_NAME
WEST SUNBURY PUMP STATION
CE ME

2) Analog
TOTAL_FLOW_RATE
1260.578
CE MI

3) Logical
FLOW_ALARM
OFF
CE MI AE NA

E4.1.7 Signing-Off

Once you have logged-on, use the [INIT] key at any time to log-off. When this key has been pressed, the screen will look like Figure 13. Press Yes (F1) to sign-off. You are signed-off when the Identifier Display (Figure 3C) appears.

If you do not want to log-off, press Exit (F4) to leave the Log-Off Display.

Once you are signed-on an automatic sign-off will occur if 20 minutes has elapsed since the last key was pressed.

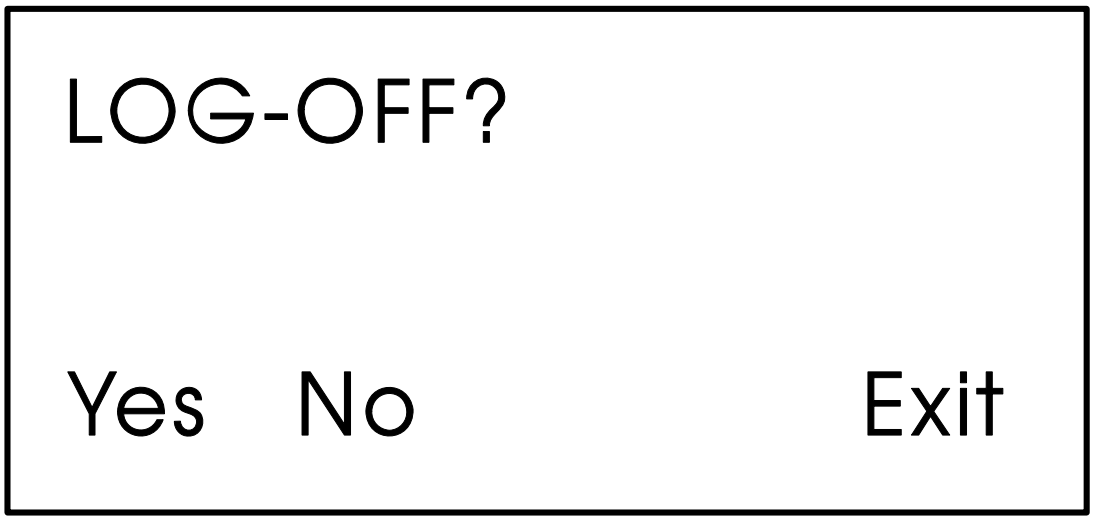


Figure 13 - Log-Off Display

E5.1 KEYPAD IDENTIFICATION & INSTALLATION INFO.

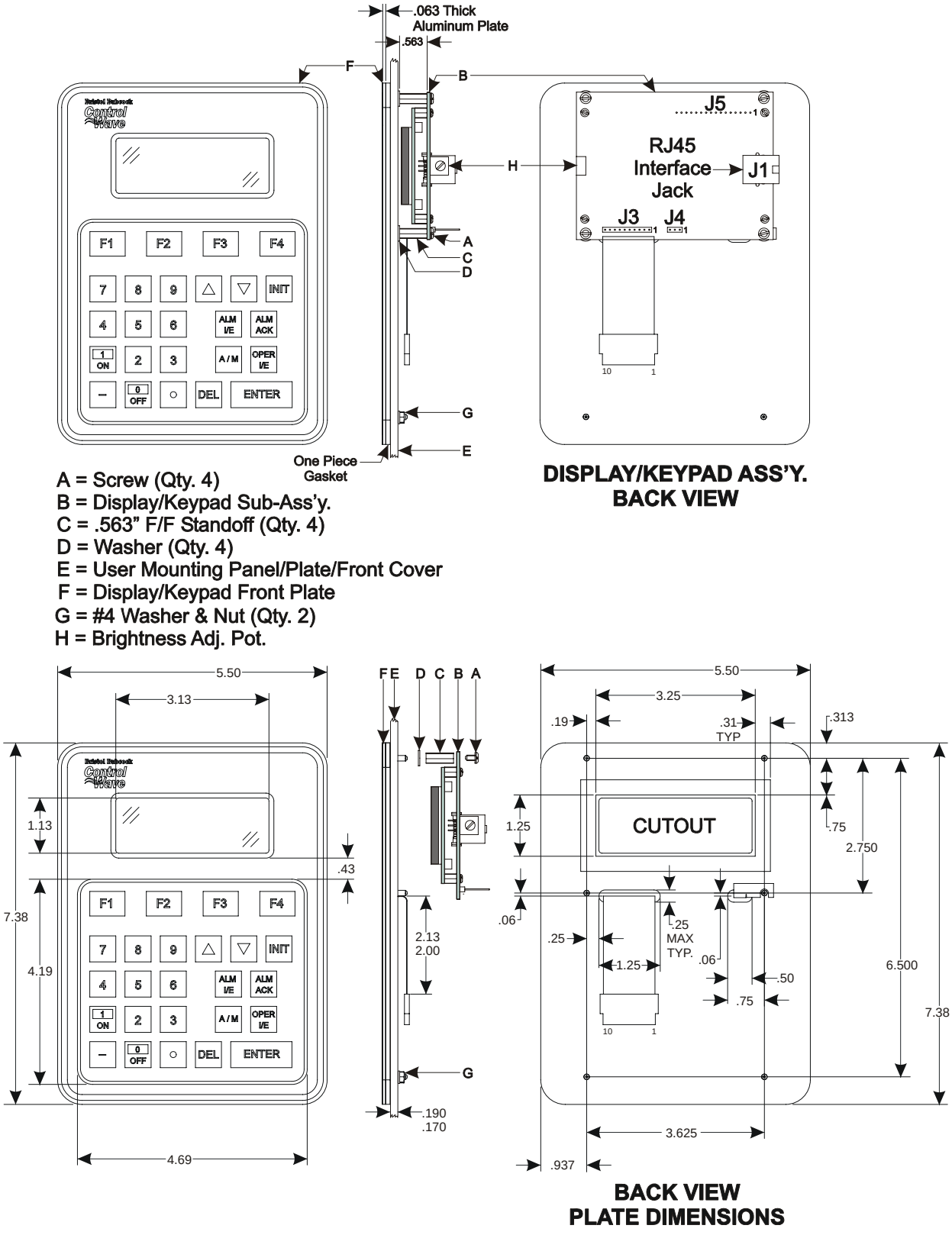


Figure 14 - 25-Button Display/Keypad Assembly Installation Drawing

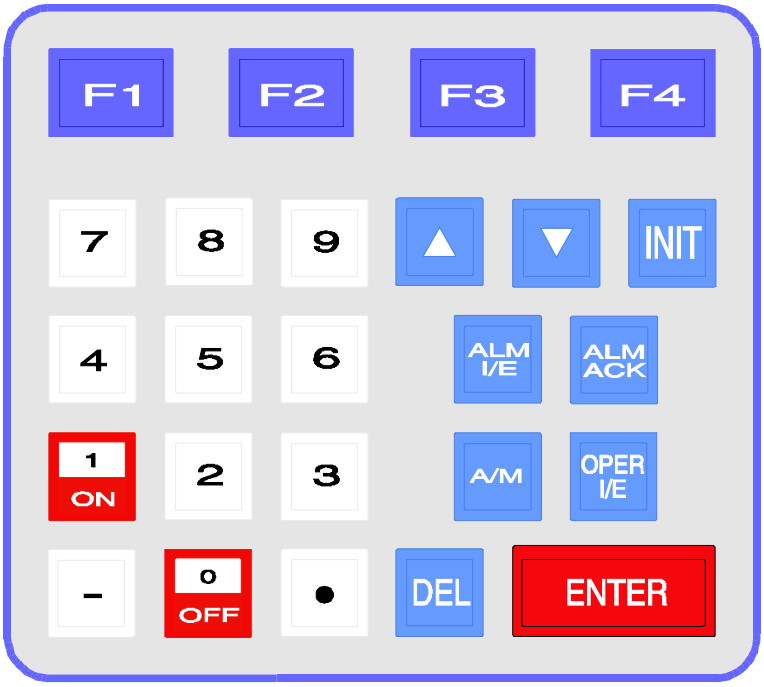


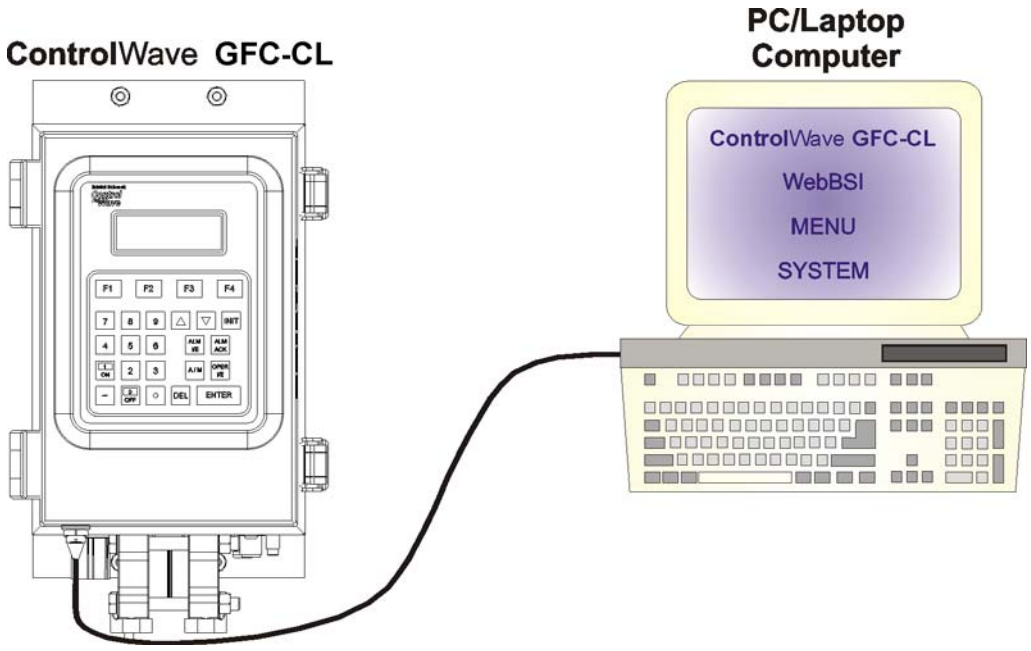
Figure 15 - 25 Button Keypad

Table 1 - 25 Button Keypad Keys

KEY	FUNCTION
F1, F2, F3, F4	Function keys will take on a variety of different functions depending on the situation. The function of these keys is listed on the legend line (bottom line) of the display.
INIT	The INIT key is used to terminate the keyboard session and sign-off.
0 to 9, -, .	These keys are used to change the value of analog variables in the CONFIGURATION mode. The 0/OFF and 1/ON keys are used to change the state of logical variables.
Δ	Each press of this key will raise an analog variable value by 1% of the displayed value or turn a logical variable ON.
∇	Each press of this key will lower an analog variable value by 1% of the displayed value or turn a logical variable OFF.
ALM I/E	Use this key to enable or inhibit alarm variables.
ALM ACK	Use this key to acknowledge alarms.
A/M	Toggle between AUTO (CE) and MANUAL (CI) with this key.
OPER I/E	Toggle between manual inhibit (MI) and enable (ME) with this key.
DEL	Use this backspace key to erase digits that have been entered on the keypad.
ENTER	This key is used to enter new data from the display into the controller, e.g., password or variable values.

Using ControlWave GFC Classic *WebBSI* Web Pages

Appendix F



APPENDIX F

ControlWave GFC Classic
Using ControlWave GFC Classic
WebBSI Web Pages

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ControlWave GFC Classic
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Appendix F
Using **Control**Wave **GFC-CL**
WebBSI Web Pages

F.1 GENERAL OVERVIEW

The **Control**Wave **GFC-CL** is configured and monitored using WebBSI Web pages developed specifically for the standard application program. The Web pages are stored and displayed on a personal computer (PC), and use either OpenBSI Network edition or Local edition to interface to the **Control**Wave **GFC-CL**. Web pages provide:

* *Sign-on to the* **Control**Wave **GFC-CL**
* *Invoke menus to configure the* **Control**Wave **GFC-CL** *for operation*
* *Read current gas flow and total information*
* *Set the* **Control**Wave **GFC-CL** *Date and Time*
* *Change the* **Control**Wave **GFC-CL** *network address*
* *Collect & Display the Daily, Hourly, Periodic, & Audit Logs*

F.1.1 Viewing WebBSI

WebBSI is best viewed under these conditions:

- The Internet Explorer window should be maximized or be viewed full-screen.
- The resolution of the monitor should be at least 800x600 or above (preferably 1024x768 or above).
- The color depth should be at least 16 bit high color or above (preferably 24 bit true color or above).
- The text size of Internet Explorer should be "Medium" or smaller (preferably "Medium").
- JavaScript and ActiveX Controls should be enabled in Internet Explorer.

Pop-up Help windows for WebBSI Web pages can be accessed by clicking the Help button on the left side of WebBSI Web pages. The help windows must be closed in order to open another.

On pages that contain tables of controls:

- A white background on a control means that it is read/write.
- A beige background on a control means that it is read only.

F.2 INSTALLING WebBSI SOFTWARE & **Control**Wave **GFC-CL** Web Pages

The WebBSI software requires a PC (computer) running either OpenBSI Network Edition or OpenBSI Local Edition, with the WebBSI ActiveX controls installed and registered on the PC (see appropriate document for details).

ControlWave **GFC-CL** Web pages will be installed in the following directory as the default: C:\OpenBSI\WebGFC_CL\ and the default startup page will be CW_MICRO_GFC.htm

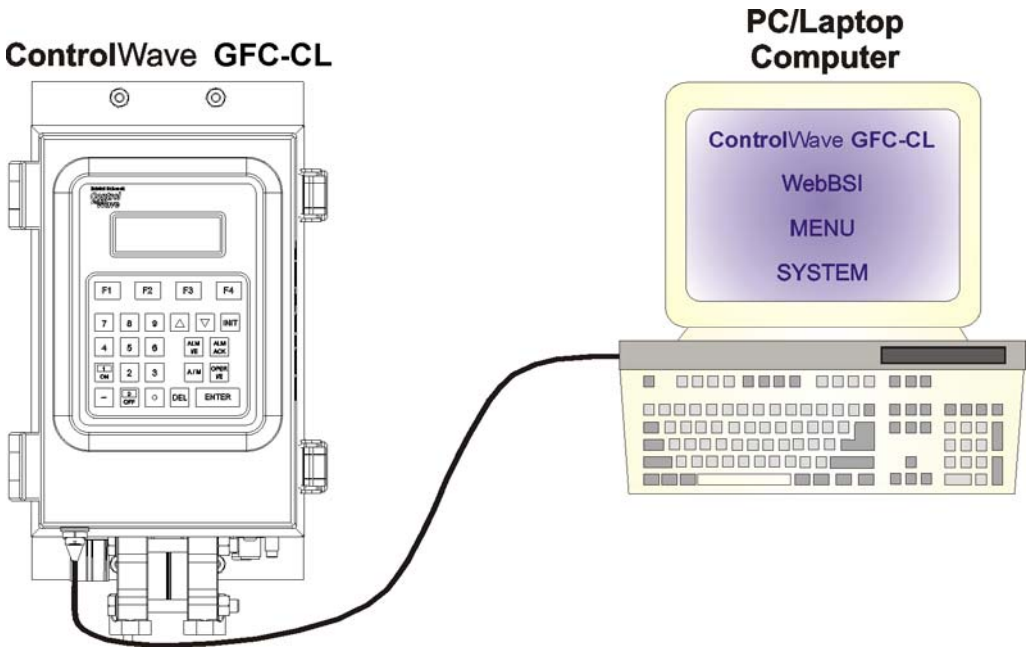


Figure F-1 - ControlWave GFC-CL
Connected to PC via the Local Communications Cable

F.2.1 Communication Connections

The **Control**Wave **GFC-CL** communicates with the PC through the Local Port as shown in Figures F-1 through F-2B or through the Network if configured. The Local Port has been provided specifically for installation/startup and on-site configuration and data collection.

For **Control**Wave **GFC-CL**s equipped with a Local Port that utilizes a D-Type connector, local communications between the **Control**Wave **GFC-CL** and the PC is provided over a standard **Control**Wave null-modem cable (see Figure F-2A). Units equipped with the circular 3-pin Local Port utilize a special cable as illustrated in Figure F-2B.

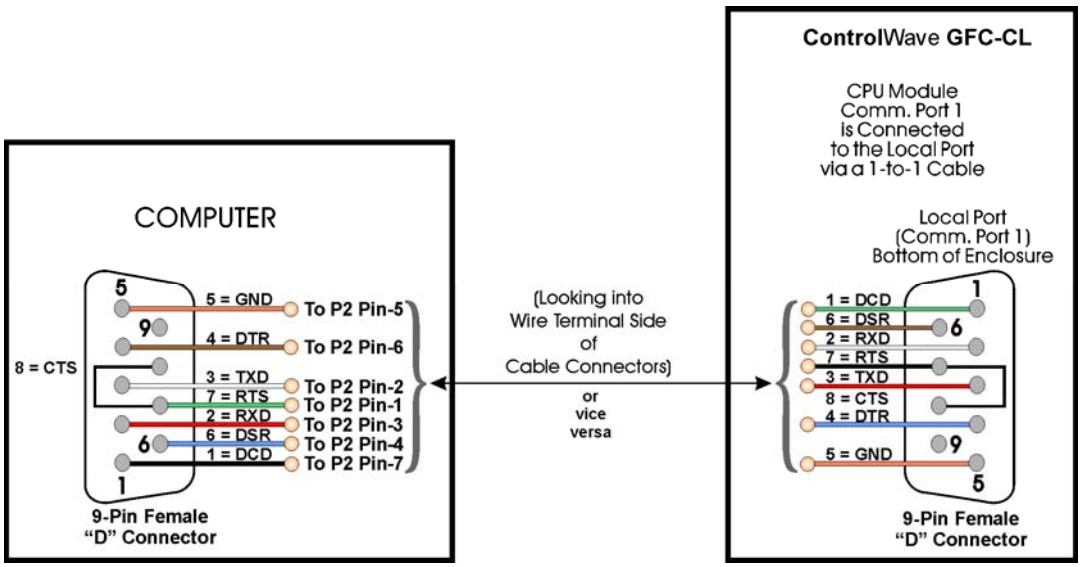


Figure F-2A - ControlWave GFC-CL
Null Modem Cable (Bristol P/N 392843-01-3) Connection Diagram
Note: Connector J19 on the CPU/System Controller Board also = the Local Port

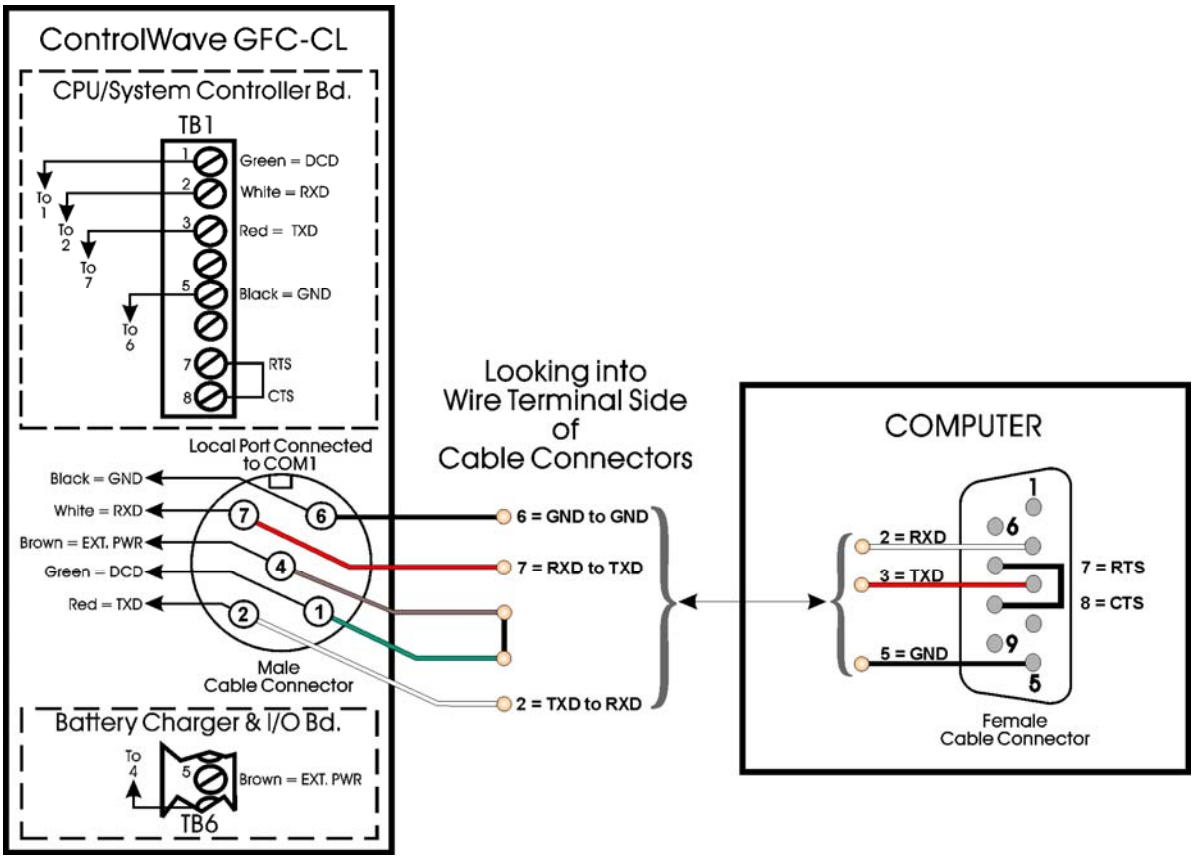


Figure F-2B - PC Connected to Control Wave **GFC-CL via Local Port (Circular Connector Version)**
Bristol Part Number 395402-01-8 = 10 Foot Comm. Cable
Bristol Part Number 395402-02-6 = 25 Foot Comm. Cable

F.3 WebBSI PROGRAM STARTUP

Ensure that the Local Communications Cable connections (at both the **Control**Wave **GFC-CL** & the PC) are secure.

If the WebBSI Web pages for the **Control**Wave **GFC-CL** have been assigned as the default Web pages for a node in OpenBSI, they can be invoked either from OpenBSI by right clicking on the appropriate RTU and selecting RTU -> WebPage Access. Web pages are also accessible by selecting Start -> Programs-> OpenBSI Tools-> WebPage Access -> CW GFC-CL Pages.

Seven Category Functions are provided as follows:

Section F.4 (Security)
Section F.5 (Station)
Section F.6 (Meter Run)
Section F.7 (Chromatograph)
Section F.8 (Logs)
Section F.9 (Load/Save)
Section F.10 (Special Functions)

F.4 SECURITY CATEGORY FUNCTIONS

Three Web pages are accessible from the Security category section of WebBSI.

- Sign On/Off (Section F.4.1)
- Locate Nodes (Section F.4.2)
- Contacts (Section F.4.3)

F.4.1 Signing On/Off

When the WebBSI Web pages for the **Control**Wave **GFC-CL** are first accessed, the **SIGN On/Off** Web page is displayed. A user must select the RTU Name from the drop down menu. If using OpenBSI Network Edition, this drop down menu will include all nodes available on the network. If using OpenBSI Local Edition, only the default node (RTU) will be available.

Figure F-3 - Sign On/Off Web Page

F.4.1.1 Selecting a Node and Signing On

The user must choose the Node they want to sign-on to from the RTU Name list box. The user must enter the Username and Password. The user must then click on the **Sign On** button. If the sign-on attempt is successful, the message Access Granted will appear (in green text) within the message area. Failure messages appear in red text and informational messages appear in black text.

F.4.1.2 Signing Off from the Node

To sign off from a Node, the user must click on the [Sign Off] push button. If the sign-off attempt is successful, the message "Sign Off Successful" will appear in green (failures are in red).

Note: For Security Maintenance functions refer to CW MICRO Quick Setup Guide – D5124 – Part 2 – Configuring User Accounts & Privileges.

F.4.2 Locating Nodes

The user may identify which node(s) they would like to communicate with by using the Locator page. The Nodes can be identified either by loading a proxy file, or by loading Open BSI information. In either case, they will be displayed as icons in a tree on the left side of the page.

The **Node Locator** Web page is accessible by clicking on the **Security** category button and choosing the Locate Nodes drop-down menu selection.

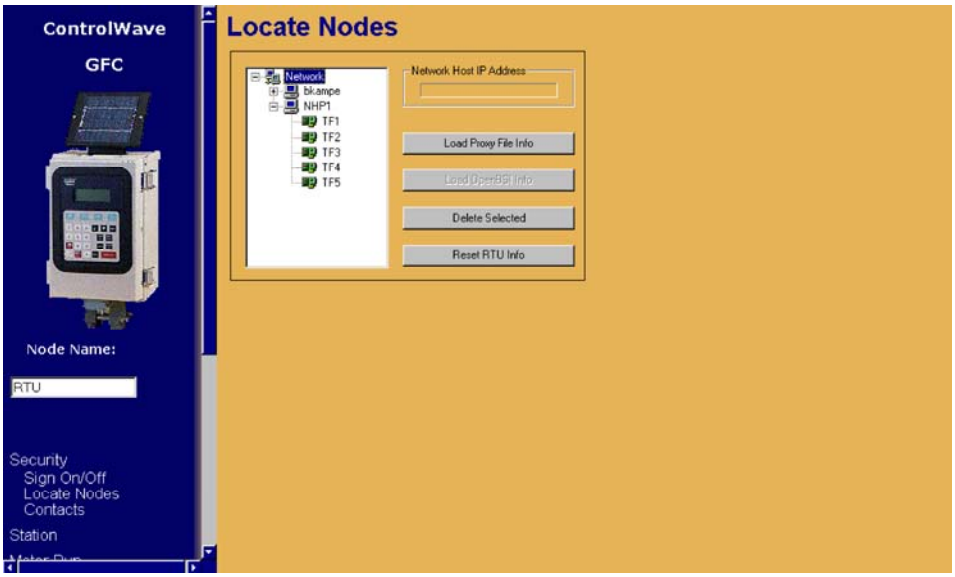


Figure F-4 - Locate Nodes Web Page

F.4.3 Contacts

A list of Bristol Inc. offices is provided under the topic Contacts.

The Contacts Page is accessible by clicking on the **Security** category button and choosing the Contacts drop-down menu selection.

F.5 STATION CATEGORY FUNCTIONS

The standard application program for the **Control**Wave **GFC-CL** allows the user to configure a station with up to four meter runs. Users must configure Station parameters from the **Station Configuration** category section of WebBSI. Seven Web Pages are accessible from the **Station Configuration** category section of WebBSI.

- Station Summary (Section F.5.1)
- Sampler & Odorizer (Section F.5.2)
- Mechanical Counter (Section F.5.3)
- Nominations (Section F.5.4)
- Flow Control (Section F.5.5)
- Run Switching (Section F.5.6)
- Radio & Modem Control (Section F.5.7)

F.5.1 Station Summary

Station Summary Web Pages display corrected and uncorrected flow rates and volumes for the station and each run. Corrected Volumes, Uncorrected Volumes and Accumulated Energy totals are displayed for the previous hour and previous day.

Figure F-5 - Station Summary Web Page

F.5.2 Sampler and Odorizer Configuration

See section F.5.2.1 for Sampler Configuration or F.5.2.2 for Odorizer Configuration.

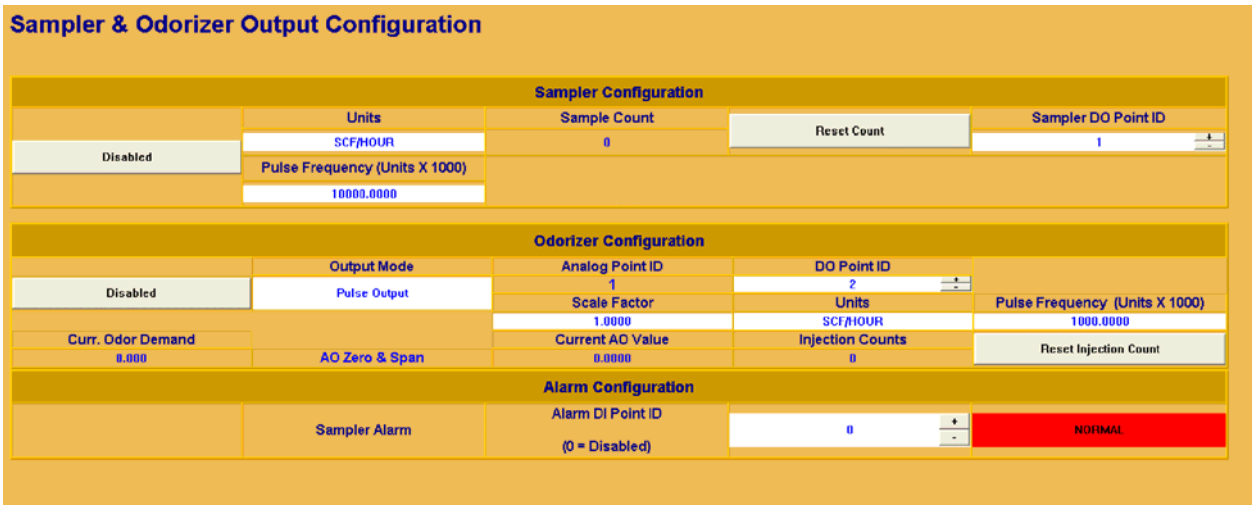


Figure F-6 - Sampler & Odorizer Configuration Web Page

F.5.2.1 Sampler Configuration

The user may enable or disable the Sampler by using the **Enable/Disable** button. If enabled, the Sampler will operate at a frequency set by the Pulse Frequency setpoint (in cubic feet). Users must select which Digital Output (DO) Point will be used. A running count of samples taken will be displayed. Users may reset this count by pressing the **Reset Count** button.

F.5.2.2 Odorizer Configuration

Users may enable or disable the Odorizer by using the **Enable/Disable** button. The user also selects the Output Mode, i.e., Analog Output or Digital Output. If the Analog Output Mode is selected, Analog Point ID 1 is assigned. If the Digital Output Mode is selected, the Digital Output Point to be used is selected via the DO Point ID field.

When the Analog Output Mode is selected, the user must set the Scale Factor. The Scale Factor is a ratio of the amount of odorant to be injected per cubic foot of gas. Users must know the maximum output of the Odorizer and calculate the ratio accordingly.

The Current Odor Demand is the raw value of the odorant required. If this value is greater than that which is allowed by the AO Zero and Span, the actual odorizer output will be clamped to the maximum AO value.

When the Digital Output Mode is used, the user must enter the frequency of the pulses per volume through the meter (in cubic feet).

F.5.3 Mechanical Counter Configuration

The **Mechanical Counter Configuration** section of the **Sampler & Mechanical Counter Configuration** Web Page is used to simulate a mechanical counter. An **Enable/Disable** button is used to activate/deactivate this function. Synchronization of the **Control**Wave **GFC-CL** Counter with an external Mechanical Counter is achieved via the Initial Count field. Determination of the volume of gas per pulse is performed utilizing the Pulse Frequency field. Current Count is the actual number of pulses received by the unit. Users must select which HSC Input will be used with the Mechanical Counter.

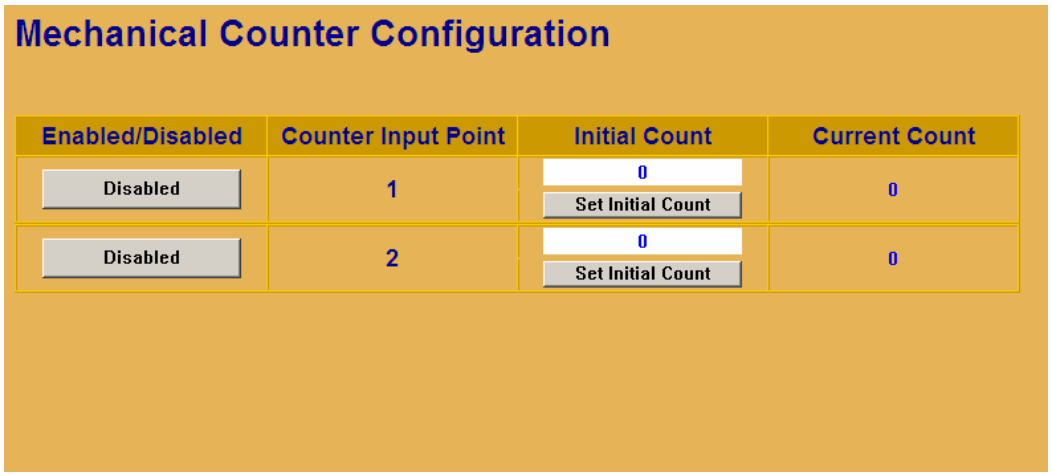


Figure F-7 - Mechanical Counter Configuration Web Page

F.5.4 Nomination

Users configure the nominations control from the **Nomination** WebPage. Nominations functionally provide the user with the ability to set the **Control**Wave **GFC-CL** to allocate precise amounts of gas flow during specific time periods. These periods are called "*nomination periods*." A nomination may be set for any duration of time (not to exceed one month). The volume to be delivered (nominated) during a nomination period is the *target*. Targets may be specified in terms of volume or energy. Users set a nomination period by keying in the desired day of the month and hour to begin the period and the desired day of

the month and hour to end the period. The *daily nomination* feature is used if the user desires the same start/stop times every day. A unit programmed with a daily nomination, will ignore the programmed start and end day numbers and will perform the nomination in question at the same time once per day.

The delivery of the nominated quantity (volume or energy during the nomination period) may be performed via one of the two unique schemes listed below.

Valve Control
The *Valve Control* method overrides PID flow control and allows the valve to be independently controlled, thus permitting full flow of gas through the meter in order to arrive at the target (volume or energy) as quickly as possible without regard to the programmed end time.

Flow Control
The *Flow Control* method internally enables the PID flow control algorithm in order to hit the target volume/energy at exactly the programmed end time.

The user programs the **Control**Wave **GFC-CL** (via the 'Stop Mode' button) to either close the valve upon reaching the target or leave it in its last position.

F.5.4.1 Nomination Operation (See sections F.5.4.1.1 through F.5.4.1.5)

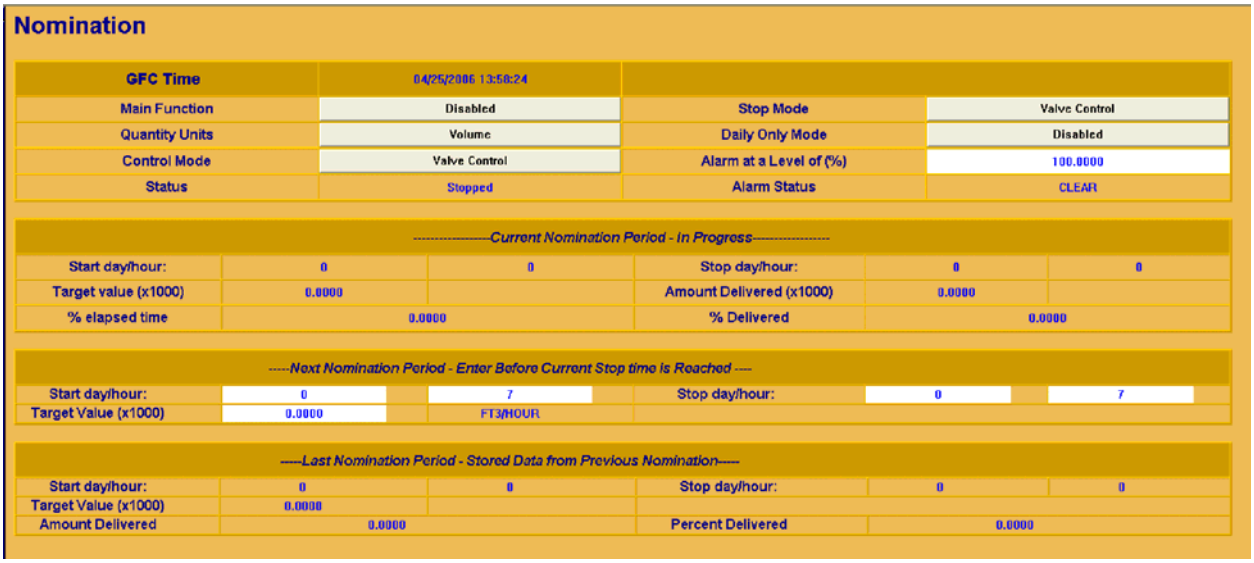


Figure F-8 - Nomination Web Page

F.5.4.1.1 Enabling the Nomination Function

The nomination function runs once per calculation cycle after the volume and energy accumulations have been updated by the **Control**Wave **GFC-CL**. To setup and enable this feature follow the steps below.

1. Setup of the nominations feature depends on the desired control mode selection, i.e., the *Fast approach* mode or *PID* mode. Fast approach mode is the default mode for nominations. If the desired control mode is the Fast approach mode, proceed to step 2; however, if the desired control mode selection is the PID mode, you must first program all the PID tuning parameters such as gain and integral. **Note: DON'T** enable the PID flow control algorithm or the **Control**Wave **GFC-CL** will automatically disable

nomination. When properly configured the **Control**Wave **GFC-CL** will automatically enable the PID flow control algorithm during nomination periods.

2. Select the Nomination Web Page (Figure F-8) via the Nomination button under the **Station** Category Function (also see Figure F-9).

   A description of the menu entries (Figure F-8) used to implement the nomination function follows:

   NOMINATION CONTROL – In addition to the Time, this section of the Nomination Web Page provides the following eight areas for nomination setup/selection:

   Main function
   The *Main function* selection is used to enable/disable the nomination function. If this signal is set to the disable state, nomination will not occur.

   Quantity units
   The *Quantity units* selection is used to set the target units as MCF or MMBTU.

   Control mode
   Control mode provides for the selection of either the Valve Control or Flow Control modes of nomination operation.

   Status
   The Status signal is an output of the nominations algorithm that indicates whether there is currently a nominations period in progress. The user may change the state of this signal to end an in progress nomination immediately, or to start the next period immediately (see Manually Starting/Ending a Nomination Period).

   Stop Mode
   The *Stop mode* selection allows the user to automatically have the valve closed, i.e., shut-in on stop mode, or left in the last position upon reaching the target (or programmed end period).

   Daily Only Mode
   When Daily mode is enabled, only the programmed start and end hours are used by the **Control**Wave **GFC-CL**; the Start/Stop days are ignored, i.e., nomination begins and ends within a 24 hour period every day.

   Alarm at a level of %
   The *Alarm at a level of %* setting can be configured as percentage of Volume (MCF) or Energy (MMBTU). This feature allows the **Control**Wave **GFC-CL** to provide an alarm (logical nomination alarm) or indication to an operator or computer that a specified amount of target has been reached. The number entered (1 to 100) sets the percentage at which the logical nomination alarm will occur. The status of this setting, i.e., whether or not a nomination alarm has occurred, can be determined via the Alarm Status signal (see Figure F-8).

   Alarm Status
   When the amount specified in 'Alarm at a Level of (%)' is reached, the value of the signal will be set true.

CURRENT NOMINATION PERIOD - This section allows the operator to view the following information associated with a nomination which is currently in progress:

Start: day/hour
The actual time and day of the month when the current nomination period started is displayed. This may be the programmed time or the time at which an operator manually started a period.

Stop: day/hour
The programmed end time and day of the month at which the current nomination period will end. If using the Fast approach mode, the period may end sooner, i.e., when the target is reached. If using the daily nomination feature, the stop date (day) will show 0 to indicate that only the hour matters.

Target value (x 1000)
The Target value provides the value of Volume/Energy to be delivered during this period.

Amount Delivered (x 1000)
The Amount Delivered reading provides the actual amount of volume/energy delivered so far during this period.

Percent elapsed time
This signal shows the percentage of time which has elapsed for the current nomination period, e.g., 4 hours into a 100 hour nomination period would cause this value to be 4.0.

Percent Delivered
This signal provides the percentage of target delivered to this point in the current nomination period.

NEXT NOMINATION PERIOD - This section allows the operator to set/view the following parameters associated with the next nomination which is to be programmed (has been programmed): *Note: New entries must be made prior to the ending of the current nomination period.*

Start: day/hour
The actual start day of the month (1-31) and start hour (0-23) when the next nomination period is to start is displayed or entered. The start day is ignored if the daily nomination feature is enabled.

Stop: day/hour
The actual stop day of the month (1-31) and stop hour (1-23) when the next nomination period is to end is displayed or entered. The stop day is ignored if the daily nomination feature is enabled.

Target Value (x 1000)
The Target value is used to set the value of Volume/Energy to be delivered during the next nomination period.

LAST NOMINATION PERIOD - This section allows the operator to view information associated with the last nomination period which was completed. Information displayed remains valid until the next time a nomination period ends (when the information is up-graded to reflect the new "last" nomination period). Start and end times stored here

indicate the actual time that the nomination period ended, which is not necessarily the programmed time (because of the time required to close/open valves or complete other actions). The days are valid even if the daily nomination mode is active.

3. Program all the configuration items for the **NEXT Nomination Period** such as start and stop times and target value.

4. Set the desired parameters for **NOMINATION CONTROL** such as *Quantity units*, *Control mode*, *Stop mode*, *Daily only mode* and *Alarm at a level of* and then set the *Main function* signal to the Enable State.

5. If a radio or modem is to be used in conjunction with a "logical nomination alarm," access the Radio & Modem Control Configuration Web Page (see Figure F-11) via the Radio Control button. See Section F.5.6 to configure the radio or modem for logical nomination alarms.

F.5.4.1.2 Beginning a Nomination Period

When no nomination period is in progress, the **Control**Wave **GFC-CL** compares the NEXT start date and time to the current time. If the date and time match (or time only for the daily nomination mode), a new period is begun. The current time is copied into the CURRENT START signals, and the next target is copied into the current target. The accumulators for the current period are zeroed and the current stop time is set to the next start time. If the PID mode is selected, a new flow setpoint is calculated and stored in the setpoint signal. The PID setpoint is recalculated every 15 minutes and whenever any parameter is changed.

F.5.4.1.3 Ending a Nomination Period

If shut-in on stop mode is in use, the current period will end when the target accumulation is reached. At this time, the **Control**Wave **GFC-CL** attempts to close the control valve. If PID control is being used, the setpoint is set to 0.0, the current cycle will ramp down accordingly. When the flow rate reaches 0.0, the current cycle accumulations and the actual end time are copied into the LAST signals. If the valve fails to close, the volume will continue to accumulate until the programmed end time. If the shut-in on stop mode is not in use, the nomination period continues until the programmed end time.

F.5.4.1.4 Changing the Nomination Target

To change the target of the next period, the user should change the NEXT TARGET signal.

F.5.4.1.5 Manually Starting/Ending a Nomination Period

When a Nomination Period is not in progress, the user can immediately begin the NEXT period by setting the Status signal to the ON state. The current start time will reflect the time that the user started the cycle. The target and stop times used will be those of the NEXT period. The user may immediately end a nomination period which is in progress by setting the Status signal to the OFF state. The current time will be stored as the LAST stop time.

F.5.5 Flow Control & Valve Control

The Flow Control & Valve Control Web Page (Figure F-9) is accessible via the **Flow Control** button. The PID Controller is utilized in the **Control**Wave **GFC-CL** for Flow Rate Control. Sections F.5.5.1 through F.5.5.4 provide information on the four major functions accessible from the Flow Control & Valve Control Web Page (see Figure F-9).

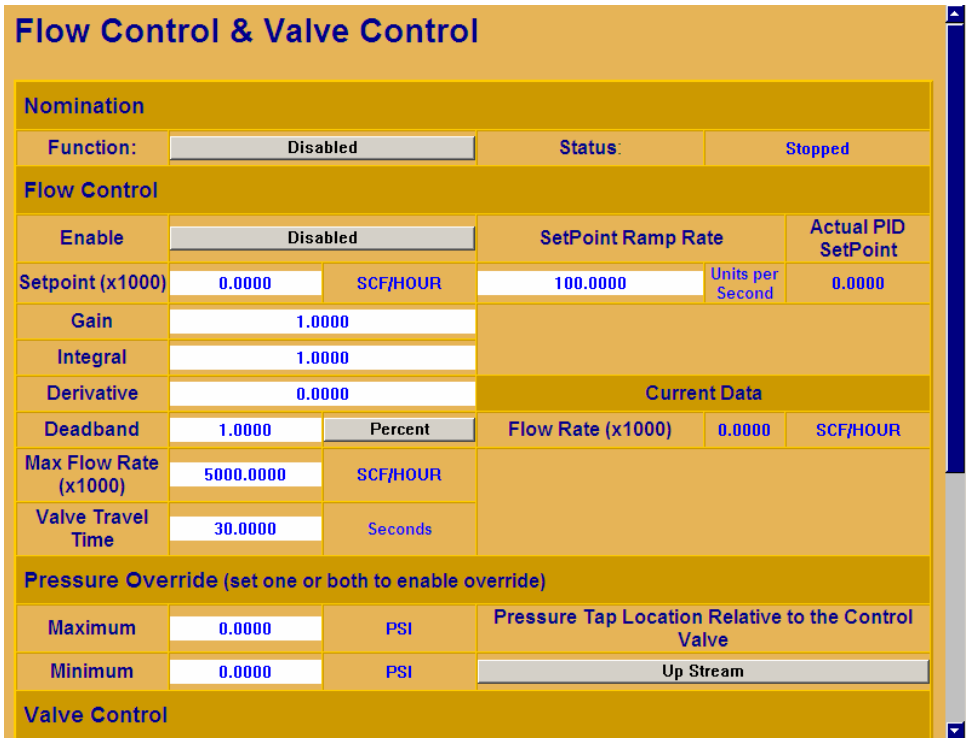


Figure F-9 - Flow Control & Valve Control Web Page

Users are cautioned to test the regular override controller actions to verify correct valve movement for all expected conditions.

F.5.5.1 Nomination

Function
The Nominations Function provides for enabling/disabling the nominations feature (see Section F.5.3). If this signal is set to the disable state, no nomination will be performed.

Status
The Status signal is an output of the nominations algorithm that indicates whether there is currently a nominations period in progress. The user may change the state of this signal to end an in progress nomination immediately, or to start the next period immediately (see Manually Starting/Ending a Nomination Period in Section F.5.3).

F.5.5.2 Flow Control

Enable
Pressing the button to the right of Enable will allow the operator to toggle between **PID Flow Control** Enabled and Disabled. It is recommended that GAIN, INTEGRAL and DERIVATIVE adjustments be checked before turning a controller ON.

Warning

Do not enable PID Flow Control without first checking the external process control loop. The initial values displayed on the PID Menu may drive some critical processes beyond the extremes of safe limits. This could result in fire, explosion, property damage, and injury to persons. When setting the WebBSI Web Page parameters, make sure the associated process is observed and protected.

Setpoint (x1000)
This field contains the operating point at which the flow rate is to be controlled. Set-point units are MSCFH with a default setting of 1000 MSCF per Hour. To change the Setpoint value, right click on the field and select Change Signal Value.

Gain
Gain controls the amount of output change resulting from a change of the measured variable. The default value of 1.00 is typically used as a starting point; final gain is usually less. To change the Gain value, right click on the field and select Change Signal Value.

Integral
Integral determines the time it will take the PID to correct an error in the measured variable. The number of times the output is adjusted in a given time period is specified in seconds. An entry of 60 seconds can be used as a starting point; this would provide one (1) repeat per minute. To change the Integral value, right click on the field and select Change Signal Value.

Derivative
Derivative compensates for a rapidly changing measured variable. The time is specified in seconds (SECS) and most applications will use a setting of zero (0). To change the Derivative value, right click on the field and select Change Signal Value.

Deadband
Deadband provides a means of specifying a 'window' in which the variable does not affect the output. This entry is in percent (%) of the SETPOINT signal. As an example, a 5% entry would mean that the controller output must exceed the present setpoint by 5% before the output is changed. To change the Deadband value, right click on the field and select Change Signal Value.

Max Flow Rate (x1000)
Max Flow Rate represents the maximum flow rate allowed. If the number entered in the Setpoint field exceeds the Max Flow Rate value, the Max Flow Rate value will be used. To change the Max Flow Rate (x1000) value, right click on the field and select Change Signal Value.

Valve Travel Time
Valve Travel Time is the amount of time it takes a Control Valve to go from being fully open to fully closed (or visa-versa). The default value is 30 Seconds. To change the Valve Travel Time value, right click on the field and select Change Signal Value.

Current Data Flow Rate (x1000)
The Flow Rate value is Read Only data; it is the present calculated flow rate per hour.

F.5.5.3 Pressure Override (set one or both to enable override)

When the PID controller is active in flow-control mode, it will adjust a pressure valve to maintain the established flow rate setpoint. Pressure override is used in situations where full line pressure should not be applied to the downstream equipment or in circumstances where a minimum pressure must be maintained.

Maximum & Minimum
A Maximum and Minimum pressure can be configured which set the PID controller to switch to pressure control mode whenever the line pressure attempts to go outside the defined limits. The pressure override mode becomes active when either or both limits are set to a non-zero value.

Pressure Tap Location Relative to the Control Valve
The Pressure Tap location is specified as either upstream UPSTRM or downstream DNSTRM with respect to the control valve. The action of the override controller depends on the configured Tap location. When the pressure tap is configured as Downstream of the control valve, pressure will rise as the valve opens to increase the flow rate. Increasing demand will cause the valve to open more. Should conditions occur that cause the pressure to exceed the maximum pressure limit, the override will take control and close the valve to maintain the configured maximum pressure. Should the valve attempt to close and reduce pressure below the configured minimum pressure, the override will take control to maintain the minimum pressure. When the pressure tap is configured as Upstream, the action is reversed, i.e., when the maximum pressure is exceeded the valve will open to lower the pressure. When the minimum pressure is exceeded the valve will be closed.

F.5.5.4 Valve Control

A user may select the Valve Control type, i.e., Analog Output or Raise/Lower control via the Digital Outputs. If the operator selects Analog Output control, Analog Output 1 will be used by default. Current Data will show the value of the Analog Output in percent (4mA = 0%, 20mA = 100%).

Users may set the valves Output Control into either Manual or Automatic (Auto). When Manual Mode has been selected, the current value of the Analog Output will be frozen. Users may change the Manual Analog Output value, by right clicking on the field and entering a new value. When the mode is changed back to Automatic, the valve control starts from the last Manual value entered for Bumpless transfer.

If the user selects Raise Lower Mode, the DO associated with raising the valve must be selected and a separate DO must be selected for lowering the valve. When the Raise Lower Mode is being used, the Current Data section will display if the Raise DO is Off' or Raising and it will display the Lower DO state, i.e., Off or Lowering.

In the Manual Control mode, users may select whether to Raise or Lower the valve by using the Manual Raise or Manual Lower Output buttons. If the valve is raising and the operator pushes the Manual Lower Output button, the Raise Output will be automatically set to Off. If the valve is lowering and the **Manual Raise Output** button, is pressed, the Lower DO will automatically be set Off.

When switching back and forth between the Automatic and Manual Modes, both Raise and Lower DOs will be set to Off.

F.5.6 Run Switching

Sections F.5.6.1 and F.5.6.2 provide information on run switching properties (see Figure F-10). Enable/Disable Run Switching via a button to the right of Run Switching.

F.5.6.1 Common Properties

Current Rank shows how many runs are required to be open. Maximum Rank is selected by the user (from 1 to 2). Process Variable (PV) Selection can be Differential Pressure, Frequency or Flow Rate. The Transition Time is the amount of time required to allow run switching to access (opening or closing a run). Valve Settle Time is the amount of time allowed after the Transition Time for the process variable (PV) to settle, before allowing another run switching action to occur.

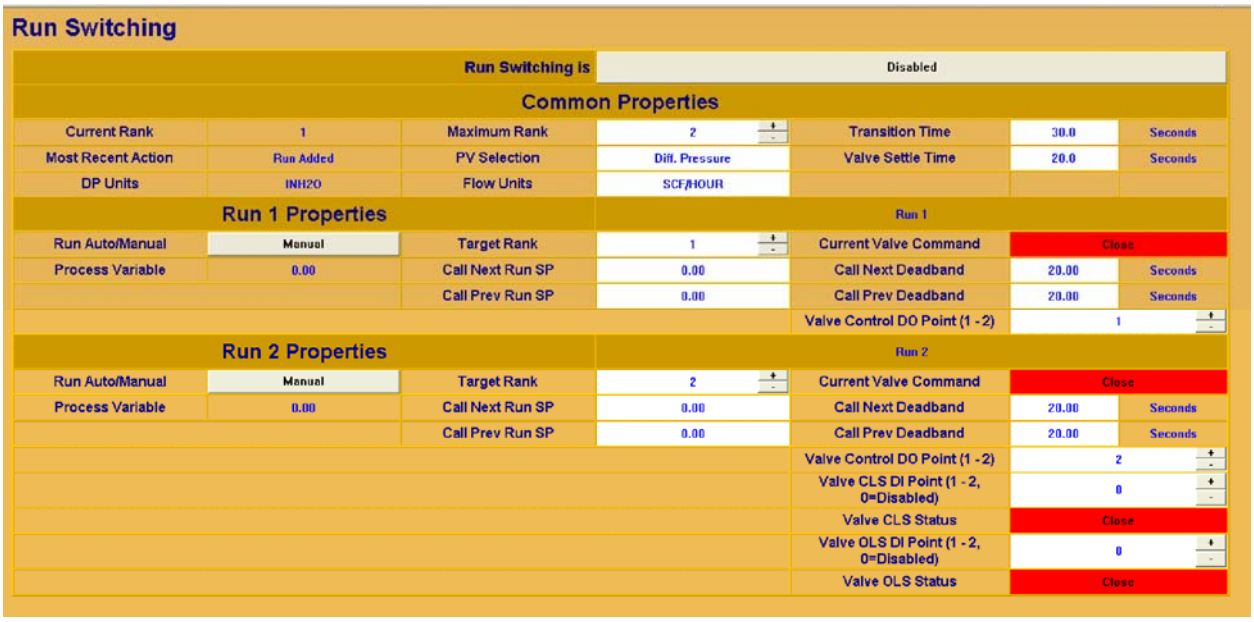


Figure F-10 – Run Switching Web Page

F.5.6.2 Run1 & 2 Properties

When a run is in Manual Mode (selected by the **Run Auto/Manual** button), the valve may be opened or closed by right clicking on the field to the right of the Current Valve Command and toggling the valve. When a run is in Auto Mode and Run Switching is enabled, the valve is controlled by the run switching logic. If the Target Rank of a run is 1, the valve will always be open. The Call Next Run Setpoint (SP) is the value if the process variable (DP, Frequency or Flow Rate) that will cause the next run to open. The process variable for calling runs is the PV from the run selected as Target Rank 1. If the run with Target Rank 1 is open, and the run with Target Rank 2 is not open when the PV for Target Rank 1 exceeds the Call Next Run SP, the Target Rank 2 will be opened. Likewise, if the PV for Target Rank 2 drops below the Call Prev Run SP, the highest ranked run that is open will be closed.

Call Next Deadband is the amount of time that the PV has to be greater than the Call Next Run SP value before the next run will be opened.

Call Previous Deadband is the amount of time that the PV has to be less then the Call Prev Run SP value before the lowest rank run will be closed.

Valve Control DO Point is the digital output point used for valve control.

F.5.7 Radio and Modem Control

The **Radio & Modem Control Configuration** Web Page is accessible for users by selecting Radio & Modem Control.

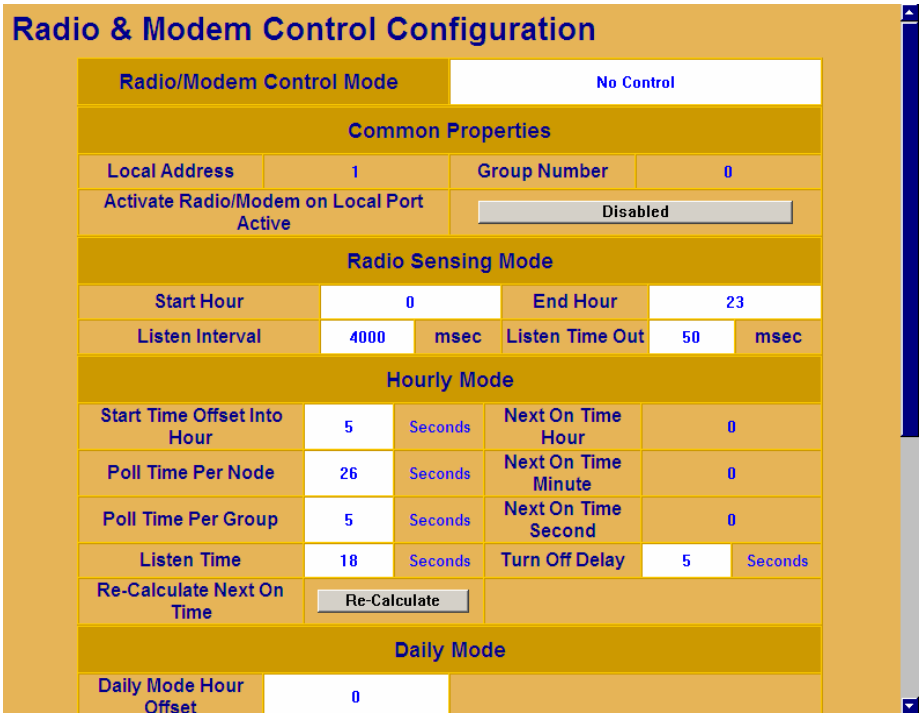


Figure F-11 – Radio and Modem Control Configuration Web Page

F.5.7.1 Radio/Modem Control Mode

Enable/Disable Radio/Modem Control via a control button to the right of Radio/Modem Control Mode.

F.5.7.2 Common Properties

Local Address
Local Address of the **Control**Wave **GFC-CL** is set via the **RTU Configuration Parameters** Page in NETVIEW or LOCAL VIEW.

Group Number
Group Address of the **Control**Wave **GFC-CL**. This is set via the **RTU Configuration Parameters** Page in NETVIEW or LOCAL VIEW.

Activate Radio/Modem on Local Port Active
When using any of the radio/modem port scheduling modes (Radio Sensing, Hourly, Daily or Daylight) Port 2 (the Radio/Modem Port) is inactive unless communications are scheduled. However, by enabling the Activate Radio on Local Port Active mode, Port 1 (the Local Port) can be used to control the state of Port 2.

F.5.7.3 Radio Sensing Mode

Radio sensing allows a user to activate the radio for very short time intervals (specified in milliseconds under Listen Time Out) every so many milliseconds (specified in seconds under Listen Interval) to 'sense' a valid BSAP message on the radio's carrier frequency. If a message is not detected, the radio is deactivated. If a message is detected, the radio is left activated until it responds, after which it remains ON for another listen time interval. If no more valid messages are detected, the radio returns to 'sense' mode. This mode allows the system to use as little energy as possible to detect traffic throughout the day. Energy usage depends on the activation time and activation rate (INTERVAL). Assuming a 1 watt radio then a 200 millisecond listening period every 5 seconds is equivalent to .04 watts. Users can configure the Interval and Rate (Listening period) to suit their energy needs. Radio Sensing occurs between the START HOUR and END HOUR specified by the operator.

F.5.7.4 Hourly Mode

Start Time Offset Into Hour Seconds
Start Time Offset Into Hour Seconds specifies a user supplied offset which is used when computing the radio/modem On Time. Start Time Offset is a factor used to calculate the On Time.

Poll Time Per Node Seconds
Poll Time Per Node Seconds sets the duration of time (seconds) allocated for communications per node. Poll Time Per Node time is also used to calculate the On Time.

Poll Time Per Group Seconds
Poll Time Per Group Seconds sets the duration of time (seconds) allocated for communications per group. Poll Time Per Group time is also used to calculate the On Time.

Listen Time Seconds
Listen Time Seconds is the amount of time (in seconds) that the radio/modem will be enabled for (at the scheduled time, i.e., the enabled time before it will shut off due to the lack of communications.

Re-Calculate Next On Time
If the user makes any changes to the items that affect the On Time, it must re-calculate the Next On Time using this button.

Next On Time Hour/Minute/Second
When the Radio/Modem Control Mode is selected for Hourly, Daily or Daylight, these values represent the next time that the radio will be turned on.

Turn Off Delay Seconds
Turn Off Delay Seconds is the amount of time (in seconds) that the radio/modem will remain enabled after successful communications have been established and completed. The radio will remain active for the time period specified at the Turn Off Delay.

F.5.7.5 Daily Mode

Daily Mode Hour Offset
When the Daily Mode is selected, the radio/modem will be turned on once during the day. The Daily Mode Hour Offset determines which hour (0 - 23) that the radio will be turned on. On Time Minutes and On Time Seconds are calculated.

F.5.7.6 Day Light Mode

A user may want to conserve battery power by using the radio/modem only during day light hours. This is accomplished by selecting Daylight as the Radio/Modem Control Mode. Users select the start of day light using the Day Light Mode Start Hour and Day Light Mode Start Minute fields. Users select the end of day light using the Day Light Mode End Hour and Day Light Mode End Minute field.

F.5.7.7 Statistic

Current/Previous Hour Radio On Time
Current/Previous Day Radio On Time
Current/Previous Month Radio On Time

F.6 METER RUN CATEGORY FUNCTIONS

Up to four WebBSI Web Pages are accessible under the **Meter Run Category** Section of WebBSI; these include:

- Overview (Section F.6.1)
- I/O Configuration (Section F.6.2)
- Flow Equation (Section F.6.3)
- Compressibility Setup (Section F.6.4)

The Web Page of Figure F.12 will appear when either the 'Overview' or 'Flow Equation' category has been selected, if a **Meter Run Type** (Differential or Linear) has not been configured.

F.6.1 Meter Run Overview

See section F.6.1.1 for AGA3 Orifice Meters or F.6.1.2 for AGA7 Frequency Meters.

F.6.1.1 AGA3 - Orifice Meter

If the meter is configured as an Orifice Meter the following Read Only items are displayed:

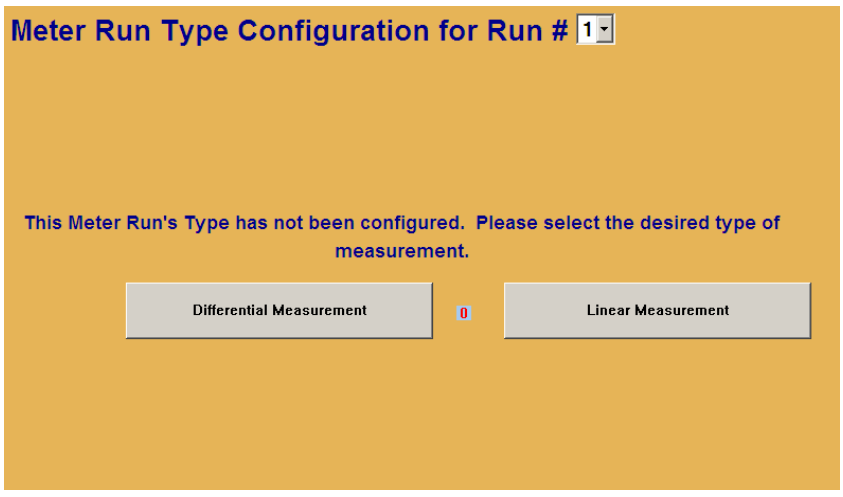


Figure F-12 - Meter Run Type Configuration WebPage

Pipe Diameter & Orifice Diameter – To change these items, select Flow Equation from the left side menu section.

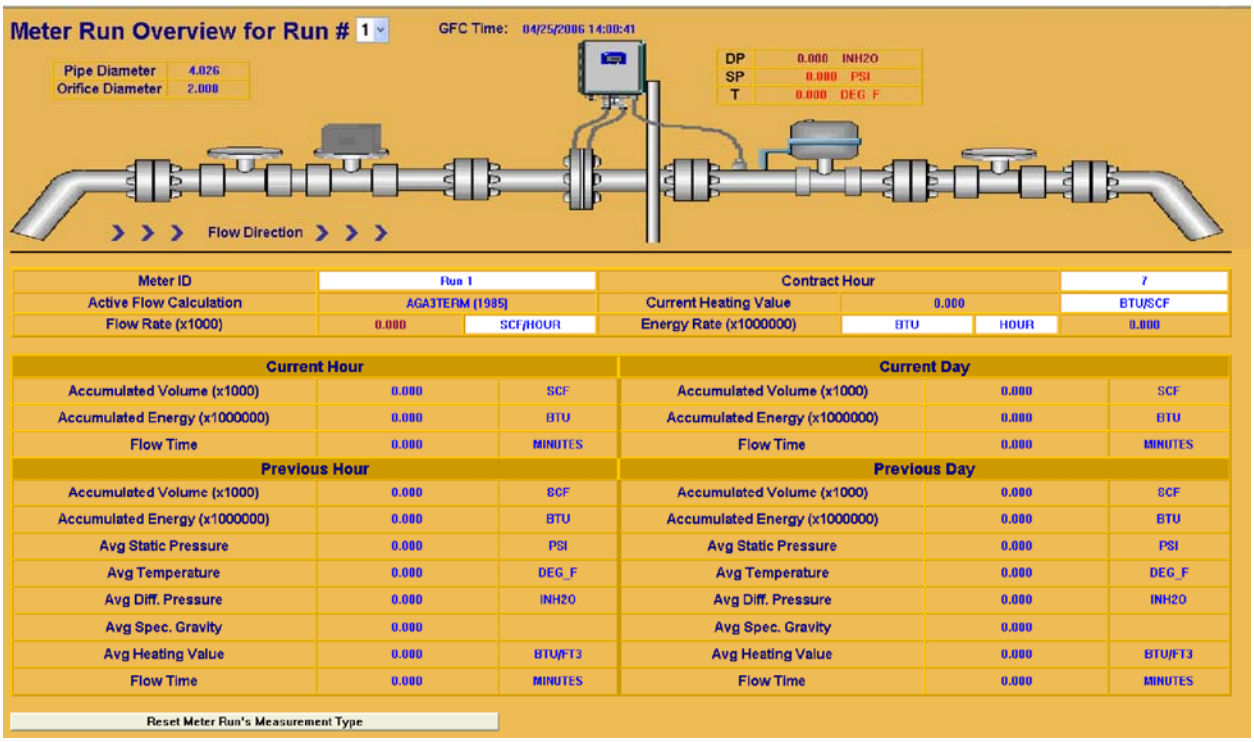


Figure F-13A - Meter Run Overview (1985 AGA3 – Orifice Meter) Web Page

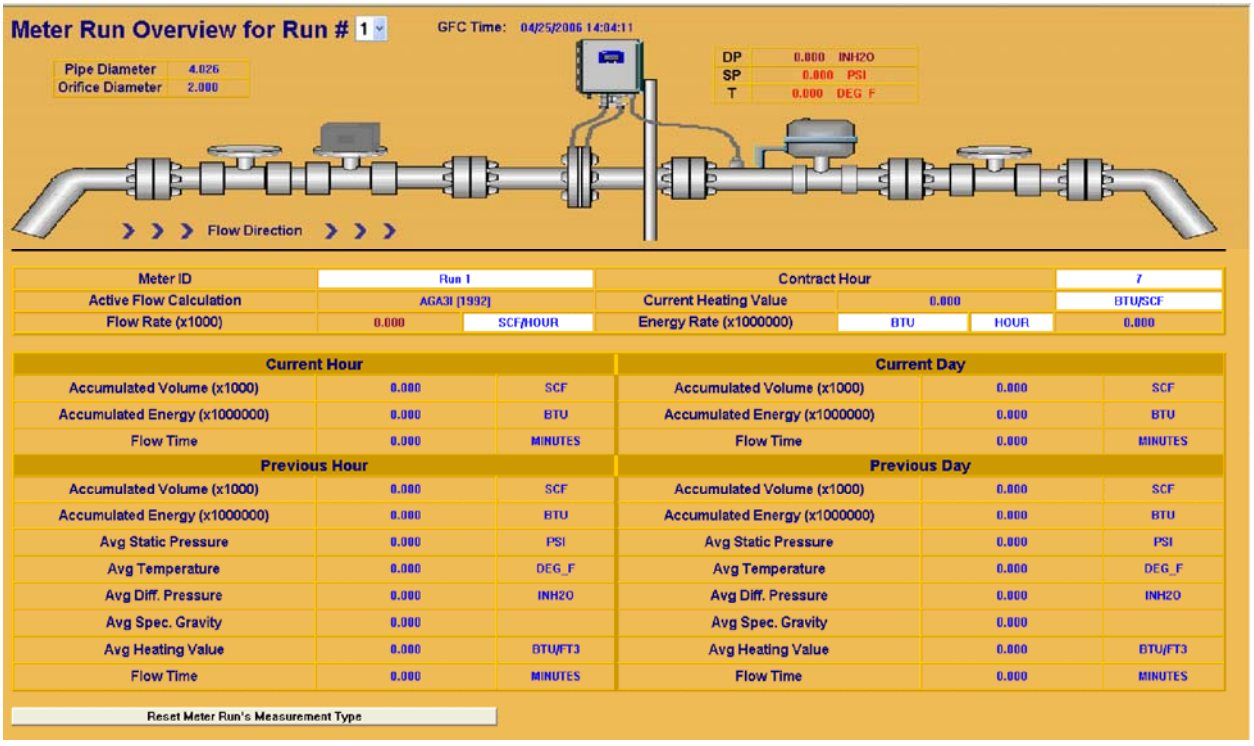


Figure F-13B - Meter Run Overview (1992 AGA3 – Orifice Meter) Web Page

DP (Differential Pressure), SP (Static Pressure) and T (Temperature) – Live Values from the Transmitters being used for calculation (selected via the I/O Configuration Page).

Active Flow Calculation – (AGA3I (1992) or AGA3 (1985) – To change an item, select Flow Equation from the left side menu section.

Current Heating Value – The instantaneous value is provided.

Flow Rate (x1000) – The instantaneous value is provided.

Accumulated Volume and Accumulated Energy 'Read Only' fields are provided for the Current Hour and Current Day:

Accumulated Volume, Accumulated Energy, Avg. Static Pressure, Avg. Temperature, Avg. Diff. Pressure, Avg. Specific Gravity, Avg. Heating Value and Flow Time 'Read Only' fields are provided for the Previous Hour and Previous Day:

The following five fields accommodate user changes:

Meter ID – a string signal identifying the meter run (default is 'Run n,') (n = the Run #).

Contract Hour – The user enters the Contract Hour for the start of the current day here.

Current Heating Value (Units) – The user may select the Heating Value units from a drop down menu; default units are BTU/Ft^3.

Flow Rate (Units) – The user may select the Flow Rate units from a drop down menu; default units are Ft^3/Hour.

Energy Rate (x1000000) – The user may select the Energy Rate - Energy Units from a drop down menu; default units are BTU. The user may select the Energy Rate - Rate Units from a drop down menu; default units are HOUR.

Reset Meter Run's Measurement Type - This button (bottom of menu) allows the user to reset the meter run's measurement type (if a mistake has occurred during configuration).

F.6.1.2 AGA7 Frequency Meter

If the meter is configured as a Linear Meter, following Read Only items are displayed:

Active Flow Calculation – Always AGA7
Corrected Flow Rate – Instantaneous Value
Uncorrected Flow Rate – Instantaneous Value
Current Heating Value – Instantaneous Value
Energy Value – Instantaneous Value

The following information is displayed for the Current Hour and Current Day:

Corrected Volume
Uncorrected Volume
Accumulated Energy

The following information is displayed for the Previous Hour and Previous Day:

Corrected Volume
Uncorrected Volume
Accumulated Energy
Average Static Pressure
Average Temperature

Average Specific Gravity
Average Heating Value
Flow Time

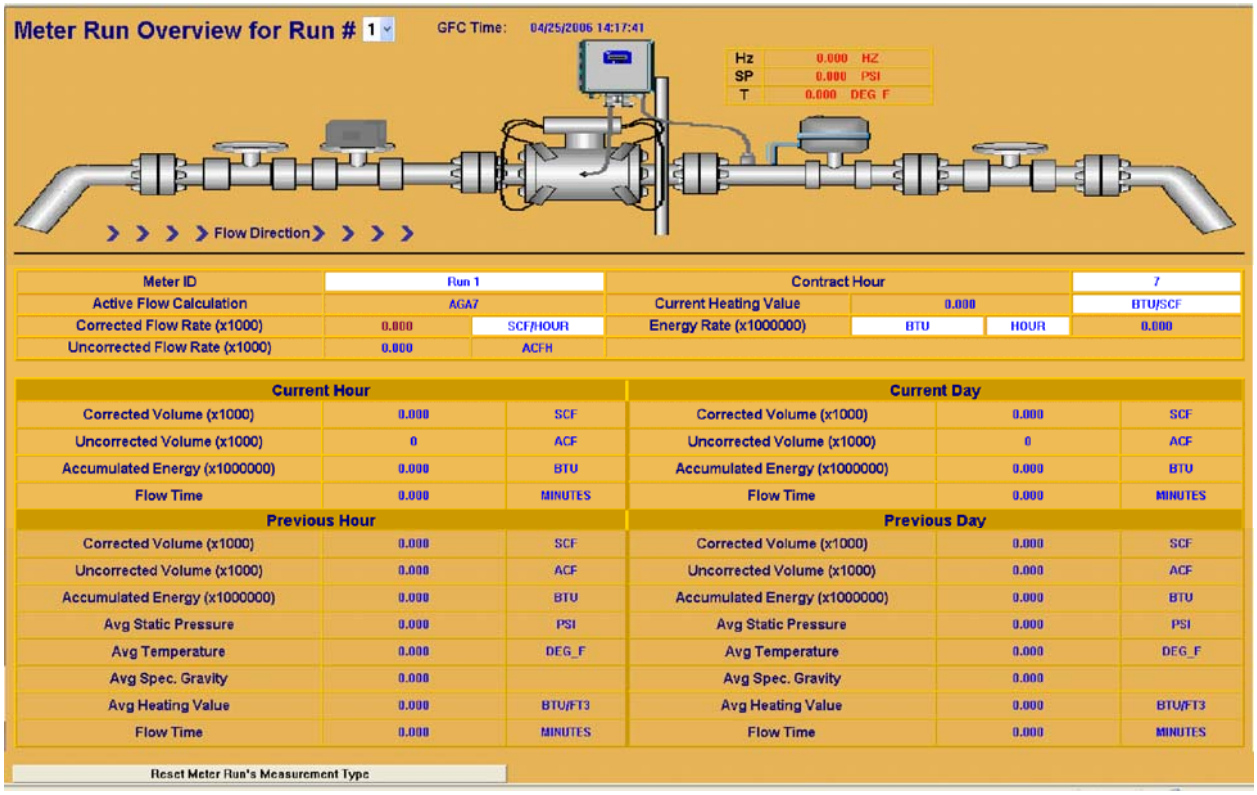


Figure F-14 - Meter Run Overview (AGA7 - Frequency Meter) Web Page

There are five fields that allow the user to make changes:

Meter ID – a string signal identifying the meter run (default is 'Run n,') (n = the Run #).

Contract Hour – Users enter the Contract Hour for the start of the Contract Day here.

Current Heating Value (Units) – The user may select the Heating Value units from a drop down menu; default units are BTU/Ft^3.

Flow Rate (Units) – The user may select the Flow Rate units from a drop down menu; default units are Ft^3/Hour.

Energy Rate (x1000000) – The user may select the Energy Rate - Energy Units from a drop down menu; default units are BTU. The user may select the Energy Rate - Rate Units from a drop down menu; default units are HOUR.

Reset Meter Run's Measurement Type - This button (bottom of menu) allows the user to reset the meter run's measurement type (if a mistake has occurred during configuration).

F.6.2 Meter Run I/O Configuration

Retrieving Configuration Please Wait will initially be posted on the WebBSI Web Page when **I/O Configuration** has been selected followed by the Meter Run I/O Configuration Web Page (see Figure F-15).

The **Meter Run I/O Configuration** Web Page provides the mechanism for assigning the source for the inputs to the meter run calculations. From this page, the user would assign specific transmitters and meters to a meter run. The user may select from analog transmitters connected to I/O points, or from Smart Transmitters using BSAP or MODBUS connected via an RS-485 serial port. In addition, the user would select the source of the heating value, whether it is from a chromatograph and analog inputs or manually entered.

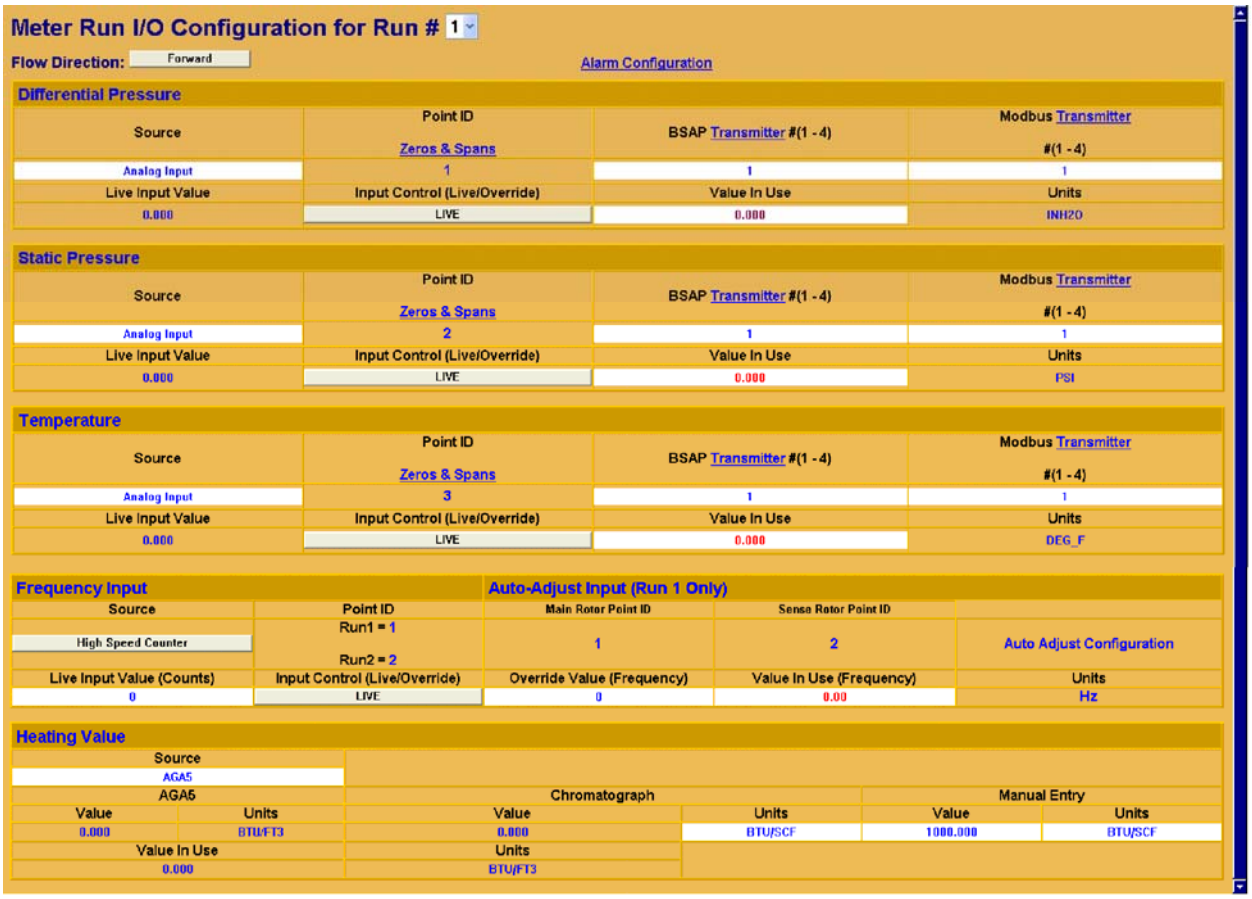


Figure F-15 - Meter Run I/O Configuration Web Page

F.6.2.1 Differential Pressure, Static Pressure and Temperature Inputs

To select the source for pressure, differential pressure, and temperature, the user selects 'Source,' 'Point ID' and either the 'BSAP Address,' or 'MODBUS Address.'

Analog Input is used when a transmitter is connected to the **Control**Wave **GFC-CL** via a 4-20mA or 1-5Vdc signal. The user must then select the Point ID on the I/O board to which the transmitter is physically connected. In addition, the zero and span settings and the engineering units must be assigned by clicking the 'Zeros & Spans' link.

Wet End is used when the internal transmitter is used. No other configuration is required.

'BSAP' is selected when an external Bristol Smart Transmitter (either the TeleTrans or the MVT) is used via RS-485 communications. The only configuration required is to assign the BSAP address (1-127) of the Bristol Smart Transmitter connected to the RS-485 port.

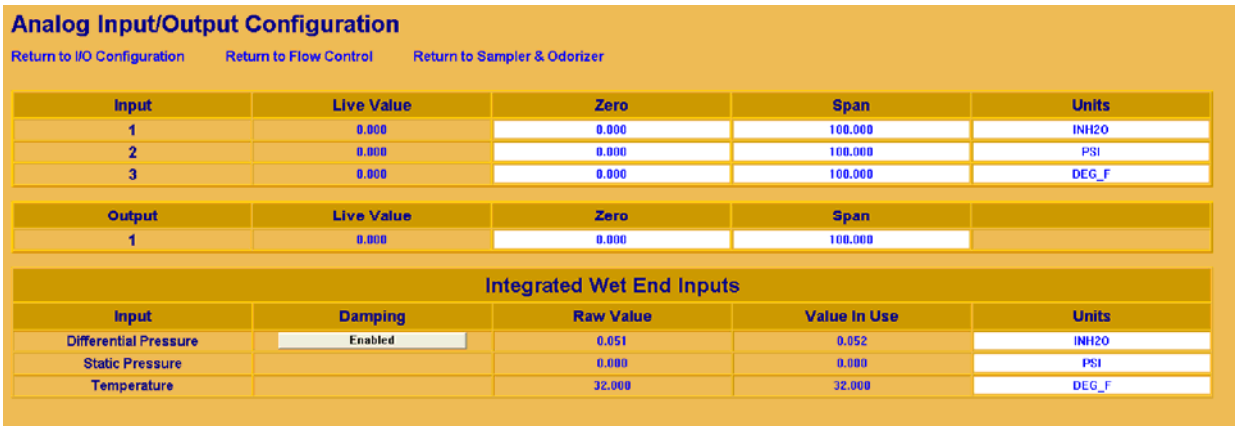


Figure F-16A – Analog Input Configuration Web Page
(Accessed from Meter Run I/O Configuration Web Page)

'MODBUS' is selected when an external Smart Transmitter is used via RS-485 communications. The MODBUS interface supports the register list of the Rosemount 3095 smart multivariable transmitter. No additional configuration is required. **Note: This functionality is only available when the Expansion Communications Module is used.**

If a Zeros & Spans Button is pressed an Analog Input Configuration Web Page Menu will appear (see Figure F16A). Zero, Span and Units can be configured for analog inputs 1 through 3. The Analog Input Configuration Web Page also allows the user to enable/disable the Damping function.

F.6.2.2 Frequency Input

The frequency input must be brought into one of the two high-speed counter (HSC) inputs on the I/O board. Users select the two I/O points to which the typical turbine, PD, or ultrasonic meter is connected. However; if using an Invensys Auto-Adjust Turbo-Meter, both HSC inputs are used to select the Auto-Adjust Algorithm. To select the Auto-Adjust Algorithm, the user will toggle the push button under Source from High Speed Counter to Auto Adjust Module. In this case, the user selects which point will be used for the Main Rotor and which point will be used for the Sense Rotor.

Further configuration of the Auto-Adjust Turbine Meter is performed via the Auto-Adjust Configuration Page. (For a description of the items on the Auto-Adjust Configuration Page, see the ACCOL3 Function Block Help Documentation).

If the user selects the Auto-Adjust Configuration button the Auto-Adjust Configuration for Run # Web Page will appear (see Figure F-16B). This page provides Calibration Data, Configuration Data and Calculated Factors.

F.6.2.3 Heating Value Input

The user has three options for the source of the heating value, Manual Entry, Chromatograph or AGA5.

Manual Entry is selected when the heating value will be directly entered. This value may be entered via the Meter Run I/O Configuration Web Page, or may be written to a signal externally.

Chromatograph is selected when the heating value is read directly from the chromatograph via the MODBUS interface.

AGA5 is selected when the component mole % values are fed into the AGA5 equation. Source of the component mole % values is determined by settings made on the Chromatograph Setup Page.

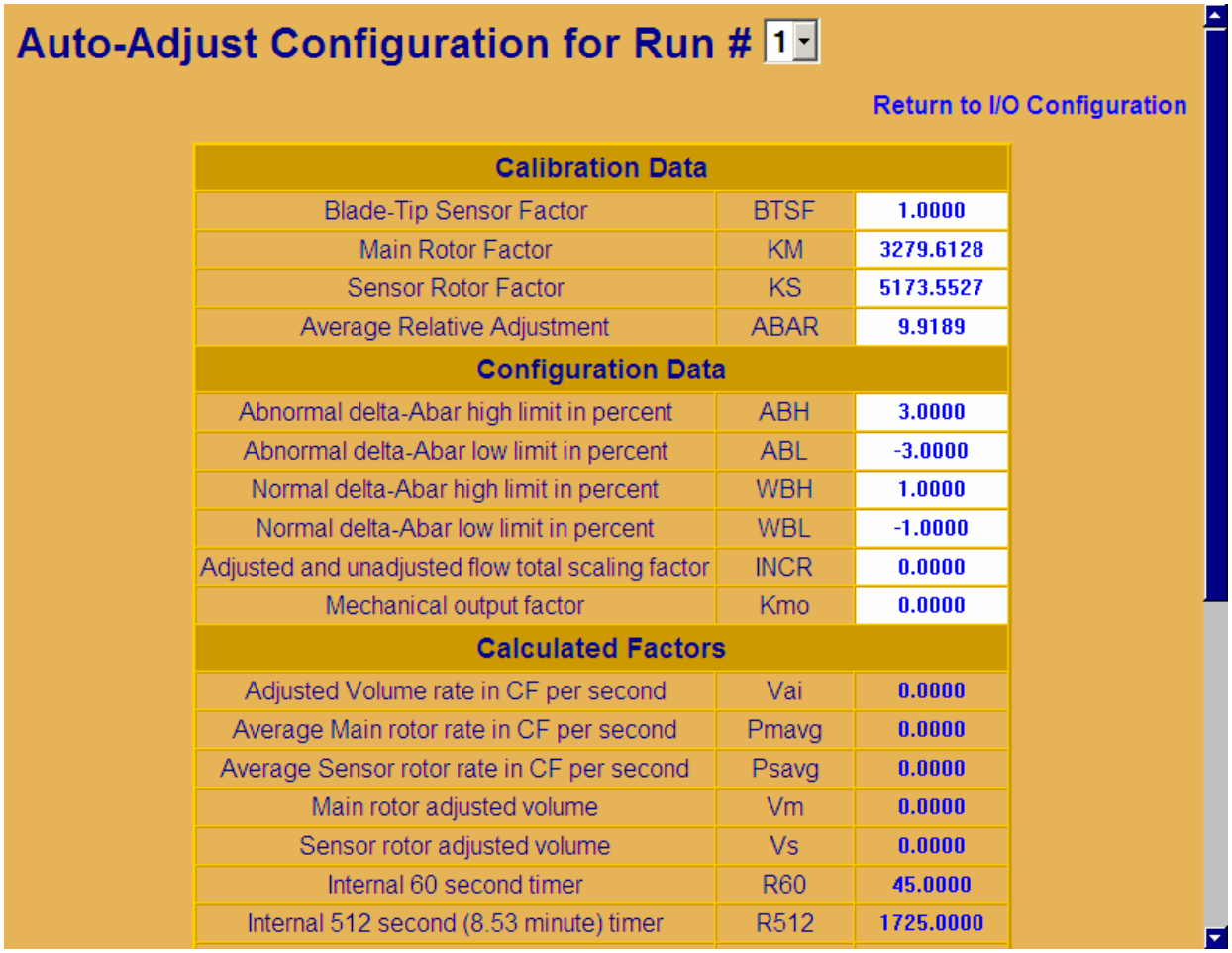


Figure F-16B – Auto-Adjust Configuration for Run# Web Page (Accessed from Meter Run I/O Configuration Web Page)

F.6.2.4 Alarm Configuration (Accessed via Meter Run I/O Configuration)

Enable/Disable - the alarm function on a per point basis.

Units and Current Value - are read from the I/O source.

Alarm Limit - are set via the appropriate alarm limit point.

Deadband - dead bands represent a range just below the high limits or just above the low limits in which the alarm variable remains in an alarm state, despite the fact that its value no longer exceeds the alarm limit. Should the alarm variable rapidly fluctuate above and below the alarm limit (without the use of dead band settings), the system will be flooded with alarm messages.

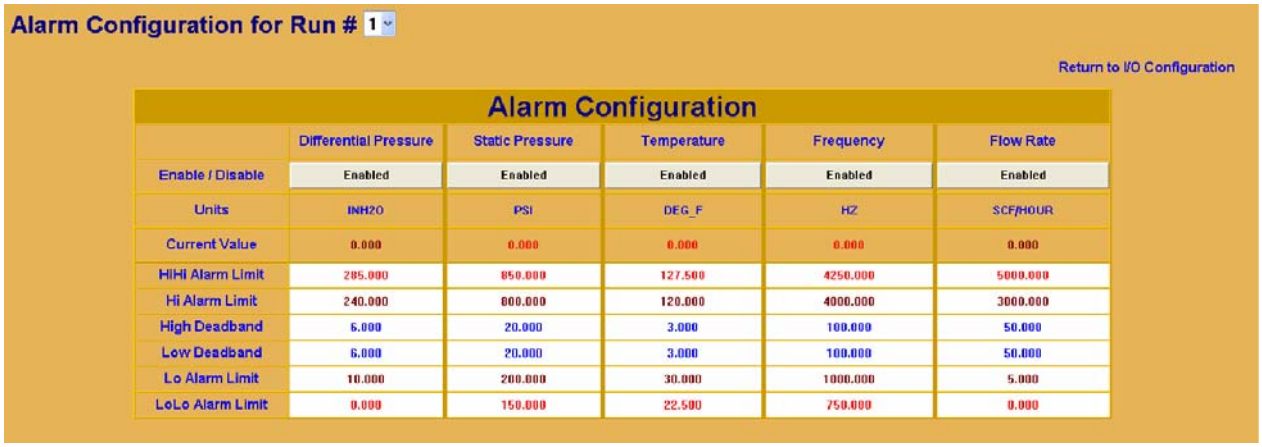


Figure F-17 - Alarm Configuration Web Page
(Accessed from Meter Run I/O Configuration Web Page)

F.6.3 Flow Equations

When the user pushes the Flow Equation button (on the left side of the menu) the Flow Equation Setup Web Page that is appropriate for the meter type will appear. If the meter type has not been configured, the screen shown for Figure F.12 will appear. A user must then select the Meter Run Type to be used.

F.6.3.1 Orifice Flow Equation Setup

F.6.3.1.1 Differential Measurement

If the user configures the meter as a Differential Measurement type, the Flow Equation defaults to the AGA3 (1985) equation. Users may change to the AGA3 (1992) equation by toggling the push button labeled Click Here to select AGA3I (1992).

F.6.3.1.2 1985 AGA3 Equation Configuration

The user must configure the inputs to the equation.

Pressure Tap - The user must select Pressure Tap type and location. The type is defined Flange or Tap and the location is defined as Upstream or Downstream. Pressure Tap is selected as follows:

1 DOWNSTREAM FLANGE
2 UPSTREAM FLANGE
3 DOWNSTREAM PIPE
4 UPSTREAM PIPE

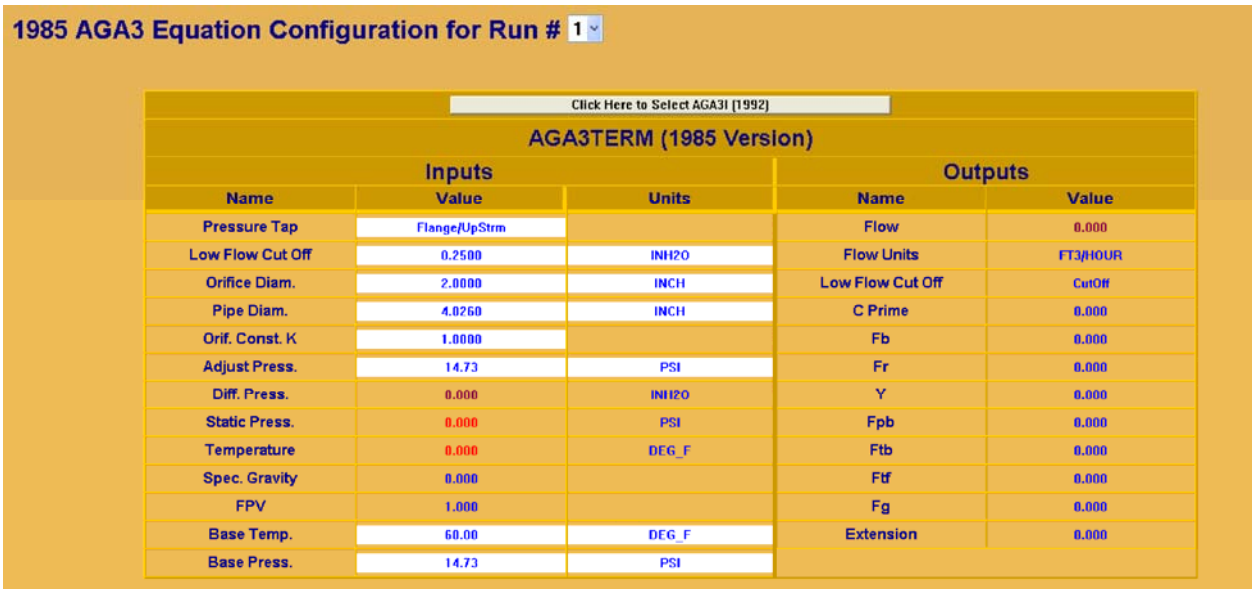


Figure F-18A - (1985 AGA3) Orifice Flow Equation Setup Web Page

Low Flow Cut Off - When the differential pressure drops below the low flow cut off value, the flow rate will be set to zero. Default units are "inches of water."

Orifice Diameter - Orifice diameter is entered here. Default units are "inches."

Pipe Diameter - Diameter of the pipe is entered here. Default units are "inches."

Orifice Constant - K (AGA3 1985) - Orifice constant is entered here.

Adjust Press. - Users enter Average Barometric Pressure here.

Diff. Pressure - Actual value of Differential Pressure (Inches H_2O) are displayed here.

Static Pressure - Actual value of Static Pressure (psig) are displayed here.

Temperature - Actual value of Temperature (Deg. F) are displayed here.

Specific Gravity - Specific Gravity of the gas being measured is displayed here.

FPV - Supercompressibility Factor (FPV) is displayed here.

Base Temperature - Required or Contract Base Temperature is entered here (Deg. F).

Base Pressure - Required or Contract Base Pressure is entered here (psig).

The following outputs from the AGA3 calculation are displayed:

MSCF/H - Flow rate in thousands of standard cubic feet per hour

Low Flow Cut Off - Cutoff (if the DP drops below the low flow cut off value) or OK

C Prime - Orifice Flow Constant

Fb - Basic Orifice Factor

Fr - Reynolds Number Factor

Y - Expansion Factor

Fpb - Pressure Base Factor

Ftb - Temperature Base Factor

Ftf - Flowing Temperature Facture

Fg - Specific Gravity Factor

Extension - Square Feet of the Product of Differential Pressure and Static Pressure

F.6.3.1.3 1992 AGA3 Equation Configuration

The user must configure the inputs to the equation.

Pressure Tap - The user must toggle between pressure tap settings **Flange/Upstrm** and **Flange/Dnstrm**.

Low Flow Cut Off - When the differential pressure drops below the low flow cut off value, the flow rate will be set to zero. Default units are **inches of water (H_2O)**.

Orifice Diameter - Orifice diameter is entered here. Default units are **inches**.

Pipe Diameter - Diameter of the pipe is entered here. Default units are **inches**.

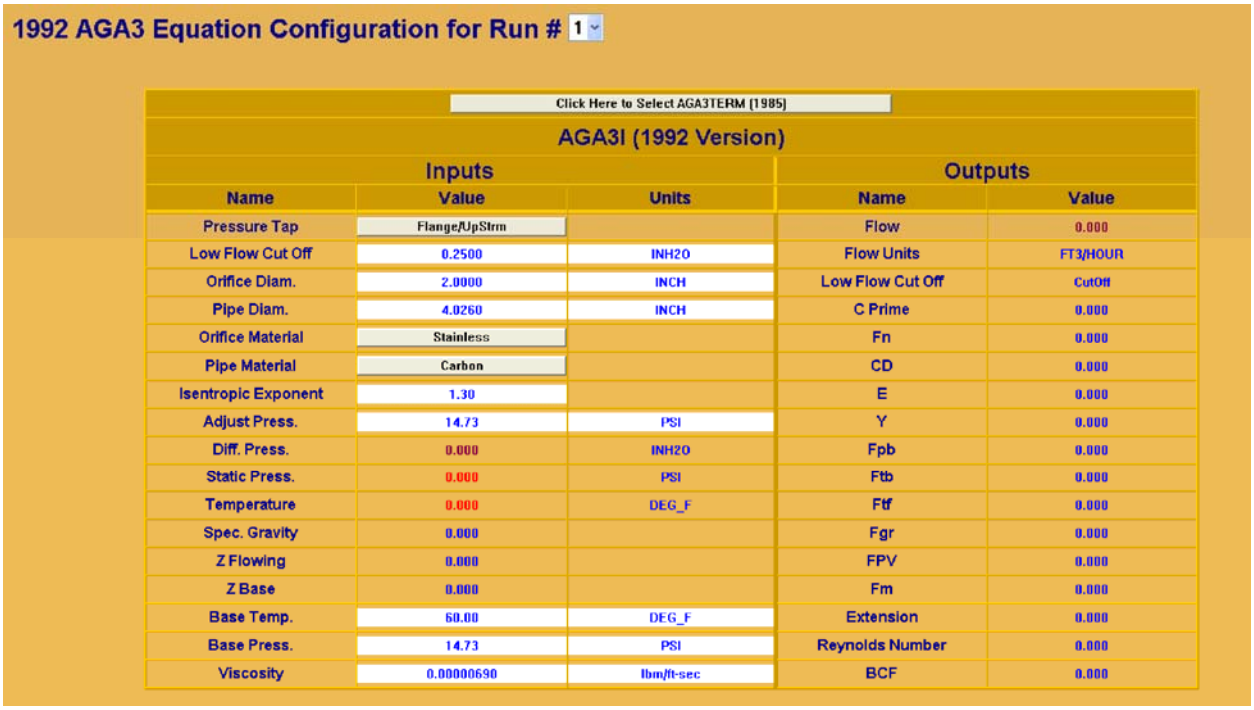


Figure F-18B - (1992 AGA3) Orifice Flow Equation Setup Web Page

Orifice Temp. Coefficient - Orifice coefficient of thermal expansion is entered here (Inches per Inch-degree F).

Pipe Temp. Coefficient - Pipe coefficient of thermal expansion is entered here (Inches per Inch-degree F).

Isentropic Exponent - Gas Isentropic Exponent is entered here. This should not be changed unless the Gas Isentropic Exponent is known to be other than the 1.3 value given in the 1992 American Gas Association (AGA3) Report.

Adjust Press. - Users enter Average Barometric Pressure here (psia).

Diff. Press. - Actual value in use is displayed here.

Static Pressure - Actual value in use is displayed here.

Temperature - Actual value in use is displayed here.

Spec. Gravity - Specific Gravity of the gas being measured is displayed here.

Z Flowing - Flowing compressibility Factor, Zf, generated from the AGA8 calculation referenced to upstream conditions.

Z Base - Base compressibility Factor from the AGA8 Gross calculation.

Base Temperature - Required and Contract Base Temperate is entered here (Deg. F).

Base Pressure - Required or Contract Base Pressure is entered here (psia).

The following outputs from the AGA3 calculation are displayed:

MSCF/H - Flow rate in thousands of standard cubic feet per hour

Low Flow Cut Off - Cutoff (if the DP drops below the low flow cut off value) or OK

C Prime - Orifice Flow Constant

Fn - Numeric Conversion factor which includes Ev (the velocity of approach factor)

CD - Orifice Coefficient of Discharge

Y - Expansion Factor

Fpb - Pressure Base Factor

Ftb - Temperature Base Factor

Ftf - Flowing Temperature Facture

Fpv - Supercompressibility Factor

Fm - Additional Correction Factor

Extension - Square Root of the product of Diff. Pressure and Static Pressure ($\sqrt{DP \times SP}$)

Reynolds Number - Computed Pipe Reynolds Number

BCF - Base Correction (Zb/Zf)

F.6.3.2 Frequency Flow Equation Setup

If the user configures a meter as a linear meter, the AGA7 Calculation page appears (see Figure F-19).

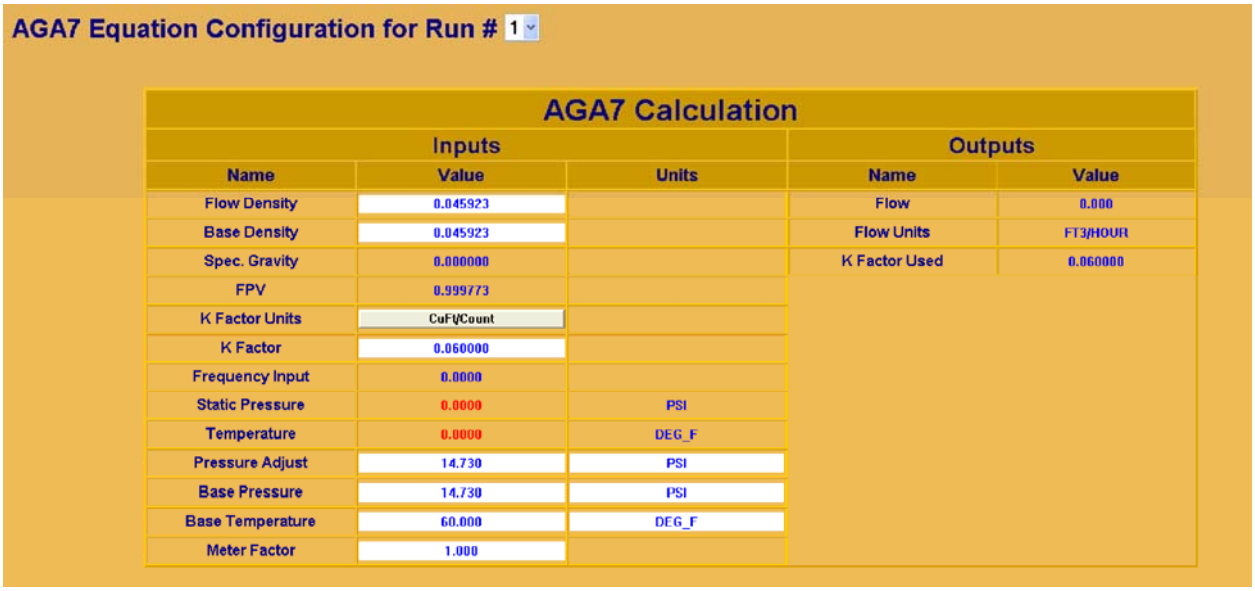


Figure F-19 - Frequency Flow Equation Setup Web Page

Densisty Switch - Users may select whether a density meter or Gravitometer is used as an input to the equation.

Gravitometer Press. Switch - Users may save the default value for Pressure or Volume entered in the Gravitometer Press. Used field.

Gavitometer Temp. Switch - Users may use the default temperature value of the value entered in the Gravitometer Temp. Used field.

Specific Gravity - Specific Gravity of the gas being measured is displayed here.

FPV - Supercompressibility Factor is displayed here.

K Factor Units - Users may select whether the factor is in units of CuFt/Count or Counts/CuFt.

K Factor - Actual Gas Volume represented per count is entered here. The relationship is controlled by the K Factor Units switch. If the K Factor Units switch is set to CuFt/Count, and each pulse from the meter represents 100 cubic feet, the K Factor is entered as 100. If the K Factor Units switch is set to Counts/CuFt and each pulse from the meter represents 100 cubic feet, the K Factor is entered as 1/100 or 0.01.

Frequency Input - The frequency from the meter (Hz) is displayed here.

Frequency Input Max - If the frequency input exceeds the Frequency Input Max value, the Frequency Input Max value is used in the flow equation.

Static Pressure - Actual values in use for the calculation

Temperature - Actual values in use for the calculation

Pressure Adjustment - Average Barometric Pressure (psia)

Base Pressure - Required or Contract base pressure (psia)

Base Temperature - Required or Contract base temperature (Deg. F)

Calibration Factor - Sometimes referred to as Meter Factor, this is an adjustment factor issued by the meter manufacturer to account for known meter adjustments. The default 1, i.e., no adjustments required.

MSCF/H - Flow rate in thousands of standard cubic feet per hour.

MSCF/H (Max) - The maximum flow value allowed through the meter at the maximum frequency input.

F.6.4 Supercompressibility Setup

When the 1985 AGA3 calculation is selected, the Supercompressibility (Fpv) value is calculated using the NX-19 equations. When the 1992 AGA3 calculation is used the Flowing (Zf) and Base (Zb) compressibility factors are calculated using either the AGA8 Detail or AGA8 Gross module. The AGA8 Gross module provides either (G, C, N) or (HV, G, C) modes.

Figure F-20 - Supercompressibility Configuration Web Page

If the Base Pressure or Base Temperature differ from Standard conditions (14.73 psia @ 60 °F) and the 1992 AGA3 calculation is in use, an AGA8 Detail or AGA8 Gross module will be executed to calculate standard compressibility Zs for the defined gas composition. The calculation of Zs will be done once per minute or whenever a related gas constant changes.

Users may select which Supercompressibility equation to use on a per run basis. The user will click on the appropriate button to select the calculation equation to be used. The selected compressibility calculation will be shown.

When using the AGA8 Gross Calculation, the user must select the Gross Mode1 or the Gross Mode2 calculation. The user may change the Base Pressure and the Base Temperature for this screen.

Flowing Static Pressure, Flowing Temperature, BTU and Specific Gravity in use are displayed on this page.

Values of the gas components used to calculate the Supercompressibility are displayed along with the FPV, Zflowing and ZBase values calculated by the Supercompressibility equation in use.

F.7 CHROMATOGRAPH CATEGORY FUNCTIONS

The standard application program is configured for communicating with a Daniel 2251 Gas Chromatograph, via a serial MODBUS interface. Users will configure the Chromatograph interface from the "Chromatograph Setup" Web Page (Figure F-21).

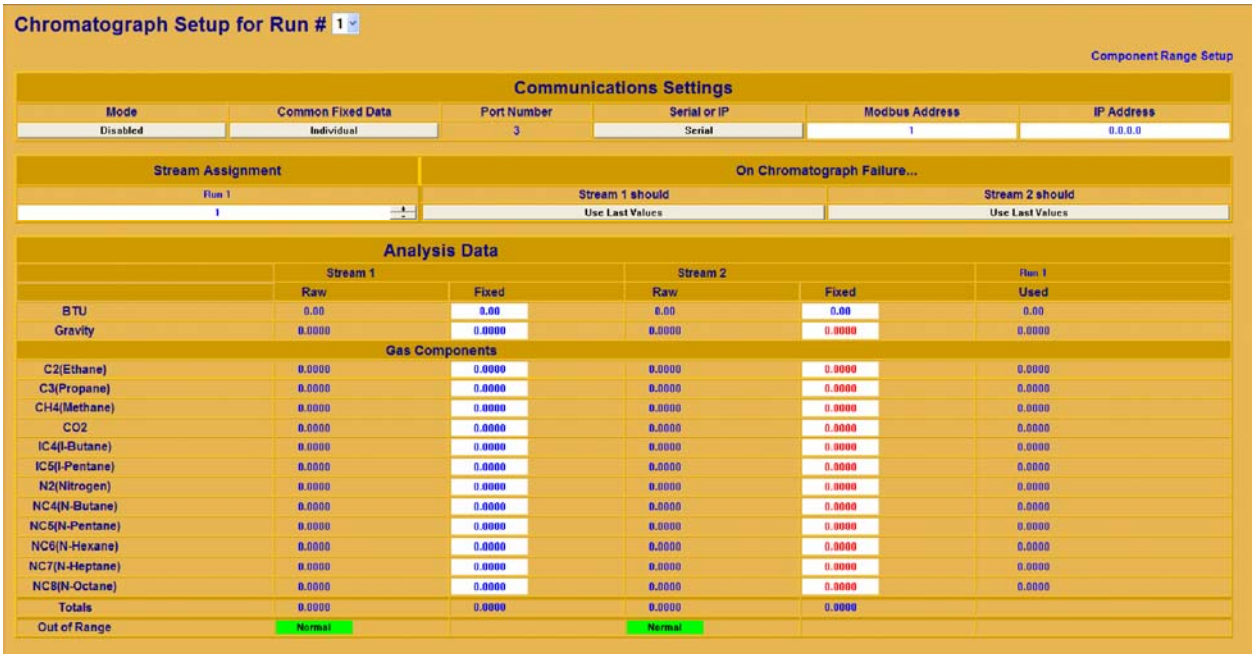


Figure F-21 - Chromatograph Setup Web Page

F.7.1 Communication Settings

Mode – Enabled/Disabled - When this signal is ENABLED, a chromatograph is present, and gas component data is provided by the chromatograph interface. When this signal is DISABLED, the fixed values for the gas component data are used.

Common Fixed Data - When COMMON is selected fixed chromatograph values for all runs will come from the Stream 1 fixed values. When INDIVIDUAL is selected, fixed chromatograph values will come from the individual stream assigned to each run.

Port Number - When a chromatograph is present, this is the port number on the **Control**-Wave **GFC-CL** to which the chromatograph is connected. Default Port in the load is Port 3.

MODBUS Address - When a chromatograph is present, this is the MODBUS Address (1-246) of the chromatograph.

Serial or IP - Select the appropriate Interface for the Chromatograph.

IP Address - Enter the IP Address of the Chromatograph in dotted decimal format, e.g., (xxx.xxx.xxx.xxx).

F.7.2 Stream Assignment and Setup

The Daniel 2251 can provide gas properties for up to 4 individual streams. The standard application program allows the user to assign any stream to any meter run (up to two streams and two runs). Each meter run may be assigned to the same stream, or each may be assigned to a different stream.

In the event of a chromatograph failure, the user may assign either fixed values to use for each gas component, or the last good values retrieved from the chromatograph. This mode is selectable on a per stream basis.

F.7.3 Analysis Data

The Raw values of BTU and Specific Gravity from the Chromatograph will be displayed for each stream. Fixed values for BTU and Specific Gravity may be entered for each stream.

F.7.4 Gas Components

The Raw value of each gas component from the chromatograph will be displayed for each stream. Fixed values for each gas component may be entered for each stream.

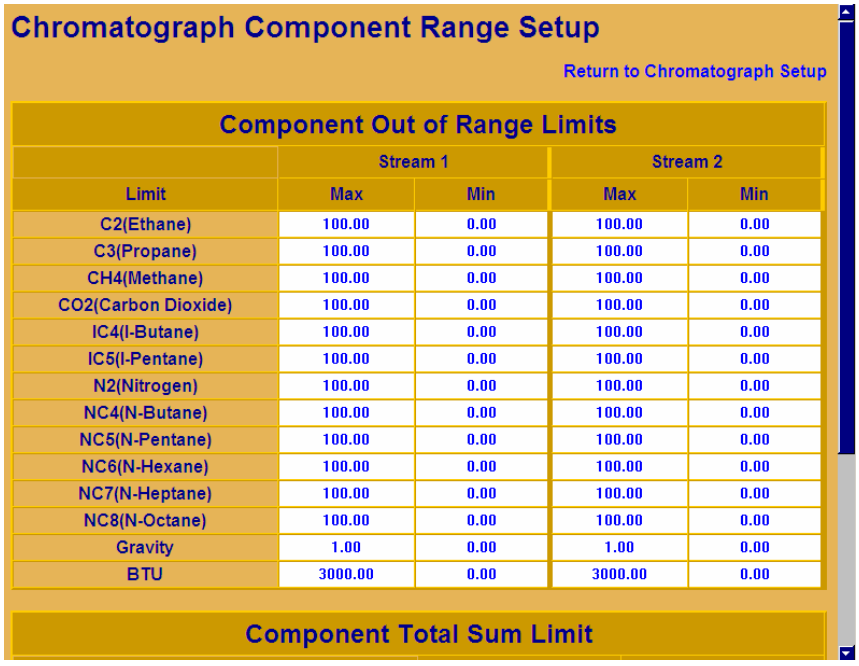


Figure F-22 - Chromatograph Component Range Setup Web Page

F.7.5 Chromatograph Component Range Setup

Values of BTU, Specific Gravity and each gas component of each stream are compared to user configured (high and low) allowable limits. These limits are set from the Chromatograph Component Range Setup Web Page, accessible from the Chromatograph Setup Web Page. If a component is found to be outside the user defined limits, the value will be clamped at the closest configured limit.

It also checks the sum of the components; if the sum is outside the configurable limits, a Boolean signal is set indicating so. If any component or the total is out of range, either fixed or last values will be used.

F.8 LOGS CATEGORY FUNCTIONS

Four WebBSI Web Pages are accessible under the Logs Category Section of WebBSI; these are:

- View Archives (Section F.8.1)
- View Audit Trail (Section F.8.2)
- View Signal List (Section F.8.3)
- Collection (Section F.8.4)

F.8.1 Meter Run Archive Files

When View Archive has been selected, the **Meter Run Archive Files** WebBSI Web Page will be displayed (see Figure F-23). **Meter Run Archive Files** Web Pages provide three types of archive files, i.e., Hourly, Daily & 15 Minute for each of the two runs.

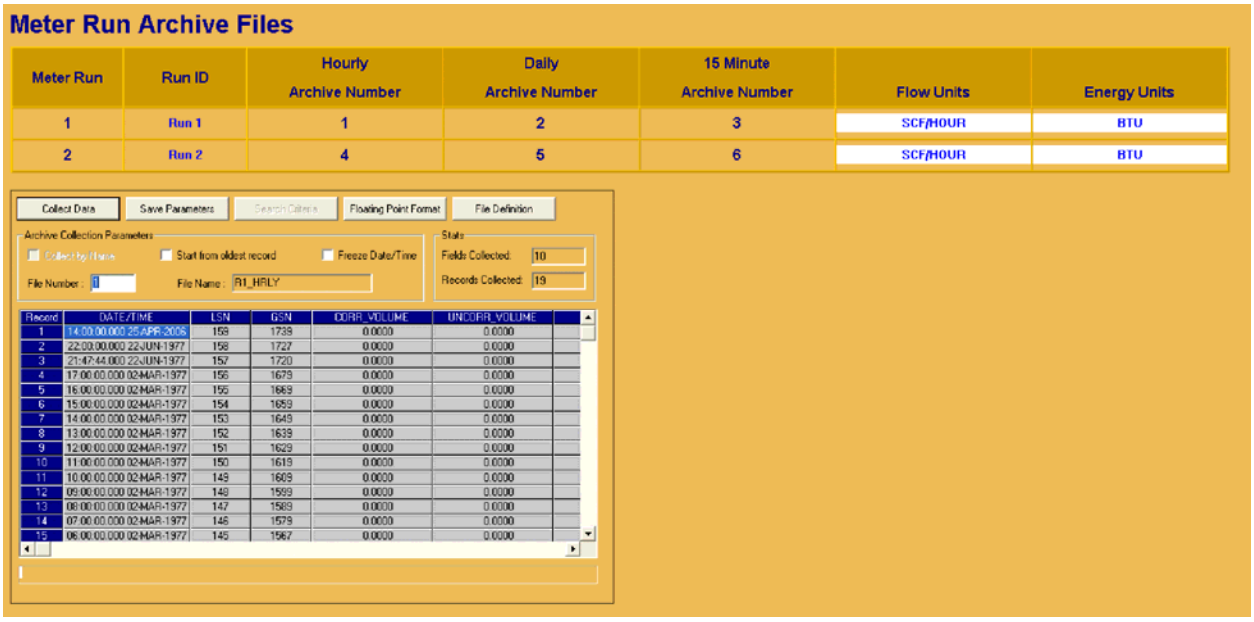


Figure F-23 - Meter Run Archive File Web Page (Hourly Archive Shown)

Meter Run Archive File Web page pushbuttons allow the user to Collect Data, Save Parameters, Search Criteria, select Floating Point Format and show File Definition. Users can select one of the following Archive Collection Parameters: File Number To Collect, Select from oldest record or Freeze Date/Time. Users can select the archive file, (Hourly,

Daily or 15 Minutes) for the run in question by entering a number from 1 to 12 in the field adjacent to File Number:.

Meter Run	Run ID	Hourly Archive Number	Daily Archive Number	15 Minute Archive Number
1	Run 1	1	2	**3**
2	Run 2	4	5	6

The Web page opens by default configured to view Archive 1 (R1_HOURLY). To view another archive, the user will enter the desired archive number in the File Number: field and then press the **Collect Data** button.

To save the collected archive data, the user would press the **Save Parameters** button. A Save Parameters dialog box will appear which will allow the user to select the file name to save the data as, and select the folder to save the data in. After selecting the file Name and Path (each box) and checking Save Archive Data, the file will be saved by clicking OK on the Save Parameters Dialog. The file saved is a binary file. To view the file, the user may use the Data File Conversion Utility or the UOI Dump Utility (UOIDMP.exe).

By clicking on the Floating Point Format button, the user may change the way Analog Values are displayed. By clicking on the File Definition button, the user can view how the archive file is configured. Additionally, the **Meter Run Archive** Web page provides the number of Fields Collected and Records Collected under the Stats field.

F.8.2 Meter Run Audit Trail

The **Control**Wave **GFC-CL** keeps an Audit Trail Buffer capable of storing the most recent 500 Alarms and the most recent 500 Events. Internally, these buffers are maintained separately to prevent recurring alarms from overwriting configuration audit data. Externally, they are reported to the user as a single entity. Both operate in a circular fashion with new entries overwriting the oldest entry when the buffer is full.

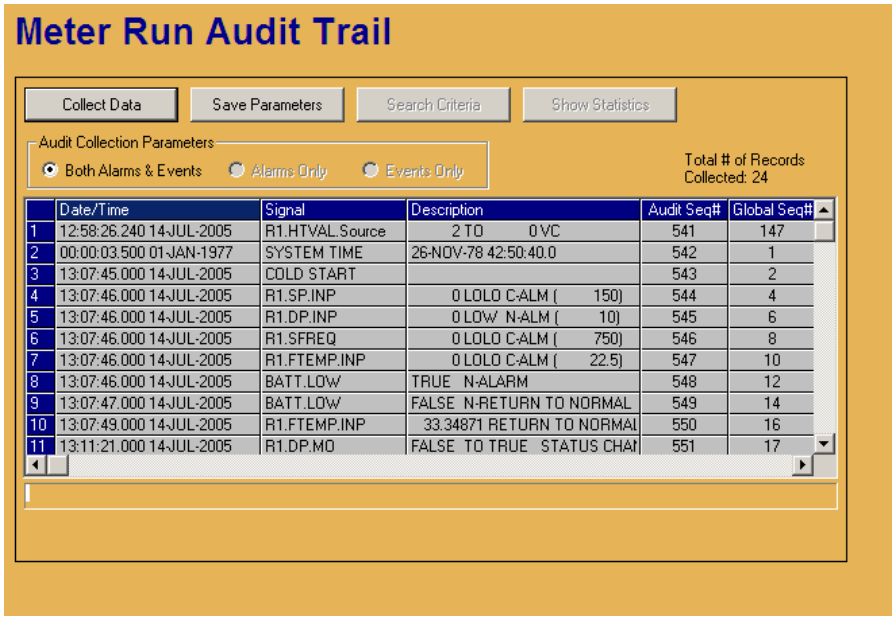


Figure F-24 - Meter Run Audit Trail Web Page (Both Alarms & Events Selected)

When View Audit Trail is selected, the **Meter Run Audit Trail** Web Page (see Figure F.24) will be displayed. **Meter Run Audit Trail** Web page buttons allow the user to Collect Data, Save Parameters, Search Criteria, and Show Statistics. Additionally, the **Meter Run Audit Trial** Web page posts the Total # of Records Collected near the top right side of the page. When the page is initially opened, only the 24 most recent records are gathered. To view more records, the user may scroll down using the Vertical Scroll Bars.

F.8.3 View Signal List

Signal List Information: Number - List Number to be viewed

Start Index - List Element to start collecting

Max Signals to Collect – Number of Signals to collect

Collect List: Starts list collection

Floating Point Format: Select this button to change the appearance of Floating Point Values

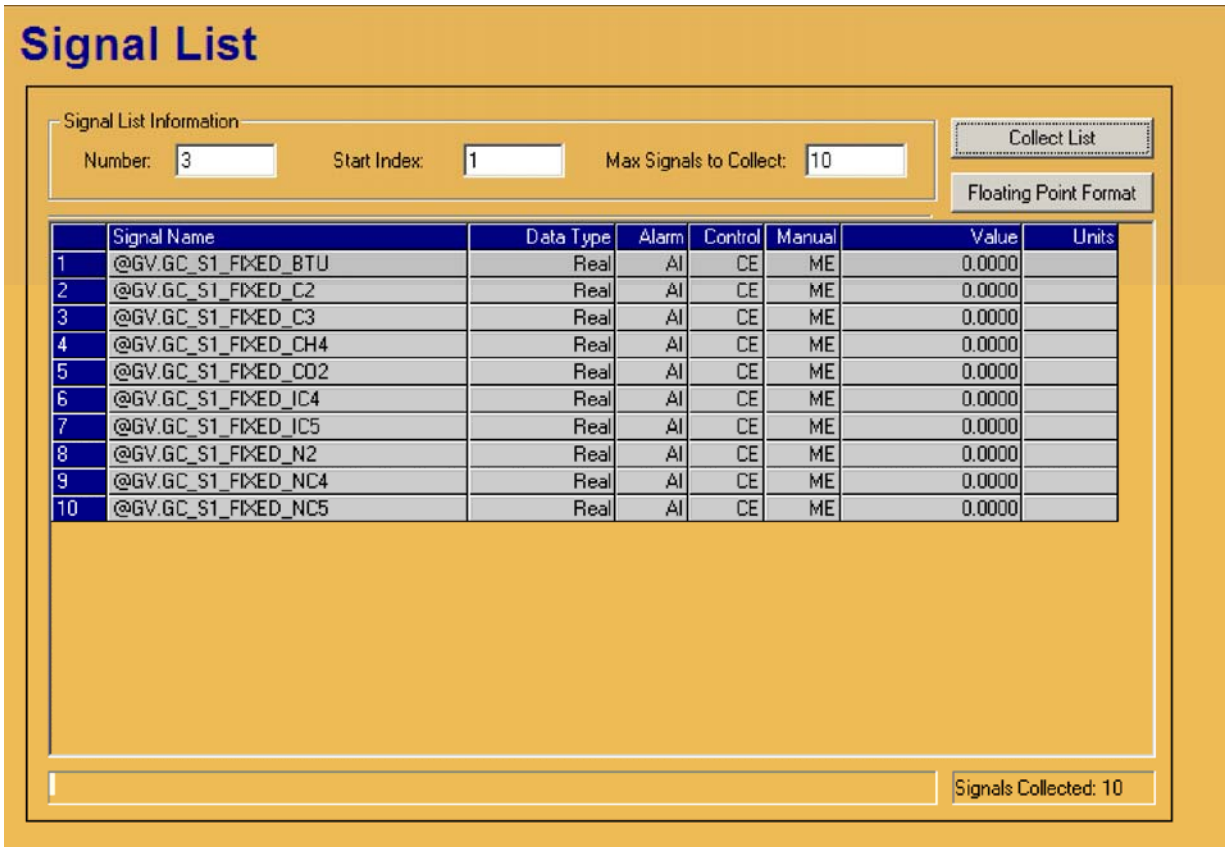


Figure F-25 - Signal List Web Page

F.8.4 Archive File Collection

When Collection is selected, an Archive File Collection Web Page (see Figure F.26) will be displayed. Log Break Configuration buttons are provided on the Archive File Collection Web Page to enable/disable log breaks for configuration changes and Gas Chromatograph operation and configuration. Log Breaks are 'Disabled' by default.

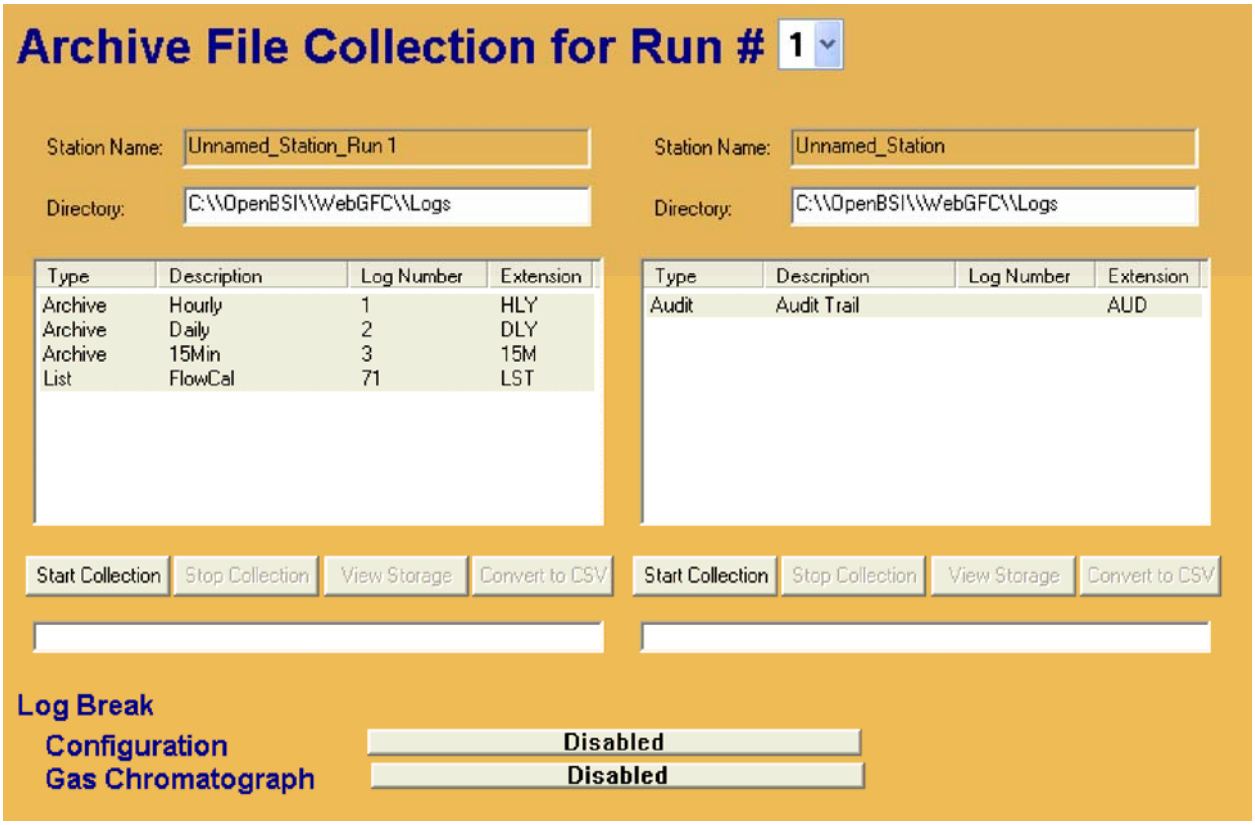


Figure F-26 - Archive File Collection Web Page

F.9 LOAD/SAVE CATEGORY FUNCTION

One WebBSI Web page is accessible under the Load/Save Category Section of WebBSI; this is called the Meter Run Save/Load Configuration Web page (see Figure F-27).

This page allows a user to save configuration parameters from a **Control**Wave **GFC-CL** or load a saved configuration down to a **Control**Wave **GFC-CL**. The page opens from defaults and the information displayed is retrieved from the following file:

(C:\OpenBSI\WebGFC\Config\DefaultMGFC.RCP).

The information displayed is returned from this file. If a user has made changes to the configuration of the unit, upgrade of the values can be changed by clicking on Load from RTU. The values in the configuration now reflect the actual configuration of the unit.

Users may save their configuration to a file. First the user should select the file where the configuration should be save. This is done by clicking on Browse, and selecting an existing file, or by typing in a new file name to save the configuration. After the file has been selected, the date is saved by clicking on Write to File.

A user may download a previously saved configuration to the **Control**Wave **GFC-CL**. Users would select the file to download to the unit by clicking on the Browse button to locate it. A user would then click on Load from File. This will update the recipe with the information from the file. To load the configuration to the **Control**Wave **GFC-CL**, the user would click on Write to RTU. By defaults the RCP files are stored in the following folder:

(C:\OpenBSI\WebGFC\Config).

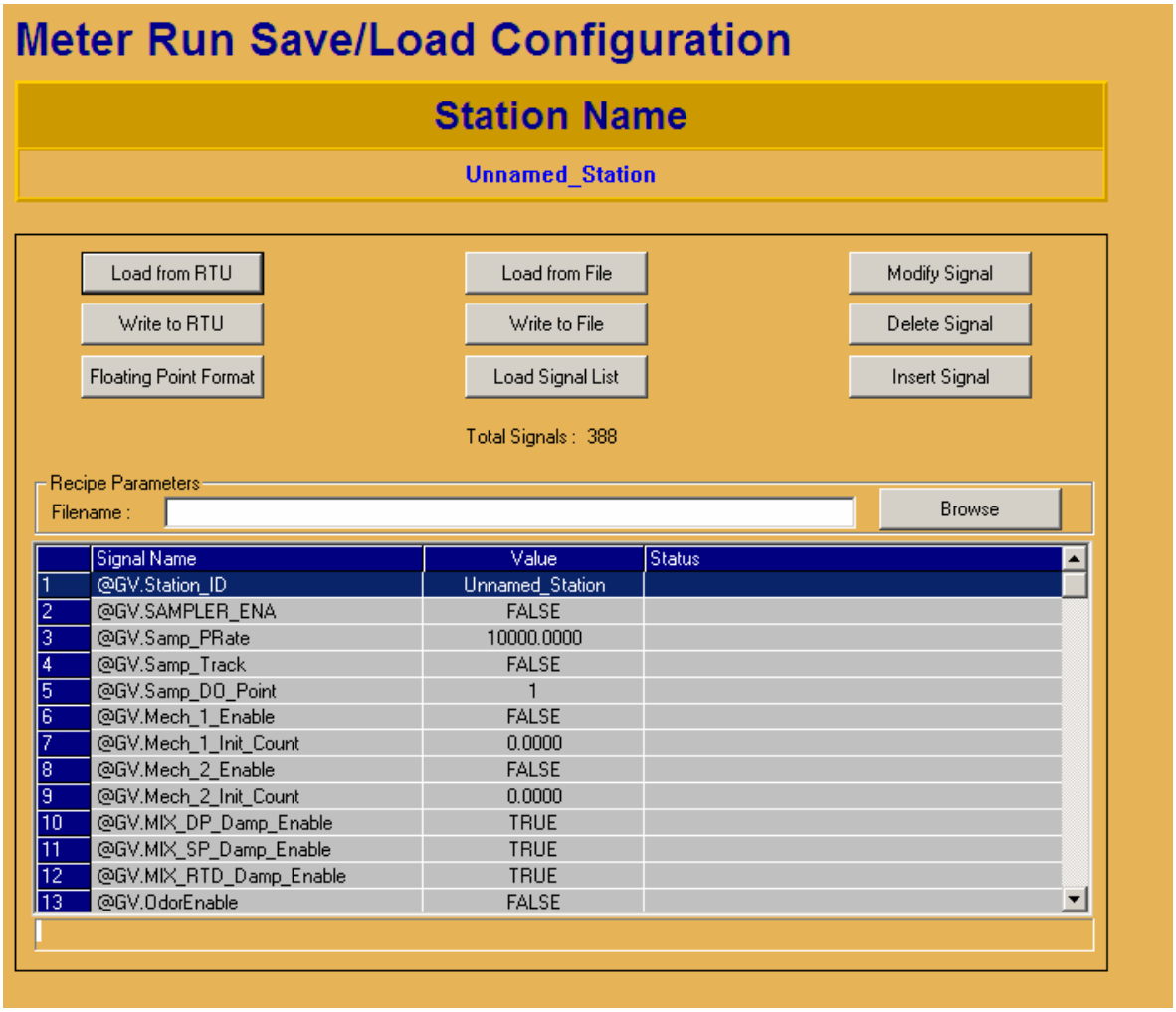


Figure F-27 - Meter Run Save/Load Configuration Web Page

The RCP file can be edited with a text editor such as WordPad. Users may save a configuration from one meter, use a text editor to change the configuration parameters for a different meter and read the configuration from the file, and download the modified configuration to a new meter.

Users may modify the value of a signal from the **Meter Run Save/Load Configuration** page. A user would highlight the signal that needs to be modified and then click on the **Modify Signal** button. A dialog box will open with the Signal Name and Value. Users may either enter the new value for String Signals and Analog Signals or select the new value from the drop down menu (for logical signals). To write the change down to the **Control**Wave **GFC-CL**, the user must click on Write to RTU. To ensure a saved configuration, the user must click on Write to File.

Typical Steps:

1. Open Page – Values from DefaultMGFC.RCP are shown. If there is another configuration that the user would like to use, skip to Step 7.

2. Update Values with actual settings by clicking on Load from RTU.

3. Review settings and make modifications as required using the **Modify Signal** button.

4. Click on Write to RTU.

5. Select the file to save the configuration to by clicking on Browse. Find an existing file to update or enter the name of a new file to create.

6. Click on Write to File. - FINISHED

7. Select another file to use by clicking on Browse and the desired .RCP file.

8. Click on Load from File. - Return to Step 2.

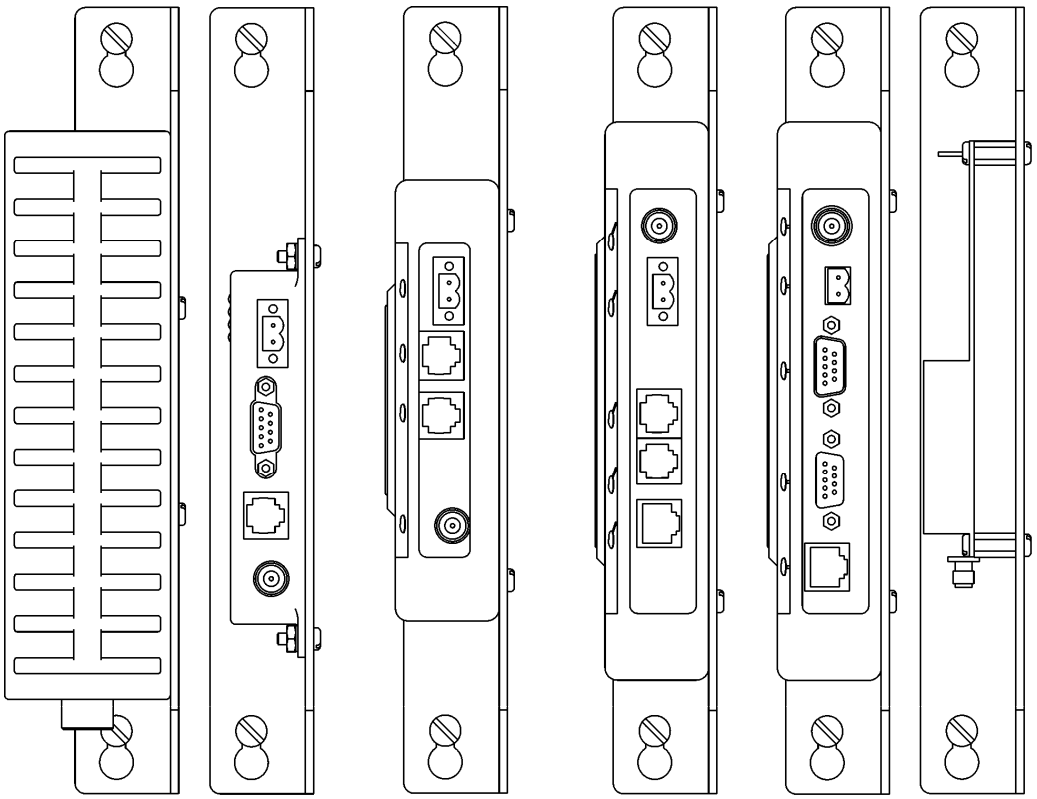
F.10 SPECIAL FUNCTIONS

A special Sync Date & Time web page (see Figure F-28) is accessible from the Special Functions Category Section of WebBSI.

Figure F-28 - Sync Date & Time Web Page Display

Radio Ready Installation Guide
P/N 721700-02-0

Appendix G



MDS Radios Models: 4710A, 4710B, 9710A, 9710B & 9810

MDS Transnet Radio

MDS entraNET 900 Serial Remote & Ethernet Remote Radios

MDS entraNET 900 Access Point Radio

MDS iNET 900 Radios

FreeWave Radio

ControlWave

APPENDIX G

ControlWave GFC Classic

Radio Ready Installation Guide

TABLE OF CONTENTS

Appendix G
RADIO READY INSTALLATION GUIDE

G1.1 GENERAL INTRODUCTION

ControlWave **GFC-CL** Gas Flow Computers may be ordered "Radio Equipped," or "Radio Ready." Radio Ready units contain all hardware required to field install a Bristol provided radio except the radio and radio installation hardware (such as screws, nuts and washers. Radio Ready units will include either an Internal RF Radio Cable with Bulk Head Antenna Connector or an Internal RF Radio Cable that mates to an optional Polyphaser (Surge/Impulse Suppresser).

Radios are shipped with all necessary installation hardware and are to be secured to the factory installed Radio Mounting Bracket which in turn mounts to the **Control**Wave **GFC-CL** Battery Bracket.

ControlWave **GFC-CL** Gas Flow Computers may be equipped with one of the external radios listed below or may be shipped with the hardware necessary to install one of these radios at a future date. The term "external radio," refers to those radios that mount on a Radio Mounting Bracket instead of piggy-back on the CPU/System Controller Board Assembly.

MDS 4710A Remote Data Transceiver (Radio)
MDS 4710B Data Transceiver (Radio)
MDS 9710A Remote Data Transceiver (Radio)
MDS 9710B Data Transceiver (Radio)
MDS 9810 Spread Spectrum Data Transceiver (Radio)
MDS entraNET 900 Extended Range IP Networking Transceivers
MDS *i*NET 900 Ethernet Radio
MDS Transnet 900 Spread Spectrum Data Transceiver
FreeWave Radio Spread Spectrum Data Transceiver Model FGRM-501X005

Radios are shipped with the following additional hardware:

MDS 4710A/B, MDS 9710A/B & MDS 9810 models are provided with four (4) 6-32 x 5/16 Countersunk Screws, a Power Cable and a Radio Interface Cable.

MDS entraNET 900 Serial Remote and Ethernet Remote models are provided with four (4) 6-32 x 5/16 Countersunk Screws, a Power Cable and a Radio Interface Cable.

MDS entraNET 900 Access Point and MDS iNET 900 (Remote Serial Gateway, Remote Ethernet Bridge or Access Point/Remote Dual Gateway) models are provided with four (4) 6-32 x 5/16 Countersunk Screws, a Power Cable and a Radio Interface Cable.

MDS TRANSNET radios are provided with four (4) 6-32 x 5/16 Countersunk Screws, four (4) #6 Flat 5/16 O.D. Washers and four (4) 6-32 Hex Nuts and a Power Cable and a Radio Interface Cable.

FreeWave radios are provided with eight (4) 6-32 x 5/16 Pan Head Screws and four (4) 6-32 x .500 F/F Standoffs, four (4) 6-32 x 5/16 Countersunk Screws and a Radio Intf. Cable.

G2.1 RADIO INSTALLATION

DANGER

Radios provided by Bristol for use in the Control Wave **GFC-CL Gas Flow Computers are approved for use in Class I, Division 2, Groups A, B, C & D hazardous locations. Radios may also be used in non-hazardous locations. The installer must be familiar with hazardous location installation guidelines before installation or maintenance is undertaken. Do not begin radio installation or service to the Control**Wave **GFC-CL unless the area is known to be non-hazardous.**

NOTE

Only the external radios listed on page 1 of this document may be used in Class I, Division 2, Groups A, B, C & D hazardous locations! Use of other external radios in Class I, Division 2, Groups A, B, C & D hazardous locations is not allowed!

AVOID OPERATING EQUIPMENT DURING AN ELECTRICAL STORM. AN IMPULSE SUPPRESSOR MAY SAVE EQUIPMENT FROM DANGER, BUT SHOULD NOT BE CONSIDERED AS BEING SAFE FOR PERSONNEL.

G2.1.1 Installation of a Radio into a Radio Ready Control Wave GFC-CL

Radio Ready **Control**Wave **GFC-CL** Gas Flow Computers contain all the hard-ware required (except the radio and securing hardware) to accommodate installation and operation of the radio option.

1. Open the Instrument Front Cover.

2. Remove the Radio Mounting Bracket. To do this, loosening the four Pane Head Screws that secure it to the Battery Bracket and then slid it upward until it can be removed.

3. Using the mounting hardware provided with the radio, mount and secure the radio to the Radio Mounting Bracket removed in step 2 (see Figures 1 through 5 as required).

4. Re-install the Radio Mounting Bracket to the Battery Bracket using the four 10-32 x 3/8 Pan Head Screws that were loosened in step 2.

5. Connect the radio's RF cable to the radio. The other end of the radio's internal RF cable should already be installed onto either a Polyphaser or a RF Bulk Head/Antenna Interface connector.

6. Connect the user supplied antenna cable to either the Polyphaser or Bulk Head antenna cable connector jack on the bottom of the **Control**Wave **GFC-CL** (see Figure 6).

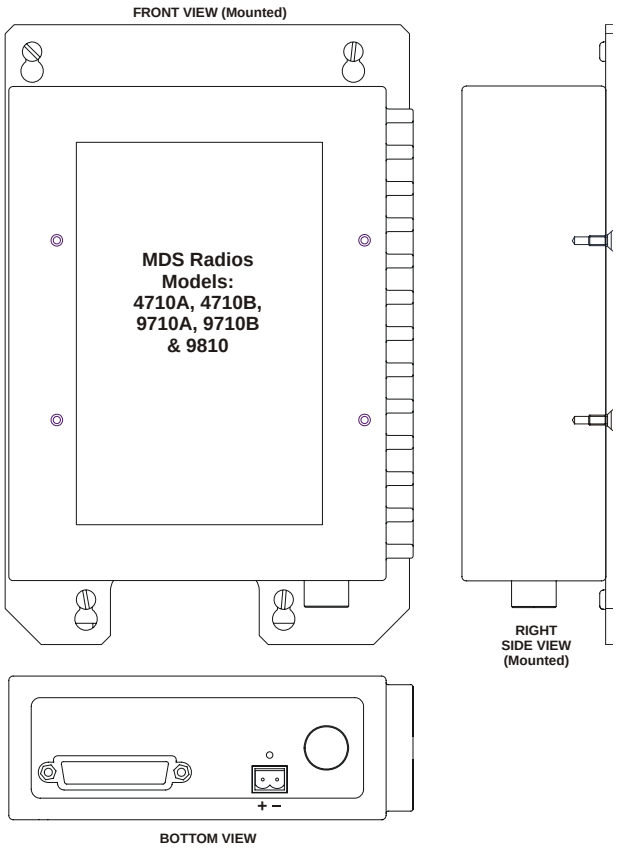


Figure 1 - Radio Installation/Mounting Diagram - MDS Radios Models 4710A, 4710B, 9710A, 9710B & 9810

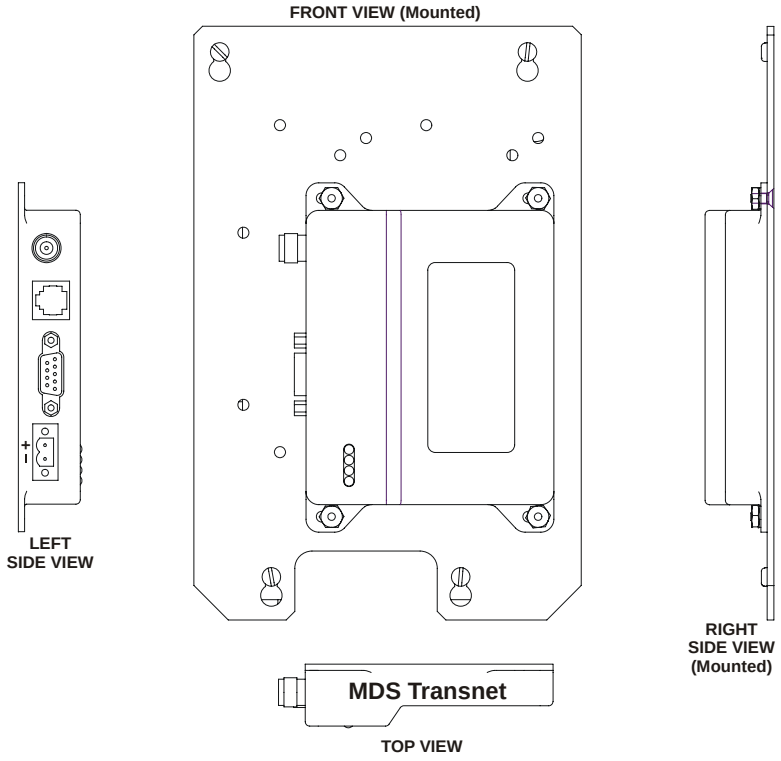


Figure 2 - Radio Installation/Mounting Diagram - MDS Transnet Radio

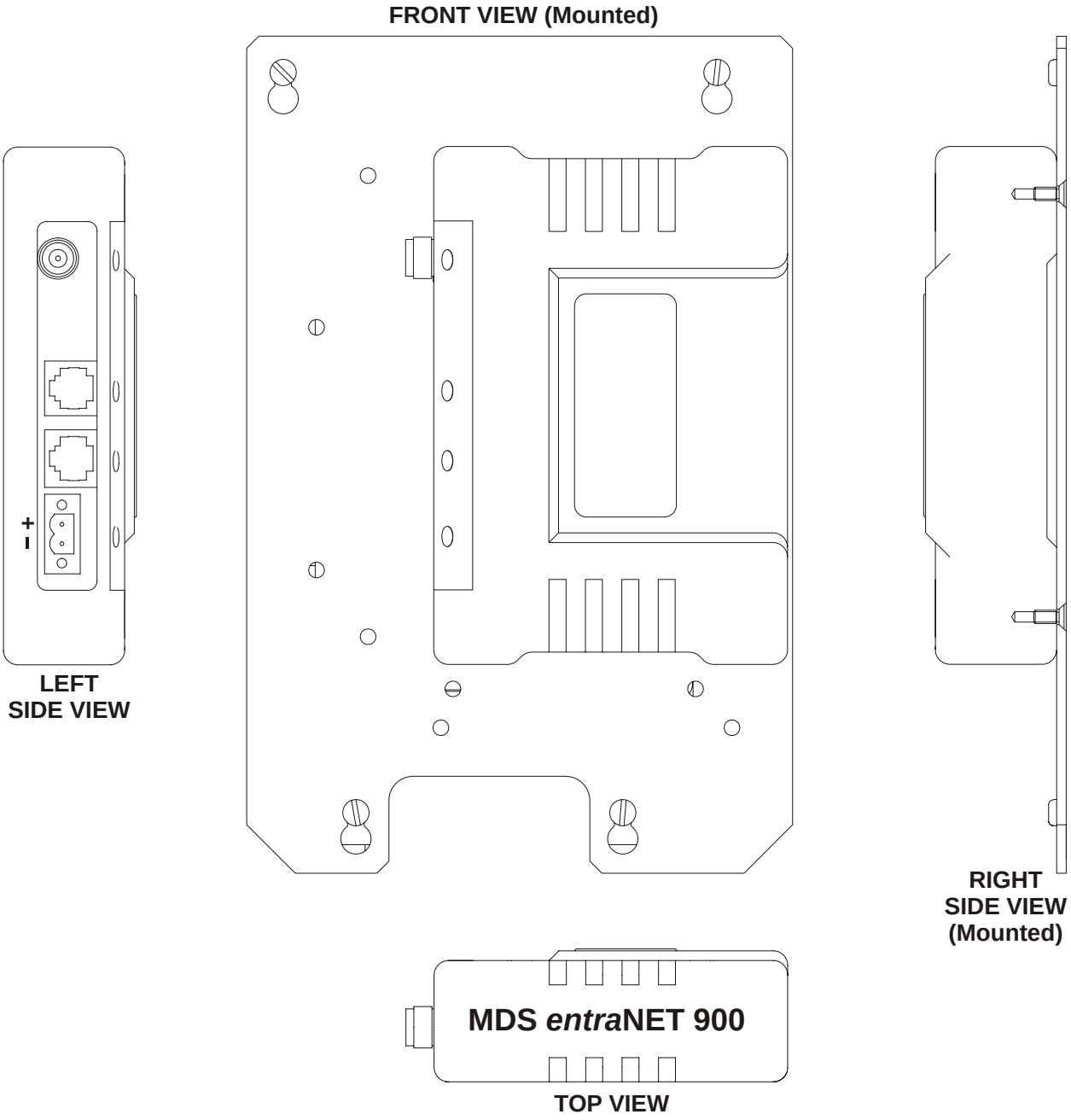


Figure 3 - Radio Installation/Mounting Diagram - MDS *entra*NET 900 Radio

7. Plug the Radio Interface Cable into the radio's Comm. Port. Plug the other end of this cable into Comm. Port 2 on the CPU/System Controller Board Assembly. In the case of the FreeWave Radio, power is also supplied via the Interface Cable.

8. Remove the MDS Radio's Power Connector from the MDS Radio in question and connect the unterminated ends of the MDS Power Cable to the MDS Power Connector (Red = Pos. and Black = GND). Plug the end of the MDS Radio Power Cable that you just dressed into the MDS Radio. Connect the other end of the MDS Radio Power Cable to connector TB4 of the Battery Charger & I/O Board Assembly (Red = Pin-1, Black = Pin-2).

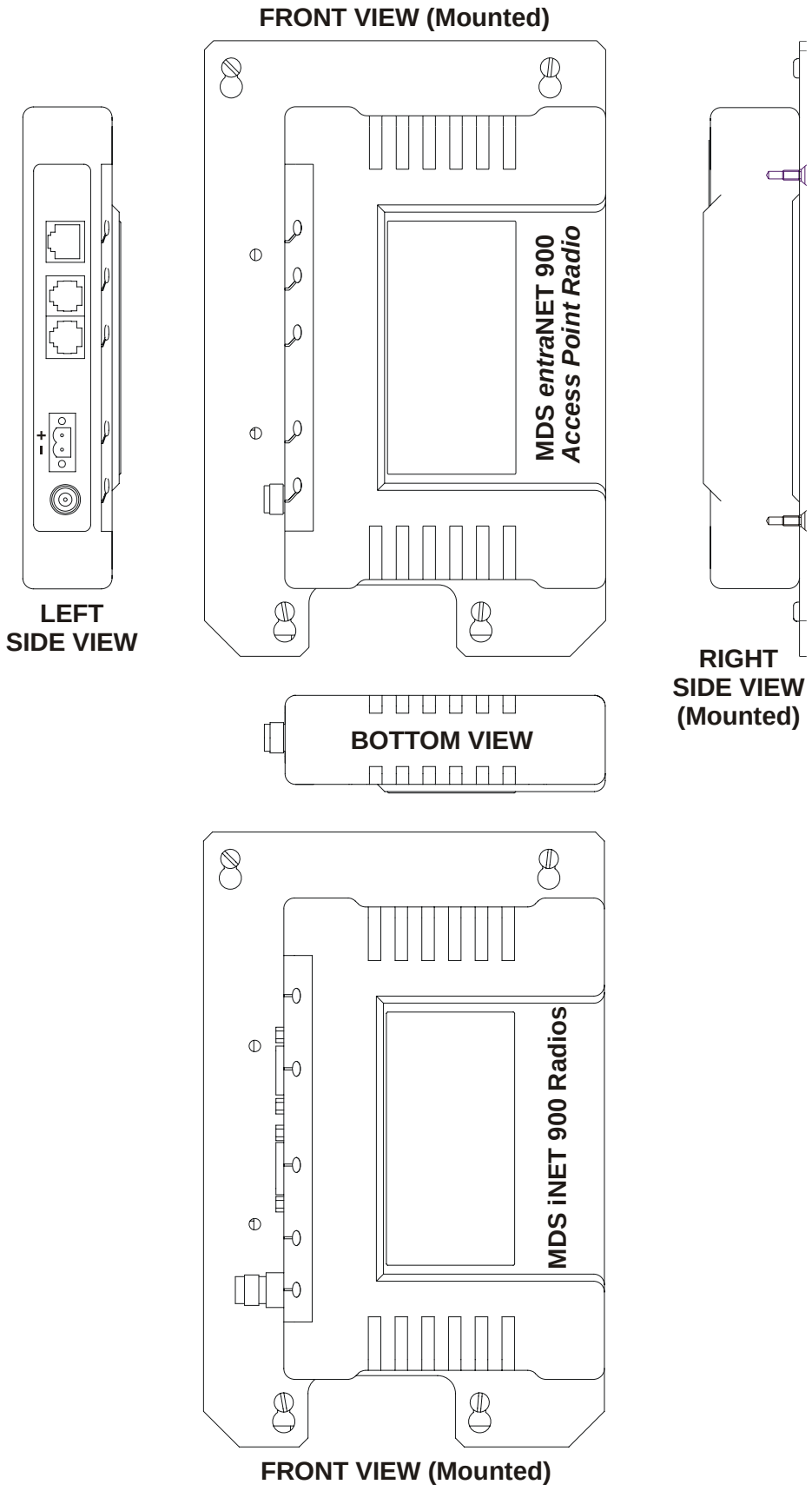


Figure 4- Radio Installation/Mounting Diagram - MDS Radios
MDS *entra*NET900 Access Point Radio & MDS iNET 900 Radios

9. After testing the unit, close and secure the Door.

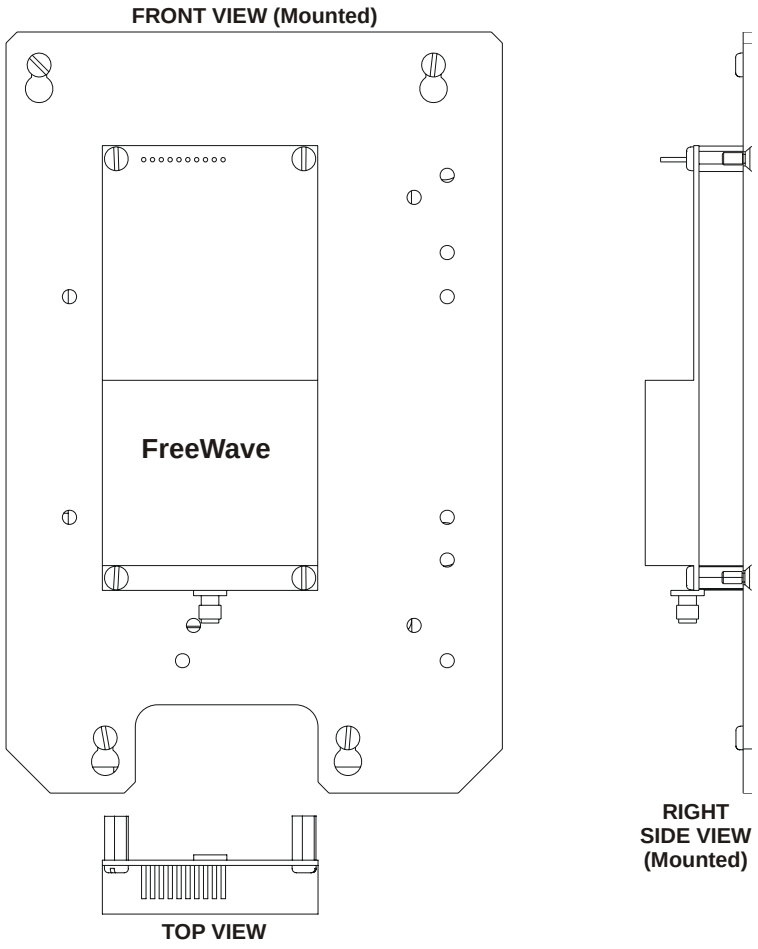


Figure 5 Radio Installation/Mounting Diagram – FreeWave Radio

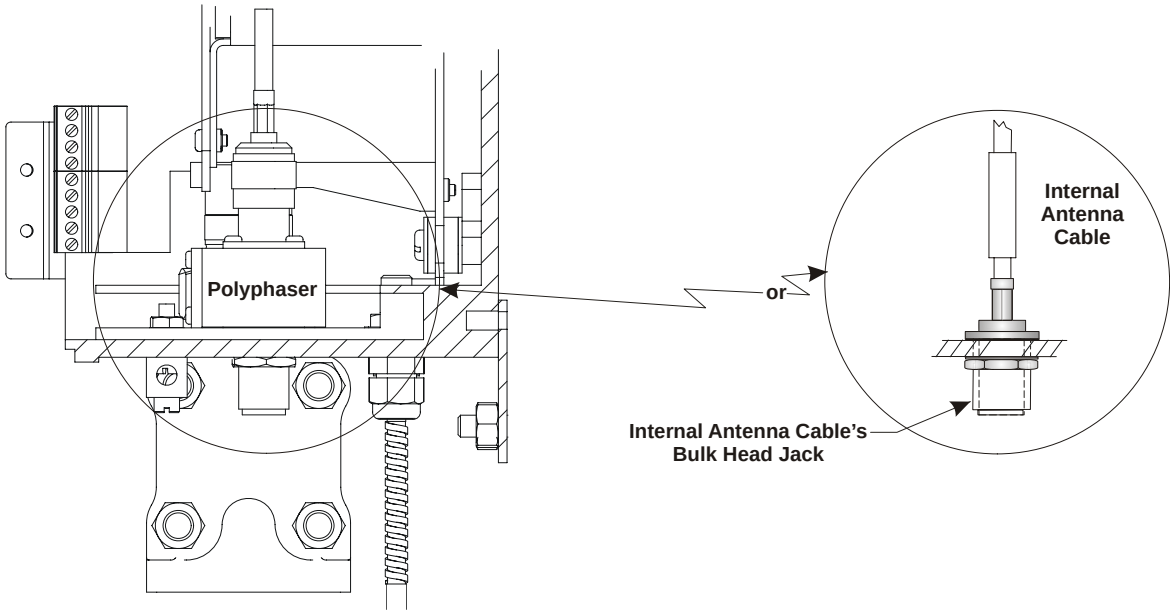


Figure 6- Partial View - Control Wave **GFC-CL with/without Polyphaser**

G2.2 ADDITIONAL FreeWave INFORMATION

The FreeWave Spread Spectrum Data Transceiver Model FGRM-501X005 User Manual contains in-depth details on modem parameters, operation, installation, tuning transceiver performance, and more. Copies of the FreeWave Spread Spectrum Data Transceiver Model FGRM-501X005 User Manual can be obtained from FreeWave Technologies, Inc. (electronically) by contacting their Technical Support Group.

FreeWave Tech. Support can be reached at 303-444-3862 or at www.freewave.com.

Follow the "Tuning Transceiver Performance" section of the FreeWave Technologies, Inc. FreeWave Spread Spectrum Data Transceiver Model FGRM-501X005 User Manual to configure the radio.

Note:

The setup program is invoked by setting CPU/System Controller Board Jumper W8 across pins 1 & 2, connecting the ControlWave GFC-CL Local Port to any PC equipped with a terminal program (such as Hyperterminal), setting the parameters for that terminal to those of Table 1, and putting the radio into setup mode. Connection to the PC requires connection to ControlWave GFC-CL Comm. Port 1 (via J19 on the CPU/System Controller Bd. or the Local Port on the bottom of the Instrument Front Cover (see Figures 8 & 9). The terminal program must be running before invoking the setup program. The setup program is invoked by shorting MTA-100 Connector pins 4 (GND) and 2 (MENU) together.

Table 1 - Setup Menu Terminal Settings

PARAMETER	SETTING
Baud Rate	19,200
Data Rate	8
Parity	None
Stop Bits	1
Parity Check	None/Off
Carrier Detect	None/Off

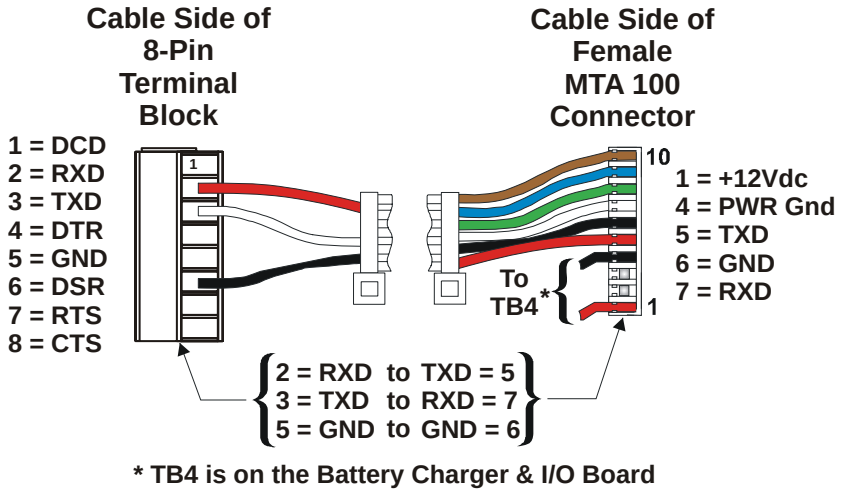


Figure 7 - Cable Diagram for Radio to COM2 (TB2) Interface & Radio Power

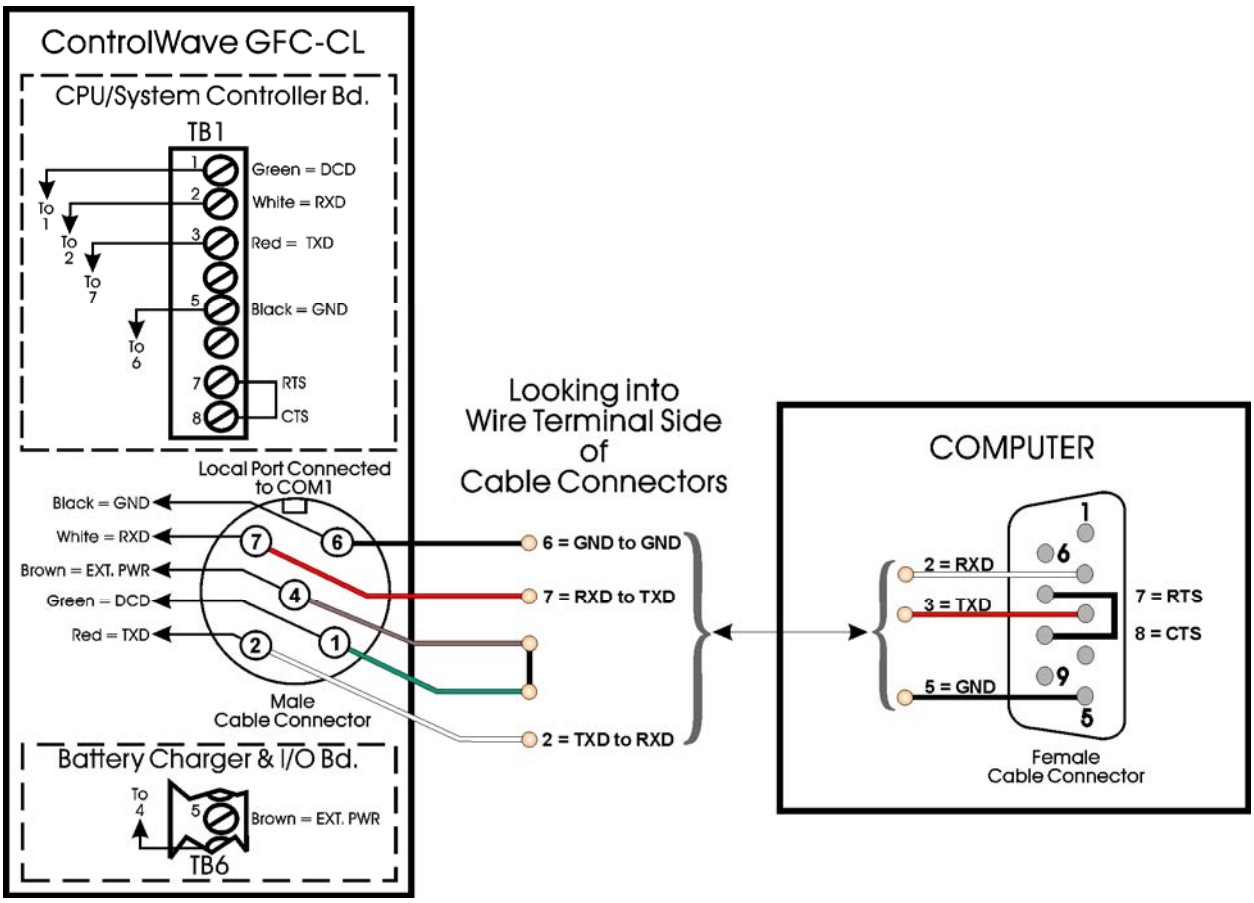


Figure 8 - PC Connected to ControlWave GFC-CL (COM1) via Local Port
Bristol Cable Part Number 395402-01-8 = 10 Foot Comm. Cable
Bristol Cable Part Number 395402-02-6 = 25 Foot Comm. Cable

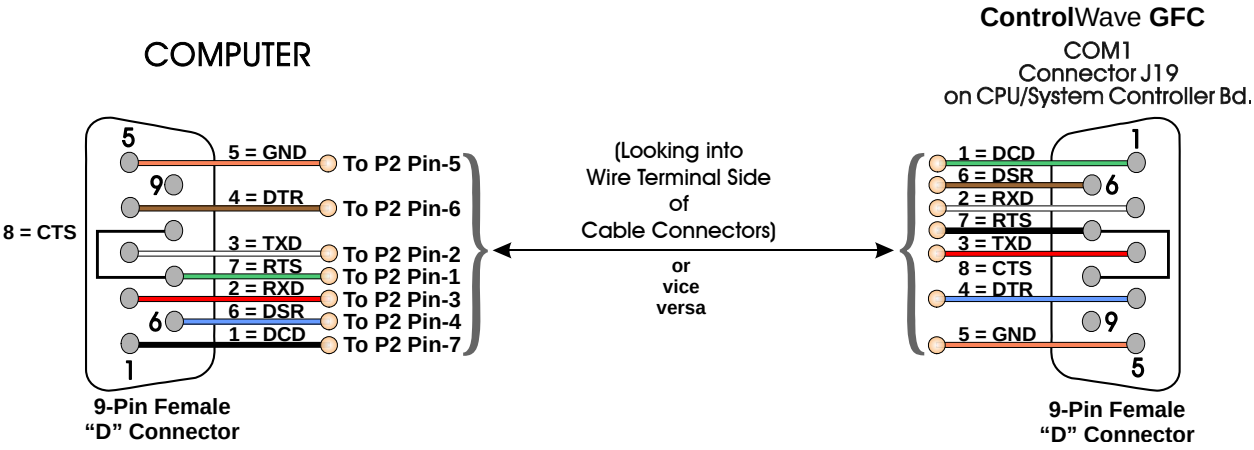


Figure 9 - PC Connected to ControlWave GFC-CL (COM1) via J19 on CPU/System Controller Bd. (Use Null Modem Cable - Bristol Part Number 392843-01-3)

ControlWave **GFC Classic**
Material Safety Data Sheets

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

Material Safety Data Sheets are provided below.

MSDS for Control Wave **GFC Classic Instruction Manual (**CI-ControlWave GFC-CL**)**

Manufacturer	General Description	Part Number
DURACELL	3V Lithium Manganese Dioxide Battery	DL 2450

Bristol Battery Part Number = 395620-01-5

Manufacturer	General Description	Part Number
Tadiran	Two - 7.2 Vdc Lithium Battery Packs (Each Pack Composed of two 3.6V, 35AH Batteries)	Individual Battery Part No. = TL-5137

Bristol Battery Pack Part Number = 39413-01-0

Manufacturer	General Description	Part Number
Tadiran	7.2 Vdc Lithium Battery Pack (Composed of two 3.6V, 35AH Batteries)	Individual Part No. = TL-5137

Bristol Battery Pack Part Number = 395413-01-0

Manufacturer	General Description	Part Number
Power Sonic	6V, 7AH Lead Acid Battery -Used with 1W, 6V Solar Panel or 5W, 6V Solar Panel	PS-670

Bristol Battery Part Number = 395407-01-0

Manufacturer	General Description	Part Number
Power Sonic	12V, 7AH Lead Acid Battery -Used with 5W, 12V Solar Panel	PS-1270

Bristol Battery Part Number = 395407-02-8

Manufacturer	General Description	Media Notes
Dow Corning	Silicone 200(R) Fluid, 100 CST	Pressure Transducer Media Fill

Gillette
Environment
Health and Safety

37 A Street
Needham, MA 02492
Tel 781.292.8151

MATERIAL SAFETY DATA SHEET

NAME: DURACELL LITHIUM MANGANESE DIOXIDE COIN BATTERIES

CAS NO: Not applicable **Effective Date:** 8/8/03 **Rev:** 3

A. — IDENTIFICATION

	%
Manganese Dioxide (1313-13-9)	65-75
Propylene Carbonate (108-32-7)	10-15
Lithium (7439-93-2)	5-10
Graphite, synthetic (7440-44-0)	5-10
1,2-Dimethoxyethane (110-71-4)	1-10
Lithium Perchlorate (7791-03-9)	<1.5

Formula: Mixture — Mixture

Molecular Weight: NA

Synonyms: Lithium Manganese Dioxide Coin Cells: 3V-DL2016; DL2025; DL2430; DL2450; DL2032; DL1616; DL1620

B. — PHYSICAL DATA

Boiling Point	Melting Point	Freezing Point
NA °F NA °C	NA °F NA °C	NA °F NA °C
Specific Gravity (H_2O=1)	**Vapor Density (air=1)**	**Vapor Pressure @ ____ °F**
NA	NA	NA mm Hg
Evaporation	**Saturation in Air**	**Autoignition Temperature**
(Ether =1)	(by volume@ ____ °F)	____ °F ____ °C
NA	NA	NA
% Volatiles	**Solubility in Water**	**pH**
NA	NA	NA

Appearance/Color: Coin cells. Contents dark in color.

Flash Point and Test Method(s): 1,2-Dimethoxyethane (Approximately 3-7% of contents): 42.8 °F, 6°C (Closed Cup)

Flammable Limits in Air (% by volume): Lower NA % Upper NA %

C. — REACTIVITY

Stability				Polymerization			
	[X]	stable	[ ] unstable		[ ]	may occur	[X] will not occur

Conditions to Avoid	Conditions to Avoid
Do not heat, crush, disassemble, short circuit or recharge.	Not applicable
Incompatible Materials	**Hazardous Decomposition Products**
Contents incompatible with strong oxidizing agents.	Thermal degradation may produce hazardous fumes of manganese and lithium; oxides of carbon and other toxic by-products.

*** IF MULTIPLE INGREDIENTS, INCLUDE CAS NUMBERS FOR EACH** **NA=NOT AVAILABLE**

Footnotes

Not applicable

D. — HEALTH HAZARD DATA

Occupational Exposure Limits PEL's, TLV's, etc.)

8-Hour TWAs: Manganese Dioxide (as Mn) - 5 mg/m^3 (Ceiling) (OSHA); 0.2 mg/m^3 (ACGIH/Gillette)
1,2-Dimethoxyethane - 0.15 ppm (Gillette)
Graphite (all kinds except fibrous) - 2 mg/m^3 (synthetic, ACGIH); 15 mg/m^3 (total, OSHA); 5 mg/m^3 (respirable, OSHA)

These levels are not anticipated under normal consumer use conditions.

Warning Signals

Not applicable

Routes/Effects of Exposure

These chemicals and metals are contained in a sealed can. For consumer use, adequate hazard warnings are included on both the package and on the battery. Potential for exposure should not exist unless the battery leaks, is exposed to high temperature, is accidentally swallowed or is mechanically, physically, or electrically abused.

1. Inhalation	Not anticipated. Respiratory (and eye) irritation may occur if fumes are released due to heat or an abundance of leaking batteries.
2. Ingestion	An initial x-ray should be obtained promptly to determine battery location. Batteries lodged in the esophagus should be removed immediately since leakage, burns and perforation can occur as soon as 4-6 hours after ingestion. Irritation to the internal/external mouth areas may occur following exposure to a leaking battery.
3. Skin	a. Contact Irritation may occur following exposure to a leaking battery. b. Absorption Not anticipated.
4. Eye Contact	Irritation may occur following exposure to a leaking battery.
5. Other	Not applicable

E. — ENVIRONMENTAL IMPACT

1. Applicable Regulations	All ingredients listed in TSCA inventory.
2. DOT Hazard Class -	Not applicable
3. DOT Shipping Name -	Not applicable

While lithium batteries are regulated by IATA and ICAO, the type of lithium batteries offered for sale by DURACELL are considered non-hazardous per provision A45 of the IATA Dangerous Goods Regulations and provision A45 of the ICAO Technical Instructions For The Safe Transport Of Dangerous Goods By Air. Per section A45 of the IATA and ICAO regulations, properly marked, labeled and packaged DURACELL consumer lithium batteries, which are of the solid cathode type, with less than 1g lithium per cell and less than 2g lithium per battery, are exempt from further regulation. When these batteries are separated to prevent short circuits and properly packaged in strong packaging (except when installed in electronic devices), they are acceptable for air transport as airfreight without any other restrictions. In addition, when installed in equipment or when no more than 24 cells or 12 batteries meeting the A45 provision are shipped, they are not subject to special packaging, marking, labeling or shipping documentation requirements. Thus, these batteries are not considered hazardous under the current regulations and are acceptable for air transport.

Environmental Effects

These batteries pass the U. S. EPA's Toxicity Characteristic Leaching Procedure and therefore, maybe disposed of with normal waste.

F. — EXPOSURE CONTROL METHODS

Engineering Controls

General ventilation under normal use conditions.

Eye Protection

None under normal use conditions. Wear safety glasses when handling leaking batteries.

Skin Protection

None under normal use conditions. Use butyl gloves when handling leaking batteries.

Respiratory Protection

None under normal use conditions.

Other

Keep batteries away from small children.

G. — WORK PRACTICES

Handling and Storage

Store at room temperature. Avoid mechanical or electrical abuse. **DO NOT** short or install incorrectly. Batteries may explode, pyrolize or vent if disassembled, crushed, recharged or exposed to high temperatures. Install batteries in accordance with equipment instructions. Replace all batteries in equipment at the same time. Do not carry batteries loose in pocket or bag.

Normal Clean Up

Not applicable

Waste Disposal Methods

No special precautions are required for small quantities. Large quantities of open batteries should be treated as hazardous waste. Dispose of in accordance with federal, state and local regulations. Do not incinerate, since batteries may explode at excessive temperatures.

H. — EMERGENCY PROCEDURES

Steps to be taken if material is released to the environment or spilled in the work area

Evacuate the area and allow vapors to dissipate. Increase ventilation. Avoid eye or skin contact. **DO NOT** inhale vapors. Clean-up personnel should wear appropriate protective gear. Remove spilled liquid with absorbent and contain for disposal.

Fire and Explosion Hazard	Extinguishing Media
Batteries may burst and release hazardous decomposition products when exposed to a fire situation. See Sec. C.	As for surrounding area. Dry chemical, alcohol foam, water or carbon dioxide. For incipient fires, carbon dioxide extinguishers are more effective than water.

Firefighting Procedures

Cool fire-exposed batteries and adjacent structures with water spray from a distance. Use self-contained breathing apparatus and full protective gear.

I. — FIRST AID AND MEDICAL EMERGENCY PROCEDURES

Eyes

Not anticipated. If battery is leaking and material contacts eyes, flush with copious amounts of clear, tepid water for 30 minutes. Contact physician at once.

Skin

Not anticipated. If battery is leaking, irrigate exposed skin with copious amounts of clear, tepid water for a least 15 minutes. If irritation, injury or pain persists, consult a physician.

Inhalation

Not anticipated. Respiratory (and eye) irritation may occur if fumes are released due to heat or an abundance of leaking batteries. Remove to fresh air. Contact physician if irritation persists.

Ingestion

Consult a physician. Published reports recommend removal from the esophagus be done endoscopically (under direct visualization). Batteries beyond the esophagus need not be retrieved unless there are signs of injury to the GI tract or a large diameter battery fails to pass the pylorus. If asymptomatic, follow-up x-rays are necessary only to confirm passage of larger batteries. Confirmation by stool inspection is preferable under most circumstances. If mouth area irritation/burning has occurred, rinse the mouth and surrounding area with clear, tepid water for at least 15 minutes.

Notes to Physician

1) For information on treatment, telephone (202)-625-3333 collect.
2) Potential leakage of less than 50 milligrams of propylene carbonate (CAS #108-32-1) and dimethoxyethane (CAS #110-71-4).
3) Dimethoxyethane readily evaporates.
4) Under certain misuse conditions and by abusively opening the battery, exposed lithium can react with water or moisture in the air causing potential thermal burns or fire hazard.

Replaces # 1461

The information contained in the Material Safety Data Sheet is based on data considered to be accurate, however, no warranty is expressed or implied regarding the accuracy of the data or the results to be obtained from the use thereof.

MSDS No.- T-36-01 (Revision. -G)

MATERIAL SAFETY DATA SHEET

SECTION 1- CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Manufacturer Name- Tadiran Batteries Ltd., P. O. Box 1, Kiryat Ekron, Israel 70500.

US office address- 2 Seaview Blvd. Port Washington NY 11050

Emergency Telephone No. – CHEMTREC: 1-800-424-9300
Tel. for information: 1-516-621-4980
Tel. for information 972-8-944-4503

Products Name: Primary Lithium Thionyl Chloride ($Li/SOCl_2$) cells and batteries, Non-rechargeable. Cells include the models of TL, TLH, and TLL, 3.6V series.

SECTION 2- COMPOSITION, INFORMATION ON INGREDIENTS

Ingredient Name	CAS #	%	ACGIH (TLV)	OHSA (PEL)	CHIP Classification
Lithium Metal (Li)	7439-93-2	<5%	Not Established	None	**F:** R14/15 **C:** R34 **R:** 14/15, 34 **S:**(1/2), 8,43,45
Thionyl Chloride ($SOCl_2$)	7719-09-7	<47 %	**1** ppm (5 mg/M^3)	5 mg/m^3	**R:** 14,20/22,29, 35. **S:** (1/2),26,36/ 37/39, 45
Carbon (C)	1333-86-4	<6%	3.5 mg/m^3	3.5 mg/m^3	None known
Aluminum Chloride ($AlCl_3$)	7446-70-0	<5%	2 mg/m^3 (Al salt, soluble)		**R:** 34 **S:** (1/2),7/8,28, 45
Lithium Chloride (LiCl)	7447-41-8	<2%	Not Established		
Glass		<1%	Not Established		
PVC	9002-86-2	<1%	Not Established		
PTFE	9002-84-0	<1%	Not Established		

SECTION 3 - HAZARD IDENTIFICATION

The lithium Thionyl chloride batteries described in this MSDS are hermetically sealed units, which are not hazardous when used according to the recommendations of the manufacturer.

Under normal condition of use of the batteries, the electrode materials and the liquid electrolyte they contained are non-reactive provided the battery integrity is maintained. Risk of exposure exists only in case of mechanical, electrical or thermal abuse. Thus the batteries should not short circuit, recharge, puncture, incinerate, crush, immerse in water, force discharge, or expose to temperatures above the temperature range of the cell or battery. In these cases there is risk of fire or explosion

SECTION 4- FIRST AID MEASURES

In case of battery rupture, explosion, or major leakage, evacuate personnel from contaminated area and provide good ventilation to clear out corrosive fumes, gases or the pungent odor. Seek immediate medical attention.

Eyes - First rinse with plenty of water for 15 minutes (remove contact lenses if easily possible), and then seek medical attention.

Skin - Remove contaminated clothes and rinse skin with plenty of water or shower for 15 min. Refer to medical attention.

Inhalation - Remove to fresh air, rest, and half-upright position, use artificial respiration if needed, and refer to medical attention.

Ingestion - rinse mouth, ***DO NOT*** induce vomiting, give plenty of water to drink, and refer to medical attention.

SECTION 5- FIRE FIGHTING MEASURES

FLASH POINT:	NA	LOWER (LEL):	NA
FLAMMABLE LIMIT IN AIR:	NA	UPPER (LEL):	NA

EXTINGUISHING MEDIA:

1. Lith- X (Class D extinguishing media) is the **only** effective on fires involving a few lithium batteries. If the cells are directly involved in a fire **DO NOT USE:** WATER, SAND, CO_2, HALON, and DRY POWDER OR SODA ASH EXTINGUISHERS.

2. If the fire is in adjacent area and the cells that are either packed in their original containers or unpacked, the fire can be fought based on fueling material, e.g., paper and plastic products. In these cases the use of copious amounts of **cold** water is effective extinguishing media. Storage area may employ sprinkler system with cold water.

AUTO-IGNITION: NA

SPECIAL FIRE FIGHTING PROCEDURES: Wear self-contained breathing apparatus to avoid breathing of irritant fumes (NIOSH approved SCBA & full protective equipment). Wear protective clothing and equipment to prevent body contact with electrolyte solution.

Fire may be fought, but only from safe fire-fighting distance. Evacuate all persons from immediate area of fire.

UNUSUAL EXPLOSION AND FIRE EXPLOSION: Battery may explode when subject to: excessive heat (above 150ºC), recharged, over-discharged (discharge below 0V), punctured and crushed. During thermal decomposition generation of chlorine (Cl_2), hydrogen chloride (HCl), and sulfur dioxide (SO_2) can be formed.

SECTION 6- SPILL OR LEAKAGE PROCEDURES

PROCEDURES TO CONTAIN AND CLEAN UP LEAKS OR SPILLS: The material contained within the battery would only be released under abusive conditions.

In the event of battery rapture and leakage: contain the spill while wearing proper protective clothing and ventilate the area. Than, cover with sodium carbonate

(Na_2CO_3) or 1:1 mixture of soda ash and slaked slime. Keep away from water, rain, and snow. Placed in approved container (after cooling if necessary) and disposed according to the local regulations.

NEUTRALIZING AGENT: Sodium carbonate (Na_2CO_3) or 1:1 mixture of soda ash and slaked slime.

WASTE DISPOSAL METHOD: Product decomposed by water must be neutralized. May be added to waste water in sufficiently diluted form.

PRECAUTIONS IN HANDLING AND STORING; Avoid short-circuiting, over-charging and heating to high temperatures. Store the batteries in dry and cool area and keep container dry and tightly closed in well-ventilated area. Store away from food and drink.

OTHER PRECAUTIONS; Never attempt to disassemble, machine, or otherwise modify batteries or injury may result.

SECTION 7- HANDLING AND STORAGE

The batteries should not be opened, destroyed or incinerate, since they may leak or rupture and release to the environment the ingredients that they normally contained in the hermetically sealed container.

HANDLING- Do not short circuit terminals, or expose to temperatures above the temperature rating of the battery, over charge the battery, forced over-discharge (voltage below 0.0V), throw to fire.

Do not crush or puncture the battery, or immerse in liquids.

STORAGE- Storage preferably in cool (below 30ºC), dry and ventilated area, which is subject to little temperature change.

Do not place the battery near heating equipment, nor expose to direct sunlight for long periods. Elevated temperatures can result in shortened battery life and degrade performance.

Keep batteries in original packaging until use and do not jumble them.

Do not store batteries in high humidity environment for long periods.

OTHER- the cells and the batteries are not rechargeable batteries and should not be charged.

Applying pressure and deforming the battery may lead to disassembly followed by eye skin and throat irritation.

Follow manufacturers recommendations regarding maximum recommended current and operating temperature range.

SECTION 8 - EXPOSURE CONTROLS & PERSONAL PROTECTION

RESPIRATORY PROTECTION: None necessary under normal use. In case of abuse and leak of liquid or fumes, use NIOSH approved Acid Gas Filter Mask or Self-Contained Breathing Apparatus.

VENTILATION: Not necessary under normal use. In case of abuse, use adequate mechanical ventilation (local exhaust) for battery that vent gas or fumes.
PROTECTIVE GLOVES: None under normal use. In case of spill use PVC or Nitrile gloves of 15 mils (0.015 inch) or thicker.

EYE PROTECTION: Use ANSI approved chemical worker safety goggles or face shield.

OTHER PROTECTIVE EQUIPMENT: Chemical resistance clothing is recommended along with eye wash station and safety shower should be available meeting ANSI design criteria.

WORK HYGIENIC PRACTICES: Use good chemical hygiene practice. Wash hands after use and before drinking, eating or smoking. Launder contaminated cloth before reuse.

SUPPLEMENTARY SAFETY AND HEALTH DATA: If the battery is broken or leaked the main hazard is the electrolyte. The electrolyte is mainly solution of Lithium chloride (LiCl), and aluminum chloride ($AlCl_3$) in Thionyl chloride ($SOCl_2$).

Fires may be fought but only from safe fire fighting distance, evacuate all persons from immediate area of fire.

Prevent heating of the battery, charging the battery, discharge to predetermined limit, do not crush, disassemble, incinerate or short circuit.

SECTION 9- PHYSICAL DATA

BOILING POINT (760 mm Hg)	NA, unless individual components exposed
VAPOR PRESSURE (mm Hg, 25ºC)	NA, unless individual components exposed
VAPOR DENSITY (air=1)	NA, unless individual components exposed
DENSITY (gr/cc)	> 1 gr/cc
VOLATILE BY VOLUME (%)	NA
EVAPORATION RATE (butyl acetate=1)	NA, unless individual components exposed
PHYSICAL STATE	Solid
SOLUBILITY IN WATER (% by weight)	NA, unless individual components exposed
PH	NA, unless individual components exposed
APPEARANCE	Geometric Solid Object
ODOR	If leaking, gives off pungent corrosive odor

SECTION 10- STABILITY AND REACTIVITY

STABLE OR NOT STABLE — Stable

INCOMPATIBILITY (MATERIAL TO AVOID) — Strong mineral acids, water and alkali solutions.

HAZARDOUS DECOMPOSITION PRODUCTS

1. Reaction of lithium with water: Hydrogen (H_2), Lithium hydroxide (LiOH).
2. Thermal decomposition over 150ºC: Sulfur oxides, (SO_2, SO_3), Sulfur chorides (SCl_2, S_2Cl_2), Chlorine (Cl_2), Lithium oxide (Li_2O).
3. Electrolyte with water: Hydrogen Chloride (HCl) and SO_2

DECOMPOSITION TEMPERATURE (ºF) — NA

HAZARDOUS POLYMERIZATION: May Occur____ Will Not Occur __X__

CONDITIONS TO AVOID — Avoid mechanical abuse, and electrical abuse such as short-circuiting, overcharge, over-discharge, (voltage reversal) and heating.

SECTION 11- TOXICOLOGICAL INFORMATION

THRESHOLD LIMIT VALUE (TLV) AND SOURCE: NA

HEALTH HAZARD ACUTE AND CHRONIC: Inhalation, skin contact, eye contact and ingestion are not likely by exposure to sealed battery.

Inhalation, skin contact and eye contact are possible when the battery is opened. Exposure to internal contents, the corrosive fumes will be very irritating to skin, eyes and mucous membranes. Overexposure can cause symptoms of non-fibrotic lung injury and membrane irritation.
Carcinogenicity- NTP: No
Carcinogenicity- IARC: No
Carcinogenicity- OSHA: No

Explanation of Carcinogenicity- No ingredient of a concentration of 0.1% or greater is listed as a carcinogen or suspected carcinogen.

SIGNS AND SYMPTOMS OF OVEREXPOSURE: Exposure to leaking electrolyte from ruptured or leaking battery can cause:

Inhalation- Burns and irritation of the respiratory system, coughing, wheezing, and shortness of breath.

Eyes- Redness, tearing, burns. The electrolyte is corrosive to all ocular tissues.

Skin- The electrolyte is corrosive and causes skin irritation and burns.

Ingestion- The electrolyte solution causes tissue damage to throat and gastro/ respiratory track.

MEDICAL CONDITION AGGRAVATED BY EXPOSURE: Preexisting skin, asthma and respiratory diseases are generally aggravated by exposure to liquid electrolyte vapors or liquid. For further information refer to section 4.

SECTION 12- ECOLOGICAL INFORMATION

1. When properly used and disposed the battery does not present environmental hazard.

2. The battery does not contain mercury, cadmium, or lead.

3. Do not let internal components enter marine environment. Avoid release to waterways, wastewater or ground water.

SECTION 13- DISPOSAL CONSIDERATIONS

1. Disposal must be in accordance with the applicable regulations in every country and state.

2. Disposal of the Lithium batteries should be performed by permitted, professional disposal firms knowledgeable in Federal, State or Local requirements of hazardous waste treatment and hazardous waste transportation.

3. Incineration should never be performed by battery users, but eventually by trained professional in authorized facility with proper gas and fume treatment.

4. Recycling of battery can be done in authorized facility, through licensed waste carrier.

SECTION 14- TRANSPORTATION /SHIPPING

Lithium batteries UN number 3090, class 9 (miscellaneous)

Lithium batteries contained in equipment, UN number 3091, class 9 (miscellaneous).

Packing instructions for 3090- ICAO 903 for air transport
IMDG 903 for sea transport
ADR/RID 903 and 903a for road /rail transport

Packing instructions for 3091- ICAO 912/918 for air transport
IMDG 903 for sea transport
ADR/RID 903 and 903a for road /rail transport

In the USA transportation is according to Code of Federal Regulations (CFR 49 Chapter 1, paragraph 173.185)

A list of Tadiran batteries and cells that are subject to transport regulations and those that are exempted can be obtained from Tadiran Batteries Ltd.

Identification and labeling in compliance with the product drawing should include the battery title, nominal voltage, lot number and warning.

SECTION 15- REGULATORY INFORMATION

1. The transport of the lithium batteries is regulated by the United Nations, "Model Regulations on Transport of Dangerous Goods", 13 revised edition-2003 (special provisions 188, 230, and 310).

2. Within the US the lithium batteries and cells are subject to shipping requirements under 49 CFRCh. 1, paragraph 173.185, "lithium batteries".

3. Shipping of lithium batteries in aircrafts are regulated by the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) 2003 requirements in Special Provisions A45, A88 and A99.

4. Shipping of lithium batteries on sea are regulated the International Maritime Dangerous Goods (IMDG) 2002 requirements in special provisions 188, 230 and 310.

5. Shipping of lithium batteries on Road and Rail, 2002 requirements in special provisions 188, 230 and 310.

6. The internal component (thionyl chloride) is hazardous under the criteria of the Federal OHSA Hazard Communication Standard 29 CFR 1920.1200.

SECTION 16- OTHER INFORMATION/DISCLAIMER

The information and the recommendations set forth are made in good faith and believed to be accurate at the date of preparation. The present file refers to normal use of the product in question. Tadiran Batteries makes no warranty expressed or implied.

MATERIAL SAFETY DATA SHEET

Product Name: Sealed Maintenance Free Lead-Acid Batteries	

DATE:	10/1/2003	ISSUED BY	ENGINEERING	TELEPHONE NO.	(619) 661-2030

HAZARDOUS COMPONENTS

COMPONENTS	WEIGHT %	TLV	LD50	LC50	LC50
			ORAL	INHALATION	CONTACT
Lead (Pb, $Pb0_2$, $PBSO_4$)	about 70%	N/A	(500) mg/kg	N/A	N/A
Sulfuric Acid	about 20%	1mg/m^3	(2,140) mg/kg	N/A	N/A
Fiberglass Separator	about 5%	N/A	N/A	N/A	N/A
ABS Plastic	about 5%	N/A	N/A	N/A	N/A

PHYSICAL DATA

COMPONENTS	DENSITY	MELTING POINTS	SOLLUBILITY (H_2O)	ODOR	APPEARANCE
Lead	11.34	327.4º C (Boiling)	None	None	Silver-Gray Metal
Lead Sulfate	6.2	1070º C (Boiling)	40 mg/l(15º C)	None	White Powder
Lead Dioxide	9.4	290º C (Boiling)	None	None	Brown Powder
Sulfuric Acid	about 1.3	about 114º C (Boiling)	100%	Acidic	Clear Colorless Liquid
Fiberglass Separator	N/A	N/A	Slight	Toxic	White Fibrous Glass
ABS Plastic	N/A	N/A	None	No Odor	Solid

FLAMMABILITY DATA

COMPONENTS	FLASHPOINT	EXPLOSIVE LIMIT	COMMENTS
Lead	None	None	
Sulfuric Acid	None	None	
Hydrogen		4% - 72.4%	Sealed batteries can emit hydrogen if over charged (float voltage > 2.40 VPC).
Fiberglass Separator	N/A	N/A	Toxic vapors may be released. In case of fire, wear self-contained breathing apparatus.
ABS Plastic	None	N/A	Temp. over 300º C (572º F) may release combustible gases. In case of fire: wear positive pressure self-contained breathing apparatus.

FIRST AID

SULFURIC ACID PRECAUTIONS	
Skin Contact:	Flush with water, see physician if contact area is large or if blisters form.
Eye Contact:	Call physician immediately and flush with water until physician arrives.
Ingestion:	Call physician. If patient is conscious, flush mouth with water, have patient drink milk or sodium bicarbonate solution.

Continued on Page 2

MATERIAL SAFETY DATA SHEET

REACTIVITY DATA

COMPONENT	Sulfuric Acid
STABILITY	Stable at all temperatures
COLYMERIZATION	Will not polymerize
INCOMPATIBILITY	Reactive metals, strong bases, most organic compounds
DECOMPOSITION PRODUCTS	Sulfuric dioxide, trioxide, hydrogen sulfide, hydrogen
CONDITIONS TO AVOID	Prohibit smoking, sparks, etc. from battery charging area. Avoid mixing acid with other chemicals

SPILL OR LEAK PROCEDURES

Steps to take in case of leak or spill:	If sulfuric acid is spilled from a battery, neutrilize acid with bicarbonate (baking soda), sodium carbon (soda ash), or calcium oxide (lime). Flush area with water and discard to the sewage system. Do not allow unneutralized acid into sewage system.
Waste disposal method:	Neutrilized acid may be flushed down the sewer. Spent batteries must be treated as hazardous waste and disposed of according to local, state, and federal guidelines. A copy of this MSDS must be supplied to any scrap dealer or secondary lead smelter with battery.

PROTECTION

EXPOSURE SITE	PROTECTION	COMMENTS
SKIN	Rubber gloves, Apron	Protective equipment must be worn if the battery is cracked or otherwise damaged. A respirator should be worn during reclaim operations if the TLV is exceeded.
RESPIRATORY	Respirator (for lead)	
EYES	Safety goggles, Face Shield	

ELECTRICAL SAFETY

Due to the battery's low internal resistance and high power density, high levels of short circuit current can be developed across the battery terminals. Do not rest tools or cables on the battery. Use insulated tools only. Follow all installation instructions and diagrams when installing or maintaining battery systems.

HEALTH HAZARD DATA

LEAD: The toxic effects of lead are accumulative and slow to appear. It affects the kidneys, reproductive, and central nervous systems. The symptoms of lead overexposure are anemia, vomiting, headache, stomach pain (lead colic), dizziness, loss of appetite, and muscle and joint pain. Exposure to lead from a battery most oftern occurs during lead reclaim operations through the breathing or ingestion of lead dust or fumes.

SULFURIC ACID: Sulfuric acid is a strong corrosive. Contact with acid can casue severe burns on the skin and in eyes. Ingestion of sulfuric acid will cause GI tract burns. Acid can be released if the battery case is damaged or if vents are tampered with.

FIBERGLASS SEPARATOR: Fibrour glass is an irritant of the upper repiratory tract, skin and eyes. For exposure up to 10F/CC use MSA Comfoll with type H filter. Above 10F/CC up to 50F/CC use Ultra-Twin with type H filter. This product is not considered carcinogenic by NTP or OSHA.

ALL DATA MUST BE PASSED TO ANY SCRAP DEALER OR SMELTER WHEN BATTERY IS RESOLD.

Power-Sonic Corporation
9163 Siempre Viva Road, San Diego, CA 92154 Tel (619) 661-2020 Fax (619) 661-3650
Website: www.power-sonic.com E-Mail: battery@power-sonic.com

DOW CORNING

DOW CORNING CORPORATION
Material Safety Data Sheet

DOW CORNING 200(R) FLUID, 100 CST.

1. IDENTIFICATION OF THE SUBSTANCE AND OF THE COMPANY

Dow Corning Corporation
South Saginaw Road
Midland, Michigan 48686

24 Hour Emergency Telephone: (989) 496-5900
Customer Service: (989) 496-6000
Product Disposal Information: (989) 496-6315
CHEMTREC: (800) 424-9300

MSDS No.: 01013190 Revision Date: 2002/12/09

Generic Description: Silicone
Physical Form: Liquid
Color: Colorless
Odor: Characteristic odor

NFPA Profile: Health 0 Flammability 1 Instability/Reactivity 0

Note: NFPA = National Fire Protection Association

2. OSHA HAZARDOUS COMPONENTS

None present. This is not a hazardous material as defined in the OSHA Hazard Communication Standard.

3. EFFECTS OF OVEREXPOSURE

Acute Effects

Eye: Direct contact may cause temporary redness and discomfort.

Skin: No significant irritation expected from a single short-term exposure.

Inhalation: No significant effects expected from a single short-term exposure.

Oral: Low ingestion hazard in normal use.

Prolonged/Repeated Exposure Effects

Skin: No known applicable information.

Inhalation**:** No known applicable information.

Oral: No known applicable information.

Signs and Symptoms of Overexposure

No known applicable information.

Medical Conditions Aggravated by Exposure

No known applicable information.

The above listed potential effects of overexposure are based on actual data, results of studies performed upon similar compositions, component data and/or expert review of the product. Please refer to Section 11 for the detailed toxicology information.

4. FIRST AID MEASURES

Eye:	Immediately flush with water.
Skin:	No first aid should be needed.
Inhalation:	No first aid should be needed.
Oral:	No first aid should be needed.
Comments:	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point:	> 214 °F / > 101.1 °C (Closed Cup)
Autoignition Temperature:	Not determined.
Flammability Limits in Air:	Not determined.
Extinguishing Media:	On large fires use dry chemical, foam or water spray. On small fires use carbon dioxide (CO2), dry chemical or water spray. Water can be used to cool fire exposed containers.
Fire Fighting Measures:	Self-contained breathing apparatus and protective clothing should be worn in fighting large fires involving chemicals. Use water spray to keep fire exposed containers cool. Determine the need to evacuate or isolate the area according to your local emergency plan.
Unusual Fire Hazards:	None.

Hazardous Decomposition Products

Thermal breakdown of this product during fire or very high heat conditions may evolve the following hazardous decomposition products: Carbon oxides and traces of incompletely burned carbon compounds. Silicon dioxide. Formaldehyde.

6. ACCIDENTAL RELEASE MEASURES

Containment/Clean up: Determine whether to evacuate or isolate the area according to your local emergency plan. Observe all personal protection equipment recommendations described in Sections 5 and 8. For large spills, provide diking or other appropriate containment to keep material from spreading. If diked material can be pumped, store recovered material in appropriate container. Clean up remaining materials from spill with suitable absorbant. Clean area as appropriate since some silicone materials, even in small quantities, may present a slip hazard. Final cleaning may require use of steam, solvents or detergents. Dispose of saturated absorbant or cleaning materials appropriately, since spontaneous heating may occur. Local, state and federal laws and regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which federal, state and local laws and regulations are applicable. Sections 13 and 15 of this MSDS provide information regarding certain federal and state requirements.

Note: See section 8 for Personal Protective Equipment for Spills. Call Dow Corning Corporation, (989) 496-5900, if additional information is required.

7. HANDLING AND STORAGE

Use with adequate ventilation. Avoid eye contact.

Use reasonable care and store away from oxidizing materials.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Component Exposure Limits

There are no components with workplace exposure limits.

Engineering Controls

Local Ventilation: None should be needed.
General Ventilation: Recommended.

Personal Protective Equipment for Routine Handling

Eyes: Use proper protection - safety glasses as a minimum.

Skin: Washing at mealtime and end of shift is adequate.

Suitable Gloves: No special protection needed.

Inhalation: No respiratory protection should be needed.

Suitable Respirator: None should be needed.

Personal Protective Equipment for Spills

Eyes: Use proper protection - safety glasses as a minimum.

Skin: Washing at mealtime and end of shift is adequate.

Inhalation/Suitable Respirator:	No respiratory protection should be needed.
Precautionary Measures:	Avoid eye contact. Use reasonable care.
Comments:	When heated to temperatures above 150 degrees C in the presence of air, product can form formaldehyde vapors. Formaldehyde is a potential cancer hazard, a known skin and respiratory sensitizer, and an irritant to the eyes, nose, throat, skin, and digestive system. Safe handling conditions may be maintained by keeping vapor concentrations within the OSHA Permissible Exposure Limit for formaldehyde.

Note: These precautions are for room temperature handling. Use at elevated temperature or aerosol/spray applications may require added precautions. For further information regarding aerosol inhalation toxicity, please refer to the guidance document regarding the use of silicone-based materials in aerosol applications that has been developed by the silicone industry (www.SEHSC.com) or contact the Dow Corning customer service group.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical Form:	Liquid
Color:	Colorless
Odor:	Characteristic odor
Specific Gravity @ 25°C:	0.965
Viscosity:	100 cSt
Freezing/Melting Point:	Not determined.
Boiling Point:	> 65 °C
Vapor Pressure @ 25°C:	Not determined.
Vapor Density:	Not determined.
Solubility in Water:	Not determined.
pH:	Not determined.
Volatile Content:	Not determined.

Note: The above information is not intended for use in preparing product specifications. Contact Dow Corning before writing specifications.

10. STABILITY AND REACTIVITY

Chemical Stability:	Stable.
Hazardous Polymerization:	Hazardous polymerization will not occur.
Conditions to Avoid:	None.
Materials to Avoid:	Oxidizing material can cause a reaction.

11. TOXICOLOGICAL INFORMATION

Special Hazard Information on Components

No known applicable information.

12. ECOLOGICAL INFORMATION

Environmental Fate and Distribution

Air: This product is a high molecular weight liquid polymer which has a very low vapour pressure (<1 mm Hg). As a result it is unlikely to become an atmospheric contaminant unless generated as an aerosol.

Water: This product has a very low water solubility (< 100 ppb). As it has a specific gravity of < 1, if discharged to water, it will initially form a surface film. As the product is non volatile and has a high binding affinity for particulate matter, it will adsorb to particulates and sediment out.

Soil: If discharged to surface water, this product will bind to sediment. If discharged in effluent to a waste water treatment plant, the product is removed from the aqueous phase by binding to sewage sludge. If the sewage sludge is subsequently spread on soil, the silicone product is expected to degrade.

Degradation: This product, polydimethylsiloxane, degrades in soil abiotically to form smaller molecules. These in turn are either biodegraded in soil or volatilized into the air where they are broken down in the presence of sunlight. Under appropriate conditions, the ultimate degradation products are inorganic silica, carbon dioxide and water vapour. Due to the very low water solubility of this product, standard OECD protocols for ready and inherent biodegradability are not suitable for measuring the biodegradability of this product. The product is removed >80% during the sewage treatment process.

Environmental Effects

Toxicity to Water Organisms: Based on analogy to similar materials this product is expected to exhibit low toxicity to aquatic organisms.

Toxicity to Soil Organisms: Experiments show that when sewage sludge containing polydimethylsiloxane is added to soil, it has no effect on soil micro-organisms, earthworms or subsequent crops grown in the soil.

Bioaccumulation: This product is a liquid and is a high molecular weight polymer. Due to its physical size it is unable to pass through, or be absorbed by biological membranes. This has been confirmed by testing or analogy with similar products.

Fate and Effects in Waste Water Treatment Plants

This product or similar products has been shown to be non-toxic to sewage sludge bacteria.

Ecotoxicity Classification Criteria

Hazard Parameters (LC50 or EC50)	High	Medium	Low
Acute Aquatic Toxicity (mg/L)	<=1	>1 and <=100	>100
Acute Terrestrial Toxicity	<=100	>100 and <= 2000	>2000

This table is adapted from "Environmental Toxicology and Risk Assessment", ASTM STP 1179, p.34, 1993.

This table can be used to classify the ecotoxicity of this product when ecotoxicity data is listed above. Please read the other information presented in the section concerning the overall ecological safety of this material.

13. DISPOSAL CONSIDERATIONS

RCRA Hazard Class (40 CFR 261)

When a decision is made to discard this material, as received, is it classified as a hazardous waste? No

State or local laws may impose additional regulatory requirements regarding disposal.

Call Dow Corning Corporate Environmental Management, (989) 496-6315, if additional information is required.

14. TRANSPORT INFORMATION

DOT Road Shipment Information (49 CFR 172.101)

Not subject to DOT.

Ocean Shipment (IMDG)

Not subject to IMDG code.

Air Shipment (IATA)

Not subject to IATA regulations.

Call Dow Corning Transportation, (989) 496-8577, if additional information is required.

15. REGULATORY INFORMATION

Contents of this MSDS comply with the OSHA Hazard Communication Standard 29 CFR 1910.1200.

TSCA Status: All chemical substances in this material are included on or exempted from listing on the TSCA Inventory of Chemical Substances.

EPA SARA Title III Chemical Listings

Section 302 Extremely Hazardous Substances:

None.

Section 304 CERCLA Hazardous Substances:

None.

Section 312 Hazard Class:

Acute: No
Chronic: No
Fire: No
Pressure: No
Reactive: No

Section 313 Toxic Chemicals:

None present or none present in regulated quantities.

Supplemental State Compliance Information

California

Warning: This product contains the following chemical(s) listed by the State of California under the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) as being known to cause cancer, birth defects or other reproductive harm.

None known.

Massachusetts

No ingredient regulated by MA Right-to-Know Law present.

New Jersey

CAS Number	Wt %	Component Name
63148-62-9	> 60.0	Polydimethylsiloxane

Pennsylvania

CAS Number	Wt %	Component Name
63148-62-9	> 60.0	Polydimethylsiloxane

16. OTHER INFORMATION

Prepared by: Dow Corning Corporation

These data are offered in good faith as typical values and not as product specifications. No warranty, either expressed or implied, is hereby made. The recommended industrial hygiene and safe handling procedures are believed to be generally applicable. However, each user should review these recommendations in the specific context of the intended use and determine whether they are appropriate.

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Supplement Guide - S1400CW

Issue: 04/05

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

Bristol Babcock

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

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SITE CONSIDERATIONS FOR EQUIPMENT INSTALLATION, GROUNDING & WIRING

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Section 5 - WIRING TECHNIQUES (Continued)

REFERENCE DOCUMENTS

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

Section 1 - Overview

1.1 INTRODUCTION

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

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

1.2 MAJOR TOPICS

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

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

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

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

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

Section 2 - Protection

2.1 PROTECTING INSTRUMENT SYSTEMS

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

2.1.1 Quality Is Conformance To Requirements

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

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

2.2 PROTECTING EQUIPMENT & PERSONNEL

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

2.2.1 Considerations For The Protection of Personnel

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

Table 2-1 - Installation Site Safety Evaluation Guide

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

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

2.2.2 Considerations For The Protection of Equipment

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

Table 2-2 - Equipment Protection Site Safety Evaluation Guide

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

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

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

2.3 OTHER SITE SAFETY CONSIDERATIONS

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

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

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

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

Section 3 - Grounding & Isolation

3.1 POWER & GROUND SYSTEMS

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

3.2 IMPORTANCE OF GOOD GROUNDS

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

WARNING

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

3.3 EARTH GROUND CONNECTIONS

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

3.3.1 Establishing a Good Earth Ground

A common misconception of a ground is that it consists of nothing more than a metal pipe driven into the soil. While such a ground may function for some applications, it will often

not be suitable for a complex system of sophisticated electronic equipment. Conditions such as soil type, composition and moisture will all have a bearing on ground reliability.

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

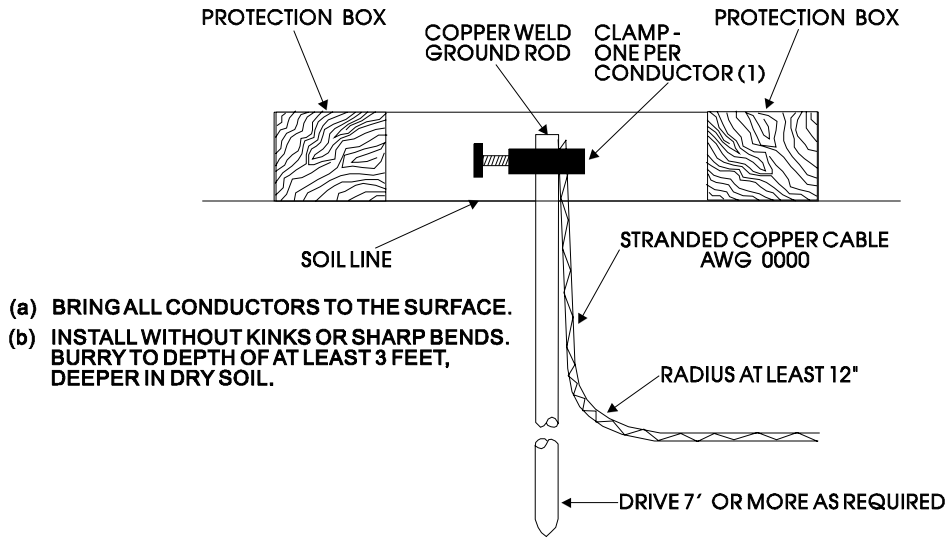

Figure 3-1 - Basic Ground Rod Installation

3.3.1.1 Soil Conditions

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

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

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

3.3.1.2 Soil Types:

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

Ground Beds must always be tested for conductivity prior to being placed into service. A brief description of ground bed testing in 'Good Soil' and 'Poor Soil' is provided herein. Details on this test are described in the National Electrical Code Handbook. Once a reliable

ground has been established, it should be tested on a regular basis to preserve system integrity.

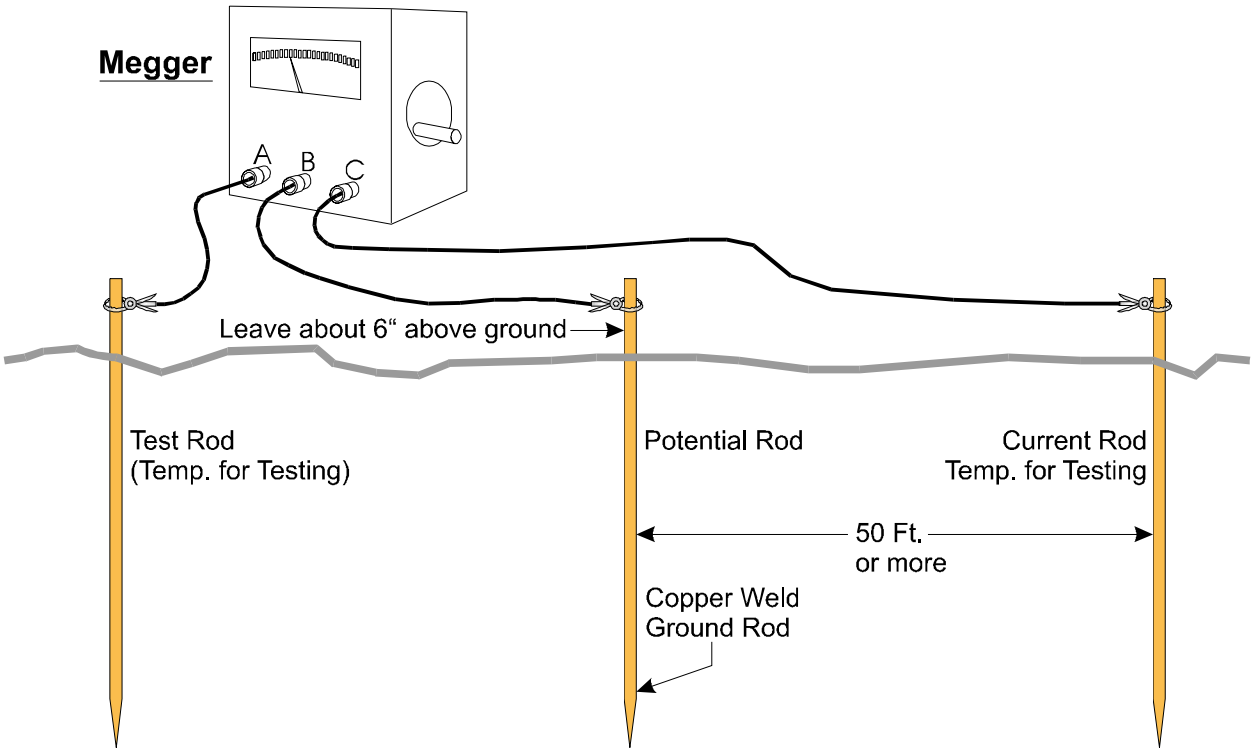

Figure 3-2 - Basic Ground Bed Soil Test Setup

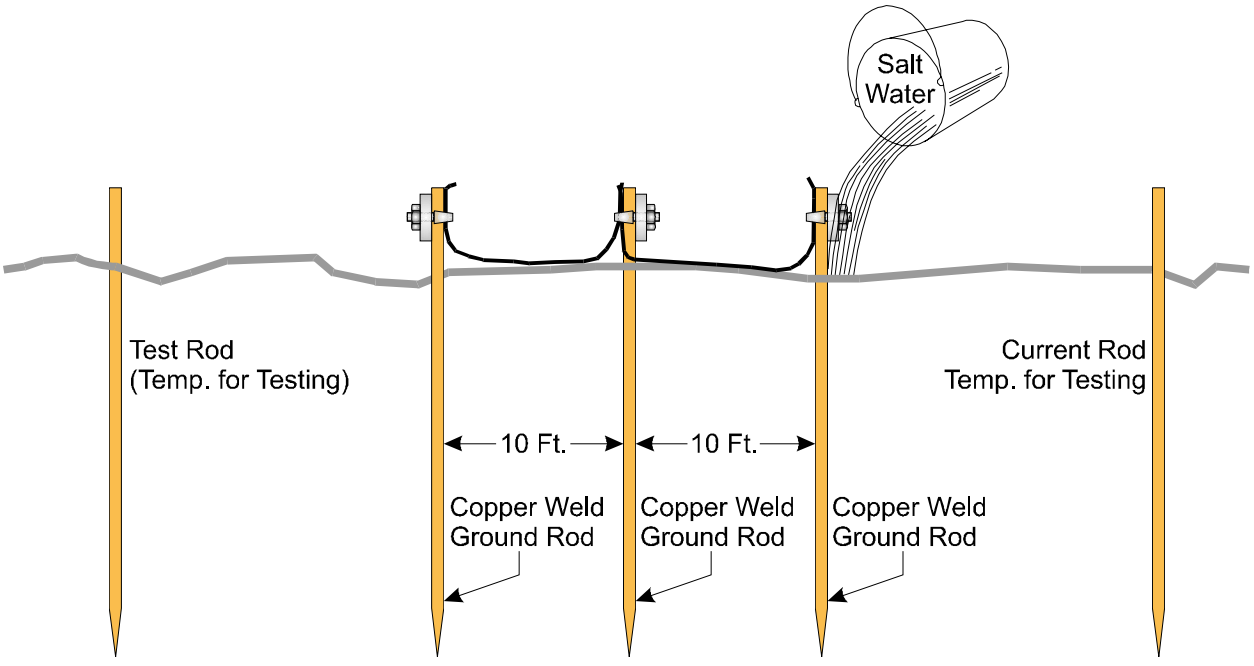

Figure 3-3 - Basic Ground Bed Soil Test Setup with Additional Ground Rods

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

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

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

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

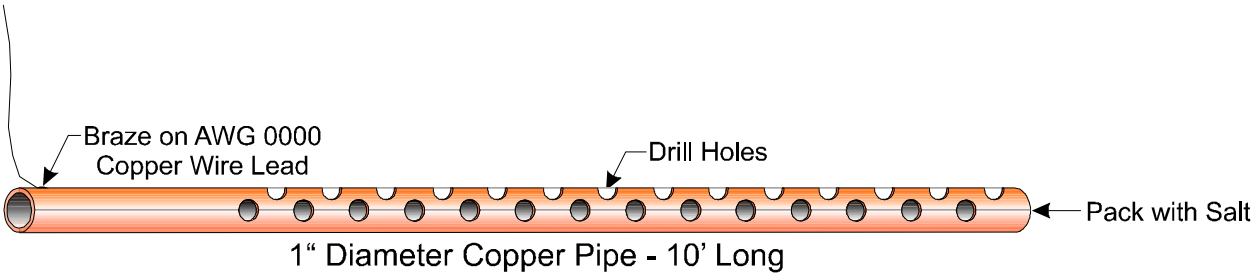

Figure 3-4 - Ground Electrode Construction for Poor Soil Conditions

3.3.1.3 Dry, Sandy or Rocky Soil

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

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

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

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

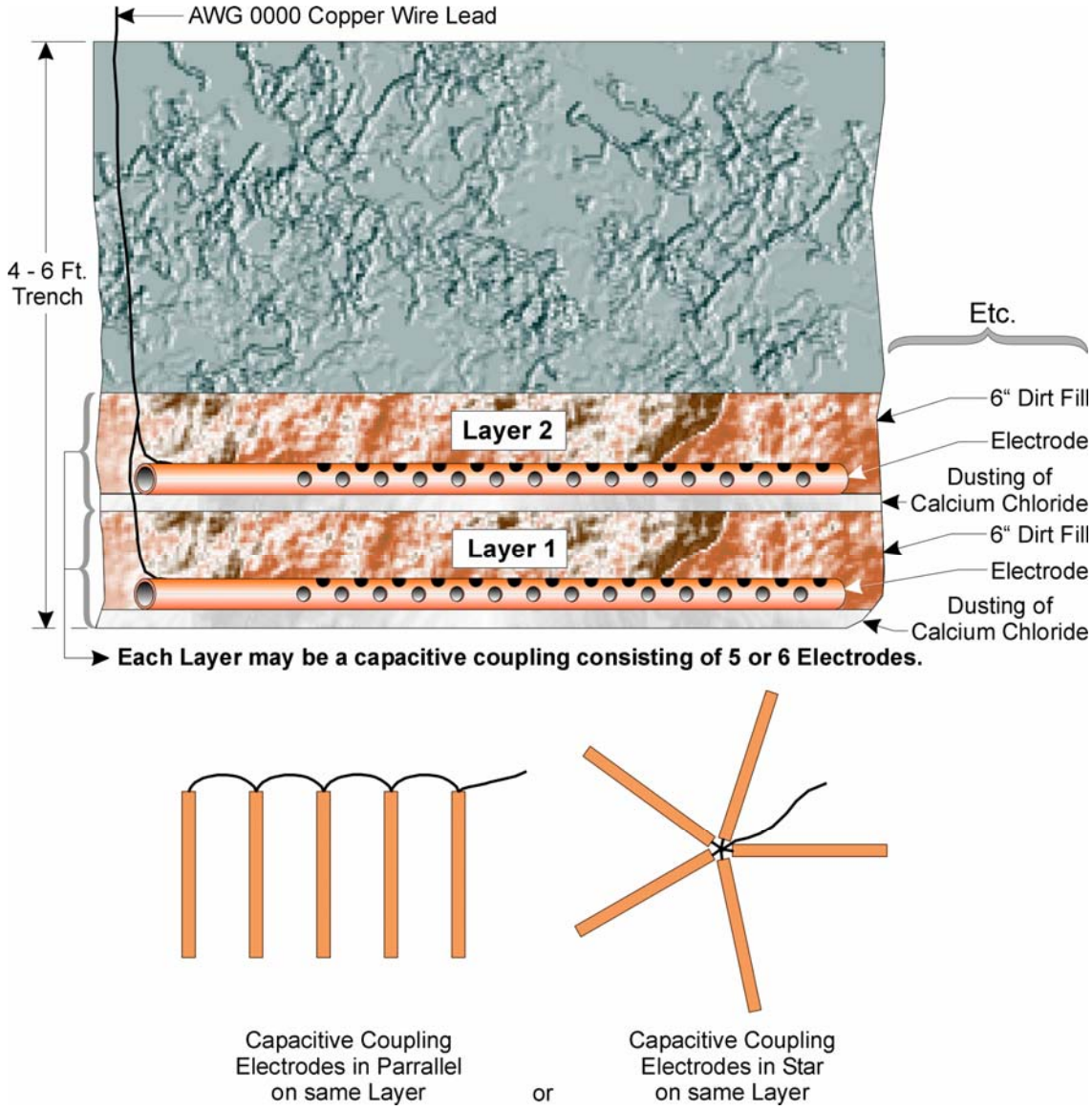

Figure 3-5 - Poor Soil Ground Bed Construction Diagram

3.3.2 Ground Wire Considerations

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

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

ControlWave**LP** Process Automation Controller

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

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

General Considerations

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

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

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

3.3.3 Other Grounding Considerations

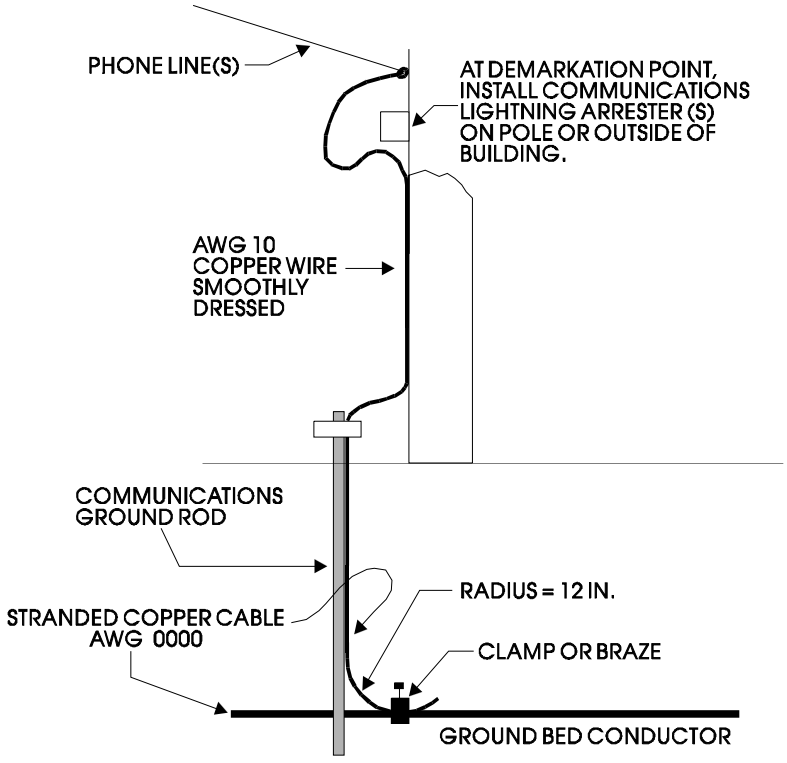

Figure 3-6 - Grounding of Phone Line

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

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

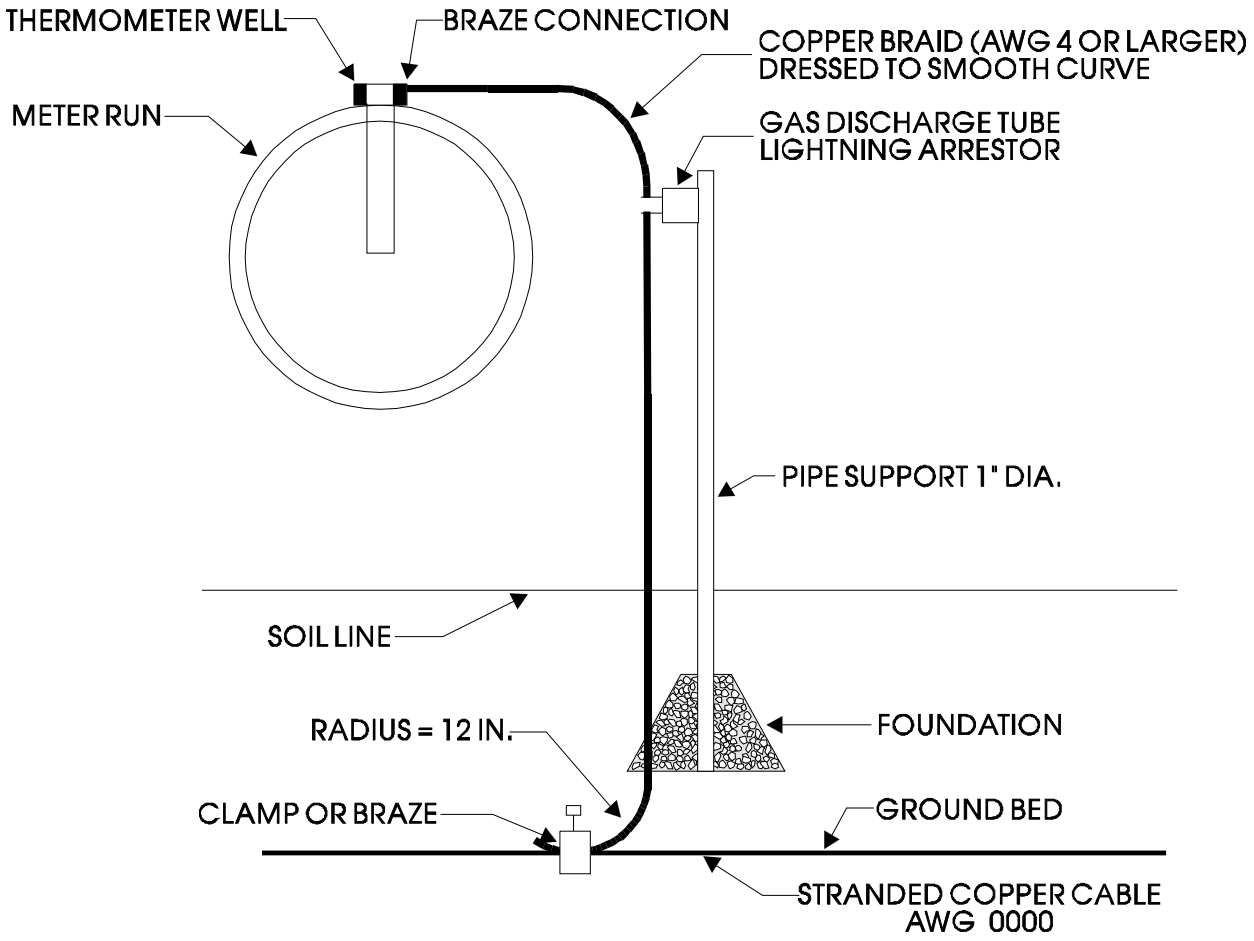

Figure 3-7 - Grounding of Thermometer Well in Gas Line

3.4 ISOLATING EQUIPMENT FROM THE PIPELINE

3.4.1 Meter Runs Without Cathodic Protection

ControlWave **EFM/GFC/XFC**'s may be mounted directly on the pipeline or remotely on a vertical stand-alone two-inch pipe (see Figure 3-8). The Earth Ground Cable is to run between the **Control**Wave **EFM/GFC/XFC**'s Ground Lug and Earth Ground (Rod or Bed) even though the **Control**Wave **EFM/GFC/XFC**'s Multivariable Transducer may be

grounded to the pipeline. If any pressure transmitters or pulse transducers are remotely mounted, connect their chassis grounds to the pipeline or earth ground.

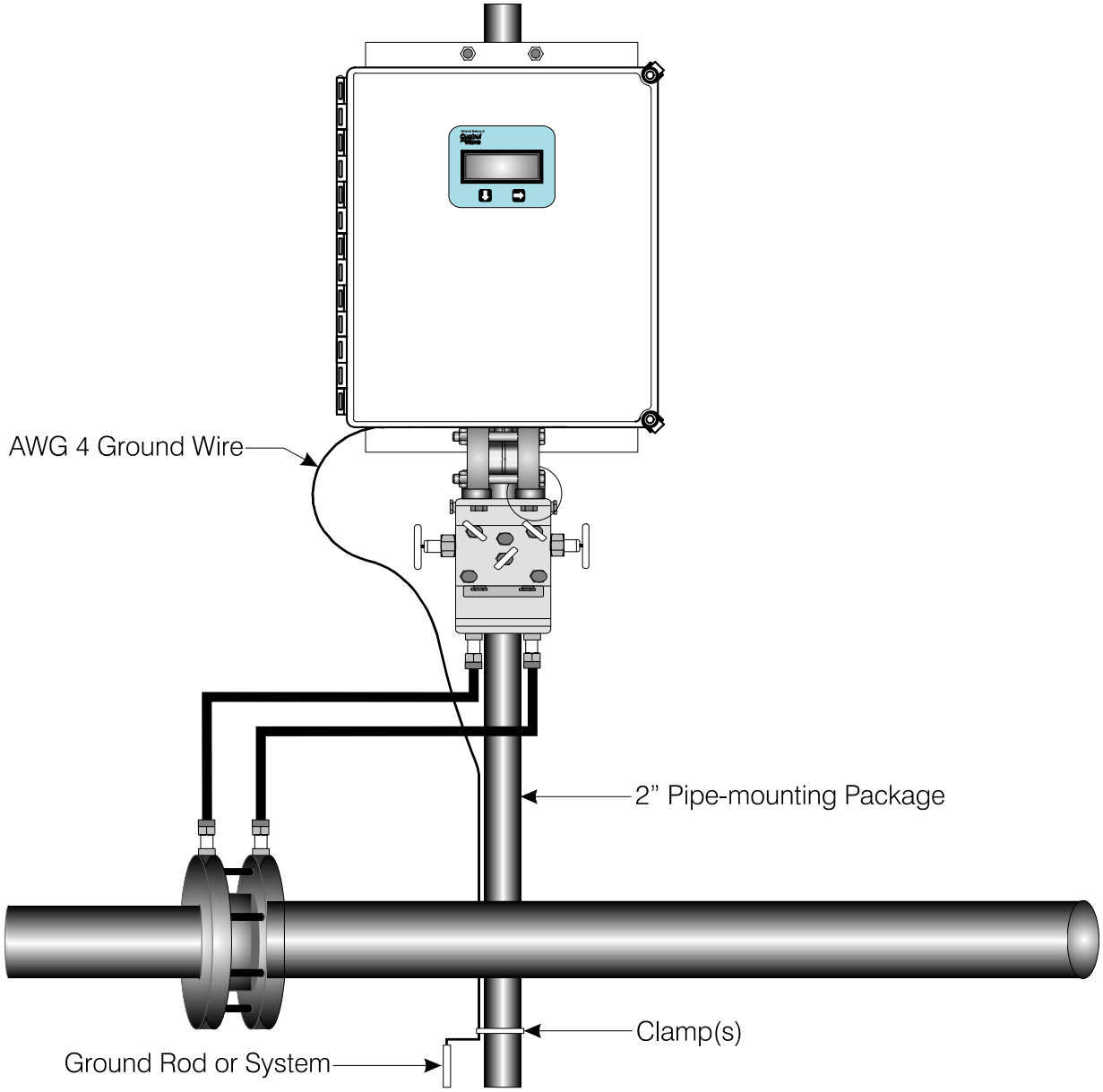

Figure 3-8 - Control Wave **EFM (Installation is similar to GFC/XFC)**
Remote Installation without Cathodic Protection

3.4.2 Meter Runs With Cathodic Protection

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

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

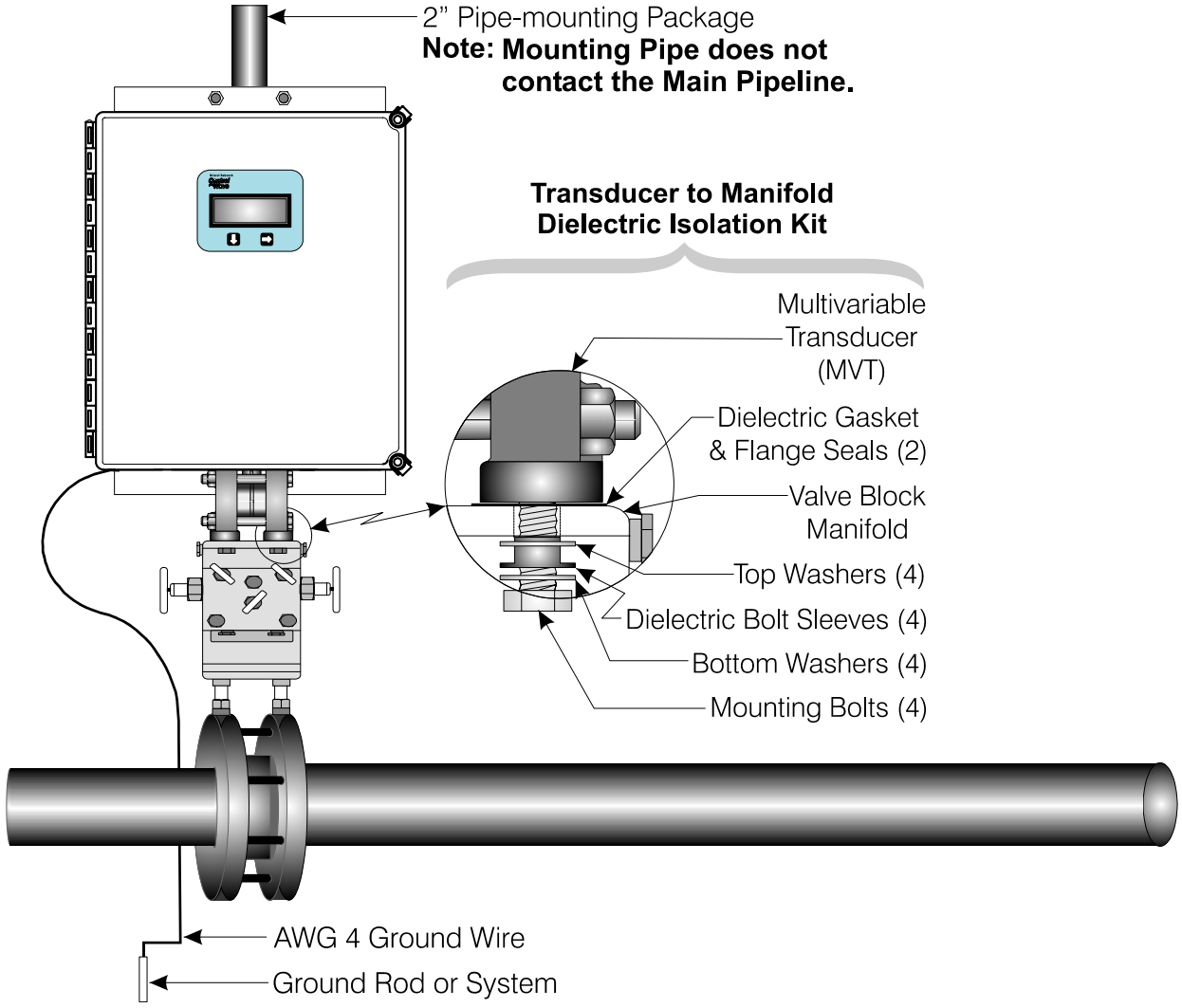

Figure 3-9 - Control Wave **EFM (Installation is similar to EFM/GFC/XFC) Direct Mount Installation (with Cathodic Protection)**

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

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

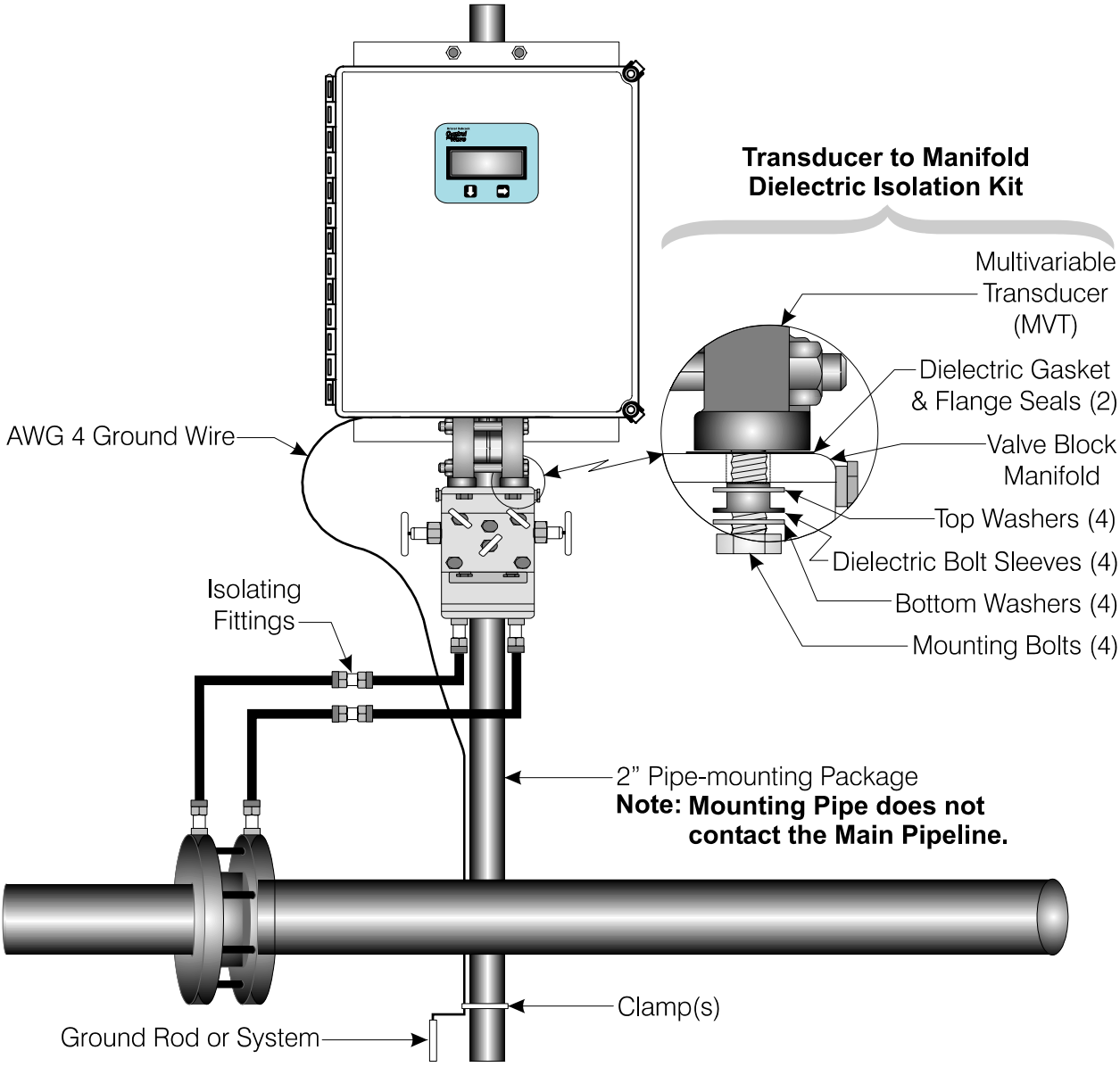

Figure 3-10 – ControlWave EFM (Installation is similar to GFC/XFC)
Remote Installation (with Cathodic Protection)

Section 4 - Lightning Arresters & Surge Protectors

4.1 STROKES & STRIKES

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

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

4.1.1 Chance of Being Struck by Lightning

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

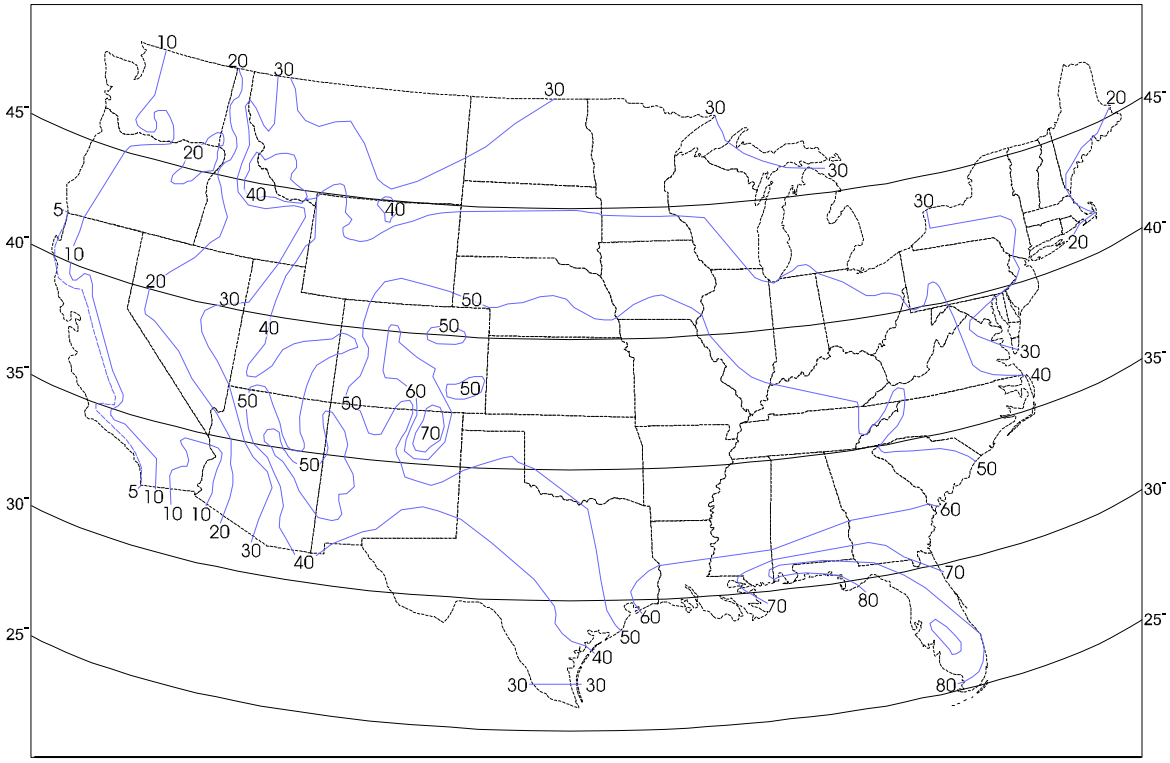

Figure 4-1 - Average Thunderstorm Days of the Year (for Continental USA)

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

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

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

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

Chart 1

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

Chart 2

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

Note for these charts:

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

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

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

Since **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control-**Wave**LP** and **Control**Wave**EXP** units are dc operated systems that are isolated from AC grids, they are typically immune to lightning strikes to power lines or power equipment (except for inductive flashover due to close installation proximity). However, once a radio or

modem has been interfaced to a **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control**Wave**LP**, or **Control**Wave**EXP** the possibility of damage due to a lightning strike on power or telephone lines or to a radio antenna or the antenna's tower must be considered. It is recommended that the additional lightning protection considerations listed below be followed for units installed in areas with a high possibility or history of stroke activity.

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

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

4.1.2 Antenna Caution

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

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

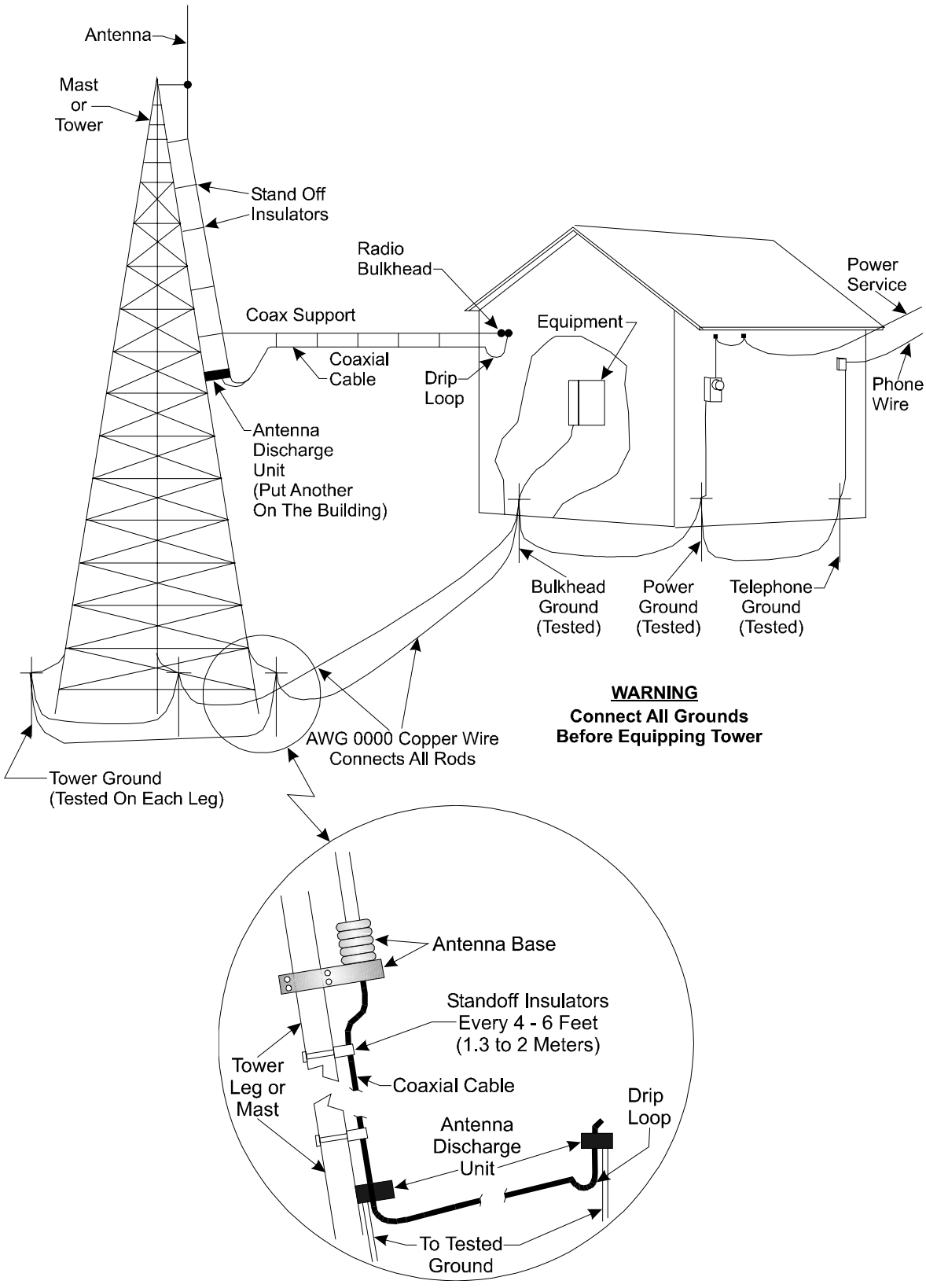

Figure 4-2 - Radio Antenna Field Installation Site Grounding Diagram

For all systems it is best to have all communication equipment input/output grounds tied together. In the case of **Control**Wave units, this is accomplished via the unit's Chassis Ground (Typically at a ground lug, ground bus or ground plate). However additional

communication equipment lightning arresters and surge suppressors should be tied to the same system ground. System ground consists of the tower leg grounds utility ground and bulkhead-equipment ground-stakes that are tied together via bare copper wire.

4.1.3 Ground Propagation

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

4.1.4 Tying it all Together

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

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

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

4.1.5 Impulse Protection Summary

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

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

4.2 USE OF LIGHTNING ARRESTERS & SURGE PROTECTORS

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

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

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

Lightning Arresters are applied to circuits as follows:

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

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

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

Section 5 - Wiring Techniques

5.1 OVERVIEW

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

5.2 INSTRUMENT WIRING

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

Rule 1 - Never utilize common returns.

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

Rule 3 - Ground cable shields at one end only.

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

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

Rule 6 - Perform all work neatly and professionally.

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

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

Rule 9 - Use lightning arresters and surge protectors.

Rule 10 - Make sure all wiring connections are secure.

5.2.1 Common Returns

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

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

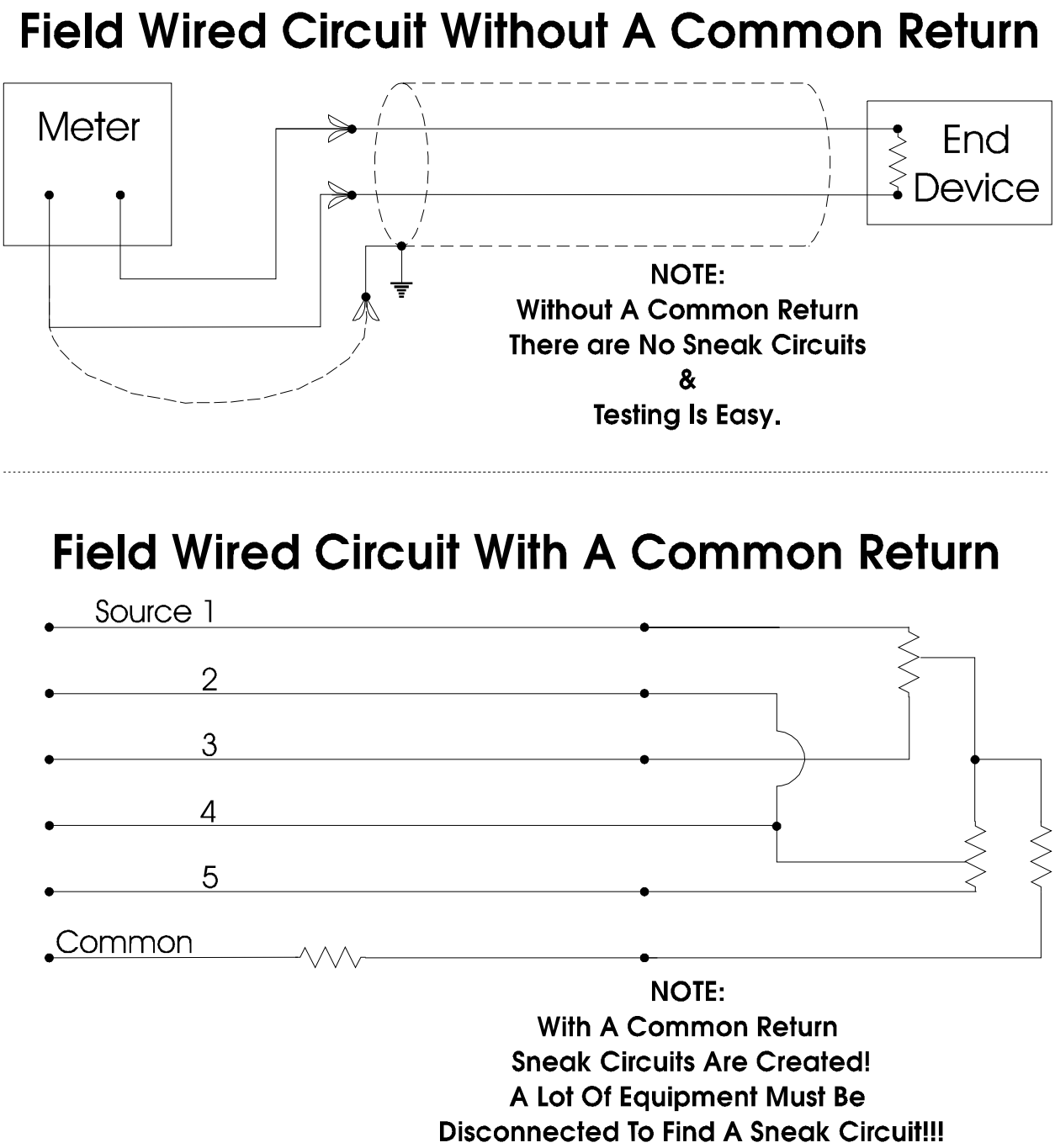

Figure 5-1 - Field Wired Circuits With & Without A Common Return

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

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

5.2.3 Grounding of Cable Shields

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

5.2.4 Use of Known Good Earth Grounds

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

5.2.5 Earth Ground Wires

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

5.2.6 Working Neatly & Professionally

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

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

5.2.7 High Power Conductors and Signal Wiring

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

5.2.8 Use of Proper Wire Size

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

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

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

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

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

22 = 24 - 2 where 2V = (20 Ω) x 0.1 A

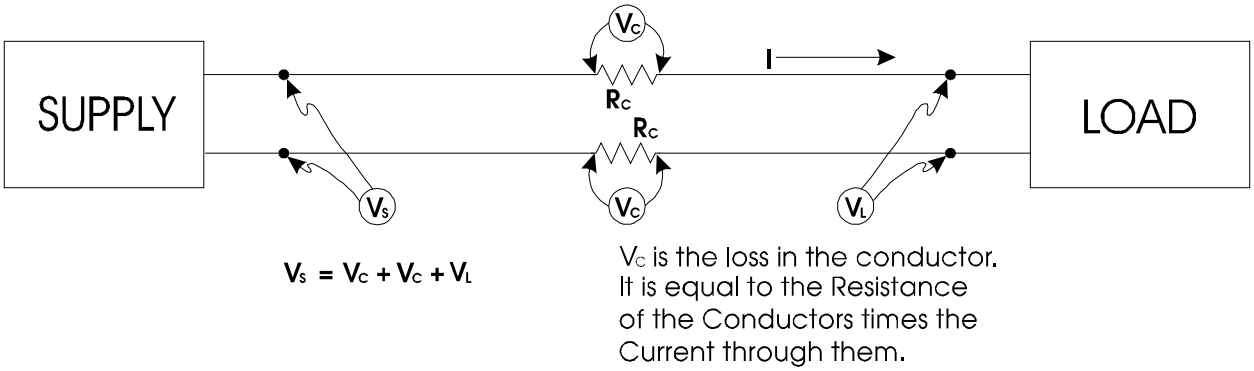

Figure 5-2 - Calculating Load Voltage due to Line Resistance

5.2.9 Lightning Arresters & Surge Protectors

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

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

5.2.10 Secure Wiring Connections

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

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

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ISSUE DATE: APR., 2005
COMMENT/COMPLAINT:

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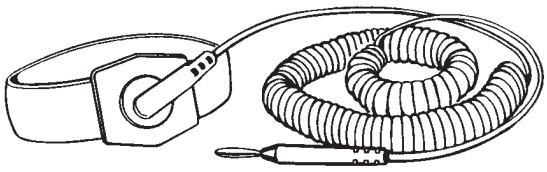
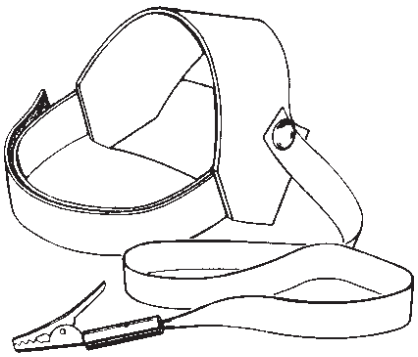
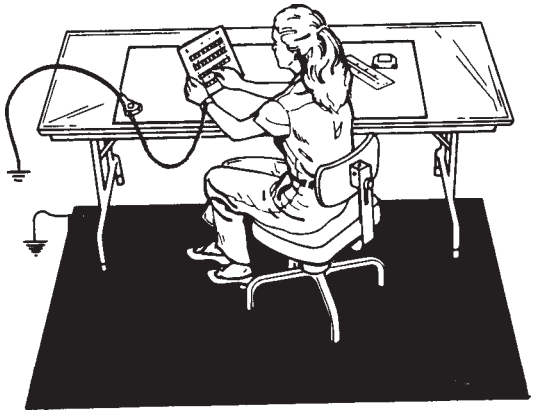
ESDS Manual
S14006
4/15/92

CARE AND HANDLING OF PC BOARDS AND ESD-SENSITIVE COMPONENTS







BRISTOL BABCOCK

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TOOLS AND MATERIALS REQUIRED

1. Tools

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

1. A work surface (10mm conductive plastic sheet with a female snap fastener in one corner for ground cord attachment).

2. A 15-foot long ground cord for grounding the work surface.

3. Wrist strap (available in two sizes, large and small, for proper fit and comfort) with a female snap fastener for ground cord attachment.

4. A coiled ground cord with a practical extension length of 10 feet for attachment to the wrist strap.

Toothbrush (any standard one will do)

2. Materials

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

ESD-SENSITIVE COMPONENT HANDLING PROCEDURE

1. Introduction

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

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

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

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

Table 1

Typical Electrostatic Voltages

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

2. General Rules

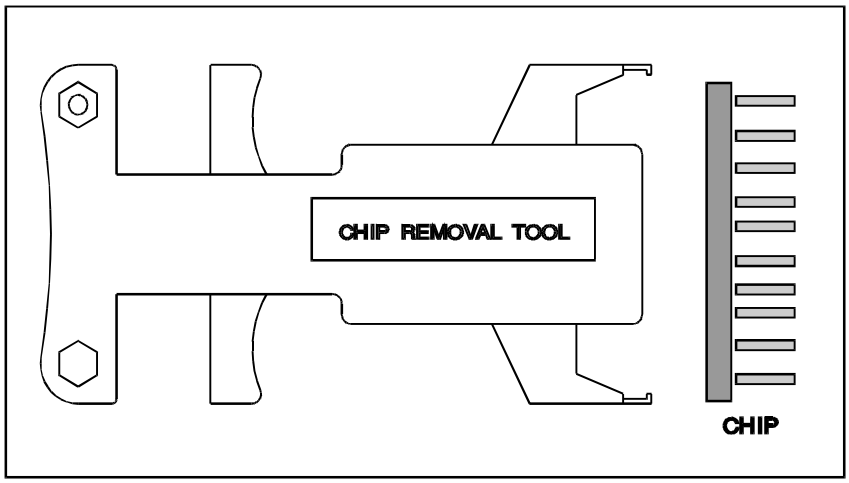
(1) ESD-sensitive components shall **only** be removed from their static-shielding bags by a person who is properly grounded.

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

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

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

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



Typical Chip Removal Tool

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

(7) Power the system down before removing or inserting comb connectors/plugs or removing and reinstalling PC boards or ESD-sensitive components from card files or mounting hardware. Follow the power-down procedure applicable to the system being serviced.

(8) Handle all defective boards or components with the same care as new components. This helps eliminate damage caused by mishandling. Do not strip used PC boards for parts. Ship defective boards promptly to Bristol Babcock in a static-shielding bag placed *inside* static-shielding foam and a box to avoid damage during shipment.

CAUTION

Don't place ESD-sensitive components and paperwork in the same bag.

The static caused by sliding the paper into the bag could develop a charge and damage the component(s).

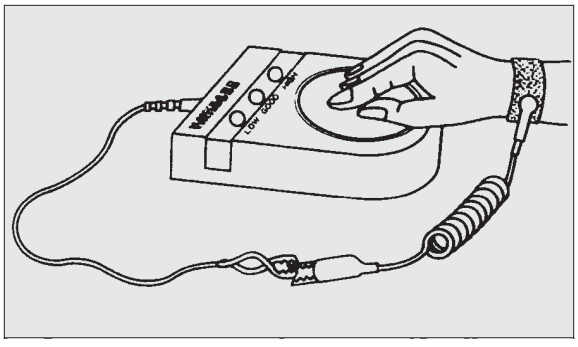
(9) Include a note, which describes the malfunction, in a *separate* bag along with each component being shipped. The repair facility will service the component and promptly return it to the field.

3. Protecting ESD-Sensitive Components

(1) As stated previously, it is recommended that an electrically-conductive anti-static field kit be kept on any site where ESD-sensitive components are handled. A recommended ESD-protective workplace arrangement is shown on page 7. The anti-static safety kit serves to protect the equipment as well as the worker. As a safety feature, a resistor (usually of the one-megohm, 1/2-watt, current-limiting type) has been installed in the molded caps of the wrist strap cord and the ground cord. This resistor limits current should a worker accidently come in contact with a power source. Do not remove the molded caps from grounded cords. If a cord is damaged, replace it immediately.

(2) Be sure to position the work surface so that it does **not** touch grounded conductive objects. The protective resistor is there to limit the current which can flow through the strap. When the work surface touches a grounded conductive object, a short is created which draws the current flow and defeats the purpose of the current-limiting resistor.

(3) Check resistivity of wrist strap periodically using a commercially-available system tester similar to the one shown in the figure below:



Note: If a system checker is not available, use an ohmmeter connected to the cable ends to measure its resistance. The ohmmeter reading should be **1 megohm +/- 15%**. Be sure that the calibration date of the ohmmeter has not expired. If the ohmmeter reading exceeds **1 megohm by +/- 15%**, replace the ground cord with a new one.

4. Static-safe Field Procedure

(1) On reaching the work location, unfold and lay out the work surface on a convenient surface (table or floor). Omit this step if the table or floor has a built-in ESD-safe work surface.

(2) Attach the ground cord to the work surface via the snap fasteners and attach the other end of the ground cord to a reliable ground using an alligator clip.

(3) Note which boards or components are to be inserted or replaced.

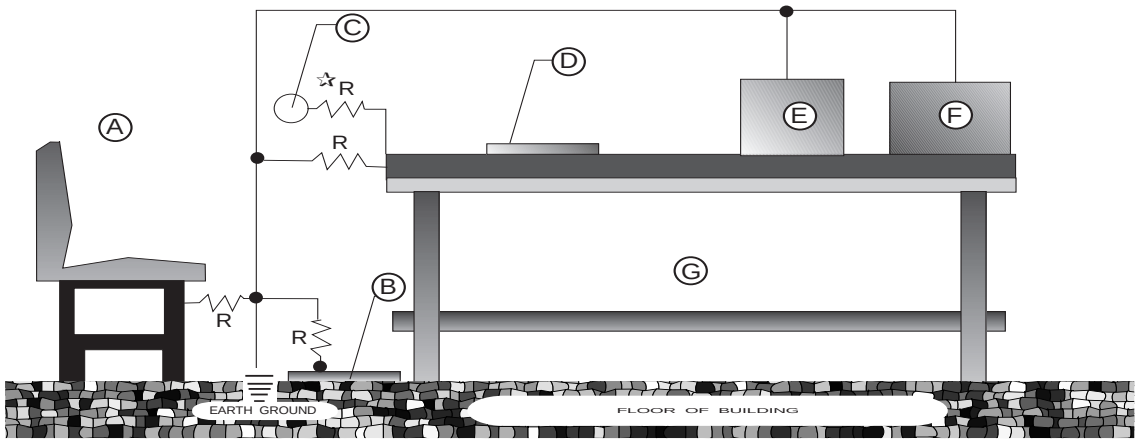
(4) Power-down the system following the recommended power-down procedure.

(5) Slip on a known-good wristband, which should fit snugly; an extremely loose fit is not desirable.

(6) Snap the ground cord to the wristband. Attach the other end of the ground cord to a reliable ground using the alligator clip.

(7) The components can now be handled following the general rules as described in the instruction manual for the component.

(8) Place the component in a static-shielding bag before the ground cord is disconnected. This assures protection from electrostatic charge in case the work surface is located beyond the reach of the extended ground cord.



LEGEND

A - Chair with ground (optional)

B - ESD protective floor mat (optional)

C - Wrist strap

D - ESD protective trays, etc.

E - Ionizer

F - Other electrical equipment

G - Workbench with ESD protective table top

☆ NOTE: ALL RESISTORS 1M Ω +/-10% 1/2W

(9) If a component is to undergo on-site testing, it may be safely placed on the grounded work surface for that purpose.

(10) After all component work is accomplished, remove the wrist straps and ground wire and place in the pouch of the work surface for future use.

5. Cleaning And Lubricating

The following procedure should be performed periodically for all PC boards and when a PC board is being replaced.

CAUTION

Many PC board connectors are covered with a very fine gold-plate.

Do not use any abrasive cleaning substance or object such as a pencil eraser to clean connectors.

Use only the approved cleaner/lubricants specified in the procedure following.

WARNING

Aerosol cans and products are extremely combustible.

Contact with a live circuit, or extreme heat can cause an explosion.

Turn OFF all power and find an isolated, and ventilated area to use any aerosol products specified in this procedure.

(1) Turn the main line power **OFF**. Blow or vacuum out the component. This should remove potential sources of dust or dirt contamination during the remainder of this procedure.

(2) Clean PC board connectors as follows:

a. Review the static-safe field procedure detailed earlier.

b. Following the ESD-sensitive component handling procedures, remove the connectors from the boards and remove the PC boards from their holders.

c. Use cleaner to remove excessive dust build-up from comb connectors and other connectors. This cleaner is especially useful for removing dust.

d. Liberally spray all PC board contacts with Inhibitor. The inhibitor:

- Provides a long lasting lubricant and leaves a protective film to guard against corrosion
- Improves performance and reliability
- Extends the life of the contacts
- Is nonconductive, and is safe for use on most plastics

e. Clean the comb contacts using a **lint-free** wiping cloth.

f. Lightly mist all comb contacts again with Inhibitor.

NOTE: Do not use so much Inhibitor that it drips.

g. Repeat the above procedure for the other PC boards from the device.

(3) Cleaning PC edge connectors

a. Use cleaner to remove excessive dust build-up from connectors. This cleaner is especially useful for removing dust.

b. Liberally spray the outboard connector with Inhibitor.

c. Lightly brush the outboard connector with a soft, non-metallic, bristle brush such as a toothbrush.

d. Spray the connector liberally to flush out any contaminants.

e. Remove any excess spray by shaking the connector or wiping with either a toothbrush, or a **lint-free** wiping cloth.

6. Completion

(1) Replace any parts that were removed.

(2) Make sure that the component cover is secure.

(3) Return the system to **normal** operation.

(4) Check that the component operates normally.

ControlWave GFC-CL (Gas Flow Computer)

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