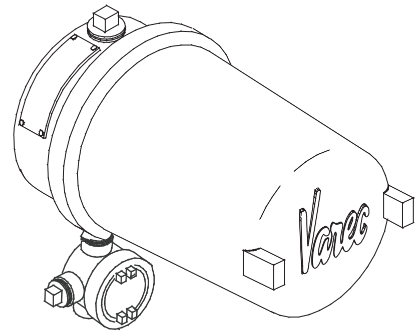
IOM012GVAE1110

Installation and Operations Manual

# 2900 Float & Tape Transmitter

Precision absolute optical encoder instrument designed to provide accurate level and temperature information from the tank-side to the control room



Automation Solutions for oil & gas, defense and aviation applications

Varec®

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# Safety Precaution Definitions

**Caution!** Damage to equipment may result if this precaution is disregarded.

**Warning!** Direct injury to personnel or damage to equipment which can cause injury to personnel may result if this precaution is not followed.

# Safety Precautions

Read this manual carefully and make sure you understand its contents before using this product. Follow all instructions and safety guidelines presented in this manual when using this product. If the user does not follow these instructions properly, Varec cannot guarantee the safety of the system.

**Note** Comply with all applicable regulations, codes, and standards. For safety precautions, the user should refer to the appropriate industry or military standards.

**Caution!** **Electrical Hazard!** Read and understand static and lightning electrical protection and grounding described in API 2003. Make certain that the tank installation, operation, and maintenance conforms with the practice set forth therein.

**Warning!** **Striking the gaugehead of the transmitter with a metal object could cause a spark to occur.** When removing or replacing the gaugehead in flammable or hazardous liquid storage areas, take necessary measures to protect the gaugehead from impact.

**Warning!** **Volatile fumes may be present!** Ensure that the tank has been leak and pressure tested as appropriate for the liquid to be stored. Observe appropriate safety precautions in flammable or hazardous liquid storage areas. Do not enter a tank that has contained hydrocarbons, vapors, or toxic materials, until a gas-free environment is certified. Carry breathing equipment when entering a tank where oxygen may be displaced by carbon dioxide, nitrogen, or other gases. Wear safety glasses as appropriate. Use a hard hat.

**Warning!** **Sparks or static charge could cause fire or explosion!** The mechanical connections between the guide cables, the float, the tape, and the gaugehead provide a resistance to ground that is adequate for the safe electrical drain of electrostatic charges that may accumulate in the tank and the product. Worker activity and worker clothing may accumulate electrostatic charges on the body of a worker. Care should be used in flammable environments to avoid the hazard.

**Warning!** **Broken negator motor spring pieces can cause injury when the back cover of the gaugehead is removed!** Whenever the back cover is removed, stand to one side as the last bolt is removed.

# Contents

# 1 Introduction

This manual provides the information needed to install, maintain, and troubleshoot the Varec 2900 Float & Tape Transmitter (FTT).

## 1.1 Overview

The 2900 Float & Tape Transmitter (FTT) is a precision digital instrument designed to mount directly to most mechanical float and tape tank gauges and transmit level and other data to an inventory management system.

The 2900 FTT is available for Mark/Space, Modbus, GSI Modbus, or Tankway (L&J) field communications. It can be mounted to the Varec 2500 Automatic Tank Gauge (ATG) as well as GSI, L&J, and others.

*Figure 1-1:2900 FTT - Installed on Varec 2500 ATG*

The 2900 FTT is explosion proof and approved for use in hazardous-classified locations, making it particularly suitable for bulk storage applications found in the oil and gas industry.

## 1.2 Function & System Design

### 1.2.1 System Functionality

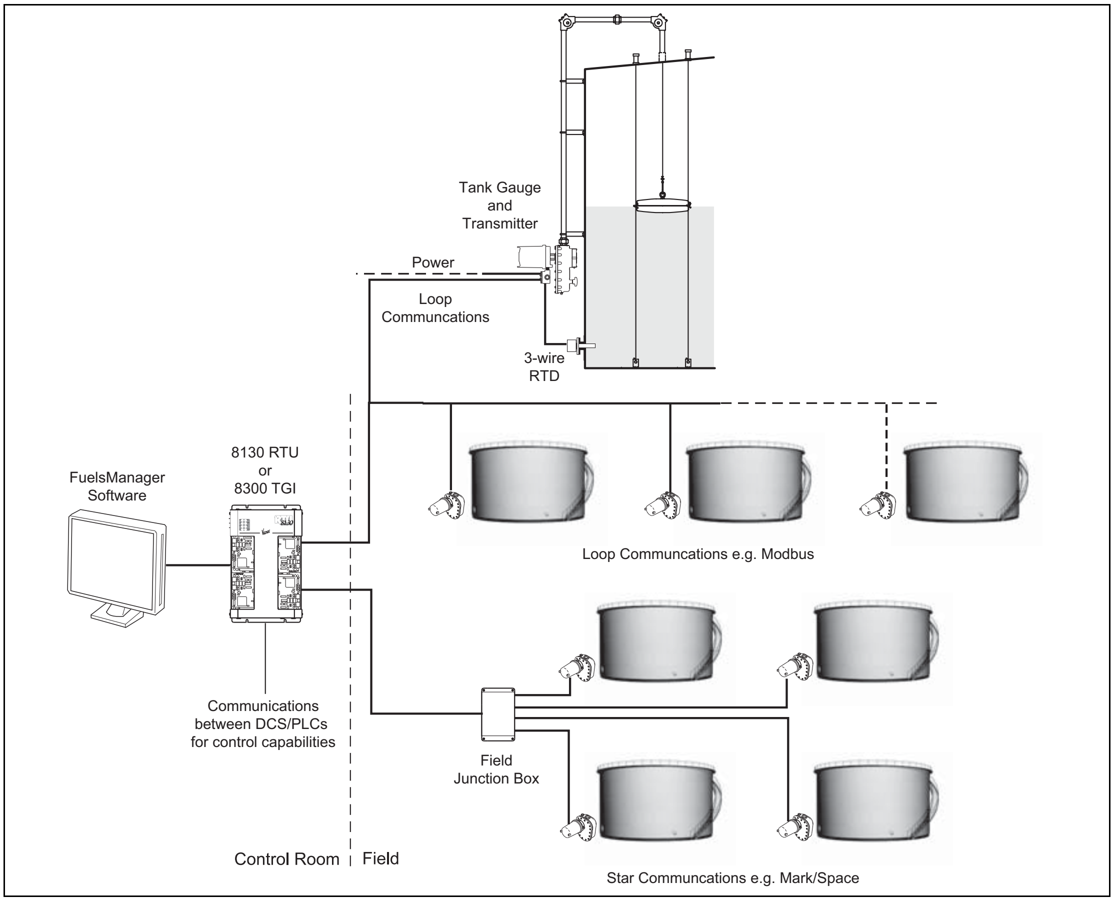



*Figure 1-2: 2900 FTT System Diagram*

1. In response to changes in liquid level, the mechanical level gauge rotates the 2900 FTT encoder drive shaft.
2. The 2900 FTT's precision direct drive gearing turns two encoder discs.
3. A dual-sided infra-red sensor circuit board reads the reflective tracks on the rotating encoder disks, and produces an encoded level value.
4. If a spot temperature RTD (Resistance Temperature Detector) is used, the communications board translates the RTD input to a digital temperature value.
5. The communications circuit board converts the encoded level and temperature to a specific field communications protocol.
6. The communications circuit board transmits the data via a junction box or interface device to a control room inventory management system, such as FuelsManager.

### 1.2.2 Internal System Design

The 2900 FTT is constructed with the following assemblies, as shown in Figure 1-3:

A. Enclosure Cover
B. Communications Circuit Board
C. AC Power Circuit Board (Optional)
D. Connector Circuit Board
E. Optical Encoder Assembly and Gearing System
F. Enclosure Base
G. Junction Box with wiring bundle

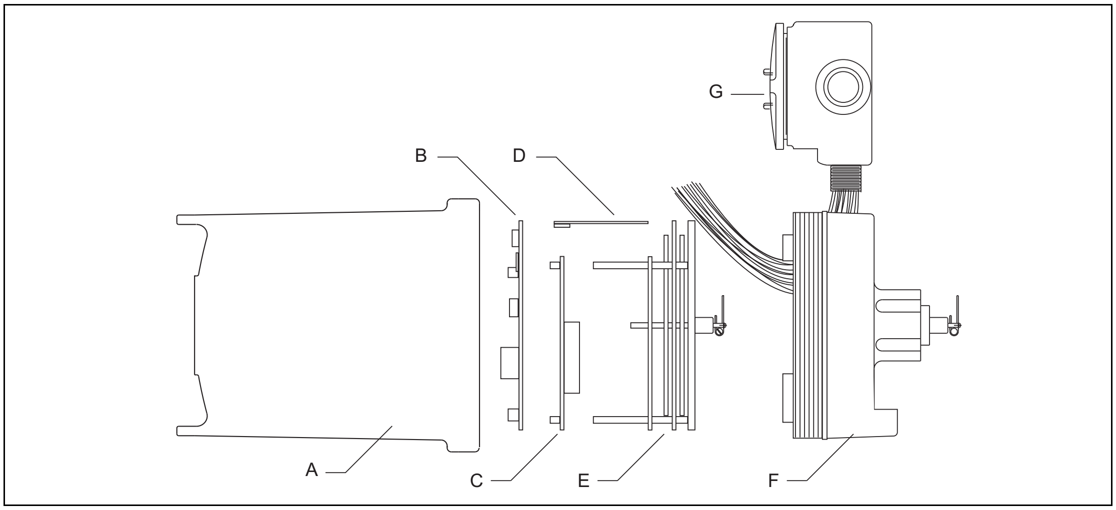



*Figure 1-3: System Components - Exploded View*

All standard electronics for the 2900 FTT are contained on the communications circuit board (B). This includes DC power, field communications, a 3-wire temperature input and two discrete inputs.

An optional circuit board (C) contains an AC power supply, two additional discrete inputs and four contact outputs. These inputs/outputs can be used to maintain a safer working facility and provide basic automation and control by activating alarms or relays.

# 2 Preparing for Installation

This chapter provides a pre-installation checklist, safety information, unpacking instructions, and an overview of the installation steps.

## 2.1 Site Preparation Checklist

Before you install the 2900 FTT transmitter on a mechanical float and tape gauge, you should ensure that:

1. The mechanical float gauge is operating correctly.
2. There is sufficient space around the mechanical gauge to install the transmitter and accessories (such as conduit and cabling). Refer to Figure 2-1.

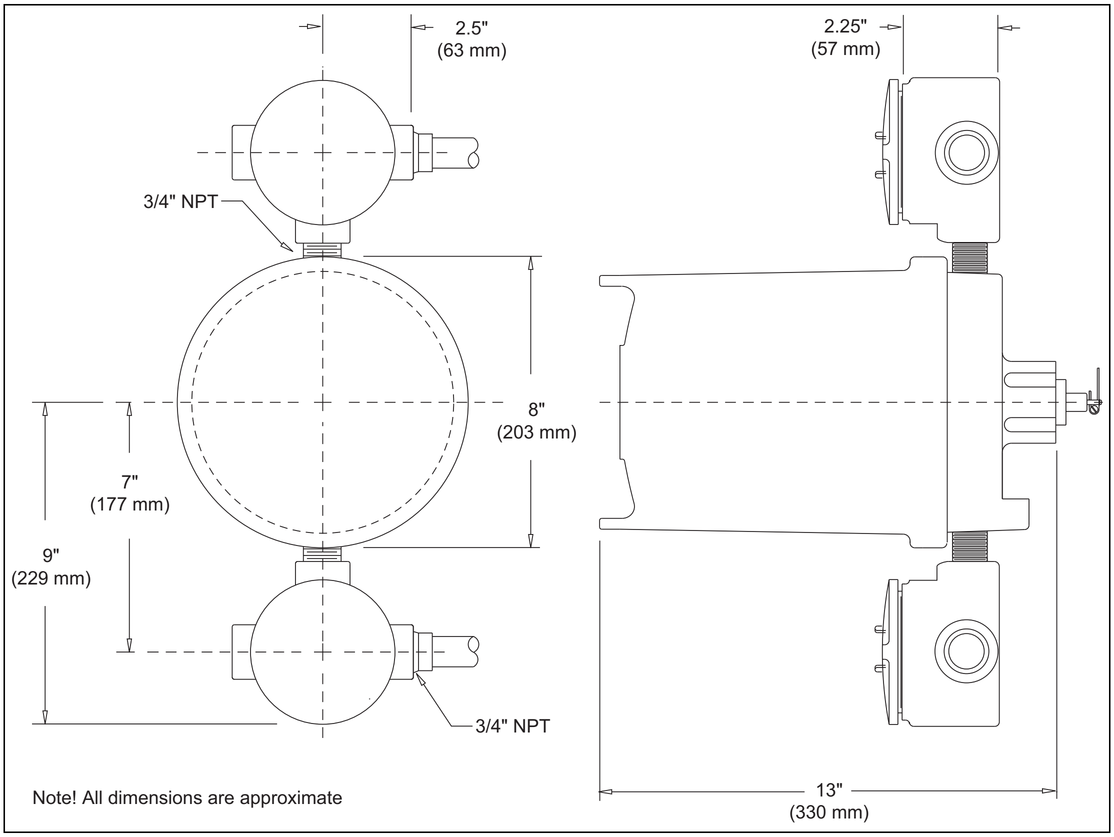



*Figure 2-1: 2900 FTT Dimensions*

3. You have the correct transmitter/mechanical gauge adaptor, if required.
4. You have the correct field connections at the gaugehead ready to connect to the 2900 FTT (i.e. power, communications and temperature sensor wiring).
5. You are in compliance with safety guidelines described in Section 2.2 on page 6.

The tank can remain in-service and the mechanical float gauge can remain in place while you install and configure the 2900 FTT.

## 2.2 General Safety Guidelines

The 2900 FTT is certified to be used in Class I, Division 1, Groups C and D, and Class I, Zone 1, Group IIB hazardous locations.

The user should follow other local safety guidelines for additional protection. Information may also be obtained from the following sources:

- National Electric Code (NEC)
- National Fire Protection Association (NFPA)
- Instrument Society of America (ISA)
- Factory Mutual Research Corporation (FM)
- Underwriters' Laboratories Incorporated (UL)

When in doubt about the safety of an area, the user should check with the local safety authorities. Always observe equipment labels and warning signs posted in the area.

## 2.3 Unpacking

Varec 2900 Float & Tape Transmitters are shipped fully assembled and ready for installation.

To unpack the 2900 FTT:

1. Place the shipping container on a secure bench.
2. Open the shipping container, taking care not to damage the contents.
3. Carefully remove transmitter from the shipping container and place it on the bench.
4. Inspect the transmitter for shipping damage. Report any damage to the carrier.

   **Note** If the transmitter must be stored prior to installation, it should be repacked in its shipping container and stored in a temperature- and humidity- controlled environment.

## 2.4 Installation Overview

To install the transmitter, follow the steps shown in the following flowchart:

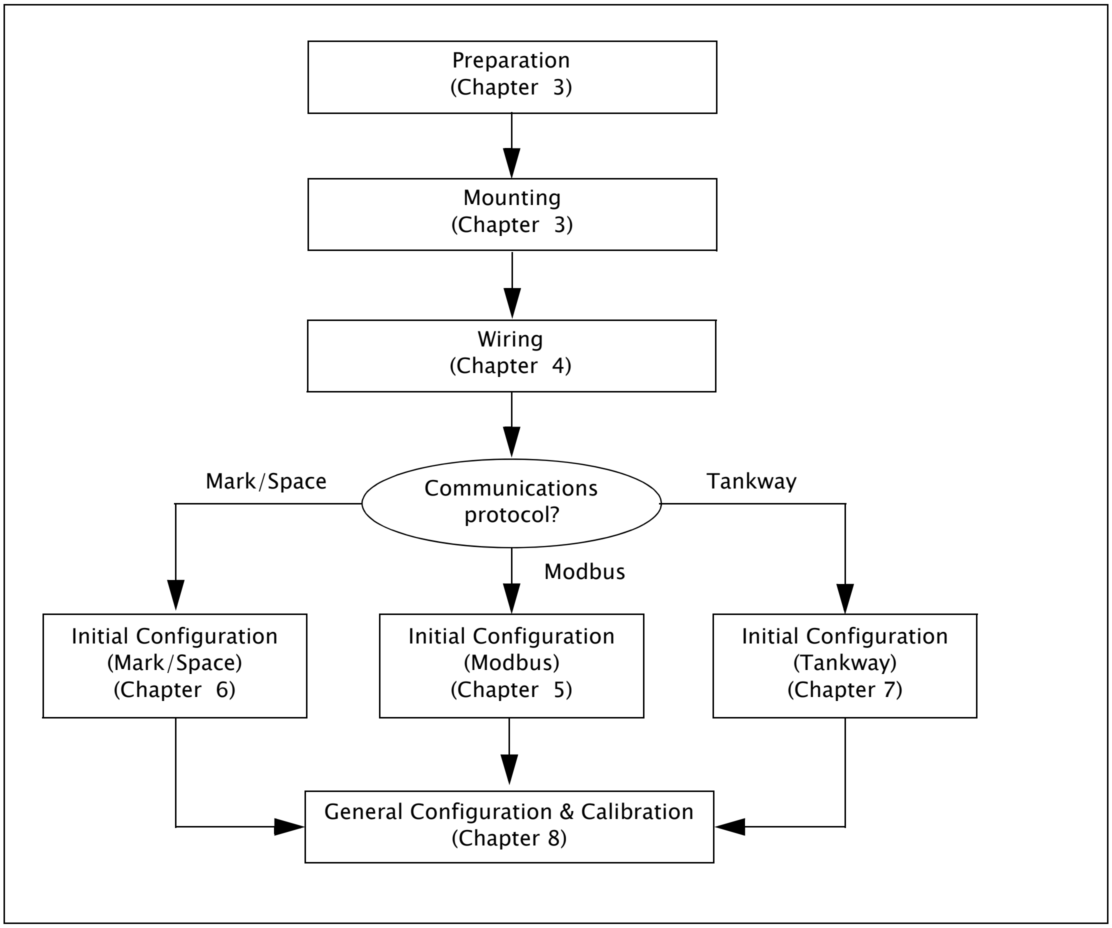



*Figure 2-2: 2900 FTT Installation Sequence*

# 3 Mounting

You can mount the 2900 FTT in one of three ways:

- Mount the complete transmitter on a 2500 ATG gaugehead (see Section 3.2, "Mounting on a Varec Gaugehead" on page 10).
- Mount the complete transmitter on a non-Varec gauge (see Section 3.3, "Mounting on Alternate Gaugeheads" on page 11).
- Upgrade a Varec 1900 4-Wire Transmitter (1900 MWT) by replacing the 1900 MWT electronics encoder assembly with the 2900 FTT electronics encoder assembly (see Section 3.4, "Upgrading an Installed 1900 MWT Transmitter" on page 12).

This chapter describes each of the above procedures.

The tank can remain in-service and the mechanical float gauge can remain in place while you install and configure the 2900 FTT.

**Note** Please read the safety guidelines section before you begin.

## 3.1 Installation Safety Guidelines

- This equipment should be installed only by qualified personnel familiar with the installation of tank gauging equipment.
- Caution should be exercised when entering any area that is posted or otherwise assumed to contain hazardous gases. Always follow other local guidelines.
- Obtain a hot permit before removing the transmitter cover with power applied.
- To prevent shock hazards, the housing of all units should be properly grounded in accordance with the National Electric Code. A grounding conductor should be wired to the grounding terminal provided on the 2900 FTT.

**Warning!** Before attempting installation of the 2900 FTT, review the General Safety Guidelines described in Chapter 2 "Preparing for Installation" on page 5. Installation and maintenance personnel should become familiar with any hazards present as well as any agency requirements before working with any equipment.

## 3.2 Mounting on a Varec Gaugehead

This procedure provides instructions to mount the transmitter on a 2500 ATG gaugehead, as shown in Figure 3-1.

Instructions applicable to other tank gauges follow in later paragraphs. To install the gaugehead, refer to the 2500 Automatic Tank Gauge Installation and Operations Manual. The exploded view in that manual shows the mechanical relationship between this accessory and the gaugehead.

> **Warning!** Whenever the back cover of the gaugehead is removed, stand to one side as the last bolt is removed. If the negator motor spring is broken, the broken pieces may cause injury when the cover is removed.

> **Warning!** The mechanical connections between the gauge float guide cables, the float, the tape and the gaugehead provide a resistance to ground that is adequate for the safe electrical drain of electrostatic charges that may accumulate in the tank and the product. Worker activity and worker clothing may accumulate electrostatic charges on the body of a worker. Care should be used in flammable environments to avoid the hazard.

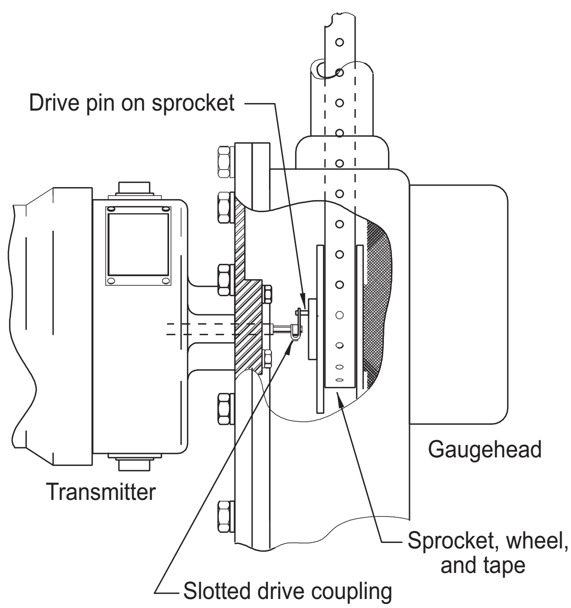



*Figure 3-1: Typical Transmitter Mounting*

1. Remove the back cover of the gaugehead (see the *2500 Automatic Tank Gauge Installation and Operations Manual*).
2. Remove the access cap from the back cover of the gaugehead (see the *2500 Automatic Tank Gauge Installation and Operations Manual*). Remove and discard the four fiber washers.
3. Mount the transmitter in place of the cap onto the back cover of the gaugehead, using the four hex head cap screws that attached the access cap. Make sure that the top of the 2900 FTT housing (marked with "TOP") lines up with the top of the back cover.
4. Position the back cover and transmitter so that the drive pin on the gaugehead sprocket passes through the slotted drive coupling on the transmitter drive shaft.
5. Fasten the back cover to the gaugehead.
6. Proceed with field wiring, as described in Chapter 4 "Wiring" on page 13.

## 3.3 Mounting on Alternate Gaugeheads

The following steps describe the typical tasks required for mounting the transmitter on other manufacturers' gaugeheads. An adapter is required. Refer to Chapter 9 "Maintenance and Troubleshooting" on page 53.

The gaugehead is assumed to be installed on the tank. See Figure 3-1 on page 10 and perform the following steps.

1. Remove the mounting plate from the gaugehead.
2. Remove the access cap from the mounting plate of the gaugehead (see the *2500 Automatic Tank Gauge Installation and Operations Manual*).
3. Mount the transmitter to the adapter.
4. Install the transmitter with adapter on the gaugehead mounting plate, using the four hex head cap screws that attached the cover cap. Make sure that the top of the 2900 FTT housing (marked with "TOP") lines up with the top of the mounting plate.
5. Position the mounting plate and transmitter so that the drive pin on the gaugehead sprocket passes through the slotted drive coupling on the transmitter drive shaft.
6. Fasten the mounting plate to the gaugehead.
7. Proceed with field wiring, as described in Chapter 4 on page 13.

## 3.4 Upgrading an Installed 1900 MWT Transmitter

A new 2900 FTT electronics assembly can be fitted to an existing 1900 MWT as described in this section.

To replace the 1900 MWT electronics assembly:

1. Disconnect the power supply to the existing transmitter.
2. Open the cover of the existing 1900 MWT housing while it is still connected to your mechanical float and tape gauge.
3. Disconnect all power, communications, temperature and contact wiring on the existing electronics assembly.
4. Loosen the four mounting screws and then remove the entire electronics assembly from the housing.
5. Remove the mounting screws, discard the mounting tabs, and then refasten the screws loosely.
6. Place the new 2900 FTT assembly over the mounting screws and hold in place.

   **Note** Position the assembly so that a baseplate cutout is aligned with each junction box and wiring bundle. The wiring bundle can then pass through the cutout.

7. Rotate the top encoder disk until the slotted drive coupling in the electronics assembly aligns with the transmitter drive pin. Push the coupling over the pin.
8. Rotate the electronics assembly to secure it on the mounting screws, and then tighten the mounting screws to lock the assembly in place.

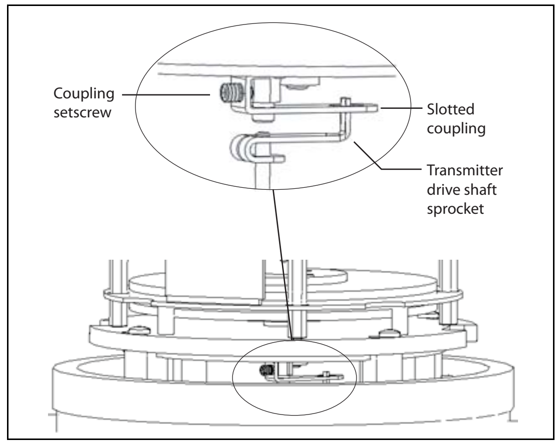



*Figure 3-2:Transmitter Coupling*

9. Replace the terminal board in the transmitter junction box with the terminal board supplied with the 2900 electronics assembly.
10. Connect wiring to the electronics assembly as described in Section 4.9, "Connecting Wiring in the Transmitter" on page 24.

# 4 Wiring

This chapter describes how to connect wiring terminations for the 2900 FTT. Wiring should be done after the unit is mounted as described in Chapter 3 "Mounting" on page 9.

## 4.1 Overview

The wiring of the junction boxes to the 2900 FTT varies based on the order options. Figure 4-1 shows the wiring options available for the 2900 FTT. Some typical order options are illustrated in this section.

The following table presents typical ordering codes with a description of the options and the associated figure:

| Order Code | Option Description | Associated Figure |
|---|---|---|
| N2900-B-1-xx-0-0-yy | AC Only | Figure 4-2 on page 16 |
| N2900-B-1-xx-1-2-yy | Discrete I/O, 2 Limit Switches, and AC | Figure 4-3 on page 17 |
| N2900-B-0-xx-0-2-yy | 2 Limit Switches | Figure 4-4 on page 18 |
| N2900-B-1-xx-1-4-yy | Discrete I/O, 4 Limit Switches, and AC | Figure 4-5 on page 19 |

*Table 4-1: Typical Order Options*

Field wiring the 2900 FTT Transmitter consists of the following steps:

1. Calculating line resistance (see Section 4.3, "Checking Line Resistance" on page 15).
2. Connecting field wiring to the junction box terminals (see Section 4.8, "Terminating System Wiring at the Transmitter" on page 20).

To connect the internal wiring for the 2900 FTT, see Section 4.9, "Connecting Wiring in the Transmitter" on page 24.

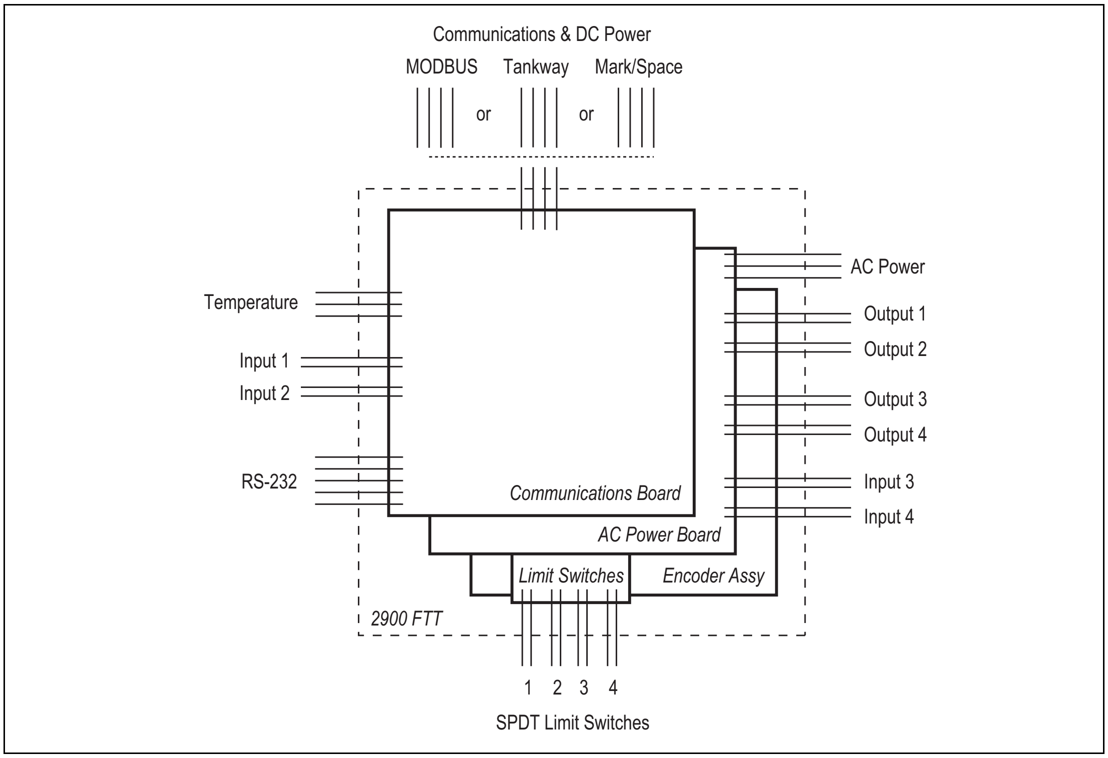



*Figure 4-1: 2900 FTT Diagram with Standard and Optional Connections*

## 4.2 Safety Guidelines

- Maintenance should be performed only by authorized personnel.
- Caution should be exercised when entering any area that is posted or otherwise assumed to contain hazardous gases. Always follow local guidelines.
- Obtain a hot permit before removing the transmitter cover with power applied.
- Before installing/repairing any wiring to the 2900 FTT, make sure that the power is turned off at the main circuit breaker or switch. The power switch should be locked in the OFF position and labeled to prevent other personnel from turning the power on during installation.
- To prevent shock hazards, the housing of all units should be properly grounded in accordance with the National Electric Code. A grounding conductor should be wired to the grounding terminal provided on the 2900 FTT.
- Do not apply power to the transmitter until all wiring connections have been made and the cover of the transmitter has been replaced.
- Do not apply power until the instrumentation current loop has been checked (see Section 4.3, "Checking Line Resistance" on page 15).
- Do not apply power in a hazardous environment until the explosion proof case is closed.
- Incorrect field wiring connections can damage the transmitter electronics and cause system malfunctions.

## 4.3 Checking Line Resistance

The amount of line resistance between the 2900 FTT and the control room is critical to the reliability of the entire system. Before you wire 2900 FTT(s) to your system, ensure that the field wiring meets the following criteria:

- The number of transmitters wired in each area does not exceed 31 (Modbus) or 50 (Mark/Space). See Section 4.8.3, "Communications Wiring" on page 22 for more information.
- Wiring distance of each communication line does not exceed 10,000 feet (Mark/Space) or 4,000 feet (Modbus).

When existing or proposed wiring does not meet these limits, the Varec Engineering department should be consulted for a specific evaluation.

## 4.4 2900 FTT Wiring Diagram — AC Option

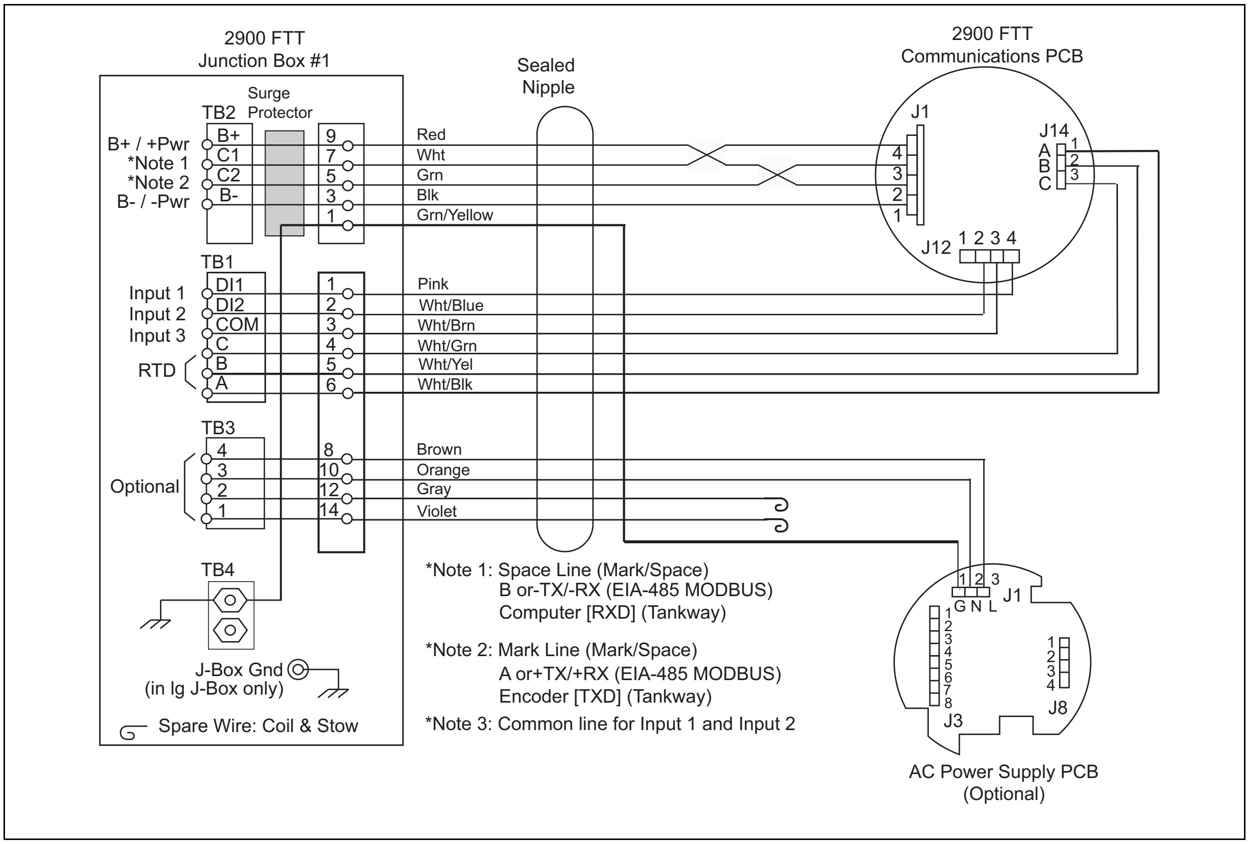



*Figure 4-2: 2900 FTT Internal Wiring Diagram — AC Option (Order Code:* N2900-B-1-xx-0-0-yy)

## 4.5 2900 FTT Wiring Diagram — Discrete I/O, AC, and 2 Limit Switches Option

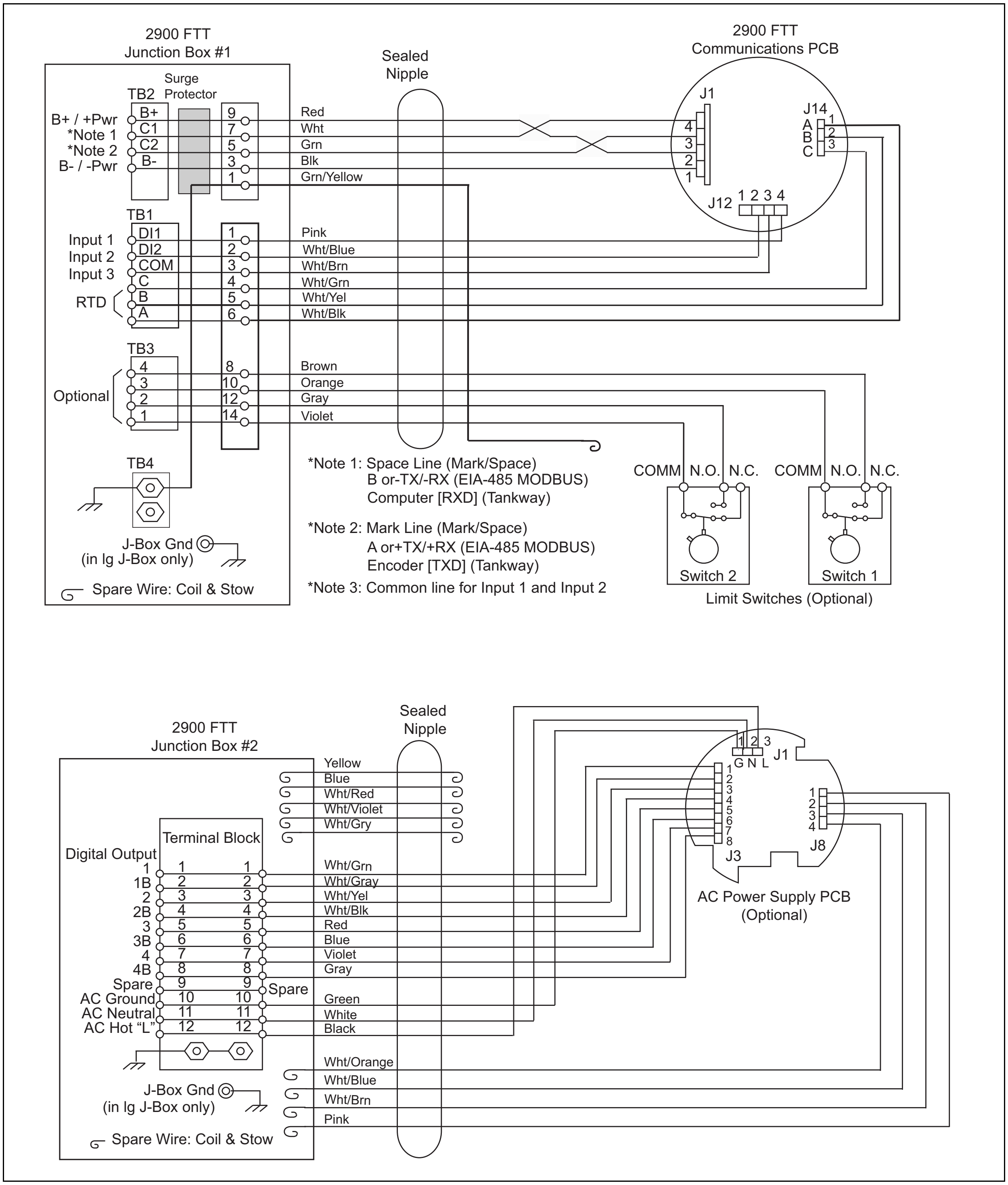



*Figure 4-3: 2900 FTT Wiring Diagram — Discrete I/O, AC, and 2 Limit Switches Option (Order Code:* N2900-B-1-xx-1-2-yy)

## 4.6 2900 FTT Wiring Diagram — Discrete I/O and 2 Limit Switches Option

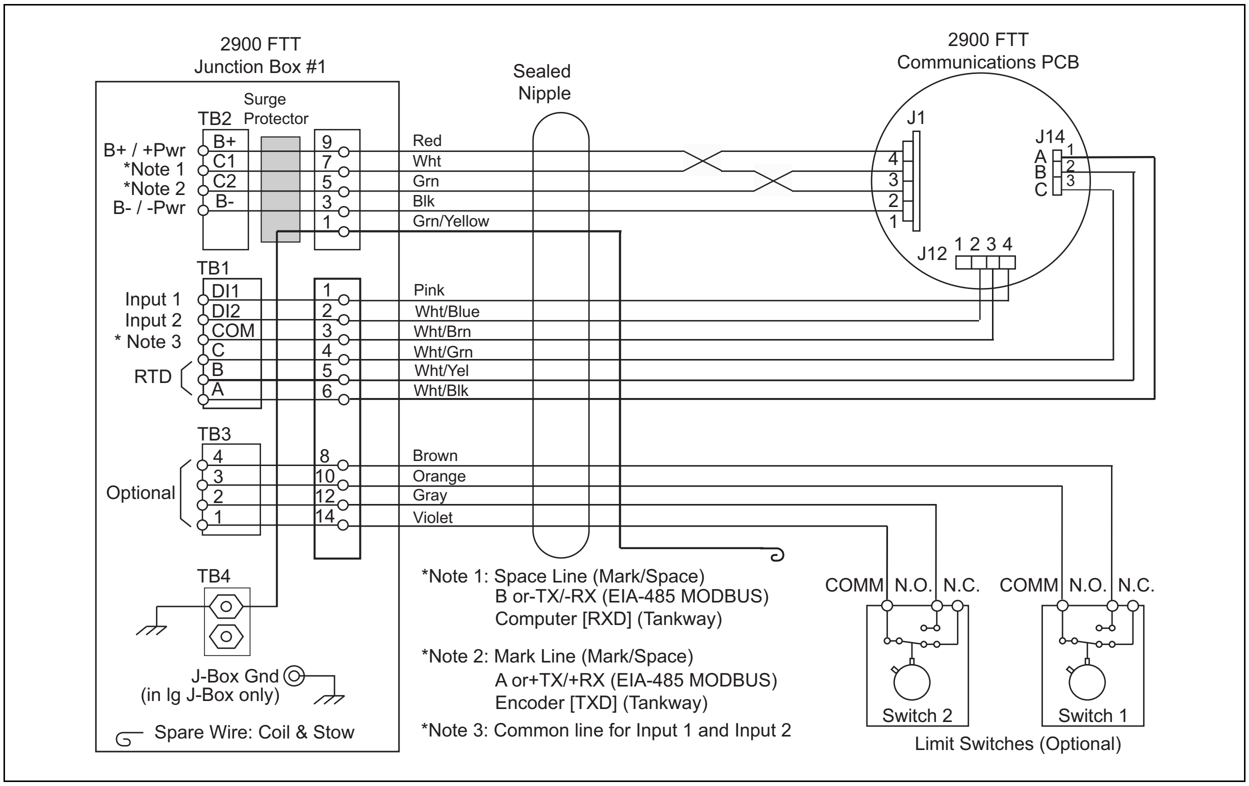



*Figure 4-4: 2900 FTT Internal Wiring Diagram — Discrete I/O and 2 Limit Switches Option (Order Code:* N2900-B-0-xx-0-2-yy)

## 4.7 2900 FTT Wiring Diagram — Discrete I/O, AC, and 4 Limit Switches Option

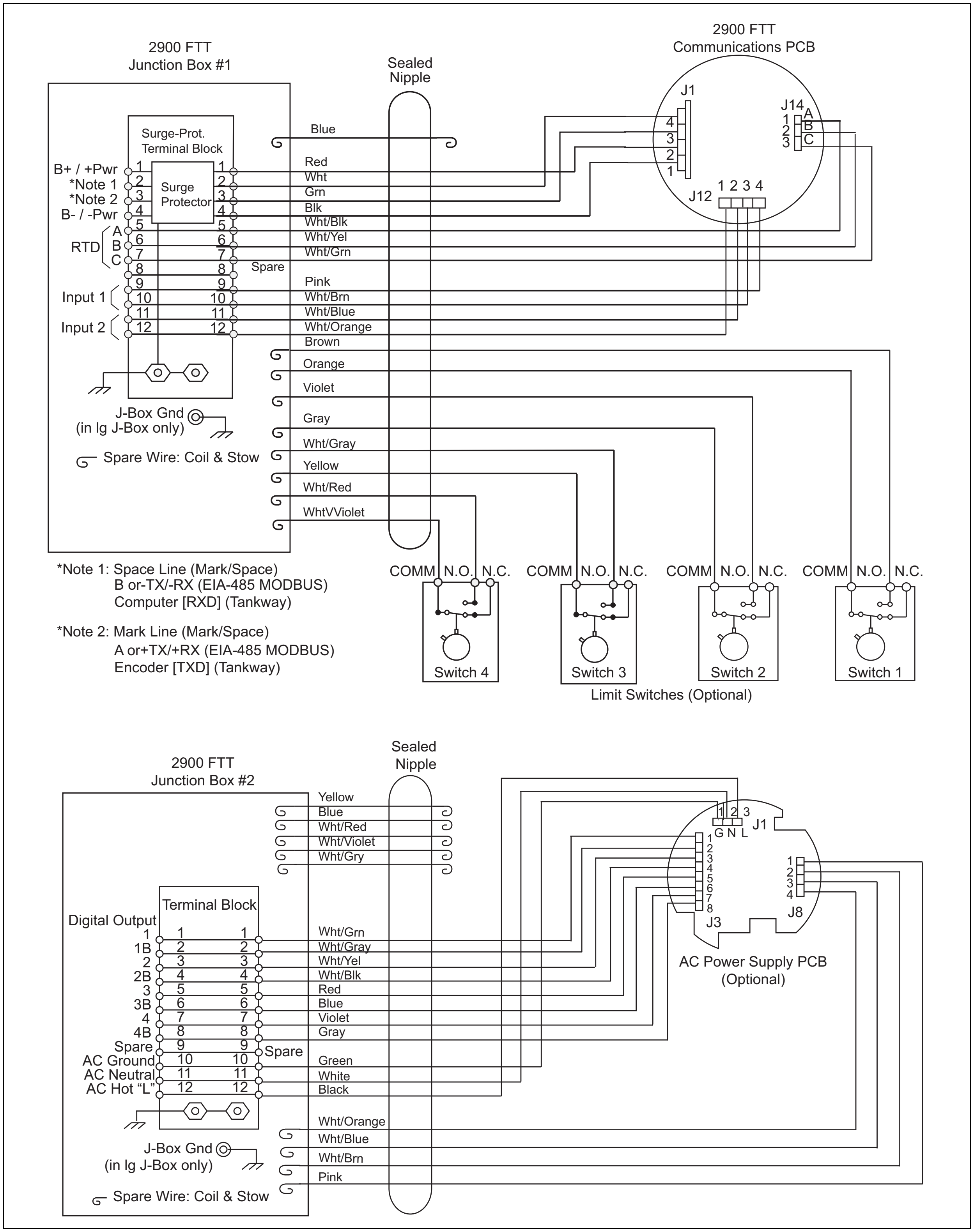



*Figure 4-5: 2900 FTT Wiring Diagram — Discrete I/O, AC, and 4 Limit Switches Option (Order Code: N2900-B-1-xx-1-4-yy)*

## 4.8 Terminating System Wiring at the Transmitter

This section provides field wiring termination information for the 2900 FTT, including junction box terminal connections, communications and RTD wiring, discrete inputs, contact outputs, and input power.

### 4.8.1 Junction Box Terminals

All wiring from the 2900 FTT to the tank gauging system is terminated at one or more junction boxes connected to the transmitter housing. The standard junction box, provides 14 terminals using pluggable terminal connectors, and includes two earth ground terminals. The standard junction box is shown in Figure 4-6. The 1900 MWT- compatible junction box contains 12 terminals. One junction box is included in the standard configuration, and fittings are provided for additional junction boxes if they are required.

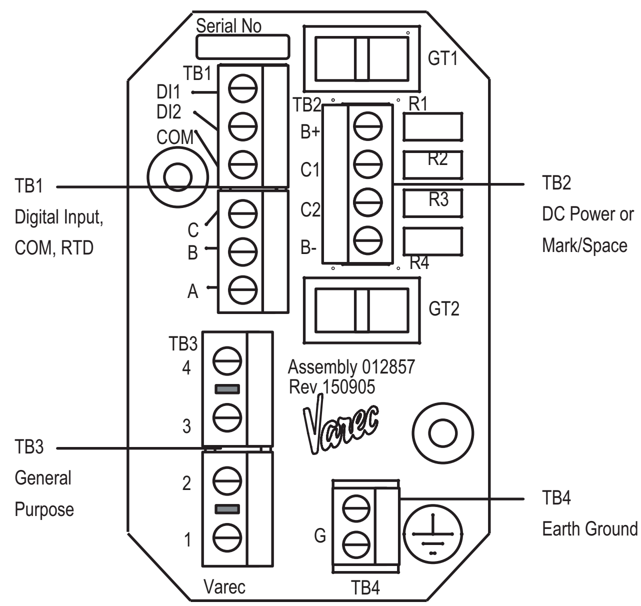



*Figure 4-6: Earth Ground Connector, Terminal Circuit Board (Junction Box)*

Table 4-2 on page 21 describes the terminal connections for the terminal circuit board. For a transmitter wiring diagram, see Figure 4-5 on page 19.

> **Note** Earth Ground is located on the terminal circuit board in the junction box as shown in Figure 4-6. For the 1900 MWT-compatible junction box, see Figure 4-9 on page 25.

### 4.8.2 Terminal Assignments: Terminal Circuit Board

| Terminal/Function | Terminal | Assignment | Description |
|---|---|---|---|
| TB1 - Digital Input / Temperature Input | DI1 | Digital Input 1 | Digital Input |
| | DI2 | Digital Input 2 | Digital Input |
| | COM | Digital Input Common | For DI1 & DI2 |
| | C | C - | RTD Return 2 |
| | B | B - | RTD Return 1 |
| | A | A - | RTD Signal |
| TB2 - Communications | B+ | B+ / +Power | (All Boards) |
| | C1 | Space Line | (Mark/Space) |
| | | B or -TX/-RX | (EIA-485 Modbus) |
| | | Computer (RXD) | (Tankway) |
| | C2 | Mark LIne | (Mark/Space) |
| | | A or +TX/+RX | (EIA-485 Modbus) |
| | | Encoder (TXD) | (Tankway) |
| | B- | B- / -Power (Gnd) | (All Boards) |
| TB3 - Optional | 1 | None | Optional |
| | 2 | None | |
| | 3 | None | |
| | 4 | None | |
| TB4 - Earth Ground | G | Earth Ground | Earth Ground to Junction Box |
| | G | Earth Ground | |

*Table 4-2: Terminal Assignments - Terminal Circuit Board*

### 4.8.3 Communications Wiring

Table 4-3 describes the wiring considerations for each communications protocol.

| Communication Protocol | Description |
|---|---|
| Mark/Space | Two shielded, twisted pairs of 18 AWG wire (Mark/Space wires) are recommended. This option provides compatibility with the Varec Tank Scanning Unit (TSU), RTU 8130 or Tank Gate interface devices. The 2900 FTT can then be multi-dropped on the same Mark/Space data highway as the Varec 1800/1900 MWT/4000 Transmitter or MFT/HIU devices. Up to 50 devices can be connected. Mark/Space Communications requires 48 VDC. |
| EIA-485 Modbus | The 2900 FTT uses a 3-wire EIA-485 hardware interface to communicate with the Modbus master. EIA-485 is a high speed differential communications network which allows up to 32 devices to operate on one network. The 2900 FTT and Modbus® master communicate over a maximum distance of 4000 feet (1230 meters).<br>The EIA-485 communications interface is compatible with the RTU 8130 (along with any Modbus-compatible device) and other Modbus masters. |
| L&J Tankway | L&J Tankway is a 4-wire system which includes power and ground connections. Fifty or more devices can be connected on the field communication bus. |

*Table 4-3: Communications Wiring Information*

### 4.8.4 RTD wiring

To use a 4-wire RTD with the 2900 FTT, tie two of the RTD return wires together electrically.

### 4.8.5 Discrete inputs

As standard the 2900 FTT contains 2 discrete inputs for connection to ancillary devices such as limit switches and float switches. The 2900 FTT then provides a Open/Closed signal to the host system. All wiring must be connected to the appropriate terminals in the junction box(es) supplied with the 2900 FTT. The discrete input connector (J12) is located on the underside of the main PCB.

When the AC Power option is installed, an additional 2 discrete inputs are available. These additional inputs are located on the AC Power PCB.

### 4.8.6 Contact outputs

When the AC Power option is installed, 4 contact outputs are provided. These are software driven "Normally Open/Closed" outputs. The outputs can be configured using a Modbus host interface or a computer running ViewRTU. They can be set to trigger alarm lights, horns etc. for temperature or level alarms.

### 4.8.7 Input power

The standard 2900 FTT uses 20-65 V DC power, supplied through the main communications board. With an optional AC power PCB, the 2900 FTT can also be supplied with 40-65 VAC, 110 VAC, or 220 - 240 VAC at 50/60 Hz. Both options are galvanically-isolated from the micro controller.

Two junction boxes are required when the AC Power option is used.

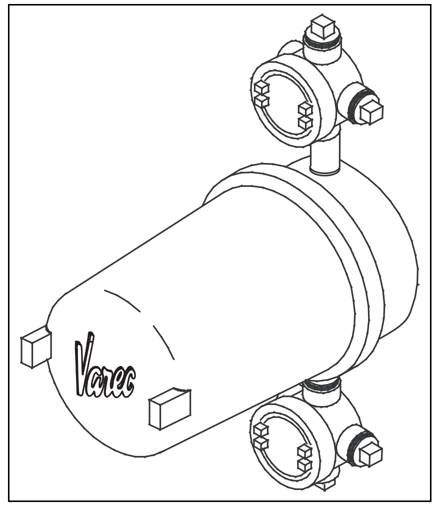



*Figure 4-7: Transmitter Housing with Two Junction Boxes*

To connect DC or AC power to the transmitter, connect the power wires to the appropriate terminals in the junction box(es) supplied with the 2900 FTT.

> **Note** Before connecting power wires to the 2900 FTT, ensure that power is switched off and the instrument is correctly grounded.

## 4.9 Connecting Wiring in the Transmitter

### 4.9.1 Overview

All standard electronics for the 2900 FTT are contained on the main communications circuit board. This includes 20-65 VDC power, field communications, 3-wire temperature input and two discrete inputs. An optional secondary circuit board contains an AC power supply with three voltage ranges, two additional discrete inputs and four discrete outputs. See Section 4.8.7, "Input power" on page 23 and Section 4.9.7, "Selecting the AC Voltage Setting" on page 29 for more information.

All wiring is terminated in junction boxes containing 12 terminals and one ground connector. A standard application requires one junction box for communications, temperature and two SPDT contacts. Depending on the complexity of the application, multiple junction boxes can be attached to the transmitter housing.

To connect wires to the electronics assembly, refer to Sections 4.9.3 through 4.9.9 for connector locations, terminal assignments, and special instructions. The system wiring diagram is shown in Figure 4-5 on page 19.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

**Note** Earth Ground is located on the terminal circuit board in the junction box, as shown in Figure 4-8 (standard) and Figure 4-9 (1900 MWT-compatible version).

### 4.9.2 Earth Ground Locations

#### 4.9.2.1 Standard Terminal Board

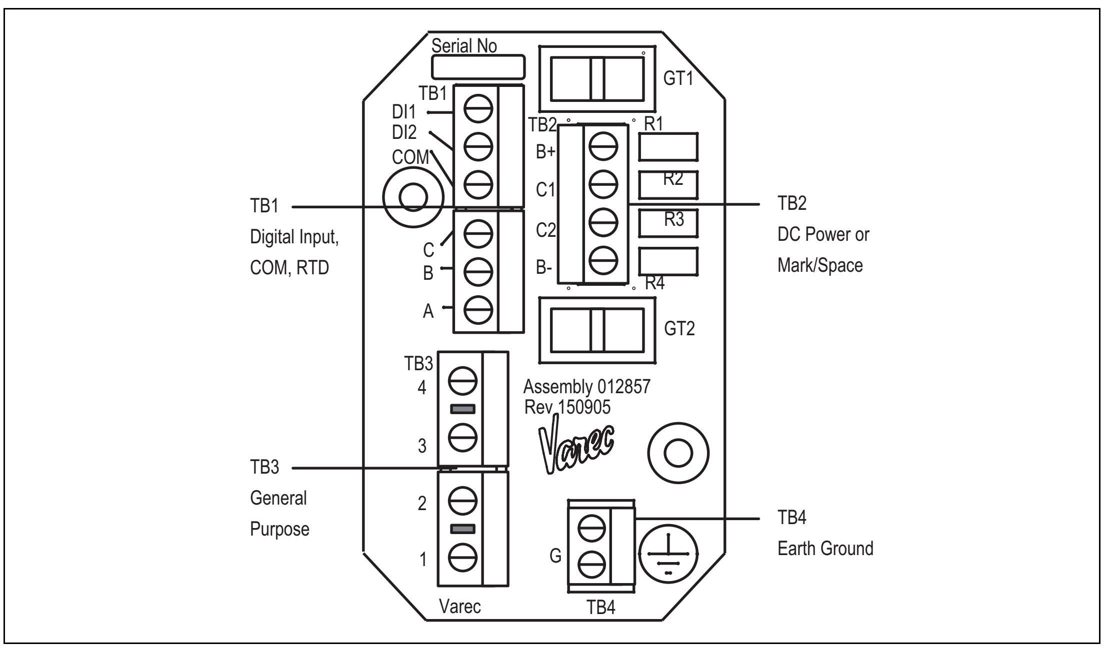



*Figure 4-8: Earth Ground Connector, Standard Terminal Board Junction Box*

#### 4.9.2.2 Earth Ground Location 1900 MWT-Compatible Terminal Board

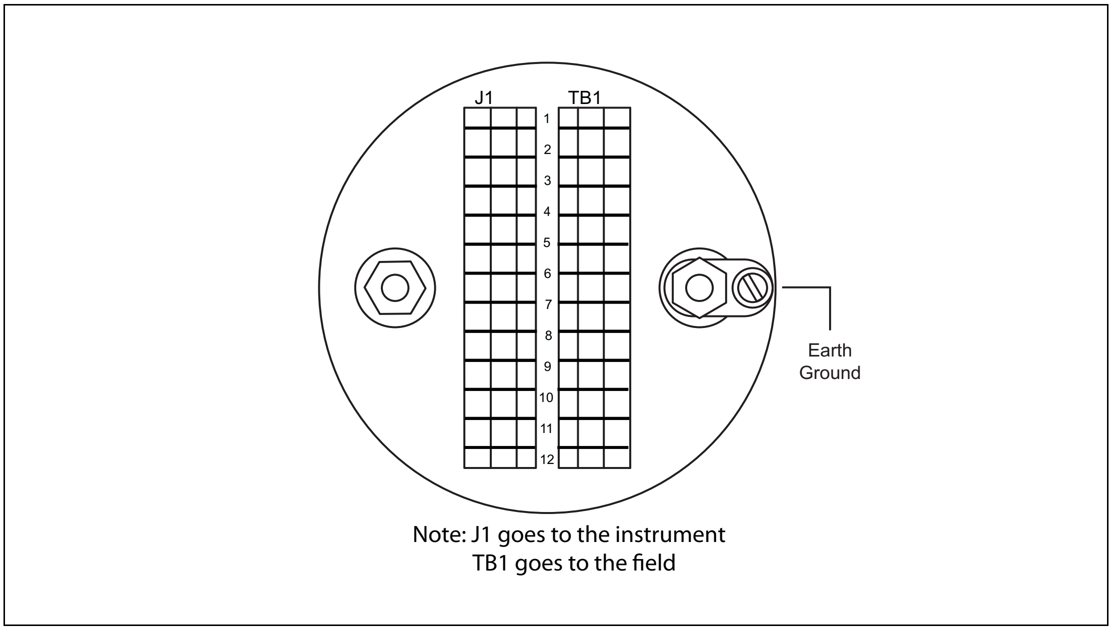



*Figure 4-9: Earth Ground Connector, 1900 MWT-Compatible Terminal Board*

### 4.9.3 Connector Locations: Communications Circuit Board

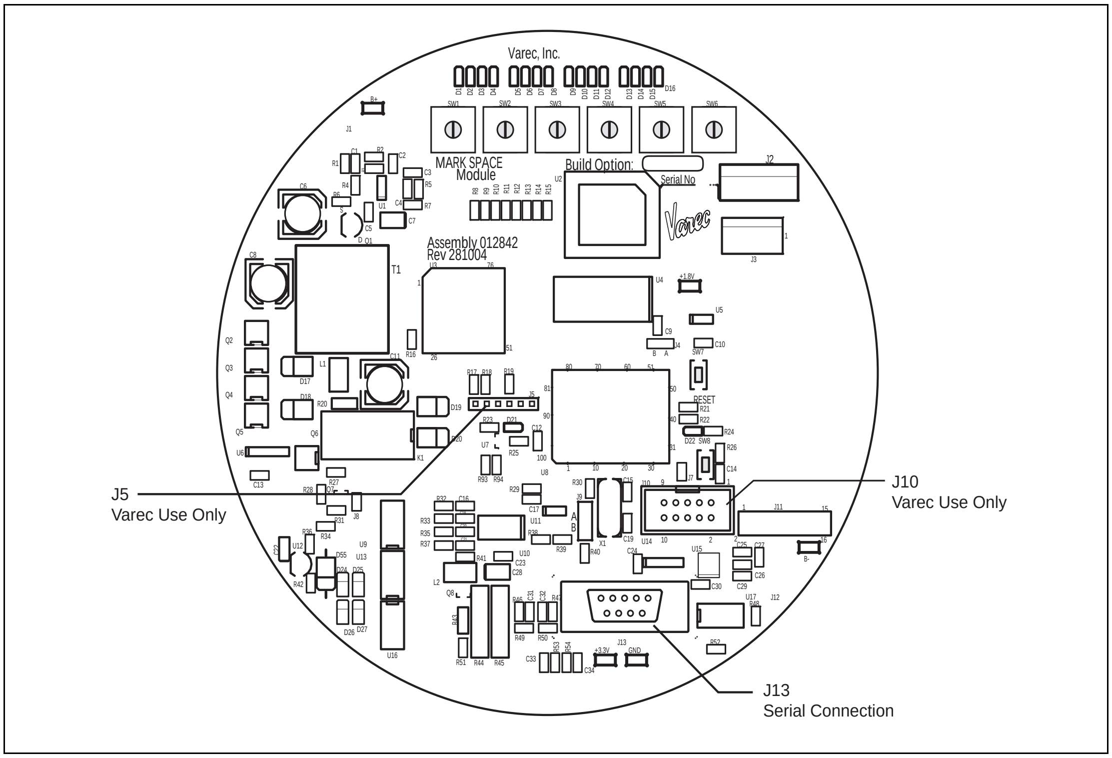



*Figure 4-10: Communication Board Connectors, Top View (Mark/Space shown)*

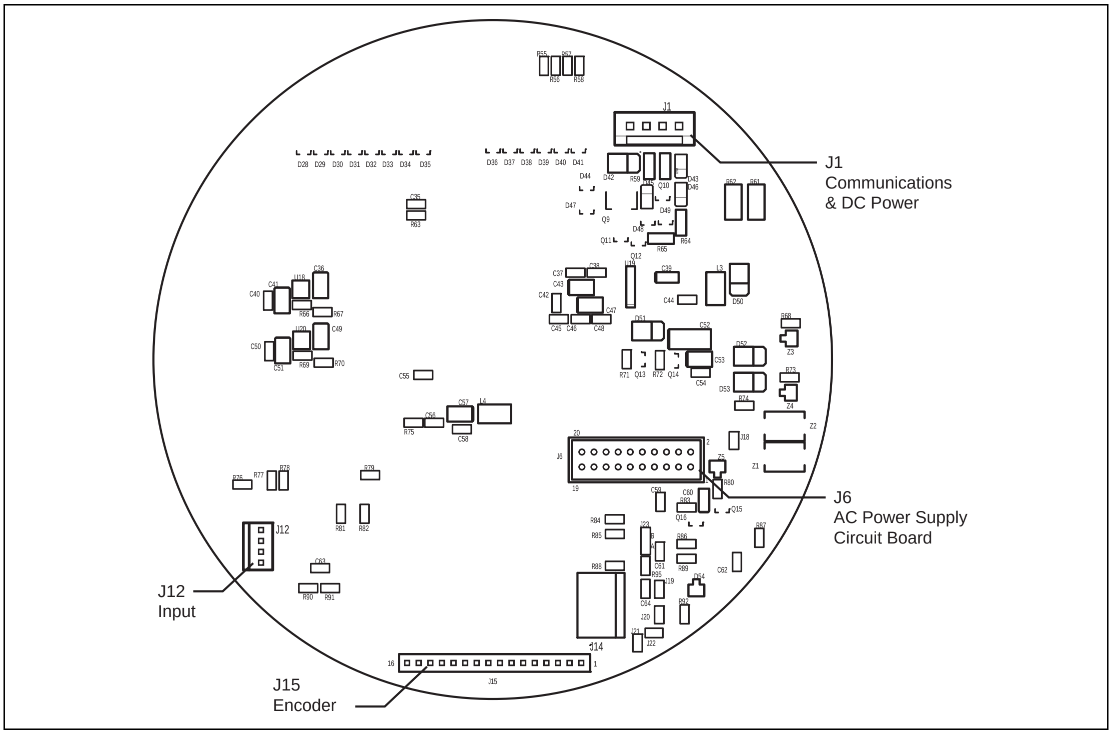



*Figure 4-11: Communication Board Components, Bottom View (Mark/Space shown)*

### 4.9.4 Connector Assignments: Communications Circuit Board

| Connector/Function | Terminal | Assignment | Description |
|---|---|---|---|
| J1 - Communications | 1 | B- / -Power (Gnd) | (All Boards) |
| | 2 | B+ / +Power | (All Boards) |
| | 3 | Mark Line | (Mark/Space) |
| | | A or +TX/+RX | (EIA-485 Modbus) |
| | | Encoder (TXD) | (Tankway) |
| | 4 | Space Line | (Mark/Space) |
| | | B or -TX/-RX | (EIA-485 Modbus) |
| | | Computer (RXD) | (Tankway) |
| J5 - Programming | | | (Varec Use Only) |
| J6 - AC Power Circuit Board | | | Connection to optional AC Power Circuit Board |
| J9 - ROM Selection | | Position A: selects microcontroller & internal Flash | Jumper Pins for selection of ROM source |
| | | Position B: selects PROM located in U2 (plug-in EPROM) | |
| J10 - Programming | | | Flash Programming<br>(Varec Use Only) |

*Table 4-4: Connector Assignments: Communications Circuit Board*

| Connector/Function | Terminal | Assignment | Description |
|---|---|---|---|
| J12 – Alarms (Discrete Inputs) | 1 | B– | Common return |
| | 2 | Alarm 1 | |
| | 3 | B– | Common return |
| | 4 | Alarm 2 | |
| J13 – Serial Connection (RS-232) | 2 | RXD | |
| | 3 | TXD | |
| | 5 | RS-232 Gnd | |
| J14 – 3-Wire Temperature Input | 1 | A – | RTD Signal |
| | 2 | B – | Return 1 |
| | 3 | C – | Return 2 |

*Table 4-4: Connector Assignments: Communications Circuit Board*

### 4.9.5 Connector and Switch Locations: AC Power Supply Circuit Board

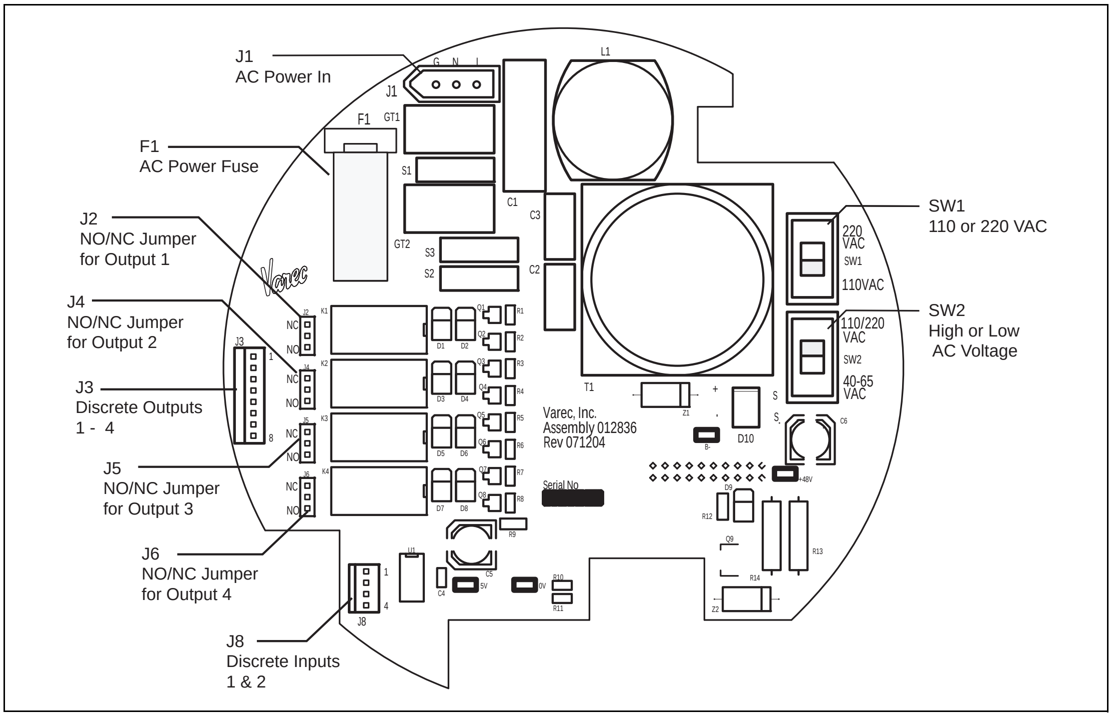



*Figure 4-12: AC Power Supply Circuit Board, Top View*

### 4.9.6 Connector Assignments: AC Power Supply Circuit Board

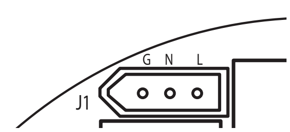
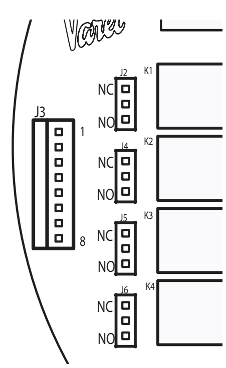
| Connector/Function | Terminal | Assignment | Illustration |
|---|---|---|---|
| J1<br>AC Power | L | Line |  |
| | N | Neutral | |
| | G | Ground | |
| J3<br>Discrete Outputs (4) | 1 | Output 1 + |  |
| | 2 | Output 1 – | |
| | 3 | Output 2 + | |
| | 4 | Output 2 – | |
| | 5 | Output 3 + | |
| | 6 | Output 3 – | |
| | 7 | Output 4 + | |
| | 8 | Output 4 – | |

*Table 4-5: Terminal Assignments - AC Power Circuit Board*

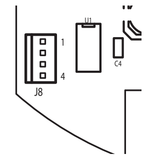
| Connector/Function | Terminal | Assignment | Illustration |
|---|---|---|---|
| J8<br>Discrete Inputs (2) | 1 | Input 1 + |  |
| | 2 | Input 1 – | |
| | 3 | Input 2 + | |
| | 4 | Input 2 – | |

*Table 4-5: Terminal Assignments – AC Power Circuit Board*

> **Note** Switches SW1 and SW2 on the AC Power circuit board determine the AC voltage setting for the 2900 FTT. See for instructions for setting the AC Power level.

> **Note** Each optional discrete output is set to NO or NC using a jumper setting. See for instructions

### 4.9.7 Selecting the AC Voltage Setting

The optional AC Power Supply circuit board can operate at one of three voltage ranges: low (40 – 65 VAC), medium (110 VAC), or high (220 – 240 VAC).

To set the voltage:

1. Set SW2 to low voltage (40 – 65 VAC) or medium/high voltage (110/220 VAC).
2. If SW2 is set to 110/220 VAC, set SW1 to 110 VAC or 220 VAC as appropriate.

   **Caution!** If SW2 is set to 40 – 65 VAC, set SW1 to 110 VAC to avoid blowing fuse F1.

Figure 4-13 shows AC voltage switches SW1 and SW2.

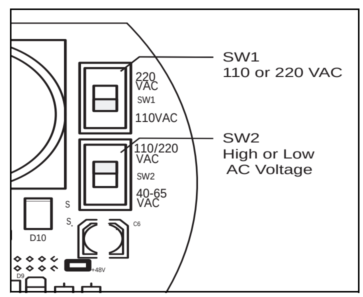



*Figure 4-13:AC Voltage Selection Switches*

### 4.9.8 Setting Optional Outputs as NC or NO

Each of the four discrete outputs on the AC Power Supply circuit board can be set to operate as Normally Closed (NC) or Normally Open (NO). A jumper connector determines the setting for each output, as shown in Figure 4-12 and in Table 4-5.

To set each output, push the jumper onto the NC and center pins for NC operation, or onto the NO and center pins for NO operation.

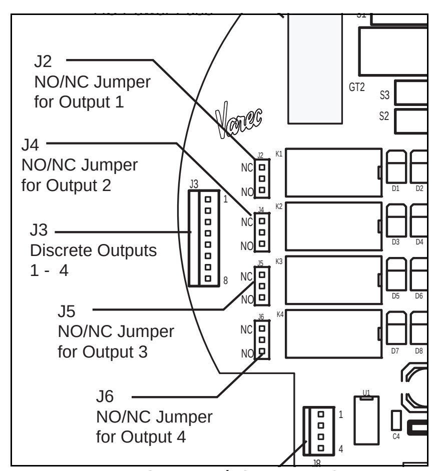



*Figure 4-14:Optional Outputs & Jumpers*

| Output | Jumper |
|---|---|
| 1 | J2 |
| 2 | J4 |
| 3 | J5 |
| 4 | J6 |

*Table 4-6: Output – Jumper Assignments – AC Power Circuit Board*

> **Note** Outputs are set to NC at the factory.

### 4.9.9 Wiring Limit Switches

Each of the optional SPDT limit switches can be wired for Normally Open (NO) or Normally Closed (NC) operation by using the appropriate terminals:

- Common and Normally Open
- Common and Normally Closed

Figure 4-6 shows the limit switch terminal connections.

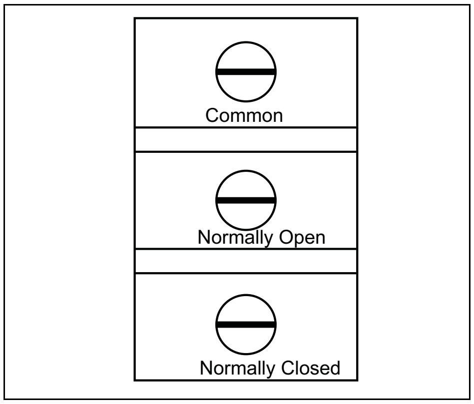



*Figure 4-15:Limit Switch Contacts*

# 5 Initial Configuration (Modbus or GSI Modbus)

After the 2900 FTT has been mounted and wired, it must be calibrated/configured as described in the list below. To transmit GSI Modbus data, see step 3.

1. Set the unit address (see Section 5.1, "Setting the Unit Address" on page 33).
2. Choose the communication setting (see Section 5.2, "Choosing Communications Settings" on page 34).
3. Set the data format (English or Metric units, Modbus or GSI Modbus) and rotation direction (see Section 5.3, "Setting the Data Format" on page 35).
4. Choose the RTD type (see Section 5.4, "Setting the RTD Type" on page 36).
5. Terminate the Modbus network (if required) (see Section 5.5, "Terminating the Modbus Network" on page 36).
6. Set the bias current (see Section 5.6, "Setting the Bias Current" on page 37).
7. Calibrate transmitter level and limit switches, and configure outputs (see Chapter 8 on page 47).

    **Note** This chapter contains instructions relevant to a Modbus or GSI Modbus application. If you are using Mark/Space, see Chapter 6 on page 39; for Tankway, see Chapter 7 on page 43.

Alarm and output setpoints can be configured via Modbus registers. See the “Appendix A — Modbus Implementation” section for an explanation of the Modbus protocol and Modbus register mapping tables.

Figure 5-1 shows the Modbus communications circuit board switch and LED locations.

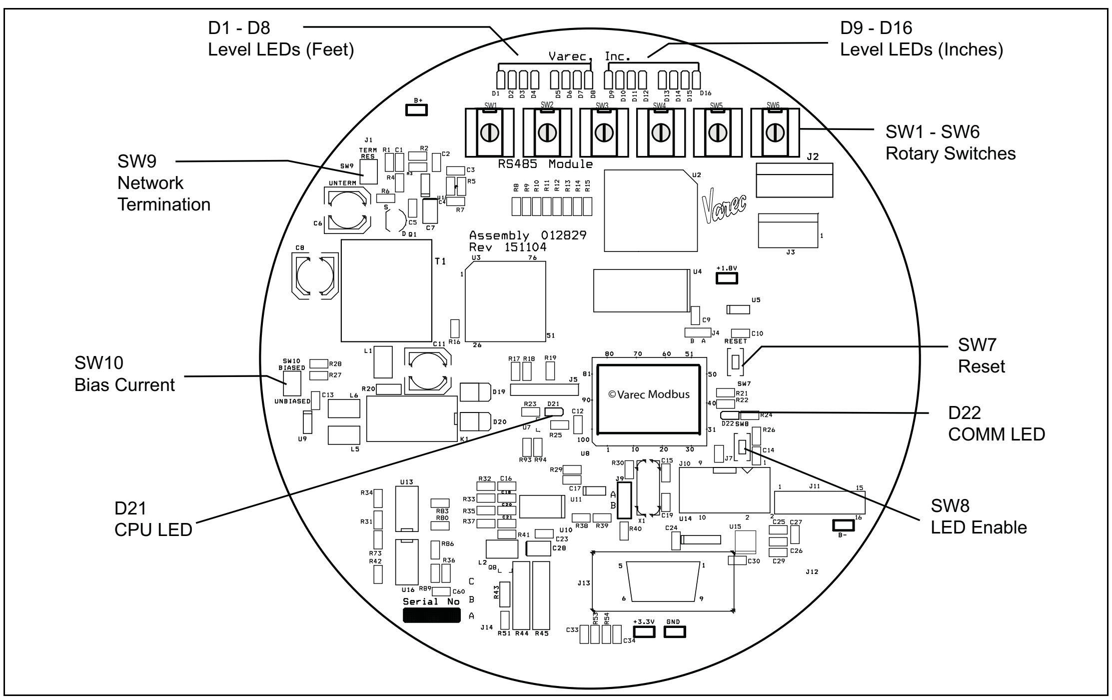



*Figure 5-1: Modbus Communication Board Switches and LEDs*

**Note** Firmware version indicates Modbus.

**Note** To check the status of the communications circuit board CPU, see Section 9.1.2, "Checking the CPU Status" on page 55. To check communications status, see Section 9.1.3, "Checking Communications Status" on page 56.

**Note** To activate the LEDs on the communications circuit board, press switch SW8 shown in Figure 5-1 on page 31. The LEDs will be enabled for about three minutes.

## 5.1 Setting the Unit Address

The unique address that identifies the 2900 FTT is set using rotary switches SW1–SW3. An address from 000 to 255 can be selected.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the unit address:

1. Remove the transmitter cover.
2. Set SW1 to SW3 to the desired unit address.
   For example: to assign an address of 001, set SW1 = 0, SW2 = 0, and SW3 = 1.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 5.2 Choosing Communications Settings

For the 2900 FTT in the Modbus configuration, switch SW4 is used to select the communication baud rate and parity setting.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To select communications settings:

1. Remove the transmitter cover.
2. Rotate switch SW4 to the appropriate position, as identified in the following table.

| Position | Setting | Description |
|---|---|---|
| 0 | 19200 N | 19200 Baud, no parity |
| 1 | 19200 O | 19200 baud, odd parity |
| 2 | 19200 E | 19200 baud, even parity |
| 3 | 9600 N | 9600 Baud, no parity |
| 4 | 9600 O | 9600 baud, odd parity |
| 5 | 9600 E | 9600 baud, even parity |
| 6 | 4800 N | 4800 Baud, no parity |
| 7 | 4800 O | 4800 baud, odd parity |
| 8 | 4800 E | 4800 baud, even parity |
| 9 | 2400 N | 2400 Baud, no parity |
| A | 2400 O | 2400 baud, odd parity |
| B | 2400 E | 2400 baud, even parity |
| C | 1200 N | 1200 Baud, no parity |
| D | 1200 O | 1200 baud, odd parity |
| E | 1200 E | 1200 baud, even parity |
| F | 9600 O | 9600 Baud, no parity |

*Table 5-1: Rotary Switch SW4 Positions*

3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 5.3 Setting the Data Format

The 2900 FTT can transmit data as standard Modbus data in feet or meters, with forward or reverse rotation. The 2900 FTT can also transmit GSI Modbus data in forward or reverse rotation. The position of switch SW5 determines which of those settings is used.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the data format:

1. Remove the transmitter cover.
2. Rotate switch SW5 to the appropriate position, as identified in the following table.

| Position | Setting |
|---|---|
| 0 | Feet & Forward Rotation |
| 1 | Meters & Forward Rotation |
| 2 | Feet & Reverse Rotation |
| 3 | Meters & Reverse Rotation |
| 4 | GSI Modbus MAP & Forward Rotation |
| 5 | GSI Modbus MAP & Reverse Rotation |
| 6 – F | Feet & Forward Rotation |

*Table 5-2: Rotary Switch SW5 Positions*

**Note** Setting the 2900 FTT data format to Meters assumes that the transmitter is/will be installed on a metric mechanical gauge. Setting the data format to Feet assumes that the transmitter is/will be installed on an Imperial mechanical gauge.

3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 5.4 Setting the RTD Type

To accurately obtain readings from a spot temperature RTD (Resistance Temperature Detector), the 2900 FTT must be set to match the RTD type and temperature format. Types vary according to the metal used, the probe resistance, and the temperature format (Fahrenheit/Centigrade).

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the RTD type:

1. Remove the transmitter cover.
2. Rotate switch SW6 to the appropriate position, as identified in the following table.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

| Position | Setting | Description |
|---|---|---|
| 0 | Pt100 & F | Platinum, 100 ohms, Fahrenheit |
| 1 | Pt100 & C | Platinum, 100 ohms, Centigrade |
| 2 | Cu100 & F | Copper, 100 ohms, Fahrenheit |
| 3 | Cu100 & C | Copper, 100 ohms, Centigrade |
| 4 | Cu90 & F | Copper, 90 ohms, Fahrenheit |
| 5 | Cu90 & C | Copper, 90 ohms, Centigrade |
| 6 | NO Temperature | Temperature disabled |

*Table 5-3: Rotary Switch SW6 Positions*

## 5.5 Terminating the Modbus Network

In a Modbus network, the transmitter that is located the farthest from the master on the main Modbus communication trunk normally terminates the network. You can terminate the network at a 2900 FTT by closing a switch to apply a 100-ohm resistor across the network line. This switch is normally set in the UNTERM position.

**Note** A terminator resistor is not needed for Modbus networks operating at a baud rate below 9600.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To terminate the network line at the transmitter:

1. Remove the transmitter cover.
2. On the communications circuit board, set switch SW9 to the TERM RES (up) position.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

**Note** No more than one transmitter on a communications bus should terminate the network.

## 5.6 Setting the Bias Current

In a Modbus network, during periods of no communications, all devices on the trunk are in high-impedance states. This causes the data+ and data- lines to “float” meaning that they may not have a fixed voltage.

To remedy this situation, pull-up and pull-down resistors are typically used to provide a small bias current on the network. This current holds the data+ and data- lines at predetermined high and low voltage settings. Bias current is normally provided at the host, but you can provide it at the 2900 FTT using switch SW10.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To apply the bias resistors to the Modbus network:

1. Remove the transmitter cover.
2. On the communications circuit board, set switch SW10 to the BIASED (up) position.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

**Note** Applying the Bias Current on multiple 2900 FTT transmitters could cause poor performance in the Modbus communications bus.

# 6 Initial Configuration (Mark/Space)

After the 2900 FTT has been mounted and wired, it must be calibrated/configured as described in the list below.

1. Set the unit address (see Section 6.1, "Setting the Unit Address" on page 40).
2. Choose the communication setting (see Section 6.2, "Choosing Communications Settings" on page 40).
3. Set the data format (see Section 6.3, "Setting the Data Format" on page 41).
4. Choose the RTD type (see Section 6.4, "Setting the RTD Type" on page 42).
5. Calibrate transmitter level, calibrate limit switches, and configure outputs (see Chapter 8 "Configuration & Calibration — Level, Limits, Outputs" on page 47).

   **Note** This chapter contains instructions relevant to a Mark/Space application. If you are using Modbus or GSI Modbus, see Chapter 5 "Initial Configuration (Modbus or GSI Modbus)" on page 31; for Tankway, see Chapter 7 "Initial Configuration (Tankway)" on page 43.

See Figure 6-1 for the location of the switches and LEDs on the 2900 FTT Mark/Space communications circuit board.

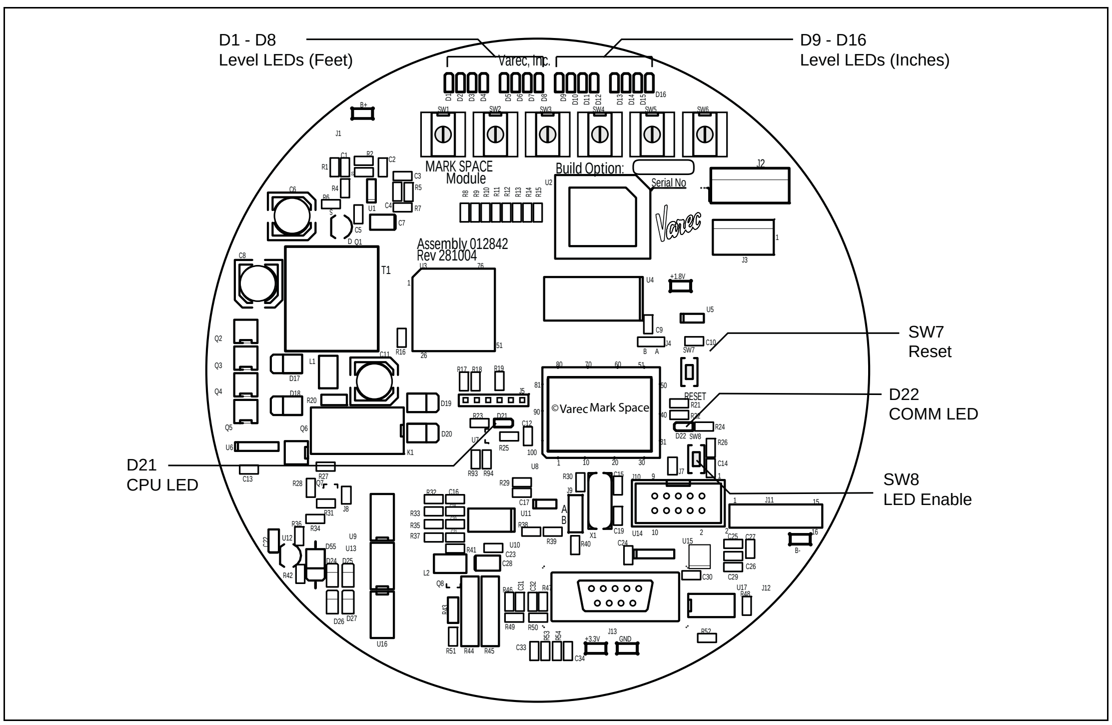



*Figure 6-1: Mark/Space Communication Board Switches and LEDs*

**Note** Firmware version indicates Mark/Space.

**Note** To check the status of the communications circuit board CPU, see Section 9.1.2, "Checking the CPU Status" on page 55. To check communications status, see Section 9.1.3, "Checking Communications Status" on page 56.

**Note** To activate the LEDs on the communications circuit board, press switch SW8, shown in Figure 6-1. The LEDs will be enabled for about three minutes.

## 6.1 Setting the Unit Address

The unique address that identifies the 2900 FTT is set using rotary switches SW1–SW3. An address from 000 to 255 can be selected.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the unit address:

1. Remove the transmitter cover.
2. Set SW1 to SW3 to the desired unit address.
   For example: to assign an address of 001, set SW1 = 0, SW2 = 0, and SW3 = 1.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 6.2 Choosing Communications Settings

The 2900 FTT can operate as a Varec 1800 or 1900 MWT transmitter, or as a GSI 2000 transmitter for level and temperature format. The data speed can be set to high or low, and the transmitter can be set for forward or reverse rotation.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To select communications settings:

1. Remove the transmitter cover.
2. Rotate switch SW4 to the appropriate position, as identified in the following table.

| Position | Setting |
|---|---|
| 0 | 1900 MWT & High Speed & Forward Rotation |
| 1 | 1900 MWT & High Speed & Reverse Rotation |
| 2 | 1900 MWT & Low Speed & Forward Rotation |
| 3 | 1900 MWT & Low Speed & Reverse Rotation |
| 4 | 1800 & High Speed & Forward Rotation |
| 5 | 1800 & High Speed & Reverse Rotation |
| 6 | 1800 & Low Speed & Forward Rotation |
| 7 | 1800 & Low Speed & Reverse Rotation |
| 8 | GSI 2000 & High Speed & Forward Rotation |
| 9 | GSI 2000 & High Speed & Reverse Rotation |
| 10 | GSI 2000 & Low Speed & Forward Rotation |
| 11 | GSI 2000 & Low Speed & Reverse Rotation |
| C–F | 1900 MWT & High Speed & Forward Rotation |

*Table 6-1: Rotary Switch SW4 Positions*

3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 6.3 Setting the Data Format

The 2900 FTT can transmit data in English or Metric format.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the data format:

1. Remove the transmitter cover.
2. Rotate switch SW5 to the appropriate position, as identified in the following table.

| Position | Setting |
|---|---|
| 0 | Fractional Feet |
| 1 | Decimal Feet |
| 2 | 0-20 Meters |
| 3 | 0-28.8 Meters |
| 4-F | Fractional Feet |

*Table 6-2: Rotary Switch SW5 Positions*

**Note** Setting the 2900 FTT data format to Meters assumes that the transmitter is/will be installed on a metric mechanical gauge. Setting the data format to Feet assumes that the transmitter is/will be installed on an Imperial mechanical gauge.

3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 6.4 Setting the RTD Type

To accurately obtain readings from a spot temperature RTD (Resistance Temperature Detector), the 2900 FTT must be set to match the RTD type and temperature format. Types vary according to the metal used, the probe resistance, and the temperature format (Fahrenheit/Centigrade).

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the RTD type:

1. Remove the transmitter cover.
2. Rotate switch SW6 to the appropriate position, as identified in the following table.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

| Position | Setting | Description |
|---|---|---|
| 0 | Pt100 & F | Platinum, 100 ohms, Fahrenheit |
| 1 | Pt100 & C | Platinum, 100 ohms, Centigrade |
| 2 | Cu100 & F | Copper, 100 ohms, Fahrenheit |
| 3 | Cu100 & C | Copper, 100 ohms, Centigrade |
| 4 | Cu90 & F | Copper, 90 ohms, Fahrenheit |
| 5 | Cu90 & C | Copper, 90 ohms, Centigrade |
| 6 | NO MS Temperature | no temperature input<br>40-bit Mark/Space Response message |
| 7 | Pt100 & F & 100 Offset | Platinum, 100 ohms, Fahrenheit, 100 deg. offset |
| 8 | Pt100 & C & 100 Offset | Platinum, 100 ohms, Centigrade, 100 deg. offset |
| 9 | Cu100 & F & 100 Offset | Copper, 100 ohms, Fahrenheit, 100 deg. offset |
| A | Cu100 & C & 100 Offset | Copper, 100 ohms, Centigrade, 100 deg. offset |
| B | Cu90 & F & 100 Offset | Copper, 90 ohms, Fahrenheit, 100 deg. offset |
| C | Cu90 & C & 100 Offset | Copper, 90 ohms, Centigrade, 100 deg. offset |
| D-F | Pt100 & F & 100 Offset | Platinum, 100 ohms, Fahrenheit, 100 deg. offset |

*Table 6-3: Rotary Switch SW6 Positions*

# 7 Initial Configuration (Tankway)

After the 2900 FTT has been mounted and wired, it must be calibrated/configured as described in the list below.

1. Set the unit address (see Section 7.1, "Setting the Unit Address" on page 44).
2. Choose the communication setting (see Section 7.2, "Choosing Communications Settings" on page 44).
3. Choose the RTD type (see Section 7.3, "Setting the RTD Type" on page 45).
4. Calibrate transmitter level, calibrate limit switches, and configure outputs (see Chapter 8 on page 47).

   **Note** This chapter contains instructions relevant to an L&J Tankway application. If you are using Mark/Space, see Chapter 6; for Modbus or GSI Modbus, see Chapter 5.

See Figure 7-1 for the location of the switches and LEDs on the 2900 FTT Mark/Space communications circuit board.

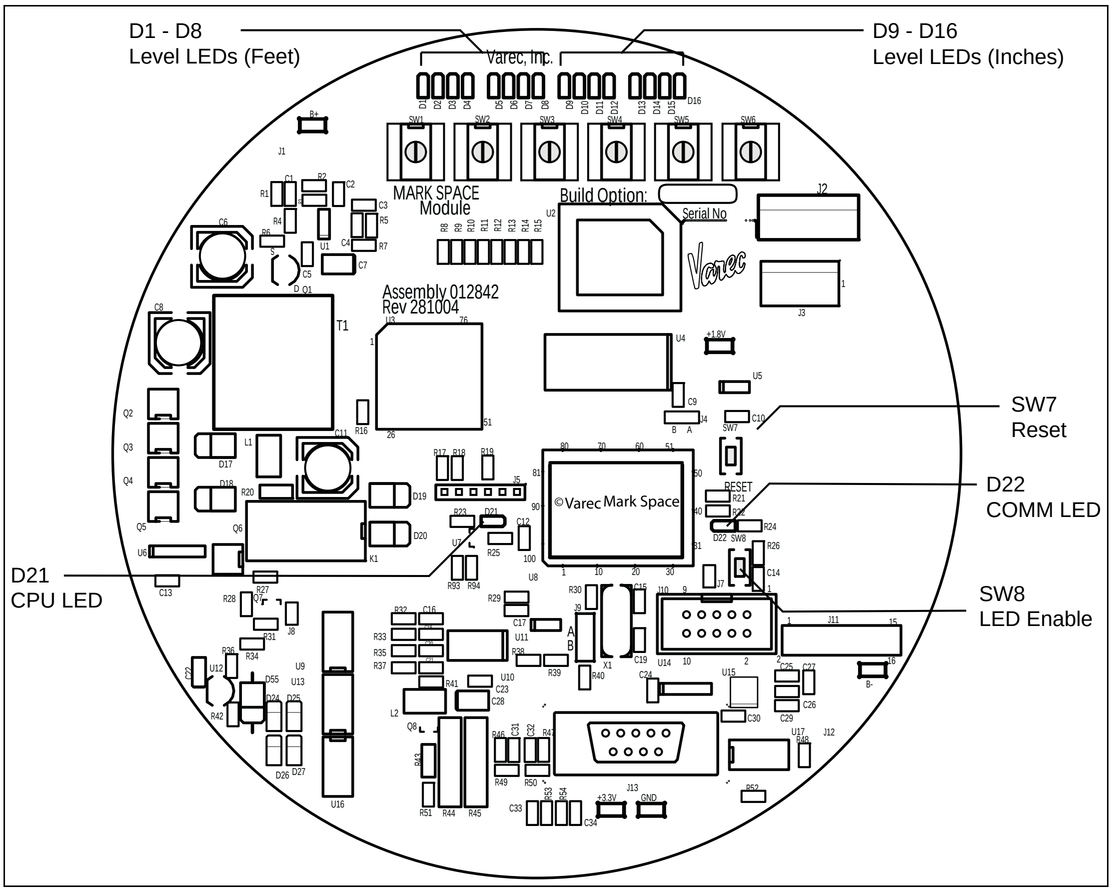



*Figure 7-1: Mark/Space Communication Board Configured for L&J Tankway – Switches and LEDs*

**Note** Firmware version indicates Tankway.

**Note** To check the status of the communications circuit board CPU, see Section 9.1.2, "Checking the CPU Status" on page 55. To check communications status, see Section 9.1.3, "Checking Communications Status" on page 56.

**Note** To activate the LEDs on the communications circuit board, press switch SW8, shown in Figure 7-1. The LEDs will be enabled for about three minutes.

## 7.1 Setting the Unit Address

The unique address that identifies the 2900 FTT is set using rotary switches SW1–SW3. An address from 000 to 127 can be selected.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the unit address:

1. Remove the transmitter cover.
2. Set SW1 to SW3 to the desired unit address.
   For example: to assign an address of 001, set SW1 = 0, SW2 = 0, and SW3 = 1.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 7.2 Choosing Communications Settings

The 2900 FTT can operate as an L&J 1000 MWT, 1500 MWT, or 2000 MWT. The Tank Data can be set for 1 or 4 data modes.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To select communications settings:

1. Remove the transmitter cover.
2. Rotate switch SW4 to the appropriate position, as identified in the following table.

| Position | Setting | Description |
|---|---|---|
| 0 | Device Type 1 | L&J 2000 MWT, for Varec gauges (forward encoding) |
| 1 | Device Type 2 | L&J 2000 MWT, for Shand & Jurs gauges (reverse encoding) |
| 2 | Device Type 3 | L&J 1000 MWT / 1500 MWT |
| 3 | Device Type 4 | L&J 1000 MWT / 1500 MWT |
| 4–F | Device Type 1 | L&J 2000 MWT, for Varec gauges (forward encoding) |

*Table 7-1: Rotary Switch SW4 Positions*

3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

## 7.3 Setting the RTD Type

To accurately obtain readings from a spot temperature RTD (Resistance Temperature Detector), the 2900 FTT must be set to match the RTD type and temperature format. Types vary according to the metal used and the probe resistance.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the RTD type:

1. Remove the transmitter cover.
2. Rotate switch SW6 to the appropriate position, as identified in the following table.
3. Press switch SW7 to reset the CPU.
4. Replace the transmitter cover.

| Position | Setting | Description |
|---|---|---|
| 0 | Pt100 | Platinum, 100 ohms |
| 1 | Cu100 | Copper, 100 ohms |
| 2 | Cu90 | Copper, 90 ohms |
| 3 | none | RTD not used |
| 4 - F | Pt100 | Platinum, 100 ohms |

*Table 7-2: Rotary Switch SW6 Positions*

# 8 Configuration & Calibration — Level, Limits, Outputs

After the you have performed the protocol-specific configuration procedures for the 2900 FTT, the following configuration & calibration tasks remain:

1. Take a manual reading of the tank contents.
2. Set the transmitter level to match the tank gauge level reading (see Section 8.1.2, "Setting the Transmitter Level" on page 48).
3. Calibrate limit switches (if used) to the desired tank level (see Section 8.2, "Calibrating Limit Switches" on page 49).
4. Configure outputs (if used) (Section 8.3, "Configuring Outputs" on page 50).

   **Note** Configuration is not required for input devices. Each input must be wired to the 2900 FTT as described in Chapter 4 "Wiring" on page 13. The input (alarm) status can then be monitored from the system master as described in Section C.4.2.2, "Monitoring Input Devices" on page 103.

See Figure 8-1 for the location of the switches and LEDs on the 2900 FTT Mark/Space communications circuit board.

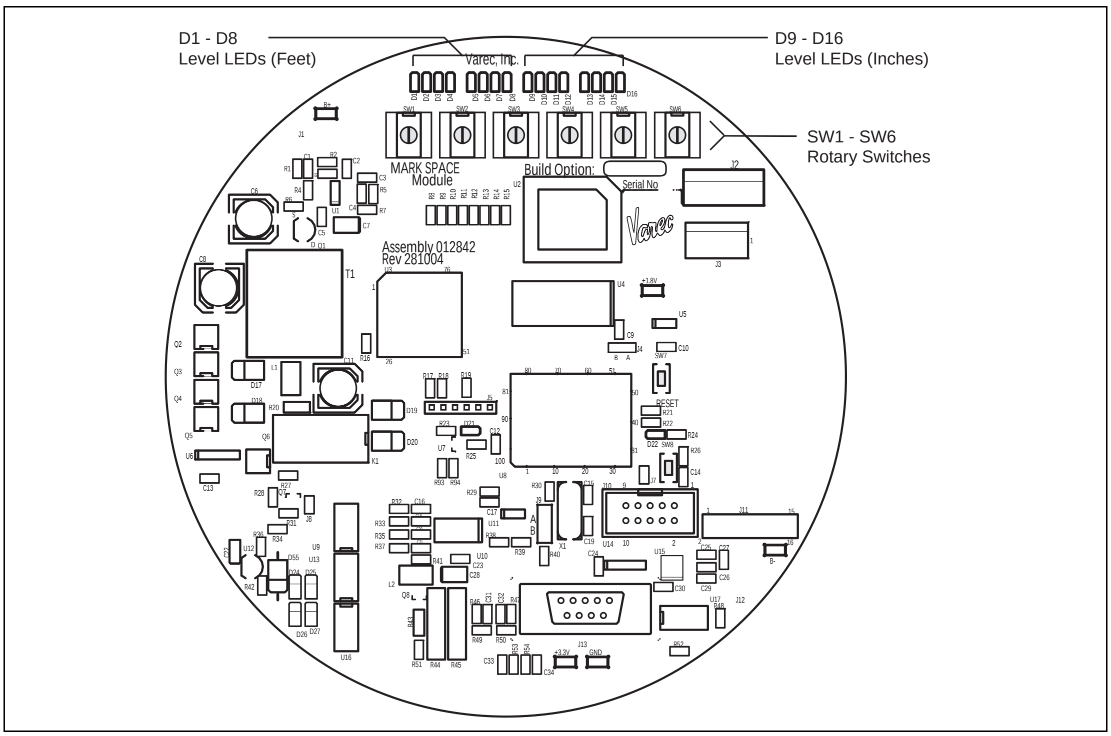



*Figure 8-1: Mark/Space Communication Board Switches and LEDs*

## 8.1 Calibrating the Transmitter Tank Level

### 8.1.1 Before You Begin

Before setting the transmitter level, perform a manual tank level reading and verify that the level gauge is calibrated properly. If it is not, calibrate the gauge as directed in the gauge installation and operation manual.

This procedure assumes that the transmitter has been mounted to the gaugehead back cover and wired.

**Note** The 2900 FTT utilizes an absolute encoder that maintains the correct level reading during and after a power outage, without a battery backup. No additional configuration is required after a power outage.

### 8.1.2 Setting the Transmitter Level

To set the transmitter level:

1. Remove the transmitter cover.

   **Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

2. Loosen the setscrew on the encoder driveshaft coupling, as shown in Figure 8-2. This allows the encoder to rotate freely without rotating the coupling.

   **Caution!** Excessively loosening the setscrew will cause the coupling to fall. Loosen the setscrew only to the extent required to free the encoder.

3. Rotate the encoder assembly until the correct level reading is displayed by the host system, a laptop running ViewRTU, a VTA, or diagnostic LEDs D1 - D16.

   **Note** To use the LEDs for calibration, see “Appendix B — Setting the Transmitter Level Using the LEDs” on page 89.

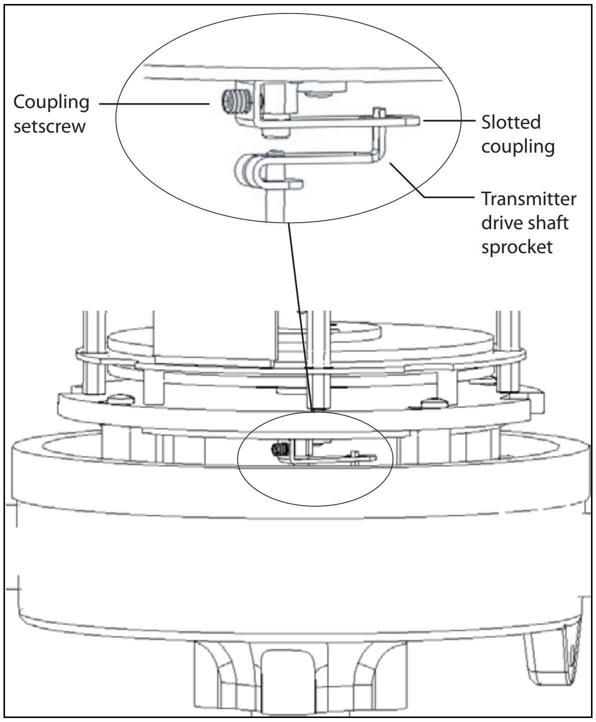



*Figure 8-2:2900 FTT Drive Shaft Coupling*

   **Note** ViewRTU displays the 2900 FTT level reading in feet, inches, and sixteenths, when ViewRTU is running on a laptop connected directly to the 2900 FTT. This information is in the ENC data block. For more information, see “Appendix C — Database Points” on page 97, and Section 9.2.2, "Using ViewRTU to Troubleshoot the 2900 FTT" on page 62.

4. Tighten the setscrew on the encoder coupling.
5. Replace the transmitter cover.

## 8.2 Calibrating Limit Switches

Limit switches are cam-operated SPDT (Single-Pull, Double-Throw) switches that are used to turn on alarms or other devices when the tank contents reach a predetermined level. Two or four limit switches are available as an option with the 2900 FTT.

Limit switches are mounted on the 2900 FTT encoder assembly and are mechanically driven directly from the transmitter drive shaft. Each switch can be set to close or open at any tank level.

> **Note** All limit switches are wired Normally Open (NO) at the factory. If Normally Closed (NC) contacts are required, you must change the wiring at the switch. See Section 4.9.9, "Wiring Limit Switches" on page 30.
>
> **Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To calibrate limit switches:

1. Remove the transmitter cover.
2. Loosen the coupling on the transmitter drive shaft (see Figure 8-2 on page 48).
3. Rotate the 2900 FTT encoder disks until the level reading to activate the switch is displayed by the host, VTA, or diagnostic LEDs D1 - D16.

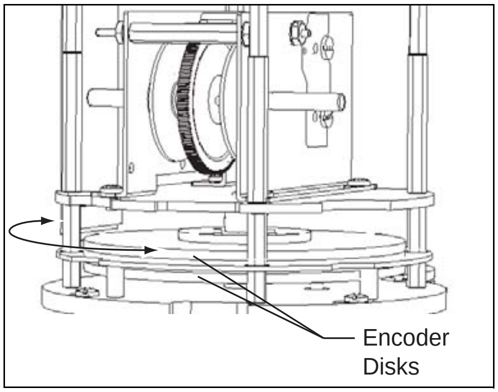



*Figure 8-3:Encoder Disks*

4. Turn the cam until the switch activates with an audible click.
5. Gently turn the encoder disks back and forth to verify that the switch is operating properly.
6. Repeat steps 4 through 7 for each of the remaining limit switches.
7. Rotate the 2900 FTT encoder disks until the correct level reading (matching the gauge) is displayed by the host system, VTA, or diagnostic LEDs D1 - D16.

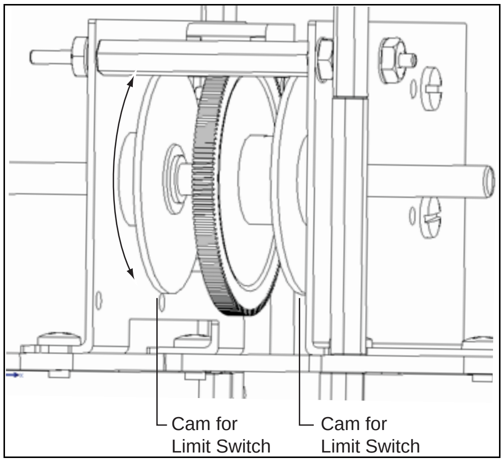



*Figure 8-4:Limit Switch Cams*

8. Tighten the coupling on the transmitter drive shaft.
9. Replace the transmitter cover.

## 8.3 Configuring Outputs

To configure outputs for the 2900 FTT, you must connect a laptop computer running the ViewRTU software to the RS-232 port. You then use ViewRTU to define alarm conditions and to assign a condition to each output.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

**Note** For more detailed information regarding the ViewRTU program, refer to any Varec RTU Installation and Operation manual.

To configure outputs:

1. Remove the 2900 FTT cover.
2. Connect a laptop computer running ViewRTU software to the RS-232 connector (J13) on the communications circuit board. Figure 8-5 shows the connector.

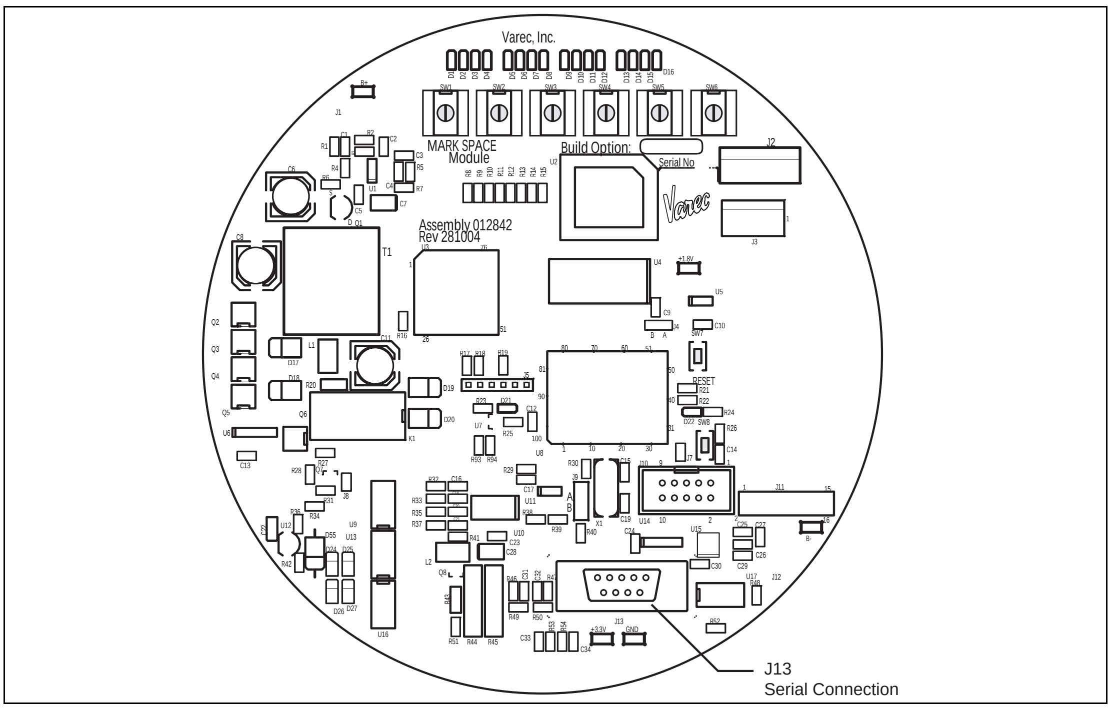
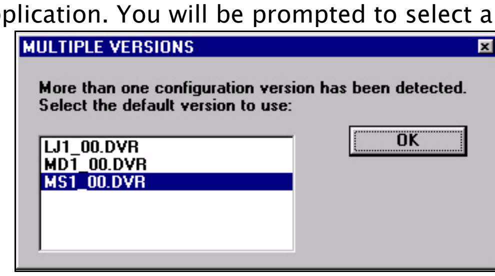



*Figure 8-5: Communication Board Connectors, Top View (Mark/Space shown)*

**Note** Input and output contacts are identified in Table 4-4 on page 26 and Table 4-5 on page 28.

3. Start the ViewRTU application. You will be prompted to select a firmware version file.




In the file names, LJ = L&J Tankway, MD = Modbus, and MS = Mark/Space.

4. Select the file that matches the communications protocol used by the 2900 FTT, and then click OK.The main screen appears, as shown in Figure 8-6.

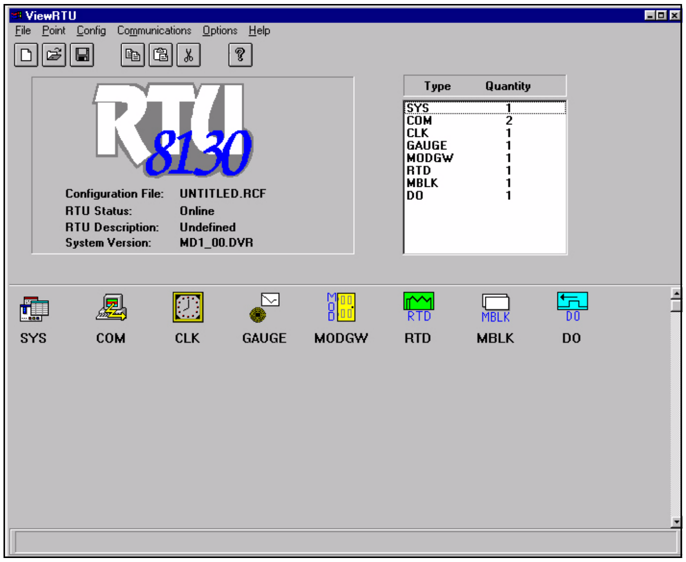


*Figure 8-6: ViewRTU Main Window*

5. Using the icons or the Point menu, select the MBLK point. The MBLK dialog box appears, showing data items that can be modified.

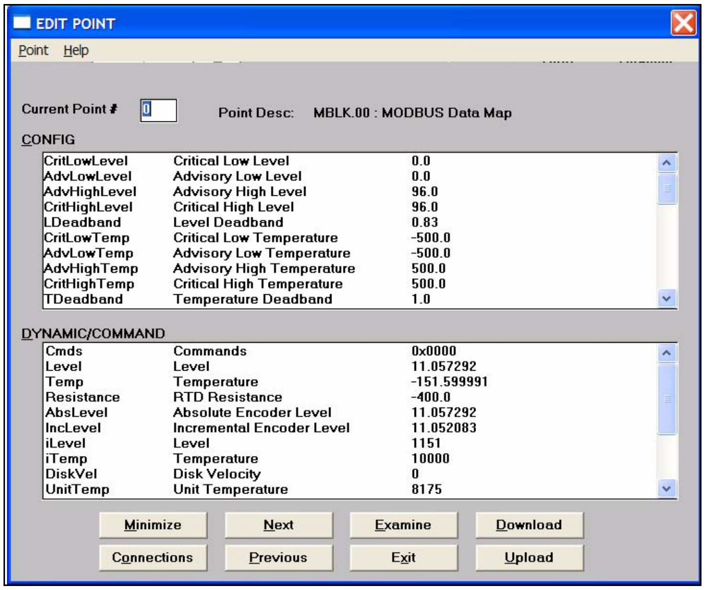


*Figure 8-7: ViewRTU Edit Point - MBLK Window*

6. Define the alarm conditions that can be used for outputs. At minimum, set values for the following parameters:

   CritLowLevel, AdvLowLevel, AdvHighLevel, CritHighLevel, LDeadband, CritLowTemp, AdvLowTemp, AdvHighTemp, CritHighTemp, TDeadband, MinLevel, MaxLevel, MinTemp, MaxTemp

   Refer to Section C.4, "Modbus Register Block (MBLK)" on page 103 for information about each point (parameter).

7. Set any other MBLK parameters as appropriate.
8. Click the Exit button to return to the main screen.
9. Using the icons or the Point menu, select the DO point. The DO dialog box appears, showing data items that can be modified.

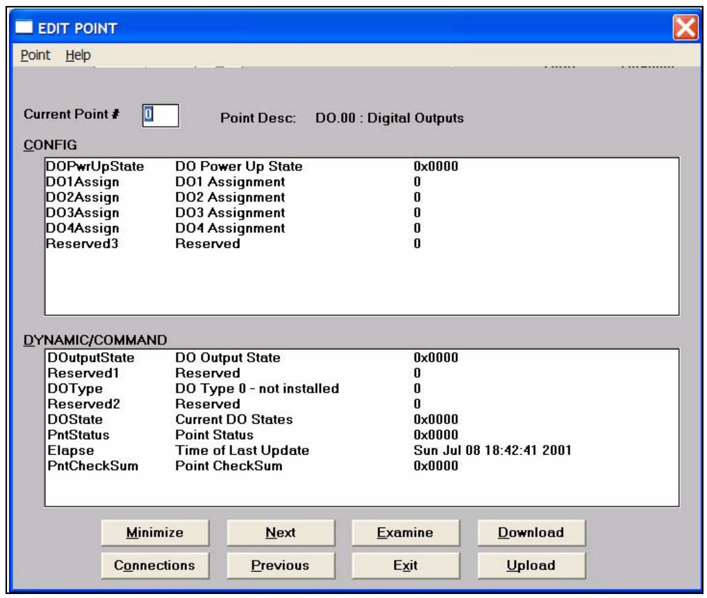



*Figure 8-8: ViewRTU Edit Point - DO Window*

10. Assign a control & activation event to each direct output by defining parameters DO1Assign - D04Assign. Refer to Section C.5, "Digital Outputs (DO)" on page 107 for more information.
11. To make a relay active at system startup, set the appropriate register in the DOPwrUpState parameter.
12. Click the Exit button.
13. Close ViewRTU.
14. Disconnect the laptop computer cable from the RS-232 connector.
15. Replace the 2900 FTT cover.

# 9 Maintenance and Troubleshooting

## 9.1 Maintenance

The 2900 FTT is designed and manufactured to provide accurate and reliable operation with no scheduled maintenance. The microprocessor is galvanically isolated from the power supply and optically isolated from the communications circuits. The 2900 FTT can also perform self-diagnostics. If a problem is encountered, the transmitter will isolate itself from the field communication bus.

Firmware upgrades and additional features can be installed in the field using a plug-in EPROM. For instructions, see Section 9.1.5, "Upgrading Software" on page 60.

Varec can provide spare parts, maintenance kits, preventive maintenance advice, training, and warranties upon request.

**Note** To activate the LEDs on the communications circuit board, press switch SW8, shown in Figure 9-1 on page 54. The LEDs will be enabled for about three minutes.

**Note** The communications board must be reset to register configuration changes, including changes to rotary switches. To restart the CPU, see Section 9.2.4, "Resetting the 2900 FTT" on page 64.

### 9.1.1 Aligning the Encoder Disks

To detect changes in level, the 2900 FTT uses optical detector arrays to monitor the positions of two rotating encoder disks. In the factory, each disk is positioned precisely in relationship to the detector arrays to ensure accurate readings. If the encoder assembly is disassembled at any time after shipment, the encoder disks must be realigned using the following procedure.

#### *9.1.1.1 Before You Begin*

You must decouple the 2900 FTT driveshaft from the level gauge before aligning the encoder disks. Although this can be performed with the 2900 FTT mounted on a level gauge (see Section 8.1.2, "Setting the Transmitter Level" on page 48 for decoupling instructions), the procedure can be performed more quickly on the bench.

#### *9.1.1.2 Aligning the Encoder Disks*

To align the encoder disks:

1. Ensure that the 2900 FTT driveshaft is spinning freely (decoupled or removed to the bench).
2. Press switch SW8 on the communications circuit board to enable the LEDs. To locate SW8, see Figure 9-1 on page 54.

   **Note** The LEDs will remain on for approximately three minutes after SW8 is pressed.

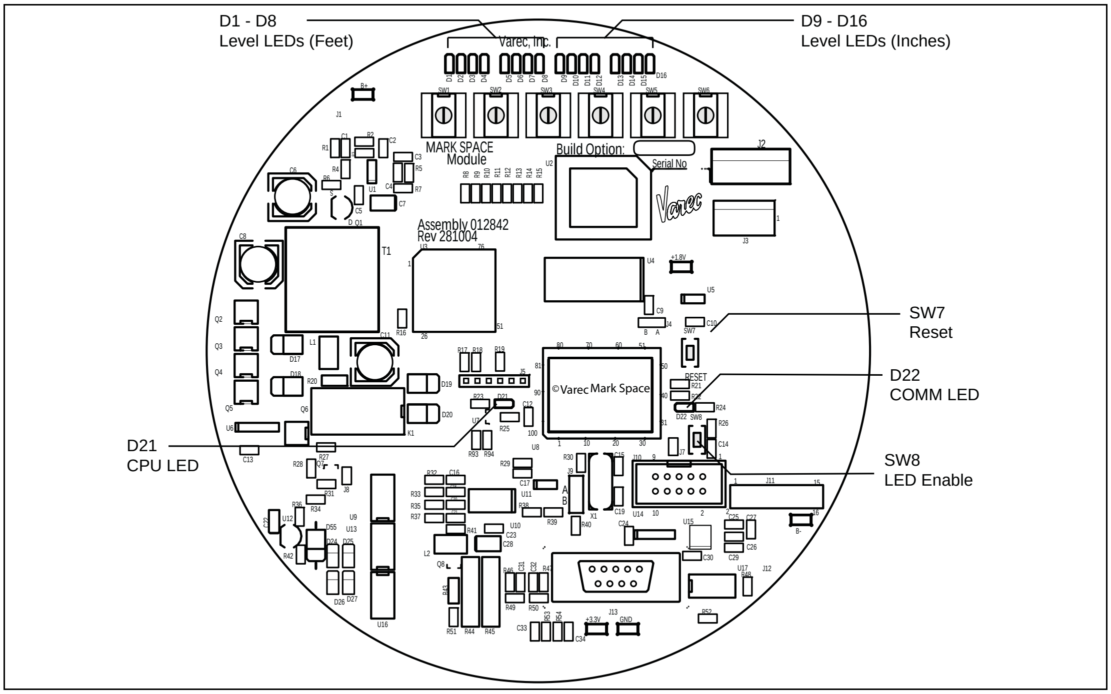



*Figure 9-1: Communications Board Diagnostic Switches and LEDs (Mark/Space shown)*

3. Rotate the encoder to ensure that each level LED (D1- D16) lights at least once.
4. Rotate the encoder to the 48-foot level.


*Figure 9-2: LEDs D1 - D9 - Indication for 48 feet*

For instructions for using the LEDs to set the transmitter level, "Appendix B — Setting the Transmitter Level Using the LEDs" on page 89.

5. Loosen both setscrews on the Inch disk hub. This allows the foot disk to be rotated with the shaft without moving the inch disk.

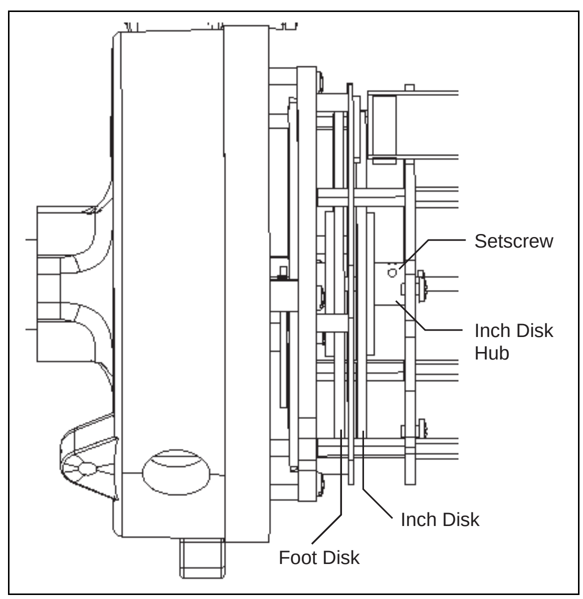



*Figure 9-3: Encoder Disks & Setscrews*

6. Re-tighten one setscrew slightly. This will keep the inch disk coupled to the shaft with a small amount of friction so that adjustments to the inch disk will remain in place during free rotation of the encoder.
7. Rotate the shaft until LEDs D1 - D8 transition between the 47 1/2-foot and 48-foot points (see Figure 9-2). Hold the shaft in place. This is the Foot disk transition point.

8. While holding the shaft in place, rotate the Inch disk until LEDs D9 – D16 transition between the 5 15/16-inch and 6-inch points (see Figure 9-2 on page 54). This is the Inch disk transition point.
9. Hold the shaft and the Inch disk at the transition point and tighten both setscrews on the Inch disk hub.

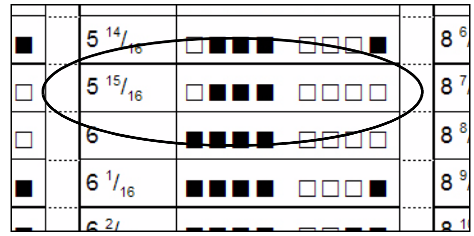



*Figure 9-4: LEDs D9 – D16 – Indication for 6 Inches*

10. Check alignment by spinning the disks back to the transition point and watching LEDs D1 – D9 and D10 – D16. Both the foot and inch disks should arrive at the transition point at the same time.

### 9.1.2 Checking the CPU Status

The 2900 FTT provides a CPU status LED (D21) on the communications circuit board. You can visually check this LED to ensure that processor is operating properly.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To check the processor status:

1. Remove the 2900 FTT cover.
2. Press switch SW8 on the communications circuit board. The LEDs illuminate. See Figure 9-5 for switch and LED locations.
3. Verify that LED D21 (CPU) flashes on and off about once every three seconds. This indicates normal CPU operation.

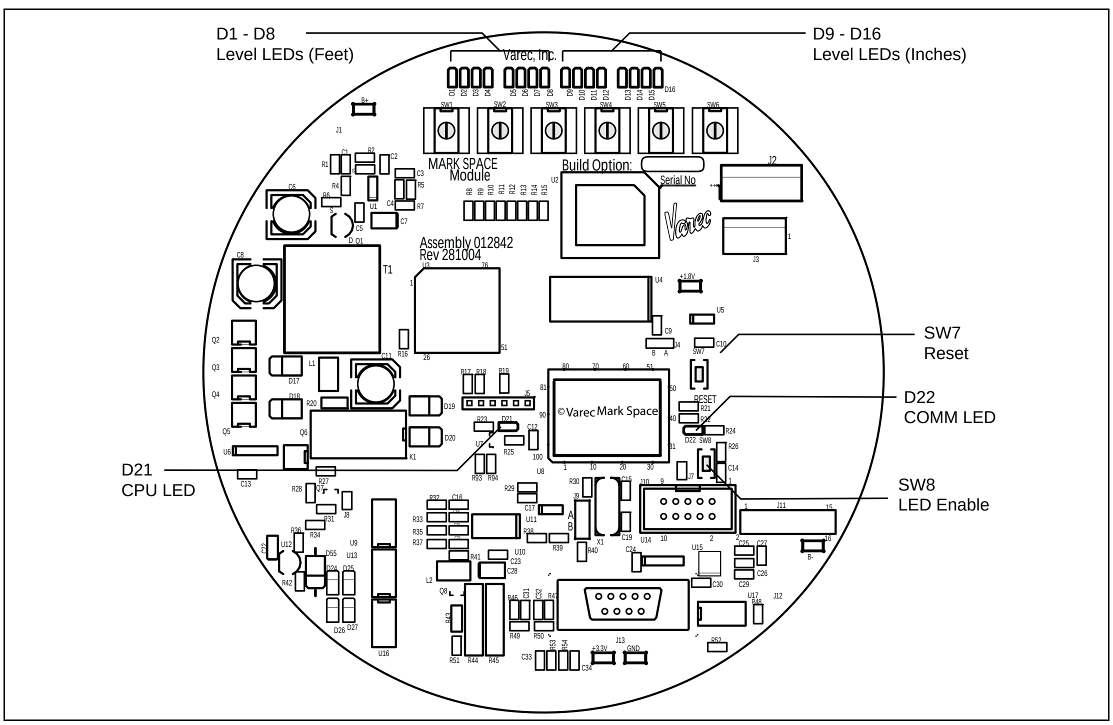



*Figure 9-5: Communications Board Diagnostic Switches and LEDs (Mark/Space shown)*

### 9.1.3 Checking Communications Status

The 2900 FTT provides a COMM status LED (D22) on the communications circuit board. You can use this LED to visually verify that the circuit board is being polled by a host system and/or is transmitting information.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To check the processor status:

1. Remove the 2900 FTT cover.
2. Press switch SW8 on the communications circuit board. The LEDs illuminate. See Figure 9-6 for switch and LED locations.
3. Check LED D22 (COMM):
   - If the LED flashes on and off periodically, the 2900 FTT is communicating with an external system (being polled and/or transmitting). The rate is dependent on the communications baud rate.
   - If the LED stays on (illuminated) or off, the 2900 FTT is not communicating with an external system.

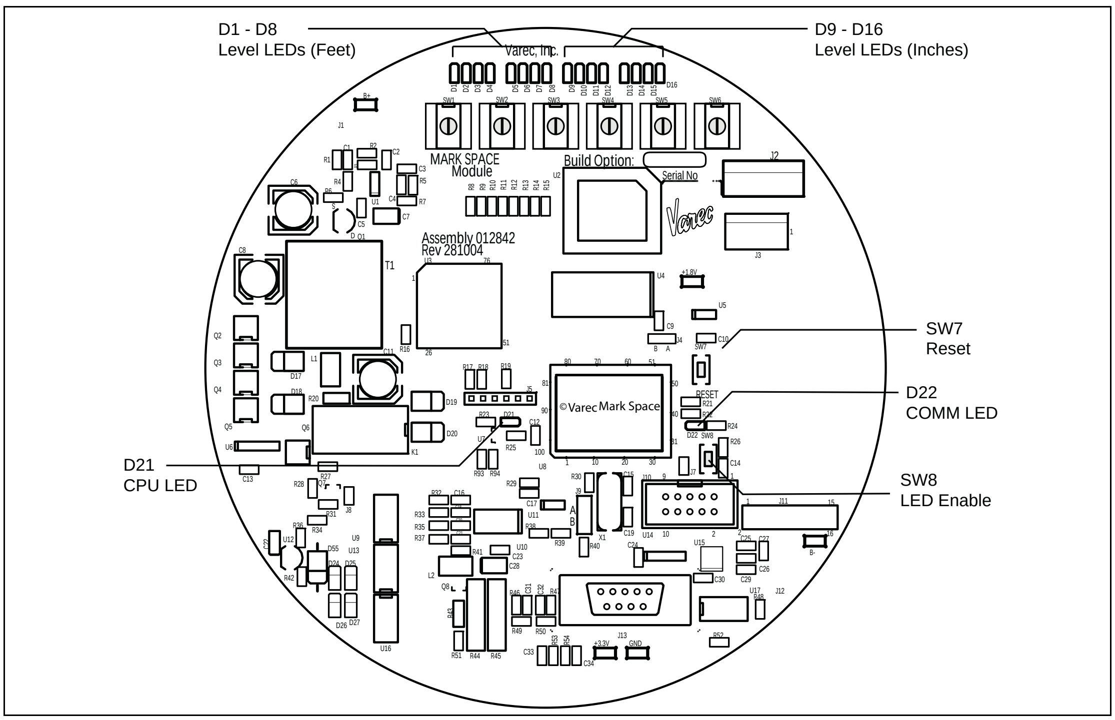



*Figure 9-6: Communications Board Diagnostic Switches and LEDs (Mark/Space shown)*

### 9.1.4 Spare Parts

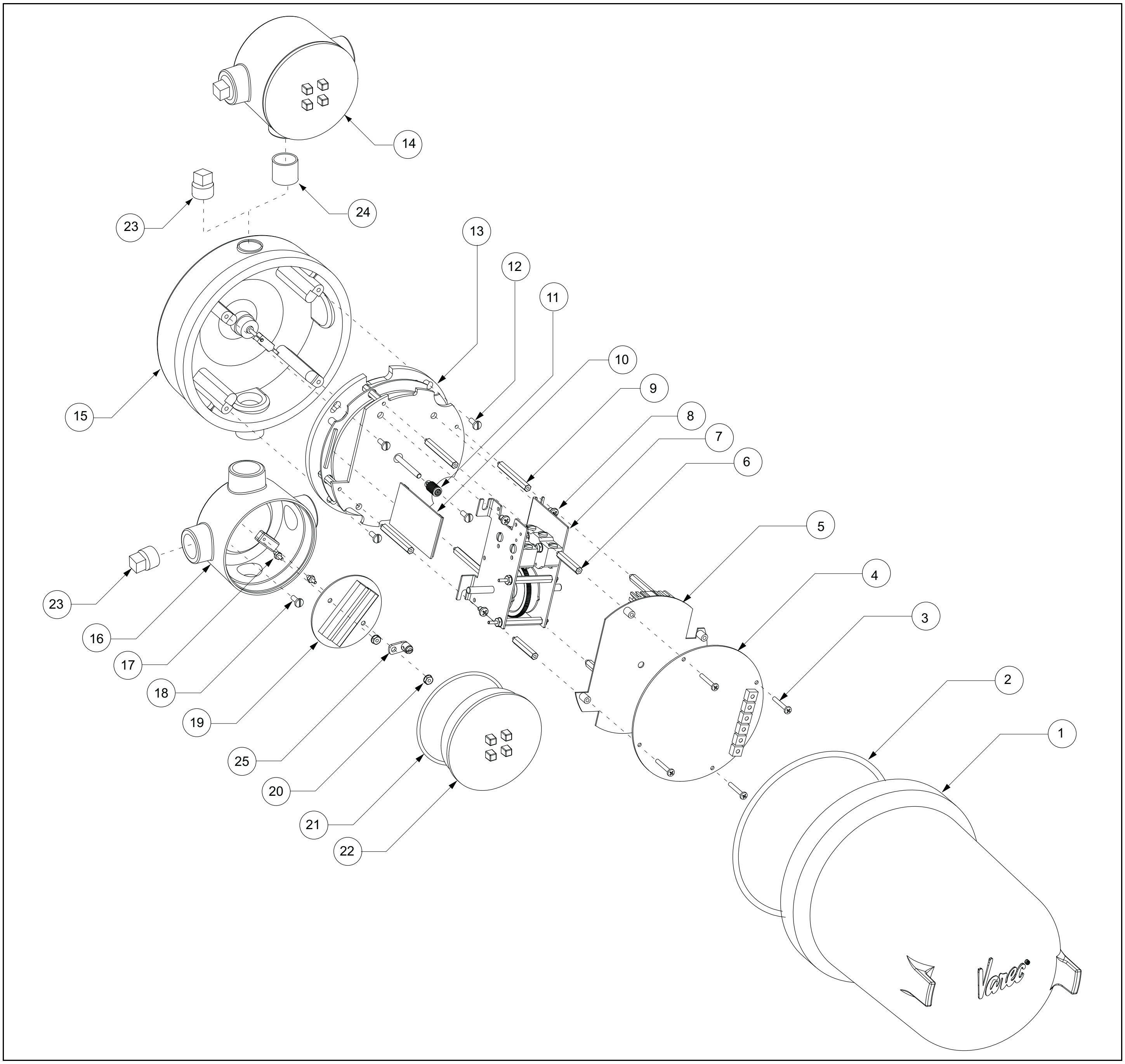



*Figure 9-7: 2900 FTT Exploded Parts Diagram*

| Drawing # | Spare Part # | Description |
|---|---|---|
| 1 | D5235-011 | 2900 FTT enclosure cover |
| 2 | P104-18-5235 | Enclosure cover O-ring |
| 3 | 283061477 | Communications board machine screw (x4) |
| 4a | 08-12842-1 | Mark/Space communications PCB |
| 4b | 08-12829 | EIA-485 communications PCB |
| 4c | 08-12842-2 | L&J Tankway communications PCB |
| 5 | 08-12836 | AC power supply & input/output PCB |
| 6 | P102-21-102 | 1.5" PCB standoff (x4) |
| 7a | 06-01429-ACA | Limit switch assembly (2 switches) |
| 7b | 06-01429-AEA | Limit switch assembly (4 switches) - not shown |
| 8 | 283061477 | Limit switch assembly screw (x4) |
| 9 | P102-21-106 | 1.75" PCB standoff (x4) |
| 10a | 08-12839 | Long connections PCB |
| 10b | 08-12848 | Short connections PCB |
| 11 | Supplied with 7a or 7b | Worm Gear |
| 12 | P31-807 | Optical encoder assembly mounting screw |
| 13 | BME10290 | Optical encoder assembly |
| 14 | N/A | Terminal junction box assembly (includes parts 16, 21, 22, 23x3) |
| 15a | B10290-100 | Enclosure base assembly (includes part 14x1 (junction box) mounted bottom and part 24) |
| 15b | B10290-200 | Enclosure base assembly (with optional AC power supply (includes part 14x2 (junction boxes) mounted top and bottom and part 24) |
| 16 | N/A | Terminal junction box base |
| 17 | N/A | Terminal junction box PCB mounting bolt |
| 18 | N/A | Terminal junction box ground screw |
| 19 | 08-12856 | Terminal junction box PCB - Standard (not shown) (includes part 14 and part 24) |
| | 08-08744 | Terminal junction box PCB - 1900 MWT-compatible (shown) |
| 20 | N/A | Terminal junction box hex nut |
| 21 | N/A | Terminal junction box o-ring |
| 22 | N/A | Terminal junction box cover |
| 23 | P109-16-034 | 3/4” Close up plug |
| 24 | N/A | Nipple assembly and wire bundle (standard) |
| | N/A | Nipple assembly and wire bundle (1900 MWT-compatible) |
| 25 | P102-02-094 | Ground connector |
| Part Kit | 06-01283-1 | Optical encoder assembly with two (2) SPDT limit switches (contains parts 13, 12x4, 11, 10a, 9x4, 8x4, 7a, 6x4) |

*Table 9-1: 2900 FTT Spare Parts List*

| Drawing # | Spare Part # | Description |
|---|---|---|
| Part Kit | 06-01283-2 | Optical encoder assembly with two (2) SPDT limit switches + AC power supply (contains parts 13, 12x4, 11, 10a, 9x4, 8x4, 7a, 6x4, 5) |
| Part Kit | 06-01283-3 | Optical encoder assembly with four (4) SPDT limit switches (contains parts 13, 12x4, 11, 10a, 9x4, 8x4, 7b, 6x4) |
| Part Kit | 06-01283-4 | Optical encoder assembly with four (4) SPDT limit switches + AC power supply (contains parts 13, 12x4, 11, 10a, 9x4, 8x4, 7b, 6x4, 5) |
| Part Kit | 06-01284-1 | Optical encoder assembly with PCB mounting posts (contains parts 13, 12x4, 10b, 6x4) |
| Part Kit | 06-01284-2 | Optical encoder assembly with PCB mounting posts + AC power supply<br>(contains parts 13, 12x4, 10b, 6x4, 5) |
| Part Kit | 06-10290 | Terminal junction box assembly |

*Table 9-1: 2900 FTT Spare Parts List*

### 9.1.5 Upgrading Software

The 2900 FTT uses a Flash EPROM module for upload software upgrades or service packs to the application software.

> **Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To upgrade the software:

1. Remove the 2900 FTT cover.
2. Insert the EPROM module into the EPROM socket (U2), shown in Figure 9-7.

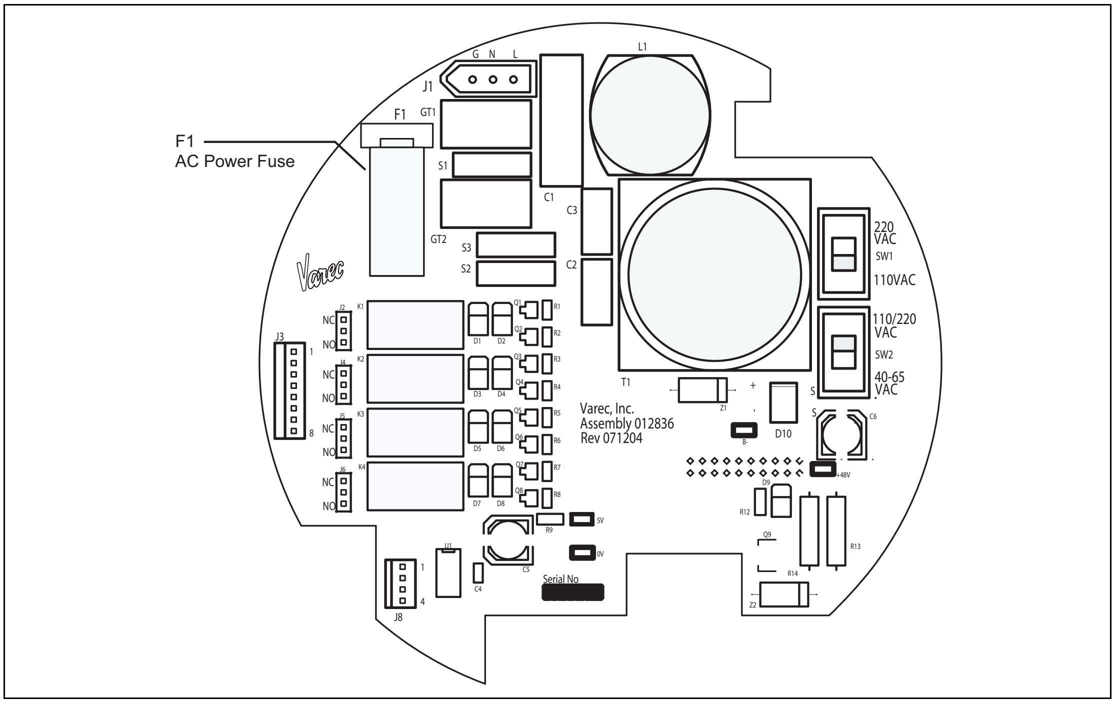



*Figure 9-8: EPROM Socket on Communications Circuit Board (Mark/Space shown)*

3. Set jumper J9 to position B.
4. Replace the 2900 FTT cover.

## 9.2 Troubleshooting

This section provides instructions for:


- 9.2.1, "Replacing the AC Power Supply Fuse" on page 61
- 9.2.2, "Using ViewRTU to Troubleshoot the 2900 FTT" on page 62
- 9.2.3, "Returning the 2900 FTT to Factory Default Settings" on page 64
- 9.2.4, "Resetting the 2900 FTT" on page 64
- 9.2.5, "Using the LEDs to Check the Transmitter Level" on page 65
- 9.2.6, "Verifying Temperature Data – Checking RTD Resistance" on page 65


### 9.2.1 Replacing the AC Power Supply Fuse

To replace the AC Power Supply fuse:

1. Remove power from the 2900 FTT.
2. Remove the 2900 FTT cover.
3. With a common screwdriver, unscrew the cylindrical fuse and remove it from the fuse holder on the AC Power Supply circuit board.

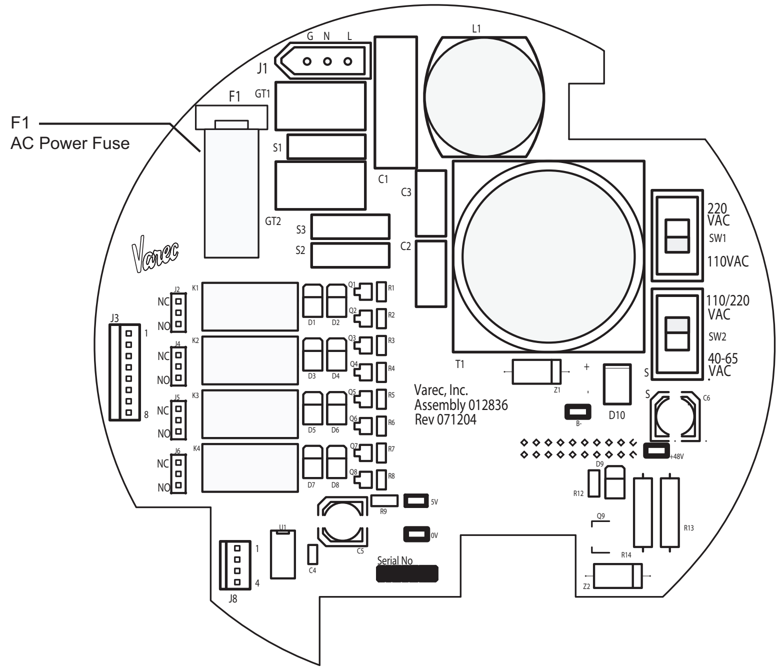



*Figure 9-9: AC Power Supply Circuit Board, Top View*

4. Insert the new fuse and tighten it.
5. Replace the 2900 FTT cover.

### 9.2.2 Using ViewRTU to Troubleshoot the 2900 FTT

For diagnostics and troubleshooting of the 2900 FTT, a laptop computer running the ViewRTU software can be connected to the RS-232 port. You can then use ViewRTU to run diagnostics or perform other troubleshooting procedures on the transmitter.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

**Note** For more detailed information regarding the ViewRTU program, refer to any Varec RTU Installation and Operation manual.

1. Remove the 2900 FTT cover.
2. Connect a laptop computer running ViewRTU software to the RS-232 connector (J13) on the communications circuit board. Figure 9-9 shows the connector.

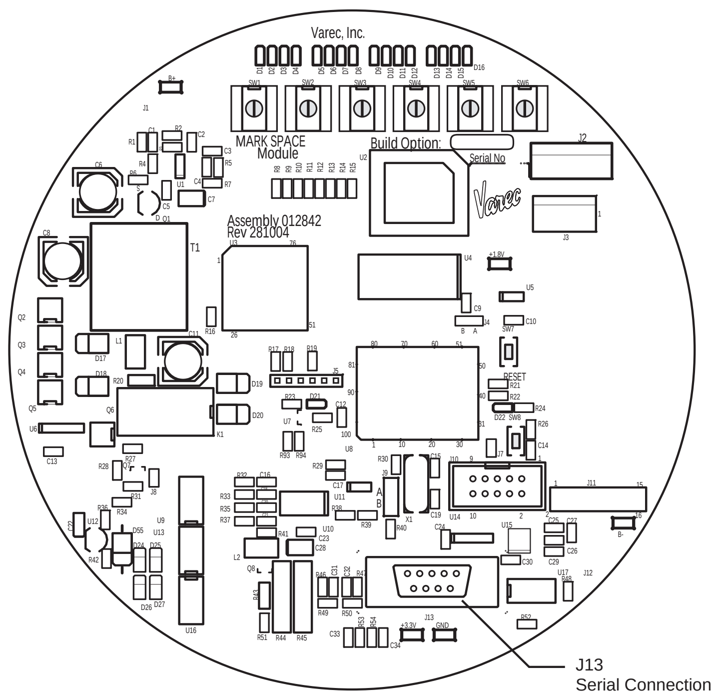
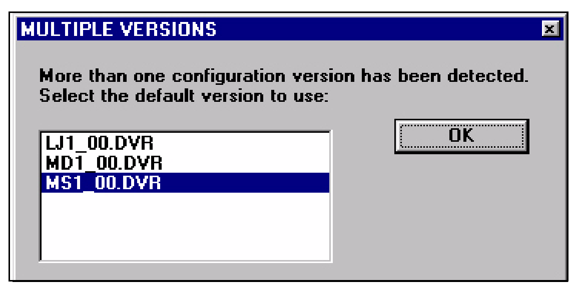



*Figure 9-10: RS-232 Connector on Communications Circuit Board (Mark/Space shown)*

3. Start the ViewRTU application.
   You will be prompted to select a firmware version file. Select the file that matches the communications protocol used by the 2900 FTT, and then click OK.

In the file names, LJ = L&J Tankway, MD = Modbus, and MS = Mark/Space.



4. The main screen appears, as shown in Figure 9-10.

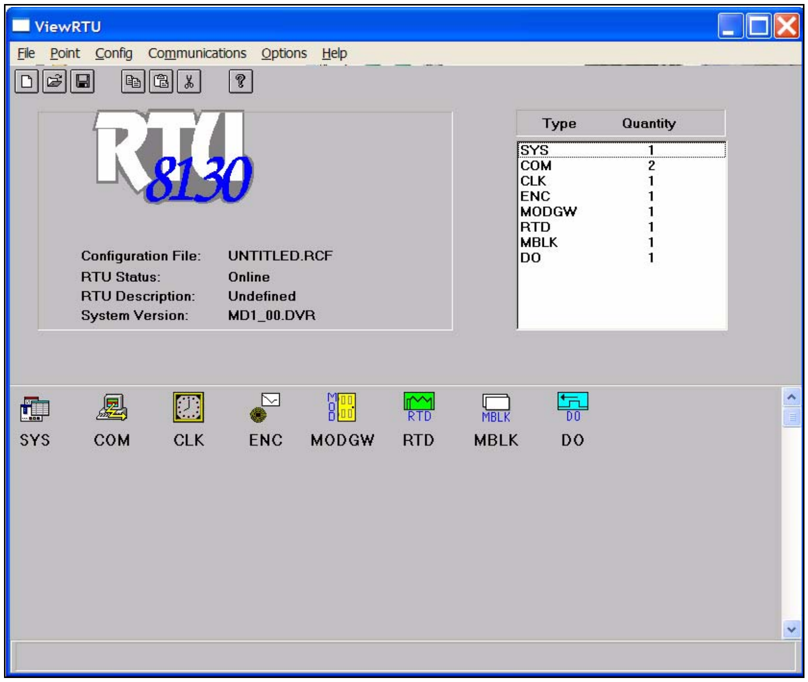



*Figure 9-11: ViewRTU Main Window*

5. Using the icons or the Point menu, select a point. The dialog box for that point appears.
6. View or edit the information as needed. Refer to "Appendix C — Database Points" on page 97 for information about each database point.
7. Repeat steps 5 and 6 as needed for other points.
8. Close ViewRTU.
9. Disconnect the laptop computer cable from the RS-232 connector.
10. Replace the 2900 FTT cover.

### 9.2.3 Returning the 2900 FTT to Factory Default Settings

**Note** This procedure will reset all level and temperature alarm setpoints.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To initialize all 2900 FTT configuration parameters to factory default settings:

1. Remove the 2900 FTT cover.
2. Press switches SW7 and SW8 simultaneously. See Figure 9-12 for switch locations.

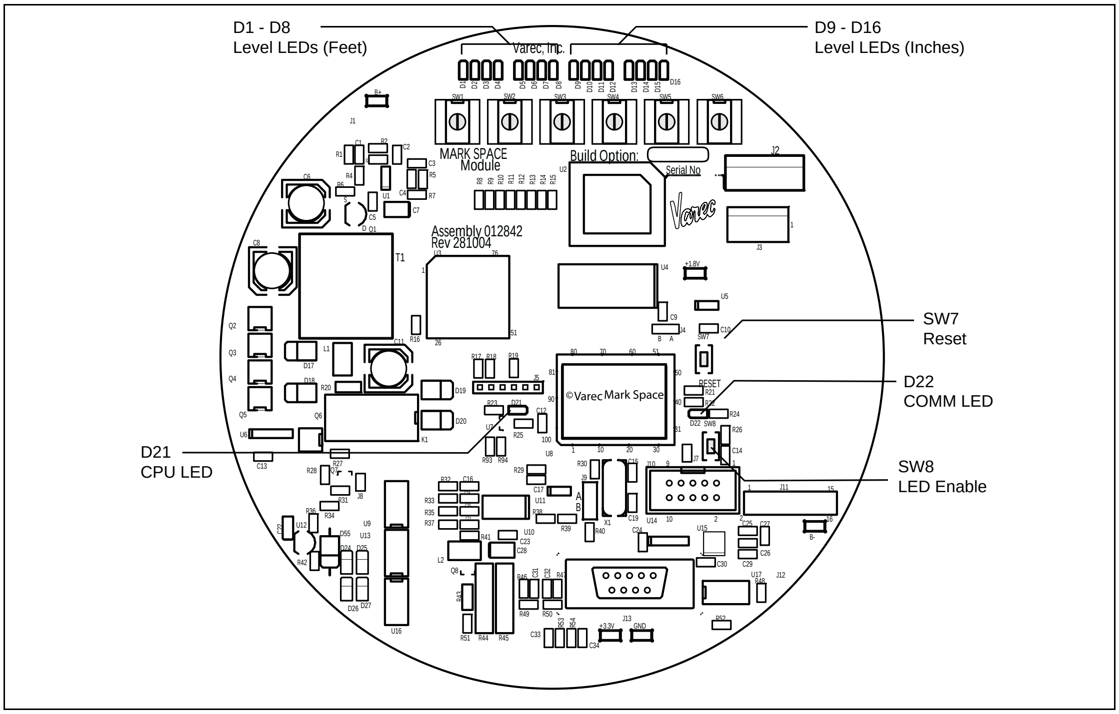



*Figure 9-12: Communications Board Diagnostic Switches and LEDs (Mark/Space shown)*

3. Release SW7. Continue pressing SW8 until LEDs D21 and D22 illuminate.
4. Replace the 2900 FTT cover.

### 9.2.4 Resetting the 2900 FTT

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

1. Remove the 2900 FTT cover.
2. Press RESET switch SW7 (see Figure 9-12) to restart the application program.
3. Replace the 2900 FTT cover.

### 9.2.5 Using the LEDs to Check the Transmitter Level

LEDs D1 – D16 on the communications circuit board (see Figure 9–12) indicate the transmitter level setting from 0 to 95 ft. 15/16 in., in 1/16 inch increments.

Refer to "Appendix B — Setting the Transmitter Level Using the LEDs" on page 89 for detailed information about the level LEDs and LED pattern tables.

### 9.2.6 Verifying Temperature Data - Checking RTD Resistance

To verify the accuracy of the 2900 FTT temperature data, you can determine if the RTD probe resistance is correct for the tank temperature.

**Warning!** Obtain a hot permit before removing the junction box or transmitter cover with power applied.

To check 2900 FTT encoder level setting:

1. Remove the 2900 FTT junction box cover.
2. Disconnect the RTD wires from the terminal block.
3. Measure the actual tank temperature, using the analog tank thermometer or another method.
4. Check the RTD resistance. Compare this to the actual tank temperature using the appropriate table for the RTD element type in "Appendix D — RTD Resistance – Temperature Charts" on page 109.
5. Reconnect the RTD wires to the terminal block.
6. Replace the cover on the junction box.

# 10 Specifications

## 10.1 Environmental

| Item | Description |
|---|---|
| Operating Temperature | -4 °F and +185 °F (-20 °C and +85 °C) |
| Operating Humidity | 0 to 95% relative humidity, non-condensing |
| Safety Approvals | Factory Mutual (FM)<br>Explosion Proof, Class I, Division 1, Groups C & D, T5 Ta = +85 °C: Enclosure NEMA 4 Rated |
| | ATEX<br>Flameproof, Ex II 2 G, Ex d IIB, T5<br>Ta = +85 °C |
| | IECEx (IC)<br>Flameproof, Ex d IIB T5 Ta = +85 °C |
| Environmental Approvals | IP66, NEMA 4 |

## 10.2 Encoder

| Item | Description |
|---|---|
| Type | Absolute, infrared, reflective, optical encoder |
| Accuracy | +/- 1/16" (1.58 mm) |
| Repeatability | +/- 1/16" (1.58 mm) |

## 10.3 Functional

| Item | Description |
|---|---|
| Power Requirements | 20 to 65 VDC 0.2A<br>40 to 65 / 110 / 220 - 240 VAC 500 mW nominal, 50/60 Hz |
| Available Ranges | Meters: 0 - 29 m<br>Feet: 0 - 96 ft |
| Conduit Entries | 2900 FTT Die cast housing 2 x 3/4” NPT<br>Conduit junction box supplied with 3 x 3/4” NPT (utilizes one entry on 2900 FTT housing above) |

## 10.4 Primary Components

| Component | Description |
|---|---|
| Main Processor Board | Modbus, Mark/Space, or Tankway options |

## 10.5 Switches and Indicators

| Item | Description |
|---|---|
| Reset Switch | Sends reset signal to processor |
| Rotary Switches | 6 16-position rotary switches |
| Status Indicators | 18 LEDs |
| Limit Switches | 2 or 4 SPDT limit switches (optional):<br>• 20 amp – 125, 250, 460 VAC<br>• 10 amp – 125 VAC Tungsten filament Lamp Load<br>• 1 HP – 115 VAC, 2 HP – 250 VDC<br>• 1/2 amp – 125 VDC, 1/4 amp – 250 VDC |

## 10.6 Input/Output Options

| Item | Description |
|---|---|
| Digital Inputs | Dry Contact (100 ohm maximum) |

# 11 Ordering Information

## 11.1 Order Codes

| Housing | |
|---|---|
| A | No housing required (electronics upgrade only) |
| B | Housing included (complete unit) |

| Power Input | |
|---|---|
| 0 | 20 – 65 VDC |
| 1 | 40 – 65/110/220 – 240 VAC |
| | Option1 includes 2 additional discrete inputs and 4 output contacts |

| Communications | |
|---|---|
| M4 | Mark/Space |
| 48 | EIA-485 Modbus |
| LJ | Tankway (L&J) |

| Inputs/Outputs | |
|---|---|
| 0 | No additional Inputs/ Outputs |
| 1 | Two (2) additional discrete inputs and four (4) output contacts<br>AC powered transmitter |
| 2 | Two (2) additional discrete inputs and four (4) output contacts<br>DC powered transmitter |

| Limit Switches | |
|---|---|
| 0 | No additional limit switches |
| 2 | Two (2) SPDT - Normally open limit switches |
| 3 | Two (2) SPDT - Normally closed limit switches |
| 4 | Four (4) SPDT - Normally open limit switches |
| 5 | Four (4) SPDT - Normally closed limit switches |

| Approvals | |
|---|---|
| FM | FMus- Explosion Proof - Class I, Division 1, Groups C & D T5<br>Ta = +85 °C: Flameproof Class I, Zone 1, AEx d IIB T5 Ta=+85°C,<br>Enclosure NEMA 4 |
| CS | cFM- Explosion Proof - Class I, Division 1, Groups C & D T5<br>Ta = +85 °C: Flameproof Class I, Zone 1, Ex d IIB T5 Ta=+85°C,<br>Enclosure NEMA 4 |
| AT | ATEX - Flameproof - Ex II 2 G, Ex d IIB T5, Ta=85 °C |
| IC | IECEx - Flameproof - Ex d IIB T5, Ta=85 °C |

| N2900- | | | | | | | Complete product designation |
|---|---|---|---|---|---|---|---|

## 11.2 Transmitter Adapter Kits

| Part | Description |
|---|---|
| 13-05956-102 | Adapter kit for mounting to L&J 92514, 92020 and 92030 gauges |
| 13-05956-202 | Adapter kit for mounting to L&J 92006 and Whessoe Varec 2006, 2026, and 2036 gauges |

# 12 Identification

## 12.1 Device Designation

### 12.1.1 Warning

The following warning is posted on the instrument:

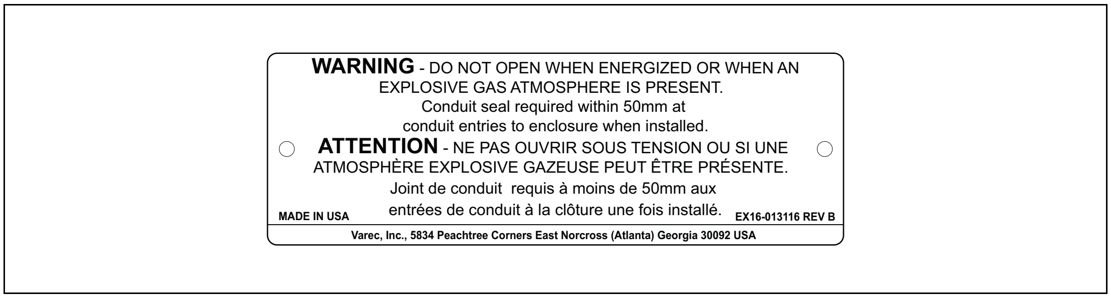



*Figure 12-1: 2900 FTT Warning*

### 12.1.2 Nameplate

The following technical data are given on the instrument nameplate:

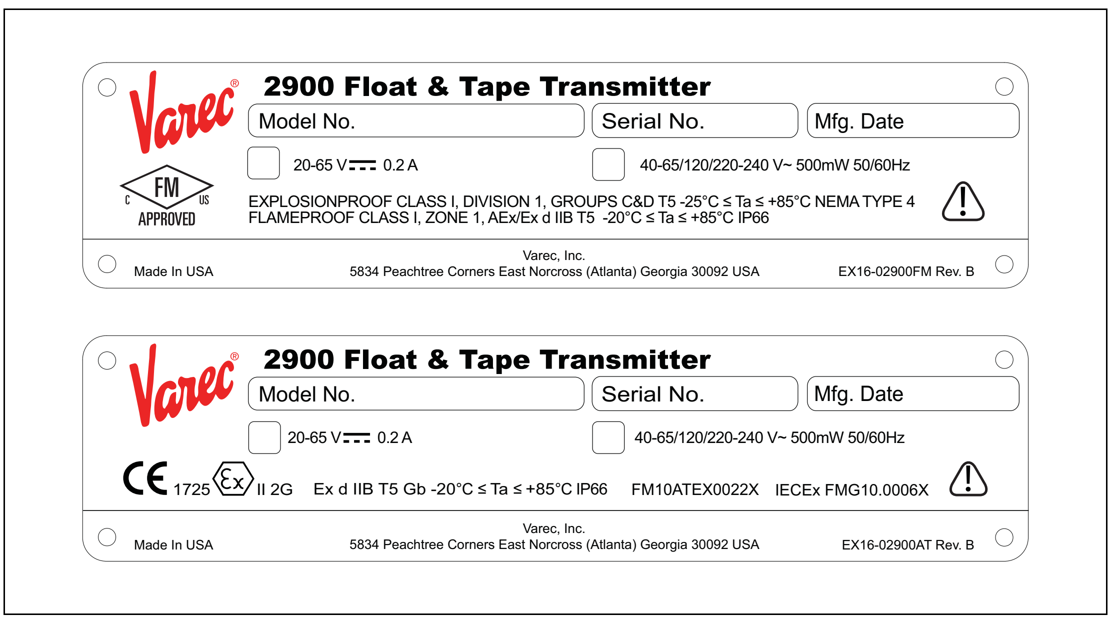



*Figure 12-2: 2900 FTT Nameplate*

# A Appendix A — Modbus Implementation

## A.1 Introduction

This protocol guide explains the operation of the Modbus as it pertains to the 2900 Float & Tape Transmitter.

## A.2 Implementation

The implementation of the Modbus protocol for the 2900 FTT provides a standard form of digital communications. An effort has been made to parallel current implementations to the greatest extent possible, so that the 2900 FTT communicates with existing Modbus masters.

Check compatibility carefully to ensure that the 2900 FTT is properly configured for the data format expected by the host computer. Exceptions made because of the unique requirements of the 2900 FTT application have been noted. This is no guarantee, however, that the interpretation made here will be the same as that followed by the Modbus master.

The 2900 FTT implementation of the Modbus protocol provides for the passing of measured and calculated variables, configuration information, and diagnostics in data registers. Data is sent in these registers as floating-point values, integer values, numeric codes related to configuration lists, status summary words (packed bits), or individual status flags (single bits).

One master and up to 31 2900 FTTs may be multi-dropped on a single EIA485 communication bus.

The Modbus functions implemented in the 2900 FTT are listed in Table A-1.

## A.3 Configuration

The Modbus port on the 2900 FTT must be configured to establish communications, as described in Section 5.2, "Choosing Communications Settings" on page 34.

2900 FTT addresses provide unique identification for the host. The 2900 FTT address is set via rotary switches, as described in Section 5.1, "Setting the Unit Address" on page 33. This address may range from 1 to 254 and must be unique. Each 2900 FTT only responds when a query has been sent to its unique address by the host.

The Modbus protocol supports two modes of transmission, Remote Terminal Unit (RTU) or ASCII (American Standard Code for Information Interchange). The choice between these two modes is dependent on the preference of the host. RTU is often the preferred protocol because of its improved error detection capabilities and higher throughput. ASCII mode uses ASCII printable characters to represent hexadecimal values. This mode of transmission requires almost twice as many characters to pass information as does the RTU transmission mode. The 2900 FTT only supports the RTU mode of communications.

| Function Code | Function | Information Type | Modbus Nomenclature |
|---|---|---|---|
| 01 | Read | Bits | Read output status |
| 02 | Read | Bits | Read input status |
| 03 | Read | Integer, Code, Status word, Floating point | Read output registers |

*Table A-1: Modbus Functions*

| Function Code | Function | Information Type | Modbus Nomenclature |
|---|---|---|---|
| 04 | Read | Integer, Code, Status word, Floating point | Read input registers |
| 05 | Write | Bits | Force single output status |
| 06 | Write | Integer, Code, Status word | Preset single register |
| 15 | Write | Bits | Force multiple outputs |
| 16 | Write | Integer, Code, Status word, Floating point | Preset multiple registers |
| 65 | Read | Floating point | Read floating point registers |
| 66 | Write | Floating point | Write floating point registers |

*Table A-1: Modbus Functions*

**Note** Exception: Because the 2900 FTT does not distinguish between inputs and outputs, function codes 01 and 02 as they apply to bits, and function codes 03 and 04 as they apply to numeric values refer to the same data registers. For example, either function code 03 or function 04 can be used to read the integer form of the true mass variable at data address 0053.

| Configuration Item | Valid Entries (default in bold type) | Modbus Configurable | ViewRTU Configurable |
|---|---|---|---|
| Modbus Address | 1 to 254 | No | No |
| Maximum Integer Size | Whole number (0 to 65,534) (default: **8**) | Yes | Yes |
| Integer Scaling Factors | Floating point number | Yes | Yes |
| Unit Selection | Coding list | No | No |
| Baud Rate | 300, 600, 1200, 2400, 4800, **9600**, 19200 | No | No |
| Number of Stop Bits | **1** | No | No |
| Parity | Odd, Even, **None** | No | No |

*Table A-2: Modbus Configuration Information*

**Note** Default communications settings are shown in bold type in Table A-2.

## A.4 Functions and Data Formats

The Modbus data in the 2900 FTT is arranged in integer registers, floating point registers, and status bits. The assignments for these registers are found at the end of this appendix.

Function codes 03, 04, 06, and 16 are used with integer registers.

Because of the multiple Modbus hosts available today, the 2900 FTT supports two floating-point data formats: a two 16-bit register format and a one 32-bit register format. These two formats provide maximum system flexibility. In the two 16-bit registers format, function codes 03 and 04 are used to read floating-point registers while function code 16 is used to write floating-point registers. In the one 32-bit register format, function code 65 is used to read floating-point registers, while function code 66 is used to write floating-point registers.

Function codes 01, 02, 05, and 15 are used with status bits.

A complete description of all the preceding commands, except floating point, can be found in the Modicon Modbus Protocol Reference Guide, document number PI-MBUS-300 Rev B.

## A.5 Integer Registers

Integer registers are the most commonly used type of Modbus data and are supported by most Modbus hosts. In the 2900 FTT implementation, the Modbus registers are arranged in one of the following four formats:

Integer Data - a scaled number from 0 to the maximum Modbus integer

Coded Data - Multiple choice configuration data chosen from a coded list

Packed Bit Data - Register form of 16 packed single bits

The integer, and coded data registers contain all of the information needed to configure and read process data. Any integer register may be read with function code 03 or function code 04. These same registers may be written one at a time with function code 06 or multiple registers can be written with function code 16.

For future compatibility, the 2900 FTT accepts reads and writes to reserved registers. Writes to reserved registers have no effect. Reads from reserved registers return a zero (0).

| Term | Definition |
|---|---|
| Address | User-assigned address of the slave device |
| Function Code | Function the slave is to perform |
| Start Register (H) | High-order data address byte of the number of registers to read or write |
| Start Register (L) | Low-order data address byte of the first register to read or write |
| Number of Registers (H) | High-order byte of the number of registers to read or write |
| Number of Registers (L) | Low-order byte of the number of registers to read or write |
| Byte Count | Number of data bytes |
| Data MSB | Data register's most significant byte |
| Data LSB | Data register's least significant byte |
| Status Bit (H) | High-order data address byte of the first bit to read or write |
| Status Bit (L) | Low-order data address byte of the first bit to read or write |
| Error Check | Message checksum CRC (Cyclical Redundancy Check) |

*Table A-3: Terms and Definitions*

**Note** In all of the following communication examples, the error check value is dependent upon the mode of transmission.

### A.5.1 Integer Data

The integer data is a whole number between 0 and the maximum Modbus integer (inclusive). The maximum Modbus integer is a user-configurable variable that is a whole number between 0 and 65,535 (inclusive). The integer data must also be scaled for each data type by entering the desired units, a minimum, and a maximum value. In order for the integer value to be correctly interpreted, these scaling factors must match the format expected by the host system. Scaling of the integer parameters is accomplished through floating-point registers or by using the ViewRTU application via the RS-232 (RS-232) connection.

The following communication example shows the request for one register starting at register 0 (0000 Hex).

For the following example, assume:

- minimum = 1 meter
- maximum = 15 meters
- maximum Modbus integer = 65,534

| Host Request | | | | | | |
|---|---|---|---|---|---|---|
| Address | Function Code | Start Reg H | Start Reg L | # of Reg H | # of Reg L | Error Check |
| 01 | 03 | 00 | 00 | 00 | 01 | XX |
| **2900 FTT Response** | | | | | | |
| Address | Function Code | Byte Count | Data MSB | Data LSB | Error Check | |
| 01 | 03 | 02 | 41 | 24 | XX | |

*Table A-4: Communication Examples*

> **Note** A formula for converting numbers to scaled integer format is provided in Section A.5.2, "Integer Data" on page 76.

### A.5.2 Integer Data

- Hexadecimal representation
- 4124 Decimal equivalent: 16,676

The data returned for data address 56 is 16,676 (4124 Hex). This value must be scaled using the following formula to give it meaning.

$$\text{result} = \frac{\text{data} * (\text{max} - \text{min})}{\text{max integer value}} + \text{min}$$

$$\text{result} = \frac{16{,}676 * (15 - 1)}{65{,}534} + 1$$

$$\text{result} = 4.54 \text{ meters}$$

If a variable goes out-of-bounds (outside the minimum or maximum scale points), a value equal to the maximum Modbus integer + 1 is returned. Writing to dynamically calculated parameters has no effect on those parameters.

### A.5.3 Coded Data

Coded data represents a table look-up value. Data written to these registers must be a valid table entry. Invalid data may cause a Configuration Error to occur. The following example shows coded data at data address 20 (0014 Hex) representing level units. The value 2 (0002 Hex) returned from the 2900 FTT corresponds to level units = FT-IN-16TH.

| Host Request | | | | | | |
|---|---|---|---|---|---|---|
| Address | Function Code | Start Reg H | Start Reg L | # of Reg H | # of Reg | Error Check |
| 01 | 03 | 00 | 14 | 00 | 01 | XX |
| **2900 FTT Response** | | | | | | |
| Address | Function Code | Byte Count | Data MSB | Data LSB | Error Check | |
| 01 | 03 | 02 | 00 | 01 | XX | |

*Table A-5: Coded Data Look-Up Value Registers*

- Hexadecimal representation 0001
- Level unit table representation: FT

### A.5.4 Packed Bit Data

Packed bits represent 16 individual status bits packed into one register. The status bits have been packed this way for systems that prefer handling only register information. These bits may also be read or written individually using a bit command. The bits within the packed registers are grouped by data or function type. The following communication example of packed bits shows alarm status information at data address 5 (0005 Hex) returned by the 2900 FTT.

| Host Request | | | | | | |
|---|---|---|---|---|---|---|
| Address | Function Code | Start Reg H | Start Reg L | # of Reg H | # of Reg L | Error Check |
| 01 | 03 | 00 | 05 | 00 | 01 | XX |
| **2900 FTT Response** | | | | | | |
| Address | Function code | Byte Count | Data MSB | Data LSB | Error Check | |
| 01 | 03 | 02 | 00 | 01 | XX | |

*Table A-6: Status Bits Packed Registers*

**Note** Bit #0 is ON indicating a critical low level Alarm

## A.6 Floating-Point Registers

Although not part of the Modbus protocol specification, floating point numbers have been implemented using the IEEE 754 standard. Floating point numbers reduce the complexity required in scaling integer values and provide a means to transmit numbers used by the 2900 FTT that are not easily scaled (such as the scaling factors themselves).

### A.6.1 Floating-Point Data

The 2900 FTT is capable of using a two 16-bit registers format and a one 32-bit register format. Examples and descriptions of both formats follow.

**Note** Although this type of data does not require scaling, it is important that the measurement unit selected in the 2900 FTT be the same as that expected by the host. In addition, where possible, data is available in both integer and floating-point formats.

### A.6.2 The Two 16-bit Registers Format

Function code 03 or 04 is used to read floating-point registers in this format. Function code 16 is used to write floating-point registers in this format. An example of reading the temperature, register 102 (0066 Hex), in floating-point format from the 2900 FTT is shown as follows:

| Host Request | | | | | | | |
|---|---|---|---|---|---|---|---|
| Address | Function Code | Start Reg H | Start Reg L | # of Reg H | # of Reg L | Error Check | |
| 01 | 03 | 00 | 66 | 00 | 02 | XX | |
| 2900 FTT Response | | | | | | | |
| Address | Function Code | Byte Count | Data MSB | Data LSB | Data MSB | Data LSB | Error Check |
| 01 | 03 | 04 | 42 | C8 | 00 | 00 | XX |

*Table A-7: 16-Bit Floating-Point Registers*

### A.6.3 Floating Point Data

- Hexadecimal representation: 42 C8 00 00
- Decimal equivalent: 100.00

Floating-point registers that are defined as reserved have zero (0) as their only legal value. A write command to a reserved floating-point register is ignored.

### A.6.4 The One 32-bit Register Format

Function code 65 (41 Hex) is used to read floating-point registers in this format. An example of a floating-point register read is shown below with the a temperature of 100.0 degrees is being read from register 1 (0001 Hex).

| Host Request | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Address | Function Code | Start Reg H | Start Reg L | # of Reg H | # of Reg L | Error Check | | |
| 01 | 41 | 00 | 01 | 00 | 01 | XX | | |
| 2900 FTT Response | | | | | | | | |
| Address | Function Code | # of Reg H | # of Reg L | Data MSB | Data | Data | Data LSB | Error Check |
| 01 | 41 | 00 | 01 | 42 | C8 | 00 | 00 | XX |

*Table A-8: 32-Bit Floating-Point Registers*

### A.6.5 Floating Point Data

- Hexadecimal representation: 42 C8 00 00
- Decimal equivalent: 100.00

Function code 66 (42 Hex) is used to write floating-point registers. An example of a floating-point register write is shown below with the value 100.0 being written into the Advisory High Temperature Alarm Setpoint, register 12 (000C Hex).

| Host Request | | | | | | |
|---|---|---|---|---|---|---|
| Address | Function Code | Start Reg H | Start Reg L | # of Reg H | # of Reg L | Data MSB |
| 01 | 42 | 00 | 0C | 00 | 01 | 42 |
| | | | Data | Data | Data LSB | Error Check |
| | | | C8 | 00 | 00 | XX |
| 2900 FTT Response | | | | | | |
| Address | Function Code | # of Reg H | # of Reg L | Error Check | | |
| 01 | 03 | 02 | 41 | XX | | |

*Table A-9:*

### A.6.6 Floating Point Data

- Hexadecimal representation: 42 C8 00 00
- Decimal equivalent: 100.00

Floating-point registers that are defined as reserved have zero (0) as their value. A write command to a reserved floating-point register will be ignored.

## A.7 Status Bits

In the 2900 FTT implementation, status bits contain alarms, commands, and status information. The state of a Modbus status bit is defined as either ON (true) or OFF (false). The ON state is represented by a "1". The status bits may be read with function code 1 or 2. They may be written one at a time with function code 5 or multiple bits may be written with function code 15. An example of a read message for bits 2 through 6 as returned by the 2900 FTT is shows as follows.

| Host Request | | | | | | |
|---|---|---|---|---|---|---|
| Address | Function Code | Start Reg H | Start Reg L | # of Reg H | # of Reg L | Error Check |
| 01 | 02 | 00 | 02 | 00 | 04 | XX |
| **2900 FTT Response** | | | | | | |
| Address | Function Code | Byte Count | Data | Error Check | | |
| 01 | 02 | 01 | 12 | XX | | |

*Table A-10:*

### A.7.1 Status Bit Data

Binary representation 1 0010 (bits 6-2)

Bit #2: High Advisory Alarm OFF

Bit #3: High Critical Alarm ON

Bit #4: Unauthorized Mass Movement OFF

Bit #5: Standard Density Alarm OFF

Bit #6: Critical Zone Alarm ON

## A.8 Exception Responses

The exception responses returned by the 2900 FTT are listed below:

| Exception | Response | Reason |
|---|---|---|
| 01 | Illegal Function | Message is not allowed |
| 02 | Illegal Data Address | Data address (bit or register) requested is not defined |
| 03 | Illegal Data Value | Data value being written is out of range |
| 04 | Busy | During power-up |

*Table A-11: Exception Responses Returned by the 2900 FTT*

In addition, messages that are received with a parity error, checksum error, or message format error will be ignored.

## A.9 Data Out of Range

When integer data calculated by the 2900 FTT is outside the minimum or maximum scale points or is otherwise out of range, the value returned is that of the maximum Modbus integer + 1. For example, if the maximum Modbus integer is 65,534 (as used in our previous examples) the “data out of range” value is 65,535. The “data out of range” convention does not apply to the status bits, packed status bits, character data, and coded data.

The following error conditions will also cause the 2900 FTT to return scaled integer values of maximum Modbus integer + 1.

- Off-line Mode
- Strap Error
- No CALC
- API Correction Error
- CALC Error

This permits a host to detect a serious failure without monitoring other 2900 FTT status bits.

## A.10 Loopback Test

In accordance with the Modbus specification, function code 8 initiates a loopback test. The purpose of this test is to check the communication system. It does not affect the operation of the 2900 FTT. The 2900 FTT supports only diagnostic code 00. This is a request to return query data. Upon receiving a loopback message containing this code, the 2900 FTT will echo the message sent by the host. The entire message returned will be identical to the message transmitted by the host field-per-field. An example of a loopback message is as follows:

| Host Request | | | | | | |
|---|---|---|---|---|---|---|
| Address | Function Code | Code HO | Code LO | Data | Data | Error Check |
| 01 | 08 | 00 | 02 | F3 | 26 | XX |
| 2900 FTT Response | | | | | | |
| Address | Function Code | Code HO | Code LO | Data | Data | Error Check |
| 01 | 08 | 00 | 00 | F3 | 26 | XX |

*Table A-12: Function Code — Loopback Test*

## A.11 Hardware Implementation

The 2900 FTT uses a 2-Wire EIA485 hardware interface to communicate with the Modbus master. EIA485 is a high speed differential communications network which allows up to 32 devices to operate on one network. The 2900 FTT and Modbus master share a twisted pair of wires to communicate.

The communication distance EIA485 can reliably travel is dependent on baud rate (communication speed), wire quality, environmental noise, wiring configuration, and the number of multi-dropped 2900 FTTs. The recommended wire for EIA485 systems is 18-gauge or larger, shielded, twisted pairs. The shield should be earth grounded at the Modbus master (control system or computer end). The shield at the 2900 FTT should be open. The 2900 FTT-power line acts as a common reference tie to the Modbus master.

Termination resistors of 120 Ohms are shown at each end of the communication bus to minimize reflections on the line. Termination resistors may not be necessary at baud rates of 9600 bits per second or slower.

Pull-up and pull-down resistors are also shown at the Modbus master end of the cable. These resistors minimize the affects of noise when the lines are idle. Only one set of pull-up or pull-down resistors are required per twisted pair cable. These resistors are included in the 2900 FTT and can be included in the circuit using the procedure described in Chapter 5 on page 31.

## A.12 Integer Register Map

| Register Number | Type | Description |
|---|---|---|
| 0 | Scaled | Level |
| 1 | Scaled | Temperature |
| 2 – 4 | Reserved | |
| 5 | Bit Field | AimStat<br>Bit Usage<br>0 CRIT LO LEVEL<br>1 ADV LO LEVEL<br>2 ADV HI LEVEL<br>3 CRIT HI LEVEL<br>4 CRIT LO TEMP<br>5 ADV LO TEMP<br>6 ADV HI TEMP<br>7 CRIT HI TEMP<br>8 HW IN 1<br>9 HW IN 2<br>10 HW IN 3 *<br>11 NW IN 4 *<br>12 – 15 RESERVED<br>* when optional AC Power module is installed |
| 6 | Bit Field | DiagStat<br>Bit Usage<br>0 BAD LEVEL<br>1 BAD TEMP<br>2 – 15 RESERVED |
| 7 | Bit Field | CmdsBit Usage<br>0 – 4 RESERVED<br>5 CALIB LEVEL<br>6 – 15 RESERVED |
| 8 | Reserved | Reserved |
| 9 | Reserved | Reserved |
| 10 | Scaled | Crit Low Level Setpoint |
| 11 | Scaled | Adv Low Level Setpoint |
| 12 | Scaled | Adv High Level Setpoint |
| 13 | Scaled | Crit High Level Setpoint |

*Table A-13: Integer Register Map*

| Register Number | Type | Description |
|---|---|---|
| 14 | Scaled | Level Deadband |
| 15 | Scaled | Crit Low Temp Setpoint |
| 16 | Scaled | Adv Low Temp Setpoint |
| 17 | Scaled | Adv High Temp Setpoint |
| 18 | Scaled | Crit High Temp Setpoint |
| 19 | Scaled | Temp Deadband |
| 20 | Code<br>Read-only | Level Units<br>0 - METERS<br>1 - FEET |
| 21 | Code<br>(Read-only) | Temp Units<br>0 - C<br>1 - F |
| 22 | Code<br>(Read-only) | Level Type<br>1 - FORWARD<br>2 - REVERSE |
| 23 | Code<br>(Read-only) | Temp Type<br>0 - Pt100<br>1 - Cu100<br>2 - PLATINUM RTD |
| 24 | Scaled | Manual Temperature |
| 25 | Code | Max Integer Value |
| 26 | Reserved | |
| 27 | Scaled | Calibration Level |
| 28 - 99 | Reserved | |
| 100 | Float | Level |
| 102 | Float | Temp |
| 104 | Float | RTD Resistance |
| 106 | Reserved Float | |
| 108 | Reserved Float | |
| 110 | Float | Crit Low Level |
| 112 | Float | Adv Low Level |
| 114 | Float | Adv High Level |
| 116 | Float | Crit High Level |
| 118 | Float | Level Deadband |
| 120 | Float | Crit Low Temp |
| 122 | Float | Adv Low Temp |
| 124 | Float | Adv High Temp |
| 126 | Float | Crit High Level |
| 128 | Float | Temp Deadband |
| 130 | Float | Min Level |
| 132 | Float | Max Level |

*Table A-13: Integer Register Map*

| Register Number | Type | Description |
|---|---|---|
| 134 | Float | Min Temp |
| 136 | Float | Max Temp |
| 138 | Reserved Float | |
| 140 | Float | Man Temp |
| 142 | Float | Calib Level |
| 144 - 199 | Reserved Float | |
| 200 | Float | Level |
| 202 | Float | Temp |
| 204 | Float | RTD Resist |
| 206 | Reserved Float | |
| 208 | Reserved Float | |
| 210 | Bit Field | AlmStart |
| 211 | Bit Field | DiagStat |
| 212 - 214 | Reserved | Reserved |
| 215 | Code (Read-only) | Level Units |
| 216 | Code (Read-only) | Temp Units |
| 217- 219 | Reserved | Reserved |
| 220 | Code (Read-only) | Level Type |
| 221 | Code (Read-only) | Temp Type |
| 222 - 229 | Reserved | Reserved |
| 230 | Float | Crit Low Level |
| 232 | Float | Adv Low Level |
| 234 | Float | Adv High Level |
| 236 | Float | Crit High Level |
| 238 | Float | Level Deadband |
| 240 | Float | Crit Low Temp |
| 242 | Float | Adv Low Temp |
| 244 | Float | Adv High Temp |
| 246 | Float | Crit High Level |
| 248 | Float | Temp Deadband |
| 250 | Float | Min Level |
| 252 | Float | Max Level |
| 254 | Float | Min Temp |
| 256 | Float | Max Temp |
| 258 | Reserved Float | |
| 260 | Float | Man Temp |
| 262 - 267 | Reserved | Reserved |

*Table A-13: Integer Register Map*

| Register Number | Type | Description |
|---|---|---|
| 268 | Reserved Long | Reserved |
| 270 | Bit Field | DO State<br><u>Bit Usage</u><br>0 – Output #1<br>1 – Output #2<br>2 – Output #3<br>3 – Output #4<br>4 - 15 - Reserved |
| 271 | Bit Field | DO Output in power-up state; when set the DO will close at power-up.<br><u>Bit Usage:</u><br>0 – Output #1<br>1 – Output #2<br>2 – Output #3<br>3 – Output #4 |
| 272 - 284 | Reserved | Reserved |
| 285 | Code | DO #1 Output Assignment:<br>0 – Not Assigned<br>1 – Host Control<br>2 – Critical High Level<br>3 – Advisory High Level<br>4 – Advisory Low Level<br>5 – Critical Low Level<br>6 – Critical High Temp<br>7 – Advisory High Temp<br>8 – Advisory Low Temp<br>9 – Critical Low Temp |
| 286 | Code | DO #2 Output Assignment:<br>0 – Not Assigned<br>1 – Host Control<br>2 – Critical High Level<br>3 – Advisory High Level<br>4 – Advisory Low Level<br>5 – Critical Low Level<br>6 – Critical High Temp<br>7 – Advisory High Temp<br>8 – Advisory Low Temp<br>9 – Critical Low Temp |

*Table A-13: Integer Register Map*

| Register Number | Type | Description |
|---|---|---|
| 287 | Code | DO #3 Output Assignment:<br>0 – Not Assigned<br>1 – Host Control<br>2 – Critical High Level<br>3 – Advisory High Level<br>4 – Advisory Low Level<br>5 – Critical Low Level<br>6 – Critical High Temp<br>7 – Advisory High Temp<br>8 – Advisory Low Temp<br>9 – Critical Low Temp |
| 288 | Code | DO #4 Output Assignment:<br>0 – Not Assigned<br>1 – Host Control<br>2 – Critical High Level<br>3 – Advisory High Level<br>4 – Advisory Low Level<br>5 – Critical Low Level<br>6 – Critical High Temp<br>7 – Advisory High Temp<br>8 – Advisory Low Temp<br>9 – Critical Low Temp |
| 289 – 300 | Reserved | Reserved |

*Table A-13: Integer Register Map*

## A.13 32-bit Floating Point Register Map

| Register Number | Description |
|---|---|
| 0 | Level |
| 1 | Temp |
| 2 | RTD Resist |
| 3 | Reserved |
| 4 | Reserved |
| 5 | Crit Low Level |
| 6 | Adv Low Level |
| 7 | Adv High Level |
| 8 | Level Deadband |
| 9 | Adv Low Temp |
| 10 | Crit High Level |
| 11 | Min Level |
| 12 | Min Temp |
| 13 | Reserved |

*Table A-14: 32-Bit Floating Point Register Map*

| Register Number | Description |
|---|---|
| 14 | Reserved |
| 15 | Reserved |
| 16 | Reserved |
| 17 | Reserved |
| 18 | Reserved |
| 19 | Reserved |
| 20 | Reserved |
| 21 | Reserved |

*Table A-14: 32-Bit Floating Point Register Map*

## A.14 Status Bit Register Map

| Register Number | Description |
|---|---|
| 0 – 15 | AlmStat |
| 16 – 31 | Diag Stat |
| 32 – 47 | Cmds |

*Table A-15: Status Bit Register Map*

# B Appendix B — Setting the Transmitter Level Using the LEDs

The 2900 FTT communications circuit board contains LEDs that indicate the transmitter level setting to the 1/16 inch. This section provides instructions and visual tables for using the LEDs to set the transmitter level.

## B.1 Before You Begin

### B.1.1 LEDs and Switch Functions and Locations

Figure B-1 shows the LED locations on the communications circuit board. LEDs D1 – D8 indicate the level in feet, in 1/2 – foot increments. LEDs D9 – D16 indicate the level in inches, in 1/16 – inch increments.

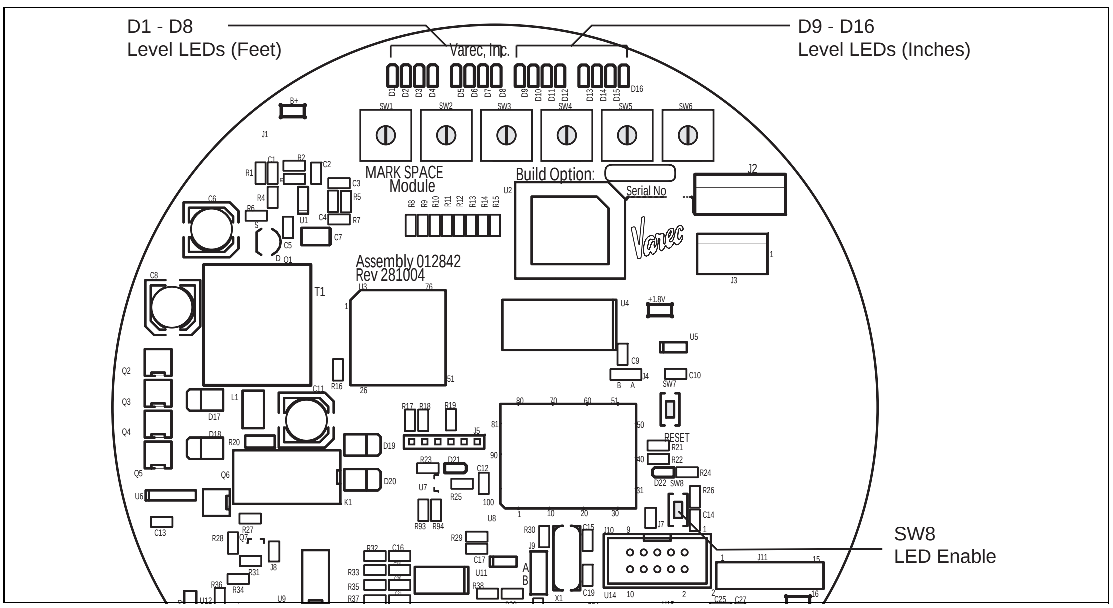



*Figure B-1: LED and Switch Locations (Mark/Space Communications circuit board, top view)*

**Note** To activate the LEDs on the communications circuit board, press switch SW8, shown in Figure B-1. The LEDs will be enabled for about three minutes.

### B.1.2 Forward or Reverse Encoding

The level indicated by the LEDs is depends on the transmitter’s encoder direction setting. If the transmitter is set for forward encoding, refer to Section B.2, "Setting the Transmitter Level Using the LEDs (with Forward Encoding)" on page 90. Refer to Section B.3, "Setting the Transmitter Level Using the LEDs (with Reverse Encoding)" on page 93 if the transmitter is set for reverse encoding.

The encoder direction is set with a rotary switch. For more information, refer to the relevant Initial Configuration chapter.

## B.2 Setting the Transmitter Level Using the LEDs (with Forward Encoding)

**Note** If the transmitter (Modbus version) has had a Modbus level calibration, an internal offset will cause the LED pattern to differ from the transmitted level.

**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the encoder level:

1. Remove the 2900 FTT cover.
2. Press switch SW8 to enable the LEDs.
3. Refer to Table B-1 on page 91. Find the whole number entry that matches your target level in feet.

   For example, if the target level is 41 feet, 8 9/16 inches, locate the entry for 41 feet.


*Figure B-2:LED Table Example – Feet*

4. Rotate the encoder disks clockwise or counter-clockwise until LEDs D1 – D9 (Feet) display the desired foot pattern. The actual level is now slightly below the target.

   **Note** ■ = LED On
   □ = LED Off

5. Rotate the encoder disks **clockwise** to increase the level until LEDs D9 – D16 (Inches) display the zero-inch pattern shown in Figure B-3.

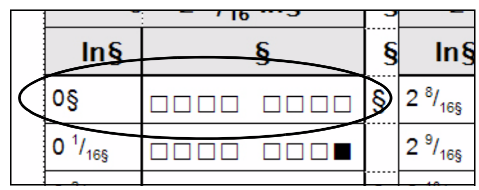



*Figure B-3:LED Table Example – Inches*

Refer to Table B-2 on page 92. Find the entry that matches your target level in inches and 1/16 units, as shown in the example in Figure B-4.

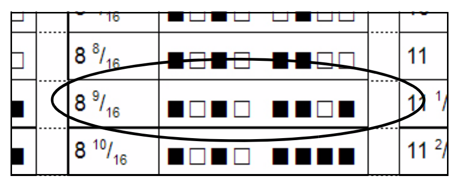



*Figure B-4:LED Table Example – Inches*

6. Rotate the encoder disks clockwise to increase the level until LEDs D9 – D16 display the target pattern.
7. Replace the 2900 FTT cover.

### B.2.1 LEDs D1 - D8: Level in Feet (Forward Encoding)

| 0 – 19 Ft | |
|---|---|
| Ft | LEDs |
| 0 | ■□□□ □□□□ |
| 0 1/2 | ■□□□ □□□■ |
| 1 | ■□□□ □□■■ |
| 1 1/2 | ■□□□ □□■□ |
| 2 | ■□□□ □■■□ |
| 2 1/2 | ■□□□ □■■■ |
| 3 | ■□□□ □■□■ |
| 3 1/2 | ■□□□ □■□□ |
| 4 | ■□□□ ■■□□ |
| 4 1/2 | ■□□□ ■■□■ |
| 5 | ■□□□ ■■■■ |
| 5 1/2 | ■□□□ ■■■□ |
| 6 | ■□□□ ■□■□ |
| 6 1/2 | ■□□□ ■□■■ |
| 7 | ■□□□ ■□□■ |
| 7 1/2 | ■□□□ ■□□□ |
| 8 | ■□□■ ■□□□ |
| 8 1/2 | ■□□■ ■□□■ |
| 9 | ■□□■ ■□■■ |
| 9 1/2 | ■□□■ ■□■□ |
| 10 | ■□□■ ■■■□ |
| 10 1/2 | ■□□■ ■■■■ |
| 11 | ■□□■ ■■□■ |
| 11 1/2 | ■□□■ ■■□□ |
| 12 | ■□□■ □■□□ |
| 12 1/2 | ■□□■ □■□■ |
| 13 | ■□□■ □■■■ |
| 13 1/2 | ■□□■ □■■□ |
| 14 | ■□□■ □□■□ |
| 14 1/2 | ■□□■ □□■■ |
| 15 | ■□□■ □□□■ |
| 15 1/2 | ■□□■ □□□□ |
| 16 | ■□■■ □□□□ |
| 16 1/2 | ■□■■ □□□■ |
| 17 | ■□■■ □□■■ |
| 17 1/2 | ■□■■ □□■□ |
| 18 | ■□■■ □■■□ |
| 18 1/2 | ■□■■ □■■■ |
| 19 | ■□■■ □■□■ |
| 19 1/2 | ■□■■ □■□□ |

| 20 – 39 Ft | |
|---|---|
| Ft | LEDs |
| 20 | ■□■■ ■■□□ |
| 20 1/2 | ■□■■ ■■□■ |
| 21 | ■□■■ ■■■■ |
| 21 1/2 | ■□■■ ■■■□ |
| 22 | ■□■■ ■□■□ |
| 22 1/2 | ■□■■ ■□■■ |
| 23 | ■□■■ ■□□■ |
| 23 1/2 | ■□■■ ■□□□ |
| 24 | ■□■□ ■□□□ |
| 24 1/2 | ■□■□ ■□□■ |
| 25 | ■□■□ ■□■■ |
| 25 1/2 | ■□■□ ■□■□ |
| 26 | ■□■□ ■■■□ |
| 26 1/2 | ■□■□ ■■■■ |
| 27 | ■□■□ ■■□■ |
| 27 1/2 | ■□■□ ■■□□ |
| 28 | ■□■□ □■□□ |
| 28 1/2 | ■□■□ □■□■ |
| 29 | ■□■□ □■■■ |
| 29 1/2 | ■□■□ □■■□ |
| 30 | ■□■□ □□■□ |
| 30 1/2 | ■□■□ □□■■ |
| 31 | ■□■□ □□□■ |
| 31 1/2 | ■□■□ □□□□ |
| 32 | ■■■□ □□□□ |
| 32 1/2 | ■■■□ □□□■ |
| 33 | ■■■□ □□■■ |
| 33 1/2 | ■■■□ □□■□ |
| 34 | ■■■□ □■■□ |
| 34 1/2 | ■■■□ □■■■ |
| 35 | ■■■□ □■□■ |
| 35 1/2 | ■■■□ □■□□ |
| 36 | ■■■□ ■■□□ |
| 36 1/2 | ■■■□ ■■□■ |
| 37 | ■■■□ ■■■■ |
| 37 1/2 | ■■■□ ■■■□ |
| 38 | ■■■□ ■□■□ |
| 38 1/2 | ■■■□ ■□■■ |
| 39 | ■■■□ ■□□■ |
| 39 1/2 | ■■■□ ■□□□ |

| 40 – 59 Ft | |
|---|---|
| Ft | LEDs |
| 40 | ■■■■ ■□□□ |
| 40 1/2 | ■■■■ ■□□■ |
| 41 | ■■■■ ■□■■ |
| 41 1/2 | ■■■■ ■□■□ |
| 42 | ■■■■ ■■■□ |
| 42 1/2 | ■■■■ ■■■■ |
| 43 | ■■■■ ■■□■ |
| 43 1/2 | ■■■■ ■■□□ |
| 44 | ■■■■ □■□□ |
| 44 1/2 | ■■■■ □■□■ |
| 45 | ■■■■ □■■■ |
| 45 1/2 | ■■■■ □■■□ |
| 46 | ■■■■ □□■□ |
| 46 1/2 | ■■■■ □□■■ |
| 47 | ■■■■ □□□■ |
| 47 1/2 | ■■■■ □□□□ |
| 48 | □■■■ □□□□ |
| 48 1/2 | □■■■ □□□■ |
| 49 | □■■■ □□■■ |
| 49 1/2 | □■■■ □□■□ |
| 50 | □■■■ □■■□ |
| 50 1/2 | □■■■ □■■■ |
| 51 | □■■■ □■□■ |
| 51 1/2 | □■■■ □■□□ |
| 52 | □■■■ ■■□□ |
| 52 1/2 | □■■■ ■■□■ |
| 53 | □■■■ ■■■■ |
| 53 1/2 | □■■■ ■■■□ |
| 54 | □■■■ ■□■□ |
| 54 1/2 | □■■■ ■□■■ |
| 55 | □■■■ ■□□■ |
| 55 1/2 | □■■■ ■□□□ |
| 56 | □■■□ ■□□□ |
| 56 1/2 | □■■□ ■□□■ |
| 57 | □■■□ ■□■■ |
| 57 1/2 | □■■□ ■□■□ |
| 58 | □■■□ ■■■□ |
| 58 1/2 | □■■□ ■■■■ |
| 59 | □■■□ ■■□■ |
| 59 1/2 | □■■□ ■■□□ |

| 60 – 79 Ft | |
|---|---|
| Ft | LEDs |
| 60 | □■■□ □■□□ |
| 60 1/2 | □■■□ □■□■ |
| 61 | □■■□ □■■■ |
| 61 1/2 | □■■□ □■■□ |
| 62 | □■■□ □□■□ |
| 62 1/2 | □■■□ □□■■ |
| 63 | □■■□ □□□■ |
| 63 1/2 | □■■□ □□□□ |
| 64 | □□■□ □□□□ |
| 64 1/2 | □□■□ □□□■ |
| 65 | □□■□ □□■■ |
| 65 1/2 | □□■□ □□■□ |
| 66 | □□■□ □■■□ |
| 66 1/2 | □□■□ □■■■ |
| 67 | □□■□ □■□■ |
| 67 1/2 | □□■□ □■□□ |
| 68 | □□■□ ■■□□ |
| 68 1/2 | □□■□ ■■□■ |
| 69 | □□■□ ■■■■ |
| 69 1/2 | □□■□ ■■■□ |
| 70 | □□■□ ■□■□ |
| 70 1/2 | □□■□ ■□■■ |
| 71 | □□■□ ■□□■ |
| 71 1/2 | □□■□ ■□□□ |
| 72 | □□■■ ■□□□ |
| 72 1/2 | □□■■ ■□□■ |
| 73 | □□■■ ■□■■ |
| 73 1/2 | □□■■ ■□■□ |
| 74 | □□■■ ■■■□ |
| 74 1/2 | □□■■ ■■■■ |
| 75 | □□■■ ■■□■ |
| 75 1/2 | □□■■ ■■■■ |
| 76 | □□■■ □■□□ |
| 76 1/2 | □□■■ □■□■ |
| 77 | □□■■ □■■■ |
| 77 1/2 | □□■■ □■■□ |
| 78 | □□■■ □□■□ |
| 78 1/2 | □□■■ □□■■ |
| 79 | □□■■ □□□■ |
| 79 1/2 | □□■■ □□□□ |

| 80 – 95 Ft | |
|---|---|
| Ft | LEDs |
| 80 | □□□■ □□□□ |
| 80 1/2 | □□□■ □□□■ |
| 81 | □□□■ □□■■ |
| 81 1/2 | □□□■ □□■□ |
| 82 | □□□■ □■■□ |
| 82 1/2 | □□□■ □■■■ |
| 83 | □□□■ □■□■ |
| 83 1/2 | □□□■ □■□□ |
| 84 | □□□■ ■■□□ |
| 84 1/2 | □□□■ ■■□■ |
| 85 | □□□■ ■■■■ |
| 85 1/2 | □□□■ ■■■□ |
| 86 | □□□■ ■□■□ |
| 86 1/2 | □□□■ ■□■■ |
| 87 | □□□■ ■□□■ |
| 87 1/2 | □□□■ ■□□□ |
| 88 | □□□□ ■□□□ |
| 88 1/2 | □□□□ ■□□■ |
| 89 | □□□□ ■□■■ |
| 89 1/2 | □□□□ ■□■□ |
| 90 | □□□□ ■■■□ |
| 90 1/2 | □□□□ ■■■■ |
| 91 | □□□□ ■■□■ |
| 91 1/2 | □□□□ ■■□□ |
| 92 | □□□□ □■□□ |
| 92 1/2 | □□□□ □■□■ |
| 93 | □□□□ □■■■ |
| 93 1/2 | □□□□ □■■□ |
| 94 | □□□□ □□■□ |
| 94 1/2 | □□□□ □□■■ |
| 95 | □□□□ □□□■ |
| 95 1/2 | □□□□ □□□□ |

*Table B-1: LEDs D1 – D8: Level in Feet*

**Note** ■ = LED On
□ = LED Off

### B.2.2 LEDs D9 - D16: Level in Inches (Forward Encoding)

| 0 – 2 7/16 In | | 2 8/16 – 4 15/16 In | | 5 – 7 7/16 In | | 7 8/16 – 9 15/16 In | | 10 – 11 15/16 In | |
|---|---|---|---|---|---|---|---|---|---|
| In | | In | LEDs | In | LEDs | In | LEDs | In | LEDs |
| 0 | □□□□ □□□□ | 2 8/16 | □□■■ ■■□□ | 5 | □■■■ ■□□□ | 7 8/16 | ■■■□ □■□□ | 10 | ■□□■ □□□□ |
| 0 1/16 | □□□□ □□□■ | 2 9/16 | □□■■ ■■□■ | 5 1/16 | □■■■ ■□□■ | 7 9/16 | ■■■□ □■□■ | 10 1/16 | ■□□■ □□□■ |
| 0 2/16 | □□□□ □□■■ | 2 10/16 | □□■■ ■■■■ | 5 2/16 | □■■■ ■□■■ | 7 10/16 | ■■■□ □■■■ | 10 2/16 | ■□□■ □□■■ |
| 0 3/16 | □□□□ □□■□ | 2 11/16 | □□■■ ■■■□ | 5 3/16 | □■■■ ■□■□ | 7 11/16 | ■■■□ □■■□ | 10 3/16 | ■□□■ □□■□ |
| 0 4/16 | □□□□ □■■□ | 2 12/16 | □□■■ ■□■□ | 5 4/16 | □■■■ ■■■□ | 7 12/16 | ■■■□ □□■□ | 10 4/16 | ■□□■ □■■□ |
| 0 5/16 | □□□□ □■■■ | 2 13/16 | □□■■ ■□■■ | 5 5/16 | □■■■ ■■■■ | 7 13/16 | ■■■□ □□■■ | 10 5/16 | ■□□■ □■■■ |
| 0 6/16 | □□□□ □■□■ | 2 14/16 | □□■■ ■□□■ | 5 6/16 | □■■■ ■■□■ | 7 14/16 | ■■■□ □□□■ | 10 6/16 | ■□□■ □■□■ |
| 0 7/16 | □□□□ □■□□ | 2 15/16 | □□■■ ■□□□ | 5 7/16 | □■■■ ■■□□ | 7 15/16 | ■■■□ □□□□ | 10 7/16 | ■□□■ □■□□ |
| 0 8/16 | □□□□ ■■□□ | 3 | □□■□ ■□□□ | 5 8/16 | □■■■ □■□□ | 8 | ■□■□ □□□□ | 10 8/16 | ■□□■ ■■□□ |
| 0 9/16 | □□□□ ■■□■ | 3 1/16 | □□■□ ■□□■ | 5 9/16 | □■■■ □■□■ | 8 1/16 | ■□■□ □□□■ | 10 9/16 | ■□□■ ■■□■ |
| 0 10/16 | □□□□ ■■■■ | 3 2/16 | □□■□ ■□■■ | 5 10/16 | □■■■ □■■■ | 8 2/16 | ■□■□ □□■■ | 10 10/16 | ■□□■ ■■■■ |
| 0 11/16 | □□□□ ■■■□ | 3 3/16 | □□■□ ■□■□ | 5 11/16 | □■■■ □■■□ | 8 3/16 | ■□■□ □□■□ | 10 11/16 | ■□□■ ■■■□ |
| 0 12/16 | □□□□ ■□■□ | 3 4/16 | □□■□ ■■■□ | 5 12/16 | □■■■ □□■□ | 8 4/16 | ■□■□ □■■□ | 10 12/16 | ■□□■ ■□■□ |
| 0 13/16 | □□□□ ■□■■ | 3 5/16 | □□■□ ■■■■ | 5 13/16 | □■■■ □□■■ | 8 5/16 | ■□■□ □■■■ | 10 13/16 | ■□□■ ■□■■ |
| 0 14/16 | □□□□ ■□□■ | 3 6/16 | □□■□ ■■□■ | 5 14/16 | □■■■ □□□■ | 8 6/16 | ■□■□ □■□■ | 10 14/16 | ■□□■ ■□□■ |
| 0 15/16 | □□□□ ■□□□ | 3 7/16 | □□■□ ■■□□ | 5 15/16 | □■■■ □□□□ | 8 7/16 | ■□■□ □■□□ | 10 15/16 | ■□□■ ■□□□ |
| 1 | □□□■ ■□□□ | 3 8/16 | □□■□ □■□□ | 6 | ■■■■ □□□□ | 8 8/16 | ■□■□ ■■□□ | 11 | ■□□□ ■□□□ |
| 1 1/16 | □□□■ ■□□■ | 3 9/16 | □□■□ □■□■ | 6 1/16 | ■■■■ □□□■ | 8 9/16 | ■□■□ ■■□■ | 11 1/16 | ■□□□ ■□□■ |
| 1 2/16 | □□□■ ■□■■ | 3 10/16 | □□■□ □■■■ | 6 2/16 | ■■■■ □□■■ | 8 10/16 | ■□■□ ■■■■ | 11 2/16 | ■□□□ ■□■■ |
| 1 3/16 | □□□■ ■□■□ | 3 11/16 | □□■□ □■■□ | 6 3/16 | ■■■■ □□■□ | 8 11/16 | ■□■□ ■■■□ | 11 3/16 | ■□□□ ■□■□ |
| 1 4/16 | □□□■ ■■■□ | 3 12/16 | □□■□ □□■□ | 6 4/16 | ■■■■ □■■□ | 8 12/16 | ■□■□ ■□■□ | 11 4/16 | ■□□□ ■■■□ |
| 1 5/16 | □□□■ ■■■■ | 3 13/16 | □□■□ □□■■ | 6 5/16 | ■■■■ □■■■ | 8 13/16 | ■□■□ ■□■■ | 11 5/16 | ■□□□ ■■■■ |
| 1 6/16 | □□□■ ■■□■ | 3 14/16 | □□■□ □□□■ | 6 6/16 | ■■■■ □■□■ | 8 14/16 | ■□■□ ■□□■ | 11 6/16 | ■□□□ ■■□■ |
| 1 7/16 | □□□■ ■■□□ | 3 15/16 | □□■□ □□□□ | 6 7/16 | ■■■■ □■□□ | 8 15/16 | ■□■□ ■□□□ | 11 7/16 | ■□□□ ■■□□ |
| 1 8/16 | □□□■ □■□□ | 4 | □■■□ □□□□ | 6 8/16 | ■■■■ ■■□□ | 9 | ■□■■ ■□□□ | 11 8/16 | ■□□□ □■□□ |
| 1 9/16 | □□□■ □■□■ | 4 1/16 | □■■□ □□□■ | 6 9/16 | ■■■■ ■■□■ | 9 1/16 | ■□■■ ■□□■ | 11 9/16 | ■□□□ □■□■ |
| 1 10/16 | □□□■ □■■■ | 4 2/16 | □■■□ □□■■ | 6 10/16 | ■■■■ ■■■■ | 9 2/16 | ■□■■ ■□■■ | 11 10/16 | ■□□□ □■■■ |
| 1 11/16 | □□□■ □■■□ | 4 3/16 | □■■□ □□■□ | 6 11/16 | ■■■■ ■■■□ | 9 3/16 | ■□■■ ■□■□ | 11 11/16 | ■□□□ □■■□ |
| 1 12/16 | □□□■ □□■□ | 4 4/16 | □■■□ □■■□ | 6 12/16 | ■■■■ ■□■□ | 9 4/16 | ■□■■ ■■■□ | 11 12/16 | ■□□□ □□■□ |
| 1 13/16 | □□□■ □□■■ | 4 5/16 | □■■□ □■■■ | 6 13/16 | ■■■■ ■□■■ | 9 5/16 | ■□■■ ■■■■ | 11 13/16 | ■□□□ □□■■ |
| 1 14/16 | □□□■ □□□■ | 4 6/16 | □■■□ □■□■ | 6 14/16 | ■■■■ ■□□■ | 9 6/16 | ■□■■ ■■□■ | 11 14/16 | ■□□□ □□□■ |
| 1 15/16 | □□□■ □□□□ | 4 7/16 | □■■□ □■□□ | 6 15/16 | ■■■■ ■□□□ | 9 7/16 | ■□■■ ■■□□ | 11 15/16 | ■□□□ □□□□ |
| 2 | □□■■ □□□□ | 4 8/16 | □■■□ ■■□□ | 7 | ■■■□ ■□□□ | 9 8/16 | ■□■■ □■□□ | | |
| 2 1/16 | □□■■ □□□■ | 4 9/16 | □■■□ ■■□■ | 7 1/16 | ■■■□ ■□□■ | 9 9/16 | ■□■■ □■□■ | | |
| 2 2/16 | □□■■ □□■■ | 4 10/16 | □■■□ ■■■■ | 7 2/16 | ■■■□ ■□■■ | 9 10/16 | ■□■■ □■■■ | | |
| 2 3/16 | □□■■ □□■□ | 4 11/16 | □■■□ ■■■□ | 7 3/16 | ■■■□ ■□■□ | 9 11/16 | ■□■■ □■■□ | | |
| 2 4/16 | □□■■ □■■□ | 4 12/16 | □■■□ ■□■□ | 7 4/16 | ■■■□ ■■■□ | 9 12/16 | ■□■■ □□■□ | | |
| 2 5/16 | □□■■ □■■■ | 4 13/16 | □■■□ ■□■■ | 7 5/16 | ■■■□ ■■■■ | 9 13/16 | ■□■■ □□■■ | | |
| 2 6/16 | □□■■ □■□■ | 4 14/16 | □■■□ ■□□■ | 7 6/16 | ■■■□ ■■□■ | 9 14/16 | ■□■■ □□□■ | | |
| 2 7/16 | □□■■ □■□□ | 4 15/16 | □■■□ ■□□□ | 7 7/16 | ■■■□ ■■□□ | 9 15/16 | ■□■■ □□□□ | | |

*Table B-2: LEDs D9 - D16: Level in Inches*

**Note** ■ = LED On
□ = LED Off

## B.3 Setting the Transmitter Level Using the LEDs (with Reverse Encoding)

**Note** If the transmitter (Modbus version) has had a Modbus level calibration, an internal offset will cause the LED pattern to differ from the transmitted level.
**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

To set the encoder level:

1. Remove the 2900 FTT cover.
2. Press switch SW8 to enable the LEDs.
3. Refer to Table B-3 on page 94. Find the whole number entry that matches your target level in feet.

   For example, if the target level is 41 feet, 8 9/16 inches, locate the entry for 41 feet.


*Figure B-5:LED Table Example - Feet*

4. Rotate the encoder disks clockwise or counter-clockwise until LEDs D1 - D9 (Feet) display the desired foot pattern. The actual level is now within 12 inches above the target level in feet.

   **Note** ■ = LED On
   □ = LED Off

5. Rotate the encoder disks clockwise to decrease the level, until LEDs D9 - D16 (Inches) display the zero-inch pattern shown in Figure B-6.

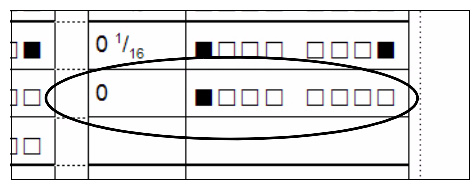



*Figure B-6:(LED Table Example - Inches*

6. Refer to Table B-4 on page 95. Find the entry that matches your target level in inches and 1/16 units. An example is shown in Figure B-7.
7. 


*Figure B-7:LED Table Example - Inches*

8. Rotate the encoder disks counter-clockwise to increase the level until LEDs D9 - D16 display the target pattern.

### B.3.1 LEDs D1 - D8: Level in Feet (Reverse Encoding)

| 95 – 76 Ft | | 75 – 56 Ft | | 55 – 36 Ft | | 35 – 16 Ft | | 15 – 0 Ft | |
|---|---|---|---|---|---|---|---|---|---|
| Ft | LEDs | Ft | LEDs | Ft | LEDs | Ft | LEDs | Ft | LEDs |
| 95 1/2 | ■□□□ □□□□ | 75 1/2 | ■□■■ ■■□□ | 55 1/2 | ■■■■ ■□□□ | 35 1/2 | □■■□ □■□□ | 15 1/2 | □□□■ □□□□ |
| 95 | ■□□□ □□□■ | 75 | ■□■■ ■■□■ | 55 | ■■■■ ■□□■ | 35 | □■■□ □■□■ | 15 | □□□■ □□□■ |
| 94 1/2 | ■□□□ □□■■ | 74 1/2 | ■□■■ ■■■■ | 54 1/2 | ■■■■ ■□■■ | 34 1/2 | □■■□ □■■■ | 14 1/2 | □□□■ □□■■ |
| 94 | ■□□□ □□■□ | 74 | ■□■■ ■■■□ | 54 | ■■■■ ■□■□ | 34 | □■■□ □■■□ | 14 | □□□■ □□■□ |
| 93 1/2 | ■□□□ □■■□ | 73 1/2 | ■□■■ ■□■□ | 53 1/2 | ■■■■ ■■■□ | 33 1/2 | □■■□ □□■□ | 13 1/2 | □□□■ □■■□ |
| 93 | ■□□□ □■■■ | 73 | ■□■■ ■□■■ | 53 | ■■■■ ■■■■ | 33 | □■■□ □□■■ | 13 | □□□■ □■■■ |
| 92 1/2 | ■□□□ □■□■ | 72 1/2 | ■□■■ ■□□■ | 52 1/2 | ■■■■ ■■□■ | 32 1/2 | □■■□ □□□■ | 12 1/2 | □□□■ □■□■ |
| 92 | ■□□□ □■□□ | 72 | ■□■■ ■□□□ | 52 | ■■■■ ■■□□ | 32 | □■■□ □□□□ | 12 | □□□■ □■□□ |
| 91 1/2 | ■□□□ ■■□□ | 71 1/2 | ■□■□ ■□□□ | 51 1/2 | ■■■■ □■□□ | 31 1/2 | □□■□ □□□□ | 11 1/2 | □□□■ ■■□□ |
| 91 | ■□□□ ■■□■ | 71 | ■□■□ ■□□■ | 51 | ■■■■ □■□■ | 31 | □□■□ □□□■ | 11 | □□□■ ■■□■ |
| 90 1/2 | ■□□□ ■■■■ | 70 1/2 | ■□■□ ■□■■ | 50 1/2 | ■■■■ □■■■ | 30 1/2 | □□■□ □□■■ | 10 1/2 | □□□■ ■■■■ |
| 90 | ■□□□ ■■■□ | 70 | ■□■□ ■□■□ | 50 | ■■■■ □■■□ | 30 | □□■□ □□■□ | 10 | □□□■ ■■■□ |
| 89 1/2 | ■□□□ ■□■□ | 69 1/2 | ■□■□ ■■■□ | 49 1/2 | ■■■■ □□■□ | 29 1/2 | □□■□ □■■□ | 9 1/2 | □□□■ ■□■□ |
| 89 | ■□□□ ■□■■ | 69 | ■□■□ ■■■■ | 49 | ■■■■ □□■■ | 29 | □□■□ □■■■ | 9 | □□□■ ■□■■ |
| 88 1/2 | ■□□□ ■□□■ | 68 1/2 | ■□■□ ■■□■ | 48 1/2 | ■■■■ □□□■ | 28 1/2 | □□■□ □■□■ | 8 1/2 | □□□■ ■□□■ |
| 88 | ■□□□ ■□□□ | 68 | ■□■□ ■■□□ | 48 | ■■■■ □□□□ | 28 | □□■□ □■□□ | 8 | □□□■ ■□□□ |
| 87 1/2 | ■□□■ ■□□□ | 67 1/2 | ■□■□ □■□□ | 47 1/2 | □■■■ □□□□ | 27 1/2 | □□■□ ■■□□ | 7 1/2 | □□□□ ■□□□ |
| 87 | ■□□■ ■□□■ | 67 | ■□■□ □■□■ | 47 | □■■■ □□□■ | 27 | □□■□ ■■□■ | 7 | □□□□ ■□□■ |
| 86 1/2 | ■□□■ ■□■■ | 66 1/2 | ■□■□ □■■■ | 46 1/2 | □■■■ □□■■ | 26 1/2 | □□■□ ■■■■ | 6 1/2 | □□□□ ■□■■ |
| 86 | ■□□■ ■□■□ | 66 | ■□■□ □■■□ | 46 | □■■■ □□■□ | 26 | □□■□ ■■■□ | 6 | □□□□ ■□■□ |
| 85 1/2 | ■□□■ ■■■□ | 65 1/2 | ■□■□ □□■□ | 45 1/2 | □■■■ □■■□ | 25 1/2 | □□■□ ■□■□ | 5 1/2 | □□□□ ■■■□ |
| 85 | ■□□■ ■■■■ | 65 | ■□■□ □□■■ | 45 | □■■■ □■■■ | 25 | □□■□ ■□■■ | 5 | □□□□ ■■■■ |
| 84 1/2 | ■□□■ ■■□■ | 64 1/2 | ■□■□ □□□■ | 44 1/2 | □■■■ □■□■ | 24 1/2 | □□■□ ■□□■ | 4 1/2 | □□□□ ■■□■ |
| 84 | ■□□■ ■■□□ | 64 | ■□■□ □□□□ | 44 | □■■■ □■□□ | 24 | □□■□ ■□□□ | 4 | □□□□ ■■□□ |
| 83 1/2 | ■□□■ □■□□ | 63 1/2 | ■■■□ □□□□ | 43 1/2 | □■■■ ■■□□ | 23 1/2 | □□■■ ■□□□ | 3 1/2 | □□□□ □■□□ |
| 83 | ■□□■ □■□■ | 63 | ■■■□ □□□■ | 43 | □■■■ ■■□■ | 23 | □□■■ ■□□■ | 3 | □□□□ □■□■ |
| 82 1/2 | ■□□■ □■■■ | 62 1/2 | ■■■□ □□■■ | 42 1/2 | □■■■ ■■■■ | 22 1/2 | □□■■ ■□■■ | 2 1/2 | □□□□ □■■■ |
| 82 | ■□□■ □■■□ | 62 | ■■■□ □□■□ | 42 | □■■■ ■■■□ | 22 | □□■■ ■□■□ | 2 | □□□□ □■■□ |
| 81 1/2 | ■□□■ □□■□ | 61 1/2 | ■■■□ □■■□ | 41 1/2 | □■■■ ■□■□ | 21 1/2 | □□■■ ■■■□ | 1 1/2 | □□□□ □□■□ |
| 81 | ■□□■ □□■■ | 61 | ■■■□ □■■■ | 41 | □■■■ ■□■■ | 21 | □□■■ ■■■■ | 1 | □□□□ □□■■ |
| 80 1/2 | ■□□■ □□□■ | 60 1/2 | ■■■□ □■□■ | 40 1/2 | □■■■ ■□□■ | 20 1/2 | □□■■ ■■□■ | 0 1/2 | □□□□ □□□■ |
| 80 | ■□□■ □□□□ | 60 | ■■■□ □■□□ | 40 | □■■■ ■□□□ | 20 | □□■■ ■■■■ | 0 | □□□□ □□□□ |
| 79 1/2 | ■□■■ □□□□ | 59 1/2 | ■■■□ ■■□□ | 39 1/2 | □■■□ ■□□□ | 19 1/2 | □□■■ □■□□ | | |
| 79 | ■□■■ □□□■ | 59 | ■■■□ ■■□■ | 39 | □■■□ ■□□■ | 19 | □□■■ □■□■ | | |
| 78 1/2 | ■□■■ □□■■ | 58 1/2 | ■■■□ ■■■■ | 38 1/2 | □■■□ ■□■■ | 18 1/2 | □□■■ □■■■ | | |
| 78 | ■□■■ □□■□ | 58 | ■■■□ ■■■□ | 38 | □■■□ ■□■□ | 18 | □□■■ □■■□ | | |
| 77 1/2 | ■□■■ □■■□ | 57 1/2 | ■■■□ ■□■□ | 37 1/2 | □■■□ ■■■□ | 17 1/2 | □□■■ □□■□ | | |
| 77 | ■□■■ □■■■ | 57 | ■■■□ ■□■■ | 37 | □■■□ ■■■■ | 17 | □□■■ □□■■ | | |
| 76 1/2 | ■□■■ □■□■ | 56 1/2 | ■■■□ ■□□■ | 36 1/2 | □■■□ ■■□■ | 16 1/2 | □□■■ □□□■ | | |
| 76 | ■□■■ □■□□ | 56 | ■■■□ ■□□□ | 36 | □■■□ ■■□□ | 16 | □□■■ □□□□ | | |

*Table B-3: LEDs D1 – D8: Level in Feet*

**Note** ■ = LED On
□ = LED Off

### B.3.2 LEDs D9 - D16: Level in Inches (Reverse Encoding)

| 11 15/16 – 9 8/16 In | | 9 7/16 – 7 In | | 6 15/16 – 4 8/16 In | | 4 7/16 – 2 In | | 1 15/16 – 0 In | |
|---|---|---|---|---|---|---|---|---|---|
| In | | In | LEDs | In | LEDs | In | LEDs | In | LEDs |
| 11 15/16 | □□□□ □□□□ | 9 7/16 | □□■■ ■■□□ | 6 15/16 | □■■■ ■□□□ | 4 7/16 | ■■■□ □■□□ | 1 15/16 | ■□□■ □□□□ |
| 11 14/16 | □□□□ □□□■ | 9 6/16 | □□■■ ■■□■ | 6 14/16 | □■■■ ■□□■ | 4 6/16 | ■■■□ □■□■ | 1 14/16 | ■□□■ □□□■ |
| 11 13/16 | □□□□ □□■■ | 9 5/16 | □□■■ ■■■■ | 6 13/16 | □■■■ ■□■■ | 4 5/16 | ■■■□ □■■■ | 1 13/16 | ■□□■ □□■■ |
| 11 12/16 | □□□□ □□■□ | 9 4/16 | □□■■ ■■■□ | 6 12/16 | □■■■ ■□■□ | 4 4/16 | ■■■□ □■■□ | 1 12/16 | ■□□■ □□■□ |
| 11 11/16 | □□□□ □■■□ | 9 3/16 | □□■■ ■□■□ | 6 11/16 | □■■■ ■■■□ | 4 3/16 | ■■■□ □□■□ | 1 11/16 | ■□□■ □■■□ |
| 11 10/16 | □□□□ □■■■ | 9 2/16 | □□■■ ■□■■ | 6 10/16 | □■■■ ■■■■ | 4 2/16 | ■■■□ □□■■ | 1 10/16 | ■□□■ □■■■ |
| 11 9/16 | □□□□ □■□■ | 9 1/16 | □□■■ ■□□■ | 6 9/16 | □■■■ ■■□■ | 4 1/16 | ■■■□ □□□■ | 1 9/16 | ■□□■ □■□■ |
| 11 8/16 | □□□□ □■□□ | 9 | □□■■ ■□□□ | 6 8/16 | □■■■ ■■□□ | 4 | ■■■□ □□□□ | 1 8/16 | ■□□■ □■□□ |
| 11 7/16 | □□□□ ■■□□ | 8 15/16 | □□■□ ■□□□ | 6 7/16 | □■■■ □■□□ | 3 15/16 | ■□■□ □□□□ | 1 7/16 | ■□□■ ■■□□ |
| 11 6/16 | □□□□ ■■□■ | 8 14/16 | □□■□ ■□□■ | 6 6/16 | □■■■ □■□■ | 3 14/16 | ■□■□ □□□■ | 1 6/16 | ■□□■ ■■□■ |
| 11 5/16 | □□□□ ■■■■ | 8 13/16 | □□■□ ■□■■ | 6 5/16 | □■■■ □■■■ | 3 13/16 | ■□■□ □□■■ | 1 5/16 | ■□□■ ■■■■ |
| 11 4/16 | □□□□ ■■■□ | 8 12/16 | □□■□ ■□■□ | 6 4/16 | □■■■ □■■□ | 3 12/16 | ■□■□ □□■□ | 1 4/16 | ■□□■ ■■■□ |
| 11 3/16 | □□□□ ■□■□ | 8 11/16 | □□■□ ■■■□ | 6 3/16 | □■■■ □□■□ | 3 11/16 | ■□■□ □■■□ | 1 3/16 | ■□□■ ■□■□ |
| 11 2/16 | □□□□ ■□■■ | 8 10/16 | □□■□ ■■■■ | 6 2/16 | □■■■ □□■■ | 3 10/16 | ■□■□ □■■■ | 1 2/16 | ■□□■ ■□■■ |
| 11 1/16 | □□□□ ■□□■ | 8 9/16 | □□■□ ■■□■ | 6 1/16 | □■■■ □□□■ | 3 9/16 | ■□■□ □■□■ | 1 1/16 | ■□□■ ■□□■ |
| 11 | □□□□ ■□□□ | 8 8/16 | □□■□ ■■□□ | 6 | □■■■ □□□□ | 3 8/16 | ■□■□ □■□□ | 1 | ■□□■ ■□□□ |
| 10 15/16 | □□□■ ■□□□ | 8 7/16 | □□■□ □■□□ | 5 15/16 | ■■■■ □□□□ | 3 7/16 | ■□■□ ■■□□ | 0 15/16 | ■□□□ ■□□□ |
| 10 14/16 | □□□■ ■□□■ | 8 6/16 | □□■□ □■□■ | 5 14/16 | ■■■■ □□□■ | 3 6/16 | ■□■□ ■■□■ | 0 14/16 | ■□□□ ■□□■ |
| 10 13/16 | □□□■ ■□■■ | 8 5/16 | □□■□ □■■■ | 5 13/16 | ■■■■ □□■■ | 3 5/16 | ■□■□ ■■■■ | 0 13/16 | ■□□□ ■□■■ |
| 10 12/16 | □□□■ ■□■□ | 8 4/16 | □□■□ □■■□ | 5 12/16 | ■■■■ □□■□ | 3 4/16 | ■□■□ ■■■□ | 0 12/16 | ■□□□ ■□■□ |
| 10 11/16 | □□□■ ■■■□ | 8 3/16 | □□■□ □□■□ | 5 11/16 | ■■■■ □■■□ | 3 3/16 | ■□■□ ■□■□ | 0 11/16 | ■□□□ ■■■□ |
| 10 10/16 | □□□■ ■■■■ | 8 2/16 | □□■□ □□■■ | 5 10/16 | ■■■■ □■■■ | 3 2/16 | ■□■□ ■□■■ | 0 10/16 | ■□□□ ■■■■ |
| 10 9/16 | □□□■ ■■□■ | 8 1/16 | □□■□ □□□■ | 5 9/16 | ■■■■ □■□■ | 3 1/16 | ■□■□ ■□□■ | 0 9/16 | ■□□□ ■■□■ |
| 10 8/16 | □□□■ ■■□□ | 8 | □□■□ □□□□ | 5 8/16 | ■■■■ □■□□ | 3 | ■□■□ ■□□□ | 0 8/16 | ■□□□ ■■□□ |
| 10 7/16 | □□□■ □■□□ | 7 15/16 | □■■□ □□□□ | 5 7/16 | ■■■■ ■■□□ | 2 15/16 | ■□■■ ■□□□ | 0 7/16 | ■□□□ □■□□ |
| 10 6/16 | □□□■ □■□■ | 7 14/16 | □■■□ □□□■ | 5 6/16 | ■■■■ ■■□■ | 2 14/16 | ■□■■ ■□□■ | 0 6/16 | ■□□□ □■□■ |
| 10 5/16 | □□□■ □■■■ | 7 13/16 | □■■□ □□■■ | 5 5/16 | ■■■■ ■■■■ | 2 13/16 | ■□■■ ■□■■ | 0 5/16 | ■□□□ □■■■ |
| 10 4/16 | □□□■ □■■□ | 7 12/16 | □■■□ □□■□ | 5 4/16 | ■■■■ ■■■□ | 2 12/16 | ■□■■ ■□■□ | 0 4/16 | ■□□□ □■■□ |
| 10 3/16 | □□□■ □□■□ | 7 11/16 | □■■□ □■■□ | 5 3/16 | ■■■■ ■□■□ | 2 11/16 | ■□■■ ■■■□ | 0 3/16 | ■□□□ □□■□ |
| 10 2/16 | □□□■ □□■■ | 7 10/16 | □■■□ □■■■ | 5 2/16 | ■■■■ ■□■■ | 2 10/16 | ■□■■ ■■■■ | 0 2/16 | ■□□□ □□■■ |
| 10 1/16 | □□□■ □□□■ | 7 9/16 | □■■□ □■□■ | 5 1/16 | ■■■■ ■□□■ | 2 9/16 | ■□■■ ■■□■ | 0 1/16 | ■□□□ □□□■ |
| 10 | □□□■ □□□□ | 7 8/16 | □■■□ □■□□ | 5 | ■■■■ ■□□□ | 2 8/16 | ■□■■ ■■□□ | 0 | ■□□□ □□□□ |
| 9 15/16 | □□■■ □□□□ | 7 7/16 | □■■□ ■■□□ | 4 15/16 | ■■■□ ■□□□ | 2 7/16 | ■□■■ □■□□ | | |
| 9 14/16 | □□■■ □□□■ | 7 6/16 | □■■□ ■■□■ | 4 14/16 | ■■■□ ■□□■ | 2 6/16 | ■□■■ □■□■ | | |
| 9 13/16 | □□■■ □□■■ | 7 5/16 | □■■□ ■■■■ | 4 13/16 | ■■■□ ■□■■ | 2 5/16 | ■□■■ □■■■ | | |
| 9 12/16 | □□■■ □□■□ | 7 4/16 | □■■□ ■■■□ | 4 12/16 | ■■■□ ■□■□ | 2 4/16 | ■□■■ □■■□ | | |
| 9 11/16 | □□■■ □■■□ | 7 3/16 | □■■□ ■□■□ | 4 11/16 | ■■■□ ■■■□ | 2 3/16 | ■□■■ □□■□ | | |
| 9 10/16 | □□■■ □■■■ | 7 2/16 | □■■□ ■□■■ | 4 10/16 | ■■■□ ■■■■ | 2 2/16 | ■□■■ □□■■ | | |
| 9 9/16 | □□■■ □■□■ | 7 1/16 | □■■□ ■□□■ | 4 9/16 | ■■■□ ■■□■ | 2 1/16 | ■□■■ □□□■ | | |
| 9 8/16 | □□■■ □■□□ | 7 | □■■□ ■□□□ | 4 8/16 | ■■■□ ■■□□ | 2 | ■□■■ □□□□ | | |

*Table B-4: LEDs D9 – D16: Level in Inches*

**Note** ■ = LED On
□ = LED Off

# C Appendix C — Database Points

This appendix describes the 2900 FTT database points. These points contain configuration parameters for the transmitter, as well as dynamic (real-time) data that show status during transmitter operation.

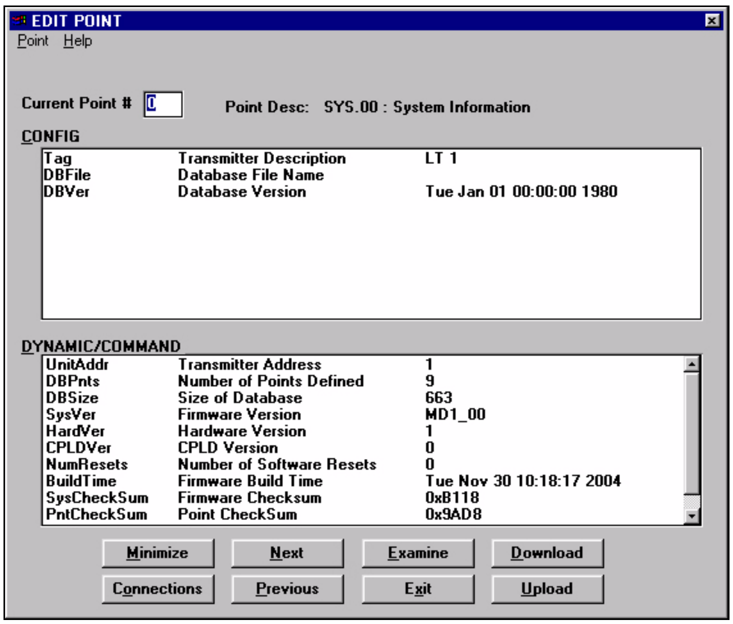
To access the points, you must connect a laptop computer running the ViewRTU software to the RS-232 (EIA232) connector. See Section 8.3, "Configuring Outputs" on page 50, or “Section 9.2.2, "Using ViewRTU to Troubleshoot the 2900 FTT" on page 62.

## C.1 System Information (SYS)

### C.1.1 Description

The System Information Point lists the hardware and software specifications of the system. Other information includes the hardware version.

### C.1.2 ViewRTU Dialog Box: EDIT POINT




### C.1.3 Parameters

The database parameters used by the SYS point are listed and described below:

| Configuration Parameters | Function |
|---|---|
| Tag | The Tag contains 7 bytes of data to identify the transmitter. The format of the TAG is “LT xxx” where xxx is the transmitter address. |
| DBFile | The database file name. DBFile is the name of the RCF database configuration file. |
| DBVer | The database version. |

*Table C-1: View RTU Dialog Box: EDIT POINT — Parameters*

| Dynamic Parameters | Function |
|---|---|
| UnitAddr | The transmitter Unit Address (SW1-SW3) |
| DBPnts | The number of database points defined |
| DBSize | The size of the database in bytes |
| SysVer | The Firmware version |
| HardVer | The PCB hardware version |
| CPLDVer | The CPLD program version |
| NumResets | Records the number of system resets that have occurred since the last "Hard Reset" of the system |
| BuildTime | The Date and Time the database structure was generated |
| SysCheckSum | CRC-16 Checksum of the Firmware |
| PntCheckSum | CRC-16 Checksum of point's static Configuration Parameters |
| PntStatus | Byte value indicating status of point Values are:<br>0: No error |

*Table C-2: View RTU Dialog Box: EDIT POINT — Dynamic Parameters*

## C.2 Encoder Information (ENC)

### C.2.1 Description

The ENC Information Point lists the parameters associated with the internal operation of the transmitter hardware. This includes parameters associated with the operation of the optical encoder.

### C.2.2 Application

The ENC point is used to diagnose the current operation of the transmitter. The parameters can be used to evaluate the proper operation of the rotary switches as well as the proper operation of the encoders. The raw absolute and incremental encoder values can be evaluated. The current disk track states can be evaluated. The calculated reference values can be evaluated.

### C.2.3 ViewRTU Dialog Box: EDIT POINT - ENC

### C.2.4 Parameters

The database parameters used by the ENC point are listed and described below:

| Configuration Parameters | Function |
|---|---|
| Command | This parameter is reserved for future use. |
| EncValue | This parameter is a 16-bit value indicating the incremental value. |
| FDisk | This parameter is an 8-bit value indicating the track pattern read from the Foot encoder disk. |
| IDisk | This parameter is an 8-bit value indicating the track pattern read from the Inch encoder disk. |
| EncState | This is a diagnostic code that describes the encoder state. |
| Level | This parameter represents the level in feet derived from the absolute encoding process. This parameter is always encoded in the forward rotation direction. |
| IncLevel | This parameter represents the level in feet derived from the incremental encoding process. This parameter is always encoded in the forward rotation direction. |
| Feet | This parameter indicates the feet portion of the level derived from the absolute encoding process. This parameter is shown in foot units. |
| Inches | This parameter indicates the inches portion of the level derived from the absolute encoding process. This parameter is shown in inch units. |
| Sixteenths | This parameter indicates the 1/16-inch portion of the level derived from the absolute encoding process. This parameter is shown in 1/16-inch units. |
| Ref0 | This parameter is the voltage reference value calculated for the Foot disk. |

*Table C-3: Encoder Information (ENC) — Configuration Parameters*

| Configuration Parameters | Function |
|---|---|
| Ref1 | This parameter is the voltage reference value calculated for the Inch disk. |
| PntStatus | Byte value indicating status of point Values are:<br>0: No error |
| Elapse | Time of last Point update. |
| PntCheckSum | CRC-16 Checksum of point's static Configuration Parameters |

*Table C-3: Encoder Information (ENC) — Configuration Parameters*

## C.3 Resistive Temperature Detector (RTD)

### C.3.1 Description

The Resistive Temperature Detector point displays the data associated with the temperature measurement circuit on the 2900. The RTD point processes temperature using SI units, so the temperature is always displayed in degrees Celsius within the RTD point.

### C.3.2 Parameters

The database parameters used by the RTD point are listed and described below:

| Configuration Parameters | Function |
|---|---|
| TempMode | This parameter is set using SW6. The value of this parameter indicates the type of RTD to be interfaced with the 2900.<br>0: PT100<br>1: Cu100<br>2: Cu90 |
| Cal1-Cal5 | These parameters are used to provide additional calibration to the RTD circuit. The factory default values are 20, 60, 100, 140, and 180. These values are sufficient for most applications. Set these parameters to adjust the interpolation points used in temperature calculation. |
| Filter | Value between 1-10 indicating the number of temperature samples used in temperature filtering. The default value is 4. |

*Table C-4: Resistive Temperature Detector (RTD) — Configuration Parameters*

| Dynamic Parameters | Function |
|---|---|
| Command | Parameter used to activate calibration parameters. |
| Temp | Measured temperature in degrees Celsius. |
| RawValue | Un-calibrated resistance measurement value. |
| Resistance | Calibrated Resistance measure value. The Value used to calculate the actual temperature parameter. |
| Value1-Value3 | Parameters used in ratio metric resistance measurement. |
| Ref100 | 24-bit value representing the ratio metric value of a 100-ohm precision reference resistor. |
| Ref200 | 24-bit value representing the ratio metric value of a 200-ohm precision reference resistor. |
| PntStatus | Byte value indicating status of point Values are:<br>0x0001: Hardware Failure<br>0x0002: Measurement is over range<br>0x0004: Measurement in under range<br>0x0008: Measurement is using modified calibration values |

*Table C-5: Resistive Temperature Detector (RTD) — Dynamic Parameters*

| Dynamic Parameters | Function |
|---|---|
| Elapse | Time of last Point update. |
| PntCheckSum | CRC-16 Checksum of point's static Configuration Parameters |

*Table C-5: Resistive Temperature Detector (RTD) — Dynamic Parameters*

## C.4 Modbus Register Block (MBLK)

### C.4.1 Description

The Modbus Register Block point serves a data block to store user configuration data as well as converted data to be transmitted to the Host. The data block is organized in a structure useful for efficient Modbus transactions, but this data block is also used as an access point for other versions of the 2900 FTT.

### C.4.2 Application

The MBLK point is used to set advanced configuration parameters. These parameters include level and temperature alarm set points as well as Relay Output control sources. Configuration parameters can be written and read either using ViewRTU or in the case of the RS485 Modbus communications module using Modbus.

#### *C.4.2.1 Scaled Integers vs. Floating Point Values*

Configuration data can be written either as scaled integers or floating point. Writing data to floating point values will cause the associated scaled integer data to be updated and, writing data to scaled integer values will cause the associated floating point values to be updated. For a description of scaled integers see Section A.3, "Configuration" on page 73.

#### *C.4.2.2 Monitoring Input Devices*

The status of each input device wired to the 2900 FTT is shown in a unique register in the dynamic parameter AlmStat described in Table C-7 on page 106. These registers are 0x0100, 0x0200, 0x0400 and 0x0800.

### C.4.3 Parameters

The database parameters used by the MBLK point are listed and described below:

| Configuration Parameters | Function |
|---|---|
| CritLowLevel | Floating-point value representing the Critical Low Level Set point for Level alarms. The parameter must be set in current Level units. |
| AdvLowLevel | Floating-point value representing the Advisory Low Level Set point for Level alarms. The parameter must be set in current Level units. |
| AdvHighLevel | Floating-point value representing the Advisory High Level Set point for Level alarms. The parameter must be set in current Level units. |
| CritHighLevel | Floating-point value representing the Critical High Level Set point for Level alarms. The parameter must be set in current Level units. |
| LDeadband | Floating-point value used to determine change in level alarm state. The Level value must be above Low Level set points and below high level set points by this amount for the alarm condition to clear. The parameter must be set in current Level units. |
| CritLowTemp | Floating point value representing the Critical Low temperature Set point for temperature alarms. The parameter must be set in current temperature units. |

*Table C-6: Configuration Parameters*

| Configuration Parameters | Function |
|---|---|
| AdvLowTemp | Floating point value representing the Advisory Low temperature Set point for temperature alarms. The parameter must be set in current temperature units. |
| AdvHighTemp | Floating point value representing the Advisory High temperature Set point for temperature alarms. The parameter must be set in current temperature units. |
| CritHighTemp | Floating point value representing the Critical High temperature Set point for temperature alarms. The parameter must be set in current temperature units. |
| TDeadband | Floating-point value used to determine change in temperature alarm state. The temperature value must be above Low Temp set points and below high Temp set points by this amount for the alarm condition to clear. The parameter must be set in current Temp units. |
| MinLevel | Floating point value representing the minimal level value used in calculating scaled integer level parameters. The parameter must be set in current Level units. |
| MaxLevel | Floating point value representing the maximum level value used in calculating scaled integer level parameters. The parameter must be set in current Level units. |
| MinTemp | Floating point value representing the minimal temperature value used in calculating scaled integer temperature parameters. The parameter must be set in current temperature units. |
| MaxTemp | Floating point value representing the maximum temperature value used in calculating scaled integer temperature parameters. The parameter must be set in current temperature units. |
| Reserved3 | This value is used to maintain compatibility with the 4000 ATT register map. |
| ManTemp | Floating-point value representing a manual temperature value. |
| Cleave | Floating-point value used to calibrate to the current level. This parameter is used in conjunction with Cmds parameter to set the transmitter level. The parameter must be set in current level units. |
| NoiseRej | This value is used to maintain compatibility with the 4000 ATT register map. Setting this parameter has no effect, as by default the A/D circuit rejects both 50 and 60 Hz noise. |
| LoLoLevSet | Scaled Integer value representing the Critical Low Level Set point for Level alarms. |
| LowLevSet | Scaled Integer value representing the Advisory Low Level Set point for Level alarms. |
| HighLevelSet | Scaled Integer value representing the Advisory High Level Set point for Level alarms |
| HiHiLevSet | Scaled Integer value representing the Critical High Level Set point for Level alarms. |

*Table C-6: Configuration Parameters*

| Configuration Parameters | Function |
|---|---|
| LevDead | Scaled Integer value used to determine change in level alarm state. The Scaled Integer Level iLevel value must be above Low Level set points and below high level set points by this amount for the alarm condition to clear. |
| LoLoTempSet | Scaled Integer value representing the Critical Low temperature Set point for temperature alarms. |
| LowTempSet | Scaled Integer value representing the Advisory Low temperature Set point for temperature alarms. |
| HighTempSet | Scaled Integer value representing the Advisory High temperature Set point for temperature alarms |
| HiHiTempSet | Scaled Integer value representing the Critical High temperature Set point for temperature alarms. |
| TempDead | Scaled Integer value used to determine change in temperature alarm state. The Scaled Integer temperature iTemp value must be above Low temperature set points and below high temperature set points by this amount for the alarm condition to clear. |
| LevUnits | Read only parameter – Units for Level to be transmitted to the Host interface. This value is derived from the rotary switches at startup.<br>0: M (Meters)<br>1: F (Feet) |
| TempUnits | Read only parameter – Units for temperature data to be transmitted to the Host interface. This value is derived from the rotary switches at startup<br>0: C (Celsius)<br>1: F (Fahrenheit) |
| LevType | This Read only parameter sets the rotation direction for the Level Gauge. This value is derived from the rotary switches at startup.<br>1: Forward<br>2: Reverse |
| TempType | This Read only parameter sets the RTD type. This value is derived from the rotary switches at startup.<br>0: PT100<br>1: Cu100<br>2: Cu90 |
| iManTemp | Scaled Integer value representing a manual temperature value. |
| MaxInt | This parameter sets the maximum integer value used in Scaled Integer calculations. |
| DampVal | This value is used to maintain compatibility with the 4000 ATT register map. |
| iCalLevel | Scaled Integer value used to calibrate to the current level. This parameter is used in conjunction with Cmds parameter to set the transmitter level. |

*Table C-6: Configuration Parameters*

| Dynamic Parameters | Function |
|---|---|
| Cmds | Parameter used to send commands to the transmitter 0x20: Calibrate Level. |
| Level | Transmitted Level. This parameter reflects a value calculated using the encoding direction, Level units, and any calibration level. |
| Temp | Transmitted Temperature. This parameter reflects the set temperature units. |
| Resistance | Transmitted Resistance measure value |
| AbsLevel | This parameter represents the level in feet derived from the absolute encoding process. This parameter is always encoded in the forward rotation direction. |
| IncLevel | This parameter represents the level in feet derived from the incremental encoding process. This parameter is always encoded in the forward rotation direction. |
| iLevel | Transmitted Scaled integer Level. |
| iTemp | Transmitted Scaled integer Temperature. |
| DiskVel | Integer Value indicates the relative rotation speed of the encoder. |
| NumResets | Records the number of system resets that have occurred since the last “Hard Reset” of the system |
| AlmStat | Integer Value indicating any alarm conditions.<br>0x0001: Critical Low Level<br>0x0002: Advisory Low Level<br>0x0004: Advisory High Level<br>0x0008: Critical High Level<br>0x0010: Critical Low Temperature<br>0x0020: Advisory Low Temperature<br>0x0040: Advisory High Temperature<br>0x0080: Critical High Temperature<br>0x0100: Digital Input 1<br>0x0200: Digital Input 2<br>0x0400: Digital Input 3<br>0x0800: Digital Input 4 |
| DiagStat | Integer Value indicating any diagnostic alarm conditions.<br>0x0001: Invalid Level<br>0x0002: Invalid Temperature |
| PntStatus | Byte value indicating status of point Values are:<br>0: No Errors |
| Elapse | Time of last Point update. |
| PntCheckSum | CRC-16 Checksum of point's static Configuration Parameters |

*Table C-7: Dynamic Parameters*

## C.5 Digital Outputs (DO)

### C.5.1 Description

The Digital Output point contains the configuration and control parameters for activating the 4 optional output relays.

### C.5.2 Parameters

| Configuration Parameters | Function |
|---|---|
| DOPwrUpState | This parameter is used to force a Relay to be active at startup.<br>0x0001: Relay 1 Activated at Startup<br>0x0002: Relay 2 Activated at Startup<br>0x0004: Relay 3 Activated at Startup<br>0x0008: Relay 4 Activated at Startup |
| DO1Assign – D04Assign | These parameters are used to assign the control and activation source for the output relays.<br>0: Not Assigned<br>1: Host Interface (Modbus<br>2: Critical High Level<br>3: Advisory High Level<br>4: Advisory Low Level<br>5: Critical Low Level<br>6: Critical High Temperature<br>7: Advisory High Temperature<br>8: Advisory Low Temperature<br>9: Critical Low Temperature |
| Reserved3 | This value is used to maintain compatibility with the 4000 ATT register map. |

*Table C-8: Configuration Parameters*

| Dynamic Parameters | Function |
|---|---|
| DOOutputState | This is a command parameter used to activate the output relays.<br>0x0001: Activate Relay 1 (When set for HOST Control)<br>0x0002: Activate Relay 2 (When set for HOST Control)<br>0x0004: Activate Relay 3 (When set for HOST Control)<br>0x0008: Activate Relay 4 (When set for HOST Control) |
| Reserved1 | This value is used to maintain compatibility with the 4000 ATT register map. |
| DOType | This value is used to maintain compatibility with the 4000 ATT register map. |
| Reserved2 | This value is used to maintain compatibility with the 4000 ATT register map. |

*Table C-9: Dynamic Parameters*

| Dynamic Parameters | Function |
|---|---|
| DOState | This parameter indicates the current state of the Output Relays.<br>0x0001: Relay 1 Activated<br>0x0002: Relay 2 Activated<br>0x0004: Relay 3 Activated<br>0x0008: Relay 4 Activated |
| PntStatus | Byte value indicating status of point Values are:<br>0x0001: Hardware Failure |
| Elapse | Time of last Point update. |
| PntCheckSum | CRC-16 Checksum of point's static Configuration Parameters |

*Table C-9: Dynamic Parameters*

# D Appendix D — RTD Resistance - Temperature Charts

This appendix describes the relationship between temperature and resistance for the three RTD types that can be used with the 2900 FTT. This information can be used to verify the accuracy of the RTD probe used with the 2900 FTT.

The following tables are provided:


- Section D.1, "Pt100 RTD Resistance vs. Temperature" on page 109
- Section D.2, "Cu100 RTD Resistance vs. Temperature" on page 113
- Section D.3, "Cu90 RTD Resistance vs. Temperature" on page 116


For troubleshooting instructions, see Section 9.2.6, "Verifying Temperature Data – Checking RTD Resistance" on page 65.

## D.1 Pt100 RTD Resistance vs. Temperature

| Pt100 | | |
|---|---|---|
| **RTD Resistance** | **Temp °C** | **Temp °F** |
| 16.76 | –204.0 | –335.2 |
| 18.49 | –200.0 | –328.0 |
| 20.22 | –196.0 | –320.8 |
| 21.94 | –192.0 | –313.6 |
| 23.66 | –188.0 | –306.4 |
| 25.37 | –184.0 | –299.2 |
| 27.08 | –180.0 | –292.0 |
| 28.78 | –176.0 | –284.8 |
| 30.47 | –172.0 | –277.6 |
| 32.16 | –168.0 | –270.4 |
| 33.85 | –164.0 | –263.2 |
| 35.53 | –160.0 | –256.0 |
| 37.21 | –156.0 | –248.8 |
| 38.88 | –152.0 | –241.6 |
| 40.55 | –148.0 | –234.4 |
| 42.21 | –144.0 | –227.2 |
| 43.87 | –140.0 | –220.0 |
| 45.52 | –136.0 | –212.8 |
| 47.18 | –132.0 | –205.6 |
| 48.82 | –128.0 | –198.4 |
| 50.47 | –124.0 | –191.2 |
| 52.11 | –120.0 | –184.0 |
| 53.74 | –116.0 | –176.8 |

*Table D-1: Pt100 RTD Resistance vs. Temperature*

| Pt100 | | |
|---|---|---|
| RTD Resistance | Temp °C | Temp °F |
| 55.38 | -112.0 | -169.6 |
| 57 | -108.0 | -162.4 |
| 58.63 | -104.0 | -155.2 |
| 60.25 | -100.0 | -148.0 |
| 61.87 | -96.0 | -140.8 |
| 63.49 | -92.0 | -133.6 |
| 65.11 | -88.0 | -126.4 |
| 66.72 | -84.0 | -119.2 |
| 68.33 | -80.0 | -112.0 |
| 69.93 | -76.0 | -104.8 |
| 71.53 | -72.0 | -97.6 |
| 73.13 | -68.0 | -90.4 |
| 74.73 | -64.0 | -83.2 |
| 76.33 | -60.0 | -76.0 |
| 77.92 | -56.0 | -68.8 |
| 79.51 | -52.0 | -61.6 |
| 81.1 | -48.0 | -54.4 |
| 82.69 | -44.0 | -47.2 |
| 84.27 | -40.0 | -40.0 |
| 85.85 | -36.0 | -32.8 |
| 87.43 | -32.0 | -25.6 |
| 89.01 | -28.0 | -18.4 |
| 90.59 | -24.0 | -11.2 |
| 92.16 | -20.0 | -4.0 |
| 93.73 | -16.0 | 3.2 |
| 95.3 | -12.0 | 10.4 |
| 96.87 | -8.0 | 17.6 |
| 98.44 | -4.0 | 24.8 |
| 100 | 0.0 | 32.0 |
| 101.56 | 4.0 | 39.2 |
| 103.12 | 8.0 | 46.4 |
| 104.68 | 12.0 | 53.6 |
| 106.24 | 16.0 | 60.8 |
| 107.79 | 20.0 | 68.0 |
| 109.35 | 24.0 | 75.2 |
| 110.9 | 28.0 | 82.4 |
| 112.45 | 32.0 | 89.6 |
| 113.99 | 36.0 | 96.8 |
| 115.54 | 40.0 | 104.0 |

*Table D-1: Pt100 RTD Resistance vs. Temperature*

| Pt100 | | |
|---|---|---|
| RTD Resistance | Temp °C | Temp °F |
| 117.08 | 44.0 | 111.2 |
| 118.62 | 48.0 | 118.4 |
| 120.16 | 52.0 | 125.6 |
| 121.7 | 56.0 | 132.8 |
| 123.24 | 60.0 | 140.0 |
| 124.77 | 64.0 | 147.2 |
| 126.31 | 68.0 | 154.4 |
| 127.84 | 72.0 | 161.6 |
| 129.37 | 76.0 | 168.8 |
| 130.89 | 80.0 | 176.0 |
| 132.42 | 84.0 | 183.2 |
| 133.94 | 88.0 | 190.4 |
| 135.46 | 92.0 | 197.6 |
| 136.98 | 96.0 | 204.8 |
| 138.5 | 100.0 | 212.0 |
| 140.02 | 104.0 | 219.2 |
| 141.53 | 108.0 | 226.4 |
| 143.04 | 112.0 | 233.6 |
| 144.55 | 116.0 | 240.8 |
| 146.06 | 120.0 | 248.0 |
| 147.57 | 124.0 | 255.2 |
| 149.07 | 128.0 | 262.4 |
| 150.57 | 132.0 | 269.6 |
| 152.08 | 136.0 | 276.8 |
| 153.58 | 140.0 | 284.0 |
| 155.07 | 144.0 | 291.2 |
| 156.57 | 148.0 | 298.4 |
| 158.06 | 152.0 | 305.6 |
| 159.55 | 156.0 | 312.8 |
| 161.04 | 160.0 | 320.0 |
| 162.53 | 164.0 | 327.2 |
| 164.02 | 168.0 | 334.4 |
| 165.5 | 172.0 | 341.6 |
| 166.98 | 176.0 | 348.8 |
| 168.46 | 180.0 | 356.0 |
| 169.94 | 184.0 | 363.2 |
| 171.42 | 188.0 | 370.4 |
| 172.9 | 192.0 | 377.6 |
| 174.37 | 196.0 | 384.8 |

*Table D-1: Pt100 RTD Resistance vs. Temperature*

| Pt100 | | |
|---|---|---|
| RTD Resistance | Temp °C | Temp °F |
| 175.84 | 200.0 | 392.0 |
| 177.31 | 204.0 | 399.2 |

*Table D-1: Pt100 RTD Resistance vs. Temperature*

## D.2 Cu100 RTD Resistance vs. Temperature

| Cu100 | | |
|---|---|---|
| RTD Resistance | Temp °C | Temp °F |
| 12.78 | -204.0 | -335.2 |
| 14.3 | -200.0 | -328.0 |
| 15.82 | -196.0 | -320.8 |
| 17.35 | -192.0 | -313.6 |
| 18.87 | -188.0 | -306.4 |
| 20.39 | -184.0 | -299.2 |
| 21.92 | -180.0 | -292.0 |
| 23.44 | -176.0 | -284.8 |
| 24.97 | -172.0 | -277.6 |
| 26.49 | -168.0 | -270.4 |
| 28.01 | -164.0 | -263.2 |
| 29.54 | -160.0 | -256.0 |
| 31.06 | -156.0 | -248.8 |
| 32.58 | -152.0 | -241.6 |
| 34.11 | -148.0 | -234.4 |
| 35.63 | -144.0 | -227.2 |
| 37.15 | -140.0 | -220.0 |
| 38.68 | -136.0 | -212.8 |
| 40.2 | -132.0 | -205.6 |
| 41.72 | -128.0 | -198.4 |
| 43.25 | -124.0 | -191.2 |
| 44.77 | -120.0 | -184.0 |
| 46.3 | -116.0 | -176.8 |
| 47.82 | -112.0 | -169.6 |
| 49.34 | -108.0 | -162.4 |
| 50.87 | -104.0 | -155.2 |
| 52.39 | -100.0 | -148.0 |
| 53.91 | -96.0 | -140.8 |
| 55.44 | -92.0 | -133.6 |
| 56.96 | -88.0 | -126.4 |
| 58.48 | -84.0 | -119.2 |
| 60.01 | -80.0 | -112.0 |
| 61.53 | -76.0 | -104.8 |
| 63.06 | -72.0 | -97.6 |
| 64.58 | -68.0 | -90.4 |
| 66.1 | -64.0 | -83.2 |

*Table D-2: Cu100 RTD Resistance vs. Temperature*

| Cu100 | | |
|---|---|---|
| **RTD Resistance** | **Temp °C** | **Temp °F** |
| 67.63 | –60.0 | –76.0 |
| 69.15 | –56.0 | –68.8 |
| 70.67 | –52.0 | –61.6 |
| 72.2 | –48.0 | –54.4 |
| 73.72 | –44.0 | –47.2 |
| 75.24 | –40.0 | –40.0 |
| 76.77 | –36.0 | –32.8 |
| 78.29 | –32.0 | –25.6 |
| 79.81 | –28.0 | –18.4 |
| 81.34 | –24.0 | –11.2 |
| 82.86 | –20.0 | –4.0 |
| 84.39 | –16.0 | 3.2 |
| 85.91 | –12.0 | 10.4 |
| 87.43 | –8.0 | 17.6 |
| 88.96 | –4.0 | 24.8 |
| 90.48 | 0.0 | 32.0 |
| 92 | 4.0 | 39.2 |
| 93.53 | 8.0 | 46.4 |
| 95.05 | 12.0 | 53.6 |
| 96.57 | 16.0 | 60.8 |
| 98.1 | 20.0 | 68.0 |
| 99.62 | 24.0 | 75.2 |
| 101.15 | 28.0 | 82.4 |
| 102.67 | 32.0 | 89.6 |
| 104.19 | 36.0 | 96.8 |
| 105.72 | 40.0 | 104.0 |
| 107.24 | 44.0 | 111.2 |
| 108.76 | 48.0 | 118.4 |
| 110.29 | 52.0 | 125.6 |
| 111.81 | 56.0 | 132.8 |
| 113.33 | 60.0 | 140.0 |
| 114.86 | 64.0 | 147.2 |
| 116.38 | 68.0 | 154.4 |
| 117.9 | 72.0 | 161.6 |
| 119.43 | 76.0 | 168.8 |
| 120.95 | 80.0 | 176.0 |
| 122.48 | 84.0 | 183.2 |
| 124 | 88.0 | 190.4 |
| 125.52 | 92.0 | 197.6 |

*Table D-2: Cu100 RTD Resistance vs. Temperature*

| Cu100 | | |
|---|---|---|
| RTD Resistance | Temp °C | Temp °F |
| 127.05 | 96.0 | 204.8 |
| 128.57 | 100.0 | 212.0 |
| 130.09 | 104.0 | 219.2 |
| 131.62 | 108.0 | 226.4 |
| 133.14 | 112.0 | 233.6 |
| 134.66 | 116.0 | 240.8 |
| 136.19 | 120.0 | 248.0 |
| 137.71 | 124.0 | 255.2 |
| 139.24 | 128.0 | 262.4 |
| 140.76 | 132.0 | 269.6 |
| 142.28 | 136.0 | 276.8 |
| 143.81 | 140.0 | 284.0 |
| 145.33 | 144.0 | 291.2 |
| 146.85 | 148.0 | 298.4 |
| 148.38 | 152.0 | 305.6 |
| 149.9 | 156.0 | 312.8 |
| 151.42 | 160.0 | 320.0 |
| 152.95 | 164.0 | 327.2 |
| 154.47 | 168.0 | 334.4 |
| 155.99 | 172.0 | 341.6 |
| 157.52 | 176.0 | 348.8 |
| 159.04 | 180.0 | 356.0 |
| 160.57 | 184.0 | 363.2 |
| 162.09 | 188.0 | 370.4 |
| 163.61 | 192.0 | 377.6 |
| 165.14 | 196.0 | 384.8 |
| 166.66 | 200.0 | 392.0 |
| 168.18 | 204.0 | 399.2 |

*Table D-2: Cu100 RTD Resistance vs. Temperature*

## D.3 Cu90 RTD Resistance vs. Temperature

| Cu90 | | |
|---|---|---|
| RTD Resistance | Temp °C | Temp °F |
| 51.77 | -100.00 | -148.00 |
| 53.32 | -96.0 | -140.8 |
| 54.87 | -92.0 | -133.6 |
| 56.42 | -88.0 | -126.4 |
| 57.97 | -84.0 | -119.2 |
| 59.52 | -80.0 | -112.0 |
| 61.07 | -76.0 | -104.8 |
| 62.61 | -72.0 | -97.6 |
| 64.16 | -68.0 | -90.4 |
| 65.71 | -64.0 | -83.2 |
| 67.26 | -60.0 | -76.0 |
| 68.81L | -56.0 | -68.8 |
| 70.36 | -52.0 | -61.6 |
| 71.91 | -48.0 | -54.4 |
| 73.46 | -44.0 | -47.2 |
| 75.01 | -40.0 | -40.0 |
| 76.56 | -36.0 | -32.8 |
| 78.11 | -32.0 | -25.6 |
| 79.66 | -28.0 | -18.4 |
| 81.20 | -24.0 | -11.2 |
| 82.75 | -20.0 | -4.0 |
| 84.30 | -16.0 | 3.2 |
| 85.85 | -12.0 | 10.4 |
| 87.40 | -8.0 | 17.6 |
| 88.95 | -4.0 | 24.8 |
| 90.50 | 0.0 | 32.0 |
| 92.05 | 4.0 | 39.2 |
| 93.60 | 8.0 | 46.4 |
| 95.15 | 12.0 | 53.6 |
| 96.70 | 16.0 | 60.8 |
| 98.25 | 20.0 | 68.0 |
| 99.80 | 24.0 | 75.2 |
| 101.34 | 28.0 | 82.4 |
| 102.89 | 32.0 | 89.6 |
| 104.44 | 36.0 | 96.8 |
| 105.99 | 40.0 | 104.0 |
| 107.54 | 44.0 | 111.2 |

*Table D-3: Cu90 RTD Resistance vs. Temperature*

| Cu90 | | |
|---|---|---|
| RTD Resistance | Temp °C | Temp °F |
| 109.09 | 48.0 | 118.4 |
| 110.64 | 52.0 | 125.6 |
| 112.19 | 56.0 | 132.8 |
| 113.74 | 60.0 | 140.0 |
| 115.29 | 64.0 | 147.2 |
| 116.84 | 68.0 | 154.4 |
| 118.39 | 72.0 | 161.6 |
| 119.93 | 76.0 | 168.8 |
| 121.48 | 80.0 | 176.0 |
| 123.03 | 84.0 | 183.2 |
| 124.58 | 88.0 | 190.4 |
| 126.13 | 92.0 | 197.6 |
| 127.68 | 96.0 | 204.8 |
| 129.23 | 100.0 | 212.0 |
| 130.78 | 104.0 | 219.2 |
| 132.33 | 108.0 | 226.4 |
| 133.88 | 112.0 | 233.6 |
| 135.43 | 116.0 | 240.8 |
| 136.98 | 120.0 | 248.0 |
| 138.53 | 124.0 | 255.2 |
| 140.07 | 128.0 | 262.4 |
| 141.62 | 132.0 | 269.6 |
| 143.17 | 136.0 | 276.8 |
| 144.72 | 140.0 | 284.0 |
| 146.27 | 144.0 | 291.2 |
| 147.82 | 148.0 | 298.4 |
| 149.37 | 152.0 | 305.6 |
| 150.92 | 156.0 | 312.8 |
| 152.47 | 160.0 | 320.0 |
| 154.02 | 164.0 | 327.2 |
| 155.57 | 168.0 | 334.4 |
| 157.12 | 172.0 | 341.6 |
| 158.66 | 176.0 | 348.8 |
| 160.21 | 180.0 | 356.0 |
| 161.76 | 184.0 | 363.2 |
| 163.31 | 188.0 | 370.4 |
| 164.86 | 192.0 | 377.6 |
| 166.41 | 196.0 | 384.8 |
| 167.96 | 200.0 | 392.0 |

*Table D-3: Cu90 RTD Resistance vs. Temperature*

| Cu90 | | |
|---|---|---|
| **RTD Resistance** | **Temp °C** | **Temp °F** |
| 169.51 | 204.0 | 399.2 |
| 198.94 | 280.00 | 536.00 |

*Table D-3: Cu90 RTD Resistance vs. Temperature*

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