

# 2920 Float & Tape Transmitter

Precision instrument for remote monitoring of tank level and temperature information



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Varec, Inc.  
5834 Peachtree Corners East  
Peachtree Corners, Georgia 30092  
Phone: (770) 447-9202  
Fax: (770) 662-8939

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Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

**Note** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 18 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. Any modifications made to this device that are not approved by Varec, Inc. may void the users authority to operate this equipment.

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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.

**Note** Qualified personnel are required for installation of this product in a hazardous environment.

## 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.

**Warning!** Discard plastic conduit entry plugs. Use the metal plugs that are shipped loose in a bag to replace and seal ALL open conduit holes not used. Not sealing all conduit holes with metal conduit plugs negates the explosion-proof rating of the housing.

**Warning!** Explosion and water ingress hazard. Tighten cover and tighten and seal ALL conduit and plugs with pipe sealant prior to operation. Failure to do so voids manufacturer's warranty.

**Warning!** Possible buildup of electrostatic charges on non-conducting surfaces. To clean, wipe equipment with a damp cloth.

**Warning!** The flamepath joints are not repairable by the end user. Consult the factory for repair or replacement.

**Warning!** Conduit seal required within 50 mm of conduit entries to enclosure when installed.

**Attention!** Joint de conduit requis à moins de 50 mm aux entrées de conduit à la clôture une fois installé.

**Warning!** Install models with I.S. HART per Associated Intrinsically Safe (AIS) (Appareillage Connexe) Control Drawing 28-013355, Appendix D.

**Warning!** Improper connections, component substitutions, or tampering may impair intrinsic safety and create a hazardous condition.

**Avertissement!** La substitution de composants peut compromettre la sécurité intrinsèque.

**Warning!** Do not open the display or expansion junction boxes while energized due to an explosion hazard.

**Note** The I.S. HART terminal box is labeled with a light blue sticker. It is intrinsically safe and may be opened while energized.

**Specific Conditions of Use** Consult the manufacturer if dimensional information on the flameproof joints is necessary.



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# Change History

Revision #	Minor Rev.	Date	Author	Approved By	Description of Change
A		6/21/2021	J. M. Rollins		Initial Change History table addition
B		10/05/2021	J. M. Rollins	J. Kolb	Added LED Reset & Contrast Adjustment Steps
C		4/5/2022	J. M. Rollins	J. Kolb	Added UKCA logo and updated product labels
D		3/23/2023	J. M. Rollins	T. Gibson	Added hydrostatic functionality
E		6/27/2023	Charlyn Lez Moss	Dirk Holcomb	Updates to Modbus Tables and Tank Ullage implementation

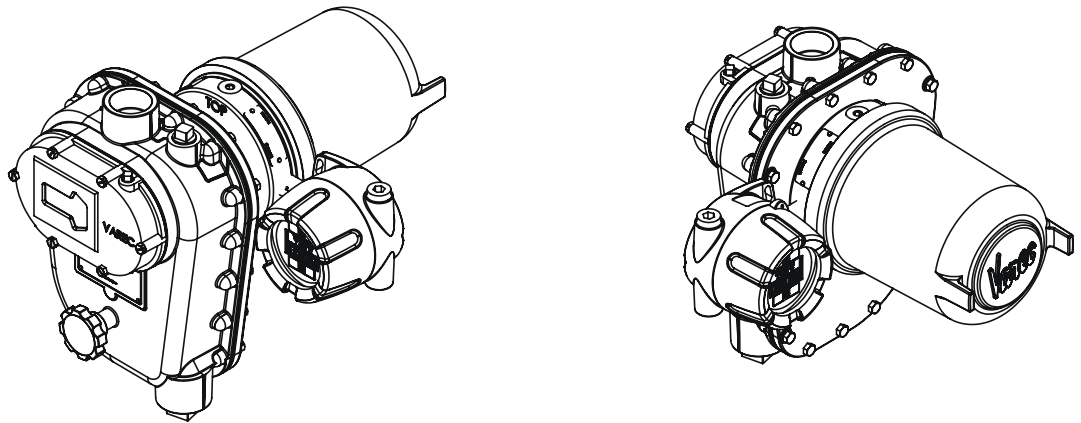


# 1 Introduction

This manual provides the information needed to install, maintain, and troubleshoot the Varec 2920 Float & Tape Transmitter (FTT).

The 2920 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.

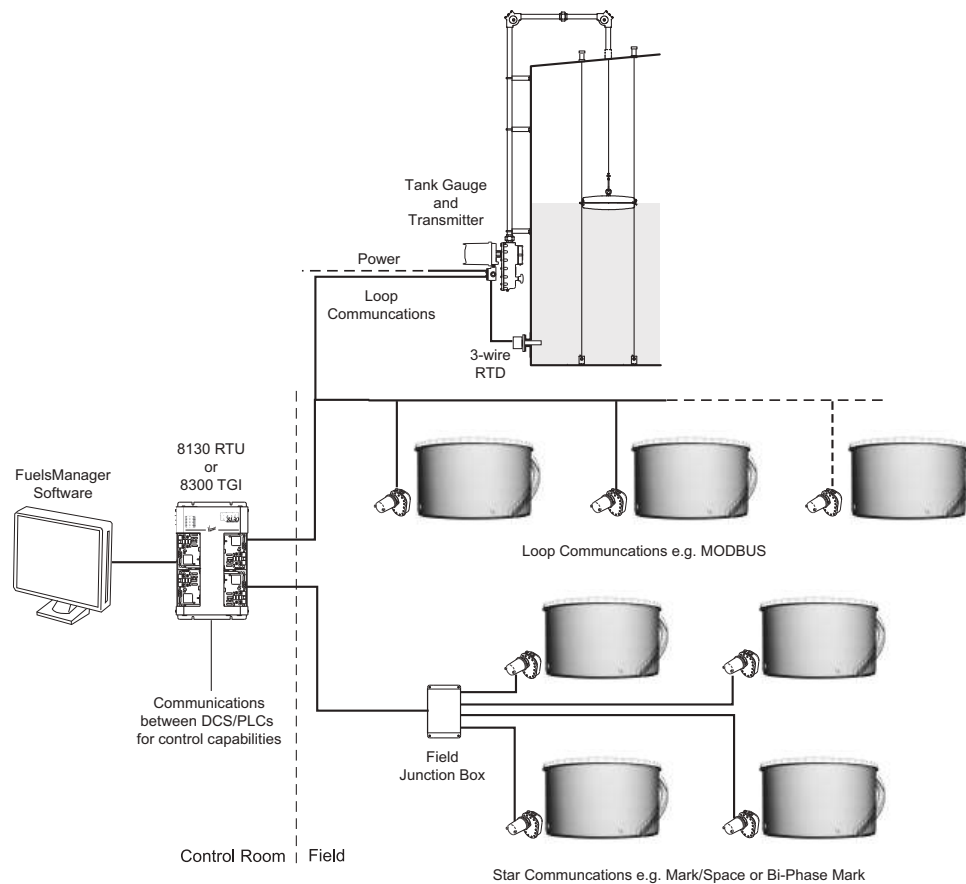
The 2920 FTT is available for Bi-Phase Mark, MODBUS, L&J TankWay, or Mark/Space field communications. It can be mounted directly to most manufacturers' tank gauges, including GSI, L&J, and others. The following figure shows the 2920 FTT mounted to the Varec 2500 Automatic Tank Gauge (ATG) in both front-facing and back-facing configurations.



The 2920 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.

# Function & System Design

## System Functionality

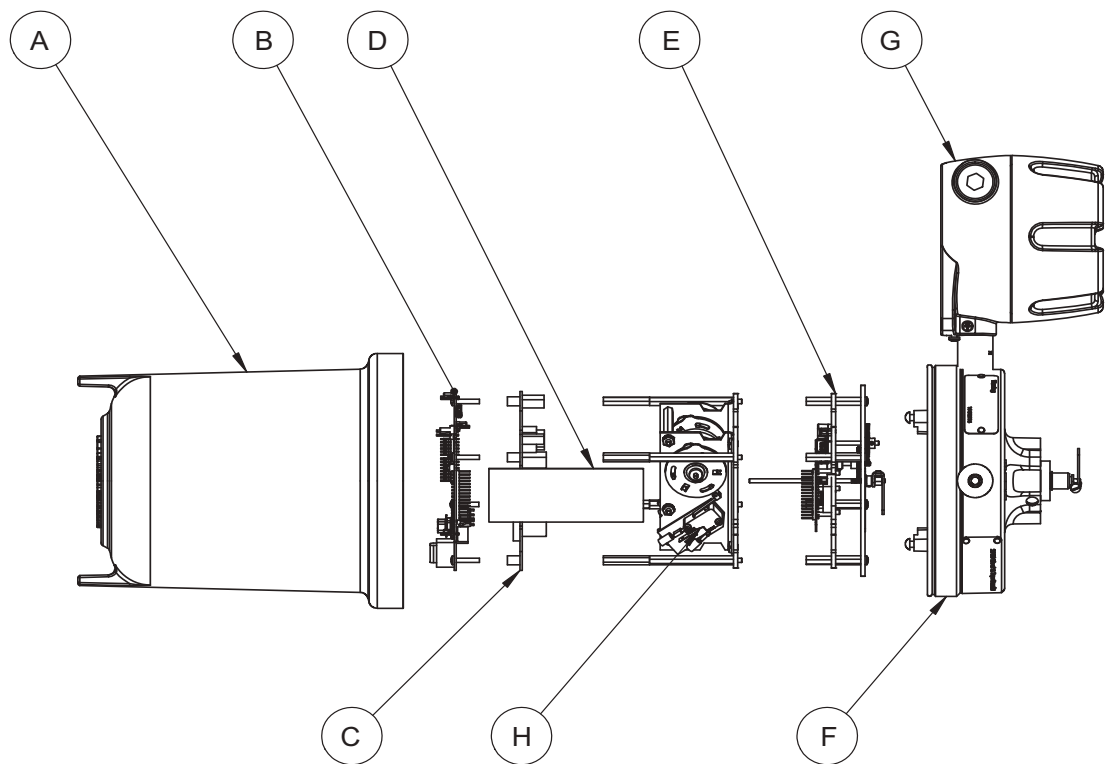


1. In response to changes in liquid level, the mechanical level gauge rotates the 2920 FTT encoder drive shaft.
2. The 2920 FTT's precision direct drive gearing turns a high resolution encoder which detects the angular position of the drive shaft and produces a level value.
3. If a spot temperature RTD (Resistance Temperature Detector) is used, the communications board translates the RTD input to a digital temperature value.
4. The communications circuit board converts the encoded level and temperature to a specific field communications protocol.
5. The communications circuit board transmits the data to an interface device for display in a control room by an inventory management system, such as FuelsManager.

## Internal System Design

The 2920 FTT is constructed with the following assemblies, as shown in the following figure:

- A. Enclosure Cover
- B. Communications Circuit Board
- C. AC Power Circuit Board (Optional)
- D. Connector Circuit Board or Optional HART IS Barrier Board
- E. Encoder Assembly
- F. Enclosure Base
- G. Junction Box
- H. Limit Switch Assembly (Optional)



All standard electronics for the 2920 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. The optional limit switch assembly (H) can support up to four limit switches. These limit switches and inputs/outputs can be used in safety applications such as overfill protection, level switch inputs, local alarm control, permissives, and interlocks. The limit switches and inputs/outputs can also provide basic automation control.

## Product Labels

The figure below contains the 2920 FTT product labels.

Order Code: N2920ACbccdefg0i

<b>Varec® 2920 Float &amp; Tape Transmitter</b>		
Model No.	Serial No.	Mfg. Date
<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A	<input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz	
UK CA 1725	CE 2809 Ex II 2G Ex db IIB T5 Gb -40°C ≤ Ta ≤ +85°C IP66	FM22UKEX0021X FM10ATEX0022X IECEX FMG10.0006X
Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA		IOM 118 16-02920AC Rev. C

Order Code: N2920ATbccdefg0i

<b>Varec® 2920 Float &amp; Tape Transmitter</b>		
Model No.	Serial No.	Mfg. Date
<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A	<input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz	
UK CA 1725	CE 2809 Ex II 2G Ex db IIB T5 Gb -20°C ≤ Ta ≤ +85°C IP66	FM22UKEX0021X FM10ATEX0022X IECEX FMG10.0006X
Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA		IOM 118 16-02920AT Rev. E

Order Code: N2920FCbccdefg0i

<b>Varec® 2920 Float &amp; Tape Transmitter</b>		
Model No.	Serial No.	Mfg. Date
<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A	<input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz	
FM APPROVED	Class I, Division 1, Groups C&D, T5, -40°C ≤ Ta ≤ +85°C, Type 4 Class I, Zone 1, IIB, T5, IP66 (USA) Zone 1 per CEC 18-100 (CAN) FM16CA0114X	IOM 118
Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA		16-02920FC Rev. D

Order Code: N2920FMbccdefg0i

<b>Varec® 2920 Float &amp; Tape Transmitter</b>		
Model No.	Serial No.	Mfg. Date
<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A	<input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz	
FM APPROVED	Class I, Division 1, Groups C&D, T5, -25°C ≤ Ta ≤ +85°C, Type 4 Cl. I, Zn. 1, AEx db IIB T5 Gb, -20°C ≤ Ta ≤ +85°C, IP66 (USA) Ex db IIB T5 Gb, -20°C ≤ Ta ≤ +85°C, IP66, FM16CA0114X (CAN)	IOM 118
Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA		16-02920FM Rev. D

Order Code: N2920ACbccdefg1i

<b>Varec® 2920 Float &amp; Tape Transmitter</b>		
Model No.	Serial No.	Mfg. Date
<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A	<input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz	
UK CA 1725	CE 2809 Ex II 2(1)G Ex db [ia Ga] IIB T5 Gb -40°C ≤ Ta ≤ +85°C IP66 Refer to control drawing 28-013355 for installation requirements.	FM22UKEX0021X FM10ATEX0022X IECEX FMG10.0006X
Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA		IOM 118 28-013355 16-013391AC Rev. C

Order Code: N2920ATbccdefg1i


<b>Varec® 2920 Float &amp; Tape Transmitter</b>		
Model No.	Serial No.	Mfg. Date
<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A	<input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz	
UK CA 1725	CE 2809 Ex II 2G Ex db IIB T5 Gb -20°C ≤ Ta ≤ +85°C IP66	FM22UKEX0021X FM10ATEX0022X IECEX FMG10.0006X
Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA		IOM 118 16-02920AT Rev. E

Order Code: N2920FCbccdefg1i

 <b>2920 Float &amp; Tape Transmitter</b>		Model No.	Serial No.	Mfg. Date
		<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A <input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz		
	Associated Apparatus provides Intrinsically Safe Circuits for Class I, Division 1, Groups C&D, T5, -40°C ≤ Ta ≤ +85°C, Type 4 Class I, Zone 1, IIB, T5, IP66 (USA) Zone 1 per CEC 18-100 (CAN) FM16CA0114X			  IOM 118 Refer to control drawing 28-013355 for installation requirements.
	Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA			16-013391FC Rev. E

Order Code: N2920FMbccdefg1i

 <b>2920 Float &amp; Tape Transmitter</b>		Model No.	Serial No.	Mfg. Date
		<input type="checkbox"/> 20-65 V $\overline{\text{---}}$ 0.2 A <input type="checkbox"/> 40-65/120/220-240 V~ 500mW 50/60Hz		
	Associated Apparatus provides Intrinsically Safe Circuits for Class I, Division 1, Groups C&D, T5, -25°C ≤ Ta ≤ +85°C, Type 4 Cl. I, Zn. 1, AEx db[ia Ga] IIB T5 Gb, -20°C ≤ Ta ≤ +85°C, IP66 (USA) Ex db[ia Ga] IIB T5 Gb, -20°C ≤ Ta ≤ +85°C, IP66, FM16CA0114X (CAN)			  IOM 118 Refer to control drawing 28-013355 for installation requirements.
	Varec, Inc. 5834 Peachtree Corners East, Peachtree Corners (Atlanta), Georgia 30092 USA			16-013391FM Rev. D

 IOM 118 28-013355	See Installation Instruction Document (IOM118) See Associated Intrinsically Safe Apparatus control drawing 28-013355, Appendix D
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## 2 Installation

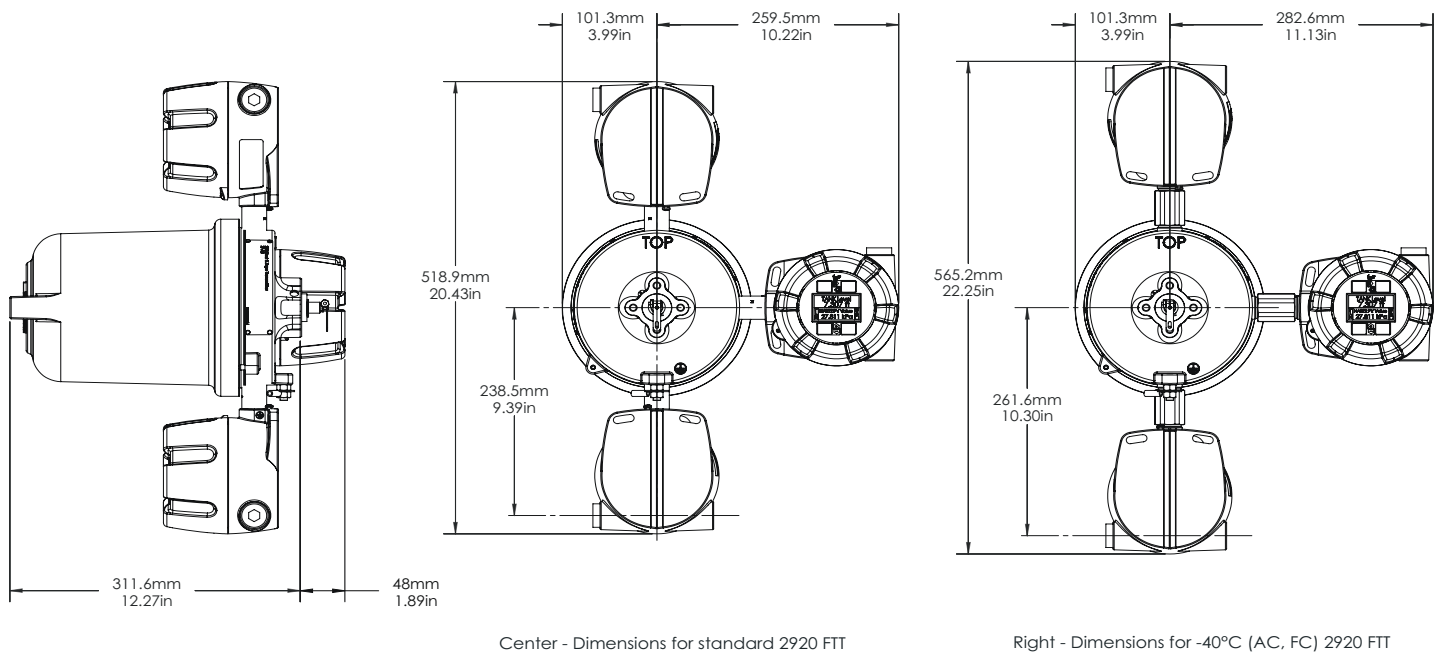
This chapter provides a pre-installation checklist, safety information, unpacking instructions, grounding instructions, and an overview of the installation steps.

### Site Preparation Checklist

Before installing the 2920 FTT transmitter on a mechanical float and tape gauge, 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 the following figure.
3. The correct transmitter/mechanical gauge adaptor is available, if required.
4. The gaugehead shall be adequately grounded for the safe electrical drain of electrostatic charges that may accumulate in the tank and the product (see “Grounding the Equipment”).
5. The correct field connections at the gaugehead are ready to connect to the 2920 FTT (i.e., power, communications, and temperature sensor wiring).
6. The installation complies with all safety guidelines as described in “General Safety Guidelines”.

The tank can remain in-service and the mechanical float gauge can remain in place while installing and configuring the 2920 FTT.



## General Safety Guidelines

The 2920 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)
- FM Approvals LLC (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.

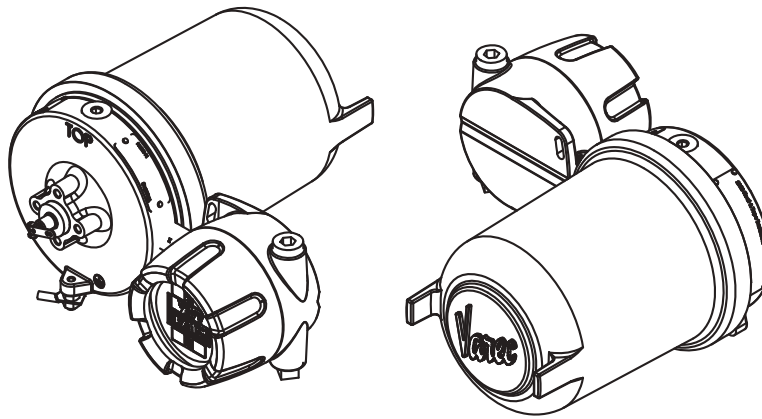
## Unpacking

Varec 2920 Float & Tape Transmitters are shipped fully assembled and ready for installation.

### To Unpack the 2920 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.
5. Remove and discard the plastic conduit entry shipping plugs.

**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.



## Becoming Familiar with the 2920 FTT

The 2920 FTT is housed within an explosion-proof enclosure. The cover is provided to permit access to the 2920 FTT's electronics (i.e., circuit boards). O-Ring seals are provided to prevent moisture from entering the termination or electronics compartments.

The 2920 FTT housing provides an external grounding lug and 3/4-inch NPT conduit entries. The conduit entries permit access to the 2920 FTT wiring connections.

## Grounding the Equipment

**Warning!** The 2920 FTT must be grounded before communication and power connections are made.

An external grounding lug is provided on the 2920 FTT. A connection from the ground lug to earth ground must be made before any other wiring connections are made.

**Note** For proper operation of the 2920 FTT, a ground strap must be attached to the FTT. Grounding through mounting kits or pipe coupling is not adequate.

Properly seal all ports to prevent moisture or other contamination from entering the wiring compartment.

## Water and Dust Ingress Protection

The enclosure and junction boxes have been designed and tested to IP66 and NEMA 4 for water and dust ingress. To ensure that the unit is protected against water and dust ingress and that the explosion proof/flame proof integrity of the enclosure is not compromised, ensure the following:

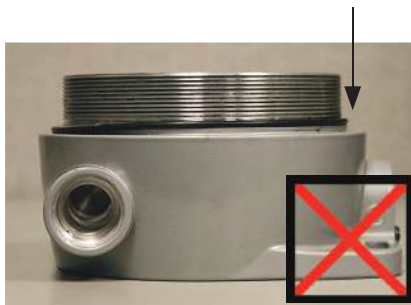
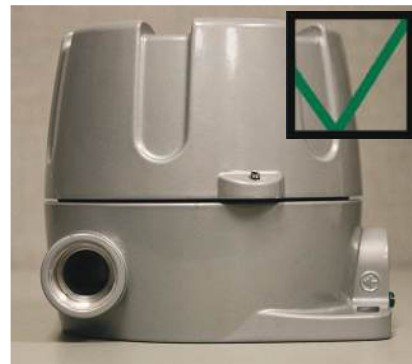
1. Cover o-rings are installed, undamaged, and properly seated (see below) prior to tightening. See the Correct Sealing of the Junction Box Covers section below for an illustration and an explanation.
2. The plastic shipping conduit entry plugs are discarded and replaced by the metal, explosion proof/flameproof plugs that were provided with the transmitter.
3. Conduit seals are installed per the local code. Varec recommends that a potting compound be used that will not absorb water. Varec also recommends a drain on vertical conduit runs with an explosion proof/flameproof flame arrestor.
4. Seal all pipe threads (e.g., conduit and plugs) with pipe sealant or Teflon tape.
5. The cover set screws are backed out enough to allow the covers to be fully tightened and the covers are fully tightened. The covers may be locked, if desired, with the set screws after the covers are tight.

## Correct Sealing of the Junction Box Covers



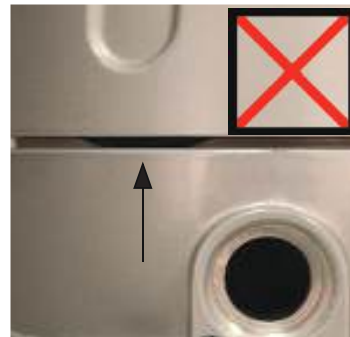
**Above:** O-ring correctly seated at the base.

**Right:** The cover is properly sealed.



**Above:** O-ring not correctly seated.

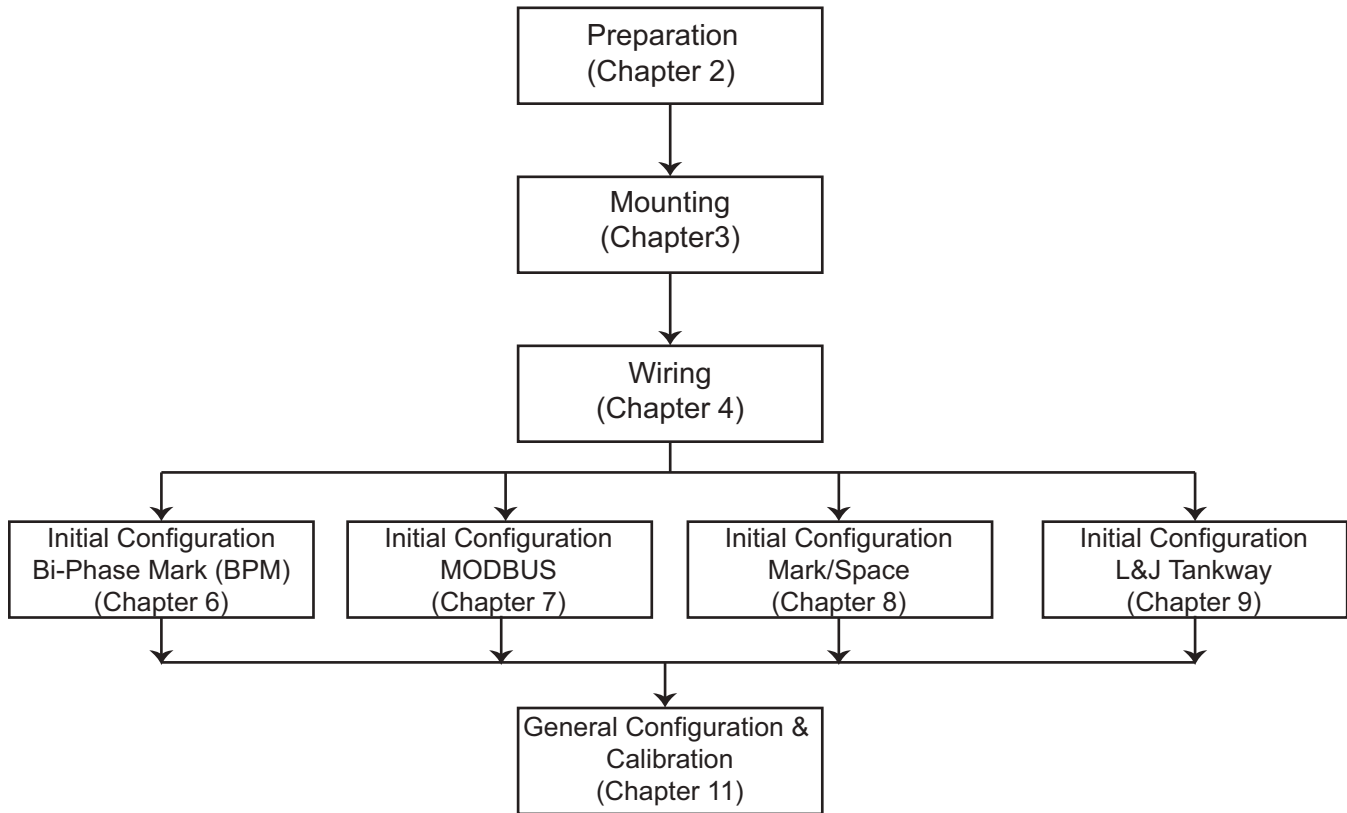
**Right:** The O-ring bulges after the cover is attached, thereby causing a gap and preventing a proper seal.



The 2920 float and tape transmitter housing has been designed and tested for NEMA 4 & IP66. However, the covers must be correctly installed and tightened to maintain the seal. Note that the junction box o-ring must be properly seated around the small boss. Review the above images shown, which show the o-ring both properly and improperly seated. If improperly seated, it can leave a gap or bulge out, which will cause leaks.

# Installation Overview

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



## 3 Mounting

The 2920 FTT can be mounted in the following ways:

- Mount the complete transmitter on a 2500 ATG gaugehead (see “Mounting on a Varec Gaugehead”).
- Mount the complete transmitter on a non-Varec gauge (see “Mounting on Alternate Gaugeheads”).
- Mount standalone on a 2" pipe for gauging applications where the 2920 FTT functions as a tank side integrator for HART level instrumentation (i.e., radar) as well as spot temperature or HART average temperature.

This chapter describes each of the above procedures.

The tank can remain in-service and the mechanical float gauge can remain in place while installing and configuring the 2920 FTT.

**Note** Please read the safety guidelines section before beginning the mounting process.

## 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 2920 FTT.
- Refer to Chapter 2, Installation: "Correct Sealing of the Junction Box Covers" make sure the o-ring is properly seated on the base of the cover.

**Warning!** Before attempting installation of the 2920 FTT, review the General Safety Guidelines. Installation and maintenance personnel should become familiar with any hazards present as well as any agency requirements before working with any equipment.

## Mounting on a Varec Gaugehead

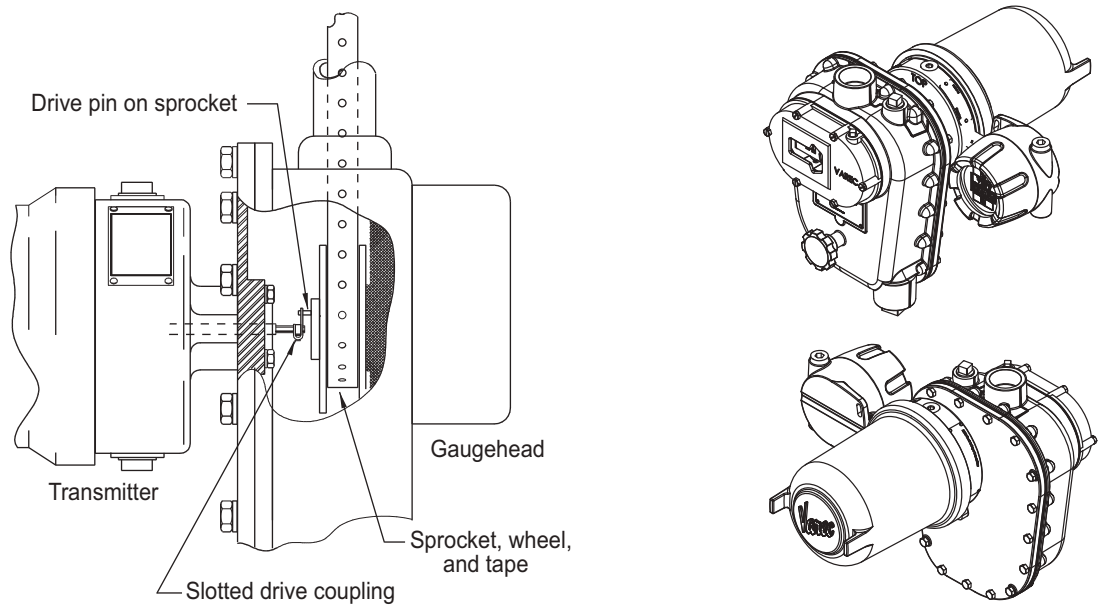
This procedure provides instructions to mount the transmitter on a 2500 ATG gaugehead.

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.

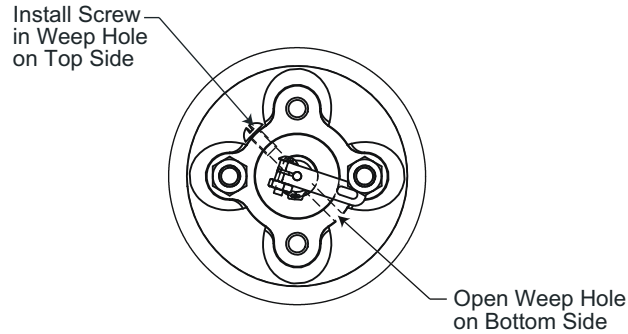
**Warning!** Whenever the back cover of the gaugehead is removed, stand to one side as the last bolt is removed. If the negator motor spring is broken, the broken pieces may cause injury when the cover is removed.

**Warning!** The mechanical connections between the gauge float guide cables, the float, the tape, and the gaugehead provide an adequate ground connection for the safe 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.

**Make certain grounding straps are fastened properly to the case of each unit. Ground connections via mounting clamps and bolts are not sufficient to ensure proper ground.**



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. The preferred mounting of the transmitter is to secure the transmitter onto the back cover of the gaugehead, using the four hex head cap screws that are attached to the access cap. Make sure that the top of the 2920 FTT housing (marked with "TOP") lines up with the top of the back cover. Position the circular gasket with the four bolt holes between the transmitter and 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. Ensure the top side weep hole is plugged with the included screw as shown in the following figure to prevent ingress of water into the transmitter.



6. Fasten the back cover to the gaugehead.
7. Proceed with field wiring, as described in "Wiring".

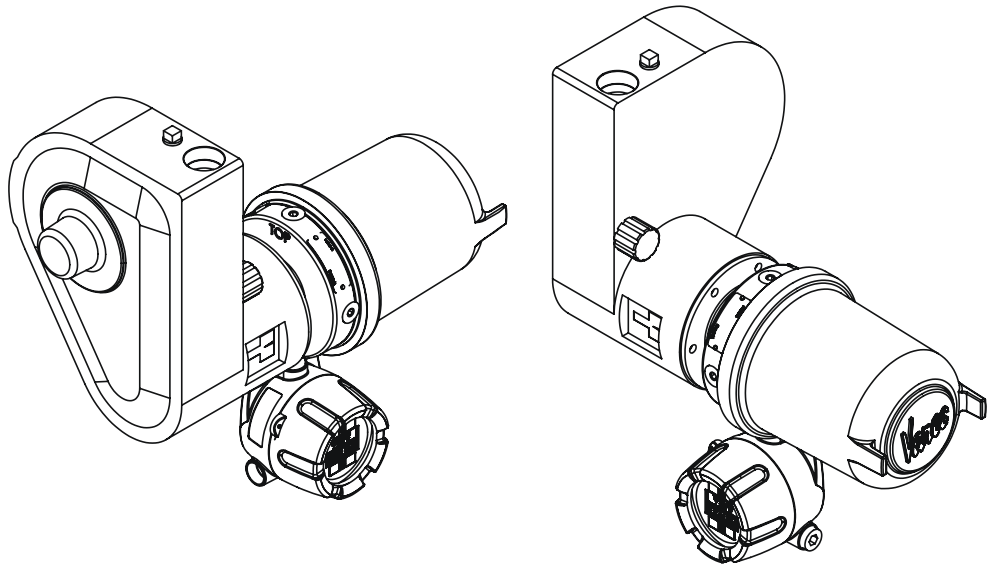
## Mounting on Alternate Gaugeheads

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

The gaugehead is assumed to be installed on the tank. See the previous figure on page 10 and perform the following steps.

1. Remove the mounting plate (back cover) from the gaugehead.
2. Remove the access cap from the mounting plate of the gaugehead. Keep the original gasket and bolts.
3. Mount the transmitter to the adapter, using the included gasket.
4. Install the transmitter with adapter on the gaugehead mounting plate, using the four hex head cap screws that are included with the adapter kit. Use the manufacturer's original gaugehead gasket between the mounting plate and the adapter. Make sure that the top of the 2920 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 "Wiring".

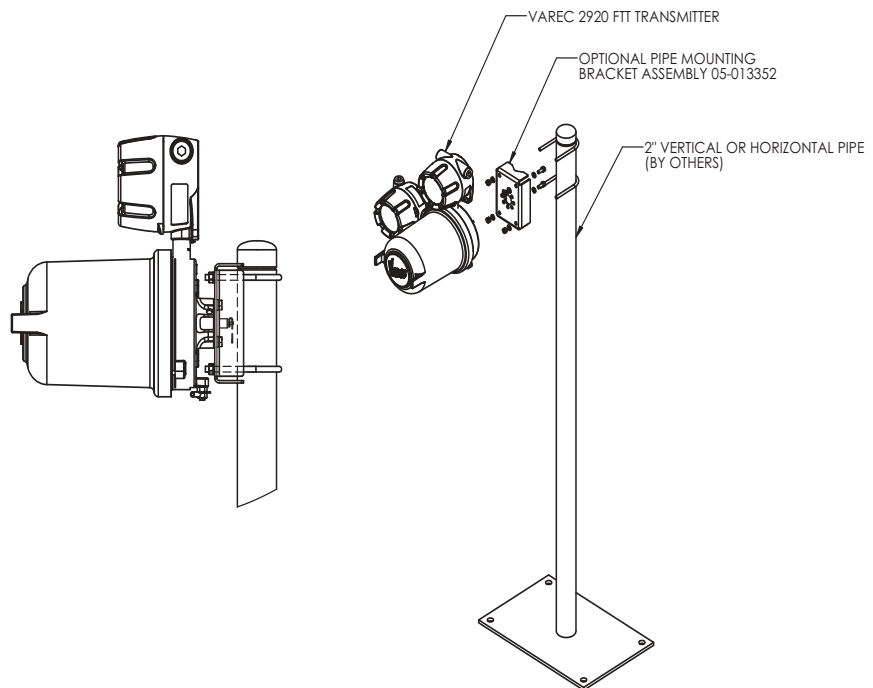
The following figure shows the 2920 mounted on a S & J Gauge.



## Pipe Mount Option

The 2920 FTT can be used standalone without a mechanical gauge for radar applications as a tank side integrator. It can talk to HART radars and temperature devices.

In this situation, it will mount on a 2" pipe as shown.

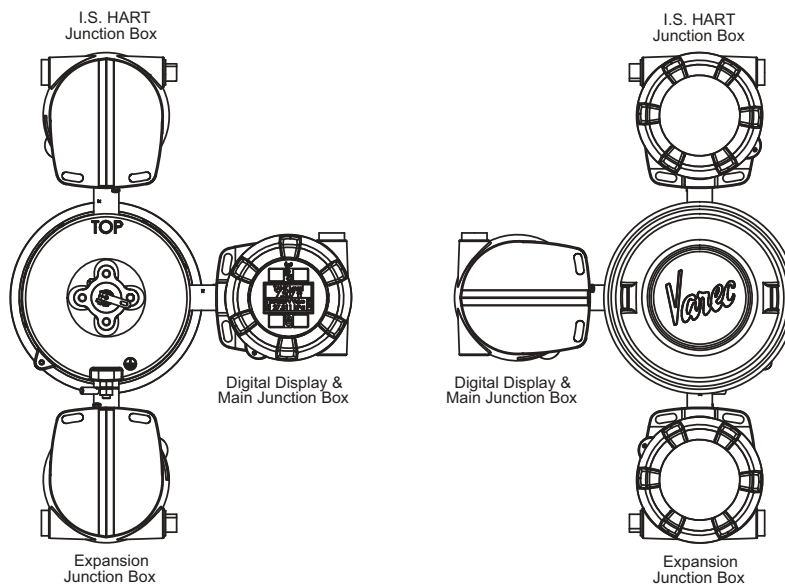


## 4 Wiring

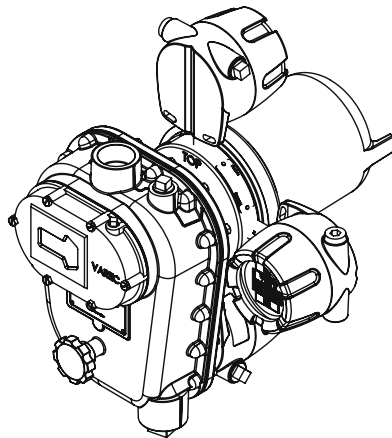
This chapter describes how to connect wiring terminations for the 2920 FTT. Wiring should be done after the unit is mounted as described in "Mounting".

### Overview

The wiring of the junction boxes to the 2920 FTT varies based on the order options. The 2920 FTT will be configured with additional junction boxes depending on the ordered options. The maximum number and arrangement of junction boxes is shown in the following figure.



The following figure shows a typical mounting arrangement with the Varec 2500 gauge.



## 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 2920 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 2920 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's communications network has been checked (see "Checking Line Resistance").
- Do not apply power in a hazardous environment until the explosion proof enclosure is closed.
- Incorrect field wiring connections can damage the transmitter electronics and cause system malfunctions.

## Checking Line Resistance

The specification, quality, and condition of the cable between the 2920 FTT and the control room is critical to the reliability of the entire system. Before wiring the 2920 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 10 (Biphase Mark). See "Communications Wiring" for more information.
- Wiring distance of the entire communications network does not exceed 10,000 feet (Biphase Mark) or 4,000 feet (MODBUS).
- For Biphase Mark, the wiring loop must not exceed 200 ohms (100 ohms per wire) and cable capacitance must not exceed 1 microFard (1  $\mu$ F).
- For Mark/Space, the number of transmitters wired in each area must not exceed 50.
- For Mark/Space, the wiring distance of the entire communications network must not exceed 10,000 feet.
- For TankWay, 4-Field Wires, use 20 AWG minimum.

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

# Terminating System Wiring at the Transmitter

This section provides field wiring termination information for the 2920 FTT, including junction box terminal connections for communications, RTD input, discrete inputs, contact outputs, and input power.

**Note** Varec recommends using 18 AWG shielded twisted pair wiring.

**Caution!** Use supply wires suitable for 105°C above surrounding ambient.

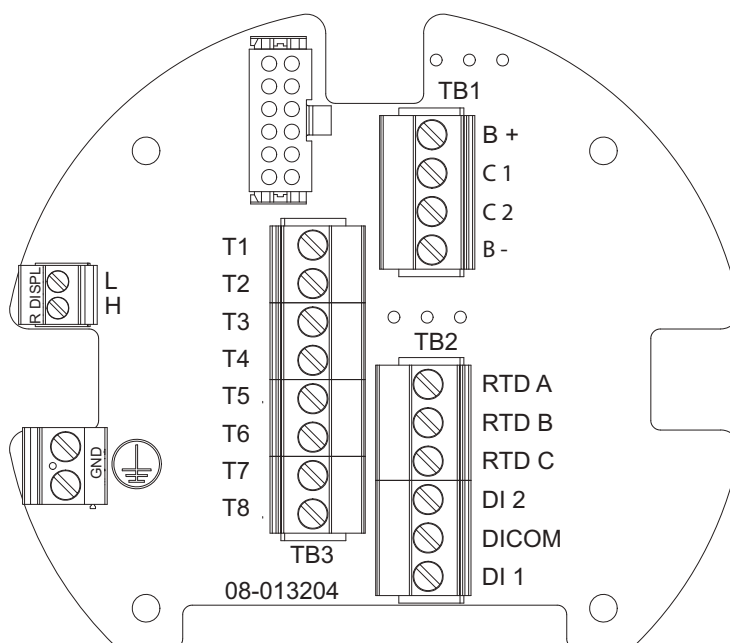
**Attention!** Utiliser des fils d'alimentation qui conviennent a une temperature de 105°C au-dessus de la temperature ambiante.

## Junction Box Terminals

All wiring from the 2920 FTT is terminated at one or more junction boxes connected to the transmitter housing.

### Digital Display and Main Junction Box

The digital display and main junction box provides 18 terminals using pluggable terminal connectors and includes two earth ground terminals. The digital display and main junction box also incorporates an LCD and user interface buttons. The terminal board for the main junction box is shown in the following figure.



The following table shows the Main Junction Board terminal descriptions.

Terminal / Function	Terminal	Assignment	Description
TB1 — DC Power & Communications	B+	Positive Terminal - DC Power	All Boards
	C1	Biphase Mark Communications (Interchangeable - No polarity)	Biphase Mark Interface
		- TX1/- RX (B)	EIA-485 MODBUS
		Space	Mark/Space
		Computer (RXD)	TankWay
	C2	Biphase Mark Communications (Interchangeable - No polarity)	Biphase Mark Interface
		+ TX1/ + RX (A)	EIA-485 MODBUS
		Mark	Mark/Space
		Encoder (TXD)	TankWay
	B-	Negative Terminal - DC Power	All Boards
TB2 — Digital Input/ Temperature Input	RTD A	RTD Signal	All Boards
	RTD B	RTD Return 1	
	RTD C	RTD Return 2	
	DI2	Digital Input 2/Alarm 1 (Mark/Space)	
	DI COM	Digital Input Common	
	DI1	Digital Input 1/Alarm 0 (Mark/Space)	
TB3	See wiring diagrams for each order code on the following pages		
TB4	GND	Earth Ground	All Boards
	GND		
TB5	HART+	Ex d HART+ (Non-I.S.)	All boards, unless I.S. HART Master I/O option selected, and then not used.
	HART-	Ex d HART- (Non-I.S.)	
J1	J1	Display Interface	ALL Boards

## Communications Wiring

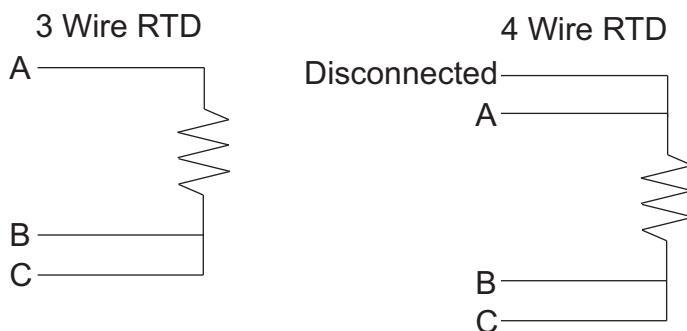
The following table describes the wiring considerations for each communications protocol.

Communications Protocol	Description
Biphase Mark	Shielded, twisted pair of 18 AWG wire is recommended. This option provides compatibility with Enraf (Honeywell) Biphase Mark Level products. Cable capacitance is 1 microFared (1 $\mu$ F) maximum. Resistance is 200 Ohms per wire (400 Ohms per loop.)

Communications Protocol	Description
EIA-485 MODBUS	<p>The 2920 FTT uses a 2-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 2920 FTT and MODBUS master communicate over a maximum distance of 4000 feet (1230 meters).</p> <p>The EIA-485 communications interface is compatible with the RTU 8130 (along with any MODBUS-compatible device) and other MODBUS masters.</p> <p>This connection can typically be accomplished with two (2) shielded, twisted pairs of 18 AWG wires.</p>
Mark/Space	<p>Two shielded, twisted pairs of 18 AWG wire are recommended. This option provides compatibility with the Varec Tank Scanning Unit (TSU), RTU 8130 or Tank Gate interface devices. The 2920 FTT can then be multi-dropped on the same Mark/Space data highway as the Varec 1800/1900 MWT/4000 ATT /2900/2910 FTT or 4100/4200 HIU/MFT devices. Up to 50 devices can be connected. Mark/Space Communications requires 48 VDC.</p>
L&J TankWay	<p>L&amp;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.</p> <p>The network is typically installed using two (2) shielded, twisted pairs of wires.</p>

## RTD Wiring

To use a 4-wire RTD with the 2920 FTT, connect one of the 2 parallel leads to RTD A and leave the other lead disconnected, as shown in the following figure.



## Discrete Inputs

As standard, the 2920 FTT contains 2 discrete inputs for connection to ancillary devices such as limit switches and float switches. The 2920 FTT then provides an Open/Closed signal to the host system. All wiring must be connected to the appropriate terminals DI1, DI2, and DICOM in the junction box supplied with the 2920 FTT.

When either the "AC Power Input" option or the "4 Digital Inputs + 4 Dry Contact Outputs" option is installed, an additional 2 discrete inputs are available. Review the terminal assignment tables to determine the terminal locations of DI3 and DICOM for the appropriate order code. The terminal for DI4 is located on the terminal board in the Expansion Junction box.

The status of the Discrete Inputs can be seen on the home screen of the local display. Refer to "Indicators" section in section 5, "Display and Configuration Interface" on page 51

The status of the Discrete Inputs can also be seen in the AlmStat status word in the transmitter's menu at Tank Data/Display Only/AlmStat. Refer to the "Tank Data" section in section 5, "Display and Configuration Interface" on page 51.

With the Mark/Space protocol, part of the transmitter response to polls is the status of "Alarm 0" and "Alarm 1". These alarms are typically external devices with dry contacts, such as high level switches, connected to the first two Discrete Inputs (DI) of the transmitter.

In the Mark/Space 2920FTT, the status of DI 1 is internally mapped to "Alarm 0". And the status of DI 2 is internally mapped to "Alarm 1". There is no configuration required.

## Input Power

**Warning** Never apply A/C power to terminals B+ and B-. Damage to the main board will result.

**Warning** Verify the positions of switches SW1 and SW2 on the A/C power board before applying A/C power to the transmitter. Damage to the transmitter may result. See "Connector and Switch Locations: AC Power Supply Circuit Board" on page 47.

The standard 2920 FTT uses 20-65 V DC power, supplied through the main communications board. With an optional AC power PCB, the 2920 FTT can also be supplied with 40-65 VAC, 100-120 VAC, or 220 - 240 VAC at 50/60 Hz.

DC power is connected to the B+ and B- terminals on the terminal board in the Main Junction box. Review the terminal assignment tables to determine the terminal locations of LINE (AC Line) and NEUT (AC Neutral) for the appropriate order code.

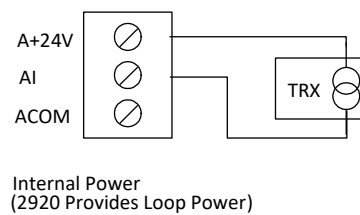
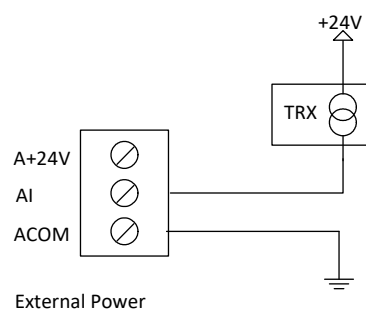
**Note** Before connecting power wires to the 2920 FTT, ensure that power is switched off and the instrument is correctly grounded.

Terminals T1 through T8 are dependent on order codes. See the wiring diagrams for terminal assignments based on order codes.

**Note** Each junction box includes Earth Ground terminal located on the terminal circuit board. Ensure the external ground is connected.

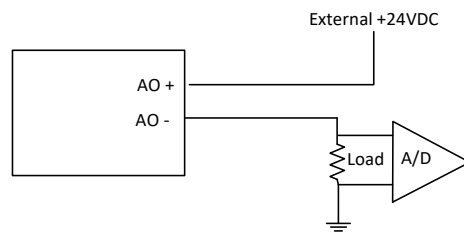
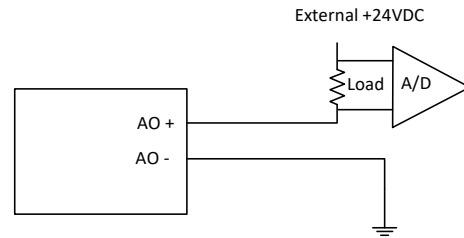
## Analog Input

The Analog Input power drawings are shown below.

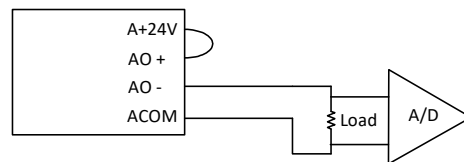
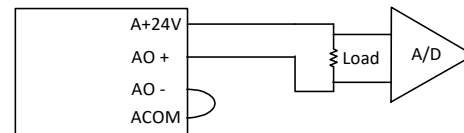


## Analog Output

The Analog Output power drawings below apply to either the AO1 or AO2 terminals.



External Power



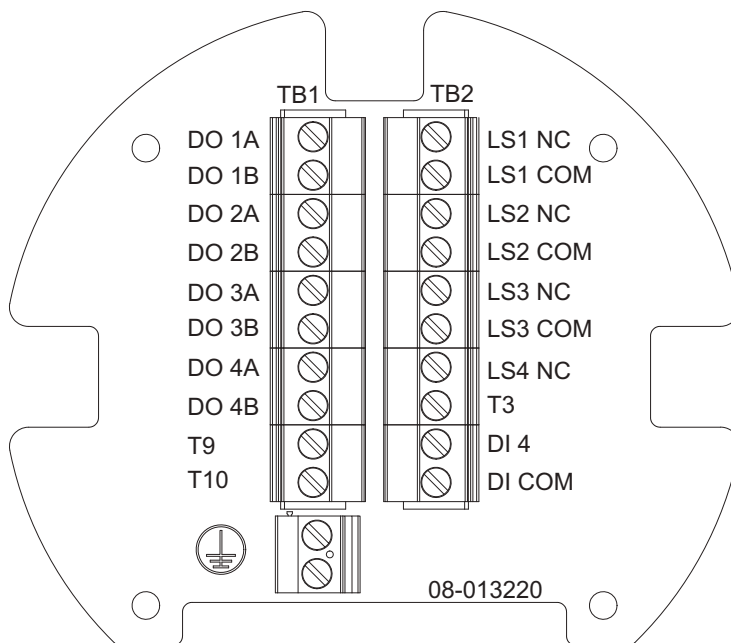
Internal Power  
(2920 Provides Loop Power)

## Expansion Junction Box

The expansion junction box provides 20 terminals using pluggable terminal connections and includes two earth ground terminals. The expansion junction box terminal board has

dedicated terminals for 4 contact outputs and 4 limit switches. The following figure shows the typical Expansion Junction Box.

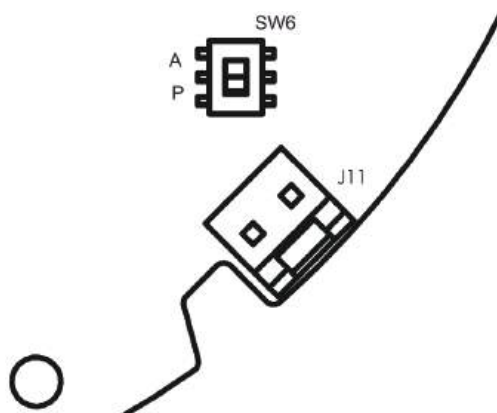
**Note** The terminals and labels will vary based on the options selected.



## HART Master Active/Passive Configuration

Switch 6 (SW6) on the Communications Board sets the 2920 FTT HART bus to Active (A) or Passive (P).

- With SW6 set to A, the 2920 will supply voltage to the HART bus. This is the default.
- With SW6 set to P, a HART slave device with an active output will supply voltage to the HART bus.



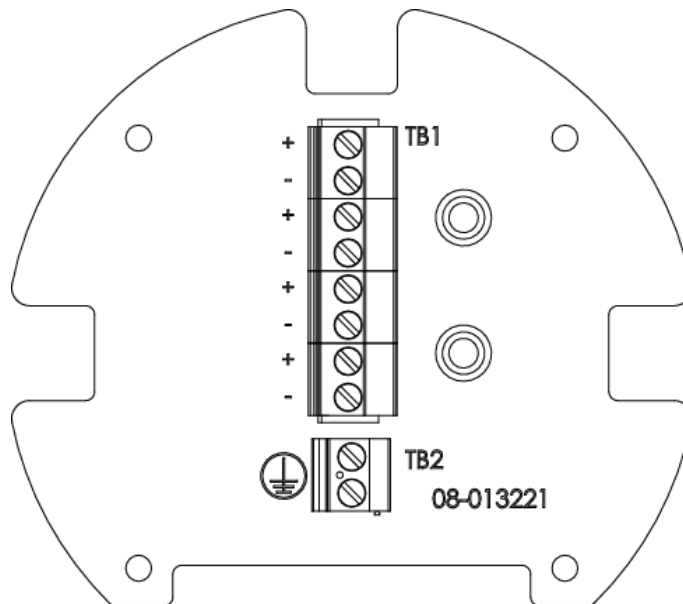
## Contact Outputs

When specified by the order code, 4 contact outputs are provided. These are software driven “Normally Open/Closed” outputs. The outputs can be configured using a Biphasic Mark Host, through the local display interface, or a computer running ViewRTU. They can be set to trigger (alarm lights, horns, and so on) for temperature or level alarms.

## I.S. HART Junction Box

The I.S. HART junction box provides 8 intrinsically safe terminals using pluggable terminal connectors and includes 2 earth ground terminals. The 8 terminals are used to connect HART SMART transmitters. The terminals are labeled + for positive HART connections and – for negative HART connections. The terminals are grouped into 4 + and – terminals so each HART transmitter can easily be connected individually. The following figure shows the typical I.S. HART Junction Box terminal board.

Refer to the associated intrinsically safe apparatus control drawing 28-013355, Appendix D.



**Note** The I.S. HART junction box is labeled with a light blue sticker. It is intrinsically safe and may be opened while energized.

**Note** An Ex d HART/Non-I.S. HART option is available on models without the I.S. HART option on the L & H terminals in the main junction box.

## Wiring Diagrams

Following are the wiring diagrams for each variant of the 2920. These diagrams are categorized by order codes.

At the top of every wiring diagram is the list for that particular order code.

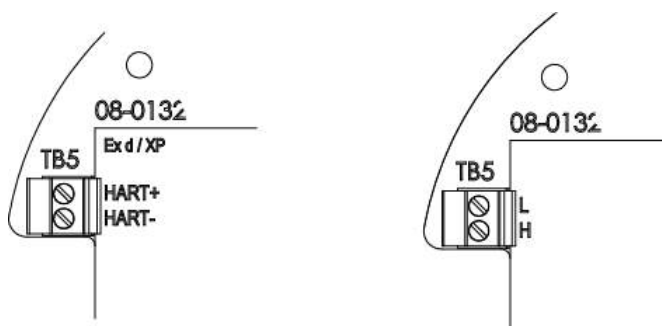
1	2 (aa)	3 (b)	4 (cc)	5 (d)	6 (e)	7 (f)	8 (g)	9 (h)	10 (i)
N2920	AT FC FM	1	BP MB MS LI	1	A B C D E F	1	N A B C	0 1	A B C

Here's a breakdown of what each column means:

1. Name of the product
2. Approval (AT = ATEX/IECEX, FC = cFMus -40°C, FM = -20/25°C cFMus)
3. Power (1 = DC, 2 = AC)
4. Communications board (BP = Biphase Mark, MB = RS-485 MODBUS, MS = Mark/Space, LI = L&J TankWay)
5. Limit Switch (Number of limit switches: 0 = 0 LS, 1 = 2 LS, 2 = 4 LS)
6. Limit Switch Range (N = NA if column d = 0, A = 0-25 ft LS range, B = 0-50 ft LS range, C = 0-100 ft LS range, D = 0-7.5 m LS range, E = 0-15 m LS range, F = 0-30 m LS range)
7. Additional Digital Inputs/Outputs (0 = no additional DIDO, 1 = additional DIDO)
8. Analog Inputs/Outputs (N = no analog I/O, A = analog input, B = analog outputs, C = analog inputs and outputs)
9. HART (0 = Explosion-proof HART, 1 = I.S. HART)
10. Display Orientation (A = forward facing display, B = backwards facing display, C = right-side facing display)

## Explosion Proof and I.S. HART

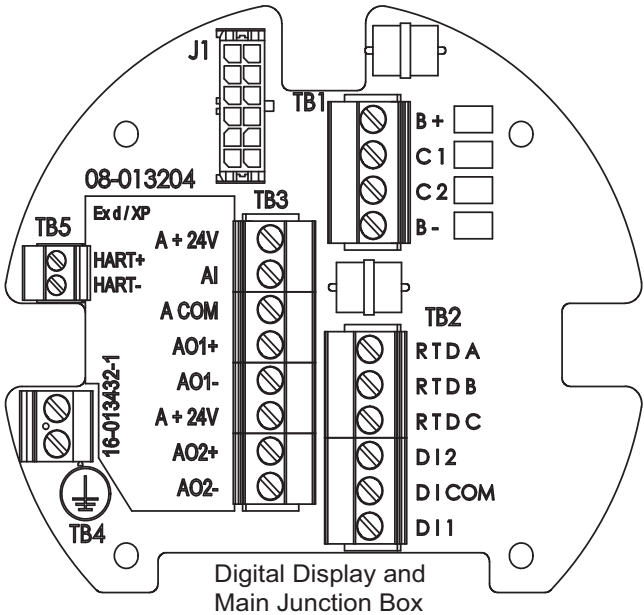
Varec optionally provides an Intrinsically Safe (I.S.) HART I/O to be used with I.S. field devices, such as radars and temperature transmitters. I.S. HART models have a separate I.S. junction box for field terminations. Models that do not have I.S. HART have explosion-proof HART I/O denoted as **HART+** and **HART-** on TB5 on the main terminal board with the display (as shown on the left below). Explosion-proof I/O can only be used with explosion-proof field devices. I.S. HART models have **L** and **H** terminals on TB5 (as shown on the right below). The L & H terminals are for future functionality and are not used at this time.



Product Order Code: N2920-aa-1-cc-0-N-1-g-h-i

The following terminals apply to a 2920 FTT with DC power, 2 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below.

N2920	AT FC FM	1	BP MB MS LJ	0	N	1	N A B C	0 1	A B C
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Terminal Board Abbreviation Legend:

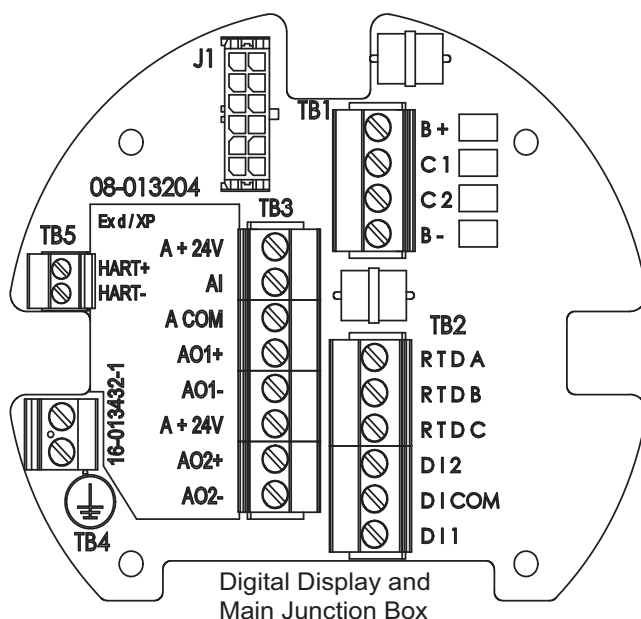
A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24 V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C 1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C 2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
D I x	Digital Input x
D I COM	Digital Input Common
DO	Digital Output
HART+*	+ Ex d HART (Non-I.S. models)
HART-*	- Ex d HART (Non-I.S. models)
R T D x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

## Product Order Code: N2920-aa-1-cc-0-N-2-g-h-i

The following terminals apply to a 2920 FTT with DC power, no limit switches, 4 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below.

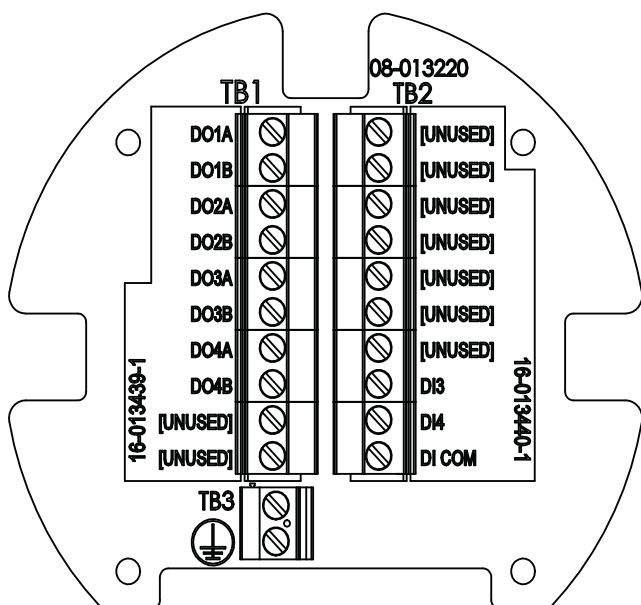
N2920	AT FC FM	1	BP MB MS LJ	0	N	2	N A B C	0 1	A B C
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### Terminal Board Abbreviation Legend:

A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24 V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C 1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C 2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
D I x	Digital Input x
D I COM	Digital Input Common
DOxx	Digital Output
HART+*	+ Ex d HART (Non-I.S. models)
HART-*	- Ex d HART (Non-I.S. models)
R T D x	Resistance Temperature Detector x

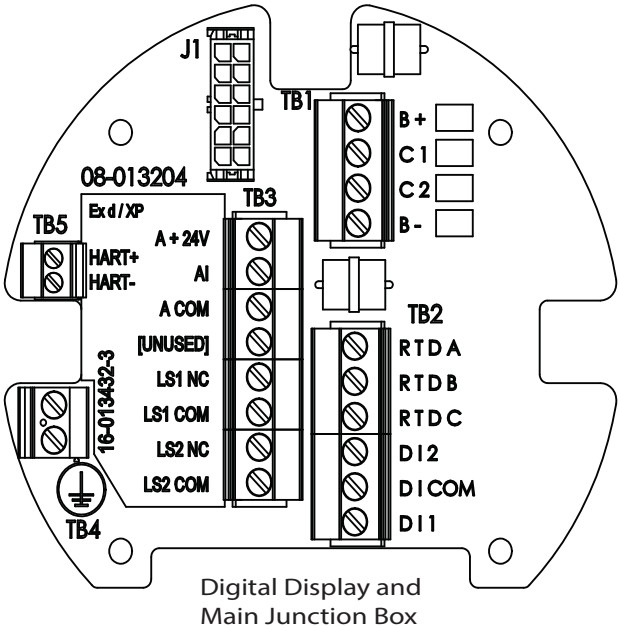
\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



Product Order Code: N2920-aa-1-cc-1-e-1-g-h-i

The following terminals apply to a 2920 FTT with DC power, 2 limit switches, 2 digital inputs, and optional analog input. Other product options can be variable as shown in the table below.

N2920	AT FC FM	1	BP MB MS LJ	1	A B C D E F	1	N A	0 1	A B C
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Terminal Board Abbreviation Legend:

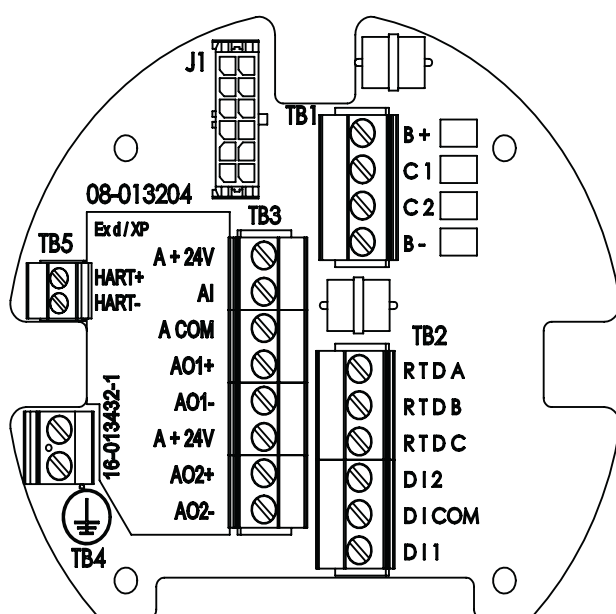
A COM	Analog Common
AI	Analog Input
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable
	MODBUS: -TX/-RX
	Space
	TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable
	MODBUS: +TX/+RX
	Mark
	TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
RTD x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

## Product Order Code: N2920-aa-1-cc-1-e-1-g-h-i

The following terminals apply to a 2920 FTT with DC power, 2 limit switches, 2 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below.

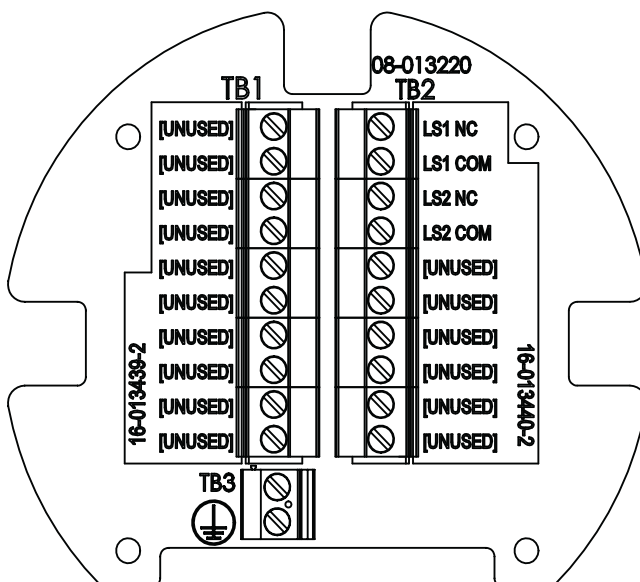
N2920	AT FC FM	1	BP MB MS LI	1	A B C D E F	1	B C	0 1	A B C
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### Terminal Board Abbreviation Legend:

A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
RT D x	Resistance Temperature Detector x

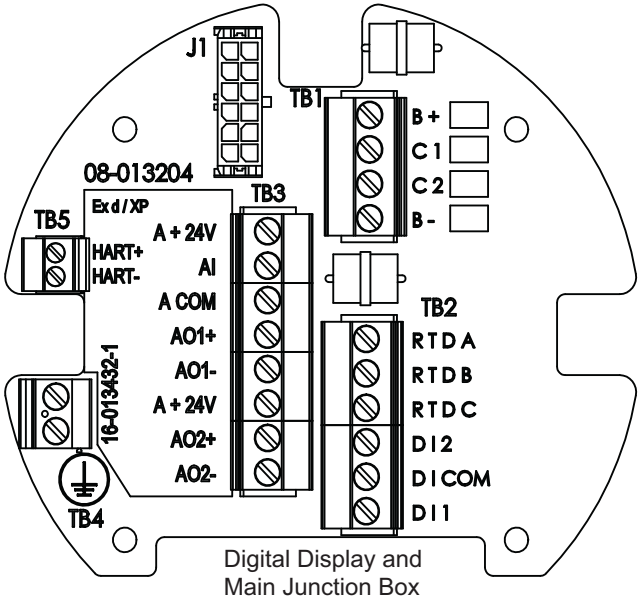
\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



Product Order Code: N2920-aa-1-cc-1-e-2-g-h-i

The following terminals apply to a 2920 FTT with DC power, 2 limit switches, 4 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below.

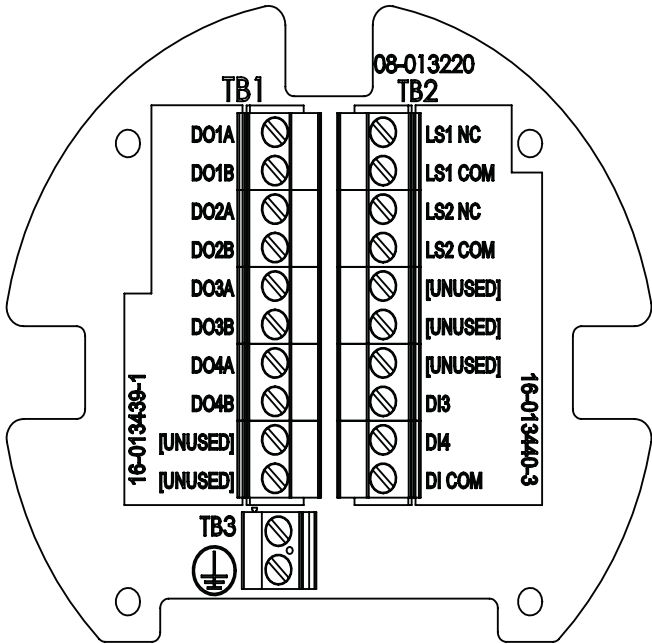
N2920	AT FC FM	1	BP MB MS LJ	1	A B C D E F	2	N A B C	0 1	A B C
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Terminal Board Abbreviation Legend:

A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
D I x	Digital Input x
D I COM	Digital Input Common
DOx	Digital Output
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
R T D x	Resistance Temperature Detector x

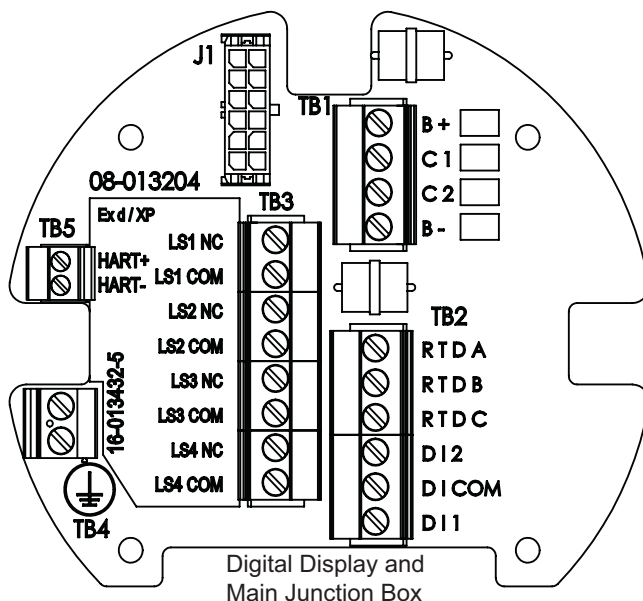
\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



## Product Order Code: N2920-aa-1-cc-2-e-1-N-h-i

The following terminals apply to a 2920 FTT with DC power, 4 limit switches, 2 digital inputs, and no analog inputs or analog outputs. Other product options can be variable as shown in the table below.

N2920	AT FC FM	1	BP MB MS LI	2	A B C D E F	1	N	0 1	A B C
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### Terminal Board Abbreviation Legend:

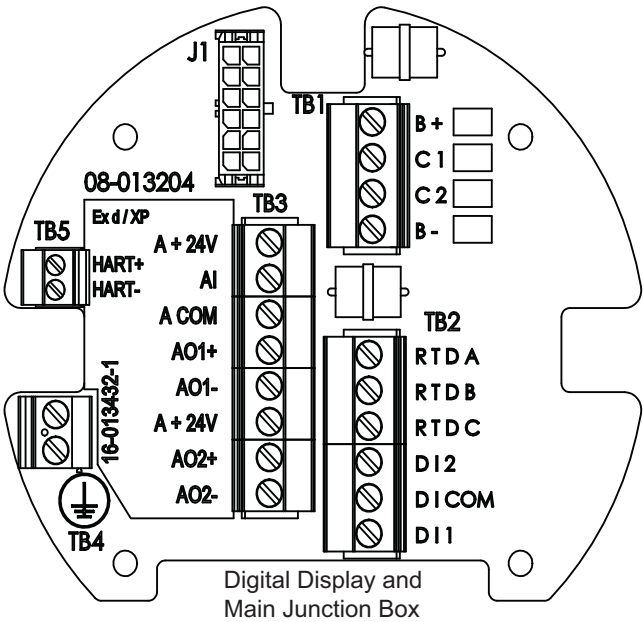
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
RTD x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

Product Order Code: N2920-aa-1-cc-2-e-1-g-h-i

The following terminals apply to a 2920 FTT with DC power, 4 limit switches, 2 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below.

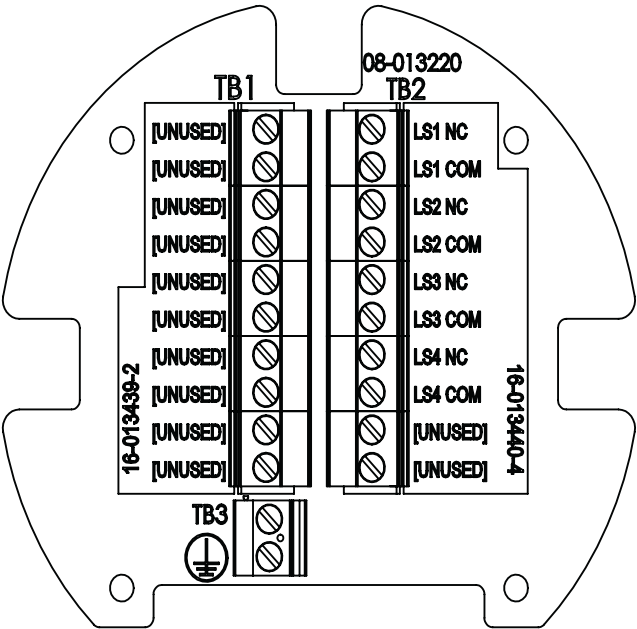
N2920	AT FC FM	1	BP MB MS LJ	2	A B C D E F	1	A B C	0 1	A B C
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Terminal Board Abbreviation Legend:

A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
RT D x	Resistance Temperature Detector x

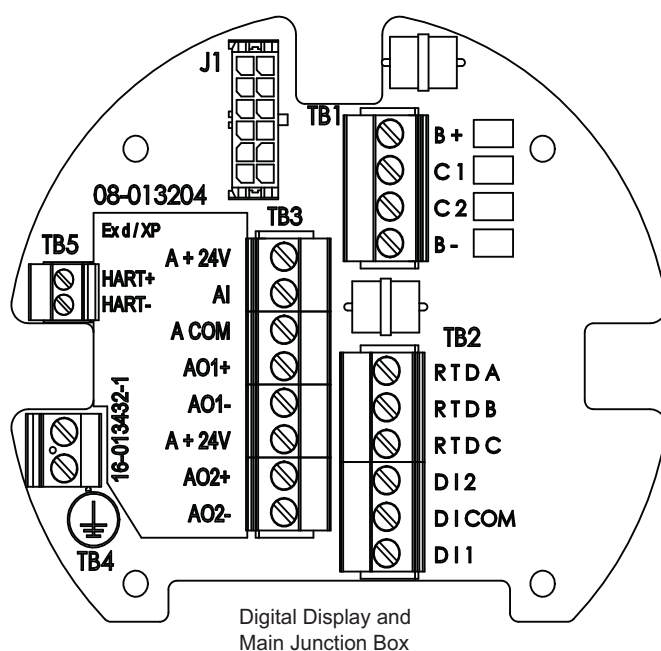
\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



## Product Order Code: N2920-aa-1-cc-2-e-2-g-h-i

The following terminals apply to a 2920 FTT with DC power, 4 limit switches, 4 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below.

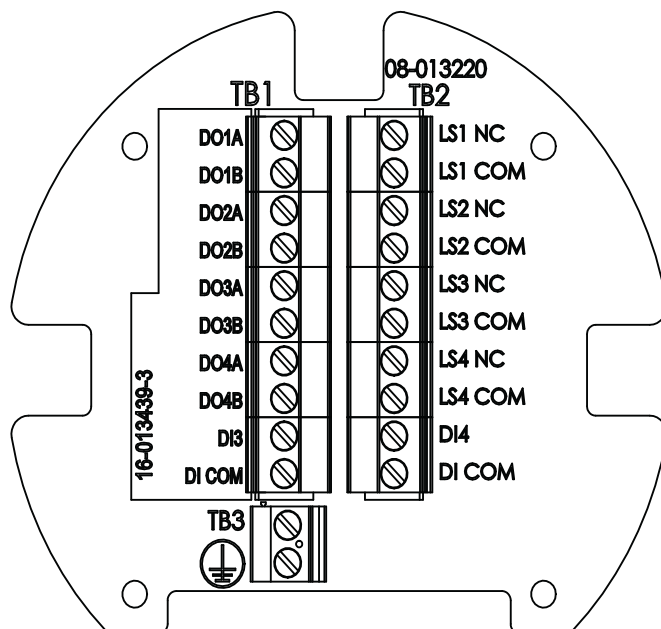
N2920	AT FC FM	1	BP MB MS LI	2	A B C D E F	2	N A B C	0 1	A B C
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### Terminal Board Abbreviation Legend:

A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
DOx	Digital Output
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
RT D x	Resistance Temperature Detector x

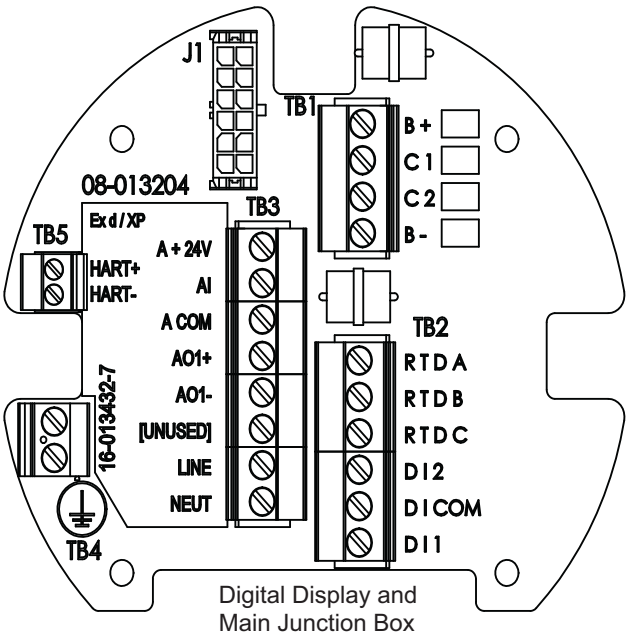
\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



Product Order Code: N2920-aa-2-cc-0-N-1-g-h-i

The following terminals apply to a 2920 FTT with AC power, no limit switches, 2 digital inputs and an optional analog input. Other product option can be variable as shown in the table below.

N2920	AT FC FM	2	BP MB MS LJ	0	N	1	N A	0 1	A B C
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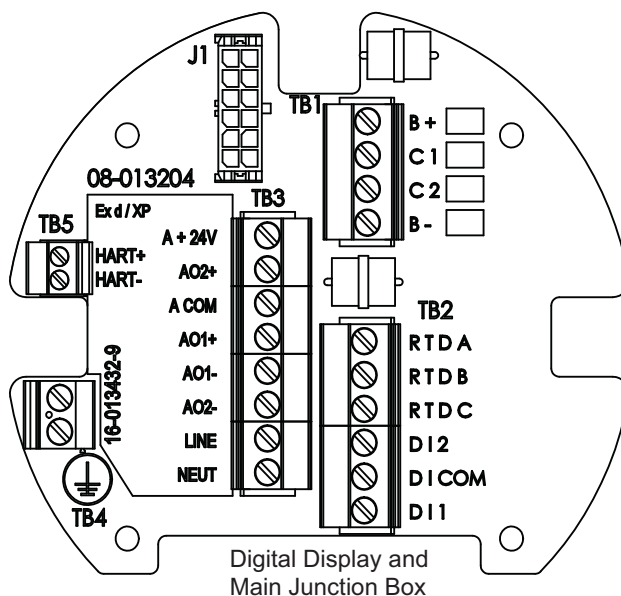
Terminal Board Abbreviation Legend:	
A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable
	MODBUS: -TX/-RX
	Space
	TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable
	MODBUS: +TX/+RX
	Mark
	TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
NEUT	Neutral
RT D x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

## Product Order Code: N2920-aa-2-cc-0-N-1-B-h-i

The following terminals apply to a 2920 FTT with AC power, no limit switches, 2 digital inputs, and analog outputs. Other product options can be variable as shown in the table below.

N2920	AT FC FM	2	BP MB MS LJ	0	N	1	B	0 1	A B C
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### Terminal Board Abbreviation Legend:

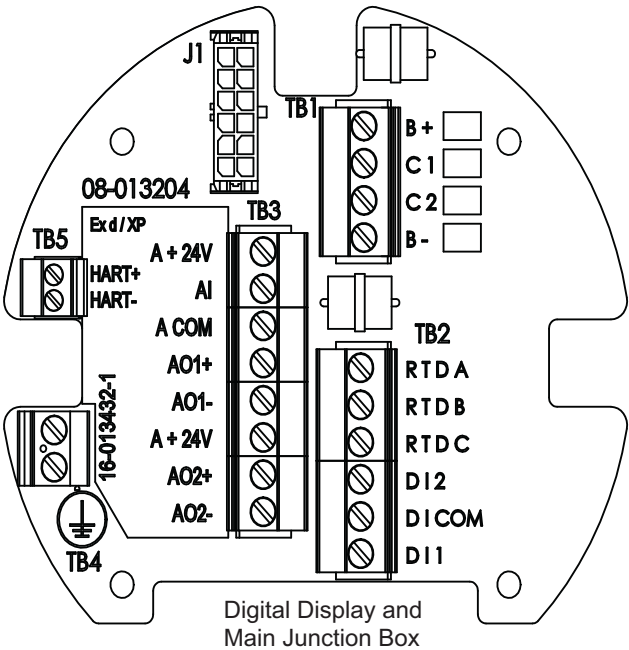
A COM	Analog Common
AOx	Analog Output
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
NEUT	Neutral
RTD x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

Product Order Code: N2920-aa-2-cc-0-N-f-g-h-i

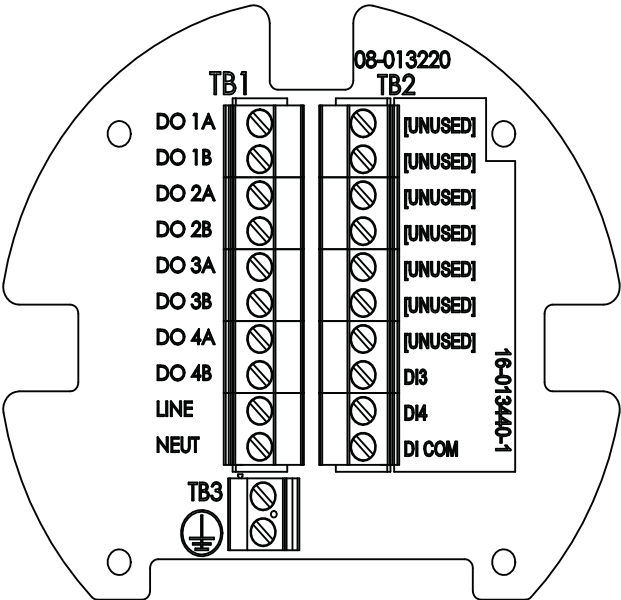
The following terminals apply to a 2920 FTT with AC power, no limit switches, 2 or 4 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below. If two digital inputs are selected, then the only analog input/output choice is C. If four digital inputs are selected, then all analog inputs/outputs are available.

N2920	AT FC FM	2	BP MB MS LJ	0	N	1 2	N A B C	0 1	A B C
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Terminal Board Abbreviation Legend:	
A COM	Analog Common
AI	Analog Input
AOx	Analog Output
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
DO x	Digital Output x
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
NEUT	Neutral
RTD x	Resistance Temperature Detector x

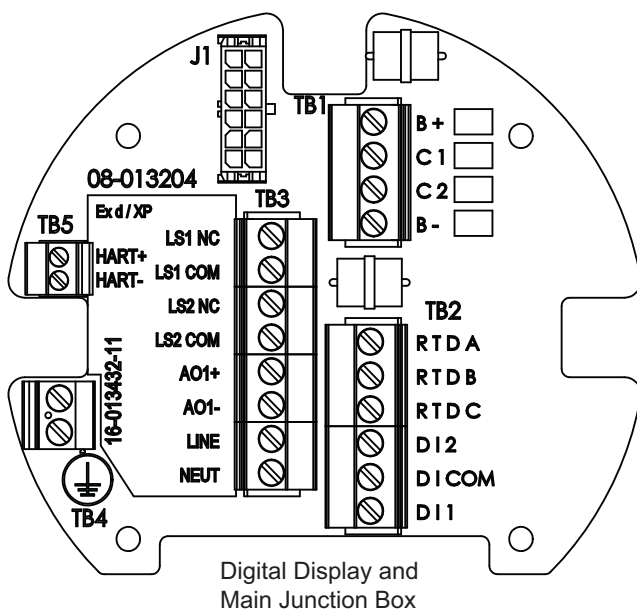
\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



## Product Order Code: N2920-aa-2-cc-1-e-1-N-h-i

The following terminals apply to a 2920 FTT with AC power, 2 limit switches, 2 digital inputs, and no analog inputs or outputs. Other product options can be variable as shown in the table below.

N2920	AT FC FM	2	BP MB MS LJ	1	A B C D E F	1	N	0 1	A B C
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### Terminal Board Abbreviation Legend:

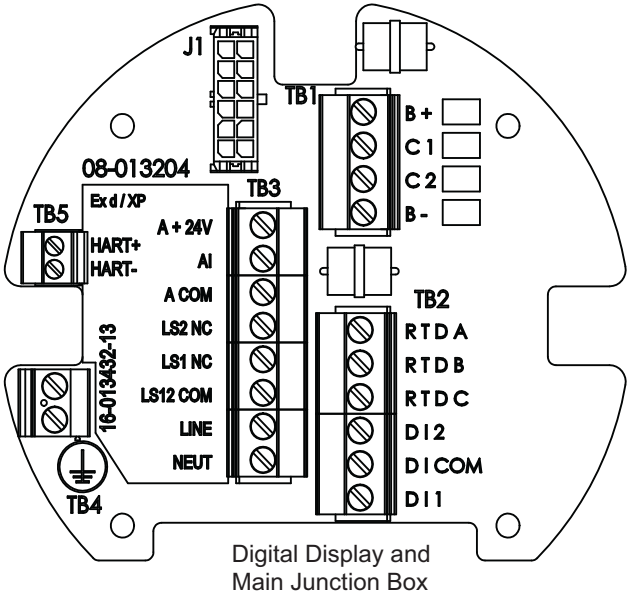
AOx	Analog Input x
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
NEUT	Neutral
RTD x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

Product Order Code: N2920-aa-2-cc-1-e-1-A-h-i

The following terminals apply to a 2920 FTT with AC power, 2 limit switches, 2 digital inputs, and one analog input. Other product options can be variable as shown in the table below.

N2920	AT FC FM	2	BP MB MS LJ	1	A B C D E F	1	A	0 1	A B C
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Terminal Board Abbreviation Legend:

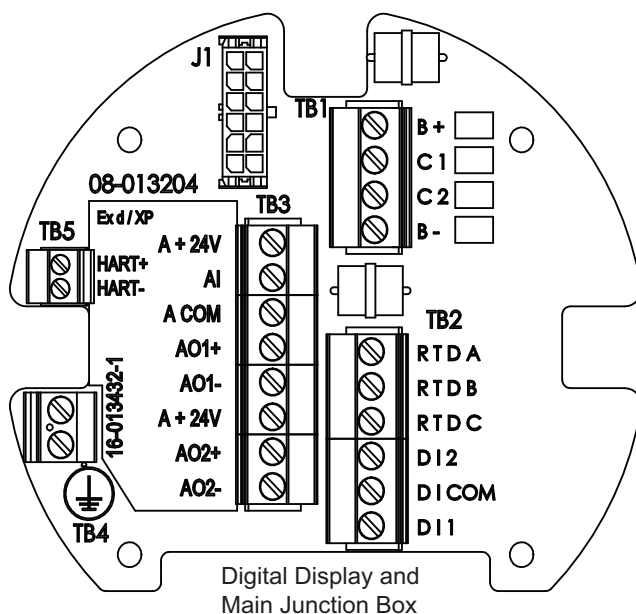
A COM	Analog Common
AI	Analog Input
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
NEUT	Neutral
RT D x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

## Product Order Code: N2920-aa-2-cc-1-e-f-g-h-i

The following terminals apply to a 2920 FTT with AC power, 2 limit switches, 2 or 4 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below. If two digital inputs are selected, then the analog input/output choices are either B or C. If four digital inputs are selected, then all analog inputs/outputs are available.

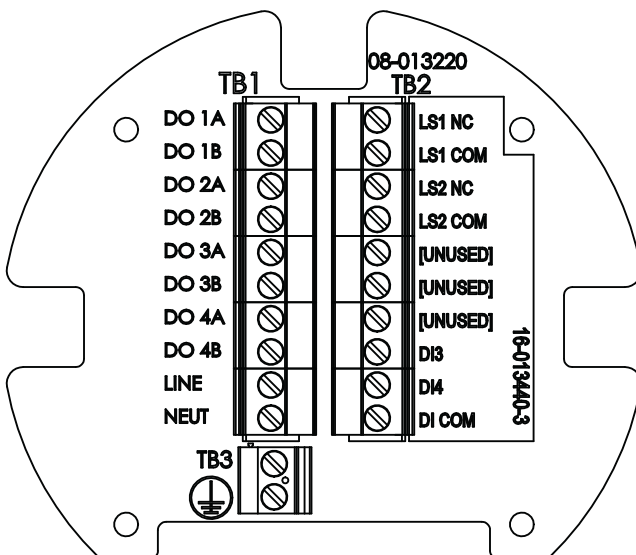
N2920	AT FC FM	2	BP MB MS LJ	1	A B C D E F	1 2	N A B C	0 1	A B C
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### Terminal Board Abbreviation Legend:

A COM	Analog Common
AI	Analog Input
AOx	Analog Output x
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
D I x	Digital Input x
D I COM	Digital Input Common
DO x	Digital Output x
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
NEUT	Neutral
R T D x	Resistance Temperature Detector x

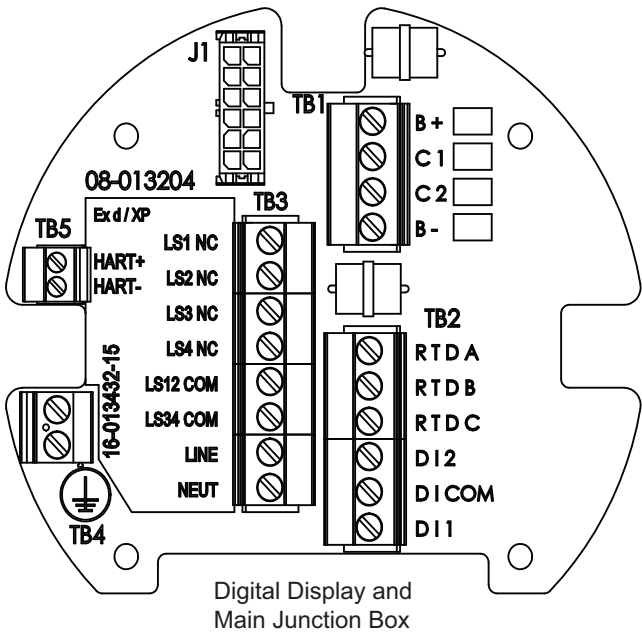
\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



Product Order Code: N2920-aa-2-cc-2-e-1-N-h-i

The following terminals apply to a 2920 FTT with AC power, 4 limit switches, 2 digital inputs, and no analog inputs or outputs. Other product options can be variable as shown in the table below.

N2920	AT FC FM	2	BP MB MS LJ	2	A B C D E F	1	N	0 1	A B C
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Terminal Board Abbreviation Legend:

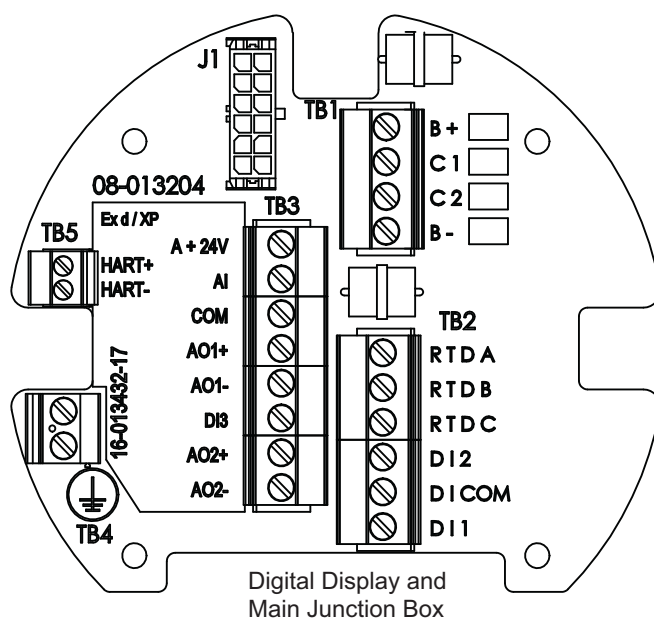
B+	Power +
B-	Power -
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
D I x	Digital Input x
D I COM	Digital Input Common
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
NEUT	Neutral
R T D x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.

## Product Order Code: N2920-aa-2-cc-2-e-f-g-h-i

The following terminals apply to a 2920 FTT with AC power, 4 limit switches, 2 or 4 digital inputs, and optional analog input/analog outputs. Other product options can be variable as shown in the table below. If two digital inputs are selected, then the analog input/output choices are A, B, or C. If four digital inputs are selected, then all analog inputs/outputs are available.

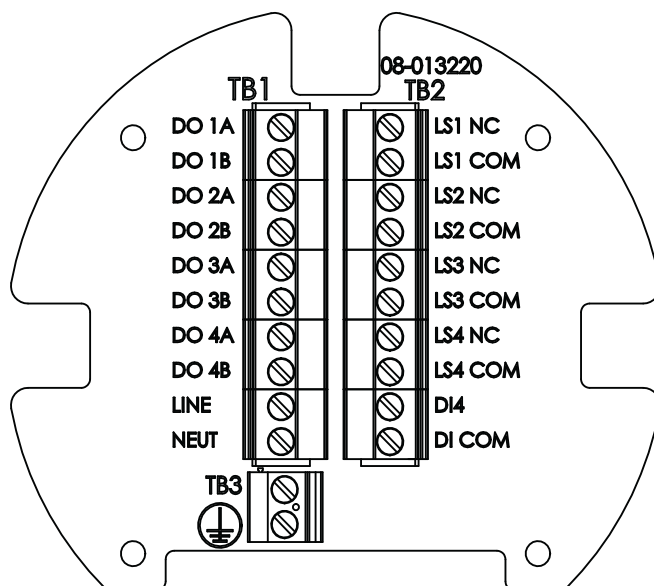
N2920	AT FC FM	2	BP MB MS LJ	2	A B C D E F	1 2	N A B C	0 1	A B C
-------	----------------	---	----------------------	---	----------------------------	--------	------------------	--------	-------------



### Terminal Board Abbreviation Legend:

AI	Analog Input
AOx	Analog Output x
A +24V	Analog +24 Volt Power Output
B+	Power +
B-	Power -
COM	Common
C1	Bi-Phase Mark: Interchangeable MODBUS: -TX/-RX Space TankWay: Computer (RXD)
C2	Bi-Phase Mark: Interchangeable MODBUS: +TX/+RX Mark TankWay: Encoder (TXD)
DI x	Digital Input x
DI COM	Digital Input Common
DO x	Digital Output x
HART+*	+ Ex d HART (Non-I.S.)
HART-*	- Ex d HART (Non-I.S.)
LINE	Line
LSx NC	Limit Switch Normally Closed
LSx COM	Limit Switch Common
NEUT	Neutral
RTD x	Resistance Temperature Detector x

\* See the I.S. HART Junction Box section for I.S. HART terminals, when I.S. HART option is selected.



## Connecting Wiring in the Transmitter

All standard electronics for the 2920 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 “Input Power” and “Selecting the AC Voltage Setting” for more information.

All wiring is terminated in junction box(es). A standard application requires one junction box for communications, temperature, two discrete inputs. Depending on the order code, multiple junction boxes may be attached to the transmitter housing.

To connect wires to the electronics assembly, refer to previous sections for connector locations, terminal assignments, and special instructions.

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

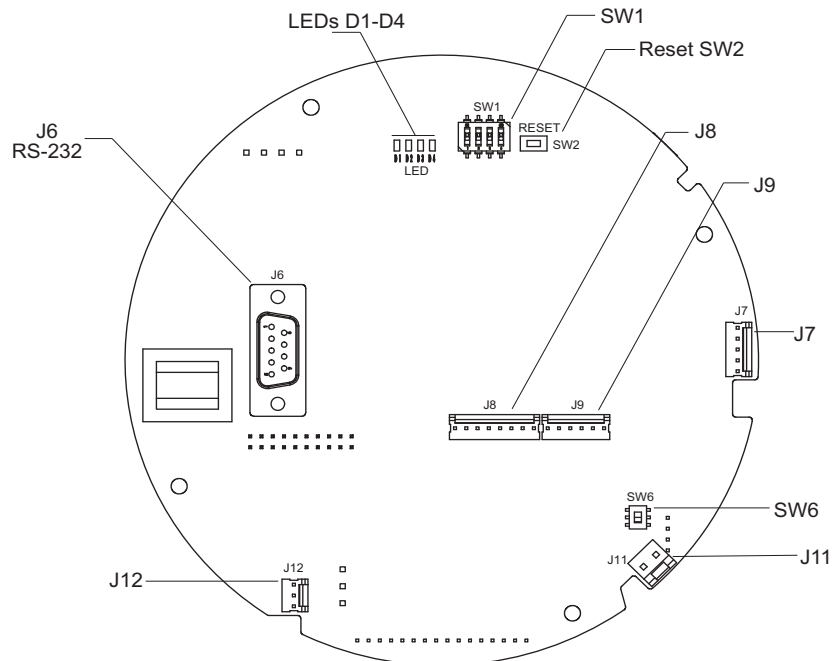
**Note** Earth Ground terminals are located on the terminal circuit board in each junction box. Ensure the external ground is connected.

**Caution!** Signal wiring connected in this box must be rated at least 300V.

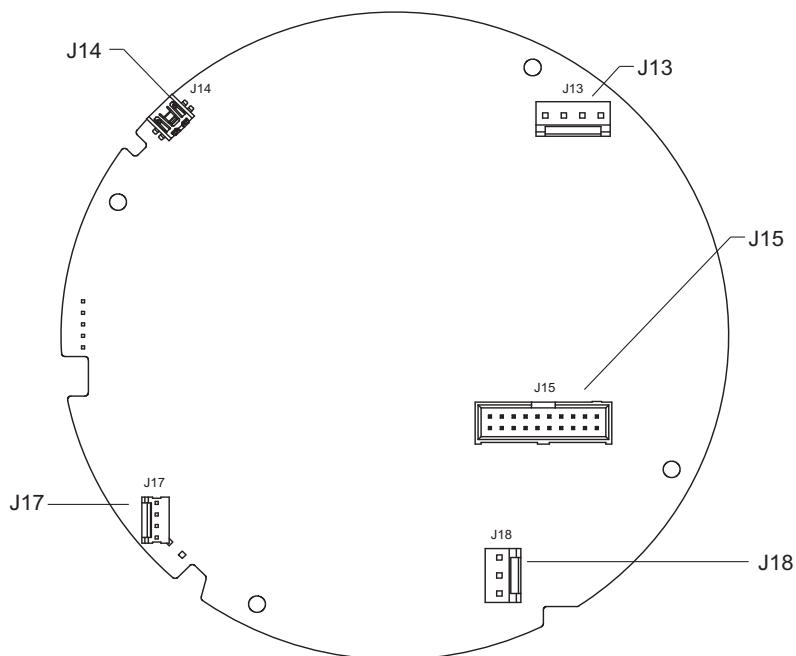
**Attention!** Le câblage de signalisation raccorde dans cette boîte doit convenir pour une tension nominale d'au moins 300 V.

### Connector Locations: Communications Circuit Board

The following figure shows the Communications Board connectors, as viewed from the top. The Biphase Mark board is shown.



The following figure shows the Communications Board connectors, as viewed from the bottom. The Biphase Mark board is shown.



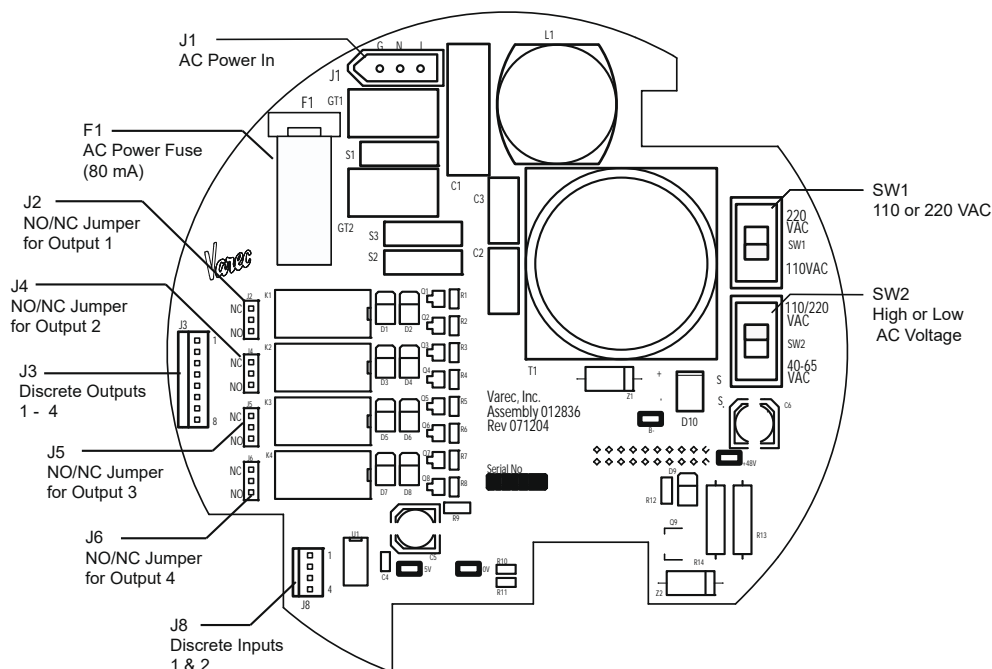
## Connector Assignments: Communications Circuit Board

Connector / Function	Terminal	Assignment	Description
J13 – DC Power & Communications	1	B- DC Power Negative Terminal	All DC Power Transmitters
	2	B+ DC Power Positive Terminal	
	3	Biphase Mark Communications 1	Biphase Mark Communication Option
		+ TX1/ + RX (A)	EIA-485 MODBUS
		Mark	Mark/Space
		TankWay	Encoder (TXD)
	4	Biphase Mark Communications 2	Biphase Mark Communication Option
		- TX/ - RX (B)	EIA-485 MODBUS
		Space	Mark/Space
		TankWay	Computer (RXD)
J15 – AC Power & Digital I/O Board			Connection to Optional AC Power & Digital I/O Board
J14 – Mini USB			Varec Use Only
J17 – Alarms (Discrete Inputs)	1	Common	All Transmitters
	2	Input 1/Alarm 0 (Mark/Space)	
	3	Common	
	4	Input 2/Alarm 1 (Mark/Space)	

Connector / Function	Terminal	Assignment	Description
J6 – Serial Connection (RS-232)	2	Receive Data (RXD)	All Transmitters
	3	Transmit Data (TXD)	
	5	RS-232 Gnd	
J18 – 3 Wire RTD Input	1	A - RTD Signal	All Transmitters
	2	B - Return 1	
	3	C - Return 2	
J12 – 4-20 mA Analog Input	1	+24 VDC Output (50 mA maximum)	Order Code Dependent
	2	Analog Input Signal	
	3	+24 VDC Return	
J7 – Dual Channel 4-20 mA Analog Output	1	AO Channel 2 Return	Order Code Dependent
	2	AO Channel 2 Signal	
	3	+24 VDC Output (50 mA maximum)	
	4	AO Channel 1 Return	
	5	AO Channel 1 Signal	
J11 – HART Interface	1	HART Return	Order Code Dependent
	2	HART Signal	
J1 – CAN Interface (Controller Area Network)	1	CAN H	Order Code Dependent
	2	CAN L	
J8 – LCD Interface		Liquid Crystal Display Interface	All Transmitters
J9 – Button Interface		Configuration Button Interface	All Transmitters

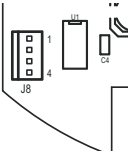
## Connector and Switch Locations: AC Power Supply Circuit Board

The following figure shows the AC Power Supply circuit board as viewed from the top.



## Connector Assignments: AC Power Supply Circuit Board

Connector/Function	Terminal	Assignment	Illustration
J1 AC Power	L	Line	
	N	Neutral	
	G	Ground	
J3 Discrete Outputs (4)	1	Output 1 A	
	2	Output 1 B	
	3	Output 2 A	
	4	Output 2 B	
	5	Output 3 A	
	6	Output 3 B	
	7	Output 4 A	
	8	Output 4 B	

Connector/Function	Terminal	Assignment	Illustration
J8 Discrete Inputs (2)	1	Common	
	2	Input 3	
	3	Common	
	4	Input 4	

**Warning!** Never apply A/C power to terminals B+ and B-. Damage to the main board will result.

**Warning!** Verify the positions of SW1 and SW2 on the A/C power board before applying A/C power to the transmitter. Damage to the transmitter may result. See “Connector and Switch Locations: AC Power Supply Circuit Board” on page 47.

**Note** Switches SW1 and SW2 on the AC Power circuit board determine the AC voltage setting for the 2920 FTT. See below for instructions on setting the AC Power level.

**Note** Each optional discrete output is set to NO or NC using a jumper setting. See below for instructions on setting optional outputs as NC or NO using the appropriate jumper.

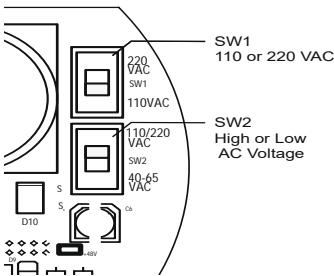
Selecting the AC Voltage Setting

**Warning!** If the AC Power Selection Switches are not set properly, equipment damage may occur.

The optional AC Power Supply circuit board can operate at one of three voltage ranges:

- Low (40 – 65 VAC)
- Medium (100-120 VAC)
- High (220 – 240 VAC).

The following figure shows the voltage selection switches.



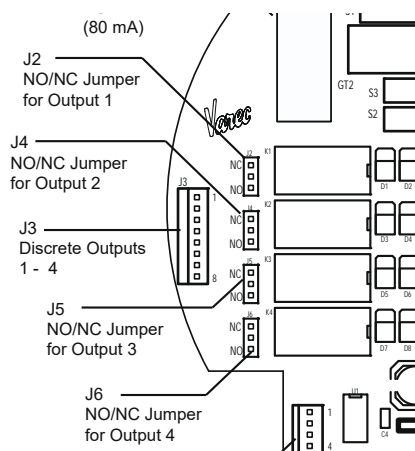
To Set the Voltage:

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 (80 mA).

## 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 the following figure and in the table below the figure.



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.

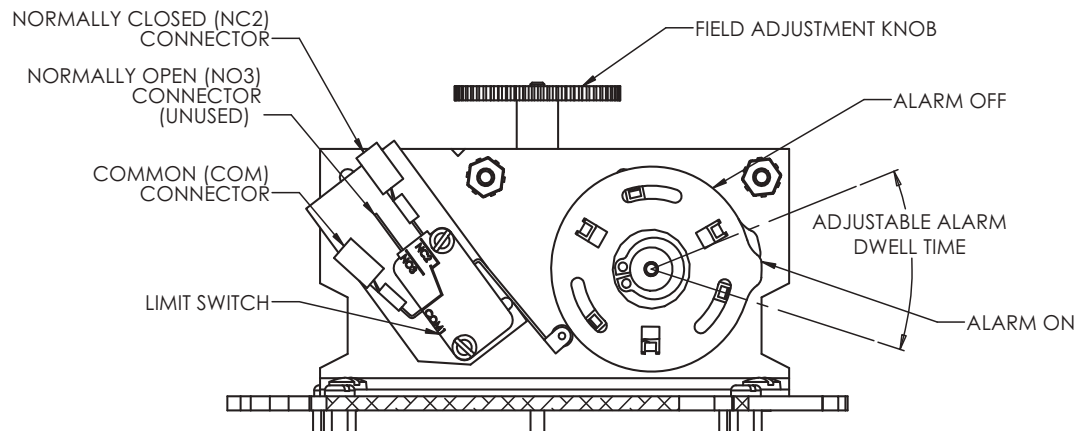
Output	Jumper
1	J2
2	J4
3	J5
4	J6

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

## 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:

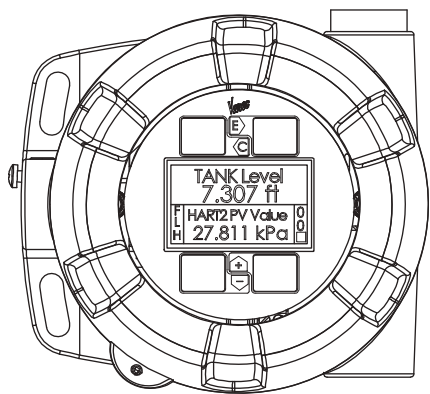
- Under normal operating conditions, the Normally Closed (NC2) and Common (COM1) terminals of the limit switch are connected. The Normally Open (NO3) and Common (COM1) terminals of the limit switch become connected as the switch arm rides up the cam, as shown in the following figure.



- When the limit switch arm rides up on the cam, it makes contact between the Normally Open (NO3) and Common (COM1), but it also breaks the connection between the Normally Closed (NC2) and Common (COM1).

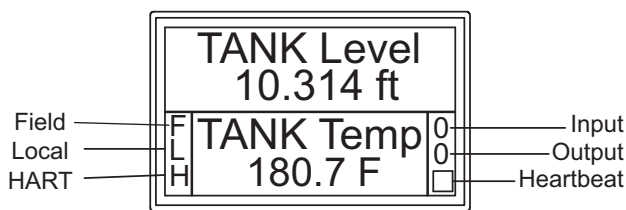
# 5 Display and Configuration Interface

The 2920 FTT local display serves two functions: It displays tank information and communication status indicators as well as allows you to program all features and functions of the 2920 FTT. A hot work permit is not required when configuring the Transmitter. The display provides a system of menus that navigates you through the set up process. The digital display is shown in the following figure.



## Indicators

By default, the display shows the Tank Level, Tank Temperature, and status indicators on both the left and right lower portion of the display, as shown below:



The left status indicators display when the unit is communicating with other components, as follows:

Indicator Symbol	Description
F	Field communications that shows valid communication transactions with a Host system. The indicator clears after a few seconds of inactivity.
L	Local communications that shows valid communication transactions with ViewRTU using the local RS-232 port. The indicator clears after a few seconds of inactivity.
H	HART communications that shows valid communication transactions with one or more HART Slave devices. The indicator clears after a few seconds of inactivity.

The right status indicators display input and output status, and an indicator that shows the unit is functioning normally.

The top indicator displays digital input status, as a single hexadecimal digit, 0 to F. Bit 0 indicates digital input 1. Bit 1 indicates digital input 2. Bit 2 indicates digital input 3. Bit 3 indicates digital input 4. A value of 0 indicates that no digital inputs are active. A value of F indicates that all for digital input are active.

The middle indicator displays the output relay status as a single hexadecimal digit, 0 to F. Bit 0 indicates digital relay 1. Bit 1 indicates digital relay 2. Bit 2 indicates digital relay 3. Bit 3 indicates digital relay 4. A value of 0 indicates that no relays are active. A value of F indicates that all for relays are active.





The following table shows the activity of the Digital Input or Output Relay for each hexadecimal digit.

Hex Indicator	Input 1/ Relay 1	Input 2/ Relay 2	Input 3/ Relay 3	Input 4/ Relay 4
0	Inactive	Inactive	Inactive	Inactive
1	Active	Inactive	Inactive	Inactive
2	Inactive	Active	Inactive	Inactive
3	Active	Active	Inactive	Inactive
4	Inactive	Inactive	Active	Inactive
5	Active	Inactive	Active	Inactive
6	Inactive	Active	Active	Inactive
7	Active	Active	Active	Inactive
8	Inactive	Inactive	Inactive	Active
9	Active	Inactive	Inactive	Active
A	Inactive	Active	Inactive	Active
B	Active	Active	Inactive	Active
C	Inactive	Inactive	Active	Active
D	Active	Inactive	Active	Inactive
E	Inactive	Active	Active	Active
F	Active	Active	Active	Active

The lower indicator is a bar that sequences about every 1/2 second to indicate the transmitter CPU is running. This indicator is commonly referred to as the heartbeat.

# Configuration

The display provides 4 capacitive-touch buttons and a 4-line LCD display. The buttons have the following functions:

	Name	Function
	Cancel	Cancels the operation and returns you to the previous menu
	Enter	Enters the selection or confirms the selection made
	Minus (-)	Scrolls down through the menu options
	Plus (+)	Scrolls up through the menu options

**Note** To adjust the LCD contrast on the screen, go to the Main Data display by pressing the E and Plus (+) or the E and Minus (-) to adjust the contrast up or down respectively. To access the configuration menu tree, press Enter.

The Main Menu appears as shown below:

Main Menu	00→
System Menu	
Basic Setup	
Local RS-232	

Use the Plus (+) and Minus (-) buttons to navigate through the Main menu. The selections in the Main menu and a description of each are listed in the table below.

Menu Selection	Description
System Data	Lists the software specifications of the system. Allows configuration of how the 2920 FTT presents data, such as data scroll rate or how the zero is displayed, and so on.
Basic Setup	Contains basic configuration parameters, such as baud rate, level and temperature display units, and so on.
Local RS-232	Contains communication parameters associated with the local RS-232 interface.
System Time	Contains parameters about time, such as system ticks, time zone, and so on.
Encoder Data	Contains parameters about the encoder, such as unit temperature, number of resets, and so on.
RTD Data	RTD data is pre-configured at the factory. It contains calibration data.

Menu Selection	Description
Tank Data	Contains data about tank levels such as critical high level, advisory high level, and so on.
Digital Outputs	Contains data for configuring the operation and state of the Digital Outputs.
Analog Input	AI data is pre-configured calibration data. Also, these points provide configuration parameters for setting the scale and offset of the measurement and reference data.
Analog Output	AO data is pre-configured calibration data. Also, these points provide configuration parameters for setting the scale and offset of the measurement and reference data.
BPM Data	Contains data about the operation of the Biphase Mark interface such as number of data requests, type of data request, and data message. This point is only applicable to BPM transmitters.
MODBUS	Contains data about the operation of the MODBUS interface such as number of data requests, type of data request, and data message. This point is only applicable to MODBUS transmitters.
Mark/Space	Contains data about the operation of the Mark/Space interface such as number of data requests, type of data request, and data message. This point is only applicable to Mark/Space transmitters.
NMT Prothermo	Contains parameters about temperature data from various elements.
Hart Device	Contains parameters used by HART protocol devices.
FMR Radar	Contains parameters used by radar gauges, such as echo quality, distance from flange, and so on.
Hart Master	Contains parameters for controlling and configuring the operation of the HART Master interface. The search command tells the HART Master to try to identify instruments connected on the HART bus.
Calibration	Allows you to re-calibrate the transmitter by providing shortcuts to the RTD, AI, and AO points.

**Note** Depending on your specific equipment, some of these points may or may not be used. For instance, if you have no radar gauges, the FMR point is not used.

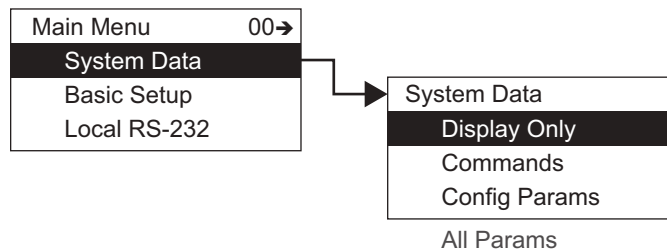
## System Data

The System Data is used to configure how the 2920 FTT user interface presents system data. System Data menu presents 4 options:

- Display Only — displays the current reading, such as with a level or temperature, or current setting such as feet or degrees Fahrenheit
- Commands — displays the commands available, such as align sensors
- Config Params — allows you to change the configuration parameters in System Data
- All Params — scrolls through the Display, Commands, and Config parameters in one all inclusive list

## To Access the System Data:

1. Press Enter to access the Main Menu. The System Data point is automatically highlighted.



2. Press Enter to open the System Data parameters and the System Data options appear.
3. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.
4. Refer to the table below for more information on each System Menu option.

Display Only		Description
	Software Version	The firmware version.
	Hardware Version	The PCB hardware version.
	Field Protocol	Specifies the type of the interface hardware available for the primary interface, such as Biphase Mark, MODBUS, Mark/Space, and so on.
	Number DB Pnts	The number of database points defined.
	DB Size	The size of the database in bytes.
	Build Date	The date the database structure was generated.
	Sys Checksum	CRC-16 Checksum of the firmware.
	Pnt Checksum	CRC-16 Checksum of point's static configuration parameters.
Commands		Description
	Admin PIN	Allows you to set the administrative PIN code. See "Administrative PIN".
	User PIN	Allows you to set the user PIN code. See "User PIN".
	Display Test	The Display test temporarily illuminates all segments of the graphical display to test the operation of the display.
	Reset Cmd	<p>The Reset Command allows reset of the transmitter through the user interface. A soft reset restarts the application. A hard reset resets all configuration data to default values.</p> <p><b>Note</b> Be careful not to perform a hard reset inadvertently.</p>

Config Params		Description
	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.
	Decimal Sep.	Selects the display of the decimal separator, either a period (.) or a comma (,).
	Format of Zero	Selects either a zero or a zero with a slash.
	Leading Zeroes	Select to display leading zeros in front of the numerical values.
	Scroll Rate	The bottom portion of the display can display up to four data values by scrolling through the items. This parameter sets (in seconds) how long each item is displayed.
	Backlight Ctrl	Sets how long the LCD back light is illuminated after the last key press. Setting this value to zero, causes the back light to illuminate continuously.
	LCD Contrast	Set the contrast on the LCD. The LCD contrast can be adjusted from the Main Data display by pressing the E and Plus (+) or the E and Minus (-) to adjust the contrast up or down respectively.
	Display Timeout	The time in seconds without a key press before the Display will returns to the main data display screen.
	Order Code	The product order code of the encoder assembly can be added during production.
	Product SN	The product serial number can be added to the device during production.
	Prim Display	This determines data value displayed in the upper (primary) portion of the LCD. The default in Tank Level.
	Sec. Display 1 through 4	These parameters determine which data items is displayed in the lower (secondary) area of the display. Display 1 defaults to Tank Temperature. Display 2 to 4 default to no value (undefined).
All Params		Lists all Display, Commands, and Config Params in a list.

## PIN Codes

PIN codes operate independently and are used to restrict access to configuration or to local calibration data.

PINs are numerical and the range is between 1 and 9999 inclusively. A PIN code of 0 (zero) indicates there is no PIN set, the PIN has timed out, or the PIN needs to be entered. The time out period is about 10 minutes. If the PIN times out, you must re-enter the PIN to continue working with the 2920.

The Administrative PIN locks all setup configuration menus for the 2920. However, it does not prevent access of the Level Calibration. The User PIN prevents access to Level Calibration. Using both PINs, you can completely prevent casual access to the 2920.

After the PINs are set, the appropriate PIN window opens depending on the type of data you are trying to access. For instance, if you are trying to access System Setup information, the Admin PIN window opens. If you are trying to set a Temperature Offset, the User PIN window opens.

## Administrative PIN

The Administrative PIN is set in the System Data menu. When set, the Admin PIN prohibits access to all configuration data.

### To Set the Admin PIN:

1. Press E to gain access to the menus.
2. Press E to open the System Data menu.
3. Press E one time to access the Commands menu and the Admin PIN option opens.

**Note** If no PIN has been set, the Admin PIN displays a 0 (zero).

4. Press E to open Admin PIN.
5. Use the + and - keys to select the first number.
6. Press E to advance to the next digit.
7. Continue setting digits as needed.
8. With the Return arrow highlighted, press E two times. A message is shown "Editing enabled" to indicate that the PIN has been accepted and you can edit any configuration settings.

**Note** After about 10 minutes of no key presses, the 2920 forces you to re-enter the PIN before allowing access.

## User PIN

The User PIN is set in the System Data menu. When set, the User PIN prohibits access to the following calibration data:

- Level
- Temperature Offset
- Manual Temperature
- Manual Level

**Note** The Admin PIN must be set before the User PIN can be set. Likewise, if the Admin PIN is removed, the User PIN is also removed.

### To Set the User PIN:

1. Press E to gain access to the menus.
2. Press E to open the System Data menu.

- 3. Press E one time to access the Commands menu and Enter Admin PIN option opens.
- 4. Enter the Admin PIN.
- 5. Scroll down to User PIN.
- 6. Press E to open User PIN.
- 7. Use the + and - keys to select the first number.
- 8. Press E to advance to the next digit.
- 9. Continue setting digits as needed.
- 10. With the Return arrow highlighted, press E two times. A message is shown "Editing enabled" to indicate that the PIN has been accepted and you can edit the above listed calibration settings.

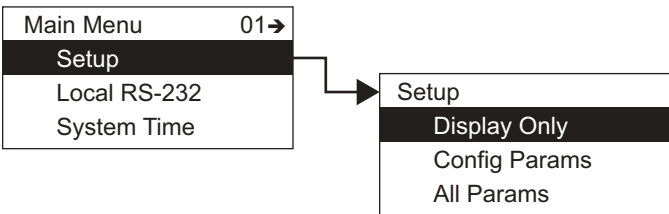
Basic Setup

The Basic Setup menu is used to configure various parameters of the device, such as level, temperature, communications and so on. The Basic Setup parameters menu presents 3 options:

- Display Only — displays the current reading, such as with a level or temperature, or current setting such as feet or degrees Fahrenheit
- Config Params — allows you to change the configuration parameters in Basic Setup
- All Params — scrolls through the Display, Commands, and Config parameters in one all inclusive list

To Access the Basic Setup:

- 1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



- 2. Press Minus one time to move the highlight to Basic Setup.
- 3. Press Enter and the Basic Setup menu opens.
- 4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Basic Setup option.

Display Only		Description
	Pnt Checksum	CRC-16 Checksum of point's static configuration parameters.

Config Params		Description
	Unit Address	<p>The transmitter Unit Address:</p> <ul style="list-style-type: none"> <li>• MODBUS – Range 1 to 254</li> <li>• Biphase Mark – Range 1 to 99</li> <li>• Mark/Space – Range 1 to 999</li> <li>• L&amp;J TankWay – Range 1 to 127</li> </ul>
	Baud Rate	<p>Primary protocol baud rate. Selections are:</p> <p>1200 2400 4800 9600 19200 38400</p> <p><b>Note</b> Biphase Mark only supports 1200/2400.</p>
	Enc Direction	<p>The direction the encoder turns:</p> <ul style="list-style-type: none"> <li>• Forward for Varec 2500</li> <li>• Reverse for L&amp;J</li> </ul>
	Gauge Type	<p>Mechanical Gauge Type:</p> <ul style="list-style-type: none"> <li>• English for 2500 English</li> <li>• Metric for 2500 Metric</li> </ul>
	Encoder Type	<p>The Encoder Type applies to both the L&amp;J encoder and the Mark/Space encoders.</p> <p>The L&amp;J encoders support the following:</p> <ul style="list-style-type: none"> <li>• 2000 (Forward Encoding - Varec gauges</li> <li>• 2000 (Reverse Encoding - Shand &amp; Jurs gauges</li> <li>• 1000/1500 Type 3 (Reverse Encoding - Shand &amp; Jurs gauges)</li> <li>• 1000/1500 Type 4 (Reverse Encoding - Shand &amp; Jurs gauges)</li> </ul> <p>The Mark/Space encoders support the following:</p> <ul style="list-style-type: none"> <li>• 1900</li> <li>• 1800</li> <li>• GSI 2000</li> </ul>
	Lev Disp Units	<p>Level Display Units - How the level is formatted on the Display , for example, in decimal feet, or feet, inches &amp; 16ths, meters, and so on.</p>
	Level COM Units	<p>Level Communications Units - How the level data is formatted before sending the data to the Host system.</p> <p>Note: This parameter is for BPM devices only.</p>
	RTD Type	<p>PT100, Cu90, or Cu100.</p>
	Temp Disp Units	<p>How the temperature is formatted on the display, either F or C.</p>
	Temp COM Units	<p>How the temperature data is sent to the host system.</p> <p>Note: This parameter is for BPM devices only.</p>

	Cal Level	<p>Calibration Level is used to set (calibrate) the encoder level.</p> <p><b>Note</b> If you enter a decimal value, the 2920 interprets the measurement as a decimal value and applies the Level Display Units to format the level. If you enter a string of numbers separated by a dash (xx - xx - xx), the 2920 applies the format of feet-inches-sixteenths.</p>
	Control	<p>This parameter is used to enable the +24VDC power bus. This bus can be used for Active HART, 4-20 input and 4-20 outputs. The Bus can provide ~50 mA of current.</p>
	Parity	<p>Communications Parity. Selections are:</p> <p>None Even Odd</p> <p><b>Note</b> This parameter is for MODBUS devices only.</p>
	MODBUS Reg MAP	<p>Selections are:</p> <p>29XX Map GSI Map MFT/HIU MAP TSM ver 1.x MAP TSM4590 MAP NMS53 MAP NMx8/NRF8 MAP</p> <p><b>Note</b> This parameter is for MODBUS devices only.</p>
	Temp Offset Mode	<p>Applies 100° temperature offset to detected value. Selections are:</p> <p>No offset Offset Temp 100°</p> <p><b>Note</b> This parameter is for Mark/Space devices only.</p>
	Temp Disp Units	<p>Indicates the display units of Temperature. Selections are:</p> <p>°F °C</p>

	Data Mode	Pulse code format of the Mark/Space message. Selections are: Fractional + Temp Decimal + Temp 20 meters + Temp 30 meters + Temp Fract. No Temp Decimal No Temp 20 meters No Temp 30 meters No Temp <b>Note</b> This parameter is for Mark/Space devices only.
	Speed Mode	Indicates timing of the message. Selections are: High Low <b>Note</b> This parameter is for Mark/Space devices only.
<b>All Params</b>		Lists all Display and Config Params in a list.

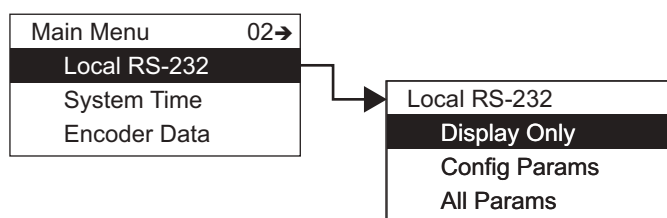
## Local RS-232

The RS-232 menu is used to configure the communications between the 2920 FTT and the local interface (ViewRTU). The RS-232 menu presents 3 options:

- Display Only — displays the current reading, such as with a level or temperature, or current setting such as feet or degrees Fahrenheit
- Config Params — allows you to change the configuration parameters in RS-232
- All Params — scrolls through the Display, Commands, and Config parameters in one all inclusive list

### To Access the RS-232 Menu:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus two times to move the highlight to RS-232.
3. Press Enter and the Select Number menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each RS-232 menu option.

<b>Display Only</b>		<b>Description</b>
	Comm Status	Online or offline for active communications.
	State	Current Communication state, this value is dependent on the type of communications protocol used by the port.
	Cmd	Current communications command which is protocol dependant.
	Status	Protocol dependant.
	Value	Protocol dependant.
	Comm Errors	Number of communication errors.
	Num Trans	Number of communication transactions.
	Elapse	Time of last update.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
	Pnt Checksum	CRC-16 Checksum of point's static configuration parameters.
<b>Config Params</b>		<b>Description</b>
	Protocol	RTU_Slave Disabled
	Baud Rate	Select the baud rate from the list presented.
	Comm Params	Select from: 8E - 8 bits, even parity 8O - 8 bits, odd parity 8N - 8 bits, no parity
	Timeout	Reserved for compatibility.
	Response Delay	The amount of time (if any) a slave protocol will wait to respond after valid request.
<b>All Params</b>		Lists all Display and Config Params in a list.

## System Time

The System Time (or Clock) point is used to set parameters that relate to time (such as time zone) and timing (such as System Time or ticks). System Time menu presents 4 options:

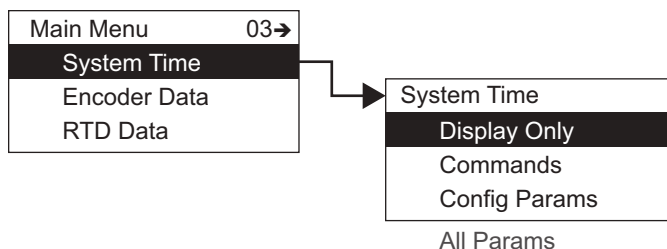
- Display Only — data display, such as time zone
- Commands — commands that can be executed from the System Time menu
- Config Params — parameters that are used to configure data in System Time data, such as System Time

- All Params — scrolls through the Display, Commands, and Config parameters in one menu

Refer to the table below for more information on each System Time option.

### To Access System Time:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus three times to move the highlight to System Time.
3. Press Enter and the System Time menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Display Only		Description
	Time Zone	Used for compatibility with other devices.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
Commands		
	Sys Time	System Time - Actual system time in milliseconds.
	Sys Ticks	System Ticks - Number of time quantum since the transmitter started.
Config Params		Description
	TZ	Used for compatibility with other devices.
All Params		Lists all Display, Commands, and Config Params in a list.

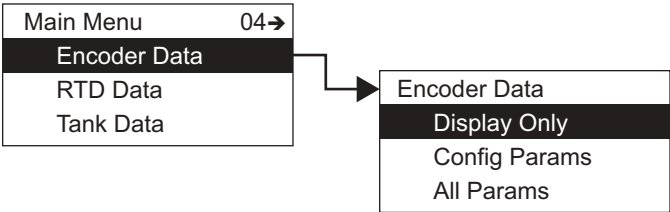
## Encoder Data

The Encoder Data point lists the parameters associated with the internal operation of the transmitter hardware. This includes parameters associated with the operation of the encoder. The Encoder Data 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 sensor states can be evaluated. The calculated reference values can be evaluated. Encoder Data menu presents 3 options:

- Display Only — data display, such as level, or field voltage
- Commands — commands that can be executed from the Encoder Data menu
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

To Access Encoder Data:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus four times to move the highlight to Encoder Data.
3. Press Enter and the Encoder Data menu opens as shown below.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Encoder Data option.

Display Only		Description
	Level	This parameter represents the level in feet derived from the absolute encoding process. This parameter is always encoded in the forward rotation direction.
	Field Voltage	The value of the DC Voltage (Field Voltage) applied to the transmitter to power the unit.
	Internal Temp.	The temperature in degrees Fahrenheit of the internal electronics.
	Number Resets	Shows the number of times the transmitter has reset - soft or power resets. This value resets to zero when a hard reset is performed.
	FDisk	This parameter is a 12-bit value indicating the level read from the foot encoder sensor.
	IDisk	This parameter is a 16-bit value indicating the level read from the fractional foot (inches) encoder sensor.
	Enc State	This is a diagnostic code that describes the encoder state.
	Feet	This parameter indicates the feet portion of the level derived from the absolute encoding process. This parameter is shown in foot units from zero to ninety-nine in binary.
	Inches	This parameter indicates the inches portion of the level derived from the absolute encoding process. This parameter is shown in inch units from zero to eleven in binary.
	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.
	Lev Disp Units	Indicates the level units that have been set to display level on the LCD. Set in Basic Setup.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
	Elapse	Time of last Point update.

Commands		
	Command	<p>To access the Encoder Alignment function, use the following steps:</p> <ol style="list-style-type: none"> <li>1. Go to the <b>Main Menu</b>.</li> <li>2. Scroll down to the 4th menu option, and select <b>Encoder Data</b>.</li> <li>3. Select <b>Commands</b>.</li> <li>4. Ignore the message "Command No Action", and press <b>Enter</b>.</li> <li>5. Select <b>Encoder Alignment</b>, and press <b>Enter</b>.</li> </ol> <p><b>Note</b> Unless a previous offset was configured, the level should display 120 feet. This is the top of the encoder range and indicates a proper encoder alignment was done.</p> <p>After the encoder alignment has been performed:</p> <ol style="list-style-type: none"> <li>1. Go to the <b>Main Menu</b>.</li> <li>2. Scroll down to the 4th menu option, and select <b>Encoder Data</b>.</li> <li>3. Select <b>Display Only</b>.</li> <li>4. Scroll down to <b>iDisk</b> and monitor that the encoder bit data is not changing when there is no movement being made. (This is the encoder that handles inches.)</li> <li>5. Scroll to the next option, <b>FDisk</b>, and again monitor that the encoder bit data is not changing when there is no movement being made. (This is the encoder that handles feet.)</li> <li>6. If either one or both encoders have bit data that fluctuates without movement, the encoder is going bad and the unit needs to be sent to Varec for repair.</li> </ol>
All Params		Lists all Display and Commands in a list.

## RTD Data

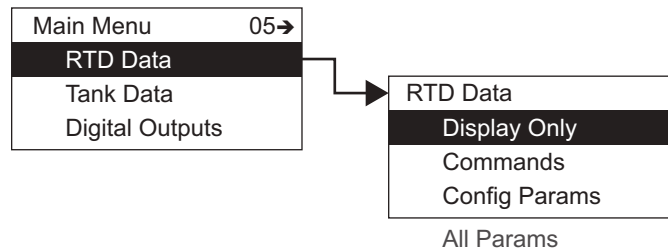
The RTD (Resistive Temperature Detector) Data point displays the data associated with the temperature measurement circuit on the 2920. The RTD point processes temperature using SI units, so the temperature is always displayed in degrees Celsius within the RTD data. RTD Data menu presents 4 options:

- Display Only — data display
- Commands — commands that can be executed from the RTD Data menu
- Config Params — parameters that are used to configure data in RTD Data data
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

**Note** RTD is pre-configured at the factory.

### To Access RTD Data:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus five times to move the highlight to RTD Data.
3. Press Enter and the RTD Data menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each RTD Data option.

Display Only		Description
	Temp	Measured temperature in degrees.
	Raw Value	Un-calibrated resistance measurement value.
	Resistance	Calibrated Resistance measure value. The Value used to calculate the actual temperature parameter.
	Value1	Parameters used in ratio metric resistance measurement.
	Value2	Parameters used in ratio metric resistance measurement.
	Value3	Parameters used in ratio metric resistance measurement.
	100 Ohm RefRes	24-bit value representing the ratio metric value of a 100-ohm precision reference resistor.
	200 Ohm RefRes	24-bit value representing the ratio metric value of a 200-ohm precision reference resistor.
	Temp Dis Units	Indicates the temperature units that have been set to display temperature on the LCD. Set in Basic Setup.
	Pnt Status	RTD PntStatus values: 0x0001 - RTD Temperature Invalid 0x0002 - Resistance is below table value (Under Range - RTD may be shorted) 0x0004 - Resistance is above table value (Over Range - RTD may be opened) 0x0008 - RTD is uncalibrated 0x0010 - Hardware Failure
	Elapse	Time of last update
	Pnt Checksum	CRC-16 Checksum of point's static configuration parameters.
Command		
	Cal. Command	Parameter used to activate calibration parameters.

Config Params		
	Cal. Point #1	These parameters are used to provide additional calibration to the RTD circuit. This Cal. Point value is 20 ohms. These parameters adjust the interpolation points used in temperature calculations.
	Cal. Point #2	These parameters are used to provide additional calibration to the RTD circuit. This Cal. Point value is 60 ohms. These parameters adjust the interpolation points used in temperature calculations.
	Cal. Point #3	These parameters are used to provide additional calibration to the RTD circuit. This Cal. Point value is 100 ohms. These parameters adjust the interpolation points used in temperature calculations.
	Cal. Point #4	These parameters are used to provide additional calibration to the RTD circuit. This Cal. Point value is 140 ohms. These parameters adjust the interpolation points used in temperature calculations.
	Cal. Point #5	These parameters are used to provide additional calibration to the RTD circuit. This Cal. Point value is 180 ohms. These parameters adjust the interpolation points used in temperature calculations.
	Avg Filter	Value between 1-10 indicating the number of temperature samples used in temperature filtering. The default value is 4.
All Params		Lists all Display, Commands, and Config Params in a list.

## Tank Data

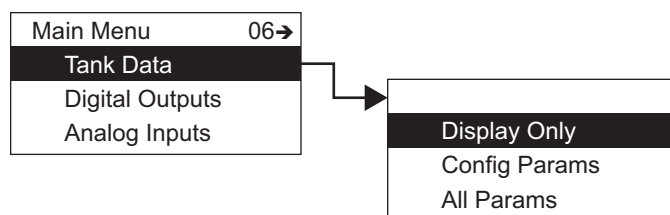
The Tank data item displays specific parameters and allows configuration of the tank point functions.

Tank Data menu presents 3 options:

- Display Only — data display, such as level or temperature
- Config Params — parameters that are used to configure data in Tank data, such as critical low temperature or advise low level
- All Params — scrolls through the Display and Config parameters in one menu

## To Access Tank Data:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus six times to move the highlight to Tank Data.
3. Press Enter and the Tank Data menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Tank Data option.

Display Only		Description
	Level	Indicates the current measured or calculated level after corrections are applied.
	Temp	Indicates the current product temperature.
	Secondary Lvl	Indicates the secondary tank level.
	Water Level	Indicates the measured water level.
	AlmStat	Integer value indicating any alarm conditions, as follows: 0x0001: Critical Low Level 0x0002: Advisory Low Level 0x0004: Advisory High Level 0x0008: Critical High Level 0x0010: Critical Low Temperature 0x0020: Advisory Low Temperature 0x0040: Advisory High Temperature 0x0080: Critical High Temperature 0x0100: Digital Input 1/Alarm 0 (Mark/Space) 0x0200: Digital Input 2/Alarm 1 (Mark/Space) 0x0400: Digital Input 3 0x0800: Digital Input 4
	DiagStat	Integer Value indicating any diagnostic alarm conditions, as follows: 0x0001: Invalid Level 0x0002: Invalid Temperature
	Ullage	Indicates the calculated Ullage value.
	PntStat	Integer value indicating status of point, as follows: 0: No Errors

	Elapse	Time of last update.
	Pnt Checksum	CRC-16 Checksum of point's static configuration parameters.
<b>Config Params</b>		
	LevelRef	ENC Level (Default) ENC Field Voltage ENC Internal Temp RTD Temp Tank Ullage Level AI Value AO1 Value AO1 Current AO1 % Range AO2 Value AO2 Current AO2 % Range NMT53 Avg Temp NMT53 Vap Temp NMT elem. #00 through #17 NMT53 Water Level HART1 PV Value HART1 SV Value HART2 PV Value HART2 SV Value HART3PV Value HART3 SV Value FMR Level FMR Measured Dist. FMR Meas. Level HSCAN +24V output Hydro Level Hydro P1 - Bot pre Hydro P2 - Mid pre Hydro P1 - Top pre Hydro Air Temp Hydro Vap Temp Hydro Obs. density Hydro Std. Density Hydro VolCorFactor Undefined

	TempRef	ENC Level ENC Field Voltage ENC Internal Temp RTD Temp (Default) RTD Resistance Tank Ullage Level AI Value AO1 Value AO1 Current AO1 % Range AO2 Value AO2 Current AO2 % Range NMT53 Avg Temp NMT53 Vap Temp NMT elem. #00 through #17 NMT53 Water Level HART1 PV Value HART1 SV Value HART2 PV Value HART2 SV Value HART3PV Value HART3 SV Value FMR Level FMR Measured Dist. FMR Meas. Level HSCAN +24V output Hydro Level Hydro P1 - Bot pre Hydro P2 - Mid pre Hydro P1 - Top pre Hydro Air Temp Hydro Vap Temp Hydro Obs. density Hydro Std. Density Hydro VolCorFactor Undefined
	CritLowLevel	This value indicates the point at which the Critical Low Level alarm should be activated. When the incoming value falls below this point the alarm is activated and de-activated when the value is above this point. Default - 0'00-00/16"

	AdvLowLevel	This value indicates the point at which the Low Alarm Level should be activated. When the incoming value falls below this point the alarm is activated and de-activated when the value is above this point. Default - 0'00-00/16"
	AdvHighLevel	This value indicates the point at which the High Alarm Level should be activated. When the incoming value rises above this point the alarm is activated and de-activated when the value is below this point. Default - 80'00-00/16"
	CritHighLevel	This value indicates the point at which the Critical High Level alarm should be activated. When the incoming value rises above this point the alarm is activated and de-activated when the value is below this point. Default - 80'00-00/16"
	LDeadband	A floating-point value used to determine change in level alarm state. The product level value must be above the 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. Default - 0'01-00/16"
	Manual Level	Manual level allows the user to enter a manual level value, if the Level Reference is undefined. Default - 0'00-00/16"
	CritLowTemp	This value indicates the point at which the Critical Low Temperature alarm should be activated. When the incoming value falls below this point the alarm is activated and de-activated when the value is above this point. Default - 0.0 °F
	AdvLowTemp	This value indicates the point at which the Low Alarm Temperature should be activated. When the incoming value falls below this point the alarm is activated and de-activated when the value is above this point. Default - 0.0 °F
	AdvHighTemp	This value indicates the point at which the High Alarm Temperature should be activated. When the incoming value rises above this point the alarm is activated and de-activated when the value is below this point. Default - 500.0 °F
	CritHighTemp	This value indicates the point at which the Critical High Temperature alarm should be activated. When the incoming value rises above this point the alarm is activated and de-activated when the value is below this point. Default - 500.0 °F

	TDeadband	A 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. Default - 1.0 °F
	ManTemp	A floating-point value representing a manual temperature value. This parameter is valid if the Temperature Reference is undefined. Default - 0.0 °F
	TempOffset	A floating point value to add a linear (positive or negative) offset to the measured temperature value. Default - 0.0 °F
	2 <sup>nd</sup> Level Ref	Indicates the reference for secondary (tank) level. ENC Level (Default) ENC Field Voltage ENC Internal Temp RTD Temp Tank Ullage Level AI Value AO1 Value AO1 Current AO1 % Range AO2 Value AO2 Current AO2 % Range NMT53 Avg Temp NMT53 Vap Temp NMT elem. #00 through #17 NMT53 Water Level HART1 PV Value HART1 SV Value HART2 PV Value HART2 SV Value HART3PV Value HART3 SV Value FMR Level FMR Measured Dist. FMR Meas. Level HSCAN +24V output Hydro Level Hydro P1 - Bot pre Hydro P2 - Mid pre Hydro P1 - Top pre

		Hydro Air Temp Hydro Vap Temp Hydro Obs. density Hydro Std. Density Hydro VolCorFactor Undefined
	Level2Units	Indicates the level units for displaying the secondary level. ft (Default) m in mm 16th ft-in-16 ft-in-8
	WaterRef	Indicate the reference for water level. ENC Level ENC Field Voltage ENC Internal Temp. RTD Temp. RTD Resistance Tank Ullage level AI Value AO1 Value AO1 Current AO1 % Range AO2 Value AO2 Current AO2 % Range NMT53 Avg Temp NMT53 Vap Temp NMT elem. #00 through #17 NMT53 Water Level (Default) HART1 PV Value HART1 SV Value HART2 PV Value HART2 SV Value HART3 PV Value HART3 SV Value FMR Level FMR Measured Dist. FMR Meas. Level HSCAN +24V output Hydro Level

		Hydro P1 - Bot pre Hydro P2 - Mid pre Hydro P1 - Top pre Hydro Air Temp Hydro Vap Temp Hydro Obs. density Hydro Std. Density Hydro VolCorFactor Undefined
	WaterUnits	Indicates the level units used for displaying the water level.  ft (default) m in mm 16th ft-in-16 ft-in-8
	Tank Ref hght	Indicates the Reference Tank Height used for Ullage calculation.  Default - 80'00-00/16"
	Lev Ref Ullage	Indicates the Level reference used for Ullage calculation.  ENC Level (Default) ENC Field Voltage ENC Internal Temp. RTD Temp. RTD Resistance Tank Ullage level AI Value AO1 Value AO1 Current AO1 % Range AO2 Value AO2 Current AO2 % Range NMT53 Avg Temp NMT53 Vap Temp NMT elem. #00 through #17 NMT53 Water Level HART1 PV Value HART1 SV Value HART2 PV Value HART2 SV Value HART3 PV Value HART3 SV Value

		FMR Level FMR Measured Dist. FMR Meas. Level HSCAN +24V output Hydro Level Hydro P1 - Bot pre Hydro P2 - Mid pre Hydro P1 - Top pre Hydro Air temp. Hydro Vap temp. Hydro Obs. density Hydro Std. Density Hydro VolCorFactor Undefined
<b>All Params</b>		Lists all Display and Config Params in a list.

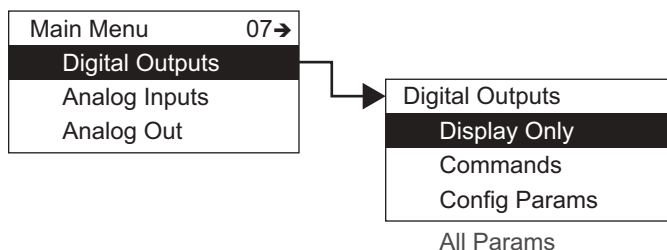
## Digital Outputs

The Digital Output menu contains the configuration and control parameters for activating the 4 optional output relays. Digital Outputs menu presents 4 options:

- Display Only — data display, such as the current Digital Output state
- Commands — commands that can be executed from the Digital Outputs menu
- Config Params — parameters that are used to configure data in Digital Outputs data
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

### To Access Digital Outputs:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus seven times to move the highlight to Digital Outputs.
3. Press Enter and the Digital Outputs menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Digital Outputs option.

Display Only		Description
	DOState	Current DO State
	PntStatus	Point Status
	Elapse	Time of last update.
	Pnt Checksum	CRC-16 Checksum of point's static configuration parameters.
Command		
	DOutputState	<p>This is a command parameter used to activate the output relays.</p> <p>0x0001: Activate Relay 1 (When set for HOST Control)</p> <p>0x0002: Activate Relay 2 (When set for HOST Control)</p> <p>0x0004: Activate Relay 3 (When set for HOST Control)</p> <p>0x0008: Activate Relay 4 (When set for HOST Control)</p>

Config Params		
	DOPwrUpState	<p>This parameter is used to force a Relay to be active at startup.</p> <p>0x0001: If Controlled at Startup, Relay 1 will be set to Active</p> <p>0x0002: If Controlled at Startup, Relay 2 will be set to Active</p> <p>0x0004: If Controlled at Startup, Relay 3 will be set to Active</p> <p>0x0008: If Controlled at Startup, Relay 4 will be set to Active</p> <p>0x0010: Relay 1 Is Controlled at Startup</p> <p>0x0020: Relay 2 Is Controlled at Startup</p> <p>0x0040: Relay 3 Is Controlled at Startup</p> <p>0x0080: Relay 4 Is Controlled at Startup</p>
	DO1 Assignment	<p>These parameters are used to assign the control and activation source for the output relays.</p> <p>0: Not Assigned</p> <p>1: Host Interface</p> <p>2: Critical High Level</p> <p>3: Advisory High Level</p> <p>4: Advisory Low Level</p> <p>5: Critical Low Level</p> <p>6: Critical High Temperature</p> <p>7: Advisory High Temperature</p> <p>8: Advisory Low Temperature</p> <p>9: Critical Low Temperature</p>
	DO2 Assignment	
	DO3 Assignment	
	DO4 Assignment	
	Duration1	<p>Sets the duration of Digital Output 1. If set to a non-zero value, when the Relay activates, the relay activates for the amount of time (in seconds) specified by the duration then the relay deactivates. Setting the value to zero, means the relay stays active indefinitely. The default value is 0.</p>
	Duration2	<p>Sets the duration of Digital Output 2. If set to a non-zero value, when the Relay activates, the relay activates for the amount of time (in seconds) specified by the duration then the relay deactivates. Setting the value to zero, means the relay stays active indefinitely. The default value is 0.</p>
All Params		Lists all Display, Commands, and Config Params in a list.

## Analog Input

The Analog Input software point provide a mean for converting a 4-20 mA signal into a useful data value, such as level or temperature. The Analog Input point provides an offset value (Zero)

and Scaling value (Span) for converting the 4-20 mA signal. Measurement units can also be associated with the 4-20 mA signal. The conditioned Analog Input value can be used as the data reference for the transmitter level or temperature, can be displayed on the LCD, or can be used to drive a 4-20 mA Output channel.

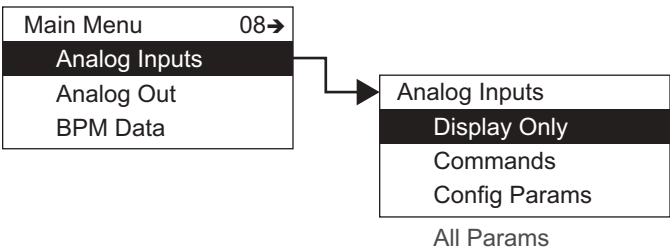
Analog Input menu presents 4 options:

- Display Only — data display, such as Analog Status
- Commands — commands that can be executed from the Analog Input menu
- Config Params — parameters that are used to configure data in Analog Input data
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

**Note** The Analog Input is pre-configured at the factory.

**To Access Analog Input:**

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus eight times to move the highlight to Analog Input.
3. Press Enter and the Analog Input menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Analog Input option.

Display Only		Description
	Analog Status	A value of 1 indicates the analog value is valid and within range; a value of 0 indicates some the value is out of range.
	Pnt Status	Point Status, as follows: 0x0001 - Hardware Failure 0x0002 - Value 1 Over range 0x0004 - Value 1 Under range 0x0008 - AI is uncalibrated
	Value	A value of 4-20 mA signal with the calibration correction applied.
	Raw Value1	A value of 4-20 mA signal before calibration correction is applied.
	Elapse	Time of last update.
	Pnt CheckSum	CRC-16 Checksum of point's static configuration parameters.
Command		
	Command	Calibration Command
Config Params		
	Avg Filter	The Analog Input value can be averaged over several samples to improve stability of the measurement. The filter can be set between 0 and 7.
	Zero Span	Zero and Span together determine how the input value is scaled. The Analog input measures a value between 0 and 22 mA. The measurement value is typically in the range of 4 to 20 mA with 4 mA the minimum value and 20 mA the maximum value. (A 0 to 4 mA and 20 to 22 mA values are generally used to indicate a fault condition.) If the 4 to 20 mA data came from a level instrument with a range of 0 to 30 feet, the Zero parameter would be set to 0 and the Span parameter would be set to 30.0.
	Cal. Point #1 Cal. Point #2	The Analog Input uses a two point calibration points: Point # 1 is the Calibration Value for 8 mA. Point #2 is the Calibration Value for 16 mA.

	Units	The 4 to 20 mA signal, can be assigned a units parameter. This is useful for units conversion and when displaying a value on the LCD. Possible Values are:	
		percent m/s <sup>2</sup> undefined ft m in mm 16 <sup>th</sup> ft-in-16 ft-in-8 °F °C °API kg/m <sup>3</sup> lb/ft <sup>3</sup> in H <sub>2</sub> O PSI bar Mbar Pa	kPa MPa US Gal l m <sup>3</sup> bbl gal/min l/min bbl/min bbl/hr m <sup>3</sup> /min m <sup>3</sup> /hr sec min hr mA Volts mV Ohms
All Params		Lists all Display, Commands, and Config Params in a list.	

## Analog Input User Calibration

To calibrate the Analog Input do the following:

**Warning!** Obtain a hot working permit before beginning this procedure.

1. Connect a calibrated 4-20 mA current source to terminals AI & AI COM
2. Select Calibration from the Main Menu on the 2920.
3. Select Analog Input.
4. Set the Current Source to 8 mA and wait 5 to 10 seconds for signal to stabilize.
5. Press the E to accept the 8 mA value.
6. Set the Current Source to 16 mA and wait 5 to 10 seconds for signal to stabilize.
7. Press the E to accept the 8 mA value.
8. Press the C button twice to exit to the main menu.
9. Select Analog Input from the main Menu on the 2920.
10. Select Display menu.
11. Scroll the menu to the Value parameter.

12. Adjust the 4-20 mA current source and verify the Value parameter updates:

4 mA = 0.0 +/- 0.01

8 mA = 25.0 +/- 0.01

12 mA = 50.0 +/- 0.01

16 mA = 75.0 +/- 0.01

20 mA = 100.0 +/- 0.01

## Analog Out

The Analog Out software points can be configured as either Manual or Automatic.

- Manual indicates the output is controlled by setting the Value parameter, either by the communications interface or the user interface.
- Automatic indicates some parameter within the transmitter database is controlling the output. The database item used to control the output is set using the Pnt Ref parameter. A predefined list of database items is available when setting the Pnt Ref parameter.

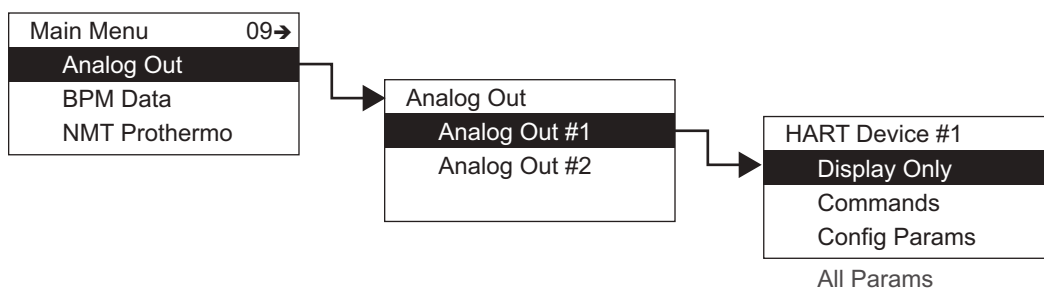
**Note** The Analog Out is pre-configured at the factory.

Analog Out menu presents 4 options:

- Display Only — data display, such as reference values and percent range
- Commands — commands that can be executed from the Analog Out menu, such as Raw Value
- Config Params — parameters that are used to configure data in Analog Out data
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

### To Access Analog Out:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus nine times to move the highlight to Analog Out.
3. Press Enter and the Select Number menu opens.
4. Select either Analog Out #1 or Analog Out #2.

**Note** The parameters for Analog Out #1 and Analog Out #2 are identical. However, each Analog Out can be configured differently. Analog Out #1 is used as an example below.

5. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Analog Out option.

Display Only		Description
	RefValue	Displays the data value from the PntRef data item. When the Control is set to enable, this value control the AO output value.
	Percent Range	Displays the percent of range for the analog output value. A 0 percent is 4 mA, and 100 is 20 mA.
	EIapse	Time of last update.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
	Pnt CheckSum	CRC-16 Checksum of point's static configuration parameters.
Commands		
	Command	Used to reset the calibration curve back to factory default values.
	Raw Value	This value is set to manually control the 4-20 mA output. Setting the Raw Value does not apply the calibration correction to the signal.
	Value	This value is set to manually control the 4-20 mA output. Setting the Value applies the calibration correction (if available) to the output signal.

Config Params		
	Pnt Ref	The reference parameter used to automatically control the 4-20 mA output signal. Some examples are Tank Level, Tank Temperature, Encoder Level, and so on.
	Control	When the Control Parameter is set to Enable, the data value from the PntRef is used to control the output value of the AO channel.
	Zero	The Zero, Span, and Calibration points are similar to that in the AI point. In this case, the AO is generating a 4-20 mA signal. If you wanted to send the 4 to 20 mA as a level in the range of 0 to 25 feet. The zero would be 0 and the Scale would be 25. When the level was at 0 ft the AO would send 4 mA, and when the level is at 25 ft, the AO would send 20 mA.
	Span	
	Cal. Point #1	Calibration points form a curve which is used to correct the output signal, #1 corresponds to 4 mA.
	Cal. Point #2	Calibration points form a curve which is used to correct the output signal, #2 corresponds to 8 mA.
	Cal. Point #3	Calibration points form a curve which is used to correct the output signal, #3 corresponds to 12 mA.
	Cal. Point #4	Calibration points form a curve which is used to correct the output signal, #4 corresponds to 16 mA.
	Cal. Point #5	Calibration points form a curve which is used to correct the output signal, #5 corresponds to 20 mA.
All Params		Lists all Display, Commands, and Config Params in a list.

## Analog Output User Calibration

To calibrate the Analog Output, do the following:

**Warning!** Obtain a hot working permit before beginning this procedure.

### Output Calibration of Channel 1

1. Connect terminals A+24V and AO1+.
2. Connect a calibrated 4-20 mA Meter to terminals AO1- & AI COM.
3. If the 24VDC Output Power supply is not turned on, turn it on using the following steps:
  - a. Select the Basic Setup from the main Menu on the 2920.
  - b. Scroll to the Config Params menu.
  - c. Scroll to the Control parameter.
  - d. Set the control parameter to On.
4. Select Calibration from the main Menu on the 2920.
5. Select Analog Output.
6. Select Analog Output #1.

7. Monitor the 4-20 mA meter, and Press the E button.
8. Enter the value from the 4-20 mA Meter into the Cal. Point #1.
9. Repeat this process for calibration points 2 through 5.
10. Press the C button twice to exit to the main menu
11. Select Analog Output from the main Menu on the 2920.
12. Select Analog Output #1.
13. Scroll to the Commands menu.
14. Scroll the menu to the Value parameter.
15. Enter values 0 to 100 (percent) and verify the measurement on the 4-20 mA Meter:  
 $0.0 = 4.00 \pm 0.01$   
 $25.0 = 8.00 \pm 0.01$   
 $50.0 = 12.00 \pm 0.01$   
 $75.0 = 16.00 \pm 0.01$   
 $100.0 = 20.00 \pm 0.01$

### Output Calibration of Channel 2

1. Connect terminals A+24V and AO2+.
2. Connect a calibrated 4-20 mA Meter to terminals AO2- & AI COM.
3. If the 24VDC Output Power Supply is turned off (default), turn it on using the following steps:
  - a. Select the Basic Setup from the main Menu on the 2920.
  - b. Scroll to the Config Params menu.
  - c. Scroll to the Control parameter.
  - d. Set the control parameter to On.
4. Select Calibration from the main Menu on the 2920.
5. Select Analog Output.
6. Select Analog Output #2.
7. Monitor the 4-20 mA meter, and Press the E button.
8. Enter the value from the 4-20 mA Meter into the Cal. Point #1.
9. Repeat this process for calibration points 2 through 5.
10. Press the C button twice to exit to the main menu
11. Select Analog Output from the main Menu on the 2920.
12. Select Analog Output #2.
13. Scroll to the Commands menu.
14. Scroll the menu to the Value parameter.
15. Enter values 0 to 100 (percent) and verify the measurement on the 4-20 mA Meter:  
 $0.0 = 4.00 \pm 0.01$   
 $25.0 = 8.00 \pm 0.01$

50.0 = 12.00 +/- 0.01

75.0 = 16.00 +/- 0.01

100.0 = 20.00 +/- 0.01

## BPM Data

**Note** The BPM (Biphase Mark) Data menu is used only when monitoring communications or when configuring a Biphase Mark Device.

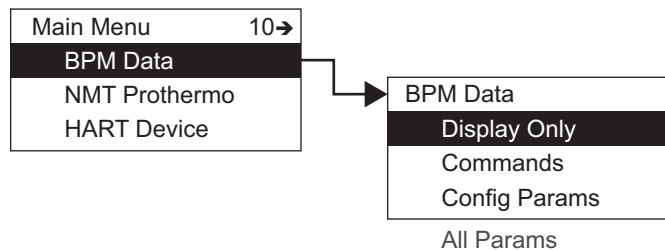
The BPM Data menu contains parameters and allows configuration of the BPM data point.

**BPM Data menu presents 3 options:**

- Display Only — data display, such as message and number of requests
- Config Params — parameters that are used to configure data in BPM data, such as response delay
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

### To Access BPM Data:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus ten times to move the highlight to BPM Data.
3. Press Enter and the BPM Data menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each BPM Data option.

Display Only		Description
	Message	Current Request
	Command	Type of Record
	Num Requests	Number of Requests
	Num Com Errors	Number of Requests with Errors
Config Params		
	Response Delay	Response Delay

All Params	Lists all Display and Config Params in a list.
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# MODBUS Data

**Note** The MODBUS Data menu is used only when monitoring communications or when configuring a MODBUS Device.

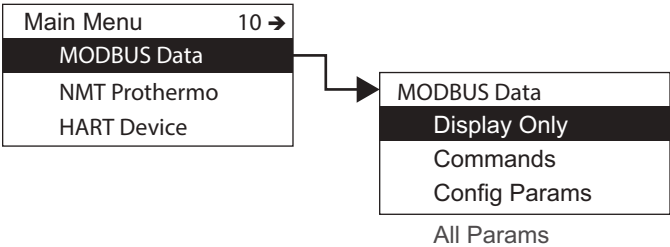
The MODBUS Data menu contains parameters and allows configuration of the MODBUS data point.

The MODBUS Data menu presents 4 options:

- Display Only — data display, such as average temperature or vapor temperature
- Commands — commands that can be executed from the MODBUS menu
- Config Params — parameters that are used to configure data in MODBUS
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

## To Access MODBUS:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus ten times to move the highlight to MODBUS Data.
3. Press Enter and the MODBUS Data menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each MODBUS Data option.

Display Only		Description
	Request	Current Request
	Cmd	Current Function Request
	Addr	Current Data Address
	NumRequests	Number of Requests
	NumComErrors	Number of Requests with Errors
	RS485Term	RS-485 Termination
	Elapse	Time of Request
	Level	Level (Int)
	Temp	Temp (Int)
	UnitTemp	Unit Temp (Int)
	AnalogInput	Analog Input (Int)
	PntStatus	Point Status
	PntChecksum	Point CheckSum
Config Params		
	RespDelay	Response Delay 0 - 1000 milliseconds
	MinLevel	Minimum Tank Level
	MaxLevel	Maximum Tank Level
	MinTemp	Minimum Temperature
	MaxTemp	Maximum Temperature
	MaxInt	Maximum Integer Value
	CritLowLevel	Critical Low Level (Int)
	AdvLowLevel	Advisory Low Level (Int)
	AdvHighLevel	Advisory High Level (Int)
	CritHighLevel	Critical High Level (Int)
	LDeadband	Level Deadband (Int)
	CritLowTemp	Critical Low Temperature (Int)
	AdvLowTemp	Advisory Low Temperature (Int)
	AdvHighTemp	Advisory High Temperature (Int)
	CritHighTemp	Critical High Temperature (Int)
	ManTemp	Manual Temperature (Int)
	CalLevel	Calibration Level (Int)

Command		
	RS485Bus	RS-485 Bus Status 0 - RS485 Isolated (Isolate the transmitter from the RS485 Bus) 1 - RS485 Connected (Connect Transmitter to the RS-485 Bus) 2 - RS485 Test (Test RS-485) Hardware
	AnalogOutput1	Analog Output 1 (Int)
	AnalogOutput2	Analog Output 2 (Int)
All Params		Lists all Display and Config Params in a list.

## Mark/Space Data

**Note** The Mark/Space Data menu is used only when monitoring communications or when configuring a Mark/Space Device.

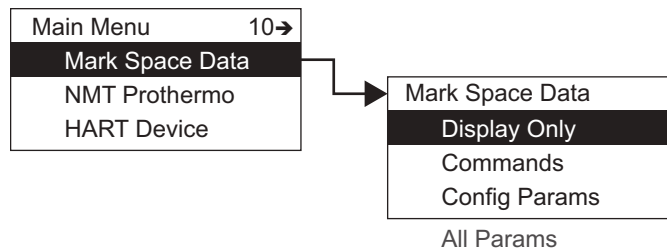
The Mark/Space Data menu contains parameters and allows configuration of the Mark/Space message. The Mark/Space message usually contains both level and temperature parameters, with up to 3 level and temperature pairs per message. Each message uses a message address parameter passed with the message.

The Mark/Space menu presents 4 options:

- Display Only — data display, such as average temperature or vapor temperature
- Commands — commands that can be executed from the Mark/Space menu
- Config Params — parameters that are used to configure data in Mark/Space
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

### To Access Mark/Space:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus ten times to move the highlight to Mark/Space.
3. Press Enter and the Mark/Space menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Mark/Space option.

Display Only		Description
	Poll Addresses	Displays the current addresses being polled by a connected Host system
	Num Com Errors	Displays the number of communication errors
	Num Requests	Displays the number of times the Host system has polled the transmitter
Command		
	MS Bus Status	<p>This parameter is both an indicator of the current Mark/Space bus state and a control for changing or testing the bus state. Selections are:</p> <p><b>Bus Connected</b> — Indicates the transmitter is currently connected to the Mark/Space and the field relay is closed.</p> <p>If the bus is connected, the command to Isolated can be issued to disconnect the transmitter and open the field relay.</p> <p><b>Bus Isolated</b> — Indicates the transmitter is currently disconnected from the Mark/Space bus and the field relay is open.</p> <p>If the bus is isolated, the command to Connected can be issued to connect the transmitter back to the bus and close the field relay.</p> <p><b>Bus Test</b> — This command initiates a test of the Mark/Space interface hardware. The transmitter disconnects from the bus and tests the transceiver hardware. If the hardware test is successful, the transmitter reconnects to the Mark/Space bus and the status displays Connected. If the hardware test fails, the transmitter remains disconnected from the bus and the status displays Isolated.</p>

<b>Config Params</b>		
	Response Delay	30
	2nd TX Address	Set this Address between 1 and 999 to have the transmitter respond to a 2nd Mark/Space address. This Address must be different than the Unit Addr (Basic Setup) and the 3rd MS Address. Also, this address must be different than all other transmitters on the same Mark/Space bus. The default value is 0 which means the transmitter will not respond.
	2nd Level Ref	This is set if the transmitter needs to respond to the a second Mark/Space address. This allows the transmitter to send additional data items.  If the 2nd MS Address is set, this selects the data item in the transmitter to be sent as the level portion of the Mark/Space message. Depending on the transmitter Data Mode (Basic Setup), this parameter is transmitted in the range up to 0 to 80 with 0.001 resolution.
	2nd Temp Ref	This is set if the transmitter needs to respond to the a second Mark/Space address. This allows the transmitter to send additional data items.  If the 2nd MS Address is set, this selects the data item in the transmitter to be sent as the temperature portion of the Mark/Space message. This parameter is transmitted in the range -799.9 to 799.9 with 0.1 resolution.
	3rd TX Address	Set this Address between 1 and 999 to have the transmitter respond to a 3rd Mark/Space address. This Address must be different than the Unit Addr (Basic Setup) and the 2nd MS Address. Also, this address must be different than all other transmitters on the same Mark/Space bus. The default value is 0 which means the transmitter will not respond.
	3rd Level Ref	If the 3rd MS Address is set, this selects the data item in the transmitter to be sent as the level portion of the Mark/Space message. Depending on the transmitter Data Mode (Basic Setup), this parameter is transmitted in the range up to 0 to 80 with 0.001 resolution.
	3rd Temp Ref	If the 3rd MS Address is set, this selects the data item in the transmitter to be sent as the temperature portion of the Mark/Space message. This parameter is transmitted in the range -799.9 to 799.9 with 0.1 resolution.
<b>All Params</b>		Lists all Display, Commands, and Config Params in a list.

## LJ Data

**Note** The LJ Data menu is used only when monitoring communications or when configuring a L&J TankWay Device.

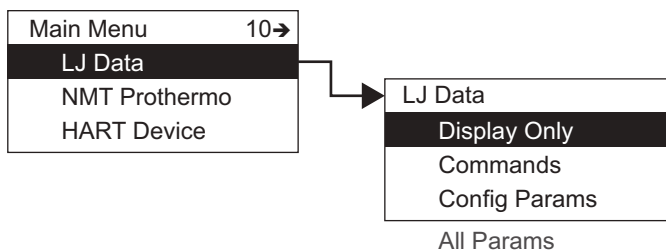
The LJ Data menu contains parameters and allows configuration of the L&J TankWay message. The L&J TankWay message usually contains both level and temperature parameters, with up to 3 level and temperature pairs per message. Each message uses a message address parameter passed with the message.

The LJ Data menu presents 4 options:

- Display Only — data display, such as average temperature or vapor temperature
- Commands — commands that can be executed from the L&J TankWay menu
- Config Params — parameters that are used to configure data in L&J TankWay
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

### To Access LJ Data:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus ten times to move the highlight to LJ Data.
3. Press Enter and the LJ Data menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each LJ Data option.

Display Only		Description
	Poll Addresses	Displays the current addresses being polled by a connected Host system
	Num Com Errors	Displays the number of communication errors
	Num Requests	Displays the number of times the Host system has polled the transmitter

Command		
	TW Bus Status	<p>This parameter is both an indicator of the current L&amp;J TankWay bus state and a control for changing or testing the bus state. Selections are:</p> <p><b>Bus Connected</b> — Indicates the transmitter is currently connected to the L&amp;J TankWay and the field relay is closed.</p> <p>If the bus is connected, the command to Isolated can be issued to disconnect the transmitter and open the field relay.</p> <p><b>Bus Isolated</b> — Indicates the transmitter is currently disconnected from the L&amp;J TankWay bus and the field relay is open.</p> <p>If the bus is isolated, the command to Connected can be issued to connect the transmitter back to the bus and close the field relay.</p> <p><b>Bus Test</b> — This command initiates a test of the L&amp;J TankWay interface hardware. The transmitter disconnects from the bus and tests the transceiver hardware. If the hardware test is successful, the transmitter reconnects to the L&amp;J TankWay bus and the status displays Connected. If the hardware test fails, the transmitter remains disconnected from the bus and the status displays Isolated.</p>

Config Params		
	Response Delay	The default for the L&J response delay is 2 mS.
	2nd TX Address	Set this Address between 1 and 127 to have the transmitter respond to a 2nd TankWay address. This Address must be different than the Unit Addr (Basic Setup) and the 3rd TX Address. Also, this address must be different than all other transmitters on the same L&J TankWay bus. The default value is 0 which means the transmitter will not respond.
	2nd Level Ref	<p>This is set if the transmitter needs to respond to the a second L&amp;J TankWay address. This allows the transmitter to send additional data items.</p> <p>If the 2nd TX Address is set, this selects the data item in the transmitter to be sent as the level portion of the L&amp;J TankWay message. The Encoder Type (Basic Setup) determines the data range and resolution.</p> <ul style="list-style-type: none"> <li>• 2000: 0 to 96 with a resolution of 0.01</li> <li>• 1000/1500 Type 3: 0 to 255.9 with a resolution of 0.02</li> <li>• 1000/1500 Type 4: 0 to 170.66 with a resolution of 0.003</li> </ul>
	2nd Temp Ref	<p>This is set if the transmitter needs to respond to the a second L&amp;J TankWay address. This allows the transmitter to send additional data items.</p> <p>If the 2nd MS Address is set, this selects the data item in the transmitter to be sent as the temperature portion of the L&amp;J TankWay message. This parameter is transmitted in the range -819.0 to 819.0 with 0.1 resolution.</p>
	3rd TX Address	Set this Address between 1 and 127 to have the transmitter respond to a 3rd L&J TankWay address. This Address must be different than the Unit Addr (Basic Setup) and the 2nd TX Address. Also, this address must be different than all other transmitters on the same L&J TankWay bus. The default value is 0 which means the transmitter will not respond.
	3rd Level Ref	<p>If the 3rd TX Address is set, this selects the data item in the transmitter to be sent as the level portion of the L&amp;J TankWay message. The Encoder Type (Basic Setup) determines the data range and resolution.</p> <ul style="list-style-type: none"> <li>• 2000: 0 to 96 with a resolution of 0.01</li> <li>• 1000/1500 Type 3: 0 to 255.9 with a resolution of 0.02</li> <li>• 1000/1500 Type 4: 0 to 170.66 with a resolution of 0.003</li> </ul>
	3rd Temp Ref	If the 3rd MS Address is set, this selects the data item in the transmitter to be sent as the temperature portion of the L&J TankWay message. This parameter is transmitted in the range -819.0 to 819.0 with 0.1 resolution.

All Params	Lists all Display, Commands, and Config Params in a list.
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# NMT Prothermo

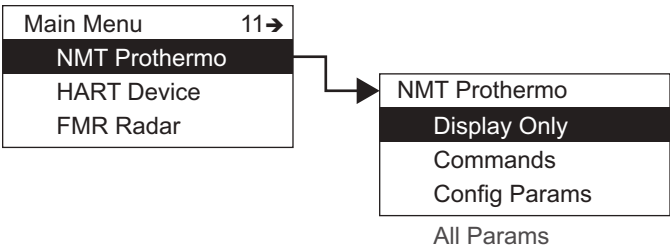
The NMT Prothermo menu contains parameters and allows configuration of the NMT Prothermo software point ATS connected to the gauge.

NMT Prothermo menu presents 4 options:

- Display Only — data display, such as average temperature or vapor temperature
- Commands — commands that can be executed from the NMT Prothermo menu
- Config Params — parameters that are used to configure data in NMT Prothermo
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

## To Access NMT Prothermo:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus eleven times to move the highlight to NMT Prothermo.
3. Press Enter and the NMT Prothermo menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each NMT Prothermo option.

Display Only		Description
	Avg Temp	Average temperature
	Vap Temp	Average vapor temperature
	Elem #00	Temperature conversion value of internal precision 100 Ohm resistor.
	Elem #01 through #16	Temperature measured by element #1 through element #16
	Elem #17	Temperature conversion value of internal precision 200 Ohm resistor.
	Meas Level	The liquid level used for the average temperature calculations, it is automatically updated by the 2920 to be the actual measured level.
	Status	Status code of the NMT.
	Diag Code	When the NMT electronics detect an error this parameter shows the error code detected.
	Univ Cmd Rev	Revision of the universal command set the NMT supports.
	Dev Cmd Rev	Revision of the device commands that the NMT supports.
	Softw. Version	The software version of the NMT.
	Hardw. Version	The hardware version of the NMT.
	Cmd Status	The status of command, as follows: <ul style="list-style-type: none"> <li>• Start</li> <li>• Complete</li> <li>• Error</li> </ul>
	Cmd Error	The number of error if Command fails.
	Comm. Tries	The number of times the 2920 has polled the NMT.
	Comm. Fails	The number of time the communications from the 2920 to the NMT has failed.
	Elapse	Time of last update.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
	Pnt CheckSum	CRC-16 Checksum of point's static configuration parameters.
	<b>Command</b>	
	Level	The measure level sent from the 2920 to the NMT.
	Command	The current command sent to the NMT.
	Scan Cmd	The command used to set the type of scanning used by the 2920 - Controlled by the application.

Config Params		
	Addr	The short HART address used to detect this device.
	Manuf ID	The Unique ID of the Manufacturer that build the HART device. For NMT and FMR, this is 17 - E+H.
	Device Type	The unique device type specified by the HART device manufacturer. For FMR, 0 to 49; for NMT, 180 to 199.
	Device ID	The long HART ID number read from the HART device, containing manufacturer, device type and ID number.
	Preambles Cmd	The number of Preambles in the Request.
	Frame Format	Type of message framing supported by the NMT.
	Temp Disp Units	Temperature displayed units used by the NMT.
	Level Disp Units	Level displayed units used by the NMT.
	Access Code	Access code to allow the parameters in the NMT to be changed. Code 530 unlocks the NMT while any other code locks it.
	No. of Elem	Specifies the number of measuring elements connected to the NMT.
	Type of Spacing	Indicates if the measuring elements connected to the NMT are spaced at regular or irregular intervals: <ul style="list-style-type: none"> <li>Regular: Element spacing value is used between each element.</li> <li>Irregular: Allows the position of each element to be individually set.</li> </ul>
	Elem Spacing	When element interval type is set to regular, this value specifies the distance between each element.
	Element #1 Pos through Element #16 Pos	Position of element #1 through element #16
	Bottom	The bottom point specifies the level of the lowest temperature element inside the tank, this is then used as the reference to determine which elements are covered at a specific liquid level.
	Level Offset	An element is only used for the average liquid temperature calculation when it is this distance below the liquid level.
	Select Element	Specifies a particular element for calibration.
	Zero	Used to adjust the average temperature calculation zero.
	Span	Used to adjust the average temperature calculation span.
	Override Short	Short Circuit Error Value: When a short-circuit fault is detected on an element, this error value is returned instead of the normal measured temperature.
	Override Open	Open Circuit Error Value: When an open-circuit fault is detected on an element, this error value is returned instead of the normal measured temperature.

All Params	Lists all Display, Commands, and Config Params in a list.
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## HART Device

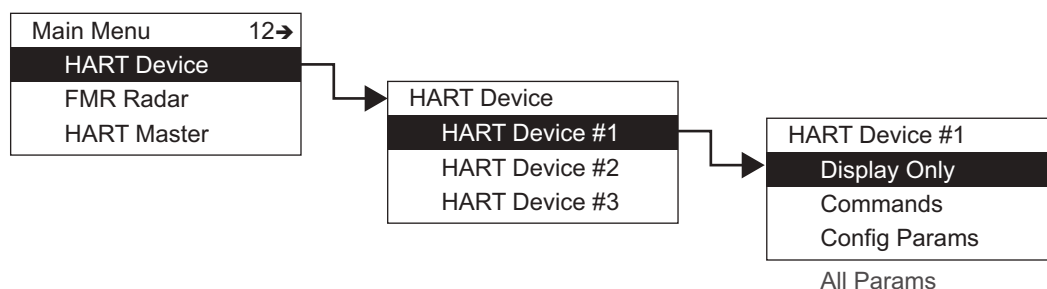
The HART Device menu contains parameters and allows configuration of HART devices connected to the 2920 FTT. When HART device is detected, the device is given an entry in this menu. Each device is shown with it's polling address shown as "N" after the device name.

HART Device menu presents 4 options:

- Display Only — data display, such as current or percent range
- Commands — commands that can be executed from the HART Device menu
- Config Params — parameters that are used to configure data in HART Device
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

### To Access HART Device:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus twelve times to move the highlight to HART Devices.
3. Press Enter and the HART Device Selection menu opens.
4. Select the appropriate HART Device by moving the highlight and pressing Enter.
5. The entries for each HART Device are identical, but can contain different parameters depending on how the HART Device is used. HART Device #1 is used as an example below.
6. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each HART Device option.

Display Only		Description
	Current	Primary measurement variable current (in mA) value from the HART device.
	PV Value	Primary measurement variable value from the HART device.
	SV Units	The secondary value units.
	SV Value	Secondary measurement variable value from the HART device.
	Percent Range	The primary measurement variable value as a percentage of range read from the HART device.
	Univ Cmd Rev	The revision of the universal command set the HART device supports.
	Dev Cmd Rev	The revision of the device commands that the HART device supports.
	Softw. Version	The software version of the HART device.
	Hardw. Version	The hardware version of the HART device.
	Cmd Status	The status of command, as follows: <ul style="list-style-type: none"> <li>• Start</li> <li>• Complete</li> <li>• Error</li> </ul>
	Cmd Error	The number of errors if Command fails.
	Comm Tries	The number of times the 2920 has polled the HART Device.
	Comm Failures	The number of time the communications from the 2920 to the HART Device has failed.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
	Elapse	Time of last update.
	Pnt CheckSum	CRC-16 Checksum of point's static configuration parameters.
Command		
	PV Units	Primary Value measurement units.

Config Params		
	Addr	The short HART address used to detect this device.
	Manuf ID	The Unique ID of the Manufacturer that build the HART device. For Endress+Hauser HART devices, the Manuf ID is 17 - E+H.
	Device Type	The device information (sensor and primary value settings) read from the HART device.
	Device ID	The long HART ID number read from the HART device, containing manufacturer, device type, and ID number.
	Preambles Cmd	The number of Preambles: The minimum number of pre-amble the HART device is requesting for communication.
	Frame Format	Type of message framing supported by the NMT.
	Scan Mode	This parameter sets the types of commands sent to the HART devices. This is for development purposes, and should not normally be adjusted by the user.
<b>All Params</b>		Lists all Display, Commands, and Config Params in a list.

## FMR Radar

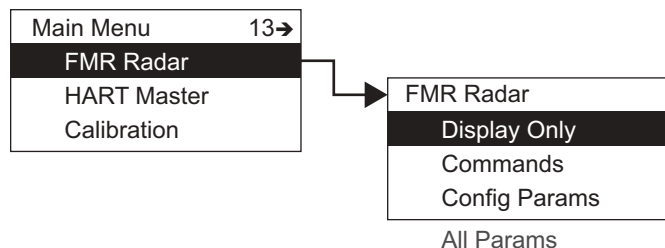
The FMR Radar menu contains parameters and allows configuration of Varec radars that are connected to the 2920 FTT.

FMR Radar menu presents 4 options:

- Display Only — data display, such as current and level units
- Commands — commands that can be executed from the FMR Radar menu
- Config Params — parameters that are used to configure data in FMR Radar
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

### To Access FMR Radar:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus thirteen times to move the highlight to FMR Radar.
3. Press Enter and the FMR Radar menu opens as shown below.

4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each FMR Radar option.

Display Only		Description
	Current	The current the FMR is sinking.
	Level Units	The display units of the FMR.
	Level	Measured Level: Output the measured level.
	Percent Range	The range (0 to 100%) of the Primary Value.
	Status	FMR operational status.
	Mapping Dist.	Present Map Range: Displays the current active noise suppression (map).
	Echo Quality	Echo Quality in dB.
	Present Error	Actual Error: Communication: the diagnostic code with the highest priority on display: list with all active diagnostic codes sorted for priority.
	Previous Error	Last Error: Communication: the diagnostic code which goes away at last on display: list with all diagnostic codes which were before active.
	Measured Dist.	Measured Distance: output the measured distance.
	Meas. Level	Measured Level: Output the measured level.
	Appl Param	Application Parameter: Status of the application parameters may have been changed by settings of user in service matrix.
	Sw. Ver. Appl	The software build number.
	Univ Cmd Rev	Revision of the universal command set the FMR supports.
	Dev Cmd Rev	Revision of the device commands that the FMR supports.
	Softw. Version	The software version of the FMR.
	Hardw. Version	The hardware version of the FMR.

	Cmd Status	The status of command, as follows: <ul style="list-style-type: none"> <li>• Start</li> <li>• Complete</li> <li>• Error</li> </ul>
	Cmd Error	The number of error if Command fails.
	Comm Tries	The number of times the 2920 has polled the FMR.
	Comm. Fails	The number of time the communications from the 2920 to the FMR has failed.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
	Elapse	Time of last update.
	Pnt CheckSum	CRC-16 Checksum of point's static configuration parameters.
<b>Command</b>		
	Command	This parameter sends send various commands directly to the FMR. This is for development purposes, and should not normally be adjusted by the user.
	Scan Cmd	This parameter reads certain data directly from the FMR. This is for development purposes, and should not normally be adjusted by the user.
<b>Config Params</b>		
	Addr	The short HART address used to detect this device.
	Manuf ID	The Unique ID of the Manufacturer that build the HART device. For FMR, this is 17 - E+H.
	Device Type	The unique device type specified by the HART device manufacturer. For FMR, 0 to 49
	Device ID	The long HART ID number read from the HART device, containing manufacturer, device type and ID number.
	Preambles Cmd	The number of Preambles: The minimum number of pre-ambls the FMR device is requesting for communication.
	Frame Format	Type of message framing supported by the FMR.
	Tank Shape	This is a selectable parameter to choose the tank shape.
	Medium Prop.	This is a selectable parameter to choose the dielectric constant of the product.
	Process Prop.	This is a selectable parameter in which the process conditions are described. The FMR53x will work with "mm accuracy" if the options "standard" or "calm surface" are selected.
	Empty Calibra.	Distance from sensor flange to minimum level of the tank.The value is displayed in distance unit (m/ft/inch/mm).The Empty calibration is used to calculate the level value.

	Full Calibra.	Span minimum to maximum level.
	Pipe Diameter	Inner diameter of bypass or stilling well used for calculating the velocity of the microwaves. (only valid when Tank Shape is set to Bypass or Stilling Well.)
	Check Distance	Before effecting a noise suppression (map) the available mapping distance to the product level should be checked.
	Mapping Range	Suppression Distance: Distance until mapping is recorded.
	Start Mapping	Indicates when the mapping of the tank reflections has started.
	Cust. Tank Map	Custom Tank Map: Selects the user defined tank map.
	Output Damping	Time constant for the output damping of signal in seconds.
	Blocking Dist.	Distance from flange in which no measuring is possible.
	Clear Error	This parameter is used to clear the last device error history.
	Unlock Param	Operation Code: This code determines how the operator interacts with the device, and which parameter they are allowed to modify.
	Scan Mode	This parameter sets the types of data commands sent to the FMR. This is for development purposes, and should not normally be adjusted by the user.
<b>All Params</b>		Lists all Display, Commands, and Config Params in a list.

## HART Master

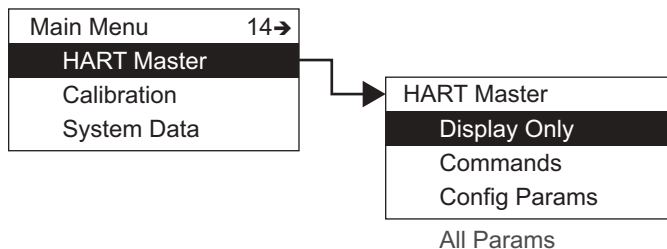
The HART Master menu allows configuration of the 2920 FTT as a HART Master.

HART Master menu presents 4 options:

- Display Only — data display, such as address or HART Type
- Commands — commands that can be executed from the HART Master menu
- Config Params — parameters that are used to configure data in HART Master
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

## To Access HART Master:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus fourteen times to move the highlight to HART Master.
3. Press Enter and the HART Master menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each HART Master option.

Display Only		Description
	Addr	The short address of current Slave Device.
	Cmd	The current command issued to slave device.
	Request	The current request message issued to slave device.
	Reply	The current reply message from Slave device.
	HARTType	Hart Bus Configuration, as follows: <ul style="list-style-type: none"> <li>• Active: 2920 provides power to HART bus</li> <li>• Passive: HART bus is power by external supply</li> </ul>
	Num Inst. List	The number of Slave devices currently being polled.
	Num Requests	The number of message requests sent out by the HART master.
	Num Responses	The number of message responses from slave devices.
	Pnt Status	Byte value indicating status of point. Values are: 0: No error
	Elapse	Time of last update.
	Pnt CheckSum	CRC-16 Checksum of point's static configuration parameters.

Command		
	Command	<p>This is the HART Master control command. Four commands are valid:</p> <ul style="list-style-type: none"> <li>• Search - This causes the HART Master to start looking for devices connected to the HART Bus. This is the first step in utilizing data from a HART device. Once a device has been found, it is remembered by the 2920 FTT until a Hard Reset is performed.</li> <li>• Enable - This command enables Scanning on the HART Bus.</li> <li>• Suspend - This command temporarily suspends scanning of the HART Bus. The scanning automatically resumes after several minutes.</li> <li>• Disable - This command disables scanning on the HART Bus. This is the default setting for the Bus.</li> </ul>
Config Params		
	Mode	This parameter controls if the HART Master is the Primary or Secondary Master. This parameter is for future enhancements. The current setting is Primary Master.
	HARTMode	This parameter enables or disables the HART Bus.
	Max Busy Retries	<p>This parameter sets how many times the HART Master will retry a data command if the HART devices has responded with a busy response. The default is 2.</p> <p>Max Other Retries - This parameter sets how many times the HART Master will retry a data command if communications fails. The default is 2.</p>
	Max Other Retry	This parameter sets how many times the HART Master retries a data command if communications fails. The default is 2.
	Interleave	If connected, the FMR is considered a higher priority HART device. The FMR is polled at a higher rate with other HART devices interleaved. This parameter determines how many other devices are interleaved with the scanning of the FMR. The default is 1.
	Fast Scan Max	This parameter determines how many FMR commands are executed each time an FMR is scanned at the higher rate. The default is one.
	Start Delay	This is the delay between when the HART Bus powers up and when the HART Master starts scanning devices. This allows the HART devices to power up and stabilize before the Master starts scanning. The parameter is in milliseconds. The default value is 12000 (12 seconds).
	Scan Delay	This parameters determines how long the HART Master waits after scanning all HART devices before starting another round of scanning. The parameter is in milliseconds. The default value is 1500 (1.5 seconds).
All Params		Lists all Display, Commands, and Config Params in a list.

# Hydro Calcs

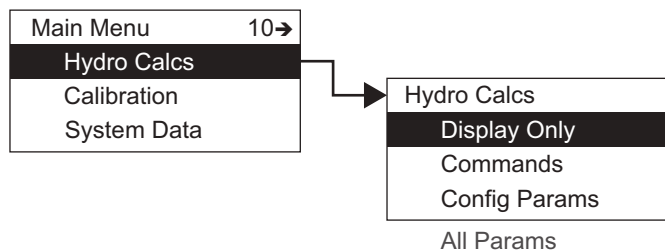
The Hydro Calcs menu allows configuration of the 2920 FTT for hydrostatic calculations.

Hydro Calcs menu presents 4 options:

- Display Only — data display, such as Pressure, Density, and Level
- Commands — commands that can be executed for configuration
- Config Params — parameters that are used to configure and setup hydrostatic calculations
- All Params — scrolls through the Display, Commands, and Config parameters in one menu

## To Access Hydro Calcs:

1. Press Enter to access the Main Menu. The System Menu point is automatically highlighted.



2. Press Minus fifteen times to move the highlight to Hydro Calcs.
3. Press Enter and the Hydro Calcs menu opens.
4. To select one of the options, press Plus or Minus to move the highlight to the option you want and then press Enter.

Refer to the table below for more information on each Hydro Calcs option.

Display Only		Description
	Level	The hydrostatic tank level
	Pnt Checksum	The point checksum
	Elapse	Time of last update
	Pnt Status	Byte value indicating status of point. The value is: <ul style="list-style-type: none"> <li>• 0x6269</li> </ul>
	Vol Cor Factor	The volume correction factor
	Std. Density	The standard density
	Obs. Density	The observed density
	Vap. temp	The vapor temperature
	Air temp	The air temperature
	P3 - Vap press	The P3 top pressure
	P2 - Mid press	The P2 middle pressure
	P3 - Bot. press	The P1 bottom pressure

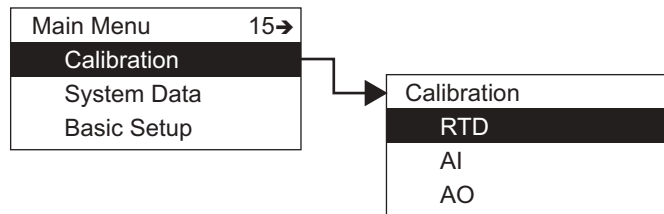
Command		
	Command	<p>This is the Hydro Calcs control command. Two commands are valid:</p> <ul style="list-style-type: none"> <li>• No Action</li> <li>• Factory Reset — Resets all configuration parameters to the default values</li> </ul>
Config Params		
	Mode	<p>The type of TG:</p> <ul style="list-style-type: none"> <li>• Level Only (default)</li> <li>• HTMS:Level+P1</li> <li>• HTG:P1+P2</li> <li>• HTG:P1 Only</li> <li>• HTG:P2 Only</li> </ul>
	Temp. Deadband	The deadband for VCF update: 0.0°F (default)
	CorrMethod	<p>The correction method:</p> <ul style="list-style-type: none"> <li>• API6A (default)</li> <li>• API6B</li> <li>• API6C</li> <li>• API6D</li> <li>• API53A</li> <li>• API53B</li> <li>• API53D</li> <li>• API54A</li> <li>• API54B</li> <li>• API54C</li> <li>• None</li> </ul>
	local gravity	The manually configured gravitation constant in m/sec <sup>2</sup> : 9.807 m/s <sup>2</sup> (default)
	Man. Vap. dens	The manually configured vapor density: 0.0749 lb/ft <sup>3</sup> (default)
	Man. Air dens	The manually configured air density: 0.0749 lb/ft <sup>3</sup> (default)
	Man. Vap temp	The manually configured vapor temperature: 60.0°F (default)
	ManAirTemp	The manually configured air temperature: 60.0°F (default)
	ManStdDens	The manually configured standard density: 62.4280 lb/ft <sup>3</sup> (default)
	Man Vap press	The manually configured vapor pressure: 0.0000 PSI (default)
	Tnk shell temp	The tank shell temperature: 60.0°F (default)
	ThermExp coeff	Thermal expansion coefficient: 0.000 (default)
	Altitude	Tank altitude: 0'00-00/16" (default)

	P3 Offset	The offset for top pressure P3: 0.0000 PSI (default)
	P2 Offset	The offset for middle pressure P2: 0.0000 PSI (default)
	P1 Offset	The offset for bottom pressure P1: 0.0000 PSI (default)
	min HTMS level	The minimum level for HTMS calculations: 0'00-00/16" (default)
	P3 position	The distance from P3 to tank zero: $H_{p3}$ : 0'00-00/16" (default)
	P1-P2 distance	The distance between P1 and P2: $H_{p2}$ : 0'00-00/16" (default)
	P1 position	The distance from P1 -- tank zero
	VaporTempRef	Links the device to the vapor temperature point
	AirTempRef	Links device to the ambient temperature point
	P3 Ref - Top	Links the device to the P3 vapor
	P2 Ref - Middle	Links the device to the P2 middle
	P1 Ref - Bottom	Links the device to the P1 bottom
	LevelRef	The level reference (HTMS)
	DensityUnits	The density dimension: <ul style="list-style-type: none"> <li>• lb/ft<sup>3</sup> (Default)</li> <li>• lb/gal</li> <li>• SGU</li> <li>• °API</li> <li>• kg/m<sup>3</sup></li> <li>• g/ml</li> </ul>
	PressUnits	The pressure dimension: <ul style="list-style-type: none"> <li>• PSI (Default)</li> <li>• bar</li> <li>• mbar</li> <li>• Pa</li> <li>• kPa</li> <li>• MPa</li> <li>• inH2O</li> </ul>
<b>All Params</b>		Lists all Display, Commands, and Config Params in a list.

## Calibration

The Calibration menu selection contains shortcuts to RTD, AI, and AO data.

**Note** After the Calibration menu selection, the menu rolls over to beginning (System Data) and continues through the menu sequence.



## Calibrate Level Shortcut

You can use a shortcut to calibrate the product level for the 2920. This procedure opens the Cal Level configuration parameter in the Basic Setup menu.

To use the Cal Level shortcut:

1. Press and hold the C button for 4 to 5 seconds.
2. The display opens the Cal Level so you can set it.

Basic Setup menu and Cal Level description can be found in “Basic Setup”.

**Note** Level can be entered in either decimal format (*nnn.nnn*) or in Ft-In-16ths format (*nnn-nn-nn.*) If the level is entered in decimal format, the 2920 assumes the value is the same unit as specified in the transmitter setup (Basic Setup > Level Disp Units.) The level can be entered in Ft-In-16ths format regardless of the level display units. If the transmitter is set up for level units other than Ft-In 16ths, the level is converted to the transmitter level display units automatically.

## 6 Biphase Mark

After the 2920 FTT is mounted and wired, it must be calibrated or configured to operate efficiently and effectively. This chapter contains information about configuring the Biphase Mark communication protocol, including the following:

- Setting the Unit Address
- Setting Communications Protocols
- Setting the Data Format
- Setting the RTD Type
- Calibrate the transmitter level, including calibrating the level switches and configuring outputs as outlined in Configuration & Calibration — Level, Limits, and Outputs.

### Basic Parameters

The 2920 FTT requires the setting of several Basic Parameters to enable it to operate in your particular environment. These parameters are:

- Unit Addr
- Baud Rate
- Lev Com Units
- Temp Com Units
- Gauge Type
- Encoder Direction
- RTD Type

All these parameters are located in the Basic Setup menu. The procedure below details the steps to set the Unit Addr. and can be used to set other Basic parameters by substituting the appropriate parameter name for Unit Addr. Of course, the number of times you press Minus or Plus to access a parameter will be different.

**Note** The units for transmitting the level and temperature must match the configuration of the host system. However, the units selected to display the level and temperature on the LCD can be different than the units used for data transmission. The Lev Disp Units and Temp Disp Units parameters determine the units used by the LCD display. The Lev Com Units and Temp Com Units parameters determine the format of the units transmitted to the host system.

For proper communications, the following parameters must match the setting of the host system:

- Baud Rate, Lev Com Units, Temp Com Units

### To Set the 2920 FTT Unit Address

1. Press Enter to open the Main Menu.
2. Press Minus one time to select the Basic Setup menu.
3. Press Enter to open the Basic Setup menu.
4. Press Minus one time to select the Config Params menu.
5. Press Enter to open the Config Params menu.
6. Press Minus or Plus to locate the Unit Addr parameter.
7. Press Enter to modify the Unit Addr parameter.
8. Press Minus or Plus to move to the appropriate number for this device.

**Note** To backspace, press Minus to access the back arrow (←). Press Enter to backspace.

9. If the Unit Addr requires a two-digit number, press Enter to move to the next digit.
10. Select the second digit using Minus or Plus.
11. Press Enter to select the Return arrow (↵) and save the Unit Addr.
12. Press Cancel to exit each menu and return to the Home display.

### To Set the 2920 FTT Baud Rate

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Baud Rate.
3. Press Enter to modify the Baud Rate parameter.
4. Press Minus or Plus to move to the appropriate Baud Rate for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### To Set the 2920 FTT Lev Com Units

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Lev Com Units.
3. Press Enter to modify the Lev Com Units parameter.
4. Press Minus or Plus to move to the appropriate Lev Com Units for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### To Set the 2920 FTT Temp Com Units

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Temp Com Units.
3. Press Enter to modify the Temp Com Units parameter.
4. Press Minus or Plus to move to the appropriate Temp Com Units for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

**To Set the 2920 FTT Gauge Type**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Gauge Type.
3. Press Enter to modify the Gauge Type parameter.
4. Press Minus or Plus to select English or Metric for the gauge type.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

**To Set the 2920 FTT Encoder Direction**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Enc Direction.
3. Press Enter to modify the Enc Direction parameter.
4. Press Minus or Plus to select Forward or Reverse for the encoder direction for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

**To Set the RTD Type**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select RTD Type.
3. Press Enter to modify the RTD Type parameter.
4. Press Minus or Plus to select one of the following for the RTD Type for this device.
  - Pt100 – Platinum 100 RTD
  - Cu100 – Copper 100 RTD
  - Cu90 – Copper 90 RTD
5. Continue following steps 9 through 12 above to complete the baud rate setup.



# 7 MODBUS

After the 2920 FTT is mounted and wired, it must be calibrated or configured to operate efficiently and effectively. This chapter contains information about configuring the MODBUS communication protocol, including the following:

- Setting the Unit Address
- Setting Communications Baud Rate and Parity
- Setting the MODBUS Register Map
- Setting the RTD Type
- Calibrate the transmitter level, including calibrating the level switches and configuring outputs as outlined in "Configuration & Calibration — Level, Limits, and Outputs".

## Basic Parameters

The 2920 FTT requires the setting of several Basic Parameters to enable it to operate in your particular environment. These parameters are:

- Unit Addr
- Baud Rate
- Parity
- Gauge Type
- Encoder Direction
- RTD Type
- Register Map

All these parameters are located in the Basic Setup menu. The procedure below details the steps to set the Unit Addr. and can be used to set other Basic parameters by substituting the appropriate parameter name for Unit Addr. Of course, the number of times you press Minus or Plus to access a parameter will be different.

For proper communications, the following parameters must match the setting of the host system:

- Baud Rate, Lev Com Units, Temp Com Units

### To Set the Unit Address

1. Press Enter to open the Main Menu.
2. Press Minus one time to select the Basic Setup menu.
3. Press Enter to open the Basic Setup menu.
4. Press Minus one time to select the Config Params menu.
5. Press Enter to open the Config Params menu.
6. Press Minus or Plus to locate the Unit Addr parameter.
7. Press Enter to modify the Unit Addr parameter.
8. Press Minus or Plus to move to the appropriate number for this device.

**Note** To backspace, press Minus to access the back arrow (←). Press Enter to backspace.

9. If the Unit Addr requires a two-digit number, press Enter to move to the next digit.
10. Select the second digit using Minus or Plus.
11. Press Enter to select the Return arrow (↵) and save the Unit Addr.
12. Press Cancel to exit each menu and return to the Home display.

### To Set the Baud Rate

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Baud Rate.
3. Press Enter to modify the Baud Rate parameter.
4. Press Minus or Plus to move to the appropriate Baud Rate for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### To Set the Parity

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Parity.
3. Press Enter to modify the Parity parameter.
4. Press Minus or Plus to move to the appropriate Parity for this device.
5. Continue following steps 9 through 12 above to complete the Parity setup.

### To Set the Lev Com Units

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Lev Com Units.
3. Press Enter to modify the Lev Com Units parameter.
4. Press Minus or Plus to move to the appropriate Lev Com Units for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### **To Set the Temp Com Units**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Temp Com Units.
3. Press Enter to modify the Temp Com Units parameter.
4. Press Minus or Plus to move to the appropriate Temp Com Units for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### **To Set the Gauge Type**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Gauge Type.
3. Press Enter to modify the Gauge Type parameter.
4. Press Minus or Plus to select English or Metric for the gauge type.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### **To Set the Encoder Direction**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Enc Direction.
3. Press Enter to modify the Enc Direction parameter.
4. Press Minus or Plus to select Forward or Reverse for the encoder direction for this device.
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### **To Set the RTD Type**

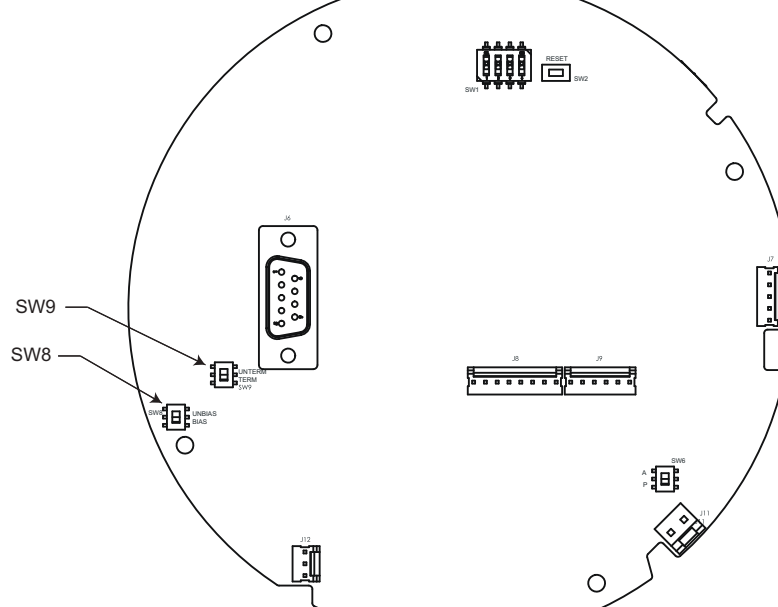
1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select RTD Type.
3. Press Enter to modify the RTD Type parameter.
4. Press Minus or Plus to select one of the following for the RTD Type for this device.
  - Pt100 – Platinum 100 RTD
  - Cu100 – Copper 100 RTD
  - Cu90 – Copper 90 RTD
5. Continue following steps 9 through 12 above to complete the baud rate setup.

### **To Set the MODBUS Register Map**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select MODBUS Register Map.
3. Press Enter to modify the MODBUS Register Map parameter.

The MODBUS hardware setup consists of the following procedure

- Terminating the MODBUS network
- Setting the bias current



In an EIA485 network, devices at each end of the communications network are typically

**Note** Typically, a terminating 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 (down) position.
3. Replace the transmitter cover.

**Note** Typically, no more than one transmitter on a communications bus should terminate the network.

## Setting the Bias Current

In a MODBUS network, during periods of no communications, all devices on the network 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 can be provided at the 2920 FTT using switch SW8.

**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 SW8 to the BIASED (down) position.
3. Replace the transmitter cover.

**Note** Applying the bias current on multiple 2920 FTT transmitters could cause poor performance in the EIA485 communications network.



## 8 Mark/Space

After the 2920 FTT is mounted and wired, it must be calibrated or configured to operate efficiently and effectively. This chapter contains information about configuring the Mark/Space communication protocol, including the following:

- Setting the Transmission Speed
- Setting Encoder Type
- Setting the Data Format
- Setting the Temperature Offset Mode

### Basic Parameters

The 2920 FTT requires the setting of several Basic Parameters to enable it to operate in your particular environment. These parameters are:

- Unit Addr
- Encoder Direction
- Level Display Units
- RTD Type
- Temp Display Units
- Calibration Level
- Control

All these parameters are located in the Basic Setup menu. The procedure below details the steps to set the Unit Addr and can be used to set other Basic parameters by substituting the appropriate parameter name for Unit Addr. Of course, the number of times you press Minus or Plus to access a parameter will be different.

**Note** The units for transmitting the level and temperature must match the configuration of the host system. However, the units selected to display the level and temperature on the LCD can be different than the units used for data transmission. The Lev Disp Units and Temp Disp Units parameters determine the units used by the LCD display. The Type and Data Format parameters determine the format of the units transmitted to the host system.

With the Mark/Space protocol, part of the transmitter response to polls is the status of "Alarm 0" and "Alarm 1". These alarms are typically external devices with dry contacts, such as high level switches, connected to the first two Discrete Inputs (DI) of the transmitter.

In the Mark/Space 2920FTT, the status of DI 1 is internally mapped to "Alarm 0". And the status of DI 2 is internally mapped to "Alarm 1". There is no configuration required.

### To Set the Unit Address

1. Press Enter to open the Main Menu.
2. Press Minus one time to select the Basic Setup menu.
3. Press Enter to open the Basic Setup menu.
4. Press Minus one time to select the Config Params menu.
5. Press Enter to open the Config Params menu.
6. Press Minus or Plus to locate the Unit Addr parameter.
7. Press Enter to modify the Unit Addr parameter.
8. Press Minus or Plus to move to the appropriate number for this device.

**Note** To backspace, press Minus to access the back arrow (←). Press Enter to backspace.

9. If the Unit Addr requires a two-digit number, press Enter to move to the next digit.
10. Select the second digit using Minus or Plus.
11. Press Enter to select the Return arrow (↵) and save the Unit Addr.
12. Press Cancel to exit each menu and return to the Home display.

### To Set the 2920 FTT Speed Mode

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Speed Mode.
3. Press Enter to modify the Speed Mode parameter.
4. Press Minus or Plus to select either High or Low for this device.
5. Continue following steps 9 through 12 above to complete the Speed Mode setup.

### To Set the 2920 FTT Encoder Type

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Encoder Type setting.
3. Press Enter to modify the Encoder Type parameter.
4. Press Minus or Plus to move to the appropriate Encoder Type setting for this device.
5. Continue following steps 9 through 12 above to complete the Encoder Type setup.

### To Set the 2920 FTT Data Format

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Data Mode setting.
3. Press Enter to modify the Data Mode parameter.
4. Press Minus or Plus to move to the appropriate Data Mode setting for this device.
5. Continue following steps 9 through 12 above to complete the Data Mode setup.

**To Set the 2920 FTT Temp Offset Mode**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Temp Offset Mode.
3. Press Enter to modify the Temp Offset Mode parameter.
4. Press Minus or Plus to move to the appropriate Temp Offset Mode Setting for this device.
5. Continue following steps 9 through 12 above to complete the Temp Offset Mode setup.



## 9 L&J TankWay

After the 2920 FTT is mounted and wired, it must be calibrated or configured to operate efficiently and effectively. This chapter contains information about configuring the L&J TankWay communication protocol, including the following:

- Setting Encoder Type
- Setting the Data Format

### Basic Parameters

The 2920 FTT requires the setting of several Basic Parameters to enable it to operate in your particular environment. These parameters are:

- 2920 Unit Address
- Gauge Type
- Encoder Type
- RTD Type
- Level Display Units
- RTD type
- Temp Display Units
- Control

All these parameters are located in the Basic Setup menu. The procedure below details the steps to set the 2920 Unit Address and can be used to set other Basic parameters by substituting the appropriate parameter name for 2920 Unit Address. Of course, the number of times you press Minus or Plus to access a parameter will be different.

**Note** The units for transmitting the level and temperature must match the configuration of the host system. However, the units selected to display the level and temperature on the LCD can be different than the units used for data transmission. The Lev Disp Units and Temp Disp Units parameters determine the units used by the LCD display. The Type and Data Format parameters determine the format of the units transmitted to the host system.

#### To Set the Unit Address

1. Press Enter to open the Main Menu.
2. Press Minus one time to select the Basic Setup menu.
3. Press Enter to open the Basic Setup menu.
4. Press Minus one time to select the Config Params menu.
5. Press Enter to open the Config Params menu.
6. Press Minus or Plus to locate the 2920 Unit Address parameter.

7. Press Enter to modify the 2920 Unit Address parameter.
8. Press Minus or Plus to move to the appropriate number for this device.  
**Note** To backspace, press Minus to access the back arrow (←). Press Enter to backspace.
9. If the 2920 Unit Address requires a two-digit number, press Enter to move to the next digit.
10. Select the second digit using Minus or Plus.
11. Press Enter to select the Return arrow (↵) and save the 2920 Unit Address.
12. Press Cancel to exit each menu and return to the Home display.

### **To Set the 2920 FTT Gauge Type**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Gauge Type.
3. Press Enter to modify the Gauge Type parameter.
4. Press Minus or Plus to select the appropriate Gauge Type setting for this device.
5. Continue following steps 9 through 12 above to complete the Gauge Type setup.

### **To Set the 2920 FTT Encoder Type**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Encoder Type setting.
3. Press Enter to modify the Encoder Type parameter.
4. Press Minus or Plus to move to the appropriate Encoder Type setting for this device.
5. Continue following steps 9 through 12 above to complete the Encoder Type setup.

### **To Set the 2920 FTT Level Display Units**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Level Display Units setting.
3. Press Enter to modify the Level Display Units parameter.
4. Press Minus or Plus to move to the appropriate Level Display Units for this device.
5. Continue following steps 9 through 12 above to complete the Level Display Units setup.

### **To Set the 2920 FTT RTD Type**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select RTD Type.
3. Press Enter to modify the RTD Type parameter.
4. Press Minus or Plus to move to the appropriate RTD Type for this device.
5. Continue following steps 9 through 12 above to complete the RTD Type setup.

**To Set the 2920 FTT Temp Display Units**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Temp Display Units.
3. Press Enter to modify the Temp Display Units parameter.
4. Press Minus or Plus to move to the appropriate Temp Display Units for this device.
5. Continue following steps 9 through 12 above to complete the Temp Display Units setup.

**To Set the 2920 FTT Calibration Level**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Calibration Level.
3. Press Enter to modify the Calibration Level parameter.
4. Press Minus or Plus to move to the appropriate Calibration Level for this device.
5. Continue following steps 9 through 12 above to complete the Calibration Level setup.

**To Set the 2920 FTT Control Mode**

1. Follow steps 1 through 5 in the 2920 FTT unit address procedure (above).
2. In the Config Params menu, select Control.
3. Press Enter to modify the Control parameter.
4. Press Minus or Plus to move to the appropriate Control setting for this device.
5. Continue following steps 9 through 12 above to complete the Control setup.



# 10 Configuring HART Devices

The process for identifying and using HART connected instruments are as follows:

- Connecting the HART instrument to 2920 FTT using the I.S. HART terminal board as explained in “I.S. HART Junction Box”, or to the Ex d HART terminals in the main junction box
- Searching for the HART instrument
- Configuring the HART instrument for the 2920 FTT

HART instruments can be used as level or temperature data acquisition devices and when connected to the 2920 FTT can display the data from the HART instrument on the LCD.

After the HART instrument is connected to the 2920 FTT, you need to search for the instrument.

**Note** All these parameters are located in the HART Master menu. The procedure below details the steps to search for a HART instrument but can be used to set other HART Master parameters by substituting the appropriate parameter name for Searching. Of course, the number of times you press Minus or Plus to access a parameter will be different.

## Steps for Configuring HART Devices

### Searching for a HART Instrument

1. Press Enter to open the Main Menu.
2. Press Minus multiple times to select the HART Master menu.
3. Press Enter to open the HART Master menu.
4. Press Minus 2 times to select the Commands menu.
5. Press Enter to open the Commands menu.
6. Press Enter to open the Scan Cmd.
7. Press Minus 2 times to select Search.
8. Press Enter to begin searching for a HART instrument. When the search is complete, the display changes to Enable.
9. Continue to verify communications with the HART instrument.

### Verifying Communications with the HART Instrument

1. Follow steps 1 through 3 above to open the HART Master menu.
2. Press Minus one time to open the Display Only menu.
3. Press Minus to locate Num Inst List. The number displayed below Num Inst List is the number of HART instruments connected to the 2920 FTT. The number can be between 1 and 5. A 0 (zero) indicates no HART instruments are connected.

Next, you can verify the type of instrument connected. With this release, only temperature devices, RADAR devices, or generic HART devices are supported with the 2920 FTT.

### Verifying Communications with a Temperature Device

Do the following to verify communications with a Varec or E+H multi-element temperature device:

1. Press Enter to open the Main Menu.
2. Press Minus multiple times to select the NMT Prothermo menu.
3. Press Enter to open the NMT Prothermo menu.
4. Press Enter to open the Display Only menu.
5. Press Minus 2 times to locate the Pnt Status.

If the Pnt Status is...	Then Communications are...
0000	Online
0x01	Offline

### Verifying Communications with a Level Device

Do the following to verify communications with a Varec or E+H RADAR device:

1. Press Enter to open the Main Menu.
2. Press Minus multiple times to select the FMR Radar menu.
3. Press Enter to open the FMR Radar menu.
4. Press Enter to open the Display Only menu.
5. Press Minus 2 times to locate the Pnt Status.

If the Pnt Status is...	Then Communications are...
0000	Online
0x01	Offline

### Verifying Communications with a Generic HART Device

Do the following to verify communications with a generic HART device:

1. Press Enter to open the Main Menu.
2. Press Minus multiple times to select the HART Device menu.
3. Press Enter to open the HART Device menu.
4. Select one of the HART Device #s.
5. Press Enter to open the HART Device # menu.
6. Press Minus 2 times to locate the Pnt Status.

If the Pnt Status is...	Then Communications are...
0000	Online

If the Pnt Status is...	Then Communications are...
0x01	Offline

## Using Level Data from HART Devices

You can use the level data from Varec level devices, E+H devices or from generic HART-connected devices as follows:

1. Press Enter to open the Main Menu.
2. Press Minus multiple times to the Tank Data menu.
3. Press Enter to open the Tank Data menu.
4. Press Minus 1 time to select the Config Params menu.
5. Press Enter to open the Config Params menu.
6. Press Enter to select Level Ref.
7. Press minus to scroll through the list of values, as follows:
  - FMR Level
  - HART# PV (primary variable)
  - HART# SV (secondary variable)
8. Press Enter to select the value.

## Using Temperature Data from HART Devices

You can use the temperature data from Varec level devices, E+H devices, or from generic HART connected devices as follows:

1. Press Enter to open the Main Menu.
2. Press Minus multiple times to the Tank Data menu.
3. Press Enter to open the Tank Data menu.
4. Press Minus 1 time to select the Config Params menu.
5. Press Enter to open the Config Params menu.
6. Press Enter to select TempRef.
7. Select Minus to scroll through the list of values, as follows:
  - NMT Value
  - NMT elem #
  - HART# PV (primary variable)
  - HART# SV (secondary variable)
8. Press Enter to select the value.

## Displaying HART Data on the LCD

The 2920 FTT display defaults to display the Tank temperature in the secondary display (or lower half) of the LCD when connected to a temperature device.

You can set the 2920 FTT to display other HART data (Varec or E+H Radar data, multi-element temperature data, or generic HART data) on the secondary display of the LCD. Also, you can set up to 4 data items to scroll at intervals of up to 10 seconds. For instance, you can set the secondary display to show product temperature, vapor temperature, and product pressure at 5 second intervals.

### To Set the Secondary Display

1. Press Enter to open the Main Menu.
2. Press Enter to open the System Data menu.
3. Press Minus 2 times to the Config Params.
4. Press Enter to open the Config Params menu.
5. Press Minus to the Sec. display 1. If the 2920 FTT has not been changed from the default, the Sec. display 1 shows TANK Temp.
6. Press Enter to open the Sec. display 1.
7. Press Minus to move through the display options for Sec. display 1.
8. Press Enter to select the appropriate display.

### To Set Additional Items to Display

1. Press Enter to open the Main Menu.
2. Press Enter to open the System Data menu.
3. Press Minus 2 times to the Config Params.
4. Press Enter to open the Config Params menu.
5. Press Minus to the Sec. display 1. If the 2920 FTT has not been changed from the default, the Sec. display 1 shows TANK Temp.
6. Press Enter to open the Sec. display 1.
7. Press Minus to move through the display options for Sec. display 1.
8. Continue steps 5 through 7 for each Sec. display #.
9. In the Config Params menu, press Minus (or Plus) to locate Scroll Rate.
10. Press Enter to open Scroll Rate.
11. Press Plus to increment the Scroll rate one second per press.
12. Press Enter to save the appropriate Scroll rate.
13. Press Cancel to return to the Main menu. When the LCD returns to the default view, the secondary display changes to the variables selected at the selected interval.

# 11 Configuration & Calibration — Level, Limits, and Outputs

After the user has performed the protocol-specific configuration procedures for the 2920 FTT, the following configuration & calibration tasks remain:

1. Perform a manual measurement of the tank level (hand dip).
2. Set the transmitter level to match the tank gauge level reading (see “Setting the Transmitter Level”).
3. Calibrate limit switches (if used) to the desired tank level (see “Calibrating Limit Switches”).
4. Configure outputs, if used (“Configuring Outputs”).

## Calibrating the Transmitter Tank Level

### Before Beginning the Calibration Process

Before setting the transmitter level, perform a manual tank level measurement (hand dip) 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 2920 FTT utilizes a capacitive 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.

### Setting the Transmitter Level

To set the transmitter level:

1. Press Enter to open the Main Menu.
2. Press Minus one time to select the Basic Setup menu.
3. Press Enter to open the Basic Setup menu.
4. Press Minus one time to select the Config Params menu.
5. Press Enter to open the Config Params menu.
6. Press Minus or Plus to locate the CalLevel parameter.
7. Press Enter to modify the CalLevel parameter.
8. Press Minus or Plus to move to the appropriate number for the level.

**Note** To backspace, press Minus to access the back arrow (←). Press Enter to backspace.

9. If the CalLevel requires a two-digit number, press Enter to move to the next digit.
10. Select the second digit using Minus or Plus.
11. Press Enter to select the Return arrow (↵) and save the Unit Addr.
12. Press Cancel to exit each menu and return to the Home display.

## Calibrating Limit Switches

Limit switches are cam-operated SPDT (Single-Pole, Double-Throw) switches that are used to turn on alarms or other devices when the tank contents reach a predetermined level. The adjustable cams on the 2920 FTT provide a limited amount of dwell adjustment. The adjustable dwell can be used to extend the duration of an alarm. Assemblies containing two or four limit switches are available as an option with the 2920 FTT.

Limit switches are mounted on the 2920 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.

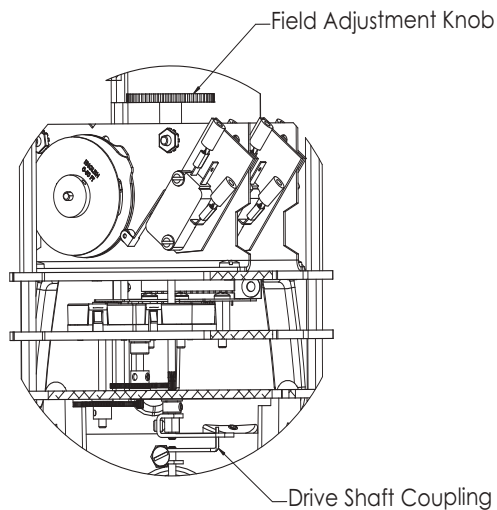
**Note** All limit switches are wired to operate as a Normally Closed (NC) circuit at the factory. If a Normally Open (NO) operation is required, the user must change the wiring at the switch. See “Wiring Limit Switches”.

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

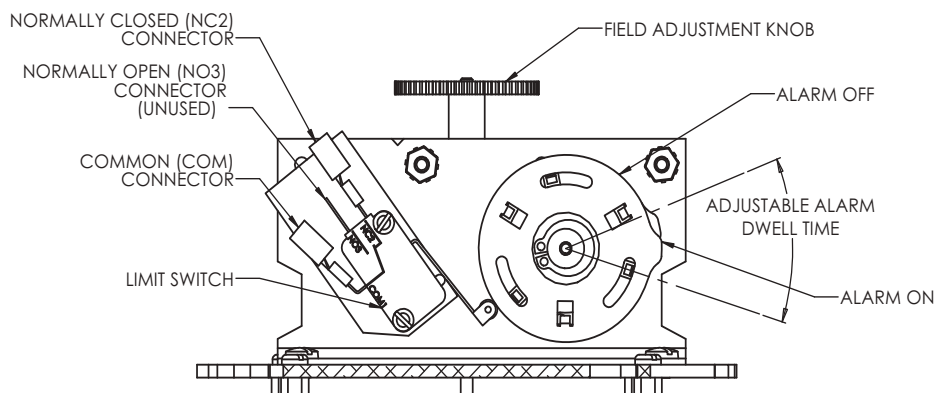
### To Calibrate Limit Switches:

1. Remove the transmitter cover.
2. Loosen the slotted coupling on the transmitter drive shaft.

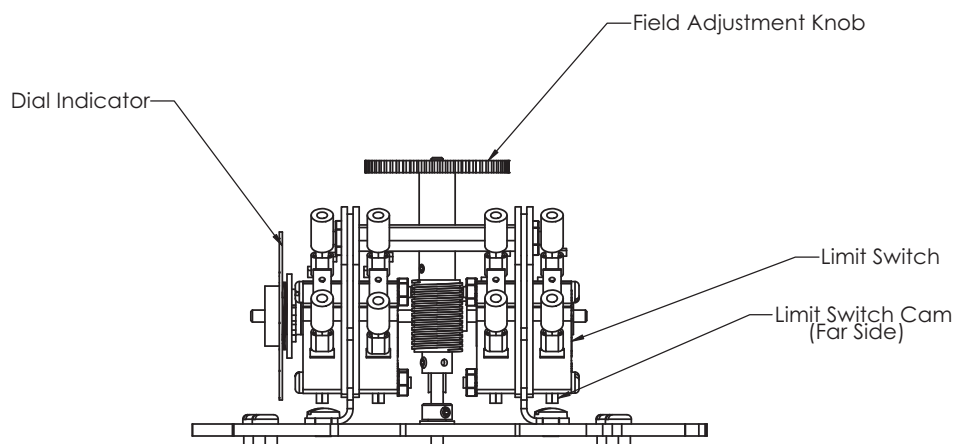
**Caution!** Excessively loosening the set screw will cause the coupling to fall. Loosen the set screw only to the extent required to free the encoder.
3. Rotate the 2920 FTT encoder shaft until the level reading to activate the switch is displayed on the display or at the local host.



4. Turn the cam until the switch activates with an audible click.

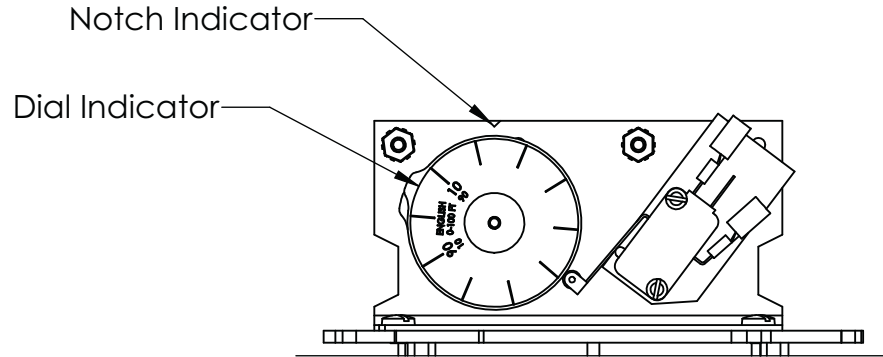


5. Gently turn the encoder shaft back and forth to verify that the switch is operating properly.



6. Twist the adjustable cams relative to each other to adjust the length of the dwell (the duration of the alarm).

**Note** Care should be taken to avoid having too much dwell that will cause the low alarm to sound at the high levels and vice versa.



7. After adjusting the dwell, verify that the level that the limit switch activates did not change.
8. Repeat steps 3 through 7 for each of the remaining limit switches.
9. Rotate the 2920 FTT encoder shaft until the correct level reading (matching the gauge) is displayed by the local display.
10. Tighten the coupling on the transmitter drive shaft.
11. Replace the transmitter cover.

## Configuring Outputs

To configure outputs for the 2920 FTT use the local display interface or the user must connect a laptop computer running the ViewRTU software to the RS-232 port. Then use ViewRTU to define alarm conditions and to assign a condition to each output. For the Biphasic Mark 2920 FTT, the outputs can also be configured through the Biphasic Mark interface by writing data items using the appropriate commands.

**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. Using the local display: Digital Outputs> Config Params.  
Optionally, you can use the Biphasic Mark host system.

**Note** For more information and specific details for configuring Digital Outputs, see “Digital Outputs”.

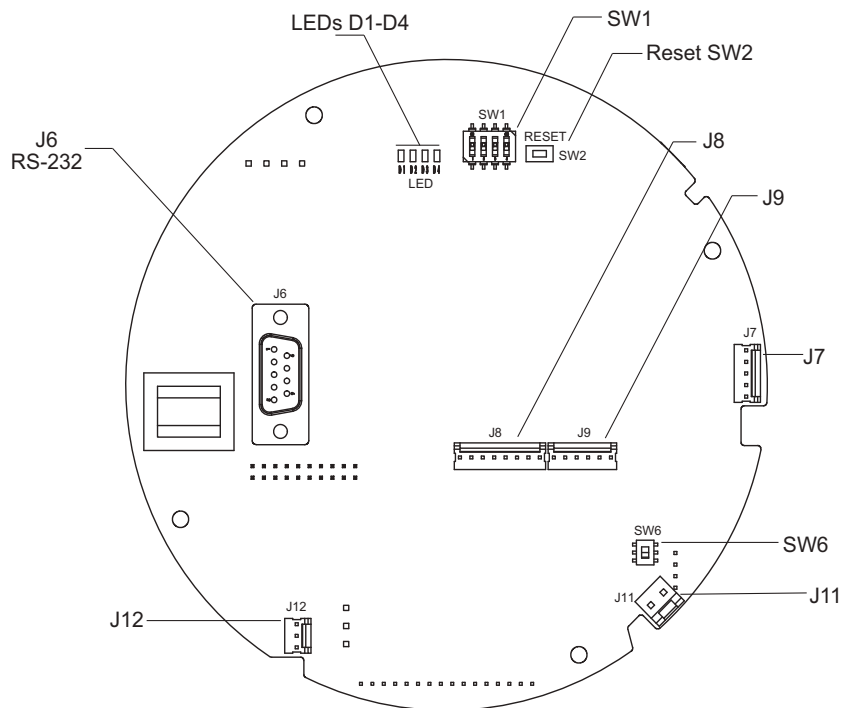
2. For the Biphasic Mark 2920 FTT, you can use the Biphasic Mark interface to configure the outputs by writing data using the appropriate item command.

Optionally, use ViewRTU as follows:

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

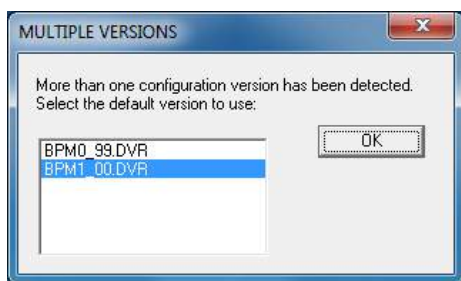
1. Remove the 2920 FTT cover.

2. Connect a laptop computer running ViewRTU software to the RS-232 connector (J6) on the communications circuit board. The following figure shows the connector.

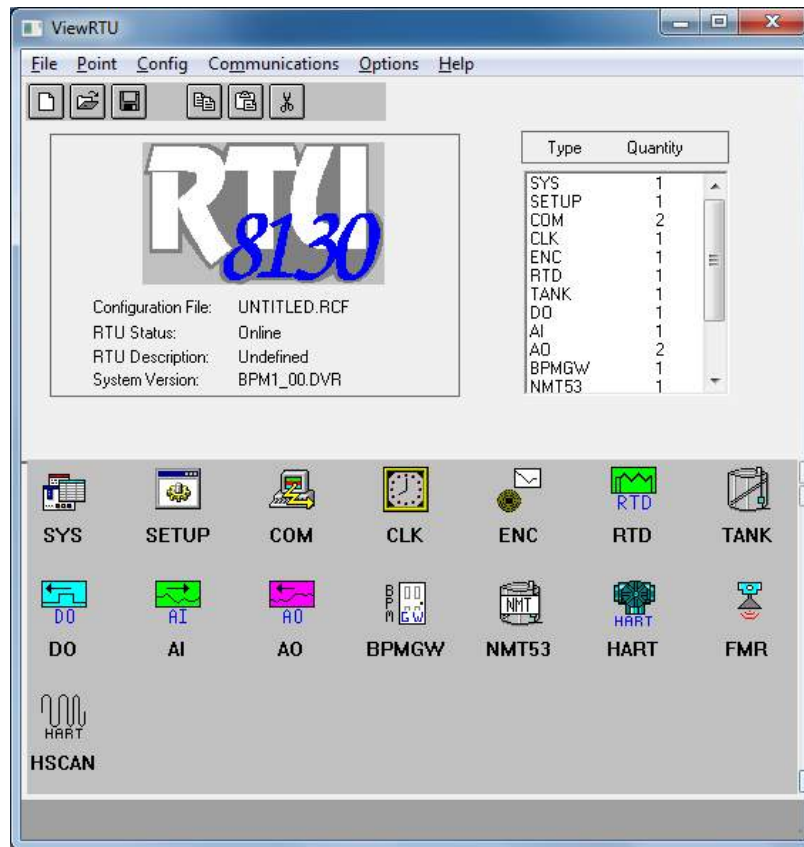


**Note** Input and output terminals are identified in a table on page 35.

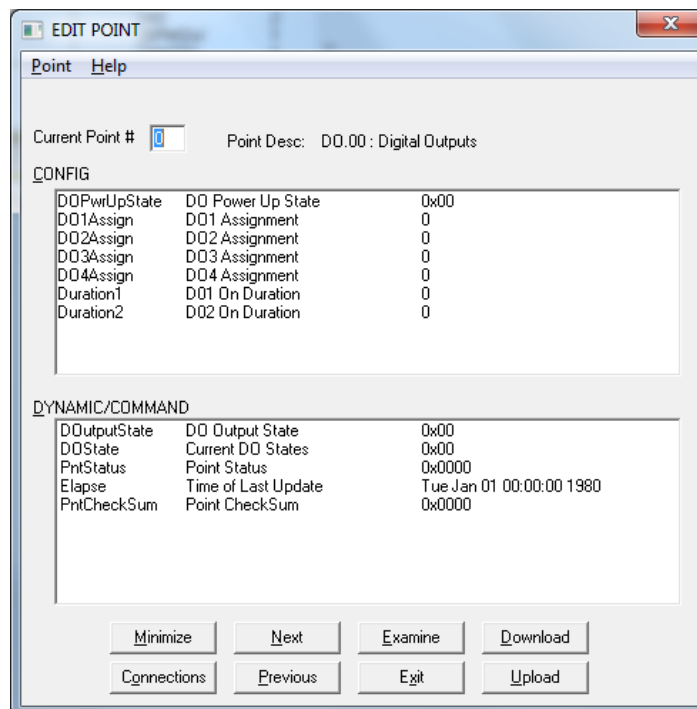
Start the ViewRTU application. The user is prompted to select a firmware version file as shown in the following figure.



3. Select the file that matches the communications protocol used by the 2920 FTT, and then click OK. The main screen appears, as shown in the following figure.



- Using the icons or the Point menu, select the TANK point. The TANK dialog box appears, showing data items that can be modified in the following figure.

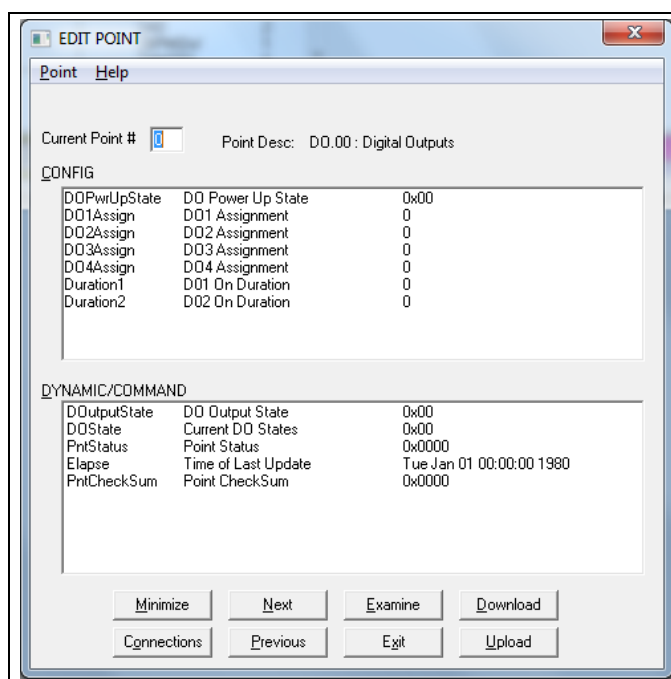


- Define the alarm conditions that can be used for outputs. At minimum, set values for the following parameters:

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

Refer to “Tank Data” for information about the TANK point (parameter).

- Set any other TANK parameters as appropriate.
- Click the Exit button to return to the main screen.
- Using the icons or the Point menu, select the DO point. The DO dialog box appears, showing data items that can be modified in the following figure.



- Assign a control & activation event to each direct output by defining parameters DO1Assign – DO4Assign.
- To make a relay active at system startup, set the appropriate register in the DOPwrUpState parameter.
- Click the Exit button.
- Close ViewRTU.
- Disconnect the laptop computer cable from the RS-232 connector.
- Replace the 2920 FTT cover.



# 12 Maintenance and Troubleshooting

The 2920 FTT is designed and manufactured to provide accurate and reliable operation with no scheduled maintenance. The microprocessor is galvanically isolated from the communications circuits. The 2920 FTT can also perform self-diagnostics. If a problem is encountered, the transmitter isolates itself from the field communication bus.

## Reading the LED Lights

The LED lights on the 2920 FTT provide a quick glance for the user to determine the general status of the device.

- **LED (D1)** lights up when there is a HART device connected to the 2920, and they are communicating with each other.
- **LED (D2)** lights up when there is a connection to the RS-232 port on the board and communication has been established.
- **LED (D3)** lights up when RS-485 communication has been established.
- **LED (D4)** blinks every second when the CPU is receiving power and is operating correctly.

## Maintenance

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

### Checking the CPU Status

The 2920 FTT provides a CPU status LED (D4) on the communications circuit board. The user can visually check this LED to ensure that processor is operating properly.

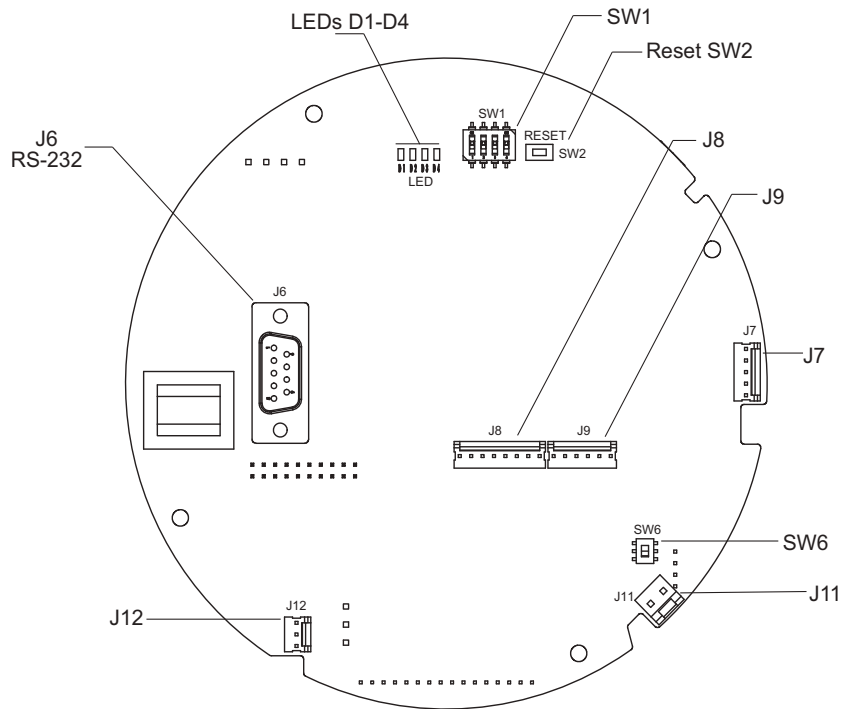
**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

#### To Check the Processor Status:

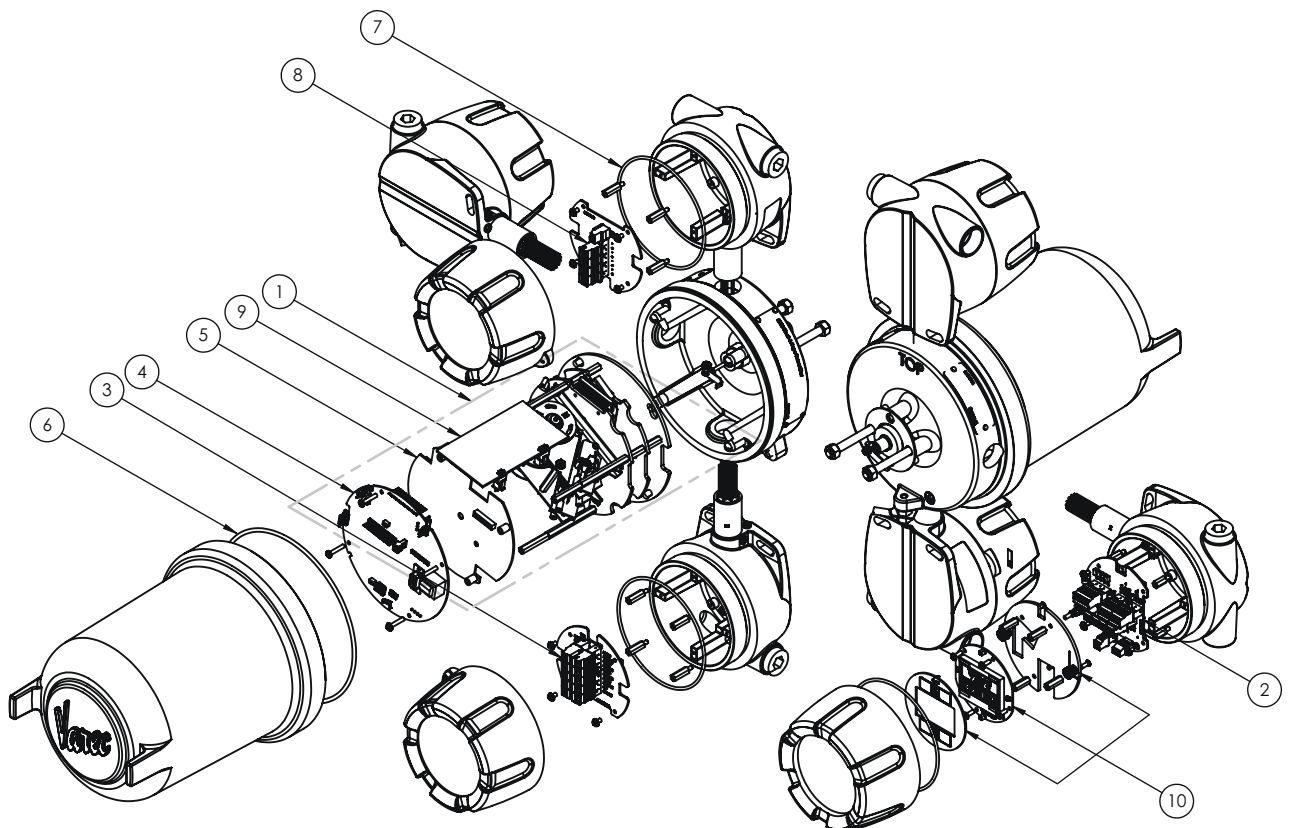
1. Remove the 2920 FTT cover.
2. Verify that LED D4 (CPU) flashes on and off about once every second. This indicates normal CPU operation.

**Note** If LED D4 does not flash on and off about once every second, return the unit for service.

The following figure shows the Communications Board: Diagnostic Switches and LEDs. The Biphase Mark communications board is shown as an example.



## 2920 FTT Exploded View



## 2920 FTT Spare Parts List

Reference the 2920 FTT Exploded View graphic to matching images with the numbers in the table below.

Draw #	Spare Part #	Description
1	06-013290	2920 Encoder Assembly (No communication module, no limit switches)
2	08-013204	2920 Terminal Board Assembly
3	08-013220	2920 Expansion Terminal Board Assembly
4	08-013125	2920 GPU Bi-Phase Mark Communication Board Assembly
4	08-013232	2920 Modbus Communication Board Assembly
4	08-013233-1	2920 Mark/Space Communication Board Assembly
4	08-013233-2	2920 L&J Tankway Communication Board Assembly
5	08-12836	29xx AC & DI/DO Board Assembly (includes 55-012836-F1 fuse)
5	55-012836-F1	29xx AC Board Fuse F1 (80 mA)
6	P14-170	O-Ring, Standard Transmitter Housing Cover, 7" ID
7	P14-182	O-Ring, Junction Box
8	08-013221	2920 HART Terminal Board Assembly
9	08-013219	2920 HART IS Barrier PCB Assembly
9	08-12839	29xx Long Interconnection Board
9	08-12848	29xx Short Interconnection Board
10	13-082920	2920 Display Assembly (support, display PCB, touch PCB, standoffs & fasteners)
	B4596-003	Hex L-Key, Standard Tip, 5/64" Size, 6" Length (not shown)
	05-013303	2920 Display Cable (connections item 2 to 10, not shown)
	05-013352	2920 Pipe Mount Bracket for Tankside Display (not shown)
	<b>13-B12133</b>	Transmitter Slotted Drive Coupling Replacement Kit (not shown)
	<b>P109-16-034</b>	5/8" Recessed Plug, 3/4" MNPT, Copper Free Aluminum, XP-Rated (not shown)
	<b>06-013039-BCA</b>	2-Switch Assembly, 0-100 Feet Range (not shown)
	<b>06-013039-BCB</b>	2-Switch Assembly, 0-50 Feet Range (not shown)
	<b>06-013039-BCC</b>	2-Switch Assembly, 0-25 Feet Range (not shown)
	<b>06-013039-BCD</b>	2-Switch Assembly, 0-30 Meter Range (not shown)
	<b>06-013039-BCE</b>	2-Switch Assembly, 0-15 Meter Range (not shown)
	<b>06-013039-BCF</b>	2-Switch Assembly, 0-7.5 Meter Range (not shown)
	<b>06-013039-BEA</b>	4-Switch Assembly, 0-100 Feet Range (not shown)
	<b>06-013039-BEB</b>	4-Switch Assembly, 0-50 Feet Range (not shown)
	<b>06-013039-BEC</b>	4-Switch Assembly, 0-25 Feet Range (not shown)

Draw #	Spare Part #	Description
	<b>06-013039-BED</b>	4-Switch Assembly, 0-30 Meter Range (not shown)
	<b>06-013039-BEE</b>	4-Switch Assembly, 0-15 Meter Range (not shown)
	<b>06-013039-BEF</b>	4-Switch Assembly, 0-7.5 Meter Range (not shown)

## 2920FTT Electronics Assembly

Housing Approvals	
EA	No Housing / Approvals, Electronics Assembly Only
Power Input	
1	DC Power Input
2	AC Power Input
Communication	
MS	Mark/Space Communications
MB	EIA-485 MODBUS/GSI Type MODBUS Communications
LJ	Tankway (L&J) Communications
BP	Bi-Phase Mark Communications
Limit Switches	
0	No Limit Switches
1	2 SPDT Limit Switches (180° adjustable dwell, positive activation)
2	4 SPDT Limit Switches (180° adjustable dwell, positive activation)
Range (Applies only to models with limit switches)	
N	N/A Range, No Limit Switches (Select this option if no limit switches are supplied)
A	0-25 ft Limit Switch Range
B	0-50 ft Limit Switch Range
C	0-100 ft Limit Switch Range
D	0-7.5 m Limit Switch Range
E	0-15 m Limit Switch Range
F	0-30 m Limit Switch Range

<b>Digital I/O</b>	
1	2 Digital Inputs
2	4 Digital Inputs + 4 Dry Contact Outputs
<b>Analog I/O</b>	
N	No Analog Inputs or Outputs
A	Option no longer used. Use Option N or Option C.
B	Option no longer used. Use Option N or Option C.
C	1 Analog Input & 2 Outputs (4-20 mA)
<b>HART Inputs/Outputs (HART Master)<sup>3</sup></b>	
0	XP/Ex db HART Master
1	I.S. HART Master, Associated Intrinsically Safe (XP-AIS/Ex db[ia Ga])
<b>Display Options</b>	
A	Electronics Assembly, No Display
B	Not Used for Housing / Approvals option EA
C	Not Used for Housing / Approvals option EA
<b>Example Order Code: N2920-EA-1-MB-0-N-1-C-0-A</b>	

## Upgrading Software

The 2920 FTT uses a flash-based microcontroller which can be upgraded in the field.

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

Consult Varec for available firmware updates and update procedures.

## Troubleshooting

This section provides instructions for:

- “No LCD Display or the LCD Is Too Dark”
- “Using ViewRTU to Troubleshoot the 2920 FTT”
- “Returning the 2920 FTT to Factory Default Settings”
- “Resetting the 2920 FTT”

- "Using the Display to Check the Transmitter Level"
- "Adjusting the Display Contrast"
- "Verifying Temperature Data - Checking RTD Resistance"
- "Random Key Presses when Replacing the Display Cover"
- "Unit not Communicating"
- "Incorrect Level or Level Losing Calibration"
- "Problems with the Set Up of the 2920 4-20ma Output"

## No LCD Display or the LCD Is Too Dark

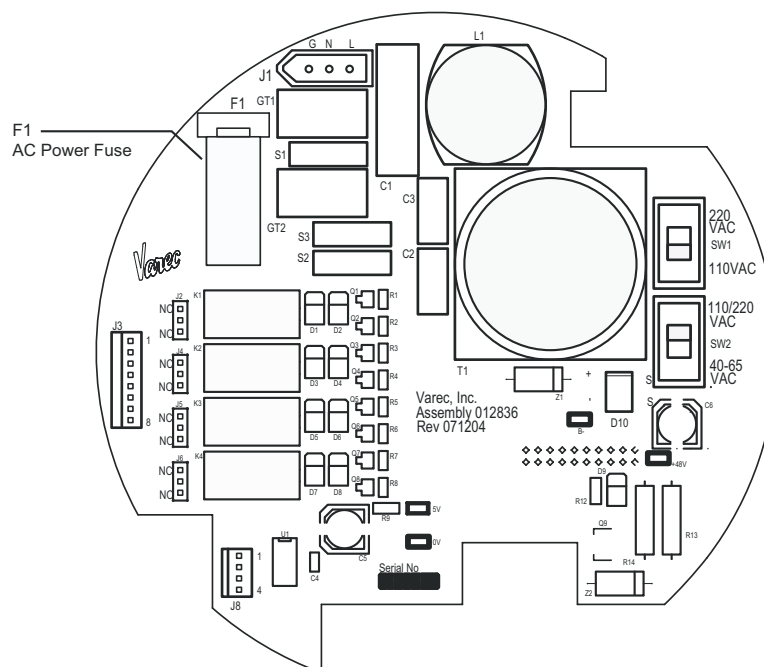
If the LCD display is either too dark to read or the LCD display doesn't appear to be working, try the following steps:

- Check the contrast adjustment. Often removal of the cover/glass can cause this to change unexpectedly.
- Try a factory reset with the switch on the CPU board. (See "Returning the 2920 FTT to Factory Default Settings" on page 148 for details on how to perform a factory reset.)

## Replacing the AC Power Supply Fuse

To replace the AC Power Supply fuse:

1. Remove power from the 2920 FTT.
2. Remove the 2920 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 as shown on the follow figure.



4. Insert the new fuse and tighten it.
5. Replace the 2920 FTT cover.

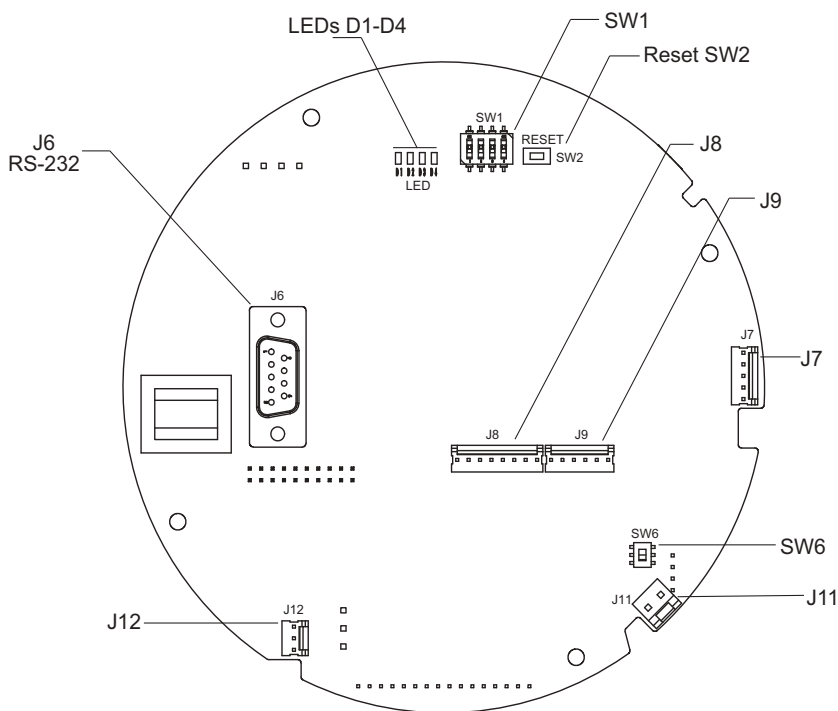
## Using ViewRTU to Troubleshoot the 2920 FTT

For diagnostics and troubleshooting of the 2920 FTT, a laptop computer running the ViewRTU software can be connected to the RS-232 port. The user can then use ViewRTU to run diagnostics or perform other troubleshooting procedures on the transmitter.

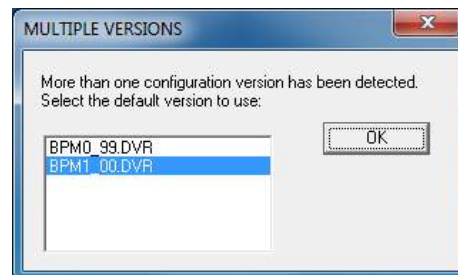
**Warning!** Obtain a hot permit before removing the transmitter cover with power applied.

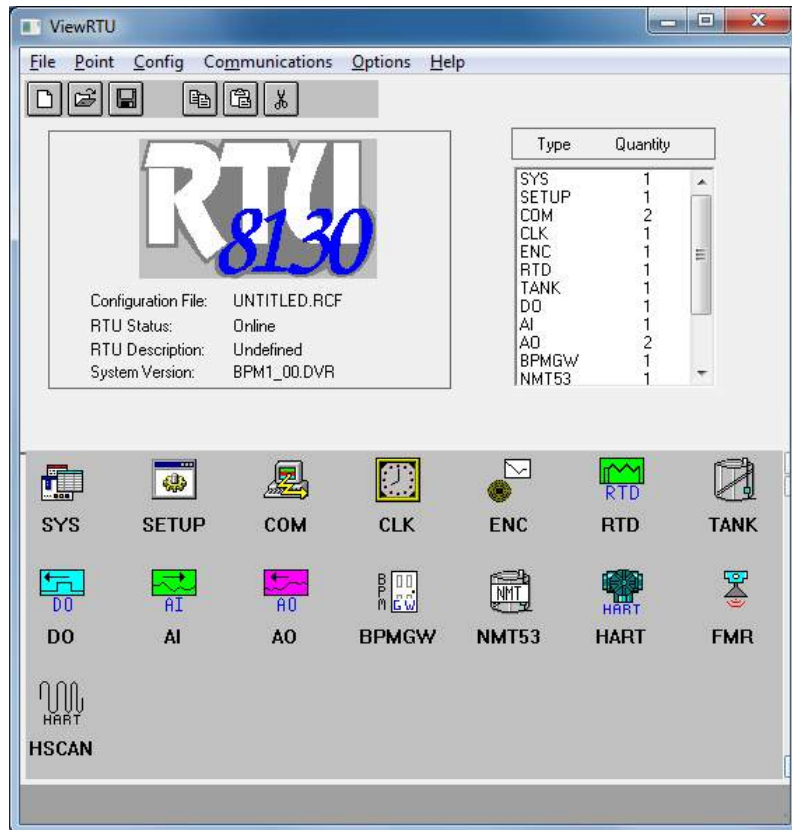
**Note** For more detailed information regarding the ViewRTU program, refer to any Varec RTU Installation and Operation manual.

1. Remove the 2920 FTT cover.
2. Connect the communications port of a laptop computer running ViewRTU software to the RS-232 connector (J6) on the communications circuit board using a crossover (Null MODEM) cable. The following figure shows the connector.



3. Start the ViewRTU application. You are prompted to select a firm-ware version file. Select the file that matches the communications protocol used by the 2920 FTT, and then click OK.
4. The main screen appears, as shown in the following figure.





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 "Display and Configuration Interface" 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 2920 FTT cover.

## Returning the 2920 FTT to Factory Default Settings

**Note** This procedure resets all level and temperature alarm setpoints.

The 2920 FTT can be reset to factory default setting in using either of the procedures below:

This procedure initializes all 2920 FTT configuration parameters to factory default settings, using the display interface.

### To Reset the 2920 FTT Using the Display Interface

1. Press Enter to open the Main Menu.
2. Press Enter to open the System Data menu.
3. Press Minus one time to highlight the Commands menu.
4. Press Minus multiple times to locate the Reset Cmd.
5. Press Enter to open the Reset Cmd. The default command is No action.
6. Press Minus multiple times to highlight Factory Reset.
7. Press Enter to reset the 2920 FTT to factory settings.

The following procedure initializes the 2920 FTT to the factory default settings using the Reset switch.

### To Reset the 2920 FTT with the Reset Switch

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

1. Remove the 2920 FTT cover.
2. Set SW1 (Switch1) in the ON position.
3. Press and release the RESET switch (SW2).
4. Set SW1 (Switch1) to the OFF position.

**Note** The four LEDs will flash once to verify that the reset was successful.

## Resetting the 2920 FTT

The software reset, when executed, does not change any of the values previously set in the 2920 FTT, but has the effect of stopping all processes and restarting them, similar to a computer reboot.

To perform a soft reset:

1. Press Enter to open the Main Menu.
2. Press Enter to open the System Data menu.
3. Press Minus one time to highlight the Commands menu.
4. Press Minus multiple times to locate the Reset Cmd.
5. Press Enter to open the Reset Cmd. The default command is No action.
6. Press Minus multiple times to highlight Software Reset.
7. Press Enter to reset the 2920 FTT.

## Using the Display to Check the Transmitter Level

### To Check the Transmitter Level

1. On the display interface, press Enter to open the Main Menu.
2. Press Minus multiple times to highlight Tank.
3. Press Enter to open the Tank menu.
4. Press Enter to open Display Only.
5. Press Minus multiple times to highlight Level. The level displays in the units set as Level Display Units.
6. If necessary, you may need to change the level units on the LCD display by doing the following:
  - a. Press Enter to access the Main Menu.
  - b. Press Minus to highlight Basic Setup.
  - c. Press Enter to open the Basic Setup Menu.
  - d. Press Minus to highlight Config Params.
  - e. Press enter to open Config Params menu.
  - f. Press Minus to highlight Level Display Units.
  - g. Press Enter to open Level Display Units.
  - h. Select the appropriate units of measure by using Minus or Plus to highlight and Enter to accept the selection.

**Note** The Level Display Units changes only the units displayed on the 2920 FTT gauge. This setting does not change the units that are communicated to the host system.

## Adjusting the Display Contrast

Just use **E** and **+** to increase the contrast or **E** and **-** to decrease the contrast on the display.

## Verifying Temperature Data - Checking RTD Resistance

To verify the accuracy of the 2920 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 Verify Probe Resistance

1. Remove the 2920 FTT junction box cover.
2. Disconnect the RTD wires from the terminal block.
3. Measure the actual tank temperature, using an analog tank thermometer or other method.

4. Check the RTD resistance. Compare this to the actual tank temperature using the appropriate table for the RTD element type in Appendix B — RTD Resistance - Temperature Charts.
5. On the display interface, press Enter to open the Main Menu.
6. Press Minus multiple times to highlight Tank.
7. Press Enter to open the Tank menu.
8. Press Enter to open Display Only.
9. Press Minus multiple times to highlight Temperature. The level displays in the units set as Level Display Units.
10. If necessary, you may need to change the temperature units on the LCD display by doing the following:
  - a. Press Enter to access the Main Menu.
  - b. Press Minus to highlight Basic Setup.
  - c. Press Enter to open the Basic Setup Menu.
  - d. Press Minus to highlight Config Params.
  - e. Press enter to open Config Params menu.
  - f. Press Minus to highlight Temp Display Units.
  - g. Press Enter to open Temp Display Units.
  - h. Select the appropriate units of measure by using Minus or Plus to highlight and Enter to accept the selection.
- Note** The Temp Display Units changes only the units displayed on the 2920 FTT gauge. This setting does not change the units that are communicated to the host system.
11. Reconnect the RTD wires to the terminal block.
12. Replace the cover on the junction box.

## Random Key Presses when Replacing the Display Cover

When replacing the display cover with power applied to the 2920, you may see what appears to be random key presses. This is due to the touch keys recalibrating when the cover is replaced.

To prevent these random key presses, disconnect power from the unit prior to replacing the display cover. When power is reapplied, the unit automatically re-calibrates to compensate for the cover glass.

## Unit not Communicating

There are a number of issues that can affect the 2920's ability to communicate. The following things to check is not meant to be exhaustive, but potential issues that could fix issues with communicating.

- Check for water intrusion
- Check that the comm wires are connected properly

- Check for power and proper voltage (see the power requirements in Chapter 13)
- Check internal wires or the transmitter for loose or damaged wires
- Check the terminal board for any problems or damage

## Incorrect Level or Level Losing Calibration

In case the 2920 is displaying the incorrect level or the level is losing calibration, try either of the following potential fixes to address the issue:

- Try sending the command to align the encoders, and then recalibrate the level. Follow the steps on page 65 on how to perform an encoder alignment as listed in the table under Command.
- Try a factory reset with the switch on the CPU board. (See “Returning the 2920 FTT to Factory Default Settings” on page 143 for details on how to perform a factory reset.)

## Problems with the Set Up of the 2920 4-20ma Output

If there is a problem setting up the 2920 FTT's 4-20ma output, the following settings are necessary to ensure 4-20ma functionality is properly set up. The following settings are found by following this path to access them: **Main Menu > Analog Out > Analog Out #1 (or #2) > Config Params**

1. Pnt Ref - Normally set to Level or Temp. Choose what value you want to encode on this output.
2. Control - Set to Enable. This means that the Pnt Ref will control the output.
3. Zero - Normally set to zero. This is what value you want the 4ma to represent.
  - a. This value must match the zero/minimum value of the remote system that is reading this output.
4. Span - Set this setting to the max value you want to encode. This setting is for the value you want the 20ma to represent.
  - a. For example: For a 25' tank, you might enter 25. (Whole numbers are recommended.)
  - b. The setting you enter must match the span and maximum value of the remote system that is reading this output.
5. Cal Points - These are set at the factory and should not require any adjustment for the 4-20ma output to work correctly.

# 13 Specifications

## Environmental

Item	Description
Operating Temperature	N2920AC: -40°F to 185°F (-40°C to +85°C) N2920AT: -4°F to 185°F (-20°C to +85°C) N2920FC: -40°F to 185°F (-40°C to +85°C) N2920FM (Div.): -13°F to 185°F (-25°C to +85°C) N2920FM (Zones): -4°F to 185°F (-20°C to +85°C)
Operating Humidity	0 to 95% relative humidity, non-condensing

Item	Description
Safety Approvals	<p>Models without I.S. HART:</p> <p>ATEX &amp; IECEx -(Low Temp.) [N2920ACbccdefg0i] Ex db IIB T5 Gb, -40°C ≤ Ta ≤ +85°C, IP66</p> <p>ATEX &amp; IECEx - (Std. Temp.) [N2920ATbccdefg0i] Ex db IIB T5 Gb, -20°C ≤ Ta ≤ +85°C, IP66</p> <p>Factory Mutual (cFMus) - (Low Temp. USA and Canada) [N2920FCbccdefg0i] Class I, Division 1, Groups C&amp;D, T5, -40 °C ≤ Ta ≤ +85 °C, Type 4 Class I, Zone 1, Group IIB, T5, -40°C ≤ Ta ≤ +85 °C, IP66 (USA) Zone 1 per CEC 18-100, -40°C ≤ Ta ≤ +85 °C, IP66 (CAN)</p> <p>Factory Mutual (cFMus) - (Std. Temp. USA and Canada) [N2920FMbccdefg0i] Class I, Division 1, Groups C&amp;D, T5, -25 °C ≤ Ta ≤ +85 °C, Type 4 Class I, Zone 1, AEx db IIB T5 Gb, -20°C ≤ Ta ≤ +85 °C, IP66 (USA) Ex db IIB T5 Gb, -20°C ≤ Ta ≤ +85°C, IP66 (CAN)</p> <hr/> <p>Models with I.S. HART (XP-AIS):</p> <p>ATEX &amp; IECEx -(Low Temp.) [N2920ACbccdefg1i] Ex db[ia Ga] IIB T5 Gb, -40°C ≤ Ta ≤ +85°C, IP66</p> <p>ATEX &amp; IECEx - (Std. Temp.) [N2920ATbccdefg1i] Ex db[ia Ga] IIB T5 Gb, -20°C ≤ Ta ≤ +85°C, IP66</p> <p>Factory Mutual (cFMus) - (Low Temp. USA and Canada) [N2920FCbccdefg1i] Class I, Division 1, Groups C&amp;D, T5, -40°C ≤ Ta ≤ +85 °C, Type 4 Class I, Zone 1, Group IIB, T5, -40°C ≤ Ta ≤ +85 °C, IP66 (USA) Zone 1 per CEC 18-100, -40°C ≤ Ta ≤ +85 °C, IP66 (CAN)</p> <p>Factory Mutual (cFMus) - (Std. Temp. USA and Canada) [N2920FMbccdefg1i] Class I, Division 1, Groups C&amp;D, T5, -25°C ≤ Ta ≤ +85 °C, Type 4 Class I, Zone 1, AEx db[ia Ga] IIB T5 Gb, -20°C ≤ Ta ≤ +85 °C, IP66 (USA) Ex db[ia Ga] IIB T5 Gb, -20°C ≤ Ta ≤ +85 °C, IP66 (CAN)</p>
Environmental Approvals	IP66, Type 4

## Entity Parameters

Associated Intrinsically Safe (AIS) Apparatus

	Gas Group C/IIB	Gas Group D/ IIA
Um =	240 V	240 V
Uo =	28 V	28 V
Io	120 mA	120 mA
Po =	840 mW	840 mW
Co =	0.65 $\mu$ F	2.15 $\mu$ F
Lo =	9.87 mH	19.75 mH
	Refer to Control Drawing 28-013355, Appendix D.	

## Encoder

Item	Description
Type	Absolute Capacitance Encoder
Accuracy	+/- 1/16" (1.58 mm)

## Functional

Item	Description
Power Requirements	20 to 65 VDC 0.05A 40 - 65 / 100 - 120 / 220 - 240 VAC 750 mW nominal, 50/60 Hz
Available Ranges	Feet: 0 - 120 ft Meters: 0 - 36 m <b>Note</b> Limit switch ranges up to 100 feet.

## Primary Components

Component	Description
Main Processor Board	Biphase Mark or EIA-485 MODBUS

## Switches and Indicators

Item	Description
Graphical Liquid Crystal Display	Four-button capacitive user interface
Reset Switch	Sends reset signal to processor
Status Indicators	4 LEDs
Limit Switches	2 or 4 SPDT limit switches (optional): <ul style="list-style-type: none"><li>• 11 amp - 125, 250, 277 VAC</li><li>• 4 amp - 125 VAC Tungsten filament Lamp Load</li><li>• 1/3 HP - 125 VAC, 250 VDC</li><li>• 1/2 amp - 125 VDC, 1/4 amp - 250 VDC</li></ul>

## Fuse

Item	Description
F1 Fuse (80 mA, 250 VAC, Slow-blow)	Littelfuse 0218.080HXP
	Schurter 0034.3106

## Input/Output Options

Item	Description
Digital Inputs	3.3 V pull up voltage, (100 ohm maximum for activation)

**Caution!** Do not exceed voltages specified above.

## Physical

Item	Description
Net Weight	13 lbs (5.9 kg)
Shipping Weight	18 lbs (8.2 kg)
Enclosure	Explosion proof die-cast aluminium
Conduit Entries	Conduit junction box(s) supplied with 2 x 3/4" NPT for customer use.

## Digital Output Relay Ratings

Digital Outputs		
Load	Resistive load (power factor = 1)	Inductive load (power factor = 0.4) (L/R = 7 mS)
Rated Load	0.30 A at 125 VAC, 1 A at 30 VDC	0.20 A at 125 VAC, 0.50 A at 30 VDC
Contact material	AgPd (Au clad)	AgPd (Au clad)
Carry current	3 A	3 A
Maximum operating voltage	250 VAC, 220 VDC	250 VAC, 220 VDC
Maximum operating current	2 A	1 A
Maximum switching capacity	125 VA, 60 W	62.50 VA, 30 W
Minimum permissible load	10 $\mu$ A, 10 mVDC	10 $\mu$ A, 10 mVDC

## Analog 4-20 mA Input

Internal Load to ground	100 $\Omega$
Measuring Range	0 to 20 mA
Accuracy	$\pm 15$ $\mu$ A (after linearisation and calibration)

## Analog 4-20 mA Outputs (2)

Output Current	3.5 to 22 mA
Output Voltage	U = 24 V - ILOAD 400 $\Omega$
Output Load Max	500 $\Omega$
Accuracy	$\pm 15$ $\mu$ A (after linearisation and calibration)

## I.S. HART Interface

IS (Intrinsically Safe)	HART Master for measuring device
Source Voltage	U = 24 V (Typical)
Total I <sub>max</sub>	Startup currents not to exceed 27 mA max
Connectable Sensors	Typically 4 max, depending on current consumption (including startup current)

**Warning!** Do not substitute electrical components. Substitution may impair intrinsic safety and cause a hazardous condition.

**Note** Refer to Control Drawing 28-013355, Appendix D.

## **Explosion-proof/Flameproof (Ex d) HART Interface (Non-I.S.)**

Ex d HART	HART Master for measuring device
Source Voltage	U = 24 V (Typical)
Total I <sub>max</sub>	Startup currents not to exceed 27 mA max
Connectable Sensors	Typically 4 max, depending on current consumption (including startup current)

# 14 Ordering Information

## Order Code Table

<b>N2920</b>	
	<b>Housing / Approvals - IP66 / NEMA 4</b>
<b>FC</b>	<b>cFMus (USA &amp; Canada) - Low Temperature Range, without I.S. HART</b> <ul style="list-style-type: none"> <li>Explosion proof, Class I, Division 1, Groups C&amp;D T5 -40 °C ≤ Ta ≤ +85 °C</li> <li>Zone 1 per CEC 18-100 -40 °C ≤ Ta ≤ +85 °C (CAN)</li> <li>Flameproof, Class I, Zone 1, IIB T5 -40 °C ≤ Ta ≤ +85 °C (USA)</li> </ul> <b>cFMus (USA &amp; Canada) - Low Temperature Range, with I.S. HART</b> <ul style="list-style-type: none"> <li>Explosion proof with IS Class I, Division 1, Groups C&amp;D T5 -40 °C ≤ Ta ≤ +85 °C</li> <li>Flameproof, Class I, Zone 1, IIB T5 -40 °C ≤ Ta ≤ +85 °C (USA)</li> <li>Zone 1 per CEC 18-100 -40 °C ≤ Ta ≤ +85 °C (CAN)</li> </ul>
<b>FM</b>	<b>cFMus (USA &amp; Canada) - Standard Temperature Range, without I.S. HART</b> <ul style="list-style-type: none"> <li>Explosion proof, Class I, Division 1, Groups C&amp;D T5 -25 °C ≤ Ta ≤ +85 °C</li> <li>Flameproof, Class I, Zone 1, AEx db IIB T5 Gb -20 °C ≤ Ta ≤ +85 °C (USA)</li> <li>Flameproof, Ex db IIB T5 Gb -20 °C ≤ Ta ≤ +85 °C (CAN)</li> </ul> <b>cFMus (USA &amp; Canada) - Standard Temperature Range, with I.S. HART</b> <ul style="list-style-type: none"> <li>Explosion proof, Class I, Division 1, Groups C&amp;D T5 -25 °C ≤ Ta ≤ +85 °C</li> <li>Flameproof, Class I, Zone 1, AEx db [ia Ga] IIB T5 Gb -20 °C ≤ Ta ≤ +85 °C (USA)</li> <li>Flameproof, Ex db [ia Ga] IIB T5 Gb -20 °C ≤ Ta ≤ +85 °C (CAN)</li> </ul>
<b>AC</b>	ATEX/IECEX (International) - Low Temperature Range Flameproof, II 2 G Ex db IIB T5 Gb -40 °C ≤ Ta ≤ +85 °C Flameproof, II 2 (1) G Ex db [ia Ga] IIB T5 Gb -40 °C ≤ Ta ≤ +85 °C
<b>AT</b>	ATEX/IECEX (International) - Standard Temperature Range Flameproof, II 2 G Ex db IIB T5 Gb -20 °C ≤ Ta ≤ +85 °C Flameproof, II 2 (1) G Ex db [ia Ga] IIB T5 Gb -20 °C ≤ Ta ≤ +85 °C

<b>N2920</b>			
		<b>Power Input</b>	
		<b>1</b>	DC Power Input
		<b>2</b>	AC Power Input
		<b>Communication<sup>6</sup></b>	
		<b>MS</b>	Mark/Space Communications
		<b>MB</b>	EIA-485 MODBUS/GSI Type MODBUS Communications
		<b>LJ</b>	TankWay (L&J) Communications
		<b>BP</b>	Biphase Mark Communications
		<b>Limit Switches</b>	
		<b>0</b>	No Limit Switches
		<b>1</b>	2 SPDT Limit Switches (180°adjustable dwell, positive activation) <sup>1</sup>
		<b>2</b>	4 SPDT Limit Switches (180°adjustable dwell, positive activation) <sup>1</sup>
		<b>Limit Switch Range<sup>3</sup></b>	
		<b>N</b>	N/A Range, No Limit Switches (Select this option if no limit switches are supplied) <sup>2</sup>
		<b>A</b>	0-25 ft Limit Switch Range
		<b>B</b>	0-50 ft Limit Switch Range
		<b>C</b>	0-100 ft Limit Switch Range
		<b>D</b>	0-7.5 m Limit Switch Range
		<b>E</b>	0-15 m Limit Switch Range
		<b>F</b>	0-30 m Limit Switch Range

N2920											
						Digital I/O <sup>3</sup>					
						1	2 Digital Inputs				
						2	4 Digital Inputs + 4 Dry Contact Outputs				
						Analog I/O <sup>3</sup>					
						N	No Analog Inputs or Outputs ( <b>only</b> with 'AC Power Input' & '2 Digital Inputs' options.)				
						A	Option no longer used. Use Option N or Option C.				
						B	Option no longer used. Use Option N or Option C.				
						C	1 Analog Input & 2 Analog Outputs (4-20 mA)				
						HART Inputs/Outputs (HART Master) <sup>3</sup>					
						0	XP/Ex db HART Master				
						1	I.S. HART Master, Associated Intrinsically Safe (XP-AIS/Ex db[ia Ga])				
						Display Options <sup>4</sup>					
						A	Forward (Standard) Facing Display <sup>5</sup>				
						B	Reverse Facing Display <sup>7</sup>				
						C	Right Side (L&J Gauges) Facing Display				
Example Order Code: N2920-FM-2-MB-0-N-1-N-0-A											

**Notes:**

<sup>1</sup> Ensure a Limit Switch Range option from A to F has been selected.

<sup>2</sup> Applies only to Limit Switch option 0. Otherwise select an option from A to F.

<sup>3</sup> The number of junction boxes supplied from the factory depends on the Communication, number of limit switches, Digital Input/Output, Analog Input/Output, and I.S. HART options selected. Transmitters are supplied with 1-3 junction boxes dependent on the terminal and wiring requirements.

<sup>4</sup> Select the appropriate Display Option depending on the tank gauge used with the 2920 transmitter.

<sup>5</sup> Use this option for Electronic Assemblies without housings. (Approvals order code = EA)

<sup>6</sup> All communication options come with XP/Ex d HART unless "HART Inputs/Outputs (HART Master)" option 1 is selected.

<sup>7</sup> Typical for use when the 2920FTT is used as standalone pipe-mounted device (i.e., not mounted to F&T gauge). Also requires the use of part number **05-013352** "2920 Pipe Mount Bracket for Tankside Display".



# Appendix A — MODBUS Implementation

## Introduction

This protocol guide explains the operation of the MODBUS as it pertains to the 2920 Float & Tape Transmitter.

## Implementation

The implementation of the MODBUS protocol for the 2920 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 2920 FTT communicates with existing MODBUS masters.

Check compatibility carefully to ensure that the 2920 FTT is properly configured for the data format expected by the host computer. Exceptions made because of the unique requirements of the 2920 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 2920 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 2920 FTTs may be multi-dropped on a single EIA485 communication bus.

The MODBUS functions implemented in the 2920 FTT are listed in the table below.

## Configuration

The 2920 FTT address provides a unique identification for the host. The 2920 FTT address is set using the configuration interface explained in “Basic Setup” on page 58. This address may range from 1 to 254 and must be unique. Each 2920 FTT only responds when a query has been sent to its unique address by the host.

Advanced MODBUS settings are configured in the “MODBUS Data” on page 88. The 2920 FTT only supports the MODBUS RTU mode of communications.

Function Code	Function	Information Type	MODBUS Nomenclature
01	Read	Bits	Read output status
02	Read	Bits	Read input status

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

**Note** Exception: Because the 2920 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 level variable at data address 0.

Configuration Item	Valid Entries (default in bold type)	MODBUS Configurable	ViewRTU Configurable
MODBUS Address	1 to <b>254</b>	No	Yes
Maximum Integer Size	Whole number (0 to 65,534) (default: <b>9999</b> )	Yes	Yes
Integer Scaling Factors	Floating point number	Yes	Yes
Unit Selection	Coding list	No	No
Baud Rate	300, 600, 1200, 2400, 4800, <b>9600</b> , 19200	No	Yes
Parity	Odd, Even, <b>None</b>	No	No

**Note** Default communications settings are shown in bold type above.

## Functions and Data Formats

The MODBUS data in the 2920 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 2920 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.

## Integer Registers

Integer registers are the most commonly used type of MODBUS data and are supported by most MODBUS hosts. In the 2920 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 2920 FTT accepts reads and writes to reserved registers. Writes to reserved registers have no effect. Reads from reserved registers will return undocumented values.

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)

**Note** In all of the following communication examples, the error check value is dependent upon the function code and message content.

## 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 minimum and maximum value. In order for the integer value to be correctly interpreted, these scaling factors must match the format expected by the host system.

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	84 0A
2920 FTT Response						
Address	Function Code	Byte Count	Data MSB	Data LSB	Error Check	
01	03	02	41	24	88 0F	

**Note** A formula for converting numbers to scaled integer format is provided below.

### Calculating Integer Data

- Hexadecimal representation: 4124
- Decimal equivalent: 16,676

The data returned for data address 0 is 16,676 (4124 Hex). This value must be scaled using the following formula to give it meaning.

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

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

$$\text{result} = 4.56 \text{ meters}$$

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.

## 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 44 (002C Hex) returned from the 2920 FTT corresponds to level units = Feet.

Host Request						
Address	Function Code	Start Reg H	Start Reg L	# of Reg H	# of Reg L	Error Check
01	03	00	14	00	01	C4 0E
2920 FTT Response						
Address	Function Code	Byte Count	Data MSB	Data LSB	Error Check	
01	03	02	00	2C	B9 99	

- Hexadecimal representation 0001
- Level unit table representation: FT

## 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 2920 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	94 0B
2920 FTT Response						
Address	Function code	Byte Count	Data MSB	Data LSB	Error Check	
01	03	02	00	01	79 84	

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

## 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 2920 FTT that are not easily scaled (such as the scaling factors themselves).

## Floating-point Data

The 2920 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 2920 FTT be the same as that expected by the host. In addition, where possible, data is available in both integer and floating-point formats.

### 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 2920 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	24 14	
2920 FTT Response							
Address	Function Code	Byte Count	Data MSB	Data LSB	Data MSB	Data LSB	Error Check
01	03	04	42	C8	00	00	6F B5

#### Example of Floating-point Data

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

Floating-point registers that are defined as reserved will respond with undocumented values. A write command to a reserved floating-point register is ignored.

### 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	AD C5		
2920 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	78 85

### Example of 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	Error
			C8	00	00	Check
2920 FTT Response						
Address	Function Code	# of Reg H	# of Reg L	Error Check		
01	42	00	01	60 0C		

### Example of Floating-point Data

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

Floating-point registers that are defined as reserved will respond with undocumented values. A write command to a reserved floating-point register will be ignored.

## Status Bits

In the 2920 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 2920 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	02	00	02	00	04	C8 09
2920 FTT Response						
Address	Function Code	Byte Count	Data	Error Check		
01	02	01	03	E1 89		

### Example of Status Bit Data

Start Register 0002

Number of Registers 0004

This reads Alarm Status bit 2 through 5. The response data is 03.

Bit #2: High Advisory Alarm ON

Bit #3: High Critical Alarm ON

Bit #4: Critical Low Temp OFF

Bit #5: Advisory Low Temp OFF

## Exception Responses

The exception responses returned by the 2920 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

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

## Data Out of Range

When integer data calculated by the 2920 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 2920 FTT to return scaled integer values of maximum MODBUS integer + 1.

- Off-line Mode
- No CALC
- CALC Error

This permits a host to detect a serious failure without monitoring other 2920 FTT status bits.

## 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 2920 FTT. The 2920 FTT supports only diagnostic code 00. This is a request to return query data. Upon receiving a loopback message containing this code, the 2920 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
2920 FTT Response						
Address	Function Code	Code HO	Code LO	Data	Data	Error Check
01	08	00	00	F3	26	XX

## Hardware Implementation

The 2920 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 2920 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 2920 FTTs. The recommended wire for EIA485 systems is 18-gauge or larger, shielded, twisted pair. The shield should be earth grounded at the MODBUS master (control system or computer end). The shield at the 2920 FTT should be open. The 2920 FTT-power line acts as a common reference tie to the MODBUS master.

Termination resistors of 100 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 2920 FTT and can be included in the circuit using the procedure described in “Setting the Bias Current”.

## Integer Register Map

Register Number	Type	Description
0	Scaled	Level (MODBUS > Level)
1	Scaled	Temperature (MODBUS > Temp)
2	Scaled	Secondary Level
3	Scaled	Unit Temperature (Encoder Data > Internal Temp)
4	Integer	Number of Resets (Encoder Data > NumberResets)
5	Bit Field	AlmStat (Tank Data > AlmStat) Bit Usage 0 CRIT LO LEVEL 1 ADV LO LEVEL 2 ADV HI LEVEL 3 CRIT HI LEVEL 4 CRIT LO TEMP 5 ADV LO TEMP 6 ADV HI TEMP 7 CRIT HI TEMP 8 HW IN 1 9 HW IN 2 10 HW IN 3 * 11 NW IN 4 * 12 – 15 RESERVED * when optional AC Power module is installed

Register Number	Type	Description
6	Bit Field	DiagStat (Tank Data > DiagStat) Bit Usage 0 BAD LEVEL 1 BAD TEMP 2 – 13 RESERVED 14 BAD ENCODER 15 BAD RTD TEMP
7	Bit Field	CmdsBit Usage 0 – 15 RESERVED
8	Integer	FDISK (Encoder Data > FDisk)
9	Integer	IDISK (Encoder Data > IDisk)
10	Scaled	Crit Low Level Setpoint (MODBUS > CritLowLevel)
11	Scaled	Adv Low Level Setpoint (MODBUS > AdvLowLevel)
12	Scaled	Adv High Level Setpoint (MODBUS > AdvHighLevel)
13	Scaled	Crit High Level Setpoint (MODBUS > CritHighLevel)
14	Scaled	Level Deadband (MODBUS > LDeadband)
15	Scaled	Crit Low Temp Setpoint (MODBUS > CritLowTemp)
16	Scaled	Adv Low Temp Setpoint (MODBUS > AdvLowTemp)
17	Scaled	Adv High Temp Setpoint (MODBUS > AdvHighTemp)
18	Scaled	Crit High Temp Setpoint (MODBUS > CritHighTemp)
19	Scaled	Temp Deadband (MODBUS > TDeadband)
20	Coded	Level Units (Setup > Lev Disp Units) 45 - METERS 44 - FEET 47 - INCHES 241 - FT-IN-16THS 240 - 16th of an INCH 49 - MILLIMETERS 243 - FT - IN - 8THS
21	Coded	Temp Units (Setup > Temp Disp Units) 32 - C 33 - F
22	Coded	Level Type (Setup > Enc Direction) 0 - FORWARD 1 - REVERSE
23	Coded	Temp Type (Setup > RTD Type) 0 - Pt100 1 - Cu100 2 - Cu90 3 - None

Register Number	Type	Description
24	Scaled	Manual Temperature (Tank > Manual Temp)
25	Integer	Max Integer Value
26	Coded	Gauge Type (Setup > Gauge Type) 0 - Metric 1 - English
27	Scaled	Calibration Level (Setup > CalLevel)
28	Integer	Enc Command 0 - No Action 1 - Align Sensors
29	Coded	Secondary Level Units 45 - METERS 44 - FEET 47 - INCHES 241 - FT-IN-16THS 240 - 16th of an INCH 49 - MILLIMETERS 243 - FT - IN - 8THS
30	Tag	Firmware Version (characters 1 & 2)
31	Tag	Firmware Version (characters 3 & 4)
32	Tag	Firmware Version (characters 5 & 6)
33	Tag	Firmware Version (characters 7 & 8)
34	Tag	Firmware Version (characters 9 & 10)
35	Scaled	Value
36	Scaled	Value
37	Scaled	Value
38	Integer	AI Status (Analog Input > Analog Status)
39	Integer	AI Filter (Analog Input > Avg Filter)
40	Scaled	Water Level
41	Coded	Water Level Units 45 - METERS 44 - FEET 47 - INCHES 241 - FT-IN-16THS 240 - 16th of an INCH 49 - MILLIMETERS 243 - FT - IN - 8THS
42	Scaled	Hydrostatic Tank Level
43	Scaled	P1 Bottom Pressure
44	Scaled	P2 Middle Pressure

Register Number	Type	Description
45	Scaled	P3 Top Pressure
46	Scaled	Air Temperature
47	Scaled	Vapor Temperature
48	Scaled	Observed Density
49	Scaled	Standard Density
50	Scaled	Volume Correction Factor
51	Integer	Hydro PntStatus
52	Scaled	Tank Ullage
53	Scaled	Tank Reference Height
54 – 81	Reserved	
82	Integer	Encoder Feet
83	Integer	Encoder Inches
84	Integer	Encoder Sixteenths
85	Integer	RS485 Bus Status
86	Integer	Encoder PntStatus
87	Integer	RTD PntStatus
88 – 99	Reserved	
100	Float	Level
102	Float	Temp
104	Float	RTD Resistance
106	Float	Secondary Level
108	Float	Level
110	Float	Crit Low Level (Tank Data > CritLowLevel)
112	Float	Adv Low Level (Tank Data > AdvLowLevel)
114	Float	Adv High Level (Tank Data > AdvHighLevel)
116	Float	Crit High Level (Tank Data > CritHighLevel)
118	Float	Level Deadband (Tank Data > LDeadband)
120	Float	Crit Low Temp (Tank Data > CritLowTemp)
122	Float	Adv Low Temp (Tank Data > AdvLowTemp)
124	Float	Adv High Temp (Tank Data > AdvHighTemp)
126	Float	Crit High Temp (Tank Data > CritHighTemp)
128	Float	Temp Deadband (Tank Data > TDeadband)
130	Float	Min Level (Tank Data > MinLevel)
132	Float	Max Level (Tank Data > MaxLevel)
134	Float	Min Temp (Tank Data > MinTemp)
136	Float	Max Temp (Tank Data > MaxTemp)

Register Number	Type	Description
138	Float	Level (Tank Data > Level)
140	Float	Man Temp (Tank Data > Manual Temp)
142	Float	Calib Level (Basic Setup > CalLevel)
144	Float	AI Value (Analog Input > Value)
146	Float	AO1 Value (Analog Out #1> Analog Output1)
148	Float	AO2 Value (Analog Out #2 > Analog Output2)
150	Float	AI Offset (Analog Input > Offset)
152	Float	AI Scale (Analog Input > Scale)
154	Float	AO1 Offset (Analog Output #1 > Offset)
156	Float	AO1 Scale (Analog Output #1 > Scale)
158	Float	AO2 Offset (Analog Output #2 > Offset)
160	Float	AO2 Scale (Analog Output #2 > Scale)
162	Float	Encoder Temperature
164	Float	AO1 Calibration Pt1 (4 mA)
166	Float	AO1 Calibration Pt2 (8 mA)
168	Float	AO1 Calibration Pt3 (12 mA)
170	Float	AO1 Calibration Pt4 (16 mA)
172	Float	AO1 Calibration Pt5 (20 mA)
174	Float	AO2 Calibration Pt1 (4 mA)
176	Float	AO2 Calibration Pt2 (8 mA)
178	Float	AO2 Calibration Pt3 (12 mA)
180	Float	AO2 Calibration Pt4 (16 mA)
182	Float	AO2 Calibration Pt5 (20 mA)
184	Float	Water Level
186	Float	Field Voltage
188	Float	24V Output Voltage
190	Float	RTD Calibration Pt1
192	Float	RTD Calibration Pt2
194	Float	RTD Calibration Pt3
196	Float	RTD Calibration Pt4
198	Float	RTD Calibration Pt5
200	Float	Level (Tank Data > Level)
202	Float	Temp (Tank Data > Temp)
204	Float	RTD Resist
206	Float	Secondary Level
208	Float	RTD Temperature

Register Number	Type	Description
210	Integer	AlmStat (Bit Field) (Tank Data > AlmStat)
211	Integer	DiagStat (Bit Field) (Tank Data > DiagStat)
212	Integer	AO1 Calibration Command
213	Integer	AO2 Calibration Command
214	Reserved	
215	Coded	Level Units (Local Display) 44 - Feet 45 - Meters 47 - Inches 49 - Millimeters 240 - 16ths 241 - Ft-In-16ths 243 - Ft-In-8ths
-	Coded	Temp Units (Local Display) 33 - F 32 - C
217	Coded	Secondary Level Units 45 - METERS 44 - FEET 47 - INCHES 241 - FT-IN-16THS 240 - 16th of an INCH 49 - MILLIMETERS 243 - FT - IN - 8THS
218	Coded	Water Level Units 45 - METERS 44 - FEET 47 - INCHES 241 - FT-IN-16THS 240 - 16th of an INCH 49 - MILLIMETERS 243 - FT - IN - 8THS
219	Reserved	
220	Integer	Encoder Direction
221 - 224	Reserved	
225	Coded	Gauge Type (Basic Setup > Gauge Type) 0 - Metric 1 - English

Register Number	Type	Description
226	Coded	Power Control (Basic Setup > Control) 11 - On 12 - Off
227 - 229	Reserved	Reserved
230	Float	Crit Low Level (MODBUS > CritLowLevel)
232	Float	Adv Low Level (MODBUS > AdvLowLevel)
234	Float	Adv High Level (MODBUS > AdvHighLevel)
236	Float	Crit High Level (MODBUS > CritHighLevel)
238	Float	Level Deadband (MODBUS > LDeadband)
240	Float	Crit Low Temp (MODBUS > CritLowTemp)
242	Float	Adv Low Temp (MODBUS > AdvLowTemp)
244	Float	Adv High Temp (MODBUS > AdvHighTemp)
246	Float	Crit High Temp (MODBUS > CritHighTemp)
248	Float	Temp Deadband (MODBUS > TDeadband)
250	Float	Min Level (MODBUS > MinLevel)
252	Float	Max Level (MODBUS > Maxlevel)
254	Float	Min Temp (MODBUS > MinTemp)
256	Float	Max Temp (MODBUS > MaxTemp)
258	Float	Water Level
260	Float	Man Temp (Tank Data > ManTemp)
262	Integer	FDisk (Encoder Data > FDisk)
263	Integer	IDisk (Encoder Data > IDisk)
264	Integer	Encoder State (Encoder Data > Enc State)
265	Integer	Hardware Version (System Data > Hardware Version)
266	Integer	LCD Contrast (System Data > LCD Contrast)
267	Integer	Firmware Checksum (System Data > Sys Checksum)
268	Long (Read Only)	Serial Number (System Data > Product SN)
270	Bit Field	DO Output Control (Digital Outputs > DOutputState) <u>Bit Usage</u> 0 - Output #1 1 - Output #2 2 - Output #3 3 - Output #4 4 – 15 - Reserved

Register Number	Type	Description
271	Bit Field	DO Output in power-up state; when set the DO will close at power-up. (Digital Output > DOPwrUpState) <u>Bit Usage:</u> 0 - Output #1 Power-up State 1 - Output #2 Power-up State 2 - Output #3 Power-up State 3 - Output #4 Power-up State 4 - Output #1 Controlled at Power-up 5 - Output #2 Controlled at Power-up 6 - Output #3 Controlled at Power-up 7 - Output #4 Controlled at Power-up
272	Bit Field	DO State (Digital Outputs > DOState) 0 - Output #1 1 - Output #2 2 - Output #3 3 - Output #4
273 - 284	Reserved	
285	Coded	DO #1 Output Assignment: (Digital Outputs > DO1 Assignment) 0 - Not Assigned 1 - Host Control 2 - Critical High Level 3 - Advisory High Level 4 - Advisory Low Level 5 - Critical Low Level 6 - Critical High Temp 7 - Advisory High Temp 8 - Advisory Low Temp 9 - Critical Low Temp
286	Coded	DO #2 Output Assignment: (Digital Outputs > DO2 Assignment) 0 - Not Assigned 1 - Host Control 2 - Critical High Level 3 - Advisory High Level 4 - Advisory Low Level 5 - Critical Low Level 6 - Critical High Temp 7 - Advisory High Temp 8 - Advisory Low Temp 9 - Critical Low Temp

Register Number	Type	Description
287	Coded	DO #3 Output Assignment: (Digital Outputs > DO3 Assignment) 0 - Not Assigned 1 - Host Control 2 - Critical High Level 3 - Advisory High Level 4 - Advisory Low Level 5 - Critical Low Level 6 - Critical High Temp 7 - Advisory High Temp 8 - Advisory Low Temp 9 - Critical Low Temp
288	Coded	DO #4 Output Assignment: (Digital Outputs > DO4 Assignment) 0 - Not Assigned 1 - Host Control 2 - Critical High Level 3 - Advisory High Level 4 - Advisory Low Level 5 - Critical Low Level 6 - Critical High Temp 7 - Advisory High Temp 8 - Advisory Low Temp 9 - Critical Low Temp
289	Integer	DO1 Output on Duration (Seconds) (Digital Outputs > Duration1)
290	Integer	DO2 Output on Duration (Seconds) (Digital Outputs > Duration2)
291	Integer	DO State (Digital Outputs > DOState)
292 - 301	Reserved	
302	Float	Hydrostatic Tank Level
304	Float	P1 Bottom Pressure
306	Float	P2 Middle Pressure
308	Float	P3 Top Pressure
310	Float	Air Temperature
312	Float	Vapor Temperature
314	Float	Observed Density
316	Float	Standard Density
318	Float	Volume Correction Factor
320	Integer	Hydro PntStatus
321 - 339	Reserved	

Register Number	Type	Description
340	Integer	Hydrostatic Mode
341	Integer	Hydrostatic Pressure Units 1- in H2O 6 - PSI 7 - Bar 8 - mBar 11 - Pa 12 - kPa 237 - Mpa
342	Integer	Hydrostatic Density Units 104 - API 92 - kg/m3 95 - g/ml 94 - lbs/ft3 93 - lbs/gal 90 - SGU
343	Integer	Hydrostatic Correction Method
344	Float	Hydrostatic P1 Distance
346	Float	Hydrostatic P1 - P2 Distance
348	Float	Hydrostatic P3 Height
350	Float	Hydrostatic min. level for HTMS calc
352	Float	Hydrostatic Offset for Bottom Pressure P1
354	Float	Hydrostatic Offset for Middle Pressure P2
356	Float	Hydrostatic Offset for Top Pressure P3
358	Float	Hydrostatic Tank Altitude
360	Float	Hydrostatic Thermal Expansion Coefficient
362	Float	Hydrostatic Install Temp
364	Float	Hydrostatic Manual Vapor pressure
366	Float	Hydrostatic Manual Standard Density
368	Float	Hydrostatic Manual Air Temp
370	Float	Hydrostatic Manual Air Density
372	Float	Hydrostatic Manual Vapor Temp
374	Float	Hydrostatic Manual Vapor Density
376	Float	Hydrostatic gravitation const. in m/sec2
378	Integer	Hydrostatic Command
400	Float	Float Temperature Offset
402	Float	Minimum Pressure
404	Float	Maximum Pressure

Register Number	Type	Description
406	Float	Minimum Density
408	Float	Maximum Density
410	Float	Tank Reference Height
3019	Float	FMR Level (FMR Radar > Level)
3021	Float	FMR Status (FMR Radar > Status)
3023	Float	FMR Measured Level (FMR Radar > Meas. Level)
3025	Float	FMR Distance (FMR Radar > Measured Dist.)
3027	Integer	FMR Custody Mode
3028	Integer	FMR Media Type/Application Parameter (FMR Radar > Medium Prop.)
3029	Integer	FMR Pnt Status (FMR Radar > Pnt Status)
3030	Float	Average Temperature (NMT Prothermo > Avg Temp)
3032	Float	Vapor Temperature (NMT Prothermo > Vap Temp)
3034	Float	Temp0 (NMT Prothermo > Elem#01)
3036	Float	Temp1 (NMT Prothermo > Elem#02)
3038	Float	Temp2 (NMT Prothermo > Elem#03)
3040	Float	Temp3 (NMT Prothermo > Elem#04)
3042	Float	Temp4 (NMT Prothermo > Elem#05)
3044	Float	Temp5 (NMT Prothermo > Elem#06)
3046	Float	Temp6 (NMT Prothermo > Elem#07)
3048	Float	Temp7 (NMT Prothermo > Elem#08)
3050	Float	Temp8 (NMT Prothermo > Elem#09)
3052	Float	Temp9 (NMT Pr))othermo > Elem#10
3054	Float	Temp10 (NMT Prothermo > Elem#11)
3056	Float	Temp11 (NMT Prothermo > Elem#12)
3058	Float	Temp12 (NMT Prothermo > Elem#13)
3060	Float	Temp13 (NMT Prothermo > Elem#14)
3062	Float	Temp14 (NMT Prothermo > Elem#15)
3064	Float	Temp15 (NMT Prothermo > Elem#16)
3066	Float	Average Number
3068	Float	Measured Level (NMT Prothermo > Meas. level)
3070	Integer	Error code (NMT Prothermo > Cmd Error)
3071	Long	Status (NMT Prothermo > Cmd Status)
3073	Integer	Diag Code (NMT Prothermo > Diag Code)
3074	Integer	Custody Mode
3075	Integer	Pnt Status (NMT Prothermo > Pnt Status)

Register Number	Type	Description
3076	Float	HART0 PV (HART Device #1 > PV Value)
3078	Float	HART0 SV (HART Device #1 > SV Value)
3080	Integer	HART0 Pnt Status (HART Device #1 > Pnt Status)
3081	Float	HART1 PV (HART Device #2 > PV Value)
3083	Float	HART1 SV (HART Device #2 > SV Value)
3085	Integer	HART1 Pnt Status (HART Device #2 > Pnt Status)
3086	Float	HART2 PV (HART Device #3 > PV Value)
3088	Float	HART2 SV (HART Device #3 > SV Value)
3090	Integer	HART2 Pnt Status (HART Device #3 > Pnt Status)

## 32-Bit Floating Point Register Map

Register Number	Description
0	Level
1	Temp
2	RTD Resist
3	Secondary Level
4	Reserved
5	Crit Low Level
6	Adv Low Level
7	Adv High Level
8	Crit High Level
9	Level Deadband
10	Crit Low Temp
11	Adv Low Temp
12	Adv High Temp
13	Crit High Temp
14	Temp Deadband
15	Min Level
16	Max Level
17	Min Temp
18	Max Temp
19	Reserved
20	Manual Temp

Register Number	Description
21	Calibration Level
22 – 30	Reserved
31	Water Bottom Level
32 – 35	Reserved
36	Product Temperature
37	Encoder Temperature
38	NMT Element 1 - Tb
39	NMT Element 2 - Tm
40	NMT Element 3 - Tt
41 – 43	Reserved
44	HART 0 PV
45	HART 1 PV
46	HART 2 PV
47 – 49	Reserved
50	RTD Resistance
51	AI Value - 4-20 mA Current
52	Minimum Pressure
53	Maximum Pressure
54	Minimum Density
55	Maximum Density
56	Tank Reference Height
364	Calibration Level

## Status Bit Register Map

Register Number	Description
0 – 15	AlmStat
16 – 31	Diag Stat
32 – 47	Cmds
48 - 63	Reserved
64 - 79	Reserved
80 - 95	DO Output Control
96 - 111	DO Output Power-up State
112 - 127	DO State

Register Number	Description
128- 143	DO1 Assign
144 - 159	DO2 Assign
160 - 175	DO3 Assign
176 - 191	DO4 Assign
192 - 207	DO1 Output Duration

## Device Emulation Using Modbus Register MAPs

The 2920 FTT has the ability to emulate other devices by choosing pre-defines Modbus Registers Maps. Device emulation is configured by selecting the appropriate Modbus mapping to emulate. The configuration setting MODBUS Reg MAP is located in the Config Params of the Basic Setup Menu:

**Basic Setup > Config Params > MODBUS Reg MAP**

### 29XX MAP

This is the default Modbus map for the 2920 FTT. This map allows access to the Modbus parameters maps outlined in this appendix.

### GSI MAP

This Modbus map is used for emulating GSI Modbus level transmitters and gauges.

### MFT/HIU MAP

This Modbus map is used for emulating Varec 4100/4200 Hydrostatic Interface Unit/Multi-Function Transmitters. Although the 2920 FTT does not support all data parameters available from the MFT/HIU, the 2920 FTT will respond to many of the Modbus registers specific to the MFT/HIU. This setting is useful when using a 2920 FTT to replace an MFT/HIU in legacy system like the 8130 RTU.

### TSM ver 1.x MAP

This Modbus map is used for emulating an E+H version 1 Tank Side Monitor (TSM). Although the 2920 FTT does not support all data parameters available from the TSM, the 2920 FTT will respond to many of the Modbus registers specific to the TSM. This setting is useful when using a 2920 FTT to replace a TSM in legacy system like the 8130 RTU.

## **TSM4590 MAP**

This Modbus map is used for emulating newer versions of the E+H Tank Side Monitor (TSM). Although the 2920 FTT does not support all data parameters available from the TSM, the 2920 FTT will respond to many of the Modbus registers specific to the TSM. This setting is useful when using a 2920 FTT to replace a TSM in legacy system like the 8130 RTU.

## **NMS53 MAP**

This Modbus map is used for emulating E+H NMS 5x Proservo Tank Gauges. Although the 2920 FTT does not support all data parameters available from the Proservo, the 2920 FTT will respond to many of the Modbus registers specific to the Proservo. This setting is useful when using a 2920 FTT to replace or emulate a Proservo in an 8130 or 8810 RTU system.

## **NMx8/NRF8 MAP**

This Modbus map is used for emulating E+H NMS8x, NMR8x and NRF8x devices. Although the 2920 FTT does not support all data parameters available from the E+H devices, the 2920 FTT will respond to many of the specific Modbus registers. This setting is useful when using a 2920 FTT to emulate an E+H 8x device in an 8810 RTU system.

# Appendix B — RTD Resistance - Temperature Charts

This appendix describes the relationship between temperature and resistance for the three RTD types that can be used with the 2920 FTT. This information can be used to verify the accuracy of the RTD probe used with the 2920 FTT.

The following tables are provided:

- “Pt100 RTD Resistance vs. Temperature”
- “Cu100 RTD Resistance vs. Temperature”
- “Cu90 RTD Resistance vs. Temperature”

For troubleshooting instructions, see “Verifying Temperature Data - Checking RTD Resistance”.

## 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

Pt100		
RTD Resistance	Temp °C	Temp °F
52.11	-120.0	-184.0
53.74	-116.0	-176.8
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

Pt100		
RTD Resistance	Temp °C	Temp °F
115.54	40.0	104.0
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

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

## 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

Cu100		
RTD Resistance	Temp °C	Temp °F
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
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

Cu100		
RTD Resistance	Temp °C	Temp °F
120.95	80.0	176.0
122.48	84.0	183.2
124	88.0	190.4
125.52	92.0	197.6
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

## Cu90 RTD Resistance vs. Temperature

Cu90		
RTD Resistance	Temp °C	Temp °F
51.77	-100.00	-148.00

Cu90		
RTD Resistance	Temp °C	Temp °F
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
109.09	48.0	118.4
110.64	52.0	125.6
112.19	56.0	132.8
113.74	60.0	140.0

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

## Appendix C — Biphase Mark Implementation

This protocol chapter explains the operation of the Biphase Mark as it pertains to the 2920 Float & Tape Transmitter.

### Implementation

The implementation of the Biphase Mark (BPM) protocol on the 2920 supports a variety of commands represented by a TOR (Type of Request) and some of them further by an item. All of them are defined by an ASCII character on the request frame.

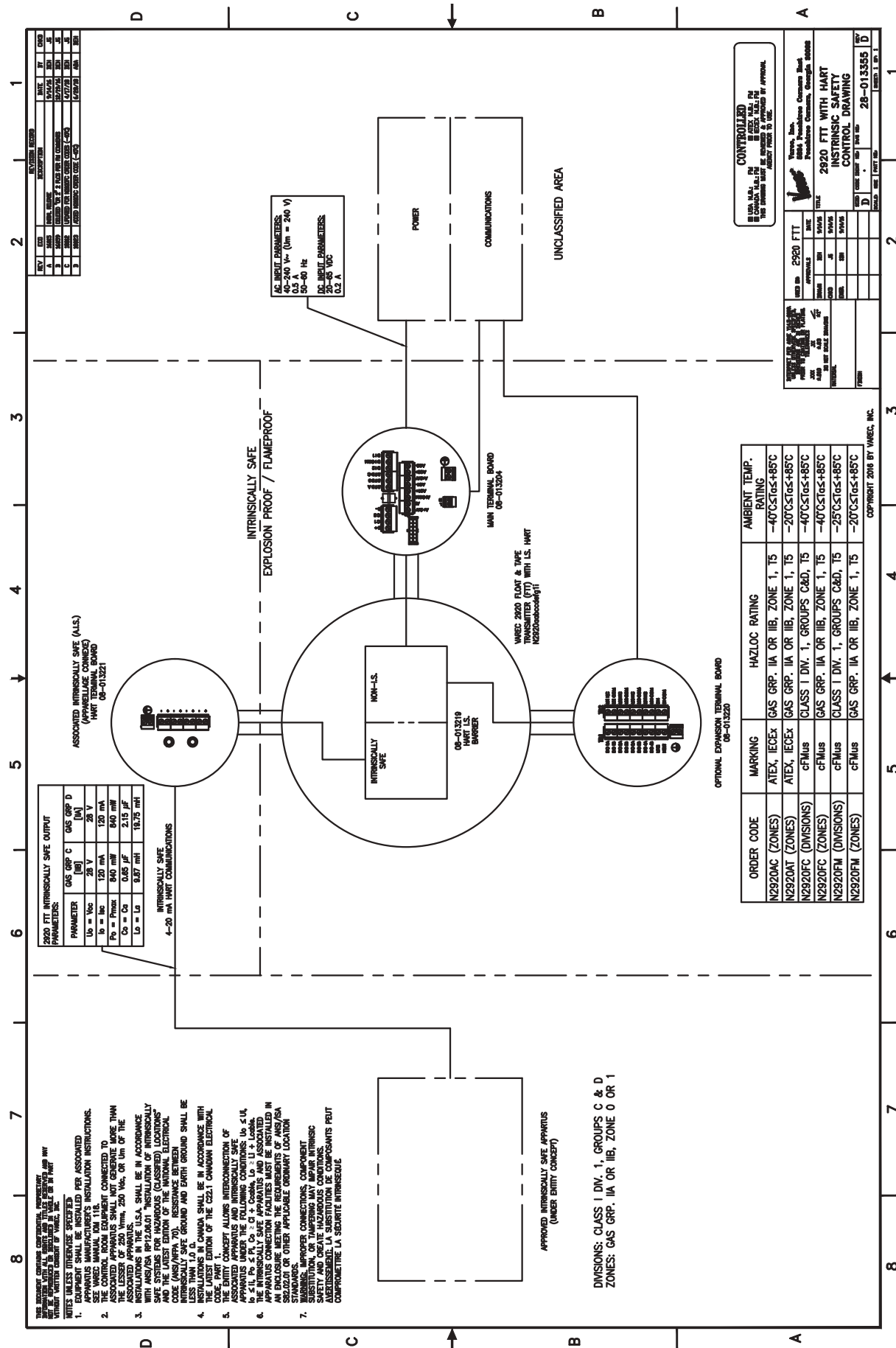
The Biphase Mark functions implemented in the 2920 FTT are listed in the table below.

TOR	Item	Description
A		Alarm Status Record
B		Alarm Status and Level Record
C		Alarm Status and Temperature Record
D		Alarm Status, Level, and Temperature Record
L		Alarm Status and Level Record
Z	AF	Analog Output Overwrite With this item, the user can manually overwrite the current output through the Host interface.
	AK	Analog 1 Output Mode This item determines under what conditions the analog output current will operate. Overwrite mode (Host can send output value): D, O & P Level Output (Output follows a valid Tank Level): L, M, A, B, I, and J .
	AL	Tank Level Read current tank level.
	AM	Analog Output 4 mA value (Offset) This item must be programmed with the level value which corresponds with an output current of 4 mA.
	AN	Analog Output 20 mA value (Scale) This item must be programmed with the level value which corresponds with an output current of 20 mA.
	HA	High Alarm If the tank level rises above the high alarm level, the relevant bit is set in the Level status. This bit remains set until the displacer drops below the high alarm level.
	HH	High High Alarm High High Alarm sets the high-high alarm level. The monitoring of High High is identical to the High Alarm.

TOR	Item	Description
	LA	Low Alarm The low alarm level is triggered with the level falls below the LA, the relevant level status bit is set. This bit remains set until the level is again above the low level alarm setting.
	LL	Low Low Alarm Low Low sets the low-low alarm level. Monitoring of Low Low is identical to the Low Alarm.
	TD	Temperature Dimension (C or F) The units in which the measured temperature is transmitted.
	LD	Level Dimension (M, F, I, P) The units in which the level is transmitted. Valid values are Meters, Feet, Inches, P-fractions (feet, inches, 1/16ths).
	AR	Accept Reference After issuing the AR command, the processor accepts the reference level (RL) as the current level. AR is used during level calibration.
	LQ	Innage Servo Level Request—responds with Tank Level Computes innage level with status characters.
	RL	Reference Level Temporary storage for level until an AR command is issued.
	RN	Relay Command A—Activate, D—Deactivate, K—Acknowledge (used with DO 1 & 2) If the relays have been set for remote control, the relays can be activated or deactivated using the item RN.
	RX	Relay Status A—Active, T—Active with a Duration, D—Deactive, FF—Failure The current setting or status of the relays can be read using the RX item.
	RY	Relay Alarm Mode RC—Remote Control (Host Control), HH—High High, HA—High Alarm, LA—Low Alarm, LL—Low Low Alarm, NM—Not Mounted Using the RY item, the relay can be used: <ul style="list-style-type: none"> <li>An alarm relay coupled to one of the programmable software alarms</li> <li>Remote controlled relay using the receiving system</li> </ul>

## **Appendix D — Associated Intrinsically Safe Control Drawing**

The drawing on the following page depicts the 2920 Float and Tape Transmitter with HART Associated Intrinsic Safety.



## Appendix E — Mark/Space Coding

This protocol chapter explains how Mark/Space coding works as it pertains to the 2920 Float & Tape Transmitter.

### Mark/Space Coding

All communications between the receiver and the 2920 FTT are accomplished over a common pair of Mark/Space pulse code lines. a pulse is sensed as a low (line drops from +48 VDC to approximately 0 VDC) to indicate the presence of either a Mark or Space.

If the Mark line is pulsed low, it is designated a Mark and considered a logic "1". If the Space line is pulsed low, it is designated a Space and considered a logic "0". If both the Mark and Space lines are simultaneously low, it is an error or fault condition.

Two basic data rates are supported over the Mark/Space interface: low speed and high speed. The poll and response data bit timing is illustrated in Figure 1:

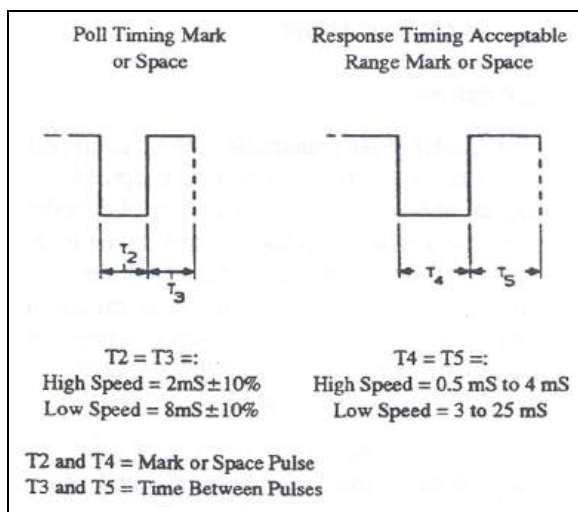


Figure 1: Mark/Space Bit Timing

The poll/response timing requirements for a Mark/Space interface are indicated in Figure E-2.

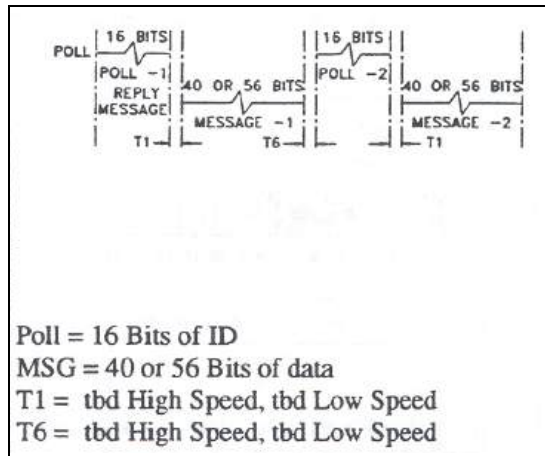


Figure E-2 Poll/Response Timing

## Message Structure

The data transfer between the 2920 FTT and a receiver are accomplished over the common pair of Mark/Space data lines. The message protocol used is an interrogate/response protocol. The receiver places a 16-bit interrogation message on the data lines containing the ID of the device from which a response is desired. If the ID in the interrogation matches the ID of the transmitter, it responds with a 40- or 56-bit response message.

## Interrogation (Poll) Message

The interrogation message is a 16-bit message consisting of the following bits (see Figure E-3):

Bit(s)	Interpretation
1	Start bit (Mark)
2	Unused
3	Raise command (for 6500 Servo Gauge)
4	Reset command (for 6500 Servo Gauge)
5-8	Most significant ID bits (ID x 100)
9-12	Next most significant ID bits (ID x 10)
13-16	Least significant ID bits (ID x 1)

Table E-1 16-bit Interrogation (Poll) Message

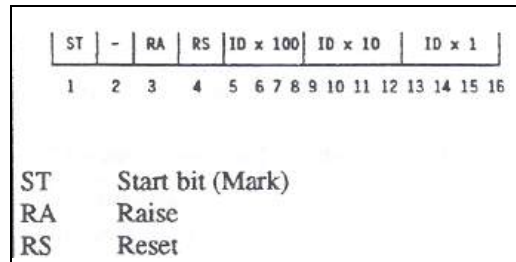


Figure E-3 Interrogate Data Structure

## Response Message

The return message from the 2920 FTT can be either 40 or 56 bits long, depending on whether temperature reporting is configured. The basic format of the 40-bit level message is indicated in Figure E-4.

The 40-bit response message consists of the following bits:

Bit(s)	Interpretation
1	Start bit (Mark)
2, 3	Unused
4-7	Most significant ID bits (ID x 100)
8-11	Next most significant ID bits (ID x 10)
12-15	Least significant ID bits (ID x 1)
16	First data bit (always a Space)
17-37	Level Data
38	Alarm 1 (optional external alarm)
39	Alarm 0 (optional external alarm)
40	Parity

Table E-2 40-bit Transmitter Response Message Bits

The Start bit is always a Mark. Bits 2 and 3 are unused. Bits 4 through 15 are the ID of the responding transmitter. Bit 16 is always a Space. Bits 17 through 37 contain the actual level data. Bits 38 and 39 reflect the state of the optional external alarm inputs. All unused bits in the message are transmitted as Space pulses.

Bit 40 is the parity bit. The parity bit is a Mark when the number of Mark pulses in the preceding portion of the data message (bits 1 through 39) are even. When the number of Mark pulses is odd, the parity bit will be a Space. Note that in all cases, the entire 40-bit message will contain an odd number of Mark pulses.

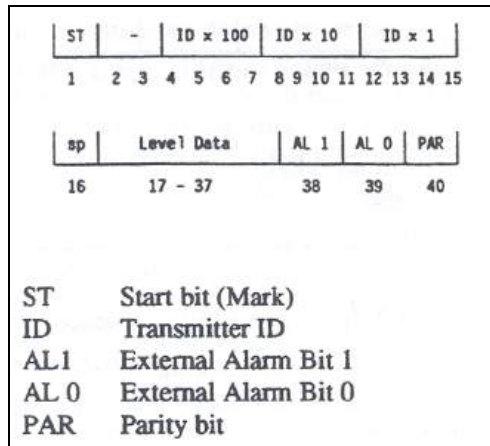


Figure E-4 40-bit Transmitter Response Message Example

The basic format of the 56-bit level message is indicated in Table E-3.

The 56-bit response message consists of the following bits:

Bit(s)	Interpretation
1	Start bit (Mark)
2, 3	Unused
4-7	Most significant ID bits (ID x 100)
8-11	Next most significant ID bits (ID x 10)
12-15	Least significant ID bits (ID x 1)
16	First data bit (always a Space)
17-37	Level Data
38	Alarm 1 (optional external alarm)
39	Alarm 0 (optional external alarm)
40	X100 temp bit
41	Sign
42	X200 temp bit
43	X400 temp bit
44-47	Temp x 10
48-51	Temp x 1
52-55	Temp x 0.1
56	Parity

Table E-3 56-bit Transmitter Response Message Bits

Bits 1 through 39 of the 56-bit response message are identical to the 40-bit level response message. Bit 40 is the X100 digit, bit 41 is the sign bit, bit 42 is the X200 bit and bit 43 is the X400 bit. Bits 44 through 55 contain the 3 temperature digits in BCD format. Bit 56 is the parity bit and acts the same as bit 40 in the 40-bit level response message.

As an example, a temperature of +256.8 degrees would have bits 40 through 55 as follows:

Bits:	40	41	42	43	44-47	48-51	52-55
Data:	0	1	1	0	0101	0110	1000
Temp:	-	+	200	-	5	6	8

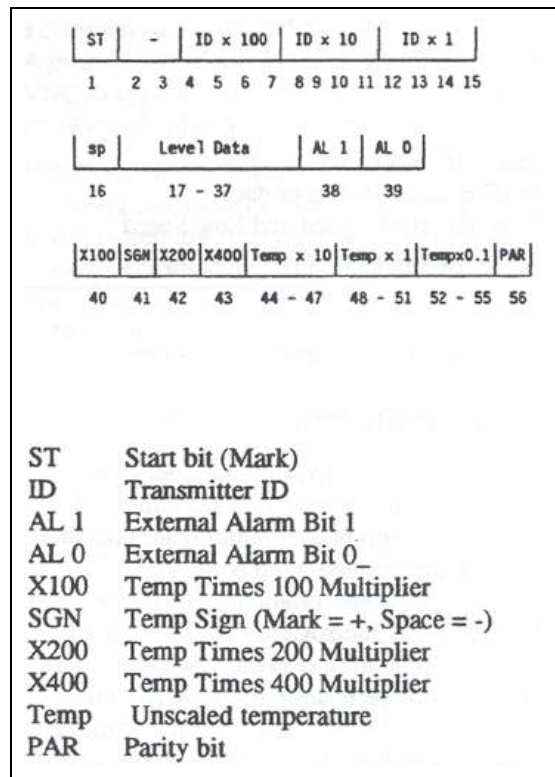


Figure 5: 56-bit Transmitter Response Message Example

## Encoder Pulse Format

To minimize transmission errors, all pulse code signals consist of Marks (1) and Spaces (0) and have three characteristics:

1. For English unit transmissions, the first level pulse is always a Mark (1).
2. The number of pulses in a message is always constant for a specific type of transmit and does not vary with the data (always 40 or 56 bits).
3. Only one level data code element (bit) will change between any two adjacent data increments. For example, only one Mark (1) will change to a Space (0) for a single bit change of data between 29.98 feet (001 1000 0000 0001) and 29.99 feet (001 1000 0000 0000).

The pulse code format for level data used by the transmitter is reflected binary Gray pulse code. Figure E-6 shows a decimal English code sequence with a range of 00.00 to 79.99 feet in 0.01 foot increments. Code element one, the start pulse that is always a Space, is not shown.

Note that in the 0.01 foot increment column, there is only one element change as the level increases from 0.00 to 0.09. Over an 80-foot range, however, this code is required to repeat 8,000 times. Under these conditions, 0.09 and 0.00 become adjacent increments. This would not be difficult if only the FT x 0.01 column were involved. The FT x 0.1, FT x 1 and FT x 10 columns, however, also come into play.

The above conflict is resolved by using the code itself to determine the code elements. In the FT x 0.01 column in Figure E-6, when the level has reached 0.09, the code begins to repeat the preceding in a reflected format. This results in 0.09 being the same as 0.00. The reflected portion of the code is labeled as ODD and refers to the next significant digit in this case, the FT x 0.1 column.

Zero (0) is considered to be an even number as are 2, 4, 6, and 8. All other numbers are considered as odd. Note that the requirement that only one code element change between adjacent increments is still satisfied. When the level reaches 0.19, the code is 0001 0000 and has reached a point where 0.09 (odd) is the same code as 0.00 (even). When the level reaches the next increment, only one code element changes (#11) from 0 to 1, and the code reads 0011 0000. The 0.1 code is now even, and the 0.01 code now used is also even. This similarity applies to the relationship between FT x 0.1 and FT x 1.0. The even and odd groups for the FT x 0.1 code refer to the odd and even conditions of the FT x 1 code, and the even and odd groups for the FT x 1 code refer to the odd and even conditions of the FT x 10 code. This coding principle also applies when the level increments are 1 mm in the metric system (see Figure E-7). A fractional code chart is also provided in Figure E-8.

## **Troubleshooting Considerations**

When troubleshooting, the following points, the following points should be taken into consideration:

- Only one bit in the code changes between any two successive points of data
- Whether the code for a given digit is odd or even depends on whether or not the preceding digit is odd or even
- Always start with the most significant digit (msd) and go to the least significant digit (lsd).

# Code Charts

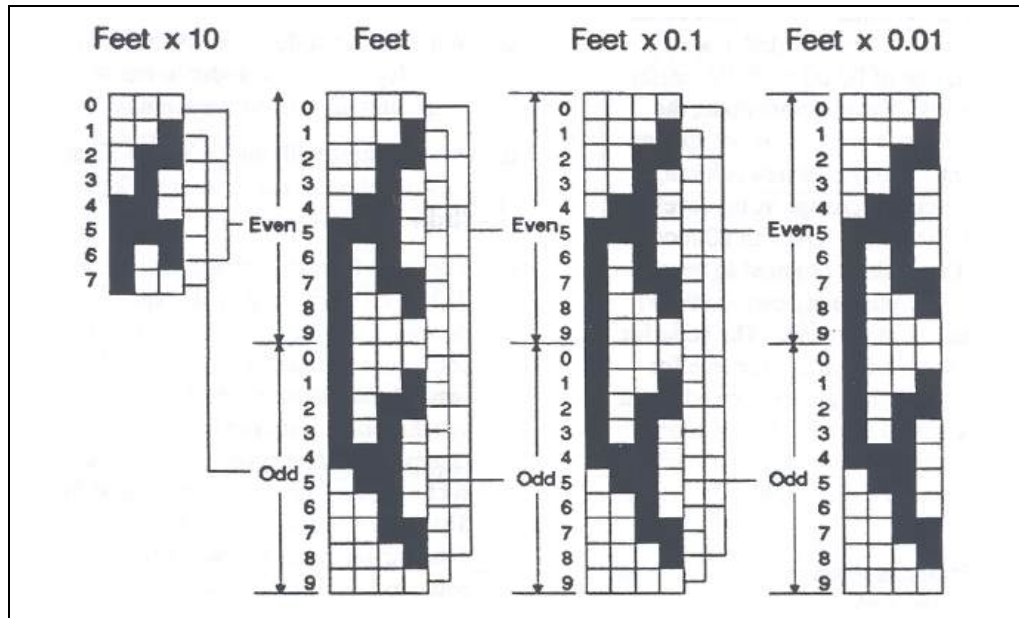


Figure E-6 Decimal Feet Code Chart

The use of ODD or EVEN code depends on the ODD or EVEN condition of the preceding significant digit.

Shaded (black) areas represent Mark (1). Unshaded (white) represents Space (0).

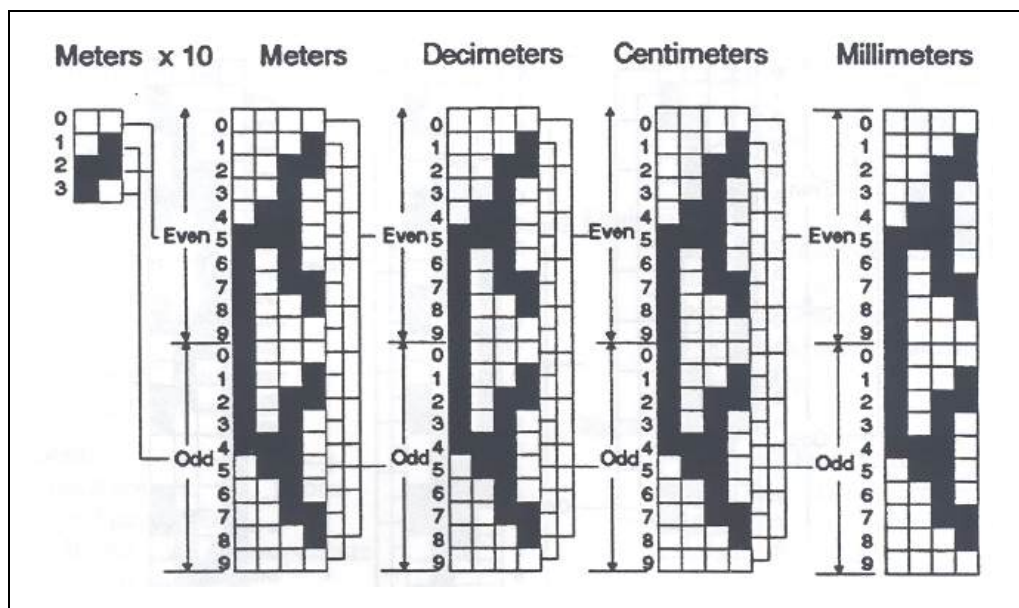


Figure E-7 Metric Code Chart

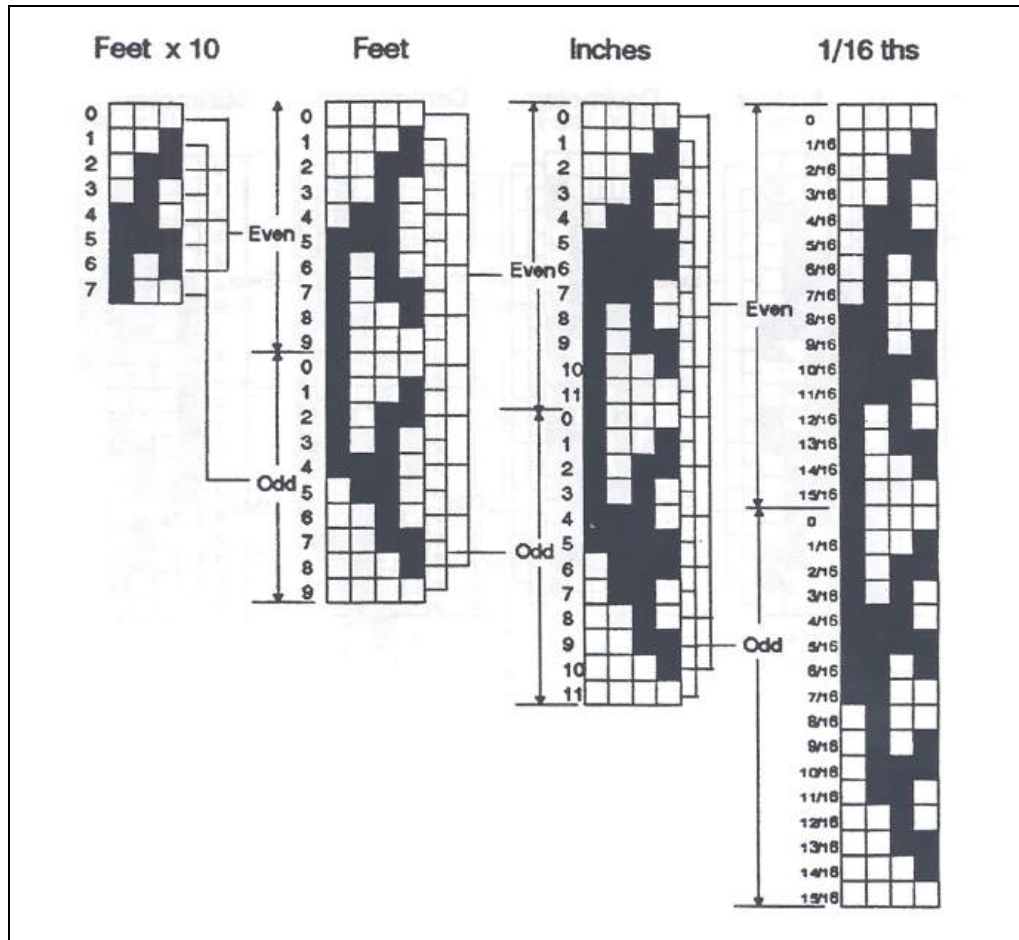


Figure E-8 Fractional Feet Code Chart

The use of ODD or EVEN code depends on the ODD or EVEN condition of the preceding significant digit.

Shaded (black) areas represent Mark (1). Unshaded (white) represents Space (0).

# Appendix F — Hydrostatic Calculations

## Introduction

Depending on the tank instrumentation, the 2920 FTT not only displays and communicates measured values to the Host System, but is also able to perform hydrostatic calculations.

For tanks equipped with 2 or 3 pressure sensors and temperature sensors, the (observed) product level and the product density can be calculated.

For tanks equipped with level, temperature and at least one pressure sensor, the observed product density can be calculated.

These capabilities were released in firmware versions XXXX 3\_00.

## HTG - Measurement Principles

### Overview

Hydrostatic Tank Gauging (HTG) is a method to calculate the level and the density of the product inside a tank using pressure measurements only. The pressure is measured at different heights of the tank using one, two or three pressure sensors. With these data either the density or the level of the product (or both) can be calculated. Fig 1 shows a simple conic roof tank and the position of the various pressure sensors ( $P_1$  to  $P_3$ ).

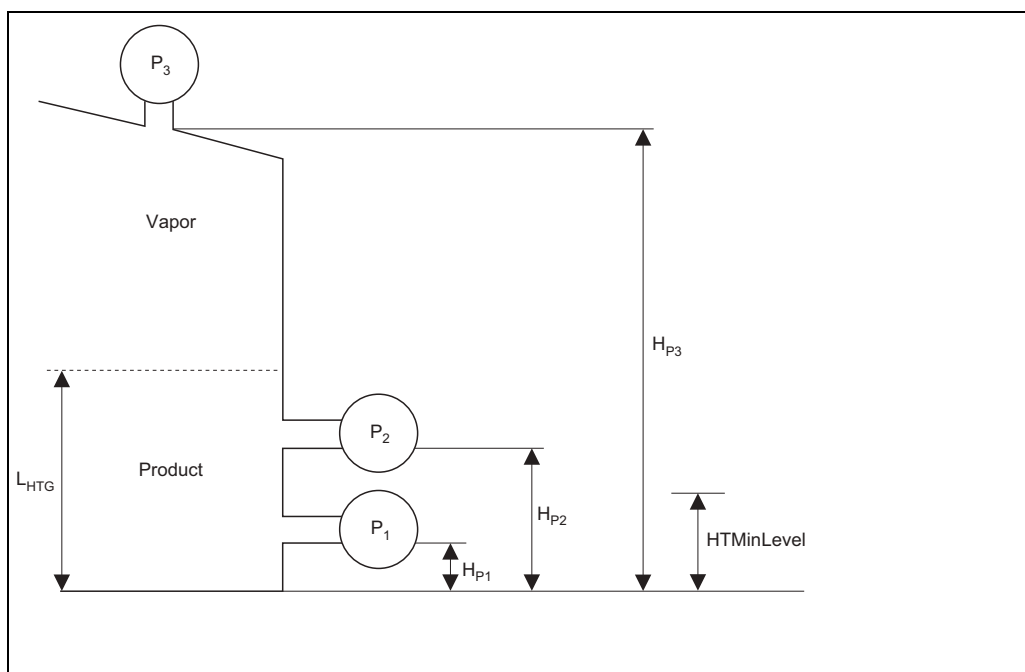


Figure 1-1 HTG overview Diagram

## HTG Modes and Equations

### HTG Modes

Two parameters can be calculated with HTG: the level of product in the tank and the density of this product.

To calculate the density both pressure sensors  $P_1$  and  $P_2$  must be present. The density is needed to calculate the level. If the density cannot be calculated (either because the pressure sensor  $P_2$  is not present or because the level of the liquid is too low) then the manual value will be used. The value given by an extra pressure sensor ( $P_3$ ) located on the top of the tank can be used to make level calculations more accurate.

Configurations are available in the 2920 FTT (selected through the parameter mode):

- One configuration uses a single pressure sensor ( $P_1$  or  $P_2$ ). In this mode only the level can be calculated and the density has to be entered manually (parameter ManStdDens).
- Another configuration uses pressure sensors  $P_1$  and  $P_2$ . Both density and level are calculated in this mode.
- If  $P_3$  is valid, it will be used to improve these calculations.

### HTG Equations

Single Pressure:  $P_1$  (Bottom) or  $P_2$  (Middle)

$$D_{\text{obs}} = D_{\text{man}} \qquad L_{\text{HTG}} = \frac{P_1}{D_{\text{obs}} * g} + H_{P1}$$

Figure 1-2 Single Pressure Diagram

Single Pressure + Top Pressure:  $P_1$  (Bottom) +  $P_3$  (Top) or  $P_2$  (Middle) +  $P_3$  (Top)

$$D_{\text{obs}} = D_{\text{man}} \qquad L_{\text{HTG}} = \frac{\frac{P_1 - P_3}{g} + H_{P1-P3} * D_{\text{air}} - H_{P1-P3} * D_{\text{vap}}}{D_{\text{obs}} - D_{\text{vap}}} + H_{P1}$$

Figure 1-3 Mode 2 –  $P_1$  (Bottom) +  $P_3$  (Top) Diagram

Density:  $P_1$  (Bottom) +  $P_2$  (Middle)

$$D_{\text{obs}} = \frac{P_1 - P_2}{H_{P1-P2} * g} + D_{\text{air}}$$

$$L_{\text{HTG}} = \frac{P_1}{D_{\text{obs}} * g} + H_{P1}$$

Figure 1-4 Two Pressure Probes – Density –  $P_1$  (Bottom) +  $P_2$  (Middle) Diagram

Three Pressure Probes: P<sub>1</sub> (Bottom) + P<sub>2</sub> (Middle) + P<sub>3</sub> (Top)

$$D_{\text{obs}} = \frac{P_1 - P_2}{H_{P1-P2} * Ig} + D_{\text{air}}$$

$$L_{\text{HTG}} = \frac{\frac{P_1 - P_3}{Ig} + H_{P1-P3} * D_{\text{air}} - H_{P1-P3} * D_{\text{vap}}}{D_{\text{obs}} - D_{\text{vap}}} + H_{P1}$$

Figure 1-5 Three Pressure Probes – P<sub>1</sub> (Bottom) + P<sub>2</sub> (Middle) + P<sub>3</sub> (Top) Diagram

Level and density are calculated according to following parameters:

P<sub>1</sub>: pressure measured by pressure sensor P<sub>1</sub> [Pa]

P<sub>2</sub>: pressure measured by pressure sensor P<sub>2</sub> [Pa]

P<sub>3</sub>: pressure measured by pressure sensor P<sub>3</sub> [Pa]

Ig: local gravity (= 9,807 m/s<sup>2</sup>)

H<sub>P1</sub>: distance between P<sub>1</sub> and the tank zero [m]

H<sub>P1-P2</sub>: distance between P<sub>1</sub> and P<sub>2</sub> [m]

H<sub>P1-P3</sub>: distance between P<sub>1</sub> and P<sub>3</sub> [m]

D<sub>man</sub>: manual density (kg / m<sup>3</sup>) (same as ManStdDens)

D<sub>obs</sub>: observed product density (kg / m<sup>3</sup>)

D<sub>air</sub>: density of the air outside the tank (kg / m<sup>3</sup>) (same as Man. Air dens)

D<sub>vap</sub>: density of the vapor in tank (kg / m<sup>3</sup>) (same as Man. Vap. dens)

L<sub>HTG</sub>: calculated product level [m]

## Parameter Range

### *Calculated/Held Density and Level*

To calculate level or density by HTG with the required accuracies, P<sub>1</sub> respectively P<sub>2</sub> have to be covered by a certain product level. If the product level falls below the position of the pressure sensor P<sub>1</sub>, calculating the level becomes impossible. Density calculations can only be performed as long as the product level remains above the position of the pressure sensor P<sub>2</sub>.

Additionally, if the product level gets too low and gets close to either P<sub>1</sub> or P<sub>2</sub>, the uncertainty of the pressure measurement increases. To avoid these uncertainties in the HTG calculations, the calculation will stop before the level reaches the position of the pressure sensor.

Levelmin parameter sets the minimum level for hydrostatic calculations.

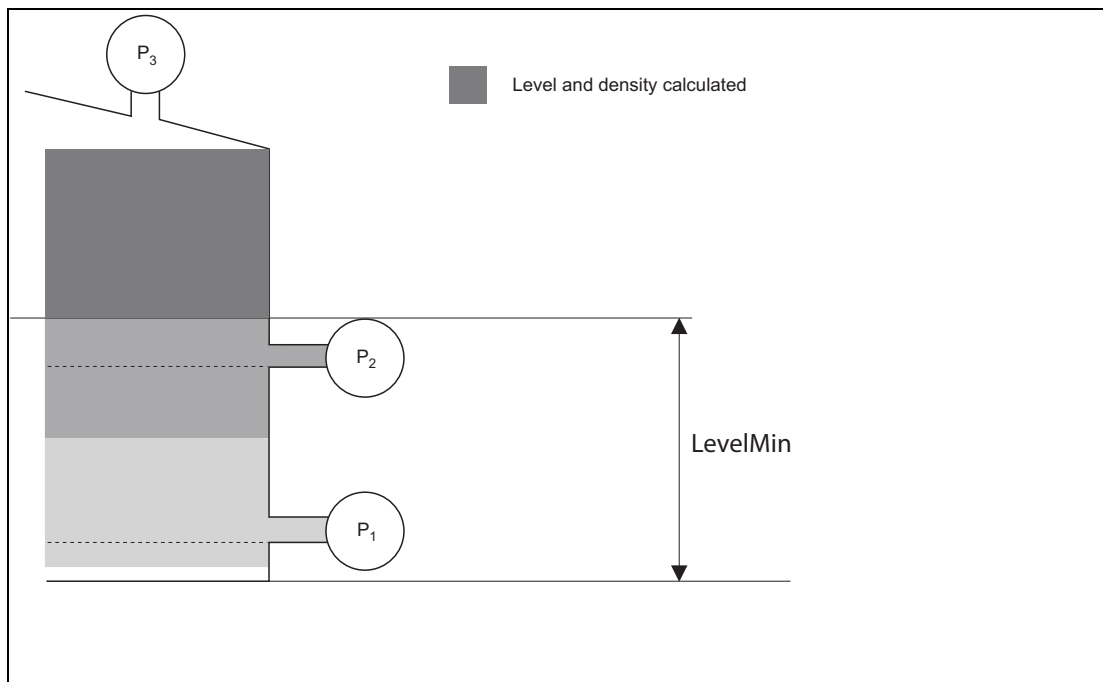


Figure 1-6 Level Minimum

## Error Handling

The program handles the errors/failures of the devices as follow:

- **$P_1$ ,  $P_2$  or  $P_3$  failure:** if one of the pressure transmitters fails or goes offline this will immediately be reported to the density.
- **Database reading error:** if an error occurs during the reading any of the value used for HTG calculations then both Observed Density and HTGLevel are set to an invalid value.

# HTMS - Measurement Principles

## Overview

The Hybrid Tank Measurement System (HTMS) is a method to calculate the density of a product in a tank based on both a (top mounted) level and at least one (bottom mounted) pressure measurement. An additional pressure sensor can be installed at the top of the tank to provide information about the vapour pressure and to make the density calculation more accurate. The calculation method implemented in the 2920 FTT also takes into account a possible level of water at the bottom of the tank to make density calculations as accurate as possible.

Figure 1 represents a simple conic roof tank. This tank is filled with a product and water. On the top of the tank a level gauge is installed to measure the product level in the tank (e.g., float & tape, a radar, or servo), a pressure sensor  $P_1$  installed at the bottom of the tank measures the pressure of the liquid. An optional pressure sensor  $P_3$  on top of the tank measures the vapour pressure in the upper part of the tank.

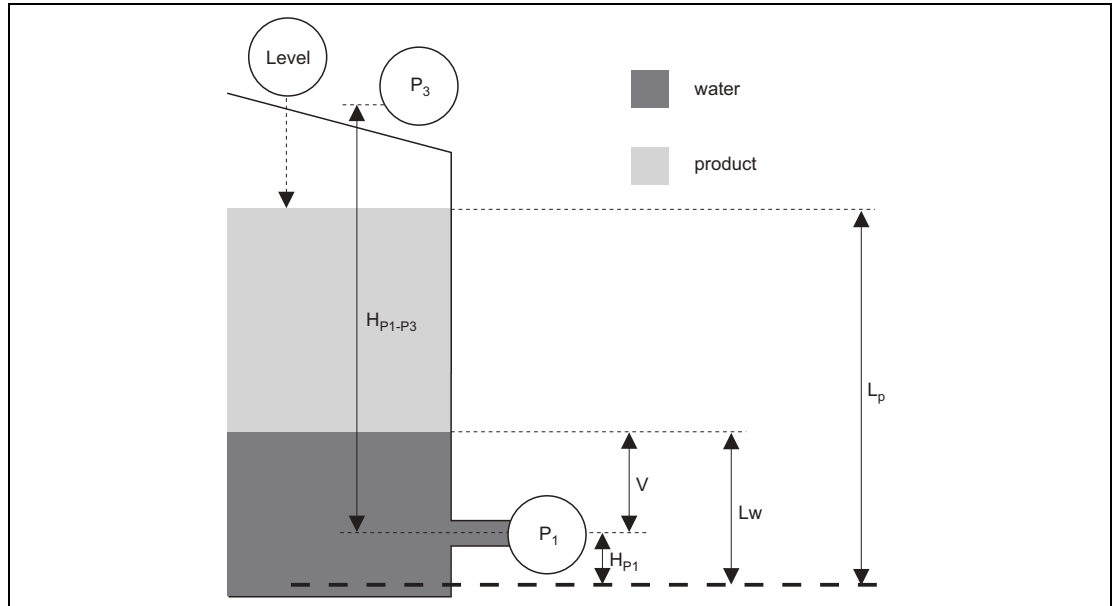


Figure 1-7 Principle of HTMS Calculations

## HTMS Equations

Single Pressure:

$$D_{\text{obs}} = \frac{P_1}{lg^* (L_p - v - H_{P1})} - \frac{v^* D_w}{L_p - v - H_{P1}}$$

Bottom Pressure & Top Pressure:

$$D_{\text{obs}} = \frac{P_1 - P_3}{lg^* (L_p - v - H_{P1})} - \frac{v^* D_w + (H_{P1} - (L_p - H_{P1-P3}))^* D_{\text{vap}} - H_{P1-P3}^* D_{\text{air}}}{L_p - v - H_{P1}}$$

with:

Level and density are calculated according to following parameters:

$P_1$ : pressure measured by pressure sensor  $P_1$  [Pa]

$P_3$ : pressure measured by pressure sensor  $P_3$  [Pa]

$lg$ : local gravity (= 9,807 m/s<sup>2</sup>)

$L_p$ : product level (m)

$H_{P1}$ : distance between  $P_1$  and the tank zero [m]

$v = L_w - H_{P1}$ : water above  $P_1$  (m)

$H_{P1-P3}$ : distance between  $P_1$  and  $P_3$  [m]

$D_{\text{obs}}$ : observed product density (kg / m<sup>3</sup>) (same as Obs. Density)

$D_{\text{air}}$ : density of the air outside the tank (kg / m<sup>3</sup>) (same as Man. Air dens)

$D_{\text{vap}}$ : density of the vapor in tank (kg / m<sup>3</sup>) (same as Man. Vap. dens)

$L_{\text{HTG}}$ : calculated product level (m)

**Note** The above formulas are valid for  $v \geq 0$  (water level above pressure sensor  $P_1$ ) if the water level is under the position of the pressure sensor  $P_1$  then the density is calculated with  $v=0$ .

## Limits of Validity

*Minimum Level (min HTMS level — the minimum level for HTMS calculations)*

"min HTMS level" is the minimum level for HTMS calculations displayed as a configuration parameter. If the level used for HTMS calculation falls below the min HTMS level, a point status bit is set and density value is no longer updated.

## Error Handling

The program handles the error/failures of the devices as follow:

- **Level,  $P_1$  or  $P_3$  failure:** if one of the measuring devices (pressure or level transmitter) fails or goes offline this will immediately be reported to the density.
- **Negative Density:** if the calculations results in a negative value for the density (because of a pressure  $P_3$  being greater as  $P_1$  for example) then an error value will be returned instead.

# Appendix G — Tank Ullage

## Introduction

The 2920 FTT can provide an Ullage value. This value can also be used as the level reference value transmitted as product level.

The Ullage calculation uses a Tank Reference Height and a Level Reference for Ullage to calculate an Ullage value.

The Ullage value can then be used as the Level Reference for the Tank and the Transmitter (transmitted level).

## Tank Data

Refer to the table below for more information on each Tank Data option.

Display Only		Description
	Ullage	Indicates the calculated Ullage value.

Config Params		Description
	Tank Ref hght	Indicates the reference tank height used for Ullage calculation.
	Lev Ref Ullage	<p>Indicates the Level reference used for Ullage calculation.</p> <p>ENC Level (Default)</p> <p>ENC Field Voltage</p> <p>ENC Internal Temp.</p> <p>RTD Temp.</p> <p>RTD Resistance</p> <p>Tank Ullage level</p> <p>AI Value</p> <p>AO1 Value</p> <p>AO1 Current</p> <p>AO1 % Range</p> <p>AO2 Value</p> <p>AO2 Current</p> <p>AO2 % Range</p> <p>NMT53 Avg Temp</p> <p>NMT53 Vap Temp</p> <p>NMT elem. #00 through #17</p> <p>NMT53 Water Level</p> <p>HART1 PV Value</p> <p>HART1 SV Value</p> <p>HART2 PV Value</p> <p>HART2 SV Value</p> <p>HART3 PV Value</p> <p>HART3 SV Value</p> <p>FMR Level</p> <p>FMR Measured Dist.</p> <p>FMR Meas. Level</p> <p>HSCAN +24V output</p> <p>Hydro Level</p> <p>Hydro P1 - Bot pre</p> <p>Hydro P2 - Mid pre</p> <p>Hydro P1 - Top pre</p> <p>Hydro Air temp.</p> <p>Yydro Vap temp.</p> <p>Hydro Obs. density</p> <p>Hydro Std. Density</p> <p>Hydro VolCorFacto</p> <p>Undefined</p>

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