

NUFLO™

# Scanner® 2200 EFM

## Hardware User Manual



# Important Safety Information

## *Symbols and Terms Used in this Manual*



**WARNING:** This symbol identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

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**CAUTION:** Indicates actions or procedures which if not performed correctly may lead to personal injury or incorrect function of the instrument or connected equipment.

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**Important:** Indicates actions or procedures which may affect instrument operation or may lead to an instrument response which is not planned.

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## *Symbols Marked on Equipment*



Attention! Refer to manual



Protective (earth) ground

## *Technical Support Contact Information*

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## Section 1—Introduction

The NuFlo™ Scanner 2200 EFM (Figure 1.1, page 11) is a low-power electronic readout device designed for measuring gas, liquid or steam using the differential pressure output of an orifice or cone meter or the pulse output of a turbine, positive displacement or vortex flowmeter. The instrument can be powered with a solar or DC power supply, and can be used to power a radio or other communications device when external power is provided.

Instruments designed for external power are shipped with either an integral solar charge controller or a DC charge controller and a 12V lead acid battery (up to 33-amp-hour). The 14-in. by 12-in. by 8-in. weatherproof enclosure provides ample space for the instrument electronics and a radio or modem. A lithium battery pack supplied with each instrument can power the instrument (excluding communications) up to 1 year and is a dependable backup power source when external power is provided.

The Scanner 2200 is an economical chart recorder replacement and flow computer, all in one.

Commonly supported applications include:

- AGA-3 compliant gas measurements using the integral MVT and a process temperature input
- AGA-7 compliant gas measurements using a pulse output gas meter (turbine, rotary or vortex)
- Compensated liquid measurements using an orifice, cone, or averaging pitot tube meter
- Temperature-compensated liquid measurements using a liquid turbine meter and an in-line RTD
- Steam measurements using an orifice plate, cone meter, or averaging pitot tube meter

The combination of the integral MVT and two turbine inputs enables the Scanner 2200 to measure up to three separate flow runs, which could represent a gas measurement, water measurement and oil measurement. Two pulse/contact inputs, two analog inputs, two digital outputs, and an analog output are also provided on the Scanner 2200 circuit board.

Every Scanner 2200 EFM is shipped with software for configuring hardware and flow calculations, calibrating inputs, and collecting and viewing flow history. Measurements can be logged as frequently as every 5 seconds, or once every 12 hours. The instrument can log 768 daily records (more than 2 years), 6,392 interval records (more than 8 months at 1-hour intervals), and 1152 event/alarm records.

Data downloads are quick and easy, and the external USB port mounted in the side panel of the instrument makes laptop connections more convenient than ever. For users who prefer to retrieve their data via radio, radio power controls can be configured to power the radio only during desired download periods.

With hardware and software included in the standard product offering, the Scanner 2200 EFM is a complete alternative to the chart recorder. High-speed communication via industry standard Modbus® and Enron Modbus® protocols makes it easy to integrate the Scanner into other measurement systems.

For a complete list of specifications, see [Table 1.1, page 12](#).

## Flow Rate Calculations

The Scanner 2200 calculates flow rates and fluid properties for natural gas, steam and liquid flow. These flow calculations and data storage methods conform to industry standards including AGA-3, AGA-7, AGA-8, API 11.1, API 21.1, ASME MFC-3M, ASME MFC-12M, ASME MFC-14.3, IAPWS IF-97, ISO-5167, and ISO-12213. The calculations compensate for the effects of pressure, temperature, and fluid composition to determine the mass and the volume at specified base conditions. The fluid corrections typically require configuration of inputs including static pressure and temperature; the flow calculation requires configuration

of differential pressure or pulse (frequency) input.

The integral multi-variable transmitter (MVT) is used to measure static pressure and differential pressure. A 4-wire, 100-ohm platinum RTD is recommended for measuring process temperature. Where temperature is relatively constant, a fixed temperature value may be configured.

### **Orifice Meter, AGA-3 (1992)**

The Scanner 2200 supports the orifice metering calculations described in AGA Report No. 3 (1992). This meter covers pipe sizes of nominal 2 inch and larger; there is no stated maximum limit, but the largest size listed in the standard is nominal 36 inch. Beta ratio must lie between 0.1 and 0.75. The AGA-3 orifice meter can be used to measure natural gas, steam, and liquids.

### **Orifice Meter, AGA-3 (2012)**

The Scanner 2200 supports the orifice metering calculations described in AGA Report No. 3 (2012). The AGA-3 orifice meter covers pipe sizes of nominal 2 inch and larger; there is no stated maximum limit, but the largest size listed in the standard is nominal 36 inch. Beta ratio must lie between 0.1 and 0.75. The 2012 report offers an improved expansion factor correction and is recommended for use except where contractual or regulatory requirements specify the 1992 standard. The AGA-3 orifice meter can be used to measure natural gas, steam, and liquids.

### **Orifice Meter, ISO 5167-2 (2003)**

The Scanner 2200 supports the orifice metering calculations described in Part 2 of ISO-5167 (2003). This meter covers pipe sizes of nominal 50 mm (2 inch) to a maximum of 1000 mm (39 inch). Beta ratio must lie between 0.1 and 0.75. In ASME MFC-3M (2004), the ISO-5167 orifice flow calculation was adopted without modification. The ISO orifice meter can be used to measure natural gas, steam, and liquids.

### **Small Bore Orifice, ASME MFC-14M (2003)**

For low flow applications, the Scanner 2200 supports the small bore orifice described in ASME MFC-14M (2003). Meter sizes between nominal 1/2 inch to 1-1/2 inch pipe size are covered by this standard. Beta ratio must lie between 0.1 and 0.75. The ASME small bore orifice meter can be used to measure natural gas, steam, and liquids.

### **NuFo Cone Meter (DP Input)**

The Scanner 2200 calculates fluid flow rate of cone meters using industry-recognized algorithms identified in the NuFlo Cone Meter User Manual. The Cone meter can be used to measure natural gas, steam, and liquids.

### **Averaging Pitot Tube (Annubar®)**

The Scanner 2200 calculates fluid flow rate from an Averaging Pitot Tube (APT) using calculations found in ASME MFC-12M (2006). The averaging pitot tube can be used to measure natural gas, steam, and liquids.

### **Gas Turbine Meter (Frequency Input)**

This class of flowmeter includes all linear pulse-output meters, including turbine meters, vortex shedding meters, pulser-equipped positive displacement (PD) meters, Coriolis meters having volumetric pulse output, and other types. Turbine meters can be used to measure natural gas and liquids; see Fluid Property Calculations. Steam measurement requires a meter that can withstand high temperature; some vortex-shedding meters are suitable (consult the manufacturer).

## Fluid Property Calculations

### Natural Gas (Detailed)

The worldwide standard for calculating the physical properties of natural gas and similar gases is the AGA-8 92DC equation originally described in AGA Report No. 8 (1992). Use of this calculation requires a gas analysis, ie knowledge of the mole fractions of 21 gas components: the alkanes methane through decane, common diluents including nitrogen, carbon dioxide, hydrogen sulfide, and assorted trace components. In ISO standard ISO 12213-2 (1997), the AGA-8 92DC equation was adopted without modification.

The AGA-8 92DC equation is most accurate between temperatures of 17°F and 143°F (-8°C to 62°C) and at pressures up to 1750 psia (12 MPa). If lesser accuracy is acceptable, the range can be extended from -200°F to 400°F (-130°C to 200°C) and pressures up to 20,000 psi (140 MPa). For additional accuracy and application information, see the report.

The heating value for energy measurement is calculated according to Part 3 of AGA Report No. 3 (1992), Appendix F, "Heating Value Calculation," using the data from GPA-2145 (2008).

### Natural Gas (Gravity-CO2-Nitrogen)

When the detailed composition of the gas is unknown, an alternative method of characterizing the gas is available. It is based on the gross properties: real gas relative density (gas gravity), and content of carbon dioxide and nitrogen. This Gravity-CO<sub>2</sub>-N<sub>2</sub> (GCN) method detailed in AGA Report No. 8 (1994) and ISO 12213-3, is based on the SGERG-88 equation. The GCN method should only be used at temperatures between 17°F and 143°F (-8°C to 62°C) and at pressures below 1750 psia (12 MPa). Gravity range is from 0.554 to 0.87; up to 28.94% carbon dioxide, and up to 53.6% nitrogen. The GCN method should not be used outside of these limits.

### Saturated Steam

Saturated steam properties, including density (inverse specific volume), enthalpy (heat content) and viscosity are computed in accordance with the International Steam Tables, IF-97 (1997), for regions 2 and 4. The temperature range is from 32°F to 662°F (0°C to 350°C) and pressures up to 2380 psi (16.4 MPa) can be used. For saturated steam, only a pressure input is required; temperature is a calculated value. Steam mass and energy measurement can be accomplished with any meter type that can withstand the high temperatures involved. By use of proper installation methods, orifice meters, NuFlo cone meters, averaging pitot tubes, and some vortex-shedding meters can be used.

### Liquid Hydrocarbon

The temperature and pressure correction factors for hydrocarbon liquids including crude oil, refined products (gasoline, jet fuel, fuel oils) and lubricating oils are calculated according to API MPMS Chapter 11.1 (2004). For crude oils, the density range is 610.6 to 1163.5 kg/m<sup>3</sup>, temperature range is from -58°F to 302°F (-50°C to 150°C), and pressure range is from 0 to 1500 psig (0 to 10340 kPa). Note that for DP meters, the viscosity at operating temperature is a required input to the flow computer, and it must be determined as accurately as possible.

### Generic Liquid

Many applications (such as water disposal) require nothing more than a simple turbine and totalizer, with no need for temperature or pressure correction applied to the liquid. However, because the moving parts of a turbine meter eventually wear out, many operators consider the Scanner 2200 a better investment since they can replace the turbine meter with a DP meter such as a NuFlo Cone meter that will last indefinitely without maintenance. Generic Liquid is used for these and similar applications. Simple user entries are all that is needed for the DP flow calculation: liquid density and viscosity. There are no limitations on temperature or pressure.

## Multiphase Correction

Where measurement is required of a fluid stream consisting predominantly of gas, but having significant entrained liquid, the Scanner 2200 supports multiphase corrections. Entrained liquid causes the DP meter to over-register. Two methods are provided to correct for this effect:

- The Chisholm-Steven method described in ISO/TR 11583 is applicable when using an orifice or NuFlo Cone meter to measure natural gas with entrained water or hydrocarbon liquid or to measure steam with a quality less than 100%. The liquid content must be determined independently with a test separator or dye-trace methods. Chisholm-Steven can be used if the Lockhart-Martinelli parameter is less than 0.3. Contact Cameron for assistance with multiphase applications.

Note: the Chisholm-Steven method is not applicable to the ASME small bore orifice, averaging pitot tube, or turbine meter.

- The James equation is a well-known method that can be used to correct orifice meters for the quality of saturated steam.

Note: the James method is not applicable to the ASME small bore orifice meter.

## Standard Features

The standard Scanner 2200 EFM (Figure 1.1) features an enclosure with four conduit openings in the bottom for signal cable, a large LCD, an integral multi-variable transmitter with integral vent plugs, and a lithium double-D cell battery pack. MVTs are available in NACE and non-NACE models, and with bottom ports (gas measurement) and side ports (liquid and steam measurement).

The circuit board offers two turbine inputs, two communications ports, an RTD input, two digital outputs, two analog inputs, and two pulse inputs/contact inputs. See [Section 2—Installing the Scanner 2200, page 21](#), for wiring diagrams.

Up to 12 parameters can be configured for display on the LCD using ModWorX™ Pro software (provided). During normal operation, the LCD displays the selected parameters in a continuous scroll.

### **External USB Communications Port**

The USB communications port allows the connection of a Scanner 2200 directly to a laptop or PC. A user-supplied universal USB cable is required.

### **Pole-Mounting Hardware**

A mounting bracket, two U-bolts and nuts make up the hardware kit provided with all Scanner 2200 instruments for mounting the instrument to a 2-in. pole or to a flat vertical surface. For installations requiring a side-port MVT, an optional extension bracket may be required to provide added clearance from the pipe. Contact your local Cameron sales office for details. See [Mounting the Instrument, page 24](#) for mounting instructions.



Figure 1.1—Scanner 2200 EFM with integral multi-variable transmitter (MVT); MVTs are available with bottom ports (shown) or side ports

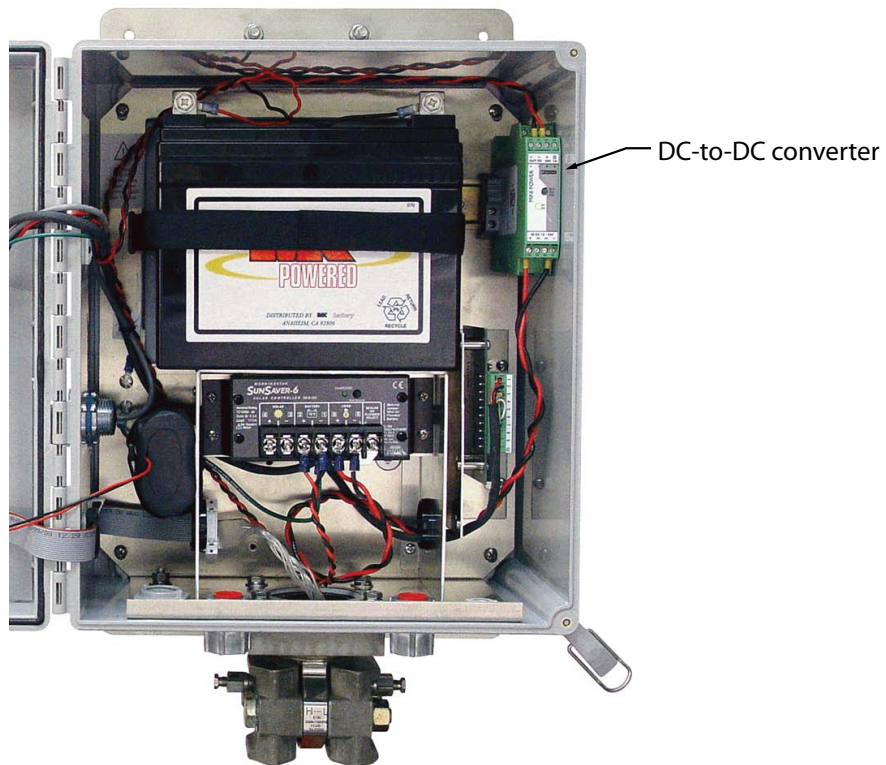


Figure 1.2— Scanner 2200 EFM, internal view

### Product Identification

Each device is labeled with a serial tag that identifies the product by model number and serial number and identifies the maximum operating pressure, working pressure, and differential pressure of the integral MVT.

### Hardware Options

A DC-to-DC power converter (shown in Figure 1.2) is optionally available to convert 12V solar power to the 24V necessary to power an analog output loop or an analog input loop. See [DC-to-DC Power Option, page 54](#), for wiring instructions.

The Scanner 2200 supports a variety of radios and modems. See [Appendix B - Radio Installation](#) for a complete listing of approved communications devices.

**WARNING EXPLOSION HAZARD—SUBSTITUTION OF COMPONENTS AND/OR THE USE OF EQUIPMENT IN A MANNER OTHER THAN THAT SPECIFIED BY CAMERON MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2. CAMERON BEARS NO LEGAL RESPONSIBILITY FOR THE PERFORMANCE OF A PRODUCT THAT HAS BEEN SERVICED OR REPAIRED WITH PARTS THAT ARE NOT AUTHORIZED BY CAMERON.**

**DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR AREA IS KNOWN TO BE NON-HAZARDOUS.**

**DO NOT OPEN EQUIPMENT UNLESS SIGNAL CIRCUITS AND POWER HAVE BEEN SWITCHED OFF OR AREA IS KNOWN TO BE NON-HAZARDOUS.**


**BATTERIES MUST ONLY BE CHANGED IN AN AREA KNOWN TO BE NON-HAZARDOUS. STATIC HAZARD. DO NOT CLEAN OR RUB ENCLOSURE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS.**

**Table 1.1—Scanner 2200 EFM Specifications**

<b>Electrical Safety Classification</b>	Approved by CSA for US and Canada Class I, Div. 2, Groups A, B, C, D T4 Rated for Internal Pollution Degree 2 CSA/UL Type 4 or 4X Enclosure Rating (Ingress Protection)—Type 4X requires MVT with stainless steel bolts ANSI 12.27.01 Single Seal (0 to 3000 psi) at process temperatures from -40 to 121°C
<b>Pressure Classification</b>	ASME pressure vessel code compliant, 0 to 3000 psi (CRN 0F10472.5C)
<b>Enclosure</b>	Fiberglass, weatherproof (14 x 12 x 8 in.)
<b>Weight</b>	50 lb (22.7 kg), approximate
<b>System Power</b>	Internal power supply Battery pack, 2 “D” batteries in series, 7.2V, lithium Battery life, 1-year, typical
	12-VDC Solar Panel, available in 10, 20, 30, 40, and 50 watts with internal battery backup. Integral charge controller with pulse-width modulation and temperature compensation optimizes battery life. Enclosure supports batteries rated for up to 33 amp-hours.
	External power supply (16 to 28 VDC @ 0.7 to 1.2A) with internal battery backup (reverse polarity protected). The external power supply must be an approved ELV source, insulated from the AC main by double/reinforced insulation per CSA C22.2 No.61010-1-04 / UL 61010-1 – 2nd Edition.



**Table 1.1—Scanner 2200 EFM Specifications**

<b>Operating Temperature</b>	Standard temperatures: -15°C to 50°C (5°F to 122°F) Extended temperatures: -40°C to 60°C (-40°F to 140°F), requires use of extended temperature battery. See battery specifications, <a href="#">Table 1.2, page 18</a> . LCD contrast is reduced below -30°C (-22°F)
 <b>WARNING: EXPLOSION RISK.</b> Housing temperature must not exceed 70°C (158°F). Excessive temperatures, which could result from ambient conditions combined with radiated and conductive heat from the process, could cause the internal lithium battery to ignite or explode.	
<b>Humidity</b>	0 to 90% non-condensing
<b>Altitude</b>	Up to 2000 meters maximum
<b>LCD Display</b>	8-digit top readout of values (7-segment characters) 6-digit bottom readout of scrolling parameters and associated engineering units (11-segment characters for easy-to-read prompts) View up to 12 user-defined parameters User-selectable units of measurement 0.5" character height Configurable scan parameters and duration Adjustable contrast and update period
<b>Logging</b>	Daily records: 768 (>2 years) Interval records: <ul style="list-style-type: none"> <li>• Adjustable from 5 sec to 12 hours</li> <li>• 6392 (&gt;8 months of 1-hour intervals)</li> </ul> Event/alarm records: 1152 Records up to 16 user-defined parameters Logs stored in non-volatile memory for up to 10 years
<b>Memory</b>	Non-volatile memory for configuration and log data 512 KB
<b>Communications/ Archive Retrieval</b>	RTU Modbus® <ul style="list-style-type: none"> <li>• two communications ports</li> <li>• full download in approximately 6 minutes</li> <li>• Enron Modbus® compliant downloads</li> <li>• User-defineable Modbus® map with up to 25 floating point values</li> </ul>
	COM Port 1 – RS-485 Selectable 9600 to 38400 baud rate Can be used simultaneously with COM Port 2 Modbus® slave
	COM Port 2 – USB, RS-232, or RS-485 Up to 3 devices can be connected to Port 2 (only one device can transmit/receive communications at a time) Can be used simultaneously with COM Port 1 Selectable 9600 to 38400 baud rate Modbus® slave or Modbus slave with radio controller 1 digital output for controlling the sleep mode on MDS TransNET radios Power management based on time of day

**Table 1.1—Scanner 2200 EFM Specifications**

<p><b>Flow Rate Calculations</b></p>	<p>Natural Gas (Orifice/NuFlo Cone):                  AGA Report No. 3 (1992, 2012)                  ISO 5167 (2003)                  Small Bore Orifice, ASME MFC-14M (2003)                  NuFlo Cone Meter User Manual, www.c-a-m.com (Measurement Systems Division page)</p> <p>Natural Gas (Turbine Meter):                  AGA Report No. 7 (2006)</p> <p>Natural Gas (Averaging Pitot Tube Meter):                  ASME MFC-12M (2006)</p> <p>Steam (Orifice/NuFlo Cone):                  AGA Report No. 3 (1992, 2012)                  ISO 5167 (2003)                  NuFlo Cone Meter User Manual, www.c-a-m.com (Measurement Systems)</p> <p>Liquids (Turbine):                  API MPMS Chapter 5.3 (2009)</p> <p>Compensated Liquids (Orifice/NuFlo Cone/Turbine):                  AGA Report No. 3 (1992, 2012)                  ISO 5167 (2003)                  NuFlo Cone Meter User Manual, www.c-a-m.com (Measurement Systems)                  AGA Report No. 7 (2006)</p>
<p><b>Fluid Property Calculations</b></p>	<p>Natural Gas:                  AGA Report No. 8 (1994)                  AGA Report No. 3, Appendix F (1992)                  GPA 2145 (2008)</p> <p>Steam:                  IAPWS Industrial-Formulation 1997 (IF-97)                  ISO/TR 11583 (2012), Chisholm-Steven Wet Correction Method for Orifice and NuFlo Cone                  James Wet Correction Method for Orifice</p> <p>Liquids:                  Generic (based on user-defined constants for density and viscosity)                  API MPMS Ch 11.1 (2004)</p>
<p><b>MVT</b></p>	<p>Provides linearized static pressure and differential pressure                  Available with bottom ports or side ports                  NACE-compliant units also available (See <a href="#">Table 2.1, page 21</a> for bolt specifications.)                  Process temperature: -40°C to 121°C (-40°F to 250°F)                  User-adjustable sample time and damping</p> <p style="background-color: black; color: white; padding: 2px;">See Temperature Warning in Operating Temperature section of this table (page 13).</p>
<p><b>MVT Accuracy</b></p>	<p>Stability: Long-term drift is less than <math>\pm 0.05\%</math> of upper range limit (URL) per year over a 5-year period</p> <p>Differential Pressure Accuracy (30 In. H<sub>2</sub>O)</p> <ul style="list-style-type: none"> <li>• <math>\pm 0.10\%</math> for spans <math>\geq 10\%</math> of the sensor URL</li> <li>• <math>\pm(0.010)</math> (URL+SPAN) for spans <math>&lt; 10\%</math> of the sensor URL</li> <li>• <math>\pm 0.30\%</math> of full scale over full operating temperature range</li> </ul> <p>Differential Pressure Accuracy (200 to 840 In. H<sub>2</sub>O)</p> <ul style="list-style-type: none"> <li>• <math>\pm 0.05\%</math> for spans <math>\geq 10\%</math> of the sensor URL</li> <li>• <math>\pm(0.005)</math> (URL+SPAN) for spans <math>&lt; 10\%</math> of the sensor URL</li> <li>• <math>\pm 0.25\%</math> of full scale over full operating temperature range</li> </ul>

**Table 1.1—Scanner 2200 EFM Specifications**

<b>MVT Accuracy (cont'd)</b>	Effect on differential pressure for a 100-psi change in static pressure:																												
	<b>SP/SWP (PSIA)</b>	<b>DP (IN H2O)</b>	<b>Max. Overrange (PSIA)</b>	<b>Zero Shift</b>	<b>Span Shift</b>																								
	100	30	150	±0.05% of URL	±0.01% of reading																								
	300	200	450	±0.007% of URL	±0.01% of reading																								
	300	840		±0.002% of URL	±0.01% of reading																								
	500	200	750	±0.010% of URL	±0.01% of reading																								
	1500	200	2250	±0.010% of URL	±0.01% of reading																								
	1500	300		±0.004% of URL	±0.01% of reading																								
	1500	400		±0.004% of URL	±0.01% of reading																								
	1500	840		±0.004% of URL	±0.01% of reading																								
	3000	200	4500	±0.010% of URL	±0.01% of reading																								
	3000	300		±0.004% of URL	±0.01% of reading																								
	3000	400		±0.004% of URL	±0.01% of reading																								
	3000	840		±0.004% of URL	±0.01% of reading																								
	5300	200	7420	±0.010% of URL	±0.01% of reading																								
	5300	300		±0.004% of URL	±0.01% of reading																								
	5300	400		±0.004% of URL	±0.01% of reading																								
	5300	840		±0.004% of URL	±0.01% of reading																								
	Static Pressure Accuracy (500 psia) <ul style="list-style-type: none"> <li>• ±0.05% for spans ≥5% of the sensor URL</li> <li>• ±(0.0025) (URL+SPAN) for spans &lt;5% of the sensor URL</li> <li>• ±0.25% of full scale over full operating temperature range</li> </ul> Static Pressure Accuracy (300, 1500, 3000 and 5300 psia) <ul style="list-style-type: none"> <li>• ±0.05% for spans ≥10% of the sensor URL</li> <li>• ±(0.0025) (URL+SPAN) for spans &lt;10% of the sensor URL</li> <li>• ±0.25% of full scale over full operating temperature range</li> </ul>																												
	<b>Inputs</b>	Board has two frequency inputs, which can be turbine meter inputs, pulse inputs, or contact inputs.																											
Turbine Meter Inputs 1 and 2																													
<ul style="list-style-type: none"> <li>• Configurable sensitivity adjustment (20, 50, 100 or 200 mV, peak-to-peak)</li> <li>• Frequency range: 0 to 3500 Hz</li> <li>• Input amplitude: 20 mV to 3000 mV, peak to peak</li> </ul>																													
<table border="1"> <thead> <tr> <th>Turbine Setting</th> <th colspan="3">Input Sensitivity</th> </tr> <tr> <td></td> <th>0 – 1000 Hz</th> <th>1000 – 2200 Hz</th> <th>2200 – 3500 Hz</th> </tr> </thead> <tbody> <tr> <td>Low (20mV)</td> <td>20 mVpp</td> <td>25 mVpp</td> <td>50 mVpp</td> </tr> <tr> <td>Med (50mV)</td> <td>50 mVpp</td> <td>70 mVpp</td> <td>110 mVpp</td> </tr> <tr> <td>High (100mV)</td> <td>100 mVpp</td> <td>150 mVpp</td> <td>250 mVpp</td> </tr> <tr> <td>Max (200mV)</td> <td>200 mVpp</td> <td>380 mVpp</td> <td>620 mVpp</td> </tr> </tbody> </table>					Turbine Setting	Input Sensitivity				0 – 1000 Hz	1000 – 2200 Hz	2200 – 3500 Hz	Low (20mV)	20 mVpp	25 mVpp	50 mVpp	Med (50mV)	50 mVpp	70 mVpp	110 mVpp	High (100mV)	100 mVpp	150 mVpp	250 mVpp	Max (200mV)	200 mVpp	380 mVpp	620 mVpp	
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<ul style="list-style-type: none"> <li>• Accepts a signal from turbine meter or positive displacement meter</li> <li>• Optically isolated</li> <li>• Input: 3 to 30 VDC or contact closure</li> <li>• Can be used as a status input when Turbine Input 1 and/or 2 is in use</li> </ul>																													

**Table 1.1—Scanner 2200 EFM Specifications**

<b>Inputs (cont'd)</b>	<p>Process Temperature Input</p> <ul style="list-style-type: none"> <li>• 100-ohm platinum RTD with 2-wire, 3-wire, or 4-wire interface</li> <li>• Sensing Range: -40°C to 427°C (-40°F to 800°F)</li> <li>• Accuracy: 0.2°C (0.36°F) over sensing range at calibrated temperature</li> <li>• Temperature effect: 0.3°C over operating range of -40°C to 70°C (0.54°F over operating range of -40°F to 158°F)</li> <li>• Resolution: 24 bits</li> <li>• User-adjustable sample time and damping</li> </ul> <hr/> <p>Analog Input (2)</p> <ul style="list-style-type: none"> <li>• 3-wire sensor interface</li> <li>• Sensor power same as external power supply (6 to 30 VDC)</li> <li>• Accuracy: 0.1% of full scale</li> <li>• Temperature effect: 0.25% of full scale over operating temperature range of -40°C to 70°C (-40°F to 158°F)</li> <li>• Resolution: 20 bits</li> <li>• User-adjustable sample time and damping</li> </ul>
<b>Outputs</b>	<p>Digital Outputs (2)</p> <ul style="list-style-type: none"> <li>• Configurable as pulse output or alarm output</li> <li>• Solid-state relay</li> <li>• Output rating: 60 mA max @ 30 VDC</li> <li>• Maximum frequency: 50 Hz</li> </ul> <p>When configured as pulse output:</p> <ul style="list-style-type: none"> <li>• Volume proportional or time-based (“periodic”)</li> <li>• Configurable pulse duration</li> <li>• Configurable pulse representation (1 pulse = 1 MCF)</li> <li>• Based on any accumulator (flow run or turbine meter run)</li> </ul> <p>When configured as alarm output:</p> <ul style="list-style-type: none"> <li>• Low/high</li> <li>• Out-of-range</li> <li>• Status/diagnostic</li> <li>• Latched/unlatched</li> <li>• Normally open/normally closed</li> </ul> <hr/> <p>Analog Output</p> <ul style="list-style-type: none"> <li>• 4-20 mA</li> <li>• Accuracy: 0.1% of full scale @ 25°C (77°F), 50 PPM/°C (27.8 PPM/°F) temperature drift</li> <li>• Represents any measured variable (e.g., differential pressure) or calculated parameter (e.g., flow rate)</li> <li>• Optically isolated</li> <li>• Resolution: 16 bits</li> </ul>
<b>Interface Software</b>	<p>Provided at no charge  Easy to use  Real-time data polling  Complete configuration</p>
	<p>Configuration upload for configuring multiple units  Multi-level security  Field calibration</p> <ul style="list-style-type: none"> <li>• 1 to 12 calibration points for each parameter</li> <li>• Three methods: multi-point, set zero point, and verify (API compliant)</li> <li>• Inputs are automatically locked during calibration</li> </ul>

**Table 1.1—Scanner 2200 EFM Specifications**

<b>Interface Software (cont'd)</b>	<p>Maintenance</p> <ul style="list-style-type: none"> <li>• Change plate</li> <li>• Change cone (linearization: 1 to 12 points)</li> <li>• Change gas composition</li> <li>• Change steam properties</li> <li>• Change flow coefficients</li> <li>• Change K-factor (linearization: 1 to 12 points)</li> <li>• Change turbine flowmeter</li> <li>• Change generic/API liquid parameters</li> </ul> <p>Archive data downloads</p> <ul style="list-style-type: none"> <li>• Configurable downloads of “all” or “new” records</li> <li>• Download types: daily, interval, and event/alarm records</li> <li>• Downloads are automatically saved in uneditable binary (SDF) files</li> </ul> <p>Exports to .xls, .csv, .rtf, .html, Flow-Cal®, and PGAS® formats Reporting</p> <ul style="list-style-type: none"> <li>• Daily logs (table or trend graph)</li> <li>• Interval logs (table or trend graph)</li> <li>• Event/alarm logs</li> <li>• Configuration settings</li> <li>• Calibration settings</li> <li>• Snapshot of current status data and calculated parameters</li> </ul>
<b>System Requirements</b>	<p>Operating System - Windows XP or later  Computer/Processor - 1 GHz or faster Pentium-compatible CPU  Memory - 128 MB of RAM  Hard Disk Space - 100 MB for program files, 30 MB for Adobe Reader, adequate space for data files  Drive - CD-ROM for install  Display - 1024 x 600, 16-bit color display or greater  Browser - Internet Explorer 7 or later  Internet Connection - for web links, tech support  Communications Port - physical or virtual RS-232 compatible serial port</p>

## Power Options

The standard Scanner 2200 EFM can be powered three ways:

- with the internal lithium battery pack
- with a solar panel, an integral solar charge controller, and a lead acid battery; the lithium battery provides backup power when an external power supply is used
- with an external customer-supplied power supply (16 to 28 VDC), an integral power supply/charge controller, and a lead acid battery; the lithium battery provides backup power when an external power supply is used



**WARNING: EXPLOSION RISK.** Housing temperature must not exceed 70°C (158°F). Excessive temperatures, which could result from ambient conditions combined with radiated and conductive heat from the process, could cause the internal lithium battery to ignite or explode.

For battery handling instructions, see [Appendix C—Lithium Battery Information](#).

Wiring diagrams are provided in [Section 3—Wiring the Scanner 2200, page 47](#).

## Lead Acid Batteries

The Scanner 2200 can accommodate up to a 33-Ah battery. See Table 1.2 for models approved for standard and extended temperature ranges.

**Table 1.2—12V Lead Acid Battery Options (Class I, Division 2)**

Standard Temperatures (-15° to 50°C; 5° to 122°F)	Extended Temperatures (-40° to 60°C; -40° to 140°F)
12-volt, 18-amp-hr, sealed, valve-regulated	12-volt, 16-amp-hr, sealed, valve-regulated
12-volt, 24 amp-hr, sealed, valve-regulated	12-volt, 26-amp-hr, sealed, valve-regulated
12-volt, 33 amp-hr, sealed, valve-regulated	—

## Solar Power

The Scanner 2200 can be powered by a solar panel. The power system provides power to the Scanner 2200, MVT, integral radio (optional), and a 1- to 5-VDC pressure transducer. This allows the Scanner 2200 to be located in remote locations as a stand-alone instrument.

[Appendix A - Solar Panel Location and Orientation](#) provides instruction for locating a proper site for the solar panel, mounting the solar panel, installing the solar charge controller, and wiring the Scanner 2200 for solar power.

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Note Ideally, when the Scanner 2200 is to be solar powered, the solar panel should be mounted near the Scanner 2200 before the Scanner 2200 is installed to facilitate wiring. For information about mounting the solar panel, see [Installation of Solar Panel, page 22](#).

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Solar power systems are limited by the amount of available sunlight and the ambient temperature for a given location. Approved panels for use with the Scanner 2200 include 12-volt panels rated for 10, 20, 30, 40 or 50 watts.

## DC Power

The NuFlo™ DC Input Power Supply/Charge Controller provides uninterrupted power to the Scanner 2200 and peripheral devices. Additionally, the device provides temperature-compensated charge control of a sealed-lead acid battery.

For specifications, see [Table 1.3—DC Input Power Supply/Charge Controller Specifications, page 19](#).

**Table 1.3—DC Input Power Supply/Charge Controller Specifications**

Electrical Classification	Class I, Division 2, Groups A, B, C and D
Temperature Code	T3C (max)
Operating Temperature	-40° to 70°C
Input Voltage	16 to 28 VDC Reverse polarity protected, transient over-voltage protected
Output Voltage	Input power present: 8.5 VDC Min/15 VDC Max Input power not-present: battery voltage Transient and over-current protected
Charge Method	Temperature-compensated float voltage Dual-step charging
Battery	12 V, 10-33 amp-hr
Battery Float Voltage	14.1 ± 0.1 VDC
Temperature Compensation of Battery Charge Voltage	-24 mV/°C to -28 mV/°C
Battery Low-Voltage Load Disconnect	Disconnects at 10.5 VDC (± 1 VDC); reconnects at 12 VDC (± 1 VDC)
Battery Charge Current	1 A max
Battery Protection	Reverse polarity, current limited for severely discharged cells
Quiescent Current - Active	10 mA max
Quiescent Current – LVD	2 mA max
Output Loading	0 to 1 amp
LED Indicators	Input power Fully charged battery
Dimensions	6.0" long x 2.2" wide x 1.5" high

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**Important** In all applications using an external power supply, a switch or circuit breaker must be included in the safe area external power supply installation within easy reach of the operator. The switch or circuit breaker must be marked as the “disconnect” for the safe area external DC power supply.

---

## Interface Software

The ModWorX™ Pro interface software is designed for simplicity and ease of use. Its intuitive, well-organized screens allow users to calibrate and configure the Scanner 2200 EFM within just a few minutes, and download log archives in an easy-to-read report. RTU Modbus® protocol and RS-485 communications ensure easy access to logs. Up to 16 user-selectable parameters can be logged and downloaded using ModWorX™ Pro software.

The software interface is designed around the most common needs of the field operator. From the Main screen (Figure 1.3, page 20), a user can view real-time totals and flow rates, input data, and system data. The Main screen also gives the user access to four task-based menus: Calibrate, Maintain Flow Run, Maintain Turbine, or Configure, and a large red “Download” button for downloading archive data.

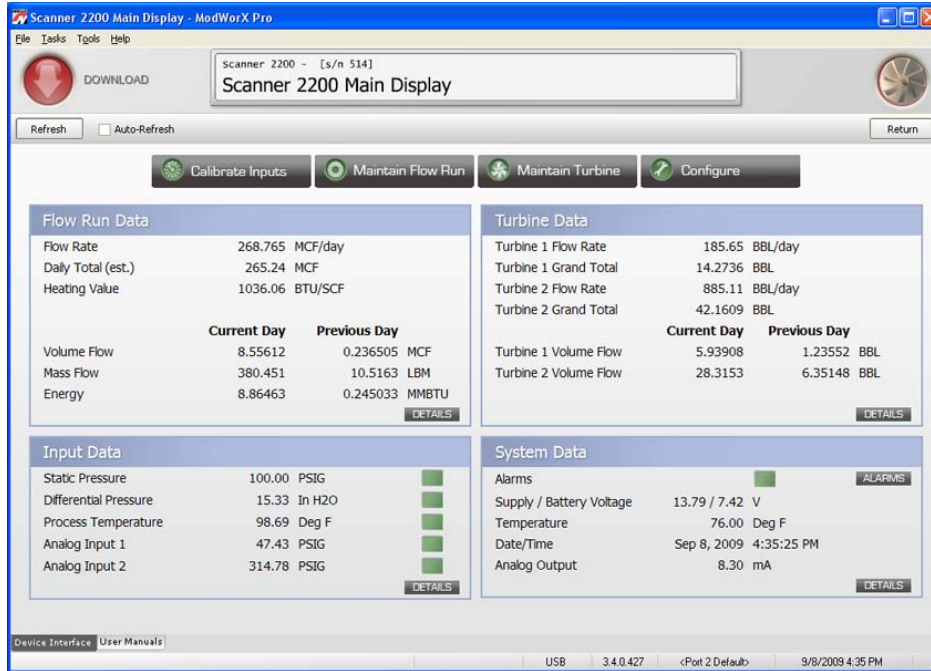


Figure 1.3—ModWorX™ Pro software interface

The Scanner 2200 saves up to 6392 interval logs (interval periods are adjustable from 5 sec to 12 hours), 768 daily logs, and 1152 event/alarm logs in nonvolatile memory. A user can selectively download data logs and instrument configuration settings using the ModWorX™ Pro software. The download files are stored in an uneditable format on the user's CPU, and can be viewed immediately or exported to an alternative format (.csv, .xls, .rtf, html, Flow-Cal® or PGAS®).

Log data can be viewed or printed as a table or a trend chart, or exported to a spreadsheet.

Event logs track user changes to flow parameters that impact log data. Such changes may include orifice plate changes, K-factor changes, input setting changes, and device events like over-range and resets. Event/alarm logs can be viewed or printed in tabular format. In addition to showing old and new values, each event log is time-stamped, and includes the register associated with the change.

Instructions for installing the software are provided on the installation CD pocket folder provided with each instrument. User manuals containing step-by-step instructions on software functions are linked to the software interface for quick and easy access (note the tabbed links at the bottom of the screen in Figure 1.3).



## Section 2—Installing the Scanner 2200

### Overview

The Scanner 2200 EFM is fully assembled at the time of shipment and ready for mounting. However, Cameron recommends that operators configure the EFM prior to mounting if the instrument is to be installed in a hazardous area. Once the instrument is mounted in a hazardous area, the enclosure should not be opened unless the area is void of combustible gas and vapors.

### Pressure Safety Precautions



**WARNING:** Before connecting the Scanner 2200 EFM to a flow line, consider the pressure rating of the sensor, and the presence of harmful gases. The tubing and fixtures used to connect the sensor to the manifold in the flow line must be manufactured from materials that are appropriate for the pressure ratings of the sensor used.



**WARNING:** If H<sub>2</sub>S is present, use a NACE sensor and take appropriate precautions to avoid exposure to this hazardous gas.

**Table 2.1—MVT Pressure Limits, Approvals and Bolt Specifications**

SP/SWP (PSIA)	DP (IN H <sub>2</sub> O)	Max. Overrange (PSIA)	ASME Pressure Vessel Code Compliant	CSA Single Seal Approved	Standard Bolts	NACE Bolts
100	30	150	X	X	B7 or 316 SS	B7M
300	200	450	X	X	B7 or 316 SS	B7M
300	840					
500	200	750	X	X	B7 or 316 SS	B7M
1500	200	2250	X	X	B7 or 316 SS	B7M
1500	300					
1500	400					
1500	840					
3000	200	4500	X	X	B7 or 17-4 SS	Inconel
3000	300					
3000	400					
3000	840					
5300	200	7420			B7	Inconel
5300	300					
5300	400					
5300	840					

### ***RTD Assembly Options (for Gas and Liquid Flow Runs Only)***

The RTD is installed in a thermowell downstream of the primary differential pressure source. The location of the thermowell should conform to the relative standard to ensure accurate measurement.

Cameron recommends the use of a 4-wire, 100-ohm RTD assembly. A 2-wire or 3-wire RTD assembly may be used to provide a process temperature input. See [Section 5—Spare Parts, page 69](#) for a list of RTDs available from Cameron.

## **Installing the Power Supply**

### ***Installation of Solar Panel***

After determining panel placement as described in [Appendix A - Solar Panel Location and Orientation](#), perform the following procedures to mount the solar panel:

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**Note** Refer to [Figure 2.1, page 23](#), for solar-panel mounting examples.

---

1. Mount the solar panel with the supplied bracket. The panel may be mounted on a 2-in. pole or surface (bulkhead) mounted, depending on conditions at the site.
2. Place a cloth or other covering over the solar panel to prevent voltage output from the panel during installation and wiring. (This covering can be removed after the solar panel is wired to the solar charge controller.)
3. Follow the wiring instructions in Section 3 to connect the solar panel to the Scanner 2200 using approved wiring methods.

---

**Caution** All field wiring must conform to the National Electric Code, NFPA 70, Article 501-4(b) for installations within the United States or as specified in Section 18-156 of the Canadian Electrical Code for installations within Canada. Local wiring ordinances may also apply. All field wiring must have a wire range of 22 to 14 AWG and terminal block screws must be tightened to a minimum torque of 5 to 7 in-lbs. to secure the wiring within the terminal block. Only personnel who are experienced with field wiring should perform these procedures.

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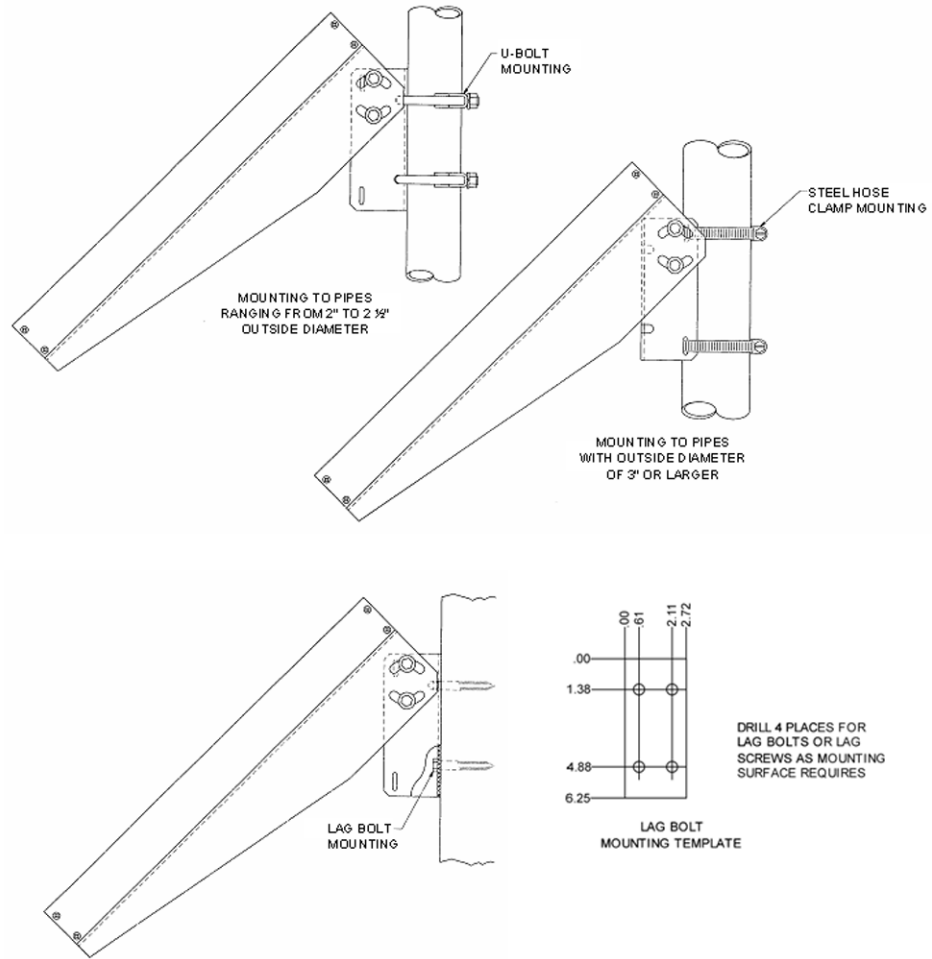


Figure 2.1—Mounting of solar panel to pole or bulkhead

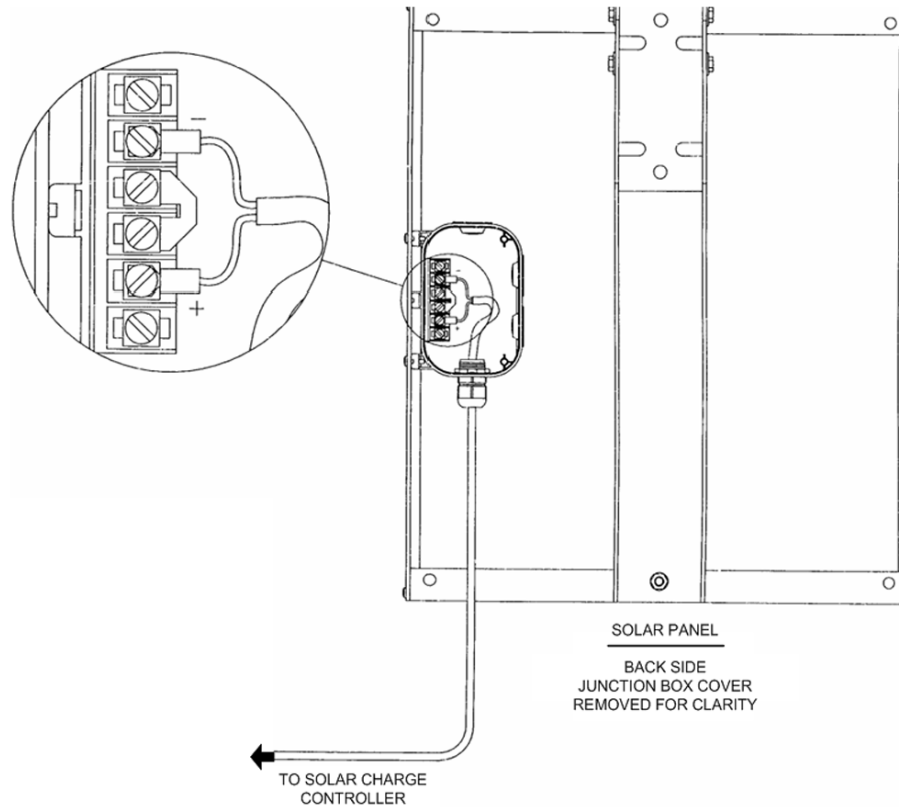


Figure 2.2—Typical installation of solar panel system

The solar panel should be mounted securely before the solar charge controller is installed.

---

**Caution**     **Make sure the solar panel is covered with a cloth or other covering to prevent voltage output from the panel during installation and wiring of the Scanner 2200.**

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## Mounting the Instrument

The instrument can be mounted on a 2-in. pole using the two U-bolts provided and the integral brackets, or mounted to a flat, vertical surface. Direct-mounting the instrument to a turbine meter or orifice run is not recommended due to the weight of the instrument and the vibrations of the pipeline, which could cause instability.

While the standard MVT has process connections on the bottom, compensated liquid and steam applications may require the use of a side-port MVT and side-mount manifold (to help eliminate air in the process line). In such installations, an optional extension bracket is recommended to provide the necessary clearance for the MVT and manifold assembly. This bracket is shown in [Figure 2.4, page 26](#). Contact your local Cameron sales office for details.

Tubing is used to connect the integral MVT to the orifice meter or cone meter. If a Scanner 2200 will be used for steam measurement, a condensate pot must also be installed to protect the Scanner 2200 from extreme temperatures. See [Measuring Steam via a Differential Pressure Meter, page 31](#), for details.

The following accessories are also recommended:

- a 5-valve manifold for connecting process lines to the integral MVT

- an RTD assembly for process temperature input on gas flow runs and compensated liquid flow runs (not recommended for steam flow runs)
- tubing and/or pipe for plumbing process connections
- signal cable for remote turbine connections (stranded, shielded cable is recommended)

To mount the Scanner 2200, perform the following steps:

1. Determine the piping configuration that will best accommodate process connections and field wiring connections. If a side-port MVT and manifold is required (typically, only for compensated liquid and steam applications, an optional extension bracket may be connected to the standard bracket to provide additional clearance from the pipe (shown in [Figure 2.4, page 26](#)).
2. Position the U-bolt around the pipe and through the support bracket provided with the U-bolt.
3. Align the mounting bracket against the pole so that the U-bolt passes through the mounting holes in the bracket. Place the mounting plate over the threaded ends of the U-bolt and against the bracket, and secure the U-bolt with the two nuts provided.
4. Install and connect process piping between the Scanner 2200 and the turbine meter with appropriate fittings. Process piping installation procedures vary with each application.

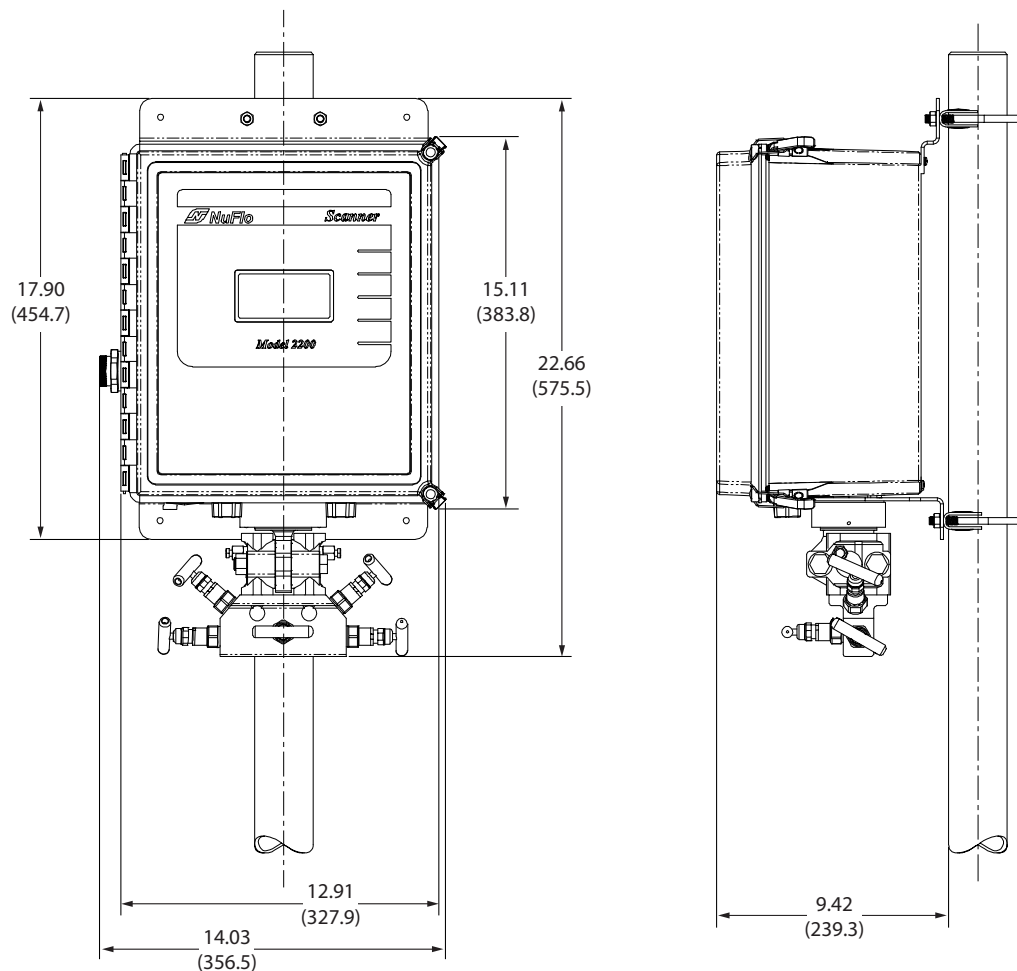


Figure 2.3—Scanner 2200 with standard bottom-port MVT and manifold on a 2-in. pole

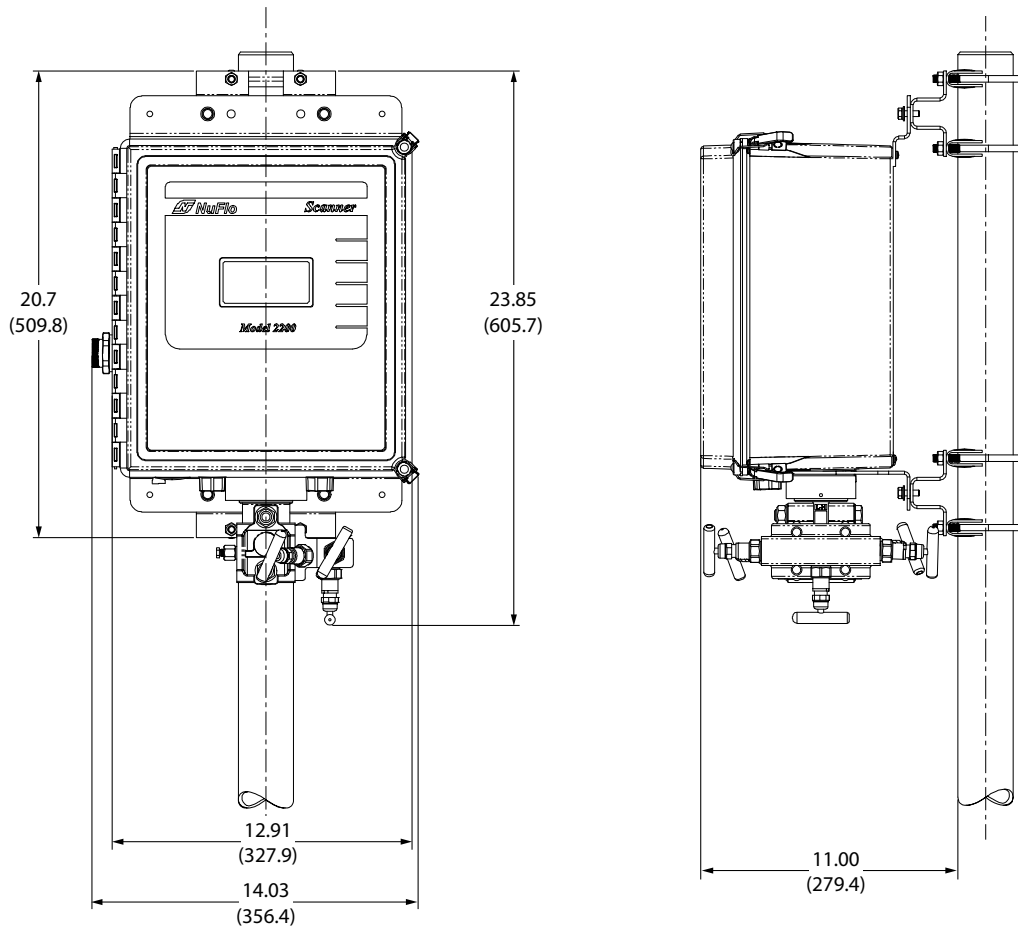


Figure 2.4—Scanner 2200 with side-port MVT and side-mount manifold on a 2-in. pole (shown here with an optional extension bracket)

## Measuring Natural Gas via a Differential Pressure Meter

Note: This section contains installation guidelines for orifice and cone meters. If installing the Scanner 2200 with an averaging pitot tube meter, refer to manufacturer instructions for installation.

### Best Practices for Orifice and Cone Meter Installation

To ensure measurement accuracy, ensure that the meter run complies with the following AGA-3 and ISO 5167 guidelines, as applicable:

- Do not place unit near vents or bleed holes that discharge corrosive vapors or gases.
- Install the sensor above the differential pressure source connections, or install a condensate (drip) pot to prevent the accumulation of liquid in interconnecting tubes. Slope all tubing upward at least 1-inch/linear foot to avoid liquid entrapment.
- Mount the Scanner 2200 as near level as possible such that the operator has a clear view of the LCD. The location should be as free from vibration as possible.
- Make sure the high port of the sensor (marked “H”) is connected to the upstream side of the meter run.

- Flow should remain subsonic throughout the measuring section and should be single phase.
- Pipe diameters (D) should be between 2 in. (50 mm) and 39 in. (1000 mm) per ISO 5167; or greater than 2 in. (50 mm) per AGA-3.
- Pipe Reynolds numbers must be above 5000.
- $d$  (orifice diameter) must be greater than or equal to 0.45 in. (11.5 mm).
- $\beta$  (diameter ratio) must be greater than or equal to 0.1 and less than or equal to 0.75.
- Gauge lines should be of uniform internal diameter and constructed of material compatible with the fluid being measured. For most applications, the bore should be no smaller than ¼ in. (6 mm) and preferably, 3/8 in. (10 mm) in diameter. The internal diameter should not exceed 1 in. (25 mm). If high-temperature fluids are likely to be encountered, make sure the measuring tube used is rated for the anticipated temperature range. See also the temperature warning on page 17.
- Gauge line length should be minimized to help prevent pulsation-induced errors.
- Gauge lines should slope downward to the meter at a minimum of one inch per foot.
- If gauge lines must slope in more than one direction, do not allow more than one bend and install a liquid or gas trap, as applicable. A liquid trap should be installed at the lowest point in a gas service installation.
- Gauge lines should be supported to prevent sag and vibration.
- Where pulsation is anticipated, full-port manifold valves with a nominal internal diameter consistent with the gauge lines are recommended.

If the Scanner 2200 is mounted to a cone meter, consider the following best practices in addition to the best practices listed above.

- Position the cone meter so that there are zero to five pipe diameters upstream of the meter and zero to three pipe diameters downstream of the meter.
- Install the meter so that the static pressure tap is upstream of the differential pressure tap. The high side of the integral Scanner 2200 sensor must also be situated upstream.
- Install shut-off valves directly on the DP meter pressure taps. Choose a shut-off valve that is rated for the ambient temperatures of the location and the operating pressure of the pipe in which it will be installed, and for use with dangerous or corrosive fluids or gases, if applicable. The valves must not affect the transmission of the differential pressure signal.

### ***Installation Procedure—Orifice Meter or Cone Meter***

A Scanner 2200 can be mounted remotely and connected to an orifice meter or cone meter with tubing for gas measurement. The setup of the meter run and plumbing configurations can vary widely, depending upon the challenges existing on location. [Figure 2.5, page 28](#), shows a typical remote-mount installation.

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**Note:** To prevent fittings from turning and/or to avoid putting tension on stainless steel tubing, use a backup wrench to attach stainless steel tubing to a manifold, shut-off valves, or sensor ports.

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1. Verify that the meter is properly installed in the flow line (per manufacturer's instructions).
2. Mount the Scanner 2200 to a 2-in. pipe or to a flat, vertical surface using bolts and the mounting holes in the enclosure.

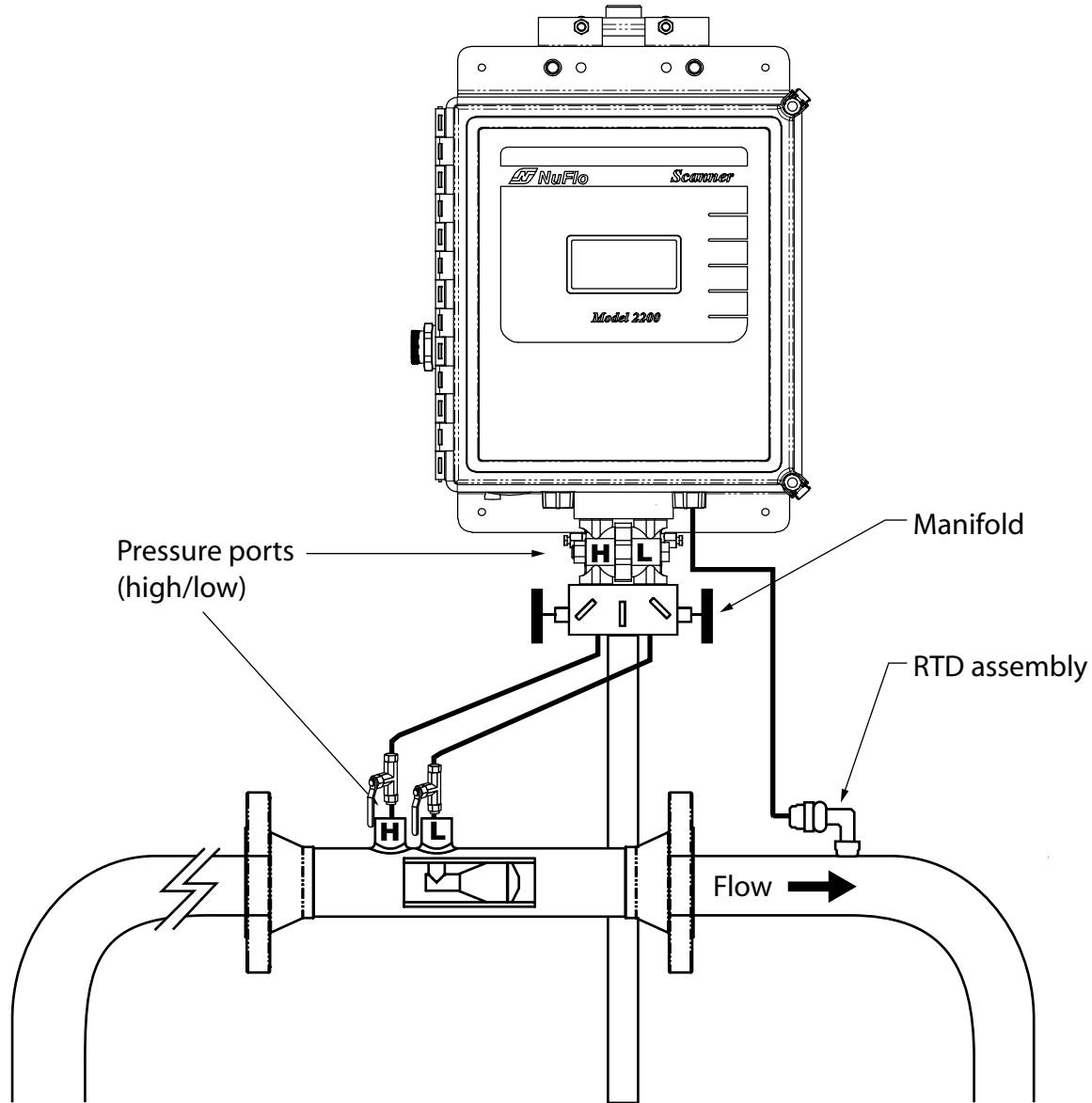


Figure 2.5—Gas run installation using a cone meter (same configuration can be used for an orifice meter run).

3. Bolt a 5-valve flange-by-NPT manifold (as recommended by Cameron) to the Scanner 2200 MVT sensor.
  - a. Locate the H and L markings on the integral MVT sensor body and position the MVT/manifold assembly so that the upstream side of the flow line can easily be connected to the sensor's "High" port and the downstream side of the flow line can be connected to the sensor's "Low" port. If rotating the MVT will simplify the installation by improving access to the high and low pressure ports on the meter, loosen the set screws on either side of the MVT adapter, rotate the MVT (up to 180°) and retighten the set screws.
  - b. Position the manifold so that all valves are accessible from the front of the instrument.
4. Install tubing and fittings to connect the Scanner 2200 and manifold assembly to the differential pressure meter, sloping the gauge lines downward to the meter at a minimum of one inch per foot. Use a suitable compound or tape on all threaded process connections.



5. Install the RTD assembly in the thermowell. Route the RTD assembly cable through the conduit opening in the bottom of the Scanner 2200 to connect to the circuit board. A wiring diagram for the RTD assembly is provided in [Figure 3.10, page 56](#).
6. Route any additional inputs/outputs or COM connections, etc. through the conduit opening in the bottom of the Scanner 2200.
7. Perform a manifold leak test as described on page 41.
8. Verify the zero offset, if required (and other calibration points, if desired). See the ModWorX™ Pro Software User Manual, Part No. 9A-30165025, for complete instructions. See also [Zero Offset \(Static Pressure or Differential Pressure\), page 41](#), [Static Pressure Calibration and Verification, page 41](#), and [Differential Pressure Calibration and Verification, page 42](#).

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**CAUTION:** Do not put the Scanner into operation until the valves are positioned properly so that pressure is supplied to both sides of the MVT. For instructions on proper valve positions, see [Placing the Scanner into Operation, page 43](#).

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## Measuring Natural Gas via a Turbine Meter

### **Best Practices**

The Scanner 2200 EFM calculates gas flow through a turbine meter in accordance with AGA-7 and API 21.1 industry standards. For optimum performance, ensure that the turbine and Scanner 2200 installation complies with the industry recommendations listed below:

- Install the turbine flowmeter in the meter run such that there are 10 nominal pipe diameters upstream and five nominal pipe diameters downstream of the meter. Both inlet and outlet pipe should be of the same nominal size as the meter.
- Straightening vanes are recommended for eliminating swirl conditions. If used, they should be installed five pipe diameters upstream of the meter.
- Where an RTD is used to facilitate compensated gas measurement from a gas turbine meter, locate the RTD within five pipe diameters downstream of the meter outlet and upstream of any valve or flow restriction.

### **Installation Procedure—Turbine Meter**

A Scanner 2200 can be mounted remotely and connected to a gas turbine meter for measuring gas in accordance with AGA-7 calculations. [Figure 2.6, page 30](#), shows an installation in which the pressure input is provided by the integral MVT. Alternatively, an external pressure transducer can be used to supply the pressure. See [Measuring Steam via a Differential Pressure Meter, page 31](#), for more information.

The setup of the meter run and plumbing configurations can vary widely, depending upon the challenges existing on location.

To connect the Scanner 2200 to a turbine meter, perform the following steps:

1. Verify that the flowmeter and magnetic pickup are installed in the flow line.
2. Mount the Scanner 2200 to a 2-in. pipe or to a flat, vertical surface using bolts and the mounting holes in the enclosure.

3. Bolt a 3-valve flange-by-NPT manifold (as recommended by Cameron) to the Scanner 2200 MVT sensor. Position the manifold so that all valves are accessible from the front of the instrument.
4. Connect the pressure port of the turbine meter to either manifold process port with tubing. The unused pressure port can be used as a “vent” as required. Always leave the equalizer valves open to allow pressure to both sides of the MVT. Use a suitable compound or tape on all threaded process connections.
5. Remove the plug from the conduit opening in the bottom of the Scanner 2200 enclosure, route the turbine signal cable through the opening, and connect it to the circuit board. A wiring diagram for the turbine input is provided in [Figure 3.9, page 56](#).

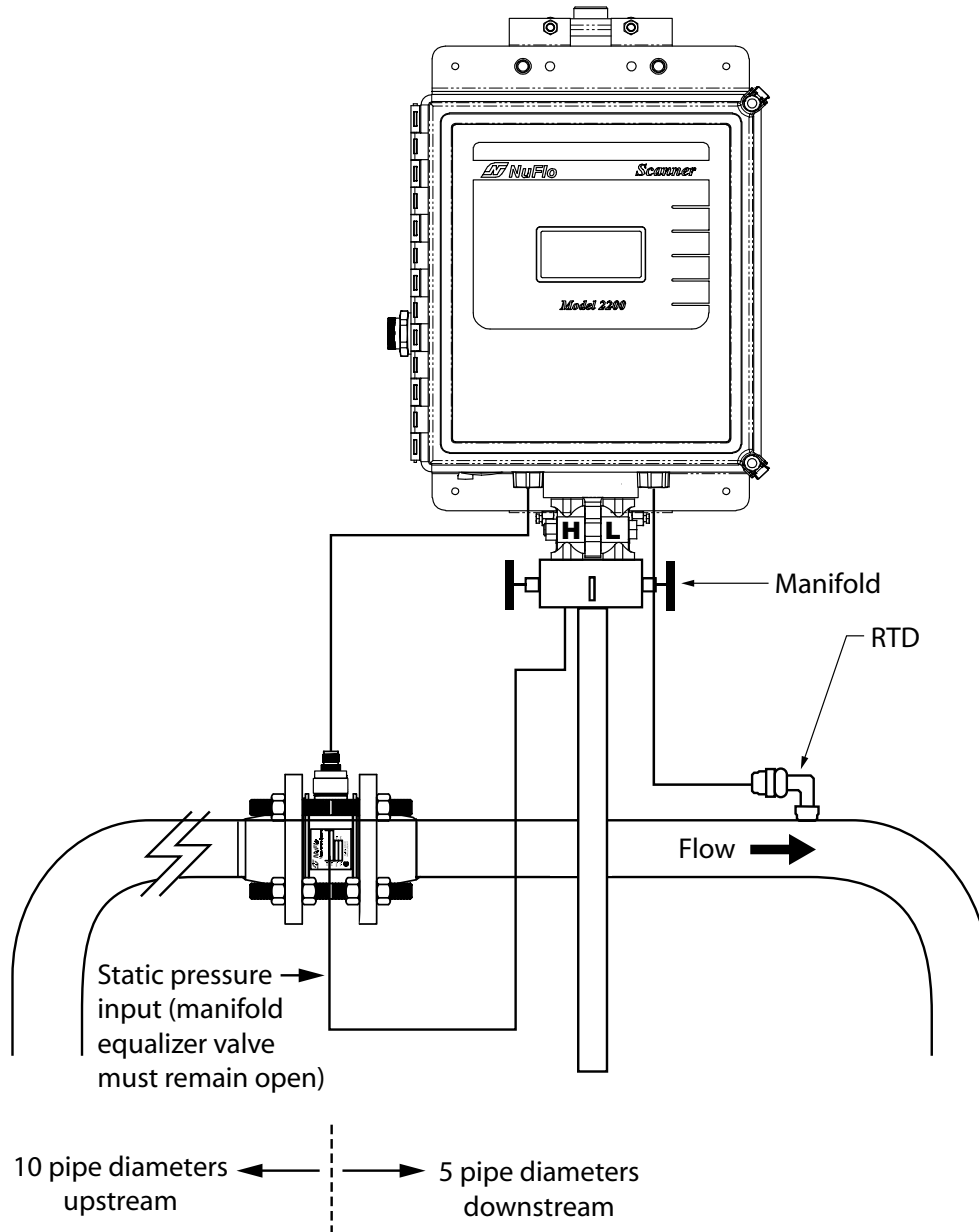


Figure 2.6—Installation in an AGA-7 turbine meter run

6. Install the RTD assembly in the thermowell. Remove the plug from the other conduit opening in the bottom of the Scanner 2200 enclosure, route the RTD assembly cable through the conduit opening, and connect it to the circuit board. A wiring diagram for the RTD assembly is provided in [Figure 3.10, page 56](#).
7. Zero the static pressure and recalibrate the static pressure, if required. See the ModWorX™ Pro Software User Manual, Part No. 9A-30165025, for complete instructions. See also [Zero Offset \(Static Pressure or Differential Pressure\), page 41](#), and [Static Pressure Calibration and Verification, page 41](#).

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**CAUTION:** Do not put the Scanner into operation until the valves are positioned properly so that pressure is supplied to both sides of the MVT. For instructions on proper valve positions, see [Placing the Scanner into Operation, page 43](#).

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## Measuring Steam via a Differential Pressure Meter

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**IMPORTANT:** This section contains installation guidelines for orifice and cone meters. If installing the Scanner 2200 with an averaging pitot tube meter, refer to manufacturer instructions for installation.

---

### **Best Practices**

The Scanner 2200 EFM calculates steam flow in accordance with IF-97, AGA-3, and ISO-5167 industry standards. For optimum performance, ensure that the Scanner 2200 installation complies with the industry recommendations listed below:

#### **Condensate pots**

- A condensate pot for a small-volume transducer like the Scanner 2200 MVT can be a simple pipe tee, oriented so that one port extends downward (into the cold leg), the opposite port extends upward and is closed by a pipe cap or blowdown valve, and the tee extends horizontally into the hot leg.
- The pots should be the highest point in the system.
- The pots should be mounted at the same level, and one or both should be adjustable vertically to remove zero shifts in the differential pressure measurement.

#### **Hot legs**

- Hot legs should be large diameter (3/8 in. or 1/2 in., if possible)
- Hot legs should be as short as possible. If these sections must be more than 1 ft. in length, insulate them.
- Elbows and bends should not form any traps in which liquid can accumulate.
- Hot legs should be sloped along their entire length to allow liquids to drain back into the pipe.

#### **Cold legs**

- Cold legs should enter the multi-variable sensor through its side ports.
- Cold legs should be a minimum of 2 ft in length to allow proper convection cooling and should be run horizontally with a slope of approximately 1 inch per foot to allow air bubbles to float up into the pots.
- Elbows and bends should not form any traps for air bubbles.
- Cold legs should be filled with a suitable antifreeze. Dibutyl phthalate is recommended.

**Antifreeze**

- Dibutyl phthalate (DBP) has the following advantages over glycol antifreeze:
  - DBP doesn't mix with water, and so doesn't become dilute over time; its specific gravity doesn't shift.
  - It is slightly denser than water, so it will stay in the pot permanently.
  - It is non-flammable.
  - It is much less toxic than glycol.
  - It is available from industrial suppliers.

**Valves**

- Use only full-opening block valves that are rated for steam service.
- Use only blowdown valves that are rated for steam service. Periodic blowdowns are recommended for preventing buildup of scale.

---

**CAUTION:** Before starting the system, remove the caps and add water or antifreeze if necessary to completely fill the pots and cold legs. Air trapped in the lines will produce errors in differential pressure measurements.

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**WARNING: EXPLOSION RISK.** Housing temperature must not exceed 70°C (158°F). Excessive temperatures, which could result from ambient conditions combined with radiated and conductive heat from the process, could cause the internal lithium battery to ignite or explode.

---

**Installation Procedure—Orifice Meter or Cone Meter**

A Scanner 2200 can be mounted remotely and connected to an orifice meter or cone meter with tubing for steam measurement. The setup of the meter run and plumbing configurations can vary widely, depending upon the challenges existing on location.

---

**CAUTION:** When measuring steam, process connections must be designed to eliminate air pockets. This is achieved by making sure all tubing in the cold legs slopes upward. A side-port MVT and block manifold (shown in [Figure 2.7, page 33](#)) is recommended to help prevent air bubbles from being trapped in the sensor.

If a bottom-port MVT is used, the bottom process ports must be plugged or replaced with a drain valve, and side vents must be used for process connections. A block manifold is not recommended for use with bottom port MVTs. Contact a Cameron field representative for assistance.

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1. Verify that the meter is properly installed in the flow line (per manufacturer's instructions).
2. Mount the Scanner 2200 to a 2-in. pipe or to a flat, vertical surface using bolts and the mounting holes in the enclosure.

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**Note:** When a side-mount MVT and manifold assembly is used with a vertical pipe mount, the MVT can be rotated 90 degrees to facilitate manifold connections. An optional extension bracket may be required to provide clearance for the manifold. Contact your local Cameron sales office for details.

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3. Mount a set of pipe tees (which serve as condensate pots) typically on either side of the Scanner 2200 at an elevation above the process connections of the Scanner 2200 MVT (for proper drainage). They should be a considerable distance (4 ft) from the sensor ports, but as close as possible to the pressure taps on the meter.
4. Install a pipe cap or a blowdown valve that is rated for steam service at the top of each pipe tee. A blowdown valve is recommended when the steam passing through the meter is known to be dirty.

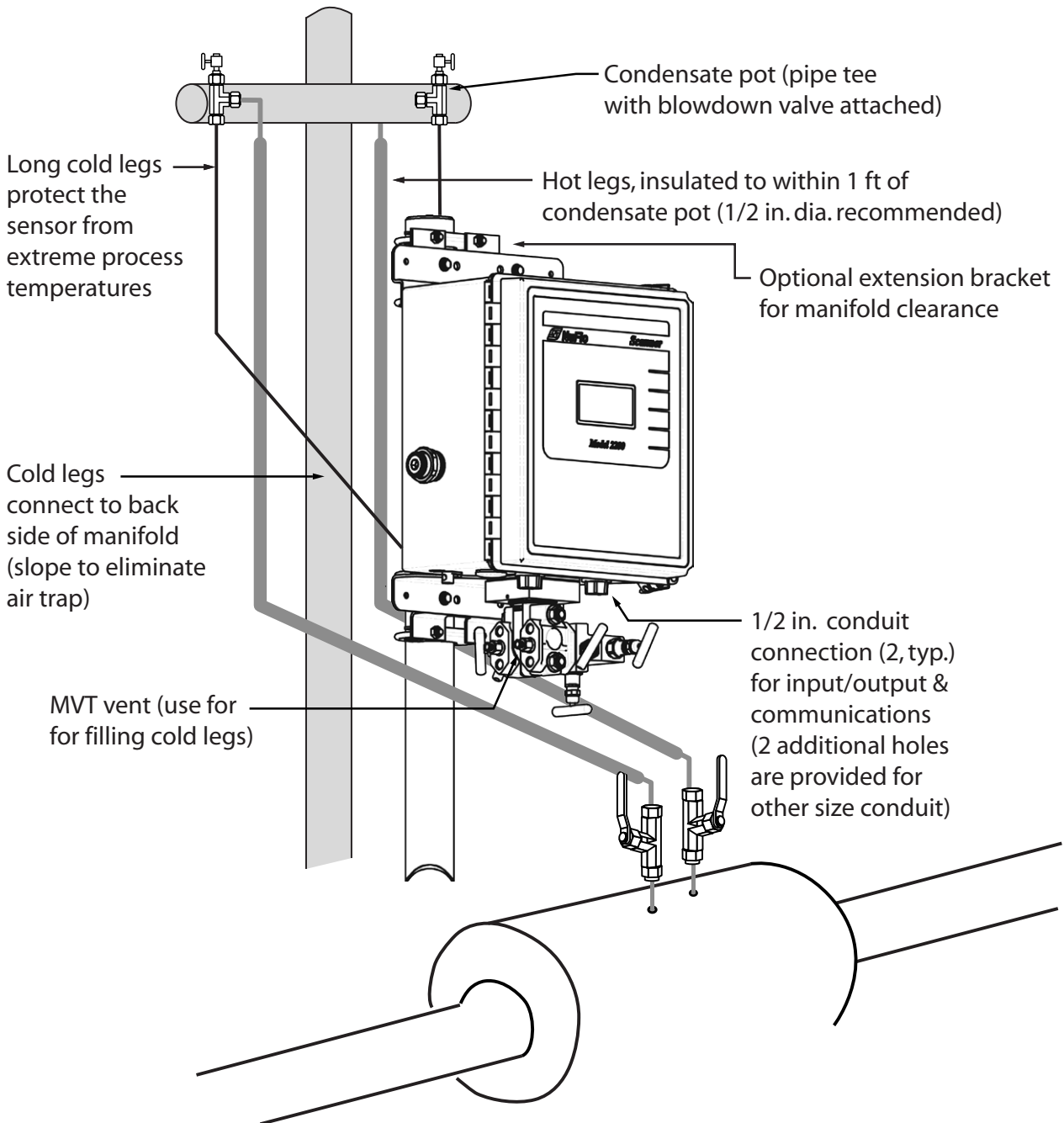


Figure 2.7—Steam run installation (shown here with a cone meter). The same configuration can be used with an orifice meter.

5. Install tubing and fittings to connect the high-pressure and low-pressure taps of the DP meter to the pipe tees. This section is typically referred to as the *hot legs* of the installation, as this section of tubing encounters steam at its highest temperature. Install a shut-off valve near the high and low ports of the DP meter. Use a suitable compound or tape on all threaded process connections.
6. Route any additional inputs/outputs or COM connections, etc. through the conduit opening in the bottom of the Scanner 2200.

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Note: To prevent fittings from turning and/or to avoid putting tension on stainless steel tubing, use a backup wrench to attach stainless steel tubing to shut-off valves, or sensor ports.

---

**CAUTION: Whenever possible, locate the hot legs of a steam installation behind the Scanner 2200 safely out of the operator's normal reach. This will help prevent accidental burns.**

---

7. Install tubing to connect the high-pressure and low-pressure process connections of the block manifold to the pipe tees installed in step 3. This tubing section is typically referred to as the *cold legs* of the installation, since it is filled with water.
8. To eliminate air bubbles, fill the cold legs with water or other fill fluid from the lowest point in the system, typically the MVT, using the following steps:
  - a. Open the blowdown valve or remove the filling plug from one of the pipe tees/condensate pots.
  - b. Open the equalizer and bypass/block valves on the block manifold. Make sure the vent valve is closed.
  - c. Remove the corresponding (high pressure or low pressure) vent screw from the side of the MVT and insert a fitting to allow connection of a hand pump or funnel. If a funnel is used, attach a length of Tygon tubing that is long enough to elevate the funnel well above the condensate pot to force the fluid up the legs.
  - d. Connect a hand pump or funnel to the fitting.
  - e. Pour fill liquid into the funnel or pump it into the cold leg, tapping the cold leg occasionally to dislodge any bubbles.
  - f. Observe the pipe tee/condensate pot and stop pouring when the fill liquid is visible at the top and no air bubbles can be seen.
  - g. Remove the fitting from the vent of the MVT and quickly replace the vent screw and tighten.
  - h. Close the blowdown valve or replace the filling plug from one of the pipe tees/condensate pots.
  - i. Repeat steps a through h for the other cold leg.
9. To eliminate an offset of the differential pressure reading, open the equalizer valves on the block manifold, remove the caps from the seal pots, and adjust either seal pot vertically to bring the water levels to the exact same elevation.
10. Perform a manifold leak test as described on page 41.
11. Verify the zero offset, if required (and other calibration points, if desired). See the ModWorX™ Pro Software User Manual, Part No. 9A-30165025, for complete instructions. See also [Zero Offset \(Static Pressure or Differential Pressure\), page 41](#), [Static Pressure Calibration and Verification, page 41](#), and [Differential Pressure Calibration and Verification, page 42](#).

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**CAUTION:** Do not put the Scanner into operation until the valves are positioned properly so that pressure is supplied to both sides of the MVT. For instructions on proper valve positions, see [Placing the Scanner into Operation, page 43](#).

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## Measuring Liquid via a Differential Pressure Meter

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**IMPORTANT:** This section contains installation guidelines for orifice and cone meters. If installing the Scanner 2200 with an averaging pitot tube meter, refer to manufacturer instructions for installation.

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### ***Best Practices***

To ensure measurement accuracy, ensure that the meter run complies with the following AGA-3 and ISO 5167 guidelines, as applicable:

- Do not place unit near vents or bleed holes that discharge corrosive vapors or gases.
- Install the sensor below the differential pressure source connections. Slope all tubing downward at least 1-inch/linear foot to avoid gas entrapment.
- Mount the Scanner 2200 as near level as possible such that the operator has a clear view of the LCD. The location should be as free from vibration as possible.
- Make sure the high port of the sensor (marked “H”) is connected to the upstream side of the meter run.
- Pipe diameters (D) should be between 2 in. (50 mm) and 39 in. (1000 mm) per ISO 5167; or greater than 2 in. (50 mm) per AGA-3.
- Pipe Reynolds numbers must be above 5000. Avoid high-viscosity liquids (greater than 15 cP).
- d (orifice diameter) must be greater than or equal to 0.45 in. (11.5 mm).
- Orifice  $\beta$  (diameter ratio) must be greater than or equal to 0.1 and less than or equal to 0.75.
- Gauge lines should be of uniform internal diameter and constructed of material compatible with the fluid being measured. For most applications, the bore should be no smaller than  $\frac{1}{4}$  in. (6 mm) and preferably,  $\frac{3}{8}$  in. (10 mm) in diameter. The internal diameter should not exceed 1 in. (25 mm). If high-temperature fluids are likely to be encountered, make sure the measuring tube used is rated for the anticipated temperature range. See also the temperature warning on page 17.
- If there is possibility of freezing, the gauge lines can be filled with a suitable seal liquid. The seal liquid should be somewhat denser than the process fluid, should not dissolve in it, should have a sufficiently low freezing point, and should be non-toxic. Alternatively, heat tracing can be used.
- Gauge line length should be minimized to help prevent pulsation-induced errors.
- Gauge lines should slope upward to the meter at a minimum of one inch per foot.
- If gauge lines must slope in more than one direction, do not allow more than one bend and install a gas trap.
- Gauge lines should be supported to prevent sag and vibration.
- Where pulsation is anticipated, full-port manifold valves with a nominal internal diameter consistent with the gauge lines are recommended.

If the Scanner 2200 is mounted to a cone meter, consider the following guidelines in addition to the best practices listed above.

- Position the cone meter so that there are zero to five pipe diameters upstream of the meter and zero to three pipe diameters downstream of the meter.
- Install the meter so that the static pressure tap is upstream of the differential pressure tap. The high side of the integral Scanner 2200 sensor must also be situated upstream.
- Install shut-off valves directly on the DP meter pressure taps. Choose a shut-off valve that is rated for the ambient temperatures of the location and the operating pressure of the pipe in which it will be installed, and for use with dangerous or corrosive fluids or gases, if applicable. The valves must not affect the transmission of the differential pressure signal.

### ***Installation Procedure—Orifice Meter or Cone Meter***

A Scanner 2200 can be mounted remotely and connected to an orifice meter or cone meter with tubing for liquid measurement (Figure 2.8, page 37). The setup of the meter run and plumbing configurations can vary widely, depending upon the challenges existing on location.

---

**CAUTION:** When measuring liquid, process connections must be designed to eliminate air pockets. This is achieved by mounting the sensor below the metering device and sloping all tubing downward from the meter to the sensor. A side-port MVT and block manifold (Figure 2.8, page 37) is recommended to help prevent air bubbles from being trapped in the sensor.

**If a bottom-port MVT is used, the bottom process ports must be plugged or replaced with a drain valve, and side vents must be used for process connections. A block manifold is not recommended for use with bottom port MVTs. Contact a Cameron field representative for assistance.**

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1. Verify that the meter is properly installed in the flow line (per manufacturer's instructions).
  2. Mount the Scanner 2200 to a 2-in. pipe or to a flat, vertical surface using bolts and the mounting holes in the enclosure.
- 

**Note:** When a side-mount MVT and manifold assembly is used with a vertical pipe mount, the MVT can be rotated 90 degrees to facilitate manifold connections. An optional extension bracket may be required to provide clearance for the manifold. Contact your local Cameron sales office for details.

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3. Install tubing and fittings to connect the high-pressure and low-pressure taps of the DP meter to the process connections of the block manifold. Install a pair of shut-off valves near the high and low ports of the DP meter. Use a suitable compound or tape on all threaded process connections.
  4. Route any additional inputs/outputs or COM connections, etc. through the conduit opening in the bottom of the Scanner 2200.
- 

**Note:** To prevent fittings from turning and/or to avoid putting tension on stainless steel tubing, use a backup wrench to attach stainless steel tubing to shut-off valves, or sensor ports.

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5. To eliminate air bubbles in the MVT, manifold, and legs connecting them to the meter, fill the legs with fluid. Choose a fluid that is safe for the environment, and stable when depressurized.
-



**Important:** If the process fluid does not present an environmental risk and is stable when depressurized, it may be used to bleed air from the lines. If the process fluid can contaminate the environment, or is highly volatile when depressurized as with liquified gases, a different seal fluid should be used to fill the legs. An ideal seal fluid is one that does not dissolve in the process fluid.

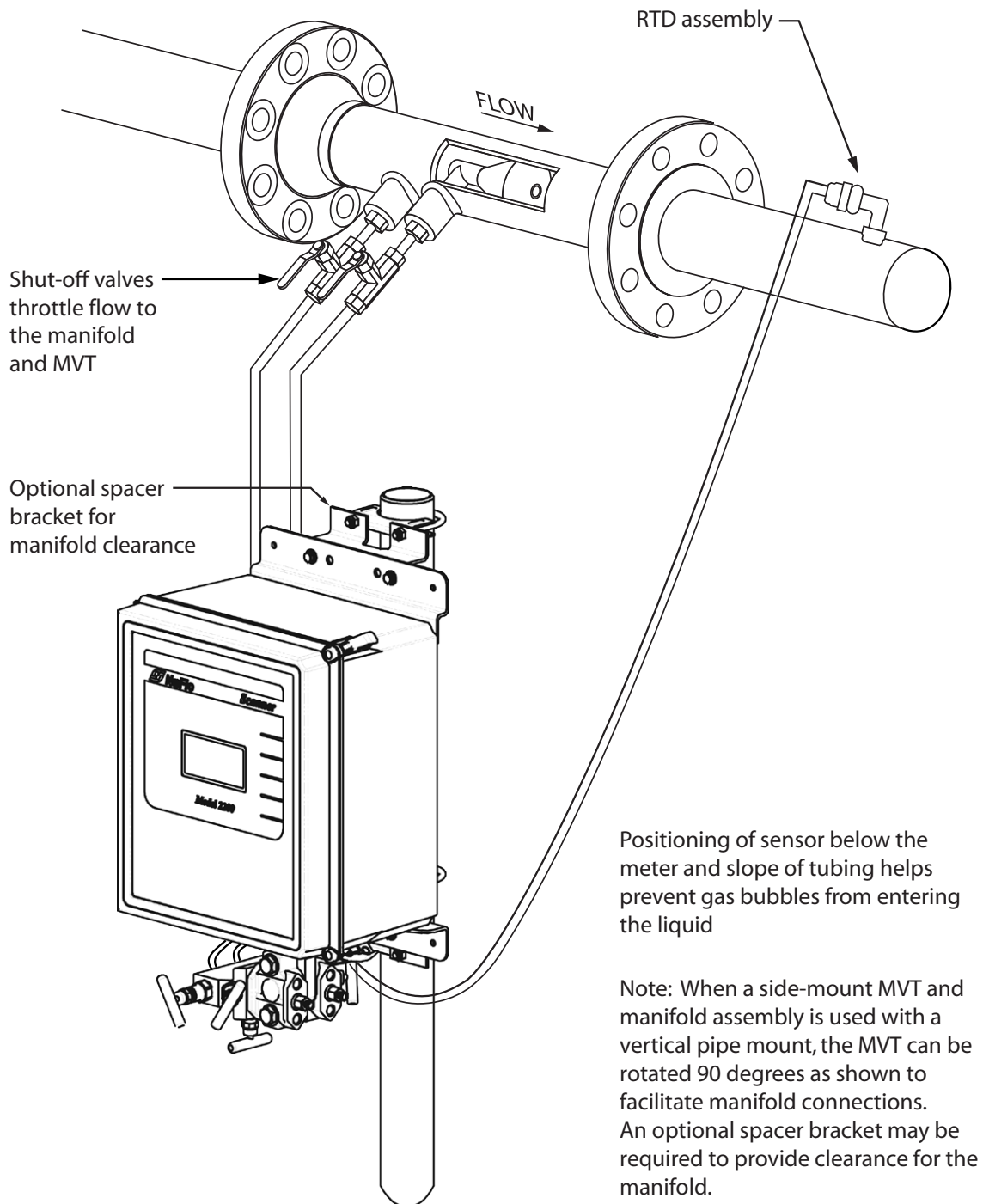


Figure 2.8—Liquid run installation (shown here with a cone meter). The same configuration can be used with an orifice meter.

**Bleeding with Process Fluid**

- a. Make sure the shut-off valves in the tubing near the meter pressure taps are closed, and the meter is filled with process fluid.
- b. Open the equalizer and bypass/block valves on the block manifold. Make sure the vent valve is closed.
- c. Open one of the shut-off valves near the meter.
- d. Slowly loosen the corresponding vent screw on the MVT, and throttle the rate of flow from the vent with the shut-off valve.
- e. When air bubbles are no longer visible around the MVT vent, tighten the MVT vent screw.
- f. Repeat steps a through e for the other leg.

**Bleeding with a Different Seal Fluid**

- a. Make sure the shut-off valves in the tubing near the pressure taps are open.
  - b. Open the equalizer and bypass/block valves on the block manifold. Make sure the vent valve is closed.
  - c. Remove the vent screw from one side of the MVT and insert a fitting to allow connection of a hand pump or funnel. If a funnel is used, attach a length of Tygon tubing that is long enough to elevate the funnel well above the meter pressure taps to force the fluid up the legs.
  - d. Connect a hand pump or funnel to the fitting.
  - e. Estimate the amount of fill fluid required to fill the tubing and push any air bubbles into the meter.
  - f. Pour fill liquid into the funnel, tapping the tubing occasionally to dislodge any bubbles.
  - g. When the leg is full of fluid, remove the fitting from the vent of the MVT and quickly replace the vent screw and tighten.
  - h. Repeat steps a through g for the other leg.
6. Perform a manifold leak test as described on page 41.
  7. Verify the zero offset, if required (and other calibration points, if desired). See the ModWorX™ Pro Software User Manual, Part No. 9A-30165025, for complete instructions. See also [Zero Offset \(Static Pressure or Differential Pressure\), page 41](#), [Static Pressure Calibration and Verification, page 41](#), and [Differential Pressure Calibration and Verification, page 42](#).

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**CAUTION:** Do not put the Scanner into operation until the valves are positioned properly so that pressure is supplied to both sides of the MVT. For instructions on proper valve positions, see [Placing the Scanner into Operation, page 43](#).

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## Measuring Liquid via a Turbine Meter

### **Best Practices**

The Scanner 2200 EFM calculates compensated liquid flow through a turbine meter in accordance with API-2540 and the measurement principles upon which the AGA-7 standard is based. The user supplies a linear or multi-point calibration factor, and the instrument performs the required compensation calculations, based on the RTD input.

For optimum performance, ensure that the turbine and Scanner 2200 installation complies with the industry recommendations listed below:

- Install the turbine flowmeter in the meter run such that there are at least 10 nominal pipe diameters upstream and five nominal pipe diameters downstream of the meter. Both inlet and outlet pipe should be of the same nominal size as the meter.
- Straightening vanes are recommended for eliminating swirl conditions. If used, they should be installed five pipe diameters upstream of the meter.

### **Installation Procedure - Compensated Liquid Measurement**

A Scanner 2200 can be mounted remotely and connected to a liquid turbine meter and an RTD for measuring compensated liquid, as shown in [Figure 2.9, page 40](#).

The setup of the meter run and plumbing configurations can vary widely, depending upon the challenges existing on location.

To connect the Scanner 2200 to a turbine meter, perform the following steps:

1. Verify that the flowmeter and magnetic pickup are installed in the flow line.
2. Mount the Scanner 2200 to a 2-in. pipe or to a flat, vertical surface using bolts and the mounting holes in the enclosure.
3. Remove the plug from the conduit opening in the bottom of the Scanner 2200 enclosure, route the turbine signal cable through the opening, and connect it to the circuit board. A wiring diagram for the turbine input is provided in [Figure 3.9, page 56](#).
4. Install the RTD assembly in the thermowell. Remove the plug from the other conduit opening in the bottom of the Scanner 2200 enclosure, route the RTD assembly cable through the conduit opening, and connect it to the circuit board. A wiring diagram for the RTD assembly is provided in [Figure 3.10, page 56](#).

### **Installation Procedure - Uncompensated Liquid Measurement**

The Scanner 2200 EFM calculates uncompensated liquid flow through a turbine meter in accordance with API MPMS, Chapter 5, Section 3, Measurement of Liquid Hydrocarbons by Turbine Meters. Install as described in the installation procedure for compensated liquid measurement on page x, except omit step 6 (no RTD is required for uncompensated measurement).

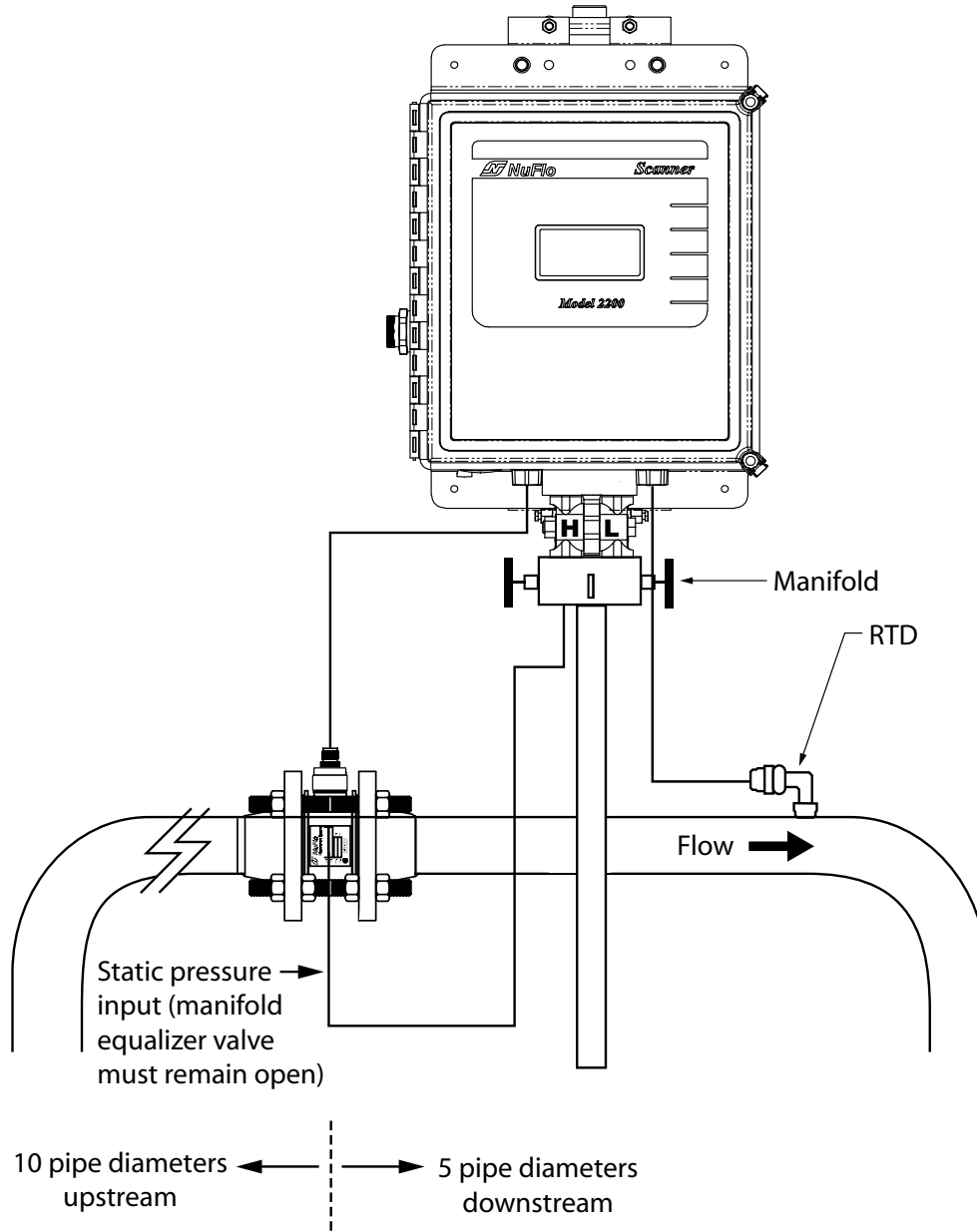
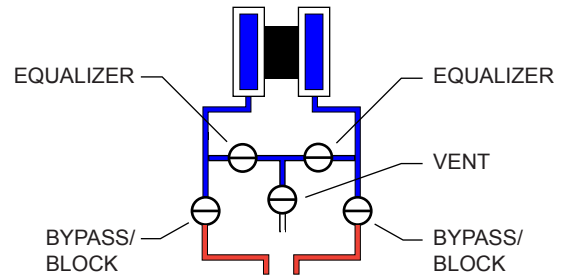


Figure 2.9—Installation in a compensated liquid turbine meter run

## Performing a Manifold Leak Test

A manifold leak test is recommended prior to operating any differential pressure meter into service. Check the manifold for leaks as follows.

1. Verify that the instrument is approximately level and is properly connected to the pressure source.
2. Make sure the vent valve in the manifold is closed. (The bypass/block valves should be open.)
3. Close both bypass/block valves on the manifold to isolate pressure between the block valve and the MVT.
4. Open both equalizer valves to distribute pressure throughout.
5. Monitor the pressure readout and watch for a steady decrease in pressure. If leakage is indicated, depressurize the system by opening both bypass/block valves, then check all manifold and piping joints. Tighten connections as necessary.
6. Repeat steps 3 through 5 to retest the manifold for leaks.



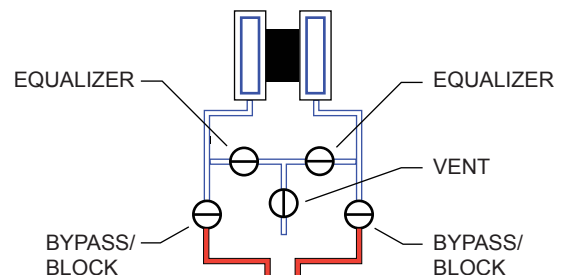
An additional test can verify the condition of the equalizing valves. Assuming the above test has confirmed the system is leak free, close both equalizing valves and open the vent. Monitor the differential pressure reading for any change. Repair or replace the manifold as required if the differential pressure varies.

## Zero Offset (Static Pressure or Differential Pressure)

The static pressure input for the Scanner 2200 is zeroed at the factory before shipment. However, changes in temperature and atmospheric pressure can cause the static pressure and differential pressure readings to vary. The inputs can be easily zeroed in the field, if necessary, prior to putting the Scanner 2200 into service.

To zero the static pressure or differential pressure

1. Close the bypass valves to isolate the pressure below the manifold.
2. Open the equalizer and vent valves.
3. Connect to the Scanner 2200 with the ModWorX™ Pro software, and apply zero pressure from the Calibrate Inputs screen (see the ModWorX™ Pro Software User Manual; Part No. 9A-30165025; for complete instructions).



## Static Pressure Calibration and Verification

**Note:** The pressure range stamped on the MVT is expressed as psia (absolute). However, Scanner 2200 pressure inputs are recalibrated as psig (gauge) at the factory before the device is shipped. Therefore, pressure readings displayed on the LCD and in the ModWorX Pro software are in terms of psig.

The static pressure and differential pressure inputs are calibrated and verified before the Scanner 2200 leaves the factory, and recalibration in the field may or may not be required. To comply with API standards for

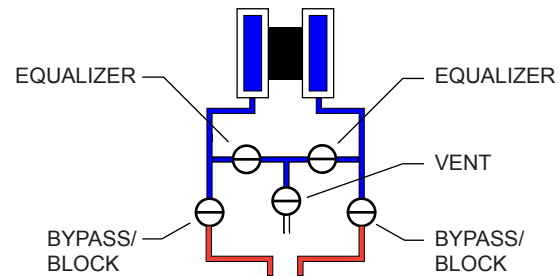
verification, “as found” readings should be recorded at approximately 0, 50, and 100 percent of the operating pressure range, increasing, and at 80, 20 and 0 percent of the operating pressure range, decreasing. For example, the static pressure measurements of a 1500-psi sensor should be verified at 0 psi, 750 psi, and 1500 psi, then at 1200 psi, 300 psi, and 0 psi.



**WARNING: Do not subject the Scanner 2200 EFM to unnecessary shock or over-range pressure during maintenance operations.**

To calibrate the static pressure

1. Close the bypass valves to isolate the pressure below the manifold.
2. Open the equalizer valves and vent valve to purge the lines.
3. Close the vent valve.
4. Connect a static pressure simulator to the manifold (either side).
5. Connect to the Scanner 2200 with the ModWorX™ Pro software. Click on the **Calibrate Inputs** menu button and proceed through the calibration per instructions in the ModWorX™ Pro Software User Manual.
6. At the appropriate software prompt, enter a known pressure.
7. Apply the same amount of pressure to the MVT using the simulator (see the ModWorX™ Pro Software User Manual for complete instructions). The ModWorX™ Pro software will display a measured value and a percentage of change.
8. Repeat steps 6 and 7 as necessary to enter multiple calibration points.
9. When all calibration points have been entered, click **Save Changes** to apply the new calibration settings.



To verify the static pressure, perform the steps described in the calibration procedure above, except instead of choosing **Calibrate** from the Change Calibration Task window, choose **Verify**. You will be prompted to enter an applied value, and you will apply the same amount of pressure to the MVT, just as in the calibration process. The ModWorX™ Pro software will display a measured value and a percentage of error. When you click Save Changes, the measured values are written to memory for reference.

### **Differential Pressure Calibration and Verification**

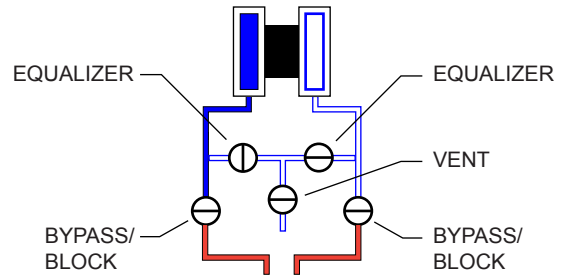
The static pressure and differential pressure inputs are calibrated and verified before the Scanner 2200 leaves the factory, and recalibration in the field may or may not be required. To comply with API standards for verification, “as found” readings should be recorded at approximately 0, 50, and 100 percent of the operating pressure range, increasing, and at 80, 20 and 0 percent of the operating pressure range, decreasing. For example, the differential pressure measurements of a 200-In. H<sub>2</sub>O sensor should be verified at 0 In. H<sub>2</sub>O, 100 In. H<sub>2</sub>O, 200 In. H<sub>2</sub>O, then at 160 In. H<sub>2</sub>O, 40 In. H<sub>2</sub>O, and 0 In. H<sub>2</sub>O.



**WARNING: Do not subject the Scanner 2200 EFM to unnecessary shock or over-range pressure during maintenance operations.**

To calibrate the differential pressure

1. Close the bypass valves to isolate the pressure below the manifold.
2. Open the equalizer valves and vent valve to purge the lines.
3. Close the high-pressure side equalizer valve.
4. Connect a pressure simulator to the high-pressure side of the manifold.
5. Connect to the Scanner 2200 with the ModWorX™ Pro software. Click on the **Calibrate Inputs** menu button and proceed through the calibration per instructions in the ModWorX™ Pro Software User Manual, Part No. 9A-30165025.
6. At the appropriate software prompt, enter a known pressure.
7. Apply the same amount of pressure to the high side of the MVT using the simulator (see the ModWorX™ Pro Software User Manual, Part No. 9A-30165025, for complete instructions). The ModWorX™ Pro software will display a measured value.
8. Repeat steps 6 and 7 as necessary, to enter multiple calibration points, and apply the new measured values from the ModWorX™ Pro interface.
9. When all calibration points have been entered, click **Save Changes** to apply the new calibration settings.

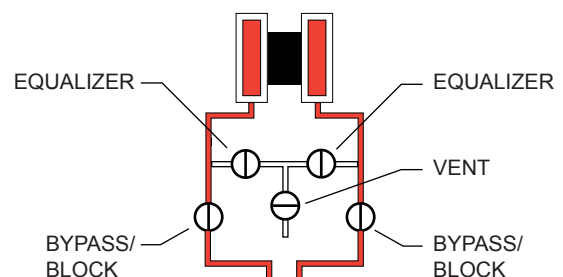


To verify the differential pressure, perform the steps described in the calibration procedure above, except instead of choosing **Calibrate** from the Change Calibration Task window, choose **Verify**. You will be prompted to enter an applied value, and you will apply the same amount of pressure to the MVT, just as in the calibration process. The ModWorX™ Pro software will display a measured value and a percentage of error. When you click **Save Changes**, the measured values are written to memory for reference.

## Placing the Scanner into Operation

To put the Scanner into operation;

1. Close the vent valve.
2. Open the equalizer valves.
3. Open the bypass/block valves to allow pressure to be supplied to both sides of the MVT.
4. Close the equalizer valves.
5. Open the vent valve (optional, some users may choose to leave the vent closed).



## Industry Standard Compliance

To ensure measurement accuracy, flow runs and turbine meter runs must be installed in accordance with industry standards. [Table 2.2, page 44](#), and [Table 2.3, page 45](#), reference the sections in these standards that apply specifically to flow run and hardware installation.

For a complete list of industry reference standards that serve as the basis for flow rate and fluid property calculations in the Scanner 2200, see [Appendix E—Industry Standards, page E-1](#).

Fluid properties used for gas measurement calculations such as compressibility factors and density are in accordance with AGA Report No. 8 (1994). For steam measurement, algorithms are based on the IAPWS Industrial-Formulation 1997 (IF-97) standard. For temperature-compensated and pressure-compensated liquid measurement, fluid property calculations are based on API MPMS Ch. 11.1 (2004).

Heating values for gas measurement are calculated in accordance with AGA Report No. 3, Part 3, Appendix F (1992) using the constants defined in GPA 2145 (2008).

For more information, see the ModWorX™ Pro Software User Manual, Part No. 9A-30165025.

**Table 2.2—Industry Standards for Orifice Meters**

Standard	Applicable Section	Description	Notes
AGA Report No. 3: Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids	Part 2: Specification and Installation Requirements, Section 2.6 (Installation requirements)	Specifications for orifice meters (to include beta ratios)  Installation requirements for orifice plates, meter tubes, flow conditioners, and thermometer wells	This standard is also distributed under the following names: API MPMS Chapter 14.3, Part 2; ANSI/API 14.3, Part 2-2200; and GPA 8185, Part 2.
ISO 5167: Measurement of Fluid Flow by Means of Pressure Differential Devices Inserted in Circular Cross-Section Conduits Running Full	Part 1: General Principles and Requirements	Installation of orifice plates inserted into a circular cross-section conduit running full  Limitation of pipe size and Reynolds number	ISO 5167 is applicable only to flow that remains subsonic throughout the measuring section and where the fluid can be considered single-phase. It is not applicable to the measurement of pulsating flow. It does not cover the use of orifice plates in pipe sizes less than 50 mm (2 in.) or more than 1000 mm (39 in.), or for pipe Reynolds numbers below 5000.
ISO 5167: Measurement of Fluid Flow by Means of Pressure Differential Devices Inserted in Circular Cross-Section Conduits Running Full	Part 2: Orifice Plates	Specifies orifice plates that can be used with flange pressure tapplings, corner pressure tapplings, D and D/2 pressure tapplings.	



Standard	Applicable Section	Description	Notes
API Manual of Petroleum Measurement Standards, Chapter 21.1 (Electronic Gas Measurement)	Section 1.7 - Equipment Installation	Installation of electronic gas measurement devices and associated communications, gauge/impulse lines, and cabling	
	Section 1.8 - Equipment Calibration and Verification	Requirements for calibrating and verifying the accuracy of electronic gas measurement devices	
ASME MFC-14M: Measurement of Fluid Flow using Small Bore Precision Orifice Meters	All sections	Specifies low-flow orifice meters smaller than 2 inch pipe size, that can be used with flange taps and corner taps.	Nominal pipe sizes 1/2 inch to 1-1/2 inch only. Beta ratio from 0.1 to 0.75. Suitable for single-phase fluids only. Subsonic flow only. Not suitable for pulsating flow.

### **Industry Standards for Cone Meters**

For installation requirements for use with a cone meter and applicable flow rate calculations, see the NuFlo™ Cone Meter User Manual, Part No. 9A-85165000.

**Table 2.3—Industry Standards for Turbine Meters**

Standard	Applicable Section	Description	Notes
AGA Report No. 7: Measurement of Natural Gas by Turbine Meters	Section 7- Installation Specifications	Installation of gas turbine meters to include flow direction, meter orientation, meter run connections, internal surfaces, temperature well location, pressure tap location, and flow conditioning  Illustrations of recommended installation configurations  Environmental considerations, the use of other devices to improve meter performance, and precautionary measures.	This specification applies to axial-flow turbine flowmeters for measurement of natural gas, typically 2-in. and larger bore diameter, in which the entire gas stream flows through the meter rotor.
API Manual of Petroleum Measurement Standards, Chapter 21.1 (Electronic Gas Measurement)	Section 1.7 - Equipment Installation	Installation of electronic gas measurement devices and associated communications, gauge/impulse lines, and cabling	
	Section 1.8 - Equipment Calibration and Verification	Requirements for calibrating and verifying the accuracy of electronic gas measurement devices	

<b>Standard</b>	<b>Applicable Section</b>	<b>Description</b>	<b>Notes</b>
API Manual of Petroleum Measurement Standards, Chapter 5 (Metering)	Section 3, Measurement of Liquid Hydrocarbons by Turbine Meters	Description of unique installation requirements and performance characteristics of turbine meters in liquid hydrocarbon service	This section does not apply to the measurement of two-phase fluids.

## Section 3—Wiring the Scanner 2200

### Field Wiring Connections



**WARNING:** To prevent ignition of hazardous atmospheres, do not open the enclosure while circuits are alive. The Scanner 2200 poses no hazard when opened in a safe area.

---

**CAUTION:** All field wiring must conform to the National Electrical Code, NFPA 70, Article 501-4(b) for installations within the United States or the Canadian Electric Code for installations within Canada. Local wiring ordinances may also apply. All field wiring must be rated for temperatures of 90°C or higher, and have a wire range of 22 to 14 AWG. Terminal block screws must be tightened to a minimum torque of 5 to 7 in-lbs. to secure the wiring within the terminal block. Only personnel who are experienced with field wiring should perform these procedures.

---

To wire the Scanner 2200 for operation, complete the following field connections, referencing [Figure 3.1, page 48](#), for terminal locations:

1. Open the door of the enclosure to access the circuit assembly.
2. Connect the lithium battery to the J5 connector on the circuit assembly.
3. Connect wiring for external power to TB1, if appropriate. See [Grounding Procedures, page 49](#), and see [Figures 3.3 through 3.6, page 51 through page 54](#), for wiring diagrams for solar power and DC power.
4. Connect wiring for the optional DC-to-DC converter, if appropriate. See [Figure 3.7](#) and [Figure 3.8, page 55](#).
5. Connect the flowmeter input wiring to terminal block TB2 or TB4, if appropriate. See [Figure 3.9, page 56](#).
6. Connect the process temperature input wiring to terminal block TB11, if appropriate. See [Figure 3.10, page 56](#).
7. Connect wiring for analog inputs and pulse inputs/contact inputs, if appropriate. See [Figure 3.11, page 57](#) and [Figure 3.12, page 58](#).
8. Connect wiring for analog output signals, if appropriate. See [Figure 3.13, page 58](#), and [Figure 3.14, page 59](#), for use with a DC power supply. See [Figure 3.15, page 59](#), for use with solar power and a DC-to-DC converter.
9. Connect wiring for digital output signals, if appropriate. See [Figure 3.16, page 60](#).
10. Recalibrate the Scanner 2200 (if necessary).
11. If external and internal power supplies were removed, reset the clock using the ModWorX™ Pro interface to ensure that the time stamps in the log data are accurate.
12. Close the enclosure cover.
13. If COM Port 1 will be used, connect wiring to TB13. See [Figure 3.17, page 60](#).

14. By default, COM Port 2 is wired to TB8 at the factory to support the external USB connector. To add a device to COM Port 2, wire as appropriate using TB6 (RS-485) or TB7 (RS-232). (Up to 3 devices can be connected to COM Port 2, however only one device can communicate with the Scanner 2200 at a time.) See [Figure 3.18, page 61](#).
15. If the Scanner 2200 will be used to power a radio or modem, connect an output cable to the Radio Out terminal on the TB1 plug, [Figure 3.19, page 61](#).

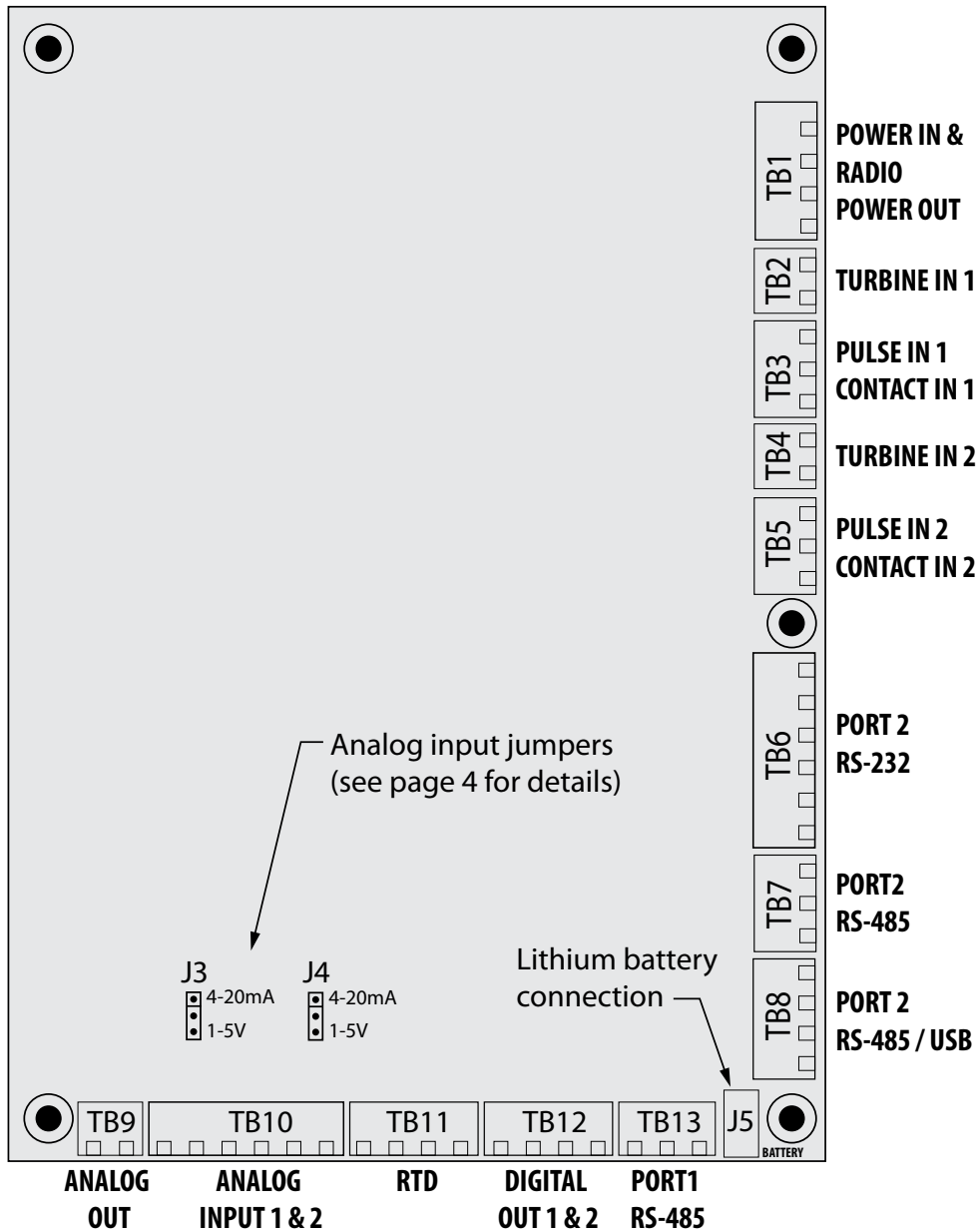


Figure 3.1—Circuit board layout

## Grounding Procedures

The Scanner 2200 is to be grounded with a protective earth grounding conductor in accordance with national and local electrical codes. To ground the device, connect a ground wire to the internal ground connection screw marked with the round sticker inside the enclosure as shown in Figure 3.2 (top image).

For DC-powered installations, the protective earth grounding conductor should be routed into the enclosure with the incoming power conductors.

For solar-powered installations, the protective earth grounding can be accomplished by connecting the device to a ground rod or other suitable system earth ground. The conductor should be terminated at the copper ground lug on the bottom of the Scanner 2200 enclosure (see Figure 3.2, bottom image). This lug will accept wire sizes from 14 AWG solid conductor to 4 AWG stranded conductor.

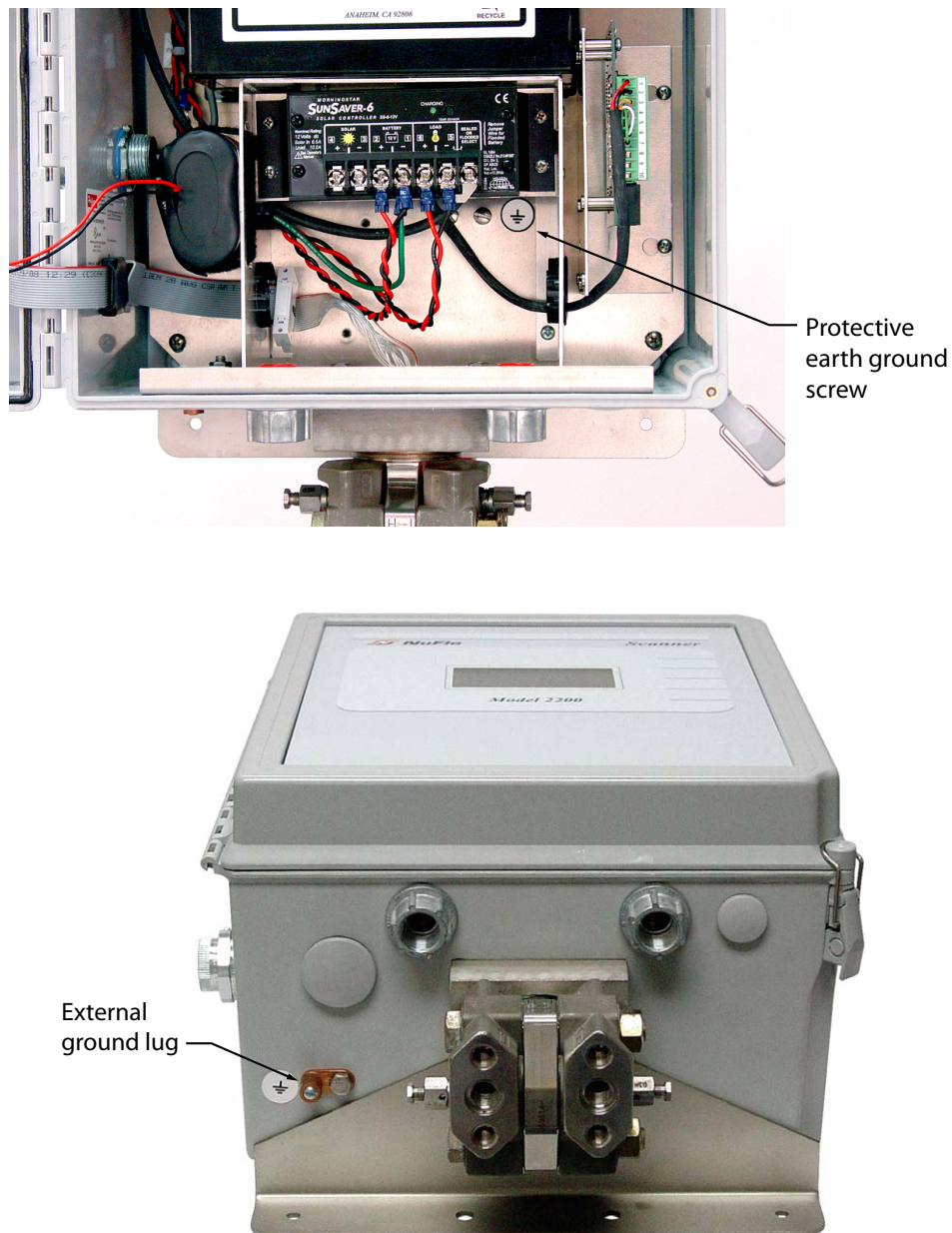


Figure 3.2—Ground screw locations; internal screw shown at top, external ground lug shown at bottom

## Power Supply Wiring

### *Internal Power Supply*

The Scanner 2200 EFM is shipped with a lithium battery pack. To supply power to the instrument, connect the battery cable to connector J5 on the circuit assembly (Figure 3.1, page 48).

Low-power microprocessor technology enables the Scanner 2200 to operate for an estimated 1 year on a lithium battery pack. The lithium battery pack is ideal for use in extreme temperatures, although extreme cold temperatures may reduce battery life.

If the Scanner 2200 is used to power a radio or other communications device, external power is recommended.

To maximize battery life,

- operate the Scanner using the following default configuration settings:
  - calculation frequency: 1 minute
  - logging frequency (interval): 1 hour
  - download frequency: monthly
- avoid the following conditions/activities:
  - operation at extremely cold temperatures
  - use of digital outputs (pulse or alarm) without external power
  - use of analog inputs without external power
  - use of COM devices without external power

When a solar panel or an external VDC power supply provides the primary power source, the lithium battery pack serves as a backup power supply. The use of an alternate power source extends battery life and helps ensure that timekeeping and volume accumulation will not be interrupted during a power failure.

### *Solar Charge Controller*

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**Important**    **Before installing the charge controller:**

- 1. Make sure the solar panel is mounted securely.**
- 2. Make sure the solar panel is covered with a cloth or other covering to prevent voltage output from the panel during installation and wiring of the Scanner 2200.**

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**Caution**    **All field wiring must conform to the National Electrical Code, NFPA 70, Article 501-4(b) for installations within the United States or as specified in Section 18-156 of the Canadian Electrical Code for installations within Canada. Local wiring ordinances may also apply. All field wiring must have a wire range of 22 to 14 AWG and terminal block screws must be tightened to a minimum torque of 5 to 7 in-lbs. to secure the wiring within the terminal block. Only personnel who are experienced with field wiring should perform these procedures.**

---

To install the solar charge controller, follow the procedure below and reference Figure 3.3 for terminal locations. As shown in Figures 3.3 and 3.4, the terminals on the solar charge controller are numbered 1 through 6 to indicate the order in which connections should be made. The power supply wiring is connected to terminal block TB1 on the circuit assembly.

1. Remove the TB1 plug from the circuit board (as shown in Figure 3.3).
2. Route the solar panel wiring through the conduit hub at the bottom of the Scanner 2200 enclosure.
3. Connect the negative wire from the 12V battery to Terminal 1 of the charge controller.
4. Connect the positive wire from the 12V battery to Terminal 2 of the charge controller.
5. Connect the negative wire from the solar panel to Terminal 3 of the charge controller.
6. Connect the positive wire from the solar panel to Terminal 4 of the charge controller.
7. Connect the negative wire from the Scanner 2200 power circuit (TB1) to Terminal 5 of the charge controller.
8. Connect the positive wire from the Scanner 2200 power circuit (TB1) to Terminal 6 on the charge controller.

---

**Caution**      **Ensure that no wiring makes contact with other wiring or electrically conductive surfaces that would short the battery terminals. Shorting the battery terminals can cause arcing, unnecessary battery discharge, or possible ignition of explosive battery gases.**

---

9. Verify that the jumper between the “LOAD-“ terminal (terminal 5) and the “SEALED OR FLOODED SELECT” terminal is in place on the photovoltaic charge controller.
10. Reconnect the TB1 plug on the circuit board.
11. Remove the covering from the solar panel.

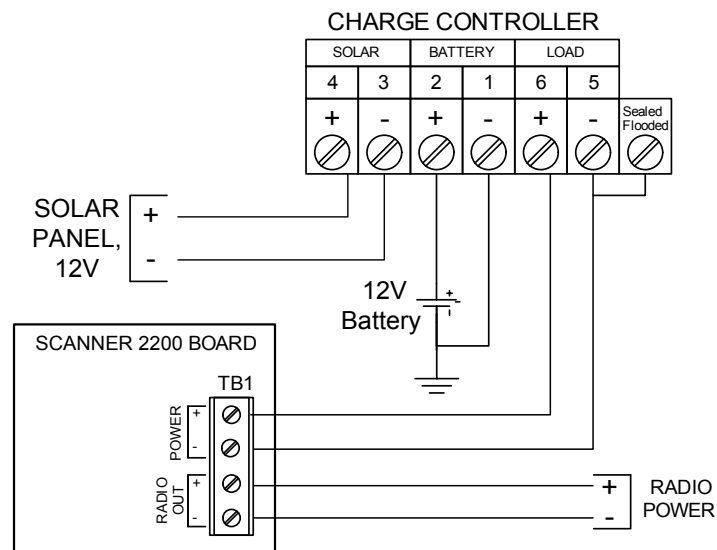


Figure 3.3—Solar power wiring

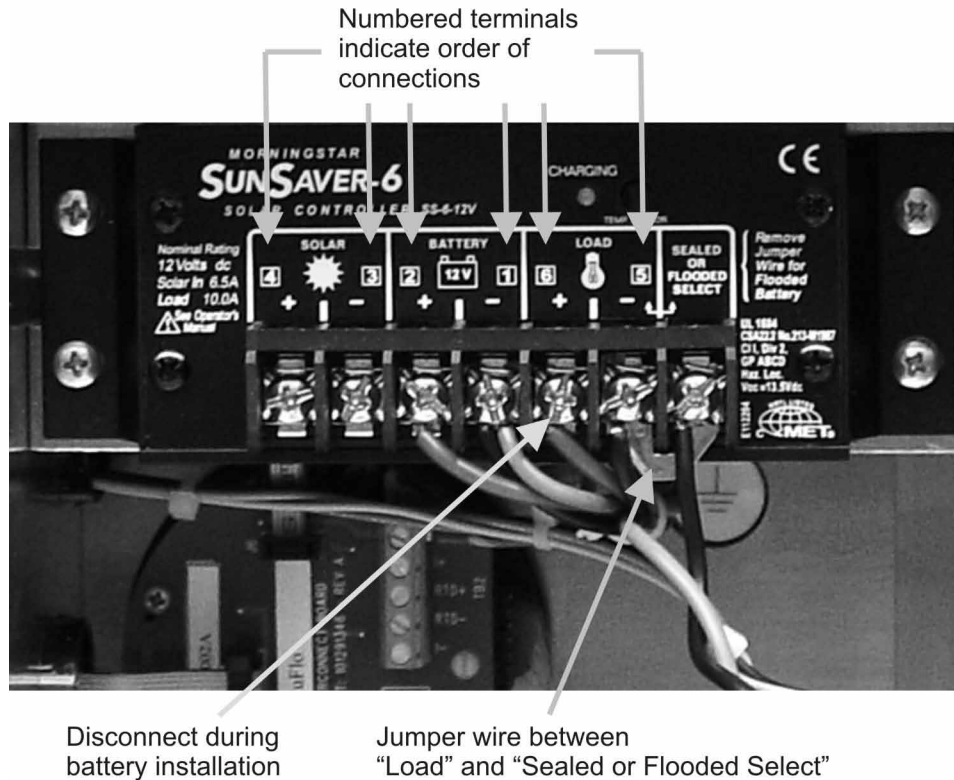


Figure 3.4—Solar charge controller

### External DC Power Supply

The Scanner 2200 can be connected to a remote DC power supply (Figure 3.5, page 53). The power supply and cable must be capable of supplying 16 to 28 VDC @ 1.2 A.

The external power supply must be an approved SELV source, insulated from the AC main by double/reinforced insulation per CSA C22.2 No.61010-1-04 / UL 61010-1 – 2nd Edition.

---

**Caution** All field wiring must conform to the National Electrical Code, NFPA 70, Article 501-4(b) for installations within the United States or as specified in Section 18-156 of the Canadian Electrical Code for installations within Canada. Local wiring ordinances may also apply. All field wiring must have a wire range of 22 to 14 AWG and terminal block screws must be tightened to a minimum torque of 5 to 7 in-lbs. to secure the wiring within the terminal block. Only personnel who are experienced with field wiring should perform these procedures.

---

To install the DC power supply, follow the procedure below and reference Figure 3.5 for terminal locations. As shown in Figure 3.5, page 53, and Figure 3.6, page 54, the terminals on the power supply are numbered, 1 through 7, to indicate the order in which connections should be made. The power supply wiring is connected to terminal block TB1 on the circuit assembly.

1. Remove the TB1 plug from the circuit board (as shown in Figure 3.5, page 53).
2. Route the solar panel wiring through the conduit hub at the bottom of the Scanner 2200 enclosure.
3. Connect the positive input power to Terminal 1 of the power supply.



4. Connect the negative input power to Terminal 2 of the power supply.
5. Make sure the input power is connected to a protected earth ground.
6. Connect the positive wire from the 12V battery to Terminal 3 of the charge controller.
7. Connect the negative wire from the 12V battery to Terminal 4 of the charge controller.
8. Connect the positive wire from the TB1 power terminal to Terminal 5 of the charge controller.
9. Connect the negative wire from the TB1 power terminal to Terminal 6 of the charge controller.
10. Connect a ground wire from Terminal 7 of the charge controller to a ground screw in the back panel of the enclosure (the screw is marked with a ground symbol sticker as shown in [Figure 3.2, page 49](#)).

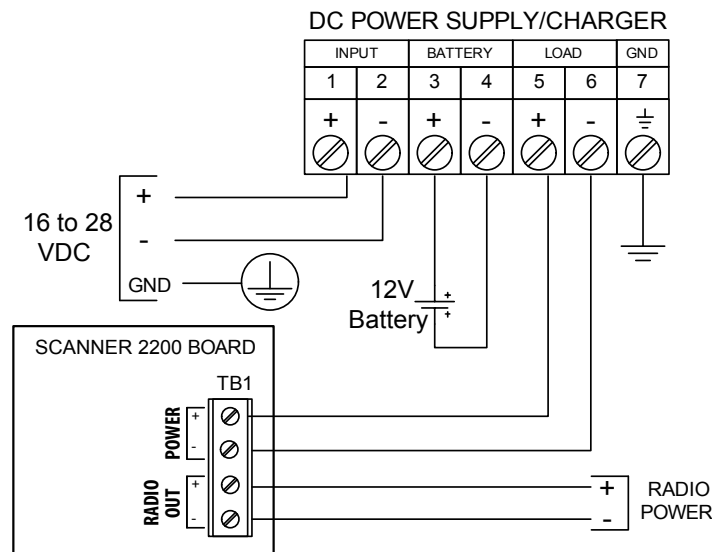


Figure 3.5—DC power supply wiring

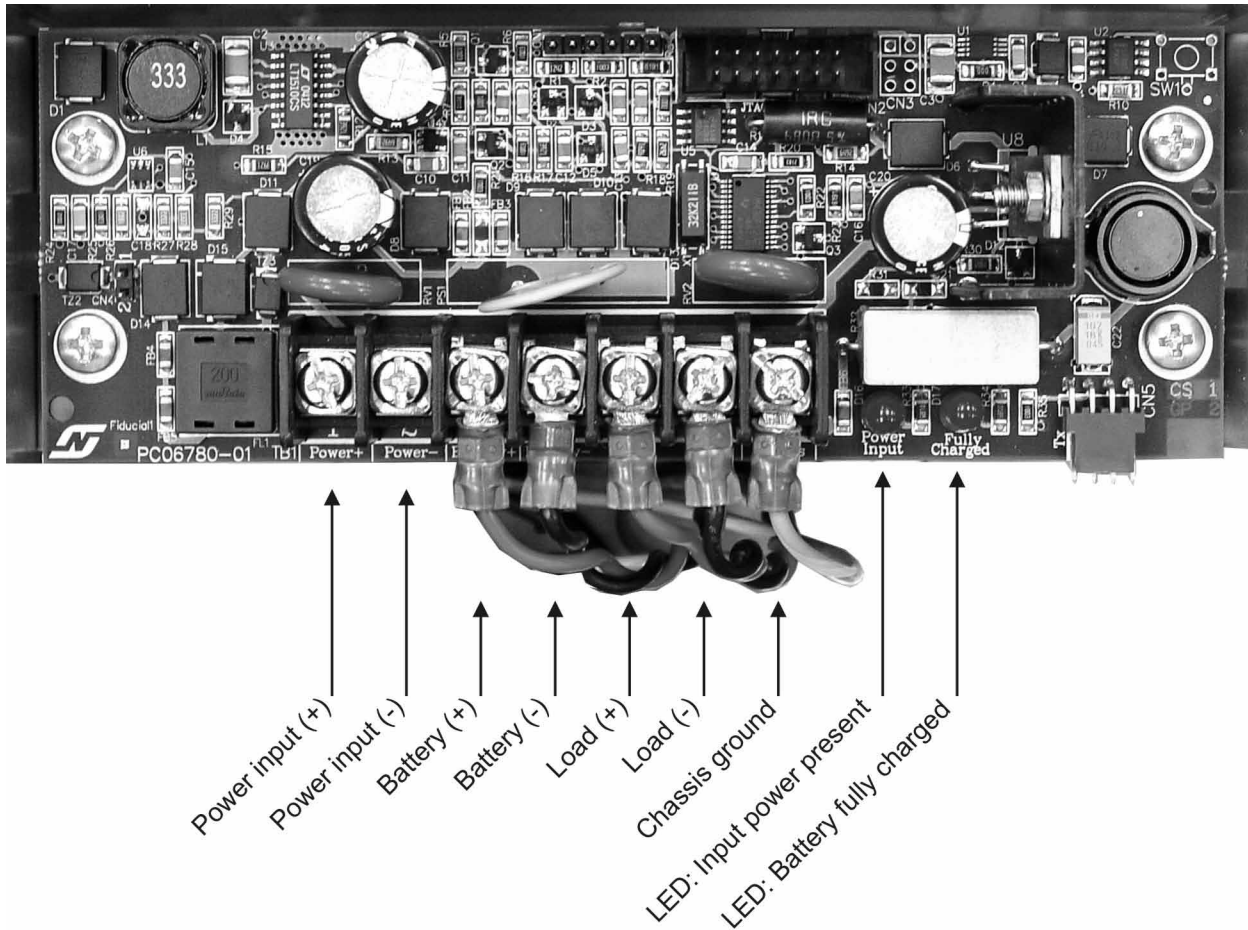


Figure 3.6—DC power board connections

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**Important:** In all applications using an external power supply, a switch or circuit breaker must be included in the safe area external power supply installation within easy reach of the operator. The switch or circuit breaker must be marked as the “disconnect” for the safe area external DC power supply.

---

### ***DC-to-DC Power Option***

A DC-to-DC power converter (Figure 3.8, page 55) is optionally available to convert 12V solar power to the 24V necessary to power an analog output loop or an analog input loop. As shown in Figure 3.7, page 55, the input connections are wired to the terminals 5 and 6 of the solar charge controller and the output connections are wired to the power terminals in TB1 on the Scanner 2200 circuit board.

When wired as shown in Figure 3.7, page 55, the DC-to-DC converter provides 24V at the radio output terminals and at the analog input power terminals.

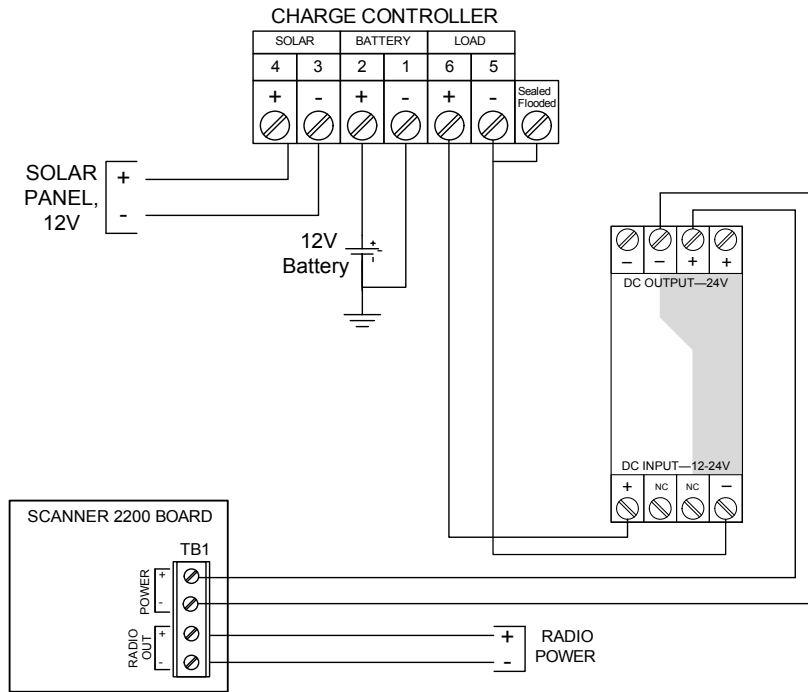


Figure 3.7—DC-to-DC converter wiring

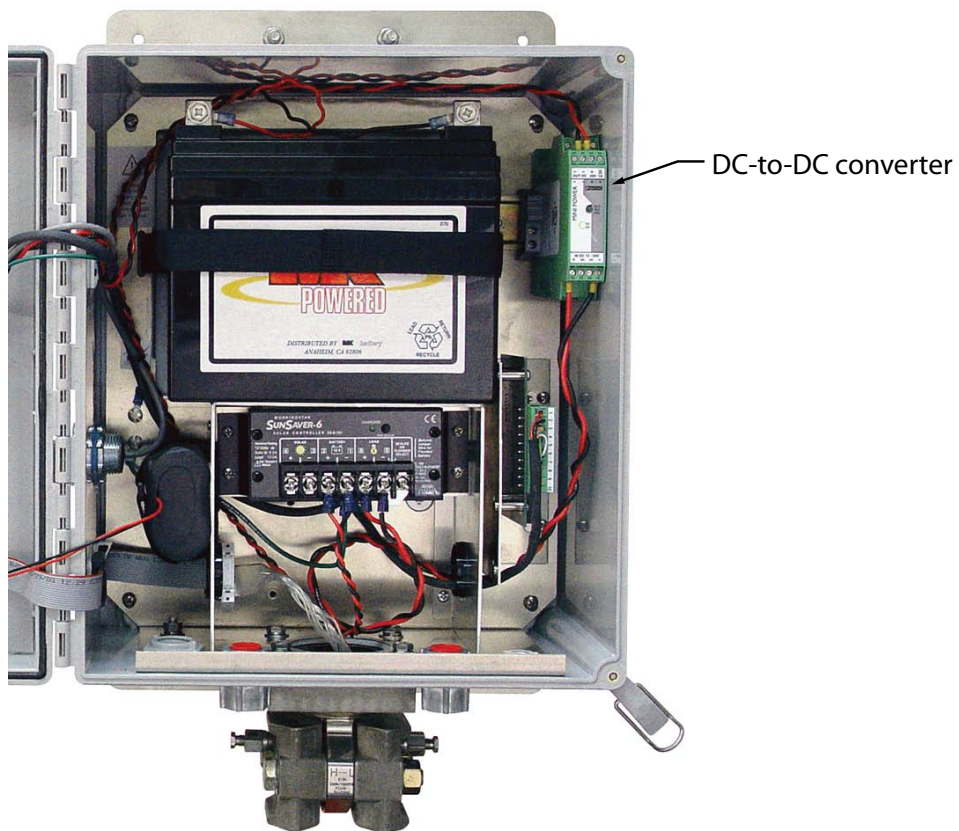


Figure 3.8—DC-to-DC converter mount

# Input Wiring

## Turbine Flowmeter Input

Turbine Inputs 1 and 2 (Terminal blocks 2 and 4) provide the turbine flowmeter input signal generated by a magnetic pickup, enabling the Scanner 2200 to calculate and display instantaneous flow rates and accumulated totals. Wire as shown in Figure 3.9.

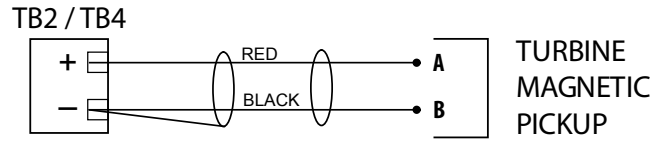


Figure 3.9—Flowmeter input wiring

## RTD Input

A 4-wire, 100-ohm platinum 0.00385 ohm/ohm°C RTD is recommended for performing orifice gas and compensated liquid calculations or gas turbine calculations, though a 2- or 3-wire RTD may prove functional. Wire as shown in Figure 3.10.

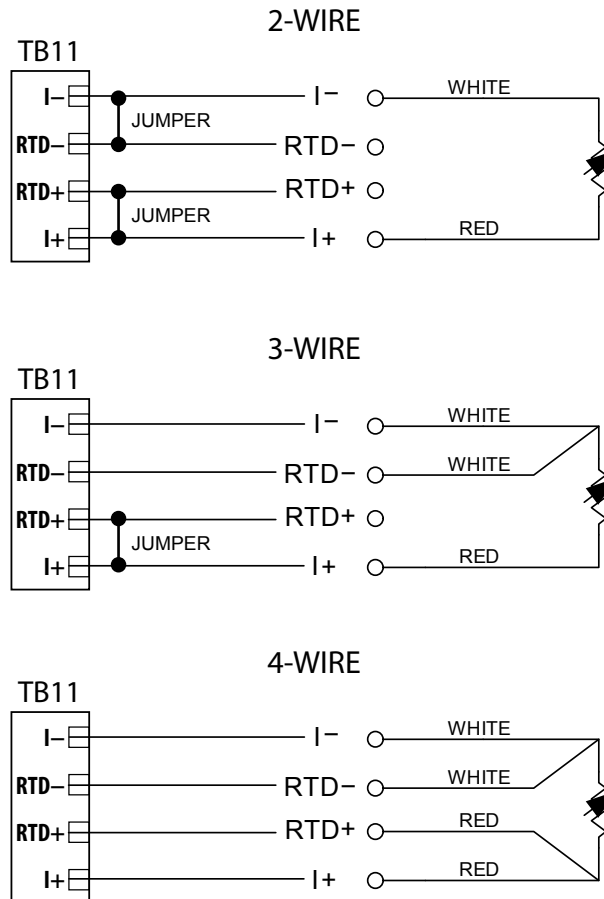


Figure 3.10—Process temperature input wiring

## Analog Inputs 1 and 2

The analog inputs, which can be configured for a 0-5 V, 1-5 V or 4-20 mA signal, can be used to receive readings from a pressure or temperature transmitter for use in AGA-7 gas calculations. Alternatively, they can be used to log measurements from any device with a 0-5 V, 1-5 V or 4-20 mA output.

To configure the device for a 0-5V input or a 1-5V input, position jumper J3 or J4 in the lowest position as shown in Figure 3.11. To configure the device for a 4-20 mA input, place the jumper in the top position. For a 4-20 mA input (top position), a 249-ohm resistor provides the shunt resistance for the measurement.

Transmitter power is provided by the Scanner 2200 only when the Scanner is powered externally with DC power connected to TB1. The output voltage equals the input voltage less 0.25 VDC, and is limited to 20 mA.

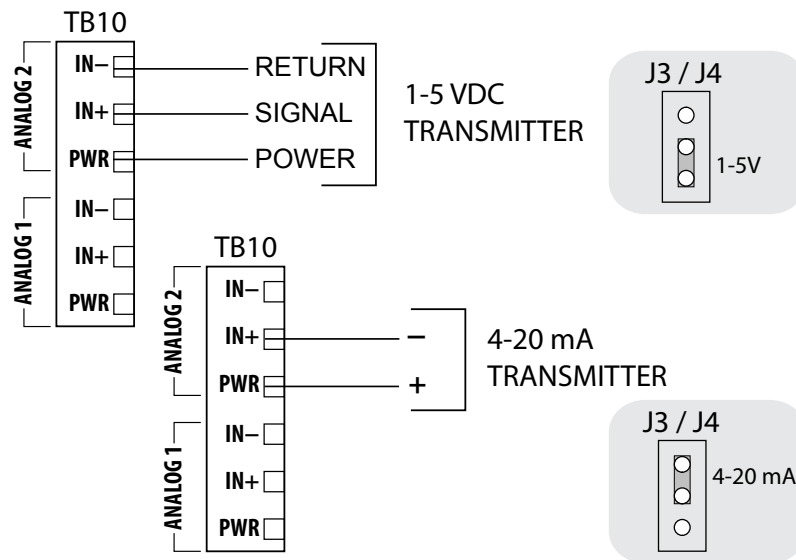


Figure 3.11—0-5 V, 1-5 V and 4-20 mA analog input wiring

When the Scanner 2200 is solar-powered, and 24-volt power is needed to power an analog input loop, a DC-to-DC power supply option is recommended to convert 12V solar power to 24 VDC. See [Figure 3.7, page 55](#), for wiring instructions.

## Pulse Input

The pulse inputs provide optically isolated inputs for high-amplitude pulse (frequency) signals, which includes signals from a turbine meter equipped with a preamplifier or signals from a positive displacement meter. [Figure 3.12, page 58](#), shows wiring for either a pulse input or a relay contact switch.

The Scanner 2200 can calculate flow from no more than two frequency inputs at a time. Therefore, a pulse input can be used simultaneously with only one turbine input.

A pulse input can also be used as a status input for monitoring a parameter via Modbus registers, even when two frequency inputs are being used to calculate flow. See [Pulse Input for Status Indication, page D-25](#), for details.

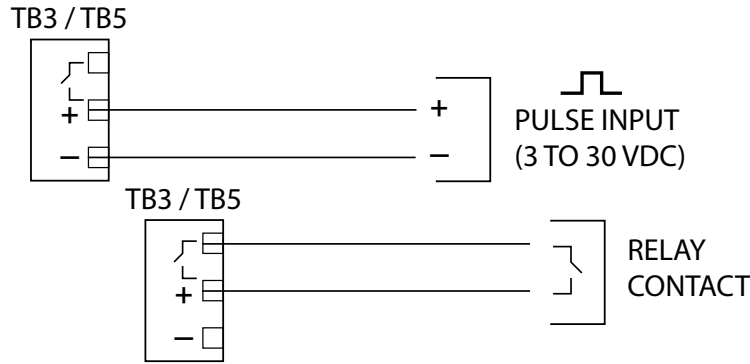


Figure 3.12—Pulse input wiring

## Output Wiring

### Analog (4-20 mA) Output

The 4-20 mA output provides a linear current output that can be configured using ModWorX Pro software to represent any parameter in the holding registers. This output can be powered by connecting the Scanner 2200 to an 8 to 30 VDC power supply (voltage required is dependent on loop resistance) and to a current readout device located nearby. See Figure 3.13.

The graph in [Figure 3.14, page 59](#), shows the minimum voltage required to power the instrument for a given loop resistance. In addition, the mathematical relationship between loop voltage and load resistance is given. For example, if a power supply voltage of 24 volts is available to power the current loop, the maximum load resistance would be 800 ohms.

Alternatively, when the Scanner 2200 is solar-powered, a DC-to-DC power supply (available as an option) is recommended to convert 12V solar power to the 24 VDC required for the analog output. See [Figure 3.15, page 59](#), for wiring instructions.

See the ModWorX Pro Software User Manual for information on configuring zero and full-scale values using ModWorX Pro software.

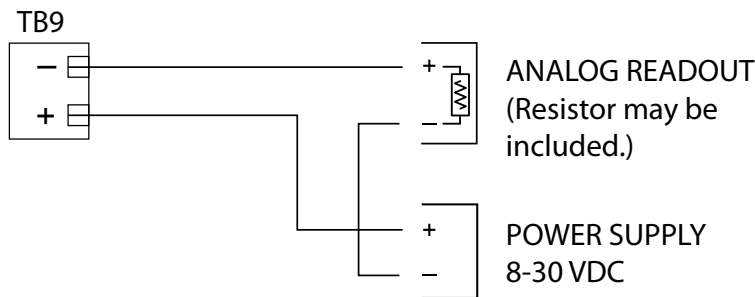


Figure 3.13—Analog (4-20 mA) output wiring with customer-supplied DC power supply

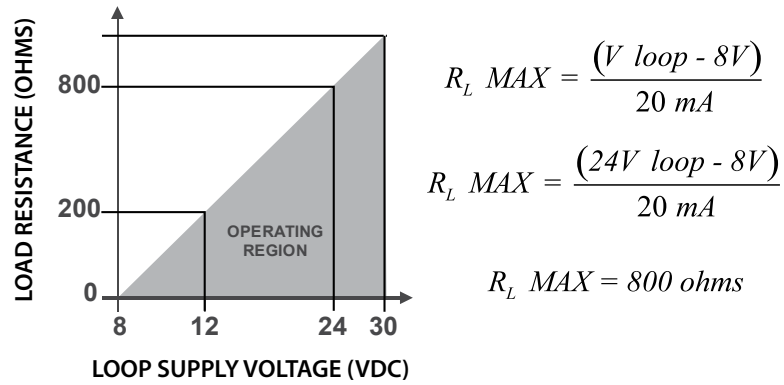


Figure 3.14—Chart showing how DC power supply voltage requirement is determined

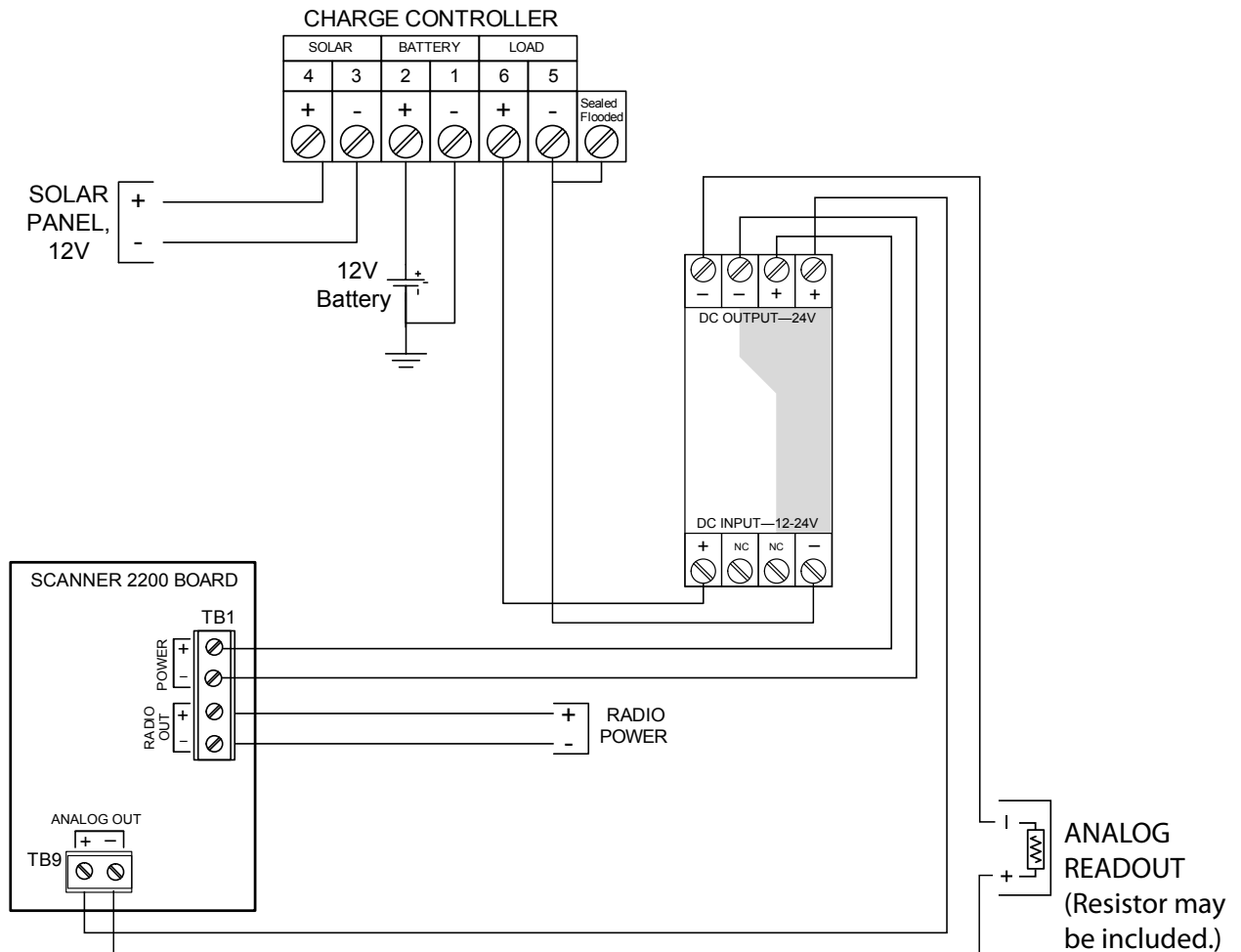


Figure 3.15—Analog (4-20 mA) output wiring with solar power and a DC-to-DC converter (optional)

## Digital Output (Pulse or Alarm)

The Scanner 2200 supports two solid-state digital outputs that are configurable as either pulse outputs or alarm outputs. As a pulse output, the pulse width duration and pulse representation are both configurable, the the output can be configured to be proportional to volume, or time-based (“periodic”). Because the circuit is isolated, it can be used in conjunction with any other feature on the Scanner 2200. A two-conductor cable from the Scanner 2200 to the remote location is required. The maximum rating of the digital output circuit is 60 mA at 30 VDC. Maximum frequency is 50 Hz. Wire as shown in Figure 3.16.

For reduced power consumption, turn the digital output feature off when it is not in use.

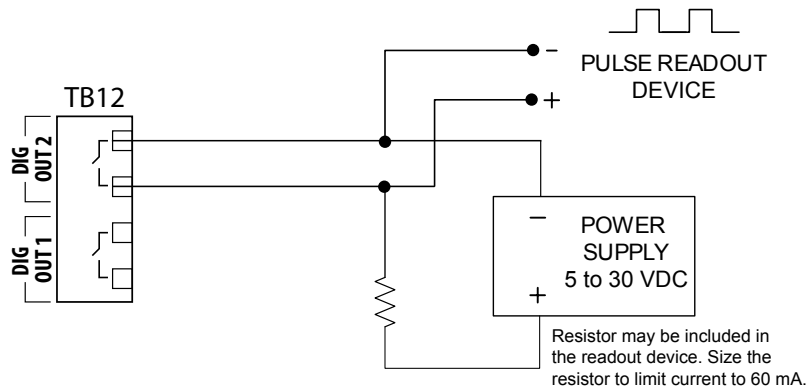


Figure 3.16—Pulse output wiring

## Com Port 1 (RS-485)

Communications Port 1 is an RS-485 output that can be used simultaneously with Communications Port 2.

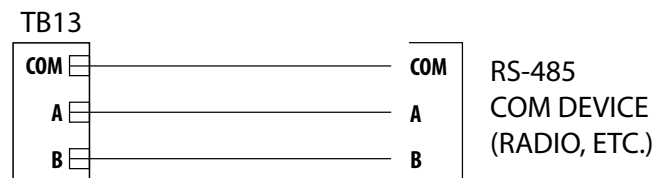


Figure 3.17—RS-485 output

## Com Port 2 (USB, RS-485, or RS-232)

Communications Port 2 is factory wired to support an external USB connector, but it can also support RS-485 and RS-232 inputs. Any of three terminals can be used to connect a device to Port 2:

- TB6—RS-232 communications
- TB7—RS-485 communications
- TB8—USB communications

While multiple devices can be wired to Port 2 simultaneously, the Scanner 2200 communicates with only one device at a time. When multiple devices are connected, USB communication (TB8) has priority over RS-232 (TB6), which has priority over RS-485 (TB7).

Example: A radio is connected to TB6 and a user connects a laptop to the external USB connector (TB8) to download data. When the Scanner 2200 detects the USB connection, communications with the radio (TB6)



are temporarily suspended. When the USB cable is disconnected from the external USB connector, radio communications via TB6 resume.

The sleep pin on TB6 is an open drain transistor output that is intended for use with radios that incorporate a hardware line for power management, such as the MDS TransNET. For information on radio control capabilities, see the Radio Power Output section below, and see the ModWorX Pro Software User Manual for instructions on configuring radio power controls.

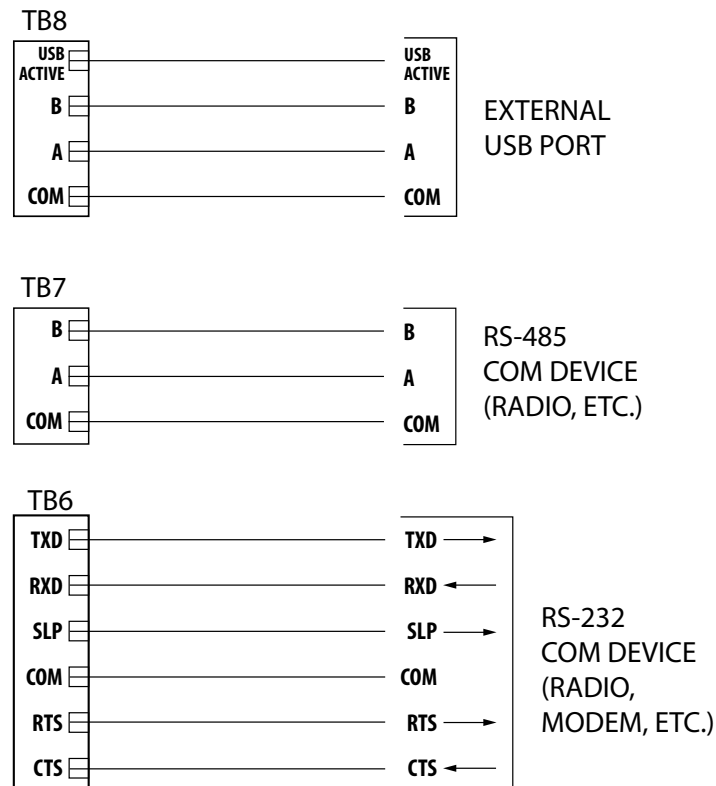


Figure 3.18—COM 2 wiring options (by default, COM 2 is wired to TB8 for enabling the external USB port when the instrument leaves the factory)

## Radio Power Output

When the Scanner 2200 is used to power a radio, a user can conserve power by controlling the power output to the radio. To enable this control, the radio power must be wired to TB1 and the radio power settings must be configured in ModWorX Pro software. The maximum voltage rating of the TB1 circuit is 30V.

The maximum current rating is 1A. See the ModWorX Pro Software User Manual for instructions on configuring radio power settings.



Figure 3.19—Radio power output

## Configuration via ModWorX™ Pro Software

A laptop connection and the ModWorX™ Pro software provided with the Scanner 2200 are required for the calibration, configuration, and maintenance of the instrument and for downloading data. An external USB port facilitates quick and easy laptop connections with a user-supplied universal USB cable.

Instructions for installing the software and the USB driver are provided on the installation CD provided with each instrument. User manuals containing step-by-step instructions on software functions are embedded in the software interface for quick and easy access.



**WARNING: To prevent ignition of hazardous atmospheres, do not open the enclosure while circuits are alive. The Scanner 2200 poses no hazard when opened in a safe area.**

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## Section 4—Scanner 2200 Maintenance

The Scanner 2200 is engineered to provide years of dependable service with minimal maintenance. Batteries require periodic replacement, and battery life depends on whether battery power is the primary or secondary power source, the configuration settings of the Scanner 2200, and ambient temperature conditions.

All configuration settings are stored in nonvolatile memory; therefore, configuration settings will not be lost in the event of battery failure.

The circuit assembly may also require replacement over the life of the instrument. Replacement procedures are provided in this section.



**WARNING:** Before servicing the Scanner 2200, disconnect all power sources/signal sources or verify that the atmosphere is free of hazardous gases.

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### Lead Acid Battery Replacement

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**Warning** Do not attempt the replacement of the lead acid battery unless the area is first declassified or is known to be nonhazardous.

---

**Important:** Keeping the lithium battery pack connected during the lead acid battery replacement should eliminate any interruption of measurement and logging. If the lithium battery pack is not connected, disconnecting the lead acid battery from the circuit board will interrupt the display and logging of accumulated flow run and turbine volume totals (grand total and previous day total), and energy and mass totals. To capture accumulated totals before disconnecting the battery, create a partial record using ModWorX Pro software. Instructions are provided in the ModWorX Pro Software User Manual.

---

To replace the sealed lead acid battery, follow the procedure below, and reference [Figure 4.1, page 64](#), as needed:

1. Disconnect the power input plug (TB1) from the circuit board.
2. Remove the battery hold-down strap.
3. Disconnect the red battery wire from the positive battery terminal.
4. Disconnect the black battery wire from the negative battery terminal.
5. Remove the battery from the shelf and replace with a new battery. Observe polarity.
6. Reconnect the power input plug (TB1) to the circuit board.

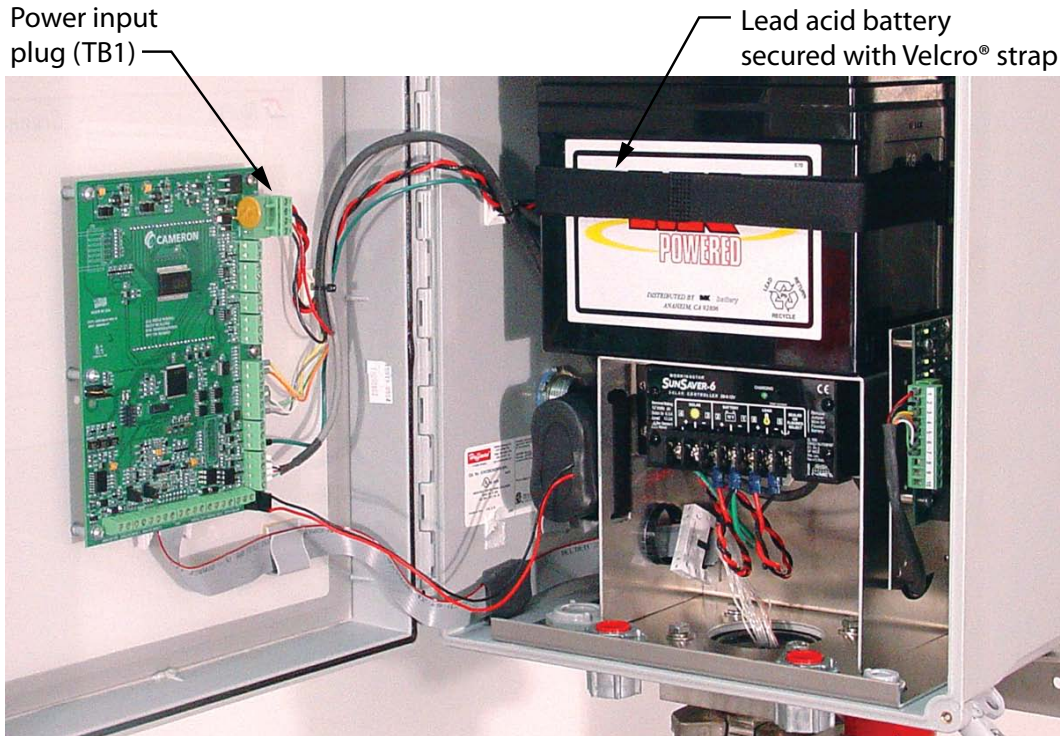


Figure 4.1—Lead acid battery replacement

## Lithium Battery Pack Replacement

The Scanner 2200 uses a lithium battery pack with a typical life expectancy of several years when used as a back-up to the lead acid battery. Due to the flat discharge characteristics of the lithium battery, it is difficult to determine how much life remains in a battery at any given time. To preserve timekeeping and flow calculations, replace the battery pack at 5-year intervals.



**WARNING:** To prevent ignition of hazardous atmospheres, do not open the enclosure while circuits are alive. The Scanner 2200 poses no hazard when opened in a safe area.

---



**WARNING:** The lithium battery pack that powers the Scanner 2200 is a sealed unit; however, should a lithium battery develop a leak, toxic fumes could escape upon opening the enclosure. Ensure that the instrument is in a well-ventilated area before opening the enclosure to avoid breathing fumes trapped inside the enclosure. Exercise caution in handling and disposing of spent or damaged battery packs. See additional information in Appendix C, Lithium Battery Information.

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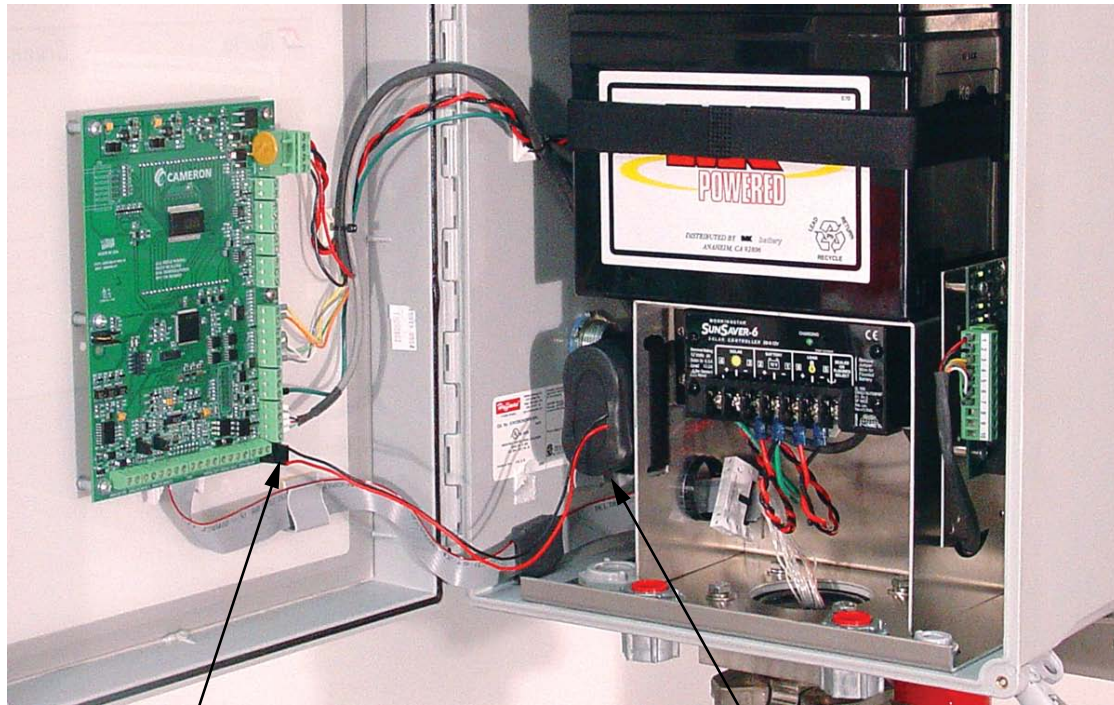
**Important:** If a sealed lead acid battery is the primary power source, keeping the lead acid battery connected during the lithium battery replacement should eliminate any interruption of measurement and logging. If the lithium battery pack is the only source of power, disconnecting the battery pack from the circuit board will interrupt the display and logging of accumulated flow run and turbine volume totals (grand total and previous day total), and energy and mass totals. To capture accumulated totals before disconnecting the battery, create a partial record using ModWorX Pro software. Instructions are provided in the ModWorX Pro Software User Manual.

---

The lithium battery pack is secured inside the enclosure by a Velcro® strap and connected to the J5 connector near the bottom of the circuit assembly.

To replace the lithium battery pack, perform the following steps, and reference Figure 4.2 as needed:

1. Disconnect the battery from the J5 connector on the circuit assembly.
2. Loosen the Velcro® strap from around the battery pack, and remove the spent battery pack from the enclosure.



J5 battery  
connector

Lithium battery  
secured with Velcro® strap

*Figure 4.2—Lithium battery pack replacement*

3. Place the new battery pack in the enclosure in the same position as the original battery pack, and secure the Velcro® strap tightly around it.
4. Connect the replacement battery pack to the J5 connector.

---

**Important:** If the lithium battery is the primary power source, the internal clock time will need to be reset following battery replacement. Reset the time using ModWorX™ Pro software. Instructions are provided in the ModWorX Pro Software User Manual.

**All configuration and calibration settings are automatically saved to non-volatile memory and are not affected by a temporary loss of battery power.**

---

## Circuit Assembly Replacement



**WARNING:** To prevent ignition of hazardous atmospheres, do not open the enclosure while circuits are alive. The Scanner 2200 poses no hazard when opened in a safe area.

---

**Important:** Static electricity can damage a circuit board. Handle new boards only by their edges, and use proper anti-static techniques (such as wearing anti-static wrist strap or touching metal to establish an earth ground) prior to handling a board.

---

**Important:** If possible, download the configuration settings and all archive logs before replacing the circuit board.

---

To replace the circuit assembly, perform the following steps, and reference [Figure 4.3, page 67](#), as needed:

1. Open the door to the enclosure to access the circuit assembly.
2. Record the locations of all cable connections to the circuit board.
3. Using a small standard blade screwdriver, remove all wiring from terminal blocks, ensuring that all wiring that is connected to powered circuits is insulated with tape.
4. Unplug the battery cable from connector J5 on the circuit board.
5. Locate the white MVT ribbon cable connector near the bottom of the board. Using your thumbs, push the sides of the connector apart to release the ribbon cable.
6. Using a small standard blade screwdriver, remove the six #6-32 × 3/8" screws from the circuit board and carefully lift the circuit board/display assembly from the enclosure.
7. Remove the replacement circuit board from its packaging.
8. Insert the ribbon cable into the white connector and push the sides of the connector together to latch, securing the ribbon cable in place.
9. Reattach the circuit board to the inside door panel with the six #6-32 × 3/8" screws removed in step 6.
10. Reconnect the battery cable to connector J5 on the circuit board.
11. Reconnect all wiring to terminal blocks.
12. Recalibrate the Scanner 2200.

---

**Important:** Do not overlook the need to recalibrate the Scanner 2200. Boards that are shipped independently of a Scanner 2200 are not calibrated to compensate for atmospheric pressure; therefore, a Scanner 2200 will not display accurate pressure readings until it is recalibrated.

---

13. Restore power to the peripheral circuitry.



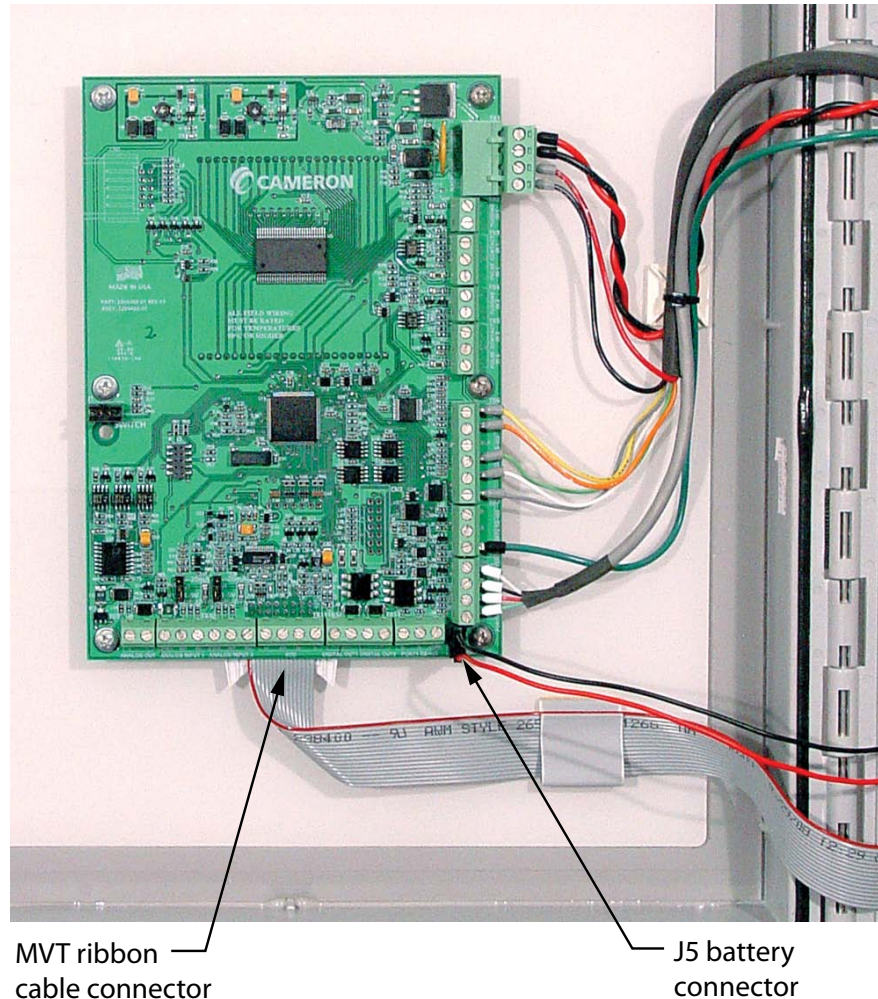


Figure 4.3—Circuit assembly replacement

## MVT Replacement

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**Important:** Disconnecting the batteries from the circuit board will interrupt the display and logging of accumulated flow run and turbine volume totals (grand total and current day total), and energy and mass totals. To capture these totals before disconnecting the battery, create a partial record using ModWorX Pro software. Instructions are provided in the ModWorX Pro Software User Manual.

---

To replace the MVT of the Scanner 2200, perform the following steps, and reference [Figure 4.4, page 68](#), as needed:

1. Open the door to the enclosure.
2. Unplug the battery cable from connector J5 on the circuit board.
3. Disconnect the power input plug (TB1) from the circuit board ([Figure 4.1, page 64](#)).
4. Locate the white MVT ribbon cable connector used to secure the sensor ribbon cable. Using your thumbs, push the sides of the connector apart to release the ribbon cable.

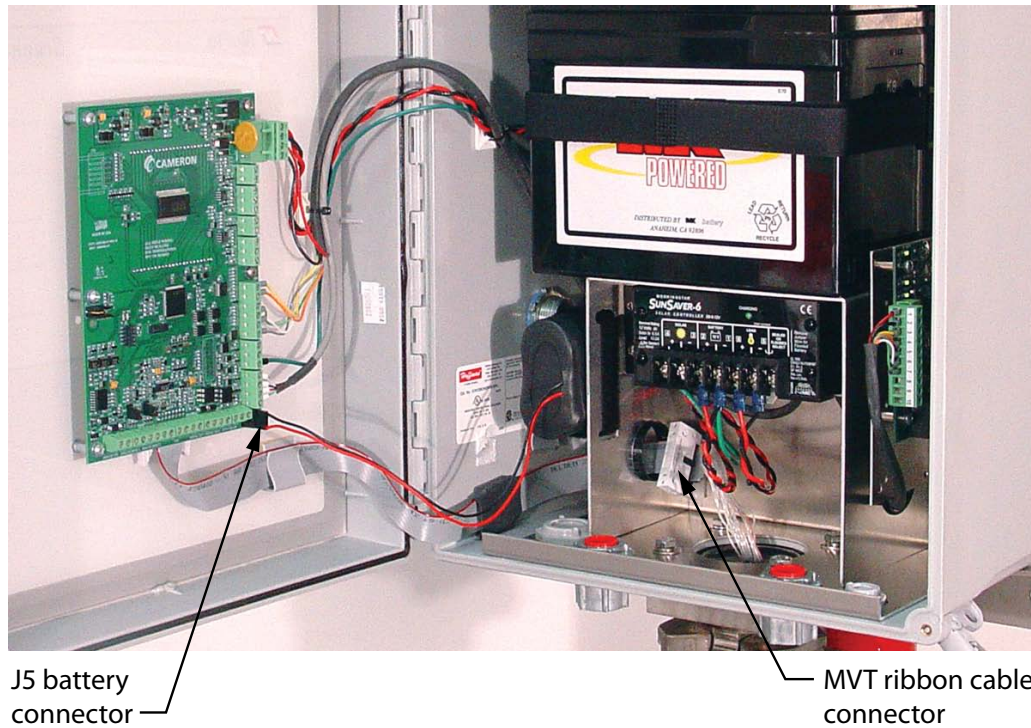


Figure 4.4—MVT replacement

5. Loosen the set screw in the side of the MVT adapter.
6. Rotate the adapter counterclockwise to break the connection with the MVT sensor body.
7. Detach the MVT sensor from the adapter, pulling the ribbon cable free.
8. Remove the replacement MVT from its packaging and route the ribbon cable through the adapter and up into the Scanner 2200 enclosure.
9. Screw the MVT into the adapter until it meets with resistance.
10. Slowly unscrew the MVT sensor until the vents on the sides of the MVT are oriented to the back of the enclosure.
11. Replace the set screw in the adapter and tighten.
12. Connect the sensor ribbon cable header to the pins of the white connector referenced in step 4, and press the sides of the connector together to latch, securing the ribbon in place.
13. Reconnect the power input plug (TB1) to the circuit board.
14. Reconnect the battery cable to connector J5 on the main board.
15. Recalibrate the Scanner 2200.

---

**Important:** Do not overlook the need to recalibrate the Scanner 2200. MVTs that are shipped independently of a Scanner 2200 are not calibrated to compensate for atmospheric pressure; therefore, a Scanner 2200 will not display accurate pressure readings until it is recalibrated.

---



## Section 5—Spare Parts



**WARNING: EXPLOSION HAZARD – Substitution of components may impair suitability for Class I, Division 2. Use of spare parts other than those identified by Cameron International Corporation voids hazardous area certification. Cameron bears no legal responsibility for the performance of a product that has been serviced or repaired with parts that are not authorized by Cameron.**

**Table 5.1—Scanner 2200 EFM Parts**

Qty.	Part Number	Description
1	2295462-01	Circuit Assembly, Scanner 2200, Main Board
1	9A-100002605	Desiccant, Humidisorb, Self Regenerate, 2 in. x 2 in. Packet with Adhesive
1	9A-30099004	Battery Pack, 2 “D” Batteries in Series, 7.2V, Lithium, with Current Limiting Resistor and Diode (CSA)
1	9A-99099016	Battery, 12V, 18 Amp-Hour
1	9A-99099014	Battery, 12V, 24 Amp-Hour
1	9A-99099001	Battery 12V, 33 Amp-Hour
1	9A-99099012	Battery, Low-Temp, Sealed Lead Acid, 12V, 16 Amp-Hour, -40 to 60°C
1	9A-99099013	Battery, Low-Temp, Sealed Lead Acid, 12V, 26 Amp-Hour, -40 to 60°C
1	2295650-01	Assembly, Ribbon Cable, 16 Conductor, 28 AWG, 0.1 IN. Dual Row Socket to Dual Row Pin Header Connector, 18 in. long
1	2295545-01	Cable Assembly, 3/4 in. NPT Explosion-Proof Union, 4-Conductor Wire, 16-in. Long, for External USB Communications
1	9A-101283116	RS-232 to RS-485 Converter, Serial Port Powered, DB9 Connector on PC End, Open Terminals on Instrument End
1	2295848-01	Bracket, Spacer, Plated Steel, Scanner 2200 (for use with side-port MVTs for liquid and steam measurement)
1	2295962-01	Kit, Converter, RS-232 and RS-422/485 Serial to Ethernet, 12 to 48 VDC Power, Class I, Div. 2 Certified
1	2295891-01	Converter, RS-232 and RS-422/485 Serial to Ethernet, 12 to 48 VDC Power, Class I, Div. 2 Certified (for replacement; contains no hardware)
1	9A-30165029	Manual, User, Quick Start, Scanner 2200 EFM
1	9A-30074033	Assembly, Installation Software CD and CD Pocket Folder, ModWorX™ Pro (includes electronic hardware and software manuals)
	See <a href="#">Table 5.2</a>	RTD and Cable Assemblies
	See <a href="#">Table 5.3</a>	Thermowells
	See <a href="#">Table 5.4</a>	Multi-Variable Transmitters (selection based on pressure requirements)
	See <a href="#">Table 5.5</a>	Solar Power Components
	See <a href="#">Table 5.6</a>	DC Power Components
	See <a href="#">Table 5.7</a>	Communications Kits
	See <a href="#">Table 5.8</a>	Radio/Modem Replacements (no hardware included)

**Table 5.2—RTD and Cable Assemblies**

Select one based on specific application.

Part No.	Description
9A-101314258	RTD, 100-ohm, 4-wire, NPT, ¼ in. OD, 180-in. 316 stainless steel flexible armor cable – for 2 in. through 6-in. pipe
9A-100026117	RTD with 12-ft cable – for 2-in. pipe
9A-100036204	RTD with 12-ft cable – for 3-in. pipe
9A-100024927	RTD with 12-ft cable – for 4-in. pipe
9A-100026118	RTD with 12-ft cable – for 6-in. pipe
9A-100024926	RTD with 12-ft cable – for 8-in. pipe
9A-100024921	RTD with 12-ft cable – for 10-in. pipe
9A-101002197	RTD with 12-ft cable – for 12-in. pipe

**Table 5.3—Thermowells**

Select one based on specific application.

Part No.	Description
9A-100026115	Thermowell for 2-in. pipe
9A-100024928	Thermowell for 3-in. pipe
9A-100024930	Thermowell for 4-in. pipe
9A-100026116	Thermowell for 6-in. pipe
9A-100024931	Thermowell for 8-in. pipe
9A-100024932	Thermowell for 10-in. pipe
9A-101002198	Thermowell for 12-in. pipe

**Table 5.4—Multi-Variable Transmitters**

Select one based on specific application. The MVTs listed below have bottom ports. Side port models are available on request.

Part No. (non-NACE)	Part No. (NACE)	Part No. (Stainless Bolts)	Description
9A-99168041	9A-99168046	9A-99168097	100 PSIA, 30 IN H2O
9A-99168042	9A-99168047	9A-99168098	300 PSIA, 200 IN H2O
9A-99168075	9A-99168086	9A-99168099	300 PSIA, 840 IN H2O
9A-99168076	9A-99168087	9A-99168100	500 PSIA, 200 IN H2O
9A-99168043	9A-99168048	9A-99168101	1500 PSIA, 200 IN H2O
9A-99168077	9A-99168088	9A-99168102	1500 PSIA, 300 IN H2O
9A-99168078	9A-99168089	9A-99168103	1500 PSIA, 400 IN H2O
9A-99168079	9A-99168090	9A-99168104	1500 PSIA, 840 IN H2O
9A-99168044	9A-99168049	9A-99168105	3000 PSIA, 200 IN H2O
9A-99168080	9A-99168091	9A-99168106	3000 PSIA, 300 IN H2O
9A-99168081	9A-99168092	9A-99168107	3000 PSIA, 400 IN H2O
9A-99168082	9A-99168093	9A-99168108	3000 PSIA, 840 IN H2O
9A-99168045	9A-99168050	—	5300 PSIA, 200 IN H2O
9A-99168083	9A-99168094	—	5300 PSIA, 300 IN H2O

**Table 5.4—Multi-Variable Transmitters (cont'd)**

Select one based on specific application. The MVTs listed below have bottom ports. Side port models are available on request.

Part No. (non-NACE)	Part No. (NACE)	Part No. (Stainless Bolts)	Description
9A-99168084	9A-99168095	—	5300 PSIA, 400 IN H2O
9A-99168085	9A-99168096	—	5300 PSIA, 840 IN H2O

**Table 5.5—Solar Power Components**

Select one based on specific application.

Part No.	Description
9A-99056001	Charge Controller, 12V, 6 Amp, without Low-Voltage Disconnect
9A-99070002*	Solar Panel, 12V, 10 Watt
9A-99070003*	Solar Panel, 12V, 20 Watt
9A-100035796	Solar Panel, 12V, 30 Watt, with CSA Label
9A-99070004	Solar Panel, 12V, 40 Watt
9A-99070005	Solar Panel, 12V, 50 Watt, with CSA Label

\* Manufacturer may vary due to availability

**Table 5.6—DC Power Components**

Part No.	Description
9A-30160007	Circuit Assembly, DC Power Supply/Battery Charger
2295820-01	DC/DC Converter, Primary Switched, 12-24VDC Input, 24VDC Output, 1A, Din Rail Mount

**Table 5.7—Communications Kits**

(includes radio or modem, power cable, coax jumper, and lightning arrester)

Part No.	Description
2295860-01	Kit, Radio, MDS TransNET 900 (Case Level)
2295861-01	Kit, Radio, MDS TransNET 900 (Board Level)
2295862-01	Kit, Radio, MDS 9810
2295863-01	Kit, Radio, FreeWave FGRM (Board Level, Small Footprint)
2295864-01	Kit, Radio, FreeWave FGR (Board Level, Long Footprint)
2295853-01	Kit, Telephone Modem, Low Power, 19.2K Baud
9A-30017001	Cable, Serial Data, DB-9, male, 28-in., TX, RXD, GND (use: Scanner COM 2 to TransNET radio, Raven modem or telephone modem)
9A-99017019	Cable, Power / Device Interface (for use with FreeWave board level radios)
2295829-01	Kit, Static IP, AirLink™ Raven XT
2295830-01	Kit, Static IP, AirLink™ Raven X

**Table 5.8—Radio/Modem Replacements**

(no installation hardware included)

<b>Part No.</b>	<b>Description</b>
9A-99167001	Radio, MDS TransNET 900 (Case Level)
9A-99167002	Radio, MDS TransNET 900 (Board Level)
9A-99167003	Radio, MDS 9810
9A-99167004	Radio, FreeWave FGRM (Board Level, Small Footprint)
9A-99167000	Radio, FreeWave FGR (Board Level, Long Footprint)
9A-101326782	Telephone Modem, Low Power, 19.2K Baud
2295828-01	Static IP, AirLink™ Raven XT
2295827-01	Static IP, AirLink™ Raven X

## Appendix A - Solar Panel Location and Orientation

### Site Survey

Specific information is required to adequately determine the suitability of using solar power. The peak sun hours/day rating is based on the average amount of hourly peak sunlight per day during the month with the least sunlight. The month with the least sunlight for the northern hemisphere is typically December. For the southern hemisphere, it is typically June.

Other factors, such as storm seasons and prolonged cloudy seasons in some regions, make other months of the year receive less useable sunlight. Keep in mind that the following recommendations are general and each site should be surveyed to determine system requirements. The site survey should include, but not be limited to the following:

- the degrees latitude of the area
- the amount of obstruction to direct sunlight to the solar panel, manmade or natural, such as buildings, fences, towers, trees, or hills
- the climactic conditions such as frequency of clouds, rain, fog, as well as smog or smoke

The insolation maps in Figures A.1 and A.2 plot equivalent insolation based on the month of the year receiving the least sunlight in each area. Insolation is expressed as equivalent sun hours. These numbers are used as an index in designing solar systems.

### Average Daily Solar Radiation Per Month DECEMBER

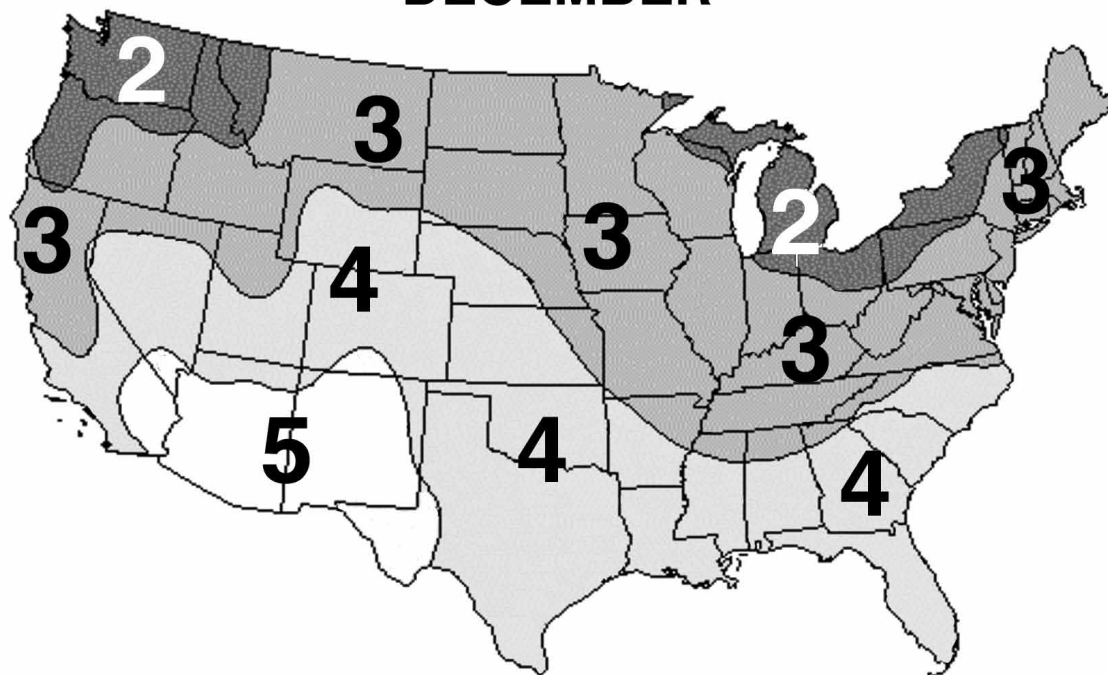


Figure A.1—Solar insolation chart for the United States



Figure A.2—Solar insolation chart for Europe

## Solar Panel Location

Note All values are angles in degrees. Tilt and obstruction are measured in degrees from horizontal.

### Variation

Variation is the difference between magnetic south and true south.

1. Use a magnetic compass to determine south in most locations.
2. Point the solar panel towards magnetic south. Then adjust for the appropriate degree variation for your area. See [Table A.1, page A-3](#).

### Latitude

Latitude is the angle of the site location from the equator. (The equator is  $0^\circ$  and the north and south poles are both  $90^\circ$ .) This angle is important in determining the tilt of the solar panel from horizontal to provide maximum efficiency. Tilt is the angle that the solar panel is pointing from the horizontal position. See [Table A.2, page A-3](#).

### Angle of Obstruction

Determine the angle of obstruction by measuring the angle from the solar panel to the top of the obstruction due south of the panel. The angle measured should be less than the angle to the sun to prevent the obstruction from blocking sunlight to the panel during the winter solstice. See [Table A.1, page A-3](#).

---

**Caution** It is critical that the location of the solar panel is such that no shadows form on the surface of the solar panel. Any shadow falling across the solar panel will effectively stop operation of the solar panel because the internal cells are wired in series. If any one cell is blocked, the whole panel stops producing electricity.

---

### ***Solar-Panel Tilt***

To determine the tilt of the solar panel, first determine the latitude of the site location, then add the angles as indicated in [Table A.2, page A-3](#).

### ***Maximum Angle of Obstruction***

To determine the maximum angle of obstruction, subtract the latitude from 67°. The highest effective obstruction angle is 33° above the horizon.

***Table A.1—Solar Panel Orientation***

<b>Location</b>	<b>Variation</b>	<b>Latitude</b>	<b>Tilt</b>	<b>Obstruction</b>
Brookwood, AL	1E	33	43	34
Bakersfield, CA	15E	35	45	32
Santa Fe Springs, CA	15E	34	44	33
Denver, CO	12E	40	50	27
Liberal, KS	9E	37	47	30
Lafayette, LA	5E	30	40	37
Duncan, OK	7E	34	44	33
Brownfield, TX	9E	33	43	34
Houston, TX	6E	30	40	37
Kilgore, TX	6E	32	42	35
Midland, TX	9E	32	42	35
Odessa, TX	9E	32	42	35
Casper, WY	12E	43	53	24

***Table A.2—Angle Adjustment***

<b>Latitude</b>	<b>Horizontal</b>
0° to 4°	10°
5° to 20°	Add 5° to latitude
21° to 45°	Add 10° to latitude
46° to 65°	Add 15° to latitude





## Appendix B - Radio Installation

### Radio Installation

The Scanner 2200 supports the following communications devices:

- MDS TransNET 900 ([Figure B.1, page B-2](#))
- MDS 9810
- FreeWave
- AirLink™ Raven modem
- NuFlo™ telephone modem
- MOXA® NPort serial-to-Ethernet converter



**WARNING: EXPLOSION HAZARD – Substitution of communications devices may impair suitability for Class I, Division 2.**

---

All field wiring enters into the Scanner 2200 through the bottom of the enclosure. Before making any wiring connections, remove all power from the board by disconnecting the lead acid battery and the lithium battery pack.

To disconnect the lead acid battery, remove the power cable of the battery module from the positive load terminal (Position 6 on the solar charge controller or Position 5 on the DC power supply), or remove the plug from the TB1 terminal block on the CPU/display circuit assembly.

To disconnect the lithium battery pack, detach the battery cable from the J5 connector near the bottom of the circuit board.

---

**Caution** All field wiring must conform to the National Electrical Code, NFPA 70, Article 501-4(b) for installations within the United States or as specified in Section 18-156 of the Canadian Electrical Code for installations within Canada. Local wiring ordinances may also apply. All field wiring must have a wire range of 22 to 14 AWG and terminal block screws must be tightened to a minimum torque of 5 to 7 in-lbs. to secure the wiring within the terminal block. Only personnel who are experienced with field wiring should perform these procedures.

---

### MDS TransNET Radio Installation

Two versions of the MDS radio are available: a blue aluminum-cased radio (Part No. 9A-99167001, shown in [Figure B.1, page B-2](#)) and a black plastic-cased radio (Part No. 9A-99167002). The blue aluminum-cased radio can be mounted directly against the mounting bracket in the Scanner 2200 enclosure. The black plastic-cased radio is designed such that the back side of the circuit board is exposed. To help protect it from contact with the metal bracket, a yellow fiberglass panel is provided, and should be inserted between the radio and the metal bracket.

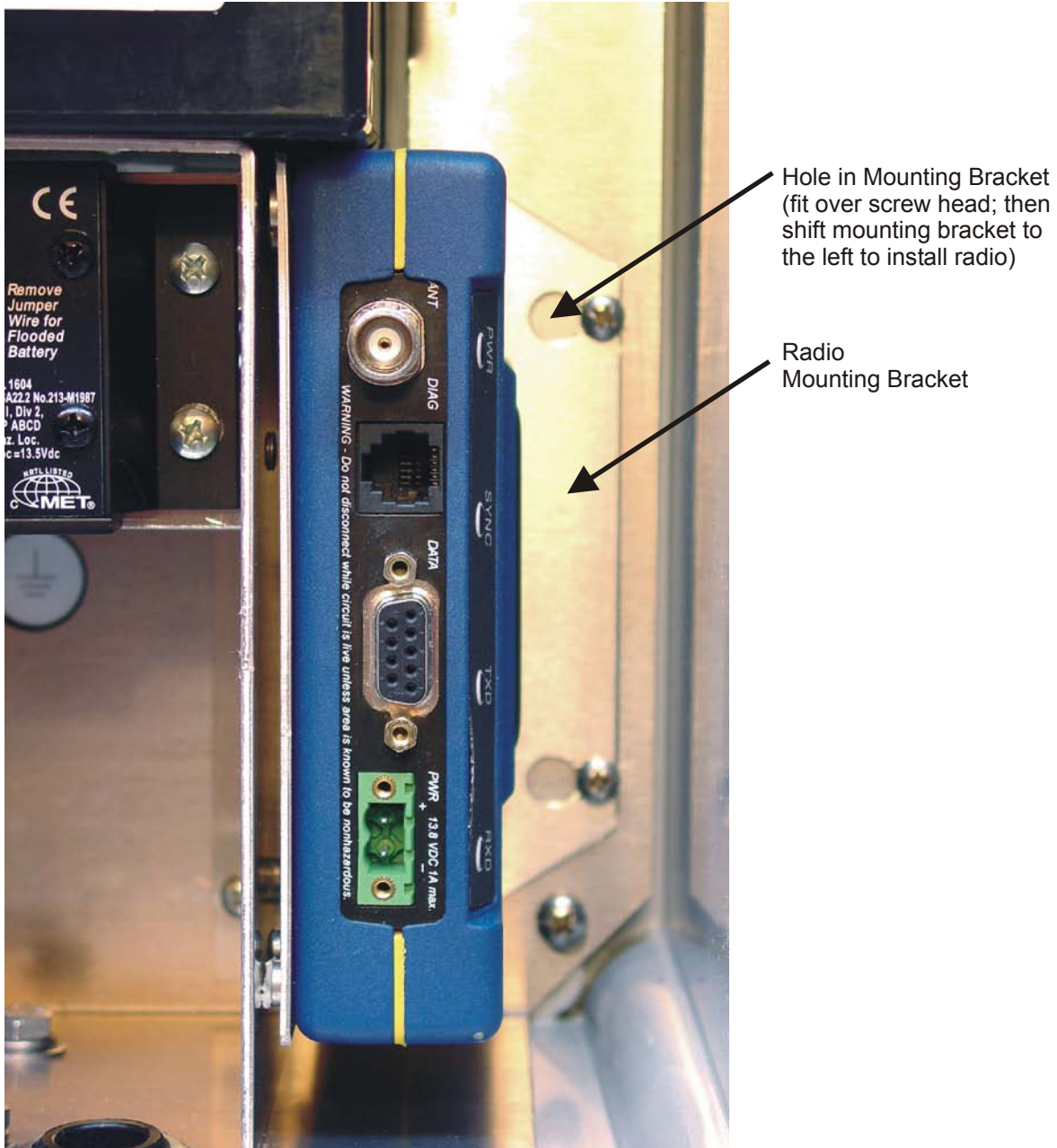


Figure B.1—Radio installation (MDS TransNET radio shown)

To install the MDS TransNET 900 radio, follow the procedure below, referring to Figure B.1 as needed:

1. Loosen the screws that attach radio mounting bracket to the back plate.
2. Slide the bracket to the right and lift it out of the enclosure.
3. Remove the four screws from the bracket.

4. Attach the radio to the mounting bracket as follows:

If the blue aluminum-cased radio (Part No. 9A-99167001) is being installed, position the radio against the mounting bracket, aligning screw holes and secure with the four screws provided with the bracket. Tighten the screws.

If the black plastic-cased radio (Part No. 9A-99167002) is being installed,

- a. Position the fiberglass plate inside the mounting bracket.
  - b. Position the radio against the fiberglass plate.
  - c. Secure the radio to the mounting bracket with the four screws provided with the bracket. Tighten the screws.
5. Drop the assembly into the Scanner 2200 enclosure, placing the screw holes over the two screws in the back of the enclosure ([Figure B.1, page B-2](#)).
  6. Slide the assembly to the left and tighten the two screws to secure the mounting bracket to the back of the Scanner 2200 enclosure.
  7. Connect the radio communications cable DB-9 male connector to the data port on the radio and tighten the two screws.
  8. Connect the DB-9 cable is connected to COM 2 (TB6) on the CPU/display board as shown in [Figure B.2, page B-4](#).
  9. Connect the two-position radio power plug to the radio power terminal and tighten the two screws. Connect the other end of the power cable to TB1 (Radio Out) on the CPU/display board as shown in [Figure B.2, page B-4](#).
  10. Remove the washer and locknut from the bulkhead N-type connector.
  11. Insert the connector through the small hole in the bottom of the enclosure and secure it with the washer and locknut.
  12. Attach the TNC end of the bulkhead connector to the antenna connection on the radio.

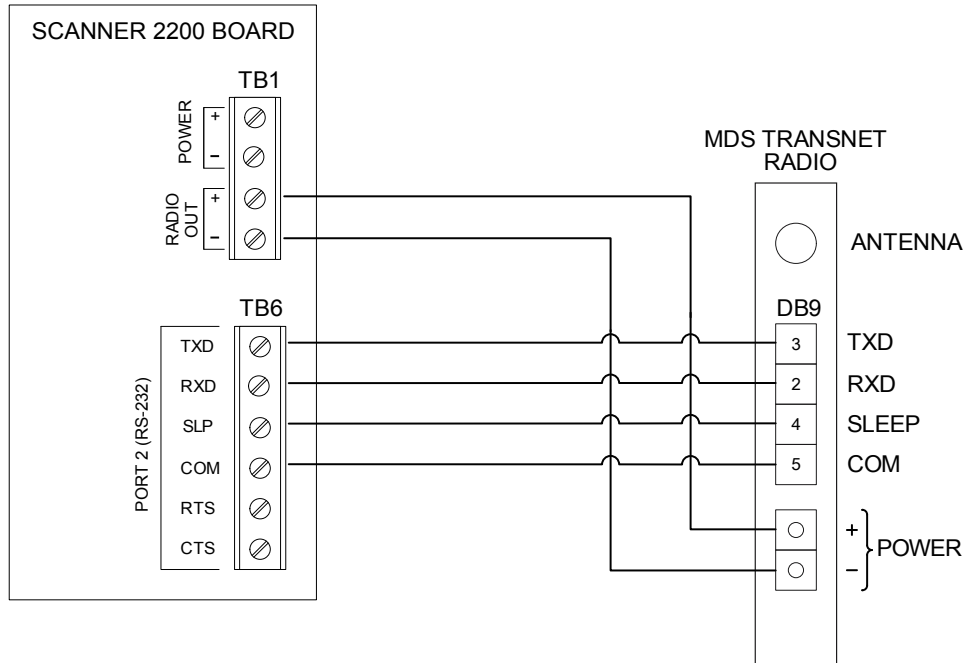


Figure B.2—MDS TransNET radio installation

To configure the MDS TransNET radio for use with the Scanner 2200, perform the following steps:

1. Program the radio using the MDS Radio Configuration Software (MDS P/N 03-27808A02). See the MDS TransNET 900™ Installation and Operation Guide for more instructions. See the on-line documentation that comes with the MDS Radio Configuration Software for instructions on its use.
2. Verify that the radio communication port parameters match the settings of the Scanner 2200 to which it is connected. The baud rate selections for COM 2 of the Scanner 2200 range from 9600 to 38400 baud (default 19200 is recommended). To minimize radio transmission time, set the baud rate to the highest setting that the communications link can reliably support. The other communication parameters should be set to no parity, 8 data bits and 1 stop bit.
3. Set the SLEEP MODE of the radio to ON if the power management features of the Scanner 2200 are required.
4. Set the DATA BUFFER mode of the radio to ON since the Scanner 2200 communicates via RTU mode Modbus®.

### **MDS 9810 Radio Installation**

To install the MDS 9810 radio, follow the procedure below.

---

**Note** The DC-to-DC converter cannot be installed simultaneously with the MDS 9810 due to space limitations inside the enclosure.

---

1. Loosen the screws that attach radio mounting bracket to the back plate.
2. Slide the bracket to the right and lift it out of the enclosure.
3. Position the radio against the mounting bracket, aligning screw holes and secure with the four screws provided with the bracket. Tighten the screws.

4. Drop the assembly into the Scanner 2200 enclosure, placing the screw holes over the three screws in the back of the enclosure.
5. Slide the assembly to the left and tighten the two screws to secure the mounting bracket to the back of the Scanner 2200 enclosure.
6. Connect the radio communications cable DB-25 male connector to the data port on the radio and tighten the two screws. Connect the other end of the cable to Port 2 (TB6) on the CPU display board as shown in Figure B.3.
7. Connect the two-position radio power plug to the radio power terminal and tighten the two screws. Connect the other end of the power cable to TB1 (Radio Out) on the CPU/display board as shown in Figure B.3.
8. Remove the washer and locknut from the bulkhead N-type connector.
9. Insert the connector through the small hole in the bottom of the enclosure and secure it with the washer and locknut.
10. Attach the TNC end of the bulkhead connector to the antenna connection on the radio.
11. Program the radio using the MDS Radio Configuration Software (MDS P/N 03-3156A01) or the MDS Hand-Held Terminal (MDS P/N 02-1501A01). See the MDS 9810/24810 Installation and Operation Guide for instructions on using the Hand-Held Terminal. See the on-line documentation that comes with the MDS Radio Configuration Software for instructions on its use. To minimize radio transmission time, set the baud rate to the highest setting that the communications link can reliably support.

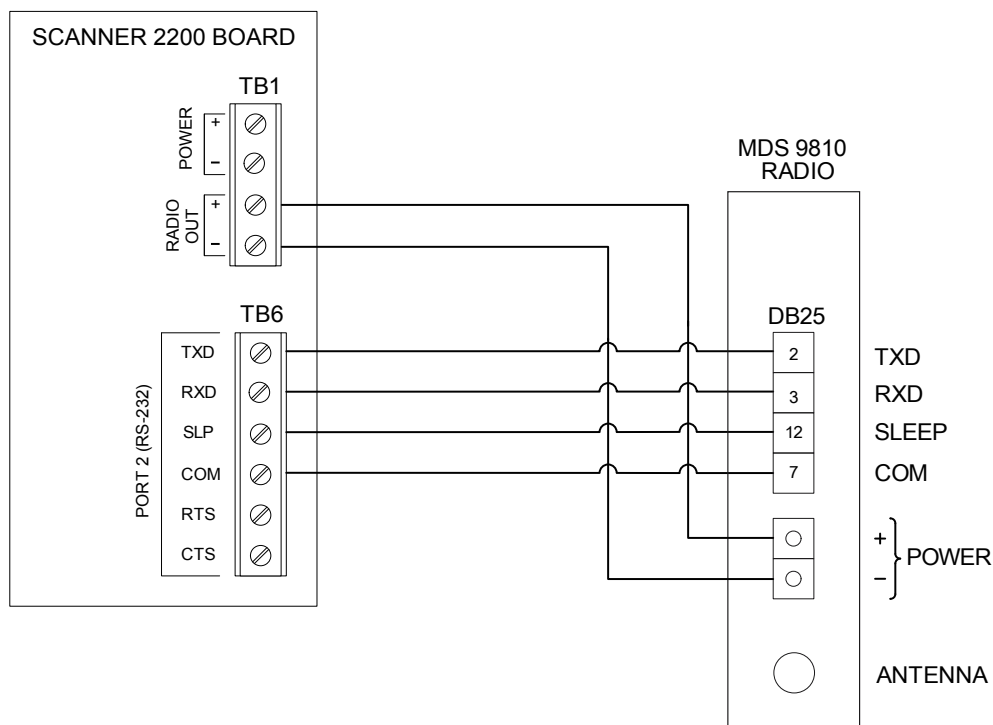


Figure B.3—MDS 9810 radio installation

## FreeWave Radio Installation

To install the FreeWave radio, follow the procedure below.

1. Loosen the screws that attach radio mounting bracket to the back plate.
2. Slide the bracket to the right and lift it out of the enclosure.
3. Mount the standoffs to the radio with the screws provided.
4. Position the radio against the bracket. Secure the radio to the mounting bracket with the three screws provided with the bracket.
5. Drop the assembly into the Scanner 2200 enclosure, placing the screw holes over the two screws in the back of the enclosure.
6. Slide the assembly to the left and tighten the two screws to secure the mounting bracket to the back of the Scanner 2200 enclosure.
7. Connect the radio wire assembly to COM 2 (TB6) on the CPU/display circuit assembly and connect the 10-position connector to the header on the radio.
8. Connect the radio power cable to TB1 (Radio Out) on the CPU/display board as shown in Figure B.4.

To configure the FreeWave radio for use with the Scanner 2200, perform the following steps:

1. Configure the radio using the FreeWave EZ-Config software provided on the CD accompanying your radio or the HyperTerminal Windows utility. Instructions on using the HyperTerminal utility can be found in document 5408AB on the support page of the FreeWave website, [www.freewave.com](http://www.freewave.com).
2. Verify that the radio communication port parameters match the settings of the Scanner 2200 to which it is connected. The baud rate selections for COM 2 of the Scanner 2200 range from 9600 to 38400 baud (default 19200 is recommended). To minimize radio transmission time, set the baud rate to the highest setting that the communications link can reliably support. The other communication parameters should be set to no parity, 8 data bits and 1 stop bit.

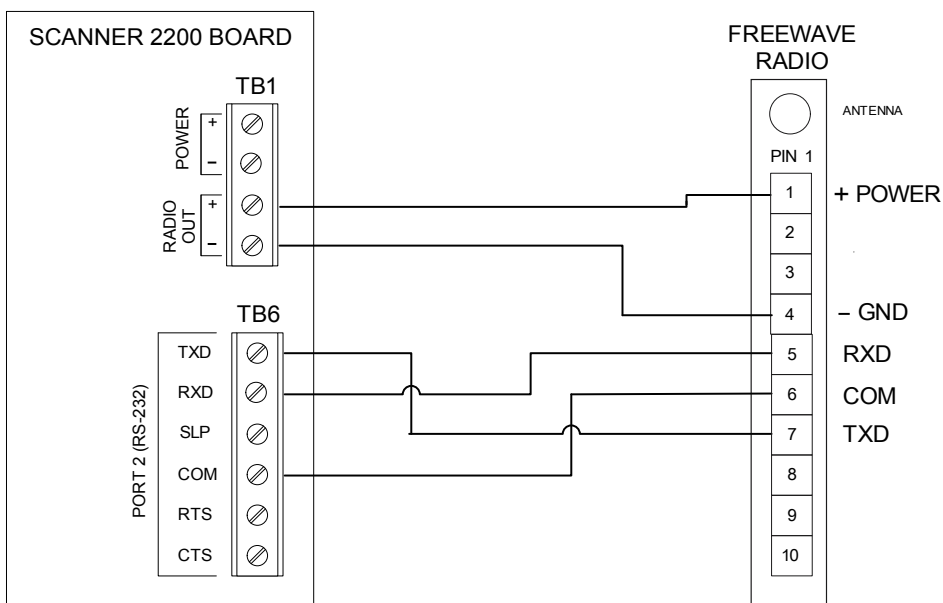


Figure B.4—Wiring connections for FreeWave radio

## ***AirLink™ Raven Modem Installation***

Two versions of the AirLink™ Raven modem are available: the Raven XT (Part No. 2295829-01) and the full-featured Raven X (Part No. 2295830-01).

To install the AirLink™ Raven modem, follow the procedure below:

1. Loosen the screws that attach radio mounting bracket to the back plate.
2. Slide the bracket to the right and lift it out of the enclosure.
3. Position the radio against the bracket. Secure the radio to the mounting bracket with the screws provided with the bracket.
4. Drop the assembly into the Scanner 2200 enclosure, placing the screw holes over the two screws in the back of the enclosure.
5. Slide the assembly to the left and tighten the two screws to secure the mounting bracket to the back of the Scanner 2200 enclosure.
6. Connect the radio communications cable DB-9 male connector to the data port on the radio and tighten the two screws.
7. Verify that the DB-9 cable is connected to Port 2 (TB6) as shown in [Figure B.5, page B-8](#).
8. Connect the radio power cable to TB1 (Radio Out) on the CPU/display board as shown in [Figure B.5, page B-8](#).

To configure the Raven modem for use with the Scanner 2200, perform the following steps:

1. Configure the Raven modem radio using the software provided by the modem manufacturer.
2. Verify that the radio communication port parameters match the settings of the Scanner 2200 to which it is connected. The baud rate selections for COM 2 of the Scanner 2200 range from 9600 to 38400 baud (default 19200 is recommended). To minimize radio transmission time, set the baud rate to the highest setting that the communications link can reliably support. The other communication parameters should be set to no parity, 8 data bits and 1 stop bit.

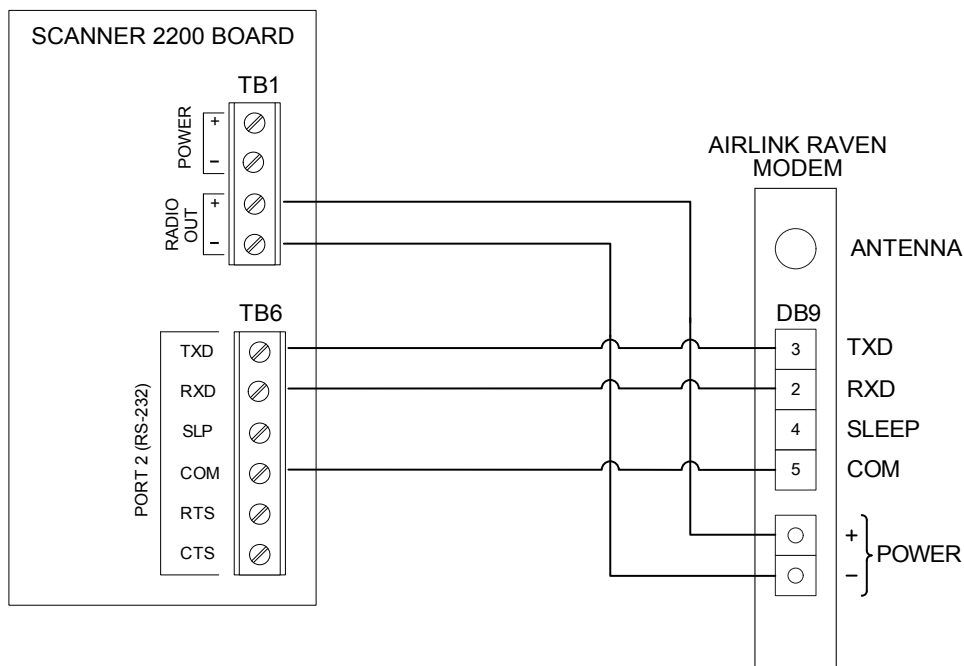


Figure B.5—AirLink™ Raven modem installation

### NuFlo™ Telephone Modem Installation

A modem is used to establish telephone communications with the Scanner 2200 and other equipment. The modem can communicate via a land line telephone or a cellular telephone. This section covers the internal modem option for the Scanner 2200. The modem in the Scanner 2200 is a two-wire dial-up modem. Once communications have been established through the modem, information can be exchanged with the Scanner 2200 in the same manner as when connected directly to the Scanner 2200.

The modem is installed inside the Scanner 2200 enclosure. The modem is mounted to the radio/modem bracket using four screws. The telephone line must be connected to the modem using the terminal blocks on the modem board or the RJ-11 jack (for a phone line that has a RJ-11 plug on the end) as shown in [Figure B.6, page B-9](#). The RS-232 communication signals on the modem are connected to the COM 2 header on the CPU/display circuit assembly. Verify that the baud rate setting for the Scanner 2200 COM 2 is set to 19200. See the ModWorX Pro Software User Manual for instructions on setting the COM 2 baud rate.

If the modem is purchased with a Scanner 2200, it will be preinstalled prior to shipment of the Scanner 2200. If the modem is purchased separately from the Scanner 2200, make wiring connections according to the diagram in [Figure B.7, page B-10](#), using the provided cable assembly.



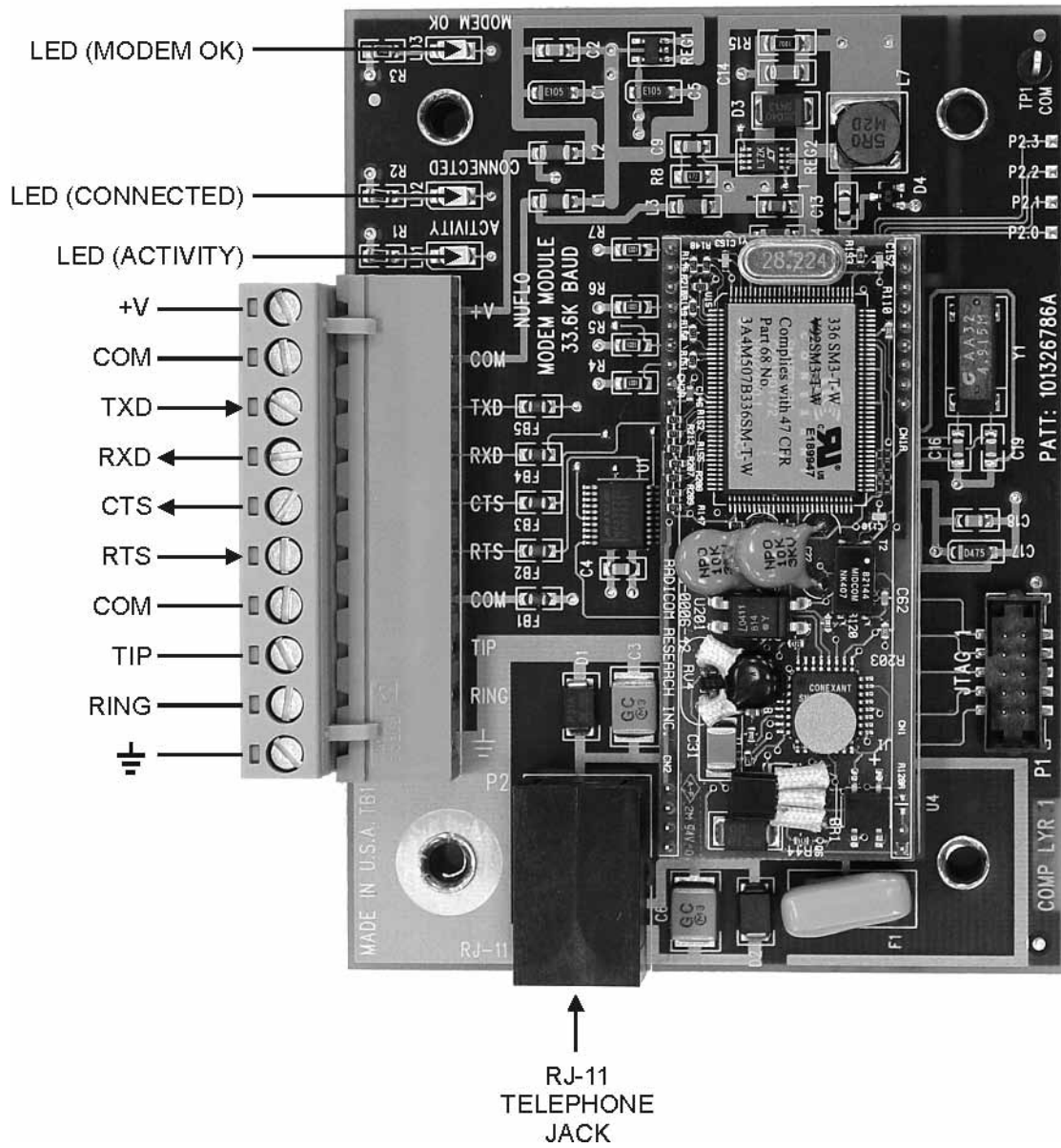


Figure B.6—Wiring connections for telephone modem

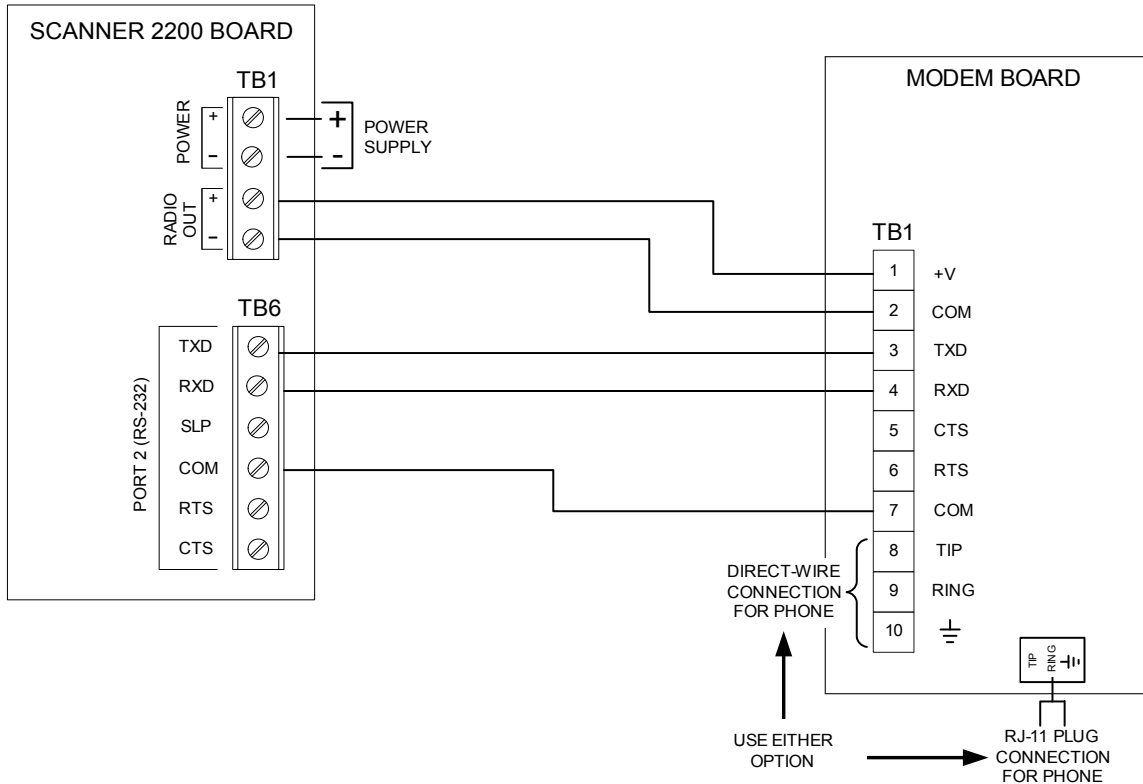


Figure B.7—Modem wiring for DC-powered Scanner 2200s

### Power

The modem is powered by the CPU/display circuit assembly through TB1 (Radio Out). When using the modem option with the Scanner 2200, Scanner 2200 communications should be configured such that power is always supplied to the modem (set Power Mode to “always on”) or to conserve maximum power, configure communications to supply power to the modem only during the hours that the modem may be used (set Power Mode to “off/on times.” See the ModWorX Pro Software User Manual for instructions on setting these parameters. When the sleep mode is enabled, the modem will enter a low-power consumption mode after a short period of inactivity. When the modem receives an incoming call, it will resume normal operation and answer the call.

### Receiving Calls

After the modem has been powered up, it is ready to receive calls. The Scanner 2200 is configured to receive calls only. It will not initiate a call. The modem will answer a call after one or two rings.

### Terminating Calls

A call is normally terminated by the originating party. However, should the call fail to be terminated, the Scanner 2200 will terminate a call after 3 minutes of inactivity.

### Cellular Telephones

The protocols used for cellular communications are supported by the modem. The modem in the Scanner 2200 adjusts to the protocol used by the originating caller. It is recommended that the originating modem force a cellular protocol connection when a cellular phone is to be used. A device to convert the cellular signals to normal telephone industry RJ11C specifications may be required to connect the modem to the cellular phone.

## MOXA® NPort Serial-to-Ethernet Converter

The NPort IA5150-T serial device server is an approved communications option for the Scanner 2200 that allows the user to connect an Ethernet network to the device.

Please note that the method used to wire the converter to the Scanner 2200 varies, depending on the method used to power the Scanner. The NPort device requires a minimum of 12 VDC power. The load output of the DC power supply/charge controller is minimally 8.5 VDC, which is not sufficient to power the NPort. If the Scanner 2200 is powered by the DC power supply/charge controller, the NPort device must be connected to the 16 to 28 VDC incoming power.

To install the server, perform the following steps:

1. Attach a short length of DIN rail to the enclosure backplate as shown in Figure B.8. If the Scanner 2200 has a DC-to-DC converter option installed, the DIN rail will already be in place.
2. Attach the NPort IA converter to the DIN rail.

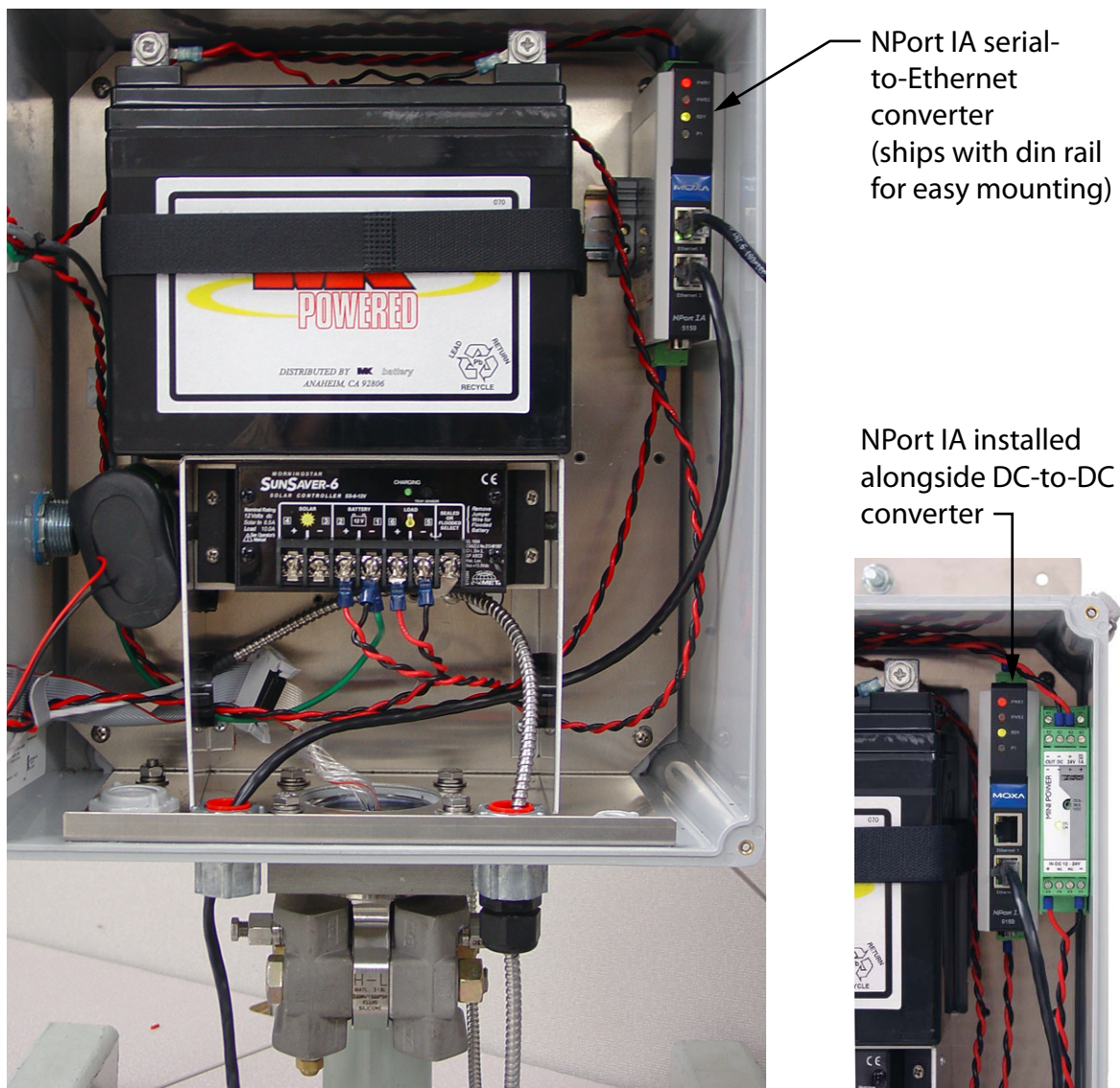


Figure B.8—NPort IA5150-T serial device option

3. Wire the NPort IA converter to the Scanner 2200 circuit board. If the instrument is powered by a solar panel and a DC-to-DC converter, wire as shown in Figure B.9. If the instrument is powered by the DC power supply/charger and a lead acid battery, wire as shown in Figure B.10, page B-13.
4. Connect the Ethernet cable to the connector and to the computer used to connect to the Scanner 2200.
5. Install the appropriate drivers on the computer using the CD supplied with the NPort converter.

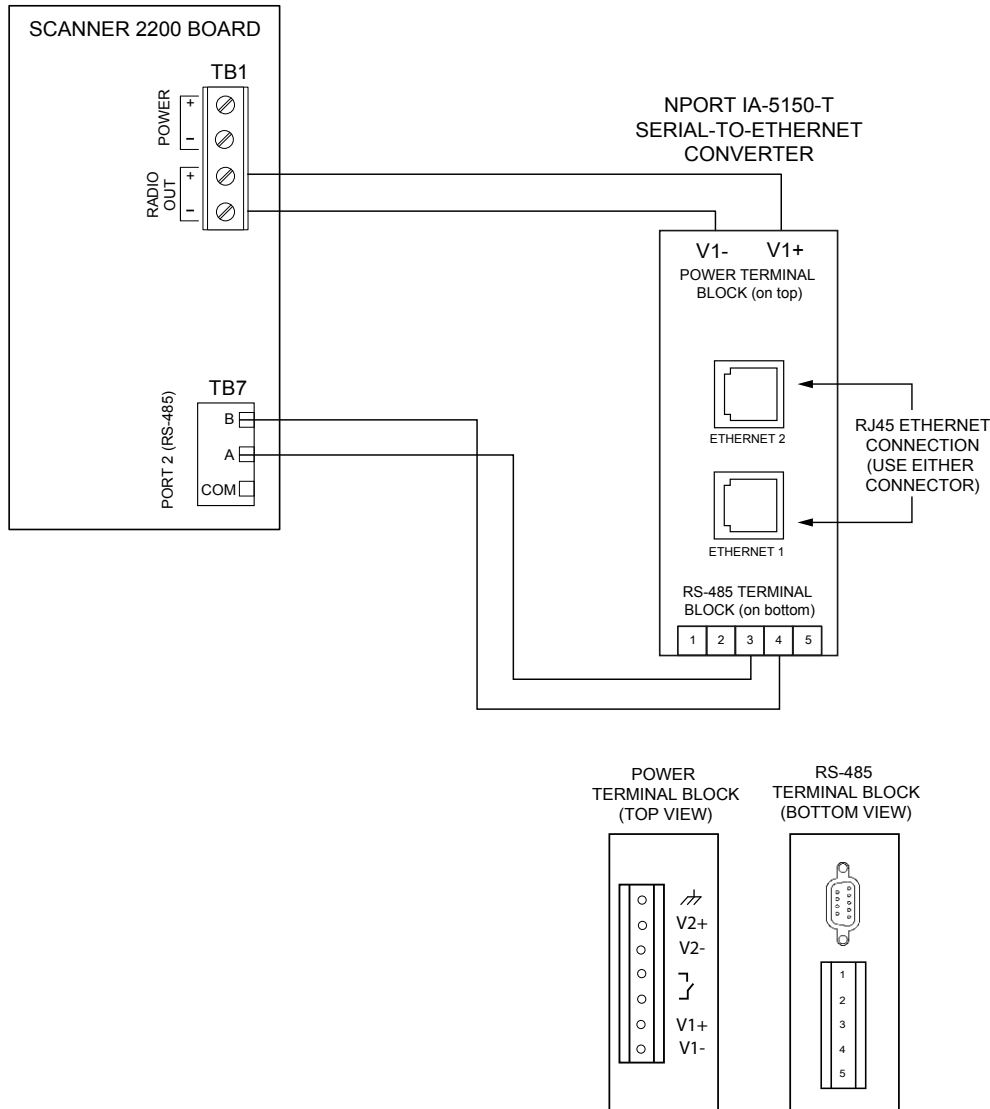


Figure B.9—Wiring for NPort IA5150-T serial device for use in solar-powered Scanner 2200

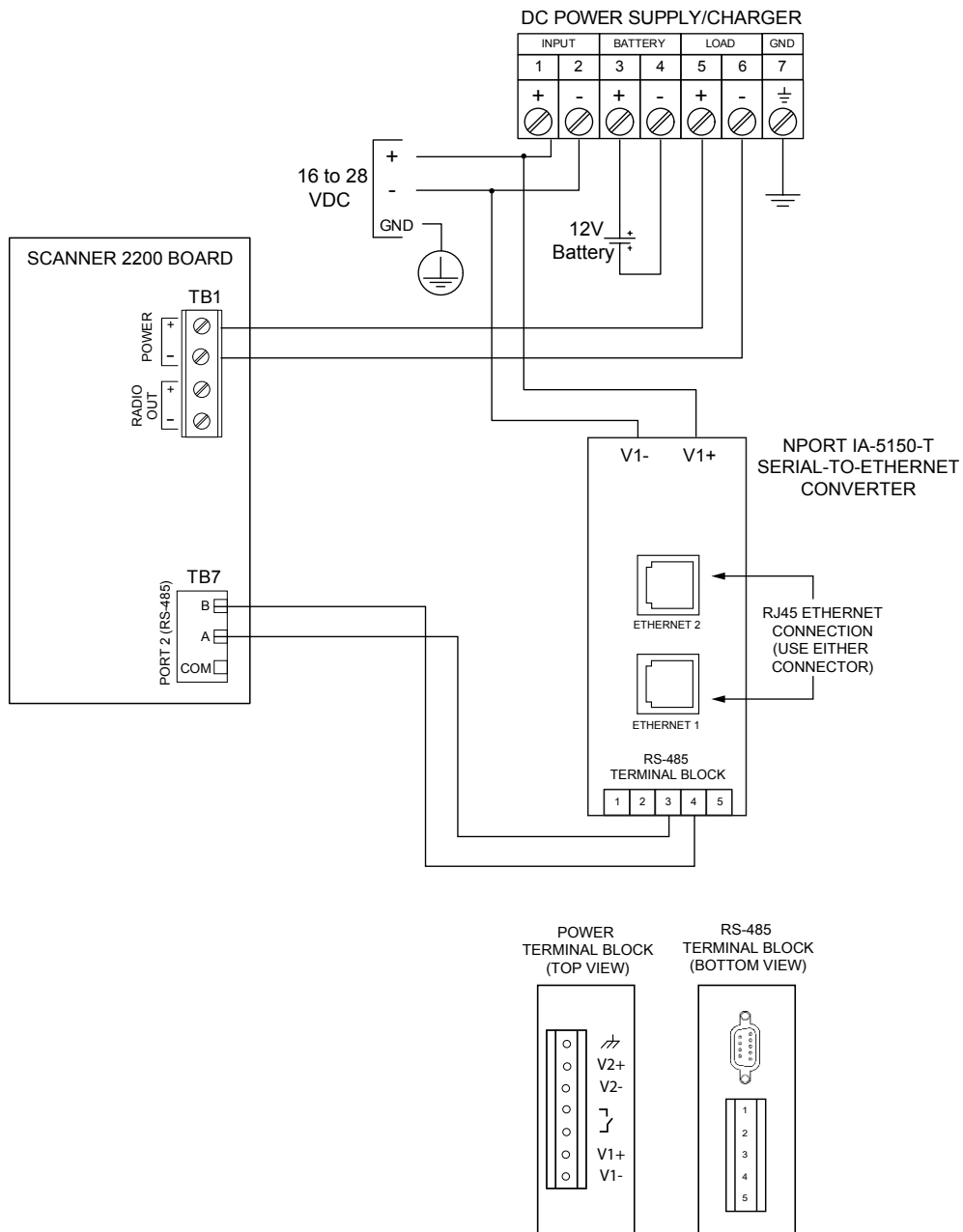


Figure B.10—Wiring for NPort IA5150-T serial device for use in Scanner 2200 powered by a DC power supply



## Appendix C—Lithium Battery Information

### Transportation Information



**WARNING: The Scanner 2200 EFM contains lithium batteries. The internal component (thionyl chloride) is hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29 CFR 1920.1200. Before shipping a lithium battery or equipment containing a lithium battery, verify that the packaging and labeling conforms with the latest version of all applicable regulations.**

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The transport of the lithium batteries is regulated by the United Nations, “Model Regulations on Transport of Dangerous Goods,” (special provisions 188, 230, and 310), latest revision.

Within the US the lithium batteries and cells are subject to shipping requirements under Part 49 of the Code of Federal Regulations (49 CFR, Parts 171, 172, 173, and 175) of the US Hazardous Materials Regulations (HMR), latest revision.

Shipping of lithium batteries in aircraft is regulated by the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) requirements in Special Provisions A45, A88 and A99, latest revision.

Shipping of lithium batteries on sea is regulated the International Maritime Dangerous Goods (IMDG) requirements in special provisions 188, 230 and 310, latest revision.

Shipping of lithium batteries on road and rail is regulated by requirements in special provisions 188, 230 and 310, latest revision.

### Lithium Battery Disposal

Once a lithium battery is removed from a device and/or is destined for disposal, it is classified as solid waste under EPA guidelines. Depleted lithium batteries are also considered to be hazardous waste because they meet the definition of Reactivity, as per 40 CFR 261.23(a)(2), (3) and (5). This document describes how the lithium reacts violently with water, forms potentially explosive mixtures with water, and when exposed to certain pH conditions, generates toxic cyanide or sulfide gases.

Federal law requires that depleted lithium battery packs be sent to a fully permitted Treatment, Storage and Disposal Facility (TSDF) or to a permitted recycling/reclamation facility.



**WARNING: Explosion/Fire Risk. Never handle or store the lithium battery in an environment that will exceed 100°C (212°F). Consult the MSDS for complete handling instructions.**

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**Important: Do not ship lithium battery packs to Cameron’s Measurement Systems Division. Cameron facilities are not permitted recycling/ reclamation facilities.**

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**CAUTION: Profiling and waste characterization procedures must be followed prior to shipping a lithium battery to a disposal site. It is the shipper’s responsibility to comply with all applicable federal transportation regulations (see below).**

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## **Material Safety Data Sheet**

For a link to the current MSDS for the lithium batteries used to power the Scanner 2200 EFM, see the Measurement Systems Division section of the Cameron website: [www.c-a-m.com](http://www.c-a-m.com).



## Appendix D—Communications Protocol

### Communications Protocol

Firmware Version: 4.18

Register Table Version: 16

### Introduction

The communications protocol for the Scanner 2200 is in accordance with Modicon, Inc. RTU Mode Modbus® as described in *Modicon Modbus Protocol Reference Guide*, PI-MBUS-300 Rev. J, June 1996. All registers are implemented as 4X or holding registers. Reading of registers is implemented via function code 03H (Read Holding Registers). Writing to registers is implemented via function code 10H (Preset Multiple Registers). The instrument provides Enron Modbus® compliant downloads for interval, daily and event records. For details on Enron Modbus®, refer to *Specifications and Requirements for an Electronic Flow Measurement Remote Terminal Unit for Enron Corp.*, Dec. 5, 1994.

### Supported Commands

The Modbus® functions supported by the Scanner 2200 are as follows:

Function Code (Hex)	Description
03	Read Holding Registers
05	Preset Boolean (for Enron event record acknowledgement)
10	Preset Multiple Registers
11	Report Slave ID

For the read holding and preset multiple registers, the instrument supports the full 250 bytes of data in a message. This corresponds to 125 registers in 16-bit holding register size and 62 registers in 32-bit holding register size.

The report slave ID function code returns the following registers:

- Product Code
- Register Table Number
- Firmware Version
- Manufacture Date
- Sales Date
- Serial Number 1
- Serial Number 2
- Power Mode
- Connected Port (0 = connected to Port 1; 1 = connected to Port 2)
- Port Mode

- Port SlaveAddress
- Port BaudRate
- Port BusDelay
- Port BusTimeout
- Real Date
- Real Time

## Data Types

Various data types are implemented in the Scanner 2200. The following table lists the formats and the numbers of bytes and registers associated with each type.

Data Type	Byte Count	Register Count
Floating Point (FP)	4	2
Floating Point (FP32)	4	1
Unsigned Word (U16)	2	1
Unsigned Long (U32)	4	2
Packed ASCII (PA)	2	1

The word ordering for multiple register data types, such as floating-point numbers or long integers, is for the most significant word to appear first in the message.

The Unsigned Word (U16) type is used for 16-bit integers and fits into one register.

The Packed ASCII (PA) type contains two bytes that are two unsigned characters. Generally, multiple Packed ASCII types are arranged consecutively for implementing strings. For example, the Device Name is a string of 20 unsigned characters that is implemented as 10 Packed ASCII registers. Here is an example of a device name that contains the string, “Test Well 413.”

Register	Hexadecimal #	ASCII Characters
240	54 65	Te
241	73 74	st
242	20 57	<SPACE> W
243	65 6C	el
244	6C 20	I<SPACE>
245	34 31	41
246	33 FF	3<UNUSED>
247	FF FF	<UNUSED><UNUSED>
248	FF FF	<UNUSED><UNUSED>
249	FF FF	<UNUSED><UNUSED>

Unused characters at the end of each string will report 0xFF hexadecimal.

## Security

To communicate with a Scanner 2200 without the use of ModWorX Pro software (i.e. via a third-party polling device), security permissions for the applicable Scanner 2200 communications port must be set to the default (unrestricted) state. If a different security level is required, contact Cameron technical support for details. Security levels can be restored to default permissions with ModWorX Pro software.

## Registers

Each register has an Access type: read-only or read-write, as described below.

Access Type	Description
Read Only (RO)	Register can only be read
Read/Write (R/W)	Register can be read and written

The registers are grouped into Modbus® map blocks according to function. The Scanner 2200 contains the following map functions.

Map	Starting Register
Control Registers	70
System Configuration	1000
Communications Configuration	1100
Real Time	1200
Power Configuration	1300
Archive Configuration	1400
Turbine 1 Configuration	2000
Turbine 1 Calibration	2030
Turbine 2 Configuration	2100
Turbine 2 Calibration	2130
Static Pressure Configuration	2200
Static Pressure Calibration	2230
RTD Configuration	2300
RTD Calibration	2330
Differential Pressure Configuration	2400
Differential Pressure Calibration	2430
Analog Input 1 Configuration	2500
Analog Input 1 Calibration	2530
Analog Input 2 Configuration	2600
Analog Input 2 Calibration	2630
Flow Run 1 Configuration	3000
Flow Run 1 Calibration	3200
Flow Run Alarms	3600
Output Configuration	4000
Holding Registers (32-bit)	7000
Holding Registers	8000
User-Defined Holding Register Configuration	9000

Map	Starting Register
User-Defined Holding Registers	9100
Device Status	9900

Note: All registers cited in this document refer to the address of the register that appears in the actual Modbus® message. For example, register 8000 has an address of 0x1F40 hexadecimal in the message.

### Control Registers

Register (Decimal)	Register (Hex)	Description	Data Type	Access
70	46	Control Register 1	U16	R/W

The Control Registers allow specific functions to be implemented via the communications port. The following table shows the value to be written to the control register to implement the desired function.

Code	Function
20000	Transfers the polling totals and averages and polling run times to the previous polling totals, averages and previous run-time registers, increments the polling index register, and resets the polling totals, averages and polling run-time registers.
30000	Clears all flow totals
30001	Clears Flow Run 1 totals
30003	Clears Turbine 1 totals
30004	Clear Turbine 2 totals
30050	Clears all pulse output latches
30051	Clears a Pulse Output 1 latch
30061	Adds pulses specified in Control Register 2 to Pulse Output 1 Accumulator
30100	Clear all Alarm States.
30101	Clear Flow Run Alarm Status
30102	Clear Input Alarm Status
40000	Loads factory defaults
40040	Resets the microcontroller (watchdog)
50050	Creates a partial archive record (daily and interval)

## System Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access
1000	3E8	Product Code and Feature Privileges	U16	RO
1001	3E9	Register Table Version	U16	RO
1002	3EA	Firmware Version	U16	RO
1003	3EB	Manufacture Date	U16	RO
1004	3EC	Sales Date	U16	RO
1005	3ED	Serial Number High	U16	RO
1006	3EE	Serial Number Low	U16	RO
1007	3EF	Sensor Serial Number[0]	PA	RO
1008	3F0	Sensor Serial Number[1]	PA	RO
1009	3F1	Sensor Serial Number[2]	PA	RO
1010	3F2	Sensor Serial Number[3]	PA	RO
1011	3F3	Sensor Serial Number[4]	PA	RO
1012	3F4	Sensor Serial Number[5]	PA	RO

### Product Code

The Product Code is a read-only parameter used for identifying a Scanner 2200 device and its enabled advanced features using the ModWorX Pro software. This parameter is defined at the factory.

### Firmware Version/Register Table Version

The Firmware Version and Register Table Version numbers are set by the factory and are read-only. To determine the version number, read the appropriate register and divide the value by 100. The general format for version numbers is A.BC. For example the firmware register number is read as 0xA7 hexadecimal. This represents the value 167 and a firmware version of 1.67.

### Manufacture Date/Sales Date

These parameters are set at the factory and are read-only. These registers are formatted as MMY. For example, a value of 0908 represents the date September 2008.

### **Communications Configuration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
1100	44C	Port 1 - Port Usage 0 - Slave 1 - Master	U16	R/W	0
1101	44D	Port 1 Slave Address [1 to 65535, excluding 252 to 255 and 64764]	U16	R/W	1
1102	44E	Port 1 - Baud Rate 5 - 9600 6 - 19200 7 - 38400	U16	R/W	5
1103	44F	Port 1 - Bus Delay mS of delay before transmitting data	U16	R/W	10
1104	450	Port 1 - Bus Timeout mS of delay before resetting communications	U16	R/W	50
1105	451	Port 2 - Port Usage 0 - Slave Only	U16	R/W	0
1106	452	Port 2 Slave Address [1 to 65535, excluding 252 to 255 and 64764]	U16	R/W	1
1107	453	Port 2 - Baud Rate 5 - 9600 6 - 19200 7 - 38400	U16	R/W	5
1108	454	Port 2 - Bus Delay mS of delay before transmitting data	U16	R/W	10
1109	455	Port 2 - Bus Timeout mS of delay before resetting communications	U16	R/W	50

### **Real Time**

Register (Decimal)	Register (Hex)	Description	Data Type	Access
1200	4B0	Year (Real Year = register value plus 2200)	U16	R/W
1201	4B1	Month [1-12]	U16	R/W
1202	4B2	Day [1-31]	U16	R/W
1203	4B3	Hour [0-23]	U16	R/W
1204	4B4	Minute [0-59]	U16	R/W
1205	4B5	Second [0-59]	U16	R/W

This block of registers is used to set the instrument's internal clock. To set the time, it is recommended that all registers be written in one message.

The time and date can also be read in the holding register groups as floating-point data.

### Power Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
1300	514	Power Mode 0 - High Power 1 - Low Power	U16	R/W	1
1301	515	Clock Override	U16	R/W	0
1302	516	Internal System Sample Period [number of seconds between battery voltage and electronics temperature measurements]	U16	R/W	60
1303	517	External Sensor Power Control Sensor Warmup Time [0 – 2048 sec] Add 32768 to lock sensor power on.	U16	R/W	32770

### Archive Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
1400	578	Archive Reference Number	U16	RO	10000
1401	579	Contract Hour [0-23]	U16	R/W	8 (AM)
1402	57A	Interval Period [5 seconds to 12 hours]	U16	R/W	3600 seconds (1 hour)
1403	57B	Partial Records 0 - Not Enabled 1 – Enabled	U16	R/W	0
1404	57C	Number of Daily Records	U16	RO	768
1405	57D	Number of Interval Records	U16	RO	6392
1406	57E	Number of Events Records	U16	RO	1152
1407	57F	Number of Parameters	U16	R/W	11
1408	580	Archive Field 1	U16	RO	Date
1409	581	Archive Field 2	U16	RO	Time
1410	582	Archive Field 3	U16	R/W	FR1 Volume
1411	583	Archive Field 4	U16	R/W	FR1 Mass
1412	584	Archive Field 5	U16	R/W	FR1 Energy
1413	585	Archive Field 6	U16	R/W	Differential Pressure
1414	586	Archive Field 7	U16	R/W	Static Pressure
1415	587	Archive Field 8	U16	R/W	Process Temperature
1416	588	Archive Field 9	U16	R/W	FR1 Run Time
1417	589	Archive Field 10	U16	R/W	T1 Volume
1418	58A	Archive Field 11	U16	R/W	T1 Run Time
1419	58B	Archive Field 12	U16	R/W	Unused

### Archive Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
1420	58C	Archive Field 13	U16	R/W	Unused
1421	58D	Archive Field 14	U16	R/W	Unused
1422	58E	Archive Field 15	U16	R/W	Unused
1423	58F	Archive Field 16	U16	R/W	Unused

### Turbine 1 Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2000	7D0	T1 - Units See <a href="#">Units Table</a>	U16	R/W	102 – BBL
2001	7D1	T1 - Time Base 0 = Second 1 = Minute 2 = Hour 3 = Day	U16	R/W	3
2002	7D2	T1 - Sampling Period (sec)	U16	R/W	5
2003	7D3	T1 - Dampening Factor	U16	R/W	0
2004	7D4	T1 - Input Configuration 0 - TFM Low (20 mV @ <1000 Hz) 1 - TFM Med (50 mV @ <1000 Hz) 2 - TFM High (100 mV @ <1000 Hz) 3 - TFM Max (200 mV @ <1000 Hz) 4 - Pulse Input	U16	R/W	1
2005	7D5	T1 - Override Enable 0 - Disabled 1 - Enabled	U16	R/W	0
2006	7D6	T1 - Override Value	FP	R/W	0.00
2008	7D8	T1 - Fail Value	FP	R/W	0.00
2010	7DA	T1 - Low Frequency Cutoff	FP	R/W	5.00
2012	7DC	T1 - Low Flow Cutoff	FP	R/W	0.00
2014	7DE	T1 - Sensor Range Low	FP	R/W	0.00
2016	7E0	T1 - Sensor Range High	FP	R/W	0.833333333
2018	7E2	T1 - Units Scale Factor	FP	R/W	0.023809524
2020	7E4	T1 - Units Offset Factor	FP	R/W	0
2022	7E6	T1 - Unit Description 1	LCD	R/W	—
2023	7E7	T1 - Unit Description 2	LCD	R/W	—
2024	7E8	T1 - Unit Description 3	LCD	R/W	—



### **Turbine 1 Calibration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2030	7EE	T1 - Calibration Type <sup>1</sup>	U16	R/W	1
2031	7EF	T1 - Linear Factor	FP	R/W	900.00
2033	7F1	T1 - Calibration Absolute Offset	FP	R/W	0.00
2035	7F3	T1 - Factor 1	FP	R/W	900.00
2037	7F5	T1 - Factor 2	FP	R/W	1.00
2039	7F7	T1 - Factor 3	FP	R/W	1.00
2041	7F9	T1 - Factor 4	FP	R/W	1.00
2043	7FB	T1 - Factor 5	FP	R/W	1.00
2045	7FD	T1 - Factor 6	FP	R/W	1.00
2047	7FF	T1 - Factor 7	FP	R/W	1.00
2049	801	T1 - Factor 8	FP	R/W	1.00
2051	803	T1 - Factor 9	FP	R/W	1.00
2053	805	T1 - Factor 10	FP	R/W	1.00
2055	807	T1 - Factor 11	FP	R/W	1.00
2057	809	T1 - Factor 12	FP	R/W	1.00
2059	80B	T1 - Frequency 1	FP	R/W	1.00
2061	80D	T1 - Frequency 2	FP	R/W	1.00
2063	80F	T1 - Frequency 3	FP	R/W	1.00
2065	811	T1 - Frequency 4	FP	R/W	1.00
2067	813	T1 - Frequency 5	FP	R/W	1.00
2069	815	T1 - Frequency 6	FP	R/W	1.00
2071	817	T1 - Frequency 7	FP	R/W	1.00
2073	819	T1 - Frequency 8	FP	R/W	1.00
2075	81B	T1 - Frequency 9	FP	R/W	1.00
2077	81D	T1 - Frequency 10	FP	R/W	1.00
2079	81F	T1 - Frequency 11	FP	R/W	1.00
2081	821	T1 - Frequency 12	FP	R/W	1.00

<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

### **Turbine 2 Configuration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2100	834	T2 - Units See <a href="#">Units Table</a>	U16	R/W	102 – BBL
2101	835	T2 - Time Base	U16	R/W	3 – Day
2102	836	T2 - Sampling Period (sec)	U16	R/W	5
2103	837	T2 - Dampening Factor	U16	R/W	0

### **Turbine 2 Configuration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2104	838	T2 - Input Configuration 0 - TFM Low (20 mV @ <1000 Hz) 1 - TFM Med (50 mV @ <1000 Hz) 2 - TFM High (100 mV @ <1000 Hz) 3 - TFM Max (200 mV @ <1000 Hz) 4 - Pulse Input	U16	R/W	1
2105	839	T2 - Override Enable 0 - Disabled 1 - Enabled	U16	R/W	0
2106	83A	T2 - Override Value	FP	R/W	0.00
2108	83C	T2 - Fail Value	FP	R/W	0.00
2110	83E	T2 - Low Frequency Cutoff	FP	R/W	5.00
2112	840	T2 - Low Flow Cutoff	FP	R/W	0.00
2114	842	T2 - Sensor Range Low	FP	R/W	0.00
2116	844	T2 - Sensor Range High	FP	R/W	0.83333333
2118	846	T2 - Units Scale Factor	FP	R/W	0.02380952
2120	848	T2 - Units Offset Factor	FP	R/W	0.00
2122	84A	T2 - Unit Description 1	LCD	R/W	—
2123	84B	T2 - Unit Description 2	LCD	R/W	—
2124	84C	T2 - Unit Description 3	LCD	R/W	—

### **Turbine 2 Calibration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2130	852	T2 - Calibration Type <sup>1</sup>	U16	R/W	1
2131	853	T2 - Linear Factor	FP	R/W	900.00
2133	855	T2 - Calibration Absolute Offset	FP	R/W	0.00
2135	857	T2 - Factor 1	FP	R/W	900.00
2137	859	T2 - Factor 2	FP	R/W	1.00
2139	85B	T2 - Factor 3	FP	R/W	1.00
2141	85D	T2 - Factor 4	FP	R/W	1.00
2143	85F	T2 - Factor 5	FP	R/W	1.00
2145	861	T2 - Factor 6	FP	R/W	1.00
2147	863	T2 - Factor 7	FP	R/W	1.00
2149	865	T2 - Factor 8	FP	R/W	1.00
2151	867	T2 - Factor 9	FP	R/W	1.00
2153	869	T2 - Factor 10	FP	R/W	1.00
2155	86B	T2 - Factor 11	FP	R/W	1.00
2157	86D	T2 - Factor 12	FP	R/W	1.00
2159	86F	T2 - Frequency 1	FP	R/W	1.00
2161	871	T2 - Frequency 2	FP	R/W	1.00

## Turbine 2 Calibration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2163	873	T2 - Frequency 3	FP	R/W	1.00
2165	875	T2 - Frequency 4	FP	R/W	1.00
2167	877	T2 - Frequency 5	FP	R/W	1.00
2169	879	T2 - Frequency 6	FP	R/W	1.00
2171	87B	T2 - Frequency 7	FP	R/W	1.00
2173	87D	T2 - Frequency 8	FP	R/W	1.00
2175	87F	T2 - Frequency 9	FP	R/W	1.00
2177	881	T2 - Frequency 10	FP	R/W	1.00
2179	883	T2 - Frequency 11	FP	R/W	1.00
2181	885	T2 - Frequency 12	FP	R/W	1.00

<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

## Static Pressure Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2200	898	SP - Units See <a href="#">Units Table</a>	U16	R/W	301
2201	899	SP - Time Base	U16	R/W	0
2202	89A	SP - Sampling Period	U16	R/W	1
2203	89B	SP - Dampening Factor	U16	R/W	0
2204	89C	SP - Input Configuration	U16	R/W	1
2205	89D	SP - Override Enable 0 - Disabled 1 - Enabled 2 - Flow Dependent Averaging	U16	R/W	2
2206	89E	SP - Override Value	FP	R/W	0.00
2208	8A0	SP - Fail Value	FP	R/W	0.00
2210	8A2	SP - Low Input Cutoff	FP	R/W	0.00
2212	8A4	SP - Low Flow Cutoff	FP	R/W	0.00
2214	8A6	SP - Sensor Range Low	FP	RO	from MVT
2216	8A8	SP - Sensor Range High	FP	RO	from MVT
2218	8AA	SP - Units Scale Factor	FP	R/W	1.00
2220	8AC	SP - Units Offset Factor	FP	R/W	0.00
2222	8AE	SP - Unit Description 1	LCD	R/W	
2223	8AF	SP - Unit Description 2	LCD	R/W	
2224	8B0	SP - Unit Description 3	LCD	R/W	

### Static Pressure Calibration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2230	8B6	SP - Calibration Type <sup>1</sup>	U16	R/W	0
2231	8B7	SP - Nominal Value	FP	R/W	1.00
2233	8B9	SP - Calibration Absolute Offset	FP	R/W	0.00
2235	8BB	SP - Calibration Actual 1	FP	R/W	0.00
2237	8BD	SP - Calibration Actual 2	FP	R/W	0.00
2239	8BF	SP - Calibration Actual 3	FP	R/W	0.00
2241	8C1	SP - Calibration Actual 4	FP	R/W	0.00
2243	8C3	SP - Calibration Actual 5	FP	R/W	0.00
2245	8C5	SP - Calibration Actual 6	FP	R/W	0.00
2247	8C7	SP - Calibration Actual 7	FP	R/W	0.00
2249	8C9	SP - Calibration Actual 8	FP	R/W	0.00
2251	8CB	SP - Calibration Actual 9	FP	R/W	0.00
2253	8CD	SP - Calibration Actual 10	FP	R/W	0.00
2255	8CF	SP - Calibration Actual 11	FP	R/W	0.00
2257	8D1	SP - Calibration Actual 12	FP	R/W	0.00
2259	8D3	SP - Calibration Measured 1	FP	R/W	0.00
2261	8D5	SP - Calibration Measured 2	FP	R/W	0.00
2263	8D7	SP - Calibration Measured 3	FP	R/W	0.00
2265	8D9	SP - Calibration Measured 4	FP	R/W	0.00
2267	8DB	SP - Calibration Measured 5	FP	R/W	0.00
2269	8DD	SP - Calibration Measured 6	FP	R/W	0.00
2271	8DF	SP - Calibration Measured 7	FP	R/W	0.00
2273	8E1	SP - Calibration Measured 8	FP	R/W	0.00
2275	8E3	SP - Calibration Measured 9	FP	R/W	0.00
2277	8E5	SP - Calibration Measured 10	FP	R/W	0.00
2279	8E7	SP - Calibration Measured 11	FP	R/W	0.00
2281	8E9	SP - Calibration Measured 12	FP	R/W	0.00

<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

### RTD Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2300	8FC	PT - Units See <a href="#">Units Table</a>	U16	R/W	501
2301	8FD	PT - Time Base 0 = Second 1 = Minute 2 = Hour 3 = Day	U16	R/W	0
2302	8FE	PT - Sampling Period (sec)	U16	R/W	5

### **RTD Configuration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2303	8FF	PT - Dampening Factor	U16	R/W	0
2304	900	PT - Input Configuration	U16	R/W	0
2305	901	PT - Override Enable 0 - Disabled 1 - Enabled 2 - Flow Dependent Averaging	U16	R/W	2
2306	902	PT - Override Value	FP	R/W	0.00
2308	904	PT - Fail Value	FP	R/W	60.00 Deg F
2310	906	PT - Low Input Cutoff	FP	R/W	-100.00 Deg F
2312	908	PT - Low Flow Cutoff	FP	R/W	-100.00 Deg F
2314	90A	PT - Sensor Range Low	FP	RO	-40.00 Deg F
2316	90C	PT - Sensor Range High	FP	RO	300.00 Deg F
2318	90E	PT - Units Scale Factor	FP	R/W	1.80
2320	910	PT - Units Offset Factor	FP	R/W	32.00
2322	912	PT - Unit Description 1	LCD	R/W	—
2323	913	PT - Unit Description 2	LCD	R/W	—
2324	914	PT - Unit Description 3	LCD	R/W	—

### **RTD Calibration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2330	91A	PT - Calibration Type <sup>1</sup>	U16	R/W	0
2331	91B	PT - Nominal Value	FP	R/W	1.00
2333	91D	PT - Calibration Absolute Offset	FP	R/W	0.00
2335	91F	PT - Calibration Actual 1	FP	R/W	0.00
2337	921	PT - Calibration Actual 2	FP	R/W	0.00
2339	923	PT - Calibration Actual 3	FP	R/W	0.00
2341	925	PT - Calibration Actual 4	FP	R/W	0.00
2343	927	PT - Calibration Actual 5	FP	R/W	0.00
2345	929	PT - Calibration Actual 6	FP	R/W	0.00
2347	92B	PT - Calibration Actual 7	FP	R/W	0.00
2349	92D	PT - Calibration Actual 8	FP	R/W	0.00
2351	92F	PT - Calibration Actual 9	FP	R/W	0.00
2353	931	PT - Calibration Actual 10	FP	R/W	0.00
2355	933	PT - Calibration Actual 11	FP	R/W	0.00
2357	935	PT - Calibration Actual 12	FP	R/W	0.00
2359	937	PT - Calibration Measured 1	FP	R/W	0.00
2361	939	PT - Calibration Measured 2	FP	R/W	0.00
2363	93B	PT - Calibration Measured 3	FP	R/W	0.00
2365	93D	PT - Calibration Measured 4	FP	R/W	0.00
2367	93F	PT - Calibration Measured 5	FP	R/W	0.00

### ***RTD Calibration***

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2369	941	PT - Calibration Measured 6	FP	R/W	0.00
2371	943	PT - Calibration Measured 7	FP	R/W	0.00
2373	945	PT - Calibration Measured 8	FP	R/W	0.00
2375	947	PT - Calibration Measured 9	FP	R/W	0.00
2377	949	PT - Calibration Measured 10	FP	R/W	0.00
2379	94B	PT - Calibration Measured 11	FP	R/W	0.00
2381	94D	PT - Calibration Measured 12	FP	R/W	0.00

<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

### ***Differential Pressure Configuration***

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2400	960	DP - Units See <a href="#">Units Table</a>	U16	R/W	401
2401	961	DP - Time Base 0 = Second 1 = Minute 2 = Hour 3 = Day	U16	R/W	0
2402	962	DP - Sampling Period (seconds)	U16	R/W	1
2403	963	DP - Dampening Factor	U16	R/W	0
2404	964	DP - Input Configuration	U16	R/W	0
2405	965	DP - Override Enable 0 - Disabled 1 - Enabled 2 - Flow Dependent Averaging	U16	R/W	2
2406	966	DP - Override Value	FP	R/W	0.00
2408	968	DP - Fail Value	FP	R/W	0.00
2410	96A	DP - Low Input Cutoff	FP	R/W	0.00
2412	96C	DP - Low Flow Cutoff	FP	R/W	0.00
2414	96E	DP - Sensor Range Low	FP	RO	from MVT
2416	970	DP - Sensor Range High	FP	RO	from MVT
2418	972	DP - Units Scale Factor	FP	R/W	1.00
2420	974	DP - Units Offset Factor	FP	R/W	0.00
2422	976	DP - Unit Description 1	LCD	R/W	—
2423	977	DP - Unit Description 2	LCD	R/W	—
2424	978	DP - Unit Description 3	LCD	R/W	—

### **Differential Pressure Calibration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2430	97E	DP - Calibration Type <sup>1</sup>	U16	R/W	0
2431	97F	DP - Nominal Value	FP	R/W	1.00
2433	981	DP - Calibration Absolute Offset	FP	R/W	0.00
2435	983	DP - Calibration Actual 1	FP	R/W	0.00
2437	985	DP - Calibration Actual 2	FP	R/W	0.00
2439	987	DP - Calibration Actual 3	FP	R/W	0.00
2441	989	DP - Calibration Actual 4	FP	R/W	0.00
2443	98B	DP - Calibration Actual 5	FP	R/W	0.00
2445	98D	DP - Calibration Actual 6	FP	R/W	0.00
2447	98F	DP - Calibration Actual 7	FP	R/W	0.00
2449	991	DP - Calibration Actual 8	FP	R/W	0.00
2451	993	DP - Calibration Actual 9	FP	R/W	0.00
2453	995	DP - Calibration Actual 10	FP	R/W	0.00
2455	997	DP - Calibration Actual 11	FP	R/W	0.00
2457	999	DP - Calibration Actual 12	FP	R/W	0.00
2459	99B	DP - Calibration Measured 1	FP	R/W	0.00
2461	99D	DP - Calibration Measured 2	FP	R/W	0.00
2463	99F	DP - Calibration Measured 3	FP	R/W	0.00
2465	9A1	DP - Calibration Measured 4	FP	R/W	0.00
2467	9A3	DP - Calibration Measured 5	FP	R/W	0.00
2469	9A5	DP - Calibration Measured 6	FP	R/W	0.00
2471	9A7	DP - Calibration Measured 7	FP	R/W	0.00
2473	9A9	DP - Calibration Measured 8	FP	R/W	0.00
2475	9AB	DP - Calibration Measured 9	FP	R/W	0.00
2477	9AD	DP - Calibration Measured 10	FP	R/W	0.00
2479	9AF	DP - Calibration Measured 11	FP	R/W	0.00
2481	9B1	DP - Calibration Measured 12	FP	R/W	0.00

<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

### **Analog Input 1 Configuration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2500	9C4	A1 - Units	U16	R/W	0
2501	9C5	A1 - Time Base	U16	R/W	0
2502	9C6	A1 - Sampling Period	U16	R/W	1
2503	9C7	A1 - Dampening Factor	U16	R/W	0
2504	9C8	A1 - Input Configuration	U16	R/W	0
2505	9C9	A1 - Override Enable	U16	R/W	0
2506	9CA	A1 - Override Value	FP	R/W	0.00

### **Analog Input 1 Configuration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2508	9CC	A1 - Fail Value	FP	R/W	0.00
2510	9CE	A1 - Low Input Cutoff	FP	R/W	2.00
2512	9D0	A1 - Low Flow Cutoff	FP	R/W	0.00
2514	9D2	A1 - Sensor Range Low	FP	RO	0.00
2516	9D4	A1 - Sensor Range High	FP	RO	0
2518	9D6	A1 - Units Scale Factor	FP	R/W	1
2520	9D8	A1 - Units Offset Factor	FP	R/W	0
2522	9DA	A1 - Unit Description 1	LCD	R/W	—
2523	9DB	A1 - Unit Description 2	LCD	R/W	—
2524	9DC	A1 - Unit Description 3	LCD	R/W	—

### **Analog Input 1 Calibration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2530	9E2	A1 - Calibration Type <sup>1</sup>	U16	R/W	0
2531	9E3	A1 - Nominal Value	FP	R/W	
2533	9E5	A1 - Calibration Absolute Offset	FP	R/W	0.00
2535	9E7	A1 - Calibration Actual 1	FP	R/W	0.00
2537	9E9	A1 - Calibration Actual 2	FP	R/W	0.00
2539	9EB	A1 - Calibration Actual 3	FP	R/W	0.00
2541	9ED	A1 - Calibration Actual 4	FP	R/W	0.00
2543	9EF	A1 - Calibration Actual 5	FP	R/W	0.00
2545	9F1	A1 - Calibration Actual 6	FP	R/W	0.00
2547	9F3	A1 - Calibration Actual 7	FP	R/W	0.00
2549	9F5	A1 - Calibration Actual 8	FP	R/W	0.00
2551	9F7	A1 - Calibration Actual 9	FP	R/W	0.00
2553	9F9	A1 - Calibration Actual 10	FP	R/W	0.00
2555	9FB	A1 - Calibration Actual 11	FP	R/W	0.00
2557	9FD	A1 - Calibration Actual 12	FP	R/W	0.00
2559	9FF	A1 - Calibration Measured 1	FP	R/W	0.00
2561	A01	A1 - Calibration Measured 2	FP	R/W	0.00
2563	A03	A1 - Calibration Measured 3	FP	R/W	0.00
2565	A05	A1 - Calibration Measured 4	FP	R/W	0.00
2567	A07	A1 - Calibration Measured 5	FP	R/W	0.00
2569	A09	A1 - Calibration Measured 6	FP	R/W	0.00
2571	A0B	A1 - Calibration Measured 7	FP	R/W	0.00
2573	A0D	A1 - Calibration Measured 8	FP	R/W	0.00
2575	A0F	A1 - Calibration Measured 9	FP	R/W	0.00
2577	A11	A1 - Calibration Measured 10	FP	R/W	0.00
2579	A13	A1 - Calibration Measured 11	FP	R/W	0.00
2581	A15	A1 - Calibration Measured 12	FP	R/W	0.00



<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

### **Analog Input 2 Configuration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2600	A28	A2 - Units	U16	R/W	0
2601	A29	A2 - Time Base	U16	R/W	0
2602	A2A	A2 - Sampling Period	U16	R/W	1
2603	A2B	A2 - Dampening Factor	U16	R/W	0
2604	A2C	A2 - Input Config	U16	R/W	0
2605	A2D	A2 - Override Enable	U16	R/W	0
2606	A2E	A2 - Override Value	FP	R/W	0.00
2608	A30	A2 - Fail Value	FP	R/W	0.00
2610	A32	A2 - Low Input Cutoff	FP	R/W	2.00
2612	A34	A2 - Low Flow Cutoff	FP	R/W	0.00
2614	A36	A2 - Sensor Range Low	FP	RO	0.00
2616	A38	A2 - Sensor Range High	FP	RO	0
2618	A3A	A2 - Units Scale Factor	FP	R/W	1
2620	A3C	A2 - Units Offset Factor	FP	R/W	0
2622	A3E	A2 - Unit Description 1	LCD	R/W	—
2623	A3F	A2 - Unit Description 2	LCD	R/W	—
2624	A40	A2 - Unit Description 3	LCD	R/W	—

### **Analog Input 2 Calibration**

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2630	A46	A2 - Calibration Type <sup>1</sup>	U16	R/W	0
2631	A47	A2 - Nominal Value	FP	R/W	
2633	A49	A2 - Calibration Absolute Offset	FP	R/W	0.00
2635	A4B	A2 - Calibration Actual 1	FP	R/W	0.00
2637	A4D	A2 - Calibration Actual 2	FP	R/W	0.00
2639	A4F	A2 - Calibration Actual 3	FP	R/W	0.00
2641	A51	A2 - Calibration Actual 4	FP	R/W	0.00
2643	A53	A2 - Calibration Actual 5	FP	R/W	0.00
2645	A55	A2 - Calibration Actual 6	FP	R/W	0.00
2647	A57	A2 - Calibration Actual 7	FP	R/W	0.00
2649	A59	A2 - Calibration Actual 8	FP	R/W	0.00
2651	A5B	A2 - Calibration Actual 9	FP	R/W	0.00
2653	A5D	A2 - Calibration Actual 10	FP	R/W	0.00
2655	A5F	A2 - Calibration Actual 11	FP	R/W	0.00
2657	A61	A2 - Calibration Actual 12	FP	R/W	0.00
2659	A63	A2 - Calibration Measured 1	FP	R/W	0.00
2661	A65	A2 - Calibration Measured 2	FP	R/W	0.00

### Analog Input 2 Calibration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2663	A67	A2 - Calibration Measured 3	FP	R/W	0.00
2665	A69	A2 - Calibration Measured 4	FP	R/W	0.00
2667	A6B	A2 - Calibration Measured 5	FP	R/W	0.00
2669	A6D	A2 - Calibration Measured 6	FP	R/W	0.00
2671	A6F	A2 - Calibration Measured 7	FP	R/W	0.00
2673	A71	A2 - Calibration Measured 8	FP	R/W	0.00
2675	A73	A2 - Calibration Measured 9	FP	R/W	0.00
2677	A75	A2 - Calibration Measured 10	FP	R/W	0.00
2679	A77	A2 - Calibration Measured 11	FP	R/W	0.00
2681	A79	A2 - Calibration Measured 12	FP	R/W	0.00

<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

### Digital Input Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
2900	B54	Digital Mode	U16	R/W	0

### Flow Run 1 Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
3000	BB8	FR1 Volume Units See <a href="#">Units Table</a>	U16	R/W	201
3001	BB9	FR1 Time Base	U16	R/W	3
3002	BBA	FR1 Flow Calculation Period (Number of seconds for each calculation)	U16	R/W	60
3003	BBB	FR1 Dampening Factor	U16	R/W	0
3004	BBC	FR1 Flow Rate Calculation (See <a href="#">definition.</a> )	U16	R/W	0
3005	BBD	FR1 Override Enable 0 - Disabled 1 - Enabled	U16	R/W	0
3006	BBE	FR1 Fluid Properties (See <a href="#">definition.</a> )	U16	R/W	3000
3007	BBF	FR1 Fluid Property Calculation (Number of flow rate calculation periods before each fluid property calculation)	U16	R/W	1

### Flow Run 1 Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
3008	BC0	FR1 Material Type: Pipe 0 - SS (304/316), AGA-3 1992 1 - Carbon Steel 2 - Monel 3 - Brass 4 - Inconel 5 - Nickel 6 - HastC22 7 - Titanium 8 - SS (304), AGA-3 2012 9 - SS (316), AGA-3 2012 10 - Monel 400, AGA-3 2012	U16	R/W	1
3009	BC1	FR1 Material Type: Plate 0 - SS (304/316), AGA-3 1992 1 - Carbon Steel 2 - Monel 3 - Brass 4 - Inconel 5 - Nickel 6 - HastC22 7 - Titanium 8 - SS (304), AGA-3 2012 9 - SS (316), AGA-3 2012 10 - Monel 400, AGA-3 2012	U16	R/W	0
3010	BC2	FR1 Tap Type (See <a href="#">definition.</a> )	U16	R/W	0
3011	BC3	FR1 Static Pressure Selection	U16	R/W	8000
3012	BC4	FR1 Differential Pressure Selection	U16	R/W	8000
3013	BC5	FR1 Process Temperature Selection	U16	R/W	8000
3014	BC6	FR1 Turbine Source	U16	R/W	0
3015	BC7	FR1 Mass Units	U16	R/W	601
3016	BC8	FR1 Energy Units	U16	R/W	701
3017	BC9	FR1 Override Value	FP	R/W	0.00
3019	BCB	FR1 Fail Value	FP	R/W	0.00
3021	BCD	FR1 Low Flow Cutoff	FP	R/W	0.00
3023	BCF	FR1 Low Cutoff	FP	R/W	0.00
3025	BD1	FR1 Base Temperature	FP	R/W	60.00 Deg F
3027	BD3	FR1 Base Pressure	FP	R/W	14.73 psi
3029	BD5	FR1 Atmospheric Pressure	FP	R/W	14.73 psi
3031	BD7	FR1 Pipe Size	FP	R/W	2.067 in.
3033	BD9	FR1 Pipe Reference Temp	FP	R/W	68.00 Deg F
3035	BDB	FR1 Plate Size	FP	R/W	1.00 in.
3037	BDD	FR1 Plate Reference Temp	FP	R/W	68.00 Deg F
3039	BDF	FR1 Isentropic Exponent - k	FP	R/W	1.30
3041	BE1	FR1 Viscosity	FP	R/W	0.010268 cP

### Flow Run 1 Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
3043	BE3	FR1 Cone Beta	FP	R/W	0.500
3045	BE5	FR1 Cone Flow Coefficient	FP	R/W	1.000
3047	BE7	FR1 Low Pressure Cutoff	FP	R/W	1.000 In H2O
3049	BE9	FR1 Specific Gravity	FP	R/W	0.60
3051	BEB	FR1 Heating Value	FP	R/W	1031.426
3053	BED	FR1 Gas Fraction/Quality	FP	R/W	1.00
3055	BEF	FR1 Configuration Parameter 1 (Absolute Density - Liquids) Liquid Density Base Fluid = Liquid : Base Density Fluid = Ngas : Liquid Oil Density Base	FP	R/W	53.06376
3057	BF1	FR1 Configuration Parameter 2 Fluid = Liquid : Flowing Density Fluid = NGas : Base liquid water density	FP	R/W	62.30385
3059	BF3	FR1 Configuration Parameter 3 Oil Fraction	FP	R/W	1.00
3061	BF5	FR1 Configuration Parameter 4	FP	R/W	0.00
3063	BF7	FR1 GC - Methane (C1)	FP	R/W	0.965222
3065	BF9	FR1 GC - Nitrogen (N2)	FP	R/W	0.002595
3067	BFB	FR1 GC - Carbon Dioxide (CO2)	FP	R/W	0.005956
3069	BFD	FR1 GC - Ethane (C2)	FP	R/W	0.018186
3071	BFF	FR1 GC - Propane (C3)	FP	R/W	0.004596
3073	C01	FR1 GC - Water (H2O)	FP	R/W	0.00
3075	C03	FR1 GC - Hydrogen Sulfide (H2S)	FP	R/W	0.00
3077	C05	FR1 GC - Hydrogen (H2)	FP	R/W	0.00
3079	C07	FR1 GC - Carbon Monoxide (CO)	FP	R/W	0.00
3081	C09	FR1 GC - Oxygen (O2)	FP	R/W	0.00
3083	C0B	FR1 GC - I-Butane (i-C4)	FP	R/W	0.000977
3085	C0D	FR1 GC - N-Butane (n-C4)	FP	R/W	0.001007
3087	C0F	FR1 GC - I-Pentane (i-C5)	FP	R/W	0.000473
3089	C11	FR1 GC - N-Pentane (n-C5)	FP	R/W	0.000324
3091	C13	FR1 GC - N-Hexane (n-C6)	FP	R/W	0.000664
3093	C15	FR1 GC - N-Heptane (n-C7)	FP	R/W	0.00
3095	C17	FR1 GC - N-Octane (n-C8)	FP	R/W	0.00
3097	C19	FR1 GC - N-Nonane (n-C9)	FP	R/W	0.00
3099	C1B	FR1 GC - N-Decane (n-C10)	FP	R/W	0.00
3101	C1D	FR1 GC - Helium (He)	FP	R/W	0.00
3103	C1F	FR1 GC - Argon (Ar)	FP	R/W	0.00
3105	C21	FR1 Unit Scale	FP	R/W	1.00
3107	C23	FR1 Unit Offset	FP	R/W	0.00

### Flow Run 1 Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
3109	C25	FR1 Unit Description 1	LCD	R/W	—
3110	C26	FR1 Unit Description 2	LCD	R/W	—
3111	C27	FR1 Unit Description 3	LCD	R/W	—
3112	C28	FR1 Mass Scale	FP	R/W	1.00
3114	C2A	FR1 Mass Description 1	LCD	R/W	—
3115	C2B	FR1 Mass Description 2	LCD	R/W	—
3116	C2C	FR1 Mass Description 3	LCD	R/W	—
3117	C2D	FR1 Energy Scale	FP	R/W	1.00
3119	C2F	FR1 Energy Description 1	LCD	R/W	—
3120	C30	FR1 Energy Description 2	LCD	R/W	—
3121	C31	FR1 Energy Description 3	LCD	R/W	—

### Flow Rate Calculation Register

The flow rate calculation register is shown below.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
			LE	Wet Correction				Flow Rate Calculation							

LE - Liquid Estimation Selection (STEAM ONLY)	
0	Do not include Liquid Estimate
1	Include Liquid Estimate
Wet Correction	
0	No Wet Correction
1	Orifice - Chisholm-Steven
2	Orifice - James (STEAM ONLY)
3	Cone - Chisholm-Steven
4	Venturi - de Leeuw correlation (beta = 0.401 only) (FUTURE)
5	Venturi - Steven correlation (beta = 0.55 only) (FUTURE)
6	Do Not Use
7	Correction Override
Flow Rate Calculation	
0	AGA-3 1992
1	Cone Spool
2	Cone Wafer
3	AGA-7
4	ISO-5167 - Orifice
5	ISO-5167 Venturi Nozzle (FUTURE)
6	ISA Nozzle (FUTURE)
7	Long Radius Nozzle (FUTURE)
8	Averaging Pitot Tube (Annubar®)
9-10	Reserved

Flow Rate Calculation	
11	Venturi Meter
12	ISO-5167 Foxboro Integral Orifice
13	ASME MFC-14M (2003), Small Bore Orifice
14	AGA-3 2012

## Fluid Property Register

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
HV	SG	V	Isen	LiqDC			GPA		SGRef						Fluid Property Calc

HV - Heating Value Selection	
0	Calculated
1	Manual Entry
SG - Specific Gravity Selection	
0	Calculated
1	Manual Entry
V - Viscosity Selection	
0	Calculated
1	Manual Entry
Isen - Isentropic Exponent Selection	
0	Calculated
1	Manual Entry
LiqDC – Liquid Density Control	
0	For Liquids: Register 3057 contains the flowing density For NGas: Register 3057 contains the base liquid oil density
1	For Liquids: Register 3057 contains the coefficient of thermal expansion For NGas: Register 3057 contains the flowing liquid oil density
GPA - GPA Table Selection	
0	Use 2008 Table
1	Use 1996 Table
SGRef - Specific Gravity Reference	
0	US (AGA) – 14.73 psi, 60 Deg F
1	Canada, UK – 103.208 kPa, 15 Deg C
2	Brazil (FUTURE)
3	France (FUTURE)
Fluid Property Calculation	
0	AGA-8 Detail
1	AGA-8 Gross
2	(FUTURE)
3	IF-97 (STEAM ONLY)
4	IF-97/James - (STEAM ONLY)
5-15	(FUTURE)
16	Generic Liquid

Fluid Property Calculation	
17	MPMS Ch. 11.1 - Crude Oil
18	MPMS Ch. 11.1 - Refined Products
19	MPMS Ch. 11.1 - Lube Oils
20	MPMS Ch. 11.1 - Special Products

## Tap Type Register

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
												Loc	Tap Type			

Loc (Pressure Tap Location)	
0	Upstream
1	Downstream

Tap Type	
0	Flange
1	Corner
2	D and D/2
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved

## Flow Run 1 Calibration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
3200	C80	FR1 Calibration Type <sup>1</sup>	U16	R/W	200
3201	C81	FR1 Nominal Flow Coefficient	FP	R/W	0.88
3203	C83	FR1 Coefficient Offset	FP	R/W	0.00
3205	C85	FR1 Flow Coefficient 1	FP	R/W	0.88
3207	C87	FR1 Flow Coefficient 2	FP	R/W	0.00
3209	C89	FR1 Flow Coefficient 3	FP	R/W	0.00
3211	C8B	FR1 Flow Coefficient 4	FP	R/W	0.00
3213	C8D	FR1 Flow Coefficient 5	FP	R/W	0.00
3215	C8F	FR1 Flow Coefficient 6	FP	R/W	0.00
3217	C91	FR1 Flow Coefficient 7	FP	R/W	0.00
3219	C93	FR1 Flow Coefficient 8	FP	R/W	0.00
3221	C95	FR1 Flow Coefficient 9	FP	R/W	0.00
3223	C97	FR1 Flow Coefficient 10	FP	R/W	0.00
3225	C99	FR1 Flow Coefficient 11	FP	R/W	0.00
3227	C9B	FR1 Flow Coefficient 12	FP	R/W	0.00
3229	C9D	FR1 Flow Coefficient 13	FP	R/W	0.00
3231	C9F	FR1 Flow Coefficient 14	FP	R/W	0.00
3233	CA1	FR1 Flow Coefficient 15	FP	R/W	0.00

### Flow Run 1 Calibration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
3235	CA3	FR1 Flow Coefficient 16	FP	R/W	0.00
3237	CA5	FR1 Reynolds Number 1	FP	R/W	1.00
3239	CA7	FR1 Reynolds Number 2	FP	R/W	0.00
3241	CA9	FR1 Reynolds Number 3	FP	R/W	0.00
3243	CAB	FR1 Reynolds Number 4	FP	R/W	0.00
3245	CAD	FR1 Reynolds Number 5	FP	R/W	0.00
3247	CAF	FR1 Reynolds Number 6	FP	R/W	0.00
3249	CB1	FR1 Reynolds Number 7	FP	R/W	0.00
3251	CB3	FR1 Reynolds Number 8	FP	R/W	0.00
3253	CB5	FR1 Reynolds Number 9	FP	R/W	0.00
3255	CB7	FR1 Reynolds Number 10	FP	R/W	0.00
3257	CB9	FR1 Reynolds Number 11	FP	R/W	0.00
3259	CBB	FR1 Reynolds Number 12	FP	R/W	0.00
3261	CBD	FR1 Reynolds Number 13	FP	R/W	0.00
3263	CBF	FR1 Reynolds Number 14	FP	R/W	0.00
3265	CC1	FR1 Reynolds Number 15	FP	R/W	0.00
3267	CC3	FR1 Reynolds Number 16	FP	R/W	0.00

<sup>1</sup> The Calibration Type register must be configured using ModWorX Pro. This register defines the type and number of calibration points used. If altered manually, calibration points must be entered in ascending order.

### Output Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
4000	FA0	Pulse Out 1 - Source	U16	R/W	16384
4001	FA1	Pulse Out 1 - Duration	U16	R/W	10
4002	FA2	Pulse Out 1 - Decimal Location	U16	R/W	2
4003	FA3	Pulse Out 1 - Data Pointer	U16	R/W	108
4004	FA4	Pulse Out 1 - Scale Factor	FP	R/W	1
4006	FA6	Pulse Out 1 - Low Level	FP	R/W	0
4008	FA8	Pulse Out 1 - High Level	FP	R/W	0
4010	FAA	Pulse Out 2 - Source	U16	R/W	16384
4011	FAB	Pulse Out 2 - Duration	U16	R/W	10
4012	FAC	Pulse Out 2 - Decimal Location	U16	R/W	2
4013	FAD	Pulse Out 2 - Data Pointer	U16	R/W	138
4014	FAE	Pulse Out 2 - Scale Factor	FP	R/W	1
4016	FB0	Pulse Out 2 - Low Level	FP	R/W	0
4018	FB2	Pulse Out 2 - High Level	FP	R/W	0
4020	FB4	Pulse Out 3 - Source	U16	R/W	16409
4021	FB5	Pulse Out 3 - Duration	U16	R/W	10
4022	FB6	Pulse Out 3 - Decimal Location	U16	R/W	2
4023	FB7	Pulse Out 3 - Data Pointer	U16	R/W	108



## Output Configuration

Register (Decimal)	Register (Hex)	Description	Data Type	Access	Default
4024	FB8	Pulse Out 3 - Scale Factor	FP	R/W	1
4026	FBA	Pulse Out 3 - Low Level	FP	R/W	60000
4028	FBC	Pulse Out 3 - High Level	FP	R/W	180000
4030	FBE	Pulse Out 4 - Source	U16	R/W	27
4031	FBF	Pulse Out 4 - Duration	U16	R/W	10
4032	FC0	Pulse Out 4 - Decimal Location	U16	R/W	2
4033	FC1	Pulse Out 4 - Data Pointer	U16	R/W	138
4034	FC2	Pulse Out 4 - Scale Factor	FP	R/W	1
4036	FC4	Pulse Out 4 - Low Level	FP	R/W	0
4038	FC6	Pulse Out 4 - High Level	FP	R/W	0
4040	FC8	Analog Out 1 - Source	U16	R/W	0
4041	FC9	Analog Out 1 - Low Value	FP	R/W	0
4043	FCB	Analog Out 1 - High Value	FP	R/W	1700
4045	FCD	Analog Out 1 - Low Adjust	U16	R/W	32768
4046	FCE	Analog Out 1 - High Adjust	U16	R/W	32768
4047	FCF	Analog Out 2 - Source	U16	R/W	0
4048	FD0	Analog Out 2 - Low Value	FP	R/W	0
4050	FD2	Analog Out 2 - High Value	FP	R/W	1700
4052	FD4	Analog Out 2 - Low Adjust	U16	R/W	0
4053	FD5	Analog Out 2 - High Adjust	U16	R/W	4095
4054	FD6	Analog Out 3 - Source	U16	R/W	0
4055	FD7	Analog Out 3 - Low Value	FP	R/W	0
4057	FD9	Analog Out 3 - High Value	FP	R/W	1700
4059	FDB	Analog Out 3 - Low Adjust	U16	R/W	0
4060	FDC	Analog Out 3 - High Adjust	U16	R/W	4095
4061	FDD	Analog Out 4 - Source	U16	R/W	0
4062	FDE	Analog Out 4 - Low Value	FP	R/W	0
4064	FE0	Analog Out 4 - High Value	FP	R/W	1700
4066	FE2	Analog Out 4 - Low Adjust	U16	R/W	0
4067	FE3	Analog Out 4 - High Adjust	U16	R/W	4095

## Pulse Input for Status Indication

While a pulse input can be configured to provide the frequency input for Turbine Input 1 or 2, a pulse input can also be used to indicate the status of a switch, even while two frequency inputs are used to calculate flow. When used for status indication, no configuration is required in ModWorX Pro. Status is derived from a simple read of the pulse input “state” and “count” registers (8624 and 8626). If no voltage is present, register 8624 will read “1”; if voltage is applied, register 8624 will read “0”. Each time the “state” goes from “1” to “0,” the value in the “count” register increments. By monitoring the “state” and “count” registers, the user can determine whether a switch is on or off, and how many times the switch has turned on or off in a given time period.

A user clears the count by writing a “0” to register 8626.

### ***Holding Registers***

<b>Register (Decimal)</b>	<b>Register (Hex)</b>	<b>Description</b>	<b>Data Type</b>	<b>Access</b>
8000	1F40	Interval Pointer	FP	RO
8002	1F42	Daily Pointer	FP	RO
8004	1F44	Event Counter	FP	RO
8006	1F46	Real Date	FP	RO
8008	1F48	Real Time	FP	RO
8010	1F4A	Flow Run Alarms	FP	RO
8012	1F4C	Flow Run Alarm Low	FP	RO
8014	1F4E	Flow Run Alarm High	FP	RO
8016	1F50	Diagnostic 1	FP	RO
8018	1F52	Diagnostic 2	FP	RO
8020	1F54	Diagnostic 3	FP	RO
8022	1F56	Diagnostic 4	FP	RO
8024	1F58	Polling Index	FP	RO
8026	1F5A	FR1 Grand Total	FP	RO
8028	1F5C	FR1 Instantaneous Flow Rate	FP	RO
8030	1F5E	FR1 Daily Total	FP	RO
8032	1F60	FR1 Interval Total	FP	RO
8034	1F62	FR1 Polling Total	FP	RO
8036	1F64	FR1 Previous Day Total	FP	RO
8038	1F66	FR1 Previous Interval	FP	RO
8040	1F68	FR1 Previous Polling Total	FP	RO
8042	1F6A	FR1 Grand Mass Total	FP	RO
8044	1F6C	FR1 Instantaneous Mass Flow Rate	FP	RO
8046	1F6E	FR1 Daily Mass Total	FP	RO
8048	1F70	FR1 Interval Mass Total	FP	RO
8050	1F72	FR1 Polling Mass Total	FP	RO
8052	1F74	FR1 Previous Day Mass	FP	RO
8054	1F76	FR1 Previous Interval Mass	FP	RO
8056	1F78	FR1 Previous Polling Mass	FP	RO
8058	1F7A	FR1 Grand Energy Total	FP	RO
8060	1F7C	FR1 Instantaneous Energy Flow Rate	FP	RO
8062	1F7E	FR1 Daily Energy Total	FP	RO
8064	1F80	FR1 Interval Energy Total	FP	RO
8066	1F82	FR1 Polling Energy Total	FP	RO
8068	1F84	FR1 Previous Day Energy	FP	RO
8070	1F86	FR1 Previous Interval Energy	FP	RO
8072	1F88	FR1 Previous Polling Energy	FP	RO
8074	1F8A	FR1 Daily Estimated Total	FP	RO
8076	1F8C	FR1 Monthly Total	FP	RO
8078	1F8E	FR1 Previous Month Total	FP	RO
8080	1F90	FR1 Daily Run Time	FP	RO

### ***Holding Registers***

Register (Decimal)	Register (Hex)	Description	Data Type	Access
8082	1F92	FR1 Interval Run Time	FP	RO
8084	1F94	FR1 Polling Run Time	FP	RO
8086	1F96	FR1 Previous Daily Run Time	FP	RO
8088	1F98	FR1 Previous Interval Run Time	FP	RO
8090	1F9A	FR1 Previous Polling Run Time	FP	RO
8092	1F9C	FR1 Static Pressure	FP	RO
8094	1F9E	FR1 Differential Pressure	FP	RO
8096	1FA0	FR1 Process Temperature	FP	RO
8098	1FA2	FR1 UnCorrected Volume	FP	RO
8100	1FA4	FR1 SqrtDP	FP	RO
8102	1FA6	FR1 Compressibility (Natural Gas); FR1 CTPL - Complete Correction Factor (Liquids)	FP	RO
8104	1FA8	FR1 Density	FP	RO
8106	1FAA	FR1 Base Compressibility (Natural Gas) FR1 CTL - Temperature Correction Factor (Liquids)	FP	RO
8108	1FAC	FR1 Base Density	FP	RO
8110	1FAE	FR1 Average Molecular Weight	FP	RO
8112	1FB0	FR1 Molar Fraction Sum	FP	RO
8114	1FB2	FR1 Mass Heating Value	FP	RO
8116	1FB4	FR1 Heating Value Volume Basis	FP	RO
8118	1FB6	FR1 Specific Gravity	FP	RO
8120	1FB8	FR1 Viscosity	FP	RO
8122	1FBA	FR1 Isentropic Exponent	FP	RO
8124	1FBC	FR1 Reynolds Number	FP	RO
8126	1FBE	FR1 Calculation Parameter 1	FP	RO
8128	1FC0	FR1 Calculation Parameter 2	FP	RO
8130	1FC2	FR1 Calculation Parameter 3	FP	RO
8132	1FC4	FR1 Calculation Parameter 4	FP	RO
8134	1FC6	FR1 Calculation Parameter 5	FP	RO
8136	1FC8	FR1 Calculation Parameter 6	FP	RO
8138	1FCA	FR1 Calculation Parameter 7	FP	RO
8140	1FCC	FR1 Calculation Parameter 8	FP	RO
8142	1FCE	FR1 Calculation Parameter 9	FP	RO
8144	1FD0	FR1 Calculation Parameter 10	FP	RO
8146	1FD2	FR1 Calculation Parameter 11	FP	RO
8148	1FD4	FR1 Calculation Parameter 12	FP	RO
8150	1FD6	FR1 Calculation Parameter 13	FP	RO
8152	1FD8	FR1 Calculation Parameter 14	FP	RO
8154	1FDA	FR1 Calculation Parameter 15	FP	RO

### ***Holding Registers***

<b>Register (Decimal)</b>	<b>Register (Hex)</b>	<b>Description</b>	<b>Data Type</b>	<b>Access</b>
8156	1FDC	FR1 Calculation Parameter 16	FP	RO
8158	1FDE	FR1 Grand Total [MCF]	FP	RO
8160	1FE0	FR1 Instantaneous Flow Rate [MCF]	FP	RO
8162	1FE2	FR1 Daily Total [MCF]	FP	RO
8164	1FE4	FR1 Interval Total [MCF]	FP	RO
8166	1FE6	FR1 Polling Total [MCF]	FP	RO
8168	1FE8	FR1 Previous Day [MCF]	FP	RO
8170	1FEA	FR1 Previous Interval [MCF]	FP	RO
8172	1FEC	FR1 Previous Polling Total [MCF]	FP	RO
8174	1FEE	FR1 Grand Mass Total [LBM]	FP	RO
8176	1FF0	FR1 Instantaneous Mass Rate [LBM]	FP	RO
8178	1FF2	FR1 Daily Mass Total [LBM]	FP	RO
8180	1FF4	FR1 Interval Mass Total [LBM]	FP	RO
8182	1FF6	FR1 Polling Mass Total [LBM]	FP	RO
8184	1FF8	FR1 Previous Day Mass [LBM]	FP	RO
8186	1FFA	FR1 Previous Interval Mass [LBM]	FP	RO
8188	1FFC	FR1 Previous Polling Mass [LBM]	FP	RO
8190	1FFE	FR1 Grand Energy Total [MMBTU]	FP	RO
8192	2200	FR1 Instantaneous Energy Rate [MMBTU]	FP	RO
8194	2002	FR1 Daily Energy Total [MMBTU]	FP	RO
8196	2004	FR1 Interval Energy Total [MMBTU]	FP	RO
8198	2006	FR1 Polling Energy Total [MMBTU]	FP	RO
8200	2008	FR1 Previous Day Energy [MMBTU]	FP	RO
8202	200A	FR1 Previous Interval Energy [MMBTU]	FP	RO
8204	200C	FR1 Previous Polling Energy [MMBTU]	FP	RO
8206	200E	FR1 Daily Estimated Total [MCF]	FP	RO
8208	2010	FR1 Monthly Total [MCF]	FP	RO
8210	2012	FR1 Previous Month Total [MCF]	FP	RO
8212	2014	FR1 Mass Heating Value [BASE]	FP	RO
8214	2016	FR1 Volumetric Heating Value [BASE]	FP	RO
8216	2018	T1 Grand Total	FP	RO
8218	201A	T1 Instantaneous Flow Rate	FP	RO
8220	201C	T1 Daily Total	FP	RO
8222	201E	T1 Interval Total	FP	RO
8224	2020	T1 Polling Total	FP	RO
8226	2022	T1 Previous Day	FP	RO
8228	2024	T1 Previous Interval	FP	RO
8230	2026	T1 Previous Polling Total	FP	RO
8232	2028	T1 Daily Estimated Total	FP	RO
8234	202A	T1 Monthly Total	FP	RO
8236	202C	T1 Previous Month Total	FP	RO

## Holding Registers

Register (Decimal)	Register (Hex)	Description	Data Type	Access
8238	202E	T1 Daily Run Time	FP	RO
8240	2030	T1 Interval Run Time	FP	RO
8242	2032	T1 Polling Run Time	FP	RO
8244	2034	T1 Previous Daily Run Time	FP	RO
8246	2036	T1 Previous Interval Run Time	FP	RO
8248	2038	T1 Previous Polling Run Time	FP	RO
8250	203A	T1 Grand Total [GAL]	FP	RO
8252	203C	T1 Instantaneous Flow Rate [GAL]	FP	RO
8254	203E	T1 Daily Total [GAL]	FP	RO
8256	2040	T1 Interval Total [GAL]	FP	RO
8258	2042	T1 Polling Total [GAL]	FP	RO
8260	2044	T1 Previous Day [GAL]	FP	RO
8262	2046	T1 Previous Interval [GAL]	FP	RO
8264	2048	T1 Previous Polling Total [GAL]	FP	RO
8266	204A	T1 Daily Estimated Total [GAL]	FP	RO
8268	204C	T1 Monthly Total [GAL]	FP	RO
8270	204E	T1 Previous Month Total [GAL]	FP	RO
8272	2050	T1 Frequency	FP	RO
8274	2052	T1 Active K-Factor	FP	RO
8276	2054	T2 Grand Total	FP	RO
8278	2056	T2 Instantaneous Flow Rate	FP	RO
8280	2058	T2 Daily Total	FP	RO
8282	205A	T2 Interval Total	FP	RO
8284	205C	T2 Polling Total	FP	RO
8286	205E	T2 Previous Day	FP	RO
8288	2060	T2 Previous Interval	FP	RO
8290	2062	T2 Previous Polling Total	FP	RO
8292	2064	T2 Daily Estimated Total	FP	RO
8294	2066	T2 Monthly Total	FP	RO
8296	2068	T2 Previous Month Total	FP	RO
8298	206A	T2 Daily Run Time	FP	RO
8300	206C	T2 Interval Run Time	FP	RO
8302	206E	T2 Polling Run Time	FP	RO
8304	2070	T2 Previous Daily Run Time	FP	RO
8306	2072	T2 Previous Interval Run Time	FP	RO
8308	2074	T2 Previous Polling Run Time	FP	RO
8310	2076	T2 Grand Total [GAL]	FP	RO
8312	2078	T2 Instantaneous Flow Rate [GAL]	FP	RO
8314	207A	T2 Daily Total [GAL]	FP	RO
8316	207C	T2 Interval Total [GAL]	FP	RO
8318	207E	T2 Polling Total [GAL]	FP	RO

### ***Holding Registers***

<b>Register (Decimal)</b>	<b>Register (Hex)</b>	<b>Description</b>	<b>Data Type</b>	<b>Access</b>
8320	2080	T2 Previous Day Total [GAL]	FP	RO
8322	2082	T2 Previous Interval [GAL]	FP	RO
8324	2084	T2 Previous Polling Total [GAL]	FP	RO
8326	2086	T2 Daily Estimated Total [GAL]	FP	RO
8328	2088	T2 Monthly Total [GAL]	FP	RO
8330	208A	T2 Previous Month Total [GAL]	FP	RO
8332	208C	T2 Frequency	FP	RO
8334	208E	T2 Active K-Factor	FP	RO
8336	2090	SP Instantaneous Reading	FP	RO
8338	2092	SP Rate Of Change	FP	RO
8340	2094	SP Daily Average	FP	RO
8342	2096	SP Interval Average	FP	RO
8344	2098	SP Polling Average	FP	RO
8346	209A	SP Previous Daily Average	FP	RO
8348	209C	SP Previous Interval Average	FP	RO
8350	209E	SP Previous Polling Average	FP	RO
8352	20A0	SP Daily Run Time	FP	RO
8354	20A2	SP Interval Run Time	FP	RO
8356	20A4	SP Polling Run Time	FP	RO
8358	20A6	SP Previous Daily Run Time	FP	RO
8360	20A8	SP Previous Interval Run Time	FP	RO
8362	20AA	SP Previous Polling Run Time	FP	RO
8364	20AC	SP Instantaneous Reading [PSI]	FP	RO
8366	20AE	SP Rate of Change [PSI]	FP	RO
8368	20B0	SP Daily Average [PSI]	FP	RO
8370	20B2	SP Interval Average [PSI]	FP	RO
8372	20B4	SP Polling Average [PSI]	FP	RO
8374	20B6	SP Previous Daily Average [PSI]	FP	RO
8376	20B8	SP Previous Interval Average [PSI]	FP	RO
8378	20BA	SP Previous Polling Average [PSI]	FP	RO
8380	20BC	DP Instantaneous Reading	FP	RO
8382	20BE	DP Rate Of Change	FP	RO
8384	20C0	DP Daily Average	FP	RO
8386	20C2	DP Interval Average	FP	RO
8388	20C4	DP Polling Average	FP	RO
8390	20C6	DP Previous Daily Average	FP	RO
8392	20C8	DP Previous Interval Average	FP	RO
8394	20CA	DP Previous Polling Average	FP	RO
8396	20CC	DP Daily Run Time	FP	RO
8398	20CE	DP Interval Run Time	FP	RO
8400	20D0	DP Polling Run Time	FP	RO

## Holding Registers

Register (Decimal)	Register (Hex)	Description	Data Type	Access
8402	20D2	DP Previous Daily Run Time	FP	RO
8404	20D4	DP Previous Interval Run Time	FP	RO
8406	20D6	DP Previous Polling Run Time	FP	RO
8408	20D8	DP Instantaneous Reading [INH2O]	FP	RO
8410	20DA	DP Rate of Change [INH2O]	FP	RO
8412	20DC	DP Daily Average [INH2O]	FP	RO
8414	20DE	DP Interval Average [INH2O]	FP	RO
8416	20E0	DP Polling Average [INH2O]	FP	RO
8418	20E2	DP Previous Daily Average [INH2O]	FP	RO
8420	20E4	DP Previous Interval Average [INH2O]	FP	RO
8422	20E6	DP Previous Polling Average [INH2O]	FP	RO
8424	20E8	PT Instantaneous Reading	FP	RO
8426	20EA	PT Rate Of Change	FP	RO
8428	20EC	PT Daily Average	FP	RO
8430	20EE	PT Interval Average	FP	RO
8432	20F0	PT Polling Average	FP	RO
8434	20F2	PT Previous Daily Average	FP	RO
8436	20F4	PT Previous Interval Average	FP	RO
8438	20F6	PT Previous Polling Average	FP	RO
8440	20F8	PT Daily Run Time	FP	RO
8442	20FA	PT Interval Run Time	FP	RO
8444	20FC	PT Polling Run Time	FP	RO
8446	20FE	PT Previous Daily Run Time	FP	RO
8448	2100	PT Previous Interval Run Time	FP	RO
8450	2102	PT Previous Polling Run Time	FP	RO
8452	2104	PT Instantaneous Reading [DEGF]	FP	RO
8454	2106	PT Rate of Change [DEGF]	FP	RO
8456	2108	PT Daily Average [DEGF]	FP	RO
8458	210A	PT Interval Average [DEGF]	FP	RO
8460	210C	PT Polling Average [DEGF]	FP	RO
8462	210E	PT Previous Daily Average [DEGF]	FP	RO
8464	2110	PT Previous Interval Average [DEGF]	FP	RO
8466	2112	PT Previous Polling Average [DEGF]	FP	RO
8468	2114	A1 Instantaneous Reading	FP	RO
8470	2116	A1 Rate Of Change	FP	RO
8472	2118	A1 Daily Average	FP	RO
8474	211A	A1 Interval Average	FP	RO
8476	211C	A1 Polling Average	FP	RO
8478	211E	A1 Previous Daily Average	FP	RO
8480	2120	A1 Previous Interval Average	FP	RO
8482	2122	A1 Previous Polling Average	FP	RO



### ***Holding Registers***

<b>Register (Decimal)</b>	<b>Register (Hex)</b>	<b>Description</b>	<b>Data Type</b>	<b>Access</b>
8484	2124	A1 Daily Run Time	FP	RO
8486	2126	A1 Interval Run Time	FP	RO
8488	2128	A1 Polling Run Time	FP	RO
8490	212A	A1 Previous Daily Run Time	FP	RO
8492	212C	A1 Previous Interval Run Time	FP	RO
8494	212E	A1 Previous Polling Run Time	FP	RO
8496	2130	A1 Instantaneous Reading [VOLT]	FP	RO
8498	2132	A1 Rate of Change [VOLT]	FP	RO
8500	2134	A1 Daily Average [VOLT]	FP	RO
8502	2136	A1 Interval Average [VOLT]	FP	RO
8504	2138	A1 Polling Average [VOLT]	FP	RO
8506	213A	A1 Previous Daily Average [VOLT]	FP	RO
8508	213C	A1 Previous Interval Average [VOLT]	FP	RO
8510	213E	A1 Previous Polling Average [VOLT]	FP	RO
8512	2140	A2 Instantaneous Reading	FP	RO
8514	2142	A2 Rate Of Change	FP	RO
8516	2144	A2 Daily Average	FP	RO
8518	2146	A2 Interval Average	FP	RO
8520	2148	A2 Polling Average	FP	RO
8522	214A	A2 Previous Daily Average	FP	RO
8524	214C	A2 Previous Interval Average	FP	RO
8526	214E	A2 Previous Polling Average	FP	RO
8528	2150	A2 Daily Run Time	FP	RO
8530	2152	A2 Interval Run Time	FP	RO
8532	2154	A2 Polling Run Time	FP	RO
8534	2156	A2 Previous Daily Run Time	FP	RO
8536	2158	A2 Previous Interval Run Time	FP	RO
8538	215A	A2 Previous Polling Run Time	FP	RO
8540	215C	A2 Instantaneous Reading [VOLT]	FP	RO
8542	215E	A2 Rate of Change [VOLT]	FP	RO
8544	2160	A2 Daily Average [VOLT]	FP	RO
8546	2162	A2 Interval Average [VOLT]	FP	RO
8548	2164	A2 Polling Average [VOLT]	FP	RO
8550	2166	A2 Previous Daily Average [VOLT]	FP	RO
8552	2168	A2 Previous Interval Average [VOLT]	FP	RO
8554	216A	A2 Previous Polling Average [VOLT]	FP	RO
8556	216C	Internal Temperature	FP	RO
8558	216E	Supply Voltage	FP	RO
8560	2170	Battery Voltage	FP	RO
8562	2172	Live FR1 Instantaneous Flow Rate [BASE]	FP	RO



### Holding Registers

Register (Decimal)	Register (Hex)	Description	Data Type	Access
8564		Reserved		
8566	2176	Live T1 Instantaneous Flow Rate [GAL]	FP	RO
8568	2178	Live T2 Instantaneous Flow Rate [GAL]	FP	RO
8570	217A	Live Turbine Frequency Differential	FP	RO
8572	217C	Live Turbine Frequency Ratio	FP	RO
8574	217E	Live Static Pressure	FP	RO
8576	2180	Live Differential Pressure	FP	RO
8578	2182	Live MVT Temperature	FP	RO
8580	2184	Live Bridge Voltage	FP	RO
8582	2186	Live Analog 1	FP	RO
8584	2188	Live Analog 2	FP	RO
8586	218A	Live Production Temperature	FP	RO
8588	218C	Live RTD Resistance	FP	RO
8590	218E	Reserved for Future	FP	RO
8592	2190	Reserved for Future	FP	RO
8594	2192	Reserved for Future	FP	RO
8596	2194	Reserved for Future	FP	RO
8598	2196	PO1 Pulses	FP	RO
8600	2198	PO2 Pulses	FP	RO
8602	219A	PO3 Pulses	FP	RO
8604	219C	PO4 Pulses	FP	RO
8606	219E	AO1 Output Current	FP	RO
8608	21A0	AO2 Output Current	FP	RO
8610	21A2	AO3 Output Current	FP	RO
8612	21A4	AO4 Output Current	FP	RO
8614	21A6	AO1 DAC Output	FP	RO
8616	21A8	AO2 DAC Output	FP	RO
8618	21AA	AO3 DAC Output	FP	RO
8620	21AC	AO4 DAC Output	FP	RO
8622	21AE	PI1 State	FP	RO
8624	21B0	PI1 Count	FP	RO
8626	21B2	PI2 State	FP	RO
8628	21B4	PI2 Count	FP	RO
8630 to 8637	Reserved			
8638	21BE	Daily Archive Date	FP	RO
8640	21C0	Interval Archive Date	FP	RO
8642	21C2	Daily Archive Time	FP	RO
8644	21C4	Interval Archive Time	FP	RO

### ***Holding Registers***

<b>Register (Decimal)</b>	<b>Register (Hex)</b>	<b>Description</b>	<b>Data Type</b>	<b>Access</b>
8646	21C6	Slave Data Point 1	FP	RO
8648	21C8	Slave Data Point 2	FP	RO
8650	21CA	Slave Data Point 3	FP	RO
8652	21CC	Slave Data Point 4	FP	RO
8654	21CE	Slave Data Point 5	FP	RO
8656	21D0	Slave Data Point 6	FP	RO
8658	21D2	Slave Data Point 7	FP	RO
8660	21D4	Slave Data Point 8	FP	RO
8662	21D6	Slave Data Point 9	FP	RO
8664	21D8	Slave Data Point 10	FP	RO
8666	21DA	Slave Data Point 11	FP	RO
8668	21DC	Slave Data Point 12	FP	RO
8670	21DE	Slave Data Point 13	FP	RO
8672	21E0	Slave Data Point 14	FP	RO
8674	21E2	Slave Data Point 15	FP	RO
8676	21E4	Slave Data Point 16	FP	RO
8678		Reserved	FP	RO
8680		Reserved	FP	RO
8682		Reserved	FP	RO
8684		Reserved	FP	RO
8686		Reserved	FP	RO
8688		Reserved	FP	RO
8690		Reserved	FP	RO
8692		Reserved	FP	RO
8694		Reserved	FP	RO
8696		Reserved	FP	RO
8698		Reserved	FP	RO
8700		Reserved	FP	RO
8702		Reserved	FP	RO
8704		Reserved	FP	RO
8706		Reserved	FP	RO
8708		Reserved	FP	RO

## Flow Calculation Parameter Registers (1-16)

The Flow Calculation Parameter Registers definition is dependent upon the flow rate calculation method that is implemented. The following table describes the function of each of these registers for each of the supported calculation methods.

Reg. Num	AGA-3	ISO-5167	Cone –Spool Cone -Wafer	AGA-7
1	Pipe Size (Corrected)	Pipe Size (Corrected)	Pipe Size (Corrected)	Pipe Size (Corrected)
2	Plate Size (Corrected)	Plate Size (Corrected)	Plate Size (Corrected)	Temperature Ratio
3	Beta (Corrected)	Beta (Corrected)	Beta (Corrected)	Pressure Ratio
4	Plate Size (configured)	Plate Size (configured)	Plate Size (configured)	Supercompressibility
5	Stability Index	Stability Index	Stability Index	<Reserved>
6	Y	Y	Y	<Reserved>
7	Cd	Cd	Cd	<Reserved>
8	Ev	Ev	Ev	<Reserved>
9	Flow Extension (sqrt["H20*lbm/cf3])	Flow Extension (sqrt[pa*kg/m3])	Flow Extension (sqrt[pa*kg/m3])	<Reserved>
10	Flowing Density (kg/m3)	Flowing Density (kg/m3)	Flowing Density (kg/m3)	Flowing Density (kg/m3)
11	Quality (Vapor Liquid Fraction) FR1 CPL - Pressure Correction Factor (Liquids)	Quality (Vapor Liquid Fraction) FR1 CPL - Pressure Correction Factor (Liquids)	Quality (Vapor Liquid Fraction) FR1 CPL - Pressure Correction Factor (Liquids)	<Reserved for Non-Liquids> FR1 CPL - Pressure Correction Factor (Liquids)
12	Liquid Heating Value	Liquid Heating Value	Liquid Heating Value	<Reserved>
13	Liquid Flowing Density	Liquid Flowing Density	Liquid Flowing Density	<Reserved>
14	Estimated Liquid Mass Flow Rate	Estimated Liquid Mass Flow Rate	Estimated Liquid Mass Flow Rate	<Reserved>
15	Apparent Mass Flow Rate	Apparent Mass Flow Rate	Apparent Mass Flow Rate	Apparent Mass Flow Rate
16	Lockhart-Martinelli	Lockhart-Martinelli	Lockhart-Martinelli	<Reserved>

## Base Units/Configured Units

The holding registers allow users to read data in terms of *configured* units of measurement and *base* units. The configured units follow the settings based on the Unit setting register and the unit scale and offset registers. The base units will always have the same unit of measurement independent of the unit, scale and offset settings. Also note that the log data is always in terms of base units. It is recommended to configure the units of measurement using the software.

## Polling Registers

The Scanner 2200 stores volumes, averaged values, and flow times since the last polling sequence in a set of polling registers. Additionally, the instrument stores the number of polls requested in the polling index.

The polling sequence is started by writing a value of 20,000 to the Control Register. This transfers the polling totals, averages, and run times to the previous polling registers, increments the polling index and resets the

polling totals, averages and run-time registers. Note that the polling registers are displayed in base units and configured units.

## Interval/Daily/Event Pointer Registers

These registers provide an index of the last record that was stored in the log data. These values start at 1 and increment with each newly created log. When the maximum number of records is reached, the pointer resets to 1 and starts incrementing again.

### *Holding Registers (32-bit)*

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7000	1B58	Interval Pointer	FP	RO
7001	1B59	Daily Pointer	FP	RO
7002	1B5A	Event Counter	FP	RO
7003	1B5B	Real Date	FP	RO
7004	1B5C	Real Time	FP	RO
7005	1B5D	Flow Run Alarms	FP	RO
7006	1B5E	Flow Run Alarm Low	FP	RO
7007	1B5F	Flow Run Alarm High	FP	RO
7008	1B60	Diagnostic 1	FP	RO
7009	1B61	Diagnostic 2	FP	RO
7010	1B62	Diagnostic 3	FP	RO
7011	1B63	Diagnostic 4	FP	RO
7012	1B64	Polling Index	FP	RO
7013	1B65	FR1 Grand Volume Total	FP	RO
7014	1B66	FR1 Instantaneous Flow Rate	FP	RO
7015	1B67	FR1 Daily Total	FP	RO
7016	1B68	FR1 Interval Total	FP	RO
7017	1B69	FR1 Polling Total	FP	RO
7018	1B6A	FR1 Previous Day Total	FP	RO
7019	1B6B	FR1 Previous Interval	FP	RO
7020	1B6C	FR1 Previous Polling Total	FP	RO
7021	1B6D	FR1 Grand Mass Total	FP	RO
7022	1B6E	FR1 Instantaneous Mass Flow Rate	FP	RO
7023	1B6F	FR1 Daily Mass Total	FP	RO
7024	1B70	FR1 Interval Mass Total	FP	RO
7025	1B71	FR1 Polling Mass Total	FP	RO
7026	1B72	FR1 Previous Day Mass	FP	RO
7027	1B73	FR1 Previous Interval Mass	FP	RO
7028	1B74	FR1 Previous Polling Mass	FP	RO
7029	1B75	FR1 Grand Energy Total	FP	RO
7030	1B76	FR1 Instantaneous Energy Flow Rate	FP	RO
7031	1B77	FR1 Daily Energy Total	FP	RO
7032	1B78	FR1 Interval Energy Total	FP	RO

**Holding Registers (32-bit)**

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7033	1B79	FR1 Polling Energy Total	FP	RO
7034	1B7A	FR1 Previous Day Energy	FP	RO
7035	1B7B	FR1 Previous Interval Energy	FP	RO
7036	1B7C	FR1 Previous Polling Energy	FP	RO
7037	1B7D	FR1 Daily Estimated Total	FP	RO
7038	1B7E	FR1 Monthly Total	FP	RO
7039	1B7F	FR1 Previous Month Total	FP	RO
7040	1B80	FR1 Daily Run Time	FP	RO
7041	1B81	FR1 Interval Run Time	FP	RO
7042	1B82	FR1 Polling Run Time	FP	RO
7043	1B83	FR1 Previous Daily Run Time	FP	RO
7044	1B84	FR1 Previous Interval Run Time	FP	RO
7045	1B85	FR1 Previous Polling Run Time	FP	RO
7046	1B86	FR1 Static Pressure	FP	RO
7047	1B87	FR1 Differential Pressure	FP	RO
7048	1B88	FR1 Process Temperature	FP	RO
7049	1B89	FR1 Uncorrected Volume	FP	RO
7050	1B8A	FR1 SqrtDP	FP	RO
7051	1B8B	FR1 Compressibility (Natural Gas); FR1 CTPL - Complete Correction Factor (Liquids)	FP	RO
7052	1B8C	FR1 Density	FP	RO
7053	1B8D	FR1 Base Compressibility (Natural Gas) FR1 CTL - Temperature Correction Factor (Liquids)	FP	RO
7054	1B8E	FR1 Base Density	FP	RO
7055	1B8F	FR1 Average Molecular Weight	FP	RO
7056	1B90	FR1 Molar Fraction Sum	FP	RO
7057	1B91	FR1 Mass Heating Value	FP	RO
7058	1B92	FR1 Heating Value Volume Basis	FP	RO
7059	1B93	FR1 Specific Gravity	FP	RO
7060	1B94	FR1 Viscosity	FP	RO
7061	1B95	FR1 Isentropic Exponent	FP	RO
7062	1B96	FR1 Reynolds Number	FP	RO
7063	1B97	FR1 Calculation Parameter 1	FP	RO
7064	1B98	FR1 Calculation Parameter 2	FP	RO
7065	1B99	FR1 Calculation Parameter 3	FP	RO
7066	1B9A	FR1 Calculation Parameter 4	FP	RO
7067	1B9B	FR1 Calculation Parameter 5	FP	RO
7068	1B9C	FR1 Calculation Parameter 6	FP	RO
7069	1B9D	FR1 Calculation Parameter 7	FP	RO

***Holding Registers (32-bit)***

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7070	1B9E	FR1 Calculation Parameter 8	FP	RO
7071	1B9F	FR1 Calculation Parameter 9	FP	RO
7072	1BA0	FR1 Calculation Parameter 10	FP	RO
7073	1BA1	FR1 Calculation Parameter 11	FP	RO
7074	1BA2	FR1 Calculation Parameter 12	FP	RO
7075	1BA3	FR1 Calculation Parameter 13	FP	RO
7076	1BA4	FR1 Calculation Parameter 14	FP	RO
7077	1BA5	FR1 Calculation Parameter 15	FP	RO
7078	1BA6	FR1 Calculation Parameter 16	FP	RO
7079	1BA7	FR1 Grand Total [MCF]	FP	RO
7080	1BA8	FR1 Instantaneous Flow Rate [MCF]	FP	RO
7081	1BA9	FR1 Daily Total [MCF]	FP	RO
7082	1BAA	FR1 Interval Total [MCF]	FP	RO
7083	1BAB	FR1 Polling Total [MCF]	FP	RO
7084	1BAC	FR1 Previous Day [MCF]	FP	RO
7085	1BAD	FR1 Previous Interval [MCF]	FP	RO
7086	1BAE	FR1 Previous Polling Total [MCF]	FP	RO
7087	1BAF	FR1 Grand Mass Total [LBM]	FP	RO
7088	1BB0	FR1 Instantaneous Mass Rate [LBM]	FP	RO
7089	1BB1	FR1 Daily Mass Total [LBM]	FP	RO
7090	1BB2	FR1 Interval Mass Total [LBM]	FP	RO
7091	1BB3	FR1 Polling Mass Total [LBM]	FP	RO
7092	1BB4	FR1 Previous Day Mass [LBM]	FP	RO
7093	1BB5	FR1 Previous Interval Mass [LBM]	FP	RO
7094	1BB6	FR1 Previous Polling Mass [LBM]	FP	RO
7095	1BB7	FR1 Grand Energy Total [MMBTU]	FP	RO
7096	1BB8	FR1 Instantaneous Energy Rate [MMBTU]	FP	RO
7097	1BB9	FR1 Daily Energy Total [MMBTU]	FP	RO
7098	1BBA	FR1 Interval Energy Total [MMBTU]	FP	RO
7099	1BBB	FR1 Polling Energy Total [MMBTU]	FP	RO
7100	1BBC	FR1 Previous Day Energy [MMBTU]	FP	RO
7101	1BBD	FR1 Previous Interval Energy [MMBTU]	FP	RO
7102	1BBE	FR1 Previous Polling Energy [MMBTU]	FP	RO
7103	1BBF	FR1 Daily Estimated Total [MCF]	FP	RO
7104	1BC0	FR1 Monthly Total [MCF]	FP	RO
7105	1BC1	FR1 Previous Month Total [MCF]	FP	RO
7106	1BC2	FR1 Mass Heating Value [BASE]	FP	RO
7107	1BC3	FR1 Volumetric Heating Value [BASE]	FP	RO
7108	1BC4	T1 Grand Total	FP	RO
7109	1BC5	T1 Instantaneous Flow Rate	FP	RO
7110	1BC6	T1 Daily Total	FP	RO

**Holding Registers (32-bit)**

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7111	1BC7	T1 Interval Total	FP	RO
7112	1BC8	T1 Polling Total	FP	RO
7113	1BC9	T1 Previous Day	FP	RO
7114	1BCA	T1 Previous Interval	FP	RO
7115	1BCB	T1 Previous Polling Total	FP	RO
7116	1BCC	T1 Daily Estimated Total	FP	RO
7117	1BCD	T1 Monthly Total	FP	RO
7118	1BCE	T1 Previous Month Total	FP	RO
7119	1BCF	T1 Daily Run Time	FP	RO
7120	1BD0	T1 Interval Run Time	FP	RO
7121	1BD1	T1 Polling Run Time	FP	RO
7122	1BD2	T1 Previous Daily Run Time	FP	RO
7123	1BD3	T1 Previous Interval Run Time	FP	RO
7124	1BD4	T1 Previous Polling Run Time	FP	RO
7125	1BD5	T1 Grand Total [GAL]	FP	RO
7126	1BD6	T1 Instantaneous Flow Rate [GAL]	FP	RO
7127	1BD7	T1 Daily Total [GAL]	FP	RO
7128	1BD8	T1 Interval Total [GAL]	FP	RO
7129	1BD9	T1 Polling Total [GAL]	FP	RO
7130	1BDA	T1 Previous Day [GAL]	FP	RO
7131	1BDB	T1 Previous Interval [GAL]	FP	RO
7132	1BDC	T1 Previous Polling Total [GAL]	FP	RO
7133	1BDD	T1 Daily Estimated Total [GAL]	FP	RO
7134	1BDE	T1 Monthly Total [GAL]	FP	RO
7135	1BDF	T1 Previous Month Total [GAL]	FP	RO
7136	1BE0	T1 Frequency	FP	RO
7137	1BE1	T1 Active K-Factor	FP	RO
7138	1BE2	T2 Grand Total	FP	RO
7139	1BE3	T2 Instantaneous Flow Rate	FP	RO
7140	1BE4	T2 Daily Total	FP	RO
7141	1BE5	T2 Interval Total	FP	RO
7142	1BE6	T2 Polling Total	FP	RO
7143	1BE7	T2 Previous Day	FP	RO
7144	1BE8	T2 Previous Interval	FP	RO
7145	1BE9	T2 Previous Polling Total	FP	RO
7146	1BEA	T2 Daily Estimated Total	FP	RO
7147	1BEB	T2 Monthly Total	FP	RO
7148	1BEC	T2 Previous Month Total	FP	RO
7149	1BED	T2 Daily Run Time	FP	RO
7150	1BEE	T2 Interval Run Time	FP	RO
7151	1BEF	T2 Polling Run Time	FP	RO

**Holding Registers (32-bit)**

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7152	1BF0	T2 Previous Daily Run Time	FP	RO
7153	1BF1	T2 Previous Interval Run Time	FP	RO
7154	1BF2	T2 Previous Polling Run Time	FP	RO
7155	1BF3	T2 Grand Total [GAL]	FP	RO
7156	1BF4	T2 Instantaneous Flow Rate [GAL]	FP	RO
7157	1BF5	T2 Daily Total [GAL]	FP	RO
7158	1BF6	T2 Interval Total [GAL]	FP	RO
7159	1BF7	T2 Polling Total [GAL]	FP	RO
7160	1BF8	T2 Previous Day Total [GAL]	FP	RO
7161	1BF9	T2 Previous Interval [GAL]	FP	RO
7162	1BFA	T2 Previous Polling Total [GAL]	FP	RO
7163	1BFB	T2 Daily Estimated Total [GAL]	FP	RO
7164	1BFC	T2 Monthly Total [GAL]	FP	RO
7165	1BFD	T2 Previous Month Total [GAL]	FP	RO
7166	1BFE	T2 Frequency	FP	RO
7167	1BFF	T2 Active K-Factor	FP	RO
7168	1C00	SP Instantaneous Reading	FP	RO
7169	1C01	SP Rate Of Change	FP	RO
7170	1C02	SP Daily Average	FP	RO
7171	1C03	SP Interval Average	FP	RO
7172	1C04	SP Polling Average	FP	RO
7173	1C05	SP Previous Daily Average	FP	RO
7174	1C06	SP Previous Interval Average	FP	RO
7175	1C07	SP Previous Polling Average	FP	RO
7176	1C08	SP Daily Run Time	FP	RO
7177	1C09	SP Interval Run Time	FP	RO
7178	1C0A	SP Polling Run Time	FP	RO
7179	1C0B	SP Previous Daily Run Time	FP	RO
7180	1C0C	SP Previous Interval Run Time	FP	RO
7181	1C0D	SP Previous Polling Run Time	FP	RO
7182	1C0E	SP Instantaneous Reading [PSI]	FP	RO
7183	1C0F	SP Rate of Change [PSI]	FP	RO
7184	1C10	SP Daily Average [PSI]	FP	RO
7185	1C11	SP Interval Average [PSI]	FP	RO
7186	1C12	SP Polling Average [PSI]	FP	RO
7187	1C13	SP Previous Daily Average [PSI]	FP	RO
7188	1C14	SP Previous Interval Average [PSI]	FP	RO
7189	1C15	SP Previous Polling Average [PSI]	FP	RO
7190	1C16	DP Instantaneous Reading	FP	RO
7191	1C17	DP Rate Of Change	FP	RO
7192	1C18	DP Daily Average	FP	RO



**Holding Registers (32-bit)**

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7193	1C19	DP Interval Average	FP	RO
7194	1C1A	DP Polling Average	FP	RO
7195	1C1B	DP Previous Daily Average	FP	RO
7196	1C1C	DP Previous Interval Average	FP	RO
7197	1C1D	DP Previous Polling Average	FP	RO
7198	1C1E	DP Daily Run Time	FP	RO
7199	1C1F	DP Interval Run Time	FP	RO
7200	1C20	DP Polling Run Time	FP	RO
7201	1C21	DP Previous Daily Run Time	FP	RO
7202	1C22	DP Previous Interval Run Time	FP	RO
7203	1C23	DP Previous Polling Run Time	FP	RO
7204	1C24	DP Instantaneous Reading [INH2O]	FP	RO
7205	1C25	DP Rate of Change [INH2O]	FP	RO
7206	1C26	DP Daily Average [INH2O]	FP	RO
7207	1C27	DP Interval Average [INH2O]	FP	RO
7208	1C28	DP Polling Average [INH2O]	FP	RO
7209	1C29	DP Previous Daily Average [INH2O]	FP	RO
7210	1C2A	DP Previous Interval Average [INH2O]	FP	RO
7211	1C2B	DP Previous Polling Average [INH2O]	FP	RO
7212	1C2C	PT Instantaneous Reading	FP	RO
7213	1C2D	PT Rate Of Change	FP	RO
7214	1C2E	PT Daily Average	FP	RO
7215	1C2F	PT Interval Average	FP	RO
7216	1C30	PT Polling Average	FP	RO
7217	1C31	PT Previous Daily Average	FP	RO
7218	1C32	PT Previous Interval Average	FP	RO
7219	1C33	PT Previous Polling Average	FP	RO
7220	1C34	PT Daily Run Time	FP	RO
7221	1C35	PT Interval Run Time	FP	RO
7222	1C36	PT Polling Run Time	FP	RO
7223	1C37	PT Previous Daily Run Time	FP	RO
7224	1C38	PT Previous Interval Run Time	FP	RO
7225	1C39	PT Previous Polling Run Time	FP	RO
7226	1C3A	PT Instantaneous Reading [DEGF]	FP	RO
7227	1C3B	PT Rate of Change [DEGF]	FP	RO
7228	1C3C	PT Daily Average [DEGF]	FP	RO
7229	1C3D	PT Interval Average [DEGF]	FP	RO
7230	1C3E	PT Polling Average [DEGF]	FP	RO
7231	1C3F	PT Previous Daily Average [DEGF]	FP	RO
7232	1C40	PT Previous Interval Average [DEGF]	FP	RO
7233	1C41	PT Previous Polling Average [DEGF]	FP	RO

***Holding Registers (32-bit)***

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7234	1C42	A1 Instantaneous Reading	FP	RO
7235	1C43	A1 Rate Of Change	FP	RO
7236	1C44	A1 Daily Average	FP	RO
7237	1C45	A1 Interval Average	FP	RO
7238	1C46	A1 Polling Average	FP	RO
7239	1C47	A1 Previous Daily Average	FP	RO
7240	1C48	A1 Previous Interval Average	FP	RO
7241	1C49	A1 Previous Polling Average	FP	RO
7242	1C4A	A1 Daily Run Time	FP	RO
7243	1C4B	A1 Interval Run Time	FP	RO
7244	1C4C	A1 Polling Run Time	FP	RO
7245	1C4D	A1 Previous Daily Run Time	FP	RO
7246	1C4E	A1 Previous Interval Run Time	FP	RO
7247	1C4F	A1 Previous Polling Run Time	FP	RO
7248	1C50	A1 Instantaneous Reading [VOLT]	FP	RO
7249	1C51	A1 Rate of Change [VOLT]	FP	RO
7250	1C52	A1 Daily Average [VOLT]	FP	RO
7251	1C53	A1 Interval Average [VOLT]	FP	RO
7252	1C54	A1 Polling Average [VOLT]	FP	RO
7253	1C55	A1 Previous Daily Average [VOLT]	FP	RO
7254	1C56	A1 Previous Interval Average [VOLT]	FP	RO
7255	1C57	A1 Previous Polling Average [VOLT]	FP	RO
7256	1C58	A2 Instantaneous Reading	FP	RO
7257	1C59	A2 Rate Of Change	FP	RO
7258	1C5A	A2 Daily Average	FP	RO
7259	1C5B	A2 Interval Average	FP	RO
7260	1C5C	A2 Polling Average	FP	RO
7261	1C5D	A2 Previous Daily Average	FP	RO
7262	1C5E	A2 Previous Interval Average	FP	RO
7263	1C5F	A2 Previous Polling Average	FP	RO
7264	1C60	A2 Daily Run Time	FP	RO
7265	1C61	A2 Interval Run Time	FP	RO
7266	1C62	A2 Polling Run Time	FP	RO
7267	1C63	A2 Previous Daily Run Time	FP	RO
7268	1C64	A2 Previous Interval Run Time	FP	RO
7269	1C65	A2 Previous Polling Run Time	FP	RO
7270	1C66	A2 Instantaneous Reading [VOLT]	FP	RO
7271	1C67	A2 Rate of Change [VOLT]	FP	RO
7272	1C68	A2 Daily Average [VOLT]	FP	RO
7273	1C69	A2 Interval Average [VOLT]	FP	RO
7274	1C6A	A2 Polling Average [VOLT]	FP	RO

**Holding Registers (32-bit)**

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7275	1C6B	A2 Previous Daily Average [VOLT]	FP	RO
7276	1C6C	A2 Previous Interval Average [VOLT]	FP	RO
7277	1C6D	A2 Previous Polling Average [VOLT]	FP	RO
7278	1C6E	Internal Temperature	FP	RO
7279	1C6F	Supply Voltage	FP	RO
7280	1C70	Battery Voltage	FP	RO
7281	1C71	Live FR1 Instantaneous Flow Rate [BASE]	FP	RO
7282	Reserved			
7283	1C73	Live T1 Instantaneous Flow Rate [GAL]	FP	RO
7284	1C74	Live T2 Instantaneous Flow Rate [GAL]	FP	RO
7285	1C75	Live Turbine Frequency Differential	FP	RO
7286	1C76	Live Turbine Frequency Ratio	FP	RO
7287	1C77	Live Static Pressure	FP	RO
7288	1C78	Live Differential Pressure	FP	RO
7289	1C79	Live MVT Temperature	FP	RO
7290	1C7A	Live Bridge Voltage	FP	RO
7291	1C7B	Live Analog 1	FP	RO
7292	1C7C	Live Analog 2	FP	RO
7293	1C7D	Live Production Temperature	FP	RO
7294	1C7E	Live RTD Resistance	FP	RO
7295	1C7F	Reserved for Future	FP	RO
7296	1C80	Reserved for Future	FP	RO
7297	1C81	Reserved for Future	FP	RO
7298	1C82	Reserved for Future	FP	RO
7299	1C83	PO1 Pulses	FP	RO
7300	1C84	PO2 Pulses	FP	RO
7301	1C85	PO3 Pulses	FP	RO
7302	1C86	PO4 Pulses	FP	RO
7303	1C87	AO1 Output Current	FP	RO
7304	1C88	AO2 Output Current	FP	RO
7305	1C89	AO3 Output Current	FP	RO
7306	1C8A	AO4 Output Current	FP	RO
7307	1C8B	AO1 DAC Output	FP	RO
7308	1C8C	AO2 DAC Output	FP	RO
7309	1C8D	AO3 DAC Output	FP	RO
7310	1C8E	AO4 DAC Output	FP	RO
7311	1C8F	PI1 State	FP	RO
7312	1C90	PI1 Count	FP	RO
7313	1C91	PI2 State	FP	RO

**Holding Registers (32-bit)**

Register (Decimal)	Register (Hex)	Description	Data Type	Access
7314	1C92	PI2 Count	FP	RO
7315 to 7318		Reserved		
7319	1C97	Daily Archive Date	FP	RO
7320	1C98	Interval Archive Date	FP	RO
7321	1C99	Daily Archive Time	FP	RO
7322	1C9A	Interval Archive Time	FP	RO
7323	1C9B	Slave Data Point 1	FP	RO
7324	1C9C	Slave Data Point 2	FP	RO
7325	1C9D	Slave Data Point 3	FP	RO
7326	1C9E	Slave Data Point 4	FP	RO
7327	1C9F	Slave Data Point 5	FP	RO
7328	1CA0	Slave Data Point 6	FP	RO
7329	1CA1	Slave Data Point 7	FP	RO
7330	1CA2	Slave Data Point 8	FP	RO
7331	1CA3	Slave Data Point 9	FP	RO
7332	1CA4	Slave Data Point 10	FP	RO
7333	1CA5	Slave Data Point 11	FP	RO
7334	1CA6	Slave Data Point 12	FP	RO
7335	1CA7	Slave Data Point 13	FP	RO
7336	1CA8	Slave Data Point 14	FP	RO
7337	1CA9	Slave Data Point 15	FP	RO
7338	1CAA	Slave Data Point 16	FP	RO
7339		Reserved	FP	RO
7340		Reserved	FP	RO
7341		Reserved	FP	RO
7342		Reserved	FP	RO
7343		Reserved	FP	RO
7344		Reserved	FP	RO
7345		Reserved	FP	RO
7346		Reserved	FP	RO
7347		Reserved	FP	RO
7348		Reserved	FP	RO
7349		Reserved	FP	RO
7350		Reserved	FP	RO
7351		Reserved	FP	RO
7352		Reserved	FP	RO
7353		Reserved	FP	RO
7354		Reserved	FP	RO

## User-Defined Modbus Registers Configuration

The Scanner 2200 provides a block of 25 floating point values that the user can assign to any register in the holding register map. This optimizes communication by allowing the parameters that are of interest for a given application to be organized and read in a single block read. For details on configuring User-Defined Holding Registers, see Section 3 of the ModWorX Pro Software User Manual. Each of the user-defined holding registers is determined by a pointer value in the holding register map. It is easiest to configure the pointer values with the ModWorX Pro software; however the pointer value can be determined with the following calculation:  $(\text{Holding Register Number} - 8000) / 2$ .

### *User-Defined Register Pointers*

Register (Decimal)	Register (Hex)	Description	Data Type	Access
9000	2328	User-Defined Starting Address (Always 9100)	U16	RO
9001	2329	Register Pointer 1	U16	R/W
9002	232A	Register Pointer 2	U16	R/W
9003	232B	Register Pointer 3	U16	R/W
9004	232C	Register Pointer 4	U16	R/W
9005	232D	Register Pointer 5	U16	R/W
9006	232E	Register Pointer 6	U16	R/W
9007	232F	Register Pointer 7	U16	R/W
9008	2330	Register Pointer 8	U16	R/W
9009	2331	Register Pointer 9	U16	R/W
9010	2332	Register Pointer 10	U16	R/W
9011	2333	Register Pointer 11	U16	R/W
9012	2334	Register Pointer 12	U16	R/W
9013	2335	Register Pointer 13	U16	R/W
9014	2336	Register Pointer 14	U16	R/W
9015	2337	Register Pointer 15	U16	R/W
9016	2338	Register Pointer 16	U16	R/W
9017	2339	Register Pointer 17	U16	R/W
9018	233A	Register Pointer 18	U16	R/W
9019	233B	Register Pointer 19	U16	R/W
9020	233C	Register Pointer 20	U16	R/W
9021	233D	Register Pointer 21	U16	R/W
9022	233E	Register Pointer 22	U16	R/W
9023	233F	Register Pointer 23	U16	R/W
9024	2340	Register Pointer 24	U16	R/W
9025	2341	Register Pointer 25	U16	R/W

### ***User-Defined Holding Registers***

Register (Decimal)	Register (Hex)	Description	Data Type	Access
9100	238C	User-Defined Holding Register 1	FP	RO
9102	238E	User-Defined Holding Register 2	FP	RO
9104	2390	User-Defined Holding Register 3	FP	RO
9106	2392	User-Defined Holding Register 4	FP	RO
9108	2394	User-Defined Holding Register 5	FP	RO
9110	2396	User-Defined Holding Register 6	FP	RO
9112	2398	User-Defined Holding Register 7	FP	RO
9114	239A	User-Defined Holding Register 8	FP	RO
9116	239C	User-Defined Holding Register 9	FP	RO
9118	239E	User-Defined Holding Register 10	FP	RO
9120	23A0	User-Defined Holding Register 11	FP	RO
9122	23A2	User-Defined Holding Register 12	FP	RO
9124	23A4	User-Defined Holding Register 13	FP	RO
9126	23A6	User-Defined Holding Register 14	FP	RO
9128	23A8	User-Defined Holding Register 15	FP	RO
9130	23AA	User-Defined Holding Register 16	FP	RO
9132	23AC	User-Defined Holding Register 17	FP	RO
9134	23AE	User-Defined Holding Register 18	FP	RO
9136	23B0	User-Defined Holding Register 19	FP	RO
9138	23B2	User-Defined Holding Register 20	FP	RO
9140	23B4	User-Defined Holding Register 21	FP	RO
9142	23B6	User-Defined Holding Register 22	FP	RO
9144	23B8	User-Defined Holding Register 23	FP	RO
9146	23BA	User-Defined Holding Register 24	FP	RO
9148	23BC	User-Defined Holding Register 25	FP	RO

## **Device Status**

The device status includes alarm status and diagnostic information such as input status and calculation status. The Scanner 2200 provides 16 user-configurable alarms designated as Flow Run Alarms. The user can assign the alarms to any parameter in the holding register map. Alarms can be defined as low alarms or high alarms. For details on configuring Flow Run Alarms, see Section 3 of the ModWorX Pro Software User Manual. The current status of the alarms can be obtained by reading the Flow Run Alarm registers in the device status map. A bit value of 1 indicates an alarm condition. Also contained in the device status map are diagnostic registers. The bits in these registers provide system status for inputs (under range, above range or failed), calculation status (for confirming whether the flow run is working properly) and details regarding the health of the MVT.

### Device Status Registers

Register (Decimal)	Register (Hex)	Description	Data Type	Access
9900	26AC	Flow Run Alarms High	U32	R/W
9902	26AE	Input Status	U32	R/W
9904	26B0	Calculation Status	U32	R/W

### Bit Definitions—Alarms and Diagnostics

Bit	Flow Run Alarm High	Flow Run Alarm Low	Diagnostic 1	Diagnostic 2	Diagnostic 3	Diagnostic 4
15	FRA16 High	FRA16 Low	FR1 Fail	FR1 High	Reserved	Reserved
14	FRA15 High	FRA15 Low	T1 Fail	T1 High	Reserved	Reserved
13	FRA14 High	FRA14 Low	T2 Fail	T2 High	T2 Calc Warning	Reserved
12	FRA13 High	FRA13 Low	SP Fail	SP High	T1 Calc Warning	Reserved
11	FRA12 High	FRA12 Low	DP Fail	DP High	Reserved	Reserved
10	FRA11 High	FRA11 Low	PT Fail	PT High	Reserved	Reserved
9	FRA10 High	FRA10 Low	A1 Fail	A1 High	Reserved	Reserved
8	FRA9 High	FRA9 Low	A2 Fail	A2 High	FR1 Calc Warning	Reserved
7	FRA8 High	FRA8 Low	FR1 Override	FR1 Low	NA	Reserved
6	FRA7 High	FRA7 Low	T1 Override	T1 Low	NA	Reserved
5	FRA6 High	FRA6 Low	T2 Override	SP Low	MVT M3 Formula Fail	Reserved
4	FRA5 High	FRA5 Low	SP Override	Reserved	MVT M2 Formula Fail	Power Mode
3	FRA4 High	FRA4 Low	DP Override	DP Low	MVT M1 Formula Fail	Reserved
2	FRA3 High	FRA3 Low	PT Override	PT Low	MVT User Parameter CRC fail	Reserved
1	FRA2 High	FRA2 Low	A1 Override	A1 Low	MVT Factory Parameter CRC fail	Device Seal
0	FRA1 High	FRA1 Low	A2 Override	A2 Low	MVT Not Present	Ext. Switch

The Scanner 2200 produces low, high and fail conditions for the inputs (not the flow alarms) in accordance with the following table.

Status	Range Check
Low	Lower Range Limit - 20% of span
Fail Low	Lower Range Limit - 200% of span
High	Upper Range Limit + 20% of span
Fail High	Upper Range Limit + 200% of span

### ***Units of Measurement***

Value	Units	Scale	Offset
101	GAL - BASE	1.000000000000	0.00
102	BBL	0.023809523810	0.00
103	M3	0.003785411780	0.00
104	LIT	3.785411784000	0.00
105	CF	0.133680555560	0.00
106	ACF	0.133680555560	0.00
107	ACM	0.003785411780	0.00
201	MCF - BASE	1.000000000	0.00
202	SCF	1000.000000000	0.00
203	M3	28.316846592	0.00
204	GAL	7480.519480271	0.00
205	BBL	178.107606673	0.00
207	LIT	28316.846592200	0.00
301	PSIG - BASE	1.00000000	0.00
302	Pa	6894.75729317	0.00
303	Kpa	6.89475729317	0.00
304	Mpa	0.00689475729317	0.00
305	Bar	0.06894757	0.00
306	In H2O	27.70500000	0.00
401	In H2O - BASE	1.000000000000	0.00
402	Pa	248.641080600000	0.00
403	Kpa	0.248641080600	0.00
404	mmHg	1.865077000000	0.00
405	In Hg	0.07342822834646	0.00
406	PSI	0.036094567768	0.00
407	kgf/cm2	0.002535630000	0.00
408	mBar	2.48641011188	0.00
501	Deg F - BASE	1.00	0.00
502	Deg C	0.555555556	-17.77777778
503	K	0.555555556	255.3722222
504	Deg R	1.00	459.67
601	LBM - BASE	1.0000000000	0.00
602	kg	0.45359237000	0.00



### **Units of Measurement**

<b>Value</b>	<b>Units</b>	<b>Scale</b>	<b>Offset</b>
701	MMBTU - BASE	1.0000000000	0.00
702	GJ	1.05505585262	0.00
703	BTU	1000000.0000000000	0.00
704	KJ	1055055.8526220000	0.00
801	GAL - BASE	1.000000000000	0.00
802	BBL	42.000000000000	0.00
803	M3	264.172052637296	0.00
804	LIT	0.264172052358	0.00
805	CF	7.480519480271	0.00
806	ACF	7.480519480271	0.00
807	ACM	264.172052637296	0.00
901	Volts	1.0000000000	0.00
902	Millivolts	1000.0000000000	0.00
1001	LBM/CU FT	1.0000000000	0.00
1002	KG/M3	16.01846433740	0.00
1201	inches	1.0000000000	0.00
1202	ft	0.08333333333	0.00
1203	yard	0.02777777778	0.00
1204	mile	0.0000157828	0.00
1205	mm	25.4000000000	0.00
1206	cm	2.5400000000	0.00
1208	m	0.0254000000	0.00
1209	km	0.0000254000	0.00
1301	Hz	1.0000000000	0.00
1302	kHz	0.0010000000	0.00
1303	MHz	0.0000010000	0.00
1401	ohms	1.0000000000	0.00
1402	kiloohms	0.0010000000	0.00
1403	megohms	0.0000010000	0.00
1501	mA	1.0000000000	0.00
1502	A	0.0010000000	0.00
1601	cP	1.0000000000	0.00
1602	lbm/ft.sec	1488.1159420290	0.00

### **Log Capacity**

<b>Log Type</b>	<b>Capacity</b>
Interval Logs	6392
Daily Logs	768
Event Logs	1152

## Enron Log Data

The Scanner 2200 provides Enron Modbus® compliant downloads. For detailed instructions on downloading interval, daily and event data, refer to *Specifications and Requirements for an Electronic Flow Measurement Remote Terminal Unit for Enron Corp.* If an Enron host is not available or is too cumbersome or inefficient for the host system, there are other methods that are available to retrieve the log data from the instrument. Contact Cameron technical support for details.

The following registers are used for interval, daily and event log registers. Interval and daily records contain 16 user-configurable values. For details on the archive configuration, see Section 3 of the ModWorX Pro Software User Manual. All of the Enron registers have an access type of Read Only (RO).

### Enron Registers

Register	Description	Data Type
32	Enron Modbus® Event Log Register	Refer to Enron Event Record Format
700	Enron Modbus® Interval Log	Refer to Enron Interval/Daily Record Format
701	Enron Modbus® Daily Log	Refer to Enron Interval/Daily Record Format
7000	Interval Pointer [1 to 6392]	FP32
7001	Daily Pointer [1 to 768]	FP32
7002	Event Counter [1 to 2304]	FP32

### Enron Interval/Daily Record Format

The interval and daily record contents are user-configurable. The following table shows the default values. For more information, see Section 3 of the ModWorX Pro Software User Manual.

Parameter	Data Type
Date (MMDDYY)	FP32
Time (HH:MM:SS)	FP32
FR1 Previous Volume (base units)	FP32
FR1 Previous Mass (base units)	FP32
FR1 Previous Energy (base units)	FP32
Differential Pressure Previous Average (InH <sub>2</sub> O)	FP32
Static Pressure Previous Average (PSIA default, can be PSIG)	FP32
Process Temperature Previous Average (DegF)	FP32
FR1 Previous Run Time (seconds of flow)	FP32
Turbine 1 Previous Volume (base units)	FP32
Turbine 1 Previous Run Time (seconds of flow)	FP32
<Parameter 12>	FP32
<Parameter 13>	FP32
<Parameter 14>	FP32
<Parameter 15>	FP32
<Parameter 16>	FP32

### ***Enron Event Record Format***

<b>Parameter</b>	<b>Data Type</b>
Status	U16
Address	U16
Time (HH:MM:SS)	FP32
Date (MMDDYY)	FP32
As-Found	FP32
As-Left	FP32

The status parameter in the event record can be decoded with the following table.

### ***Enron Alarm Decoding***

<b>Description</b>	<b>Bit</b>
<Unassigned>	0-8
User Change/Event	9
Low Low Alarm	10
Low Alarm	11
Hi Alarm	12
Hi Hi Alarm	13
<Unassigned>	14
Alarm Set/Reset (1=Set, 0=Reset)	15

### ***Enron Log Capacity***

<b>Log Type</b>	<b>Capacity</b>
Interval Logs	6392
Daily Logs	768
Event Logs	1152



## Appendix E—Industry Standards

**Table E.1—Industry Standards for Flow Rate Calculations**

AGA Report No. 3, “Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids,” American Gas Association. Part 1 - General Equations and Uncertainty Guidelines (1991, 2012) Part 2 - Specification and Installation requirements (2000) Part 3 - Natural Gas Applications (1992) Part 4 - Background, Development, Implementation [...] Equation (1992)
AGA Report No. 7, “Measurement of Natural Gas by Turbine Meters,” American Gas Association, 2006.
API MPMS Ch. 5.3, “Manual of Petroleum Measurement Standards Chapter 5 - Metering - Section 3 - Measurement of Liquid Hydrocarbons by Turbine Meters (includes addendum 1), American Petroleum Institute, 2009.
ASME MFC-3M-2004, “Measurement of Fluid Flow in Pipes using Orifice, Nozzle, and Venturi”; The American Society of Mechanical Engineers; Three Park Avenue, New York NY 10016.
ASME MFC-12M-2006, “Measurement of Fluid Flow in Closed Conduits Using Multiport Averaging Pitot Primary Elements,” The American Society of Mechanical Engineers; Three Park Avenue, New York NY 10016.
ASME MFC-14M-2003 “Measurement of Fluid Flow using Small Bore Precision Orifice Meters”.; The American Society of Mechanical Engineers; Three Park Avenue, New York NY 10016.
ISO-5167: 2003, “Measurement of Fluid Flow by Means of Differential Devices Inserted in Circular Cross Section Conduits Running Full - Part 1: General Principles and Requirements,” International Organization for Standardization.

**Table E.2—Industry Standards for Fluid Property Calculations**

AGA Report No. 3, “Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids,” Part 3, “Natural Gas Applications,” Third Edition, 1992, Appendix F, “Heating Value Calculation,” American Gas Association, catalog XQ9210.
AGA Report No. 8 (Natural Gas: AGA8-92DC equation) Savidge, J. & Starling, K; “Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases”; A.G.A Report No. 8; catalog XQ 9212; American Gas Association 1994.
API MPMS Ch 11.1, “Manual of Petroleum Measurement Standards Chapter 11 - Physical Properties Data - Section 1 - Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils,” American Petroleum Institute, 2004.
GPA 2145, “Table of Physical Properties for Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry,” Gas Processors Association, Tulsa Oklahoma, 2008.
ISO 12213-3, “Natural gas - Calculation of Compression Factor - Part 3: Calculation Using Physical Properties,” International Organization for Standardization, 2006.
ISO/TR 11583, “Measurement of Fluid Flow by Means of Differential Devices Inserted in Circular Cross Section Conduits,” International Organization for Standardization, 2012.
ISO/TR 15377, “Measurement of Fluid Flow by Means of Pressure-Differential Devices -- Guidelines for the Specification of Orifice Plates, Nozzles, and Venturi Tubes Beyond the Scope of ISO 5167,” International Organization for Standardization, 2007.
W. Wagner and A. Kruse, “Properties of Water and Steam - The Industrial Standard IAPWS-IF97 for the Thermodynamic Properties and Supplementary Equations for Other Properties,” Springer-Verlag, Berlin Heidelberg 1998, ISBN 3-540-64339-7.



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