2110L SMART LEVEL GAUGE OPERATING INSTRUCTIONS

Meriam Instrument's 2110L Smart Level Gauge is a microprocessor-based pressure sensing device with algorithms to calculate level. The various sensors provide dip-tube bubbler accommodation, or direct head level measurements. Three configurations are available: Battery, SetPoint, and Current Loop models.

All models are programmable through the front keypad, to allow configuration of the gauge. The user's program information is stored in non-volatile memory, and is retained when the power to the gauge is removed. SetPoint and Current Loop models can also be configured through the RS-232 serial communication connection.

The Battery model is powered by its internal lithium batteries only. This model does not provide any outputs or RS-232 communications.

SetPoint and Current Loop models have outputs that can be used for control or indicating/recording functions. Both models also have RS-232 communications capability. In addition to configuring the gauge, the RS-232 port can be used to monitor and log the measured level/pressure data and output status. It can also be used as part of a control system with digital capabilities.

The SetPoint model provides two SPDT relay outputs with adjustable deadband. This configuration provides normally open or normally closed contact operation for fail-safety. Switching SetPoint can be set from 0 to +120% of the full scale level/pressure range. The SetPoint model is powered by 115/230 VAC, or 24VDC.

The Current Loop model provides a 4 to 20 mA output, and is intended to be used as a level transmitter on a three or four wire loop. Zero and span are set through user-programmable registers, from 0 to +120% of the full scale pressure range. The output is capable of normal and reverse action. The Current Loop model is powered by 24VDC only.

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LEVEL DISPLAY

Indicators

During normal operation, the gauge displays the level value in large numerals, and the bottom of the display shows the current Engineering Unit. The top of the display will show **PRGM** when the gauge is in **Program Mode** (flashing when "view only"). For SetPoint models, the top of the display will show **SET1**/**SET2** to indicate activated outputs (or corresponding register opened in **Program Mode**). For Current Loop models, the top of the display will show **4-20mA** when the output is enabled (or corresponding register opened in **Program Mode**).

Performance

The 2110L Smart Level Gauge retrieves analog data from its pressure sensor, and performs an analog-to-digital (A/D) conversion for microprocessor-based data handling. The rate of A/D conversion will typically be between 9 to 13 conversions per second, depending on the various operating conditions.

To make the display easier to read, only every fourth sample is updated on the display. (This results in a display update rate of about 3 updates per second.) The internal calculations, outputs, and serial interface are updated at the full conversion rate.

Resolution

The Smart Gauge has a 4½ digit display. The resolution of the data (decimal point positioning) is defined by the range and sampling process. The resultant full scale display and data resolution is summarized in the table below. Note that since the Smart Level Gauge display is primarily user-scaled to level units, the full scale and resolution depends on the scale. If a specific value will not fit on the 4½ digit display, however, the auto-range feature will decrease the resolution to allow the value to fit the display (for example, increasing past 199.99 becomes 200.0). The auto-range feature restores the decimal resolution with a built-in deadband of 5 display counts (for example, 200.0 must drop to 199.95 before the two-digit decimal resolution is restored).

Note that the full scale display indication during power-up will not necessarily have the same decimal resolution found during actual level monitoring.

Full Scale and Resolution Summary

Note: Add 20% for Max. Capability

Sensor→	inH2O	inH2O	inH2O	PSI
Units↓	20.00	200.00	2000.0	20.000
(20°C) **inH20**	**20.00**	(1)**200.00**	(1)**2000.0**	(1)554.60
(2)**Percent**	100.00	100.00	100.00	100.00
Other	(3)(4)	(3)(4)	(3)(4)	(3)(4)

Notes:	(1)	Auto-range will reduce resolution of these values by one decimal position when the ½ digit exceeds "1".
	(2)	The gauge can be programmed to read any magnitude of "%" (range not necessarily limited to "100").
	(3)	The full scale of other units is defined by the user scaling. The limitation is the 4½ digit display (19,999).
	(4)	The number of decimal points is not user-adjustable. It starts as shown above for the base sensor, and is decreased (or increased) by one, for each factor of 10 that the display gain increases (or decreases). The display gain is the full tank level divided by the full tank hydrostatic pressure [(P9+P10)/P4], and then scaled to InH_2O for PSI-based sensors.

KEYPAD FUNCTIONS:

The keys on the front panel perform multiple functions. Their function differs depending on whether the gauge is in **Measure Mode** or **Program Mode**.

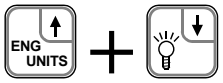
- **Measure Mode** is the normal operating mode for measuring and displaying level. This mode is always default after power-up or reset.
- **Program Mode** is used to configure the various options of the gauge. This mode is denoted by a PRGM indicator on the display.

ON/OFF / Backspace Key	 Document Symbol: **(Backspace←)**
Measure Mode	• **Battery** models: Toggles the gauge ON and OFF. • **SetPoint** and **Current Loop** models: "Resets" the gauge. <u>Sequence of power-up or reset</u> 1. Display test is performed (all segments of the LCD display are turned on). 2. Firmware revision is displayed. 3. Full scale (programmed level) is displayed in the last Engineering Unit used. 4. All prior register values are restored and activated. 5. **Measure Mode** displays level in the last Engineering Unit used.
Program Mode	**Backspace** function: From **Program Mode**, this key will exit to **Measure Mode**. When editing a register, this key is used to abort a programming operation and exit the register without making any changes. When editing a multi-digit value, each key press will backup one digit, until finally exiting the register.

ENG UNITS/Up Arrow Key	 Document Symbol: **(Up↑)**
Measure Mode	Allows the Engineering Units to be changed (see page 4). During Engineering Unit selection, the current unit indicator remains solid, and the "new" unit indicator is flashing. Scrolling through the available units is done by pressing the **Up↑** or **Down↓** keys. The flashing unit is selected using the **PRGM/Enter→** key, or the process may be aborted by using the **Backspace←** key.
Program Mode (and EU Selection)	Scroll up function. Scrolls up through the available programmable registers. Once a register is opened, this key allows editing by scrolling up through the values in the register.

Backlight/Down Arrow Key	 Document Symbol: **(Down↓)**
Measure Mode	Toggles the display Backlight on and off. Note that the default Backlight status for the Battery model is OFF to conserve battery life. The other models will retain the prior Backlight status as default.
Program Mode (and EU Selection)	Scroll down function. Scrolls down through the available programmable registers. Once a register is opened, this key allows editing by scrolling down through the values in the register.

PRGM/Enter Key	 Document Symbol: **(PRGM/Enter→)**
Measure Mode (and EU Selection)	Selects **Program Mode**, which allows access to the programmable registers. This key is also used to accept a new Engineering Unit selection.
Program Mode	Opens the selected programmable register for editing. When the desired value is displayed, pressing the **PRGM/Enter→** key accepts and stores the value, and closes the register. When editing a multi-digit value, each key press will accept the current digit and proceed to the next, until finally accepting the complete value and closing the register.

Re-ZERO Key	 Document Symbol: **(Up↑ *and* Down↓)**
Measure Mode	In **Measure Mode**, pressing the **Up↑** ***and*** **Down↓** keys at the same time resets the zero reference of the gauge (see page 5).
Program Mode (and EU Selection)	In **Program Mode**, for convenience, this function will reset the current value to default. For example, in **Program Mode** (but before *opening* a register), this function will reset the register scroll to P0. After opening a register for editing, this function will reset the register's data value to default (typically 0). Similarly, when selecting a new Engineering Unit, this function will reset the selection to the first unit (gallons). Note that even when using this "reset" function, the **PRGM/Enter→** key must be pressed to accept the new value (this allows for further editing after reset of the value).

PROGRAMMABLE REGISTER OVERVIEW

All 2110L Smart Level Gauges have programmable registers that allow the gauge to be configured to fit the level measurement application. Programmable registers are numbered P0 through P11. Each register controls a specific aspect of the gauge's performance.

Beginning on page 6 is a description of all programmable registers, and instructions for their use. Each register is found on all 2110L Smart Level Gauge models, and performs the same function described for all models, except as noted otherwise.

ENGINEERING UNITS

The following Engineering Units are available on the 2110L Smart Level Gauge:

1. **Gallons**
2. **Pounds**
3. **Cubic Feet**
4. **Liters**
5. **Percent**
6. **Kilograms**
7. **Cubic Meters**
8. **InH_2O** – Inches of Water Column (density reference temperature: 20°C)
9. **User Units** – User Defined Units

STEP BY STEP: CHANGING ENGINEERING UNITS		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Level Display.
2	Press the **ENG UNITS** (**Up↑**) key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	Current Engineering Unit[1] indicator flashes.
3	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired Engineering Unit. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to the first unit and allow selection to continue.	The current Engineering Unit indicator remains solid since it is active, and the unit to be selected flashes as the list is scrolled.
4	Press the **PRGM/Enter→** key when the desired unit is flashing.	The display switches to the new Engineering Unit[2] and returns to **Measure Mode**.
Notes	1. When scrolling through Engineering Units, *User Units* are denoted by all units flashing. 2. In **Measure Mode**, *User Units* are denoted by no Engineering Unit indicators shown on the bottom of the display. 3. Changing the Engineering Unit will automatically update the SetPoint and Capacity registers as appropriate (refer to the Automatic Update section on pages 13, 15, and 16 for further explanation). 4. If programmed in a volumetric unit (gallons, liters, $feet^3$, $meter^3$), the Smart Level Gauge will convert to other volumetric units using the **ENG UNITS** (**Up↑**) key, and likewise for mass units (pounds, kilograms). ***However, the Smart Level Gauge will not convert between volumetric units, mass units, and/or user units***. Percent (%) and InH_2O are available regardless of what unit was programmed. 5. At any time, the **Backspace←** key will abort the process and return to **Measure Mode**. 6. If there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

ZERO REFERENCE

Zeroing the gauge consists of accepting the current applied pressure value as the zero pressure reference. To set the zero reference pressure, all pressure sources should be disconnected from the gauge, and its temperature should be stable.

The Smart Level Gauge displays tank level as a function of the applied pressure. This pressure is linearly offset from the zero reference value, before applying the tank level calculations.

AFFECT ON OUTPUTS

The SetPoint and Current Loop outputs are calculated based on the displayed level. Since re-zeroing the gauge may change the displayed level, the outputs may change accordingly. For safety purposes, if the outputs are active (defined by register P5; see page 12), an extra step is required to warn the operator and confirm the desired action. For clarity, both scenarios are described below, step-by-step.

FACTORY ZERO

The "Factory Zero" can be restored through the serial port service only (SetPoint and Current Loop models only). This is the value set during calibration of the sensor, and is typically 0.0.

RANGE CHECK

The Smart Gauge can be zeroed only when the applied pressure is within ±5% of sensor full scale. If the applied pressure is greater than 5% of full scale, an error code will be displayed when zeroing is attempted.

STEP BY STEP: RE-ZEROING THE GAUGE (Disabled Outputs, P5=0)		
Step	**Action**	**Display**
1	Gauge should be in normal **Measure Mode**, with applied pressure ready for zeroing (typically vented).	Normal level display, near 0.0 (or offset from the Residual Hydrostatic Pressure, P3).
2	Press the **Up↑** *and* **Down↓** keys simultaneously. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The display will flash "**0000**" several times while the new zero is taken, and then return to **Measure Mode** with the new zero activated.

WHEN OUTPUTS ARE ACTIVE (P5>0) ...		SetPoint and Current Loop models only
1	Gauge should be in normal **Measure Mode**, with applied pressure ready for zeroing (typically vented).	Normal level display, near 0.0 (or offset from the Residual Hydrostatic Pressure, P3).
2	Press the **Up↑** *and* **Down↓** keys simultaneously. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The display will begin countdown from "**0005**" to "**0000**".
3	Press **PRGM/Enter→** before the countdown expires[1]. This acknowledges the warning.	The display will again countdown from "**0005**" to "**0000**".
4	Press ZERO again (**Up↑** *and* **Down↓**) before the countdown expires[1]. This confirms the zero action.	The display will flash "**0000**" several times while the new zero is taken.
Notes	1. During steps 2 or 3, if the countdown expires, the gauge will return to **Measure Mode** unchanged. 2. During steps 2 or 3, the **Backspace←** key will abort the process and return to **Measure Mode**. 3. The zero reference value is snapshot immediately when the ZERO keys are pressed. This temporarily stored value is accepted once the zeroing process is complete (or discarded if not completed).	

P0 – LOCKOUT CODE

All Models

This feature provides security in the Smart Gauge. It is designed to prevent unauthorized personnel from tampering with or inadvertently changing the configuration of the gauge. The lockout is controlled by a 2-digit setting in the P0 register. Once a lockout code is entered, the gauge will prompt for the lockout code before allowing any changes (similar to a "password"). Changes include Engineering Unit selection, re-zeroing, or entering **Program Mode**.

Following an operator action, if the correct code (password) is not entered when prompted, an error message is briefly displayed. If the operator action was changing Engineering Units or re-zero the gauge, the gauge will simply return to normal **Measure Mode** operation, without accepting any change. If the operator action was entering **Program Mode**, the gauge will enter a "view-only" status (see page 18), denoted by the PRGM indicator flashing.

In **Program Mode** (and during lockout code prompting), the register value is shown as "L xx" to assist in identifying the register. The "L " indicates "Lockout", and "xx" will consist of the current value.

QUICK REFERENCE: P0, LOCKOUT CODE				
Px	**Name**	**Description**	**Value Range**	**Notes**
P0	Lockout Code	Lockout for security.	00 to 99	00 = Disabled.

STEP BY STEP: P0, LOCKOUT CODE		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Pressure Display.
2	Press the **PRGM/Enter→** key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The **PRGM** annunciator shows at the top of the display, and the display shows the register name "**P0**".
3	Press **PRGM/Enter→** again, to open the register.	The display will show "**L xy**" with the first digit flashing for edit (indicating Lockout Code xy).
4	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired numeric value for the flashing digit. The Zero function (**Up↑** *and* **Down↓**) will reset the entire register to 00 and allow editing to continue.	"**L _x**", where "_" is the digit being edited (flashing).
5	Press the **PRGM/Enter→** key to accept the digit.	The next digit begins flashing for edit.
6	Repeat steps 4 and 5 for the second digit.	The complete 2-digit value will be accepted, and the register is closed (display shows P0 for selection).
7	Press the **Backspace←** key to activate the lockout and return to **Measure Mode**.	Normal Pressure Display.
Notes	1. After step 2, the **Backspace←** key will abort the process and return to **Measure Mode**. 2. After steps 3 or 4, the **Backspace←** key will abort the current digit and close the register (since it is the first digit). 3. After step 5, the **Backspace←** key will abort the current digit and backup to the first digit. Another **Backspace←** will abort the process and close the register. 4. After step 6, the **PRGM/Enter→** key will again open the register for edit. 5. During any programming operation, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

P1 – TIMEOUT VALUE

Battery Models Only

This register sets the length of time (in minutes) for automatic shutoff. The Battery model will automatically shutoff if there is no keypad activity for this length of time. This feature can be disabled by selecting 0 in the register, which allows the gauge to remain on indefinitely, or until the ON/OFF key is pressed (battery life may be reduced). During programming, the choices found in the register correspond to the actual timeout values, in minutes.

QUICK REFERENCE: P1, TIMEOUT				
Px	**Name**	**Description**	**Value Range**	**Notes**
P1	Timeout	Automatic shutoff in minutes of keypad inactivity.	0 (disabled), 1, 2, 5, 10, 15, 25	Battery model only.

STEP BY STEP: P1, TIMEOUT		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Pressure Display.
2	Press the **PRGM/Enter→** key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The **PRGM** annunciator shows at the top of the display, and the display shows the register name "**P0**".
3	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to P0 and allow selection to continue.	Display shows "**P1**".
4	Press **PRGM/Enter→** to open the register.	The display shows the current value.
5	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register value. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to default and allow editing to continue.	All available choices are scrolled. (Choices indicate actual Timeout in seconds.)
6	Press the **PRGM/Enter→** key to accept the desired value.	The value is accepted, and the register is closed. Display shows "**P1**".
7	Press the **Backspace←** key to activate the register setting and return to **Measure Mode**.	Normal Pressure Display.
Notes	1. After steps 2 and 3, the **Backspace←** key will abort the process and return to **Measure Mode**. 2. After steps 4 and 5, the **Backspace←** key will abort the edit and close the register. 3. After step 6, the **PRGM/Enter→** key will again open the register for edit. 4. During any programming operation, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

P2 – DAMP RATE

All Models

The Smart Gauge has a selectable damp rate, which is used to stabilize the display for applications with a pulsating pressure source. The damp rate setting is roughly the length of time it will take for the gauge to ramp from one stable pressure to another. The ramping is exponential, changing at a slower rate as the final value is approached.

The "time constant" of the exponential equation is roughly one-fifth of the damp rate setting. This means that the damped value will be roughly 63% of final value after a time equal to one-fifth of the register setting. The value will be roughly 86% of final value after a time equal to two-fifths of the register setting.

The damping function only affects the displayed value (LCD display and RS232 data); it does not affect the action of the SPDT relays, the 4 to 20 mA outputs, or the response to over-pressure ("OP" indication).

QUICK REFERENCE: P2, DAMP RATE				
Px	**Name**	**Description**	**Value Range**	**Notes**
P2	Damp Rate	Exponential damping time in seconds.	0.1, 0.2, 0.5, 1, 2, 5, 10, 15, 25, 50	0.1 = No Damping.

STEP BY STEP: P2, DAMP RATE		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Pressure Display.
2	Press the **PRGM/Enter→** key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The **PRGM** annunciator shows at the top of the display, and the display shows the register name "**P0**".
3	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to P0 and allow selection to continue.	Display shows "**P2**".
4	Press **PRGM/Enter→** to open the register.	The display shows the current value.
5	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register value. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to default and allow editing to continue.	All available choices are scrolled. (Choices indicate actual damp rate in seconds.)
6	Press the **PRGM/Enter→** key to accept the desired value.	The value is accepted, and the register is closed. Display shows "**P2**".
7	Press the **Backspace←** key to activate the register setting and return to **Measure Mode**.	Normal Pressure Display.
Notes	1. After steps 2 and 3, the **Backspace←** key will abort the process and return to **Measure Mode**. 2. After steps 4 and 5, the **Backspace←** key will abort the edit and close the register. 3. After step 6, the **PRGM/Enter→** key will again open the register for edit. 4. During any programming operation, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

P3 – RESIDUAL HYDROSTATIC PRESSURE

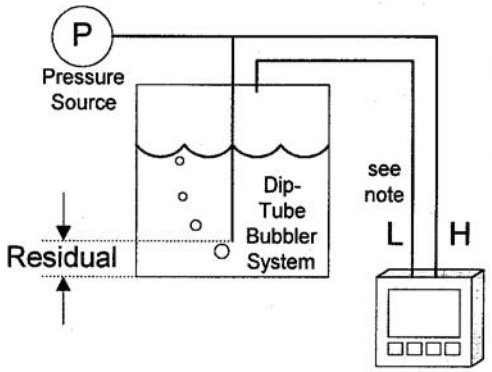
All Models

The 2110L Smart Level Gauge will correctly measure level when used with a dip tube or as a direct-head pressure reading of the tank's fluid column. Register P3 is used to describe the unmeasurable pressure below the dip tube, or the additional pressure created by a "dead leg" in the direct-head piping. This register must be specified in Inches of Water Column at 20°C reference.

QUICK REFERENCE: P3, RESIDUAL HYDROSTATIC PRESSURE				
Px	**Name**	**Description**	**Value Range**	**Notes**
P3	Residual Hydrostatic Pressure	Identifies the Pressure lost or added due to piping configurations.	-9999 to +9999 inH_2O @ 20ºC.	+Val:Dip Tube -Val: Dir.Head

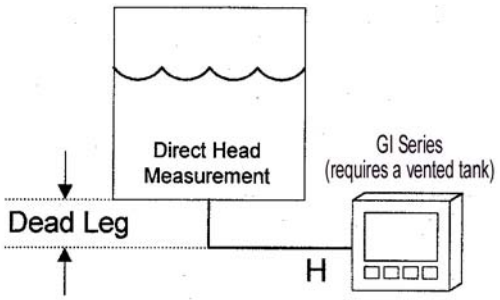
Dip Tube Application

The P3 register specifies the pressure created by the height of the fluid *below* the dip tube to the bottom of the tank. **The volume in the tank below this point cannot be measured!** To compensate for this unmeasured volume (optional), enter this register as a *positive* value.



Direct Head Measurement

The P3 register specifies the pressure caused by the vertical "dead leg" of the piping to the gauge. This is additional pressure applied to the gauge that is not due to fluid volume in the tank. To compensate for this pressure, enter this register as a *negative* value.



Note: The Low Pressure side is connected to the tank top on *pressurized* tanks only, as shown, using a differential pressure, non-isolated model (DN) Smart Level Gauge. It is recommended that a gauge-pressure, isolated sensor model (GI) Smart Level Gauge be used whenever possible for measuring fluid level (vented tank).

The differential pressure, non-isolated sensor (required for *pressurized* tanks) is compatible with clean, dry, non-corrosive gases only. This will work without modification in most bubbler system applications. However, when corrosive liquids or vapors are in the tank, a diaphragm seal will be needed on the high and low pressure lines (or on the high pressure line in a direct head pressure system). Consult the factory for information on diaphragm seal selection, limitations, and the effects on overall gauge performance.

STEP BY STEP: P3, RESIDUAL HYDROSTATIC PRESSURE		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Pressure Display.
2	Press the **PRGM/Enter→** key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The **PRGM** annunciator shows at the top of the display, and the display shows the register name "**P0**".

3	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to P0 and allow selection to continue.	Display shows "**P3**".
4	Press **PRGM/Enter→** to open the register.	The display will show the current value, with the first zero flashing for edit.
5	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired numeric value for the flashing digit. The Zero function (**Up↑** *and* **Down↓**) will reset the entire register to 0000 and allow editing to continue. The decimal point and negative sign will not be affected, and the same digit will be flashing.	"**_xxx**", where "_" is the digit being edited.
6	Press the **PRGM/Enter→** key to accept the digit.	The next digit begins flashing for edit.
7	Repeat steps 5 and 6 for the all remaining digits. The **Backspace←** key will backup one digit at a time, or abort and close the register if the first digit is flashing. The **PRGM/Enter→** key will accept one digit at a time, moving to the next, or accept the complete value and close the register after the decimal point edit.	After **Enter→** when the last digit is flashing, the decimal point flashes for edit. *Please read carefully note 4 below.*
8	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired decimal point position, and to select positive/negative. If the Zero function (**Up↑** *and* **Down↓**) is used during decimal point editing, it will still reset the register's value to 0000, and not affect the decimal point position or negative sign.	Decimal point moves accordingly. *Please read carefully note 4 below.* Negative Sign activates and de-activates when the decimal point sequence is scrolled through completely.
9	Press the **PRGM/Enter→** key to accept the complete value.	The value is accepted, and the register is closed. Display shows "**P6**" or "**P7**".
10	Press the **Backspace←** key to activate the register setting and return to **Measure Mode**.	Normal Pressure Display.

Notes

1. Preceding/Trailing zeroes are determined by where the user places the decimal point. When opening a register, the value is always shown padded with trailing zeroes.
2. Only 4 digits are available for editing (the ½ digit is not provided), plus the decimal point and negative sign (negative is not applicable to register P4). This limits keypad value entries to ±9,999, and also limits the available decimal point resolution (depending on the magnitude of the value). The serial interface provides much more flexibility.
3. After steps 2 and 3, the **Backspace←** key will abort the process and return to **Measure Mode**.
4. The display does not have a physical decimal point that can be illuminated in the least significant position (to the right of all digits on the display). Thus, if the decimal point is in that particular position, there will be no decimal point blinking (which may be confusing). When scrolling through the decimal point selection, it is important to take note that none blinking is a viable setting, and will be seen in the scrolling sequence.
5. After step 9, the **PRGM/Enter→** key will again open the register for edit.
6. During any programming operation, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.

P4 – FULL TANK HYDROSTATIC PRESSURE

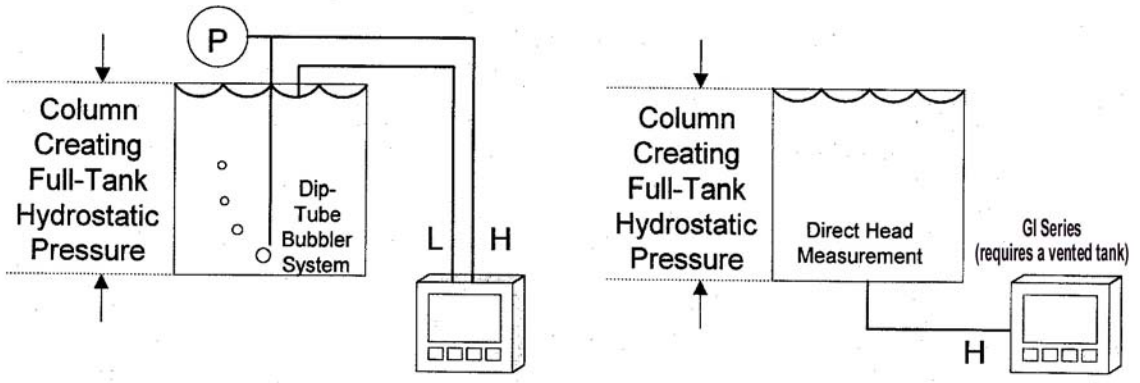
All Models

This register is used by the gauge to draw a relationship between measured static pressure and actual level in volume or mass units. This register must be set to the pressure created by a FULL COLUMN of vertical fluid in the tank, *in inches of water column at 20ºC reference temperature*.

To calculate this value, multiply the specific gravity[1] of the fluid (relative to water at 60°F) by the full distance from the *floor*[2] of the tank to the top of the maximum level to be measured. Then, using the appropriate scale factor, convert the resultant pressure value to inches of water column at 20ºC reference (for example, to convert PSI to InH_2O @20ºC, multiply by 27.72978).

Note that the P4 value is not affected by installation type (bubbler system or direct head measurement). The value is calculated in the same way for either system. *The residual pressure (page 9) is not added to or subtracted from this value.*

QUICK REFERENCE: P4, FULL TANK HYDROSTATIC PRESSURE				
Px	**Name**	**Description**	**Value Range**	**Notes**
P4	Full Tank Hydrostatic Pressure	The pressure created by a full column of fluid from the floor of the tank to the top of the maximum level to be measured.	0 to 9,999 (Keypad) 0 to 19,999 (Serial)	Pressure in inH_2O @20°C.



STEP BY STEP: P4, FULL TANK HYDROSTATIC PRESSURE
The process of programming this register is exactly the same as other real-value programmable registers. Please refer to that procedure on page 9.

[1] When the specific volume is known, perform the calculation in a similar manner, but use the inverse of the specific volume instead of the specific gravity.

[2] For non-linear tanks, use the lowest point of the tank when figuring the full distance.

P5 – SETPOINT OPTIONS

SetPoint & Current Loop Models Only

This register defines the output action for SetPoint and Current Loop models. Note that if an output is disabled by this register, the SetPoint value in its corresponding register (P6, P7) has no impact. Also note that a SetPoint value (P6, P7) may be 0.0, which is a viable output setting; thus, in order to *disable* control action, register P5 should be used to define the desired action.

In **Measure Mode**, the indicators "SET1" and/or "SET2" will illuminate when the corresponding relay is energized. The "4-20mA" indicator will illuminate when the Current Loop output is enabled. In **Program Mode**, the indicators "SET1", "SET2", and "4-20mA" will illuminate as appropriate to assist when scrolling through the register's choices. *Note that if P5 is set for active, the outputs will continue to update even in **Program Mode**, according to the currently programmed values.*

QUICK REFERENCE: P5, SETPOINT OPTIONS				
Px	**Name**	**Description**	**Value Range**	**Notes**
P5	SetPoint Options	SetPoint model: Defines which relay outputs are active.	0 = Disabled. 1 = SET1 only. 2 = SET2 only. 3 = Both enabled.	Not found on Battery model.
		Current Loop model: Defines status of the 4-20 mA output.	0 = 4-20 disabled 1 = 4-20 enabled	

STEP BY STEP: P5, SETPOINT OPTIONS		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Pressure Display.
2	Press the **PRGM/Enter→** key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The **PRGM** annunciator shows at the top of the display, and the display shows the register name "**P0**".
3	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to P0 and allow selection to continue.	Display shows "**P5**".
4	Press **PRGM/Enter→** to open the register.	The display shows the current value.
5	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register value. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to default and allow editing to continue.	All available choices are scrolled.
6	Press the **PRGM/Enter→** key to accept the value.	The value is accepted, and the register is closed. Display shows "**P5**".
7	Press the **Backspace←** key to activate the register setting and return to **Measure Mode**.	Normal Pressure Display.
Notes	1. After steps 2 and 3, the **Backspace←** key will abort the process and return to **Measure Mode**. 2. After steps 4 and 5, the **Backspace←** key will abort the edit and close the register. 3. After step 6, the **PRGM/Enter→** key will again open the register for edit. 4. During any programming operation, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

P6 and P7 – SETPOINT (SET1 and SET2)

SetPoint & Current Loop Models Only

SetPoint Model

These registers define the pressure points at which the SPDT relays will energize. The relay will energize when the pressure exceeds its corresponding value, and de-energize when the pressure drops below the value (minus deadband; see page 14). P6 defines the SET1 relay, and P7 defines the SET2 relay. P6 and P7 settings are completely independent of each other; either may be greater, less than, or equal to the other.

Current Loop Model

These registers define the 4 to 20 mA output value. P6 (SET1) sets the 4.00 mA output and P7 (SET2) sets the 20.00 mA output. (Thus, the output "zero" is defined by SET1, and the "span" is defined by SET2 – SET1.) When the pressure is at the P6 value, the output will be 4.00 mA; when the pressure is at the P7 value, the output will be 20.00 mA. Other pressures provide an output that is linearly scaled between the two values. For values beyond the defined range, however, the output is limited from 4.00 to 20.38 mA. The P6 (4 mA) register can be set greater than the P7 (20 mA) register, to create a reverse acting output. The limits are –20% to +120% full scale, but P6 and P7 cannot be set at equal values.

Data Entry

Refer to the Step by Step table below for detailed instructions.

These registers are entered in the current Engineering Unit used by the gauge. (The current Engineering Unit is illuminated during edit of these registers.) For example, if the gauge is set to read in gallons, and a value of 110 is put into the P6 register, the SET1 relay will energize at 110 gallons.

In **Program Mode**, the indicators "**SET1**", "**SET2**", and "**4-20mA**" will illuminate as appropriate to assist in identifying the register. For example, when scrolling to and/or editing P6, "**SET1**" will be illuminated, indicating that SET1 is being edited. Likewise for P7 and "**SET2**". Also, "**4-20mA**" will be illuminated if the gauge is a Current Loop model, to indicate that the 4-20mA range is being edited.

Automatic Update

If the Engineering Unit is changed in measure mode (see page 4), the value in the P6 and P7 registers will automatically change to reflect the new Engineering Unit. This allows changing the Engineering Unit in **Measure Mode** without affecting the outputs. For the above example, changing the Engineering Unit to liters will automatically update the P6 register to energize at 416.4 liters, which is equivalent to 110 gallons.

QUICK REFERENCE: P6/P7, SETPOINTS

Px	Name	Description	Value Range	Notes
P6	SET1	SetPoint model: Controls SET1 relay.	–20% to +120% of Full Scale	User defined values. On Current Loop models, SET1 cannot equal SET2.
		Current Loop model: Sets 4.00 mA value.		
P7	SET2	SetPoint model: Controls SET2 relay.	–20% to +120% of Full Scale	
		Current Loop model: Sets 20.00 mA value.		

STEP BY STEP: P6/P7, SETPOINTS

The process of programming this register is exactly the same as other real-value programmable registers. Please refer to that procedure on page 9.

P8 – DEADBAND

SetPoint Models Only

This register is found on the SetPoint model only. It sets the adjustable deadband for the SPDT relays. Deadband can be set to 0%, 0.1, 0.2, 0.5, 1, 2, 5 and 10% of full scale. The relay will energize precisely at the value in its corresponding P6 and P7 registers on increasing level. The relay will de-energize at a value equal to the corresponding P6 and P7 register, minus the deadband value, on decreasing level. With a 0% deadband setting, the relays will energize and reset precisely at the values in the corresponding P6 and P7 registers. During programming, the choices found in the register correspond to the actual deadband values in percent full scale.

QUICK REFERENCE: P8, DEADBAND				
Px	**Name**	**Description**	**Value Range**	**Notes**
P8	Deadband	Sets the amount of deadband in percent of full scale for relays.	0, 0.1, 0.2, 0.5, 1, 2, 5, 10% FS	SetPoint model only. 0 = Disabled.

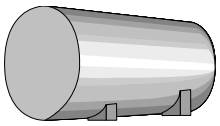
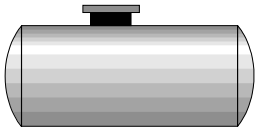
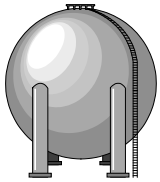
STEP BY STEP: P8, DEADBAND		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Pressure Display.
2	Press the **PRGM/Enter→** key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The **PRGM** annunciator shows at the top of the display, and the display shows the register name "**P0**".
3	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to P0 and allow selection to continue.	Display shows "**P8**", and the "**%**" annunciator is illuminated.
4	Press **PRGM/Enter→** to open the register.	The display shows the current value.
5	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register value. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to default and allow editing to continue.	All available choices are scrolled. (Choices indicate actual Deadband in percent of full scale.)
6	Press the **PRGM/Enter→** key to accept the desired value.	The value is accepted, and the register is closed. Display shows "**P8**".
7	Press the **Backspace←** key to activate the register setting and return to **Measure Mode**.	Normal Pressure Display.
Notes	1. After steps 2 and 3, the **Backspace←** key will abort the process and return to **Measure Mode**. 2. After steps 4 and 5, the **Backspace←** key will abort the edit and close the register. 3. After step 6, the **PRGM/Enter→** key will again open the register for edit. 4. During any programming operation, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

P9 – TANK CYLINDRICAL CAPACITY

All Models

The Smart Level Gauge calculates level based on measured hydrostatic pressure, by drawing a relationship between the full tank hydrostatic pressure (register P4, page 11), and the total capacity of the tank (volume or mass). The residual pressure (register P3, page 9) and tank type (register P11, page 17) are also considered in the calculations.

The P9 and P10 registers together specify the tank capacity referred to above. The P9 value may be entered in any desired Engineering Unit, except InH2O (refer to page 4 for available units); User Units and Percent are also acceptable. The value programmed in P9 depends on the type of tank, as described below:

LINEAR TANK	Cylindrical/Flat Ends	Cylindrical/Dished Ends	Spherical
P9=Volume/mass of the *full tank*. (The full volume is comprised of the entire cylindrical section.)	P9=Volume/mass of the *full tank*. (The full volume is comprised of the entire cylindrical section.)	P9=Volume/mass of the *cylindrical portion only*. (Tank capacity minus dished ends capacity.)	P9=0. (The full volume is comprised essentially of 2 dished ends, entered in the P10 register.)

QUICK REFERENCE: P9, TANK CYLINDRICAL CAPACITY				
Px	**Name**	**Description**	**Value Range**	**Notes**
P9	Tank Cylindrical Capacity	The capacity, in Engineering Units, in the cylindrical portion of the tank only.	0 to 9,999 (Keypad) 0 to 19,999 (Serial)	P9 = 0 for spherical tanks.

Automatic Update

If the Engineering Unit is changed in **Measure Mode** (see page 4), the value in the P9 and P10 registers will automatically change to reflect the new Engineering Unit. This allows changing the Engineering Unit in **Measure Mode** and maintaining a correct level display.

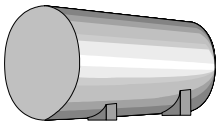
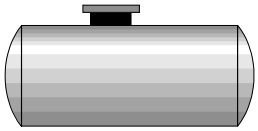
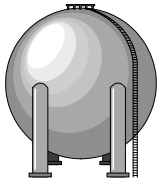
STEP BY STEP: P9, TANK CYLINDRICAL CAPACITY	
The process of programming this register is exactly the same as other real-value programmable registers. Please refer to that procedure on page 9. However, the following notes are specific to the P9 and P10 register:	
Notes	1. After completing the P9 or P10 *value* programming (step 9 on page 10), the gauge will then prompt for Engineering Unit selection by flashing the current unit. To complete P9 or P10 programming, proceed with Engineering Unit selection (described on page 4). This selection defines the units that were programmed into P9 and P10. If the units are not to be changed, you may simply re-enter or abort the Engineering Unit selection process (page 4). 2. Register P9 and P10 values always represent the same Engineering Unit. Therefore, if the unit is changed during programming of one register, it may be necessary to re-program the other. 3. If the current Engineering Unit is **InH_2O** when P9 or P10 is opened for programming, the gauge will enter a view-only mode (see page 18). The registers cannot be changed in this mode. You must first select a different Engineering Unit in order to program P9 or P10 (see page 4). This is required to maintain level scaling relationships between hydrostatic pressure and the user's fluid characteristics.

P10 – TANK ENDS CAPACITY

All Models

The Smart Level Gauge calculates level based on measured hydrostatic pressure, by drawing a relationship between the full tank hydrostatic pressure (register P4, page 11), and the total capacity of the tank (volume or mass). The residual pressure (register P3, page 9) and tank type (register P11, page 17) are also considered in the calculations.

The P9 and P10 registers together specify the tank capacity referred to above. The P10 value may be entered in any desired Engineering Unit, except InH2O (refer to page 4 for available units); User Units and Percent are also acceptable. The value programmed in P10 depends on the type of tank, as described below:

LINEAR TANK	Cylindrical/Flat Ends	Cylindrical/Dished Ends	Spherical
P10=0. (The full volume is comprised of the entire cylindrical section.)	P10=0. (The full volume is comprised of the entire cylindrical section.)	P10=Volume/mass of the *dished ends only* (total of both). (Total tank volume minus cylindrical section.)	P10=Volume/mass of the *full tank*. (The full volume is comprised essentially of 2 dished ends.)

QUICK REFERENCE: P10, TANK ENDS CAPACITY				
Px	**Name**	**Description**	**Value Range**	**Notes**
P10	Tank Ends Capacity	The total capacity of the dished ends of a horizontal cylindrical tank (includes *both* ends).	0 to 9,999 (Keypad) 0 to 19,999 (Serial)	P10 = 0 for linear tanks, or cylindrical tanks with *flat* ends.

Automatic Update

If the Engineering Unit is changed in **Measure Mode** (see page 4), the value in the P9 and P10 registers will automatically change to reflect the new Engineering Unit. This allows changing the Engineering Unit in **Measure Mode** and maintaining a correct level display.

STEP BY STEP: P10, TANK ENDS CAPACITY	
The process of programming this register is exactly the same as other real-value programmable registers. Please refer to that procedure on page 9. However, the following notes are specific to the P9 and P10 register:	
Notes	1. After completing the P9 or P10 *value* programming (step 9 on page 10), the gauge will then prompt for Engineering Unit selection by flashing the current unit. To complete P9 or P10 programming, proceed with Engineering Unit selection (described on page 4). This selection defines the units that were programmed into P9 and P10. If the units are not to be changed, you may simply re-enter or abort the Engineering Unit selection process (page 4). 2. Register P9 and P10 values always represent the same Engineering Unit. Therefore, if the unit is changed during programming of one register, it may be necessary to re-program the other. 3. If the current Engineering Unit is **InH_2O** when P9 or P10 is opened for programming, the gauge will enter a view-only mode (see page 18). The registers cannot be changed in this mode. You must first select a different Engineering Unit in order to program P9 or P10 (see page 4). This is required to maintain level scaling relationships between hydrostatic pressure and the user's fluid characteristics.

P11 – TANK TYPE

All Models

This register identifies the type of tank application, with respect to the vertical fluid pressure measurement.

Linear: The hydrostatic head change is proportional to the level change. For example, a cylindrical tank standing vertically (first tank pictured on page 16) is linear because the change in pressure produced by the fluid in the tank is proportional to the change in level (or mass).

Non-Linear: The hydrostatic head change is not proportional to the level change. For example, horizontal cylinder and spherical tanks (other tanks pictured on page 16) are non-linear, because the change in pressure produced by the fluid in the tank is not proportional to the change in level (or mass). For Non-Linear Tanks, the Smart Level Gauge discerns between a cylindrical tank with flat ends, a cylindrical tank with dished ends, and a spherical tank by the settings in the P9 and P10 registers. Refer to the examples on pages 15 and 16.

QUICK REFERENCE: P11, TANK TYPE				
Px	**Name**	**Description**	**Value Range**	**Notes**
P11	Tank Type	Identifies type of tank.	0 = Linear/Vertical 1 = Non Linear	If P11=0, verify that P10=0.

STEP BY STEP: P11, TANK TYPE		
Step	**Action**	**Display**
1	Gauge should be in the normal **Measure Mode**.	Normal Pressure Display.
2	Press the **PRGM/Enter→** key. If the lockout is active, the gauge will now prompt for entry of the lockout code. Refer to "STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)" on page 18.	The **PRGM** annunciator shows at the top of the display, and the display shows the register name "**P0**".
3	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to P0 and allow selection to continue.	Display shows "**P11**".
4	Press **PRGM/Enter→** to open the register.	The display shows the current value.
5	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired register value. The Zero function (**Up↑** *and* **Down↓**) will reset the scroll to default and allow editing to continue.	All available choices are scrolled.
6	Press the **PRGM/Enter→** key to accept the desired value.	The value is accepted, and the register is closed. Display shows "**P11**".
7	Press the **Backspace←** key to activate the register setting and return to **Measure Mode**.	Normal Pressure Display.
Notes	1. After steps 2 and 3, the **Backspace←** key will abort the process and return to **Measure Mode**. 2. After steps 4 and 5, the **Backspace←** key will abort the edit and close the register. 3. After step 6, the **PRGM/Enter→** key will again open the register for edit. 4. During any programming operation, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

LOCKOUT CODE PROMPT

All Models

DESCRIPTION

When a gauge is "locked" for security purposes, it does not allow access to change its operating state without first providing the lockout code. A gauge is "locked" by entering a lockout code in register P0 (See "STEP BY STEP: P0, LOCKOUT CODE" on page 6).

After pressing a key on a locked gauge for a desired function (ZERO, ENG UNITS, PRGM), "L 00" will appear on the display, with the first 0 flashing. This is the prompt to enter the lockout code (similar to a password).

VIEW-ONLY STATUS

If a user attempts to enter **Program Mode** without providing a correct lockout code (password), the gauge briefly provides an error message, and then enters a "view-only" status, denoted by the PRGM indicator flashing. In this mode, all registers (except the lockout code register itself) can be viewed, but not changed.

In this view-only status, the operator navigates through the registers exactly the same as if programming the registers. However, the keys that would change a value are simply ignored by the gauge. Thus, the **PRGM/Enter→** key will open a register normally; the **Backspace←** key will close the register, and then return to **Measure Mode** as expected.

STEP BY STEP: ENTERING A LOCKOUT CODE (When Prompted)		
Step	**Action**	**Display**
1	After attempting to re-zero, change Engineering Units, or enter **Program Mode**...	The display will prompt "**L 00**" with the first zero flashing for edit (indicating Lockout Code 00).
2	Press the **Up↑** or **Down↓** keys repeatedly to scroll to the desired numeric value for the flashing digit.	"**L xy**", where "x" is the digit being edited.
3	Press **PRGM/Enter→** key to accept the digit.	The next digit begins flashing for edit.
4	Repeat steps 2 and 3 for the second digit.	The complete 2-digit value will be accepted.
If the correct code was entered, the gauge will perform the requested function. Otherwise, an error message is displayed, and the gauge either returns to **Measure Mode**, or enters a "view-only" status for the programmable registers (if **Program Mode** was requested).		
Notes	1. After step 1 or 2, the **Backspace←** key will abort the process and return to **Measure Mode**. 2. After step 3, pressing the **Backspace←** key will abort the current digit and backup to the first digit. Another **Backspace←** will abort the process and return to **Measure Mode**. 3. Between steps 1 and 4, the Zero function (**Up↑** + **Down↓**) will clear the entire entry to "00" again. 4. Between steps 1 and 4, if there is no keypad activity for approximately 1 minute, the operation is aborted and the gauge returns to **Measure Mode** unchanged.	

SERIAL PORT SERVICE

SetPoint & Current Loop Models Only

The 2110L Smart Level Gauge SetPoint models and Current Loop models provide RS-232C communication capability. To use the serial service, connect a standard "dumb terminal" (or personal computer with terminal software) as shown in the wiring diagram on page 22. Set the terminal communication for 9600 baud, 8 data bits, no parity, one stop bit, and no handshaking. The terminal should be able to display at least 24 lines and 70 columns.

THE MENU

All programmable items of the gauge are available from the menu. Included with the menu is a complete summary of all data representing the current programming and operating status.

A sample view of the menu is shown below for reference. The top line identifies the gauge, firmware revision, and copyright. The second line identifies the model (SetPoint, Current Loop), the full scale sensor range, and the sensor identifier. Next is a reminder notice to the operator (explained below).

The Engineering Unit section is next. The first line shows the full scale for the current Engineering Unit, which also identifies the current Engineering Unit. All available Engineering Units are shown with a menu-selection number; the Engineering Unit is changed by simply selecting its corresponding menu-number at the terminal keyboard.

Finally, all programmable registers and functions are formatted on the menu. The menu item includes its menu-selection character, and the current register data as applicable. To change an item, simply select its character from the terminal keypad; the appropriate sub-menu, notes, and instructions are presented for operator entry. Note that the serial menu typically provides more flexibility for entering data values, compared with the gauge's keypad (for example, more decimal digits of resolution are available).

```
SmartGauge/2110L (v4.10).  (c)Copyright 1999 Meriam Instrument.
SetPoint model.  Sensor = 200.0 InH2O; ID: dn22lj16.64
-----------------------------------------------------------------
Notice!  Changing any value will PAUSE Gauge Operation; see manual!
-----------------------------------------------------------------
Current Full Scale:   1000.0 GALs
1) GALs         4) Liter        7) KGs          0) User Units
2) LBs          5) n/a          8) M^3
3) FT^3         6) %            9) inH2O
-----------------------------------------------------------------
A) P0, LockOut Code     = Disabled
B) P2, Damp Rate        = 0.2 Seconds
C) P3, Residual Press   = 10.0000   InH2O
D) P4, FullTank Press   = 180.0000  InH2O
E) P5, SetPoint Ctrl    = Disabled
F) P6, SET1             = 0.0000    GALs
G) P7, SET2             = 0.0000    GALs
H) P8, Dead Band        = 0.0 % Full Scale
J) P9, Cyl. Capacity    = 1000.0000 GALs
K) P10,Dished End Cap   = 0.0000    GALs
L) P11,Tank Type        = Linear/Vertical
M) ReZero Gauge         R) Restore Factory Zero
X) EXIT Interactive Menu

Select Choice:
```

ACCESSING THE MENU

When the gauge is powered up or reset, it will print the menu to the serial port. Also, hitting the ENTER key from the terminal will refresh/reprint the menu. If the terminal is not connected when the gauge first prints the menu, it will be missed; thus, if the terminal is connected after the gauge is already running, it will show nothing. Pressing the ENTER key will establish communications and re-print the menu.

IMPACT ON OPERATION

Use of the serial port service is independent of the operating mode of the gauge, and vice versa. It is not necessary to change to **Program Mode** to use any of the menu's features, including changing Engineering Units, editing programmable registers, and re-zeroing. The gauge continues its active operation regardless of the serial port service, except for the pausing explained in the next paragraph. Any keypad activity from the front panel of the gauge will also be processed regardless of the serial port status. If entries are made through the keypad and the serial port simultaneously, the last entry received will be active.

While the serial port is transferring data, the other functions of the gauge are paused to allow this task to complete. In this paused state, the display is frozen and the outputs are not updating. Typically, the data transfers are very short (for example, printing the menu), and thus the interruption is minimal. However, selecting a programmable register for edit will completely stop normal gauge operation, because the gauge is awaiting the operator's input (data value or selection from a sub-menu). During this state, the display is blanked to prevent mis-readings. As soon as the operator selection or entry is complete, the gauge resumes normal operation.

The Notice of "PAUSE Gauge Operation" near the top of the menu is a reminder about this explanation. It is particularly important when a gauge is in service as an in-process instrument, since the gauge will not respond to process conditions while it is paused.

TIMEOUT

When the menu is displayed, it has no impact on gauge operation or performance. Therefore, the menu will remain displayed indefinitely, or until the operator takes action or the gauge is reset. When the gauge is stopped awaiting operator input, however, the gauge's display is blanked and the outputs are frozen (for example, awaiting input while editing a register). In this state, if there is no terminal keyboard activity for approximately one minute, the operation will time-out, and the gauge is returned to its operating mode.

DATA MONITORING

Selecting "X" from the menu will EXIT the menu and begin data monitoring. (If the gauge was in **Program Mode**, it will be returned to **Measure Mode** to allow data monitoring. The "X" menu item will include this message as appropriate, when refreshed.)

During data monitoring, every analog-to-digital conversion from the pressure sensor is displayed on the terminal. The additional load of the continuous serial communication will slightly reduce the overall performance of the gauge. The resulting data rate will typically be about ten (10) conversions per second, depending on various operating conditions. Note that the data sent to the terminal *will be damped* according to the damp rate set in register P2 (see page 8).

The data includes the pressure value and Engineering Units, as well as the output status as appropriate (SET1 ON, SET2 ON, or the 4-20 mA value). Note that this status indication is the internal calculated value, as there is no feedback hardware on the gauge. Finally, "Over Pressure!" is indicated if the input pressure exceeds 120% of the full scale sensor range (this indication acts immediately, regardless of the damp rate setting).

If the gauge is taken out of **Measure Mode**, the data monitoring function will pause with a message. (The menu is available at this time, as it is at any time, by hitting ENTER from the terminal.) When the gauge is returned to **Measure Mode**, if the menu was not activated, data monitoring will automatically resume.

Data logging can be accomplished be invoking the appropriate logging function of the terminal software.

To EXIT the data monitoring function, simply hit ENTER on the terminal to restore the menu.

LOCKOUT

If the lockout feature is active (see register P0, page 6), the serial menu will prompt for the lockout code when necessary. For security purposes, an asterisk (*) is displayed instead of the character as it is typed. When entering a new lockout code through the serial port, however, the code is displayed as it is typed, since there is no confirmation step.

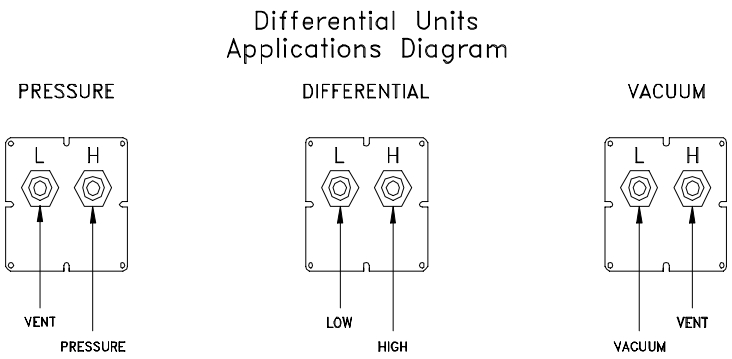
ERROR CODES

All Smart Gauge models have an error/message feature to inform the operator of problems with the operation or programming of the gauge. These Error Codes and messages are identified and described in the table below.

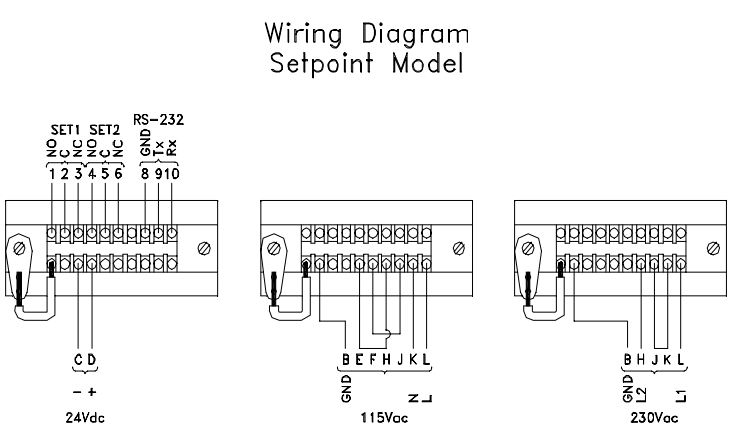
ERROR	DESCRIPTION
"OP"	Overpressure warning. The measured pressure exceeds the full scale pressure by 20% of full scale or more (high or low) . Sensor is at risk of permanent damage!
E001	Automatic Shutoff timer has expired (Battery model only); gauge is shutting down normally.
E002	Requested ZERO value is not within 5% of full scale pressure, and therefore ignored.
E003	Requested SET1 or SET2 is out of range. Must be greater than 0, and less than +120% Full Scale.
E004	Requested new SET1 or SET2 value is equal to the other programmed value on Current Loop models. This configuration is not acceptable. If attempting to disable the output, simply set programmable register P5 to 0 (see page 12).
E006	User Entered incorrect Lockout Code. Gauge is locked. A view-only status will be entered if **Program Mode** was requested (see page 18).
E007	Requested Full Tank Hydrostatic Pressure Value (P4) is invalid. Value must be > 0.
E008	Requested Cylindrical or End Volume (P9/P10) invalid. Value must be > 0 or = 0.
E010	Full Scale Range for Engineering Units selected is beyond scale of display (>19,999). This message would be seen, for example, during reset/power up of a gauge programmed for 10,000 gallons, with liters last selected, since the corresponding full scale display of 37,853 liters will not fit on the 4½ digit display.
E020	Low Battery (or power supply) Warning. This error will show repeatedly approximately every 10 seconds, so long as the voltage supply remains low.
E030*	EEProm Error. Display alternates between "E030" and a sub-error code.

* Error codes of 030 and above indicate hardware or other internal problems; if the problem cannot be corrected by cycling the input power supply on and off, please take note of the error code and operating conditions, and contact Meriam Instrument at (216) 281-1100.

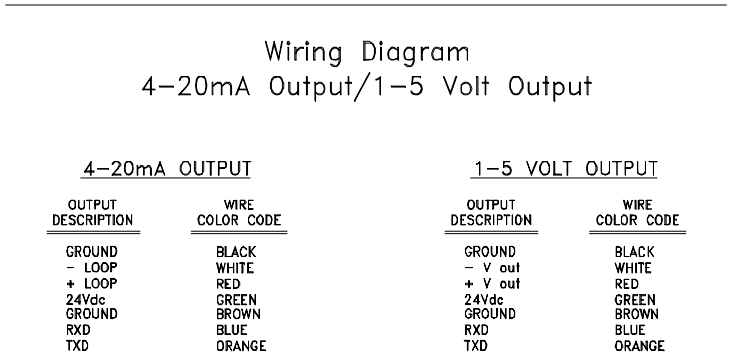
INSTALLATION AND WIRING



Differential pressure sensors have two pressure connections on the back of the gauge. The diagram at the left shows the correct connections to obtain the desired type of pressure measurement. Gauge-Isolated pressure gauges have only one pressure connection.



The **SetPoint model** utilizes the multi-function terminal strip shown at the left. This terminal strip has a NEMA 1 rating. SPDT relays are not powered by the gauge internally. Jumpers from the 24Vdc, 115Vac or 230Vac power sources can be used if required.



4–20mA OUTPUT

OUTPUT DESCRIPTION	WIRE COLOR CODE
GROUND	BLACK
– LOOP	WHITE
+ LOOP	RED
24Vdc	GREEN
GROUND	BROWN
RXD	BLUE
TXD	ORANGE

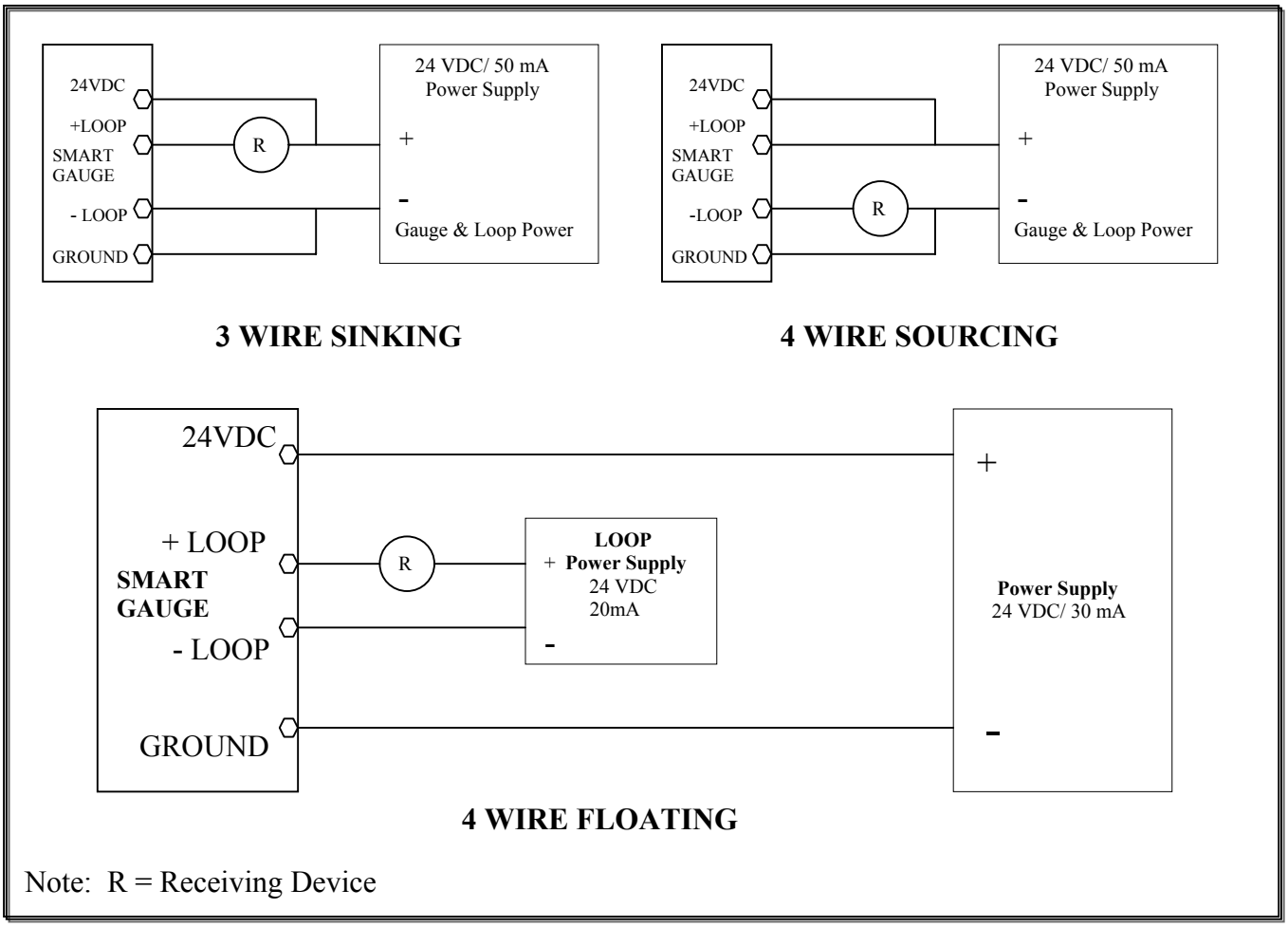
1–5 VOLT OUTPUT

OUTPUT DESCRIPTION	WIRE COLOR CODE
GROUND	BLACK
– V out	WHITE
+ V out	RED
24Vdc	GREEN
GROUND	BROWN
RXD	BLUE
TXD	ORANGE

The **Current Loop model** uses a cannon connector that is designed to meet NEMA 4X requirements. The charts at the left show the terminal and wiring arrangement. Wiring schematics for the three and four wire, 4 to 20 mA loops are shown on page 23.

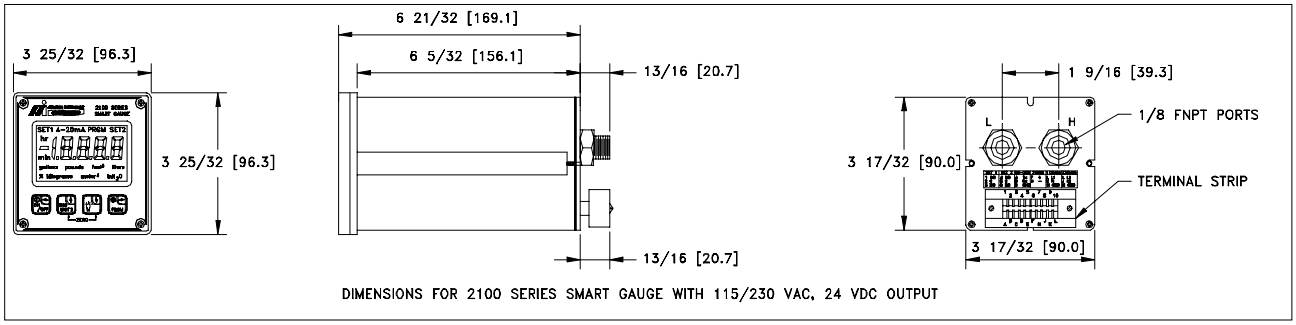
Note: The Smart Gauge comes with a 3/16" stainless steel 1/8" FNPT pressure port(s). The Smart Gauge should be panel-mounted or held firmly in one *hand* while a small wrench is used to tighten the 1/8" MNPT pipe thread. **DO NOT USE** the large nut holding the pressure connection in the bulkhead to hold the Smart Gauge while the pressure connector is installed. If the bulkhead nut is loosened, it is possible for the sensor and sensor board to be turned inside the Smart Gauge body. This can damage the sensor board.

CURRENT LOOP MODEL LOOP WIRING



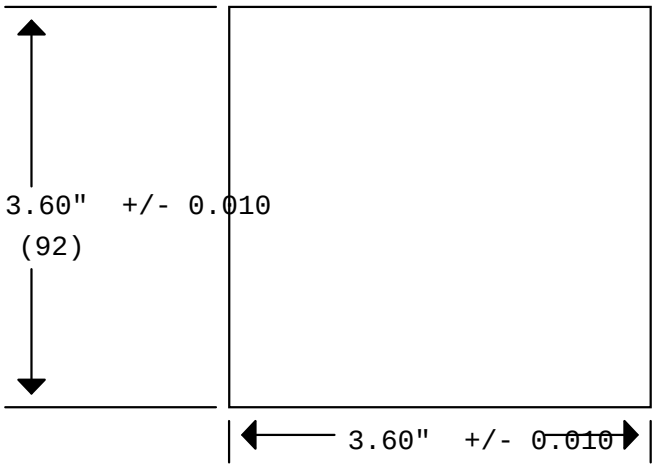
Note: R = Receiving Device

OUTLINE DIMENSIONS



PANEL MOUNTING

PANEL MOUNTING CUTOUT DIMENSIONS



( ) DIMENSIONS IN MILLIMETERS

1. Make a ¼ DIN panel cutout per drawing.
2. Remove the two 6-32 socket head screws in the grooves at the rear of the gauge.
3. Slide the panel mount jacks out of the groove.
4. Insert the gauge through the front of the panel.
5. From the rear, insert the panel mount jacks in the grooves on the side of the gauge, and slide them firmly against the panel.
6. Replace the two 6-32 socket head screws in the grooves behind the panel mount jacks.
7. Tighten the panel mount jack against the panel with the two socket head screws.
8. Refer to the note on page 22 when making pressure connections.

PROGRAMMABLE REGISTER QUICK REFERENCE

Px	Name	Description	Value Range	Notes
P0	Lockout Code	Lockout for security.	00 to 99	00 = Disabled.
P1	Timeout	Automatic shutoff in minutes of keypad inactivity.	0 (disabled), 1, 2, 5, 10, 15, 25	Battery model only.
P2	Damp Rate	Exponential damping time in seconds.	0.1, 0.2, 0.5, 1, 2, 5, 10, 15, 25, 50	0.1 = No Damping.
P3	Residual Hydrostatic Pressure	Identifies the unmeasured or added hydrostatic pressure due to piping configurations.	-9,999 to +9,999 inH_2O @ 20ºC.	+Val: Dip Tube - Val: Direct Head
P4	Full Tank Hydrostatic Pressure	The pressure created by a full column of fluid from the floor of the tank to the top of the maximum level measured.	0 to 9,999 (Keypad) 0 to 19,999 (Serial)	Pressure in inH_2O @20°C.
P5	SetPoint Options	SetPoint Model: defines which relay outputs are active.	0 = Disabled. 1 = SET1 only. 2 = SET2 only. 3 = Both enabled.	Not found on Battery model.
		Current Loop Model: defines the status of the 4 - 20 mA output.	0 = 4-20 disabled 1 = 4-20 enabled	
P6	SET1	Controls SET1 relay or 4.00 mA value.	–20% to +120% FS	User defined value.
P7	SET2	Controls SET2 relay or 20.0 mA value.	–20% to +120% FS	User defined value.
P8	Deadband	Sets the amount of deadband in percent of full scale for relays.	0 (disabled), 0.1, 0.2, 0.5, 1, 2, 5, 10%	SetPoint model only.
P9	Tank Cylindrical Capacity	The capacity, in Engineering Units, of only the *cylindrical portion* of the tank.	0 to 9,999 (Keypad) 0 to 19,999 (Serial)	P9 = 0 for spherical tanks.
P10	Tank Ends Capacity	The capacity, in Engineering Units, of only the *dished ends* of a horizontal cylindrical tank (includes *both* ends). Or, total capacity for spherical tanks.	0 to 9,999 (Keypad) 0 to 19,999 (Serial)	P10 = 0 for linear tanks, or cylindrical tanks with *flat* ends.
P11	Tank Type	Identifies type of tank.	0 = Linear/Vertical 1 = Non Linear	

PROGRAMMABLE REGISTER QUICK REFERENCE

Px	Name	Description	Value Range	Notes
P0	Lockout Code	Lockout for security.	00 to 99	00 = Disabled.
P1	Timeout	Automatic shutoff in minutes of keypad inactivity.	0 (disabled), 1, 2, 5, 10, 15, 25	Battery model only.
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