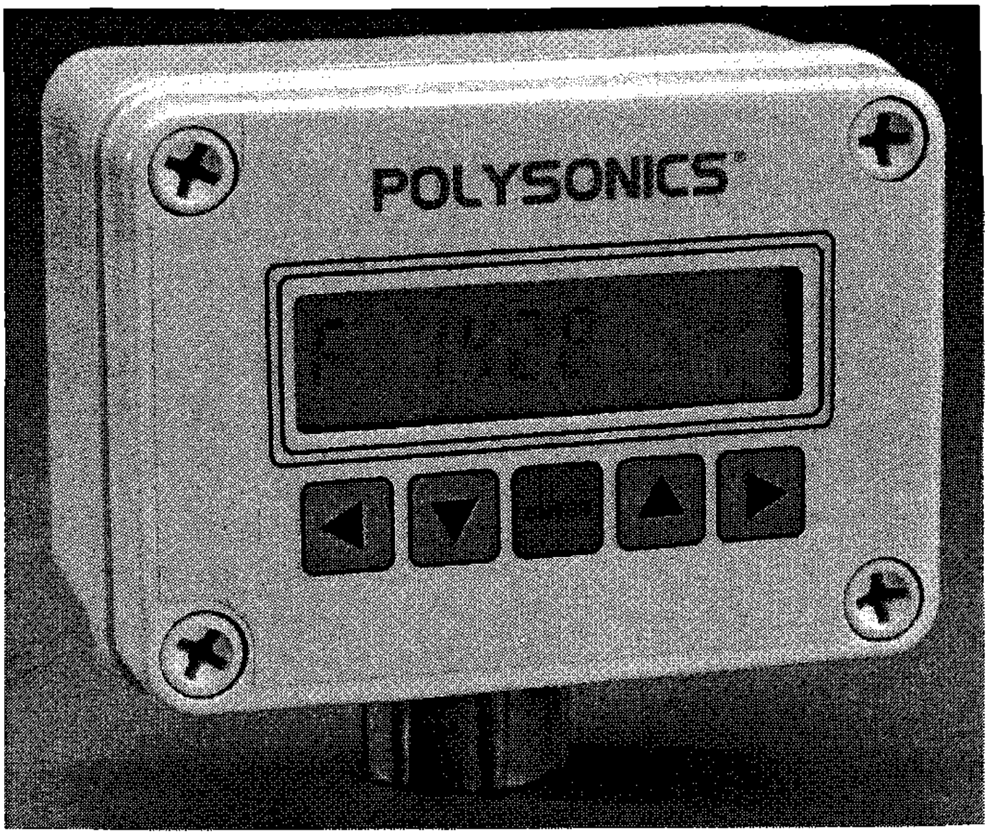
2110-8000
May 1997

2110 Flow Monitor



Software Version 1.4 Onwards

POLYSONICS®

INSTRUCTION MANUAL

2110 FLOW MONITOR

Software Version 1.4 Onwards

Notice

This manual is designed to promote personal and system safety and to optimize product performance. It should be read carefully before installing, using, or maintaining the flow monitor. If the product is used in a manner not specified by **POLYSONICS**, the protection provided by the product may be impaired.

If a problem occurs that is not resolved in the manual, refer to Chapter 4 for more information on additional service and support.

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2110 Flow Monitor

PRODUCT OVERVIEW

The 2110 flow monitor is a low-cost, battery powered, microprocessor-based instrument for measuring flow rate and totalized flow. The 2110 measures flow in pipes with inner diameters (IDs) of .5 to 96 inches (12.7 to 2438 millimeters). The flow monitor provides a digital readout of the fluid flow and totalized flow in various engineering units and scales. Its battery powered design allows operation in remote locations and eliminates the possibility of shutdown due to loss of AC power. The flow monitor has a polycarbonate enclosure that conforms to NEMA 4X (IP65) and NEMA 12 specifications.

The flow monitor is available with one of the following sensor inputs:

- Radio frequency (RF) signal type (Section 1.1) for use only with RF type sensors. The RF signal type flow monitor is designated as Model 2110R.
- Magnetic signal type (Section 1.2) for use with industry standard magnetic sensors. The flow monitor with the magnetic signal type is designated as Model 2110M.

IMPORTANT: The flow monitor's signal type must be the same as that of the sensor. (For example, if the flow monitor has an RF signal input, the sensor must also be RF signal type.)

1.1 RF Signal System

The Model 2110R determines the presence of a single ferrite target on the sensor's impeller. Unlike the magnetic signal system, the RF signal system uses no magnets. If the Model 2110R flow monitor is matched with the Model 400R sensor, it is possible to measure flows as low as 0.3 feet per second (0.09 meters per second). This system also has superior electromagnetic field (EMF) rejection to minimize interference from external sources such as motors and motor controllers.

1.2 Magnetic System

In the magnetic system, each of the six blades of the sensor's impeller contains a small magnet. As the flow stream rotates the impeller, the magnets energize a coil which produces a low level millivolt signal. The frequency of the signal is proportional to the flow rate. If the Model 2110M flow monitor is matched with the Model 400M sensor, the minimum measurable flow is 1 foot per second (0.3 meters per second).

NOTE: The Model 2110M flow monitor accepts the output from most industry standard magnetic insertion impeller sensors.

1.3 External Features

Figure 1-1 illustrates the 2110's external features:

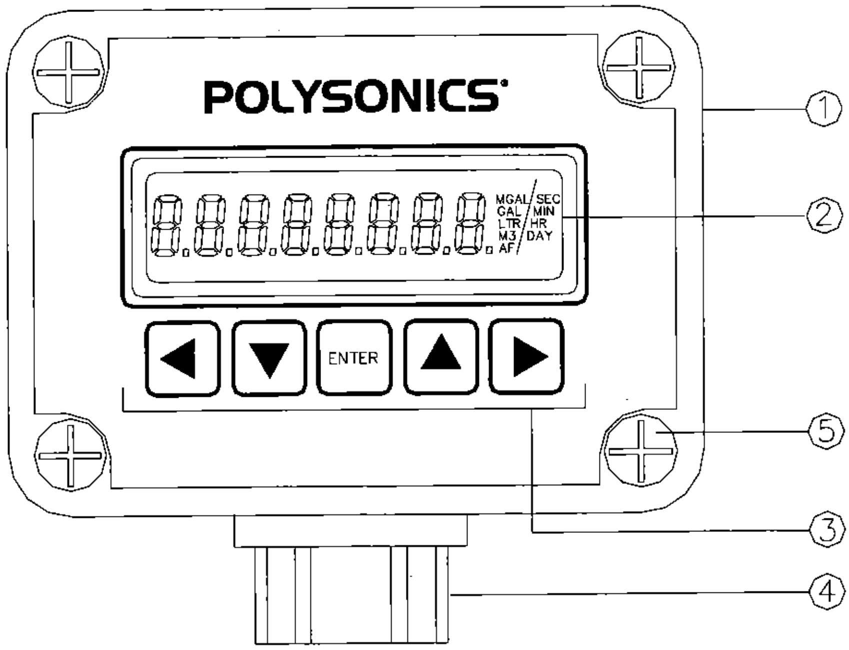

***Figure 1-1** 2110 External Components*

① NEMA-4X (IP65) enclosure

② LCD display

③ Keypad

④ 1/2 in (12.7 mm) female National Pipe Thread (FNPT) conduit fitting

⑤ Cover screws

1.4 Battery Type

The flow monitor operates on two 1.5-volt alkaline C cell batteries which are supplied. Alternatively, the unit can operate on one 3-volt lithium battery (available from most battery suppliers) by moving a jumper setting. Refer to Section 2.3 for information on battery installation and jumper settings.

1.5 Software Upgrades

The most current software version available is installed in the 2110 prior to shipment. When configuring the flow monitor, the display indicates the number of the software version currently installed in the flow monitor (Section 3.4). Contact the flow monitor representative or distributor to determine the current version that is available. Software upgrades must be performed by the factory.

1.6 Standard Configuration and Options

The standard configuration and options for the 2110 flow monitor are designated by the model code numbers listed in Table 1-1. For example, the model code 2110R1F describes a 2110 with the following options:

- RF sensor input
- Field mount

Table 1-1
2110 Flow Monitor Standard Configuration and Options

Description	Model Code Number
Product	
Battery-powered flow monitor with rate and total display	2110
Input type	
■ RF sensor input - direct mount, no signal amplifier	R1
■ RF sensor input - remote mount, complete with signal amplifier accessory	R2
■ Magnetic sensor input - remote or direct mount, no signal amplifier	M1
■ Magnetic sensor input - remote mount, complete with signal amplifier accessory	M2
Installation	
■ Field mount - NEMA 4X (IP65)	F
■ Panel mount - NEMA 4X (IP65) with bracket	P

1.7 Specifications

Table 1-2
2110 Flow Monitor Specifications

Physical specifications	
Enclosure	
Rating	NEMA 4X (IP65), NEMA 12
Material	Polycarbonate
Dimensions	Width: 4.33 in (110 mm) Height: 3.15 in (80 mm) Depth: 2.75 in (70 mm)
Conduit connection	1/2 in FNPT
Performance specifications	
Accuracy	±0.2% reading
Input frequency	Model 2110R: 0 to 52 Hz (0 to 3120 rpm) Model 2110M: 5 to 190 Hz (100 to 3800 rpm)
Pipe dimensions	0.5 to 96 in (12.7 to 2438 mm)
Resolution	± 0.1% (The internal calibration coefficients are calculated to produce a 0.1% resolution for the pipe diameter and units selected when operating at the maximum flow rate of 30 FPS [9.15 MPS].)
Scale factor	User adjustable for ±50% of flow
Volumetric units (for flow rate and totalizer)	Gallons, liters, cubic meters, acre feet, cubic feet, million gallons.
Time units (flow rate)	Second, minute, hour, day.
Totalizer display	8 digits, selectable resolution.
Display update period	1 second
Damping	Selectable: 4, 8, 16, 32, or 64 seconds
Zero time	Same as selected damping
Functional specifications	
Power requirements	Two alkaline 1.5 VDC C cell batteries or one lithium 3.0 VDC C cell battery
Battery life expectancy[1]	3 to 5 years depending on application conditions.
Non volatile memory	EEPROM
Display	8-character custom LCD. Character height 0.35 in (8.89 mm).
Operating humidity	90% (non condensing)
Operating temperature[2]	-20 to +165°F (-29 to +74°C)
Storage temperature	-30 to +176° F (-35 to +80°C)

[1] Extremes in temperature may adversely effect battery life. Use of a lithium battery is recommended for operation in temperatures below 20°F (-6.7°C).

[2] The LCD is not viewable below -4°F (-20°C)

INSTALLATION AND MAINTENANCE

The following installation and maintenance is required for operating the 2110:

- Enclosure installation (Section 2.1)
- Wiring connections (Section 2.2)
- Battery replacement (Section 2.3

⚠ *CAUTION:* To avoid damage to the flow monitor wiring, exercise caution when removing and replacing the enclosure cover.

2.1 Mounting the Enclosure

The 2110 can be directly mounted to the sensor (Section 2.1.1) or can be mounted separately from the sensor on a wall (Section 2.1.2) or in a panel (Section 2.1.3).

2.1.1 MOUNTING THE ENCLOSURE DIRECTLY ON THE SENSOR

The 2110 can be directly mounted with pipe fittings to an insertion impeller sensor. The 2110 has a 1/2-inch female National Pipe Thread (FNPT) fitting ① (Figure 2-1). Many industry standard insertion impeller sensors have a 1-inch FNPT fitting. The following pipe fittings are required for coupling the two fittings sizes together (Figure 2-1):

- 1/2-inch pipe nipple ②
- 1/2-inch to 1-inch pipe reducer ③
- 1-inch pipe nipple ④

The 1/2-inch pipe nipple ② should be sufficiently long (a minimum of 6 inches [152 millimeters] for most applications) to allow the sensor to be inserted to its proper depth. If the nipple is too short, the all-threads ⑤ will contact the flow monitor enclosure as they are tightened down.

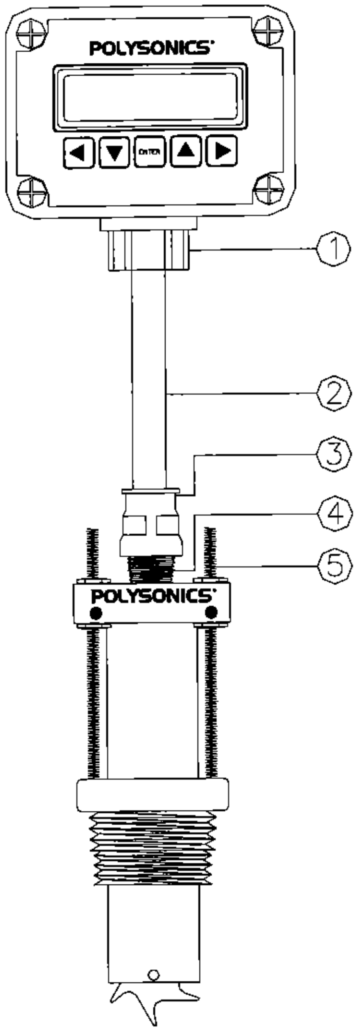

Figure 2-1 Mounting the Enclosure to the Sensor

To mount the 2110 to the sensor:

1. Unscrew the four enclosure cover screws and remove the enclosure cover.
2. Assemble the pipe fittings. Use pipe tape at all joints if metal fittings are used.
3. Route the sensor cable through the pipe fittings.
4. Screw the pipe fittings to the sensor.
5. Route the sensor cable into the 2110 through the FNPT fitting.
6. Screw the 2110 to the other end of the pipe fittings.
7. Connect the sensor wiring (Section 2.2).
8. Replace the enclosure cover.

2.1.2 MOUNTING THE ENCLOSURE TO A WALL

To mount the 2110 to a wall (Figure 2-2):

1. Select a mounting location that is within reach of the sensor wiring.
2. Unscrew the four enclosure cover screws and remove the enclosure cover.

   Four wells ① are located in the corners of the enclosure beneath the cover screws. These wells provide a passageway for inserting the enclosure mounting screws ②.
3. Place a mounting screw ② into each well and drive the screws into the wall ③.
4. Connect the sensor wiring (Section 2.2).
5. Replace the enclosure cover.

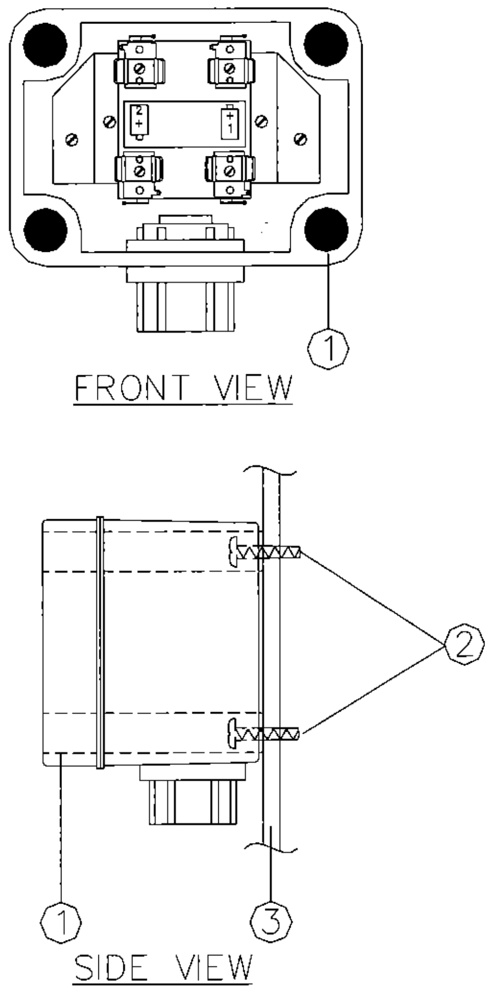

***Figure 2-2** Mounting the Enclosure to a Wall (enclosure cover not shown)*

2.1.3 MOUNTING THE ENCLOSURE IN A PANEL

If the panel mount option is ordered (Section 1.6), the flow monitor enclosure can be mounted in a panel as follows:

1. Select a mounting location that is within reach of the sensor wiring.
2. Cut a hole in the panel exactly 3.16 inches high by 4.35 inches wide (80.3 millimeters high by 110.5 millimeters wide). The corners should have a radius of 0.34 inches (8.6 millimeters).
3. Remove the enclosure cover.
4. Connect the sensor wiring (Section 2.2).
5. Position the panel-mount bracket between the enclosure and the enclosure cover and tighten the enclosure cover screws.
6. Apply structural tape (3M® #4951 or equivalent) to the exposed front perimeter of the mounting bracket.
7. From inside the panel, install the flow monitor into the precut hole and press the bracket against the panel to cause the tape to adhere.

2.2 Wiring

All wiring to the 2110 is routed through the 1/2-inch FNPT fitting. The wiring requirements vary according to which model is being installed (Model 2110M or Model 2110R).

The Model 2110M should be connected to twisted, two-wire, shielded cable with a minimum gauge of 24 AWG. The cable ① (Figure 2-3) is run from the sensor ② to the enclosure ③ with a maximum length of 1000 feet (304.8 meters). The wiring should be routed through conduit or cable gland to seal the enclosure.

NOTE: Contact the representative or dealer regarding requirements for cable runs for a Model 2110M which exceed 1000 feet (304.8 meters).

The Model 2110R uses a special two-wire, low capacitance, non-shielded cable from the factory with a maximum length of 3 feet (.91 meters). The Model 2110R cannot function if additional cable length or a different type of cable is used. The factory cable should be run through PVC conduit to seal the enclosure and to keep the cable from close proximity to metal objects. Metal conduit should not be used on a Model 2110R.

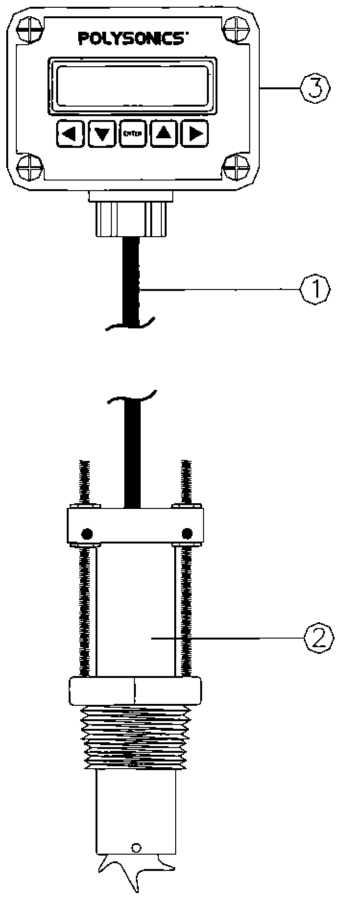

Figure 2-3 *System Wiring*

2.2.1 GENERAL WIRING CONNECTIONS

To connect the wiring to the 2110 (Figure 2-4):

1. Mount the enclosure (Section 2.1).
2. Place the cover ① above the enclosure ②.
3. Route the wiring ③ from the sensor through the FNPT fitting of the 2110 ④.
4. Connect one of the insulated sensor wires to Terminal 1 ⑤.
5. Connect the other insulated sensor wire to Terminal 2 ⑥.

   NOTE: The insulated sensor wires are interchangeable.

6. Connect the bare shield wire to Terminal S ⑦. (This applies to **POLYSONICS** magnetic style sensors.)

IMPORTANT: When connecting a magnetic sensor from a manufacturer other than **POLYSONICS**, connect the shield wire to Terminal S *only if specified by the manufacturer*. If the shield wire is connected when it is not specified, a ground loop may occur, resulting in degraded performance.

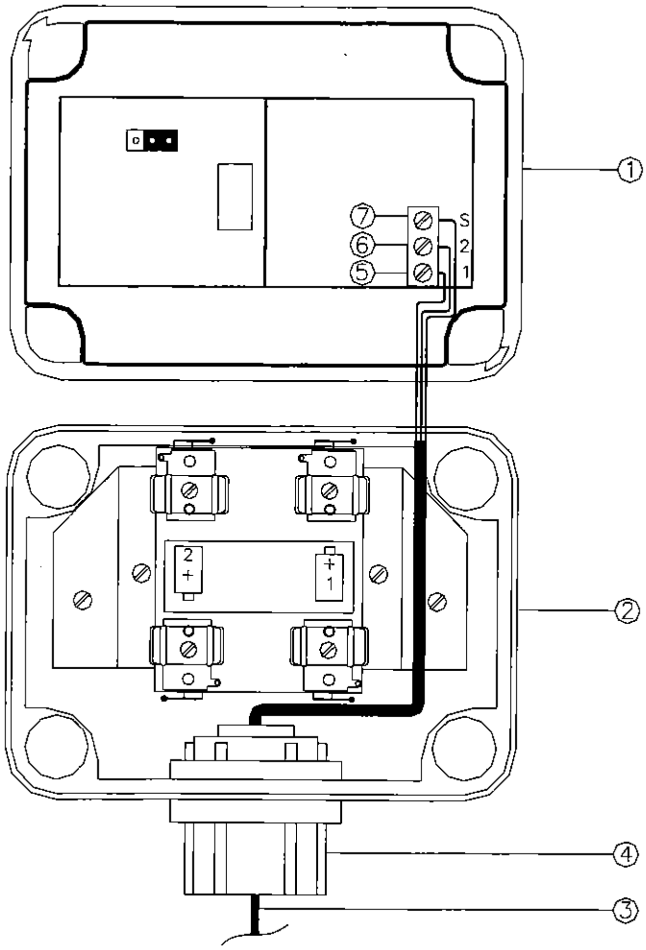

Figure 2-4 *Wiring Connections (Model 2110M shown with shield wire)*

2.3 Battery Replacement

The 2110 can operate on two 1.5-volt alkaline C cells which are supplied with the flow monitor (Figure 2-5) or one 3-volt lithium C-cell (Figure 2-6). The batteries are accessible by removing the enclosure cover. The battery type can be reconfigured by changing a jumper setting (Section 2.3.3).

NOTE: A 3-volt lithium C-cell such as the Panasonic Model BR-CSSP or the Tadiran Model TL 5920 is available from most battery suppliers. Lithium batteries are capable of performing under lower temperatures than alkaline batteries, but have a shorter life.

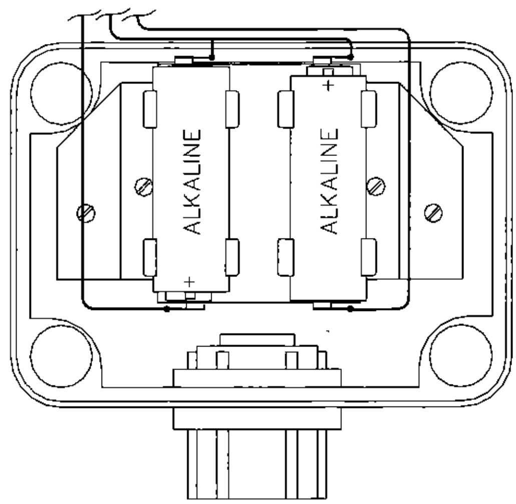

Figure 2-5 *Alkaline Batteries Installed*

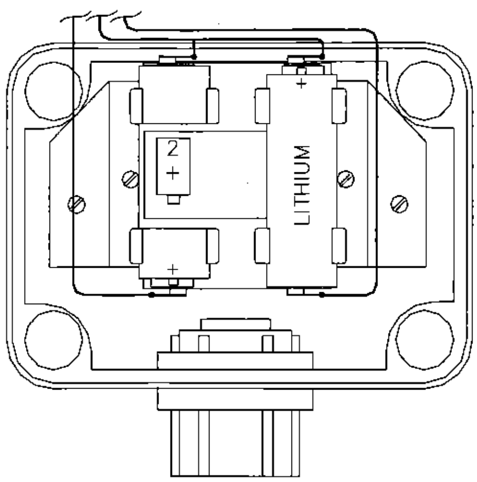

Figure 2-6 *Lithium Battery Installed*

Estimated battery life is 3 to 5 years depending on application conditions. Extremes in temperature may adversely affect battery life. Use of a lithium battery is recommended for operation in temperatures below 20°F (-6.7°C).

When battery voltage drops to approximately 2 volts, the following warning is displayed to indicate the need for battery replacement:

Lo bAtt

The low battery message displays for several weeks. When the total battery voltage drops below 1.25 volts, the 2110 shuts down. After the batteries are replaced, the flow monitor resumes operation with the same parameters and the same totalizer reading it had prior to shutdown.

NOTE: The battery compartments are designed to hold the batteries firmly in place, even in environments with high levels of vibration. A moderate amount of force may be required to remove the batteries from the battery compartments. A tool such as a screwdriver may be used to assist in removing the batteries. An intermittent display or erratic flow measurement may indicate that a battery is loose.

WARNING

Lithium batteries can explode, causing blindness, other serious injury, or death. Observe the following precautions when handling lithium batteries:

1. Use only *internally fused* or *bobbin type* lithium batteries.
2. Do not subject the lithium battery to temperatures higher than the manufacturer's rating.
3. Do not allow lithium batteries to short out. *Do not check the strength of lithium batteries with an ammeter.*

2.3.1 BATTERY REMOVAL

To remove a battery:

1. Remove the enclosure cover.

   The batteries are secured by a tie wrap to hold them in position.

2. Cut the tie wrap.
3. Lift up the battery (positive terminal end first) and remove it from its compartment.

NOTE: If removing a lithium battery, it should be disposed of in a designated hazardous waste site or returned to the manufacturer for disposal.

2.3.2 BATTERY INSTALLATION

⚠ ***CAUTION:*** To avoid damage to the flow monitor, ensure that the positive and negative orientation of the battery is correct *before* installing it. Do not install two lithium batteries or a combination of lithium and alkaline batteries.

To install a new battery:

1. If the flow monitor operates in an environment with high levels of vibration, replace the tie wrap that was used to secure the batteries.
2. Determine the correct positive and negative orientation of the battery by referring to Figures 2-5 and 2-6 or the polarity diagram on the battery compartments.

   IMPORTANT: If a lithium battery is used, it must be installed in battery compartment number 1 as indicated on the polarity diagram.
3. Place the battery (negative terminal end first) into the compartment and press firmly on the battery to seat it.

2.3.3 CHANGING THE BATTERY TYPE

The 2110 can operate on two 1.5-volt C cell alkaline batteries or one 3-volt lithium battery. A jumper is used to change the battery type.

To change from one battery type to another (Figure 2-7):

1. Remove the enclosure cover.
2. Remove the existing batteries (Section 2.3.1) and replace them with the correct number of batteries of the other type. Observe the ***WARNING*** and ***CAUTION*** statements in Sections 2.3 and 2.3.2.
3. Remove the jumper from the jumper terminal block ④.

   When the jumper is removed, the following three terminals are revealed:

   - Alkaline terminal ①
   - Common terminal ②
   - Lithium terminal ③
4. Connect the jumper as follows:

   - Between the alkaline terminal ① and the common terminal ② for alkaline usage (as shown in Figure 2-7)
   - Between the lithium terminal ③ and the common terminal ② for lithium usage

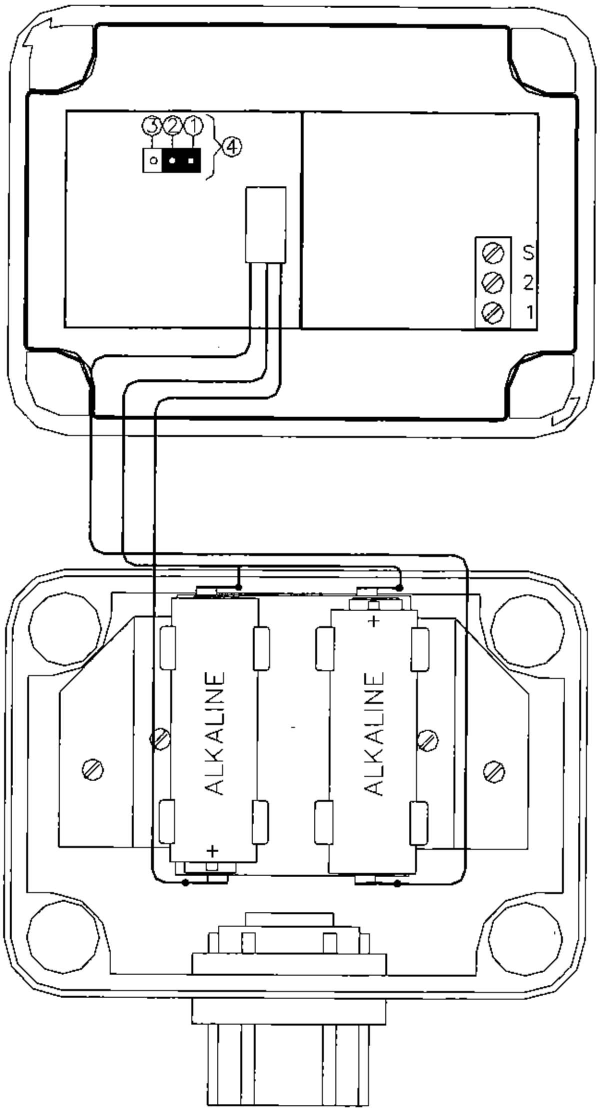

Figure 2-7 Battery Jumper (shown configured for alkalines)

CONFIGURING AND OPERATING THE 2110

The 2110 is keypad-programmable and easy to use. To program the unit, the flow units and inside pipe diameter are selected. The internal microprocessor then calculates all configuration coefficients to produce the flow rate and totalizer value. The configuration settings are stored in non-volatile memory and are retained in the event of battery failure. In addition, the totalizer value is stored in non-volatile memory every hour.

3.1 Powersaver and Constant Display Modes

The 2110 is powered up whenever the batteries contain a combined voltage greater than 1.25 volts (Section 2.4). The flow monitor can operate in the constant display mode for ease of viewing or in the powersaver mode to conserve batteries. The powersaver mode turns off the display after one minute has elapsed without a keypad entry. The display can be reactivated by pressing any key. The totalizer continues to increment during powersaver mode.

The flow monitor is shipped with powersaver mode enabled. To change from powersaver mode to constant display mode (or vice versa), refer to the configuration procedure (Section 3.4).

3.2 Displaying Flow Rate, Totalizer, and Totalizer Hours

During normal operation, the 2110 displays one of the following screens:

- Flow Rate (Section 3.2.1)
- Totalizer (Section 3.2.2)
- Totalizer Hours (the number of hours since the totalizer was last reset) [Section 3.2.3]

To switch between the screens, press any key while the display is on. Although there are only eight digits available, the flow monitor is capable of representing flow rates and totalized values which require more than eight digits to display. This is done by displaying a multiplier where required.

3.2.1 FLOW RATE SCREEN

The Flow Rate Screen is identified by an **F** on the far left of the display, followed by the flow rate. The following example indicates a flow rate of 12.58 gallons per minute:

F	1 2 .5 8	GAL / MIN

If the flow rate requires more than 4 digits to be displayed, the numeric value is followed by a multiplier in the form of an exponent. For example:

```
F   1 2.5 8   3 GAL/MIN
```

In the previous example, the display indicates a flow reading of 12.58 gallons per minute with an exponent of 3. The exponent 3 multiplies the reading by 10^3, or 1,000. Therefore the reading 12.58 3 represents 12.58 x 1,000 or 12,580 gallons per minute.

A very *low* flow reading can also be represented by displaying a *negative* exponent after the flow rate. For example:

```
F   1 2.5 8  -3 GAL/MIN
```

In the previous example, a flow reading of 12.58 gallons per minute is multiplied by a factor of 10^{-3}. (that is, multiplied by .001.) Therefore, the reading 12.58 -3 represents 12.58 x .001 or .01258 gallons per minute.

The following exponents can be displayed:

- -9, which multiplies the flow rate reading by .000000001 (shifts the decimal place left 9 places)
- -6, which multiplies the flow rate reading by .000001 (shifts the decimal left 6 places)
- -3, which multiplies the flow rate reading by .001 (shifts the decimal left 3 places)
- 3, which multiplies the flow rate reading by 1,000 (shifts the decimal right 3 places)
- 6, which multiplies the flow rate reading by 1,000,000 (shifts the decimal right 6 places)
- 9, which multiplies the flow rate reading by 1,000,000,000 (shifts the decimal right 9 places)
- No exponent, which indicates that the reading is not multiplied or divided. The reading represents the actual totalized value.

The following variables determine which exponent is displayed, the location of the decimal point, and the number of significant digits used to indicate flow:

- Pipe size
- Fluid velocity
- Resolution selection for the Flow Rate Screen

The following resolution selections are available for the Flow Rate Screen:

- HI (High resolution. Used for relatively *low* flow rates.)
- LO (Low resolution. Used for relatively *high* flow rates.)
- AU (Average resolution. Used for medium flow rates.)

If the screen is not displaying enough digits, a higher flow resolution should be selected. Alternatively, if the screen is displaying too many insignificant digits, a lower resolution should be selected. Experimentation with the resolution selections is recommended for achieving optimum results.

3.2.2 TOTALIZER SCREEN

The resolution of the totalizer (as indicated by the location of the decimal point and any multipliers) is dependent upon the selected pipe size and totalizer volumetric unit. Small pipe sizes combined with relatively large volumetric units tend to produce small numbers with several digits to the *right* of the decimal point. Alternately, large pipe sizes combined with relatively small volumetric units tend to produce large numbers with several digits to the *left* of the decimal point.

Based on the totalizer volumetric unit and pipe size, a multiplier may be displayed in the form of an exponent. This exponent is displayed as a single digit on the right of the display and is located between *two* decimal points. (If the totalized value contains only a *single* decimal point or *no* decimal point at all, the totalized value does not have a multiplier.)

Based on the selected pipe size and the totalizer volumetric unit, the flow monitor offers three optimum totalizer resolution selections during the configuration procedure (Section 3.4). For example, depending on the pipe size selected, the totalizer reading 179375.3 cubic meters could be represented by any one of the following displays:

```
0 1 7 9 3 7 5.3   M3
```

```
0 0 1 7 9 3 7 5   M3
```

```
0 0 1 7 9 3 7.1. M3
```

In the first of the three examples, there is only a single decimal point (no multiplier displayed). The display therefore simply indicates 179375.3 cubic meters. The totalizer in this example advances in 0.1 cubic meter increments.

In the second example, there is no exponent and no decimal point. The display therefore simply indicates 179375 cubic meters. The totalizer in this example advances in 1 cubic meter increments.

In the third example, there is an exponent of 1 located on the right between two decimal points. The exponent 1 multiplies the reading by 10^1, or 10, as follows: 17937 x 10 = 179370 cubic meters. The totalizer in this example advances in 10 cubic meter increments.

When selecting a totalizer resolution (Section 3.4), be aware that the higher the totalizer resolution, the faster the totalizer fills up. If the totalizer fills up, it does not increment to the next exponent. For example, if the totalizer reading was 9999999.1. GAL, the display would next roll over to 0000000.1. GAL. It would not roll over to 1000000.2. GAL.

3.2.3 TOTALIZER HOURS SCREEN

The totalizer can be reset in the configuration procedure (Section 3.4). The number of whole hours that have elapsed since the last time it was reset are displayed in the Totalizer Hours Screen and are stored in non-volatile memory:

```
00000 HR
```

A maximum of 65,536 totalizer hours can be displayed (approximately 7 1/2 years).

3.3 Keypad and Display

The keypad provides access to the microprocessor for configuring the 2110. The display has eight programmable digits and nine dedicated flow unit indicators. Numeric entries to the flow monitor are made one programmable digit at a time.

To make a numeric entry (Figure 3-1):

1. Cursor to the desired programmable digit ⑥ with the ◀ and ▶ keys ① ⑤.

   One of the digits flashes to indicate that it is active.

2. Increase or decrease the digit's value by pressing the ▼ and ▲ keys ② ④.
3. Repeat steps 1 and 2 for all digits.
4. Press **ENTER** ③.

The 2110 can display the following symbols:

- 8 variable digits or characters ⑥
- Dedicated volumetric unit indicators ⑦
- Dedicated flow rate time unit indicators ⑨
- **/** "Per" symbol, which separates the flow rate volumetric unit from the flow rate time unit, for example **LTR / MIN** (liters *per* minute)

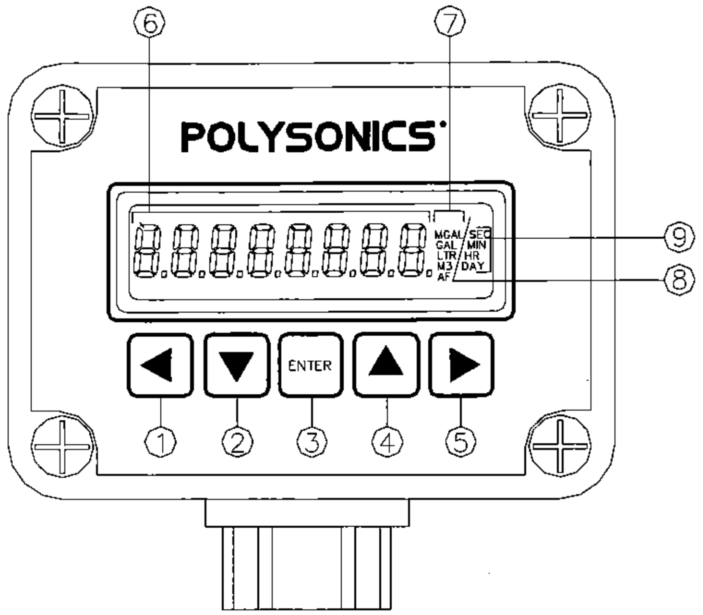

Figure 3-1 *Keypad and Display*

3.4 Configuration

The configuration function is used to program the flow monitor and to check the program setup parameters. While in the configuration mode, the totalizer continues incrementing and the powersaver feature is disabled. (The display remains on even if no keys are pressed).

To configure the 2110:

1. Simultaneously press the ▼ and ▲ keys and hold them down for several seconds.

   The following screens are displayed in sequence:

   - ConFig (indicates that the flow monitor is in the configuration sequence)
   - UEr 0.0 (indicates the software version number)

2. Complete one of the following steps to select the display operation mode (Section 3.1):

   - Press the ▶ key to select constant display mode.
   - Press the ◀ key to select powersaver mode.
   - Press **ENTER** by itself to make no selection and to leave the previous display mode in effect.

The Password screen is displayed, requesting entry of the password:

PASS.0000

NOTE: For security reasons, the password is displayed as 0000 during the configuration sequence even if a current password is in effect. To view, change, or disable the password, refer to Section 3.5.

3. Enter the valid password and press **ENTER**.

   If an invalid password is entered, the flow monitor returns to the normal operating display. If the valid password is entered, the Pipe Inner Diameter (ID) screen is displayed:

   id 02.00

4. Enter the pipe ID and press **ENTER**.

   IMPORTANT: All nominal pipe IDs (schedules and classes) should be converted to actual measurements before entering them (Appendix B). The 2110 can measure flow in pipes with IDs of .5 to 96 inches (12.7 to 2438 millimeters). In addition, if a series 475 sensor is used, the effective bore diameter listed in Appendix C in table C-1 must be entered, instead of the pipe ID.

   The Scale Factor screen is displayed:

   SF 01.00

   To accurately measure flow, insertion impeller sensors must be installed at the proper depth in the pipe. (Fluid typically flows faster near the center of the pipe. Refer to *flow profile* in Appendix D.) The scale factor multiplies the flow and totalizer values by a user-selected constant which ranges from .50 to 1.50 to adjust for depth error. If the accuracy of the flow reading or totalizer reading is known to be good, the scale factor should be set to 1.00. If an invalid scale factor is entered (that is, one outside of the .50 to 1.50 range), it is ignored by the flow monitor and the unit stays in the Scale Factor screen until a valid entry is made.

   The scale factor can be used to match another instrument in the line whose flow reading or totalizer reading is known to be accurate. For example, if the 2110 indicates 98 gallons per minute and another instrument indicates 85 gallons per minute, the 2110 can be configured to read the same as the other instrument by setting the scale factor to 85/98 or 0.87. The scale factor should be used to adjust either the flow reading or the totalizer reading, whichever is more crucial.

   NOTE: If the flow is to be measured in Idaho Miner's inches, adjust the scale factor as indicated in Section 3.4.1 before proceeding.

5. Enter the scale factor and press **ENTER**.

The Totalizer Volumetric Units screen is displayed:

t GAL

The letter t (for "totalizer") is displayed on the left of the display. The totalizer volumetric unit that is currently programmed is displayed on the right in the volumetric unit indicator section of the display ⑦ (Figure 3-1).

The following volumetric units are available to the Totalizer and Flow Rate screens and can be accessed by scrolling with the ▶ key:

- MGAL - Millions of gallons
- GAL - Gallons
- LTR - Liters
- M3 - Cubic meters
- AF - Acre feet
- F3 - Cubic feet

NOTE: F3 is displayed only in the 8-character section of the display during the configuration mode. It cannot be displayed in the flow unit indicator section of the display. Therefore, if the volumetric unit section of the display is blank during normal operation, it can be assumed that cubic feet has been selected. This can be verified by re-entering the configuration mode and viewing the selected volumetric unit.

6. Select the totalizer volumetric unit and press **ENTER**.

   The Flow Rate Volumetric Units screen is displayed:

   F GAL

   The letter F (for flow rate) is displayed on the left of the display. The volumetric unit for the flow rate that is currently programmed into the flow monitor is displayed in the volumetric unit indicator section of the display ⑦ (Figure 3-1).

7. Select the volumetric unit for the flow rate and press **ENTER**.

   NOTE: The volumetric unit selected for the flow rate can be different than the volumetric unit selected for the totalizer.

   The Flow Rate Time Units screen is displayed:

   F /MIN

   The letter F (for flow rate) is still displayed on the left of the display. The flow rate time unit that is currently programmed into the flow monitor is displayed in the flow rate time indicator section of the display ⑨ (Figure 3-1).

The following flow rate time units are available:

- SEC - Second
- MIN - Minute
- HR - Hour
- DAY - Day

8. Select the flow rate time unit and press **ENTER**.

   The Flow Resolution Screen is displayed:

   F-rES LO

   The following flow resolution selections can be viewed by scrolling with the ▶ key:

   - LO - Low
   - HI - High
   - AU - Average

9. Select the flow resolution and press **ENTER**.

   NOTE: Refer to Section 3.2.1 for more information on flow resolution.

   The first Totalizer Resolution screen is displayed.

   For example:

   _ _ _ _ _ _ _ _ GAL

   The blank characters displayed on the left represent the position of the 8 digits in the Totalizer screen. The totalizer volumetric unit is displayed on the right. Three Totalizer Resolution screens can be viewed by scrolling with one of the following keys:

   - The ◀ key to scroll to screens with greater resolution

     For example:

     _ _ _ _ _ _ _ . _ GAL

   - The ▶ key to scroll to screens with less resolution

     For example:

     _ _ _ _ _ _ _.1. GAL

   NOTE: Refer to Section 3.2.2 for more information on totalizer resolution.

10. Select a totalizer resolution format by scrolling to the appropriate Totalizer Resolution screen and pressing **ENTER**.

The Reset Totalizer screen is displayed:

rESEt n

The selections available in the Reset Totalizer screen are Y (for "yes") to reset the totalizer or n (for "no") to keep the current totalizer value. The ▶ key is used to toggle between the Y and n selections. The default selection is n.

11. Select the Y or n option in the Reset Totalizer screen and press **ENTER.**

    The Damping screen is displayed:

    dP 64

    This screen is used to select the value for the damping coefficient in seconds. The damping coefficient suppresses short term fluctuations in the indicated flow rate. The displayed flow rate is a moving average of the last n seconds where n is the damping value. Increasing the coefficient increases the response time to changes. Damping should be kept at a minimum unless the velocity fluctuates wildly. If so, damping should be increased just enough to reduce the fluctuation to an acceptable degree.

    The following damping coefficients can be accessed by scrolling with the ▶ key:

    - 4
    - 8
    - 16
    - 32
    - 64

12. Select the damping coefficient and press **ENTER.**

    The flow monitor returns to the normal operating display with the new setup parameters in effect.

NOTE: If powersaver mode was enabled in step 2, the display automatically turns itself off in 60 seconds following completion of the configuration sequence. Refer to Section 3.1 for more information on powersaver mode.

3.4.1 CONFIGURING THE FLOW MONITOR FOR MINER'S INCHES

To configure the 2110 to read in Idaho Miner's inches, complete the configuration procedures in Section 3.4 with the following exceptions:

1. Enter .83 as the scale factor. (.83 is the conversion factor for cubic feet to miner's inches).
2. Select cubic feet per minute as the flow unit.

NOTE: If an additional scale factor is required to adjust for an actual depth error, multiply the additional scale factor times .83 and enter the result.

3.5 Viewing, Changing, or Disabling the Password

To view, change, or disable the password:

1. Go to the Flow Rate Time Units screen by completing steps 1 through 7 in the configuration procedure (Section 3.4).
2. Press ▶ to scroll through the flow rate time units until the desired time unit is displayed, but *do not press* **ENTER**.
3. Simultaneously press ▼ and ▲.

   The Password Configuration screen is displayed:

   PASS.XXXX

   NOTE: XXXX stands for the digits displayed for the current password.
4. Enter a new four-digit password.

   NOTE: The password can be disabled by entering four zeros (0000) as the new password.
5. Press **ENTER.**

   The Flow Resolution Screen is displayed:

   F-rES LO
6. Complete steps 9 through 12 of the configuration procedure (Section 3.4).

SERVICE SUPPORT AND WARRANTY

This chapter covers the procedures for obtaining service support and provides warranty information for the 2110 flow monitor. Due to the complex nature of microprocessor based equipment, it is not feasible to attempt internal service in the field other than changing batteries (Section 2.3). All parts used in the repair or maintenance of the units are supplied by **POLYSONICS®**.

4.1 Resolving the Problem

If the unit does not perform satisfactorily, complete the following steps in order until the problem is resolved:

1. Verify that the flow monitor is properly installed (Chapter 2) and configured (Chapter 3) and that the application requirements are within the performance specifications of the flow monitor (Section 1.7).
2. Contact the installation contractor or the local dealer or representative from which the instrument was purchased (Section 4.2).
3. Contact **POLYSONICS®** to attempt to resolve the problem over the phone (Section 4.3).
4. Return the unit to **POLYSONICS®** for repair (Section 4.4) or arrange for **POLYSONICS®** field service (Section 4.5).

4.2 Local Dealer or Representative Support

Local **POLYSONICS®** dealers or representatives are the first contact for support. They are well equipped to answer questions and provide application assistance. Local dealers or representatives have access to product information and current software revisions.

4.3 Contacting POLYSONICS® by Phone

Before contacting **POLYSONICS®** by phone, make a note of the instrument's model and serial number. Have the operating parameters of the application available (type of fluid, pipe size, pipe material, fluid velocity, temperature, etc.). If the problem cannot be remedied over the phone, the service engineer may request that the instrument be returned to the factory for repair. The address and telephone numbers of the service centers are listed in Section 4.4.

4.4 Factory Service

If POLYSONICS® determines that the problem cannot be resolved over the phone, the entire unit should be returned to POLYSONICS® service department or arrangements made for POLYSONICS® field service (Section 4.5).

The POLYSONICS® Service Department should be contacted before returning an instrument for repair. The service department issues an RMA number which must be placed on the outside of the shipping box in order for the receiving dock to accept the shipment.

A letter should be included with the instrument fully explaining the symptoms of the failure as well as details regarding the application in which the unit was being operated (type of fluid, pipe size, pipe material, fluid velocity, temperature, etc.). This letter is required for all units including those returned for warranty repairs. Service cannot be adequately performed until this written information is received.

To ship an instrument to Peek Measurement:

1. Ensure that the instrument is well packed (in its original shipping box, if available).
2. Include the letter of explanation.
3. Write the RMA number on the outside of the shipping box.
4. Send the unit freight-paid to one of the following service centers:

North American Service Center (USA)
Peek Measurement, Inc.
10335 Landsbury, Suite 300
Houston, Texas 77099-3407 USA
Telephone: (281) 879-3700
Facsimile: (281) 498-7721

European Service Centre (UK)
Peek Measurement, Ltd.
King's Worthy
Winchester, Hampshire SO23 7QA UK
Telephone: (01962) 883200
Facsimile: (01962) 885530

Peek Measurement pays the return freight if the unit is under warranty. All repairs are made in accordance with the Peek Measurement limited warranty (Section 4.6).

4.5 Field Service

Field service is available and is recommended in some instances. All field service calls are to be scheduled in advance and paid for by the customer. Contact Peek Measurement for rates.

4.6 WARRANTY

Peek Measurement products are warranted to be free from defects in material and workmanship at the time of shipment and for one year thereafter. Any claimed defects in Peek Measurement products must be reported within the warranty period. Peek Measurement shall have the right to inspect such products at buyer's plant or to require buyer to return such products to Peek Measurement plant.

In the event Peek Measurement request return of its products, Buyer shall ship with transportation charges paid by the Buyer to Peek Measurement plant. Shipment of repaired or replacement goods from Peek Measurement plant shall be F.O.B. Peek Measurement plant. A shop charge may apply for alignment and calibration services. Peek Measurement shall be liable only to replace or repair, at its option, free of charge, products which are found by Peek Measurement to be defective in material or workmanship, and which are reported to Peek Measurement within the warranty period as provided above. This right to replacement shall be Buyer's exclusive remedy against Peek Measurement.

Peek Measurement shall not be liable for labor charges or other losses or damages of any kind or description, including but not limited to, incidental, special or consequential damages caused by defective products. This warranty shall be void if recommendations provided by Peek Measurement or its Sales Representatives are not followed concerning methods of operation, usage and storage or exposure to corrosive conditions.

Materials and/or products furnished to Peek Measurement by other suppliers shall carry no warranty except such suppliers' warranties as to materials and workmanship. Peek Measurement disclaims all warranties, expressed or implied, with respect to such products.

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POLYSONICS®

10335 Landsbury, Suite 300 ■ Houston, Texas 77099-3407 USA
Telephone: (281) 879-3700 ■ Facsimile: (281) 498-7721

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Telephone: (01962) 883200 ■ Facsimile: (01962) 885530

FLOW CONVERSION TABLES

The tables in this appendix are provided for reference in converting from one flow unit to another. Gallons listed in the tables are U.S. gallons.

Table A-1
Volumetric Flow Unit Conversion

To convert	Into	Multiply by
Acre Feet	Cubic Feet	4.356×10^{4}
	Cubic Meters	1.233×10^{3}
	Gallons	3.259×10^{5}
	Liters	1.233×10^{6}
	Million Gallons	0.3260
Cubic Feet	Acre Feet	2.296×10^{-5}
	Cubic Meters	0.02832
	Gallons	7.481
	Liters	28.32
	Million Gallons	7.481×10^{-6}
Cubic Meters	Acre Feet	8.107×10^{-4}
	Cubic Feet	35.31
	Gallons	264.2
	Liters	10^{3}
	Million Gallons	2.642×10^{-4}
Gallons	Acre Feet	3.069×10^{-6}
	Cubic Feet	0.1337
	Cubic Meters	3.785×10^{-3}
	Liters	3.785
	Million Gallons	10^{-6}
Liters	Acre Feet	8.107×10^{-7}
	Cubic Feet	0.03531
	Cubic Meters	10^{-3}
	Gallons	0.2642
	Million Gallons	2.644×10^{-7}
Million Gallons	Acre Feet	3.068
	Cubic Feet	1.337×10^{5}
	Cubic Meters	3.785×10^{3}
	Gallons	10^{6}
	Liters	3.785×10^{6}

Table A-2 Flow Rate Conversion		
To convert	**Into**	**Multiply by**
Acre ft. per day	Cubic ft. per day	4.356×10^{4}
	Cubic ft. per sec.	0.5042
	Cubic meters per day	1.233×10^{3}
	Cubic meters per sec.	0.01428
	Gallons per sec.	3.771
	Gallons per min.	226.3
	Liters per sec.	14.28
	Million gallons per day	0.3258
Cubic ft. per day	Acre ft. per day	2.296×10^{-5}
	Cubic ft. per sec.	1.157×10^{-5}
	Cubic meters per day	0.02832
	Cubic meters per sec.	3.278×10^{-7}
	Gallons per sec.	8.658×10^{-5}
	Gallons per min.	5.195×10^{-3}
	Liters per sec.	3.278×10^{-4}
	Million gallons per day	7.481×10^{-6}
Cubic ft. per sec.	Acre ft. per day	1.984
	Cubic ft. per day	8.640×10^{4}
	Cubic meters per day	2.447×10^{3}
	Cubic meters per sec.	0.0283
	Gallons per sec.	7.481
	Gallons per min.	448.8
	Liters per sec.	28.32
	Million gallons per day	0.6463
Cubic meters per day	Acre ft. per day	8.106×10^{-4}
	Cubic ft. per day	35.31
	Cubic ft. per sec.	4.088×10^{-4}
	Cubic meters per sec.	1.157×10^{-5}
	Gallons per sec.	3.057×10^{-3}
	Gallons per min.	0.1835
	Liters per min.	0.0116
	Million gallons per day	2.642×10^{-4}

Continued

Table A-2 *Continued*

To convert	Into	Multiply by
Cubic meters per sec.	Acre ft. per day	70.04
	Cubic ft. per day	3.051×10^6
	Cubic ft. per sec.	35.31
	Cubic meters per day	8.640×10^4
	Gallons per sec.	264.2
	Gallons per min.	1.585×10^4
	Liters per sec.	10^3
	Million gallons per day	22.82
Gallons per sec.	Acre ft. per day	0.2652
	Cubic ft. per day	1.155×10^4
	Cubic ft. per sec.	0.1337
	Cubic meters per day	327.1
	Cubic meters per sec.	3.78×10^{-3}
	Gallons per min.	60
	Liters per sec.	3.785
	Million gallons per day	0.0864
Gallons per min.	Acre ft. per day	4.42×10^{-3}
	Cubic ft. per day	192.5
	Cubic ft. per sec.	2.23×10^{-3}
	Cubic meters per day	5.451
	Cubic meters per sec.	6.309×10^{-5}
	Gallons per sec.	0.01667
	Liters per sec.	0.0631
	Million gallons per day	1.44×10^{-3}
Liters per sec.	Acre ft. per day	0.0700
	Cubic ft. per day	3.051×10^3
	Cubic ft. per sec.	0.0353
	Cubic meters per day	86.4
	Cubic meters per sec.	10^{-3}
	Gallons per min.	15.85
	Gallons per sec.	0.2643
	Million gallons per day	0.02282
Million gallons per day	Acre ft. per day	3.069
	Cubic ft. per day	1.337×10^5
	Cubic ft. per sec.	1.548
	Cubic meters per day	3.785×10^3
	Cubic meters per sec.	4.381×10^2
	Gallons per min.	694.4
	Gallons per sec.	11.57
	Liters per sec.	43.82

PIPE SCHEDULES

The 2110 must be calibrated using actual pipe inner diameter (ID) dimensions (Section 3.4). Nominal measurements for pipe schedules and classes can be converted using the following tables in this appendix:

- Steel, stainless steel, and PVC (Table B-1)
- Cast iron (Table B-2)
- Ductile iron (Table B-3)

The inside diameters (IDs) listed in the following tables are calculated from the outside diameter and minimum wall thicknesses as specified in applicable standards. The actual pipe inside diameter may vary from the dimension listed in the tables by as much as 25% of the pipe minimum wall thickness. The accuracy of flow rate measurement is enhanced if the pipe ID is actually measured.

Table B-1
Steel, Stainless Steel, and PVC Pipe Standard Schedules
Inside Diameter (ID) and Outside Diameter (OD) in Inches

Nominal Pipe Size	Outside Diameter (OD)	Sched. 5	Sched. 10 (Light wall)	Sched. 20	Sched. 30	Sched. 40	Sched. 60	Sched. 80	Sched. 100	Sched. 120	Sched. 140	Sched. 160	Std. Wall	X STG
1"	1.315	1.185	1.097			1.049		0.957				0.815	1.049	0.957
1.25"	1.660	1.530	1.442			1.380		1.278				1.160	1.380	1.278
1.5"	1.900	1.770	1.682			1.610		1.500				1.338	1.610	1.500
2"	2.375	2.245	2.157			2.067		1.939				1.687	2.067	1.939
2.5"	2.875	2.709	2.635			2.469		2.323				2.125	2.469	2.323
3"	3.500	3.334	3.260			3.068		2.900				2.624	3.068	2.900
3.5"	4.000	3.834	3.760			3.548		3.364					3.548	3.364
4"	4.500	4.334	4.260			4.026		3.826		3.624		3.438	4.026	3.826
5"	5.563	5.345	5.295			5.047		4.813		4.563		4.313	5.047	4.813
6"	6.625	6.407	6.357			6.065		5.761		5.501		5.187	6.065	5.761
8"	8.625	8.407	8.329	8.125	8.071	7.981	7.813	7.625	7.437	7.187	7.001	6.813	7.981	7.625
10"	10.750	10.482	10.420	10.250	10.136	10.020	9.750	9.562	9.312	9.062	8.750	8.500	10.020	9.750
12"	12.750	12.438	12.390	12.250	12.090	11.938	11.626	11.374	11.062	10.750	10.500	10.126	12.000	11.750
14"	14.000		13.500	13.376	13.250	13.124	12.812	12.500	12.124	11.876	11.500	11.188	13.250	13.000
16"	16.000	15.670	15.500	15.376	15.250	15.000	14.688	14.312	13.938	13.562	13.124	12.812	15.250	15.000
18"	18.000	17.670	17.500	17.376	17.124	16.876	16.500	16.124	15.688	15.255	14.876	14.438	17.250	17.000
20"	20.000	19.634	19.500	19.250	19.000	18.812	18.376	17.938	17.438	17.000	16.500	16.062	19.250	19.000
24"	24.000	23.564	23.500	23.250	22.876	22.624	22.062	21.562	20.938	20.376	19.876	19.312	23.250	23.000
30"	30.000	29.500	29.376	29.000	28.750	28.500							29.250	29.000
36"	36.000		35.376	35.000	34.750	34.500					31.876	31.312	35.250	35.000
42"	42.000			41.000	40.750	40.500							41.250	41.000
48"	48.000					47.250							47.250	47.000

Table B-2
Cast Iron Pipe Standard Classes
Inside Diameter (ID)[1] and Outside Diameter (OD) in Inches

	Class A		Class B		Class C		Class D		Class E		Class F		Class G		Class H	
Nominal Pipe Size	OD	ID	OD	ID	OD	ID	OD	ID	OD	ID	OD	ID	OD	ID	OD	ID
3"	3.80	3.02	3.96	3.12	3.96	3.06	3.96	3.00								
4"	4.80	3.96	5.00	4.10	5.00	4.04	5.00	3.96								
6"	6.90	6.02	7.10	6.14	7.10	6.08	7.10	6.00	7.22	6.06	7.22	6.00	7.38	6.08	7.38	6.00
8"	9.05	8.13	9.05	8.03	9.30	8.18	9.30	8.10	9.42	8.10	9.42	8.10	9.60	8.10	9.60	8.00
10"	11.10	10.10	11.10	9.96	11.40	10.16	11.40	10.04	11.60	10.12	11.60	10.00	11.84	10.12	11.84	10.00
12"	13.20	12.12	13.20	11.96	13.50	12.14	13.50	12.00	13.78	12.14	13.78	12.00	14.08	12.14	14.08	12.00
14"	15.30	14.16	15.30	13.98	15.65	14.17	15.65	14.01	15.98	14.18	15.98	14.00	16.32	14.18	16.32	14.00
16"	17.40	16.20	17.40	16.00	17.80	16.20	17.80	16.02	18.16	16.20	18.16	16.00	18.54	16.18	18.54	16.00
18"	19.50	18.22	19.50	18.00	19.92	18.18	19.92	18.00	20.34	18.20	20.34	18.00	20.78	18.22	20.78	18.00
20"	21.60	20.26	21.60	20.00	22.06	20.22	22.06	20.00	22.54	20.24	22.54	20.00	23.02	20.24	23.02	20.00
24"	25.80	24.28	25.80	24.02	26.32	24.22	26.32	24.00	26.90	24.28	26.90	24.00	27.76	24.26	27.76	24.00
30"	31.74	28.98	32.00	29.94	32.40	30.00	32.74	30.00	33.10	30.00	33.46	30.00				
36"	37.96	35.98	38.30	36.00	38.70	35.98	39.16	36.00	39.60	36.00	40.04	36.00				
42"	44.20	42.00	44.50	41.94	45.10	42.02	45.58	42.02								
48"	50.50	47.98	50.80	47.96	51.40	47.98	51.98	48.00								
54"	56.66	53.96	57.10	54.00	57.80	54.00	58.40	53.94								
60"	62.80	60.02	63.40	60.06	64.20	60.20	64.82	60.06								
72"	75.34	72.10	76.00	72.10	76.88	72.10										
84"	87.54	84.10	88.54	84.10												

[1] For pipes with cement linings, reduce the pipe inside diameter by two times the lining thickness. Standard and double cement lining thicknesses are listed in Table B-3.

Table B-3
Ductile Iron Pipe Standard Classes
Inside Diameter (ID) and Outside Diameter (OD) in Inches

Nominal Pipe Size	Outside Diameter (OD)	Inside diameter							Cement lining[1]	
		Class 50	Class 51	Class 52	Class 53	Class 54	Class 55	Class 56	Standard Thickness	Double Thickness
3"	3.96		3.46	3.40	3.34	3.28	3.22	3.16		
4"	4.80		4.28	4.22	4.16	4.10	4.04	3.98		
6"	6.90	6.40	6.34	6.28	6.22	6.16	6.10	6.04	0.125	0.250
8"	9.05	8.51	8.45	8.39	8.33	8.27	8.21	8.15		
10"	11.10	10.52	10.46	10.40	10.34	10.28	10.22	10.16		
12"	13.20	12.58	12.52	12.46	12.40	12.34	12.28	12.22		
14"	15.30	14.64	14.58	14.52	14.46	14.40	14.34	14.28		
16"	17.40	16.72	16.66	16.60	16.54	16.48	16.42	16.36		
18"	19.50	18.80	18.74	18.68	18.62	18.56	18.50	18.44	0.1875	0.375
20"	21.60	20.88	20.82	20.76	20.70	20.64	20.58	20.52		
24"	25.80	25.04	24.98	24.92	24.86	24.80	24.74	24.68		
30"	32.00	31.22	31.14	31.06	30.98	30.90	30.82	30.74		
36"	38.30	37.44	37.34	37.06	37.14	37.04	36.94	36.84		
42"	44.50	43.56	43.44	43.32	43.20	43.08	42.96	42.84	0.250	0.500
48"	50.80	49.78	49.64	49.50	49.36	49.22	49.08	48.94		
54"	57.10	55.96	55.80	55.64	55.48	55.32	55.16	55.00		

[1] For pipes with cement linings, reduce the pipe inside diameter by two times the lining thickness listed above.

MINIMUM AND MAXIMUM FLOW TABLE

The following table provides a quick reference for determining the minimum and maximum flow rates for the 2110 according to pipe size. The minimum fluid velocity for Model 2110R is 0.3 feet per second (0.09 meters per second) while the minimum for Model 2110M is 1.0 feet per second (0.3 meters per second). The maximum fluid velocity for both models is 30 feet per second (9.15 meters per second).

The flow rates listed in the table for nominal pipe sizes 2 inches or larger are based on using a series 400 sensor and Schedule 40 pipe. The flow rates for nominal pipe sizes less than 2 inches are based on using a series 475 sensor. The flow rates for these smaller sizes are not based on the pipe inner diameter (ID), but on a "bore factor" derived from the bore size and characteristics of the 475 sensor (shown in gray).

For pipe sizes that are not listed, the minimum and maximum measurable flows can be calculated by applying one of the following formulas:

- Gallons per minute = (feet per second) x (pipe inner diameter in inches)^2 x (2.45)
- Liters per minute = (meters per second) x (pipe inner diameter in millimeters)^2 x (.047)

Table C-1
Minimum and Maximum Flow Rates

Nominal Pipe Size (Sched. 40) in Inches	Pipe ID or bore factor in Inches	Minimum Flow Rate for Model 2110R at 0.3 FPS (.09 MPS)		Minimum Flow Rate for Model 2110M at 1 FPS (0.3 MPS)		Maximum Flow Rate for both models at 30 FPS (9.15 MPS)	
		GPM	LPM	GPM	LPM	GPM	LPM
.5	0.723	0.38	1.44	1.28	4.84	38.4	145
.75	0.899	0.59	2.23	1.98	7.48	59.4	225
1	1.208	1.07	4.04	3.58	13.5	107	404
1.25	1.619	1.93	7.30	6.42	24.3	193	730
1.5	1.859	2.54	9.60	8.47	32.0	254	960
2	2.067	3.14	11.9	10.5	39.7	314	1190
2.5	2.469	4.48	16.9	14.9	56.3	448	1690
3	3.068	6.90	26.1	23.1	87.3	692	2620
3.5	3.548	9.24	34.9	30.8	116	925	3500
4	4.026	11.9	45.0	39.7	150	1190	4500
5	5.047	18.7	70.7	62.4	236	1870	7070
6	6.065	27.1	102	90.1	341	2700	10200
8	7.981	46.8	177	156	590	4680	17700
10	10.020	73.8	279	246	930	7380	27900
12	11.938	105	397	349	1320	10500	39700
14	13.124	127	480	422	1600	12700	48000
16	15.000	166	627	551	2080	16500	62400
18	16.876	209	790	698	2640	20900	79000
20	18.812	260	983	867	3280	26000	98300
24	22.624	376	1420	1250	4730	37600	142000
30	28.500	597	2260	1990	7520	59700	226000
36	34.500	876	3310	2920	11000	87500	331000
42	40.500	1210	4570	4020	15200	121000	457000
48	47.250	1640	6200	5470	20700	164000	620000

GLOSSARY

Appendix D provides a glossary of terms that may be useful when using the 2110.

Accuracy
The ability of a flow monitor to produce an output within a specific tolerance (in comparison to a known standard) which corresponds to its characteristic curve. Refer to "Linearity".

Clean fluid
A fluid with few suspended particles or bubbles, such as distilled water, solvents, and alcoholic beverages.

Dirty fluid
A fluid containing suspended solids, contaminants, particles, or bubbles.

Ferrite
Of, relating to, or containing iron

Flow profile
Also called velocity profile. A side view graphical representation of the shape of flow in a pipe. Flow profile is comprised of the shape of the layers of individual local velocities inside a pipe. (Fluid typically flows faster near the center of the pipe.) Factors that determine the flow profile include the inertial and viscous forces of the fluid, inside pipe roughness, line restrictions, fittings, etc.

Linearity
The ability of the flow monitor to establish a relationship between actual flow and its output, often called the characteristic curve of the flow monitor, to approximate a straight line relationship.

Minimum velocity
The lowest speed at which liquid can travel and still be accurately measured.

Repeatability
The ability of a flow monitor to reproduce a measurement each time a set condition is repeated.

Resolution
The smallest increment of flow that can be displayed.

Totalizer
A feature of the flow monitor that counts the total volume of fluid that flows past the sensor.

CE CERTIFICATION REQUIREMENTS

This appendix provides supplemental information for European units requiring CE certification.

Table E-1 CE Certification Requirements	
Environmental operating conditions (per EN-61010-1)	■ Pollution degree: 1 ■ Installation category (over-voltage category): I
Fuse (per EN 61010-1, Section 5.1.4 and 5.4.5)	Non user-replaceable fuse: 125 mA, 125 V, Very Quick Acting