PATRIOT

INTRINSICALLY SAFE TOTALIZER-RATE INDICATOR

Operation Manual

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INTRINSICALLY SAFE TOTALIZER-RATE INDICATOR

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Warranty Statement

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⌐*Introduction*

About This Manual

This instruction manual provides information specific to the PolarTek 2000 Patriot, Intrinsically Safe Flow Totalizer and Rate Indicator. Other peripheral equipment should be supplied with its own instruction manual and that manual should be referred to for proper operation of the peripheral equipment.

It is essential that this manual be read and understood for proper installation and operation of your Patriot.

This manual includes:

INTRODUCTION: Briefly describes the key features of the Patriot.

INSTALLATION: Detailed description of mounting and connection.

PROGRAMMING: Describes the method for setting the K-Factor, display options, and other operational parameters.

OPERATION: Describes the normal operation of the Patriot.

TROUBLESHOOTING: Describes several quick problem solving techniques.

SPECIFICATIONS: Describes the Physical and operational characteristics.

TECHNICAL REFERENCE: Provides supplementary technical information.

About the Patriot

The Patriot is a low cost intrinsically safe flow totalizer and rate indicator. The Patriot accepts input pulses from a turbine meter, and uses those pulses to calculate the flow volume and flow rate in a pipeline. The Patriot displays both values at the same time on an adjustable contrast LCD display. Programming and operation is as easy as a digital watch. The patriot maintains a 36 day cumulative log of the flow totals for easy access to flow history. For true stand alone operation the Patriot uses a 3.6V lithium battery pack with an average life span of 3 to 7 years.

These features combine to make the Patriot a simple solution to your flow measurement needs.

Please refer to the Installation section of this manual for directions on how to connect and set up the Patriot.

Main Features

Enclosure:	Nema 4, 4X Polycarbonate
Input/Output:	Turbine input from 2Hz to 5.0kHz at 25mVp-p minimum at 2Hz. Very high noise rejection at default input sensitivity with an adjustment to increase noise rejection if necessary. Flow total and flow rate are displayed at the same time on an adjustable contrast LCD display.
Reliability:	Built using industrial specified components to ensure long life and high reliability even in harsh conditions.
Programming:	The Patriot is designed to be as easy to program as a digital watch. The programmable features are K-Factor (0000.0001 to 99 999 999 with up to 4 decimal digits), K-Factor units (for internal conversion to displayed units), Flow total decimal position (0 to 4 digits), Flow rate decimal position (0 to 3 digits), displayed flow units (for internal conversion from K-Factor units), Flow rate time base, 10-point linearization parameters, Display contrast level, and Security Lockout Code.
Memory:	All parameters, log entries, and the Security Lockout Code are store in nonvolatile memory to ensure that, even if the unit loses power, no loss of information occurs.

☞ Installation

Installation must be performed in compliance with local governing regulations by qualified personnel.

Note: The Patriot ships with a 3.6V intrinsically safe battery pack already installed. There is no requirement to open the case during installation.

Environmental

Choose a mounting location suited to the Patriot enclosure.

The ideal Patriot mounting location is where the:

1. Turbine pick-up is as close as possible.

2. Mounting surface has minimal vibration.

3. Abient temperature is always within -40°C to +65°C (-40°F to +149°F).

4. Cable lengths are minimal.

Avoid mounting locations where the Patriot is:

☞ Vibrating.

☞ Facing the sun directly for long periods of time (this could degrade the faceplate seal and void the NEMA 4 rating).

☞ Close to high voltage/current runs, contactors, SCR control devices, or frequency inverters.

Outline

Standard Patriot

Patriot with Remote Mounting Kit
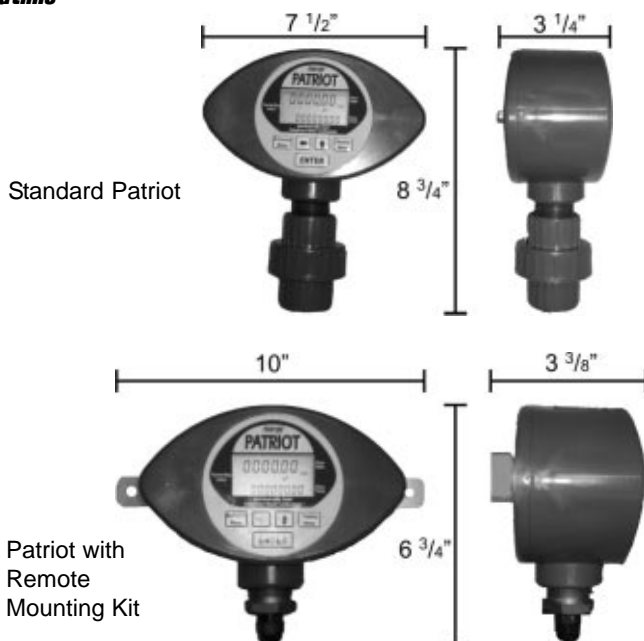
Turbine Meter Connection

The patriot can be connected to the turbine in two different manners. The Patriot comes with a 1" NPT, schedule 80, PVC union standard for mounting directly to the turbine. Alternately a remote mounting kit can be purchased for wall mounting the Patriot away from the turbine (contact your distributor for more information).

When properly installed onto a turbine meter, CSA type 4 connection, or remote mounting kit the entire Patriot body is rated CSA / NEMA 4, 4X.

Mount the Patriot directly on the turbine as follows:

**Step 1:** Ensure the turbine's magnetic pick-up is turned in hand tight.

Step 2: Extend the Patriot's pick-up cable far enough out of the unit to allow for easy attachment to the magnetic pick-up. Connect the pick-up cable to the pick-up ensuring that the restraining collar is tightened hand tight.

Step 3: Unscrew the bottom half of the 1" union from the Patriot and attach it securely to the mounting boss on the turbine.

Step 4: Feed the remaining cable into the Patriot and tighten down the upper half of the union.
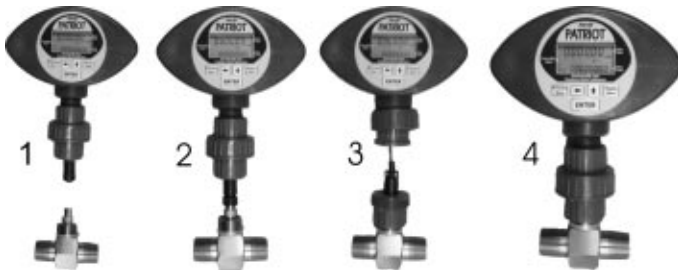
To use the remote mounting kit, mount the patriot on the wall using the holes provided in the remote mounting bar and follow step 1 and step 2 above.

Note: For important information about specifying and mounting turbine meters, please refer to the Technical Reference at the back of this manual.

Magnetic Pick-up Noise Immunity Settings

The Patriot has been designed with extremely high noise immunity while maintaining a very sensitive input. The factory default setting for noise immunity will allow the Patriot to correctly read a 3/8" turbine to about 1m^3/day (rated flow for a 3/8" turbine is 1.63m^3/day).

The noise immunity jumper should only be moved in cases where there is extreme electrical interference and *the Patriot shows evidence of being affected by the interference.* For 99% of applications the factory default position will work. Ensure that the conditions in the following chart are met before adjusting the setting.

Setting	Meter Size	Flow Rate	Use
▢▪▪	ALL	ALL	Factory default
▪▪▢	ALL	mimimum 4m^3/day on 3/8" meter	Only with extreme electrical interference

To adjust the jumper, the back of the Patriot case must be removed using a flat head screw driver. Locate the jumper as shown. Set the jumper to the left hand position.

Noise Immunity
Jumper
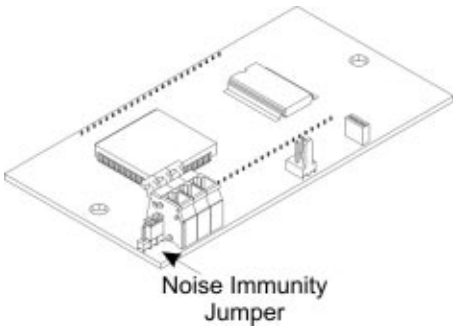
Battery Packs

!WARNING!

Substitution of components may impair intrinsic safety.

Use only PolarTek 2000 Ltd. intrinsically safe battery pack P/N **PT-IS-LI-PD.**

The following label appears on all PolarTek 2000 Ltd. intrinsically safe battery packs. If this label does not appear on the pack you are using, please contact your distributor to replace it with the correct pack.

Life Expectancy

In order to extend the battery life, the Patriot has been designed as an ultra low power device. The battery life expectancy is calculated using the battery manufacturer's rated capacity, the Patriot's worst case current +20%, and a derating to 80% of that resulting time.

Average life expectancy for the PT-IS-LI-PD battery pack is:

<div align="center">

5 Yrs. minimum at +25°C

2 Yrs. minimum at -40°C

</div>

Battery Test

To see the remaining calculated percentage of battery life press the ⬅ key. The battery percentage will appear on the top of the display. The patriot will return to the main display after about 4 seconds. For more information about the battery test function, please refer to the Operation section of this manual.
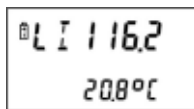
Replacing the Battery

During normal operation, the Patriot periodically performs a test on the battery. When the Patriot determines the battery to be at 30% or less the low battery indicator will turn on and remain on until the battery is replaced.

Prior to replacing the battery, press the **ENTER** key to save the current flow total (see the Operation section of this manual for more information). The configuration is always stored in nonvolatile memory and will not be affected by removing the battery.

To replace the battery follow these steps:

Step 1. Remove the back of the Patriot enclosure using a flat head screwdriver.

Step 2. Release the hook and loop fastening strap from around the battery.

Step 3. Disconnect the battery from the circuit board.

Note: Due to the ultra low power nature of the Patriot, the battery must remain disconnected for a minimum of 60 sec. If power is reapplied prior to the circuit fully discharging unpredictable operation may result.

Step 4. After allowing the Patriot to discharge for 60 sec. or more, plug the new battery in to the circuit board. The connector is polarized and will only allow the battery to be connected one way.

Step 5. Secure the battery and any excess wire using the hook and loop fastening strap.
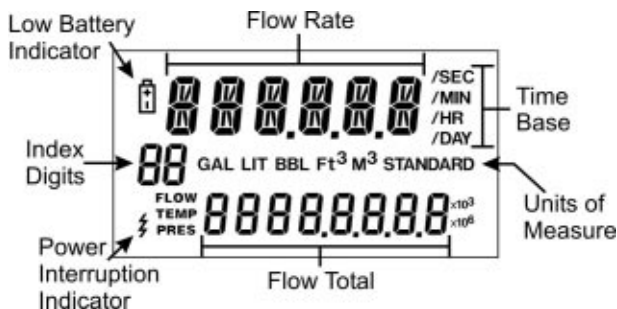
Step 6. Check to ensure that the Patriot has reinitialized and returned to normal operation.

Step 7. Replace the back of the Patriot enclosure.

☞ Programming

Display

Please refer to the following diagram for the locations of the various display components.

Programming Conventions

When programming the Patriot, the following conventions apply throughout the process:

- ✓ Flashing segments indicate the current selection.
- ✓ To change the current selection, press ⬆.
- ✓ To advance to the next selection, press ⬅.
- ✓ To exit the menu and save the changes at any time, press ENTER.
- ✓ To exit the menu without saving the changes, do not press any keys for about 90sec. The Patriot will return to the main display automatically.

Note: When programming the K-Factor and setting the display units, all conversions are performed internally. Unless the K-Factor is specified in a unit other than those shown on the display, there is no need to convert it from the units specified.

Programming the K-Factor

The K-Factor is a number which denotes the number of pulses that will be put out by a turbine for a known volume. In order for a K-Factor to be accurate, the turbine must be calibrated using known volumes and known flow rates. For most applications, a single average K-Factor provides an acceptable level of accuracy. This is the K-Factor usually found on a tag attached to the mounting boss of the turbine. For those few applications which require greater than about 1% accuracy multi-point K-Factors can be used (see the 10 Point Linearization section of this manual for more information).

When programming the K-Factor into the Patriot, it is very important to note that the units the K-Factor is programmed in will be used in the calculation of the flow rate and flow total. Internally the Patriot will perform all necessary conversions on the K-Factor to display the flow data in the desired units. The K-Factor can be entered in any of the following units: GAL, LIT, BBL, Ft^3, or M^3. The Patriot contains all the necessary information to convert any of these units into any other of the units eliminating the need for the operator to perform the conversions.

In order to allow for entry of extremely large K-Factors and eliminate the need to scale or truncate the values while maintaining the highest accuracy possible, the Patriot can accept a full 8-digit K-Factor with up to 4 decimal places. This allows for a range of K-Factors from 0.0001 to 99 999 999. A chart of typical, single point K-Factors can be found in the Technical Reference section of this manual.

Entering a Linear K-Factor

The default setting for the K-Factor on the Patriot is to use a linear (single point) K-Factor. The following procedure outlines the method for setting a single point K-Factor:

Step 1: Press [K-Factor Menu]. The message 'LINEAR K-FACTOR' will scroll across the top of the display. If the message '10-POINT K-FACTOR   ENTER SMALLEST FREQUENCY FIRST' appears, please see the Setting Advanced Options section of this manual to set the unit for a Linear K-Factor.

The word FACTOR will remain on the display to indicate that the Patriot is in the K-Factor menu. The display will change to show the current K-Factor and K-Factor units with the units blinking to indicate they are ready for editing.

Step 2: Press [↑] until the desired K-Factor units are selected. This selection should match the units that the turbine meter was calibrated in. The available K-Factor units are GAL, LIT, BBL, Ft^3, and M^3. The units will cycle through

```
FACTOR
 00200000.0
```

each of these selections every time the [↑] key is pressed. Once the desired units are blinking, press [←] to advance to the decimal position selection.

Step 3: Press ⬆ to select the position of the decimal. The decimal positions available are: no decimal, 0.0, 0.00, 0.000, and 0.0000. The decimal point will cycle through each of these selections every time the ⬆ key is pressed. Once the desired decimal location is flashing, press ⬅ to advance to the K-Factor Digits.

```
FACTOR
00200000
```

Step 4: Press ⬆ to increment the current digit. Holding ⬆ for more than 1 second will cause the digit to autoincrement by ones. When the correct value is displayed, press ⬅ to move to the next digit. Continue this procedure until all K-Factor digits are set.

```
FACTOR
00200000
```
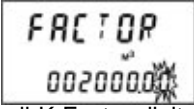
Step 5: Once all K-Factor digits have been set either press ⬅ to cycle back to the units, or press ENTER to save the new K-Factor information and exit to the main display.

10-Point Linearization

Over its entire rated flow range, a turbine meter does not show linear characteristics. This is caused by the different materials and different construction and moulding techniques used in the construction of a turbine. This is perfectly normal and has effects of less than 2%, on average, over the entire flow range. The chart shown here is an example of the actual readings from a gas turbine meter over its rated flow range. The chart shows the frequency of the output pulses (directly related to the speed at which the turbine is spinning) across the bottom and the pulses measured per US gallon (K-Factor) up the side. Please note that the overall variation in K-Factor is about 1.6% throughout the operating range. The small ticks on the curve indicate the points of measurement used for the 10-Point Linearization.

Pulses per US Gal vs.Turbine Frequency

Pulses per US Gal vs. Turbine Frequency Internal Estimation
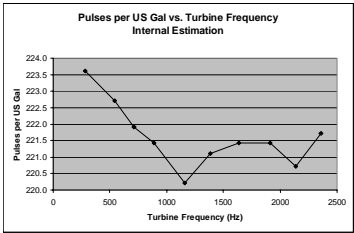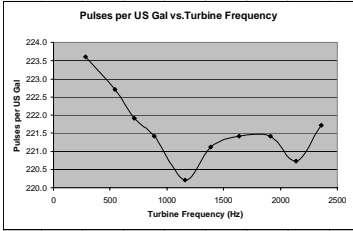
The Patriot uses these points of measure to mathematically create a straight line version of the turbine's characteristic curve as shown in this chart. This allows the Patriot to greatly increase the accuracy of its measurements by taking the frequency it is reading and comparing it to this chart to determine the best K-Factor for that frequency.

One of the benefits of 10-Point Linearization is the large increase in accuracy, however the expense of having the turbine meter proved at 10 points is usually too high to justify. A compromise, when greater accuracy is required but the expense of 10 point calibration is too much, is to use 4 or 5 points of calibration. This does not provide the precision of the 10 point calibration, however it does increase greatly from the single point, as shown in this chart which compares the characteristics generated by these three methods.

Pulses per US Gal vs. Turbine Frequency
Comparing Linear, 5-Point, and 10-Point K-Factors
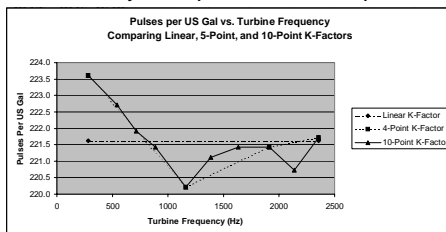
Before entering a multi point K-Factor, ensure that the turbine meter has an appropriate calibration chart indicating the correct number of frequencies. In addition to a calibration chart for the turbine, the Patriot must be set to accept multi-point K-Factors. Please see the Setting Advanced Options section of this manual for the correct method.

Entering Multiple K-Factors

In order for the 10-Point Linearization feature of the Patriot to function correctly, both the frequency and the K-Factor must be entered for each point. The data points must be entered in ascending order, smallest frequency first, largest frequency last.

If using the multi-point K-Factor feature with less than 10 points, enter the points being used in the first positions available, skipping no positions. After all the desired points have been entered, enter a very large frequency (above the operational range of the turbine is best) such as 9000Hz in the next position, the last K-Factor entered should be repeated to ensure correct operation. The remaining points can be skipped over by repeatedly pressing the [ENTER] key until the Patriot returns to the main display.

Note: The K-Factor units can be adjusted when entering each point, this will change the units for all of the K-Factors entered. Adjusting the units at any point other than the first will convert all previous K-Factors into those units, e.g. Factor #1 = 1.000 GAL, Factor #2 = 2.000 GAL, Factor #3 = 10.000 LIT, all remaining Factors entered in LIT. When returning to view the K-Factors: Factor #1 = 3.785 LIT, Factor #2 = 7.571, Factor #3 = 10.000LIT, etc.

The display shown here indicates how to view the display for multi-point K-Factors.
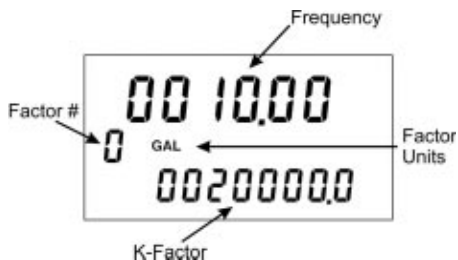
The following procedure outlines the method for setting up to 10 K-Factors:

Step 1: Press 🔲. The message '10-POINT K-FACTOR   ENTER SMALLEST FREQUENCY FIRST' will scroll across the top of the display. If the message 'LINEAR K-FACTOR' appears please see the Setting Advanced Options section of this manual to set the unit for 10-Point Linearization.

The display will change to show the current K-Factor being entered in the index digits (0 is the first entry, 9 is the last entry), the current point's frequency, and the current point's K-Factor. The lowest digit of the frequency will be flashing.

Step 2: Use the 🔼 key to increment the flashing digit. Use the 🔙 key to select the next digit. The decimal point is not able to be adjusted in the frequency, it is set to 2 decimal positions and this is sufficient for the entire range of measurement for the Patriot. When the correct frequency is set, press 🔲 to begin entering the K-Factor.

Step 3: Press 🔼 until the desired K-Factor units are selected. This selection should match the units that the turbine meter was calibrated in. The available K-Factor units are GAL, LIT, BBL, Ft³, and M³. The units will cycle through each of these selections every time the 🔼 key is pressed. Once the desired units are blinking, press 🔙 to advance to the decimal position selection for the K-Factor.

Note: The K-Factor units should only be set while editing the first point in a multi-point K-Factor.

Step 4: Press 🔼 to select the position of the decimal. The decimal positions available are: no decimal, 0.0, 0.00, 0.000, and 0.0000. The decimal point will cycle through each of these selections every time the 🔼 key is pressed. Once the desired decimal location is flashing, press 🔙 to advance to the K-Factor Digits.

Step 5: Press 🔼 to increment the current digit. Holding 🔼 for more than 1 second will cause the digit to autoincrement by ones. When the correct value is displayed, press 🔙 to move to the next digit. Continue this procedure until all K-Factor digits are set.

Step 6: Once all K-Factor digits have been set either press 🔙 to cycle back to the units, or press 🔲 to move to the next point in the multi-point K-Factor.

Step 7: Repeat Step 2 to Step 6 until all desired points have been entered. If using less than 10 points, repeat Step 2 to Step 6 to set the frequency to a value above the turbine's operating range, this will cause the Patriot to ignore all frequencies above this point. The K-Factor should be set to match the last K-Factor entered.

Step 8: Press [ENTER] repeatedly until the unit returns to the main display. This will save the new K-Factors.

Setting the Display Options

The Patriot has been designed with a highly flexible set of display options including:

- 5 selectable units of measure, GAL, LIT, BBL, Ft^3, M^3.

- 4 selectable time bases, /SEC, /MIN, /HR, /DAY.

- A 6 digit flow rate with up to 3 decimal places allowing for flow rates from 0.001 to 999 999.

- An 8 digit flow total with up to 4 decimal places allowing for flow totals from 0.0001 to 99 999 999.

All of these parameters are user programmable to assist in providing the most accurate information in the most desired way.

In addition to the flexibility of the display options, the Patriot continues to calculate and display the current flow rate and flow total as the display options are being programmed. The unit even converts the values on the fly, as the units of measure or time base are changed the Patriot updates the displayed flow total and flow rate to reflect the new setting even before it has been saved to memory. This allows the user to see the effects of the changes before committing to them.

When setting up the display on the Patriot, it is very important to note that the units the K-Factor is programmed in will be used in the calculation of the flow rate and flow total. Internally the Patriot will perform all necessary conversions on the K-Factor to display the flow data in the desired units. The K-Factor and displayed flow data can be set up in any of the following units: GAL, LIT, BBL, Ft^3, or M^3. The Patriot contains all the necessary information to convert any of these units into any other of the units eliminating the need for the operator to perform the conversions.

Display Error Messages

There are two error messages that may appear on the Patriot, 'E-RATE' and 'oVEr run'. These messages are generated when the flow data exceeds the ability for the current settings to display it. The best method for correcting this is to set the units of
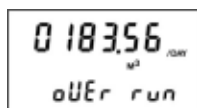
measure and time base to the desired values and adjust the decimal points until the flow data is displayed correctly. The flow total will continue to accumulate correctly even if the 'oVer run' error is displayed, once the decimal location or the units of measure allow the total to be displayed the total will be correct.

Setting the Display

The following procedure outlines the method for adjusting the display options:

Step 1: Press ⌈Display Menu⌋. DISPLAY MENU will scroll across the top of the display. A 'P' will appear in the index digits to indicate that the display is in the Display Menu. The units of measure will be blinking.

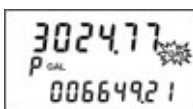**Step 2:** Press ⌈↑⌋ to select the units to display flow in. The flow rate and flow total shown will adjust to the new unit of measure automatically. Press ⌈←⌋ to advance to the time base.

Step 3: Press ⌈↑⌋ to select the time base for the flow display. The flow rate will adjust itself automatically to reflect the new time base. Press ⌈←⌋ to advance to the decimal position for the flow total.

Step 4: Press ⌈↑⌋ to select the position for the flow total decimal point. The flow total will adjust itself automatically to reflect the new decimal position. Press ⌈←⌋ to advance to the decimal position for the flow rate.
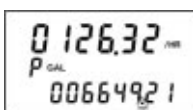
Step 5: Press ⌈↑⌋ to select the position for the flow rate decimal point. The flow rate will adjust itself automatically to reflect the new decimal location. Press ⌈←⌋ to return to the units

of measure or press **ENTER** to save the changes and exit to the main display.

Setting Advanced Options

The Patriot is equipped with several advanced options to allow for better functionality and increased security. These options are:

- Single key clear total.

- LCD contrast.

- K-Factor setup (10-Point or Linear).

- Lockout code.

- Lockout enable.

To enter the menu for the advanced options press and hold ⌈Display Menu⌋ for 3 sec. The message 'ADVANCED DISPLAY MENU' will scroll across the top of the display.

Single Key Clear Total

The first option in the Advanced Options is the single key clear total. The display will show 'CLr totL' on the bottom and 'NO' on the top. If you want to clear the totals

```
   NO
 CLr totL
```
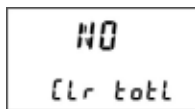
at this time, press ⬆ to change the top display to 'YES' and press **ENTER**. The unit will show 'DATA CLEArEd' to indicate that

```
   YES
 CLr totL
```

the totals have been cleared.

```
   DATA
 CLEArEd
```

If you do not want to clear the total, press **ENTER**. The unit will move on to the LCD contrast setting.

Setting the LCD Contrast

The second setting in the Advanced Options is the LCD Contrast. The display will show 'LCD   CNTRST' and a bar graph will appear at the bottom of the display. Press ⬅ to make the

```
  CNTRST
  :::::
```

display darker, press ⬆ to make the display lighter. When the contrast is set to

the desired level, press **ENTER** to move on to setting the K-Factor Type.

Note: The Patriot is designed to compensate for the ambient temperature with its display contrast. The contrast will change as the unit gets warmer or colder. This is done to ensure good visibility across the temperature range as well as power conservation.
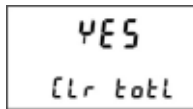
Setting the K-Factor Type

The K-Factor in the Patriot can be set in either Linear (single point) or 10-Point. This option sets the type of K-Factor being used.

The display will show 'FACTOR' on the top and either 'LinEAr' or '10 Point' on the bottom. To set the unit for single point K-Factor operation set the unit to 'LinEAr', for multi point K-Factors set the unit to '10 Point'. Use the arrow keys to toggle between the two options. See the Programming the K-Factor section of this manual to set the K-Factor itself. When the preferred K-Factor type is shown on the display, press **ENTER** to continue to the security lockout code setup.

```
  FACTOR
 10 Point
```

```
  FACTOR
  LinEAr
```

The Security Lockout Code

A security lockout code has been integrated into the Patriot to prevent the settings from being changed or the totals from being cleared. This code is stored in nonvolatile memory onboard the Patriot. Once the code has been set *and* enabled no changes can be performed on the unit without entering the code to unlock the unit. If the security lockout code is lost or forgotten the *only* way to unlock the unit is to call your distributor or PolarTek 2000 Ltd. to get a security lockout bypass code.

The functions locked by the security lockout code are:

- K-Factor programming
- Adjusting display options
- Setting advanced options
- Clearing flow data
- Resetting factory defaults

The functions not locked by the security lockout code are:

- Battery and temperature test
- Saving Flow data
- Viewing the 36 day flow log

This feature should only be used with caution. Once the lockout code is enabled the only *way to access the programming features or clear the totals is to enter the lockout code. If the lockout code is lost or forgotten you* must *contact your distributor or PolarTek 2000 Ltd.*

Setting the Security Lockout Code

The unit will display 'Loc CodE' on the bottom and the current 6 digit Security Lockout Code on the top. Setting this code will not, in itself, lock the unit after setting this code the lockout must be enabled in the next step. Use [↑] and [←] to select a 6 digit security code to lock the unit. Ensure that this number is either written down or very easy to remember. Without this number the unit will not be able to be unlocked once the lockout is enabled. Once the Security Lockout Code is set, press [ENTER] to continue to the Lockout Enable option.

Enabling the Security Lockout

This feature should only be used with caution. Once the lockout code is enabled the only *way to access the programming features or clear the totals is to enter the lockout code. If the lockout code is lost or forgotten you* must *contact your distributor or PolarTek 2000 Ltd.*

The unit will display 'LoC unit' on the bottom and either 'NO' or 'YES' on the top. To *enable* the Security Lockout code use [↑] to set the display to 'YES'. To *disable* the Security Lockout Code press [↑] to set the display to 'NO'. Once the Security Lockout Code enable option is set, press [ENTER] to exit the Advanced Options setup and return to the main display.
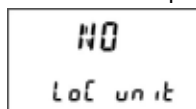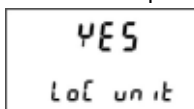
Resetting Factory Defaults

The Patriot configuration can be erased and reset to the factory defaults at any time during normal operation. To do this press and hold [ENTER] for about 10 sec.
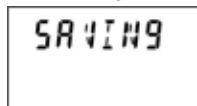
SAVING The unit will show that it is saving data, then it will show its firmware version and internal serial number, finally it will turn on all segments of the display. This last stage is meant as a display test to verify that all segments are functioning. When the display

UP 3.00
P 04860
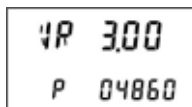
test appears the [ENTER] key can be released. The Patriot will show 'LOAD dEFAuLts'. At this time the unit will be reset to factory defaults. The flow total will not be erased and the flow rate will continue to be displayed, however the units of measure and time base for the flow data may have been changed. See the Technical Reference section of this manual for a list of the factory defaults.

LOAD
dEFAuLtS
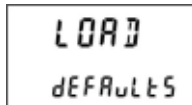
Operation

Note: When the Patriot has been set up for the first time, the total should be cleared to ensure accuracy.

During normal operation the Patriot continually calculates the flow rate and flow total as read from the turbine meter. The Patriot will update the display of this information every 4 seconds. The display is designed to show all the necessary information at all times, the flow rate is shown on the top section of the display and the flow total is shown on the bottom section. The units of measure and time base are also on the display at all times. In addition to the data displayed, the Patriot enters the flow total as displayed in the Flow Log every 24 hrs.
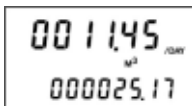
While the unit is functioning normally the following operations can be performed without affecting the calculations being performed:

Saving Flow Data and Unit Identification

The flow total currently displayed on the Patriot can be saved into nonvolatile memory at any time by pressing the `ENTER` key. The display will show 'SAVING' for about 1 second and change to the unit identification display. This display consists of the firmware version and the unique serial number programmed into the main processor.
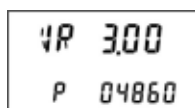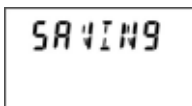
This serial number is recorded and used to track information such as date of manufacture, date of sale, and customer.

Testing the Battery and Unit Temperature

The Patriot has been designed to monitor its battery power and internal temperature. The battery power is monitored in order to allow indication of when the battery needs to be replaced. The internal temperature is monitored to allow for the Patriot to compensate for the effects of temperature on the display and the internal timing circuitry. This temperature is accurate to within 2.0°C.

Press `←` to view the current battery status and the unit temperature. The percentage of battery power remaining is displayed on the top section of the display. The temperature in $^\circ$C is displayed on the bottom section of the display.
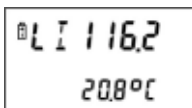
Viewing the 36 Day Flow Log

Every 24 hrs. the Patriot records the currently displayed flow total in a 36 entry flow log. This allows for 36 days of flow history to be easily viewed. This log is stored in nonvolatile memory to prevent its loss in the event of a power loss to the Patriot.

Setting the Log Time (Contract Hour)

The Patriot is equipped with a timer that counts down for 24 hrs. then resets itself and begins counting again. This timer begins counting when the battery is plugged into the unit. Because this is not a clock it can't be set like a normal clock. If a specific time for the data to be logged is required, the battery must be plugged in at that time. See the Replacing the Battery section for the proper procedure for removing and reinstalling the battery.

Reading the Flow Log

Press [↑] to view the first entry in the flow log. The display will show 'DAYLOG' on the top section, the index digits will show '00', and the most recent total will appear on the bottom of the display. This total is the flow total that was on the display at the last log time (i.e. if the log time has been set for 8:00am the total seen in the first entry was the total at 8:00am today).

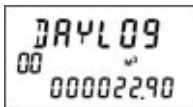The index digits show the day currently being viewed (00 to 35). Use the [←] and [↑] keys to navigate backwards and forwards through the days. As the day number gets larger the farther back the total being viewed is. If the log time is 8:00am then 0 = 8:00am today, 1 = 8:00am yesterday, 2 = 8:00am two days ago, 14 = 8:00am two weeks ago.

Because the flow log records the current total at the log time, it is fairly easy to determine the flow on any given day, provided the total was not reset during that day. To determine the total for a specific day, go to that day in the flow log and subtract the total show from the total of the following day (next lower day number). For example: the desired total is for 7 days ago, go to day 7 and record the number e.g. 764M^3, select day 6 and record the number e.g. 815M^3, subtract day 7 from day 6 to determine the total for day 7 e.g. 815M^3 - 764M^3 = 51M^3.

When finished viewing the flow log, press [ENTER] to return to the main display. If no key is pressed for about 90sec. the Patriot will exit the Flow log on its own.

Clearing the Flow Data

During normal operation the flow total can be reset to zero by pressing the [K-Factor Menu] and [Display Menu] keys at the same time. The display will show 'DATA CLEArEd' and the total will be set to zero. If the Patriot is still reading flow at that time the total will begin accumulating again immediately. This operation will not affect the configuration of the Patriot, only the displayed total is affected.

Power Interruption Indicator

The Patriot has the ability to indicate a loss of power by turning on the power interruption indicator. This indicator will turn on if the battery is removed or if the power input drops below 0.9V for more than 1/2 sec. The indicator will remain on until one of the Patriot's keys is pressed.

☞ Troubleshooting

This section details a few quick problem solving methods for the Patriot. If this section does not solve a problem, please contact your distributor.

Symptom	Possible Solution
Incorrect flow rate displayed.	Check the K-Factor.
Pump is on, no flow rate displayed.	Possible turbine problem
E-RATE appears on the display.	Adjust the decimal position for the flow rate. Adjust the time base for the flow rate. (See the Programming section of this manual)
oVEr run appears on the display.	Clear the flow total. Adjust the decimal position for the flow total. (See the programming section of this manual)
Display is blank.	Replace the battery.

☞ Specifications

Area Rating:	CSA Class 1, Div 1, Groups A, B, C, D
Enclosure:	CSA Type 4, 4X with 1" union connection for turbine
Operating Temperature:	-40°C to +65°C (-40°F to +149°F)
Relative Humidity:	0% to 90% non-condensing
Power Source:	PolarTek PT-IS-LI-PD Single Lithium Battery Pack
Life Expectancy:	3yr. min. at -40°C
	7yr. min. at +20°C
Turbine Input:	
Frequency:	2Hz to 5.0kHz
Amplitude:	25mVp-p @2Hz
Sensitivity:	High: 25mVp-p
	Low: 70mVp-p
Displayed Data:	
Total:	8 digits, 4 Programmable Decimal Positions, 5 Units of Measure
Rate:	6 digits, 3 Programmable Decimal Positions, 4 Time Bases
K-Factor:	8 digits, 4 Programmable Decimal Positions, 5 Units of Measure, Up To 10 Points of Linearization
Security:	Programmable 6 digit Password

☞ Technical Reference

This section is intended to provide supplemental, technical information about the Patriot.

Typical K-Factors

The following chart shows typical average K-Factors for a variety of turbine meter sizes.

Flow Meter Size	K-Factor		Flow Range	
	GAL (US)	M³	GAL / MIN	M³ / DAY
1"x$^3/_8$" MNPT	22000	5812400	0.3-3	1.63-16.3
1"x$^1/_2$" MNPT	14500	3830900	4.08-40.8	25-250
1"x$^3/_4$" MNPT	2950	77390	10.8-81.8	68-515
1"x1" MNPT	900	237780	5-50	27.3-272.6
1$^1/_2$"x1$^1/_2$"MNPT	325	85870	15-180	81.8-981.1
2" FNPT	55	14530	40-400	218.2-2180
2"x$^7/_8$" Wafer	2350	620870	3-30	16.3-163.4
2"x1" Wafer	900	237780	5-50	27.3-272.6
2"x1$^1/_2$" Wafer	325	85870	15-180	81.8-981.1
2"x2" Wafer	55	14530	40-400	218.0-2180
3"x3" Wafer	57	15060	60-600	327.1-3271
4"x4" Wafer	30	7930	100-1200	545.1-6541
6" Victaulic	7	1850	200-2500	1090-13627
8" Victaulic	3	790	350-3500	1908-19078

Factory Defaults

The following list details the settings as set at the factory:

K-Factor Type: Linear

K-Factor: 20000.0 GAL

Flow Total Decimal: 000000.00

Flow Rate Decimal: 0000.00

Flow Units: M³ /DAY

Security Lockout Code: 000000

Security Lockout Enabled: NO

Turbine Meter Considerations

The most common cause of incorrect flow measurement or failure is incorrect installation or specification of the turbine flow meter itself. The following guidelines should be followed when specifying and installing turbine flow meters:

- ✓ Ensure the flow rates for the application fall within the range for the turbine meter. If the flow rate is outside the turbine meter's range the accuracy of the meter may be severely affected.

- ✓ Turbine meters are usually calibrated in the horizontal position. A turbine meter will provide a more accurate reading when operated in the same position as calibrated.

- ✓ Ensure that the flow direction marked on the turbine meter matches the flow direction in the pipe.

- ✓ Do not mount the turbine meter in a low spot where solids or particles may settle.

- ✓ Do not mount the turbine meter in a location with heavy mechanical vibration. This can greatly affect the accuracy of the turbine meter

- ✓ Isolate the turbine meter from ambient electrical interference. Mount the turbine meter as far as possible from any electric motor, pump, solenoid, or transformer.

- ✓ Do not submit the turbine meter to more than its rated operating pressure.

Important Piping Requirements

Swirling and turbulent flow can cause inaccuracies in the signal from a turbine flow meter. Proper installation can minimize these effects by providing the straightest possible flow through the turbine meter. The following chart shows the minimum recommended pipe lengths both upstream and downstream from the turbine meter. These lengths are determined by the pipe diameter and the upstream piping components. The lengths are defined in terms of pipe diameters (i.e. on a 2" pipe 10D=20"). Flow straighteners may be used if the physical constraints do not allow for the recommended pipe lengths.

Components Upstream	Recommended Length Upstream	Recommended Length Downstream
Wide Open Valve Sharp Right Angle Bend Straight Run of Pipe	10D	5D
Long Radius Bend Smooth Elbow Two Elbows Partially Open Valve Another Turbine Meter	20D	5D

Special Applications

The Patriot as a Pulse / Frequency Counter

The Patriot is well suited for use on a turbine meter proving bench. The display remains on at all times and it can easily be set to act as a pulse and frequency counter.

To set the Patriot for pulse / frequency counter mode simply press and hold both the [K-Factor Menu] key and the [ENTER] key for about 10 seconds. The message 'LOAD dEFAuLtS' will appear on the display. Once this message appears the keys can be released. At this point the Patriot will have changed its K-Factor to 1 GAL, and its display will measure in GAL /SEC. This allows the flow total section of the display to show the number of pulses counted and the Flow rate section to show the frequency in Hz. The other functionality of the Patriot is not affected.

The Patriot as a Gas Recorder / Totalizer

As with liquid turbines, gas turbines measure the actual volume passing through them. Metering the actual volume of gas only provides useful information when the operating pressure and temperature are known. This is because the amount of mass within a volume of gas (density) is greatly dependant on the temperature and pressure of the gas. When sizing a gas turbine meter it is necessary to determine the flow rate in terms of actual volumes (because turbine meters measure actual volumes) such as Actual Cubic Feet per Minute (ACFM). However, when delivering gas flow data it can be more useful in terms of Standard Cubic Feet per Minute (SCFM) which represents the amount of volume at a standardized operating temperature and pressure.

Measuring Actual Gas Volumes

Gas turbine meters will be provided with K-Factors in standard units such as Pulses per Standard Cubic Foot (PPSCF). The operator can convert the factor to Pulses per Actual Cubic Foot (PPACF) using the the application's pressure and temperature data in the following formula:

$$PPACF = \frac{530 \times PPSCF \times P_a}{14.7 \times T_a}$$

Where:
PPACF = Pulses per Actual Cubic Foot
PPSCF = Pulses per Standard Cubic Foot
P_a = Operating Pressure PSIA = PSIG + 14.7
T_a = Temperature in °Rankine = °F + 460.67
    = (1.8 x °C) + 492.67

Recorded actual volumes can be converted to standard volumes using:

$$SCF = \frac{ACF \times P_a}{14.7} \times \frac{530}{T_a}$$