OPERATING INSTRUCTIONS FOR

Model 2240

Handheld Hydrogen Leak Detector

P/N M2240

1/31/2011

DANGER
Toxic and explosive gases may be present in this monitoring system. Personal protective equipment may be required when servicing this instrument. Hazardous voltages exist on certain components internally when the battery charger is connected. Do not recharge battery in a hazardous environment. Only authorized personnel should conduct maintenance and/or servicing. Before conducting any maintenance or servicing, consult with authorized supervisor/manager.

Teledyne Analytical Instruments

CONTENTS **PAGE**

Warranty

This equipment is sold subject to the mutual agreement that it is warranted by us free from defects of material and of construction, and that our liability shall be limited to replacing or repairing at our factory (without charge, except for transportation), or at customer plant at our option, any material or construction in which defects become apparent within one year from the date of shipment, except in cases where quotations or acknowledgements provide for a shorter period. Components manufactured by others bear the warranty of their manufacturer. This warranty does not cover defects caused by wear, accident, misuse, neglect or repairs other than those performed by Teledyne or an authorized service center. We assume no liability for direct or indirect damages of any kind and the purchaser by the acceptance of the equipment will assume all liability for any damage which may result from its use or misuse.

We reserve the right to employ any suitable material in the manufacture of our apparatus, and to make any alterations in the dimensions, shape or weight of any parts, in so far as such alterations do not adversely affect our warranty.

Important Notice

This instrument provides measurement readings to its user, and serves as a tool by which valuable data can be gathered. The information provided by the instrument may assist the user in eliminating potential hazards caused by his process; however, it is essential that all personnel involved in the use of the instrument or its interface, with the process being measured, be properly trained in the process itself, as well as all instrumentation related to it.

The safety of personnel is ultimately the responsibility of those who control process conditions. While this instrument may be able to provide early warning of imminent danger, it has no control over process conditions, and it can be misused. In particular, any alarm or control systems installed must be tested and understood, both as to how they operate and as to how they can be defeated. Any safeguards required such as locks, labels, or redundancy, must be provided by the user or specifically requested of Teledyne at the time the order is placed.

Therefore, the purchaser must be aware of the hazardous process conditions. The purchaser is responsible for the training of personnel, for providing hazard warning methods and instrumentation per the appropriate standards, and for ensuring that hazard warning devices and instrumentation are maintained and operated properly.

Teledyne Analytical Instruments, the manufacturer of this instrument, cannot accept responsibility for conditions beyond its knowledge and control. No statement expressed or implied by this document or any information disseminated by the manufacturer or its agents, is to be construed as a warranty of adequate safety control under the user's process conditions.

Specific Model Information

This instrument is specifically designed to measure hydrogen in air. Using this instrument to analyze any other gas mixture may result in serious error. Consult the factory for additional information for gas analysis not specified at the time of purchase.

Instrument Serial Number: _____

Instrument Range: _____
Calibrated for: _____
Background Gas: _____
Zero Gas: _____
Span Gas: _____

DANGER
COMBUSTIBLE GAS USAGE WARNING

The Model 2240 instrument is CE approved. This rating applies only to the equipment specified and installed in accordance with the information contained within this manual. It is the customer's responsibility to ensure safety especially when combustible gases are being analyzed since the potential of gas leaks always exist.

The customer should ensure that the principles of operating of this equipment is well understood by the user and that the instrument as well as any approved support equipment is properly installed. Misuse of this product in any manner, tampering with its components, or unauthorized substitution of any component may adversely affect the certification and the safety of this instrument.

Since the use of this instrument is beyond the control of Teledyne, no responsibility by Teledyne, its affiliates, and agents for damage or injury from misuse or neglect of this equipment is implied or assumed.

Read and understand this operating manual before installing or using the unit.
Only use cables, battery pack, battery charger, and AC/DC power supply from Teledyne Analytical Instruments with this unit.
If this equipment is used in a manner not specified by Teledyne Analytical Instruments, the protection provided by this equipment may be impaired.

Hydrogen is flammable at 4% in air. Take indications seriously and be prepared to take action. In the event of detection of 4% or higher of a hydrogen gas concentration there is a high probability of a hazard to safety. Inform local emergency response personnel immediately.

Safety Messages

Your safety and the safety of others is very important. We have provided many important safety messages in this manual. Please read these messages carefully.

A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the instrument. The definition of these symbols is described below:

GENERAL WARNING/CAUTION: Refer to the instructions for details on the specific danger. These cautions warn of specific procedures which if not followed could cause bodily Injury and/or damage the instrument.

CAUTION: HOT SURFACE WARNING: This warning is specific to heated components within the instrument. Failure to heed the warning could result in serious burns to skin and underlying tissue.

WARNING: ELECTRICAL SHOCK HAZARD: Dangerous voltages appear within this instrument. This warning is specific to an electrical hazard existing at or nearby the component or procedure under discussion. Failure to heed this warning could result in injury and/or death from electrocution.

Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

No Symbol

NOTE: Additional information and comments regarding a specific component or procedure are highlighted in the form of a note.

CAUTION: **THE ANALYZER SHOULD ONLY BE USED FOR THE PURPOSE AND IN THE MANNER DESCRIBED IN THIS MANUAL.**

IF YOU USE THE ANALYZER IN A MANNER OTHER THAN THAT FOR WHICH IT WAS INTENDED, UNPREDICTABLE BEHAVIOR COULD RESULT POSSIBLY ACCOMPANIED WITH HAZARDOUS CONSEQUENCES.

This manual provides information designed to guide you through the installation, calibration operation and maintenance of your new analyzer. Please read this manual and keep it available.

Occasionally, some instruments are customized for a particular application or features and/or options added per customer requests. Please check the front of this manual for any additional information in the form of an Addendum which discusses specific information, procedures, cautions and warnings that may be peculiar to your instrument.

Manuals do get lost. Additional manuals can be obtained from Teledyne at the address given in the Appendix. Some of our manuals are available in electronic form via the internet. Please visit our website at: www.teledyne-ai.com.

1. Description

Teledyne Analytical Instruments believes that protecting lives means being able to locate and find hydrogen leak as quickly as possible. With two sensing elements on the same semiconductor die, the Model 2240 can detect hydrogen leaks as low as 15 ppm and will not saturate or be destroyed when detecting concentrations of hydrogen up to 100%. The flexible cable allows the sensor probe access to virtually all potential leak sources.

2. Specifications

Sensitivity Range:	0.0015% (15 ppm) to 100% hydrogen by volume in air.
Response Time:	Indication of hydrogen within seconds. Stabilization to final value depends on concentration.
Ambient Temperatures:	Operating: 0°C to +40 °C Storage: -20°C to +45 °C
Relative Humidity:	0-95% non-condensing
Power:	Internal rechargeable Lithium Ion battery yields over 10 hours of operation and is recharged in 4 hours with included charger. Battery charger input: 100-240VAC, 50-60Hz, 0.6A.
Environmental:	Indoor/Outdoor Use Altitude up to 2000 meters Pollution degree 2 environment
Ingress Protection:	IP64 capable
Calibration Period:	Recommended user Verification/Calibration on a 12 month basis.
Weight:	975 g (2.15 lb.) unit and carrying pouch 2.2 kg (5 lb.) shipping weight (unit with accessories)
Product Life Expectancy:	10 years
Certifications:	CE c UL us LISTED

Figure 2-1: User Interface

3. Unpacking the Instrument

The Model 2240 is shipped with all the materials you need to install and prepare the system for operation. Carefully unpack the instrument and inspect it for damage. Immediately report any damage to the shipping agent. Figure 3-1 shows the items that are included in the package.

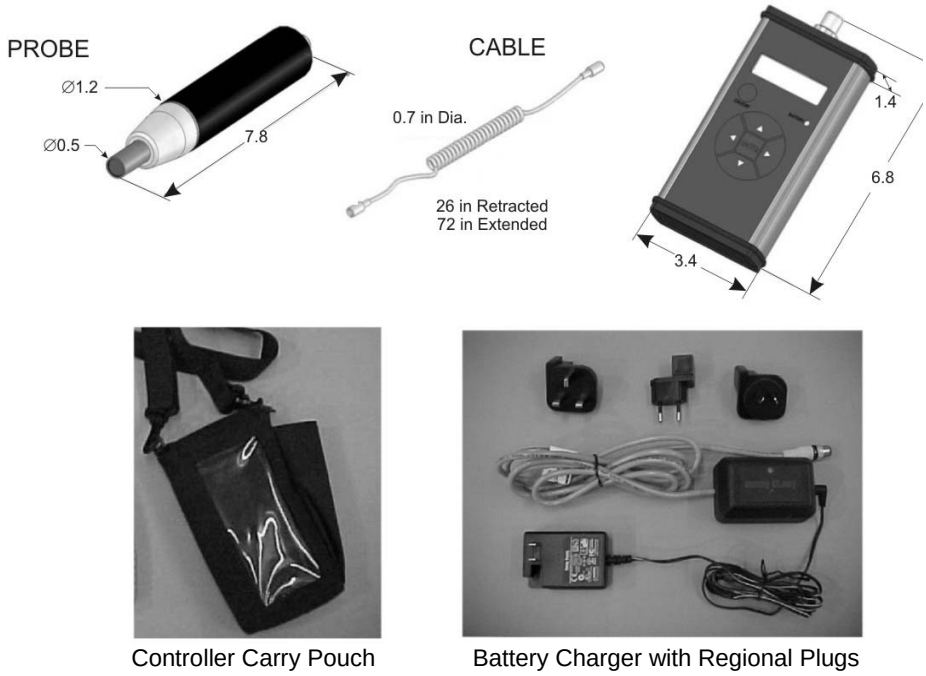


Figure 3-1: Analyzer Components

4. Operation

4.1 Startup

To power-up the Model 2240, press and hold the **ON/OFF** button until the Controller LCD display indicates an operational message.

Warning: Only power-up the instrument in a hydrogen-free environment.

After power is on, the instrument takes about ten minutes to warm-up. During this time the LCD displays a countdown to completion and the Probe Tip LED is amber. The following operations occur:

The Wide Range Sensor® reaches operating temperature.

A system self-test is run.

Upon successful completion of the above tasks the instrument zeroes itself and automatically switches to normal operation. If an error is detected the instrument will display an error code (see *Section 10*).

4.2 Shutdown

To power-down the Model 2240, press and hold the ON/OFF button for approximately two seconds until the Controller LCD display turns off.

4.3 Battery Level

After power-on the **BATTERY LED** indicates the current battery level (*times are approximate and may vary as the battery ages*):

Color	Meaning
Green	more than 60 minutes of operation remaining
Amber	approximately 15 to 60 minutes of operation remaining
Red	less than approximately 15 minutes of operation remaining

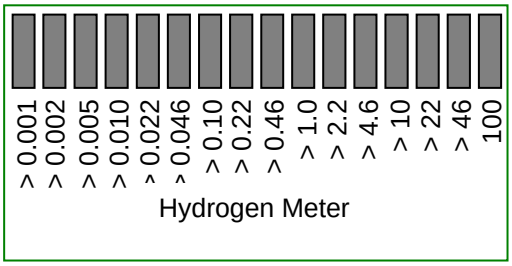
A fully charged battery should last 10 to15 hours, depending on use.

There is a small load on the battery when the unit is powered off. This load will discharge the battery of the unit in it's powered off state in about 6 months. Customers that do not use the device frequently should charge the battery and perform a bump test with hydrogen gas every one to three months to keep the battery charged and ready for use.

4.4 Normal Operation

During normal operation the instrument is detecting and reporting the hydrogen concentration near the probe tip sensor. Hydrogen readings are displayed on the controller LCD and the probe tip LED bar graph array. Note that due to the extreme sensitivity of the sensor, it may take several minutes to return to a near zero (less than 0.001%) reading after exposure to hydrogen. If the instrument does not return to an indication of less than 0.001% after 5 minutes in a hydrogen-free environment, then invoke the Reset operation (See *Section 4.6*).

The upper line of the Controller LCD indicates a numerical value or range for the percent hydrogen concentration or peak hydrogen value. The lower line is used to display the hydrogen meter, a logarithmic bar graph ranging from 0.001% (10 ppm) to 100% hydrogen by volume. An open box on the bar indicates the last peak value obtained and filled boxes indicate the current value. The following figure describes how to interpret the hydrogen meter:

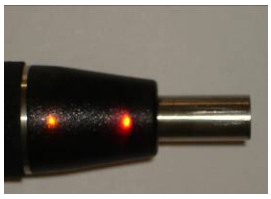


The Probe Tip LED Indicator shows an increase or decrease in hydrogen concentration. Leak detection is accomplished by watching the Probe Tip LED and the bar graph array and moving the sensor around a potential hydrogen leak.

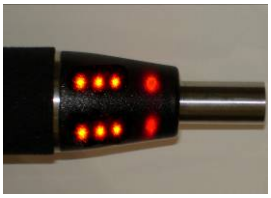
Probe Tip Colors

Solid Green - Unit ready
- < 15 ppm hydrogen

Pulsing Green - Decreasing H2 level



Solid Amber - System startup
- Steady H2 level

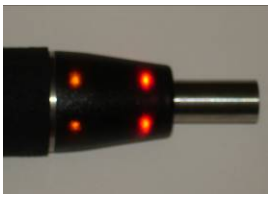


Pulsing Red - Increasing H2 level

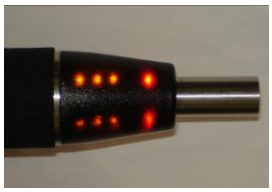
Alternating Red, Green - Fluctuating H2 level

The number of yellow LEDs lit in the Probe LED bar graph array indicates detected hydrogen concentrations in four ranges as noted below:

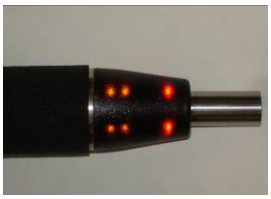
LED Bar Graph Array



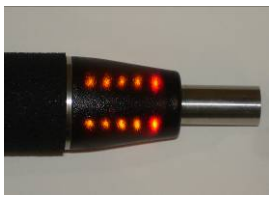
1 Yellow LED:
> 0.01% hydrogen
> 100 ppm



3 Yellow LEDs:
> 1% hydrogen
> 10,000 ppm



2 Yellow LEDs:
> 0.1% hydrogen
> 1,000 ppm



4 Yellow LEDs:
> 10% hydrogen
> 100,000 ppm

4.5 Hydrogen-Free Areas

For the purposes of this document a hydrogen-free area is one with less than 5ppm of hydrogen in the air.

It may be difficult to find a hydrogen-free area in a facility where hydrogen is used. Nearby rooms, or even the entire building, may not be hydrogen free.

To check these areas reset or zero the sensor outside, away from any hydrogen tanks, pipes, or other potential sources. Walk through the facility, watching the sensor. It is surprising how far low levels of hydrogen can spread.

If the sensor is zeroed or reset in hydrogen, there will be a negative offset in the readings that could compromise the sensor's ability to find small leaks.

4.6 Reset Operation

The Reset Operation is used to speed recovery from hydrogen exposure.

It can be invoked from the keypad while in the top menu level (measuring hydrogen) by pressing and holding ◄► (left and right arrow buttons simultaneously) or from the Reset Menu (see *Section 5*). Once invoked the user is asked to confirm the operation by pressing the **ENTER** key. Pressing any other key will abort the operation. During Reset the LCD indicates a count down to completion and the Probe tip LED is yellow.

WARNING: The instrument must be in a hydrogen free environment with the LCD indicating less than 0.1% hydrogen before invoking the Reset operation.

4.7 Zero Operation

The Zero Operation is used to zero the hydrogen reading if the instrument is reporting low levels (0.001% to 0.01%) of hydrogen when no hydrogen is present. This operation can be invoked from the keypad while in the top menu level (measuring hydrogen) by pressing and holding ◄ (left arrow button) or from the Reset Menu (see *Section 5*). Once invoked the user is asked to confirm the operation by

pressing the **ENTER** key, pressing any other key will abort the operation.

WARNING: The instrument must be in a hydrogen free environment with the LCD indicating less than 0.1% hydrogen before invoking the Zero operation.

5. Keypad

5.1 Numerical Changes

In the following sections when queried to change a numeric value the ▲ (up arrow) and ▼ (down arrow) keys are used to increment/decrement the value based on the selected digit. If the ones digit is selected the value will increment/decrement by one (9 increments to 10, 10 decrements to 9). The ◄ (left arrow) and ► (right arrow) keys are used to select another digit. To change a value of 0 to 100 first select the hundreds digit then press the ▲ up arrow. Pressing ◄► (the left and right arrows simultaneously) will clear any changes made and restore the previous value. Once the correct value is displayed press the **ENTER** key to save it.

5.2 Top Level Keypad Functions

While in the hydrogen measurement screen, the keypad has these functions:

Key	Function
ENTER	Go to the Information Display menu .
▲	Display the peak hydrogen reading.
▼	Display the current hydrogen concentration.
►	Clear the peak hydrogen value.
◄	Zero the sensor (see Section 4.7).
◄►	Reset the sensor (see Section 4.6).

5.3 General Keypad Functions (Also See Section 11)

Key	Navigation	Editing Values	Query Answer
ENTER	Enter submenu	Select Value	Yes
▲	Previous Menu	Increase Value	No
▼	Next Menu	Decrease Value	No
►	Enter Submenu	Move Cursor Right	No
◄	Exit Submenu (Back)	Move Cursor Left	No
◄►	Exit Configuration	Undo Changes	No

5.4 Information Display

The Information Display menu allows the user to view useful information about the instrument including firmware revisions, serial number, and calibration date. Enter it by can be entered by pressing and holding the **ENTER** button.

5.5 Firmware Rev:

This displays the sensor pod and controller firmware. The left most number preceded by an 'S' is the Probe firmware revision. The right most number preceded by a 'C' is the Controller firmware revision. For example: *S1.23 C2.34* for Probe firmware version 1.23 and Controller firmware version 2.34

5.6 Serial Number:

This displays the product serial number. For example: *50123*

5.7 Calibration Date:

This displays the date of last factory calibration, MM/DD/YY. For example: 5/8/06 for 8 May 2006.

5.8 Reset Sensor

The Reset Sensor menu is used to invoke the Reset Operation as described in *Section 4.6*.

5.9 Zero Sensor

The Zero Sensor menu is used to invoke the Zero Operation as described in *Section 4.7*.

5.10 Verify

The Verify menu shows the date of the last field verify and allows the user to invoke the Verify function in *Section 7.*

6. Hydrogen Sensing Considerations

From any given source, hydrogen gas disperses rapidly and generally upward due to its very low density compared to air. Understanding this behavior allows a more effective search for hydrogen leaks.

The hydrogen plume from a leak generally spreads in a roughly conical shape that is easily disturbed by environmental conditions. Certain conditions such as pressure, temperature, and leak size may act together to change the shape of the hydrogen plume from a cone to a laser-like beam. This makes finding a leak more difficult.

If the sensor element is near (and above) the leak, the concentration will likely be higher but the leak may be difficult to locate. As hydrogen dissipates the concentration decreases. Generally, greater distances will increase the chance of intercepting the leak stream, but if the sensor is too far away, the response may be too weak to detect.

When drafts or air currents are present, hydrogen will tend to be dispersed. Testing for hydrogen leaks downwind of the leak area may increase the chance of detecting the leak.

If hydrogen is rising in an enclosed building the hot air near the ceiling may slow the hydrogen's rise. Thus, sensing hydrogen near ceiling areas with high temperatures present may not be as effective as at a lower level.

Low temperatures can also affect the behavior of hydrogen. Hydrogen stored in a liquid state is at an extremely low temperature. The low temperature of any escaping hydrogen will be of a higher than normal density and may initially move downward. As the hydrogen warms, it will begin to rise upward. When checking for a leak in areas where liquid hydrogen is stored, check both above and below the area of concern.

7. Verification

Verification is performed to confirm that the MODEL 2240 is operating properly. The recommended verification interval is three months.

The MODEL 2240 requires calibration only if it fails verification. It can not be field calibrated and must be returned to Teledyne Analytical Instruments for calibration. An optional NIST traceable certificate is available.

Once verification has begun, the only way to stop it prematurely is to cycle the power.

7.1 Gases

Verification requires the availability of the following certified gases:

2.00% hydrogen by volume in air (20,000 ppm)

0.10% hydrogen by volume in air (1000 ppm)

zero grade, hydrogen-free air. Ambient air can be substituted if it is hydrogen-free.

7.2 Gas Connection

Gases are applied to the unit through the use of the Calibration Cup Assy. (P/N 50000009) available from Teledyne Analytical Instruments.

7.3 Verification Kits

Customer-specific Field Verification Kits for the MODEL 2240 are available from Teledyne Analytical Instruments.

The field verification function allows the user to check the instrument's calibration. Details on this function can be found in Table 1 on page 28.

If the unit passes verification, calibration is not required at this time.

If the unit fails verification, the unit should be returned to the factory for calibration.

8. Battery Charging

Ensure the unit is powered OFF.

Disconnect the coiled cord from the controller.

Connect the battery charger to the controller.

Using the appropriate A/C plug adapter for the region of use, plug the battery charger into the A/C supply.

The battery charger indicator light will illuminate according to charge status as follows:

Off	No Battery
Flashing Green	Fast charging
Steady Green	Fully charged
Steady Amber	Standby
Flashing Red	Error

NOTE: Complete charging may take up to 4 hours for a fully discharged battery.

9. Cleaning

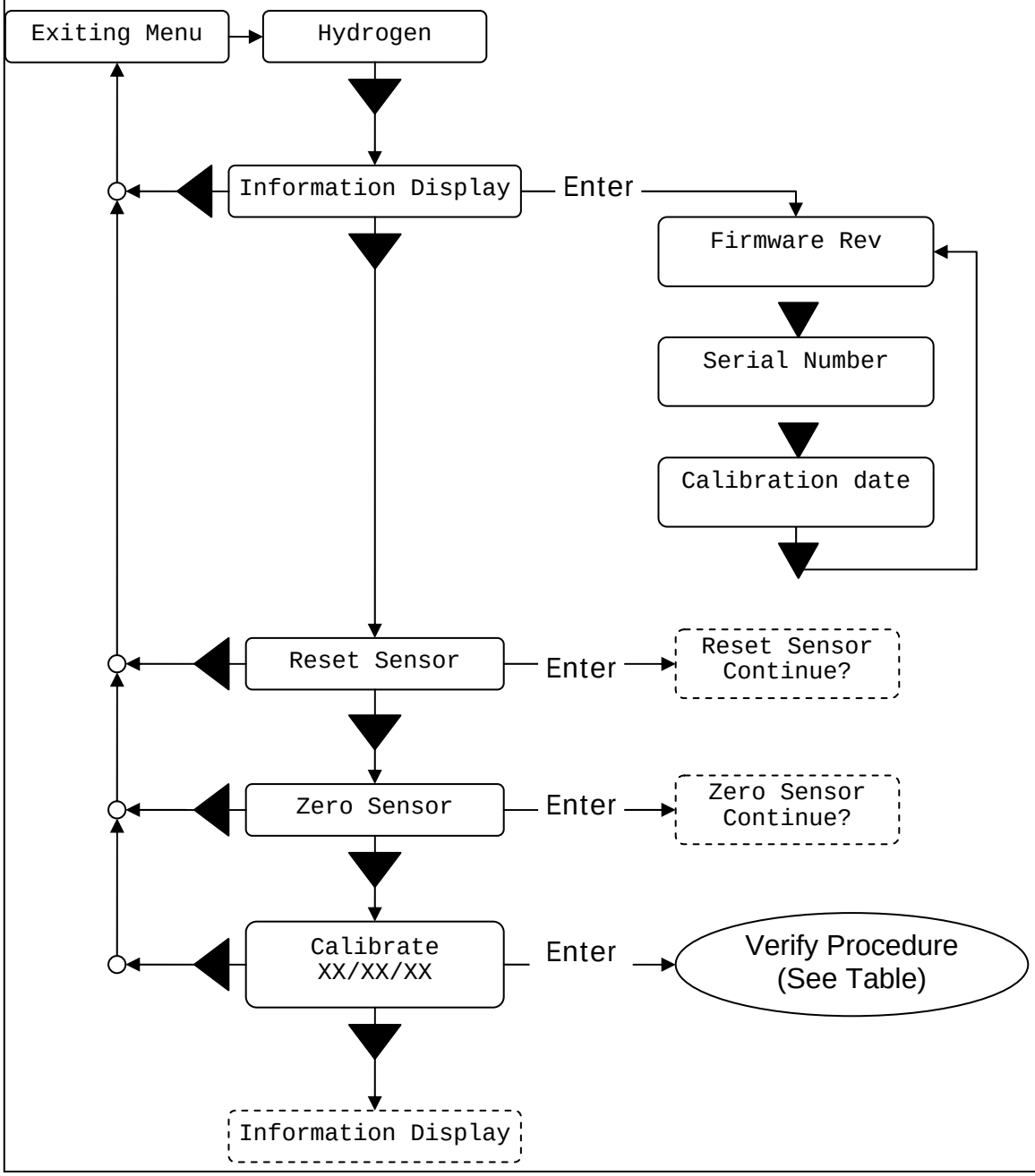
If the unit becomes soiled, clean the unit with a lint-free cloth. Use special care when cleaning the handheld probe assembly. Small debris or other material may collect over the sensor tip. Clean the tip with a gentle wiping with a clean, damp, lint-free cloth or paper. Do not use chemicals or soap.

10. Troubleshooting

Symptom	Possible Cause	Action
Sensor Error	The probe is disconnected from the controller.	Turn off the instrument and verify that the probe is properly connected to the controller.
Error 88	Faulty capacitor	Turn off the instrument.
Error 40	The PCB temperature is too high.	Turn off the instrument. Let it cool.
Error 20	The sensor temperature is incorrect.	Turn off the instrument.
Battery LED is red	The battery is very low.	Charge the battery completely. See Section 8.
Unit won't turn on	The battery is dead.	Charge the battery completely. See Section 8.
If the recommended action does not solve the problem, the MODEL 2240 should be returned to the factory for repair.		

11. Menu Structure

A dashed outline shows the next display if it is on a different page, or to avoid clutter.



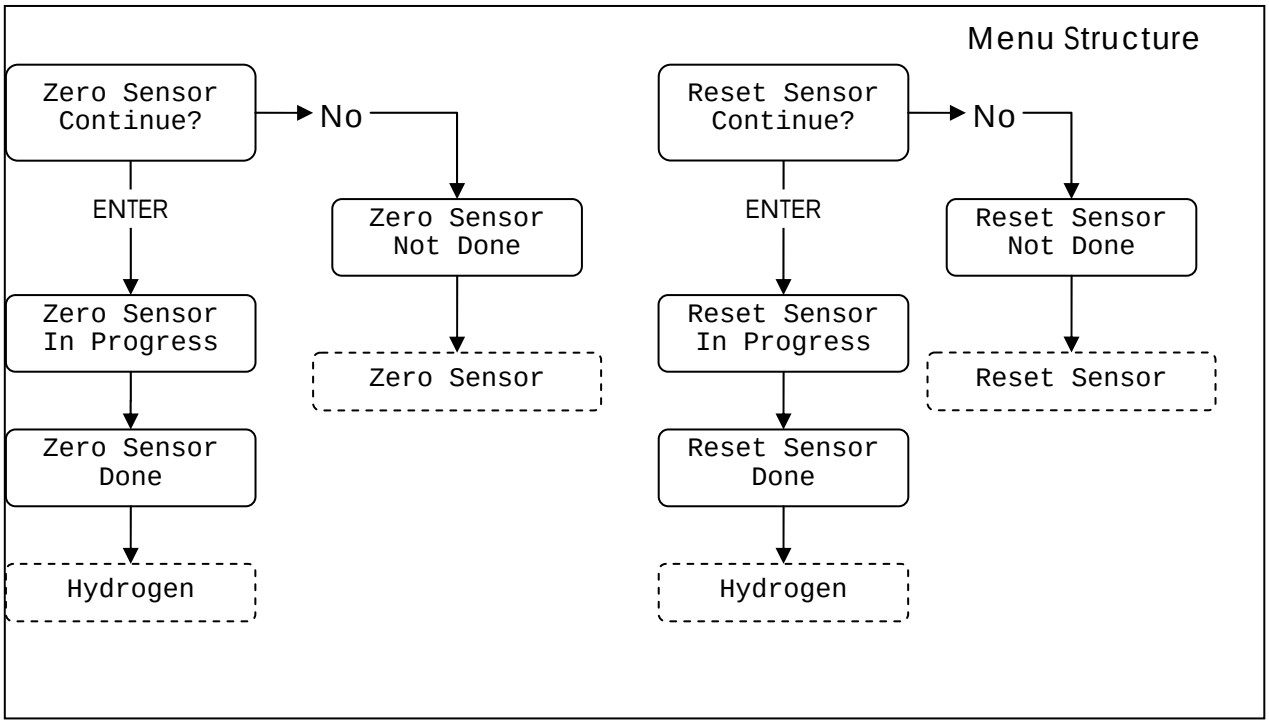

Menu Structure
Zero Sensor Continue?
No
ENTER
Zero Sensor Not Done
Zero Sensor In Progress
Zero Sensor
Zero Sensor Done
Hydrogen
Reset Sensor Continue?
No
ENTER
Reset Sensor Not Done
Reset Sensor In Progress
Reset Sensor
Reset Sensor Done
Hydrogen

Table 1 - Verify Procedure

Step	Display	User response
1	Verify Sensor	Press **ENTER**
2	Verify Sensor Continue?	Press **ENTER** to Verify sensor, **L** to exit.
3	Verify Sensor In Progress	Verify Test begins.
4	Apply 0.000%H2 Continue?	With the Calibration Cup that accompanies the MODEL 2240, apply hydrogen-free, ultra-zero air to the Probe sensor. The Probe Tip LED will remain Green. Press **ENTER**.
5	Apply 0.000%H2 In Progress	0% Verify Test starts.
6	Apply 0.000%H2 Settle	Checking sensor temperature.
7	Apply 0.000%H2 Wait xxxx	Wait for sensor reading to stabilize until **xxxx = 0**.
8	Apply 0.000%H2 Finding Average	Measuring sensor response to test gas.
9	Apply 0.100%H2 Continue?	With the Calibration Cup, apply 0.1% hydrogen to the Probe sensor. The Probe Tip LED will change from Green to Red. One (or two) yellow LEDs in the LED Bar Graph Array will turn on. Press **ENTER**.
10	Apply 0.100%H2 In Progress	0.1% Verify Test starts.

11	Apply 0.100%H2 Settle	Checking sensor temperature.
12	Apply 0.100%H2 Wait xxxx	Wait for sensor reading to stabilize until **xxxx = 0**.
13	Apply 0.100%H2 Finding Average	Measuring sensor response to test gas. Visually verify that 1-2 yellow LED's are lit up in the probe tip. If not the unit needs factory calibration
14	Apply 2.000%H2 Continue?	With the Calibration Cup, apply 2.0% hydrogen to the Probe sensor. The Probe Tip LED will remain Red. Three yellow LEDs in the LED Bar Graph Array will turn on. Press **ENTER**.
15	Apply 2.000%H2 In Progress	2.0% Verify Test starts.
16	Apply 2.000%H2 Settle	Checking sensor temperature.
17	Apply 2.000%H2 Wait xxxx	Wait for sensor reading to stabilize until **xxxx = 0**.
18	Apply 2.000%H2 Finding Average	Measuring sensor response to test gas.
19	Enter Date: 1.0000 M	Enter the current month (1-12) using the ▲ (up arrow) and ▼ (down arrow) keys.
20	Enter Date: 1.0000 D	Enter the current day (1-31) using the ▲ (up arrow) and ▼ (down arrow) keys.

21	Enter Date: 6.0000 Y	Enter the current year (7=2007, 12=2012, etc.) using the ▲ (up arrow) and ▼ (down arrow) keys.
22	Verify Sensor Passed	Verify is complete, press any key.