Model 2240

IMPORTANT: SEE CRITICAL SAFETY INFORMATION ON PAGES 1-4

Portable Handheld Hydrogen Leak Detector

Model Number 2240

Customer Support 1-626-934-1673

DEFAULT INSTRUMENT SETTINGS

Alarm Setting	2% Hydrogen
Analog Full Scale	2% Hydrogen
Analog Format	0-5 Volts and 4-20 mA

i. IMPORTANT NOTICES

READ THIS INSTRUCTION MANUAL BEFORE OPERATING OR SERVICING YOUR 2240 HYDROGEN-SPECIFIC SENSING INSTRUMENT!!

1) **HYDROGEN IS FLAMMABLE AT 4% IN AIR.**

2) **BEWARE OF THE DANGER OF APPROACHING THE FLAMMABLE LIMIT OF HYDROGEN IN AIR! TAKE 2240 INDICATIONS SERIOUSLY AND BE PREPARED TO TAKE ACTION TO ELIMINATE THE DANGER. THERE IS A HIGH PROBABILITY OF HAZARD TO PUBLIC AND PERSONAL SAFETY! IMMEDIATELY VACATE THE PREMISES AND INFORM LOCAL EMERGENCY RESPONSE PERSONNEL!**

3) **TO PREVENT DAMAGE TO THE 2240 SENSOR ELEMENT, NEVER OPERATE THE UNIT IN A CONDENSING ATMOSPHERE, TOUCH THE SENSING ELEMENT, OR POWER DOWN 2240 BEFORE OPERATING IT IN A BENIGN**

ATMOSPHERE (AIR OR NITROGEN) UNTIL THE DISPLAY READS <0.001%.

4) TELEDYNE, IS NOT RESPONSIBLE FOR THE ACTIONS TAKEN BY THE USERS OF 2240 (SEE FOLLOWING FOR MORE DETAILS ON TELEDYNE'S LIMITED LIABILITY.)

5) Teledyne WARRANTS ONLY THAT THE 2240 MEETS TELEDYNE'S PUBLISHED SPECIFICATIONS AT THE TIME OF PURCHASE, AND DISCLAIMS ALL OTHER WARRANTIES (SEE BELOW FOR MORE DETAILS ON TELEDYNE'S LIMITED WARRANTY.)

LIMITED WARRANTY

Teledyne Limited Warranty. Each 2240 portable hand-held hydrogen instrument ("Product") will conform, as to all substantial operational features, to the Product specifications set forth in this Manual and will be free of defects which substantially affect such Product's performance for twelve (12) months from the ship date for such Product. **Must Provide Notice of Defect**. If you believe a Product that you believe is defective, you must notify Teledyne in writing, within ten (10) days of receipt of such Product, of your claim regarding any such defect. **Return Product to H2scan for Repair, Replacement or Credit**. If the Product is found defective by Teledyne, Teledyne's sole obligation under this warranty is to either (i) repair the Product, (ii) replace the Product, or (iii) issue a credit for the purchase price for such Product, the particular remedy to be determined by Teledyne on a case-by-case basis.

Limitation of Warranty. THE ABOVE IS A LIMITED WARRANTY AS IT IS THE ONLY WARRANTY MADE BY TELEDYNE. TELEDYNE MAKES NO OTHER WARRANTY EXPRESS OR IMPLIED AND EXPRESSLY EXCLUDES ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. YOUR SOLE REMEDY HEREUNDER IS REPAIR OR REPLACEMENT OF THE PRODUCT OR A CREDIT FOR THE PURCHASE PRICE FOR SUCH PRODUCT, THE PARTICULAR REMEDY TO BE DETERMINED BY TELEDYNE ON A CASE-BY-CASE BASIS. TELEDYNE SHALL HAVE NO LIABILITY WITH RESPECT TO ITS OBLIGATIONS UNDER THIS AGREEMENT FOR CONSEQUENTIAL, EXEMPLARY, OR INCIDENTAL DAMAGES EVEN IF IT HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THE STATED EXPRESS WARRANTY IS IN LIEU OF ALL LIABILITIES OR OBLIGATIONS OF TELEDYNE FOR DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE DELIVERY, USE OR PERFORMANCE OF THE PRODUCTS.

LIMITATION OF LIABILITY

IN THE EVENT OF A DEFECT IN A PRODUCT, TELEDYNE SHALL NOT BE RESPONSIBLE FOR ANY DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING THERE FROM, INCLUDING, BUT NOT LIMITED TO, LOSS OF REVENUE AND/OR PROFIT.

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ii. Introducing the 2240

The 2240 system consists of a proprietary control system monitoring inputs from the TELEDYNE Wide Range Hydrogen Sensor® or WRS. This sensor receives inputs from two sensing devices. The first device is a hydrogen sensing capacitor (HCAP). The HCAP sensor is used for sensing low levels of hydrogen 50 ppm to 10,000 ppm. The second device is a hydrogen-sensing resistor (HRES). This device contains a thin film of palladium-nickel deposited on a silicon substrate and acts like a variable resistor in the presence of hydrogen. The change in resistance is used to generate a signal that is proportional to the hydrogen concentration. This device is used to sense hydrogen from 10,000 ppm to 100%. The 2240 interprets the signals from both devices and displays an approximate hydrogen concentration to the operator.

> **NOTE: The indicated concentration is an approximate value and should not be used as an analytical measurement.**

It also generates an analog signal in direct proportion to the displayed value that can be interpreted by an external monitoring/control system. Since palladium only behaves in this manner with hydrogen, there is no cross-sensitivity of the sensor with any other elemental or compound gas.

In addition to the Pd/Ni thin film, the sensor includes a temperature sensor and an on-board heater. Using these, the 2240 maintains the sensor substrate at a constant temperature. This elevated, controlled temperature assures that sensor operation is unaffected by ambient temperature. Also, the **2240** will sense hydrogen in air while being held in any position.

1. 2240 General Specifications

- Sensitivity Range: 50 ppm to 100%
- Display Mode: Values below 0.5% are displayed as a bar graph. Values above 0.5% are reported numerically in addition to the bar graph..
- Response Time: Initial response less than 1 second at hydrogen concentrations of 100 ppm and above
- Analog Output – 0-5 V and 4-20 mA
- Serial Output – 9 pin Sub-D connector in RS-232 configuration transmitting ASCII data in an 8 bit stream with no parity and 1 stop bit.
- Storage and Operating Conditions
  - 0 to 50 degrees C.
  - 0% to 95% relative humidity (non-condensing).
  - Warm-up time: 5minutes (approximately).
  - Battery Life: 6 hrs. (continuous use).
- Atmospheric Pressure Influence: As the 2240 is calibrated at standard sea level conditions, hydrogen readings must be corrected for altitude**.** To compensate for altitude variations, multiply the instrument reading by the correction factor indicated in Figure 1.

Example:

At an altitude of 800 m there is a correction factor of 1.10.
A hydrogen reading of 1.5% will be corrected for altitude as follows:

1.5%H_2 X 1.10 =1.65%H_2

Notes and Calculations – enter your corrections for altitude as a record here:

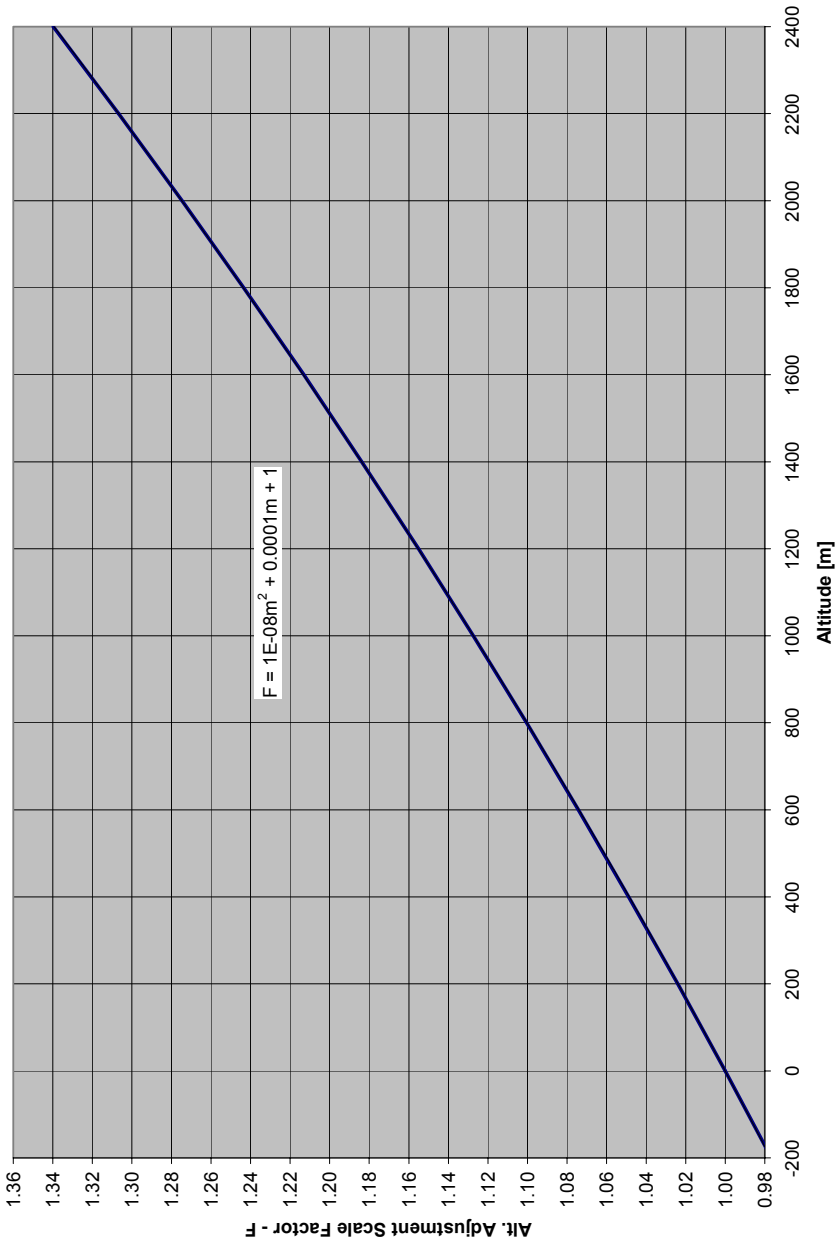


Figure 1 - Atmospheric Pressure Correction Factor

2. 2240 Functions and Features

General Features

The 2240 is designed as three section unit housed in a tough ABS carrying case with all the necessary accessories. The principle sections are:

- Controller – Containing the user interface, battery, and external electrical interfaces. (Serial and analog).
- Wand Assembly – extends the operator's reach by 24 inches, making operation highly flexible.
- Sensor Module – Containing the sensor element and sensor-specific electronics. Easily mounted on either the Controller or Wand Assembly.

Electrical Features

- Power provided by either the internal battery or through an optional Teledyne external power supply.
- Automatic self-test, activated on start-up, to confirm proper operation.
- Serial Interface: 9 pin Sub-D connector in RS-232 configuration transmitting ASCII data in an 8 bit stream with no parity and 1 stop bit.
- Analog Interface: 0-5 V and 4-20 mA. (Reference Figure 3). The analog output produces a signal proportional to the amount of hydrogen in air, an indication of Warm-Up Mode, or an indication of Error Mode as determined by the operator-selected format. (See section 5)

Operator Interface Features

- LCD: provides readable (alphanumeric) information on current readings and settings..
- Tri-colored (green/yellow/red) LED: indicates instrument status and changes in hydrogen concentration.
- Audible alarm: Operator programmable level provides a single beep each time a new peak hydrogen concentration is detected and provides a continuous series of beeps if the programmable Alarm setting is exceeded.

3. Component Identification

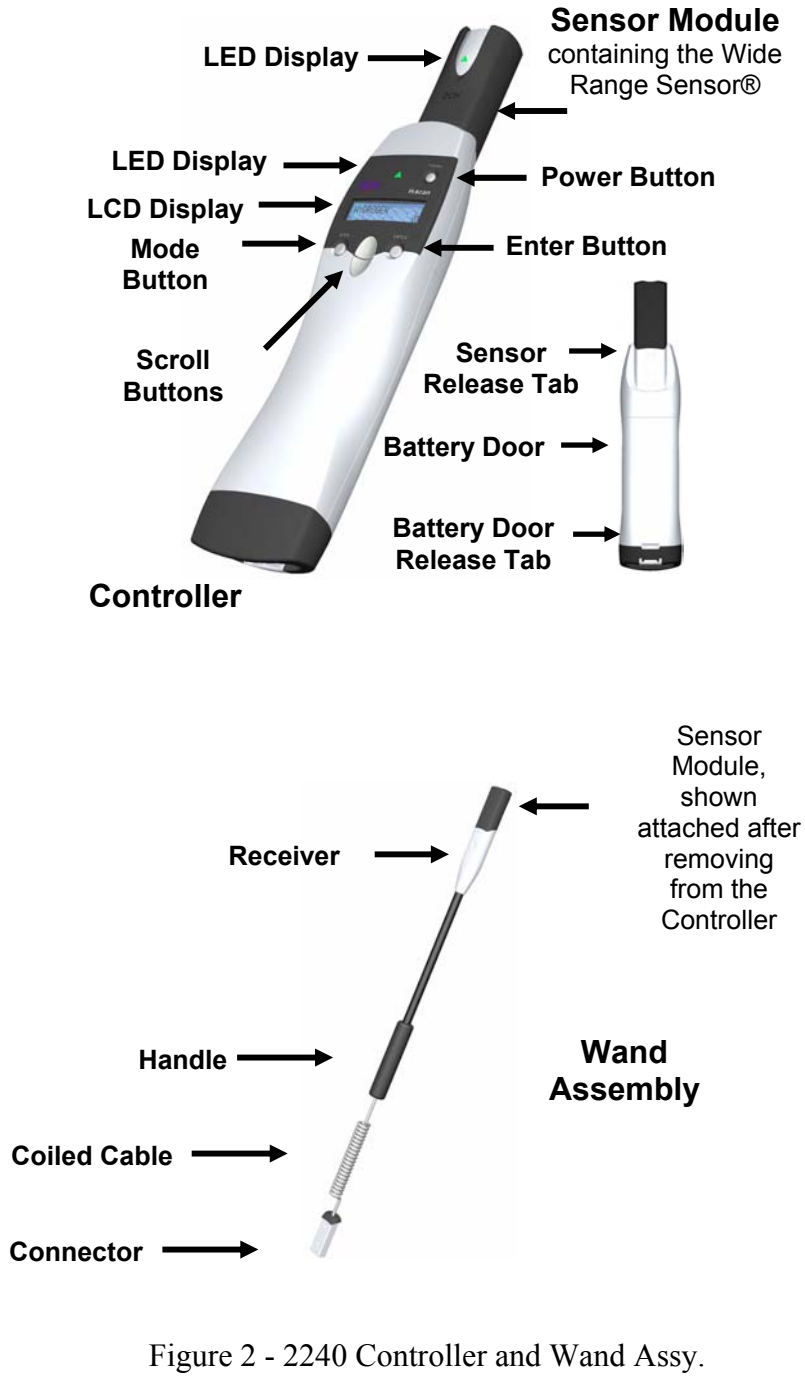
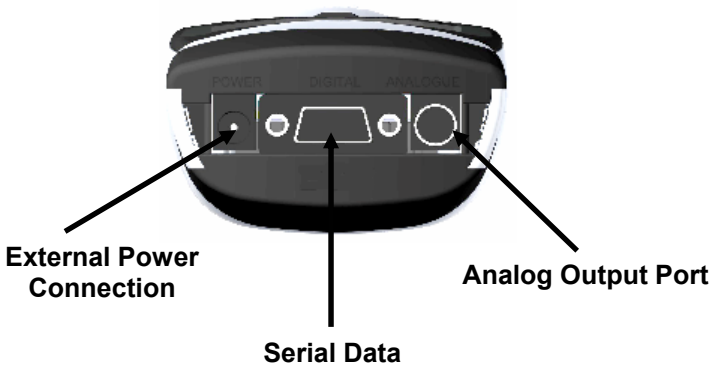


Figure 2 - 2240 Controller and Wand Assy.



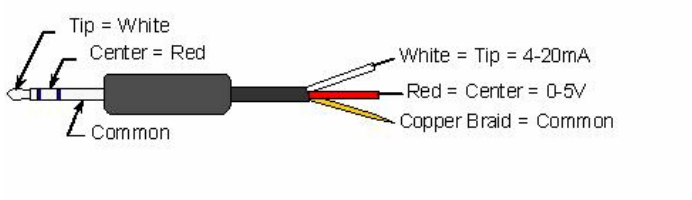


Figure 3 – Analog Output Port and Plug

4. Preparing 2240 for Operation

- Ensure that all items ordered are present. Refer to the 2240 carrying case components shown in section 3.
- 2240 is shipped with its battery separate from the Hand Held Controller. **The battery is not charged when shipped.** To charge the battery, please refer to Section 8.
- After charging the 2240 Battery, insert it into the base of the Controller.
- Remove the Controller from the carrying case.
- Remove the battery door from the back of the Controller by pressing inward while lifting up on the battery door release tab.
- Use a coin to **carefully** depress/lift the release tab.
- Insert the battery into the Hand Held Controller. The battery connections are at the top of the unit and will mate with the controller body in only one orientation.
- Replace the Battery Door.

Using the Wand Assembly

The Wand Assembly enables the operator to extend his or her reach and sense for hydrogen gas in hard-to-access areas. The Wand Assembly uses the Sensor Module attached to the Controller.

To attach the Sensor Module to the Wand Assembly:

- **Verify that power is OFF. See section 5.**
- Remove the Sensor Module from the Controller by pressing and holding down the release tab located on the back of the controller body. The Sensor Module will unlatch.
- Gently pull the Sensor Module away from the Controller body.
- **Position the Sensor Module above the Wand Assembly such that the release tab on the back of the Wand Assembly Receiver is aligned with the locking detent on the Sensor Module.**
- Gently push the Sensor Module into the Wand Assembly.
- Position the Wand Connector on the end of the coiled cable of the Wand Assembly such that the release tab on the back of the Controller is aligned with the locking detent on the body of the Wand Assembly.
- Gently insert the Wand Connector on the end of the coiled cable into the Controller.
- **Verify that the Wand Connector is fully seated and the locking tab latches into place.**

To remove the Wand Assembly:

- **Verify that power is OFF. See section 5.**
- Press and hold down the release tab located on the back on the Controller. This will unlatch the Wand Connector.
- Place a finger from the opposite hand through the loop in the Wand Connector Pull Strap and gently pull the Wand Connector away from the Controller. **Do not pull on the cable as this may damage the Wand Assembly.**

- Remove Sensor Module by pressing and holding down the release tab located on the back on the Wand Assembly Receiver and firmly pulling Sensor Module out.

5. 2240 Operation

To power-up the 2240, depress and hold the Power Button for approximately 1 second until the unit LED's illuminate. The instrument is pre-set and calibrated by the manufacturer and will automatically enter the Initialization Mode.
To power-down the 2240, depress and hold the power button for approximately 2 seconds until the LED's turn-off.
Note: The 2240 sensing element is sensitive to changes in light intensity. If operation in changing light environments produces erroneous indications follow the instructions for resetting the unit.

Modes of Operation

Initialization Mode – A warm-up/self-analysis mode that occurs automatically after power is turned on. It lasts approximately five minutes. The LCD displays a countdown to completion of the Initialization Mode.
Note: the LCD displays "Warm-up" and the LED is yellow, indicating a non-operating state.
During this time the system brings the Wide Range Sensor® to operating temperature, stabilizes system components, and performs a self-test. Upon completion, the system produces three audible beeps then automatically switches to Run Mode.

Run Mode – Measures and reports hydrogen concentration in the air using the LCD, LED's, and Beeper. The user can select several display modes for the LCD during operation:
- Pressing the UP button will display the peak hydrogen reading.
- Pressing the DOWN button will display the current percent hydrogen concentration.
- Pressing the ENTER button will clear the peak hydrogen value.

- Pressing the MODE button will switch between the battery meter and hydrogen meter.

The first line of the LCD is used to display the battery or hydrogen meter. The second line of the LCD displays the percent hydrogen concentration or peak hydrogen value. The hydrogen meter is a logarithmic bar graph covering 0.001 to 100 percent hydrogen. Open boxes on the bar indicate peak value and filled boxes indicate current value.

The LED's indicate changes in hydrogen concentration:

- **Green** indicates that hydrogen is less than 0.001% (10ppm).
- **Yellow** indicates that hydrogen has been detected.
- **Red** indicates that the hydrogen concentration is increasing over the previously sensed value.

The audible alarm sounds whenever a new peak is found.

Note: Due to the extreme sensitivity of the sensor, after a hydrogen exposure the sensor my take 60 seconds or more to return to a zero (less than 0.001%) reading.

Error Mode - The LCD displays "Error" and the LED is continuously red, indicating a non-operating state.

- **Turn off** the system and verify that the Sensor Module, and Wand Assembly if used, are properly connected and firmly seated.
- Check that the system is receiving sufficient power. Ensure that the Battery is properly installed into the Controller.
- Allow Batteries that have been in an extreme temperature to warm or cool to within 10 to 45 degrees C.
- If the instrument continues to fail to operate, call Teledyne, Customer Service at 1-626-934-1673 (USA).

Reset Mode - To improve recovery time, a user activated reset function has been incorporated. *Refer to section 7 for a more complete description of the use of this function.

- Remove the handheld detector away from the leak and into a hydrogen free environment. Wait for the unit to display <0.1%.
- **Depress** between the up and down arrows for approximately two seconds. A query will appear on the LCD display confirming the reset.
- Push the **enter** button to confirm and the unit will go through a 15 second reset during which the LED will illuminate amber. Once the reset is complete the LED will illuminate green.
- NOTE: The reset function will **not** activate until less than 0.1% hydrogen is displayed on the LCD display.

6. Configuring the 2240

The 2240 can be easily configured to best fit the needs of the operator. The following section describes how to program the instrument.

- With the system in Run Mode (LED is green), hold down both the "Mode" and "Enter" buttons for 2 seconds.
- The system will beep three times, then display "Change Config?" with a "Yes" and a "No" selection provided. (The word "Yes" appears above the Enter button and "No" above the Mode button). Press Yes (Enter button) to switch the system to Configuration Mode.
- Alternatively, press No (Mode button) to return to Run Mode.
- Once "Yes" is activated, the LCD displays "Alarm Setpoint". The LED changes to yellow, indicating a non-operating mode.
- Use the Scroll Up and Scroll Down buttons to select the desired Configuration Mode. The modes are listed below, and explanations for each follow:
  - Alarm Setpoint
  - 0-5 Volt Configuration
  - Analog Full Scale
  - Backlight
  - Controller Firmware Version

- **Alarm Setpoint –** this function is used to specify the hydrogen concentration level required to activate the audible Alarm. **Should hydrogen in air reach a concentration that triggers the Alarm, the operator receives 1 audible warning beep twice per second.**
  - Press the Enter button when "Alarm Setpoint" is displayed. The default setting of 2.0% hydrogen is displayed.
  - Press the Scroll buttons to incrementally change the selected digit.

  - Press the Mode button to select the digit to change.
  - Press the Enter key to set the displayed number into memory, and return to the Configuration Mode.

- **0-5 Volt Config** – abbreviation for 0 to 5 V Analog Output Configuration Mode.
  - Press the Enter button when "**0-5 Volt Config**" is displayed. The default setting of 0-5 Volt is displayed.
  - Press the Scroll buttons to view the available formats. When the desired format is displayed, press the Enter button to configure 2240LD to the indicated format.
  - Alternatively, press the Mode button to return to the Configuration Mode without any changes.

  Note: The 4-20 mA is not configurable except for its full scale setting

  - **1-5 Volt Format** – The system correlates an increasing presence of hydrogen to an output of 1 to 5 V. In "Warm-Up" mode a level of 0.5 V is produced. In "Error" mode a level of 0 V is produced.
  - **0.5-4.5 Volt Format** – The system correlates an increasing presence of hydrogen to an output of 0.5 to 4.5 V. In "Warm-Up" mode a level of 0 V is produced. In "Error" mode a level of 5 V is produced.
  - **0-4 Volt Format** – The system correlates an increasing presence of hydrogen to an output of 0 to 4 V. In "Warm-Up" mode a level of 4.5 V is produced. In "Error" mode a level of 5 V is produced.
  - **0-5 Volt Format (Default Setting)** – The system correlates an increasing presence of hydrogen to an output of 0 to 5 V. In "Warm-Up" mode a level of 0 V is produced. In "Error" mode a level of 5 V is produced.

- **Analog Full Scale -** abbreviation for Analog Output Full Scale Setting. The operator uses this function to specify the correlation between the Analog Output Port full scale,

both 0-5 V and 4-20 mA, and the percent of hydrogen being detected.

Note: before proceeding with this function, first select the appropriate Analog Output Configuration Mode.

- Press the Enter button while “Analog Full Scale” is displayed.
- Specify the hydrogen concentration represented by both the maximum voltage from the 0-5 V Analog Output and the maximum current from the 4-20 mA Analog Output (Default, 2% hydrogen). The minimum voltage and current value is factory set to represent 0% hydrogen, and is not configurable.
  - For example, using the second “0-5 Volt Config” format of “0.5-4.5 Volt Mode”, the operator chooses to designate the maximum voltage output, 4.5 V, to indicate 4% hydrogen in air. This results in 4.5 V = 4% hydrogen, 0.5 V= 0% hydrogen, and 2.5 V = 2% hydrogen.
  - For example, using the 4-20 mA Analog Output, the operator chooses 20 mA to indicate 10% hydrogen in air. This results in 20 mA = 10% hydrogen, 4 mA = 0% hydrogen, and 12 mA = 5% hydrogen.
- Use the Scroll buttons to increase or decrease the percent value. Use the Mode button to change the digit affected by the scroll buttons.
- Press the Enter key to set the displayed number into memory and return to the Configuration Mode.

- **Backlight –** Controls how the LCD backlight operates.

  - Press the Enter button while "Backlight" is displayed.
  - Select one of three options:
    - Always Off
    - Always On

    - On With Change - Under this option, the backlight illuminates for 15 seconds when any button is pushed, or on any Alarm. It also illuminates continuously in configuration mode.
  - Press the Enter button to select the option.
  - Press the Mode button to exit without making any change.

- **Rev X.xx –** The controller firmware revision level is displayed.

7. Hydrogen Sensing Considerations

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

Detecting hydrogen, due to its buoyancy, is not an exact science. If the sensor element is near (and above) the leak, the signal will be stronger but may be hard to locate due to the small stream diameter. The stream diameter increases farther away (higher) from the leak, but the concentration decreases. Generally, greater distance will increase the chance of intercepting the leak stream, but if the sensor is too far away, the response will be too weak to detect.

As necessary, use the Wand Assembly to locate the Sensor Module closer to the suspected leak area.

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

If the hydrogen is rising in an enclosed building – where there typically is a layer of warmer air near the ceiling -- the hot air near the ceiling will have a lower density and may act to retard the hydrogen from continuing to rise as rapidly in lower layers of air. **Thus, sensing hydrogen near ceiling areas with high temperatures present may not be as effective.**

Low temperatures can also affect the behavior of hydrogen. Hydrogen gas stored in a liquid state is at an extremely low temperature. The low temperature of any escaping gas will be of a higher than normal density and may initially move downward. As the hydrogen gas 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.**

After removing the handheld detector away from a leak, the operator may see that the length of time from detecting above approximately 1% hydrogen to indicating zero hydrogen on the LCD display may be several minutes.

To improve this recovery time, a user activated **reset function** has been incorporated. This function should be used if the operator has located a leak and is trying to find a new leak. To reset the unit follow the instructions in section 5 under **Reset Mode**.

8. Charging the 2240 battery

Equipment Required

- Battery Charger Power Supply
- Power Cord for country of use
- Battery Charger
- Single Bay Battery Charger
- Optional Dual Bay Battery Charger

Figure 4 - 2240 Dual Bay Battery Charger (optional) with Power Supply and Power Cord

Charging/Re-Charging the Battery(ies)

- Plug the power cord into the Power Supply and insert the DC output plug into the socket on the Battery Charger.
- Plug the power cord into an appropriate AC outlet. The charging status lamp(s) will flash yellow then turn off.
- Plug the battery (or two batteries with optional Dual Bay Battery Charger) into the pocket of the Battery Charger. Make sure the battery is oriented properly and firmly seated down onto the connector blades (batteries installed backwards will not make contact). The status lamp(s) will illuminate to indicate the status of the batteries as follows:
  - OFF - No battery detected
  - Red - Charging
  - Green - Battery fully charged
  - Yellow - Standby
  - Flashing Red - Error

Charging Time
The Battery Charger will completely charge a battery in less than 3 hours. (If the optional Dual Bay Battery Charger is used with two batteries inserted, they will charge sequentially. The status lamp will be green for a charged battery and yellow for a battery waiting to be charged. The second battery will automatically commence charging once the first battery is fully charged.)

Note: The 2240 Battery Charger monitors the battery temperature and will not commence charging a battery that is outside the temperature range of 10 to 45 °C. The yellow lamp will illuminate and remain illuminated as long as the battery temperature is outside this range.

An error indication (flashing red light) will be given if the battery terminals are shorted or if the battery fails to properly take a charge.

In Case of a Problem
If the Battery Charger does not function as expected, check the following:

- Make sure the wall adapter is properly connected.
- Make sure there are no foreign objects lodged in the battery bay pockets preventing the battery from properly seating.
- Make sure the batteries are installed so that they properly mate with the connector in the bottom of the pocket.