HY-OPTIMA™

HYDROGEN SPECIFIC MEASUREMENT SOLUTIONS

HY-OPTIMA™ 1700 Series

ATEX Intrinsically Safe In-line Hydrogen Process Analyzer

OPERATING MANUAL

H2scan

Hydrogen is the future, we can sense it! ™

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MISSION STATEMENT

Our Mission

Deliver unsurpassed value and optimize green initiatives with our one of a kind continuous hydrogen-specific sensing technology worldwide.

Our Value Propositions

Enable end-user customers to efficiently and effectively optimize:

- Electric utility power transformer fleet and other oil-filled assets (Grid)
- Petroleum refinery and other industrial process control
- Facility and equipment safety to minimize downtime

...at a much lower total costs of ownership than the competition.

Our Strategic Objectives

H2scan's technology accepted as the new gold standard in hydrogen sensors.

H2scan's business recognized for innovation and ingenuity, high quality products and systems, application - specific solutions, and exceptional customer service and satisfaction.

H2scan's success results from teamwork, strategic partnerships and market leadership leading to sales growth and improved profitability.

Manual release date: 09/12/2017

1700 series firmware revision at date of manual release: 1.80i (sensor board), 1.25i (display board)

IMPORTANT NOTICES

	Read and understand this operating manual before installing or using the unit. Only use cables from H2scan with this unit. If this equipment is used in a manner not specified by H2scan, 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.
	Do not apply power to the analyzer if the sensing element is exposed to air. This could severely affect accuracy and stability.

LIMITATION OF LIABILITY - SELLER SHALL UNDER NO CIRCUMSTANCES BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, PUNITIVE, OR OTHER DAMAGES, INCLUDING, BUT NOT LIMITED TO, LOSS OF BUSINESS OR PROFIT, PROMOTIONAL OR MANUFACTURING EXPENSES, INJURY TO REPUTATION, OR LOSS OF CUSTOMER, BASED ON ANY ALLEGED NEGLIGENCE, BREACH OF WARRANTY, STRICT LIABILITY, BREACH OF CONTRACT, OR ANY OTHER LEGAL THEORY ARISING OUT OF THE USE, MISUSE, PURCHASE, SALE OR POSSESSION OF ITS GOODS OR ITS PERFORMANCE OF THIS CONTRACT TO THE EXTENT THAT SUCH LIABILITY EXTENDS SELLER'S OBLIGATIONS BEYOND THE PRICE PAID BY BUYER TO SELLER FOR THE ITEM ON WHICH SUCH CLAIM IS BASED. SELLER ADVISES BUYER TO PERFORM ACCEPTABLE TESTS ON ALL HARDWARE PRIOR TO DEPLOYMENT AND TO PERFORM MAINTENANCE AS DESCRIBED IN THE SELLER'S INSTRUCTION GUIDE. UNDER NO CIRCUMSTANCES SHALL THE EQUIPMENT PROVIDED HEREUNDER BE USED IN A MANNER WHERE IT IS THE SOLE PROTECTIVE SYSTEM FOR FACILITIES, EQUIPMENT AND PERSONNEL SAFETY; THE EQUIPMENT IS INTENDED FOR USE IN CONJUNCTION WITH OTHER APPROPRIATE PROTECTIVE SYSTEMS.

LIMITED WARRANTY

H2scan Limited Warranty: Each 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 H2scan 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 H2scan, H2scan'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 H2scan on a case-by-case basis.

Voided Warranty: H2scan's 12 Month Limited Warranty is void for any of the following:

The unit is opened and the manufacturing seal is broken

Unauthorized repair work performed at the customer's location or carried out by anyone other than H2scan's factory trained technicians

Equipment or parts that have been tampered with, misused, neglected, mishandled, improperly adjusted, or modified in any way without the written consent of H2scan.

Equipment or parts that have been damaged due to shipping, misuse, accidents, mishandling, neglect, or problems with electrical power sources.

Repair work performed during the warranty period does not prolong the warranty period past the original period.

System operation in incorrect or inappropriate environments.

Usage that is not in accordance with system guidelines or an operator's failure to follow manual instructions.

LIMITATION OF WARRANTY: THE ABOVE IS A LIMITED WARRANTY AS IT IS THE ONLY WARRANTY MADE BY H2SCAN. H2SCAN 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 H2SCAN ON A CASE-BY-CASE BASIS. H2SCAN 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 H2SCAN FOR DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE DELIVERY, USE OR PERFORMANCE OF THE PRODUCTS.

Chapter 1: Model Specifications and Certifications

1.1 Description

The HY-OPTIMA™ 1700 Series, Intrinsically Safe In-line Hydrogen Process Analyzer is designed to detect and/or measure hydrogen using a solid-state, non-consumable sensor that is configured to operate in process gas streams. The H2scan thin film technology provides a direct hydrogen measurement that is not cross sensitive to other gases. The hydrogen specific solid-state sensing element is designed for ease of use, interface flexibility and true process control. The analyzer contains all the circuitry necessary to operate the sensor and present calibrated hydrogen readings to an analog current output and an RS422 digital output. The analyzer is ideal for hydrogen production and petrochemical applications where real-time measurements can enhance process plant efficiencies, diagnostics, and maintenance management.

1.2 Models

The HY-OPTIMA™ 1700 Series product family includes sensor types that are designed for specific hydrogen ranges, corrosive gas tolerances and operation when no hydrogen is present. See the guide below for more details.

MODEL	Hydrogen Range Min	Max	Hydrogen MUST be present	CO Limit	H2S Limit	Calibration Background Gas	Max Pressure
1730	0.5%	100%	Yes	<100 ppm	<1000 ppm	N2	2 atm
1740	0.5%	100%	Yes	20%	3%	N2	2 atm
1720	0.4%	5%	No[1]	0	0	O2, N2	2 atm

Notes:

1. 1720 models operated in background streams in which H2 is not typically present and may be operated in an Air, O2, or N2 background.

1.2.1 Model 1720

The HY-OPTIMA™ 1720 Process Hydrogen Analyzer has been specifically manufactured to operate in an air or inert background.

- Operation in background streams in which H2 is not typically present
- Calibration Background Gas: Air or Inert
- Hydrogen Sensitivity Range:
    - 0.4% to 5% hydrogen by volume at 1.0 atm
    - 10% to 125% hydrogen lower flammability limit

Note:

Please disregard all warnings and statements to avoid operation in air or oxygen background; these warnings and statements do not apply to the HY-OPTIMA™ 1720 Process Hydrogen Analyzers which have been manufactured for implementation in background gas streams with air.

HY-OPTIMA™ 1720 Process Hydrogen Analyzers operating in air do not require the conditioning procedure.

H2scan recommends the hydrogen gas concentrations for both the Field Verification and Field Calibration gases to be 1% and 2% hydrogen in a balance of air.

1.2.2 Model 1730

The HY-OPTIMA™ 1730 Process Hydrogen Analyzer has been specifically manufactured to operate in full range (0.5% to 100%) hydrogen conditions with the following enhanced tolerances to CO and H2S in process gas streams:

- CO tolerance: 100 ppm
- H2S tolerance: 1000 ppm

1.2.3 Model 1740

The HY-OPTIMA™ 1740 Process Hydrogen Analyzer has been specifically manufactured to operate in full range hydrogen conditions with the following enhanced tolerances to CO and H2S in process gas streams:

- CO tolerance: 20% by volume
- H2S tolerance: 3% by volume

1.3 Specifications

1.3.1 Performance Specifications

MODEL	Hydrogen Range		Hydrogen MUST be present	CO Limit	H2S Limit	T90 Response Time (sec)	Accuracy		Drift/Week		Repeatability		Linearity	
	Min	Max					Min to 10% H2	10 to Max% H2	Min to 10% H2	10 to Max% H2	Min to 10% H2	10 to Max% H2	Min to 10% H2	10 to Max% H2
1730	0.5%	100%	Yes	<100 ppm	<1000 ppm	< 60	0.3%	1.0%	0.2%	0.4%	0.2%	0.4%	0.2%	0.4%
1740	0.5%	100%	Yes	20%	3%	< 90	0.3%	1.0%	0.2%	0.4%	0.2%	0.4%	0.2%	0.4%
1720	0.4%	5%	No[1]	0	0	< 60	0.3%	N/A	0.3%	N/A	0.3%	N/A	0.3%	N/A

Note: Sensor performance specifications are absolute and assume a dry process stream, an ambient temperature of 25°C, pressure compensation, and are in addition to any errors in the calibration gases used. The accuracy is specified for the serial port and digital display output only.

1. 1720 models operated in background streams in which H2 is not typically present and may be operated in an Air, O2, or N2 background.

1.3.2 Operating Specifications

Sample Gas Flow Rate	0.1 to 10 slpm (1 slpm is recommended)
Temperature	Gas Stream: +10°C to +60°C Sensor Ambient Temperature: -20°C to +40°C Storage: -40°C to +50°C
Analyzer Input Voltage	Range: 5 VDC to 28 VDC Intrinsically Safe: 10 VDC, 6 W
Power Barrier Input Voltage	Range: 20 VDC to 28 VDC Nominal: 24 VDC
Analog Output	Isolated, Loop Powered, 4-20 mA
Serial Communication	RS422 19.2 kbps, No Parity, 8 Bit Data, 1 Stop Bit, No Flow Control (preferred) or Xon/Xoff
Certifications	CE 0359 Ex II 1 G, Ex ia II H2, d+d IIB T3 Ga ITS07ATEX25634X II 2 G, Ex ib II H2, ib d IIB T3 Gb c LC
Analyzer Weight	1 lb

1.4 Analyzer ATEX Rating

The HY-OPTIMA™ 1700 Series Analyzers are certified with a dual zone rating.

Electronics Assembly is Zone 1

Probe Tip is Zone 0

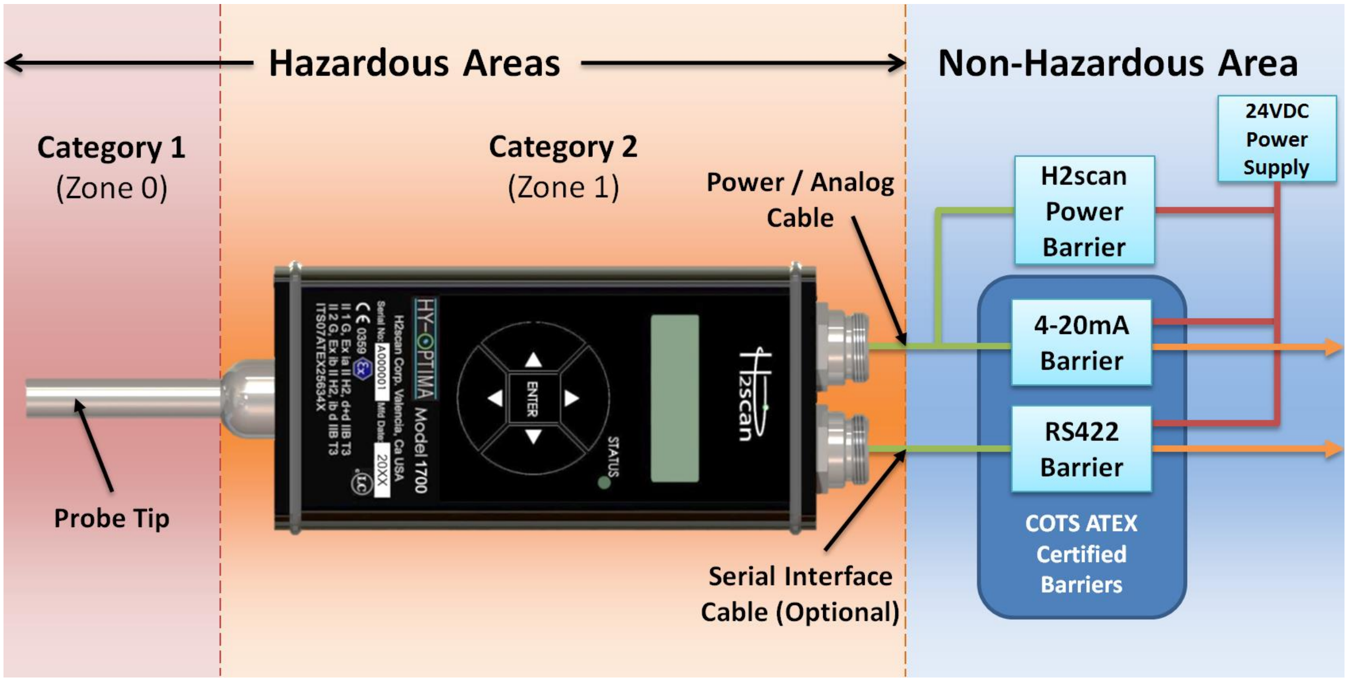


Figure 1: Hazardous Area Installation and Attachment

Input and Output Parameters			
Parameter	**J1 Pins 2&3 (Power Supply)**	**J1 Pins 4&5 (4-20 mA loop)**	**J2 Pins 1&2, 3&4 (RS422 Rx&Tx)**
Ui	11.5 V	26.7 V	3.7 V
Ii	3.27 A	91 mA	2.25 mA
Pi	9.41 W	611 mW	206 mW
Ci	0	68.2 nF	0
Li	0	0	0
Uo	n/a	n/a	5.9 V
Io	n/a	n/a	238 mA
Po	n/a	n/a	350 mW
Co	n/a	n/a	1000 uF
Lo	n/a	n/a	2.5 mH
Lo/Ro	n/a	n/a	404 uH/Ω

Table 1: Hazardous Area Equipment Ratings

1.5 Dimensions

(Units in inches)

Chapter 2: Installation

WARNING: H2scan's HY-OPTIMA™ 1730 Intrinsically Safe In-line Hydrogen Process Analyzers (ATEX) are calibrated in a hydrogen/nitrogen (H2/N2) background and should NEVER be operated in an air or oxygen background.

The analyzer can be exposed to oxygen for short periods of time without adverse effects if the analyzer is turned off. If the analyzer is operated in oxygen or stored in air for longer than a week, the hydrogen readings may be high due to oxygen adsorption on the sensor. Hydrogen exposure will then cause the readings to drift lower as adsorbed oxygen is slowly removed and the unit recovers to normal steady behavior.

If this drift behavior is observed, the sensor should be conditioned by operating in a hydrogen concentration exceeding 5% until the readings are stable. The required hydrogen conditioning may vary from several hours to several days depending on the level of oxygen exposure. Higher hydrogen concentrations used during conditioning may accelerate the process. Once stable, the analyzer should be checked for accuracy and calibrated if needed. See 5.1.3 Conditioning to Remove an Offset for more information.

2.1 Associated Equipment

WARNING: If the analyzer is installed in a classified location then it is the responsibility of the user and installer to make connections to related equipment in a manner consistent with the location classification.

Only H2scan specified cables should be used with this Analyzer. The maximum length for intrinsically safe operation of both the Power/Analog Cable and the Serial Interface Cable is 10 meters. Refer to Appendix A: Control Drawings.

When operated in a hazardous area, the HY-OPTIMA™ 1730 Analyzer must be connected to appropriately certified barriers located in a non-hazardous area using H2scan specified cables. The following barriers are approved for use with this device for an Intrinsically Safe implementation:

Intrinsically Safe Power Barrier: H2scan's custom designed barrier supplies 10VDC, 6W power to the sensor.

Intrinsically Safe Analog Output Barrier (4 mA to 20 mA): GM International D1054S or equivalent, One Channel Repeater Power Supply and Trip Amplifiers. Refer to the D1054S Operating Manual for installation and configuration of this barrier.

Intrinsically Safe Serial Interface Barrier (RS422): GM International D1061S or equivalent, RS422 / RS485 Fieldbus Isolating Repeater. Refer to the D1061S Operating Manual for installation and configuration of this barrier. This barrier also requires a null modem cable for communication between PC and Barrier.

2.2 Analyzer Mounting

The analyzer has been mounted in the system vertically with the sensor tube pointing downward to prevent liquids or potentially condensing gases from damaging the sensor.

Mounting is achieved by securing the sensor tube into the supplied fitting directly into the process stream. Optional mounting brackets which attach to the instrument housing have been included to secure the analyzer to the backplane.

The length of tube within 1.25 inches from the end plate of the analyzer is called the Ferrule Region and has a thick wall. Past this, the tube wall thickness is too thin to support a cinched fitting.

H2Scan offers a variety of fittings to mate the unit to a process stream. The following lists our standard fitting selections. Others are available upon request.

- ½" MNPT thread
- ½" FNPT thread
- -8 SAE/MS thread

Warning: Do not cinch down or tighten ferrules outside of the ferrule region of the tube or risk permanently damaging the tube and sensor assembly within.

Warning: If the unit is installed in a classified location then it is the responsibility of the user and installer to make connections to related equipment in a manner consistent with the location classification.

2.3 Power and Analog Connector

Supplied Cable: 4m (13 ft) standard

Wire Color	Description
Red	+10 VDC
Black	10 VDC Return
White	+4 mA to 20 mA
Blue	4 mA to 20 mA Return
Bare	Chassis Ground

2.4 Serial Connector

Supplied Cable: 4m (13 ft) standard

Wire Color	Description
Black	+TxD RS422
Blue	-TxD RS422
White	+RxD RS422
Brown	-RxD RS422

2.5 Startup

2.5.1 Models 1710, 1730, 1740

If the analyzer is being turned on from an off position, power on the analyzer before flowing gas across the sensor. The sequence of steps which are to be followed is:

1. Power on the analyzer and wait for the 5 minute warmup routine to complete.
2. Apply the low span calibration gas to the analyzer and wait for the reading to stabilize (typically 2 hours on first startup). See Section 4.2 Calibration Gases for choosing the low and high span gas concentrations. Do not apply greater than 10% H2/N2 to the Model 1710.
3. Perform a Field Calibration (see Chapter 4: Field Calibration).

The analyzer can be exposed to oxygen for short periods of time without adverse effects if it is turned off. If it is stored in air for longer than a week, the analyzer may read higher than the true hydrogen concentration due to oxygen absorption on the sensor. Steady hydrogen exposure will slowly remove this absorbed oxygen and cause the analyzer reading to continually drift downward until it reaches the true hydrogen concentration.

If this drift behavior is observed refer to Section 5.1.3 Conditioning to Remove an Offset for instructions and more information.

2.5.2 Model 1720

If the analyzer is being turned on from an off position, power on the analyzer before flowing gas across the sensor. The sequence of steps which are to be followed is:

1. Power on the analyzer and wait for the 5 minute warmup routine to complete.
2. Apply air for 30 minutes.
3. Perform a Field Calibration (see Chapter 4: Field Calibration).

The analyzer is designed to be exposed to an air or inert background gas where hydrogen is normally absent. For optimal performance keep any hydrogen exposure to the sensor to less than one hour. If the hydrogen exposure exceeds this time, the sensor may need to be reconditioned by leaving it powered on in air for at least 24 hours.

2.6 Shutdown

1. Purge the system using gas with a hydrogen concentration of less than 5% H2 or with 100% N2 for 5 minutes.
2. Turn off all gas flow to the analyzer.
3. Power off the analyzer.

Chapter 3: Operation and Configuration

3.1 Optimum Analyzer Performance

To maximize the performance of the analyzer:

- Verify that all electrical connections are made as recommended. Switching the polarity can cause damage to the analyzer.
- Verify the process gas stream is properly regulated with a stable pressure and flow between 0.1 and 10 slpm (1.0 slpm is recommended).
- After installation complete the conditioning steps described in the Section 2.5 Startup and perform a Field Calibration (Chapter 4: Field Calibration). Use two calibration gases for the Field Calibration for optimal results.

A back pressure controller can be installed to improve performance and stability.

3.1.1 Effect of Pressure

The analyzer is hydrogen specific and sensitive to only the hydrogen partial pressure in the gas stream. Since changes in total gas pressure will affect the hydrogen partial pressure, they will also affect the analyzer readings. At 1.0 atm, a 50% H2/N2 mixture will be reported as 50% by the analyzer. At 1.1 atm the reading will increase to 55% and 2.0 atm will result in a reading of 100%. The analyzer is capable of measuring multiple atmospheres of hydrogen, and readings above 100% H2 are interpreted as hydrogen pressures above 1.0 atm. For example, a reading of 150% H2 means 1.5 times the hydrogen pressure of a 100% H2 concentration at 1.0 atm. The analyzers are factory calibrated at 1.0 atm. Performing the Field Calibration at the operating pressure will correct the hydrogen reading for static pressures. For example, if the local atmospheric pressure is 0.97 atm, doing a Field Calibration will correct for this assuming the pressure remains static. Installing a back pressure controller can increase performance and stability of the analyzer.

3.1.2 Calibration Gas Bottle Accuracy

The inaccuracy of the gas bottle concentration will directly affect the measured accuracy by the analyzer. During factory calibration, the analyzers are calibrated with high accuracy gases (as high as +/- 0.02% accurate). It is strongly recommended that the user perform calibration with similar high accuracy gases to maintain the accuracy specified in the manual.

3.2 Analog Output

The analog output is derived from the final hydrogen value as shown on the serial display and is scaled to the hydrogen and current ranges desired. All of this is initially set to factory defaults as shown in the table below or per customer specifications at the time of order. They can also be changed with the "**`H`**" and "**`I`**" commands. If the distance between the high and low H2 range is reduced then more current resolution is obtained in the valid H2 region. This may be desirable if the system will only be operating in a specific concentration region, like 90-100% H2 concentration for example. The value of the low and high H2 current should be set according to the specifications of the measuring equipment. By default they are 4 mA and 20 mA, respectively.

Variable	Label in Device	Default Value and Units
I_{H_2Lo}	LowH2Current	4 mA
I_{H_2Hi}	HighH2Current	20 mA
H_{2Hi}	LowH2Range	0% H2
H_{2Lo}	HighH2Range	100% H2

Use the following equation to calculate hydrogen from the analog output:

$$H_2\% = \frac{I_{meas} - I_{H_2Lo}}{I_{H_2Hi} - I_{H_2Lo}} \cdot (H_{2Hi} - H_{2Lo}) + H_{2Lo}$$

Where $H_2\%$ is the concentration of hydrogen measured as a percent, I_{H_2Hi} and I_{H_2Lo} are the high and low H2 currents measured in mA, and H_{2Hi} and H_{2Lo} are the upper and lower hydrogen concentration limits as a percent. These values can be displayed using the "`D 1`"command over the serial port.

3.2.1 Calibrate the Analog Output

If the range is correct and the analog output is inaccurate, it may require calibration.

Use the "**`ci`**" command.

3.3 Serial Communication

The user can monitor and log the output and interface with the analyzer to perform calibration or adjust user settings via the serial communication connector. The serial communication is accomplished via the serial interface.

Serial Communications Software – Any serial port two-way communications software such as terminal emulators (H2scan uses Foxterm) and purpose-built software (using LabView, Visual Basic, C++, etc.) can be used to establish serial communication with the analyzer. See Appendix C: Foxterm Setup for instructions on setting up a serial connection.

3.3.1 Serial Command Summary

WARNING: If commands are sent over the serial port the display on the LCD will be unpredictable. To restore proper LCD operation, cycle the power.

Two communication modes are available:

Keystroke – This is the default mode which shows a continuous stream of output data until an ESC key is pressed. Then the H2scan prompt is displayed for the user to enter a command. After the command is finished the stream of output data continues.

Prompted – This mode is entered by executing =H2scan command at H2scan prompt. The analyzer continues with the H2scan prompt after completing each command. Enter the =0 command to end this mode and continue the stream of output data.

Keystroke Commands While Data Streams	
Keystroke	**Description**
ESC	Stops continuous display to enter a password or command. If in level zero, the continuous display will resume after executing one command.
Sp (spacebar)	Pressing the Space key while the serial output is active will display a label line showing the heading for each column of data.
A	Average readings
C	Clear peak hydrogen value

Prompted Commands @ H2Scan prompt	
Command	**Description**
=<password>	Enter the password to change security level. A null or invalid password returns to level 0. Level 0 password = "0" Level 1 password = "h2scan"
A	Modify the alarm set points (Status Indicator LED)
D	Display Product Information
G	Go, resume analyzer operation
H	Modify the hydrogen reporting range
I	Modify the DAC current output range
L	Print current hydrogen reading and pause
P	Select gas pressure in atmospheres (recommended to remain at 1.0 atm)
S	Stop the sensor, turn off heater, set DAC outputs to zero, stop serial data stream
X	Clear field calibration data (returns to last factory calibration data)
F	Perform Field Calibration

3.3.2 A Command (LED Set Points)

The A command is used to modify the alert and alarm set points that control the Status Indicator LED. In this example Alert is changed to 1% and Alarm is changed to 4%.

One method is prompted:

```
H2scan: a

Current Alert=101.00000%, Alarm=102.00000%
  Enter new Alert value: 1
  Enter new Alarm value: 4
New Alert=1.00000%, Alarm=2.00000%
  Save these values (Y/N)? y
...Wait...SAVED - Done
```

Another method is entering the settings directly on the command line. The format is: A <R1 value> <R2 value>:

```
H2scan: A 1 4
New Alert=1.00000%, Alarm=4.00000%
  Save these values (Y/N)? y
...Wait...SAVED - Done
```

3.3.3 D Commands (Display Product Information)

Display Product Information. Enter page number 0-6 or A for all pages, default (no value) is page 0.

0 – Product information
1 – User configuration

Example:

```
H2scan: d 0
H2scan hydrogen sensor
  Model Number:  1730
  Serial Number: A000001
  Sensor Board Firmware Rev:  1.71i
  Display Board Firmware Rev:  1.25i
  Table Version: 1.25
```

```
Latest Calibration
  Factory: 00/00/0000
  Field:   00/00/0000
```

3.3.4 G Command (Go, Stream Data)

The G command is used to resume analyzer operation and specify the arrangement of the data in columns. These columns are:

Header	Description
TimeStamp	The time in quarter seconds since power on.
PcbTemp	The internal electronics temperature
SnsrTemp	The sensor temperature
ResAdc	The raw hydrogen sensor measurement in ADC counts
AdjRes	The adjusted sensor measurement: these adjustments include compensation for variations in sensor temperature, sensor electronics, and other parameters
ZRes	Sensor reference value
%H2	The final hydrogen measurement
%H2_Pk	The peak hydrogen measurement
%H2_Res	The hydrogen resistor measurement
Messages	Some messages are displayed in this column
Average	Average indicates that several samples are being averaged

To change display format press ESC followed by G <fmt> <opt>; where <fmt> <opt> is a pair of two digit hexadecimal numbers. Some common formats are listed below:

Command	Columns
G	Use default
G 02 00	%H2
G 02 06	%H2 Messages
G 03 06	%H2 %H2_Pk Messages
G 07 06	ResAdc AdjRes ZRes %H2_Res %H2 %H2_Pk Messages
G 82 06	TimeStamp %H2 Messages
G B7 06	TimeStamp PcbTemp SnsrTemp ResAdc AdjRes ZRes %H2_Res %H2 %H2_Pk Messages
G FF 06	Display All Columns

3.3.5 H Command (Modify H2 Reporting Range)

Modify the hydrogen reporting range.

```
H2scan: h
Hydrogen reporting range 0.0000-5.0000% H2
Enter new H2 low range: 1
Enter new H2 high range: 25
New Hydrogen reporting range 1 - 25% H2
Save these values (Y/N)? y
...Wait...SAVED - Done
```

3.3.6 I Command (Modify Analog Output)

Modify the Isolated DAC output range.

```
H2scan: i
```

```
DAC range is 4.0mA to 20.0mA, error output is 2.0mA, not ready output is 3.0mA
Enter new low H2 output current: 4
Enter new high H2 output current: 20
Enter new error output current: 3
Enter new not ready output current: 2
New DAC range is 4.0mA to 20.0mA, error output is 3.0mA, not ready output is 2.0mA
Save these values (Y/N)? y
...Wait...SAVED - Done
```

3.3.7 X Command (Clear Field Cal)

Clear field calibration data (returns to last factory calibration setting).

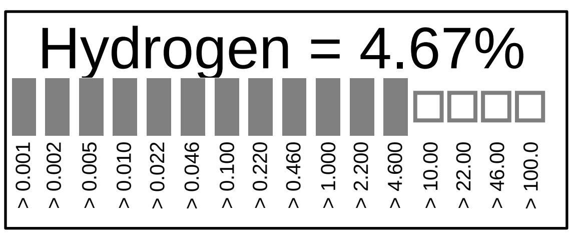
```
H2scan: x
Clear field calibration values (Y/N)? y
```

3.3.8 F Command (Field Cal)

Perform a field Calibration. See Chapter 4: Field Calibration more details.

3.4 Display

The upper row of the LCD indicates a numerical value for the percent hydrogen concentration or peak hydrogen value. The lower row of the LCD 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 current value. The following figure describes how to interpret the hydrogen meter:



3.4.1 Keypad

A 5 button keypad is used to alter the LCD, change settings, run field calibration, and initiate special functions from the Configuration Menu:

Pressing ▲ (up arrow button) displays the peak hydrogen reading.

Pressing ▼ (down arrow button) displays the current percent hydrogen concentration.

Pressing ► (right arrow button) clears the peak hydrogen value.

Pressing and holding the **ENTER** button invokes the Configuration Menu.

Pressing ▼ (down arrow button) scrolls down through function menus or scroll down through a numerical range.

Pressing ▲ (up arrow button) scrolls up through function menus or scroll up through a numerical range.

Pressing the **ENTER** button or ► (right arrow button) selects the function.

Pressing ◄ (left arrow button) backs out of menus.

3.4.2 Configuration Menu

The following functions will be found in the Configuration Menu:

Information Disp – model information

> **Firmware Rev** – firmware revisions
>
> **Serial Number** – model serial number
>
> **Factory Calibration Date** – date of the last factory calibration

Set Alert/Alarm – Define hydrogen level that will trigger the alert and alarm signals.

> **Alert Level** –the level of hydrogen that will cause the LED to turn amber
>
> **Alarm Level** – the level of hydrogen that will cause the LED to turn red

Set H2 Range – the hydrogen sensitivity range (standard factory setting: 0% to 100% hydrogen by volume)

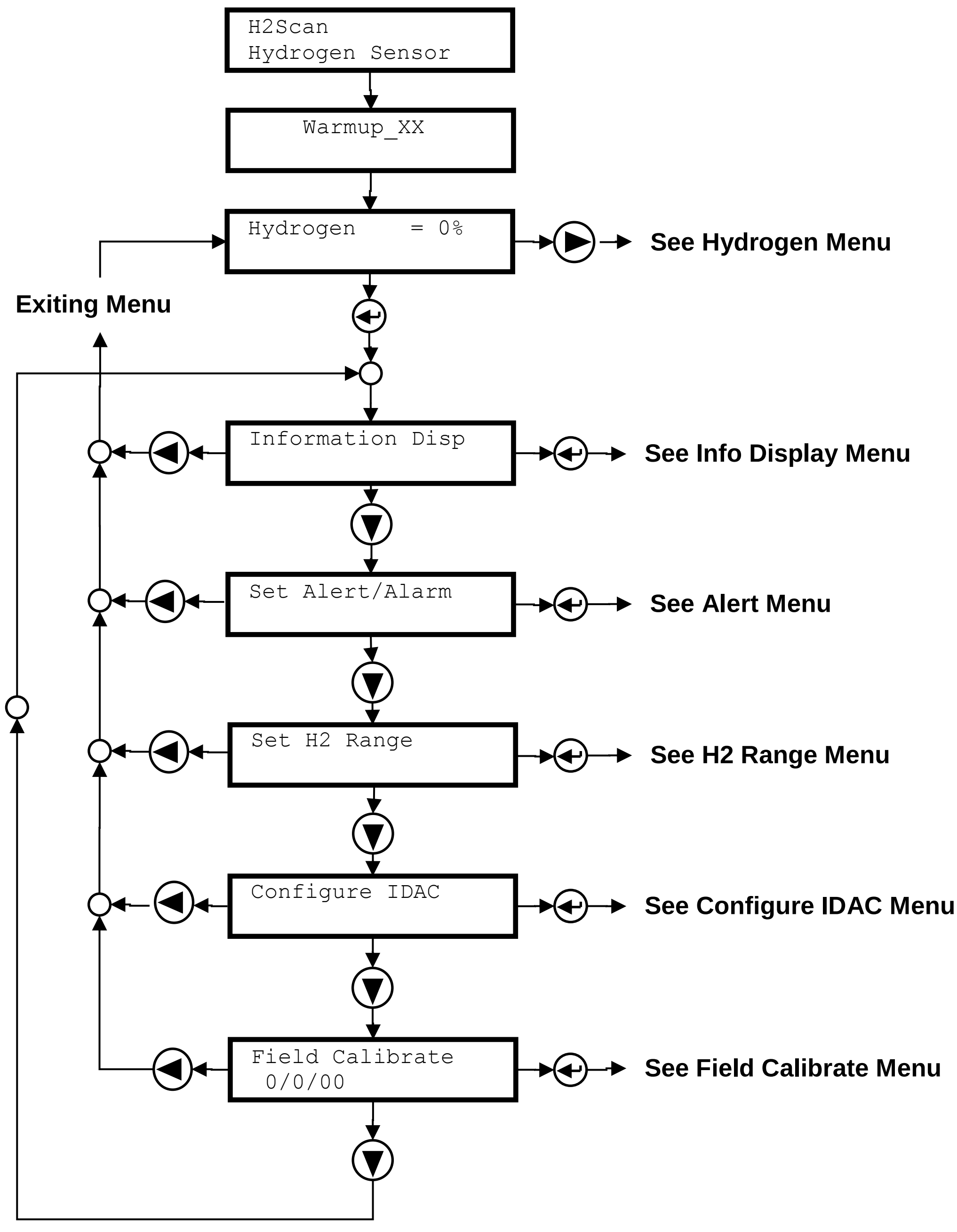
> **Low H2 Range** – lowest level of hydrogen (standard factory setting: 0% hydrogen by volume) to correspond with the low range IDAC setting
>
> **High H2 Range** – highest level of hydrogen (standard factory setting: 100% hydrogen by volume) to correspond with the highest IDAC setting

Configure IDAC –analog output range

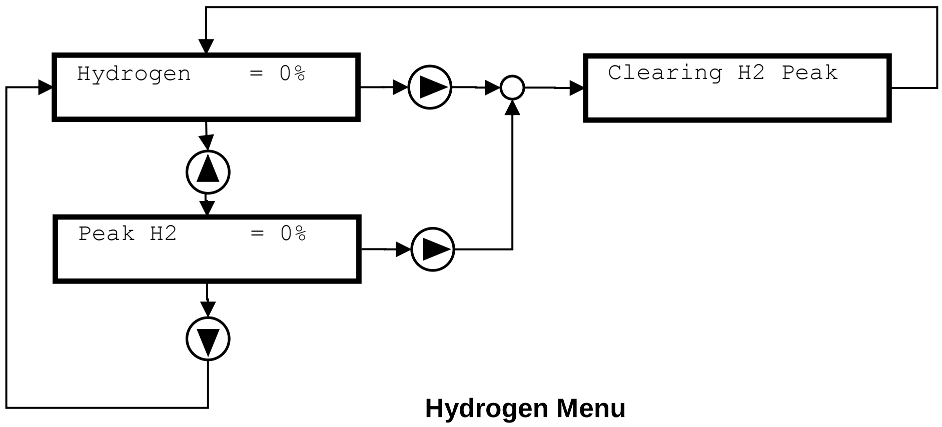
> **Low Range** – low level analog output corresponding to the lowest hydrogen range
>
> **High Range** – high level analog output corresponding to highest hydrogen range
>
> **Error** – analog output indicating an error
>
> **Not Ready** –analog output indicating the POST is running

Exit – exit Configuration Menu to standard display output setting

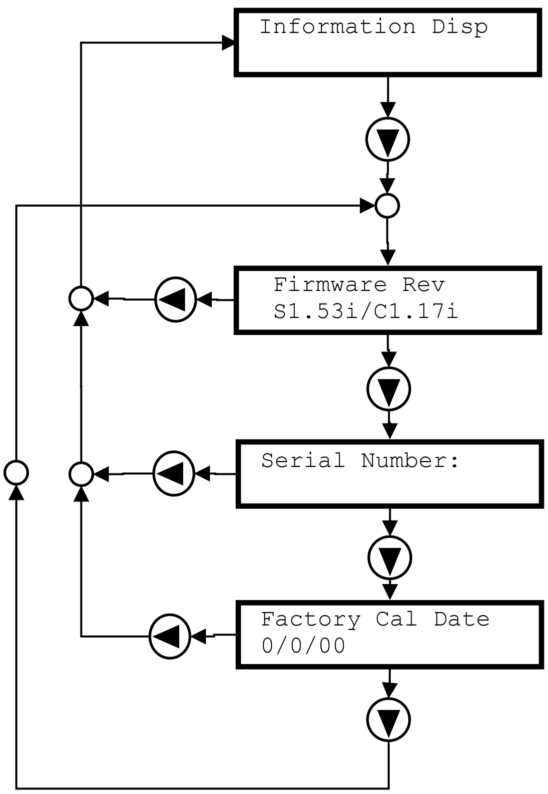
3.4.3 Display Menus



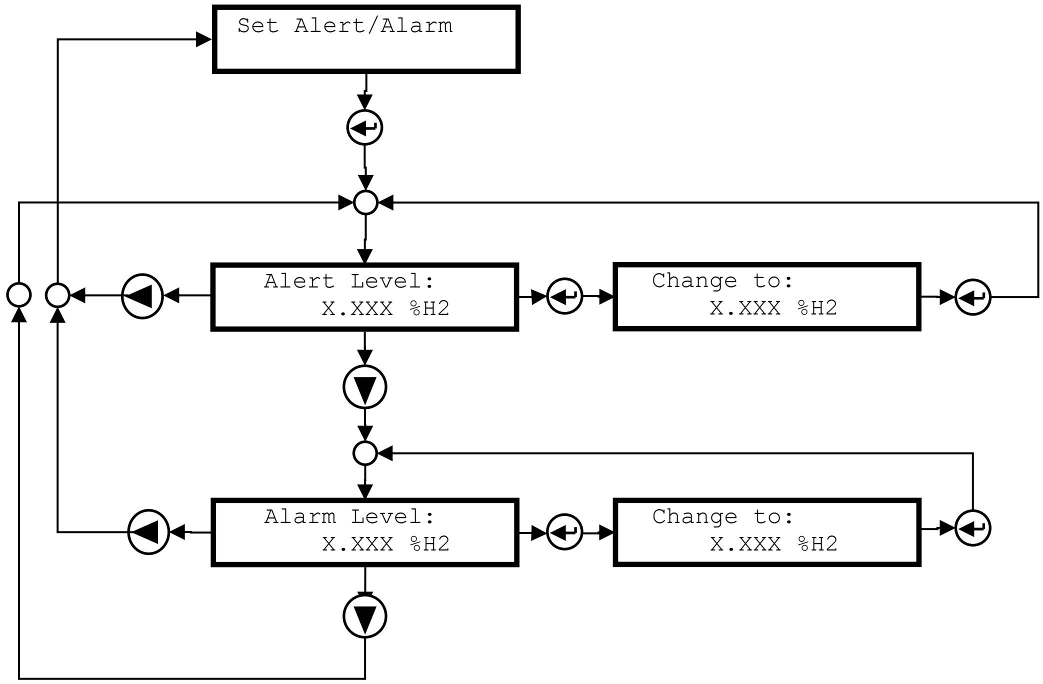
Main Menu



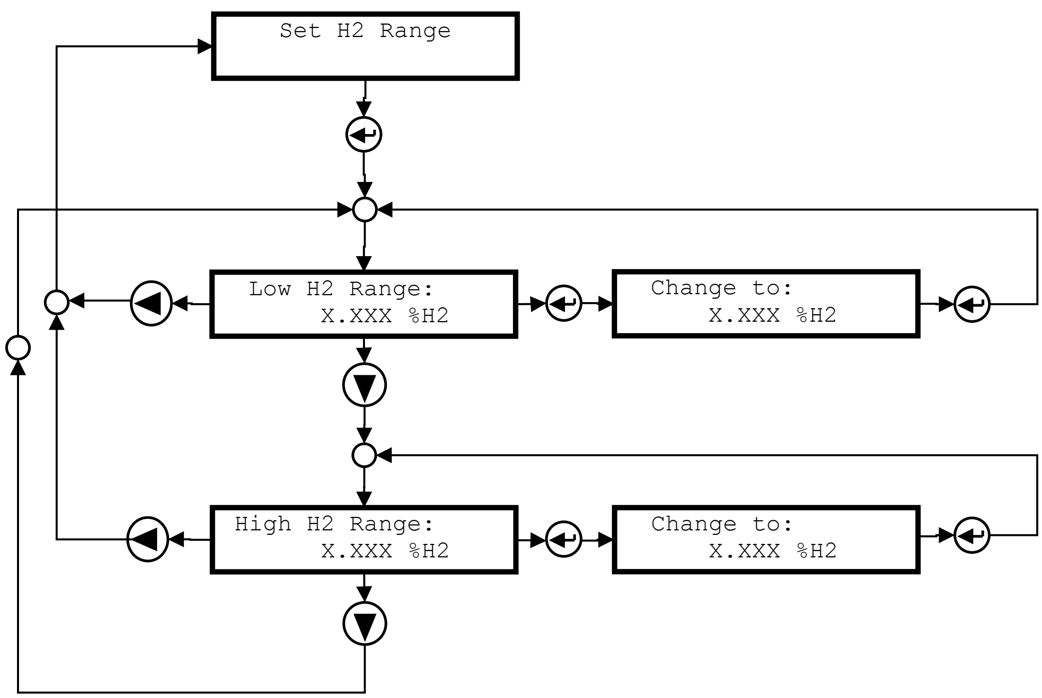
Hydrogen Menu



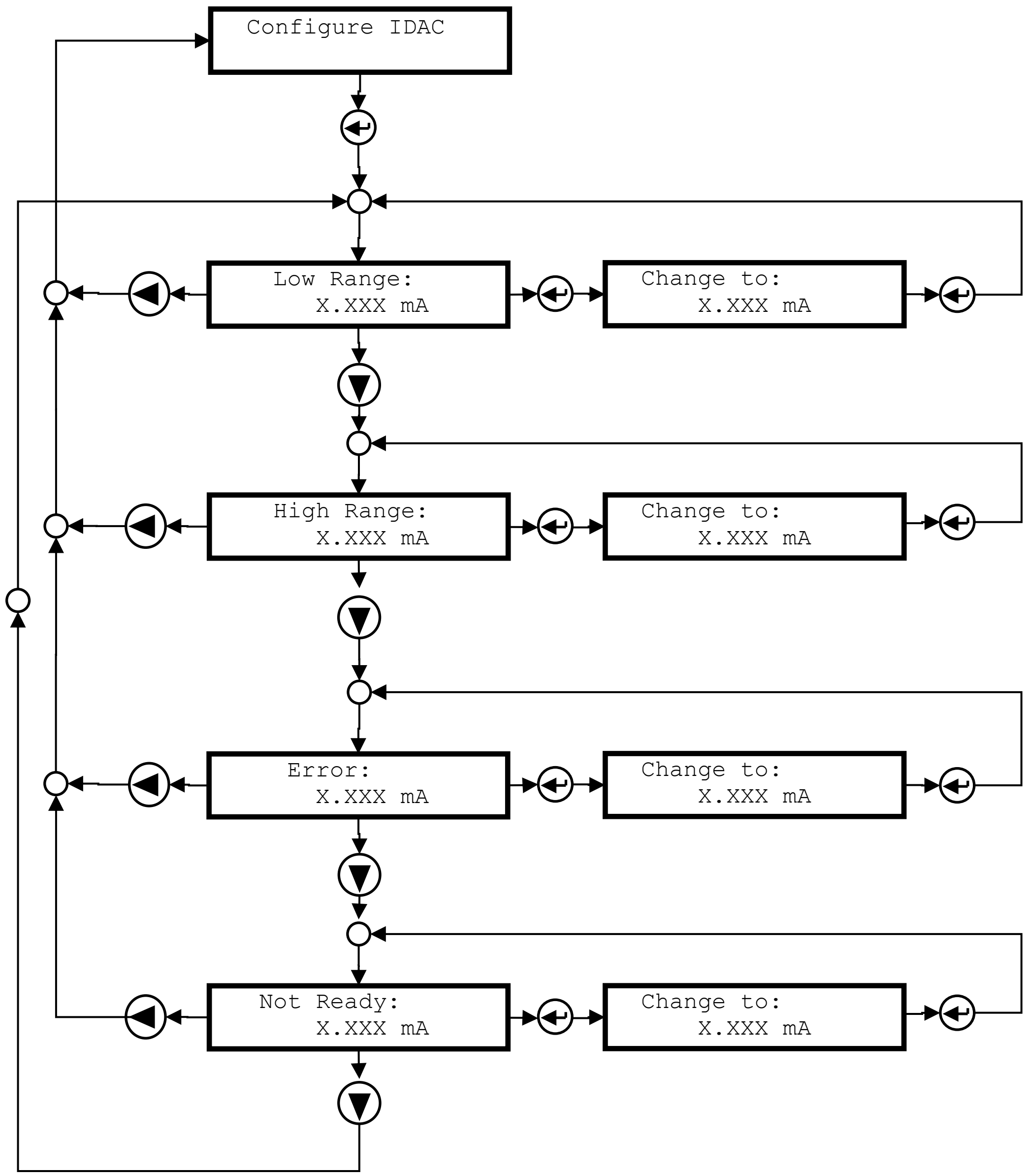
Information Display Menu



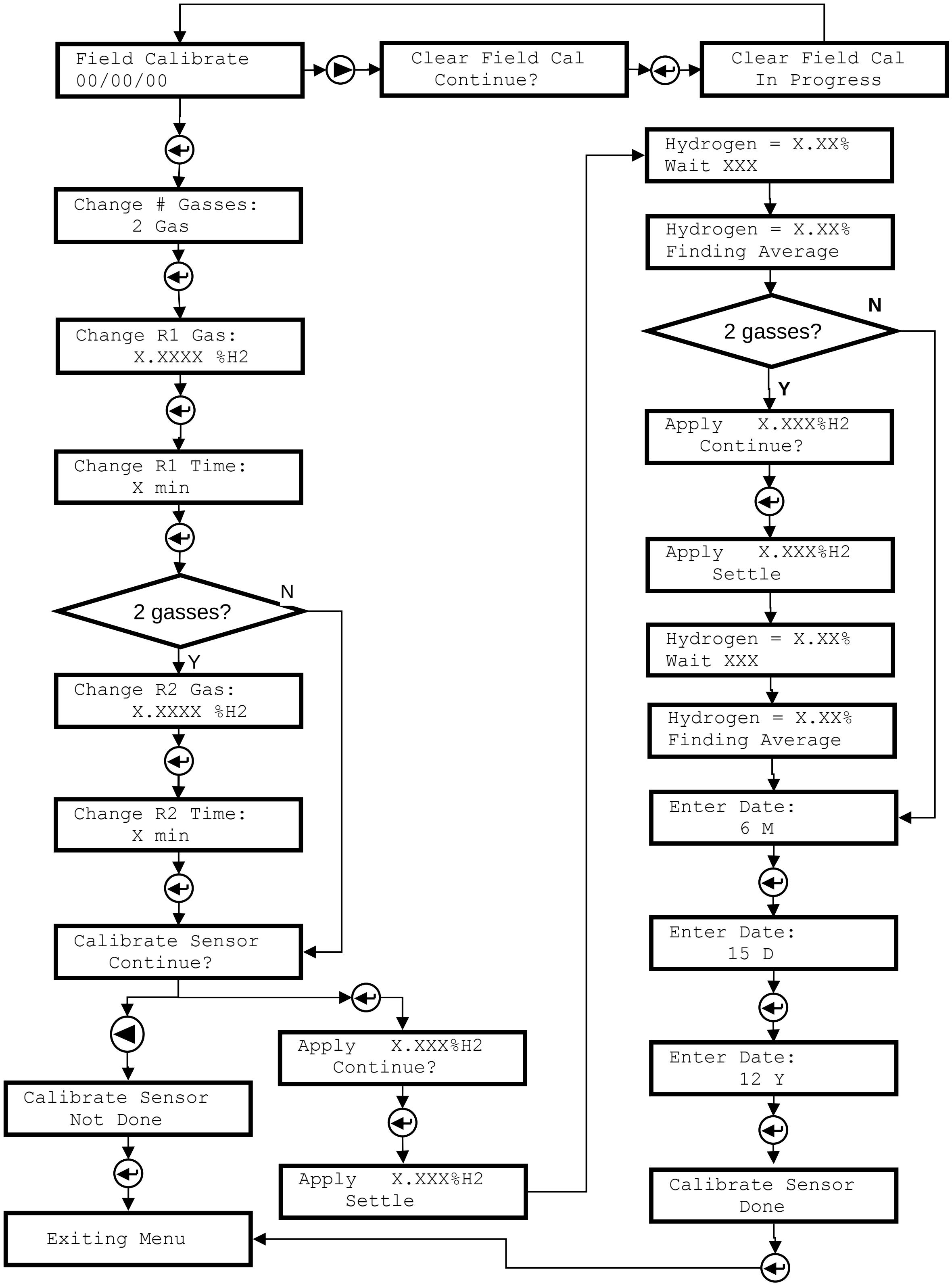
Configure Alert Menu



Set H2 Range Menu



Configure IDAC Menu



Field Calibrate Menu

Chapter 4: Field Calibration

4.1 Calibration Interval

Calibrations do not cause any wear on the sensor and can be performed as often as desired.

The recommended interval between calibrations depends on the desired tolerance. For example, if the drift specification for a given model is 0.3% per week (absolute) and the desired tolerance requires no more than 1% of drift (absolute), then the analyzer should be calibrated every three weeks. If there is not a specific desired tolerance, H2scan recommends the calibration be performed every three months. See Section 1.3.1 Performance Specifications to find the drift specification for a given model.

A weekly or biweekly verification of the analyzer is recommended when high accuracy is desired. This can be performed by exposing the sensor to a calibration gas for 15 minutes and comparing the reported value to the calibration gas specification. If the analyzer is outside the desired tolerance then perform a field calibration to restore accuracy.

4.2 Calibration Gases

WARNING: DO NOT use gases with a hydrogen concentration exceeding 10% at 1.0 atm for the 1710 or gases with a hydrogen concentration exceeding 5% at 1.0 atm for the 1720.

Two primary standard (±0.02%) gases are recommended. The option of using a single calibration gas is available if higher tolerances are acceptable and there are constraints preventing the use of two gases. However, the given accuracy specification of the analyzer does not include the error of the calibration gas certification and is only valid if two gases are used with an exposure time of at least 30 minutes per gas.

DO NOT use concentrations below 0.5% H2 as the low span calibration gas. If the process stream hydrogen concentration range is known then to obtain the highest accuracy use a low span calibration gas just below the lowest expected reading, and a high span gas just above the highest expected reading. For example, if the process stream is expected to operate between 61% and 78% H2, then calibration gases of 60% and 80% H2 would be ideal.

The recommended flow rate is 1.0 ± 0.2 slpm.

Gases are applied to the analyzer through user's plumbing.

4.2.1 Background Gases

Calibrate the analyzer in the proper background gas. For an analyzer operated in hydrogen with an inert gas background (1710, 1730, 1740), the following background gases are safe:

- N_2
- Alkanes / Alkenes / Alkynes
- CO_2
- He, Ar, etc. (Noble)

For an analyzer operated in hydrogen with an air gas background (1720), carry out calibration in hydrogen in an air background.

Contact H2scan for inquiries regarding potential background gases not listed above.

Field calibration kits are available from H2scan.

4.3 Calibration Procedure

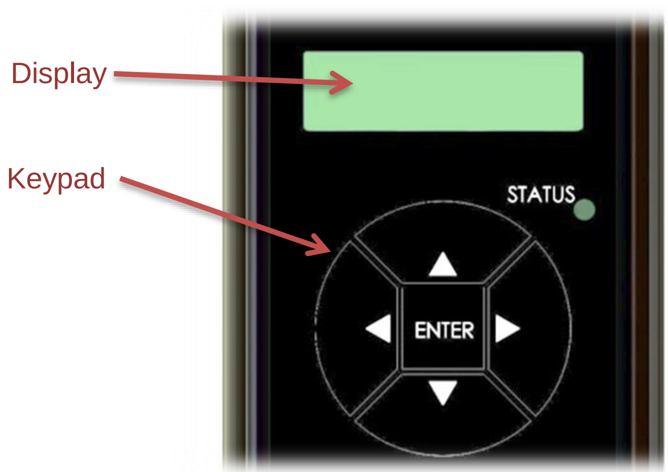
Required materials:

- ☐ Two primary standard (±0.02%) calibration gases
- ☐ Flowmeter set to 1 slpm (~2 scfh)
- ☐ 30 minutes of time per gas (roughly 75 minutes total when including setup and gas switching)
- ☐ The plumbing and tools required to flow the gases to the sensor and switch between them when necessary

  (Standard) If calibrating using the keypad and display on the analyzer, no additional tools are required.
- ☐ (Less Common) If calibrating using the serial port on the analyzer a computer with terminal emulating software and required connecting equipment (including any necessary adapters) will be necessary

Note: Deviating from the above materials may result in reduced accuracy. See Section 4.2 Calibration Gases for information.

4.3.1 Procedure Using the Keypad



1. If the analyzer is not powered on, follow the instructions in Section 2.5 Startup and return here when instructed to perform a field calibration. The analyzer display should appear as follows:

```
H2   =   4.726%
█████████████
```

2. Press ENTER on the keypad to proceed into the menus. The information menu will be displayed as shown below:

```
Information Disp
```

3. Press the up arrow on the keypad to rotate to the Field Calibration menu:

```
Field Calibrate
10/28/16
```

4. Press ENTER on the keypad to enter the field calibration parameters. The first parameter is the number of gases that will be used in calibration. It is strongly recommended to calibrate with two gases. Use the up and down arrows on the keypad to change the number of gases.

```
Change # Gases:
      2 Gas
```

5. Press ENTER on the keypad to proceed to setting the first calibration gas hydrogen concentration as shown below. Use the up and down arrows on the keypad to increase or decrease the selected digit, and use the left and right arrows on the keypad to select the digit. Set the concentration to the exact bottle certification for maximum accuracy.

   Note: The first calibration gas must be the **low** span gas.

```
Change R1 Gas:
    5.1200 %H2
```

6. Press ENTER on the keypad to proceed to the first calibration gas settling time as shown below. It is recommended to use a settling time of at least 30 minutes. Modify the value using the same method as in step 5.

```
Change R1 Time:
     30 min
```

7. If two calibration gases are being used (strongly recommended) repeat steps 5 and 6 to set the hydrogen concentration and settling time for the second calibration gas. Press ENTER on the keypad when finished.

   Note: The second calibration gas must be the **high** span gas.

```
Change R2 Gas:
    29.9200 %H2
```

```
Change R2 Time:
     30 min
```

8. The following screen will be displayed:

```
Calibrate Sensor
   Continue?
```

   If any of the settings were set in error the field calibration can be aborted by pressing the left arrow on the keypad and the process can be started again from step 1. If the settings were all set correctly press ENTER on the keypad to continue with the calibration.

9. The following screen will be displayed:

```
Apply   5.120%H2
   Continue?
```

Begin flowing the **low** span calibration gas to the sensor at 1 slpm (~2 scfh) and then press ENTER on the keypad.

```
Apply   5.120%H2
    Settle
```

```
Hydrogen = 4.59%
Wait 1695
```

After 20 seconds of settling time the analyzer will start the countdown timer for the first gas. The hydrogen value shown uses the previous calibration and may not match the applied gas concentration. This is OK. When the countdown timer reaches 0 the analyzer will take an average and then prompt the user for the next gas as shown below.

```
Hydrogen = 4.85%
Finding Average
```

```
Apply  29.920%H2
   Continue?
```

10. Repeat step 9 with the **high** span calibration gas if performing a two point field calibration.

11. Enter the month, day, and year using the up and down arrows on the keypad to increase or decrease the selected digit, the left and right arrows on the keypad to select the digit, and press ENTER on the keypad to save the value.

```
Enter Date:
          6 M
```

```
Enter Date:
          15 D
```

```
Enter Date:
          12 Y
```

12. The calibration has completed. Press ENTER on the keypad to finish.

```
Calibrate Sensor
      Done
```

The analyzer may now be returned to the process gas stream.

4.3.2 Procedure Using the Serial Interface

To calibrate using the serial interface, follow the sequence below:

Press “Esc” to get the analyzer to the command prompt “H2scan:”

Field Calibration Steps	
Display	**User response**
`H2scan:`	Type “ f” to run field calibration
`Ready to Calibrate (Y/N)?`	Type “ y”
`Gas 1`	
`Cal Gas: X.XXX%H2 (Y/N)?`	Type “ n” if incorrect
`Enter gas:`	Enter the hydrogen concentration % by volume
`Cal Gas: X.XXX%H2 (Y/N)?`	Type “ y” if correct
`Settle time: X min (Y/N)?`	Type “ n” if incorrect
`Enter time:`	Enter the duration in minutes for gas #1
`Settle time: X min (Y/N)?`	Type “ y” if correct
`Apply X.XXX%H2: Ready (Y/N)?`	Apply gas and type “y” when flowing at 1 slpm (~2 scfh)
Streaming data…	
`Taking Average… res=x.xxxxx`	Calibration Gas #1 finished.
`Gas 2 (Y/N)?`	Type “ y” if desired (highly recommended)
`Cal Gas: X.XXX%H2 (Y/N)?`	Type “ y” if correct
`Settle time: X min (Y/N)?`	Type “ y” if correct
`Apply X.XXX%H2: Ready (Y/N)?`	Apply gas and type “y” when flowing at 1 slpm (~2 scfh)
Streaming data…	
`Taking Average… res=X.XXXX`	Calibration Gas #2 finished

4.3.3 Clear Field Calibration (Restore Factory Calibration)

When in the Field Calibration menu on the display, press the right arrow on the keypad. Press ENTER on the keypad to confirm or the left arrow on the keypad to cancel. Press the left arrow on the keypad again to exit the menu.

```
Field Calibrate
10/28/16
```

```
Clear Field Cal
Continue?
```

If using the serial interface the **X** command restores the instrument to the last factory calibration.

Chapter 5: Supplemental Information and Troubleshooting

5.1 Storage

5.1.1 Storage Oxidation & Offsets

Analyzer readings will develop an offset when the sensor element is not exposed to hydrogen. This offset accumulates slowly while the sensor is in storage, and quickly while the sensor is powered on without being exposed to hydrogen. Try to minimize the time the sensor is powered on without being exposed to hydrogen.

This offset is due to oxidation of the sensing element; oxidation can be reversed (and sensor readings returned to normal) if the sensor is left powered on (conditioned) in an appropriate concentration of hydrogen gas.

5.1.2 Expected Oxidation Time and Recovery Time

The severity of sensor oxidation depends on the sensor's recent operation history.

Recent Operation History	Time Period	Oxidation	Conditioning Regime
Powered off or in storage	**Less** than 1 week	Mild	Apply conditioning gas until readings are stable. Typically less than 2 hours
Powered off or in storage	**Less** than 6 months	Mild to moderate (<1%)	Apply conditioning gas until readings are stable. Typically less than 24 hours
Powered off or in storage	**More** than 6 months	Significant (~1%)	Apply conditioning gas until readings are stable. Typically 24 - 48 hours
Powered on *without* hydrogen present	**Less** than 12 hours	Mild to moderate (<1%)	Apply conditioning gas until readings are stable. Typically less than 24 hours.
Powered on *without* hydrogen present	**More** than 12 hours	Significant (~1%)	Apply conditioning gas until readings are stable. Typically 24 - 48 hours

5.1.3 Conditioning to Remove an Offset

Generally, condition the sensor with a gas mixture that has about the same hydrogen concentration as what you expect during normal operation.

Note: Do not ever apply gas with greater than 10% H2 content to the Model 1710. This model is specially built for only low concentrations of hydrogen. Doing so will damage the sensor and void the warranty.

If you are not sure of the conditions the sensor will operate under, a hydrogen-nitrogen mix with a hydrogen concentration from 5% to 10% is a conservative (but effective) choice. Using gas with a slightly higher concentration of gas will remove the oxide layer (and the offset) slightly faster.

In all cases, **apply an appropriate conditioning gas until the hydrogen readings are stable**. Sensor readings may drift up or down during the conditioning process. In most cases, the readings stabilize after 48 hours.

Once stable, the analyzer should be checked for accuracy by performing a Field Verification; see Chapter 4: Field Calibration.

If the analyzer passes the Field Verification, the analyzer may be placed back into storage. If the analyzer fails the Field Verification, please perform a Field Calibration (Chapter 4: Field Calibration). If problems persist, contact H2scan for support.

5.1.4 Avoiding a Storage Oxidation Offset

Alternatively, some customers leave the backup analyzer in H2 gas (powered on) continuously, to eliminate any recovery time the analyzer may require. H2scan recommends this approach whenever it is feasible.

For a fee, H2scan will keep a customer's backup analyzers continuously powered on in hydrogen gas at our calibration facility, and ship out the fully conditioned backup sensor when it is needed.

5.2 Sensor Behavior

H2scan provides two different types of calibrations for sensors employed in process analyzer models. This includes sensors calibrated for continual H2 exposure (H2 measurement applications), and sensors calibrated for uncommon H2 exposure (H2 detection applications).

5.2.1 H2 Measurement

The sensors employed in Models 1710, 1730, and 1740 are designed for continual H2 exposure, i.e. H2 measurement applications. The standard range of measurement for these models is 0.5% to 100% by volume or 0.1% to 10% for the 1710.

Because these sensors are designed to see H2, if they are left on for periods of time with no H2 present, an offset will develop in the reported H2. The more oxygen that is exposed to the sensor, the faster and stronger the offset will be. Oxygen offset varies by sensor.

5.2.1.1 Inert Backgrounds

Even small amounts of H2 (2000ppm, for example) should ensure no offset takes place (as long as there is no oxygen present).

If oxygen were to cause an offset to the indication of the sensor, it can be reversed by purging the sensor with H2 and performing a field calibration (See Section 5.3 - General Troubleshooting).

5.2.2 H2 Detection

The sensor employed in Model 1720 is designed for brief H2 exposure of less than a few hours at a time, i.e. leak detection applications.

If continual H2 is exposed to this sensor, it will bond with the oxygen (on the sensor surface) and the indication of the sensor will be less than the H2 actually present.

Exposures to H2 for periods exceeding several hours may require overnight operation in H2-free air followed by a field calibration to obtain accurate readings. H2scan does not recommend use of the Model 1720 unless there is generally no H2 exposure to the sensor.

5.2.3 Diurnal Effect

Temperature changes throughout the day may induce small changes to the H2 reading of the analyzer. As explained in Section 3.1.1 - Effect of Pressure, the sensor measures the number of hydrogen molecules present which means pressure changes (brought on by temperature fluctuations) can create fluctuations in the reported H2 concentration. While the software in the analyzer corrects mostly for these effects it may still be observed in final reading. Figure 2 shows the diurnal effect across three days. Note the rise and fall in hydrogen concentration across each day correlating with the temperature. While these effects can be observed when highly zoomed in on the data plot, they are well within the specifications for the analyzer. **Adding a back pressure regulator can greatly reduce or remove this effect.**

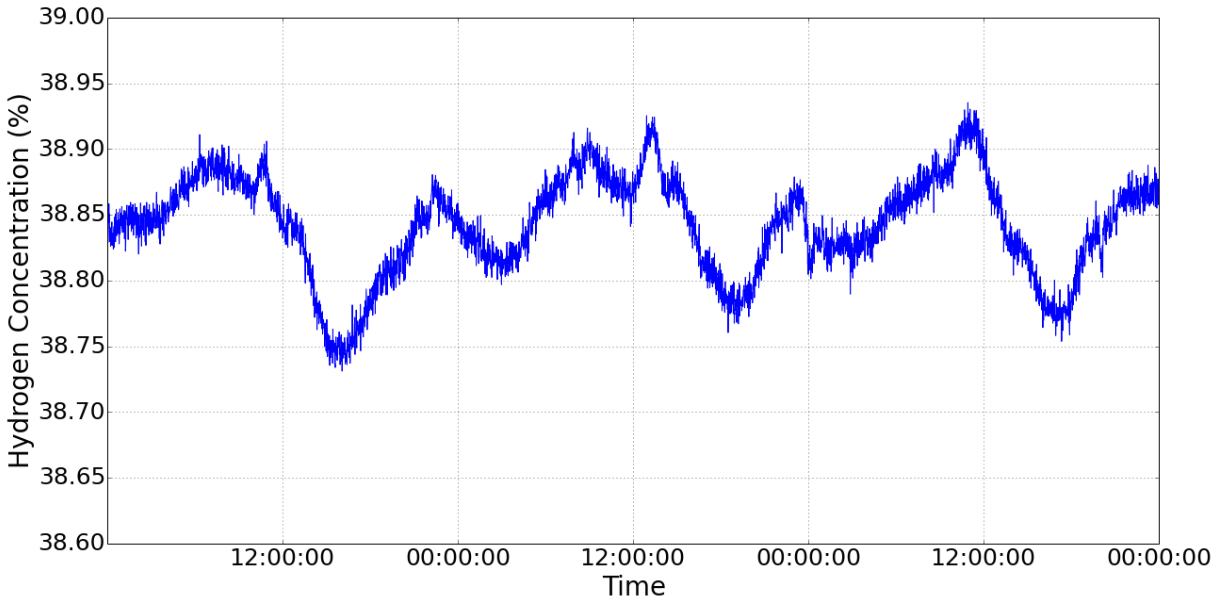


Figure 2: Diurnal Effect

5.3 General Troubleshooting

Here are some general questions to answer if problems are encountered with the analyzer.

1. Is the analyzer reporting %H2?
   - Check all connections and flow paths.
   - Reduce process or calibration gas stream pressure to 1.0 atm and power cycle the analyzer.
2. Is the pressure and the flow stable?
   - Unstable pressure or flow can cause the analyzer to behave erratically. Ensure the process gas stream is properly regulated. A back pressure regulator can be installed to improve performance and stability. The analyzer is less sensitive to changes in flow but a flow rate of 1.0 slpm is recommended.
3. Is the sensor stable?
   - Expose the analyzer to a calibration gas (40-100% H2, but not exceeding 10% H2 in the model 1710) overnight while recording the %H2 reading from the serial port (most terminal software allows saving the session to a log file).
   - Plot the %H2 reading. (You may use spreadsheet software such as Microsoft Excel). Assuming a constant pressure, temperature, and flow rate, the %H2 line for the most recent data should be flat with no perturbations outside the defined specifications for the analyzer. If it is not yet stable, leave the analyzer exposed to the calibration gas for another 24 hours or until stability is observed.
   - Once the sensor is stable, perform a field calibration with two gases.
   - If the sensor does not stabilize, contact H2scan for support.

5.4 Command Terminal Messages

The last column in the display of the terminal shows status messages.

In this section _XXX refers to a number

ramp_up

This indicates the sensor temperature is ramping up to the operating temperature

Warmup_XXX

Warmup_XXX is displayed when the sensor is turned on or reset. It will start at a time programmed at the factory and count down to 0.

Settle

When the analyzer is waiting for the die temperature to stabilize, "Settle" is displayed. The settling time varies depending on the sensor and local conditions and could take up to five minutes.

Wait_XXX

This message usually appears counting down a delay.

For example, during field calibration the analyzer is expecting the gas to be applied for a certain length of time. In this case WAIT_XXX will appear counting down the remaining time.

Wait_100 continuously displayed is a special case. It appears when the analyzer is waiting for an event that will not occur at a particular time. Once this event occurs it changes to a counter initialized to some value (Wait_XXX) and counts down from there.

If it is displayed for more than five minutes, cycle the power to the analyzer. It should return to normal operation.

htroff

The "htroff" error could be caused by one of several error conditions that cause the analyzer to turn off the sensor heater. Sometimes the error occurs because of a transient condition ("glitch"). If "htroff" is displayed, cycle the power to the analyzer. It should return to normal operation. If the error is permanent, the analyzer must be returned to H2scan for examination.

Error_XXXX

The following table lists possible errors and the code numbers that could appear on the display. These codes are hexadecimal numbers representing 16 bits with each bit representing an error. If more than one error occurs concurrently, their values add. For example, if the sensor temperature is out of range and there is a configuration error, the error code will be 24. Many of these errors could lead to a "htroff" error.

Error	Code (hex)
Error calculating hydrogen	80
PCB temperature is too high	40
Sensor temperature is out of range	20
H2 resistor value is out of range	10
Configuration error	04

5.5 Serial Communication Troubleshooting

This troubleshooting guide assumes the ICP DAS model 7561 USB adapter and FoxTerm terminal emulation program are used. More information can be found on-line at www.icpdas.com. It is important that the RxD+/-, TxD+/-, and Gnd connections for RS-422 communication are made correctly. Gnd must be connected to the DC ground line of the power supply. Avoid using a USB-Serial adaptor that has a long cable between the two ends as it can easily pick up electrical noise that will interfere with communications.

FoxTerm Error 015: The port 'COMx' does not exist: Determine which COM port is available for use.

Garbage Characters: If strange characters are seen in the FoxTerm window, either on their own or in response to pressing `Enter` then **ESC**. Verify the serial connections and FoxTerm Settings.

No H2scan: Prompt: If pressing `Enter` then **ESC** does not show the H2scan: prompt, and FoxTerm is connected to the correct COM, port refer to the Section 5.5.6 Analyzer Command Line for further instructions.

No Response to Pressing Enter: If the H2scan: prompt is present and command characters are echoed but pressing `Enter` has no affect then confirm the Newline Behavior setting for FoxTerm is "CRLF".

USB Adapter not recognized: If a USB adapter is used, Administrator Rights may be required for the computer to install and use it. Contact your network administrator to resolve this issue.

5.5.1 Connections

Review the wiring connections between the analyzer, power supply, and USB Adapter as indicated in the Operation manual. Then confirm that the power supply is on and within specifications with a voltmeter, and the LED is on. An amber LED immediately after turning on power is normal. The LED will change to green or red after the warm up period depending on hydrogen concentration.

5.5.2 COM Port Number

Administrator rights for the computer are required to examine or setup a COM port connection with the analyzer. Open Device Manager by right clicking on My Computer icon, selecting Manage and then choosing the Device Manager option in the left pane. In the right pane select Ports (COM & LPT) and determine which COM port is connected to the analyzer (e.g. COM6). The COM port should be labeled as I-756x (COM__). Make note of the COM port number shown in parenthesis for use in setting up FoxTerm. Note that the COM port number may be different when your computer is reconnected to the analyzer. For best results always use the same USB adapter and plug-in location on your computer.

To confirm that a particular COM port is actually connected to the analyzer: Open Device Manager; disconnect the USB connector from your computer and verify that the COM port disappears; then reconnect the USB connector and verify that the COM port re-appears. If the COM port is not displayed in Device Manager, unplug the USB cable and look for changes in Device Manager. Plug in the USB cable and see if a new COM port is added to the Ports (COM & LPT) section. If so, this is the COM port to use with FoxTerm.

5.5.3 USB Adaptor Device Driver:

If the COM port is not correctly displayed in the Device Manager then look for yellow warning symbols that indicate a device is not working correctly under the Universal Serial Bus (USB) controllers section. If this warning symbol goes away and returns as the USB cable is disconnected and reconnected then the device driver for the USB adapter is not installed correctly. To re-install the device driver, double click on the Warning line to bring up the properties window for the device; select the Driver tab and click on the Uninstall button. After the Uninstall is complete unplug the USB cable and reboot your computer. Re-install the driver from the CD (or internet) then plug in the USB cable and confirm that a new device is found and the driver is loaded without error. Go to the beginning of this section and determine which COM port has been assigned for the analyzer.

5.5.4 Rebooting

Sometimes when the connection between the Computer and the COM port cannot be established even after following the above procedures, the problem may be that the Computer has not released the COM port from a previous use. Reboot your computer and then use the above procedure in identifying the correct COM port number. In such cases it is best to avoid disconnecting and reconnecting the USB adaptor until the entire data download activity is complete.

5.5.5 Terminal Program

Problems with FoxTerm are best resolved by opening FoxTerm then issuing a (File|Close Session) command from the menu bar. This closes all open terminal windows and prepares FoxTerm to setup a new COM port connection. If prompted to **`Save`** the session select **`No`**. The next step is to issue the (File|New COM Port Connection…) command from the menu bar. Now fill out the New Connection dialog box with the correct COM port and settings. Click the OK button to open the terminal window. The title bar for the window shows the COM port and indicates whether it is Connected or Not Connected. If Not Connected there is something wrong with the COM port connection on the computer, or another program is using the COM port. Confirm the correct COM port is being used. Reboot the computer if the Not Connected message does not disappear. If the terminal window is connected continue to the next section to get an H2scan prompt.

5.5.6 Analyzer Command Line

The analyzer is sending data to the serial port as measurements are made which is typically every second.

Pressing the **Enter** then **ESC** keys should show the H2scan prompt. Sometimes the **ESC** key needs to be pressed twice to get the prompt. If the prompt is not displayed then press the following keys to establish communication with the analyzer:

N Enter

1 Enter

If the analyzer does not respond turn off power for 10 seconds before turning it back on. A Power-on-Reset message should be displayed in the terminal window when power is applied.

User commands like "**D0**" are issued from the H2scan prompt. These commands are followed by the **Enter** key to initiate the operation. If the prompt is displayed and the user command is echoed but pressing **Enter** doesn't initiate the command then the **"Newline Behavior"** setting in FoxTerm must be changed to "**CRLF"**.

5.6 Analog Output Troubleshooting

Sometimes the analog output shows unexpected values, such as negative hydrogen. Negative hydrogen values are never reported. This section assumes 4-20mA is the analog output. Systems with 0-5V have similar operations.

5.6.1 Verify the hydrogen values

Check the **%H2** column of the serial port output to read the actual hydrogen measurement. The analog output is derived from this hydrogen value. If the actual hydrogen measurement is OK, but the analog output does not agree with the **%H2** column check the following items.

5.6.2 Verify the H2 range

If the H2 range is set much wider than the operating range used, errors and noise can be exaggerated. Check the range with the **D1** command.

```
User configuration is:
  Hydrogen reporting range 0.0000-20.0000 %H2
  Isolated Output is enabled: 4.000 to 20.000 mAmps
    Error output is 3.000 mAmps
    Not-Ready output is 2.000 mAmps
```

In this example 4mA = 0ppm and 20mA=20%. This is an appropriate range if the hydrogen values of concern are between 0 and 20%. This would not be an appropriate range if the hydrogen values range from 1.5 to 10%.

If the range needs adjustment, use the **H** command and follow the prompts as shown below.

```
Hydrogen reporting range 0-0.2000 %H2
  Enter new H2 low range: 1.5
    Enter new H2 high range: 10
New Hydrogen reporting range 1.5000-10.000 %H2
  Save these values (Y/N)?
```

In this example the range was changed so 4mA=1.5% and 20mA=10%.

5.6.3 Verify the Analog Output

Disconnect the analog wires from the SCADA system. Using a calibrated meter, verify the current is correct. The equation is:

$$I = \frac{(H2read - H2low)}{(H2high - H2low)} * (AoutHigh - AoutLow) + AoutLow$$

where H2high is the H2 value at 20mA, H2low is the H2 value at 4mA, AoutLow is the lowest measurement analog output, AoutHigh is the highest measurement analog output, and H2read is the hydrogen measurement.

For example, for H2high=2%, H2low=0%, and H2read=1%, the current should be 12mA +/- 0.01mA.

5.6.4 Verify the SCADA analog input

If the current from the analyzer is correct, perhaps the analog input channel is measuring it incorrectly.

Inject a current from a calibrated source and verify the SCADA analog channel measures it correctly.

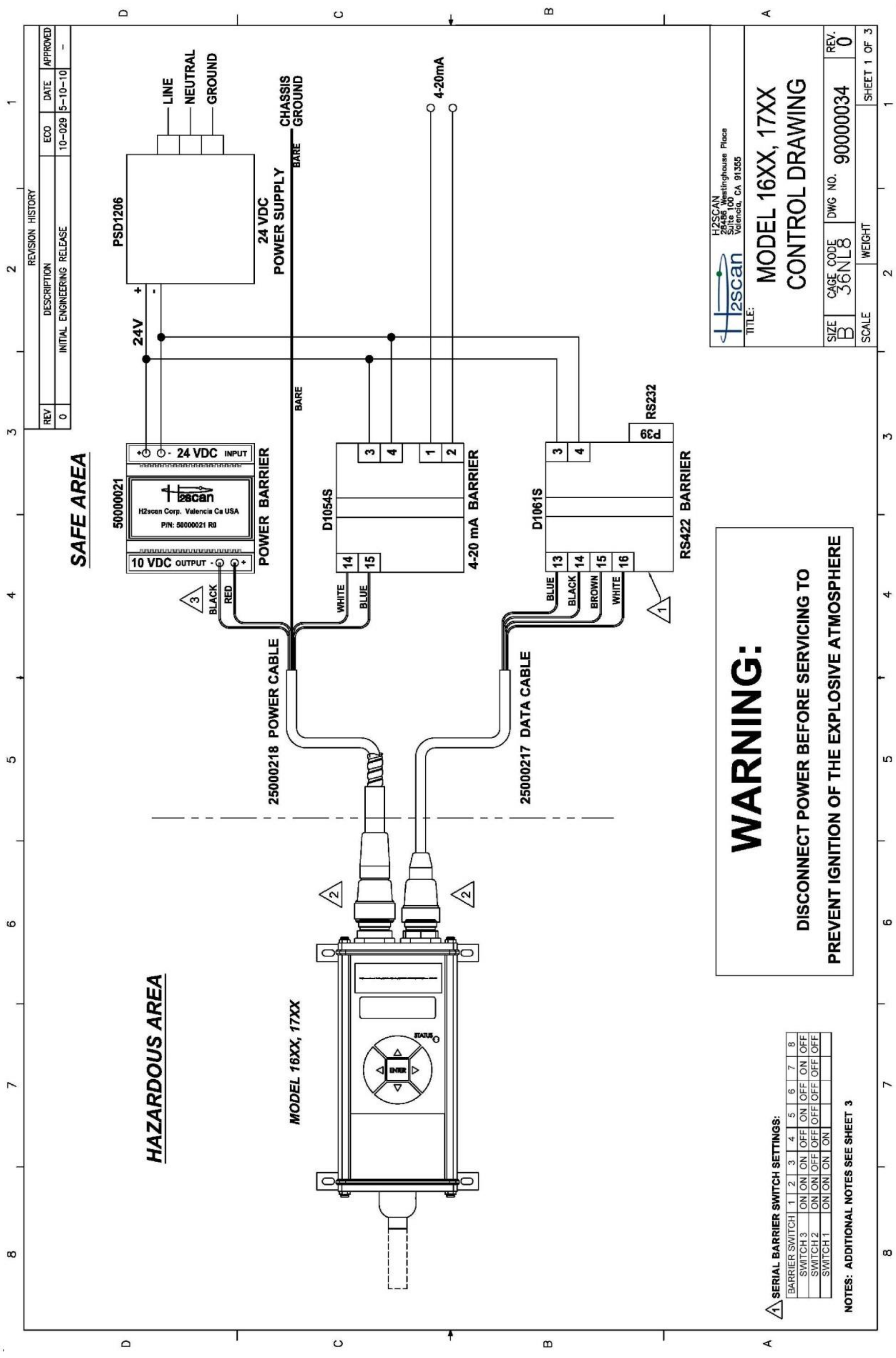
If it does not measure the current correctly, see the SCADA manual for information regarding calibration and adjustment.

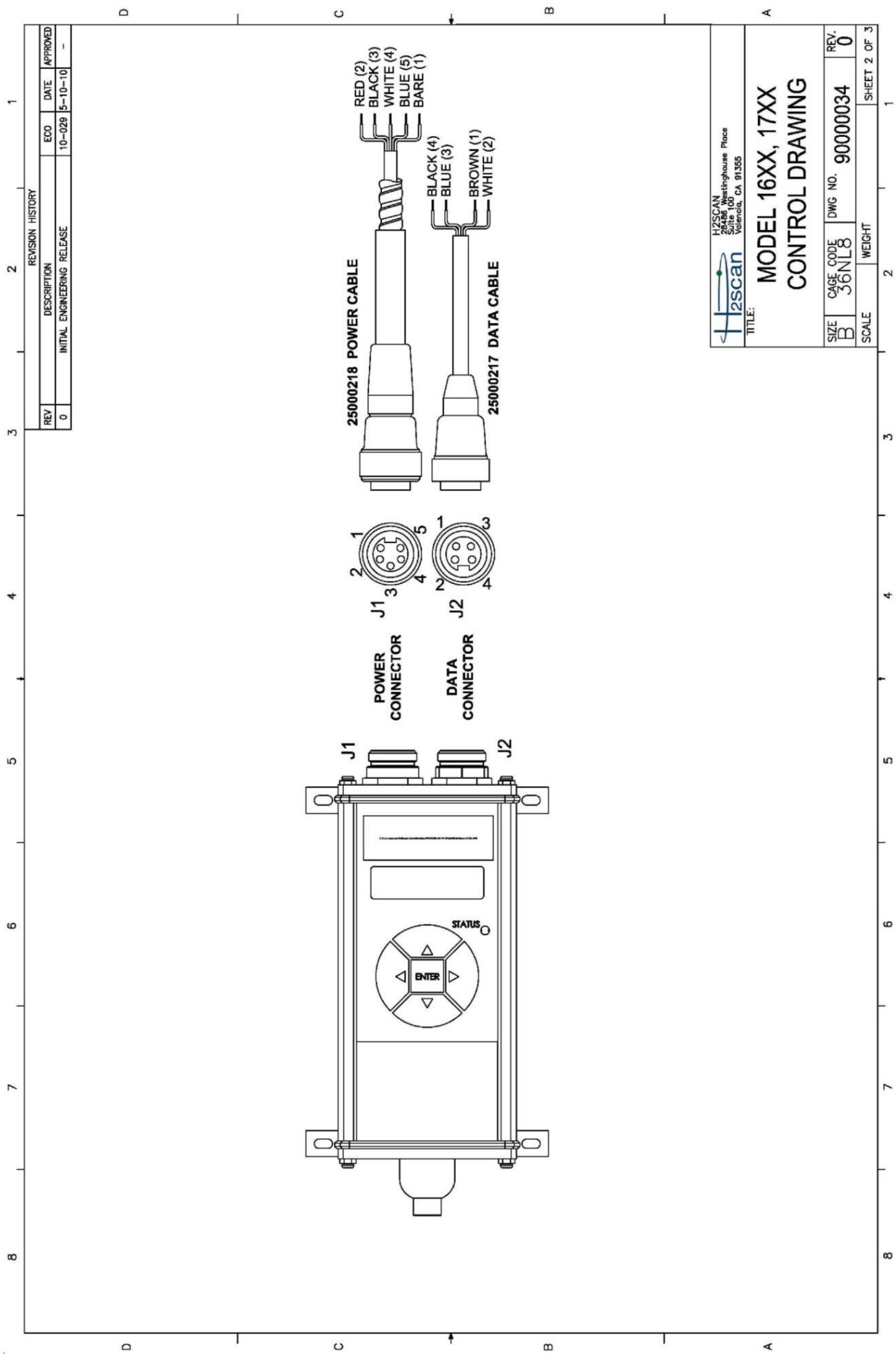
5.6.5 Calibrate the Analog Output

If the range is correct and the analog output is inaccurate, it may require calibration.

Use the "`ci`" command.

Appendix A: Control Drawings




REVISION HISTORY
REV | DESCRIPTION | ECO | DATE | APPROVED
0 | INITIAL ENGINEERING RELEASE | 10-029 | 5-10-10 | -
RED (2)
BLACK (3)
WHITE (4)
BLUE (5)
BARE (1)
25000218 POWER CABLE
BLACK (4)
BLUE (3)
BROWN (1)
WHITE (2)
25000217 DATA CABLE
J1
J2
POWER CONNECTOR
DATA CONNECTOR
STATUS
ENTER
H2SCAN
28486 Westinghouse Place
Suite 100
Valencia, CA 91355
TITLE:
MODEL 16XX, 17XX
CONTROL DRAWING
SIZE B
CAGE CODE 36NL8
DWG NO. 90000034
REV. 0
SCALE
WEIGHT
SHEET 2 OF 3

REV	DESCRIPTION	ECO	DATE	APPROVED
0	INITIAL ENGINEERING RELEASE	10-029	5-10-10	-

NOTES:

2 Intrinsically Safe Device Entity Parameters: SEE TABLE 1

3 H2scan Associated Apparatus Entity Parameters: SEE TABLE 2

4. Associated apparatus output current must be limited by a resistor such that the output voltage-current plot is a straight line drawn between open-circuit voltage and short-circuit current.

5. Associated apparatus may be in a Division 2 or Zone 2 location if so approved.

6. Selected associated apparatus must be third party listed as providing intrinsically safe circuits for the application, and have Voc or Vt not exceeding Vmax (or Uo not exceeding Ui), Isc or It not exceeding Imax (or Io not exceeding Ii), and the Po of the associated apparatus must be less than or equal to the Pmax or Pi of the intrinsically safe equipment, as shown in Table 3.

7. Capacitance and inductance of the field wiring from the intrinsically safe equipment to the associated apparatus shall be calculated and must be included in the system calculations as shown in Table 3. Cable capacitance, Ccable, plus intrinsically safe equipment capacitance, Ci, must be less than the marked capacitance, Ca (or Co), shown on any associated apparatus used. The same applies for inductance (Lcable, Li and La or Lo, respectively). Where the cable capacitance and inductance per foot are not known, the following values shall be used: Ccable = 60 pF/ft., Lcable = 0.2 μH/ft. If Po of the associated apparatus is not known, it may be calculated using the formula Po = (Voc * Isc)/4 = (Uo * Io)/4. SEE TABLE 3

8. Associated apparatus must be installed in accordance with its manufacturer's control drawing and Article 504 of the National Electrical Code (ANSI/NFPA 70) for installation in the United States, or Section 18 of the Canadian Electrical Code for installations in Canada.

8. When required by the manufacturer's control drawing, the associated apparatus must be connected to a suitable ground electrode per the National Electrical Code (ANSI/NFPA 70), the Canadian Electrical Code, or other local installation codes, as applicable. The resistance of the ground path must be less than 1 ohm.

10. Where multiple circuits extend from the same piece of intrinsically safe equipment to associated apparatus, they must be installed in separate cables or in one cable having suitable insulation. Refer to Article 504.30(B) of the National Electrical Code (ANSI/NFPA 70) and Instrument Society of America Recommended Practice ISA RP12.6 for installing intrinsically safe equipment.

11. Associated apparatus must not be used in combination unless permitted by the associated apparatus certification.

12. Control equipment must not use or generate more than 250 V rms or dc with respect to earth.

Table 1: Model 1600 - 1700 Entity Parameters

	Power Supply	4-20 mA loop	RS422 Rx&Tx	
Parameter	J1 Pins 2&3	J1 Pins 4&5	J2 Pins 1&2	J2 Pins 3&4
Vmax (or Ui)	11.5 V	26.7 V	3.7 V	n/a
Imax (or Ii)	3.27 A	91 mA	2.25 mA	n/a
Pmax (or Pi)	9.41 W	611 mW	206 mW	n/a
Ci	0	68.2 nF	0	n/a
Li	0	0	0	n/a
Voc (or Uo)	n/a	n/a	n/a	5.9 V
Isc (or Io)	n/a	n/a	n/a	238 mA
Po	n/a	n/a	n/a	350 mW
Co	n/a	n/a	n/a	1000 uF
Lo	n/a	n/a	n/a	2.5 mH
Lo/Ro	n/a	n/a	n/a	404 uH/Ohm

Table 2: P/N 50000021R0 Entity Parameters

Parameter	10VDC Output
Um	250 V
Voc (or Uo)	11.5 V
Isc (or Io)	3.27 A
Po	9.41 W
Co	11.2 uF
Lo	29 uH
Lo/Ro	33 uH/Ohm

TABLE 3: Compatability Rules

I.S. Equipment		Associated Apparatus
V max (or Ui)	≥	Voc or Vt (or Uo)
I max (or Ii)	≥	Isc or It (or Io)
P max (or Pi)	≥	Po
Ci + Ccable	≤	Ca (or Co)
Li + Lcable	≤	La (or Lo)

H2SCAN
28486 Westinghouse Place
Suite 100
Valencia, CA 91355

TITLE: MODEL 16XX, 17XX CONTROL DRAWING

SIZE	CAGE CODE	DWG NO.	REV.
B	36NL8	90000034	0
SCALE	WEIGHT		SHEET 3 OF 3

A.1 Serial Barrier Switch Settings for RS232 Connection to PC

BARRIER SWITCH	1	2	3	4	5	6	7	8
SWITCH 3	ON	ON	ON	OFF	ON	OFF	ON	OFF
SWITCH 2	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF
SWITCH 1	ON	ON	ON	ON				

Appendix B: Spare Parts

H2scan Part Number	Description
50000021	Barrier Voltage Supply Module Assembly
25000246	IS Barrier, 4-20mA, with Relays
25000247	IS Barrier, 4-20mA, no Relays
25000248	IS Barrier, RS-422
25000218-X	Cable Assembly, Armored, Power
25000217-X	Cable Assembly, Serial
25000263	USB to RS-232/422/485 Converter

Appendix C: Foxterm Setup

Installation

These instructions refer to FoxTerm, but the concepts are the same in all terminal emulators.

Download FoxTerm from www.foxterm.net.

Create a folder in “My Documents” called “H2scan”.

Unzip the FoxTerm files into the H2scan folder.

Setup

Start FoxTerm

Close the default session window (if needed).

Open a new session window.

Select the correct port as determined above (COM3 in this example).

Setup the session as shown below

Select a log file name and location. The file name should start with the current date (YYYMMDD) followed by any particular information required. This way, the files will be easy to sort. For example “20110920Yukon6.log” would be the file name for the “Yukon6” analyzer that had logging started September 20th, 2011. The “.log” extension is the default, but any extension could be used.

Newline Behavior must be set to “CRLF”.

Click OK.

Save the session as “H2scan.xml” in the FoxTerm program location.

The setup should look similar to that shown.