SuperSystems incorporated

Basic Nitriding Sampling System

Hydrogen Analyzer with Calculated % DA, % NH_3, and K_N Values

PN: 13537

Operations Manual

Please read, understand, and follow these instructions before operating this equipment. Super Systems, Inc. is not responsible for damages incurred due to a failure to comply with these instructions. If at any time there are questions regarding the proper use of this analyzer, please contact us at 513-772-0060 for assistance.

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Table of Contents

Introduction

This instrument uses the measurement of Hydrogen (H_2) to display percent Hydrogen ($\%H_2$), percent Dissociation (%DA), and percent Ammonia ($\%NH_3$). When the flow rates of Nitrogen, Ammonia, and Dissociated Ammonia are manually entered, the instrument can also calculate Nitriding Potential (K_N).

It is suggested that this device should be calibrated on a routine basis, such as once per year or as prescribed by the user's quality system requirements.

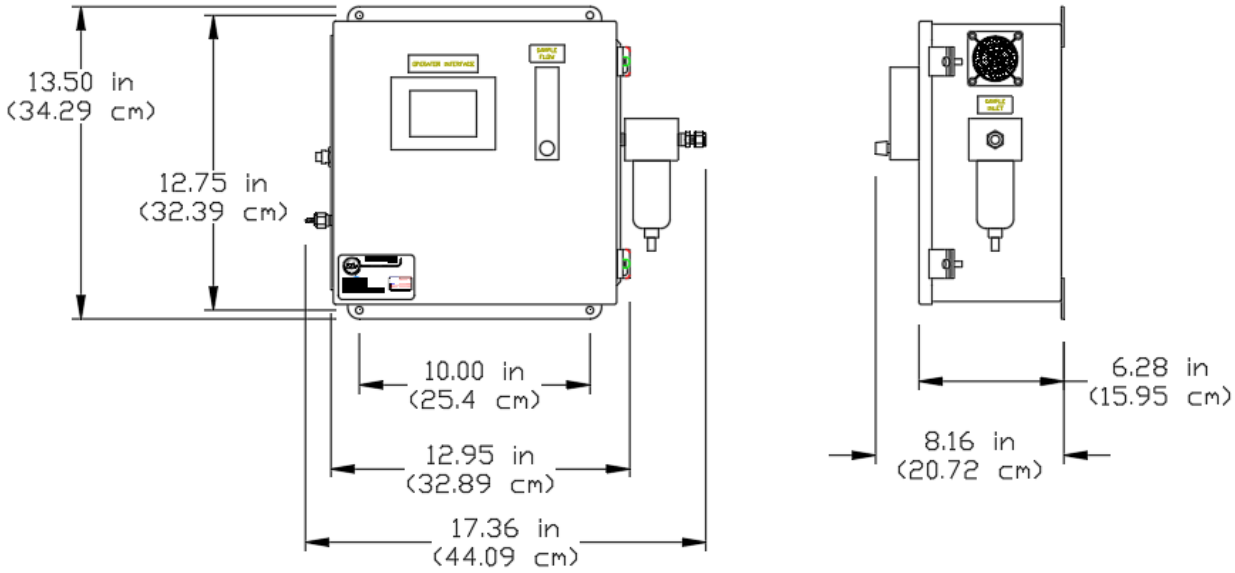
Specifications

- Power Requirements: 100-240 VAC
- Current Draw: Max. 0.2 Amps
- Sensor Technology: Thermal Conductivity
- User Interface: 3.5" Color QVGA TFT LCD Touch Screen
- Measurement Range: 0-100% H_2 of gas concentration
- Hydrogen Measurement Accuracy: ±1% of full scale (±1% of gas concentration)
- Hydrogen Measurement Repeatability: ±1%
- Hydrogen Measurement Resolution: 0.1%
- Analog Outputs: Two Isolated 4-20 mA (User Configurable)
- Analog Output Resolution: 0.005 mA
- Analog Output Accuracy: ±0.01% of Range
- Analog Output Linearity: ±0.01%
- Analog Output Load Resistance: Minimum 0 Ohm, Maximum 500 Ohm
- Digital Communications: RS485 Modbus, Ethernet
- Enclosure Size (Without Filter): Approx. 13"L x 13"W x 6"D / 330 mmL x 330 mmW x 142 mmD
- Enclosure Weight: 22.5 LB / 10.2 kg
- Enclosure Ventilation: Continuous Purge Fan, Dual Vents
- Recommended Flow Rate: 1.5 to 2.0 cfh / 0.71 to 0.94 lpm
- Process Gas Fittings: Stainless Steel Compression for ¼" OD Tubing
- Calibration Gas Fitting: 1/8" Barb (can be removed for 1/8" Female NPT Port)
- Operating Environment: 10-90 %RH (Non-Condensing)
- Operating Temperature: 32 to 122°F / 0 to 50°C
- Sample Gas Temperature: 32 to 158°F / 0 to 70°C

Electrical Connections / Terminal Assignments

Wire Number	Function
1000	AC Line Power (100-240VAC)
1002	AC Neutral Power
Ground	AC Ground
1121	Analog Output Common (+)
1111	Analog Output #1 (-)
1121	Analog Output Common (+)
1131	Analog Output #2 (-)
1081	RS485 (-)
1091	RS485 (+)

Mechanical Diagrams

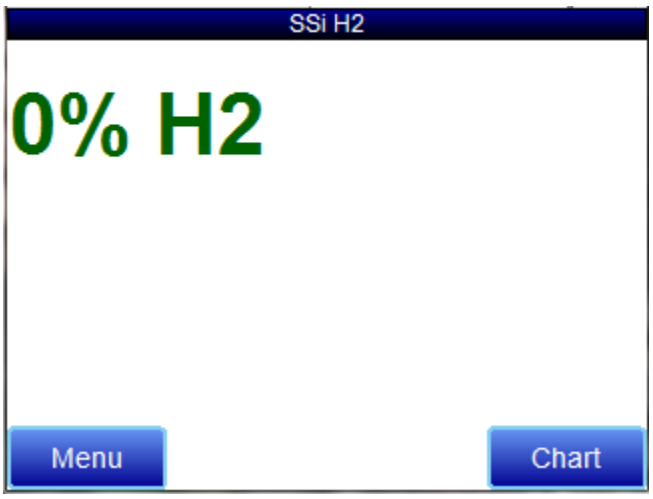


Enclosure and mounting hole measurements

Getting Started

Please refer to the above Electrical Connections/Terminal Assignments and Mechanical Diagrams as well as the enclosed drawings for instructions regarding the proper electrical and mechanical installation of this instrument. Contact SSi if additional drawings are required. The flow meter on the door of the enclosure should be adjusted to maintain 1.5 cfh of process gas flow.

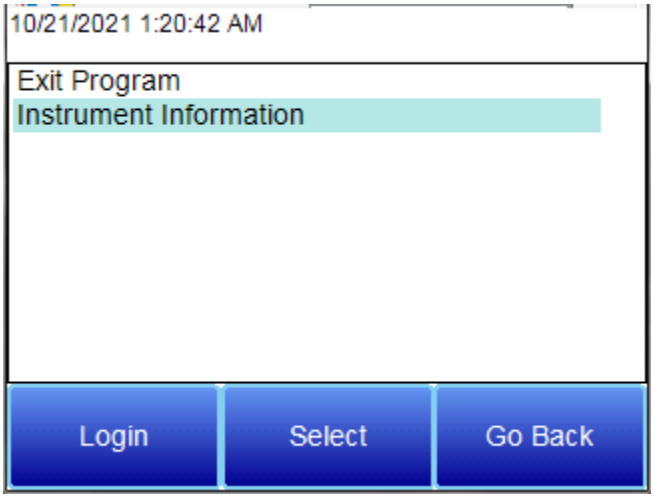
Default Settings



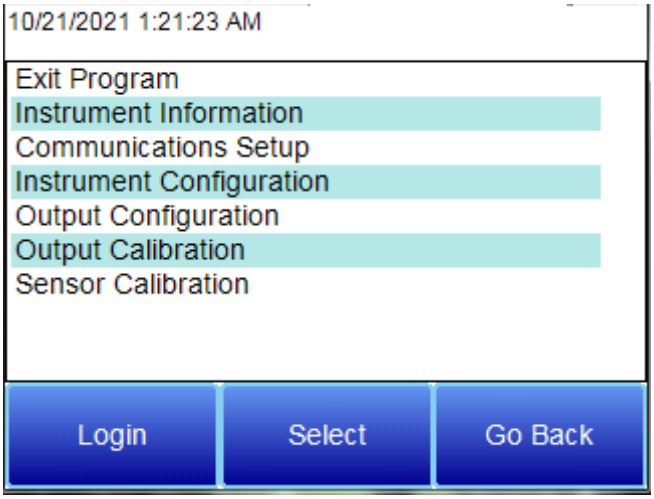
When the instrument is turned on, it will display $\%H_2$ on the screen. To display additional values (%DA, $\%NH_3$, or K_N), see the Instrument Configuration screen. The first 4-20 mA output will be set up to retransmit the $\%H_2$ value scaled for 0 to 100%, and the second output will be set up for %DA also scaled for 0-100%. Any changes to these default parameters will be stored so they will not need to be re-entered when the power is shut off to the instrument

Modifying the Default Settings

To access the operational and setup parameters, press the "Menu" button at the lower left section of the screen. This will allow you to select only two options, Exit Program and Instrument Information. To prevent unwanted modification to the operation of the instrument, these are the only options available unless the user logs in.



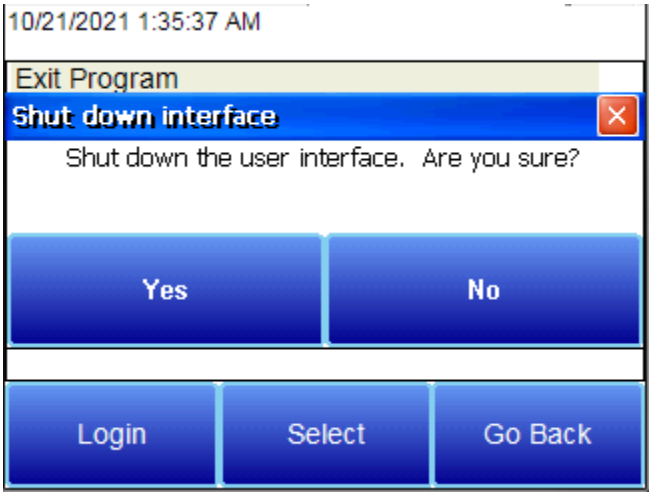
To access the other menu options, press the "Login" button and enter "2". This will give the operator access to the setup and operational parameters shown below.



Each individual menu option is described in detail below:

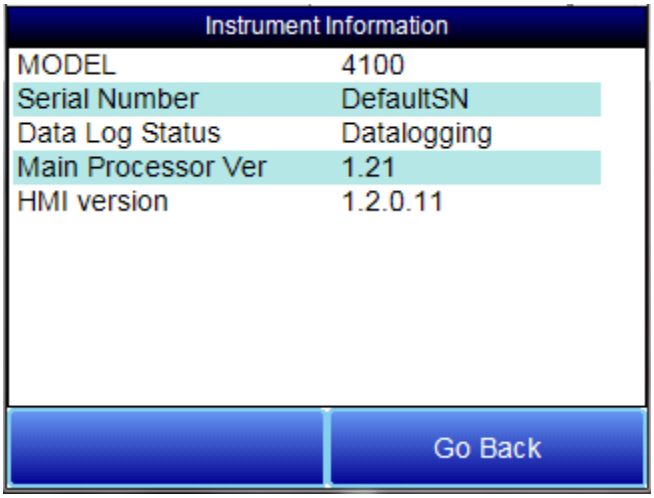
Description of Menu Items

Exit Program



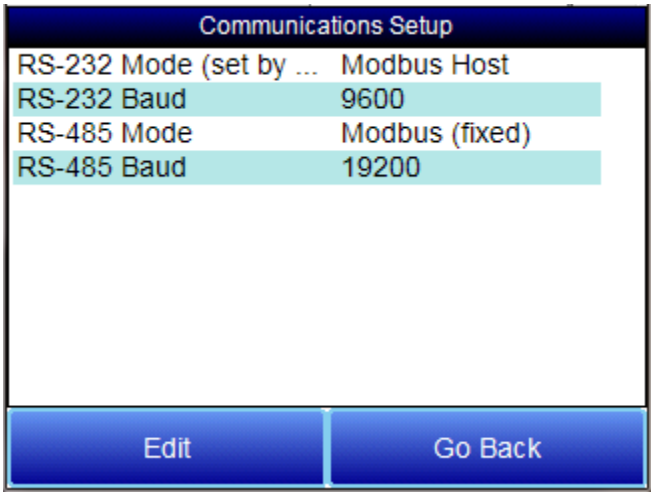
The touch screen display is constantly writing data to its SD card for storage, and it is important that the instrument not be shut down during this process. Before removing power from the enclosure, select "Exit Program". It will ask if you are sure that you want to shut down the interface. By selecting Yes, it closes the operating program in an orderly manner. Once the standard Microsoft Windows CE screen appears, it is safe to remove power from the instrument. If this procedure is not followed, there is a chance that there could be an error writing to the flash card that could cause problems with the operation of the instrument.

Instrument Information



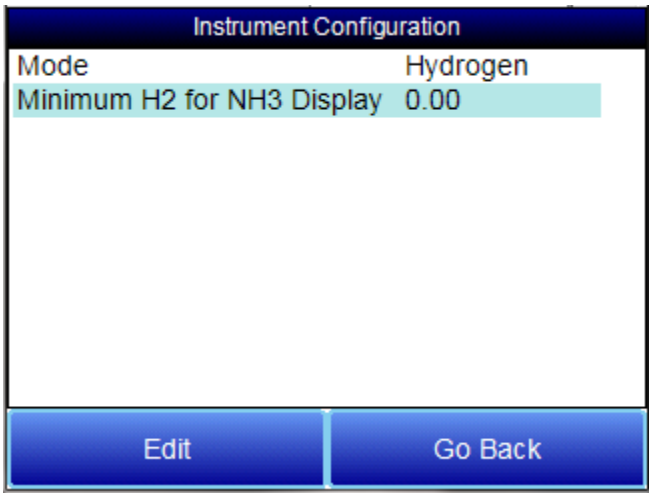
This screen provides information on any applicable revision levels and serial numbers. It also shows if the instrument is logging data. There are no functions that can be performed on this screen; it is for informational purposes only.

Communication Setup



The communication settings shown on this screen are for display only and cannot be modified. The baud rates can be adjusted but they have been optimized for this instrument and modification is not recommended.

Instrument Configuration



Mode

This instrument is capable of displaying four different parameters. Click on "Mode" to highlight that option and then press the "Edit" button. This will display the four options:

- Hydrogen (%H_2)
- Dissociation (%DA)
- NH_3 (%NH_3)
- Kn (K_N)

The %H_2 is displayed on the main screen at all times. One additional parameter can be displayed along with %H_2 by highlighting it and pressing the "OK" button. Contact SSi for a more detailed description of each of these parameters if there is additional interest.

Percent Hydrogen

The percent hydrogen (%H_2) is the amount of hydrogen that is being detected by the thermal conductivity sensor inside the instrument from the gas sample. There are no additional calculations being performed to this value.

Percent Dissociation

Percent dissociation (%DA) is derived from the amount of hydrogen in the sample gas. Gas nitriding uses ammonia (NH_3) gas as its source of nitrogen. When NH_3 is dissociated, nitrogen and hydrogen gas are produced. The accurate calculation of %DA requires the flow rates of other gases that are being introduced into the process. These flow rates are measured in cfh (cubic feet per hour). Percent dissociation can only be calculated by entering the flow of nitrogen (N_2), ammonia (NH_3) and Dissociated Ammonia (DA). These values are entered at the bottom of the main screen when %DA is selected. If no gas flow values are entered (each flow shows 0 scfh), the system will assume 100% NH_3 is flowing into the furnace. As soon as any of the gas values are changed to a value that is not 0, the calculations are based on those gas flows.

Percent Ammonia

The ammonia percentage (%NH_3) can also be calculated from the %H2 reading assuming that 100% NH_3 is flowing into the furnace. This calculation makes that assumption.

Nitriding Potential

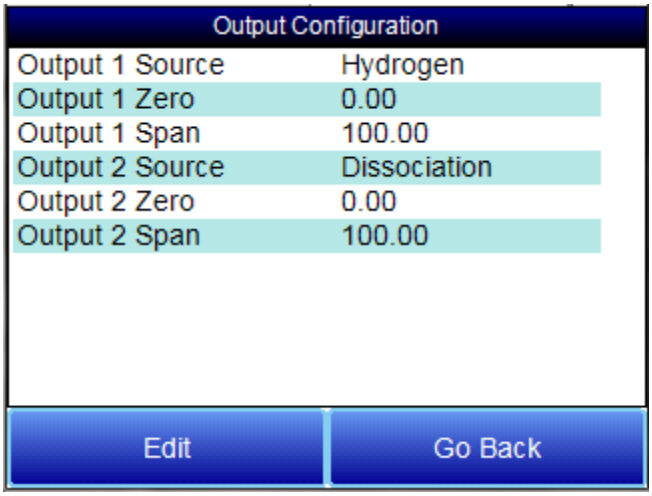
The accurate calculation of Nitriding Potential (K_N) requires the flow rates of other gases that are being introduced into the process. These flow rates are measured in cfh (cubic feet per hour). K_N can only be calculated by entering the flow of nitrogen (N_2), ammonia (NH_3) and Dissociated Ammonia (DA). These values are entered at the bottom of the main screen when K_N is selected. If no gas flow values are entered (each flow shows 0 scfh), the system will assume 100% NH_3 is flowing into the furnace. As soon as any of the gas values are changed to a value that is not 0, the calculations are based on those gas flows.

Minimum H_2 for NH_3 Display Parameter

This analyzer measures %H2 (in ppm) and calculates a gas composition of DA or NH_3 (with %DA + %NH_3 = 100%). An available analog output provides a 4-20 mA signal representing either DA or NH_3--defaulting to 4 mA when zero hydrogen is measured.

Due to the high accuracy of the sensor, trace amounts of Hydrogen may be measured in "near zero" environments, resulting in oscillations between 4- and 20 mA when configured for %NH3. To prevent such oscillations the user may define a **Minimum H2** to fix the output at 4 mA until the measured Hydrogen percentage exceeds such a threshold.

Output Configuration



There are two 4-20 mA outputs that can be configured for any of the four parameters. For each input, the operator can select the Source

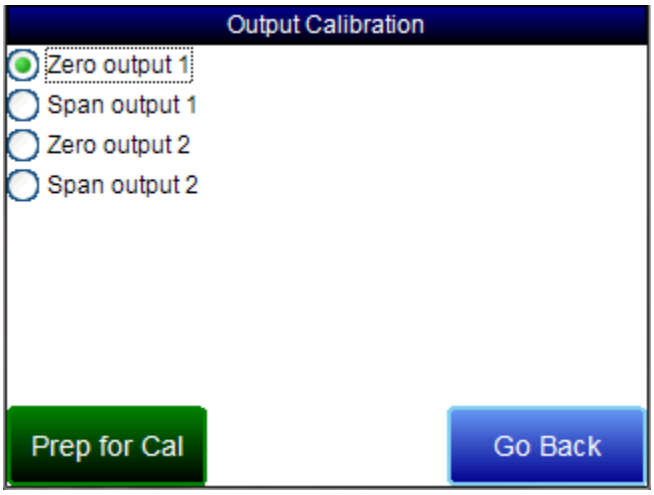
- Hydrogen
- Dissociation
- NH3
- External
- Kn

When Hydrogen, Dissociation, NH3, or Kn are selected, those measured and calculated values can be setup as a 4 – 20 mA output. The range is based on the Output Zero and Output Span values entered for each output where 4 mA will represent the Output Zero and 20 mA will represent the Output Span.

When External output mode is chosen, the sensor acts as a secondary analog output for some other external signal sent to the sensor. Contact SSi for additional details on this option if required.

- Output 1 can be measured from Terminals #1121(+) and 1111 (-).
- Output 2 can be measured from Terminals #1121(+) and 1131 (-).

Output Calibration



Accurate retransmission of the selected parameters can only be obtained through calibrating both of the analog outputs. This is done at the factory prior to shipment, however it is a relatively simple procedure that can be performed in the field if desired.

To perform a calibration, a multimeter with a current input is required. Please keep in mind that the accuracy of the instrument used to calibrate the outputs is directly related to the accuracy of the outputs after calibration, so a meter calibrated against NIST (National Institute of Standards and Technology) standards is preferred. Before performing any calibrations, all other devices must be disconnected from the analog outputs. Multiple devices on the outputs will cause inaccurate measurement of current.

SSi suggests that this device should be calibrated on a routine basis, such as once a year or as prescribed by the user's quality system requirements.

Zero Calibration

To calibrate the zero/span range for an output:

1. Attach a measuring device to the selected output.
2. Select "Zero output 1 or 2" depending on the output being calibrated
3. Press the "Prep for Cal" button.
4. Let the unit output what it has set for the zero measurement, and note the reading on your attached multimeter.
5. Touch the value being displayed next to the "Enter measured value" enter the reading from your multimeter.
6. Push the "Calibrate" button.

This will offset the mA output of the instrument in an amount that results in an exact output of 4.000 mA. When the calibration is complete, the multimeter should be reading 4.000 mA (+/- .005). The zero calibration is complete.

Span Calibration

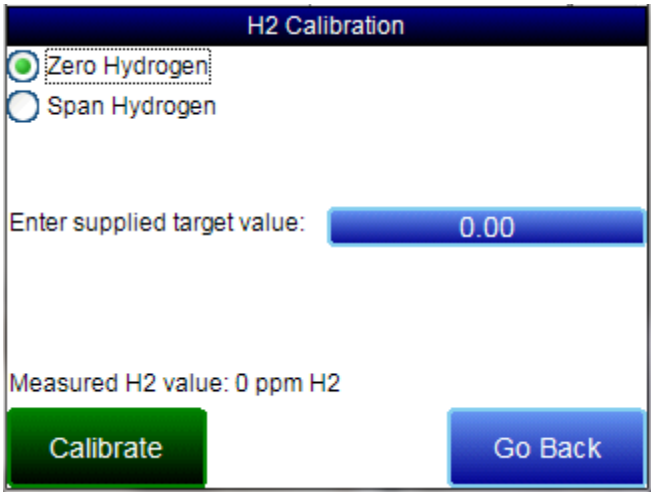
To calibrate the span:

1. Verify that the multimeter is still be attached to the selected output.
2. Select "Span output 1 or 2" depending on the output being calibrated
3. Press the "Prep for Cal" button.
4. Let the unit output what it has set for the span measurement, and note the reading on your attached multimeter.
5. Touch the value being displayed next to the "Enter measured value" enter the reading from your multimeter.
6. Push the "Calibrate" button.

This will offset the mA output of the instrument in an amount that results in an exact output of 20.000 mA. When the calibration is complete, the multimeter should be reading 20.000 mA (+/- .005). The span calibration is complete.

The multimeter will display the actual output from the instrument, and if it is not within the desired tolerance it can be calibrated using the same procedure as above.

Sensor Calibration



BEFORE YOU BEGIN:

Never perform a span calibration without first performing a zero calibration.

The Zero calibration should be performed with a gas that contains no hydrogen (0% H2). Common gases used include nitrogen, argon, or ammonia. The concentration of the Span calibration gas should closely resemble the gas that is being measured. The span gas should contain a minimum %H_2 that the sensor could be exposed to during normal operations. For example, if the sensor might see up to 75% H_2, the span gas should contain at least 75% H_2 in its chemistry.

NOTE: Since the accuracy of the calibration gas directly influences the resulting accuracy of the instrument, the highest possible accuracy grade should be obtained. Some gas suppliers refer to this as a "Certified Primary Standard". The high degree of accuracy is not required to obtain nominal values that exactly match the values shown above. The accuracy is required to know the exact composition of the gas in the cylinder. The actual composition will be shown on the bottle when it is delivered.

When flowing calibration gas into the analyzer, turn the pump off. The amount of flow from the gas cylinder should be approximately 1.5 cfh at no pressure. The gas cylinders will be under high pressure, so it is recommended that a two stage regulator with a low pressure secondary stage be used. It is good practice to begin the flow of gas before attaching the calibration gas to the instrument. This will prevent any high pressure bursts from entering the instrument.

Calibration gases can be obtained from Super Systems, however they can also be obtained from any supplier of custom gases.

Zero Calibration Procedure

1. Connect the zero gas to the "Calibration Gas Inlet" port on the side of the enclosure. It is recommended to let everything (gas and enclosure) sit for approximately thirty minutes to allow the temperature to achieve equilibrium.
2. Turn the ball valve to the "Calibration Gas" so that calibration gas can flow through the sensor.
3. Select "Sensor Calibration" from the Main Menu.
4. Select "Zero Hydrogen."
5. Tap the value shown next to the "Enter supplied target value:." This will display a keypad to enter the zero gas hydrogen percentage.
6. Enter the appropriate concentration of the calibration gas (in this case 0% since it is a zero calibration).

7. Begin the flow of gas and wait until the gas reading on the display stabilizes. This occurs when the actual values are not moving in a specific direction, and they display only slight movements up and down. This may take up to several minutes.
8. Once stabilized, press the "Calibrate" button.
9. The gas value will adjust immediately to match the calibration gas concentration entered in Step 5.

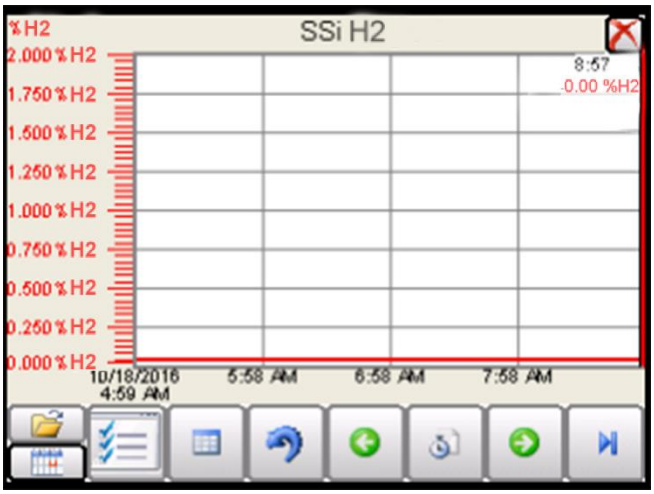
After the Zero Calibration is complete, turn off the flow of gas and disconnect it from the enclosure.

Span Calibration Procedure

1. Connect the span gas to the "Calibration Gas Inlet" port on the side of the enclosure. It is recommended to let everything (gas and enclosure) sit for approximately thirty minutes to allow the temperature to achieve equilibrium.
2. Turn the selector valve to the "Cal Gas Inlet" so that calibration gas can flow through the sensor.
3. Select "Sensor Calibration" from the Main Menu.
4. Select "Span Hydrogen."
5. Tap the value shown next to the "Enter supplied target value:." This will display a keypad to enter the span gas hydrogen percentage.
6. Enter the appropriate concentration of the calibration gas (the $\%H_2$ should be at least the maximum amount of hydrogen typically measured in operation).
7. Begin the flow of gas and wait until the gas reading on the display stabilizes. This occurs when the actual values are not moving in a specific direction, and they display only slight movements up and down. This may take up to several minutes.
8. Once stabilized, press the "Calibrate" button.
9. The current gas value will adjust to match the calibration gas concentration immediately.

After the Span Calibration is complete, turn off the flow of calibration gas, turn the ball valve back to 'Sample Gas,' and disconnect the calibration gas from the enclosure.

Trend Chart

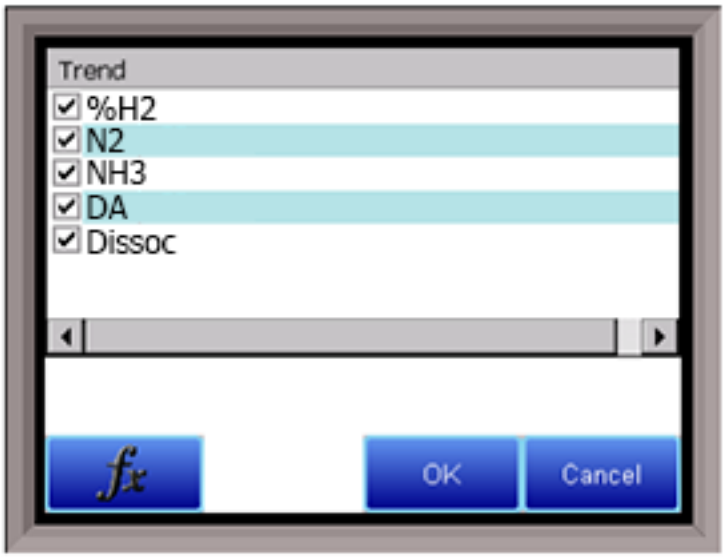


The Trend Chart Display shows between 1 hour and 24 hours of process variable data on the screen and can be scrolled back to view all of the data stored on the hard drive. The vertical timelines change as the time changes on the screen.

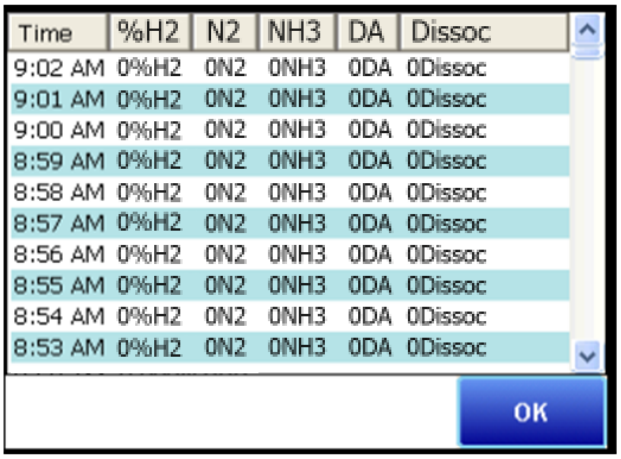
The function buttons run along the bottom of the screen.

The folder button -  - stores saved templates. A different chart template can be selected here.

The Trend Lines button -  - will allow the user to select or de-select the trend lines on the trend chart to display. If the checkbox next to each trend line is checked, then that trend line will be displayed.



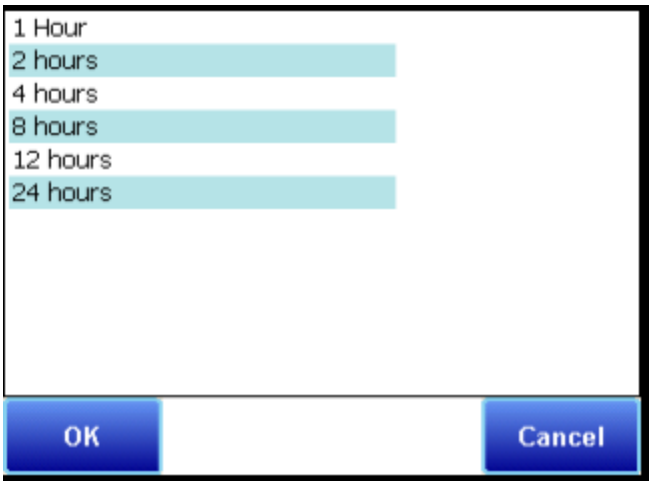
The Datagrid View button -  - will display a screen with the trend data in a grid format instead of with trend lines. The trend data is shown in 1-minute intervals. Clicking on the **OK** button on this screen will close the screen down and return to the Chart Display screen.



The Refresh button -  - will refresh the screen's trend data if the screen is not in real-time mode.

The left-pointing green arrow button -  - will move the chart's view backward in time by the specified chart interval.

The chart interval button -  - will determine the number of hours displayed on the trend chart. The options are: **1 Hour**, **2 Hours**, **4 Hours**, **8 Hours**, **12 Hours**, or **24 Hours**.

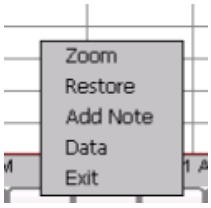


The right-pointing green arrow button -  - will move the chart's view forward in time by the specified chart interval.

The Play/Pause button -  - will put the chart into real-time mode if it is not in real-time mode, or take the chart out of real-time mode if it is. When in real-time mode, the chart will automatically be updated once a minute.

Chart Sub Menu

There is a sub-menu available by putting a finger or a stylus anywhere on the chart and holding it there for two seconds.



The sub-menu will have the following options available: **Zoom**, **Restore**, **Add Note**, **Data**, and **Exit**.

The **Zoom** option will allow the user to zoom in on a particular part of the screen. Once this has been selected, the user can take a stylus or a finger and create a box around the desired data. Once the user releases the stylus or finger, a zoom is no longer possible, and the user will need to re-select the option from the sub-menu to zoom in again.

The **Restore** option will back out of any zoom options that have been performed and display the chart screen as it initially was.

The **Add Note** option allows the operator to enter a note on the chart, similar to writing on a paper chart. The note shows up when the chart is printed out using the utility software included with the SGA instrumentation. Pressing the **Add Note** option displays a screen where the operator can enter the operator ID or initials and a note. The user has the option to enter a note using the operator interface keyboard, where he or she will be able to type in the note; or the user can use the Signature mode, which will allow them to write a note using a stylus.

The **Data** option will show the trend data as a data grid instead of the trend lines on a chart. This functionality is exactly the same as if the user pressed the Datagrid View button -  - from the chart screen.

Exit will close out the sub-menu without selecting an item.

Pressing the red 'X' in the top right-hand corner of the screen will take the user back to the status screen.

Control Interface Options

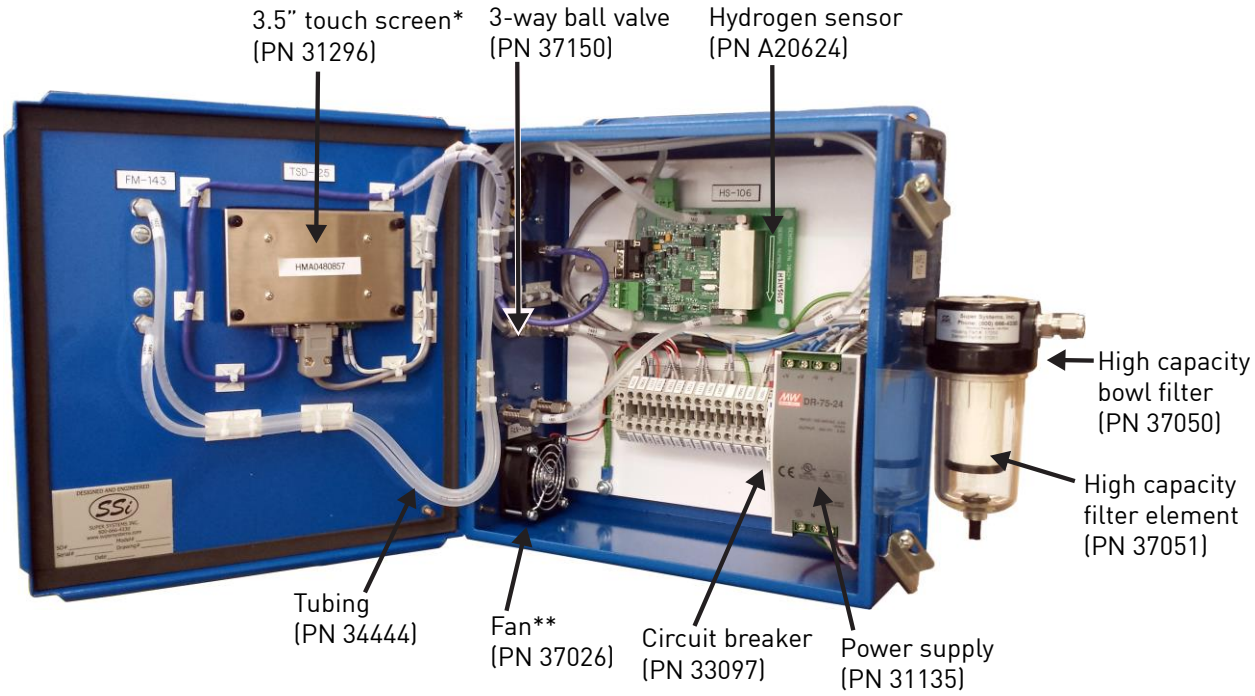
Also available is SSi's TS Manager. TS Manager is a utility program that can be loaded onto any Windows® based computer (operating Windows XP® or higher). This software will allow the computer to read the data from the TS Flashcard, and allow it to be viewed in a manner that is similar to a strip chart recorder. The screen will need to be connected to the local network (using a static IP address) for communications capabilities. The TS Manager manual can be obtained from the SSi website.

Parts List and Internal Components

The following items can be purchased as needed for the Hydrogen Nitrider Analyzer.

Part Number	Description
31604	2 GB SD card
37026	Fan (24VDC, 60mm)
37029	Fan filter assembly
37150	3-way ball valve
37050	High capacity bowl filter
37051	High capacity filter element
34444	Tubing
33097	Circuit breaker
31135	Power supply
A20624	Hydrogen sensor
31296	3.5" touch screen
Full Unit	
13537	Hydrogen Nitrider Analyzer

The following diagram illustrates the location of important internal components of the Hydrogen Nitrider Analyzer, along with relevant part numbers.



*SD card is contained within touch screen.
SSi part number for 2 GB SD card is 31604.

**Fan filter assembly (PN 37029) is contained within fan housing.

Warranty

Limited Warranty for Super Systems Products:

The Limited Warranty applies to new Super Systems Inc. (SSI) products purchased direct from SSI or from an authorized SSI dealer by the original purchaser for normal use. SSI warrants that a covered product is free from defects in materials and workmanship, with the exceptions stated below.

The limited warranty does not cover damage resulting from commercial use, misuse, accident, modification or alteration to hardware or software, tampering, unsuitable physical or operating environment beyond product specifications, improper maintenance, or failure caused by a product for which SSI is not responsible. There is no warranty of uninterrupted or error-free operation. There is no warranty for loss of data—you must regularly back up the data stored on your product to a separate storage product. There is no warranty for product with removed or altered identification labels. SSI DOES NOT PROVIDE ANY OTHER WARRANTIES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. SOME JURISDICTIONS DO NOT ALLOW THE LIMITATION OF IMPLIED WARRANTIES, SO THIS LIMITATION MAY NOT APPLY TO YOU. SSI is not responsible for returning to you product which is not covered by this limited warranty.

If you are having trouble with a product, before seeking limited warranty service, first follow the troubleshooting procedures that SSI or your authorized SSI dealer provides.

SSI will replace the PRODUCT with a functionally equivalent replacement product, transportation prepaid after PRODUCT has been returned to SSI for testing and evaluation. SSI may replace your product with a product that was previously used, repaired and tested to meet SSI specifications. You receive title to the replaced product at delivery to carrier at SSI shipping point. You are responsible for importation of the replaced product, if applicable. SSI will not return the original product to you; therefore, you are responsible for moving data to another media before returning to SSI, if applicable. Data Recovery is not covered under this warranty and is not part of the warranty returns process. SSI warrants that the replaced products are covered for the remainder of the original product warranty or 90 days, whichever is greater.

Revision History

Rev.	Description	Date	MCO#
NEW	First release		N/A
A	Revised terminal numbers; added product diagrams; added part numbers; updated format of document.	11/7/2014	2155
B	Revised specifications for hydrogen measurement.	9/23/2015	2168
C	Added minimum H2 option for NH3 Display option	6/5/2019	2267
D	Added trend chart and TS Manager info	4/30/2020	2290
E	Added calibration interval text	3/25/2021	2308
F	Updated specifications	2-15-2022	2319