OPERATIONS MANUAL

HYDROGEN SENSOR
(PART NUMBER 20624)

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 device, please contact us at (800) 666-4330 for assistance.

Super Systems Inc.
7205 Edington Drive
Cincinnati, OH 45249, USA
Tel. (513) 772-0060
Fax (513) 772-9466

Description

This sensor is designed to accurately measure Hydrogen through thermal conductivity technology. It is capable of providing additional computations based on the Hydrogen measurement, and it has multiple methods of digital and analog communications capabilities.

Features

- Measures H_2 from 0 to 100% with 0.01% resolution
- Calculates NH_3, DA, and Kn for nitrider applications
- Two isolated 4 to 20ma analog outputs
- One RS-232 port with Modbus RTU or a simple ASCII protocol
- One RS485 port with Modbus RTU protocol
- Wide power supply input range (9 to 30VDC)
- Small physical size

Specifications

- Hydrogen measurement:
  Range: 0 to 100%
  Accuracy: +/- 0.01%
  Repeatability: +/- 0.01%
  Resolution: +/- 0.01%

- Calculated Variables for simple nitrider applications:
  %NH_3 0 to 100%
  %DA (dissociated ammonia) 0 to 100%
  Kn nitriding potential

- Analog Outputs:
  Two 4-20mA outputs common supply and isolated from other electronics
  Output variables: %H2, %NH3, %DA, and Kn on either output
  Adjustable range of PV: zero and span
  Resolution: 0.005 mA
  Accuracy: +/- 0.01% of range
  Linearity: +/- 0.01%
  Minimum load resistance: 0 Ohms
  Maximum load resistance: 500 Ohms

- Sample flow rate:
  1.5-2 cfh

- RS-232 Serial Communications:
  Protocols: Modbus RTU or a simple ASCII
  Baud rates: 9600, 19200, or 38400
  Format: 8 bits No parity, 1 stop bit, No handshaking
  Connection: DB-9P

- RS-485 Serial Communications:
  Protocol: Modbus RTU
  Baud rates: 9600, 19200, or 38400.
  Format: 8 bits No parity, 1 stop bit, No handshaking

- Power requirement:
  9 to 30 volts DC @ 2 watts

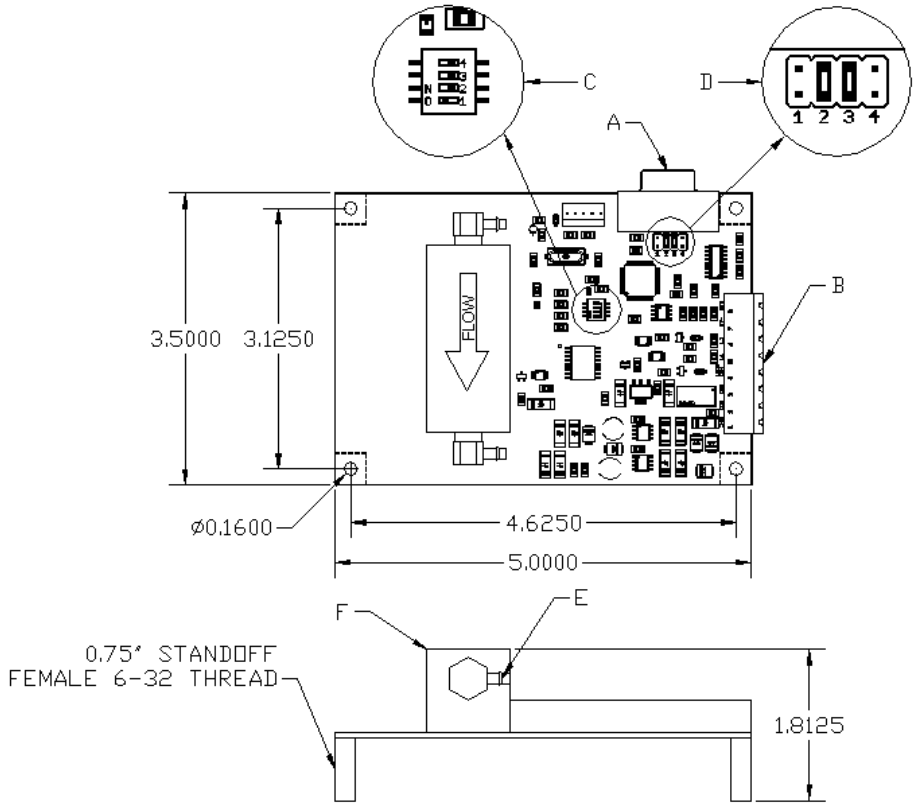
- Temperature and Humidity
  Electronics Operating: 0 to 50 °C, RH 0 to 90% non-condensing
  Sample gas: 0 to 70 °C, RH 0 to 90% non-condensing
  Storage: -20 to 70 °C, RH 0 to 90% non-condensing

- Dimensions:
  See figure 1

- Weight:
  350g

- Material:
  Stainless steel sensor housing

Figure 1



Dip Switch Settings (Item "C" in Figure 1)

The first three dip switches determine the modbus address. The address can be set for any number between 1 and 8 using a binary numbering system where Bit #1 is the least significant bit and Bit #3 is the most significant bit. The diagram below describes the switch position for each possible address. The shaded area indicates the location of the switch.

ADDRESS 1			
1		■	ON
2	■		
3	■		
4			

ADDRESS 2			
1	■		ON
2		■	
3	■		
4			

ADDRESS 3			
1		■	ON
2		■	
3	■		
4			

ADDRESS 4			
1	■		ON
2	■		
3		■	
4			

ADDRESS 5			
1		■	ON
2	■		
3		■	
4			

ADDRESS 6			
1	■		ON
2		■	
3		■	
4			

ADDRESS 7			
1		■	ON
2		■	
3		■	
4			

ADDRESS 8			
1	■		ON
2	■		
3	■		
4			

The last dip switch (#4) indicates the communication protocol. The off position is modbus rtu mode, and the on position emulates the simple ASCII protocol of the previous version of the SSI Hydrogen Sensor. The diagram below describes the switch position for each protocol. The shaded area indicates the location of the switch.

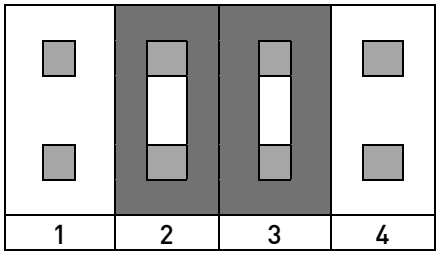
Modbus RTU Protocol			
1			ON
2			
3			
4	■		

Previous SSI Sensor Protocol			
1			ON
2			
3			
4		■	

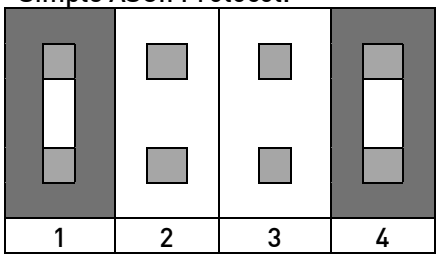
Jumper Positions (Item "D" in Figure 1)

The sensor has four jumper terminals at the base of the 9-pin connector. These jumpers determine the pins that transmit and receive data via RS232 communication. The jumpers should be on Pins 2 and 3 for normal Modbus RTU operation (pin 2 is receiving and pin 3 is transmitting). The jumpers should be on Pins 1 and 4 if the sensor is being used to communicate via the simple ASCII protocol used on the previous version of the SSI Hydrogen Sensor (pin 2 is transmitting and pin 3 is receiving).

Modbus RTU Protocol:



Simple ASCII Protocol:



8-Position Connector Assignments (Item "B" in Figure 1)

On the green 8-position connector, Pin #1 is located to the far left (when looking into the connector). Each position is labeled on the circuit board and also listed below:

Pin #1: Sensor Power (9-30 VDC)
Pin #2: Sensor Power (Ground)
Pin #3: Sensor Power (Ground)
Pin #4: 4-20mA Common (+)
Pin #5: 4-20mA Loop 1 (-)
Pin #6: 4-20mA Loop 2 (-)
Pin #7: RS485 Communication (-)
Pin #8: RS485 Communication (+)

9-Pin Connector (Item "A" in Figure 1)

The sensor has a female 9-pin connector used for RS232 communication. Only three of the nine pins are used, and their assignments are:

Pin #2: Transmit or Receive (Depends on jumper positioning)
Pin #3: Transmit or Receive (Depends on jumper positioning)
Pin #5: Ground

Plumbing Connections (Items "E" and "F" in Figure 1)

The sensor is provided with barb fittings (Item E) that are intended for use with 1/8" ID flexible tubing. These fitting can be removed at the user's discretion, and any fitting with a 1/8" male pipe thread can be used in their place. If the fittings are going to be replaced with different fittings, they must be replaced while the stainless steel sensor block (Item F) is still attached to the circuit board. Do not remove the sensor block since it's alignment with the sensors is a critical function that should only be performed by a trained technician.

Analog Output Assignments

There are two analog outputs on the sensor. The default settings result in Output 1 being set for Percent H2 (0-100%) and Output 2 being set for Percent Dissociation (0-100%). Both of these outputs can be configured for any of the following parameters:

- Percent Hydrogen (H2)
- Percent Dissociation (DA)
- Percent Ammonia (NH3)
- Nitriding Potential (Kn)
- External

In "External" output mode no calculation is performed, and the output is set to match a specific value. Modifications to the Analog Output Assignments can be performed with the SSI H2 Cell Configuration Utility Software.

Calibrating and Configuring the Sensor

The simplest way to set up the analog outputs, calibrate the analog outputs, and calibrate the Hydrogen sensor is to use the SSi H2 Configuration Utility software. This software provides a simple to use graphical interface for performing the setup and calibration functions. It communicates via Modbus (either RS232 or RS485). This is set by moving dip switch #4 to the

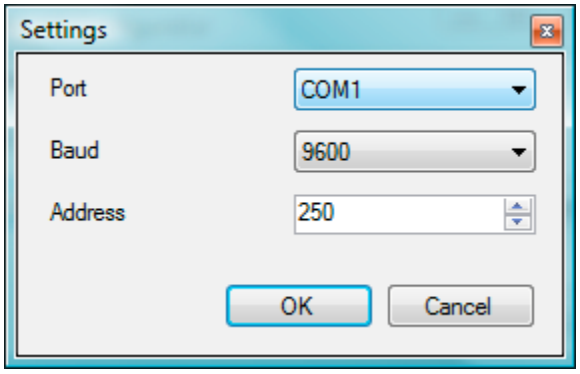
off position. To communicate via RS232, use the 9-pin connector with the jumpers in positions 2 and 3. To communicate via RS485, use the RT+ and RT- terminals on the 8 pin terminal strip.

Minimum Computer Requirements:

- Microsoft Windows XP/Vista/7
- 500 MHz CPU
- 128MB RAM
- 2MB hard disk storage space
- 1 RS-232 or RS-485 Serial Port

Configuring Communications:

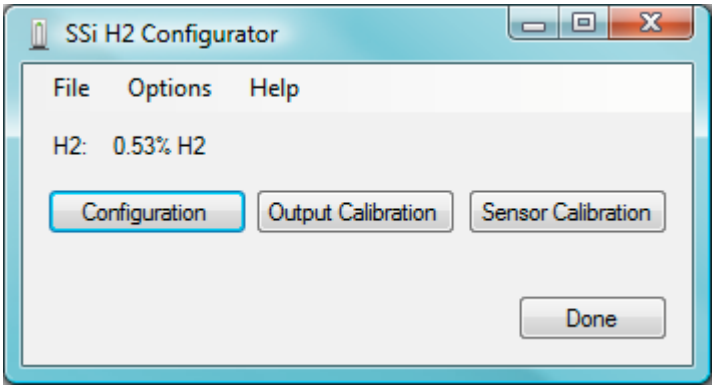
Open the H2 Configurator and click Options...Settings to open the dialog that allows you to set the serial port, baud rate and target address of the H2 cell.



When using the RS-232 port, the baud rate should be set to 9600 and the address should be set to 250. 250 is an SSi broadcast address and any H2 cell that sees the message will answer, so while the 250 address should be used for RS-232 it should not be used for RS-485 if there are multiple SSi instruments on the same serial port. The Port setting may need to be adjusted to match the port on your PC that is connected to the H2 cell. RS-232 communications use a simple straight through cable to the DB9 connector.

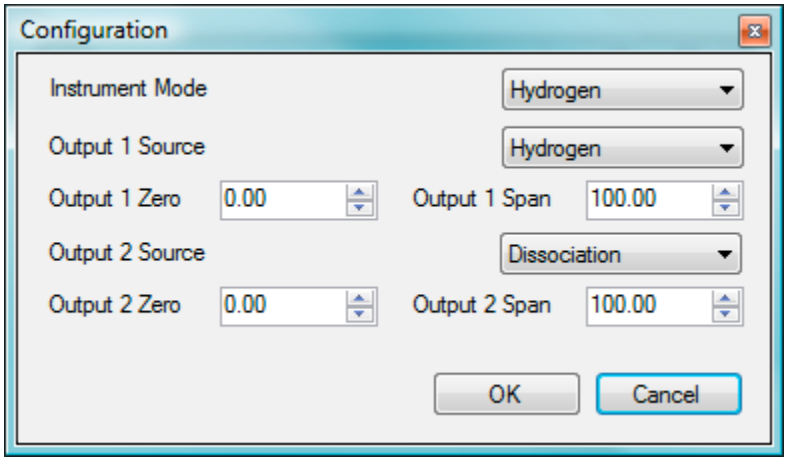
Overview Screen:

The Overview screen displays the current % H2 and the three buttons used to configure or calibrate the H2 cell.



Sensor Output Configuration :

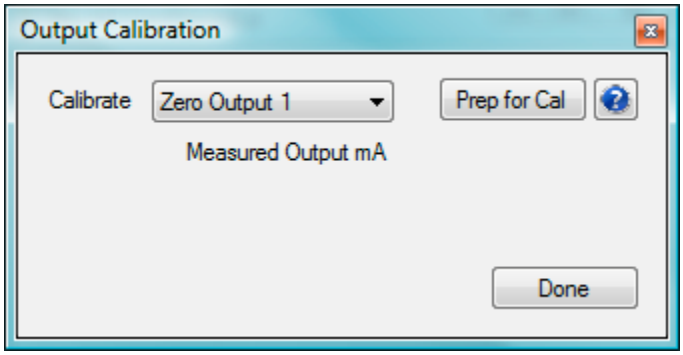
The Configuration page allows basic configuration of the H2 cell.

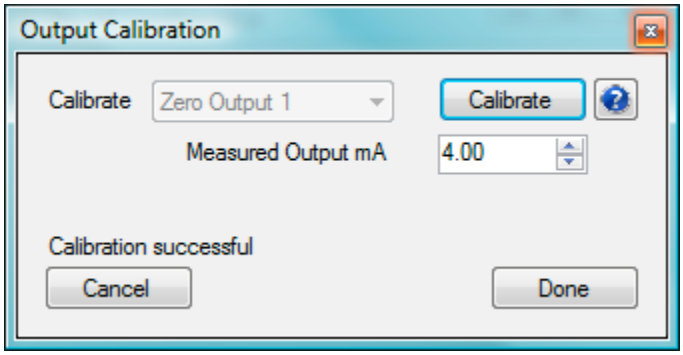


The Instrument Mode is the primary PV (Process Variable) setup. This is mainly used by the touch screen and normally does not need to be changed as the % H2 is always available. The output sources are the PVs that will be retransmitted via the selected output. The Output Zero is the PV value that will result in a 4 mA output and the output span value is the PV value that will result in a 20 mA output.

Sensor Output Calibration:

Output calibration calibrates the outputs. Each output can be zeroed and spanned. To perform this calibration a reliable measurement device capable of accurately measuring a 4-20mA signal will be required.



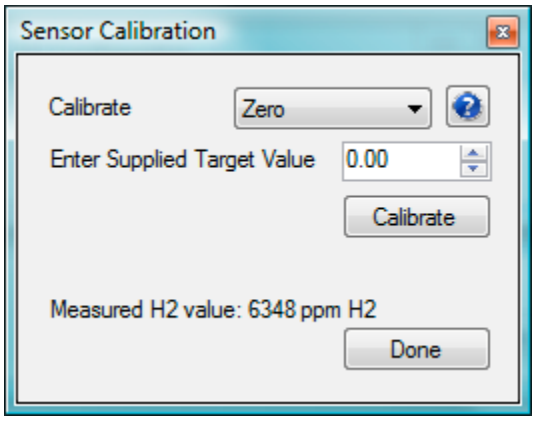


The steps to performing an output cal are as follows:

- Select an output and whether you are going to do a zero or a span.
- Click Prep for Cal. The H2 cell will set the output appropriately for measurement.

- Measure the output current at the H2 cell's terminals and input that value into the box next to 'Measured Output mA'. For example, if you are performing a zero calibration and your measurement device is indicating 4.03mA, you would enter the value of 4.03 in the "Measured Output mA" box.
- Click the Calibrate button to perform the calibration.
- When the calibration is complete, the measurement device should display the target value. For a zero calibration that would be 4.00mA, and for a span calibration that would be 20mA.

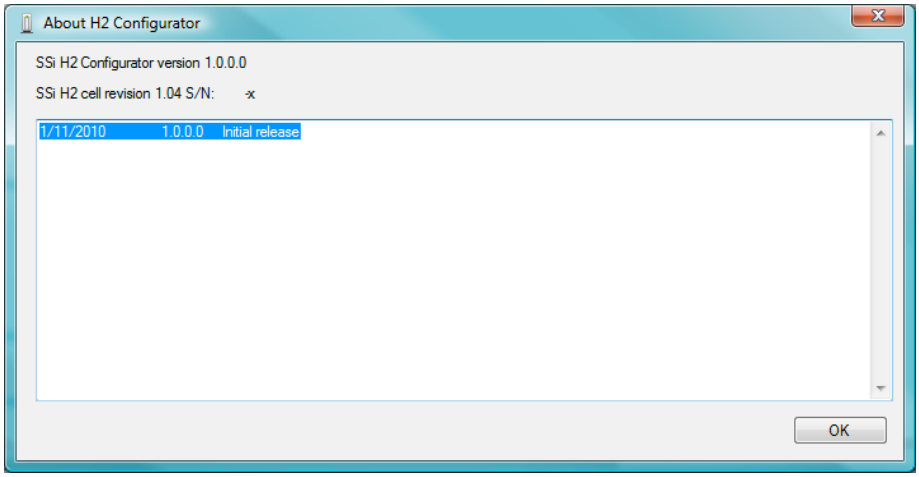
Sensor Calibration:



The sensor can be zeroed or spanned via Sensor Calibration. The gas should flow at a rate of 1.5 SCFH and the detected H2 value needs to be steady before a calibration is performed. To perform a Zero cal select Zero in the drop down box next to Calibrate. Enter the % H2 of the supplied gas (for zero this will be 0.00%). Wait for the readings to come to equilibrium and click Calibrate. To perform a Span cal select Span in the drop down list and repeat the process.

About:

The About screen is access from the overview screen by clicking Help...About. The About screen provides release information about the H2 Configuration utility and the revision of the firmware in the SSi H2 cell.



Modifying Modbus Registers

The setup parameters of the Hydrogen sensor can also be modified by adjusting the modbus registers. A list of all modbus registers can be found in Appendix A. To make modifications, you must connect the sensor to a computer that uses SSI's "Configurator" software. When communicating with Configurator, use a straight-through serial extension cable connecting the computer to the sensor. Set the baud rate in configurator to 9600. On the sensor, set DIP Switch #4 to Off for modbus communication, and be sure that the jumpers are on pins 2 and 3.

Calibrating the Sensor using Modbus Registers

Performing a zero calibration

1. Begin the flow of Zero gas (Nitrogen or Argon) at a rate of 1.5 SCFH.
2. Allow the readings from the sensor to stabilize.
3. Set Register #13 to 0 (equal to 0% H2).
4. Set Register 12 to 1.

Performing a Span Calibration

1. Begin the flow of Span gas (with a known %H2) at a rate of 1.5 SCFH.
2. Allow the readings from the sensor to stabilize.
3. Set Register #13 to the H2 value in the span gas. Multiply the gas value by 100 before entering the number (i.e. if the gas has 40.13%H2, enter a 4013 or if the gas has 9.97%H2 enter a 997 into Register 13).
4. Set Register 12 to 2.

Changing the 4-20mA Assignments using Modbus Registers

Register 19 denotes the assignment for 4-20mA #1, and register 23 denotes the assignment of 4-20mA #2. The default value for #1 is %H2, and #2 is #DA. To change the assignment, enter a number into either register according to the following list:

0 = %H2
1 = %DA
2 = %NH3
3 = %Kn
4 = External Source

Appendix A – Modbus Register Map

Register Functions and Default Values		
#	Function	Default
0	Current firmware revision level	Varies
1	RS232 communication mode (0=modbus slave, 1=ASCII /Previous SSI Sensor)	DIP Sw.
2	RS232 baud rate (0=9600, 1=19200, 2=38400)	0
3	RS485 communication mode (0=modbus slave, 1=modbus master [NOT USED])	0
4	RS485 baud rate (0=9600, 1=19200, 2=38400)	1
5	Temperature trim for thermistor 1 / ambient temperature	200
6	A/d counts for thermistor 1	Varies
7	Thermistor 1 temperature	Varies
8	%H2 A/D counts – High (Right justified: 0x00 byte, high byte, mid byte, low byte)	Varies
9	%H2 A/D counts – Low (Right justified: 0x00 byte, high byte, mid byte, low byte)	Varies
10	%H2 measured voltage	Varies
11	%H2 as found from a polynomial	Varies
12	%H2 sensor calibration (0=none, 1=zero cal, 2=span cal)	0
13	%H2 gas composition (value/100 = %H2/N2 balance)	0
14	Sensor modbus address (important for slave communications only)	DIP Sw.
15	Model Number	4100
16	Set Factory Defaults (23205=Full, 23206=%H2, 23207=Loop 1, 23208 = Loop 2)	0
17	4-20mA #1 DAC output counts	Varies
18	4-20mA #2 DAC output counts	Varies
19	4-20mA #1 Source (0=%H2, 1=%DA, 2=%NH3, 3=Kn, 4= External)	0
20	4-20mA #1 Zero value	Varies
21	4-20mA #1 Span Value	10000
22	4-20mA #1 External current loop (Used only if register 19 = 4)	0
23	4-20mA #2 Source (0=%H2, 1=%DA, 2=%NH3, 3=Kn, 4= External)	1
24	4-20mA #2 Zero value	0
25	4-20mA #2 Span Value	1000
26	4-20mA #2 External current loop (Used only if register 23 = 4)	0
27	Enable Calibration of 4-20ma output (0=disable, 1=enable)	0
28	Calibrate 4-20mA output (1=#1 zero, 2=#1 span, 3=#2 zero, 4=#2 span)	0
29	4-20mA calibration value (4000 to 20000 for 4-20mA)	0
30	Calibration result codes (9-12=successes, 13-16=failures, 20=no cal specified)	0
31	Percent DA value	Varies
32	Percent NH3 value	Varies
33	Super Kn value	Varies
34	%N2 flow	0
35	%NH3 flow	0
36	%DA flow	0
37	Process variable mode (0=H2, 1=DA, 2=NH3, 3=Kn)	0
38	Process variable value	Varies
39	%H2 mantissa	Varies
40	%H2 exponent	Varies
41	Force theroretical current loop values	0
42	Minimum H2 value	0