

# INSTRUCTION MANUAL

## M4511v5

# SuperOX™

## OXYGEN SENSOR

### Ver. 3.0

U.S. Patent No. 5,635,044



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## SuperOX SENSOR MANUAL

### INTRODUCTION

Thank you for selecting the **SuperOX™ Sensor** for your combustion control application.

SuperOX™ represents "state of the art" in oxygen sensor technology. It has been designed for use in combustion control systems for glass, power, steel reheat, chemical process and incineration applications.

SuperOX™, with its patented measuring electrode construction, is the product of a team of design and application engineers, each with over twenty years of atmosphere control experience. The SSi engineering team has long recognized that the sensor is the most critical component in a control system and has traditionally been the weakest link. Now, reliability, repeatability and accuracy are assured with the inclusion of SSi's SuperOX™ high temperature, in situ sensor in *your* system.

### SPECIFICATIONS

- ◆ Useful O<sub>2</sub> Range- 10<sup>-20</sup> to 100%
- ◆ Temperature range- 1200°F to 2900°F
- ◆ Stability- within +/- 1 mvdc
- ◆ Impedance- less than 5 kohms @ 1700F
- ◆ Useful output- -50 to 1250 mvdc
- ◆ Overall length- 18, 26.6, 30 and 36"
- ◆ Weight- 3.0 lbs.
- ◆ Insertion- to 18, 26.6, 30 and 36"
- ◆ Mounting- into 1" NPT female
- ◆ Sheath diameter - 0.75"

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## CHARACTERISTICS

The typical zirconia oxygen sensor consists of a closed end tube with the sensing portion at the tip. The tube is yttria stabilized zirconia. Fig.1 illustrates the SuperOX™ Sensor design with details omitted for clarity. The tip of the tube is spring loaded into contact with the outer, negative platinum electrode, which is in contact with the ceramic sheath. The inner, positive electrode is spring loaded into contact with the inner zirconia surface. A thermocouple is positioned close to the inner electrode surface and reference air bathes the sensing surface.

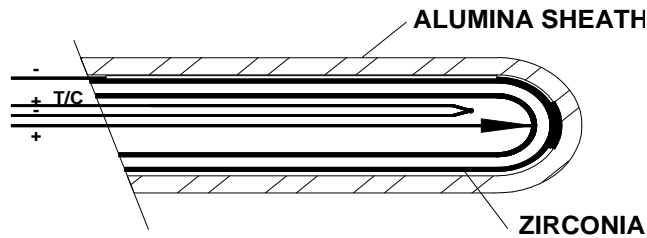


FIG. 1

To the instrument technician, the sensor looks like a battery (see Fig.2.) It displays a voltage,  $E_C$ , from which the carbon potential can be calculated. The probe thermocouple is shown next to the sensing electrode.

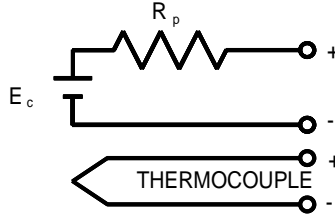
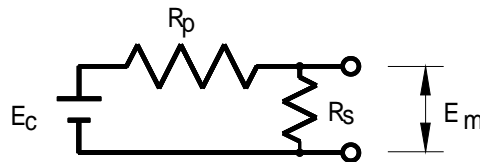


FIG. 2

The value of the internal resistance can be measured, as shown in Fig.3, by connecting a shunt resistor across the sensor terminals, measuring the resultant voltage,  $E_m$  and carrying out the simple calculation shown.



$$R_p = \left( \frac{E_C}{E_m} - 1 \right) R_s$$

FIG. 3

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### BASIC OPERATING THEORY

**Oxygen concentration** of a conventional combustion atmosphere is measured by an in situ zirconia sensor, which responds to oxygen according to the Nernst equation shown here. Because the equation is logarithmic, (to the base 10), the coefficient  $0.0496T_R$  is the number of millivolts accompanying a ten-fold change in concentration:

$$E_C = -0.02756T_R \log (P_R / P_F) \text{ millivolts}$$

where  $T_R$  is the temp in degrees Rankine and  $P_F$  and  $P_R$  are the % oxygen ( $O_2$ ) in the furnace and the reference gas.

### INSTALLATION

If your new sensor is to be installed in an existing entry port, be advised that the sensor is 100% interchangeable with your current sensor.

For new installations in furnaces, an **entry fitting** must be provided at the furnace wall, to permit the sensor to extend into the furnace chamber. The furnace is prepared by drilling a 1 1/2" diameter hole through the wall and the insulation. The hole **must** be at right angles to the wall to avoid interference with sensor insertion. A 1" coupling may then be welded to the wall to provide the gas-tight entry. Because the SuperOX™ has a 1 " NPT hub, use of conventional 1" fittings allows for appropriate installation. A combination of 1 " nipples and connectors allows for appropriate insertion depth. Figures 4a and 4b show typical installations in furnaces and glass tank regenerators.

Your **SuperOX™ Sensor** has been shipped with heavy Teflon™ pipe tape applied to the gland, so you may insert it directly into the furnace. When installing in a hot furnace, insert the first two inches directly, then at a rate of no faster than 1" per 5 minutes in order to avoid thermal shock fracture. Support the cover end of the sensor during installation.

If you already have a control system for your oxygen sensor, you have probably been provided with a reference air supply. The SuperOX™ Sensor, however, to protect the connections, has been designed with cooling fins that require an additional air supply. SSI provides a custom system, P/N 13017 that supplies both requirements.

It is imperative to emphasize that the reference air be **clean**. Any combustibles in the reference air will cause the sensor to read high in oxygen, resulting in insufficient air addition. Avoid the use of lubricated compressed plant air. Air connection at the sensor should be silicone rubber tubing to avoid problems related to the high temperatures normally encountered at the sensor connection block. Reference air flow should be in the range of 0.2 to 2 CFH at no more than 2 PSI. Cooling air flow should be in the range of 1 to 10 CFH at no more than 2 PSI.

Your final installation should resemble that shown in Fig. 4.

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This view shows the installation of a 26.6" SuperOX in the wall of a furnace, utilizing a silicon protection tube which requires a 1 1/2" coupling (or half coupling) entry. This arrangement is typically used for extremely high temperature applications. The wall is typically 13 1/2" thick. Correct location of the sensor in the protection tube may be accomplished by inserting a 1" coupling and appropriate length 1" nipple between the sensor and the protection tube. There are three lengths of protection tubes for use with sensors of 26.6", 30" and 36". When using the un-protected sensor, a 1" coupling (or half coupling) can be used for direct entry.

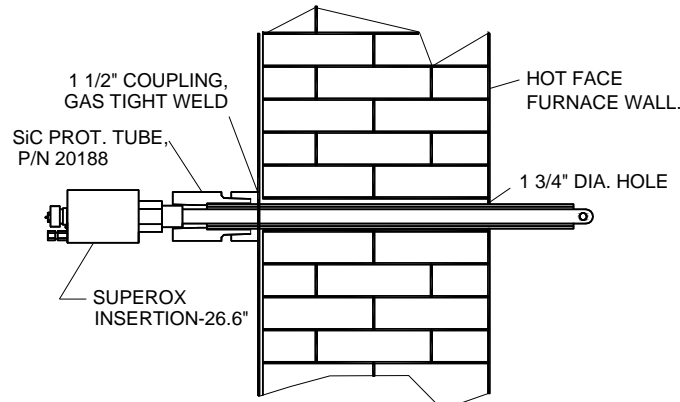


FIG. 4

The standard SuperOX™, Ver. 2.0 is provided with a 5' high temperature cable, as illustrated in FIG.5, so that a plug may be mounted for interconnection with the customer's measurement and control instrumentation. Alternatively, (and preferably), the customer may feed his instrument interconnection cable through the cord connector, and make connections directly to the internal connector.

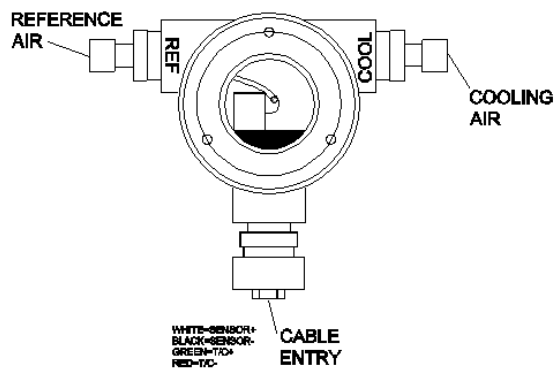


FIG. 5

Wire designation:

White (Sensor +)  
 Black (Sensor -)  
 Green (Thermocouple +)  
 Red (Thermocouple -)

## SuperOX SENSOR MANUAL

### TROUBLE SHOOTING

When trouble arises with an oxygen control system, it is important to establish where the problem is located; the sensor, signal transmission lines, the control instrument, or the combustion chamber itself. Several simple tests can help to isolate the problem quickly. It is most important to first understand the nature of the fault. Aside from erratic behavior like cycling, or failure to stabilize at the set point, the most common symptom is non-conformity of the work pieces to quality assurance specifications.

To evaluate most faults, the recommended tools are:

1. A good 3 1/2-digit millivoltmeter with at least 10 meg  $\Omega$  input impedance and 0 to 1999 mV range,
2. A temperature calibrator and
3. A simulator to output 0 to 200 millivolts at less than 50 meg  $\Omega$  output impedance.

Sensor troubleshooting: In order to establish the source of problems in your installation, first *resist the temptation to remove the SuperOX™ Sensor from the furnace*. All of the following meaningful questions must be answered while your sensor is at temperature, and exposed to a normal atmosphere under manual control:

1. Are the connections from the T/C extension wire and sensor cable clean and firmly attached at the correct sensor and control instrument terminals? Note that the shield wire in the sensor cable should be connected to ground at the control instrument end only!
2. Is the sensor impedance less than 50  $\Omega$  at temperatures above 1550°F? Conduct the test shown in Fig. 3 using a shunt resistor of about 10  $\Omega$ . Measure the voltage  $E_C$  before shunting, then  $E_M$  with the shunt in place. Calculate  $R_p$ . If it exceeds 50  $\Omega$ , proceed to step 6 below.
3. How quickly does the sensor react to a change in  $O_2$  concentration? Read the sensor millivolts with the controller or the digital meter. Short the sensor for 5 seconds, remove the short and measure the time required to return to within 1% of the original reading. If it exceeds 60 seconds, proceed to step 6, below.
4. Is there a leak in the zirconia substrate? To test this property, turn off the reference air for one minute. Measure the sensor mV as indicated by the controller or a digital voltmeter. Turn the air back on and measure the mV again. If there is a difference greater than 5 mV, replace the sensor.
5. Should it be necessary to remove your SuperOX™ Sensor from a hot furnace, do so carefully. **UNDER NO CIRCUMSTANCES** should it be removed faster than 1" per 5 minutes.
6. Failing resolution of your atmosphere control problems our technical support staff is available Mon. - Fri. 7:00 a.m. to 7:00 p.m. You may call us at (800) 666-4330.

## WARRANTY

◆ Super Systems Inc. (SSi), as manufacturer of the SuperOX™ Sensor, warrants it to be free from defects in material and workmanship for a period of six months under normal use and service. SSi's obligation under this warranty is limited to repairing or replacing, at its option, the sensor described herein, should failure occur within the warranty period. The warranty period shall commence on installation of the sensor, as certified by receipt of the postage Registration Card accompanying the sensor. If premature failure occurs, the sensor, along with the Warranty Claim Report, must be returned in the complete, original packaging to SSi. Upon receipt, SSi will conduct an examination as to the cause of failure, at which time appropriate action will be taken.

◆ There are no warranties, expressed or implied, by the distributors or representatives for the SuperOX™ Sensor, except the expressed warranty against defects described above. There will be no applicable warranty in the event of breakage resulting from thermal or mechanical shock. Additionally there will be no applicable warranty for a sensor that has been subject to misuse, negligence or accident.

◆ In order to receive warranty coverage, user must mail the Registration Card when the sensor is installed, according to the techniques and procedures described in the SuperOX™ Sensor Manual. This warranty cannot be honored unless the sensor is received in the original packaging with the Warranty Claim Report. SSi shall in no way be liable for special or consequential damages related to the use of this sensor.

## **SuperOX SENSOR MANUAL**

We suggest that you use this space to keep a record of installation date, test data and experiences with your **SuperOX™Sensor**.

### **NOTES**

## Revision History

<b>Rev.</b>	<b>Description</b>	<b>Date</b>
-	Initial Release	03-21-2001
A	Added Revision History	07-11-2001
B	Revised Fig 5 Drawing, changed Step 8 to read Step 6	02-19-2002
C	Changed "eight inches" to "two inches" Page 2 Installation Instructions	06-04-2003
D	Changed company address	05-15-2005
E	Corrected air flow parameters under Installation	6-23-2011

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