Part # ST05EMN1804EN

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# User's Manual

# ST05

## OXYGEN SENSOR TESTER and SIMULATOR

General Technologies Corp.

## Table of contents.



## 1. SAFETY RULES

- This instrument is designed for indoor use at temperatures between 32° and 104° F (0°C and 40°C) and altitudes up to 6500 ft (2,000 meters).
- To ensure that the instrument is used safely, follow all safety and operating instructions in this operation manual. If the instrument is not used as described in this operation manual, the safety features of this instrument may be impaired.
- Do not use the instrument if the instrument or test leads look damaged, or if you suspect that the instrument is not operating properly.
- When using the instrument, keep away from moving parts (fan, drive belts, etc) and hot objects (exhaust pipes, muffler , catalytic converter, etc), to avoid personal injuries and damage to the instrument or test leads.
- Disconnect the live test lead before disconnecting the common test lead.
- Make sure power is off before cutting, desoldering or, breaking the circuit wires. Small amounts of current can be dangerous.
- Do not connect or apply more than 42 VDC between connectors.
- At all times, to avoid electrical shock, use CAUTION when working with circuits above 60V DC or 25V AC rms. Such voltages pose a shock hazard.
- Do not operate this instrument with the battery cover off.
- To avoid electrical shock or damage to the instrument, do not exceed the specified input limits.

**Exceeding the limits listed above when using this apparatus, or not observing the precautions listed above can expose you to physical injury and permanently damage your instrument and parts and components of the vehicle under test.**



### 5.2 Cleaning

Keep the instrument in its carrying case when not in use and do not subject it to dampness or severe heat or cold. Do not use the instrument in the rain, if it should accidentally get wet, dry it off with a clean paper towel before storing away.

Protect the unit from contact with any solvents. Never clean with a solvent or petroleum based medium such as gasoline, as these chemicals may attack the plastic parts and cause permanent damage. Never use an abrasive cleaner. Cleaning should be limited to wiping with a clean damp paper towel and a small amount of soap if required. Dry the unit thoroughly after any cleaning.

The unit is a sealed instrument and contains no user serviceable parts other than the battery, which can be replaced by opening the drawer on the back of the unit. Opening other parts of the unit will void the warranty.

## 6. WARRANTY

With the exception of the battery, this instrument is warranted against defects of material or workmanship which develop within a period of one (1) year following the date of purchase by the original owner. Proof of date of purchase will be required when applying for repair or replacement under warranty. For this reason, we strongly suggest that you keep your sales receipt in a safe place.

In the event that a flaw develops, please return it to your dealer who will arrange for repair or replacement. The manufacturer will either repair or replace the tool (at the manufacturer’s option) free of charge providing the instrument is still under warranty. If the warranty has expired, there will be a repair charge payable to your dealer when you pick up the unit. When a unit has been repaired or replaced under warranty, the replacement unit will continue the warranty period of the original unit for six (6) months after the date of replacement or until the original warranty expires, whichever is the longest period. This warranty shall not apply to any defect, failure or damage caused by improper use or inadequate maintenance or care.

The manufacturer shall not be obligated to provide service under this warranty or to repair damage resulting from attempts by unauthorized persons to repair or service the instrument, other than to replace the battery; or to repair damage resulting from improper use. Specifically if there is evidence of an attempt to open the instrument the warranty is void.

Any implied warranties arising out of the sale of the instrument including but not limited to implied warranties of merchantability and fitness for a particular purpose are limited in duration to the above one (1) year period, the manufacturer shall not be liable for loss of use of the instrument or other incidental damages, expenses or economic loss. Some Jurisdictions do not allow limitations on how long implied warranties last or the exclusion or limitation of incidental or consequential damages, so the above may not apply to you.

# 5. MAINTENANCE

## 5.1 Battery replacement

### *Low battery indicator*

This message warns the battery voltage is below the minimum recommended and it needs to be replaced with a new battery.

If the battery voltage is low, but still allows for the operation of the instrument, when turning it on the alphanumeric display will show a low battery condition for 2 seconds and resume operation as normal.

When turning the unit on, if the battery voltage is below the absolute minimum operating voltage, it will show a low battery condition for 2 seconds, and turn off automatically in order to prevent malfunction. If the unit is operating and the battery falls below the minimum level, it will show a low battery condition for 8 seconds, and turn off automatically.

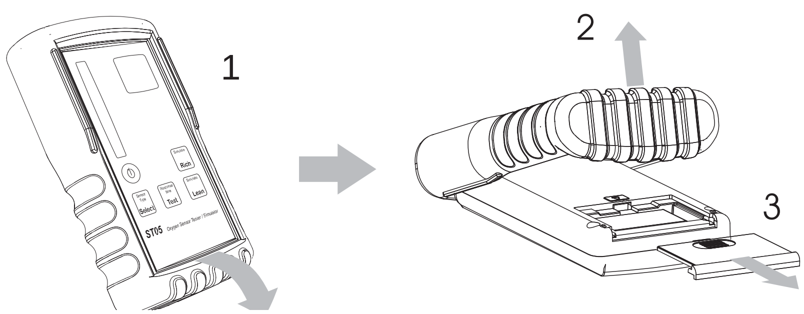


Fig 6 - Battery replacement

1- Release the rubber holster from plastic enclosure by pulling from the bottom of the holster as shown in the illustration (Fig. 6)
2- Push the rubber holster forward until the battery compartment cover is exposed
3- Slide open battery cover located at the back of the unit.
4- Connect the new battery observing the polarity of the battery connectors.
5- Replace battery cover and rubber holster.
4- Press and hold the On/Off button on the ST05 until ( approximately 1 second) the bargraph and the alphanumeric display will turn on. The alphanumeric display will show the default sensor type selected. If the bargraph and the alphanumeric display don't turn on, check the battery polarity and reinstall if necessary. To turn the unit off, press and hold the On/Off button again until the bargraph and alphanumeric displays turn off.



# 2. TECHNICAL SPECIFICATIONS

## 2.1 General Specifications

**Display:** 20 segment LED bargraph and two character alphanumeric display.

**Sample rate:** 500 samples/second.

**Sensor compatibility:** Zirconia, Titanium 1 and 5 Volt Systems.

**Power:** 9 Volt battery, type IEC 6LR61 / ANSI 1604A.

**Auto power off:** Automatically powers off after 3 min. of no operation.

**Battery life:** Approximately. 25 hours. (w/alkaline battery).

**Test leads length:** 6.5 feet (2 meters).

**Dimensions:** 6" x 4" x 1.5" (158 x 100 x 37 mm).

**Weight:** Approximately. 14 Oz. or 406 g. (Including battery).

**Included accessories:** Padded hard carrying case, user's manual, rubber holster and 1 x 9 Volt alkaline battery.

## 2.2 Electrical Specifications

- The specifications below are typical at 23° C, and will vary slightly from device to device, and with temperature. The input voltage should not exceed the indicated maximum values, to prevent personal injury or damage to the instrument.

# 3. OPERATION

| Function | Input Range | Output | Alphanumeric Display | Bargraph Display | Input/Outputs Characteristics |
|---|---|---|---|---|---|
| Zn | 0 to 1 V | - | 0 to 9.9 ± (1.5%+1) Cross-Count/Sec | 0 to 1 Volt in 50 mv Steps | Input Impedance: 1 MΩ minimum<br>Input Protection: ± 42 VDC Max. |
| T1 | | - | | | |
| T5 | 0 to 5 V | - | | 0 to 5 Volt in 250 mv Steps | |
| Response Test | 0 to 1 V | - | < 100 ± 5 mS: PASS<br>> 100 ± 5 mS: FAIL | | Input Protection: ± 42 VDC Max. |
| | 0 to 5 V | - | | | |
| Simulate RICH | 0 to 1V | 1.1V max. | Applies voltage for 4 seconds max. with 4 seconds delay in between simulations | | With > 100Ω sensor Impedance<br>Protected by current limiting: 15 mA (Typ.) |
| Simulate LEAN | Sensor set to Zn or T1 | 0.1V max. | | | |
| Simulate RICH | 0 to 5 V | 0.25 V max. | | | With > 500Ω Sensor Impedance<br>Protected by current limiting: 15 mA (Typ.) |
| Simulate LEAN | Sensor set to T5 | 5.25V max. | | | |

## 3.1 Instrument Description

1) Protective rubber holster
2) Alphanumeric display
3) Analog LED bargraph
4) Power ON/OFF button
5) Simulate sensor “RICH” condition
6) Sensor type select button
7) Simulate sensor “LEAN” condition
8) Response time test button
9) Test leads with clips

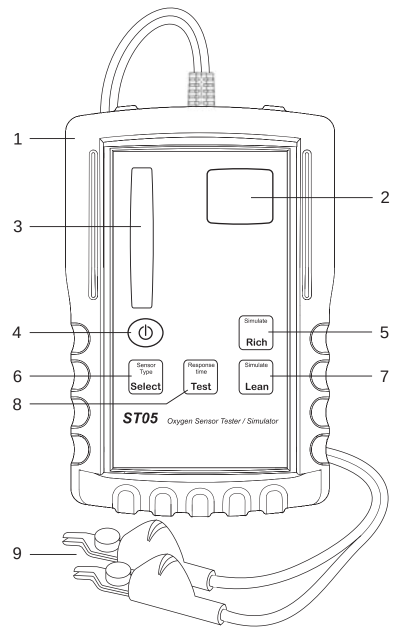


Fig. 1 - Instrument description

## 3.2 Displays Description

### 3.2.1 Analog bargraph description

***Real time signal***
Displays the actual signal voltage output of the oxygen sensor in real time.

***Maximum***
Displays the maximum voltage reached by the signal (updated every new cycle).

***Minimum***
Displays the minimum voltage reached by the signal (updated every new cycle).

***Average***
Displays a calculated time average of the oxygen sensor output, in order to detect rich or lean working conditions (updated every new cycle).

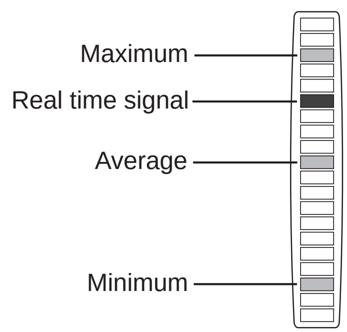


Fig. 2 - Bargraph description

- If no crossings (cycles) of the input signal are detected for more than 10 seconds or if the input voltage is out of range, only the real time signal indicator will be displayed.

- If the input signal exceeds the display range of the bargraph, only a flashing dot will be shown at the top of the bar for an overvoltage and at the bottom for an undervoltage condition. This could happen, if for example, the test leads are connected to the sensor with the polarity reversed, or if the instrument is set for Zirconia sensors, but connected to a Titanium 5 Volt system.



#### 4.2.2 On vehicle testing of post-catalytic converter sensors

Post-catalytic converter oxygen sensors are used primarily to monitor the emission after the exhaust gases have been processed in the converter, to insure that any residual hydrocarbons (fuel) and carbon monoxide present in the exhaust are completely burned before reaching the tail pipe.

A good catalytic converter and oxygen sensor will exhibit a voltage output which is steady (not switching or fluctuating between rich and lean) and near the 0.45 V level for Zirconia and Titanium 1 Volt, and 2.5 Volt for Titanium 5 Volt sensors, and the crosses per second should be 0 (in the alphanumeric display).

A fluctuating output signal (similar to a pre-catalytic converter sensor) from a post-catalytic converter sensor may indicate a damaged or non operating converter.

A constant rich or lean output may indicate a damaged oxygen sensor or faulty wiring.

Before testing a post-catalytic converter sensor, insure that the pre-catalytic converter sensor is working properly.

#### 4.2.3 Off vehicle testing of oxygen sensors (for Zirconia sensor only):

1- Remove the sensor from the vehicle.

2- Connect the test leads of the ST05 to the sensor wires as described in section ‘3.4.2 Sensor signal measurement’.

3- Hold the sensor using a vice or some insulated pliers, and with a propane torch, apply the flame directly to the sensing element until the bargraph display shows a voltage output of 0.8 Volt or above, if this voltage level can not be reached, it may point to a defective sensor.

4- The propane torch performs two functions, first it heats up the sensor to operating temperature, and second when directed at the sensor element, it removes the oxygen from it, so the sensor “sees” a rich mixture.

5- When removing the flame from the sensing element, the voltage output from the sensor should fall to 0.2 Volt or below, as the sensor detects the oxygen in the air around it.

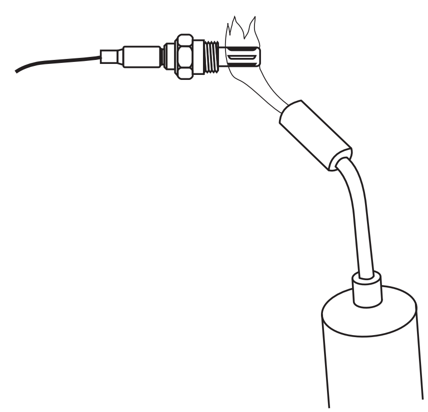

Fig. 5 - Off vehicle testing

### 4.1.4 Wide Band (Air/Fuel Ratio) dual cell sensors:

These sensors, with the Bosch LSU4 being the most popular, use two Zirconia cells, one is used as a conventional Zirconia sensor (reference or Nerst cell), and the second is used to ‘pump’ oxygen into the reference cell in order to keep it at or near the stoichiometric output. The PCM measures how much oxygen (current) it needs to pump into the reference cell to keep it at a set output ( approximately 0.45 Volts), and from this calculates the actual mixture in the exhaust.

A basic test can be performed on this type of sensor by simply measuring the output signal of the reference (Nerst) cell, and observing that a good sensor should output a signal level which is steady and near stoichiometric (0.45 Volts).

## 4.2 Oxygen sensors testing

Follow the steps as described in “3.4 OXYGEN SENSOR MEASUREMENT” to select sensor type and to connect the test leads to the sensor’s wires.

### 4.2.1 On vehicle testing of pre-catalytic converter sensors

Below are the typical readouts of a good (pre-catalytic converter) sensor:

| Sensor type | Bargraph display | | Alphanumeric display Crosses per second | Test conditions |
|---|---|---|---|---|
| | Lean | Rich | | |
| Zirconia and Titanium 1 Volt | < 0.3 Volt | > 0.6 Volt | Feedback Carburetor: 1<br>Throttle body injection: 2-3<br>Multiport fuel injection: 5-7 | Engine at 2500 RPM<br>Oxygen sensor at approximately 800 °F or 425 °C. |
| Titanium 5 Volt | > 3.5 Volt | < 1.5 Volt | | |
| Zirconia and Titanium 1 Volt | < 0.2 Volt when forced lean* | > 0.8 Volt when forced rich* | N/A | Oxygen sensor at approximately 800 °F or 425 °C. |
| Titanium 5 Volt | < 4.5 Volt when forced lean* | < 0.1 Volt when forced rich* | | |

* To force the mixture to go rich inject some propane into the intake manifold. To force the mixture to go lean, disconnect a vacuum line temporarily.



### 3.2.2 Alphanumeric display description

24 ***Numerical readout***

During normal operation, the alphanumeric display shows the number of crossings per second (cross-count) of the oxygen sensor signal.

ZN ***Selection and message readout***

When selecting the type of sensor, performing functions or during certain error conditions, the alphanumeric display shows two characters codes that identify the selection, status of a function, or error condition. Below is a table with display readouts and their descriptions.

| Display | Description |
|---|---|
| ZN | Zirconia sensor selected |
| T1 | Titanium sensor selected for 1 Volt systems |
| T5 | Titanium sensor selected for 5 Volt systems |
| T | Flashes while performing response time test |
| PA | Passed the response time test ( < 100 ms) |
| FL | Failed the response time test ( > 100 ms) |
| R | Flashes when simulating a rich fuel condition |
| L | Flashes when simulating a lean fuel condition |
| HT | Test leads connected to heater wire(s) or circuit with more than 6 Vdc |
| OL | Overload current was detected when simulating Rich or Lean |
| RP | Reverse polarity detected: to correct reverse test lead connections |
| OP | Open circuit detected: check for loose connections |
| GN | Ground connection detected: check test leads connections |
| Lb | Flashing indicates low battery: replace battery |
| DM | This message will display momentarily when selecting the demo mode |

## 3.3 Turning the power ON and OFF

***Power ON/OFF***

1- To turn the instrument ON, press and hold the (power ON/OFF) button until the display lights up (approximately 1 second)

2- To turn the instrument OFF, press and hold the (power ON/OFF) button until the display turns off (approximately 1 second)

- To extend battery life, the ST05 will automatically turn off after 3 minutes of being idle (i.e. no button pressed and no input signal). Turning the unit off manually, when not in use, will prolong battery life.
- If the unit turns off immediately after being turned on, it indicates that battery voltage is below the absolute minimum, and the battery should be replaced.

## 3.4 OXYGEN SENSOR MEASUREMENT

### 3.4.1 Setting the type of sensor

**CAUTION**

**To avoid personal injuries and damage to the instrument or test leads, always connect the test leads to the sensor before starting the engine, and when the exhaust system is cold. Wear insulating gloves when working around hot parts, and keep away from moving parts (fan, drive belts, etc) and hot objects (exhaust manifold and pipes, muffler, catalytic converter, etc.)**

The ST05 is capable of measuring and simulating three of the most common oxygen sensors: Zirconia and Titanium in 1 and 5 Volt systems. It is important to select the right type of sensor in order to obtain the correct readings when testing an oxygen sensor.

Sensor Type Select ***Sensor Type Select***

1- Make sure the instrument power is turned on, if not, turn it on by pressing and holding the power button until the display lights up.

2- Press the Sensor Type Select (Sensor Type Select) button momentarily.

3- The alphanumeric display will show the type of sensor selected.

4- To accept the sensor selection, release the button and wait until the alphanumeric display returns to normal (numeric reading).

5- To select another sensor type either press and hold the Sensor Type Select "Sensor Type Select" button until the desired type is shown on the display, and then release, or press and release the button until the desired sensor type is shown in the display.



5- Output signal levels: when operating the output signal should switch to 0.8 Volt or above on the high side (rich mixture) and to 0.2 V or below on the low side (lean mixture). At the optimal mixture for maximum efficiency, or stoichiometric point (14.7 fuel to air ratio), the sensor output is approximately 0.45 Volt, so anything above this voltage will be interpreted by the PCM as a rich mixture, and anything below as a lean mixture.

6- Response time: is the time it takes the sensor to change its output from below 0.175 Volts to above 0.8 Volts, in response to a sudden change in the fuel mixture from lean to rich. The response time should be less than 100 ms, a longer transition time or not reaching the voltage levels indicated, is indicative of a defective sensor.

### 4.1.2 Titanium (Titania)

This type of sensors uses the properties of Titanium Dioxide ($TiO_2$), which changes its electrical resistance in relation to the oxygen content of the exhaust gases. Titanium sensors do not require an external oxygen reference level, therefore are immune to external factors, like air pollution, or contamination like water.

The most important characteristics of this type of sensor are:

1- Titanium sensors require external power, which is either 1 Volt or 5 Volt depending on the vehicle and manufacturer specification.

2- These sensors are all of the heated type.

3- In order to work properly, the temperature of the sensor must be between 800 and 900° F ( 426 and 500° C).

4- Output signal levels: these depend on the external voltage supply being used, for 1 Volt systems, the signal should switch from close to 0 Volts for Lean to near 1 Volt for rich mixtures, with the stoichiometric level at 0.5 Volt. For 5 Volt systems, the output is generally reversed, near 0 Volts output for rich mixtures and 5 Volt for lean mixtures, with 2.5 as the stoichiometric level.

6- Response time: It is the time it takes the sensor to change its output from below 0.2 Volts to above 0.8 Volts, in response to a sudden change in the fuel mixture from lean to rich. The response time (as in the Zirconia sensors) should be less than 100 ms, and a longer transition time or small voltage swings are indicative of a defective sensor.

### 4.1.3 Wide Band (Air/Fuel Ratio) single cell sensors:

These sensors look like conventional Zirconia heated sensors, however a specialized circuit in the PCM controls the current to and from the sensor to obtain a signal proportional to the fuel mixture.

For testing of the sensor in the vehicle, it is necessary to disconnect the signal wires of the sensor from the PCM to prevent the circuitry from interfering with the sensor's signal, but the heater wires must remain connected. Once the signal wires are disconnected, this sensor will behave the same as a conventional Zirconia sensor. An alternative way to test this sensor is to do an off vehicle testing, (refer to section "4.2.3 Off vehicle testing of oxygen sensors").

This sensor has been in use in some Toyota vehicles since 1996.

# 4. OXYGEN SENSOR INFORMATION

The oxygen sensor is one of the most critical parts of the emission control system and fuel economy performance. This sensor measures the oxygen content in the exhaust gases, and the result is used by the PCM (Powertrain Control Module) to adjust the amount of fuel injected into the cylinders. Optimization of the fuel/air mixture minimizes the emission of pollutants and reduces fuel consumption.

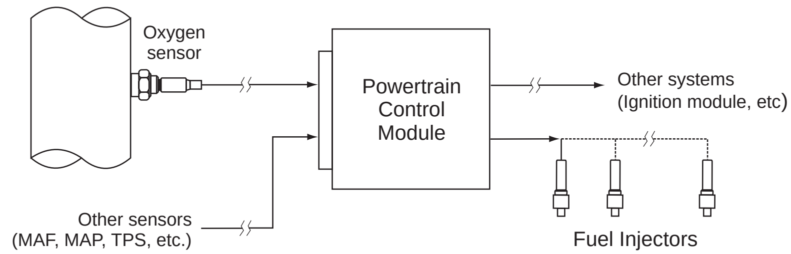


**Fig. 4 - Oxygen sensor function**

A high content (excess) of oxygen in the exhaust gases is indicative of a lean fuel mixture, which causes higher combustion temperatures responsible for producing pollutants like NOx, and may even cause permanent damage to the engine.

Low oxygen content in the exhaust indicates a rich fuel mixture, which generates Carbon Monoxide and Hydrocarbon (unburned fuel) emissions, and reduces fuel economy.

Additional oxygen sensors located after the catalytic converters, are used to measure the converter's efficiency, insuring they are working properly in reducing emissions. The optimal Air/Fuel mixture ratio is 14.7/1 (weight ratio), and it is called 'Stoichiometric'.

## 4.1 Oxygen sensor types

### 4.1.1 Zirconia (Zirconium)

This is the most commonly used type of sensor, and it is based on the properties of Zirconium Dioxide ($ZrO_2$), which becomes conductive at high temperatures, allowing oxygen ions through it, creating an electrical charge on a platinum plate. These electrical charges generate the signal output for the sensor.

The most important characteristics of this type of sensor are:

1- Zirconia sensors do not require any external power or signals, they generate their own voltage.

2- Unheated (one wire) and heated (2, 3 and 4 wire) versions are used.

3-The sensor will become active (generate a signal) at around 600°F (315°C), but to give an accurate output, the sensor temperature has to be at approximately 800 °F (425 °C).

4- These sensors require an external oxygen reference level, which is achieved by allowing some ambient air into the sensor. In some of the older versions, a small hole in the back was used to let air into one side of the sensing element. The most modern ones use the sensor wires as air conduits for the same purpose.



### 3.4.2 Sensor signal measurement

**IMPORTANT**

There are no standard connectors or color coding for oxygen sensor wiring. These may vary between sensors, vehicle models and manufacturers. Consult the wiring diagram of the vehicle in order to identify the type of sensor and its wiring before attempting to connect the test leads to the sensor wires

1- Follow steps in "3.4.1 Setting the type of sensor" to select between ZN, TI or TS sensor types.

2- Connect the red test clip to the sensor signal wire (Fig. 3)

3- Connect the black test clip to the sensor signal ground (or common) wire if available, otherwise connect to a good ground near the sensor (Fig. 3)

4- Read the output signal of the sensor on the analog bargraph and cross count on the alphanumeric display

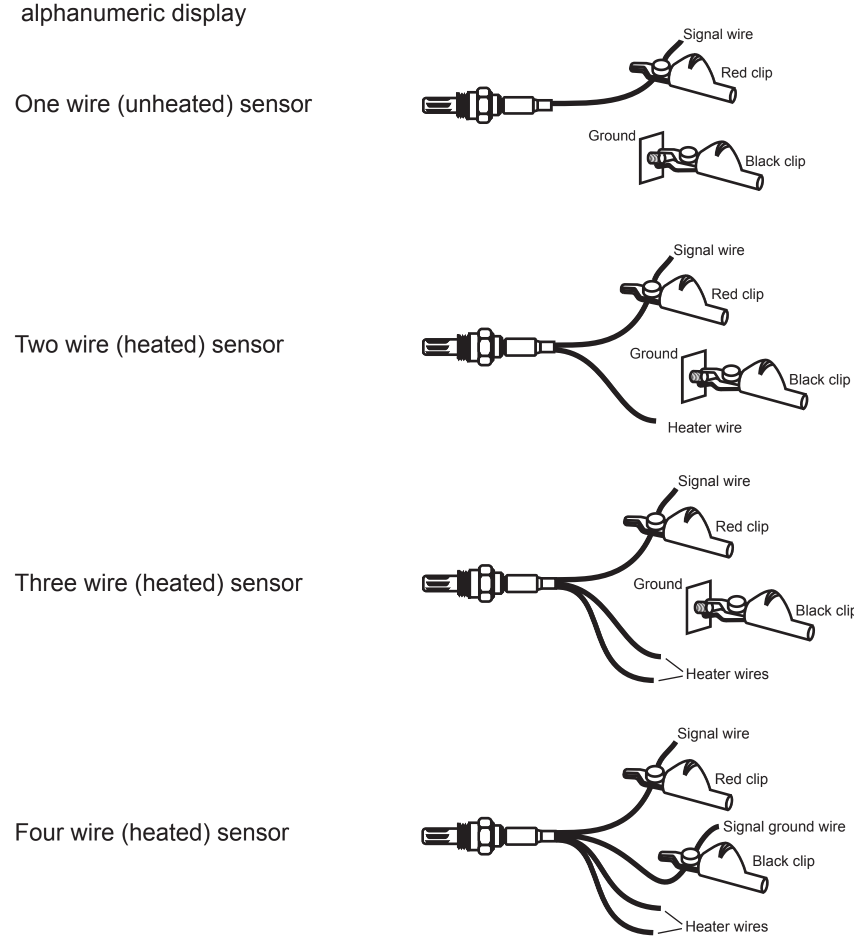


Fig. 3 - Test lead connection guide

### 3.5 Oxygen sensor response test

1- Select the sensor type to test and connect the test leads following the steps described in “3.4.1 Setting the type of sensor” and “3.4.2 Sensor signal measurement”

2- Make sure that the engine and the oxygen sensor are at normal operating temperature, by running the engine at around 2500 RPM for 3 minutes

3- Insure the engine is running at approximately 2500 RPM, and press the [Response time Test] (TEST) button once, the alphanumeric display will flash [T] for approximately 20 seconds. During this period the instrument will continuously monitor the sensor response.

4- While the display is still flashing [T], release the throttle and wait for the bargraph to show a lean signal, then snap the throttle and release. You may repeat this procedure at 2 to 3 seconds intervals while still in test mode.

5- The result will be shown on the alphanumeric display :

[PA] ***PASS***

A sensor signal response time from < 175 mV to > 800 mV in less than 100 ms, will end the test automatically, and the display will show the sensor passed the response test.

[FL] ***FAIL***

If the signal does not cross both the 175 mV and 800 mV thresholds, or if it takes longer than 100 ms to do so, the test will continue for the entire 20 seconds, and the display will show the sensor failed the response time test.

- This test can be ended at any time by pressing the [Response time Test] (Test) button again.

### 3.6 Oxygen sensor simulation

1- Select the sensor type to test and connect the test leads following the steps described in “3.4.1 Setting the type of sensor” and “3.4.2 Sensor signal measurement”

[Simulate Rich] ***Simulate Rich***

To simulate a rich fuel mixture condition for the Powertrain Control Module (PCM), press the [Simulate Rich] (Rich) button once, the alphanumeric display will then show [R] flashing during the simulation period.

[Simulate Lean] ***Simulate Lean***

To simulate a lean fuel mixture condition for the PCM, press the [Simulate Lean] (Lean) button once, the alphanumeric display will then show [L] flashing during the simulation period.

- If when pressing either of the simulation buttons, the alphanumeric display shows a flashing [Lb] (Low battery) code, it indicates that the battery is too low to operate this function, and should be replaced.
- The simulation times are limited to 4 seconds maximum, and there is a time delay of 4 seconds before the instrument is able to repeat the same simulation. These time limits are safety features designed to avoid damage to the engine and/or catalytic converter.
- The simulation can be ended at any time by pressing the button corresponding to the simulation in progress, or it can be switched from Lean to Rich or from Rich to Lean at any time.



### 3.7 Additional Functions

### 3.7.1 Accessing Demo mode

[DM] ***Demo mode***

This mode is intended to show how the instrument works, without the need to be connected to an actual oxygen sensor or any external signal. Upon entering this mode the bargraph and the alphanumeric display will show a simulated measurement of a working oxygen sensor. It also allows you to change the sensor type, test for response time and to use the simulate rich and lean functions.

1- To enable this function, the instrument should be off, if is not, turn it off by pressing and holding the Power ON/OFF button until the displays turn off.

2- Press and hold the (Test) button, then turn the instrument on by pressing the Power ON/OFF button until the alphanumeric and bargraph displays turn on, while still pressing the Test button.

3- When entering the demo mode, the alphanumeric display will momentarily show [DM] and then displays the simulated signal.

4- While in the demo mode, you may demo all the functions of the ST05.

5- To exit the Demo Mode, turn off the unit by pressing and holding the Power ON/OFF button until the displays turn off.

### 3.7.2 Error and warning codes

[HT] ***Heater wire***

The instrument test leads are connected to a heater wire(s) or a circuit with more than 6 Vdc. To correct this error, attach the test leads to the signal and ground wire of the oxygen sensor (Fig. 3).

[OL] ***Overload current***

Overload current was detected when trying to simulate a Rich or Lean conditions. This condition will not damage the instrument. It could be caused by incorrect connections of the test leads, faulty oxygen sensor or wiring, or by a sensor with an impedance (resistance) below the minimum allowed by the instrument.

[RP] ***Reverse polarity***

Test leads connected with reverse polarity. Reconnect test leads observing the polarity: red clip -> signal wire, black clip -> ground or common (Fig. 3).

[OP] ***Open connection***

Test leads are not connected, the connection is not good or the sensor wiring is faulty.

[GN] ***Ground***

The red clip (Signal) is connected to ground. This error could be caused by a connection to the wrong (ground) wire, or by a faulty (short circuit) oxygen sensor or wiring.