Bosch LSU 4.9 Broadband Oxygen Sensor switching test

Bosch part number 0 258 017 025 (*Refer to vehicle specific data for Oxygen Sensor part numbers)*

The purpose of this test is to evaluate the response of a **Bosch LSU 4.9** O2 sensor (Pre-Catalyst) in relation to the air/fuel ratio

Note: The correct operation of the O2 sensor is dependent upon the temperature of the sensing tip, the internal heating element, and the mechanical condition of the engine, fuel quality, engine temperature, and the integrity of the engine management system.

The test procedure below assumes the conditions mentioned above are all in order and the O2 sensor to be functioning correctly. Any failures identified with the operation of the O2 sensor whilst conducting these tests does not necessarily indicate a fault with the O2 sensor itself.

Often the O2 sensor will display operational characteristics that are inconsistent due to fuelling or mechanical errors, the results obtained are therefore symptoms of underlying conditions and not the cause.

It is therefore paramount to evaluate the engine mechanical condition and management system BEFORE condemning the O2 sensor

All numerical readings quoted in this help topic are typical and not applicable to all engine types.

Customers using either a PicoScope 4225 or 4425

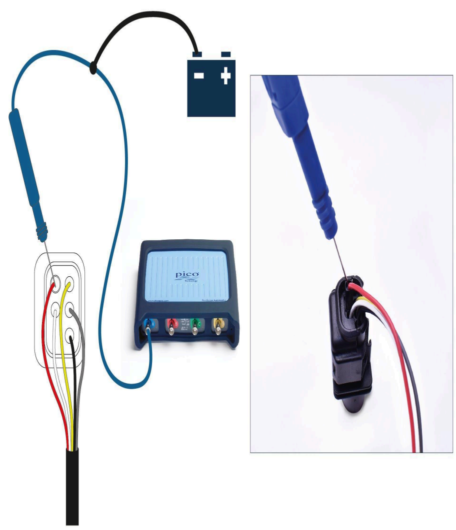
It is advisable to set the Hardware filter (Bandwidth Limit) of the 4225 or 4425 PicoScope to "On" for channel A prior to testing the LSU 4.9 O2 Sensor.

Activating the Hardware Filter

With a PicoScope 4425 connected, select Tools > Preferences > Options > and check the box marked *Show Analog Options* followed by OK. This will allow for the Hardware Filter to be activated within the Channel options menu and limit the bandwidth to 20 kHz for all incoming signals of your chosen channel.

N.B. The hardware filter cannot be switched off after capture to reveal the original signal. Any noise above 20 kHz will be rejected from entering the Scope during the test

How to perform the test



Accessories

1. 1 x TA125 TEST LEAD
2. 1 X TA162 Back pinning probe
3. 1 X TA158 Black battery clip

PicoScope settings

Channel A. x1 Test lead.
Channel A. Input range +- 5 V

Channel A. DC Coupled

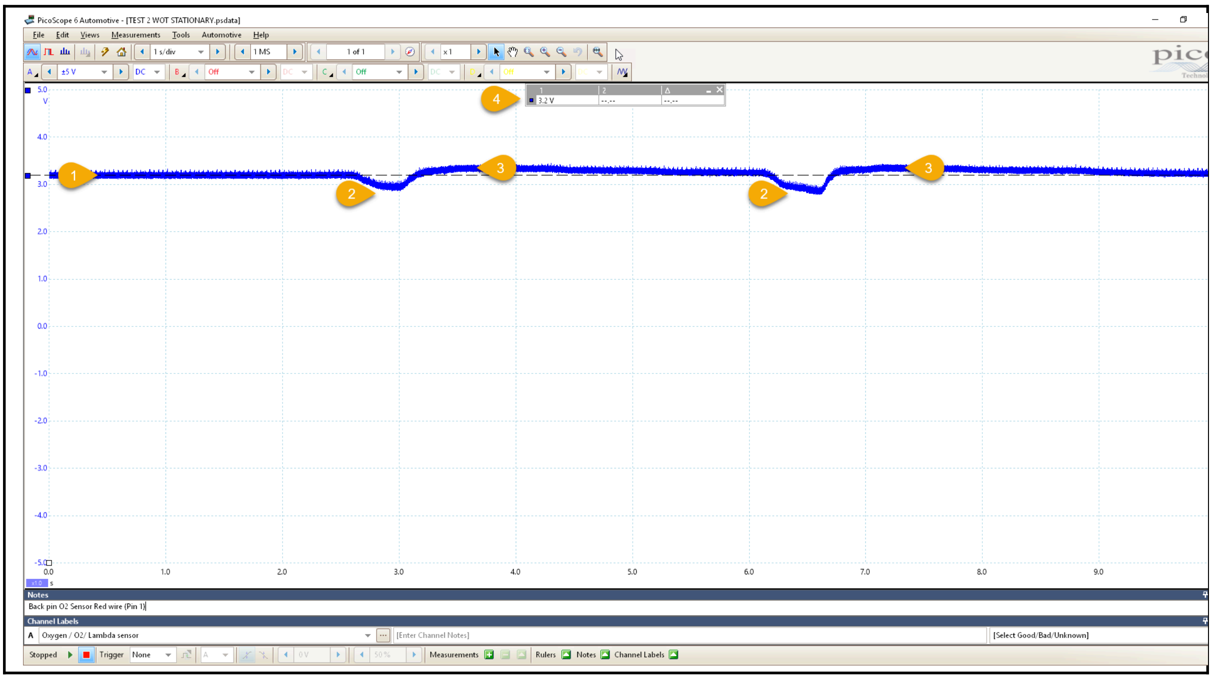
Time base 1 s/div
Sample counter 1 MS (Min)

How to connect PicoScope

1. Connect 1 x test lead to channels A of the scope
2. Connect channel A blue test lead to the O2 Sensor terminal 1 (Typically a Red Wire) and the black ground lead to the vehicle battery negative terminal using a battery crocodile clip Here we acquire the ***Pump cell*** voltage
3. Run your scope software by pressing either the space bar on your keyboard or the "start" button in PicoScope.
4. Crank and start the engine, and allow idle speed to stabilise. Noise may be present on you waveform during the warm up period of the O2 sensor. **This is an operational characteristic and not a fault**
5. **With the engine at the correct operating temperature** carry out numerous momentary Wide Open Throttle (WOT) snap tests whilst monitoring the signal on channel A (*Pump cell* voltage) Snap throttle tests will allow the air fuel ratio to momentarily increase then decrease to reveal the switching function of the *Pump cell*. **For an improved response and output from the *Pump Cell (particularly Diesel engine vehicles)* carry out a WOT road test (See Example Waveform 1)**
6. Press the start/stop button in PicoScope to halt the capture to enable waveform analysis.

Example waveform 1

Engine idling, WOT to over-run



All values included in the *Example waveforms* are typical and not specific to all engine styles.

Channel A indicates the voltage of the O2 sensor Pump cell

<u>Diagnosis</u>

Refer to vehicle technical data for specific test conditions and results.

Typical values (Engine at correct operating temperature)

1. **Engine idling:** O2 sensor *Pump cell* voltage will rise and fall depending upon the level of oxygen content detected in the exhaust system. **Under normal running conditions the voltage will remain stable at approx. 3.2 V indicating correct stoichiometric air fuel ratio of 14.7:1 petrol and 14.5:1 diesel** (Lambda 1.0)

2. **WOT snap test:** Indicates a drop in *Pump cell* voltage at the point of WOT (approx. 300 mV) as the oxygen content in the exhaust system falls due to acceleration enrichment. (Oxygen is pumped into the O2 sensor Nernst cell)

3. **Over-run "fuel cut"**: Indicates a rise in *Pump cell* voltage (approx. 185 mV) during the engine over-run "fuel cut" condition. The oxygen content in the exhaust system will therefore increase. (Oxygen is pumped out of the O2 sensor Nernst cell)

4. **Ruler Legend:** Indicates the numerical units relating to the position of the Signal Ruler for Channel A. 3.2 V is displayed in the Ruler Legend confirming the correct stoichiometric air fuel ratio of 14.7:1 petrol and 14.5:1 diesel (Lambda 1.0)

   The switching of the *Pump cell* voltage during WOT and over-run confirms the O2 sensor to be performing correctly. The response to acceleration and deceleration of the engine should be near instant confirming the O2 sensor response time to be efficient.

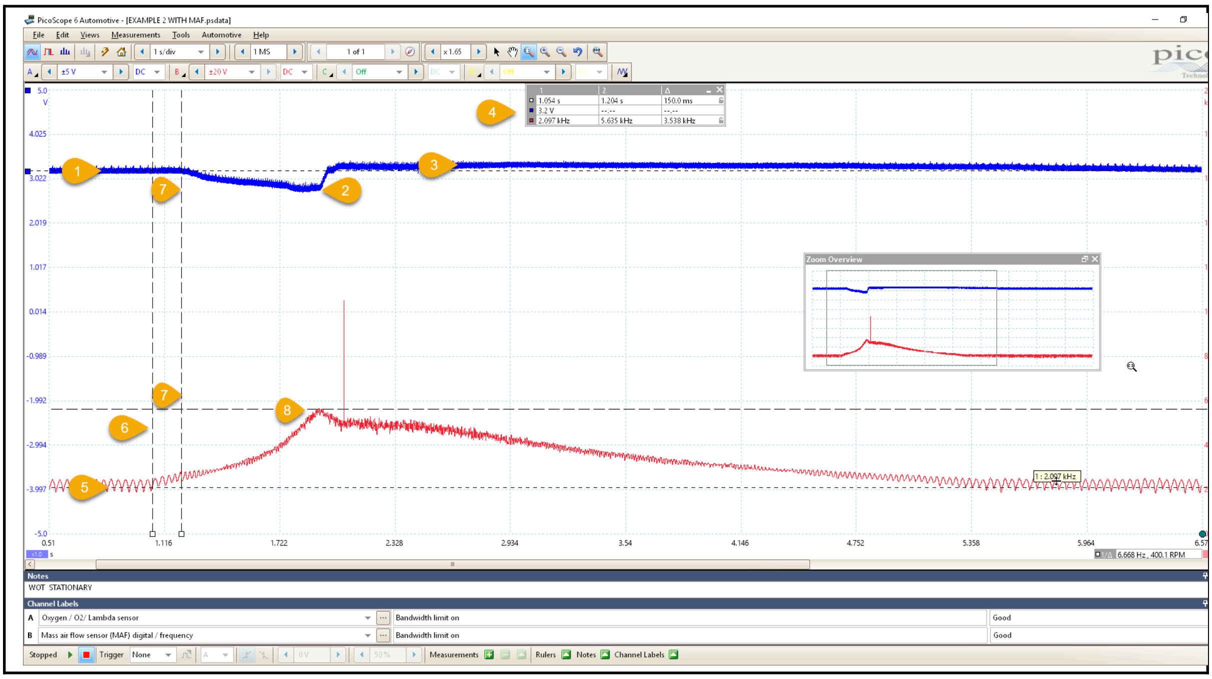
<u>The info below is useful but does not have to go into the Guided Test</u>

Qualifying the O2 sensor response time

The test procedure above will confirm "activity" from the O2 sensor in response to a change in fuelling conditions (WOT and Overrun)

As an additional test, the response time of the O2 sensor can be measured in relation to engine load using the MAF. The example waveform below utilises Channel B connected to a Digital MAF Sensor where the engine is free revved from idle, to WOT and returning to Idle

Example waveform 2



Channel A indicates the voltage of the O2 sensor Pump cell

Channel B indicates the frequency output of a Digital MAF Sensor

Diagnosis

5. **Engine idling**: MAF signal at idle speed
6. **WOT Snap test:** Here we capture the initial point at which the air flow begins to increase into the engine as the gas pedal is depressed
7. **Response time:** Using the time rulers and zoom feature of PicoScope the time between the initial increase in airflow (WOT) and response from the O2 sensor (initial fall in pump cell voltage) can be measured to reveal the O2 sensor response time in relation to engine load The time recorded here in the Ruler legend (4) is 150 ms which is typical of a good O2 sensor (Maximum permissible response time is 200 ms)
8. **WOT:** MAF signal at WOT

More information

Bosch LSU 4.9 Wideband Oxygen sensor (LSU = Lambda Sensor Universal)

Modern emission regulations have forced tighter control of engine management systems throughout all engine speed and load ranges. The traditional O2 sensor could accurately detect the stoichiometric air fuel ratio at 14.7:1 petrol (Lambda 1.0) with an output of approximately 450 mV. However, beyond the stoichiometric point, the traditional oxygen sensor would output either a *rich* *signal* (900 mV) or a *lean signal* (100 mV) with no indication of just how *rich* or how *lean*. The engine management would therefore compensate by adjusting the fuelling (closed loop control) back and forth (rich/lean) in an attempt to maintain the correct stoichiometric air fuel ratio. The traditional oxygen sensor could therefore only operate accurately in a very narrow range of air fuel ratios (14:7:1), hence the name "Narrow Band" O2 sensor

The demand for increased accuracy, faster response times and reliability has seen the redevelopment of the Narrow Band oxygen sensor to the industry standard O2 sensor utilised today across all manufacturers, the "Wideband" O2 sensor

The Wideband O2 sensor is often referred to as a Broadband sensor or Air Fuel Ratio sensor (AFR sensor) and can be installed to both petrol / diesel engine vehicles.
The name "Broadband" is derived from the sensors ability to accurately detect the air fuel ratio across a broad or wide spectrum from 10:1 to 20:1 (20:1 being ambient air) unlike the Narrowband sensors ability to only detect the stoichiometric ratio of 14.7:1 (petrol)

For information on the complete operation of the LSU 4.9 O2 Sensor please refer to the following links

https://docs.google.com/document/d/1qaJfd2Fy_aZT8pLn0NxKIJOSGB3wo145/edit?usp=sharing&ouid=116517952629835921722&rtpof=true&sd=true **Trouble-shooter guide**

Should there be no response from the O2 sensor during the above test, please refer to the following links which will guide you through the 02 sensor overview test and trouble shooter guide in order to determine if a fault lies with the O2 sensor, wiring harness or PCM

https://docs.google.com/document/d/1qaJfd2Fy_aZT8pLn0NxKIJOSGB3wo145/edit?usp=sharing&ouid=116517952629835921722&rtpof=true&sd=true

Associated links

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