FIGURE 17–1 Many fuel-control oxygen sensors are located in the exhaust manifold near its outlet so that the sensor can detect the presence or absence of oxygen in the exhaust stream for all cylinders that feed into the manifold.

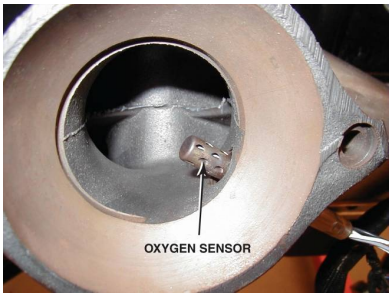

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FIGURE 17–2 A cross-sectional view of a typical zirconia oxygen sensor.

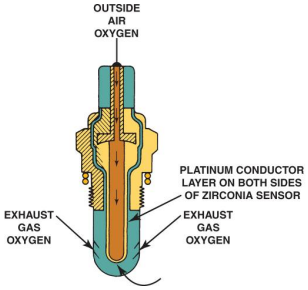

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FIGURE 17–3 A difference in oxygen content between the atmosphere and the exhaust gases enables an O2S sensor to generate voltage.

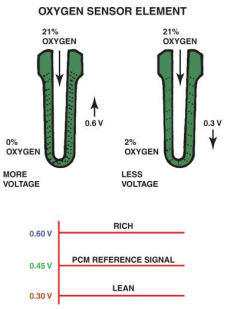

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FIGURE 17–4 The oxygen sensor provides a quick response at the stoichiometric air–fuel ratio of 14.7:1.

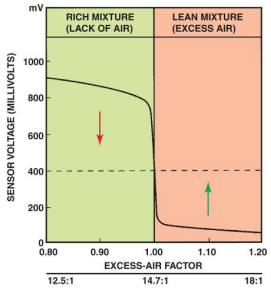

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FIGURE 17–5 A typical zirconia oxygen sensor.

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FIGURE 17–6 Number and label designations for oxygen sensors. Bank 1 is the bank where cylinder number 1 is located.

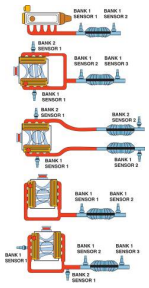

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FIGURE 17–7 The OBD-II catalytic converter monitor compares the signals of the upstream and downstream oxygen sensor to determine converter efficiency.

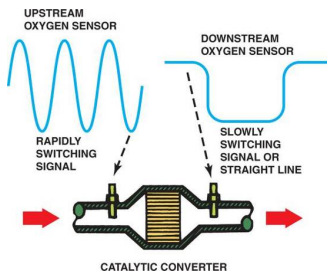

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FIGURE 17–8 Testing an oxygen sensor using a DMM set on DC volts. With the engine operating in closed loop, the oxygen voltage should read over 800 mV and lower than 200 mV and be constantly fluctuating.

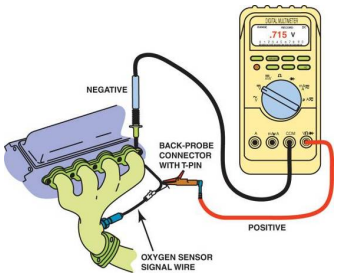

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FIGURE 17–9 Using a digital multimeter to test an oxygen sensor using the MIN/MAX record function of the meter.

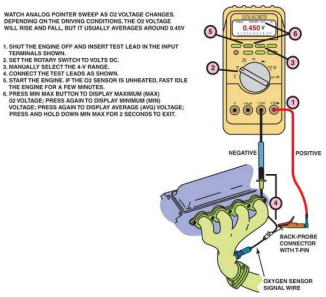

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FIGURE 17–10 Connecting a handheld digital storage oscilloscope to an oxygen sensor signal wire. The use of the low-pass filter helps eliminate any low-frequency interference from affecting the scope display.

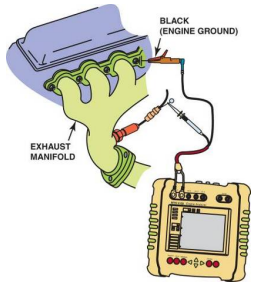

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FIGURE 17–11 The waveform of a good oxygen sensor as displayed on a digital storage oscilloscope (DSO). Note that the maximum reading is above 800 mV and the minimum reading is less than 200 mV.

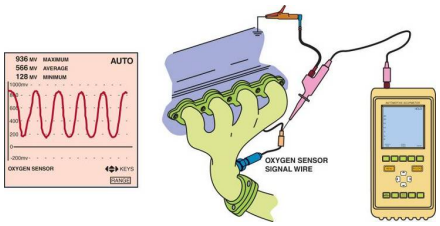

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FIGURE 17–12 A typical good oxygen sensor waveform as displayed on a digital storage oscilloscope. Look for transitions that occur between once every two seconds at idle and five times per second at higher engine speeds (0.5 and 5 Hz). *(Courtesy of Fluke Corporation)*

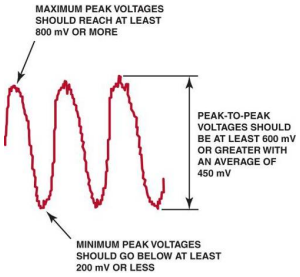

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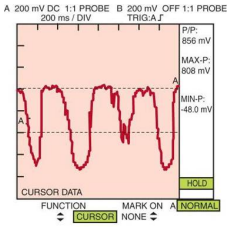
FIGURE 17–13 Using the cursors on the oscilloscope, the high- and low-oxygen sensor values can be displayed on the screen. *(Courtesy of Fluke Corporation)*



ONCE YOU'VE ACTIVATED "PEAK-TO-PEAK," "MAX-PEAK," AND "MIN-PEAK," FRAME THE WAVEFORM WITH CURSORS. LOOK FOR THE MINIMUM AND MAXIMUM VOLTAGES AND THE DIFFERENCE BETWEEN THEM IN THE RIGHT DISPLAY.

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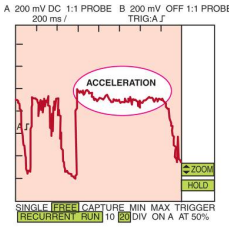
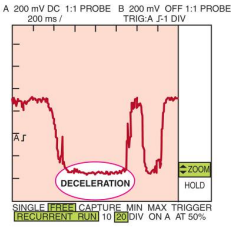
FIGURE 17–14 When the air–fuel mixture rapidly changes such as during a rapid acceleration, look for a rapid response. The transition from low to high should be less than 100 ms. *(Courtesy of Fluke Corporation)*



UNDER HARD ACCELERATION, THE AIR–FUEL MIXTURE SHOULD BECOME RICH - THE VOLTAGE SHOULD STAY FAIRLY HIGH



WHILE DECELERATING, MIXTURES BECOME LEAN. LOOK FOR LOW VOLTAGE LEVELS.

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FIGURE 17–15 Adding propane to the air inlet of an engine operating in closed loop with a working oxygen sensor causes the oxygen sensor voltage to read high.

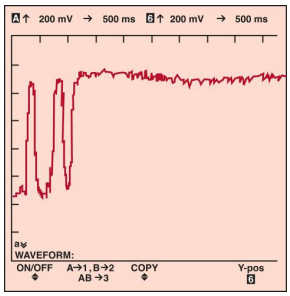

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FIGURE 17–16 When the propane is shut off, the oxygen sensor should read below 200 mV.

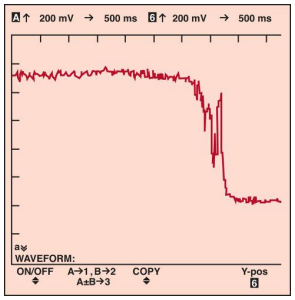

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FIGURE 17–17 When the O2S voltage rises above 450 mV, the PCM starts to control the fuel mixture based on oxygen sensor activity.

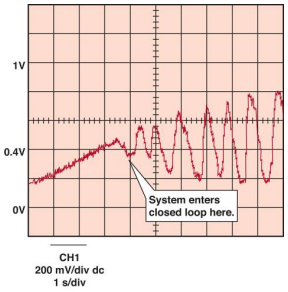

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FIGURE 17–18 Normal oxygen sensor frequency is from about one to five times per second.

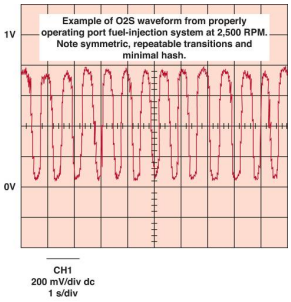

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FIGURE 17–19 Significant hash can be caused by faults in one or more cylinders, whereas amplified hash is not as important for diagnosis.

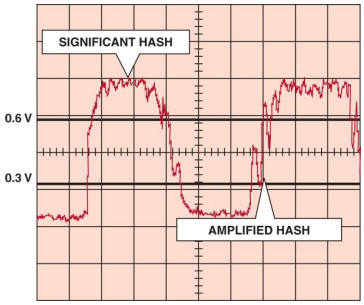

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FIGURE 17–20 Moderate hash may or may not be significant for diagnosis.

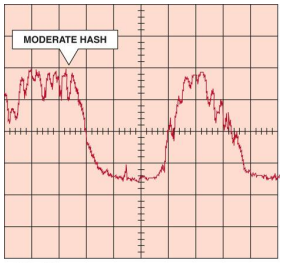

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FIGURE 17–21 Severe hash is almost always caused by cylinder misfire conditions.

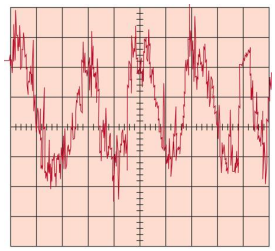

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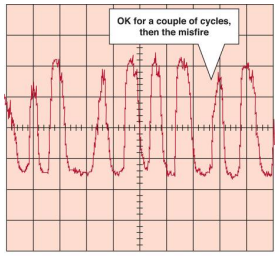
FIGURE 17–22 An ignition- or mixture-related misfire can cause hash on the oxygen sensor waveform.



CH1
200 mV/div dc
500 ms/div

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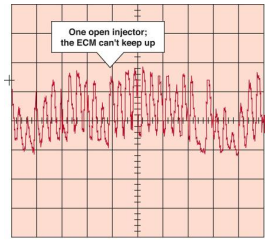
FIGURE 17–23 An injector imbalance can cause a lean or a rich misfire.



Memory 4
200 mV/div
200 ms/div

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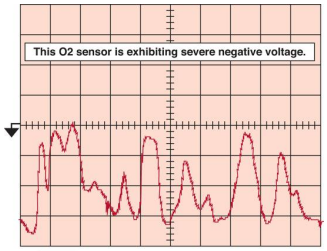
FIGURE 17–24 Negative reading oxygen sensor voltage can be caused by several problems.



WAVE 1
200 mV/div
1 s/div

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FIGURE 17–25 The post-catalytic converter oxygen sensor should display very little activity if the catalytic converter is efficient.

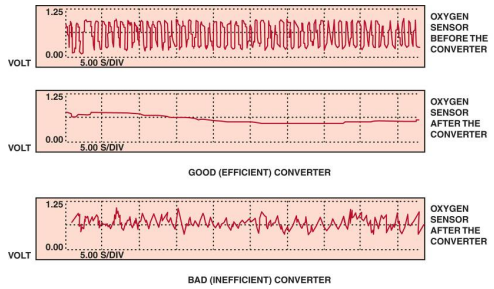

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FIGURE 17–26 The target lambda on this vehicle is slightly lower than 1.0 indicating that the PCM is attempting to supply the engine with an air–fuel mixture that is slightly richer than stoichiometric. Multiply the lambda number by 14.7 to find the actual air–fuel ratio.

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