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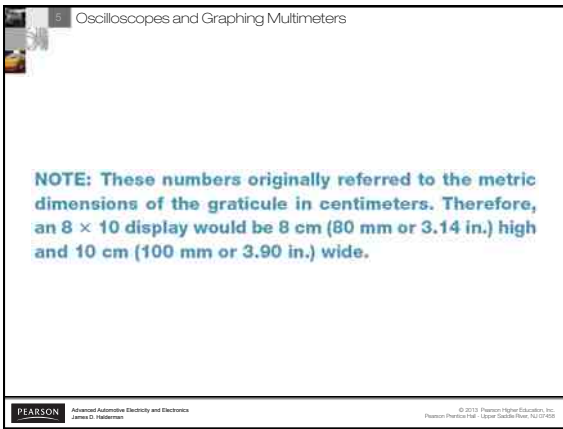
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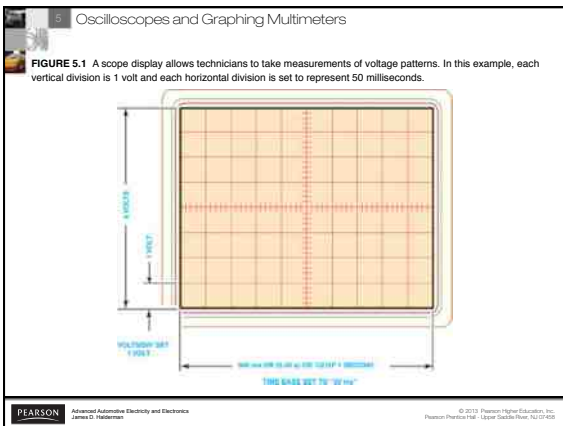
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5 Oscilloscopes and Graphing Multimeters

**CHART 5.1** The time base is milliseconds (ms) and total time of an event that can be displayed.

MILLISECONDS PER DIVISION (MS/DIV)	TOTAL TIME DISPLAYED
1	10 ms (0.010 sec.)
10	100 ms (0.100 sec.)
50	500 ms (0.500 sec.)
100	1 sec. (1.000 sec.)
500	5 sec. (5.0 sec.)
1,000	10 sec. (10.0 sec.)

**CHART 5-1**

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5 Oscilloscopes and Graphing Multimeters

**NOTE:** Increasing the time base reduces the number of samples per second.

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5 Oscilloscopes and Graphing Multimeters

**FIGURE 5.2** The display on a digital storage oscilloscope (DSO) displays the entire waveform of a throttle position (TP) sensor from idle to wide-open throttle and then returns to idle. The display also indicates the maximum reading (4.72 V) and the minimum (680 mV or 0.68 V). The display does not show anything until the throttle is opened, because the scope has been set up to only start displaying a waveform after a certain voltage level has been reached. This voltage is called the trigger or trigger point.

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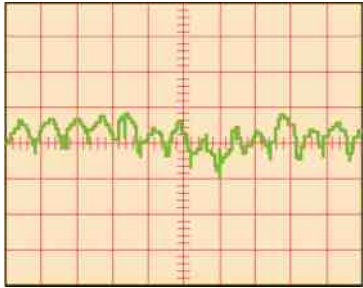
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Oscilloscopes and Graphing Multimeters

**FIGURE 5.3** Ripple voltage is created from the AC voltage from an alternator. Some AC ripple voltage is normal but if the AC portion exceeds 0.5 volt, then a bad diode is the most likely cause. Excessive AC ripple can cause many electrical and electronic devices to work incorrectly.



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Oscilloscopes and Graphing Multimeters

**NOTE:** Check the instructions from the scope manufacturer for the recommended settings to use. Sometimes it is necessary to switch from DC coupling to AC coupling or from AC coupling to DC coupling to properly see some waveforms.

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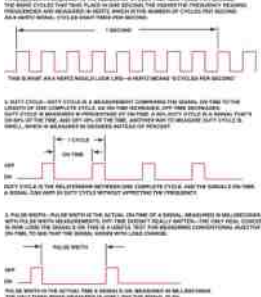
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Oscilloscopes and Graphing Multimeters

**FIGURE 5.4** A pulse train is any electrical signal that turns on and off, or goes high and low in a series of pulses. Ignition module and fuel-injector pulses are examples of a pulse train signal.



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Oscilloscopes and Graphing Multimeters

**FIGURE 5.5** (a) A scope representation of a complete cycle showing both on-time and off-time. (b) A meter display indicating the on-time duty cycle in a percentage (%). Note the trigger and negative (2) symbol. This indicates that the meter started to record the percentage of on-time when the voltage dropped (start of on-time).

(a) ON-TIME  
1 COMPLETE CYCLE

(b) DIGITAL MULTIMETER  
AUTO TRIG 082.4% 40

THE % SIGN IN THE UPPER RIGHT CORNER OF THE DISPLAY INDICATES THAT THE METER IS READING A DUTY CYCLE SIGNAL.

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Oscilloscopes and Graphing Multimeters

**FIGURE 5.6** Most automotive computer systems control the device by opening and closing the ground to the component.

GROUND CONTROLLED ON-TIME  
OFF ON  
1 COMPLETE CYCLE  
ON A GROUND-CONTROLLED CIRCUIT, THE ON-TIME PULSE IS THE LOWER HORIZONTAL PULSE.

FEED CONTROLLED ON-TIME  
ON OFF  
1 COMPLETE CYCLE  
ON A FEED-CONTROLLED CIRCUIT, THE ON-TIME PULSE IS THE UPPER HORIZONTAL PULSE.

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Oscilloscopes and Graphing Multimeters

**NOTE:** Often the capture speed of the signals is slowed when using more than one channel.

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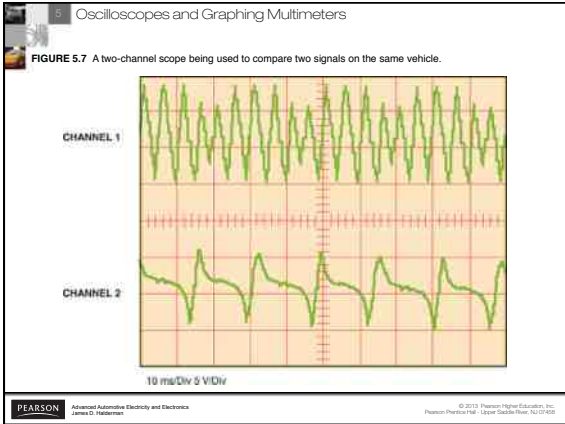
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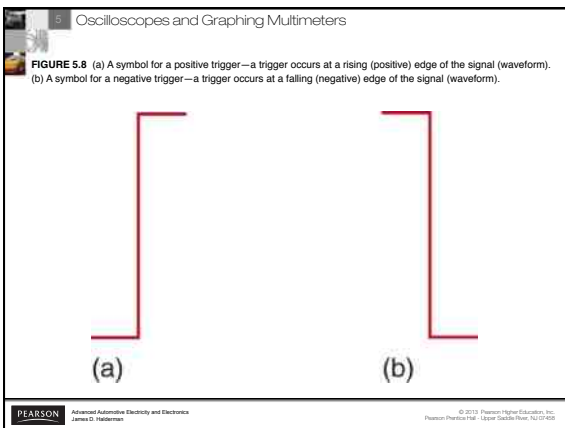
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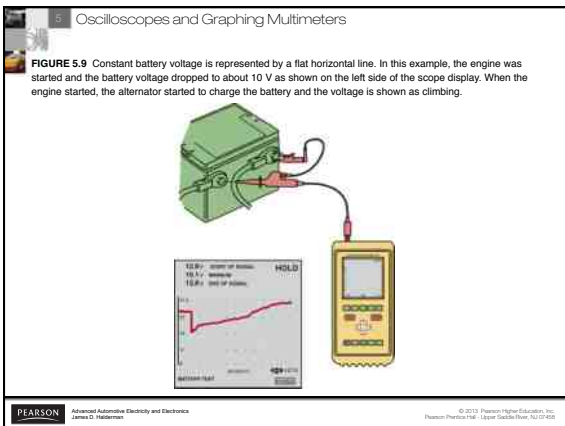
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5 Oscilloscopes and Graphing Multimeters

**FIGURE 5.10** A typical graphing multimeter that can be used as a digital meter, plus it can display the voltage levels on the display screen.



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