Universal Enterprises, Inc.
Beaverton, OR 97005

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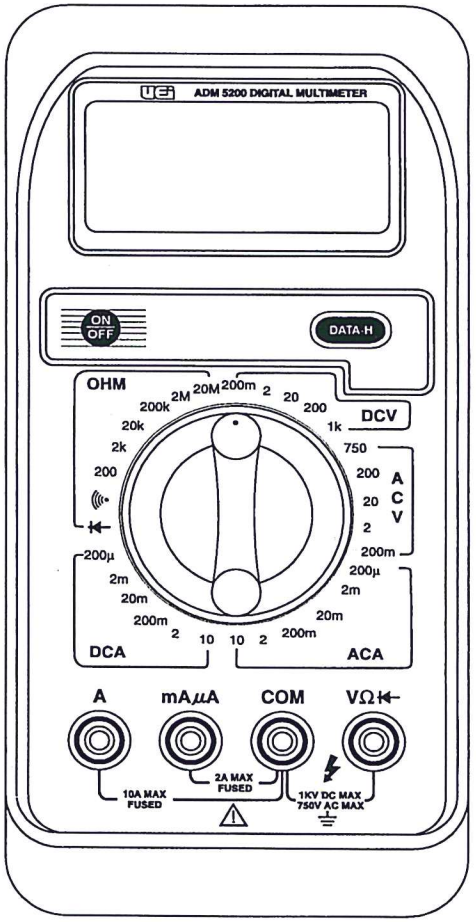

ADM 5200 USER'S GUIDE
FOR
ENGINE SERVICE TECHNICIANS

Safety Warnings & Cautions

1. Read this user's guide completely before using the ADM 5200. Save this manual. You may need these important safety and operating instructions at a later date.
2. Always wear safety goggles when working near batteries.
3. Do not smoke or allow open flames or sparks in the work area. Gasoline fumes and gases produced by batteries are highly explosive.
4. Keep cigarettes, sparks, and open flame away from battery at all times.
5. Testing should be done in a well-ventilated area.
6. Be sure all test leads are connected as instructed before proceeding with a test.
7. Be sure ignition is in the OFF position, headlights and other accessories are off, and doors are closed before disconnecting battery cables. This also helps to prevent damage to on-board computer systems.
8. Avoid making an accidental connection between battery terminals with tools, jumper leads, etc.
9. Use a suitable battery carrier when transporting batteries.
10. If considerable time is spent handling/servicing batteries, wear protective clothing.
11. Always disconnect the ground connections on all batteries before servicing the electrical system.
12. On marine applications with inboard or inboard/outboard engines, make sure work area is well ventilated. Operate bilge blower for at least four minutes before starting engine or making test lead connections.
13. Keep yourself, clothing and test equipment clear of all moving or hot engine parts.
14. Unless instructed otherwise, the parking brake should be applied and the gear selector in neutral (standard transmission) or park (automatic) and the drive wheels blocked before performing a test with the engine running. The ignition or fuel system must be disabled when performing starting system tests.
15. Exhaust gas contains deadly poison. When testing a vehicle with the engine running, test in a well-ventilated area or route exhaust gas outside.

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TERMS AND DEFINITIONS

Accuracy: Shows how closely the DMM's displayed measurement is to the actual value of the signal being measured. Usually expressed as a percentage of the reading or as a percentage of the full scale.

Analog Meter: An instrument that uses a needle movement to display the value of a measured signal. The user approximates the reading based on the position of the needle on a scale.

Annunciator: A symbol that identifies a selected range or function.

Autoranging: Automatically selects the range of voltage, current or resistance with the best resolution.

Common: The input terminal on a DMM that acts as a reference point, typically ground.

Continuity: A continuous path for the flow of electrons in a closed circuit.

Counts: A number used to specify a DMM's resolution or least significant digit.

Current Probe: An accessory to extend the current range of a DMM. Does not require breaking the circuit to make a measurement, rather it clamps around a conductor and measures its magnetic field.

Current Shunt: A low-value resistor in a DMM for measuring current. The DMM measures the voltage drop across the current shunt using Ohm's Law, to calculate the value of the current.

DMM: A digital multimeter is an instrument that uses a digital display to show the value of a measured signal. Digital multimeters have better durability, resolution and accuracy than analog meters.

Diode test: A feature that finds the voltage polarity and voltage drop across a diode. A semiconductor device that acts like a current check valve that allows current to flow in one direction and not the other.

Parasitic Load: This typically refers to the amount of current that is drawn from the battery, by various electrical components, when the ignition is in the off position.

Range: The measurement limits of a DMM. Most meters have several ranges in each function.

Resolution: The degree to which small changes in a measurement can be displayed.

INTRODUCTION

This user's manual should be used as a guide to get you started in troubleshooting. Your real learning can best be accomplished through experience. As you become more proficient in using the DMM to diagnose service conditions, you will very quickly learn how certain electrical symptoms can relate to various driveability problems.

As you go through this user's guide, we will attempt to answer the following questions about the ADM 5200: What is a Digital Multimeter? What can the ADM 5200 do? How do I make various measurements with the ADM 5200? What is the best way to get the most out of your ADM 5200?

Analog meters have been around for many years. However, these analog meters have outlived their usefulness, since they do not have the appropriate scales and functions needed to test the computers and sensors on today's vehicles. The older style analog type multimeter is not sensitive enough for use on today's vehicles, and can damage delicate computer circuitry.

Automotive electrical problems can be divided into several categories. Depending on the system in the vehicle causing the trouble, the real problem may exist in one system, while the symptoms you are testing appear in another.

A digital multimeter, like the ADM 5200, should be thought of as any other tool in your tool box. It will not solve all of your problems, it was only designed to give you some information about electrical activity (or lack of) occurring in components, sensors and wires of the vehicle's electronics.

Many technicians started repairing vehicles before DMM's were readily available and before digital automotive electronics became an integral part of monitoring and controlling vehicle emissions and performance. There may still be a lingering preference for analog meters. However, after using a digital multimeter you will see they really are a required tool to repair and troubleshoot today's current level of technology - for some very good reasons like input impedance, autoranging, input signal polarity, accuracy and data hold.

Analog meters have very low impedance inputs and draw current from the circuit they are testing. This means that small signals, such as the output from an oxygen sensor, will be changed by making a measurement using an analog meter.

Many electronic components used in automotive electronics have microscopic connections, so even small amounts of current can destroy these delicate circuits. However, the ADM 5200 has a very high input impedance, greater than 10 megohms (or 10 million ohms) which will not draw much current or change the measurement you are trying to make.

With an analog meter, a reversed polarity will cause the needle to bang hard against its zero stop, which can damage the meter movement. Digital multimeters will automatically display the polarity of the input signal (a minus sign is displayed if the leads are switched or the signal is negative).

Digital multimeters are significantly more accurate and have better resolution than analog meters. In analog meters, the error specification is usually expressed as a percentage of the full scale (typically + or - 5% or more depending on the measurement you are making). Digital multimeters are typically accurate to 1% (or better depending on the measurement you are making) of the displayed value plus or minus a few counts (a count is the least significant digit on the display, which is also the best resolution). As an example, if the signal you are measuring is actually 50 volts, on a DMM it could be displayed as any value between 48.5 and 51.5 volts and on an analog meter it could be any value between 40 to 60 volts on the 200 volt scale.

The hold function will cause the DMM to freeze (or hold) the last reading on the display. This feature is not available on analog meters and is especially useful for measuring voltage drops or capturing spikes.

As you progress through this user's guide, the benefits of using the ADM 5200 will become very obvious. The job of troubleshooting difficult electrical problems will become easier, as you become more familiar with the functions and features incorporated in the ADM 5200.

CHAPTER 1 - AUTOMOTIVE ELECTRONICS

Electrical Systems Diagnostics Using a Digital Multimeter

If you have not already discovered this, you will soon find out that, one of the most important tools you will use in troubleshooting automotive electrical systems is the "Digital Multimeter". A digital multimeter can typically measure voltage, current and resistance.

Since analog meters have a low internal resistance (known as input impedance) they draw too much power from the device they are testing and should not be used on today's computer controlled vehicles. These meters draw power from the device they are testing which will affect the accuracy of the measurement they are making.

Over twenty years ago, the digital multimeter was developed to solve the problems of analog multimeters. Digital Multimeters (DMMs) have a much higher input impedance than analog multimeters, generally 10 MΩ (million ohms). This high impedance means that the meter will draw very little power from the device under test. In addition to providing more accurate measurements, this type of meter will not damage delicate computer circuits. Using a digital multimeter can greatly reduce the risk of damage to sensitive computer circuits.

Types of Electrical Measurements

When troubleshooting automotive electrical systems there are many things you can measure: Voltage, Current, Resistance, Frequency, Duty Cycle and the list goes on. One of the most important measurements is "Voltage". Measuring the voltage level will answer the following most common questions: First, is there any voltage present? How much voltage is there? What is the voltage drop across a particular component, wire, switch or connector?

The presence of voltage lets you know the circuit is sending electricity to the component being tested. The voltage level indicates whether the right amount of voltage is getting to the component. The voltage drop across a component tells you the amount of the voltage being used by that component. For example, if a relay has 13.4 volts on the input side and only 8.1 volts on the output side, the voltage drop is said to be 5.3 volts.

Wires and connections can also cause voltage drops, especially if they are faulty, or the wires are very long or too small to carry the power to a particular component. An example of faulty wiring would be a corroded battery cable going to the starter solenoid.

Troubleshooting electrical systems uses the same skills you have already developed as an engine service technician. It is important to use a logical process of deductive reasoning to solve any problem you might encounter in a vehicle. This process is important, since you can not see inside or listen to electrical components to tell if they are functioning properly, (like you can with mechanical devices). Thinking through the process in a logical and organized way should help you determine the source of the problem the first time.

Ohm's Law - A DMM uses it every time

Voltage, current, and resistance in any electrical circuit can be calculated by using Ohm's Law, which states "the voltage in a circuit is equal to the current multiplied by the resistance". If any two values in the formula are known, the third can be determined. A DMM makes use of the principle of Ohm's Law to directly measure and display either ohms, amps, or volts. In the next few pages you will see just how easy it is to use a DMM to find the answers you need.

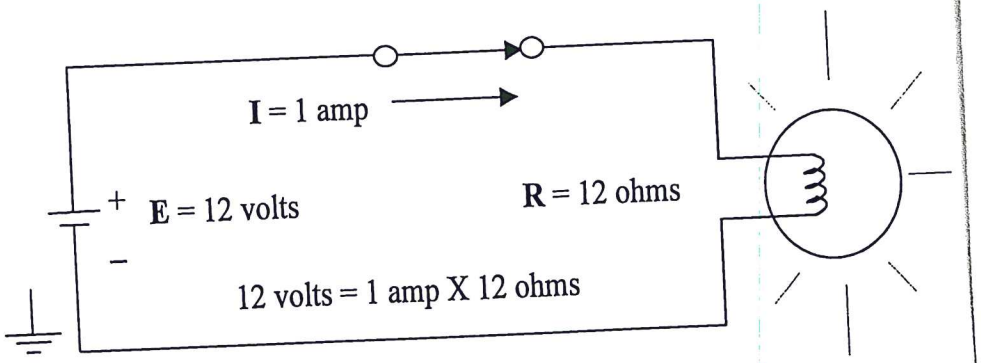

Figure 1-A: Typical Basic Circuit

As shown in the previous circuit, DMMs measure the three elements of Ohm's Law: voltage (E), current (I) and resistance (R).

Ohm's Law explains the relationship between voltage, current and resistance. The graphic below shows you how to quickly solve for the unknown value. Put your finger over the value you want to find, then multiply the remaining values if they are side-by-side or divide them if one is over the other. It is really much easier just to see the value on your DMM!

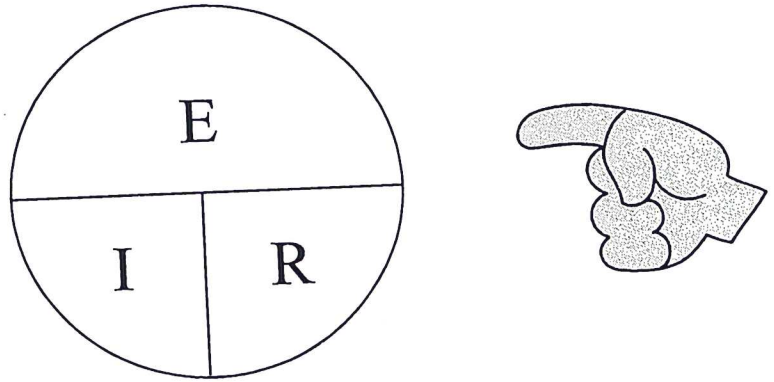

Figure 1-B: Ohm's Law Circle

To solve for E:

E = I x R
E = 1 amp x 12 Ω
E = 12 volts

To solve for I:

I = E / R
I = 12 volts / 12 Ω
I = 1 amp

To solve for R:

R = E / I
R = 12 volts / 1 amp
R = 12 Ω

(Note: In the above example "/" means "divide by" and "x" means "multiply by".)

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CHAPTER 2 - FEATURES AND FUNCTIONS

Input Terminals

The ADM 5200 has four input terminals that are protected against overloads to the limits shown in the specifications.

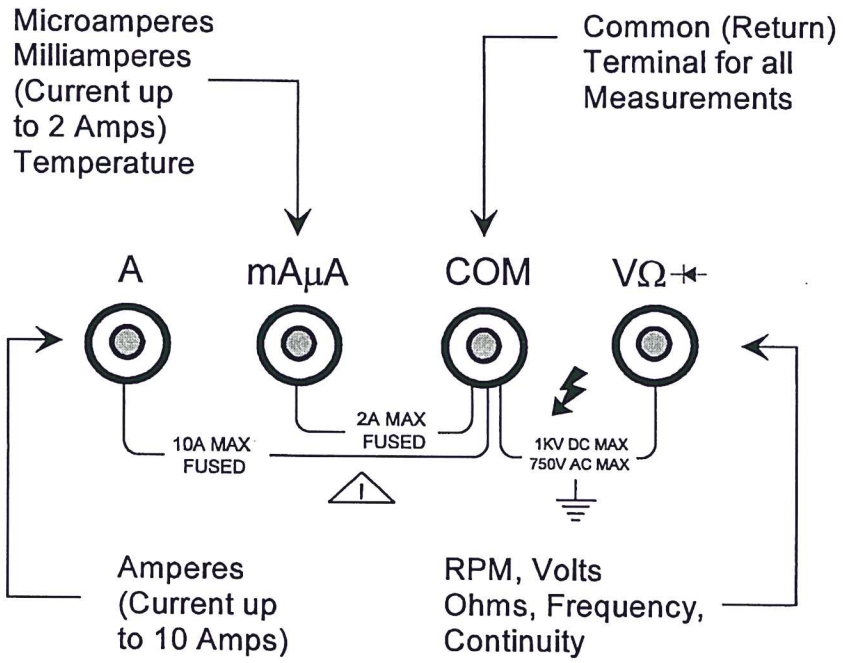

Figure 2-A: Input Terminals

Rotary Switch

To turn the meter on, press the On/Off button and turn the rotary switch to the desired function. All of the segments on the meter LCD (Liquid Crystal Display) will turn on for one second as part of a self-test routine. After the self-test is completed, the meter is ready for normal operation.

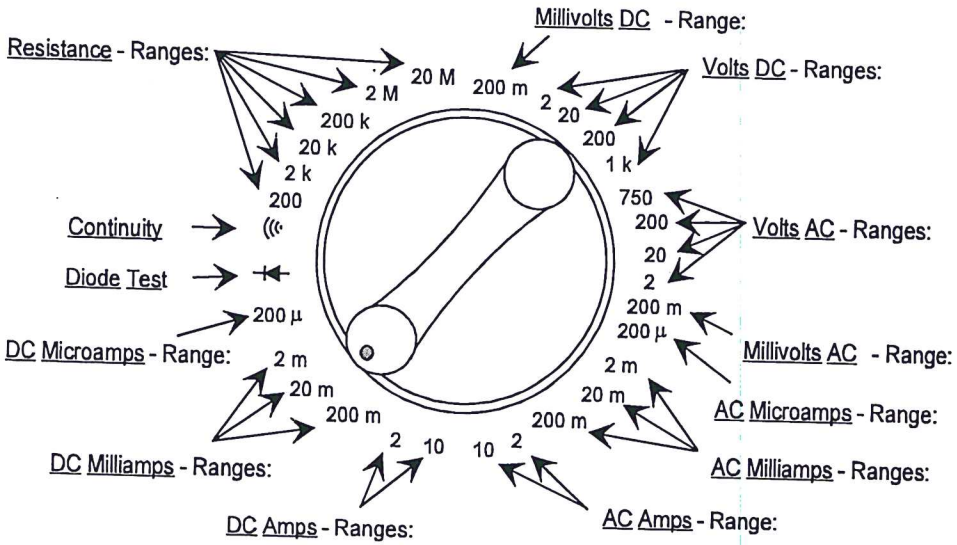

Figure 2-B: Rotary Switch

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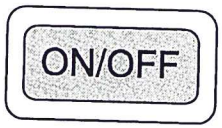
Push-buttons and Symbols



- Press to toggle the meter On or Off

- Press to hold the present reading
- Press again to exit

Figure 2-C: Push-buttons

V - Volts
mV - millivolts (1/1,000 of a volt)
A - Amperes (amps of current)
mA - milliamperes (1/1,000 of an ampere)
µA - microamperes (1/1,000,000 of an ampere)
Ω - Ohms or resistance measurement
KΩ - Kilohm (1,000 ohms of resistance)
MΩ - Megohms (1,000,000 ohms of resistance)
COM - Return Terminal for all measurements
·))) - Indicates continuity
⊣◀ - Indicates diode test

Display

The ADM 5200 offers a large easy to view digital display. If a measurement is to large to be displayed, " 1.---" (overload) is shown on the digital display

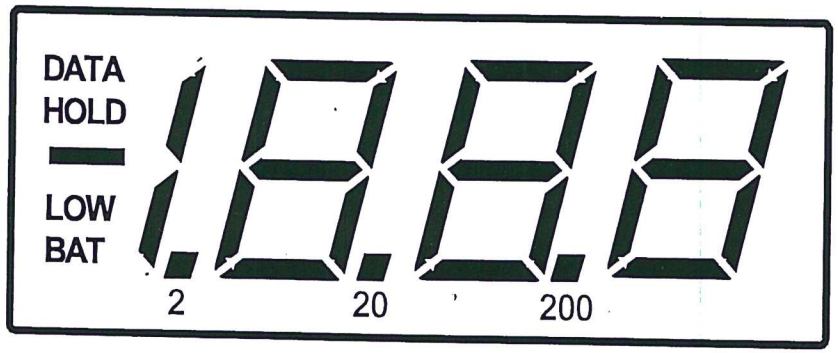


Figure 2-D: Display

CHAPTER 3 - AUTOMOTIVE MEASUREMENTS WITH A DMM

The technology around us is rapidly changing the way things work. Almost all of today's vehicles have on-board computer systems. The same type of electronic components and computers used in rockets and spacecraft are now being used in today's vehicles. Servicing, repairing and installing this electronic equipment requires many of the diagnostic tools used by the aerospace industry. One of the most common electronic diagnostic tools is a DMM. A DMM is simply an electronic yardstick for making electrical measurements.

DMMs like the ADM 5200 have special functions and features, like auto-polarity and data hold, making it easy to use when measuring volts, ohms and amperes. This next section shows some common automotive applications for troubleshooting and diagnosing electrical problems on vehicles using the ADM 5200. Each application consists of a left and right page. The left page uses an illustration to describe a particular measurement being made. The right page describes the step by step procedure required to make a particular measurement. In each application a typical value is shown only as an example, individual measurements will vary do to various operating conditions.
*(**Note:** Always refer to the vehicle manufacturer's specifications.)*

***CAUTION** - Never attempt to make a voltage measurement with the test probes in the current jacks. Even though your meter is protected, meter damage or even personal injury could still result ! This is a very common operator error and causes a direct short across the component or circuit being measured through a low-value resistor inside the DMM, called a current "Shunt". If a high enough current flows through the DMM it could still damage the meter, the circuit or even injure the operator. The ADM 5200 has current input fuse protection to prevent this kind of damage. In most cases, if you exceed the fuse rating the only thing that should happen is the fuse will blow.*

*(**Note:** If the fuse has blown, the display will read 0.00 and you will be unable to make a measurement on that range or function. Always make sure the power is off before cutting or unsoldering the circuit and inserting the DMM for current measurements. You should remember, that even small amounts of current can be dangerous.)*

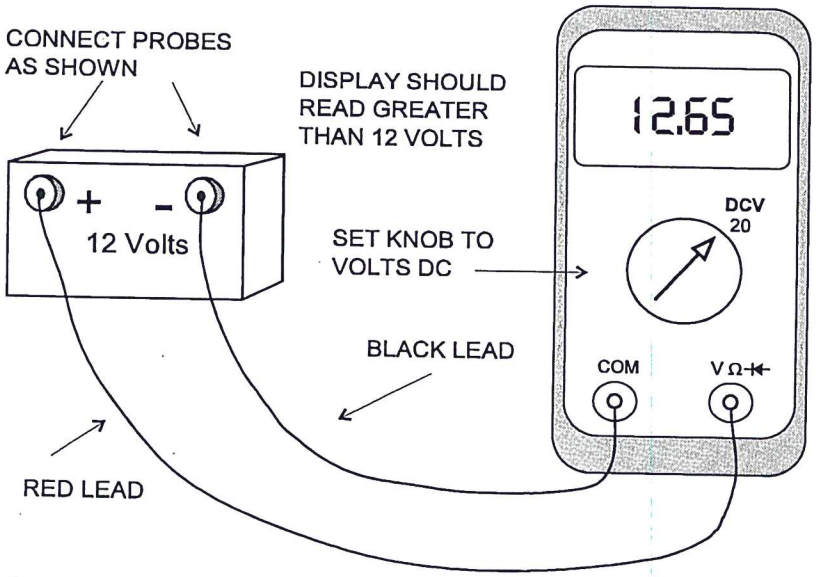


Figure 3-A: Measuring DC Voltage

Since maintenance free batteries are sealed, you can not check the electrolyte using a hydrometer. Instead, disconnect the battery from the vehicle and measure the no-load voltage to test it's charge, measuring the voltage across the battery terminals. A fully charged battery will display at least 12.6 volts (see chart on next page). On non-maintenance free batteries, individual cells should be checked using a hydrometer. Since voltage tests only show the charge state, not the battery condition, you should also perform a load test to indicate the battery's performance. *(**Note:** To perform a battery load test properly, be sure to consult the manufacturer's specifications and test procedures.)*

MEASURING DC VOLTAGE

Definition: DC stands for **D**irect **C**urrent - this means the current (and voltage) is in a steady or constant state.

Exercise explanation: This exercise will familiarize you with setting up the DMM to measure DC volts. Measuring DC voltage is probably one of the most common measurements you will be required to make.

Exercise:

1. Press the green On/Off button, to turn on the meter.
2. Set the function switch to the 20 Volts DC range.
3. Plug the black test lead into the COM input.
4. Plug the red test lead into the V Ω ⊣◄ input.
5. Connect the black test lead to the negative (-) side of the battery.
6. Connect the red test lead to the positive (+) side of the battery.
7. Note the reading on the DMM should be over 12 volts.
8. Press the data hold "DATA-H" button and compare to the chart below. *(**Note:** A low voltage battery condition does not necessarily indicate a bad battery. If you pressed the data hold button to freeze the reading, remember to press the data hold button again to return the DMM to normal operation.)*

No-Load 12 Volt Vehicle Battery Test

Actual Voltage Level	12.60V (or greater).....100%	Approximate Percent Change
	12.45V.....75%	
	12.30V.....50%	
	12.15V.....25%	

Application: The most common uses for measuring DC volts will be to check for voltage drops and to verify the proper voltage level is arriving at a sensor or circuit.

*(**Note:** For DC readings of the correct polarity (+/-) touch the red test probe to the positive side of the circuit, and the black probe to the negative side or circuit ground. If you reverse the connections, the ADM 5200 has automatic polarity and will display a minus sign indicating a negative polarity. Remember, with an analog meter you risk damaging the meter if you reverse the test leads.)*

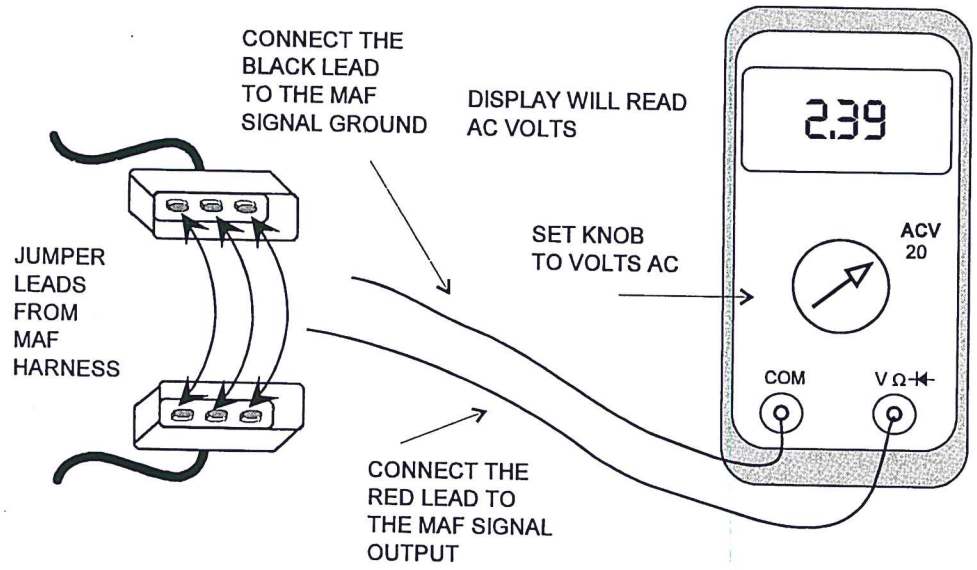


Figure 3-B Measuring AC Voltage on a Digital MAF Sensor

*(**Note:** With the engine running at a fast idle you should see a steady AC voltage. When you gently tap on the MAF sensor if the AC voltage jumps up or down and the engine misses, you may have a bad MAF sensor.)*

MEASURING AC VOLTS ON A DIGITAL MAF SENSOR

Definition: AC stands for Alternating Current - this means the current (and voltage) is alternating between a negative and a positive level.

Exercise explanation: This exercise demonstrates using the DMM to measure AC volts to find intermittent failures.

Exercise:

1. Press the green On/Off button, to turn on the meter.
2. Set the function switch to 20 Volts AC range.
3. Connect the black test lead into the COM input.
4. Connect the red test lead into the V Ω ⊣◀ input.
5. Start the engine and let the vehicle idle.
6. Connect the black test lead to the negative (-) lead at the sensor or any other good quality ground.
7. Connect the red test lead to the positive (+) or signal output of the sensor.
8. Gently tap on the MAF sensor (voltage should remain steady).
9. If the AC voltage jumps, this indicates you may have an intermittent MAF Sensor.

Application: Anytime a voltage (or current) is alternating (or changing) between a positive and a negative level you will need to use the AC function on the meter. Typical AC signals you can measure on a vehicle are wheel speed sensors, vehicle speed sensors and at the alternator output.

CHECKING CONTINUITY

Continuity is a quick go/no-go resistance test that can distinguish between an open and a closed circuit. The ADM 5200 has a continuity beeper which allows you to complete continuity tests quickly and easily. The meter beeps when it detects a closed circuit or short, so you do not have to look at the meter during the test. You can use continuity tests to determine: good or blown fuses and fusible links, open or shorted conductors and wires, the operation of switches and check circuit paths (by circuit or conductor tracing). You may want to try this by touching the test leads together.

*(**Note:** A resistance of more than a few hundred ohms will show up as an open circuit.)*

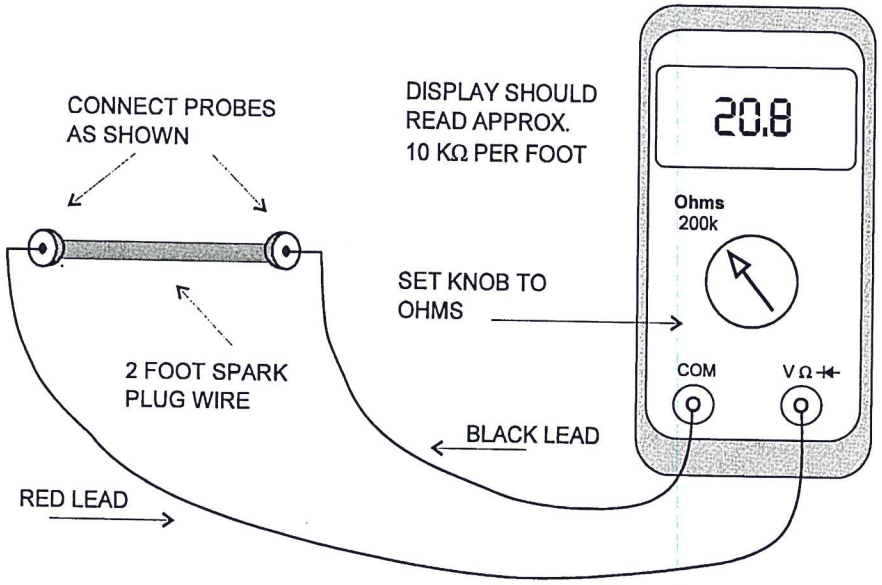


Figure 3-C: Typical Resistance Measurement

*(**Note:** This example uses a resistor spark plug wire that has been removed from a vehicle. The measurement you make will be dependent on the length of wire you select. Be sure the probe tips make contact with the center conductor of the wire.)*

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MEASURING RESISTANCE

Definition: Resistance represents the amount of opposition to current flowing through a circuit. Resistance is measured in Ohms (Ω) and resistance values can vary greatly, from a few milliohms (mΩ) for contact resistance to billions of Ohms for insulators. The ADM 5200 can measure down to about 0.1 Ohms and measure as high as 20 MΩ or (20,000,000 Ohms). Infinite resistance is displayed as " 1.---" and means the resistance is greater than the meter can measure. Open circuits will also read " 1.---" on the meter's display.

Exercise explanation: This exercise will familiarize you with setting up the DMM to measure resistance. Next to measuring DC voltage, resistance is probably the second most common measurement you will be required to make.

Exercise:

1. Press the green On/Off button, to turn on the meter.
2. Set the function switch to the 200K (Ω) Ohms.
3. Plug the black test lead into the COM input.
4. Plug the red test lead into the V Ω ⊣◀ input.
5. Remove a resistive spark plug wire from a vehicle.
6. Connect the black test lead to one side of the spark plug wire.
7. Connect the red test lead to the other side of the spark plug wire.
8. View the reading on the DMM, a typical value for a resistive spark plug wire is approximately 10 KΩ per foot. *(**Note:** Be sure to check the unit of measurement and any multipliers such as - Ohms {x1}, Kilohms {x1,000}, or Megohms {x1,000,000}.)*

CAUTION: Resistance measurements should always be made with the circuit power off, otherwise damage to the meter, the circuit or you may result.

Application: Some of the most common uses for measuring resistance are to determine the resistance of a load, the resistance of a conductor (wire, cable or switch), the value of a resistor or component and to verify the operation of a variable resistor.

*(**Note:** Touching the test leads together will tell you the lead resistance, typically between 0.5 Ω to 1.5 Ω. Normally, if the lead resistance in the test leads is greater than a few Ohms they should be replaced.)*

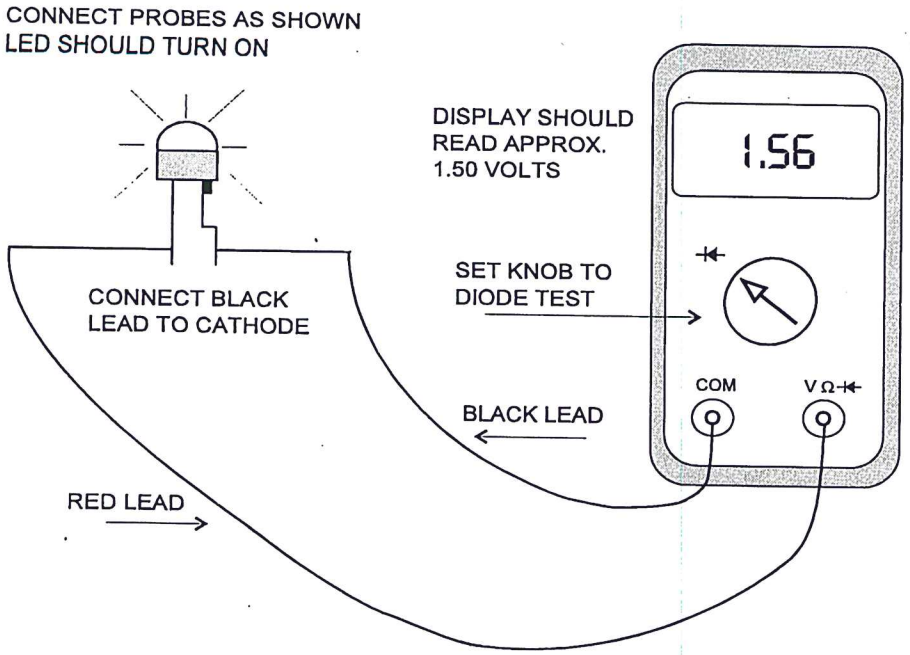

Figure 3-D: Typical Diode Test Using an LED

A good demonstration of performing a diode test is to use an **LED** (**L**ight **E**mitting **D**iode). A light emitting diode is a certain type of diode that emits light when it's junction is turned on. LED's are commonly used in many different applications in place of light bulbs because of their low power consumption. The previous example is something you can try using a common LED. *(**Note:** You may wish to purchase some inexpensive LED's from a local electronics supply store for this exercise.)*

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PERFORMING A DIODE TEST

Definition: A diode is an electronic switch that turns on when the voltage is over a certain level, generally greater than 0.3 volts for a silicon diode, and allows current to flow in one direction.

Exercise explanation: The ADM 5200 has a special mode called "Diode Test". In this mode, the readings across the diode will typically be greater than be 0.7 volts in one direction, and indicate an open circuit in the other. This indicates a good diode. If both readings are open circuit (" 1.---") then the diode is open, if both readings indicate continuity (or 0 volts) then the diode is shorted.

Exercise:

1. Press the green On/Off button, to turn on the meter.
2. Set the function switch to Diode test.
3. Connect the black test lead into the COM input.
4. Connect the red test lead into the V Ω ⊣◀ input.
5. Connect the black test lead to cathode side of the LED. *(**Note:** the cathode is normally indicated by a notch, or line on the body or lead of the diode or LED.)*
6. Connect the red test lead to the anode side of the LED.
7. Note the reading on the display.

Application: One of the most common automotive uses for the diode function is to test the diode pack on a typical alternator. The best way to perform the alternator diode test is to remove the diode pack from the alternator then touch one test probe to one side of the alternator diode pack and touch the other test probe to the other side of the alternator diode pack, record the reading then reverse the probes and repeat the test. On one of the tests the meter should display the voltage drop across any two diodes in series typically about 0.8 volts, testing in the other direction should display "1.---", which means the meter has over ranged. If the reading is approximately 0.4 volts, one diode is shorted, a reading below 0.2 volts indicates two shorted diodes.

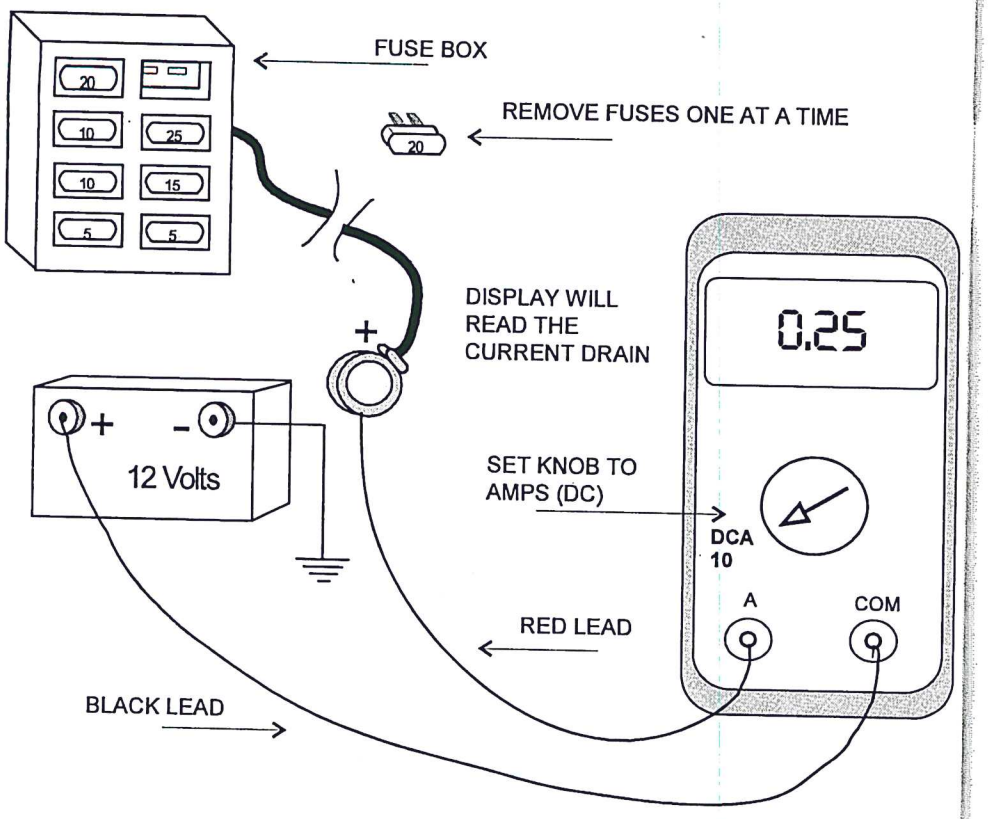

Figure 3-E: Measuring DC Current

CAUTION - When measuring current directly with your DMM, in order to avoid blowing the meter's fuse, use the 10 Amp input and never crank the engine or operate accessories that draw more than 10 amps. It is possible to damage the meter, possibly beyond repair, or at the very least, blow the 10A fuse. To check the entire system for current drains, with the key off, connect the DMM in series with the battery then set up the meter to read 10 amps. With the ignition key in the off position, this test will show the total current drain in the system, known as the normal "Parasitic Load".

MEASURING DC CURRENT

Definition: This exercise will help you locate any excessive current drains in a vehicle's electrical system by measuring DC current.

Exercise explanation: To perform this test you will need to connect the DMM in series with the battery using the current function on the 10 amp range. You should keep in mind that on most late model cars there are many computer circuits that draw current and they may not all be on the same fuse. Do not forget that hood lights, trunk lights, dome lights and computers all draw current and may be on while you are working on the vehicle. *(**Note:** Check the manufacturer's specifications to find the acceptable level of parasitic load.)*

Exercise:

1. Press the green On/Off button, to turn on the meter.
2. Set the function switch to the 10 Amp DC current position. *(**Note:** Make certain that all accessories and lights are turned off or disconnected before proceeding.)*
3. Connect the black test lead into the COM input.
4. Connect the red test lead into the 10 amp current "A" input.
5. Disconnect the positive battery cable from the battery.
6. Connect the red test lead to the positive battery cable.
7. Connect the black test lead to the positive battery terminal.
8. Note the current reading on the display.
9. You will need to isolate the circuit causing the current drain by pulling one fuse at a time while watching the multimeter display. If the current reading drops to near 0 amps you will have found the problem circuit.
10. Once the problem circuit is isolated you will need to reinstall the fuse and disconnect the components in that circuit one at a time to find the defective component.

Application: Current drains that cause dead batteries are often referred to as shorts, even though they are not actually short circuits. Each vehicle has a certain amount of parasitic load that is considered normal, any current drain that exceeds that amount should be located and stopped. On older vehicles prior to the introduction of electronic ignition and computer control systems, you will find the parasitic load will be very small, only a few milliamps or less. On newer vehicles the parasitic load can be as high as several hundred milliamps or more. *(**Note:** Check the manufacturer's specifications on normal parasitic load.)*

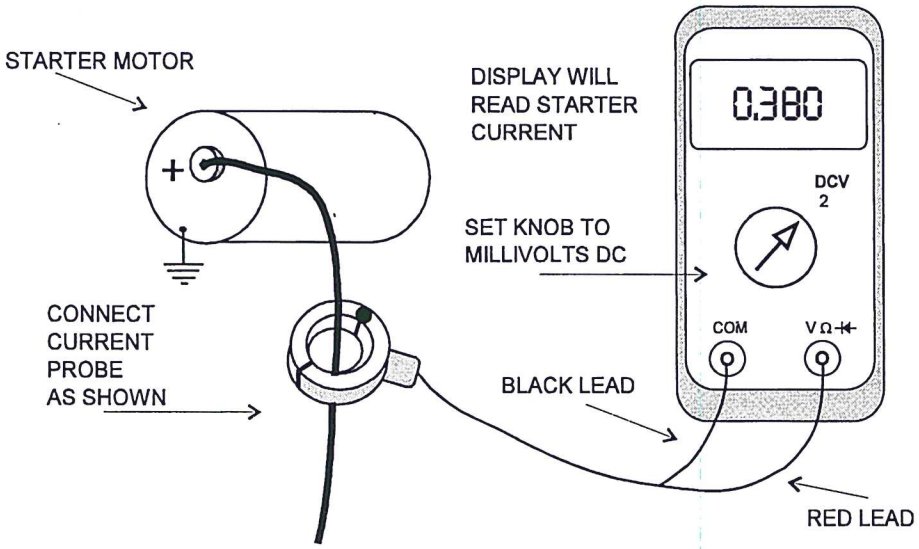

Figure 3-F: Measuring DC Current Using a DC Clamp-on Probe

There are two basic types of current probes: current transformers, which measure AC current only and Hall effect probes, which can measure AC or DC current.

The output of a current transformer type of clamp-on is typically a 1,000 to 1 or 1 milliamp per 1 amp. A 100 amp value is reduced to 100 milliamps, which can be safely measured by most DMMs. The probe leads are connected to the "mA" and "Common" input jacks, and the meter function switch is set to mA or Amps AC.

The output of a Hall effect probe is also typically 1,000 to 1, however the current is converted to a voltage. For example, 1 millivolt equals 1 amp, (AC or DC) so, 100 amps AC is converted to 100 mV AC. The probe leads are connected to the "V" and "COM" jacks and the meter function switch is set to the "V" or "mV" scale, selecting V AC for AC current or V DC for DC current measurements.

MEASURING DC CURRENT USING A DC CLAMP-ON PROBE

Definition: The DC clamp-on current probe is an accessory that allows you to make DC current measurements that exceed the 10 amp limitation of the DMM and you can make these measurements without breaking the circuit (the clamp opens up to clamp around a single wire). *(**Note:** When using a clamp-on current probe, make certain you only clamp around one wire at a time.)*

Exercise explanation: The current probe allows measuring high current (in excess of 10 amps) without breaking the circuit to make a measurement. In this example we will be using a Hall effect current probe.

Exercise:

1. Disable the vehicle, so it will not start.
2. Press the green On/Off button, to turn on the meter.
3. Set the function switch to the 2 Volts DC range.
4. Connect the black test lead, from the clamp-on, into the COM input.
5. Connect the red test lead, from the clamp-on, into the V Ω ⊣◀ input.
6. Clamp the current probe around the battery cable connected to the starter motor.
7. Crank the engine and note the reading on the display.

*(**Note:** Under normal operating conditions, with an outside air temperature of 70° F a rough approximation for calculating cranking current is one Amp per cubic inch displacement or 65 Amps per liter, plus or minus about 25%. Check the manufacturer's specifications for the correct starter cranking current.)*

Application: You can use current clamp-on probes to measure AC or DC current any time you need to measure current in excess of the 10 amp input on the meter or anytime you need to make a current measurement where it is not practical to cut a wire to make a current measurement, such as measuring the current draw of the fuel pump.

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ADM 5200 MULTIMETER SPECIFICATIONS

FUNCTION	RANGE	RESOLUTION	ACCURACY	IMPEDANCE
DC Volts 1000V DC Max. Input	200 mV 2 V 20 V 200 V 1000 V	0.1mV 0.001V 0.01V 0.1V 1V	± 0.5% rdg ± 1 digits	10 MΩ
AC Volts 750V AC Max. Input	200 mV 2 V 20 V 200 V 750 V	0.0001V 0.001V 0.01V 0.1V 1V	± 1.2% rdg ± 3 digits ± 0.8% rdg ± 3 digits	10 MΩ
DC Amps	200 µA 2 mA 20 mA 200 mA 2 A 10.00A	0.1µA 1µA 0.01mA 0.1mA 1mA 0.01A	± 0.5% rdg ± 1 digit ± 1.2% rdg ± 1 digit ± 2% rdg ± 5 digits	
AC Amps	200 µA 2 mA 20 mA 200 mA 2 A 10.00A	0.1µA 1µA 0.01mA 0.1mA 1mA 0.01A	± 1% rdg ± 3 digits ± 1.8 % rdg ± 3 digits ±3% rdg ± 7 digits	
Ohms 600V DC or Peak AC Max. Input	200 Ω 2 KΩ 20 KΩ 200 KΩ 2 MΩ 20 MΩ	0.1 Ω 0.001 KΩ 0.01 KΩ 0.1 KΩ 0.001 MΩ 0.01 MΩ	± 0.5% rdg ± 1 digit ± 1% rdg ± 2 digits	