TESTING RECTIFIER DIODES
The What, Why and How



BY BOB THOMAS

The best way to efficiently test any rectifier is by using a purpose-built diode tester or multi-component tester that was designed specifically for automotive electrical rebuilders. The JIMCO SR200 can reliably and quickly test diodes, stators or rotors, all with one piece of equipment. I highly recommend it if you are lacking this critical apparatus.

However, if you need to evaluate a used rectifier and you do not have such a tester, there are other, less convenient ways to get it done. But before we head in that direction, you must first understand exactly what you are testing for, and how that can tell you the condition of a diode.

When a diode totally fails, it is either shorted or open. If you have been in this business for a long time, then you already know that open diodes are far more common than shorted ones. That is because a shorted diode is a dead short. If the alternator is otherwise working and there is alternating current output in the stator, then a shorted diode will pass a lot of reverse current, over heat rather quickly and blow itself open. This scenario can also burn a stator winding in the process.

Open and shorted diodes can easily be found using a multi-meter to measure for resistance and then reversing the leads. But that is only giving you a minimal amount of information - if the diode is open or shorted. When reclaiming a rectifier that has no open or shorted diodes, you should also verify the condition of its diodes. There are two measurable characteristics that indicate a diode's condition. They are **forward voltage drop** and **reverse current leakage.** These are what purpose-built diode testers use to pass or fail diodes.

Forward Voltage Drop

Every diode loses some voltage as current passes through it in a forward direction. It is kind of like walking through a doorway. You must first open the door, which takes some energy. That required energy is about 0.7 volt at room temperature for the silicon diodes in virtually all automotive alternators. The drop will increase slightly as the diode's temperature rises and it can increase to as much as 1.3 volts.

To measure that drop, you must pass current through the diode. While even a small amount of current can be used, the better diode testers use 20 to 30 amps of alternating current, which simulates something close to what the diode will see in real life. The JIMCO SR200 generates 25 amps of AC to test rectifier diodes.

Home building a piece of equipment to do that would be an expensive challenge in both time and money, with no guarantees of how well your creation might work. But a constant current DC power supply can be used to determine a diode's forward voltage drop at room temperature.

These small power supplies can be purchased online from a variety of sellers for less than $100. They can be used for testing several different components by providing the option of setting either the voltage or the current level, which will remain constant when the leads are applied to a load. If you set the voltage at say, 14 volts and apply the leads to a rotor's slip rings, it will provide the current draw of that rotor.

The one that I use can produce current up to 10 A and voltage outputs up to 30 V. It allows me to control the voltage output and measure amperage, or control the amperage output and measure voltage. I have found it to be a handy tool and use it to test numerous components. It is ideal for measuring a coil's amperage draw be it a rotor or a set of generator field coils. It can supply any voltage up to its limit, down to one tenth of a volt.

To test forward voltage drop through a diode, I connect the diode to the constant current supply in the correct polarity to pass current (*see Figure 1*). This is a positive diode so the stem (stator side) is negative and the diode's body is positive. Then I slowly increased voltage, one tenth of a volt at a time. In the first photo, it was up to 0.6 volts and no current was getting through yet. As soon as I increased it to 0.7 volts (*see Figure 2*), current began to flow. When using this method, do not crank up too much voltage, as the current will rise quickly and exceed the power supply's capacity.

Reverse-bias Current Leakage

There is also a secondary current flow taking place inside the diode at the P-N junction. It is called **reverse-bias leakage.** When reverse voltage (which accounts for half of the AC output of a stator) is applied to a diode, a very small amount of that reverse current makes it through the diode. Typically measured in micro-amps, it is an insignificant amount in relation to an

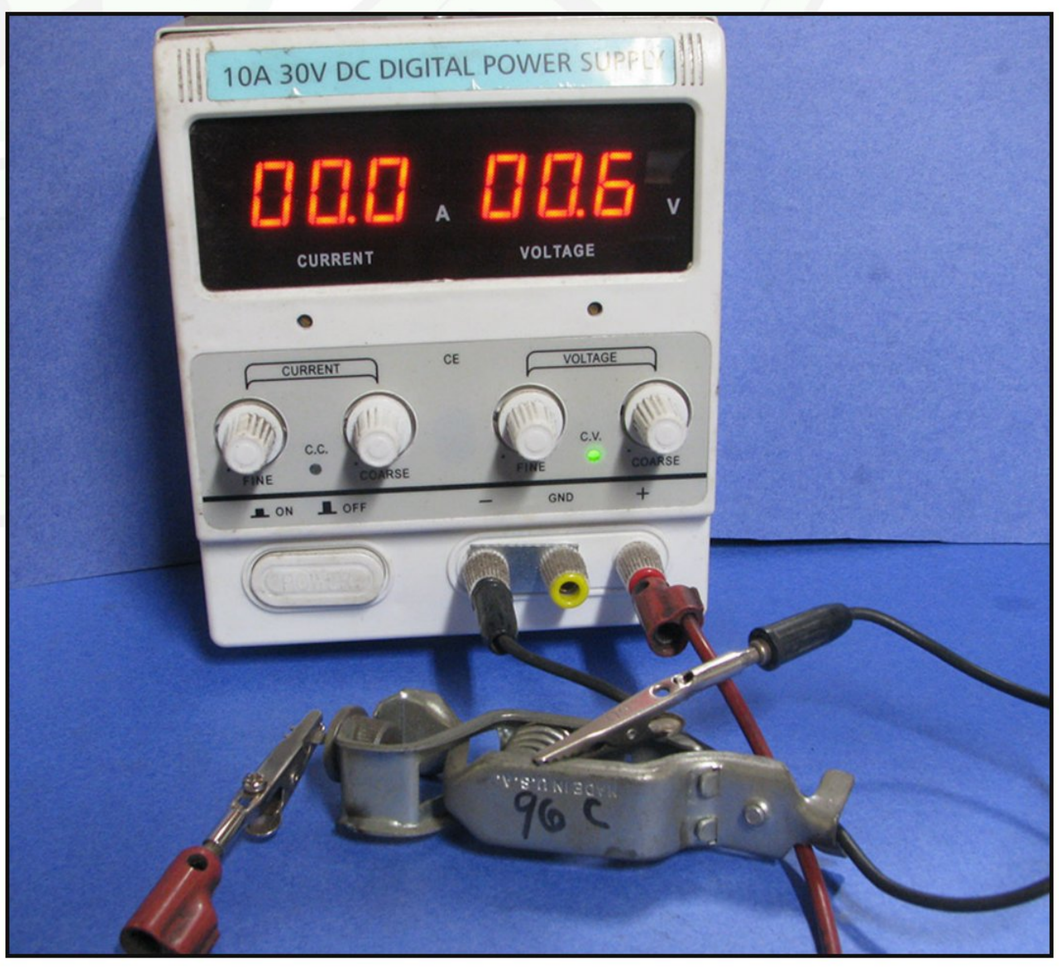


Figure 1 – Applying 0.6 V forward bias to a diode – no current flow

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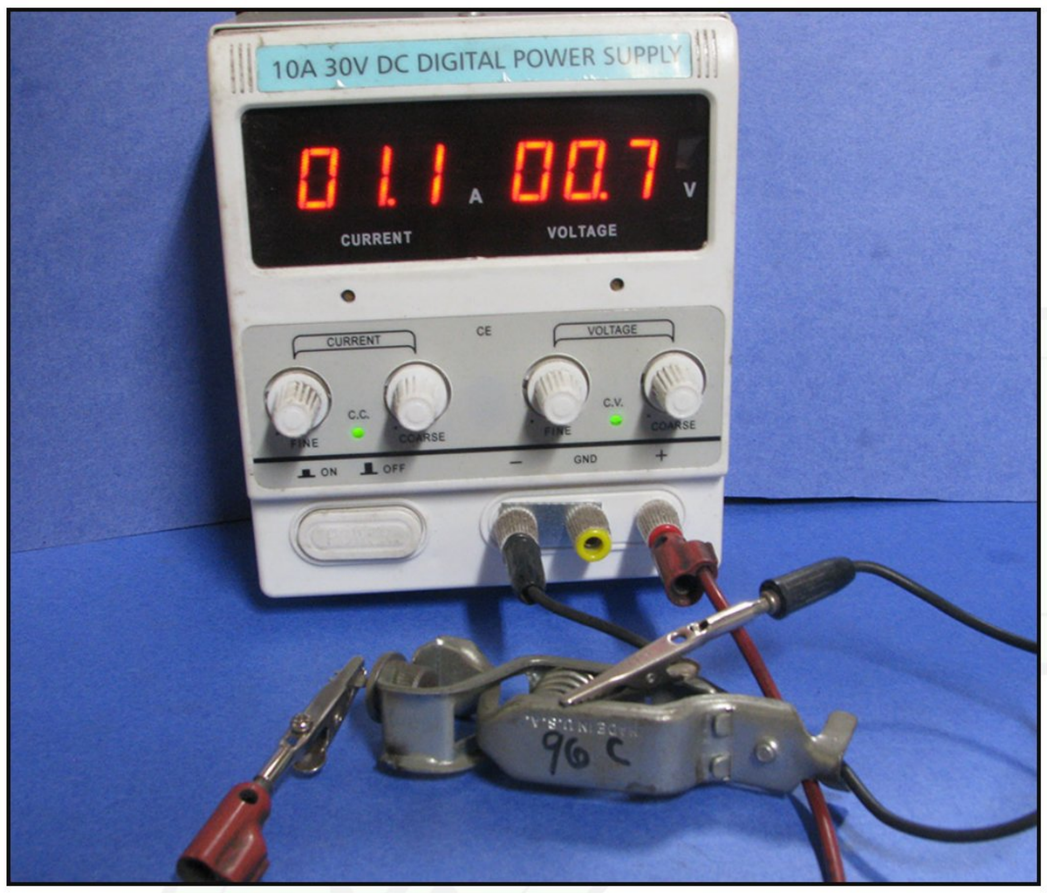


Figure 2 – Applying 0.7 V forward bias – passing current after reaching forward voltage drop.

alternator's output. One micro-amp (abbreviated µA), is equal to one millionth (1/1,000,000) of one amp.

Reverse leakage is the best indicator of the condition of the P-N junction. As a diode ages and begins to degrade, that current leakage will increase. It is very important to test any diodes that you reclaim for leakage, as this test will reveal those diodes that are already on their way to failure and would be likely to cause a warranty claim.

When testing for leakage on a used rectifier, **it must be clean and free of any contamination,** especially on the potting compound around the stem. Even a small amount of dust can fail a perfectly good diode. You must also be careful not to touch the leads when testing (*see Figure 3*). Here I am touching both leads using an Ace diode tester and you can see that the scale reads 33 µA. Tested correctly (*see Figure 4*) the meter reads 1 µA.

When testing for reverse leakage most diode testers apply a voltage that is higher than normal charging voltage. The Ace 1129 tester applies 100 volts unless it is switched to the avalanche diode setting. So about 20 volts DC, which is below avalanche voltage in most cases, can be used to measure reverse leakage in most rectifiers today. That is well within the range of a constant current power supply.

In the photo (*see Figure 5*), I am applying 27 volts reverse bias to a standard diode in a used 10SI rectifier, as it would be connected to a battery in an alternator. I am routing the current through

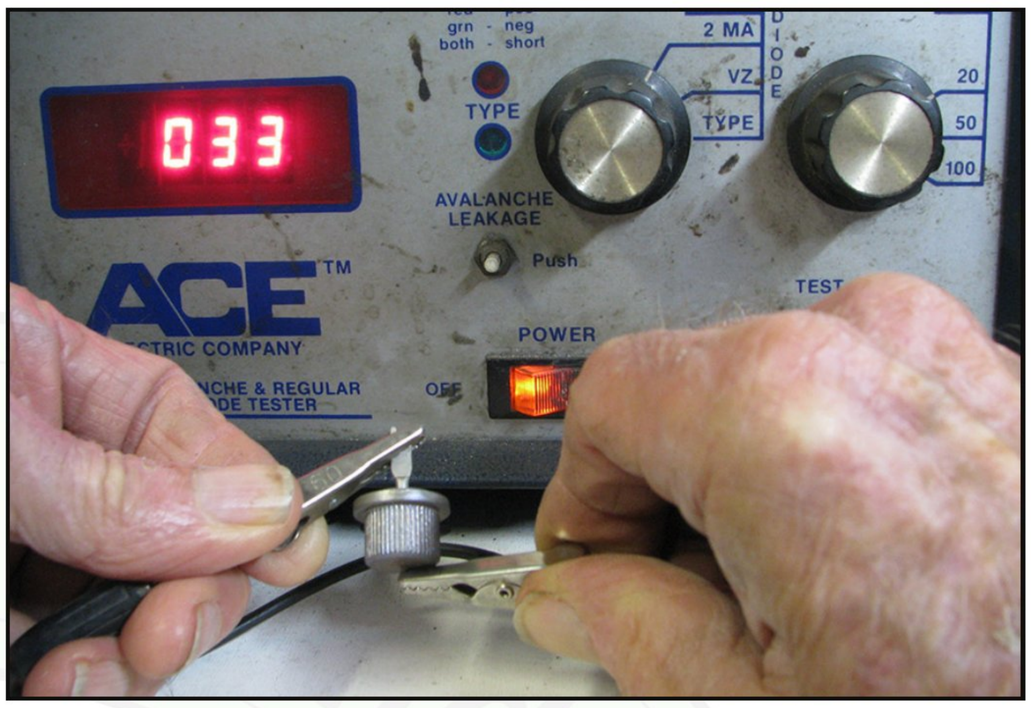


Figure 3 – Wrong way to hold leads when testing for reverse current leakage.

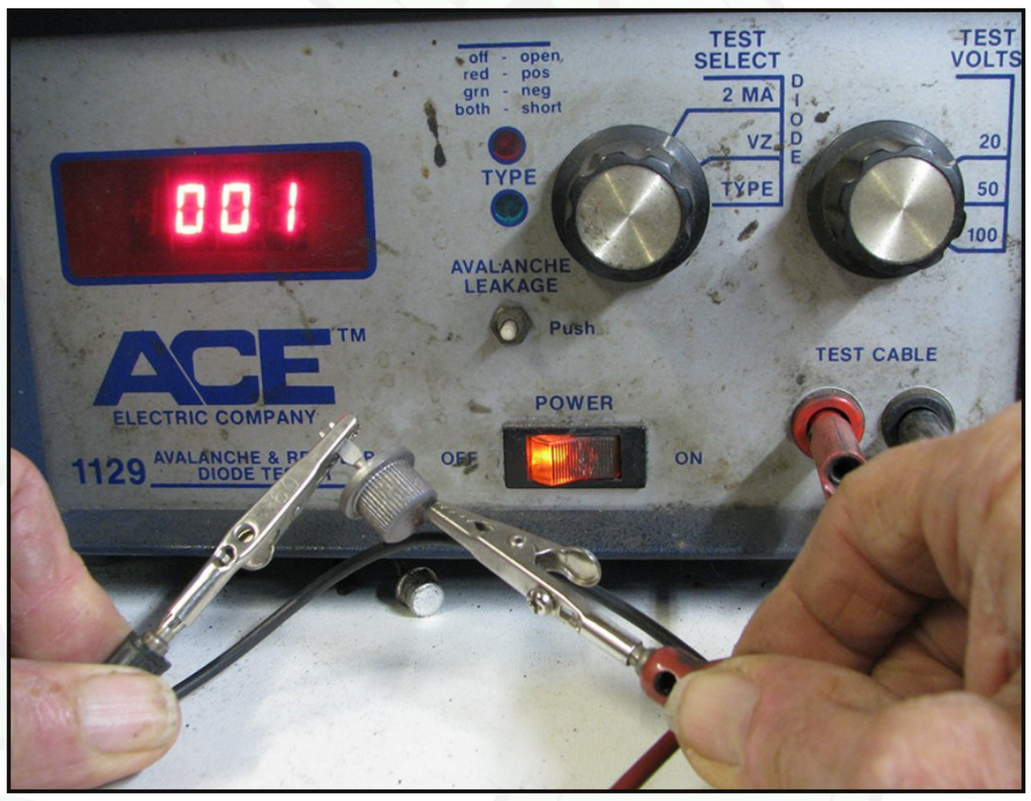


Figure 4 – Proper way to hold leads when testing for reverse current leakage.

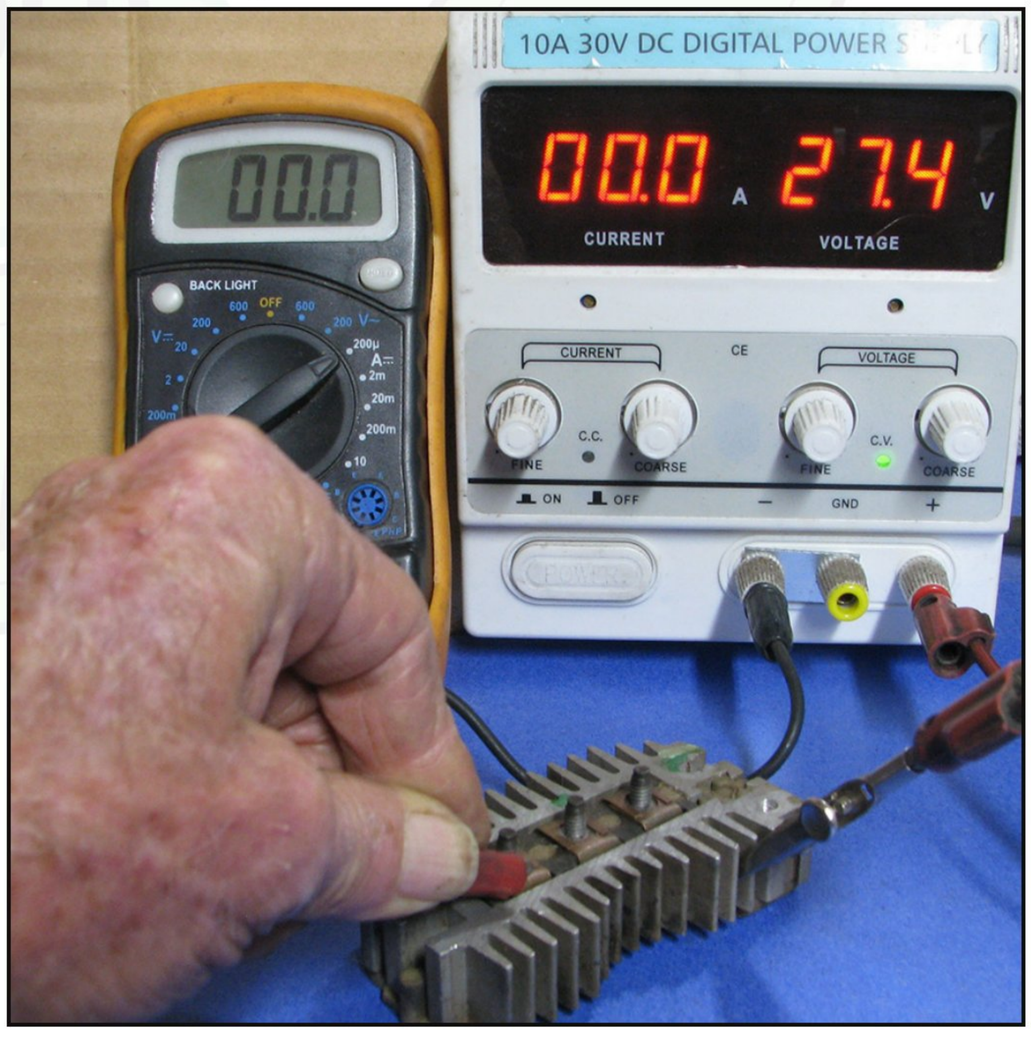


Figure 5 – Testing a 10SI rectifier for reverse-bias leakage using a constant current power supply.

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a multi-meter set on the 200 µA scale. As you can see, the meter reads zero, meaning the leakage in this diode is well below 1 µA. A reliable diode should read no higher than 2 µA.

Using the same setup, I tested a suspected Leece Neville rectifier (*see Figure 6*). The leakage was so high that I had to use the milliamp scale to read it, 0.642 mA, or 642 µA. This of course was an extreme case. This particular diode was shorted for all practical purposes.

Avalanche Diodes

Avalanche diodes are used to bleed off unwanted transient spikes and protect electronic parts in most alternator rectifiers today. When they first began to appear about two decades ago, much ado was made about verifying the correct avalanche voltage for the vehicle, which generally varied around double the charging system voltage. Most diode testers made since then have settings to determine a diode's avalanche voltage, like the Ace 1129. I probably tested several hundred rectifiers for their avalanche voltage and never found one that passed the leakage test but then failed to avalanche correctly. So if reclaiming a rectifier for the same unit that it came out of, I would probably not bother to test each diode's avalanche point.

An old friend, who was an electronics engineer, once told me, "A good used diode is just as reliable as a brand new one and in some ways even better. It has already been tested in the field." He was basically right, but I would have to add: "So long as it has been tested properly."

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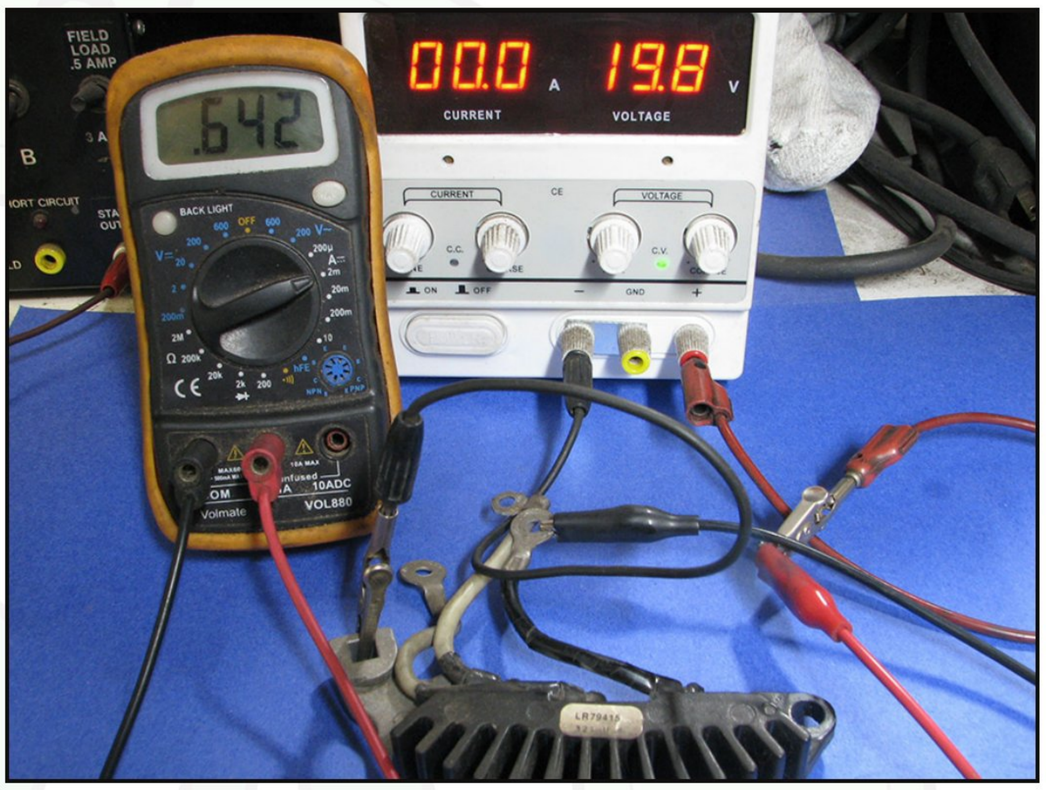


Figure 6 – Testing a faulty Leece-Neville rectifier for reverse current leakage.

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