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How To Test Industrial SCRs And Triacs With Your LC102 AUTO-Z™ And The SCR250

Silicon controlled rectifiers (or SCRs, as they are more commonly called) have become very popular as power switching devices in applications ranging from consumer grade light dimmers to industrial motor controls and welders. They are used to control as much as 2000 amps of current at several thousand volts.

Along with the SCR, the triac has become a popular switching device. Like other electronic components, SCRs and triacs can fail and need to be tested. Tech Tip 125 explains the characteristics and operation of consumer level SCRs and triacs. This tech tip covers heavy-duty and industrial SCRs and triacs, how they fail, and how you can test them with your LC102 AUTO-Z and SCR250 SCR & TRIAC TEST ACCESSORY.

How Does An SCR Work?

An SCR is a three lead device that functions like a DC switch when given the proper control signal. An SCR has a cathode lead and an anode lead just like a standard rectifier. A third lead, called the gate lead, controls the operation of the SCR. Figure 1 shows the symbol used on schematics for an SCR. An SCR functions like an open circuit when it is ''turned off'' and like a diode when the SCR is ''turned on''. This SCR action is controlled by the signal applied to the gate lead. Notice that the symbol looks similar to a diode with the exception of the gate lead.

With no gate current applied to the gate lead, the SCR acts like a switch that is in the off position. When a sufficient gate current (trigger current) is applied, the anode-cathode junction is turned on and conducts current. Once the SCR is turned on, it continues to conduct current (latch), even if the trigger current is removed. The only way to turn an SCR off is to reduce the current flowing between anode and cathode below the holding current level.

SCRs are current-operated devices, so sufficient trigger and holding currents are much more important for SCRs to operate than are the voltage potentials applied to the terminals. Trigger currents vary from only 200 microamps in small SCRs to as high as 150 mA in industrial SCRs. These large SCRs may require 200 milliamps of holding current.

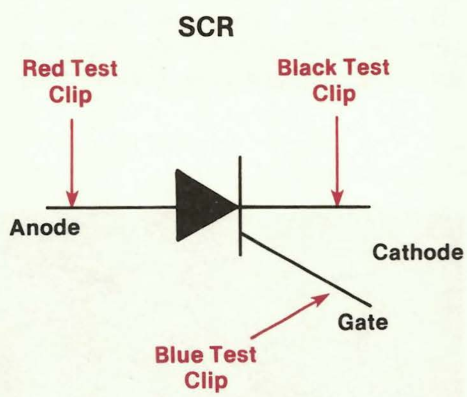

Fig. 1: Schematic symbol of an SCR with SCR250 test lead connections.

How Does A Triac Work?

A triac is a bi-directional device similar in operation to an SCR except that it passes current in both directions when ''turned on.'' Figure 2 shows the schematic symbol for a triac. Note that the symbol resembles two diodes facing opposite directions. A triac has three leads labeled: Gate, MT1, and MT2. The gate lead performs the same function as the gate lead on an SCR: it turns the device on. The other two leads are labeled differently from an SCR because the function of these leads changes with the polarity of the voltage applied to the leads. The triac lead electrically closest to the gate lead is simply called the Main Terminal 1 (MT1), and the other lead is called the Main Terminal 2 (MT2).

How Do SCRs Fail?

Most SCR failures are related to the gate. The SCR will not turn on if the gate junction opens. If the gate junction shorts to the anode, the SCR will self-trigger whenever the anode is more positive than the cathode. Finally, the SCR will not latch if the gate shorts to the cathode.

SCRs can also develop leakage. An SCR with leakage never fully turns off; it always conducts some current. Remember that industrial SCRs may have hundreds or thousands of volts across them. Some SCRs may break down at these higher voltages, so there may be no leakage until there are several hundred volts present.

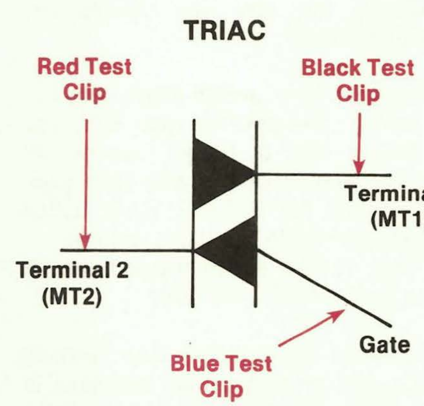

Fig. 2: Schematic symbol of a triac with SCR250 test lead connections.

How Do Triacs Fail?

Triac failures are much the same as SCR failures. They can develop opens or shorts just like SCRs. Also, a defective triac can properly pass current in one direction but fail to pass it in the other direction. The reason for this is that a triac functionally looks like two SCRs facing in opposite directions.

Like SCRs, triacs can become leaky. The SCR leakage tests apply to triacs, but in both directions. A defective triac can leak in one direction only or in both directions.

SCRs And Triacs Need A Dynamic Test

Testing industrial SCRs and triacs with an ohmmeter will miss all defects except direct shorts. An ohmmeter cannot supply enough current to trigger the SCR, nor can an ohmmeter check for most forms of leakage because it supplies only a few volts. You must use a dynamic test for reliable results.

A dynamic test must do two things. First, it must use enough current to trigger the device so you can be sure the SCR or triac actually operates. Second, it must have enough test voltage to isolate leakage problems. With the LC102 and SCR250, you have the required current capability and voltage up to 1000 volts to dynamically check all but the very largest industrial SCRs.

How To Test Industrial SCRs

You can test industrial SCRs with the SCR250 hooked between the SCR and the LC102. Using the following hints and procedures will give you reliable and consistent results:

There are two types of SCR gates: sensitive and normal. The sensitive gate SCRs use 2.6 mA or less of trigger current. All industrial type SCRs use a larger trigger current. With the NORMAL GATE button pushed, the SCR250 provides up to 62 mA of trigger current which will turn on the vast majority of industrial SCRs.

SCRs should be tested at their working voltage. You can program any voltage up to 1000 volts on the front panel of the LC102. Once you have the voltage programmed in and the SCR250 test leads hooked up to the SCR, you are ready to test.

The "turn-on" test is the first test you want to perform. First, push the SCR250's GATE CURRENT switch to the "ON" position. Now press the LC102's LEAKAGE button. The LC102 shows the current flowing from anode to cathode on its digital display. A good SCR will show flashing 888's on the LC102 digital display. This reading indicates the SCR is turned on and maximum current is flowing.

If flashing 888's are not obtained, the SCR has not turned on. This means either that the SCR is defective or the SCR's trigger current is too high to be turned on by the SCR250. A number reading on the display means the LC102 and SCR250 are reading some leakage path (possible an internal bleeder resistor), but the SCR is not turned on. The SCR250's gate current will turn most SCRs on, but a few may require a larger gate current.

Most industrial SCR failures involve either a shorted gate or leakage. The following test will find most of these failures. When in doubt, check the operating characteristics of the SCR or compare it to a known good one.

The final test for SCRs is the leakage test. First, set the GATE CURRENT button to the "OFF" position. Now, press the LC102 LEAKAGE button and note the reading on the LC102's digital display. It should show less than 10 microamps. Remember to test the SCR at its working voltage because many SCRs will not have any leakage at lower voltages. If the display shows more than 10 microamps or flashes 888's, the SCR is defective and should be replaced.

How To Test Industrial Triacs

Industrial triacs can also be tested for turn-on and leakage with the SCR250 and the LC102. Since triacs are similar to back-to-back SCRs, they must be tested in both directions. The SCR250 lets you do these tests in both directions by pushing either the POSITIVE or the NEGATIVE GATE BIAS switch.

As with SCRs, program your LC102 to the working voltage of the triac. Push the SCR250's GATE CURRENT button to the "ON" position and push the POSITIVE GATE BIAS button.

The "turn-on" test is first. Press the LC102's LEAKAGE button. A good triac will show flashing 888's on the digital display. Any other reading than flashing 888's indicates a defective triac or a triac that is out of the SCR250's turn-on range. Once again, when in doubt, check the operating characteristics or compare it to a known good one.

Fig. 3: Testing the SCR at the working voltage may show leakage when it wouldn't at a lower voltage.

The leakage test is next. This indicates the flow of current through the triac when it is turned off. This test looks for both a shorted triac and for any leakage that could be present when the triac is being operated at its working voltage.

First, set the GATE CURRENT switch to the OFF position. Next, press the LC102's LEAKAGE button and read the leakage on the digital display. If you read more than 10 microamps leakage or you read flashing 888's, the triac is leaky or shorted and should be replaced.

To check the triac in the opposite polarity, press the NEGATIVE BIAS button on the SCR250, and repeat the turn-on and leakage test.

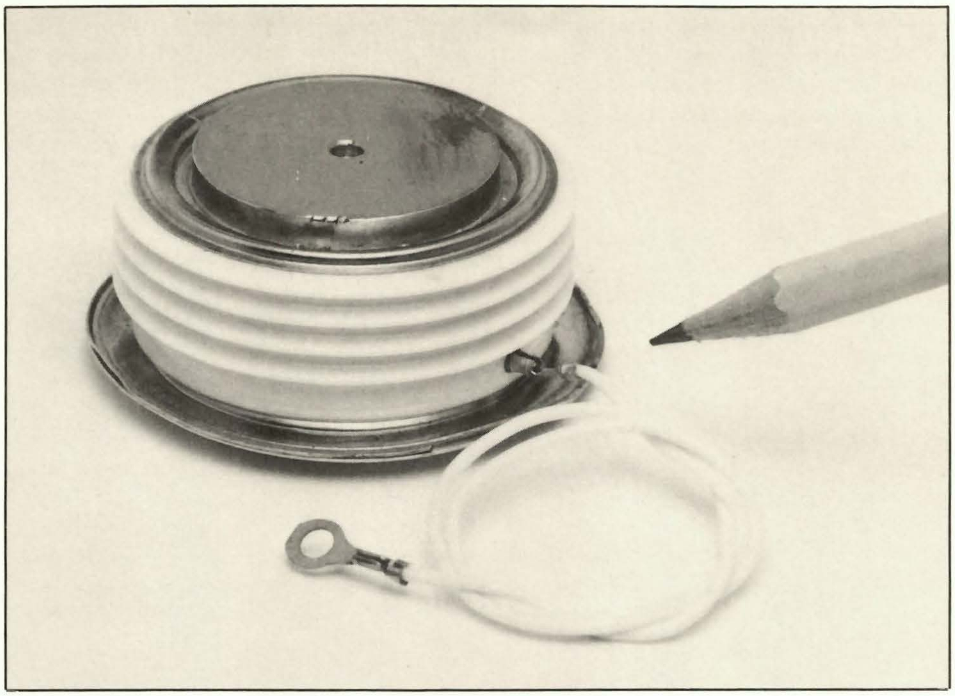

Fig. 4: The hockey-puck SCR gets its name because of its shape.

''Hockey-Puck'' SCRs

One of the most common industrial SCRs is commonly called the ''hockey-puck'' SCR. The hockey-puck SCR gets its name because of its shape as shown in figure 4. Hockey-puck SCRs test similarly to regular industrial SCRs except for a few differences.

Many hockey-puck SCRs are pressurized. A pressurized SCR will not turn on until a pressure is applied to the SCR plates. Until these plates are compressed, the gate will remain open at all times.

Typically, hockey-puck SCRs are very high-powered devices. If testing the SCR with the SCR250 and the LC102 doesn't prove the SCR good, you'll want to keep a couple of things in mind.

Check the operating characteristics of the SCR. If the trigger current is more than the SCR250 can supply, the turn-on test will not turn the SCR on. However, the leakage test will find the majority of problems in this type of SCR. When in doubt, compare the SCR to a known good one.

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