# RVSS soft starter SCR evaluation

## How to measure and evaluate SCRs in reduced voltage soft starters

### Application

A typical three-phase soft starter uses six SCRs oriented in an anti-parallel configuration to provide start and run control to industrial motors. The most common mode of SCR failure is the SCR shorting. Experience has indicated that there is often confusion in determining if an SCR has in fact become shorted, thereby shorting the power pole in which it is located.

### Overview

Checking the SCRs is a straightforward process, but several key factors must be kept in mind to conduct an accurate evaluation of the condition of the SCRs.

The proper equipment must be used to achieve accurate results. This does not necessarily translate into expensive test equipment, but a multimeter of known accuracy is crucial to obtaining reliable information. Ensure that your equipment has the capability to properly perform the test. As an example, many clamp meters from very reputable manufacturers have an ohms function. The problem is that when the specification sheet for the meter is consulted, many of these units only measure up to 2k ohms. This range is not appropriate for measuring SCR resistance.

One must also understand not only the location of the measurement points in any electrical circuit, but also the potential impact of other factors that may render test results unusable or grossly inaccurate. If any measurements are taken improperly, conclusions from these results may be costly when units are misdiagnosed.

### Understanding the process

#### Equipment

Under any given circumstances, test equipment will not provide accurate information to you. A multimeter of known quality/accuracy is critical. Furthermore, the resolution should be such that the user has a clear understanding of the values that are being indicated. The meter does not require an annual calibration to give an accurate assessment of SCR condition, but if you haven't used the meter in nine months, please keep in mind that observing a reading that does not make sense may be traced to the meter (battery?) not functioning properly and not the true condition of the SCR.

If the digital meter has an auto-ranging feature, it is often advisable to select the manual range to megohms. Some meters are known to drift significantly in their attempt to calculate the resistance scale, and the "bouncing" analog display may be difficult to interpret. In some cases, not enough time is taken to allow the reading to stabilize, leading to incorrect evaluations. Patience pays off here.

People will sometimes compare the readings from several pieces of equipment in their attempt to arrive at some meaningful conclusion. In too many cases, though, this process only complicates things further. This misinformation occasionally is used to support the diagnosis that one wants, rather than to honestly collect data to prove or disprove a suspected shorted SCR condition. Additionally, to those of you who have embarked on an activity to evaluate SCR condition, you have noted that the resistance will change depending on the angle/force you put on the probes, the condition of the probes/clips, and/or where the probes are placed on the power pole. Probe technique is not critical as long as you do the same thing the same way to each pole. Firm but not excessive probe force is normally the best method.

### Ineffective equipment test modes

Attempting to evaluate SCRs with a continuity test function and/or the diode test function does not result in any meaningful information as it only provides "pass" or "fail" type of information. In most cases, both of these functions result in an OL (overlimit or "open") indication. This only means that the SCRs and the internal bypass contactors are "open" and does not indicate any meaningful information relative to either component. In a converse fashion, if the reading is very low, either a shorted SCR, a stuck internal bypass contactor, or an undetected circuit defect may be indicated. These readings may also be misinterpreted due to the lack of an actual resistance value.

### Process

What the test is looking to achieve is to verify that a relatively high resistance of the SCRs exists. Two per-phase SCRs are oriented in positions of opposite polarity, so there is a small advantage to exchanging leads on functional SCRs to validate functionality. Both SCRs of a given phase should be relatively close to each other.

### Procedure

**Note:** Isolate the soft starter from both line and load connections. Failure to perform this simple task may invalidate any measurements taken.

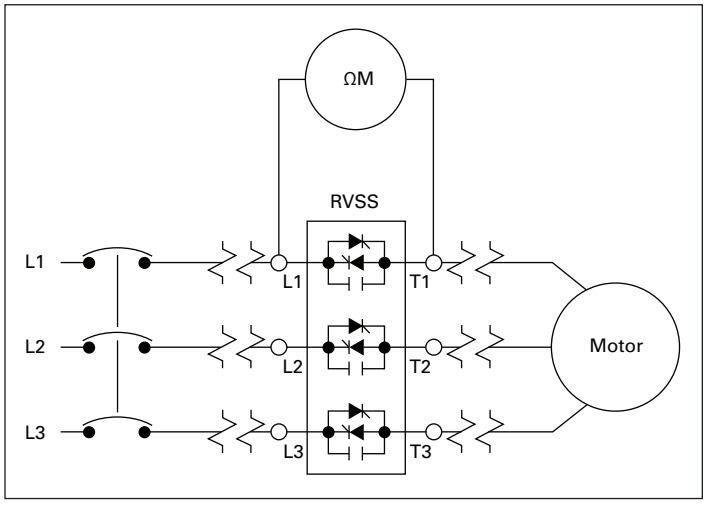


**Figure 1. Schematic**

In **Figure 1**, the soft starter has been isolated from the line and load connections. Measure the resistance of each pole from L1 to T1, L2 to T2, and L3 to T3.

With the S801+/S811+/S611 line of Eaton soft starters, the resistance value of any given SCR should be 10,000 ohms or greater. There is no "official" value nor is any particular value meaningful when attempting to determine "wear" or "remaining service life" of an SCR based on the resistance reading.

Experience has shown that the resistance of an SCR lowers over time, but there is no known tracking method that can be used to accurately correlate the working condition of an SCR with remaining service life. Additionally, significant resistance variations may exist between poles. This information also does not automatically indicate a fault in the SCRs. Typically, SCRs are functional or non-functional and do not have any values that can be used to predict future failures.

Potential SCR failure is noted when the resistance of any pole is 10 ohms or less. It is possible that an internal bypass contactor is stuck or welded. In either case, the unit will require service or replacement.

## Taking measurements with line and load connections intact

This procedure is not recommended, as often the circuit may not actually be what you think it is. Other devices and connections may participate in the circuit, resulting in inaccurate measurements and incorrect conclusions.

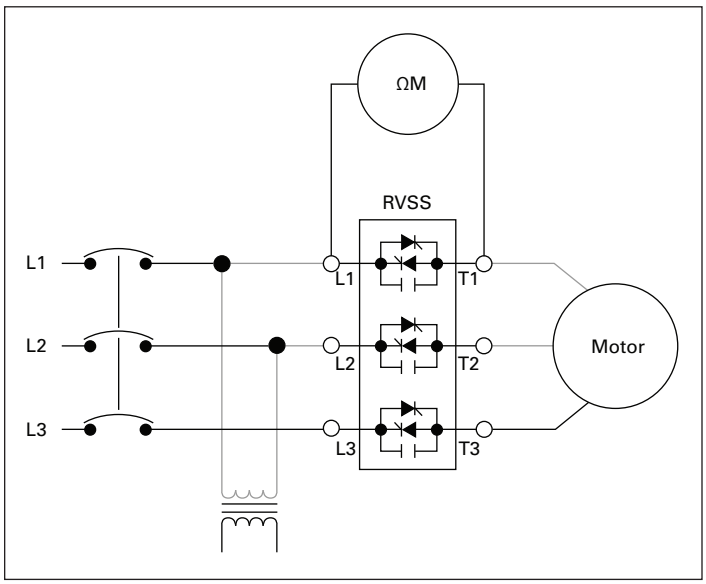


**Figure 2. Inline Connection**

When taking a measurement from L1 to T1, one would think that only those SCRs are being measured. However, the control power transformer is in the circuit, making the Phase 1 SCRs in parallel with Phase 2. This essentially makes the measurement of little value in determining SCR health. It does significantly impact the conclusion that an SCR is "shorted" due to abnormally low resistance when compared to Phase 3.

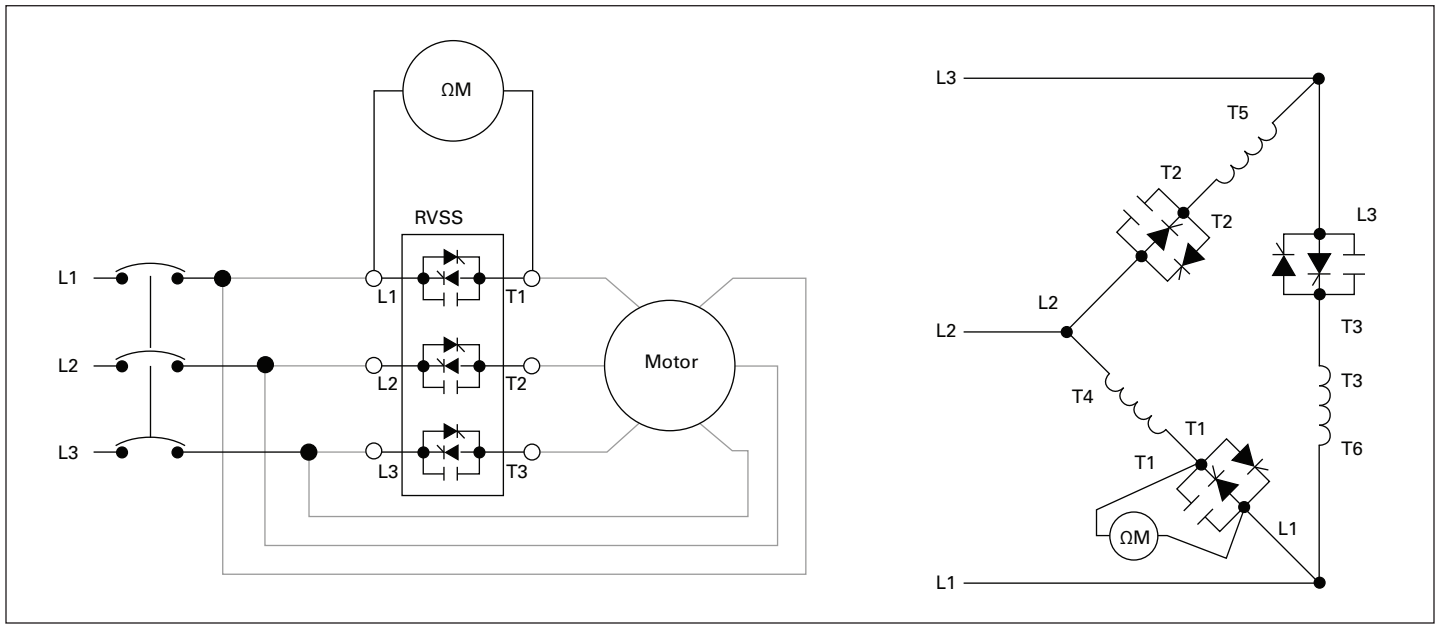


**Figure 3. Inside-the-Delta Connection**

Attempting to take resistance measurements with an Inside-the-Delta application with the line and load connections intact will always result in measurements that are invalid in determining the health of the unit's SCRs. With this type of application, failure to isolate the soft starter from the rest of the circuit results in all three power poles participating in the circuit.

If additional devices are connected to the line side of the soft starter, additional discrepancies may exist within the circuit.

## Supporting documentation

| Manuals | Reference Number |
|---|---|
| S811+ User Manual | MN03900001E |
| S801+ User Manual | MN03900002E |
| S601 User Manual | MN03902011E |

## Additional help

In the event that additional help is needed, please contact the Technical Resource Center at 1-877-ETN-CARE, Option 2, Sub Option 2.

**Eaton Corporation**
Electrical Sector
1111 Superior Avenue
Cleveland, OH 44114 USA
Eaton.com


Printed in USA
Publication No. AP03902019E / Z12601
August 2012



Powering Business Worldwide