



# Resistance testing capacitors and high-voltage components

## Application Note

### Insulation Resistance Case Study



**Measuring tools:** Fluke 1550B Megohmmeter

**Operator:** ASI Robicon, high-powered VFD manufacturer

**Test conducted:** SCR voltage, SCR heat, IGBT switching, capacitor



ASI Robicon Perfect Harmony water-cooled Variable Frequency Drive (VFD).

Tom Lasek is a field engineer with ASI Robicon, a major manufacturer of high powered solid state variable frequency drives for controlling industrial AC motors up to 20000 HP and fed by voltages up to 13,800 volts. Lasek's responsibilities include installation/commissioning, general preventive maintenance and troubleshooting these high powered drive systems. He uses a Fluke 1550B MegOhmMeter almost daily for

- Insulation resistance test and documentation for commissioning and startups on company systems.

- Troubleshooting high voltage components in high powered drives.

This case study details the high voltage component and capacitor testing methodology Lasek has developed over his 30 years of experience.

By using a 1550B as a high voltage component tester in regular preventive maintenance procedures, Lasek finds faulty components before they fail. Preventing premature failures saves both ASI Robicon and its customers time and money.

### SCR voltage testing

The Fluke 1550B MegOhmMeter can quickly determine the relative quality/weakness of non linear devices in high power solid state power supplies: SCRs (Silicon Controlled Rectifier semiconductor) and IGBT high power devices. Normal solid state component testers utilize low voltage, low current test sources and won't always pinpoint bad devices, especially if they may breakdown under load.

### Methodology

1. Isolate the device from all of its connections to ensure accurate readings.
2. Set a high voltage on the 1550B, apply it and note reading.



Sample SCR reading.

### Results

- Damaged SCR's exhibit large differential readings when tested forward biased and reversed biased (anode to cathode).
- New SCR's generally have almost equal readings in both directions (roughly 100 MΩ).
- Any high power SCR reading under 5 MΩ is damaged and should be discarded.
- If the SCR reads 50 MΩ to 200 MΩ in 1 direction and 10 MΩ to 50 MΩ in the other (4-to-1 difference), it will likely self-gate under load (instead of firing at the desired trigger point in time, it will randomly gate itself on). This is very bad. It causes extreme current pulses in the power supply and can cause commutator flash over in dc motors operated by these supplies.

### SCR heat testing

If the component is physically damaged, it may need to be physically removed for a heat test.

#### Methodology

1. Set the Fluke 1550B to the actual voltage rating of the device. Most ASI Robicon SCR's used on 480 V VFDs (variable frequency drives) are rated at 1400 V. They also use 3000 V devices stacked in series on medium voltage (2300 V and 4160 V) drives.
2. Take two readings, forward and reverse while the device is cold.
3. Warm the component to 180 °F in an oven and repeat the test.

#### Results

If the leakage is up 50 % or more, the device must be discarded.

Conventional testing of SCR's says that they are OK if they are not dead shorted. Lasek says this assumption is absolutely false. When ASI Robicon repairs SCR power supplies, their goal is to minimize further failures and down time, not minimize the parts cost of the repair.

Any device that exhibits changing, varying, non stable readings when raised to its rated voltage should be suspected as near failure and isolated. Unstable readings indicate internal arc damage or semiconductor self gating/conduction.

### IGBT switching device testing

IGBT switching devices can be heat tested as well but they all have a back diode so they can only be checked one way (forward). High power diodes can be heat checked (Cold and hot readings compared for change) as well.

Generally, diodes are much higher resistance, lower leakage than SCR's (readings 200 MΩ to 700 MΩ normal).

An SCR that reads 20 MΩ both ways is OK, but one that reads 80 MΩ one way and 20 MΩ the other is a suspect for failure. Out of the box new SCR's usually read 100 MΩ to 200 MΩ both directions and are within 50 % of being equal both directions.

### Capacitor testing

Lasek also uses the megohmmeter adjustable voltage function to test high voltage capacitors.

#### Methodology

Charge several identical capacitors and compare the time it takes them to charge to like readings.



Sample capacitor reading.

#### Results

- If a capacitor charges extremely quickly, it may be open-circuited.
- If the readings go up and down repeatedly, the capacitor may be arcing internally. Remove and replace the device.

#### Fluke Corporation

PO Box 9090, Everett, WA USA 98206

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