

1.0 PURPOSE

This Standard Test Procedure (STP) is to be used by Electrical Safety Division (ESD) investigators to determine if samples of a current limiting resistor meet the requirements of ACRI2001 "Criteria for the Evaluation and Test of Intrinsically Safe Apparatus and Associated Apparatus," Section 9.2.

2.0 SCOPE

This STP applies to resistors submitted for test as a current limiting resistor for use in intrinsically safe apparatus and associated apparatus evaluated, approved, or certified per 30 CFR Parts 18, 19, 20, 22, 23, and 27.

3.0 REFERENCES

- 3.1. ACRI2001 "Criteria for the Evaluation and Test of Intrinsically Safe Apparatus and Associated Apparatus"
- 3.2. 30 CFR Part 18 "Electric Motor-Driven Mine Equipment and Accessories"
- 3.3. 30 CFR Part 19 "Electric Cap Lamps"
- 3.4. 30 CFR Part 20 "Electric Mine Lamps other than Standard Cap Lamps"
- 3.5. 30 CFR Part 22 "Portable Methane Detectors"
- 3.6. 30 CFR Part 23 "Telephones and Signaling Devices"
- 3.7. 30 CFR Part 27 "Methane-Monitoring Systems"

4.0 DEFINITIONS

- 4.1. Current Limiting Resistor - A protective component used to limit current in an intrinsically safe circuit.

- 4.2. Maximum Fault Voltage – The highest voltage that can be applied across the current limiting resistor and fuse (if applicable), under the worst-case, two-fault condition.
- 4.3. Constant Temperature – The equilibrium temperature of the device with the prescribed test parameters. This temperature is whenever three consecutive temperature readings taken at intervals of no less than 5 minutes indicate a total temperature rise of less than 3%.

5.0 TEST EQUIPMENT

- 5.1. Data acquisition system with at least 3 channels, sufficient voltage range for the parameters of the test circuit, a resolution of at least 3 significant figures, an accuracy of at least $\pm 1.5\%$ of the reading, a minimum of 1000 data points per test, and able to record the data or plot voltage of 3 or more channels versus time with a resolution of 10 seconds or less. [Example, Agilent 34970A]
- 5.2. Power supply with adequate capacity.
- 5.3. Switch rated for the maximum voltage and current of the test circuit, as necessary.
- 5.4. Digital thermometer with analog/digital output, range of at least the maximum permissible surface temperature of the current limiting resistor, resolution of at least 0.2°C , and an accuracy of at least $\pm 1^{\circ}\text{C}$. The sensing element of this thermometer must not significantly cool the current limiting resistor. Thermocouple wires must not be larger than No. 24 AWG [Example, Fluke 2170A].
- 5.5. A current measuring resistor with a known resistance value less than or equal to 1% of the value of the current limiting resistor, or equivalent device, to measure the current flow through the test circuit. The power rating of this device shall not be exceeded during this test. [Example, Dale RH-250, 0.1Ω , 1%, 250 watt resistor]
- 5.7. Various connecting wires, test chamber, etc. as necessary.

- 5.8 An ohmmeter to measure the value of the current measuring resistor, and the current limiting resistor with a resolution of at least 3 significant figures, and an accuracy of at least $\pm 1\%$ of reading. [Example, Fluke 8842A Multimeter]

6.0 TEST SAMPLES

Ten samples of the current limiting resistor and non-replaceable fuse, if applicable, are required.

7.0 PROCEDURES

- 7.1. Conduct the test at an ambient temperature of $25 \pm 5^\circ\text{C}$.
- 7.2. Measure and record the resistance of the current limiting resistor and the measuring resistor after the resistors have stabilized at the ambient temperature.
- 7.3. Connect a current measuring resistor in series with the current limiting resistor to measure the current flowing through the current limiting resistor during each test. If the current limiting resistor is protected by a non-replaceable fuse, connect this fuse in series with the current limiting resistor.
- 7.4. Place the test circuit in a location that reduces the likelihood that air currents will affect the surface temperature of the current limiting resistor.
- 7.5. Connect one input of the data acquisition system to measure the voltage across the current measuring resistor. Configure this input to read the current. Connect a second input to measure the voltage across the current limiting resistor. Connect a third input to a thermometer installed to measure the temperature of the current limiting resistor. The math function of the data acquisition system may be used to calculate the resistance of the current limiting resistor by dividing the voltage by the current across the resistor.

- 7.6. Connect a power supply of 1.5 times the maximum fault voltage across the current limiting resistor and fuse (if applicable). See Figure 1.
- 7.6.1. While the power supply is connected in this manner, record the voltage versus time across the current limiting resistor, the current versus time through the current limiting resistor and the temperature versus time of the current limiting resistor. Continue this test until the current limiting resistor reaches a constant temperature, the current limiting resistor flames or the current limiting resistor or fuse fails in the open circuit condition.
- 7.6.2. Test two additional samples of the current limiting resistor and fuse (if applicable) per sections 7.6, and 7.6.1.
- 7.7. Resistors protected by a non-replaceable fuse shall be subjected to the following additional test.
- 7.7.1. Connect a voltage source adjusted to provide a current flow of 2 times the rating of the fuse across the current limiting resistor and the current measuring resistor. The fuse is not used for this test.
- 7.7.2. While the power supply is connected in this manner, record the voltage versus time across the current limiting resistor, the current versus time through the current limiting resistor and the temperature versus time of the current limiting resistor. Continue this test until the current limiting resistor reaches a constant temperature, the current limiting resistor flames or the current limiting resistor fails in the open circuit condition.
- 7.7.3. Test two additional samples of the current limiting resistor per sections 7.7.1 and 7.7.2.
- 7.8. If any of the current limiting resistors increase resistance by 100% during the test in section 7.6.1, 7.7.2 or the fuse opens during the test in Section 7.6.1, then the tests described in these sections shall be repeated with a new sample of the fuse and/or current limiting resistor and with a reduced voltage. The voltage or current should be increased in steps until the

maximum constant temperature of the current limiting resistor is achieved without the resistor increasing resistance by 100% or the fuse opening. During the test, record the voltage versus time across the current limiting resistor, the voltage versus time across the series connected resistor, and the temperature versus time of the resistor. One way to accomplish this is to use one of the samples to experimentally determine the fuse or resistor opening voltage or current by slowly increasing the test voltage. After determining the fuse opening voltage, increase the test voltage in 10 equal steps from 0 volts to the experimentally determined voltage. Repeat this test on two more samples of the component.

- 7.9. Measure and record the resistance of the current limiting resistor after the resistor has stabilized at the ambient temperature.

8.0 TEST DATA

- 8.1. The current limiting resistor manufacturer, model number or part number, type, power rating, resistance value and tolerance.
- 8.2. The measured resistance value of the current limiting resistor and the current measuring resistors before the test at ambient temperature and the measured resistance value of the current limiting resistor after the test at ambient temperature.
- 8.3. The fuse manufacturer, part number, and current rating.
- 8.4. The ambient temperature during the test.
- 8.5. A sketch of the circuit used during the test.
- 8.6. A listing or plot of the data points of the current limiting resistor voltage, current and temperature versus time during the test.
- 8.7. A calculation of the lowest resistance value of the current limiting resistor or a plot of the current limiting resistor voltage divided by the current.

8.8. A note of any flaming, deformation of the current limiting resistor or other hazardous results.

8.9. Equipment used for the test. This should include, manufacturer, model number, serial number, and calibration due date for each piece of equipment.

9.0 PASS/FAIL CRITERIA

During each test, the current limiting resistor shall not:

- Decrease in resistance by more than 10% of the value measured in Section 7.2;
- Flame; or

Deform in any way, including opening of the resistor, such that an adjacent conductor could decrease the resistance value of the resistor.

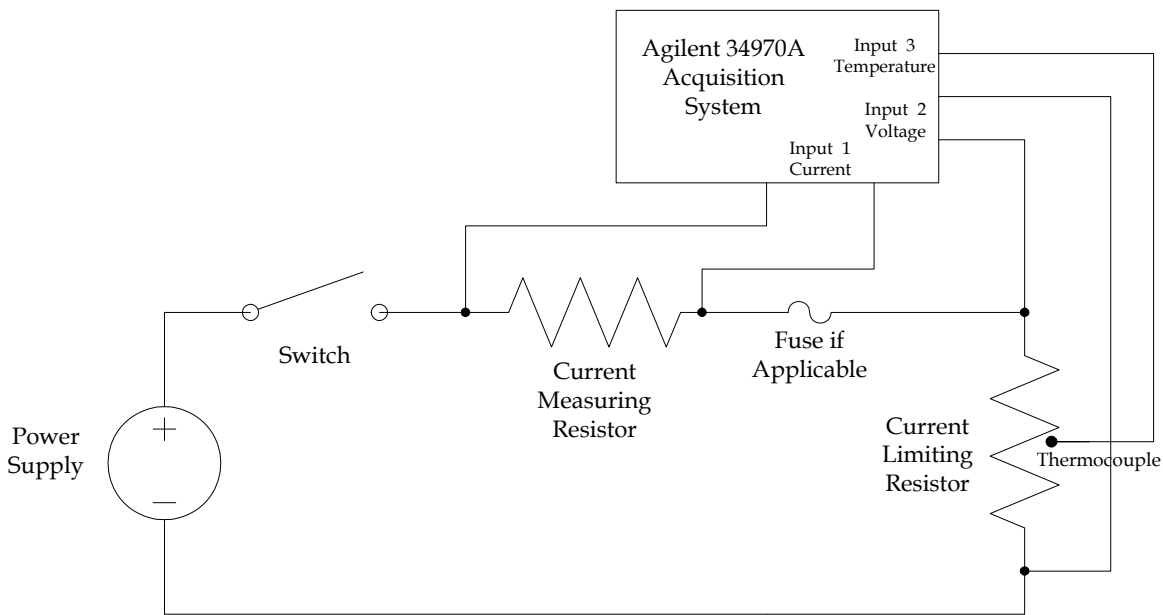


Figure 1
Test Circuit for Current Limiting Resistors
Section 7.6

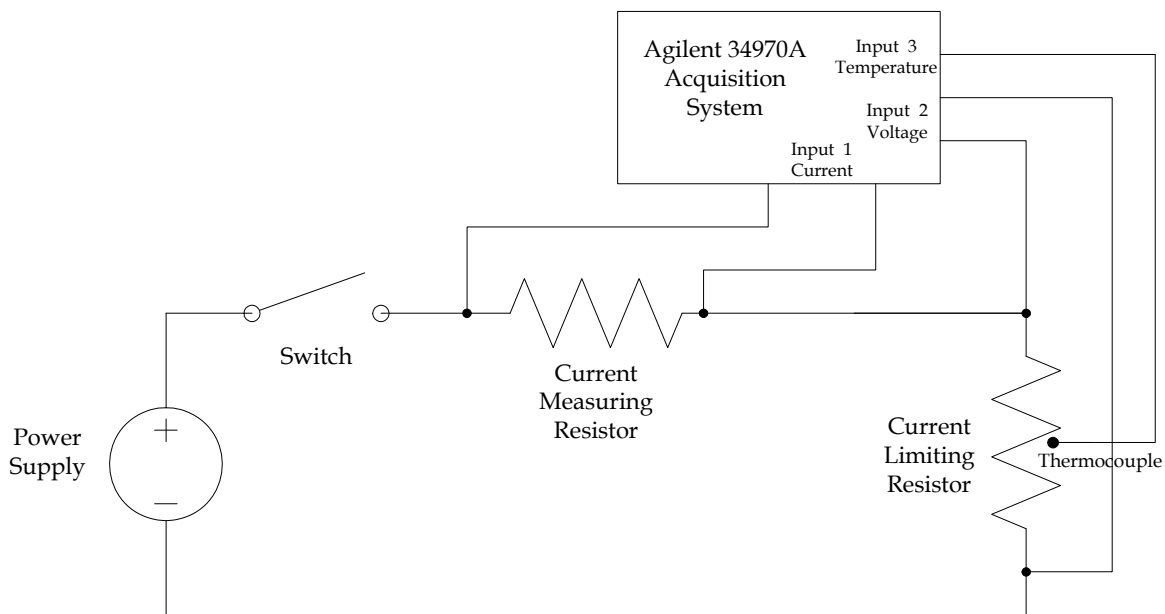


Figure 2
Test Circuit for Current Limiting Resistors
Section 7.7