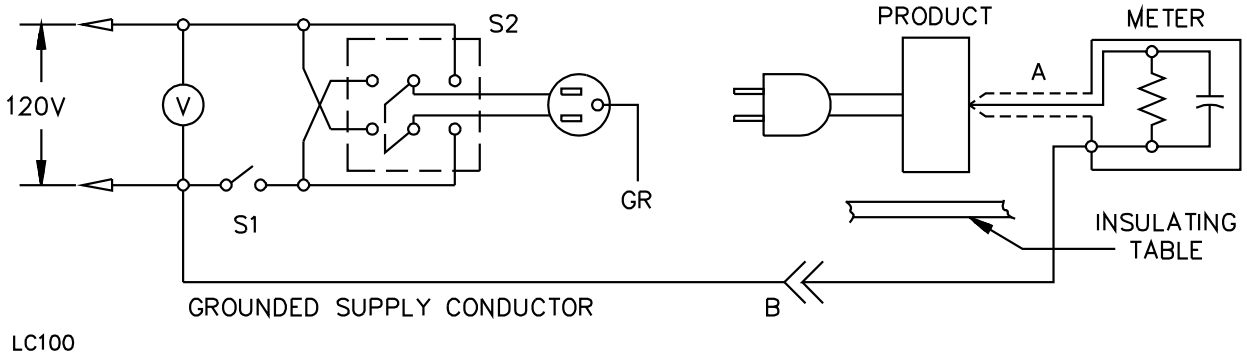
3.4.2.4.6 A sample of the product is to be tested for leakage current starting with the as-received condition – the as-received condition is without prior energization except as may occur as part of the production-line testing but with the grounding conductor, if any, open at the attachment plug. The supply voltage is to be adjusted to the product's maximum rated voltage. The test sequence, with reference to the measuring circuit, Figure 3.11, is to be as follows:

a) With switch S1 open, the product is to be without load and connected to the measuring circuit. The leakage current is to be measured using both positions of switch S2 and with the product switching devices in all their operating positions.

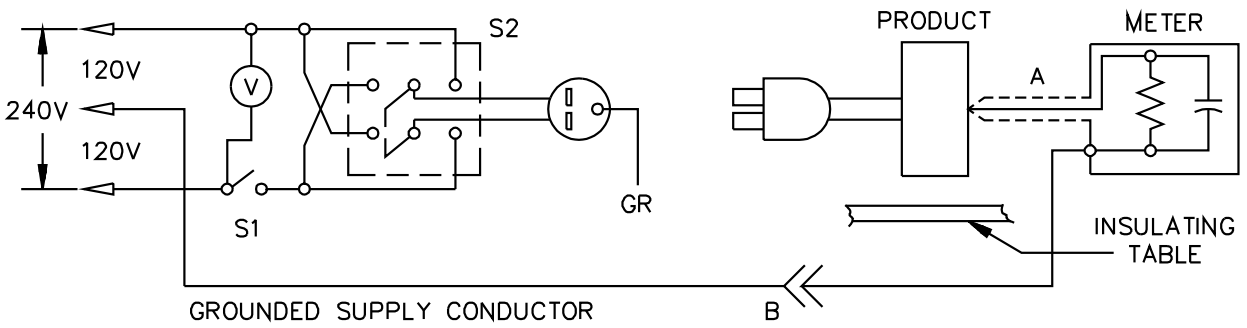
b) Switch S1 is then to be closed, energizing the product, and within 5 s the leakage current is to be measured using both positions of switch S2, and with the product switching devices in all their operating positions.

c) The leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in making this measurement. Thermal stabilization is obtained when maximum temperatures by operation as in the normal temperature test are reached.

Figure 3.11
Leakage current measurement circuit



Component intended for connection to a 120-V power supply



LC200

Component intended for connection to a 3-wire, grounded neutral power supply

A – Probe with shielded lead

B – Separated and used as clip when measuring currents from one part of neon supply to another

3.4.2.5 Dielectric voltage withstand test

3.4.2.5.1 General

3.4.2.5.1.1 A component shall withstand, without dielectric breakdown, a dielectric voltage applied between live parts of opposite polarity and between live parts and dead metal parts. The application of the dielectric withstand voltage is to be in accordance with 3.4.2.5.1.2 and 3.4.2.5.1.3. Components with voltages of 1000 V and less are subject to the procedure in 3.4.2.5.2. Components with voltages greater than 1000 V are subject to the procedure in 3.4.2.5.3.

3.4.2.5.1.2 The dielectric voltage-withstand test is to be conducted using a 500 VA or larger capacity testing transformer, the output voltage of which is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test level is reached and is to be held at that level for 1 min. The increase in the applied potential is to be at a substantially uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter. The tests are to be conducted at the rated supply input frequency of the product unless otherwise noted.

3.4.2.5.1.3 The dielectric voltage between current-carrying parts and an insulating type material (polymeric enclosure, barrier, or the like) shall be applied between metal foil covering the outside of the material and current carrying parts.

3.4.2.5.2 Dielectric voltage withstand (for products with no operating voltages greater than 1000 V)

3.4.2.5.2.1 A component is to be operated until in a heated condition and then in a heated condition, withstand without breakdown the application of a 60-Hz essentially sinusoidal potential of:

a) 1000 V plus twice the maximum rated input voltage applied between the primary circuit and dead-metal parts;

b) 1000 V plus twice the maximum rated input voltage applied between the primary circuit and the secondary circuits of isolating transformers; and

c) 1000 V between live and dead metal parts of a motor.

3.4.2.5.3 Dielectric voltage withstand (for products rated greater than 1000 V)

3.4.2.5.3.1 A sample is to be subjected to the application of a 60 Hz essentially sinusoidal potential of the voltage specified in Table 3.10 for a period of 1 min. The potential shall be applied between current carrying parts and the exterior surface of a component. For components such as neon electrode enclosures, the current carrying parts are to be located when installed in accordance with the manufacturer's installation instructions and metal placed either on the other side of the material or on the exterior of the component. The potential is to be increased at a uniform rate and as rapid as is consistent from zero until the required voltage is reached or until breakdown occurs.

Table 3.10
Dielectric withstand potential

Rating in kV ac rms to ground	Test potential in kV
2	6
3	8
5	12
6	14
7.5	17

3.4.2.6 Ground continuity test

3.4.2.6.1 The resistance from any dead-metal part that is likely to become energized to the grounding equipment means shall not exceed the resistance specified in Table 3.11 when tested in accordance with 3.4.2.6.2 and 3.4.2.6.3.

3.4.2.6.2 An alternating or direct current of 30 A from a power supply of not more than 12 V shall be passed from the point of connection of the equipment grounding means to a point in the grounding circuit required to be bonded. The voltage drop and current between the two points shall be measured.

3.4.2.6.3 The resistance in ohms is to be calculated by dividing the drop in potential (in volts) by the current (in amperes).

Table 3.11
Resistance to equipment grounding means

Point of equipment means to grounding supply	Maximum resistance in Ω
Equipment grounding lead or terminal	0.1
Grounding pin of a 6-ft or less power supply cord	0.1
Grounding pin greater than 6-ft power supply cord	0.15

3.4.2.7 Abnormal tests

3.4.2.7.1 General

3.4.2.7.1.1 Abnormal operation tests shall be conducted as described in 3.4.2.7.1.2 – 3.4.2.7.1.8, followed by a dielectric voltage-withstand test as described in 3.4.2.5.

3.4.2.7.1.2 During each abnormal test, the grounding means of the product is to be connected directly to ground through a 3-A non-time-delay fuse, the product is to be placed on a softwood surface covered with white tissue paper, and a single layer of cheesecloth is to be draped loosely over the entire component. The cheesecloth is to be untreated cotton cloth running 26 – 28 m^2/kg (14 – 15 yd^2/lb) and for any 6.5 cm^2 (1 in^2), a count of 32 threads in one direction and 28 in the other direction.

3.4.2.7.1.3 The supply circuit for components is to be connected to a supply source as specified in 3.4.2.1.1 except the supply voltage for a dc rated input shall be as follows:

a) A 15.5 Vdc supply circuit with a 30 A line fuse, when the component is rated 12 Vdc, or

b) A 31 Vdc supply circuit with a 30 A line fuse, when the component is rated 24 Vdc.

3.4.2.7.1.4 The supply circuit shall be rated at 125% of the rated input current of the product, but no less than 20 A for branch circuit connected incandescent and fluorescent sign components and 30 A for neon sign components.

3.4.2.7.1.5 A fuse provided as part of a sign component that is user accessible is to be shorted out of the circuit.

3.4.2.7.1.6 A user-operated control is to be adjusted to the position representing the most adverse operating condition.

3.4.2.7.1.7 Each abnormal test is to be continued until one of the following conditions is obtained:

a) The test continues for at least 4 h and there is no change in temperature or condition of the test sample within a ½-h time period;

b) An automatically reset protector functions during test and the test has continued for 7 h;

c) A manual reset protector which has been reset 10 times using the minimum resetting time, but not more frequently than 10 cycles of operation in a minute, continues to be operational at the completion of the test; or

d) The test has continued for 7½ h with little significant change in the operating temperature of the product.

3.4.2.7.1.8 A risk of fire or electric shock is considered to exist if any of the following occur:

a) Flame or molten metal is emitted from the enclosure of the component as evidenced by ignition, glowing, or charring of the cheesecloth or tissue paper;

b) A breakdown results from the dielectric voltage-withstand test;

c) Live parts are made accessible; or

d) The 3-A non-time-delay ground fuse opens.

3.4.2.7.1.9 Following each abnormal test, the Dielectric Voltage Withstand Test specified in 3.4.2.5, shall be conducted on the component.

3.4.2.7.2 Abnormal operation test

3.4.2.7.2.1 A component shall not result in a risk of fire or electric shock as a result of being subjected to potential misuses that are likely to exist during normal use. Examples of abnormal operation are as follows:

a) Stalling of the rotor of a fan and blower,

b) The shorting of output terminals, and

c) Leaving output terminals unconnected to a load while energized.

3.4.2.7.3 Abnormal component breakdown test

3.4.2.7.3.1 A component as specified in 3.4.2.7.3.2 that is likely to fail by experiencing an open circuit or a short circuit in a circuit shall not result in risk of fire or electric shock as a result of being subjected to the test specified in 3.4.2.7.3.3 with the component open circuited and short circuited.

3.4.2.7.3.2 The component mentioned in 3.4.2.7.3.1 includes an electrolytic capacitor, a diode, a solid state device, or any other component not previously investigated and determined to be suitable for the application. An electromagnetic and radio frequency interference capacitor, a resistor, a transformer, an inductor, or an optical isolator is not required to comply.

3.4.2.7.3.3 Three tests of each component under the open- and short-circuit conditions, using untested components for each test, are to be conducted using the guidelines specified in (a) – (f) below. A component located in a feedback circuit providing voltage, current or temperature limiting, is to be subjected to open- and short-circuit conditions. Each component fault is to be applied one fault at a time.

a) Capacitors – open-circuited;

b) Discrete semiconductor devices (triacs, transistors, diodes, and the like) – open-circuit and short-circuited;

c) Integrated circuits – critical pins shorted to ground;

d) Resistors – open-circuited;

e) Inductors – open-circuited; and

f) Other components – open-circuit and short-circuited.

3.4.2.8 Humidity exposure test

3.4.2.8.1 A sign component enclosing or insulating a live part is to comply with the Dielectric Voltage Withstand Test after being subjected to humidity conditioning. Humidity conditioning is to be on a component after being assembled in accordance with the manufacturer's installation instructions. The assemblies are to be arranged in a chamber in the position that is most likely to result in moisture accumulation and is a likely field orientation.

3.4.2.8.2 Three samples shall be exposed for 168 h to moist air having a relative humidity of 88 ±2% at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F).

3.4.2.8.3 Within 10 min of being removed from humidity conditioning, the assemblies shall comply with the Dielectric Voltage Withstand Test requirements in 3.4.2.5 for the maximum voltage rating of the component.

3.4.2.9 Condensation test

3.4.2.9.1 A sign component enclosing or insulating a live part in a damp or wet location is to comply with the Dielectric Voltage Withstand Test after being subjected to condensation conditioning. Condensation conditioning is to be on a component after being assembled in accordance with the manufacturer's installation instructions. The assemblies are to be arranged in a chamber in the position that is most likely to result in moisture accumulation and is a likely field orientation.

3.4.2.9.2 A component is to be conditioned for 24 ±1/2 h in a minus 40 ±2°C (minus 40 ±3.6°F). After 24 h, the samples are to be removed from the 40 ±2°C (minus 40 ±3.6°F) ambient and placed within 2 min into a humidity chamber maintained at 88 ±2% at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F) for 48 h.

3.4.2.9.3 At the conclusion of the 48 h in the chamber, the assemblies shall comply with the Dielectric Voltage Withstand Test requirements in 3.4.2.5 for the maximum voltage rating of the component.

3.4.2.10 Motor tests

3.4.2.10.1 Starting current test

3.4.2.10.1.1 A motor operated sign component shall start and operate normally on a circuit protected by an ordinary – not time delay – fuse having a current rating corresponding to that of the branch circuit to which the appliance should be connected. The performance is unacceptable if the fuse opens or an overload protector provided as part of the sign component trips.

3.4.2.10.1.2 The sign component is to be started three times at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of normal operation – the beginning of the normal operating cycle. The component is to be allowed to come to rest between successive starts.

3.4.2.10.2 Locked rotor test

3.4.2.10.2.1 A motor sample is to be placed on a soft wood surface covered with two layers of tissue paper. The motor is to be covered with two layers of cheesecloth. The test is to be conducted at room ambient. The motor is to be energized at rated potential with the rotor locked. The locked rotor condition is to be maintained for 7½ h. The motor enclosure is to be connected to ground through a 3-A non-time delay cartridge fuse with voltage rating based on the rating of the motor.

3.4.2.10.2.2 As a result of the locked rotor condition:

a) There shall be no indication that the cheesecloth or tissue paper glowed or flamed;

b) When subjected to the Dielectric Voltage Withstand Test specified in 3.4.2.5; there shall be no indication of dielectric breakdown;

c) There shall be no indication of softening, cracking, warping or other deformation to result in a reduction in spacings; and

d) During and at the conclusion of the test the fuse shall not have opened.

3.4.2.11 Circuit interrupting devices tests

3.4.2.11.1 Overload test

3.4.2.11.1.1 A device that interrupts an inductive (ballasts or transformers) or tungsten (incandescent lamps) load circuit shall be subjected to the overload test in 3.4.2.11.1.2 – 3.4.2.11.1.5 and the endurance test in 3.4.2.11.2.

3.4.2.11.1.2 During the test, there shall be no electrical or mechanical breakdown of the equipment, no undue burning or pitting of contacts and no welding of contacts.

3.4.2.11.1.3 With the product containing the circuit interrupting device connected to a test voltage within 5% of rated voltage, the device contacts shall be connected in the manner representative of intended use to a load that causes 1.5 times the current during intended use. If the intended load is inductive, the load shall be inductive with a power factor of 0.40 – 0.50.

3.4.2.11.1.4 The test shall consist of 100 cycles of operation being cycled at a rate of 6 – 10 cycles per minute with the on time for each cycle to be not more than 1 s.

3.4.2.11.1.5 At the conclusion of the test, the circuit-interrupting device shall be capable of performing its intended function.

3.4.2.11.2 Endurance

3.4.2.11.2.1 After being subjected to the overload test, a circuit interrupting device shall be subjected to 10,000 cycles of operation interrupting the intended load while connected to a voltage source that is within 5% of rated voltage.

3.4.2.11.2.2 At the conclusion of the endurance test a circuit interrupting device shall:

a) Be capable of performing its intended function,

b) Show no wear,

c) Show no loosening of parts, and

d) Show no indication of other damage or defect that is capable of diminishing the usefulness and reliability of the device.

3.4.11.2.3 Following the endurance test the device is to be subjected to the Dielectric Voltage Withstand Test, 3.4.2.5, with the voltage potential applied between current carrying parts and:

a) Exterior dead metal parts, or

b) In cases where there is no dead metal on the exterior, metal foil wrapped around the device.

3.4.2.11.2.4 During the test, the load is to be rated load. If the intended load is inductive, the load shall have a power factor of 0.40 – 0.50.

3.4.2.11.2.5 The test is to consist of 10,000 cycles of operation, at a rate of 18 – 24 cycles per minute for an inductive load and 6 – 10 cycles per minute for a tungsten (incandescent) load.

3.4.2.12 Printed-wiring board tests

3.4.2.12.1 Abnormal reduced spacing trace-to-trace short-circuit

3.4.2.12.1.1 A printed-wiring board shall be tested as described in 3.4.2.12.1.2 – 3.4.2.12.1.5.

3.4.2.12.1.2 Operation of an overcurrent protective device other than the branch-circuit overcurrent protective device is not prohibited from occurring during this test.

3.4.2.12.1.3 A sample of the sign component employing a printed-wiring board is to be connected to its nominal rated supply circuit. A foil trace is to be short-circuited to each adjacent trace not spaced from the foil trace as specified in Table 2.17 or 2.18 or 2.19, one at a time.

3.4.2.12.1.4 During this test, when a printed-wiring board trace opens, the gap is to be electrically shorted and the test continued until ultimate results are obtained. This procedure applies to each occurrence. When the circuit is interrupted by the opening of a component other than as described in 3.4.2.7.3, the test is to be repeated two more times using untested components as required.

3.4.2.12.1.5 The test is to be continued for 1 h or until one of the conditions described in 3.4.2.7.1.8 occurs. However, when at the end of 1 h no condition described in 3.4.2.7.1.8 occurs, and indications are that such a condition is to eventually occur, the test is to be continued until ultimate results are obtained or until the test has been run for 7 h.

3.4.2.13 Class 2 and Class 3 tests

3.4.2.14.1 Maximum output voltage test

3.4.2.13.1.1 The maximum output voltage of a Class 2 and Class 3 supply source, when tested under the conditions specified in 3.4.2.13.1.2 shall not exceed the voltages specified in Tables 2.11 and 2.12.

3.4.2.13.1.2 To determine compliance with 3.4.2.13.1.1 a Class 2 or Class 3 supply source is to be connected to the rated input. When a supply source is required to be grounded, the branch-circuit ground is to be connected to the grounding means on the supply source. The output is not to be connected to a load (open circuit). The output from lead to lead or terminal to terminal of each circuit is to be measured. A supply source that does not provide the full output voltage under open-circuit conditions shall have the circuitry responsible for limiting or interrupting the output voltage under open circuit conditions defeated.

3.4.2.13.2 Maximum output current and power test

3.4.2.13.2.1 The maximum output current and output volt-amperes specified in Tables 2.11 and 2.12 are to be determined using a current meter and a wattmeter. A resistive load is to be adjusted to result in maximum reading of the meters. With no further adjustment of the load, the sample is to be de-energized and cooled to room temperature. The sample is then to be energized and maximum current and wattage measurements are to be taken as specified in 3.4.2.13.2.2 for an inherently limited supply source and 3.4.2.13.2.4 for a not inherently limited supply.

3.4.2.13.2.2 To determine compliance with 3.4.2.13.2.1, an inherently limited Class 2 or Class 3 supply source is to be connected to the rated input. A supply source required to be grounded is to be connected to branch-circuit ground. The output from lead to lead or terminal to terminal of each circuit is to be measured under the following conditions, as applicable:

a) For a supply source employing a transformer with no form of protection, the measurement is to be made 60 s after the unit is connected to the source of supply.

b) For a supply source employing a transformer and energy limiting impedance or energy limiting circuit (a resistor, a PTC device or similar circuitry) required for the purpose, the measurement is to be made five seconds after the unit is connected to the source or supply.

c) For a supply source which employs a transformer and either a thermal cutoff, a fuse, or both, all protection is to be defeated during the test and the measurement made 60 s after the unit is connected to the supply source.

d) For a supply source that employs a transformer and a combination of a limiting impedance or circuit required for the purpose, and a protective device (such as a thermal cutoff, a fuse, or both), all protective devices are to be defeated and the measurement is to be made five seconds after the unit is connected to the supply source.

e) For a supply source that employs a dc input and a combination of a limiting impedance or circuit required for the purpose, and a protective device (i.e. thermal cutoff, fuse, or both), the protective device is to be defeated and the measurement is to be made five seconds after the unit is connected to the supply source.

3.4.2.13.2.3 During the maximum output current and power measurements specified in 3.4.2.13.2.2, the output of the supply source shall not shutoff.

3.4.2.13.2.4 To determine compliance with 3.4.2.13.2.1, a not inherently limited Class 2 or Class 3 supply source is to be connected to the rated input. A supply source required to be grounded is to be connected to branch-circuit ground. The output from lead to lead or terminal to terminal of each circuit is to be measured in accordance with 3.4.2.13.2.2 with protective devices shorted out during the test.

3.4.2.13.2.5 A protective device provided as a part of a not inherently limited unit shall operate in not more than the time indicated in Table 3.12 when the unit is delivering the specified secondary current.

Table 3.12
Maximum Acceptable Time for Protection Device Operation

Open circuit secondary potential	Secondary test current	Maximum time for overcurrent-protective device to open
V	A	min
Class 2		
20 or less	10	2
20 or less	6.75	60
Over 20 – 30	$200/V_{max}$	2
Over 20 – 30	$135/V_{max}$	60
Class 3		
Over 30 – 100	$200/V_{max}$	2
Over 30 – 100	$135/V_{max}$	60
Over 100 – 150	2	2
Over 100 – 150	1.35	60

Notes:

1) For secondary test currents of 10 and $200/V_{max}$, the load is to be adjusted continuously to maintain the test current value shown.

2) For secondary test currents of 6.75 and $135/V_{max}$, after 15 min of operation, the load is to be readjusted to return the output current to the value shown.

3) For secondary test currents of $135/V_{max}$ and $200/V_{max}$, V_{max} is the maximum output voltage regardless of load with rated input.

3.4.3 Installation and assembly test

3.4.3.1 A sign component involving any degree of assembly or installation is to be installed and assembled in a method typical of factory and field conditions in accordance with the installation instructions. An assembled and installed component shall comply with the requirements in the end product standard. Assembly and installation is to include and identify possible misuse and abnormal assembly and installation that can result in the need for either construction revisions, or, where construction revisions are not feasible, warning instructions to minimize the potential for misuse and abnormal condition.