37.4 All exposed conductive surfaces are to be tested for leakage currents. Where these surfaces are simultaneously accessible, leakage currents are to be measured from these surfaces to the grounded supply conductor individually, as well as collectively, and from one surface to another. Parts are considered to be exposed surfaces unless enclosed in a manner that reduces the risk of electric shock. Surfaces are to be considered simultaneously accessible if they can be readily contacted simultaneously by one or both hands of a person.

37.5 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured by using metal foil with an area of 100 by 200 millimeters (3.9 by 7.8 inches) in contact with the surface. The surface is less than 100 by 200 millimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the product.

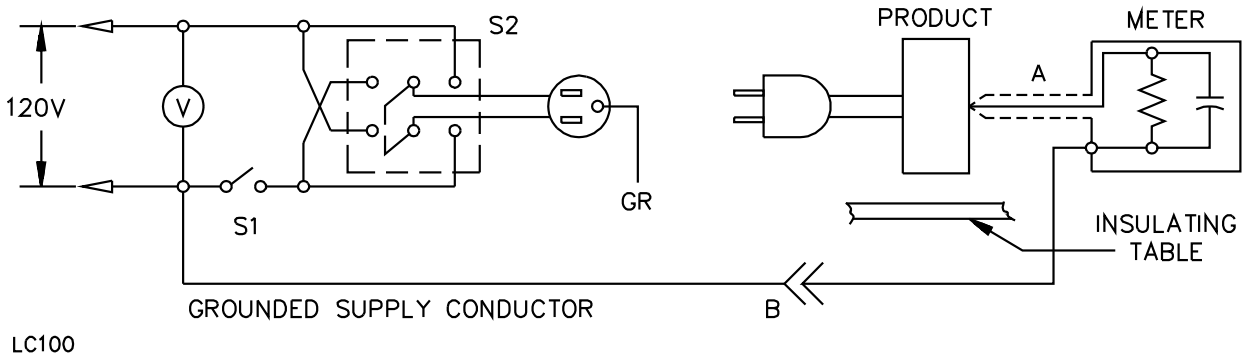
37.6 The measurement circuit for leakage current is to be as illustrated in Figure 37.1. The measurement instrument is defined in (a) – (c). The meter used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument and need not have all of the attributes of the defined instrument.

a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

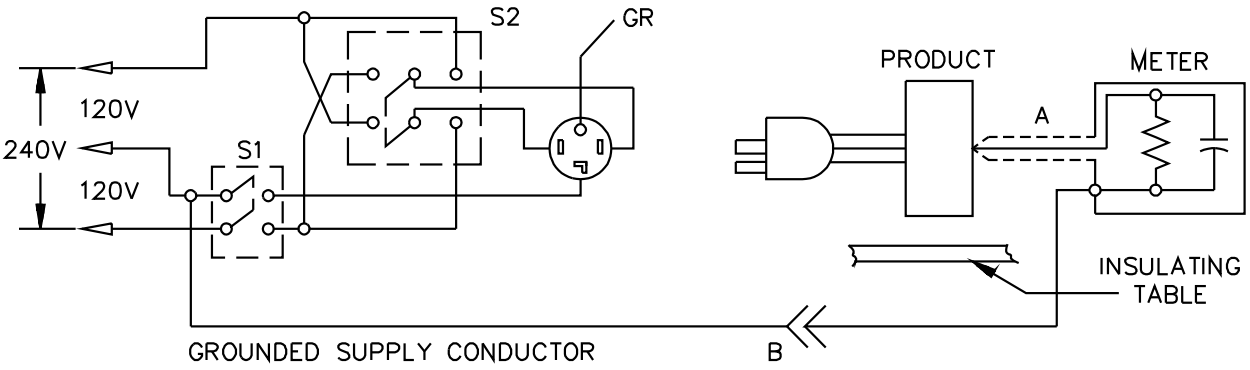
c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At indications of 0.5 and 0.75 milliamperes, the measurement is to have an error of not more than 5 percent.

Figure 37.1
Leakage current measurement circuits



LC100

(1) – Product intended for connection to a 120- or 208-volt power supply.



LC300

(2) – 240- or 208-volt product intended for connection to 3-wire, grounded-neutral power supply.

A – Probe with shielded lead – under some circumstances where higher frequency components are present, shielding of measuring instrument and its leads may be necessary.

B – Separated and used as clip when measuring currents from one part of a product to another.

37.7 A sample of the product is to be prepared and conditioned for leakage current measurement as follows:

a) The sample is to be representative of the wiring methods, routing, component location and installation, and the like, of the product.

b) The grounding conductor is to be open at the attachment plug and the test product isolated from ground.

c) The sample is to be conditioned as described in 36.1.

37.8 The test is to be conducted as soon as possible after the completion of the Humidity Test, Section 36, and the supply voltage is to be adjusted to the test voltage.

37.9 The leakage current test sequence with reference to the measuring circuit in Figure 37.1, is to be as follows:

a) With switch S1 open, the product is to be connected to the measurement circuit. Leakage current is to be measured using both positions of switch S2. All manual switching devices then are to be operated as intended and leakage currents measured using both positions of switch S2.

b) With the product switching devices in their operating positions, switch S1 then is to be closed, energizing the product and within a period of 5 seconds the leakage current is to be measured using both positions of switch S2. All manual switching devices then are to be operated as intended and leakage currents measured using both positions of switch S2.

c) The product switching devices then are to be returned to their operating positions and the product allowed to operate until thermal equilibrium is obtained. Leakage current is to be monitored continuously. For this test, thermal equilibrium is defined as that condition where leakage current is found to be either constant or decreasing in value. Both positions of switch S2 are to be used in determining this measurement.

d) Immediately following the test, any single-pole switch on the product is to be opened, and the leakage current monitored until constant or decreasing values are recorded. Readings are to be taken in both positions of switch S2.

38 Electric Shock Current Test

38.1 If the open circuit potential between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part, exceeds 42.4 volts peak, the part shall comply with the requirements of 38.2– 38.4, as applicable.

38.2 The continuous current flow through a 500-ohm resistor shall not exceed the values specified in Table 38.1 when the resistor is connected between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part.

Table 38.1
Maximum current during operator servicing

Frequency, hertz[a]	Maximum current through a 500-ohm resistor, milliamperes peak
0 – 100	7.1
500	9.4
1,000	11.0
2,000	14.1
3,000	17.3
4,000	19.6
5,000	22.0
6,000	25.1
7,000 or more	27.5

[a] Linear interpolation between adjacent values may be used to determine the maximum acceptable current corresponding to frequencies not shown. The table applies to repetitive nonsinusoidal or sinusoidal waveforms.

38.3 The duration of a transient current flowing through a 500-ohm resistor connected as described in 38.2 shall not exceed:

a) The value determined by the following equation:

$$T \leq \left(\frac{20\sqrt{2}}{I}\right)^{1.43}$$

in which:

I is the peak current in milliamperes

T is the interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 milliamperes and the time that the current falls below 7.1 milliamperes for the last time, and

b) 809 milliamperes, regardless of duration.

The interval between occurrences shall be equal to or greater than 60 seconds if the current is repetitive. Typical calculated values of maximum acceptable transient current duration are shown in Table 38.2.

Table 38.2
Maximum transient current duration

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes peak
7.1	7.26 seconds
8.5	5.58
10.0	4.42
12.5	3.21
15.0	2.48
17.5	1.99
20.0	1.64
22.5	1.39
25.0	1.19
30.0	919 milliseconds
40.0	609
50.0	443
60.0	341
70.0	274
80.0	226
90.0	191
100.0	164
150.0	92
200.0	61
250.0	44
300.0	34
350.0	27
400.0	23
450.0	19
500.0	16
600.0	12
700.0	10
809.0	8.3

38.4 The maximum capacitance between the terminals of a capacitor that is accessible during operator servicing shall comply with the following equations:

$$C = \frac{88{,}400}{E^{1.43}(\ln E - 1.26)} \quad for \quad 42.4 \leq E \leq 400$$

$$C = 35{,}288E^{-1{,}5364} \text{ for } 400 \leq E \leq 1000$$

in which:

C is the maximum capacitance of the capacitor in microfarads and

E is the potential in volts across the capacitor prior to discharge.

E is to be measured 5 seconds after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like. Typical calculated values of maximum capacitance are shown in Table 38.3.

Table 38.3
Electric shock – stored energy

Potential in volts, across capacitance prior to discharge	Maximum capacitance in microfarads
1000	0.868
900	1.02
800	1.22
700	1.50
600	1.90
500	2.52
400	3.55
380	3.86
360	4.22
340	4.64
320	5.13
300	5.71
280	6.40
260	7.24
240	8.27
220	9.56
200	11.2
180	13.4
160	16.3
140	20.5
120	26.6
100	36.5
90	43.8
80	53.8
70	68.0
60	89.4

Table 38.3 Continued on Next Page

Table 38.3 Continued

Potential in volts, across capacitance prior to discharge	Maximum capacitance in microfarads
50	124.00
45	150.00
42.4	169.00

38.5 With reference to the requirements of 38.2 and 38.3, the current is to be measured while the resistor is connected between ground and:

a) Each accessible part individually or

b) All accessible parts collectively if the parts are simultaneously accessible.

The current also is to be measured while the resistor is connected between one part or group of parts and another part or group of parts, if the parts are simultaneously accessible.

38.6 If the product has a direct-current rating, measurements are to be made with the product connected in turn to each side of a 3-wire, direct-current supply circuit.

38.7 Current measurements are to be made with any operating control, or adjustable control that is subject to user operation, in all operating positions, and either with or without a vacuum tube, separable connector, or similar component in place. These measurements are to be made with controls placed in the position that causes maximum current flow.

39 Overload Test

39.1 General

39.1.1 A household burglar-alarm system unit other than that operating from a primary battery shall operate as intended after being subjected to 50 cycles of alarm signal operation at a rate adjusted to 15 cycles per minute with the supply circuit to the product at 115 percent of the rated test voltage. Each cycle is to begin with the product energized in the normal supervisory condition, followed by initiation of an alarm, and then restoration to normal supervisory condition.

39.1.2 Rated test loads are to be connected to those output circuits of the product that are energized from the product power supply, such as remote indicators, relays, and the like. The test loads are to be those devices, or the equivalent, intended for connection to the product. If an equivalent load is employed for a normally inductive load, the equivalent load is to have a power factor of 60 percent. The rated loads are to be established with the product connected initially to a rated source of supply, in accordance with 28.2.2, following which the voltage is to be increased to 115 percent of rating.

39.1.3 For DC signaling circuits, an equivalent inductive test load is to have the required DC resistance for the test current, and the inductance is to be calibrated to obtain a power factor of 60 percent while connected to a 60-hertz AC rms potential equal to the rated DC test voltage. When the inductive load has both the required DC resistance and the required inductance, the current drawn from the AC source will be 0.6 times the current drawn from the DC source.

39.2 Separately energized circuits

39.2.1 Separately energized circuits of a product, such as dry contacts, shall operate as intended after being subjected to 50 cycles of alarm signal operation at a rate of not more than 15 cycles per minute (as defined in 39.1.1) while connected to a source of supply in accordance with 28.2.2, and with 150 percent rated loads at 60 percent power factor applied to output circuits that do not receive energy from the product.

39.2.2 The test loads are to be set at 150 percent of rated current while connected to a separate source of supply in accordance with 28.2.2.

40 Endurance Test

40.1 General

40.1.1 A household burglar-alarm system unit shall operate as intended while connected to a source of supply in accordance with 28.2.2, with rated loads connected to the product, and following 6000 cycles of setting, tripping, and restoration at a rate of not more than 15 cycles per minute.

40.2 Separately energized circuits

40.2.1 Separately energized circuits that do not receive energy from the product shall operate as intended following 6000 cycles of signal operation at a rate of not more than 15 cycles per minute while connected to a source of supply in accordance with 28.2.2, and with a rated load 60 percent power factor applied to the output circuits.

41 Jarring Test

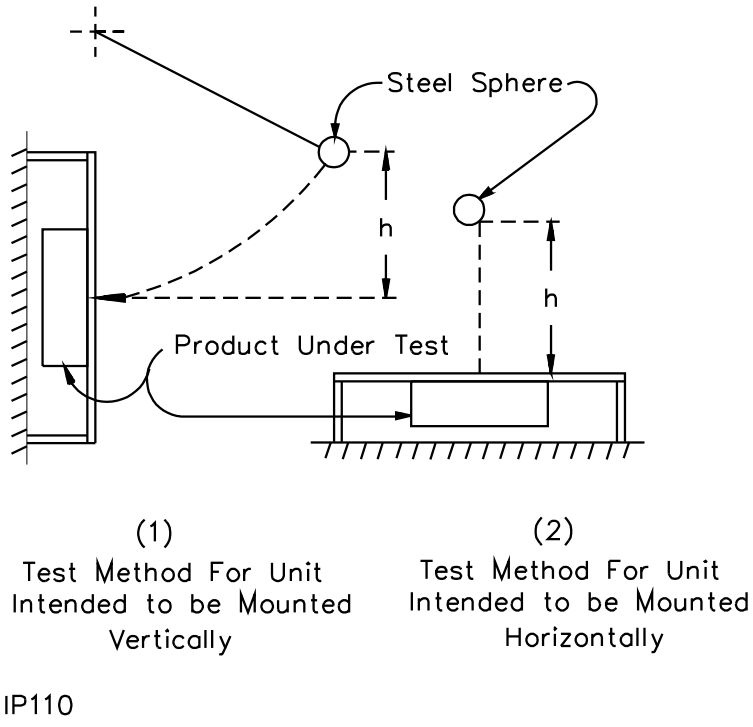
41.1 A household burglar-alarm system unit shall withstand jarring resulting from impact and vibration anticipated in the intended application, without causing signaling operation of any part and without impairing subsequent intended operation of the unit.

41.2 The product and associated equipment is to be mounted as intended to the center of a 6- by 4-foot (1.8- by 1.2-m), nominal 3/4-inch (19.1-mm) thick plywood board secured in place at four corners. A 3-foot-pound (4.08-J) impact is to be applied to the center of the reverse side of this board by means of a 1.18-pound (0.54-kg), 2-inch (50.8-mm) diameter steel sphere either:

a) Swung through a pendulum arc from a height of 30.5 inches (775 mm) or

b) Dropped from a height of 30.5 inches, depending upon the mounting of the equipment. See Figure 41.1.

Figure 41.1
Jarring test



41.3 The product is to be mounted in its intended position and jarred while the unit is in the normal supervisory condition and connected to a rated source of supply in accordance with 28.2.2. Following the jarring, the product shall be tested for its intended operation.

42 Vibration Test

42.1 A household burglar-alarm system unit shall withstand vibration without breakage or damage to parts. Following the vibration, the product shall operate for its intended signaling operation.

42.2 A sample is to be secured in its intended mounting position on a mounting board and the board, in turn, securely fastened to a variable speed vibration machine having an amplitude of 0.01 inch (0.25 mm). The frequency of vibration is to be varied from 10 to 35 hertz in increments of 5 hertz until a resonant frequency is obtained. The sample then is to be vibrated at the maximum resonant frequency for a period of 1/4 hour. If no resonant frequency is obtained, the sample is to be vibrated at 35 hertz for a period of 4 hours.

42.3 For these tests, amplitude is defined as the maximum displacement of sinusoidal motion from a position of rest or one-half of the total table displacement. Resonance is defined as a magnification of the applied vibration.

43 Dust Test

43.1 The intended operation of a household burglar-alarm system unit intended for use outdoors shall not be impaired by an accumulation of dust.

43.2 A sample in its intended mounting position is to be placed de-energized in an airtight chamber having an internal volume of at least 3 cubic feet (0.02 m^3).

43.3 Approximately 2 ounces (0.06 kg) of cement dust, maintained in an ambient room temperature of approximately 23 ±2°C (73.4 ±3°F) at 20 – 50 percent relative humidity and capable of passing through a 200-mesh screen (see Specification for Wire Cloth Sieves for Testing Purposes, ASTM E11-81), is to be circulated for 15 minutes by means of compressed air or a blower so as to completely envelop the sample in the chamber. The air flow is to be maintained at an air velocity of approximately 50 feet per minute (0.25 m/s).

43.4 Following the exposure to dust, the product is to be removed, mounted in its intended position, energized from a source of supply in accordance with 28.2.2, and tested for compliance with the requirements of the Operation Test, Section 29.

44 Component Malfunction Test

44.1 Malfunctioning of an electronic component, such as opening or shorting of a capacitor, either shall not impair the intended operation or shall be indicated by a trouble or alarm signal. See 9.2.

45 Rain Test

45.1 The section of equipment intended to be exposed to weather shall withstand a rain exposure for 1 hour without producing a risk of electric shock or affecting its intended operation. The test shall not result in the entrance of water into enclosures above the lowest electrical component other than insulated wire or in wetting live parts.

Exception: Water may enter an enclosure above the lowest electrical component if the point of entrance is not in proximity to live parts and live parts are not wetted during the rain exposure.

45.2 Electrical components are to be energized during this test, and the unit tested under the conditions most likely to cause the entrance of water into or onto electrical components. It may be necessary to operate the unit under various modes of operation or to de-energize the unit if more water entry could result. Each exposure is to be for 1 hour, and if more than one exposure is required, the unit is to be prepared for testing as indicated in 45.4 before repeating the test.

45.3 Field wiring connections are to be made in accordance with the wiring method specified for the unit. Openings intended to terminate conduit are to be sealed. Openings intended for the entry of a conductor(s) for a low-voltage circuit are not to be sealed unless seals are provided as a part of the product.

45.4 The unit is to be examined to determine that all electrical parts are not wetted and that there is no accumulation of water within the enclosures of electrical parts prior to rain exposure. Also see 45.5.

45.5 Drying of the unit prior to the second or subsequent exposure is not required if, without such preparation, the unit complies with the requirement in 45.6.

45.6 After each exposure, the unit shall have an insulation resistance between live parts and dead metal parts not less than 50,000 ohms. The insulation resistance is to be measured 1 minute after application of the voltage obtained by using the method described in 45.7, or equivalent means, and a DC circuit. After measurement of the insulation resistance, the complete unit is to comply with the requirements of the Dielectric Voltage-Withstand Test, Section 46.

45.7 Insulation resistance is to be measured by means of a voltmeter having an internal resistance of 30,000 ohms used in conjunction with a 250-volt, direct-current source.

45.8 The rain test apparatus is to consist of three spray heads mounted in a water supply rack as shown in Figure 45.1. Spray heads are to be constructed in accordance with Figure 45.2. The water pressure for all tests is to be maintained at 5 psi (34.5 kPa) at each spray head. The unit is to be brought into the focal area of the three spray heads in such position and under such conditions that the greatest quantity of water will enter the unit. The spray is to be directed at an angle of 45 degrees to the vertical toward the louvers or other openings closest to live parts.

45.9 Before the test is started, the resistivity of the water is to be no more than 3675 ohm-centimeters, measured at 25°C (77°F). At the conclusion of the test, the resistivity of the water is to be no more than 3800 ohm-centimeters at 25°C.