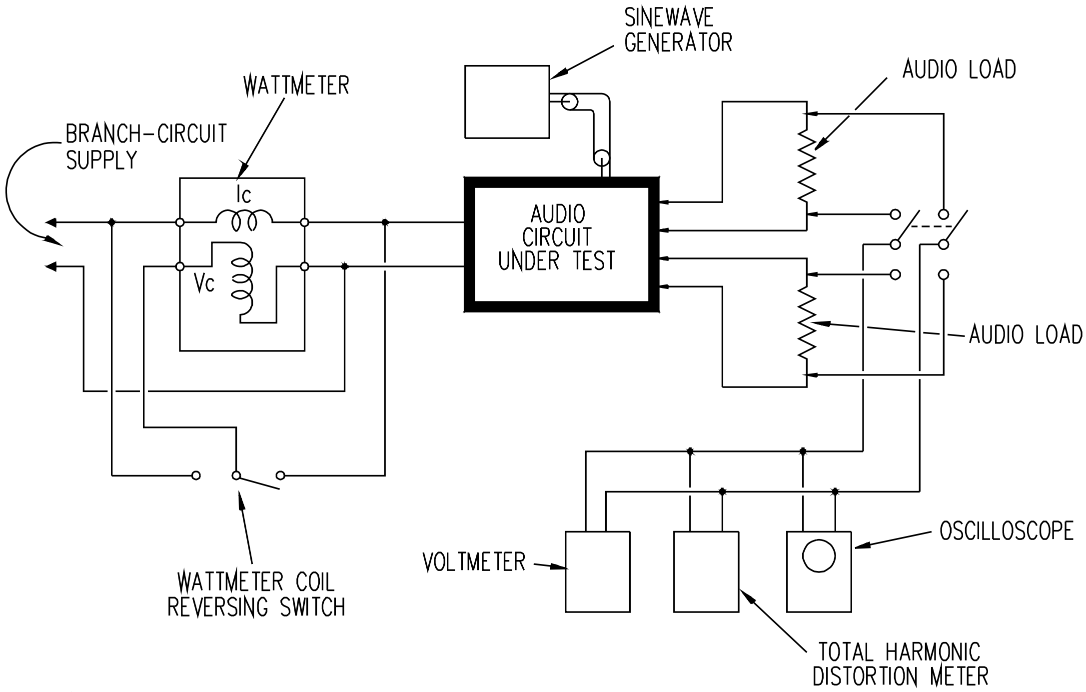
Figure 64.1
Typical input-power and input-current test circuit for an audio amplifier circuit



S2302A

65.2 Test circuit

65.2.1 The product is to be connected to a 120-V, 60-Hz supply source calibrated to represent a 20-A household branch circuit having a momentary 1000-A, short-circuit current capability. For the purpose of these requirements, a circuit having a momentary 1000-A, short-circuit current capability is defined as one complying with the requirements of the qualification tests described in 65.6.1 – 65.6.3.2.

65.2.2 The following devices are to be part of the supply source defined in 65.2.1, as shown in the test circuit illustrated in Figure 65.1:

a) A single-pole, single-throw, bounce-free type switch. For example, a wiping-blade knife switch and

b) A 0.02-ohm, high-frequency, current-viewing, resistive shunt complying with the specifications given in Table 65.1.[a]

[a]The construction details of the 0.02-ohm shunt may be found in Appendix B.

65.3 Product operating condition

65.3.1 The product controls and switches are to be adjusted as indicated in the Power Input Test, Section 64. The thermal state of the product is to maximize the magnitude of the inrush current.

65.4 Test procedure

65.4.1 The 120-V, 60-Hz test circuit to which the product has been connected is to be momentarily energized by operating the test-circuit control switch asynchronously for 60 – 100 cycles of closure and opening. The waveforms of these events are to be displayed on a storage oscilloscope connected across the 0.02-ohm, high-frequency, current-viewing, resistive shunt.

Figure 65.1
Peak inrush-current measurement test circuit

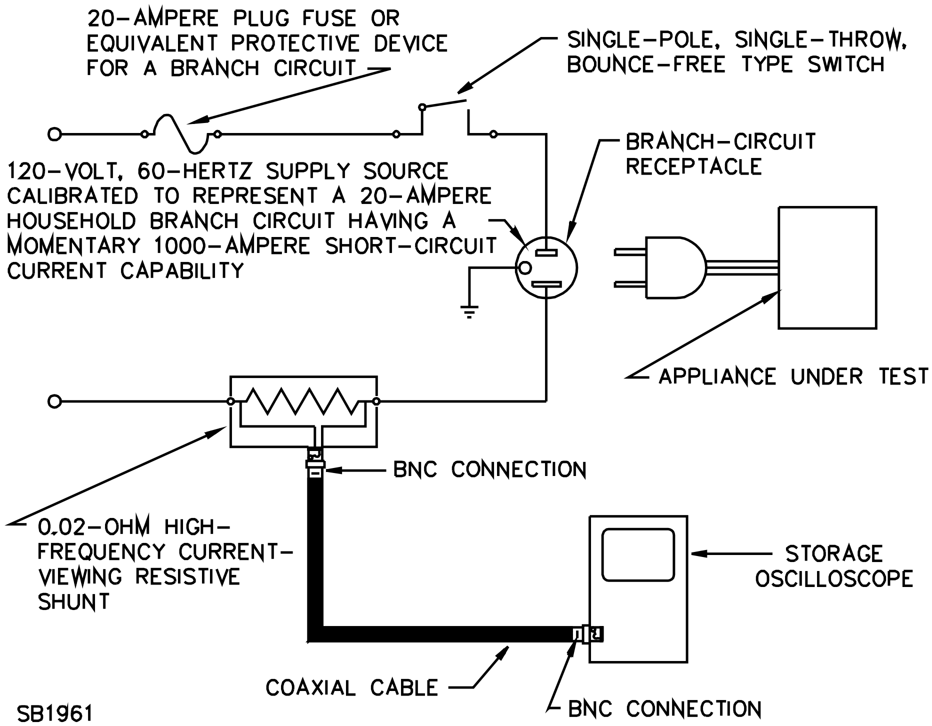


Table 65.1
Specifications for the high-frequency, current-viewing, resistive shunt used for measuring product peak inrush-current

Parameter	Specification	Tolerance
Resistance	0.02 ohms	±2.5 percent
Rise time	30 nanoseconds[a]	plus 0; minus not specified

[a] If a peak-to-peak pulse of any convenient value having a rise time of 30 nanoseconds or less is applied, there is not to be discernible rise-time degradation of the applied waveform when viewed from the current-viewing connector.

65.5 Calculation of peak inrush current

65.5.1 The peak inrush current is to be calculated according to the equation:

$$I_p = \frac{E_p}{R_s}$$

in which:

I_p is the calculated peak inrush current of the product being tested;

E_p is the maximum value of voltage measured across the 0.02-ohm, high-frequency, current-viewing, resistive shunt as displayed by the storage oscilloscope; and

R_s is the exact resistance of the high-frequency, current-viewing, resistive shunt.

65.5.2 The inrush current contributed by any product circuitry that is not controlled by the contacts of the supply-circuit control switch is to be deducted from the calculation described in 65.5.1 so as to determine the actual peak inrush current controlled by the switch contacts.

65.5.3 When observing the waveforms on the oscilloscope, narrow, low-energy-content spikes may be visible due to charging of stray wiring capacitance of the load wiring or to circuit inductance due to a component, such as a phonograph motor. These spikes, which may precede, follow, or both precede and follow the main transient after switch closing and opening, are to be disregarded provided the duration of each spike is 100 microseconds or less.

65.6 Qualification tests for peak inrush-current measuring circuit

65.6.1 General

65.6.1.1 To be considered acceptable for use in the peak inrush-current measurements described in 65.1.1 – 65.5.2, the supply capability at the branch-circuit receptacle shown in Figure 65.1 (the supply source in combination with all of the circuit elements depicted in that figure) shall be such that the following qualification tests are satisfied:

a) Static Load Regulation – The voltage measured at the receptacle shall not fall more than 2.4 V from the open-circuit value when loaded with a steady-state, 20.0-A rms resistive load. The test method and conditions are to comply with 65.6.2.1 and 65.6.2.2.

b) Dynamic Loading – The inrush current to the specified tungsten lamp test load shall achieve a value of 80 ±5 percent of the theoretical maximum inrush current which that tungsten lamp load could produce if it were to be placed across a source of zero-source impedance. The actual inrush current being produced is to be determined using the test methods and conditions described in 65.6.3.1 and 65.6.3.2.

65.6.2 Static load regulation

65.6.2.1 The static load regulation test evaluates the 60-Hz impedance of the supply source, including the inrush-current test equipment, by a measurement of the voltage drop under steady-state load conditions. Automatic voltage-regulation equipment in the supply source, which adjusts the supply voltage under load conditions, is to be connected to the supply circuit during these evaluation tests. However, the automatic voltage-control feature is to be disabled during the test in 65.6.2.2.

65.6.2.2 The open-circuit voltage at the supply receptacle of Figure 65.1 is to be adjusted to 120 V as measured with a voltmeter that has an accuracy of ±1 percent or better. For example, 120 V indicated on a 150-V, full-scale voltmeter requires an instrument accuracy of 3/4 percent full scale, or better. A resistive load is to be applied to the receptacle, and adjusted to 20.0 A rms as measured with an ammeter having an accuracy of ±1 percent – or better – at 20 A. The voltage across the receptacle is to be measured with the 20.0-A load applied, using the same instrument as for the open-circuit voltage measurement. The open-circuit voltage is to be rechecked. The difference between the open-circuit and load voltages is to be calculated. Refer to 65.6.1.1(a).

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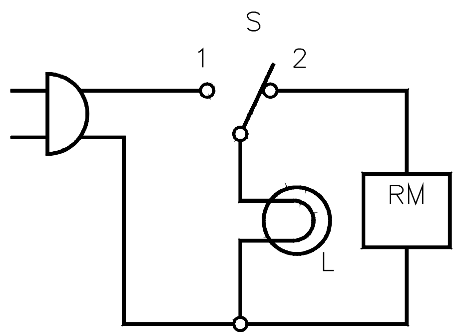
65.6.3 Dynamic loading

65.6.3.1 Prior to its use in the dynamic loading test, it is to be determined that the transient-current measurement instrumentation, which consists of an oscilloscope and high-frequency shunt, is reading the peak value of the 20.0-A rms, steady-state current used in the test in 65.6.2.2 within ±5 percent.

65.6.3.2 The test load in Figure 65.2 is to be prepared using the shortest possible, direct wiring of minimum 12 AWG (3.2 mm^2) copper wire. This test circuit is to be connected to the supply receptacle of Figure 65.1, and the receptacle voltage adjusted to 120 V using the voltmeter described in 65.6.2.2. The open-circuit voltage, Voc, is to be recorded. The maximum theoretical peak inrush current is to be calculated as Voc X 1.414/1.00. Lamp L is to be preheated by throwing switch S to position 1 briefly, then back to position 2. The cooling resistance of lamp L is to be followed to 1.00 ohm with resistance-measuring equipment. Immediately upon reaching 1.00 ohm (typically reached within 20 – 35 seconds after the last heat), switch S is to be rapidly transferred to position 1 briefly again, and then returned to position 2. The peak value of voltage measured for lamp L, except for the first cold start pre-heat cycle, is to be recorded by the use of the oscilloscope and high-frequency shunt. Closure of the 1.00 ohm tungsten load across the receptacle is to be repeated for a minimum of 60 – 100 cycles of operation of S. The value of the highest peak voltage measured during this sequence is to be noted. The highest peak inrush current is to be calculated using the equation in 65.5.1 and then its percentage of the maximum theoretical inrush current (determined by the equation above) calculated. Refer to 65.6.1.1(b).

Figure 65.2
Load for dynamic loading test



SA1956

S – Single-pole, double-throw, bounce-free type switch (for example, wiping-blade knife switch) capable of rapid transfer between contacts.

L – No. 4 photoflood lamp, 1000 W at 120 V.

RM – Resistance-measurement equipment capable of accurately measuring 1.00 ohm (Wheatstone bridge, digital ohmmeter, or the like).

66 Grounding Path Test

66.1 The resistance or the impedance of the grounding path at 60 Hz shall not exceed 0.1 ohm when measured from the grounding means of the product to the conductive part that is required to be grounded. The resistance can be determined by any resistance-measuring equipment.

Exception: If a grounding-path resistance of more than 0.1 ohm is measured, the impedance is to be determined by measuring the voltage when a current of 20 A derived from a 60-Hz source with a no-load voltage not exceeding 12 V is passed between the product grounding means (point on the product where the cord grounding conductor is attached) and the grounded conductive part. The impedance in ohms is to be calculated by dividing the drop in potential in volts by the current in amperes passing between the two points. The power-supply cord is to be excluded when this measurement is made.

67 Product-Leakage and Shock-Current Test

67.1 General

67.1.1 All accessible parts are to be tested for leakage current. All parts accessible during user-servicing are to be tested for shock current. The currents from these parts are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible.

67.1.2 Parts are considered to be simultaneously accessible when they can be contacted by one or both hands of a person at the same time. For the purpose of these requirements, one hand is considered to be able to simultaneously contact parts that are within a 10 by 20 cm rectangle. Parts that can be contacted simultaneously by a person having a reach of 2 m are considered to be touchable by both hands.

67.1.3 Leakage or shock current refers to all currents, including capacitively coupled currents.

67.1.4 Unreliable insulation such as that usually used between the points specified in (a) – (g) is to be short-circuited or open-circuited during the test.

a) Between the voice coil and the frame of a speaker,

b) Between live parts and the metal frame of a phonograph pick-up cartridge,

c) Between the two channels of a stereophonic phonograph pick-up cartridge,

d) Between the plates of an adjustable or variable air-dielectric capacitor,

e) Between the heater and cathode elements of a vacuum tube,

f) Between any two adjacent elements of a vacuum tube, between the elements of an electrolytic capacitor, and

g) Between the elements of a solid-state component (diode, transistor, integrated circuit, and the like).

Exception: A solid-state component (diode, transistor, integrated circuit, and the like) that has been found reliable to not malfunction in such a mode as to result in a risk of electric shock need not be shorted or open-circuited during the test.

67.1.5 Current measurements are to be made with any operating control or adjustable control that is considered subject to user operation in all possible positions of contact and either with or without tubes, separable connectors, and similar devices in place.

67.2 Product leakage current

67.2.1 The leakage current shall not be more than that specified in 12.1.1 (Product leakage current).

67.2.2 The measurement circuit for the product leakage-current test is to be as shown in Figure 67.1. The ideal measurement instrument is defined in (a) – (d). The meter that is actually to be used for a measurement need only indicate the same numerical value for the particular measurement as would the ideal instrument. The meter used need not have all of the attributes of the ideal instrument.

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

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 kHz, the measurement circuitry is to have a frequency response (a 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 μF capacitor to 1500 ohms. At an indication of 0.5 milliampere, the measurement is to have an error of not more than 5 percent at 60 Hz; and

d) Unless the meter is being used to measure current from one part of a product to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

67.2.3 A sample of the product is to be tested starting with the as-received condition with all of its switches closed, but with its grounding conductor, if any, open. The as-received condition is defined as the product not being energized for a minimum of 48 hours prior to the test, and with the product at room temperature. The supply voltage is to be the maximum voltage marked on the product, but not less than 120 (or 240) V. See Table 63.1. The test sequence, with regard to the measuring circuit in Figure 67.1, is to be as follows:

a) With switch S1 open, the product is to be connected to the measuring circuit. Immediately after connection, the current is to be measured using both positions of switch S2 and with the switching devices in the product in all of their operating positions.

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

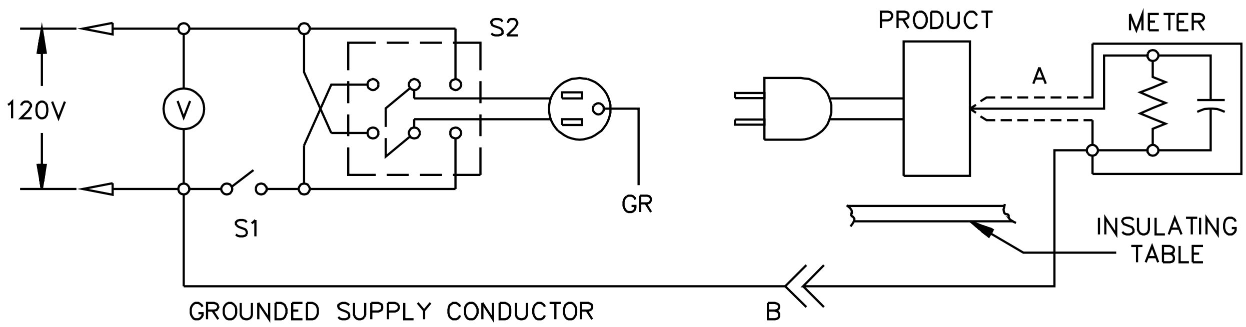
c) The current measurements of (a) and (b) are to be repeated after thermal stabilization of the product.

67.3 Electric shock at audio output circuit terminations

67.3.1 The audio output potential of an amplifier circuit having provision for connection of an external speaker or speakers shall be 100 V open circuit or less when tested as described in 67.3.2.

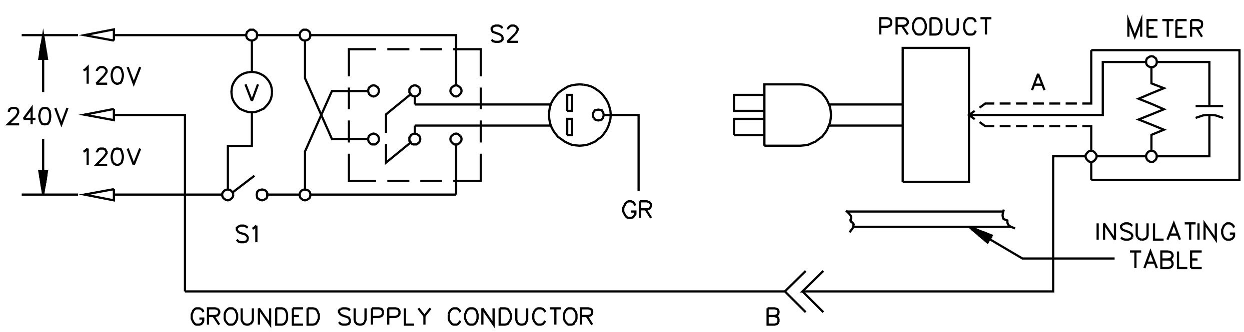
Exception: This requirement does not apply to a product that complies with the requirements in 35.11.2 – 35.11.6.

Figure 67.1
Leakage-current measurment circuit



LC100

NOTE – Product intended for connection to 120-V supply.



LC200

NOTE – Product intended for connection to a three-wire, grounded neutral power supply as illustrated above.

A – Probe with shielded lead.

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

67.3.2 A variable-frequency signal generator is to be connected to the input terminals and a matched load impedance connected across the output terminals. The input-signal voltage is to be adjusted to such a value that maximum, available, undistorted, sine-wave power is delivered to the load. The output circuit is then to be opened and the potential across the output terminals measured. The test is to be repeated over the range from 60 to 100 Hz in steps of 10 Hz by adjustment of the signal generator.

67.4 Electric shock at an audio output circuit under fault conditions

67.4.1 The voltage between:

a) Any accessible conductive part (see 18.1.2) of the audio-output circuit of an amplifier and

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