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tech tips

Servicing Hot Chassis And Performing The Leakage Test With Your PR57 "POWERITE" ®

The PR57 "POWERITE" provides a very fast and accurate check of AC leakage between the AC line and the exposed metal on an AC-operated device. This Tech Tip explains this patented leakage test, why and when it should be performed, and some extra applications where it could come in handy.

What Is The Leakage Test?

The leakage test assures that the TV set or other electronic device being returned to the customer does not have any exposed metal parts that could give the customer an electrical shock. Virtually all service literature lists a safety leakage test similar to the one shown in figure 1.

This safety check applies to all consumer units that are connected to the AC line, but it is most important when the device does not have an isolation transformer. The potential of a shock hazard increases dramatically when the set has a hot chassis.

Why Don't More Servicers Perform The Leakage Test?

Simply stated, many technicians do not perform the safety leakage test, because the test is complicated. It requires a good ground, a resistor/ capacitor combination "made up" or located among the shop parts, and the test setup takes time.

Time is something most technicians don't have.

Why Should You Perform The Leakage Test?

Even though you may find leakage on only

Leakage Current Cold Check

1. Unplug the AC cord and connect a jumper between the two prongs on the plug.
2. Turn on the receiver's power switch.
3. Measure the resistance value, with an ohmmeter, between the jumpered AC plug and each exposed metallic cabinet part on the receiver, such as screwheads, connectors, control shafts, etc. When the exposed metallic part has a return path to the chassis, the reading should be between 240 kΩ and 5.2 MΩ.

   When the exposed metal does not have a return path to the chassis, the reading must be infinite.

Leakage Current Hot Check

1. Plug the AC cord directly into the AC outlet. Do not use an isolation transformer for this check.
2. Connect a 1.5 kΩ, 10 watt resistor, in parallel with a 0.15 μF capacitor, between each exposed metallic part on the set and a good earth ground such as a water pipe.
3. Use an AC Voltmeter, with 1000 ohms/volt or more sensitivity, to measure the potential across the resistor.
4. Check each exposed metallic part, and measure the voltage at each point.
5. Reverse the AC plug in the AC outlet and repeat each of the above measurements.
6. The potential at any point should not exceed 0.75 volts RMS. A leakage current tester (Simpson Model 229 or equivalent) may be used to make the hot checks, leakage current must not exceed 1/2 milliamps. In case a measurement is outside of the limits specified, there is a possibility of a shock hazard, and the receiver should be repaired and rechecked before it is returned to the customer.

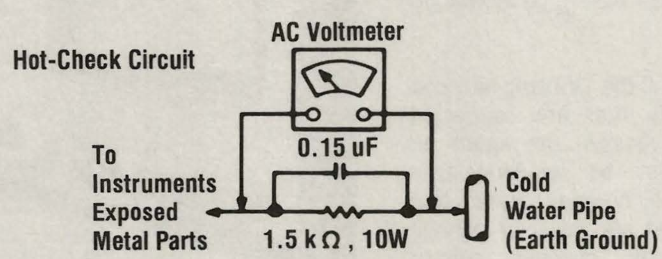

Fig. 1: Manufacturers include the leakage test in service literature, because it helps them meet their legal obligation to deliver safe products to the consumer.

one chassis out of a hundred, that's the very reason you need to safety test every chassis that leaves your shop. It only takes one leaky chassis to put you out of commission so you are unable to work. It only takes one to damage your expensive test instruments and put them out of service for a week or longer. Or, it only takes one zapped customer to bring a lawsuit against you and your shop. It only takes one before you realize that it costs you more not to make the leakage test on every chassis that goes out the door.

Most technicians add on an extra charge to the customer's bill for performing the leakage test. They find that most customers don't mind paying an extra five dollars if it means safety for themselves and their family.

What Causes Leakage?

Basically, any path that will place the customer into either direct or indirect contact with the AC line is dangerous. There are many different ways in which this can happen. The following is a list of some of the most common causes of leakage:

Shorted Antenna Bypass Capacitors: You may see a lot of shorted antenna bypass capacitors after a thunderstorm. The capacitors are in series between the antenna terminals and the chassis to isolate the hot chassis from the antenna. When one of these capacitors is shorted, the customer notices no difference in the operation of their receiver because the RF signal passes through the shorted capacitor just as well as through a good capacitor. The problem, however, is the antenna terminals have raw AC on them.

Improperly Installed Tuner: Occasionally, replacement tuners are installed improperly or with the wrong kind. Isolation capacitors must be installed properly to avoid the AC line being tied to exposed metal parts. Also, insulated shafts on tuners should be replaced with a similar kind to avoid a shock hazard on the tuning knob.

Conductive Knobs: If the TV being serviced has control shafts that are connected directly to a hot chassis, the knobs on these shafts must be insulating-type knobs. Many times, however, knobs that have been replaced are metal or chrome plated which may conduct current resulting in a shock hazard.

Defective Isolation Transformers: Older TV receivers often have built-in isolation transformers that are supposed to isolate the metal chassis from the AC line. But, these older transformers occasionally develop leakage between the primary and secondary windings, causing a hot chassis. This is especially dangerous on the older sets with metal cases or with metal pans covering the bottom of the chassis. All of the exposed metal becomes a shock hazard.

AC Bypass Capacitors: These capacitors connect between the AC line and the chassis in most electronic devices that use isolation transformers. The capacitors bypass RF interference, picked up by the metal chassis, to the AC line for shielding purposes. Older capacitors were often the wax-coated paper type which often develop leakage as the paper dielectric absorbs moisture. In some cases, a capacitor shorts completely, causing a direct connection between the AC line and the chassis. These capacitors, like antenna bypass capacitors, are commonly damaged during thunderstorms.

Bent Rabbit Ears: Many receivers have rabbit-ear antennas designed to slide down inside the back of the case. Generally, there is a plastic tube inside the case to isolate the metal antenna rods from the chassis. But the rods often get bent. When the bent rods are pushed down to the "nested" position, they touch the hot chassis. Not only is the exposed end hot, the wire coming out the back of the chassis to connect to the antenna terminals also carries the full AC line voltage.

Improper Installation Of Parts: Forgetting to replace an insulating piece of "fish paper" under a component.

Foreign Objects Touching The AC Line: Allowing a piece of wire or solder to fall between one side of the AC line and the chassis.

A Broken Safety Ground: The broken ground may allow a shaft or control to "float".

Using Long Metal Screws: Screws that are too long and go all the way through the plastic mounting tabs and touch the metal chassis.

Adding An Earphone: Accessory jacks on a set that does not have an isolation transformer — imagine the shock hazard when connected directly to the listener's head!

Foreign Objects: Coins, hairpins, or other metal objects which have fallen inside the set.

Connecting An External Speaker: Wiring accessories to a set that does not have an isolation transformer.

The list could go on and on. The key thing is that there is a shock hazard any time a piece of metal comes in contact with a hot chassis.

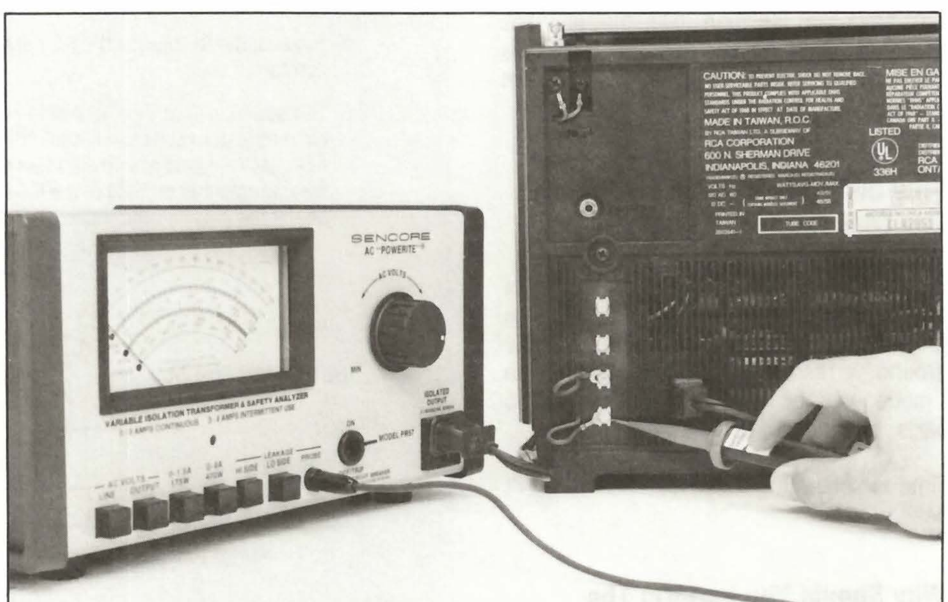

Fig. 2: To make a safety leakage test with your PR57, simply plug the chassis into the POWERITE and touch the probe to all exposed metal surfaces.

The PR57 Leakage Test: It's Fast And Simple

The PR57 simplifies the safety leakage test, because all circuits are internally referenced to the isolated output of the PR57. First, the PR57 allows the leakage test to be made while the unit under test is still connected to the isolated output. Other procedures require a direct connection to the AC line. The test should be done with the set plugged into the PR57. This reduces the chance of getting a shock while performing the test and also means that you do not have to remember to move the AC line cord to a non-isolated outlet.

The PR57 leakage test does not require earth ground reference because all of the current paths are referenced back to the secondary of the isolation transformer. This allows you to make the test anywhere, including in a home that is not wired with grounded outlets.

To perform the Leakage Test with the PR57:

1. Plug the PR57 into a properly grounded three wire AC outlet.

2. Push the AC VOLTS OUTPUT pushbutton and adjust the VOLTS control for a reading of 117 volts on the PR57 meter. This establishes a 117 volt reference for uniform test results.

3. Press the HI SIDE leakage button and plug the Safety Leakage Probe into the PROBE jack on the front panel of the PR57.

4. Touch the probe tip to every user-accessible piece of exposed metal, including screw heads, antennas, antenna terminals, knobs, all control shafts with knobs removed, handles or anything that even appears to be metallic.

5. Read the leakage on the uA LEAKAGE meter scale of the PR57. To read the true leakage current, push the button on the probe while probing the test point.

6. Push the LO SIDE LEAKAGE pushbutton and repeat the leakage test to the same points tested in step 4.

The Safety Leakage Probe has a switch which places a current-limiting resistor in series with the test circuit. The resistor is bypassed when the button on the probe is depressed.

This resistor limits the amount of current to prevent the meter from pegging when a test point with high leakage is contacted.

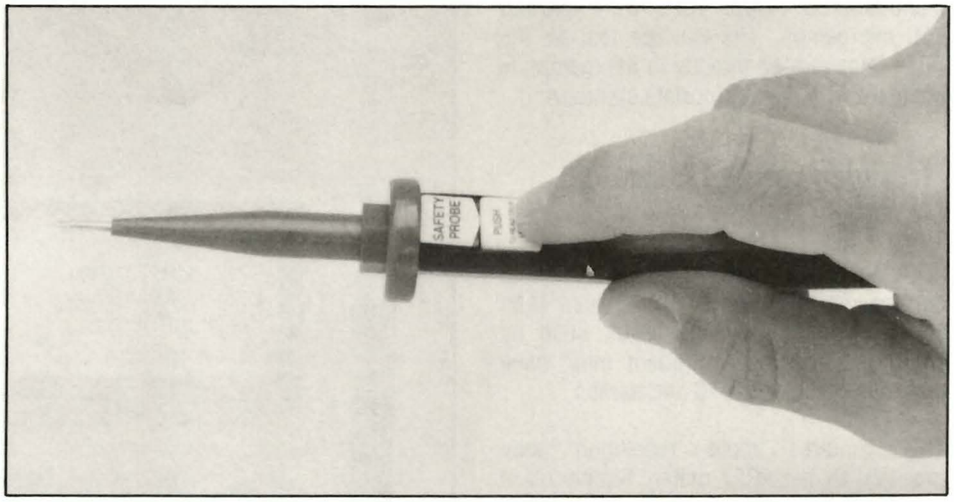

Fig. 3: The pushbutton of the Safety Leakage Probe is depressed when the actual value of leakage current is to be read on the PR57's meter.

This condition occurs when the point being tested is connected directly to either side of the AC line.

Any test point that reads close to full scale (800 uA) with the button in the "out" position is connected directly to one side of the AC line. If, for example, the meter reads full scale when the LO SIDE button is depressed, there is a direct connection to the common side of the AC line. This is the side of the polarized line cord plug with the larger connector.

Leakage readings which are less than full scale indicate that there is a leakage path (but not a dead short) to the point being tested. Simply press the button on the Safety Leakage Probe to read the actual leakage current present.

How Much Leakage Is Bad?

The chart, Figure 4, shows the effect of electrical shock on the human body. You may be surprised to learn that the most likely range of fatal current is between 30 and 250 mA. This is the area where the breathing and heart are most severely affected. The chart is based on a person weighing 150 pounds. Smaller people, especially children, are much more susceptible to shocks at lower current levels.

There should be no leakage at all, but this is not practical in real terms. Components, such as RF decoupling capacitors and antenna matching transformers, allow some current to flow. Underwriter Laboratories has established guidelines for safe leakage currents. The maximum UL allowable limit (since 1972) is 500 microamps. Consumer electronic devices

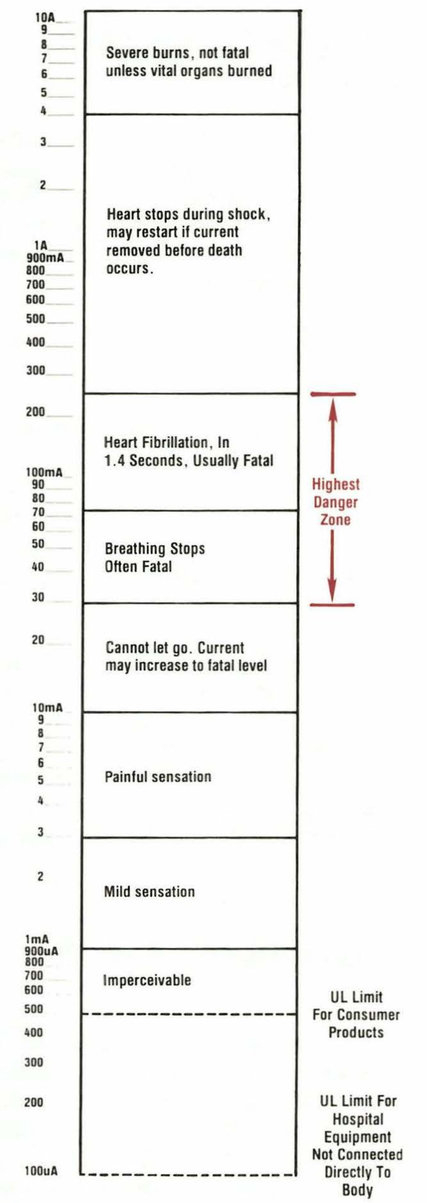

Fig. 4: The effects of electrical shock on a human being.

manufactured before 1972 were allowed 750 microamps. The leakage test on the PR57 is calibrated directly in microamps to compare with the appropriate standard.

Measuring Leakage At Lower Levels

Some equipment must be kept at a leakage current which is considerably less than consumer products. Equipment such as clinic and hospital equipment must have less than 100 or even 10 microamps.

This requires more resolution than provided by the PR57 meter. Simply place an AC current meter (such as the Sencore DVM37 or DVM56A) in series with the Safety Leakage Probe. This allows you to measure the leakage within 0.1 microamps with digital accuracy.

Checking The Calibration Of The Leakage Test

The current-limiting resistor in the Safety Leakage Probe is also a calibration resistor. The calibration of the PR57 leakage test can be tested at any time so you will know that the readings obtained during the test are correct.

To test the calibration of the PR57 leakage scale:

1. Plug the PR57 into a properly grounded three-wire AC outlet.

2. Depress the AC VOLTS OUTPUT button and turn the PR57 "ON". Adjust the AC VOLTS control for a reading of 117 volts on the PR57 meter.

3. Plug the leakage probe into the PROBE jack and depress the HI SIDE LEAKAGE pushbutton. Place the probe tip into the small blade opening of the ISOLATED OUTPUT socket in the PR57. The meter should read 780 microamps without the button pushed on the Safety Leakage Probe.

Testing Leakage On Three-Wire Units

The PR57 leakage test is designed to operate exactly the same on a unit with a two-wire AC line cord or a 3-wire (grounded) AC line cord. The ground connector on the ISOLATED OUTPUT jack is connected to earth ground through the power cord of the PR57. This assures safe operation of the unit under test as its chassis is maintained at earth potential. This ground path does not affect the safety leakage test. The leakage between the internal circuits and the chassis on these three-wire units is read exactly the same as two-wire units. You simply touch the Safety Leakage Probe to each metallic cabinet part and read the leakage directly on the PR57 meter. Do not defeat the third-wire ground on either the device under test or the PR57.

Testing For Line Cord And Extension Cord Leakage

An increasingly common cause of electrical fires is leakage between the conductors of line cords and extension cords. Leakage of this type may eventually short and/or cause sparks which may ignite a fire.

The instrument to use to test for leakage in line cords or extension cords, is your Z-Meter. Measure the leakage between the two conductors on a two wire cord or the leakage between the three conductors on a three wire cord. In either case, the leakage should be absolutely zero (with the cord unplugged from the wall or device that it supplies power to). If any leakage is detected, the cord is defective and should be replaced.

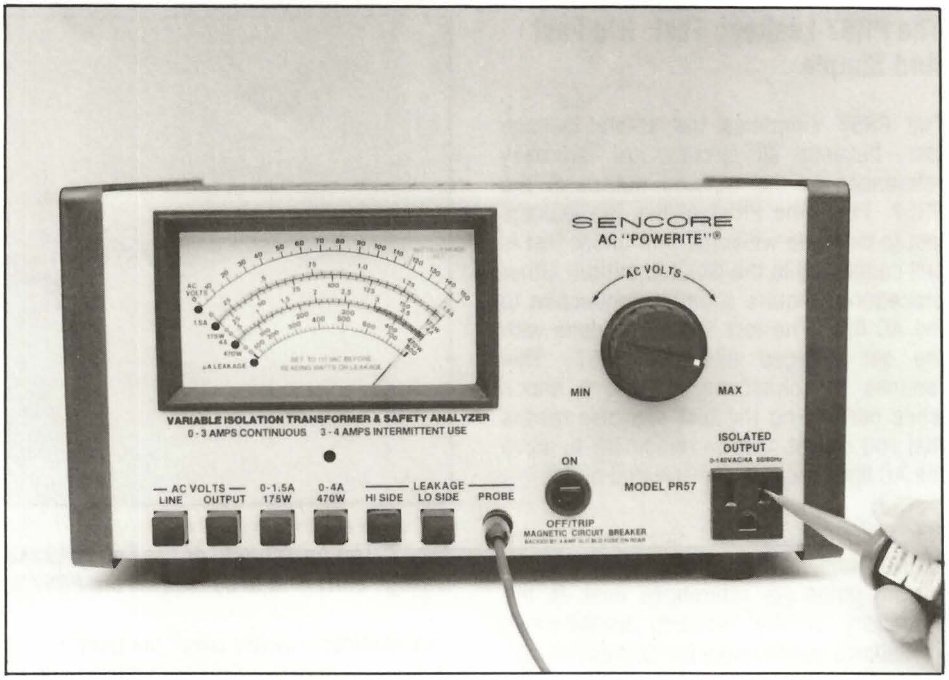

Fig. 5: The built-in calibration resistor in the Safety Leakage Probe allows a quick check of the leakage scale calibration by inserting the Safety Leakage Probe into the Isolated Output and checking for a full scale leakage reading.

For more information
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