FEATURE

Product Safety or Operator Danger?

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500 VA Safety Testing Requirements

Several years ago, the European Union began enforcing requirements for compliance safety testing of most electrical products sold into the European Community. These requirements were established to safeguard the health of both consumers and workers and to protect the environment; the intention was to provide a set of harmonized standards for product-safety and quality testing that would be accepted by all EU member states. Once it has met the test requirements, a product must be affixed with a CE approval notification before it can enter the European market. Most U.S. electrical manufacturers wishing to ship products to Europe must now face the challenge of performing tests on their products that may not previously have been required.

One of the most common of these is the Dielectric Voltage Withstand test, also known as the high-potential, or "hipot," test. This test has for many years been a standard production requirement of UL (Underwriters Laboratories) and other U.S. safety agencies, and for the most part, the methods imposed by the European requirements are very similar. However, there are a number of differences that manufacturers need to be aware of.

The hipot tests that manufacturers are required to perform under the CE directives for safety testing are largely based on the IEC (International Electrotechnical Commission) and EN (European Norms) standards. Some of these reference specifications mandate the use of a hipot tester with as much as 500 volt amperes (VA) of output power.

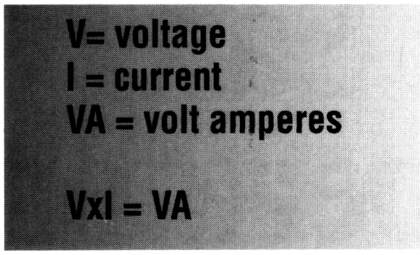
A hipot's VA rating is a measure of its output power, calculated by multiplying the maximum voltage of the hipot by its maximum current output (see Figure 1). Two important specifications that call for 500 VA of output power, without exception, are IEC 204 and EN 60204, part of the Machinery Directive, which became effective on January 1, 1995. Any electrical machine imported into Europe must pass these requirements before it is allowed to display the CE mark. For many manufacturers, this means having to test products with a hipot of a much higher output rating than they have previously used to comply with U.S. safety-agency requirements. While other specifications from UL and CSA (the Canadian Standards Association) also specify a 500 VA rating, unlike the IEC and EN specs, they permit certain exceptions.

Why 500 VA?

The requirement for a 500 VA-rated hipot was likely stipulated to ensure that the device under test, or DUT, would be tested with the correct amount of voltage under varying load conditions. Loading conditions can greatly affect the output voltage applied to the DUT when unregulated hipot testers are used. Many manufacturers adopt a standard procedure for setting the hipot voltage while the DUT is connected; this ensures that the proper test voltage will be reached when the hipot tester is operating under a loaded condition. Unfortunately, the setup procedure becomes somewhat more complicated in manufacturing environments where multiple products run down the assembly line into the testing area, since each product may represent a different load than the one for which the hipot was originally set.

A hipot with 500 VA should provide enough output power to test a device under a loaded condition without allowing the output voltage to fall below the specified setting. The applications most commonly requiring a hipot with a 500 VA rating are those in which an AC hipot voltage must be applied to a highly capacitive load. Applying an AC test voltage to a capacitive DUT causes a flow of capacitive leakage current, which can have a dramatic effect on the total leakage current that the

Figure 1: Line regulation.



measures; the capacitive leakage current is often much greater than the current that flows due to resistive leakage, and in itself could trigger the need for a 500 VA hipot.

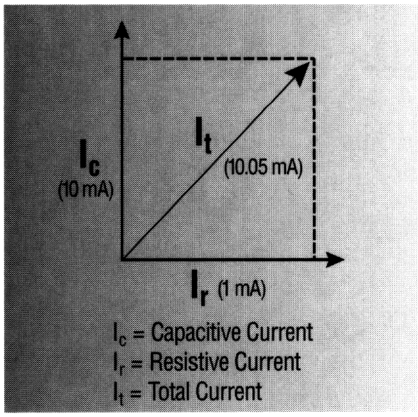
The total current measured is the vector sum of the resistive and capacitive currents. Figure 2 shows the relationship among resistive current, capacitive current, and total current. In this example, the DUT draws only 1 mA of resistive current, but because of its capacitance, it draws 10 mA of capacitive current. The vector sum of these two current components is the total current (in this instance, 10.05 mA), which represents the actual value measured by the hipot. Some common DUTs with a potentially high level of capacitive current flow include large motors, long lengths of coiled cable, and devices with large capacitive line filters.

The Risks

Unfortunately, the 500 VA output capacity poses a considerable safety risk for the hipot operator: the higher the current output of the hipot, the more potentially lethal the test. Hipot operators work in an environment that calls for extreme caution. The severity of an electrical shock is dependent on a number of factors, including voltage, current, frequency, duration of exposure, current path, and the physical condition of the person who receives the shock.

Now that 500 VA is a requirement, operators are exposed to an increased risk of harmful, and possibly even fatal, electrical shock. For example, to meet the 500 VA rating, a 5000-volt hipot would have to have an output current rating of 100 mA (5000 volts x 0.1 amps = 500 VA) . At a potential of 600

Figure 2: Vector sum relationship of capacitive current and resistive current.



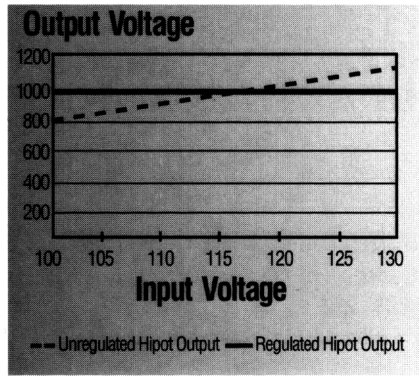
volts or less, as little as 30 mA of current can stop a person from breathing; 75 mA can cause cardiac arrest and is often fatal. At levels greater than 600 volts, skin resistance fails; at 2400 volts, burning becomes a major effect. With a 500 VA-rated tester, the risks obviously increase exponentially.

The Alternatives

Happily for all concerned, there are several ways of decreasing the shock risk to operators while still ensuring the performance of consistent tests. Many UL and CSA specifications provide that "if the output of the test-equipment transformer is less than 500VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential." The presence of such a meter in the output of the transformer allows the operator to ascertain the actual voltage being applied to the DUT. Metering in the secondary circuit directly at the output, meanwhile, gives a true indication of the output voltage and allows the operator visually to verify the output of the hipot tester. For this reason, most hipot manufacturers install metering directly in the secondary. This metering circuit meets the UL and CSA specifications that most electrical manufacturers are required to test to.

A second means of lowering the risk of a lethal shock from a 500 VA-rated hipot utilizes new technology developed expressly to allow electronic regulation of hipot testers. With the advent

Figure 3: Line regulation.

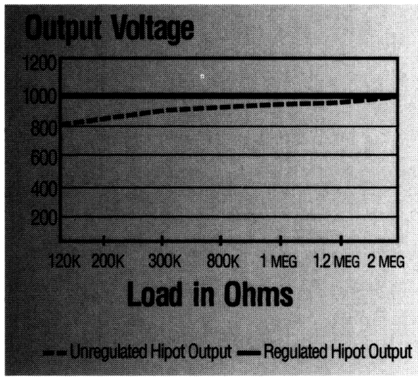


of line and load regulation, hipots can be electronically monitored and automatically adjusted so that the output voltage will remain constant under varying line voltage and loading conditions. Line-voltage fluctuations are a frequent occurrence, particularly in manufacturing settings, where several pieces of machinery may be powered by a single input-line circuit; fluctuations are also common in incoming power from the utility service. Such fluctuations in input voltage can cause drastic changes in output voltage. A hipot tester with a line-regulation circuit will maintain the output voltage at the correct setting even when input-line voltage varies (see Figure 3).

As mentioned above, differing loads may also cause variation in the output voltage of the hipot. Load regulation can maintain the correct output voltage under varying load conditions by electronically monitoring the load being tested and making adjustments automatically so that the output voltage is maintained within 1% of its setting. Older-style hipots without line and load regulation require constant adjustment to ensure that the hipot is providing the proper. test voltages; because in many production environments such adjustments either are not or cannot be made, tests are often inaccurate or unsafe. Today's hipot testers must be flexible enough to test any product without requiring the user to waste time on frequent adjustments. With line and load regulation, this objective can be accomplished.

Figure 4 shows how the output voltage can change if the load changes; note the drop in output voltage with larger loads. In this example, an unregulated hipot's output voltage can vary by as much as 200 volts. This could theoretically allow the operator to pass products that technically have not been fully tested to safety-agency specifications. Figure 4 graphically illustrates the importance of using hipots with regulated circuits for proper safety testing. Before line and load regulation, the only way to achieve this type of consistent and accurate testing was to use a hipot tester with a high current output, such as 500 VA. With line and load regulation, however, the only time a hipot with a 500 VA rating needs to be used is when the product under test actually requires a high current output

Figure 4: Load regulation.



to reach the specified output voltage. With more safety agencies' recognizing the value and safety to be had in using hipots with line and load regulation, many 500 VA requirements may become a thing of the past.

Conclusion

Through the use of microprocessors and digital technology, many instrument shortcomings have been eliminated. It is now time to amend or update testing specifications to reflect today's instrument capabilities. Just as safety-agency specifications cover product safety, line and load regulation addresses operator safety and testing accuracy. As more and more electrical safety standards become harmonized, so too should product safety, operator safety, and testing accuracy become a harmonized standard.

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