Application Note

The Easy Capacity Test and the Eaton 9395 UPS Deliver Advances in UPS Commissioning and Load Testing

Introduction

With the ability to perform a full load test and/or full battery discharge test without the connection of a load bank, the Eaton® 9395 UPS offers an unprecedented spectrum of benefits. The 9395 UPS is programmed to process power in a re-circulating fashion, using its own rectifiers and inverters as an internal load bank. This new, unique method of load testing when commissioning or servicing a UPS is generating significant savings in cost, time, coordination and power.

The challenges of traditional load testing

Every UPS deployed within a mission-critical environment should first be thoroughly tested at full power to ensure that it will deliver the levels of availability and reliability demanded. However, the process of testing the UPS at full power has always presented the following challenges:

- Due in large part to the need for a load bank, traditional testing methods require significant expense, time and coordination.
- The testing process can prove difficult since critical systems often are not yet running at full capacity in new applications.
- Comprehensive testing procedures can disrupt the vital day-to-day power demands of the enterprise in existing installations.

While traditional load bank and battery discharge tests are invaluable for validating UPS operation, not every customer has the budget or time to perform them. Also, with the current focus on “green” operations and energy savings, an increasing number of customers are requesting alternatives to traditional load bank testing.

The Easy Capacity Test saves time, money and aggravation

The new Easy Capacity Test from Eaton eliminates the expense, complexity and risks associated with full load testing. It delivers unrivaled testing capabilities without the inconvenience or expense, providing customers with the assurance that their systems are operating properly.

In addition to the two most common on-site commissioning tests – full load burn-in and battery discharge time – many end users also request step-load tests and full power load performance characteristics in order to thoroughly simulate the real-world environment for a critical power system. Eaton has responded with the development of automated tests that can be performed more quickly and at a significant cost savings.

With the Easy Capacity Test capability built right into every 9395 UPS, an Eaton authorized field service engineer can quickly and easily perform system tests without requiring special equipment. The engineer connects a laptop to the UPS and selects the appropriate preconfigured test. Even more, testing may be performed without any downtime to the facility.

Using the rectifiers and inverters of the UPS as an internal load bank, the Easy Capacity Test performs a full load test and/or full battery discharge test *without a load bank being connected to the output of the UPS.* In addition to the UPS assessing its entire power train under full load stress, an extended load test can be executed to meet burn-in requirements. Additional tests can be completed on the upstream bypass input breaker, the rectifier input breaker and all of the electrical cables in between[1]. The Easy Capacity Test quickly and efficiently completes all of the parameters included in typical load bank tests, while saving time, money and aggravation during startup and commissioning.

Conversely, customary load bank tests tend to be complex, expensive and inconvenient. In addition to consuming excessive amounts of power and requiring thousands of Euros in case of a load bank rental, the tests rely on hundreds – or thousands – of meters of expensive copper cable. These temporary cables must often be run through doors and windows, up staircases and along hallways. Even more, a service engineer is forced to race between the load bank and the UPS each time a load is added or removed.

[1] For units where input power is fed to both the rectifier and the bypass (see Figure 3)

The need to connect load banks into the electrical system results in undesirable downtime. For load banks that are kept indoors, there can also be significant costs incurred for proper cooling. The Easy Capacity Test eliminates these costs and challenges.

How Easy Capacity Test works

The key concept in understanding Easy Capacity Test is that power flow between parallel voltage sources can be manipulated by changing their phase angle. For example, Figure 1 shows two AC sources connected by the same inductance. These two AC sources have the same voltage but a phase difference of ten degrees. The inverter (red) leads the utility source (blue) in time, which means that the inverter ***delivers*** power. The result is real kW power with AC current flow through the inductor towards the utility source as indicated in Figure 2. It is important to note here that power is being transferred from one AC system to another, but there is no net consumption of energy within the system.

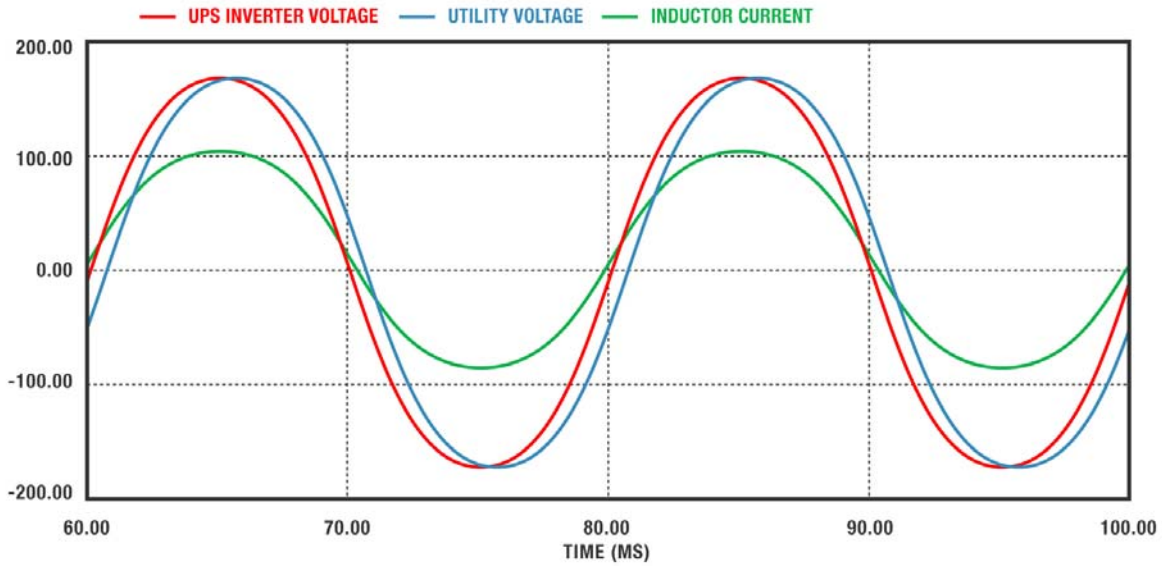

Figure 1: Two AC sources (inverter, utility) connected by the same inductance

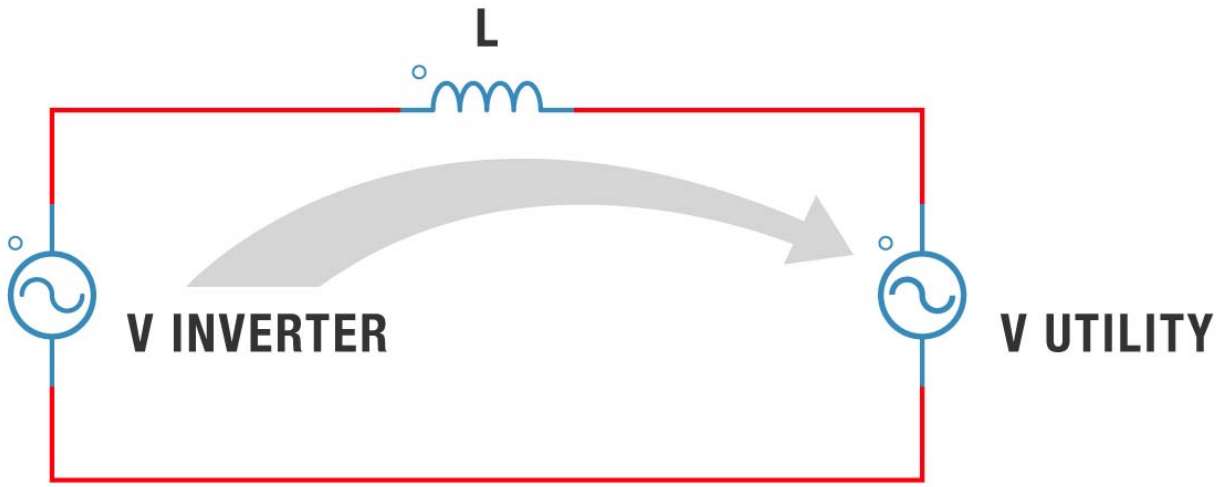

Figure 2: Power flow when inverter leads utility

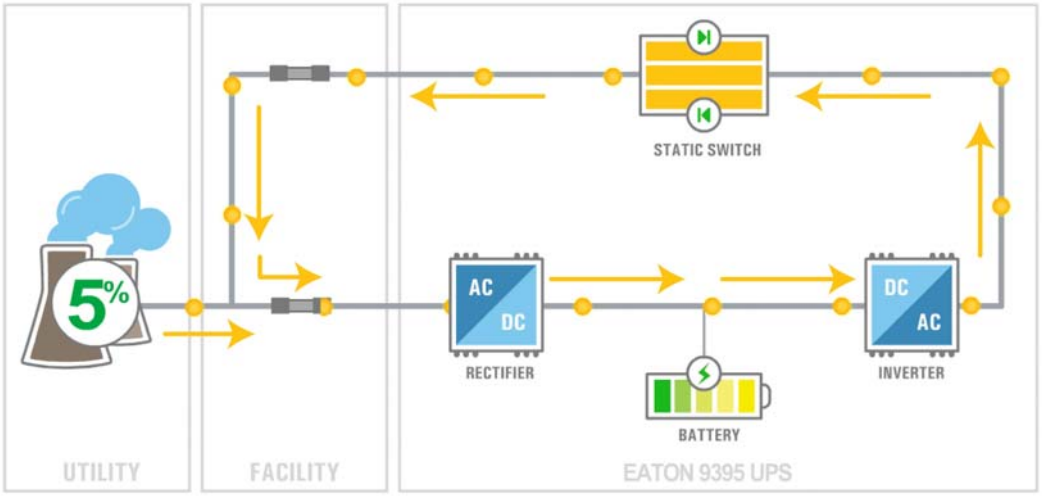

Figure 3: Easy Capacity Test power flow

Figure 3 illustrates the concept using the 9395 UPS: The automated process begins by allowing the rectifier and inverter to start normally and produce a voltage. Then, the static switch turns on and the inverter operates in parallel and in synchronization with the utility source. The test software controls the phase angle of the inverter output with respect to the utility. The inverter phase angle is then adjusted to “lead” the utility, and the two sine waves move apart. The difference in phase angle causes the inverter to deliver power into the static switch, back toward the UPS input. The rectifier then draws power and produces direct current to support the inverter to complete a circular path. In this mode, power is not fed back into the power source of the building.

The internal load is then set by the software to various percentages of rated input current. At this point, the Easy Capacity Test is providing a fully loaded system while drawing only five percent of the rated input power from the utility. The UPS, rectifier, bypass breakers and internal UPS bypass circuits are operating under full nameplate rating to enable calibration of meters, perform thermal scans and complete other key performance measurements. The entire process is completed in a real-time, full power environment that never threatens the critical computer load.

Using digital control techniques, the inverter regulates power back through the UPS internal bypass wiring by changing this phase relationship. The yellow arrows show the direction of current flow in the system. The power transferred by the rectifier is equal to the power delivered by the inverter minus the five percent efficiency losses within the UPS.

Where does the energy go? The Easy Capacity Test is designed not to consume energy but to transport it. The system is like a closed loop of water pipes with the rectifier and inverter acting as pumps. The water in the pipe circulates and the pumps function normally, but the same water simply goes around and around. Very little water is consumed. In the same manner, the inverter, bypass and rectifier simply pass the energy along as if they were powering a real load on the output of the UPS.

As Figure 4 illustrates, a battery discharge with load can be accomplished by turning off the rectifier. The UPS senses the loss of DC voltage and the battery begins to discharge. In most cases, the energy that is fed back into the input source is absorbed by the other electrical loads within the building. In instances where the facility does not require that amount of power, the excess is returned to the utility grid.

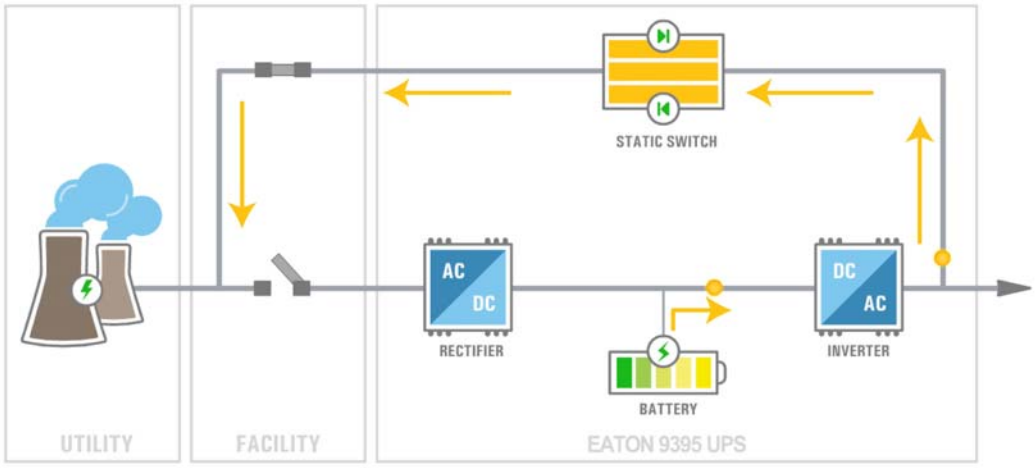

Figure 4: Easy Capacity Test battery discharge diagram

Benefits

The Easy Capacity Test enables useful and elaborate UPS assessments to ensure the protection of mission-critical loads. This new technology affords significant advantages over traditional load bank testing methods, including:

- **Time savings.** The automated Easy Capacity Test can be performed quickly, saving countless hours over procuring, installing and connecting a load bank to the output of the UPS. The service engineer simply connects a laptop to the UPS and in most cases, can perform the entire test in less than one hour (except for burn-in tests). An automated report is immediately generated and can be printed within minutes.
- **Cost savings.** Without the need to rent a load bank, customers reduce their energy bill and pay for far fewer hours of testing. In addition to the cost of a two-day load bank rental, there is no expense for an electrician to make connections to the UPS. Also The Easy Capacity Test also eliminates the tremendous waste of energy inherent in load bank testing, as the burn-in tests often last 24 hours or longer. For example, the cost of a 550 kVA UPS running full load for 24 hours at an average electrical utility rate of 0,1 € per kWH is about €1200 per day.
- **A green solution.** Because the UPS essentially circulates power through itself, while only drawing minimal power from the utility, only a small amount of utility power is lost. In comparison to a standard load bank test, overall energy consumption is greatly reduced.
- **Enhanced confidence during repairs or preventive maintenance.** When a 9395 uninterruptible power module (UPM) is de-energized for preventive maintenance or replacement of PC boards or semiconductors, there is always a concern as to whether the work was complete and comprehensive. The Easy Capacity Test can be performed on an individual UPM, allowing it to run under load for an extended time if desired. This process provides a thorough stress test of the repaired system before it is reconnected to the customer's critical computer system, resulting in enhanced reliability and facility uptime.
- **Increased safety.** You can rest assured that the Easy Capacity Test performs all parameters safely. The elimination of portable load banks and temporary wiring enhances safety. External load banks present high voltage, noise and exhaust hazards. In addition, associated cabling is often routed through windows and doorways, posing security and personal safety hazards. These problems exist as long as the load bank is in use. Easy Capacity Test eliminates these hazards entirely.

Conclusion

Incorporated into every 9395 UPS, the Easy Capacity Test delivers exceptional testing capabilities while eliminating the expense, time, complication and risks associated with traditional load bank testing. Providing the ultimate peace of mind that critical systems will be protected, the Easy Capacity Test helps safeguard UPS operation, from initial commissioning to well into the future.

To view a video on the Easy Capacity Test or to find out more about the 9395 UPS, visit the 9395 product page on Eaton's Web site: www.powerware.com/EMEA/UPS/9395_UPS.asp .