White Paper

Applications for Capacitive Load Banks

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Capacitive load banks play an important role in testing and maintaining telecommunication, computer, and uninterruptible power supply (UPS) systems. This paper differentiates categories of electrical load and identifies applications that require capacitive load bank testing.

Types of Electrical Load

Electrical loads can be classified into either resistive, inductive, or capacitive types. The following section defines each one.

Resistive Load

Resistive load results from friction associated with electrical current flow, which converts the energy into either heat or light. Examples of resistive loads include electric heaters and incandescent light bulbs, which produce heat and light, respectively. Resistive load banks use heating elements to resist electrical flow and convert it into heat that is dissipated by an integral fan. Resistive power is measured in Watts.

Inductive Load

In alternating current systems, voltage and current may not rise and fall together. The difference between the occurrence of voltage and current defines whether power is active (produces work, such as that accomplished by a spinning motor) or reactive (such as power drawn to produce a magnetic field). With these definitions in mind, inductive load resists changes in current. As a result, current 'lags' behind the measured voltage, as shown in Figure 1.

The sum of active power and reactive power is measured in Volt-Ampere-Reactive (VAr). Load banks use aluminium or copper windings with laminated iron-cored inductors to produce inductive load.

Capacitive Load

Capacitive load resists changes in voltage. As a result, voltage lags behind the current, as shown in Figure 2.

Examples of capacitive loads include UPS and certain types of telecommunication systems. As with inductive load, capacitive load is comprised of both active and reactive power, but presents an opposite polarity. Like Inductive load banks, capacitive loads are measured in VAr.

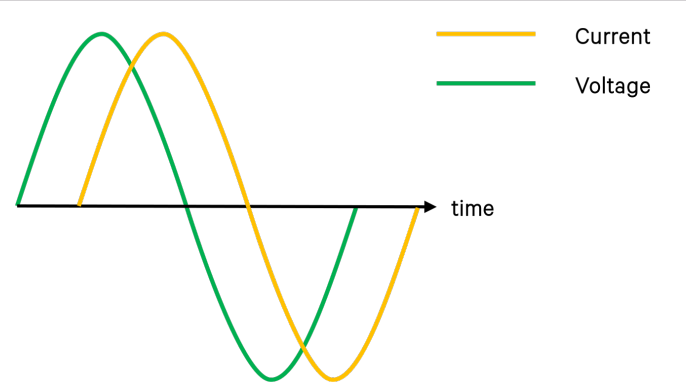

Figure 1: Positive Reactive Power. Voltage leads current.

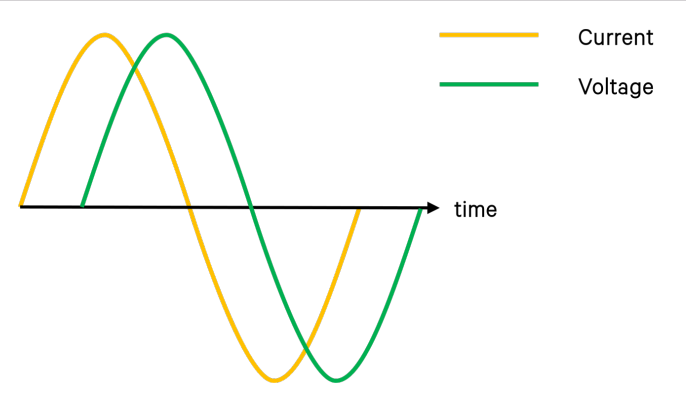

Figure 2: Negative Reactive Power. Voltage trails current.

Capacitive Load Bank Design

Load banks are available in resistive, inductive, capacitive, resistive/reactive, and Resistive-Inductive-Capacitive (RLC) models. Each type was developed to meet the demands of specific electrical test applications, and capacitive load banks are specifically designed to accurately test capacitive loads.

A capacitor consists of two conductive surfaces separated by an insulator that stores electrical energy in an electric field. In its simplest form, a capacitive load bank uses electronic capacitors in an enclosure to apply capacitive load to a power system or electronic device. A capacitive load bank is shown in Figure 3.

Figure 3: A 600 kVAr Capacitive Load Bank. Photo courtesy of Optimum Power Services.

Capacitive load banks are often operated in conjunction with resistive load banks to create a variable leading power factor. Load banks are also used to simulate capacitive load that typically occurs in certain telecommunication, computer, and UPS systems.

Capacitive load banks vary in capacity, which is measured in kilo Volt-Ampere reactive (kVAr). They typically add load in discrete steps, and sophisticated models can be controlled using microprocessor-based hand-held controls or a personal computer that feature various manual and automatic test modes.

Load Bank Standards

Load banks are designed to control and absorb a specified amount of power (kVAr) and should be designed to insure safety of the operator and equipment. The load bank must be designed to the latest applicable International Electrotechnical (IEC), National Electrical Manufacturers Association (NEMA), National Electrical Code (NEC), and American National Standards Institute (ANSI) standards. Stationary and portable load banks should carry a third party listing such as Underwriter Laboratory (UL) standard 508A, Canadian Standards Association (CSA) or the European Union's CE marking.

Capacitive Load Bank Applications

Capacitive load banks provide accurate, controllable and repeatable capacitive loads to power systems and electronic devices. The resulting test data can be used to ensure reliable and efficient power system operation. Capacitive load banks can be used in a wide range of applications that include commissioning power systems in commercial and industrial facilities, testing and maintaining power systems, and power factor correction.

Commissioning

Thorough and accurate load testing is a vital step in the process of commissioning power systems in mission critical facilities such as hospitals and data centers. Capacitive load banks are used together with resistive load banks to test systems using non-unity, leading power factors. They are also used to verify power system performance before operations of new facilities are transferred to their owners or occupants. Any performance issues can be remedied in a controlled environment to avoid the possible impacts of potential outages and downtime.

Load test results can be recorded and used to create reports that document and verify system performance. Many mission critical facilities load test their backup power systems and other ancillary equipment before going ‘live’.

Power System Testing and Maintenance

In industrial facilities, maintenance and test programs are often implemented to assure that power output and quality will meet demand. In facilities equipped with a variety of electronic, computer and telecommunication loads, a capacitive load bank may be connected to a resistive load bank. By using the both types of load banks to simulate “real-life” and theoretical conditions, engineers can ensure that power systems are fit for their designed purpose. Load tests may reveal degradation in components and equipment that can be replaced to reduce the risk of prospective failures and outages.

Power Factor Correction

Capacitive load banks are often used in industrial and manufacturing facilities for power factor correction. Power factor correction is the process of bringing power factor (P.F.) closer to unity to increase power use efficiency from the grid. The addition of capacitive load counteracts the inductive load produced by various motors, compressors and lighting in the facility to adjust the ratio of active working power. The closer to unity (1.0) P.F., the more efficient and economical a facility will become.

Data Center Power System Commissioning

Complex data centre power distribution systems, server racks, and computers often produce non-unity capacitive load in normal operation. Ensuring backup power supplies such as gen-sets and UPS systems can adjust and react to the resulting leading power factor is essential in mission critical data center environments.

Capacitive load banks are used together with resistive load banks to accurately simulate variable leading power factors for UPS systems, gen-sets, and other typical data center equipment. This testing helps ensure that these systems will be fit for their designed purpose if a failure of the normal power supply occurs.

Research and Development

Manufacturers always look for ways to improve their products. Gen-set manufacturers constantly adapt and test new ideas to produce more advanced and reliable systems. When capacitive load rises in industrial and commercial facilities, backup power systems must adjust to the associated stresses of leading power factors and still provide consistent and reliable power.

Capacitive load banks are often permanently installed into research and development facilities to test the ability of new power systems to adapt to fluctuations in capacitive load. Specific load profiles are applied to the power systems for pre-determined time periods. If a power system satisfactorily adapts to changes in capacitive load, development can progress to the next stage. Capacitive load bank testing is especially prevalent in marine gen-set testing because the use of inverters and battery packs has increased in marine systems and environments.

Anti-Islanding Testing

Resistive, inductive, and capacitive (RLC) components can be combined and constructed into a single unit. (Alternatively, singular versions of each load bank type can be connected in a network to provide a similar function.) RLC load banks are used in certain specialized test applications.

Islanding is the condition of power still being produced despite lacking any connection to the electrical power grid. Islanding is potentially dangerous to electrical engineers and produces numerous issues regarding voltage and frequency.

Anti-islanding is the process of distributed generators detecting abnormalities and disconnecting from the circuit immediately.

RLC load banks test the effectiveness and prove the working of the anti-islanding circuitry in the commissioning and maintenance of certain solar power generation applications.

Summary

The use of a capacitive load bank is important to effectively determine the operating efficiency of the power source. A capacitive load bank is an essential tool for power source verification where leading power factors are required. Most major load bank manufacturers provide practical solutions and support services to assure that your power systems will provide many years of safe operation.

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