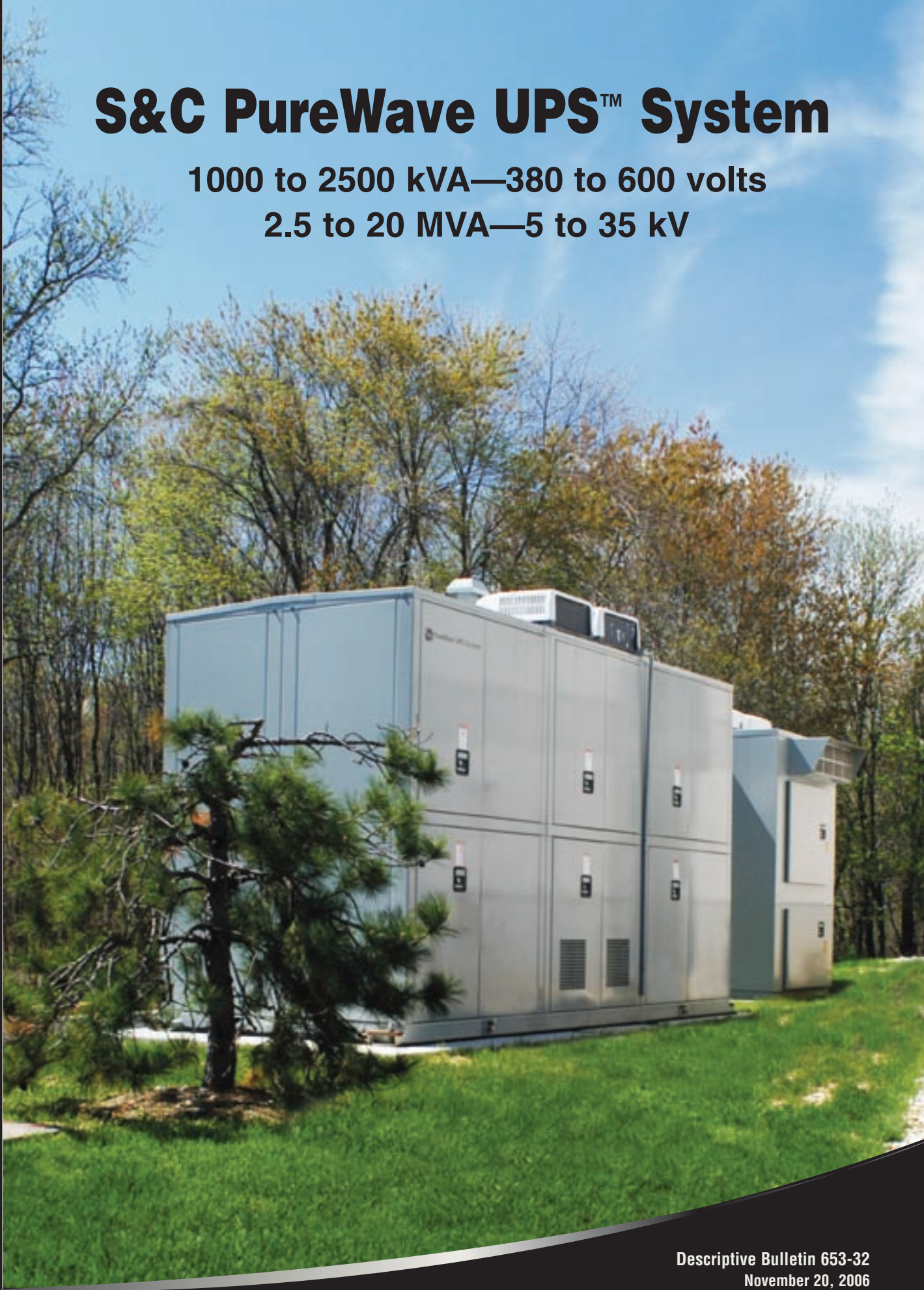


S&C PureWave UPS™ System

1000 to 2500 kVA—380 to 600 volts

2.5 to 20 MVA—5 to 35 kV



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The Problem

The increased use of computers and other sensitive electronic devices has resulted in the proliferation of loads which cannot tolerate power quality problems such as voltage magnitude and frequency excursions, and even momentary power interruptions.

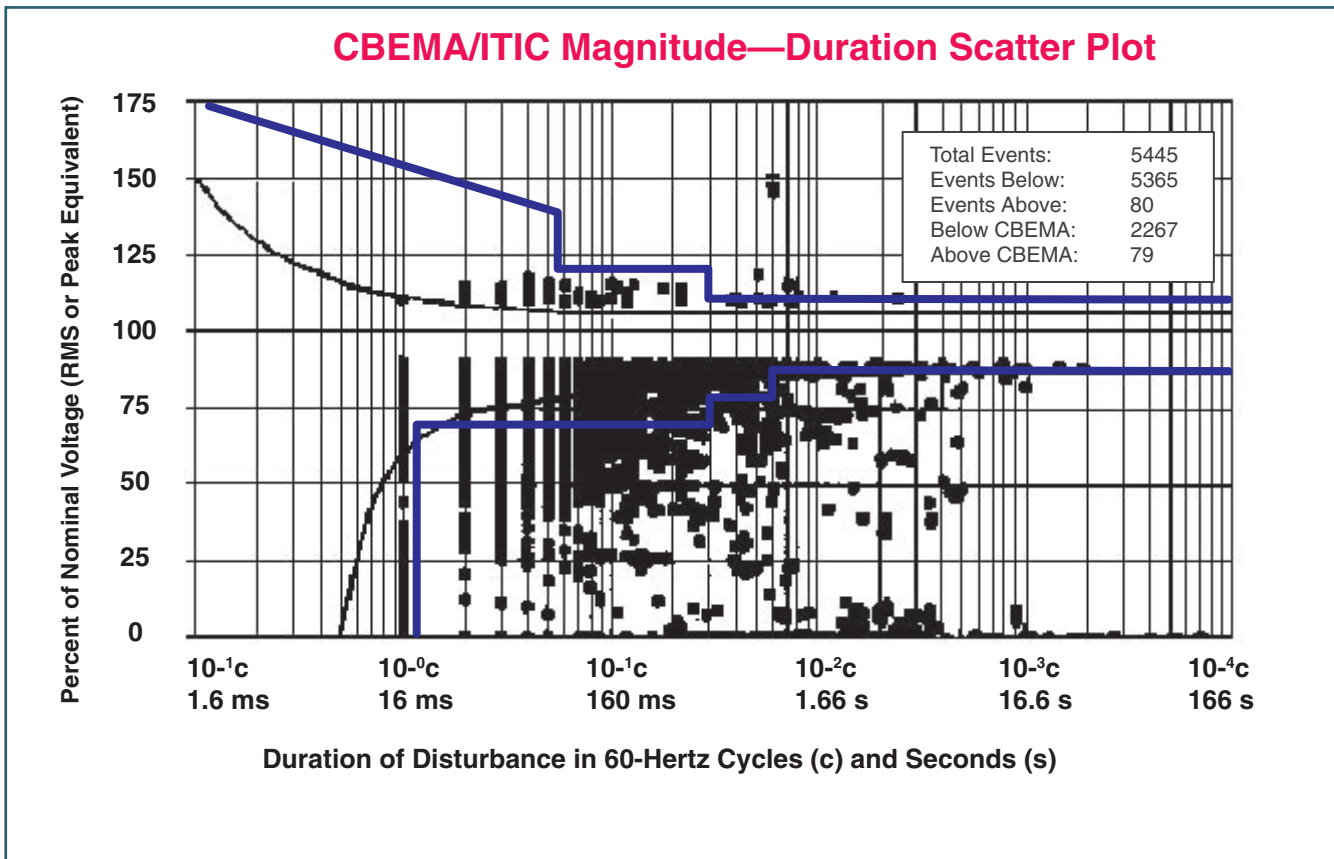
Voltage sags and momentary interruptions are the most commonly encountered power quality problem. As the results of a recent nationwide EPRI study show, 98% of all power quality problems are attributable to voltage sags and interruptions of 15-second duration or less.

Sags on the order of 10% or more are common and are generally caused by adjacent-feeder faults. The reason for this is tied to typical distribution substation construction. Distribution substations are built around one or more transformers. Often the transformers are banked and support many loads off of a common bus. A fault on a given load causes a voltage sag not only on the faulted feeder, but on all feeders fed from the same bus.

Although most disturbances occur on the distribution feeder circuit, faults on the utility transmission system—when they occur—can be more harmful to critical loads. When the resulting voltage sags are greater than 50% of nominal voltage, an uninterruptible power supply (UPS) is the only means for mitigating such deep sags.

Conventional Low-Power UPSs Are Not the Answer

Sensitive loads frequently are not concentrated in one area of a facility. Rather, these sensitive loads are often physically separated, with data processing equipment located in a central office building, and process and machine controls in remote manufacturing locations. Each of these loads could be served by its own dedicated low-power UPS, but to do so would be expensive—not only in initial cost and floor space, but in on-going maintenance costs. Conventional UPSs are thus not suitable for typical manufacturing applications.



Results of EPRI study on distribution-system voltage disturbances. (EPRI Commissioned Report RP 3098-1.)

The PureWave UPS System Solution

S&C's PureWave UPS System offers a new and better alternative to distributed low-power uninterruptible power supplies.

The maintenance-free PureWave UPS System, available in ratings from 380 volts to 35 kV, provides back-up power to the *entire facility* for a maximum of 60 seconds—eliminating up to 99% of the voltage disturbances commonly encountered on users' distribution systems. Not only is it more cost-effective than distributed low-power UPSs, but it can be installed outdoors. No valuable interior, air-conditioned floor space is required.

The PureWave UPS System is also the only large-scale UPS system that's designed completely around the performance parameters of the battery. No ongoing battery maintenance is required . . . just replacement of the batteries every six years.

And the PureWave UPS System is the only one offering a five-year/5,000-megajoule non-prorated warranty on the batteries. In a typical application, that translates into over 1,500 discharge cycles. Based on a 20-year life-cycle analysis, the PureWave UPS System has a battery cost less than half that of a conventional UPS system. The system continuously monitors the status of each battery string to ensure system availability. No single battery problem can cause a system malfunction.

The unique PureWave UPS System design offers yet another major benefit: It allows critical-load users to plan for 100% protection from extended power outages. Battery ride-through time permits start up of a new or existing backup generator.

Upon detection of an extended power outage, the PureWave UPS System provides "soft" load transfer to the backup generator. This arrangement also allows critical load users to take advantage of lower interruptible service rates from the electric utility serving their facilities. The PureWave UPS System provides seamless transfer between the utility source and the backup generator without the need for costly paralleling switchgear.



Low-voltage PureWave UPS System.



Medium-voltage PureWave UPS System.

Energy Storage Containers

Systems rated 380 to 600 volts include one energy storage container. Systems rated 5 to 35 kV include up to eight energy storage containers.

The energy storage container houses up to eight 480-volt power modules, each rated 313 kVA/250 kW. Each power module contains 48 Deka Group 31 batteries along with an IGBT-based inverter and battery charger. The power module features camlock connectors for quick connection and disconnection.

The microprocessor-based system control provides a local/remote interface to the system monitor and operator controls. The system monitoring computer provides continuous information on all system parameters.

The PureWave UPS System provides completely automatic operation. The control panel has just one switch, one push button, and one connector. With the automatic-operation ENABLED/DISABLED switch in "DISABLED,"

the bypass state is initiated; system maintenance can be performed without disturbance to the critical load. The RESET push button is used to reset latched alarm contacts. The connector is for use by S&C field service specialists.



Energy storage container rated 2500 kVA.



Power module rated 313 kVA.

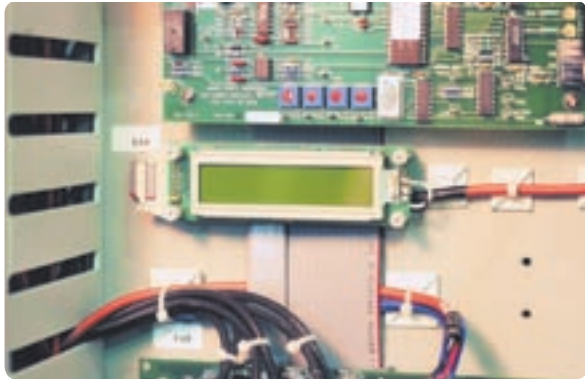


System control and system monitor.



Control panel.

A two-line, 20-character liquid-crystal display indicates overall system status and serves as a backup to the monitoring computer.



Liquid-crystal display.

Power conductor terminations and an isolation transformer are furnished in the rear-center section of the energy storage container.



Low-voltage isolation transformer. Medium-voltage isolation transformer is similar.

The batteries in each power module are connected to a hydrogen gas venting system, which is vented to the exterior of the energy storage container. An exhaust blower ensures evacuation of hydrogen during charging of the battery strings. A hydrogen detector and smoke detector are furnished behind the top rear-center door of the container, near the roof. The detectors are connected to the monitoring system.



Hydrogen and smoke detectors.

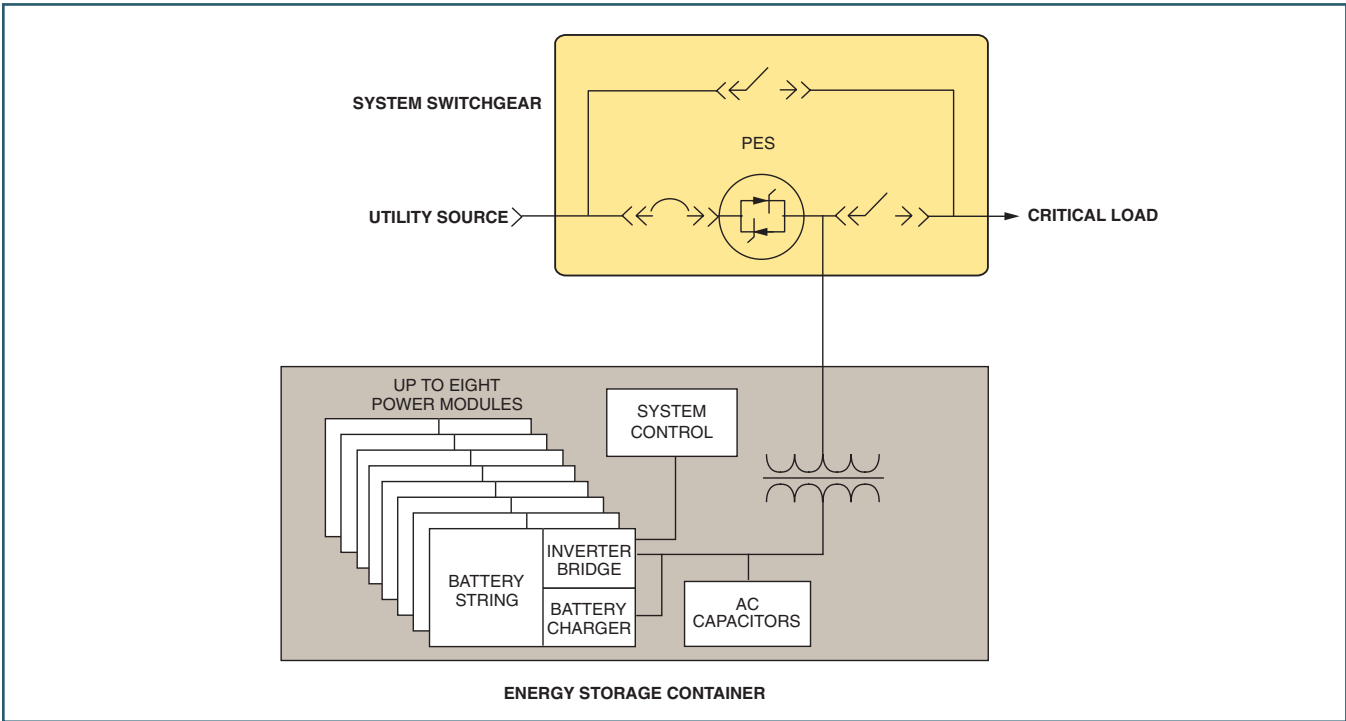
Redundant air conditioners and heaters are provided to maintain the batteries and controls at their optimum operating temperature, ensuring high reliability and long operating life. The air conditioners are located at the top of the energy storage container. The isolation transformer is cooled by ambient air circulated through the transformer compartment.



Air conditioners.

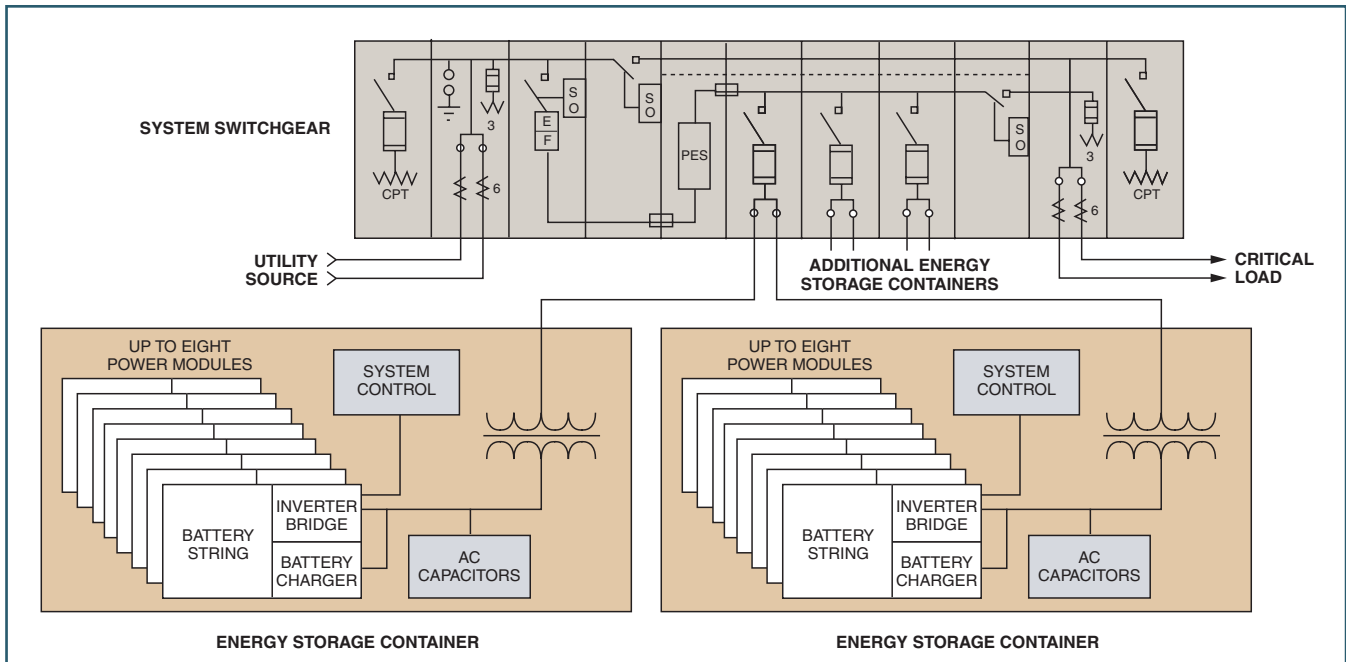
System Switchgear

In low-voltage applications, the system switchgear includes a PureWave Power-Electronic Switch and circuit breakers and switches, which provide isolation and bypass functions.



Single-line diagram of low-voltage application.

In medium-voltage applications, the system switchgear includes a PureWave Power-Electronic Switch and fused S&C load-interrupter switches, which provide isolation and bypass functions.



Single-line diagram of medium-voltage application.

S&C Metal-Enclosed Switchgear provides application flexibility, operating simplicity, and superior dependability. It features:

- **Rugged construction.** Each bay of S&C Metal-Enclosed Switchgear is fabricated from 11-gauge steel with an integral channel base. There are always double walls between adjoining bays. Accurately formed, matching enclosures ensure perfect alignment in multibay line-ups.
- **Comprehensive access controls**—all doors have heavy-duty latches and hinges and are padlockable. Manual switch handles are padlockable in both positions. Access is further limited by snaplocks or interlocks.
- **Wide bulkhead-type doors** provide convenient front access for cable termination. There's no need for rear access . . . gear can be placed back-to-back or against a wall, using a minimum of floor space.
- **Inner screen doors**—bolted closed—are a second barrier guarding against inadvertent entry.
- **Built per requirements of ANSI/IEEE Standard C37.20.3, Category B.** Enclosures can be built to Category A requirements for even greater security and vandal resistance.
- **S&C's unique Ultradur® finish** guards against corrosion. Far exceeds requirements of ANSI/IEEE Standard C37.20.3. S&C's proven finishing system provides lasting protection that cuts enclosure maintenance costs. All hardware is galvanized, zinc-nickel plated, or of stainless-steel or nonferrous materials to resist corrosion.
- **Specially designed gasketing or sealants** provide weathertight seals at door openings, at top and side edges of adjoining bays and interbay bus openings, and at the roof.
- **Insulating "no-drip" compound** on the underside of the roof checks condensation.
- **Cyposy®**, S&C's cycloaliphatic epoxy resin insulation system, insulates all live parts from ground—it's nontracking, self-scouring, nonweathering, and has greater leakage distance than comparable porcelain insulators.
- **Grounding provisions**—on all cable-termination points, and on the ground bus, accommodate portable grounding equipment.
- **Bus connections**—protected by an oxide-inhibiting compound, and designed to maintain optimum contact pressure.

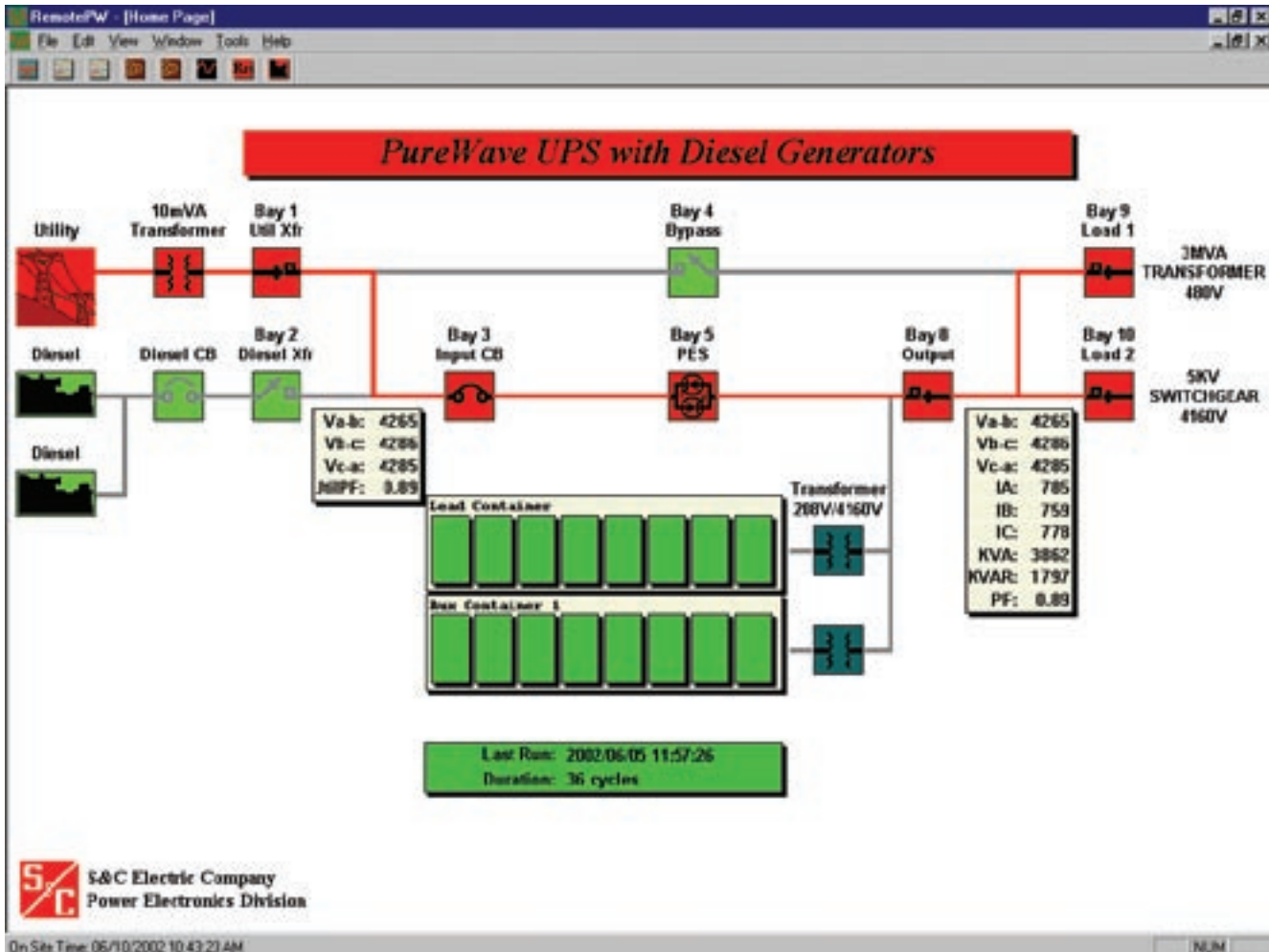


Easy-to-Use Monitoring System

The Windows®-based monitoring system is simple to set up and run. The graphical interface provides real-time system status information, the status of each energy storage container, power outage data, load voltage and current, power factor, alarm indicators, and battery warranty

status. The monitoring system may be viewed remotely via a phone line or Ethernet connection. Connection to the monitoring computer is password protected.

Real-time status information is also available via Modbus/TCP server.



Monitoring computer system status screen.

How It Works

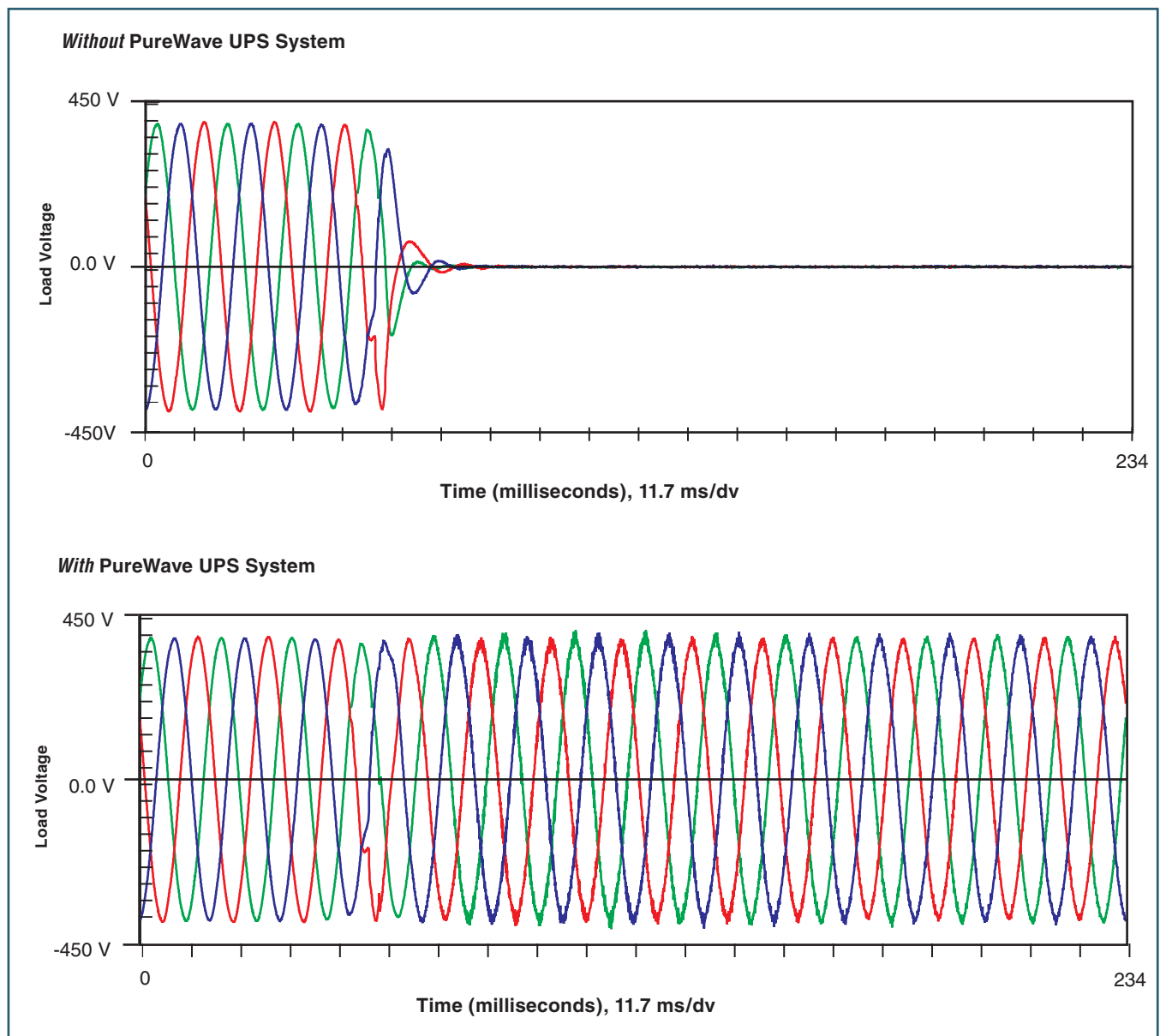
During normal operation, the load is powered by the utility source through the normally closed PureWave Power-Electronic Switch.

Voltage is continuously monitored on all three phases of the source. If the utility disturbance monitor senses a disturbance which causes the voltage to sag or swell more than 10% of its nominal value, it sends an “open” signal to the power-electronic switch, coincident with a “run” signal to the power modules. Within one millisecond, the power modules provide output voltage, regulated within $\pm 5\%$ of nominal. Load is transferred to the stored-energy source—typically in two to four milliseconds . . . fast

enough for computers and other sensitive electronic devices to ride through without malfunction.

When the utility source voltage returns to its normal limits, the PureWave UPS System synchronizes output voltage with that of the utility source, and sends a “close” signal to the power-electronic switch along with a “stop” signal to the power modules. After a few seconds, the battery chargers turn on to restore the batteries to 100% capacity.

Shown below is an example illustrating how a PureWave UPS System maintained load voltage to non-faulted feeders during an actual utility source outage.



Load phase-to-ground voltages during a utility source outage.

Performance Advantages

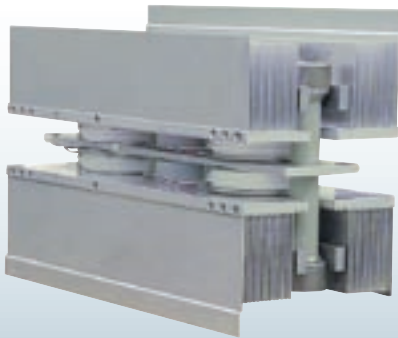
The S&C PureWave Power-Electronic Switch provides *subcycle* switching, which permits the batteries to remain in a true open-circuit state—unexposed to the harmful effect of dc ripple, as experienced with conventional UPS systems. The batteries are correctly equalize-charged every two months to ensure long life and full power capability during an outage.

The PureWave Power-Electronic Switch features multiple MOV-protected thyristor stages per pole. Each pole includes a redundant stage so—even with a shorted thyristor—the switch will continue to provide subcycle switching . . . there's no interruption of service to the load. The switch features redundant cooling fans and can operate with only one functioning fan.

A Totally Integrated System

The PureWave UPS System is the only large-scale system that's totally factory-integrated for lower installed cost and more reliable performance.

The PureWave UPS System features time-proven S&C Metal-Enclosed Switchgear. S&C load-interrupter switches isolate and bypass the PES for scheduled maintenance or testing . . . with no interruption of service to the load. And S&C power fuses provide complete protection for the PES and the load.



Thyristor stage



PureWave Power-Electronic Switch features a modular design utilizing multiple thyristor stages per pole.

Evaluating *Your Needs*

Every distribution system is different and power quality requirements vary widely. A comprehensive assessment of equipment cost and payback is essential. S&C's Power Systems Services can help by providing power quality measurements, application studies, short-circuit and coordination studies, and load-flow and voltage-regulation studies. They also offer turnkey installation, project management, preventive maintenance, training, and technical seminars to further assist with your power quality needs.

Low-Voltage PureWave UPS System Ratings

System Rating kVA/kW	Voltage Range, volts	Current Rating, RMS, Sym.	
		Cont., A	Short-Circuit, kA
1000/1000 to 2500/2000	300 to 600	Up to 3000	65 Standard

Medium-Voltage PureWave UPS System Ratings

System Rating kVA/kW	Voltage Range, kV		Current Rating, RMS, Sym.	
	Nom.	BIL	Cont., A	Short-Circuit, kA
2.5/2.0 to 20/16	4.16	60	600 or 1200	16.0, 1-cycle or 10.0, 5-cycle
	13.8	95		
	25	125	300 or 600	10.0, 5-cycle
	34.5	150		

S&C's PureWave Power Quality Systems

The PureWave UPS System is part of the most complete family of power quality solutions in the industry. In addition to the PureWave UPS System, S&C offers the following products that can solve nearly any power quality problem:



PureWave DVR™ Dynamic Voltage Restorer is a medium-voltage system which supplies voltage support to critical loads during sags and swells. It creates an appropriate compensating voltage which is injected into the line.



PureWave DSTATCOM® Distributed Static Compensator provides sub-cycle reactive current control, voltage regulation, and protection from voltage sags and flicker.



PureWave AVC™ Adaptive VAR Compensator is an economical, distribution-class VAR compensator that provides real-time voltage-support and power-factor correction for dynamically varying loads.

PureWave® Source-Transfer System is ideal for facilities served by two independent power sources. In the event of a voltage fluctuation or outage on one source, the system seamlessly transfers to the other before critical loads are affected.

