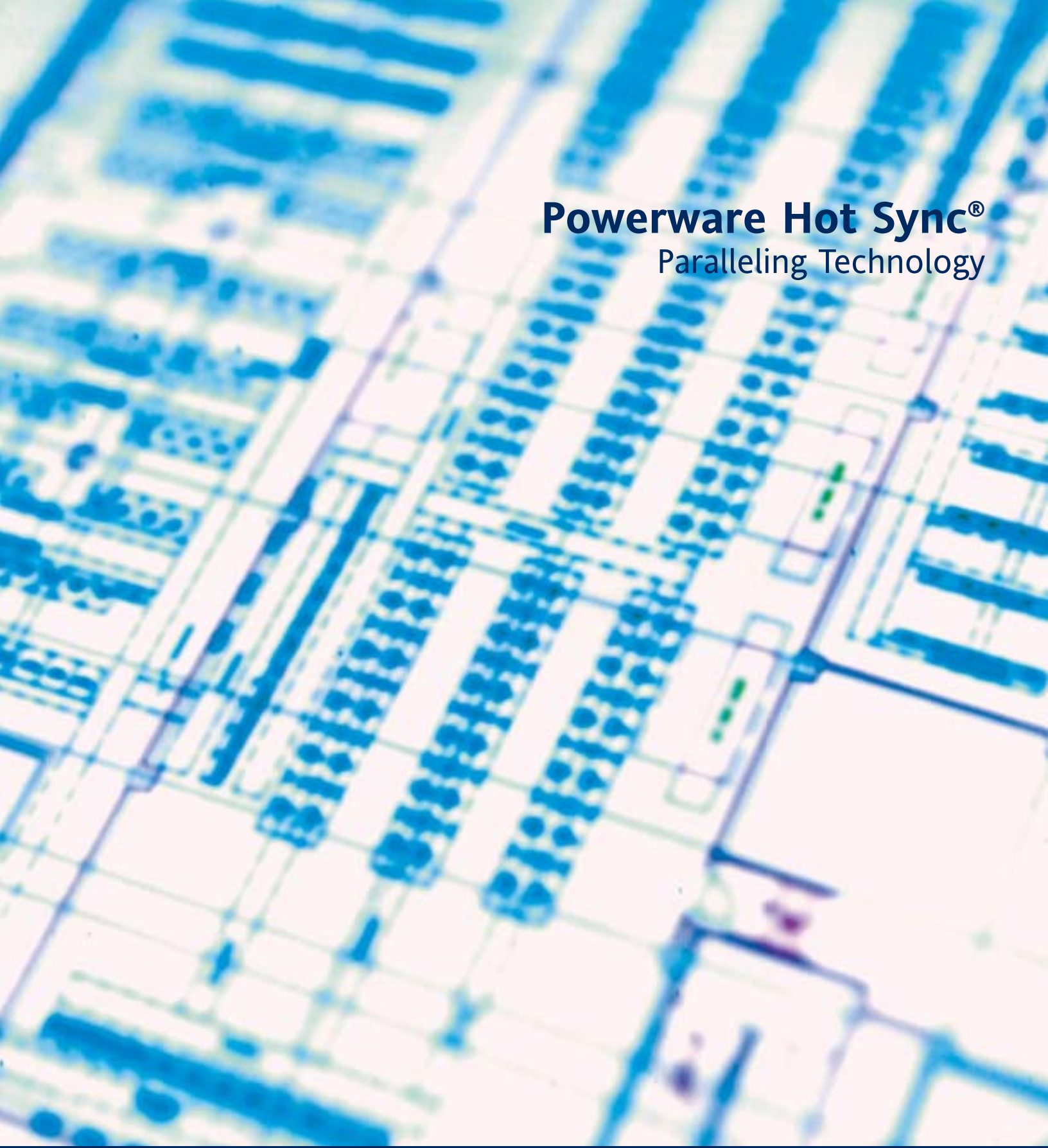


Powerware Hot Sync®

Paralleling Technology

POWERWARE®

Powerware Hot Sync®

Reliability by Design

The constant availability of your critical systems depends on your power management system providing optimal performance, regardless of conditions. And while reliable UPS technology is a good front line of defense, maximum reliability comes with redundancy. Powerware Hot Sync combines the proven reliability of Powerware's 9315 and 9330 UPS families with a patented paralleling technique. With its high-speed digital signal processing design, Powerware Hot Sync enables paralleling for redundancy or capacity with no inter-module communication. All necessary information for paralleling is available using only the modules' output power wave form.

There are two objectives that must be accomplished when two or more UPSs are operated in parallel for capacity and redundancy: load sharing and selective tripping. There are also two primary considerations for reliability: the degree of autonomy and the complexity of implementation. Powerware Hot Sync technology combines digital signal processing and an advanced control algorithm to provide automatic load sharing and selective tripping in a parallel UPS system, as well as complete autonomy of the modules and a skillfully simple implementation. There are many design features in a Powerware Hot Sync paralleled system, all increase reliability and flexibility:

- Unlike other paralleling techniques, there is no system-level single point-of-failure
- Powerware Hot Sync systems are capable of paralleling for both redundancy and capacity
- By using a peer configuration, as opposed to a "master-slave" configuration, Powerware Hot Sync ensures that each module is operating independently
- No added circuitry or components are required to be "switched in" to operate in parallel

Powerware Hot Sync is field-proven, with thousands of systems installed around the world. Organizations depending on Powerware Hot Sync include:

E*Trade
CitiBank
MFN (formerly Above.net)
Lucent Technologies
Compaq
Fidelity Investments
New York Stock Exchange

Parallel Architecture	Autonomy	Circuit Complexity	System Wiring	Integration
Master Control	Many Failure Modes	Negotiation needed for Multi-Module	Critical	Extrinsic
Master Sync	PLL buffer dependency	Master clock dependency	Critical	Intrinsic
Load Share Loop	Passive loop buffer dependency	Vector Sum dependency	Critical	Intrinsic
Powerware Hot Sync	Absolute	None	None	Intrinsic

The Powerware Hot Sync Difference

The modules using Powerware Hot Sync are completely autonomous. The only thing common among them is the critical output power bus. There has been absolutely no circuitry added to the original standalone modules to facilitate paralleling. The product is 100% mathematical firmware, which makes it more reliable than traditional paralleling techniques, as shown in the table above. Because the solution is implemented intrinsically, and Powerware Hot Sync is always active, the modules do not know whether or not they are even in parallel.

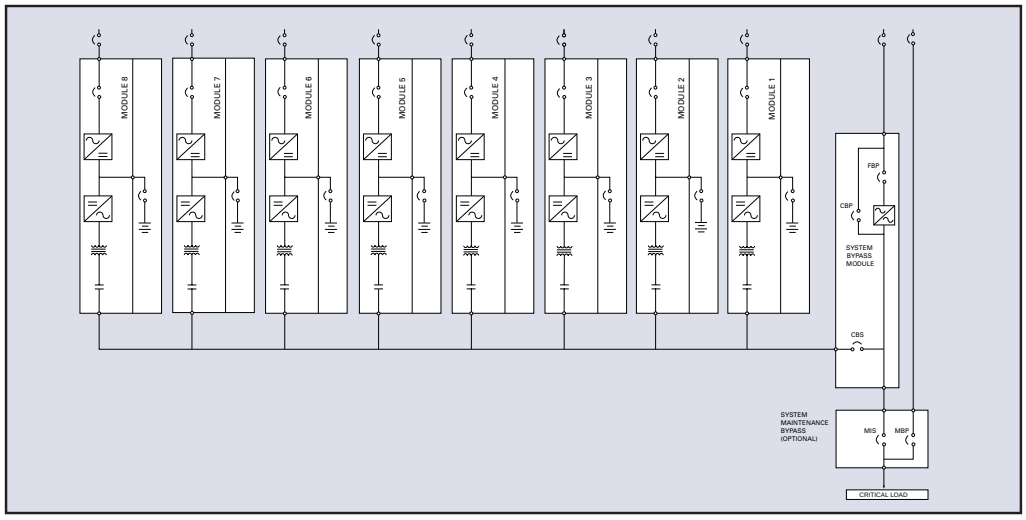
Using this approach to paralleling for redundancy and capacity, Powerware Hot Sync addresses the inherent drawbacks of traditional configurations. By eliminating communication wiring and added circuitry between the modules, and employing its unique load share and selective tripping methods, Powerware Hot Sync provides a proven path to maximum reliability and system availability.

Powerware Hot Sync - Capacity (10 - 750 kVA modules)

Parallel for Capacity

Businesses of all sizes need to protect their critical information, transactions and infrastructure. This, along with the growth of mega-data centers, telecommunication switching centers and technology-dependent organizations has created a trend to centralize power management, as well as established the need for flexible power solutions with the capability of growing to meet changing power demands. With Powerware Hot Sync-Capacity systems, modules are added in parallel to increase overall system capacity.

A Powerware Hot Sync-Capacity configuration has all of the technology benefits of Powerware Hot Sync-Redundant, including selective tripping, automatic load sharing and synchronization, but adds capacity beyond a single module. Powerware Hot Sync-Capacity systems have built-in intelligence that enables them to automatically recognize the customer's need for capacity and/or redundancy, allowing N+1, N+2, or even N+3 redundancy, depending on the load. This advanced capability is necessary to maximize availability for large load applications in data centers, server farms ISPs, ISEs and facilities.



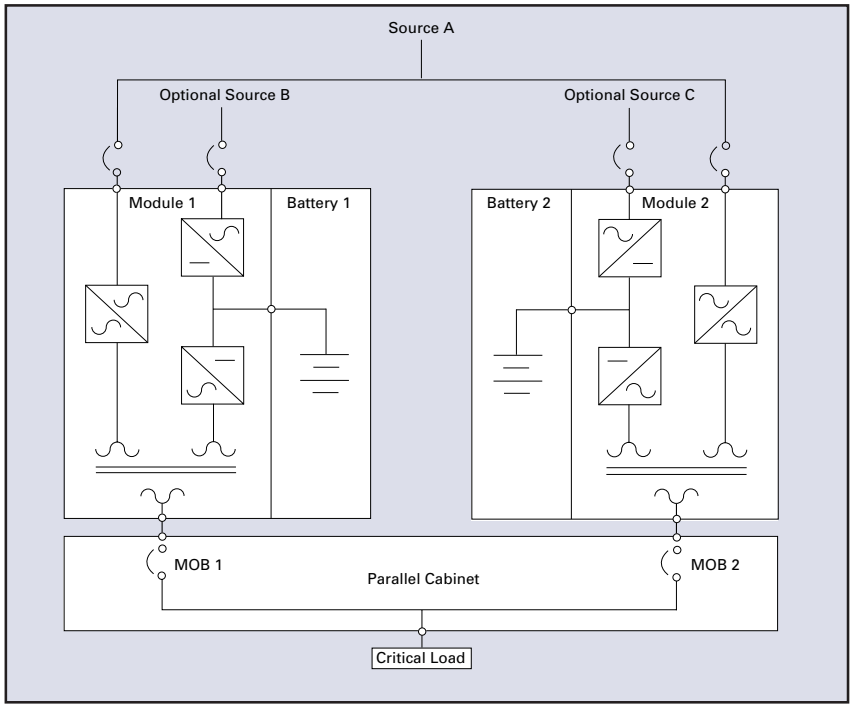
Features & Benefits:

- A system bypass module (SBM) features a system-level bypass for maintenance, fault clearing and emergency conditions, ensuring that the protected load is never at risk
- SBM microcontroller-based logic maximizes reliability by reducing component count
- Two fully redundant module monitoring networks provide system-level metering & alarm information to the SBM
- The SBM monitor panel features the same detailed information that is available on the module monitor panel
- Common or separate module battery string configurations are available enables flexible system configuration
- Field growth capability of up to 8 modules let's the system expand to meet increased power demands

Powerware Hot Sync - Redundant* (10 - 750 kVA modules)

Parallel for Redundancy

A parallel redundant UPS solution increases reliability and maximizes availability. With any type of failure in any module, the critical load is still protected. Powerware Hot Sync-Redundant's unique approach goes further by adding redundant bypass sources, eliminating critical communication wires, and utilizing two separate inputs (the modules are only tied together at their outputs). Because the modules monitor themselves for failure, a Powerware Hot Sync-Redundant system ensures the critical bus remains supported on conditioned power even if one of the modules fails.



Features & Benefits:

- In a Powerware Hot Sync system, each module features an internal emergency bypass circuit, with two parallel bypass paths. The system provides fault clearing current rated at twice the single module fault clearing current rating, and bypass redundancy. The combination of these increase overall system reliability and availability
- The parallel cabinet allows either module to be completely isolated from the critical bus for service, while the critical load remains energized with protected power. The module output breakers (MOB) also provide output wiring protection.
- Following any module maintenance action, where a module is isolated from the critical bus by opening a MOB, an indicator light is illuminated when it is okay to close the MOB. This eliminates the potential of operator error.
- Accommodates separate or common battery configurations, increasing the flexibility of the overall solution.

Powerware Hot Sync The Culmination of Power Reliability

Automatic Load Sharing

In an optimum parallel configuration, the UPS modules must share the load equally. When the critical load is shared between the modules, there should be no transfer time in shifting the load from one module to the other, should a module go offline for any reason.

In a traditional parallel UPS system, load sharing required communications wiring between the modules, which introduced a single point-of-failure. If any part of the communication link failed, so did the system. Powerware Hot Sync technology eliminates the necessity for inter-module communication, providing true wireless paralleling for the first time.

The load share control algorithms maintain synchronization and load balance by constantly making minute adjustments to variations in the output power requirements. The modules conform to demand and are not in conflict with each other for the load.

There are many other parameters that must be addressed to effectively and seamlessly share the load between paralleled modules. The load sharing algorithm in Powerware Hot Sync addresses these considerations, including:

- Load sharing while synchronized to an alternate source
- Power backfeed under imperfect sharing at light or no load
- Power backfeed with 100% load removal
- Loss of synchronizing reference by some but not all modules
- Oscillation of alternate source frequency
- Independent judgment of alternate source availability

All of these factors will affect the operation of the load share function and will frequently conflict with one another. A careful selection of priority and gain is necessary so that the action taken is the one most beneficial to the mission. For example: if one module in a two module redundant system loses information of the alternate “sync” source, the best action is to shed all load to the other module so that the system will remain “in sync” with that source, maintaining it’s redundancy. If there are three or more modules, the exact opposite action is most beneficial.

Because a one degree difference in phase angle between two modules results in a fifty percent load inbalance, the Powerware Hot Sync algorithm automatically compensates to provide exactly what is needed to share the load equally. Such precise load share control is possible because the Powerware 9315 and Powerware 9330 UPSs deploy a digital signal processing technique known as direct digital synthesis to control inverter frequency.

Selective Tripping

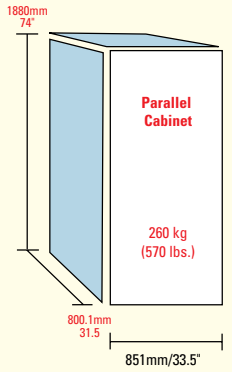
In addition to enabling precise load sharing, Powerware Hot Sync enables a module to employ a unique selective tripping approach. That is, each module need only look at itself to see if it has failed. By not relying on communication links between the modules, there are no time lapses between the time a failure occurs and the time the module is removed from the critical bus.

In a conventional paralleled system, a faulty module is identified by the system bypass. Though most module failures are benign, a failed inverter IGBT may appear as a fault on the critical bus. For this type of failure, it is essential that the failure be quickly identified and the failed module be removed from the critical bus. Because it doesn’t require inter-module communication, a failure such as this in a Powerware Hot Sync system is seamlessly compensated for, with the failed module removed instantaneously from the critical bus.

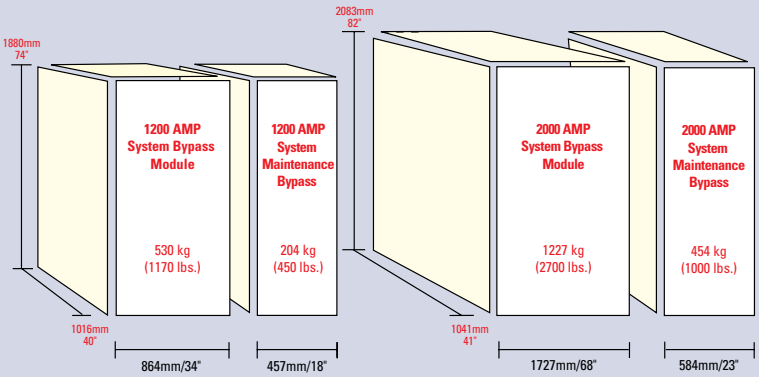
The method used is really quite straightforward. Each module keeps a running record of the voltage and current waveforms for the last cycle. It continually compares each voltage and each current with the value of one cycle ago. The difference in voltage times the difference in current for each phase is determined and summed into a single value. This sums always positive for a faulted module and always negative for a good unit. The result is that the “selective trip” detects the fault before the system’s normal sensors detect a problem and send the system to bypass. The algorithm just described here does that very efficiently.

Physical Dimensions, Weights and Specifications

Powerware Hot Sync-Redundant



Powerware Hot Sync - Capacity



**Note: 3200 amp and 4000 amp PowerHandler Switchboards available late 2001. Shipping pallet and packaging adds 50 to 300 lbs. per shipping unit.*

Environmental Specifications

Ambient Temperature:	0°C to +40°C
Storage:	–20°C to +70°C
Relative Humidity:	5-95% non-condensing
Altitude:	1500 meters (5000ft.) at 40°C ambient temperature without load derating
Audible Noise:	At 1 meter; in accordance with ISO 7779: -Powerware 9315 40-160 modules: less than 65dBA -Powerware 9315 200-300 modules: less than 69dBA -Powerware 9315 400-500 modules: less than 72dBA -Powerware 9315 625-750 modules: less than 75dBA
Electrostatic Discharge:	Withstands 25kV without damage or disturbance to the load; exceeds requirements of IEC 801-2 EMC: Meets FCC Class A, Subpart J of Part 15 and EN 50091-2 (CISPR 22, Class A)

Input Specifications

Voltage Range:	(refer to product data sheets)
Frequency Range:	(60 Hz) 57-63 Hz; (50 Hz) 47-53 Hz
Surge Protection:	Meets ANSI C62.41, Category A & B, EN 50091-2 and EN 50082-2 Power Factor: 0.95 typical at full load with input filter.
Input Current Distortion with Input Filter:	less than 7% for 9315 - 40 thru 500 less than 5% for 9315 - 625 thru 750

Output Specifications

Voltage THD:	Less than 5% (100% non-linear load with 3:1 crest factor); less than 3% (100% linear load)
Voltage Regulation:	Better than ±1%
Transient Response:	Less than 5% for 100% load step; full recovery within 1 cycle
Frequency:	(Free Run) ±0.005 Hz
Frequency Sync Range:	±0.5 Hz
Frequency Slew Rate:	1 Hz/second maximum
Voltage Adjustment Range (Operator):	±5%

Safety

UL1778 Listed
CUL CAN/CSA C22.2 NO.107.1-M95 Listed
EN 50091-1
Selectable DC ground fault detection capability

nsai
I.S. EN ISO 9001

UL LISTED

CE

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