

Power Systems Applications Guide



- ▶ **UPS Performance**
 - Digital Power Quality
 - Dynamic Response
 - System Operation
 - Input Power Conditioning

- ▶ **System Configurations**
 - Single Modules
 - Parallel Modules
 - Isolated Redundant
 - Distributed Redundant

- ▶ **Components**
 - Maintenance Bypass
 - Switchboards
 - Distribution
 - Static Transfer Switches
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- ▶ **Monitoring and Communications**

- ▶ **System Reliability**

Power Systems Solutions

M G E

UPS SYSTEMS

www.mgeups.com

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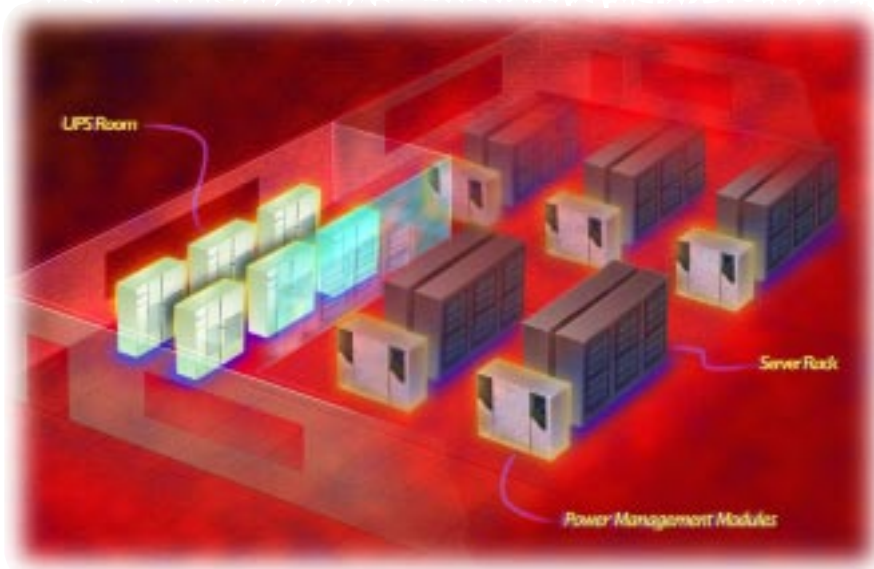


MGE UPS SYSTEMS is a pioneer in the UPS industry that has grown into the largest three-phase UPS manufacturer in the world. MGE now spans the globe with operations in more than 100 countries and a flagship 60 Hz manufacturing operation in Costa Mesa, California, MGE Americas headquarters. Keeping true to a tradition of engineering excellence, MGE continues to invest heavily in R&D, bringing customers the latest technology and best performing critical power products. Behind all MGE Power Systems is a dedicated team of critical power professionals ranging from over 120 Field Engineers to a core of Power System Managers whose minimum of 15 years industry experience is made available to every MGE customer.



Operating in over 100 countries and with the world's largest technical service organization dedicated exclusively to critical power systems, MGE has the expertise to keep you on-line.

Uninterruptible Power Provider for Internet Data Centers



MGE – The Power Behind the Internet

MGE is proud to be a major player in the Internet revolution, protecting most of the world's largest Internet data centers. Offering complete critical power system solutions including, UPSs, Power Management Modules (PMM), Static Transfer Switches and I/O Switchboards, our customers enjoy the efficiency that comes from using a single source for all their critical power protection requirements.

MGE's Power Systems Team

The People behind the Product

There's a reason the world's largest data centers and Internet Service Providers choose MGE over any other critical power provider for critical power projects. Only MGE can offer the convenience and efficiency of providing the right products, design assistance and project management from design inception to after sales support, all from one single and very experienced source. At the heart of the process is the **MGE Power Systems Team** of seasoned project managers and engineers. Combined with a complete line of critical power products and a highly flexible manufacturing environment, the Power Systems Team consistently delivers results that continue to attract the industry's leading customers and future IT leaders.



We work together with the customer and consulting engineers to ensure reliability and performance above all.

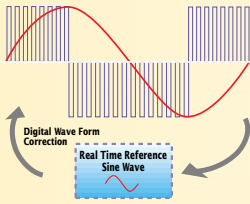
Why use the MGE Power Systems Team?

- ▶ Higher level of project coordination resulting in shorter time to completion on your projects
- ▶ In-house project management and on-site field managers during installation and commissioning
- ▶ Single source of accountability from inception to project completion
- ▶ Instant access to skilled industry professionals for fast and concise answers
- ▶ Project Engineering department to accommodate any kind of customization
- ▶ Complete product line to satisfy all project requirements
- ▶ Direct interface with manufacturing environment for an immediate response to customer issues and high manufacturing flexibility to meet custom requirements
- ▶ Cost savings through purchasing efficiencies
- ▶ Proven track record on the world's largest projects

On-Line, On Time - MGE Power Systems Team

EPS 6000 UPS

Taking IGBT technology one step further

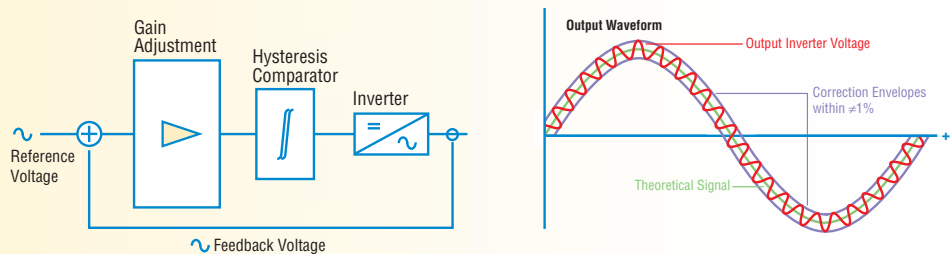


At the heart of the **Digital Power Quality** Logic management system is a feedback loop that constantly compares the output voltage to a computer generated reference sine wave. A compensating gain adjustment is then made to the waveform (generated by pulse width modulation) ensuring that it always remains distortion free and within the "power quality envelope".

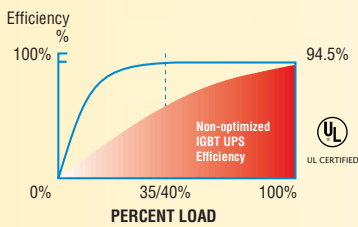
MGE's core product in the high-power UPS category is the EPS 6000 UPS. At the heart of the EPS 6000 is **IGBT (Insulated Gate Bipolar Transistor)** inverter technology that simplifies circuitry and reduces component counts, contributing to increased system reliability. While many UPS manufacturers have updated their designs by retrofitting SCRs with IGBTs in their inverters, most are still using low frequency, low resolution stepwave pulse width modulation (PWM) from the SCR era.

MGE took PWM technology one step further and became the first manufacturer to build a UPS topology to specifically take advantage of the clean switching characteristics of **IGBTs**. This switching technology permits the use of high frequency, high-resolution digital PWM to construct the output waveform.

Each one of the hundreds of fine pulses used to create the output waveform can now be precisely controlled using MGE's unique **Digital Power Quality (DPQ)** management system. DPQ operates by comparing the output voltage waveform to a computer generated reference sine wave. A feedback circuit then actively corrects any waveform imperfections caused from reflected load harmonics resulting in precise voltage regulation (**<4% THD**) even when powering **100% non-linear loads**.



MGE Flat Efficiency Curve



The reality is that many UPS modules will always be partly loaded due to redundant systems configurations. MGE's stable and high efficiency under partly loaded conditions means real savings.

The combination of digital power quality with IGBTs provide the following benefits:

- ▶ **Precision voltage regulation:** Because of the dynamic response of the inverter, output voltage is precisely regulated under all operating conditions from no load to full load, even when powering non-linear loads.
- ▶ **High efficiency:** The EPS 6000 offers very high "laboratory certified" efficiency that remains constant even when lightly loaded, where most UPSs operate. This stable efficiency is the result of the EPS 6000's variable switching frequency that is constantly optimized for specific load levels.
- ▶ **100% step load optimized:** Faced with a 100% step load change (0%-100%-0% load) the EPS 6000 will never exceed 5% output voltage transient, which is critical in isolated redundant UPS configurations where step loads may be common.
- ▶ **Fault tolerant output:** Even when exposed to dead output shorts the EPS 6000 inverter can react rapidly enough to avoid damage without clearing fuses or faulting components, and will be ready to operate the moment the fault has cleared, making it resilient enough for any critical application.

Single Module UPS Systems

MGE provides the ultimate in conditioned power for electronic equipment, increasing reliability and operating life.

Single module UPS systems are used when the critical power load is 800kVA or smaller and UPS power redundancy is not required. Since MGE utilizes true **on-line**, double-conversion topology, the load is never exposed to the utility power under normal operating conditions **ensuring continuous power protection** whatever the application.

MGE also utilizes a 100% rated, continuous duty **bypass static switch** on all single module configurations, maximizing reliability and reducing bypass control circuitry. The bypass static switch automatically provides a **seamless, uninterrupted transfer** to utility power in the event the UPS must transfer from its inverter. The 100% bypass rated static switch can also sustain much higher surges than momentary rated/contactor-based wrap-around static switches, making it ideal for applications prone to over current conditions.

EPS 6000 UPS

225-800 kVA UPS Modules
The building block for all reliable power protection

The EPS 6000 UPS offers unsurpassed reliability and performance proven in thousands of installations.

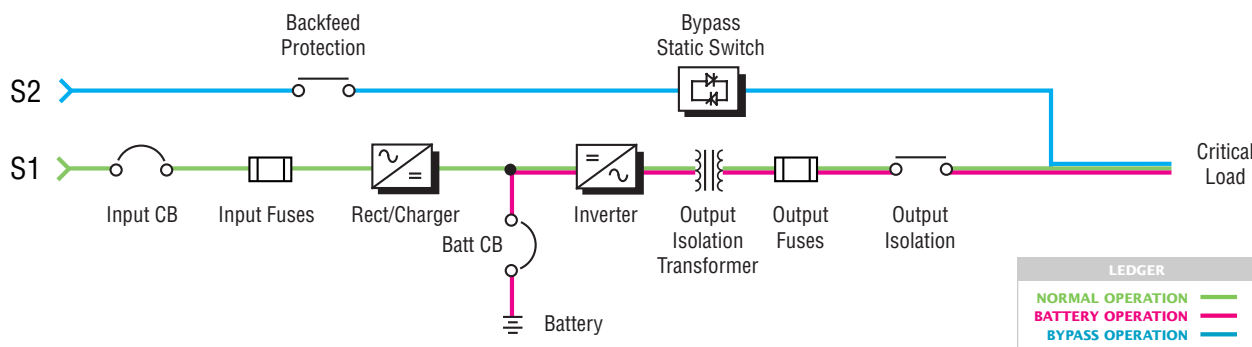
The 800 kVA/720 kW EPS 6000 has one of the highest power densities of any UPS available, with one UPS module only occupying 33 square feet, including input isolation transformer and input filter.

Available in 225, 300, 375, 500, 750 and 800 kVA modules



MGE UPS Topology

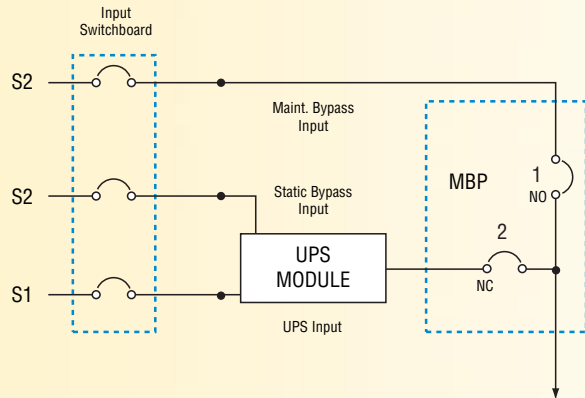
True on-line topology with 100% Regenerated power from the inverter.



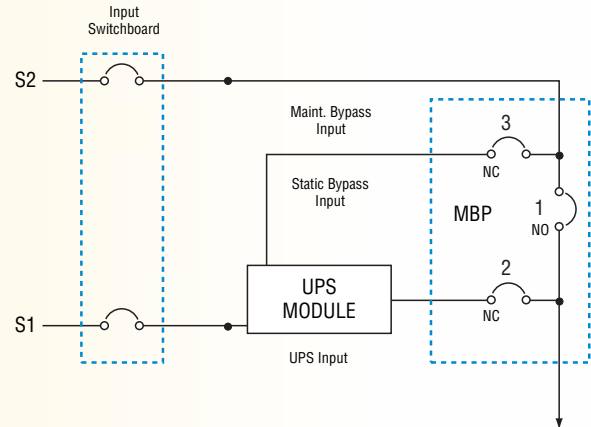
All of MGE's three phase UPSs use a true on-line topology generating 100% of the output power from the inverter thereby providing complete isolation to the critical load from the dangers of raw utility power. Even when exposed to wide variations in input power quality (voltage, frequency and distortion), the topology is robust and versatile enough to continue providing precisely regulated output power to the load. All components are strictly independent of each other (no shared functions) allowing the topology to operate as a failsafe and forgiving system.

Maintenance Bypass (MBP) Options

MGE's Single Module UPS systems utilize a pair of circuit breakers mounted inside the UPS module allowing bypass power to be directed around the internal components of the UPS for maintenance procedures. MGE can also provide various configurations of **external** maintenance bypass assemblies, typically configured in two 2-CB MBP (two circuit breaker maintenance bypass) or 3-CB designs, to meet specific site requirements. External MBPs allow for complete electrical isolation of the UPS module without interruption to critical load power. **All external MBPs are provided with electrical and mechanical interlocks to ensure error-free operation.**



The **2-CB MBP** design is used when the customer has **two separate bypass** input feeds - one for UPS **Static Bypass** and one for UPS **Maintenance Bypass**.

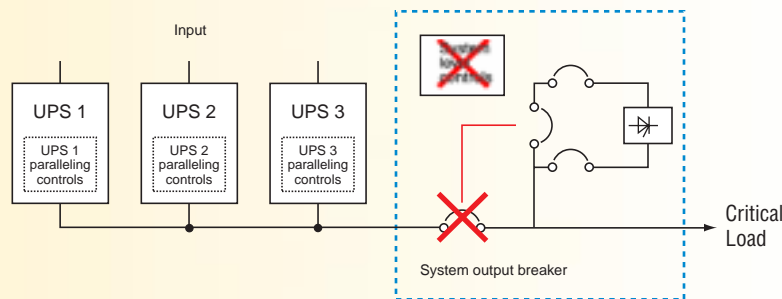


The **3-CB MBP** design is utilized when the customer desires **one bypass** input to feed both the UPS **Static Bypass** and the UPS **Maintenance Bypass**.

Shared-Parallel Technology

MGE UPS SYSTEMS is the only UPS manufacturer to utilize shared-parallel technology. This technology maximizes system reliability by eliminating system common controls and the UPS module output circuit breaker. Proven in thousands of parallel systems, shared-parallel technology is extremely versatile, sharing current identically between modules under all normal operating conditions.

While MGE provides a system static bypass (SSC) assembly to connect UPS modules, this is not for control purposes but simply to provide a source of bypass availability. All of the paralleling intelligence is held independently on each of the UPS modules.



The MGE Shared Parallel System

MGE's shared parallel systems don't rely on system level controls and eliminate common single points of failure like system output breakers improving reliability.

Parallel-for-Capacity UPS Systems

Parallel-for-Capacity UPS Systems are used when more than one UPS module is required to meet the total critical load demand. The diagram shows two UPS modules paralleled to meet the total power demand. Each module will share load current equally. If either or both of the UPS modules go off-line, the critical load will automatically be supplied by the utility source via the System Static Bypass. UPS modules must be of identical kVA rating.

The EPS 6000 also has **load dynamic redundancy**. Should the critical load fall below 50% of the rated kVA of the UPS system, the UPS becomes parallel redundant as described in the last section.

Integrated Parallel UPS Systems

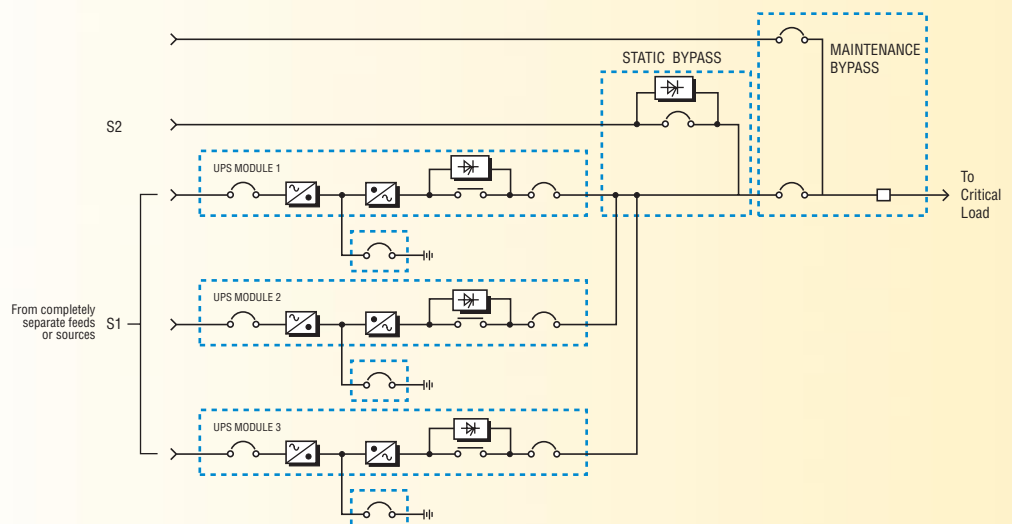
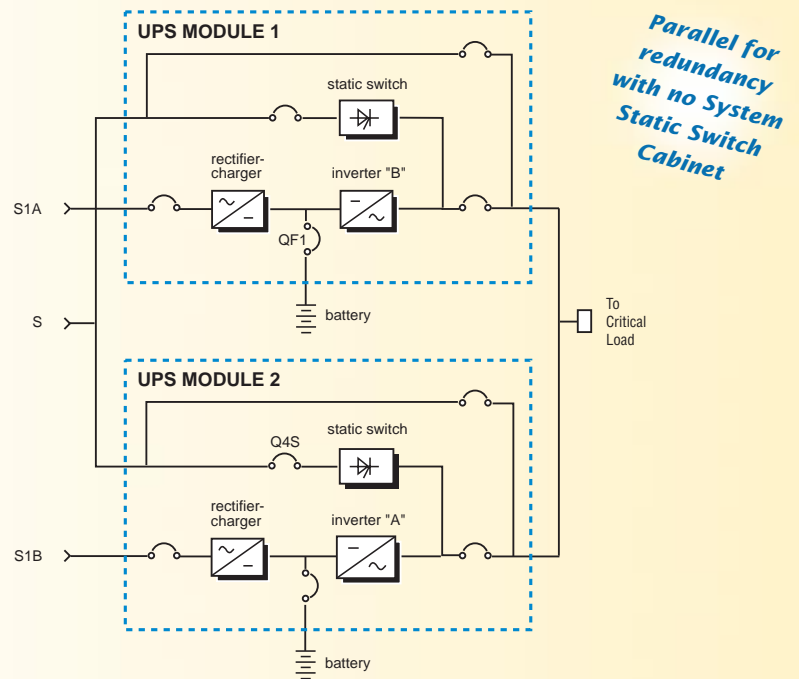
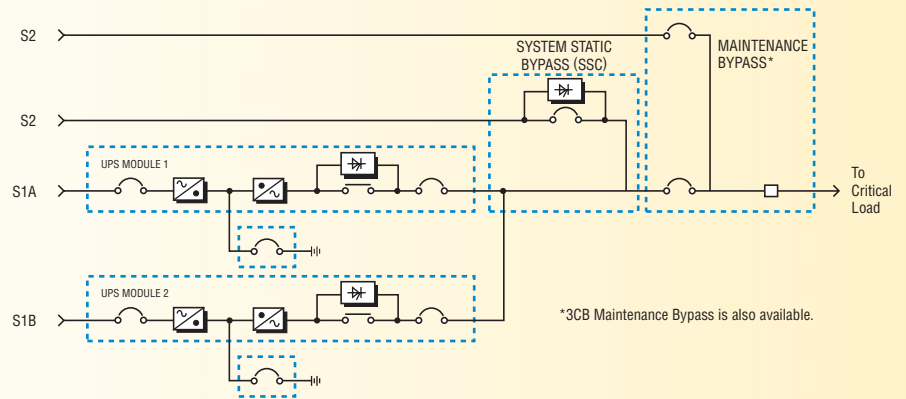
When the application demands redundancy without future expansion for capacity and you want to minimize footprint, **Integrated Parallel** is the ideal solution. It allows two identically rated "single-modules" to be connected in parallel to a common bus and share the load equally.

If either module goes off-line, the critical load will be supported by the second module. Should both UPS modules go off-line the critical load will automatically and seamlessly be transferred to the utility via both modules static switches, offering redundancy on the static bypass.

Parallel-Redundant UPS Systems

Using the exclusive **shared-parallel** design concept, the parallel redundant system is MGE's most popular configuration. The diagram shows three UPS modules paralleled with each module sharing load current equally. However, if one of the UPS modules goes off-line, the critical load will still be supported by the two remaining UPS modules. If another UPS module drops off-line, the critical load will continue to be supported by the remaining UPS module if the actual load demand is less than the rated power of the UPS module that is still on-line (**load dynamic redundancy**).

If the actual power demand is more than the rated kVA of the UPS module that is on-line, the load will be automatically and seamlessly transferred to the utility source via the static bypass.



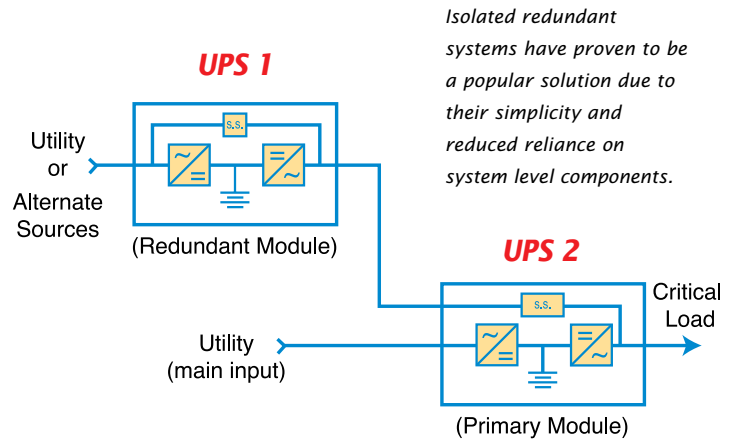
Isolated Redundant UPS Systems

For the ultimate in **reliability, maintainability** and **availability**, MGE provides the **Isolated-Redundant** UPS system configuration. This configuration offers design flexibility unmatched by any other UPS design. The basic concept of the Isolated-Redundant system is to never have the critical load fed from the utility power, regardless of UPS shut down or maintenance.

In a traditional parallel system the static switch cabinet is between the critical load and the redundant UPS modules. In an isolated redundant configuration the static switch bypass is eliminated, and each primary UPS module feeds the critical load on an isolated bus.

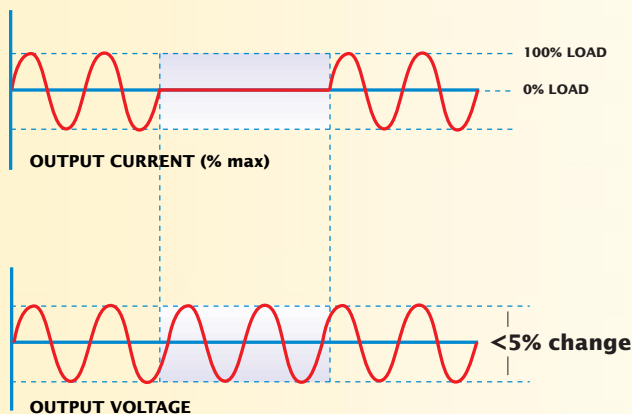
Redundancy is accomplished by installing a redundant system that feeds the bypass static switch and maintenance bypass of the primary modules.

- ▶ **Availability:** Should the primary module go off-line, power is seamlessly transferred to the redundant system.
- ▶ **Maintainability:** The primary module and the redundant module are provided with a maintenance bypass allowing complete isolation for maintenance while maintaining conditioned UPS power to the critical load bus.
- ▶ **Reliability:** Each module's operation is independent of all other modules (primary and redundant) thus eliminating any system level controls contributing to unsurpassed reliability.



The redundant UPS system is always fully operational, keeping its own battery plant charged and waiting to support the critical load. Key to the Isolated-Redundant system design is that the standby UPS must support a 100% step load with a minimal transient voltage. Since MGE UPSs can handle step loads with less than 5% voltage transient, they are ideally suited for this configuration.

100% Step Load Change



Steady output voltage regulation

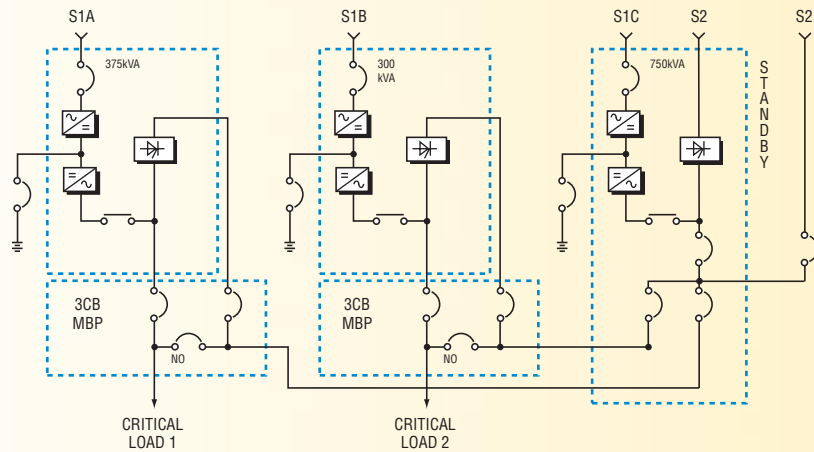
Even when exposed to a 100% step load (0% load to a 100% load instantly) MGE has less than a 5% transient on the output voltage, making it ideally suited for isolated redundant applications where step loads may be common.

Unique advantages of isolated-redundant systems:

- ▶ Mix & match module kVA sizes
- ▶ Mix and match new & existing modules, technologies and manufacturers
- ▶ Modules can be in separate rooms
- ▶ Perform maintenance on each system without exposing the load to utility power
- ▶ Better protection against operator errors
- ▶ Smaller footprint
- ▶ No control circuitry interconnection between modules
- ▶ Smaller load bank requirements
- ▶ Sequential installation & start-up
- ▶ Higher operating efficiencies and reliability
- ▶ No single point of failure
- ▶ Multi level redundancy
- ▶ Lower system cost
- ▶ Maximum overall system reliability/lowest MTBF

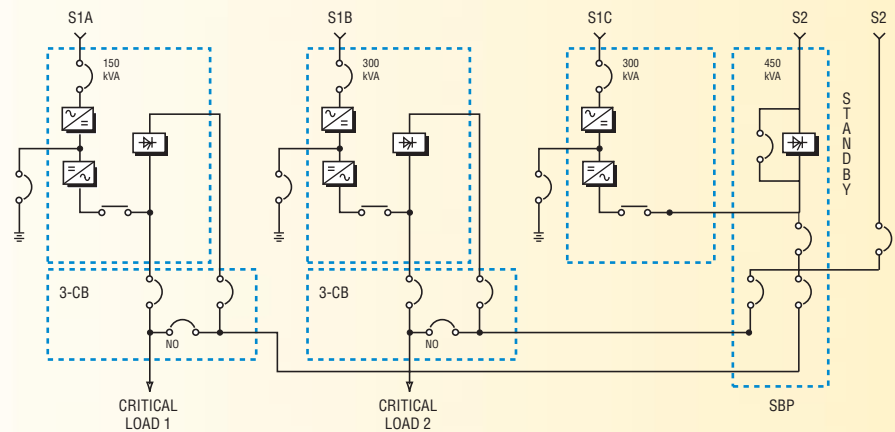
Oversized Standby UPS Module

This Isolated-Redundant design simply oversized the standby UPS system kVA rating to equal or greater than the sum of all the primary UPS system kVA ratings. Thus, the standby UPS system is ready to backup the bypass line of all the primary UPS systems simultaneously.



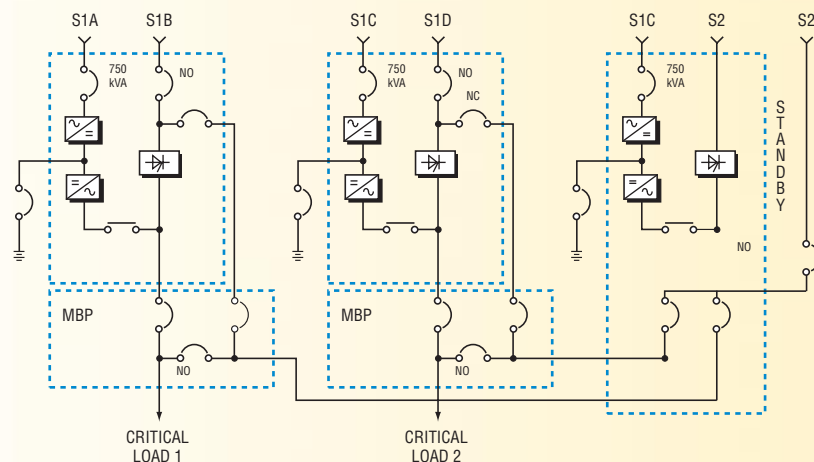
Oversized Standby Static Bypass

The oversized standby static bypass design allows for the standby UPS system to be sized equal to that of the largest primary UPS system, instead of being sized for all the primary UPS Systems in total. However, the standby UPS System's Static Bypass (SBP) is sized for the kVA sum of all the primary UPS Systems. Thus, the standby UPS Inverter will protect the load until an overload condition requires a transfer to the standby UPS Static Bypass utility line.



Primary Module Dual Bypass

This design allows for the standby UPS system to be sized equal to the largest primary UPS system kVA rating. When the standby UPS system assumes the critical load of an off-line primary UPS system, all other operational primary UPS systems automatically change their input source of Static Bypass to utility in lieu of the standby UPS system until the off-line UPS system is back on-line.



Distributed-Redundant System Configurations

The Distributed-Redundant configuration is an extremely versatile design that offers excellent reliability, availability and maintainability, but has the added advantage of **easy expandability**.

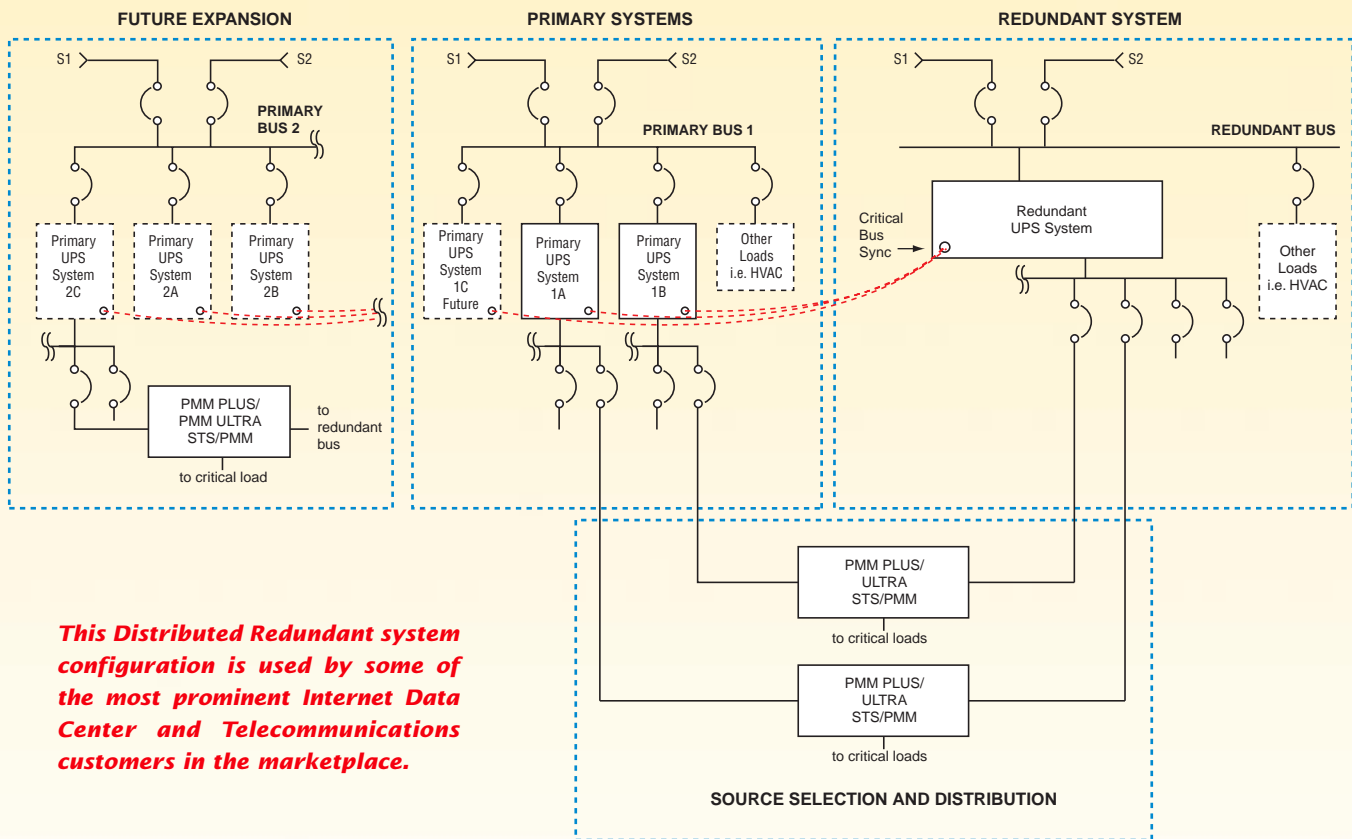
The system uses **groups of separated primary busses**, with each bus designed to support a rated load. The number of primary busses depends on the total facility power demand. There is also a single **redundant bus** that is rated equivalent to any of the primary busses.

The output of each primary UPS module is connected to the preferred input of the static transfer switch (STS). The alternate input of the STS is connected to the output of the redundant UPS system.

Advantages of Distributed-Redundant Systems:

- ▶ **Availability:** Availability is accomplished by the static transfer switch (STS). Shutdown of the primary UPS or any deviation in power quality will cause an uninterrupted transfer to the redundant system.
- ▶ **Maintainability:** The availability of a distributed redundant system allows complete isolation of the primary bus for maintenance by seamlessly transferring the load via the static transfer switch (STS) to the redundant system.
- ▶ **Reliability:** Similar to an isolated redundant system, each module operates independently of all other modules (primary and redundant) eliminating any system level controls and optimizing reliability.
- ▶ **Expandability:** Primary busses can be added to expand the power demand without impacting the existing primary busses or the redundant bus since all are independent. This allows the system to expand on an as needed basis.

DISTRIBUTED REDUNDANT SYSTEM

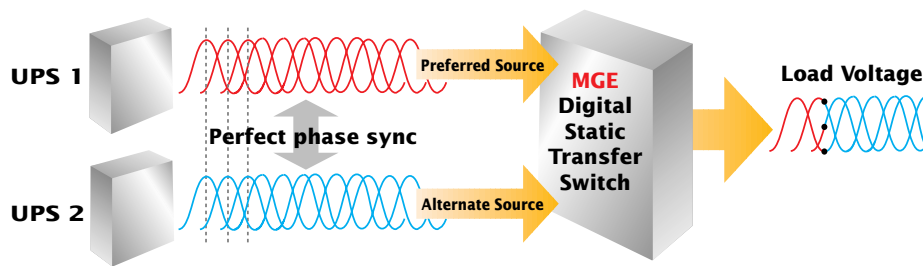


This Distributed Redundant system configuration is used by some of the most prominent Internet Data Center and Telecommunications customers in the marketplace.

Critical Bus Synchronization

In order to ensure seamless transfer from one source of the static transfer switch (STS) to the other (i.e. primary bus to the redundant bus) both sources must be kept in synchronization under all operating conditions (UPS on-line, UPS on battery, UPS input from generator, etc.). Under many conditions (such as when a common bypass power feed is not available), UPSs have no means of synchronizing with each other.

Using a Critical Bus Synchronization Module, all UPSs will always be synchronized allowing power to be seamlessly transferred between two sources of the STS at any given moment maximizing critical power availability, *under all operation conditions*.



Critical Bus Synchronization (CBS) Module

The CBS Module assures synchronization under all operating conditions, even when all UPSs are operating on battery.

Power Distribution

Power Distribution

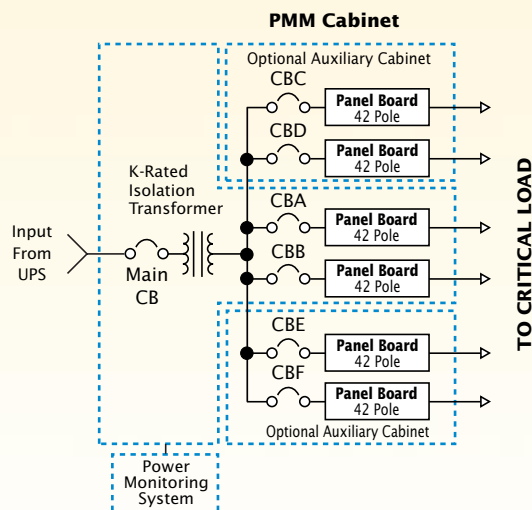
Power Management Module

The Power Management Module (PMM) is a **computer grade power distribution system**, centered around MGE's K-20 rated isolation transformer. By combining power conditioning, voltage conversion (typically 480V / 208/120 V out), isolation and advanced monitoring into one compact package, the PMM is an optimized power distribution system ideal for raised floor environments.

Designed specifically to handle the high current distortion associated with electronic equipment, the PMM uses a K-20 rated isolation or harmonic mitigation transformer and a 200% rated neutral bus that feeds up to 252 distribution breakers. This raises the reliability by resisting or eliminating thermal stresses that compromise conventional transformers. Adding circuits on the PMM is a very safe, easy and fast operation due to instant front access via hinged doors and ultra wide cable raceway spacing.



The Power Management Module provides isolation, power conditioning, monitoring, and distribution in an integrated system. Wide raceways inside the module make wiring changes fast and easy, ideal for modern data centers with weekly wiring changes.



PMM Plus / PMM Ultra

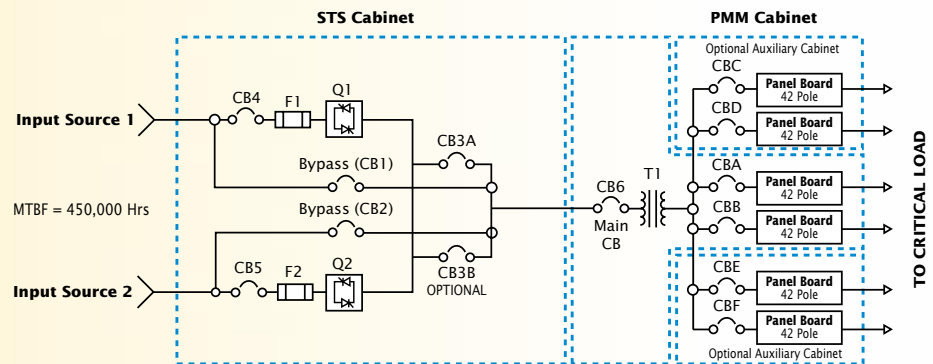


The PMM Plus and PMM Ultra combine automatic source selection and distribution into a single system. This is ideal for distributed redundant configurations that have two independent buses available to the critical load.

The **PMM Plus** and **PMM Ultra** combine MGE's Digital Static Transfer Switch with the Power Management Module distribution system. The result is a **dual input distribution system with automatic source selection**.

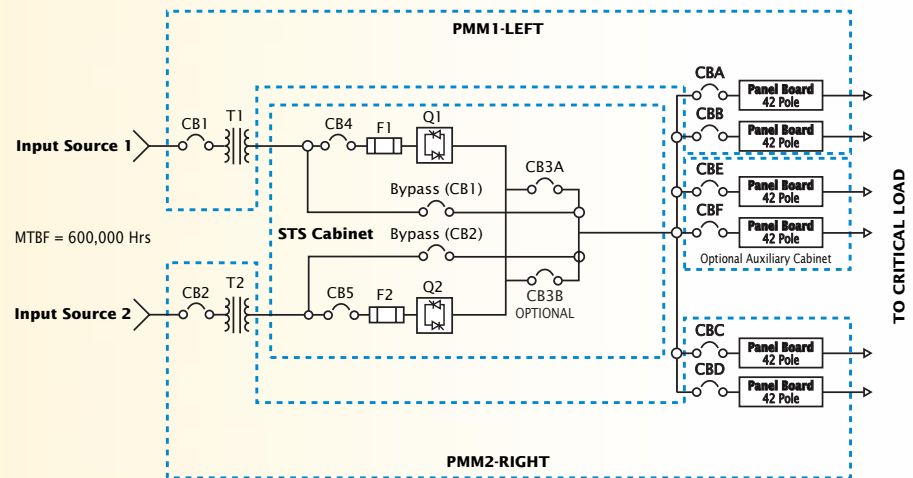
The digital static transfer switch is fed by two independent sources (a preferred or alternate source), or in the case of a Distributed-Redundant system the primary bus and redundant bus. Upon detecting any power quality deficiencies in the primary source, the STS rapidly (< 4ms) and seamlessly transfers to the alternate source, avoiding any interruption to the critical load.

In the **PMM Plus** the output of the STS is fed into a high K-factor (K-20) isolation transformer that feeds up to 252 output breakers.

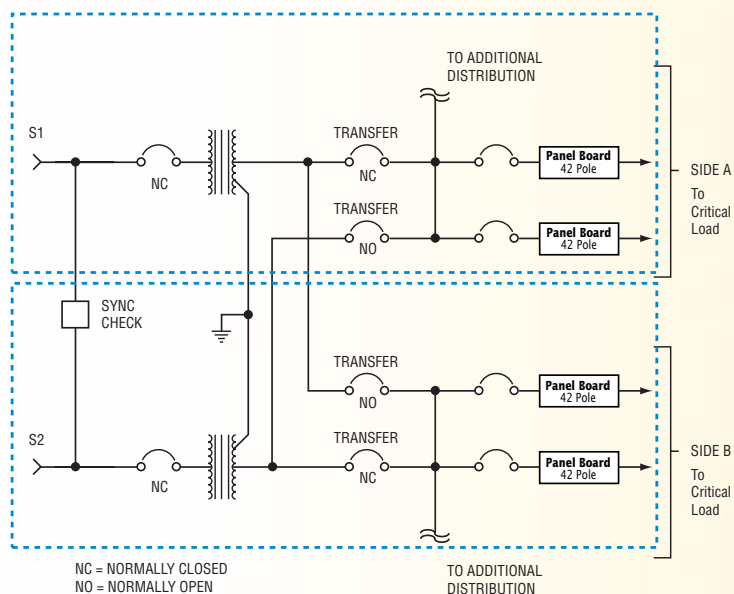


For a higher level of system maintainability, the **PMM Ultra** places an isolation transformer upstream of each STS input. The STS is now fed with stepped down (208 V) power that can be fed directly to the output distribution breakers. Each transformer can now be easily maintained simply by transferring the load the alternate transformer / input source.

The use of PMM and STS combination units as shown here, in conjunction with two or more independent UPS systems has replaced older and less reliable UPS configurations using "sync tie" or "hot tie" switch gear.



Dual Input Power Distribution Units



Dual input power distribution units (DPMMs) use input feeds going to two separate isolation transformers with each transformer output feeding dedicated sets of distribution panels. Transfer breakers also allow all distribution panels to be fed from a single transformer (via a manually initiated overlap transfer), allowing the other transformer to be maintained if necessary.

A synchronization circuit and electronic and mechanical interlocks prevent transferring into an out of sync source as well as cross connecting sources.

Dual input PMMs are ideal for dual cord loads allowing each cord (power supply) to be fed from a separate source (or the same source during maintenance procedure) enhancing distribution system reliability.

Dual input PMM's are also available in single transformer configurations, where one of two sources can be selected to feed the distribution panel boards.

Switchboards for Integrated UPS Solutions



MGE's switchboard capabilities offer the convenience of purchasing the entire critical power system from one trusted vendor. A combined knowledge of both the UPS system and the switchboard assembly simplifies the process for all involved. Our design team is managed by some of the industry's most seasoned engineers, with a proven record of providing the best solution with the highest design integrity.

Switchboards

For over 20 years MGE has offered complete design and fabrication services for custom switchboard assemblies. Our large manufacturing facility builds the complete assembly from the ground up, allowing for a fast turn around and a high degree of customization to meet any design specification.

All MGE switchboards are UL 891 certified and feature high quality circuit breakers ranging from simple molded case to fixed mount insulated case and draw-out breakers. The complete system is built in cabinets to match the UPS system providing a showcase grade system appearance. UL 1558 Switchgear is also available through MGE vendor alliances.

MGE Shunt Inductor filters keep distortion & kVAR to a minimum -allowing generator to UPS ratios as low as 1:1



Input Power Management

Perfect Generator Compatibility + Low Input Distortion

The EPS 6000's solid state input filter can be made to meet any user requirement. Available low kVAR networks **limit input current distortion between 5% - 8%** as required, while keeping kVAR content low to assure full generator compatibility.

MGE also offers a inductive compensated filter system that prevents the UPS from ever becoming a leading power factor load under all conditions, even when lightly loaded. This permits **generator to UPS sizing ratios as low as 1:1** for the ultimate in generator compatibility.

All MGE filter systems are always on-line and don't rely on load sensitive mechanical switching to engage or disengage, making them a truly reliable solution. This also eliminates input line notching associated with the hard switching of filter capacitors.

Designed as an integral part of the UPS, the filter system still allows the EPS 6000 to maintain a core efficiency around 94%.

Communications Integration

All MGE three phase products are equipped with dry contact status indicators and serial communications ports for interfacing with monitoring devices. MGE uses an open ModBus/J-Bus protocol for serial communications allowing devices to be integrated with almost all monitoring or building management systems.

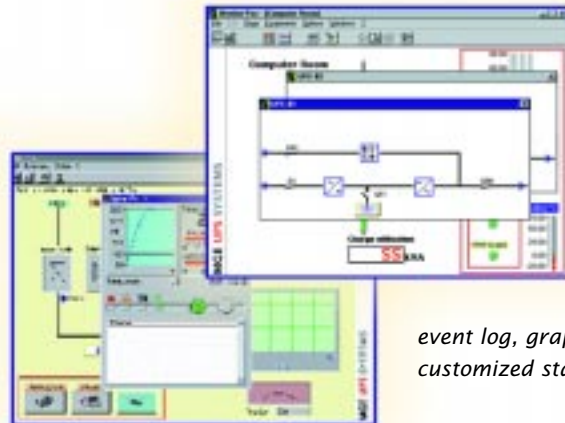
Communication and Software Options include:

- ▶ Network based power management software for automatic server control
- ▶ SNMP for direct integration with computers
- ▶ Serial communications port(s) w/86 accessible parameters
- ▶ Dry contacts for status monitoring
- ▶ Automatic dial-out alert during alarm conditions
- ▶ *Monitor-Pac* software can be used on a standard PC to provide a detailed system level overview of all UPS parameters via a GUI interface.

UPSs can also be directly integrated with networks using serial communications or a direct Ethernet connection. **Solution-Pac** or **Management-Pac** software provided by MGE can then be used to control an unlimited number of servers over the network. The software is compatible with most platforms and operating systems including enterprise management system



MGE equipment is equipped with open protocol serial interfaces as well as dry contacts for easy integration with building management systems. MGE also offers a variety of software packages for UPS monitoring and network power management.



Monitor-Pac software is an easy way to monitor all UPS parameters via a PC. Features include an active mimic diagram, alarm event log, graphing functions and customized status screens.

UPS System Reliability & Availability

At the end of the day the defining feature of a UPS system is reliability, which ultimately extends beyond the UPS module and becomes a function of total system configuration. Keep in mind that most UPS failures are due to operator error, not component failure, greatly limiting UPS component reliability statistics. MGE incorporates interlocks to limit operator error. The fundamental issues affecting reliability are listed below:

FACTORS THAT **IMPROVE** UPS RELIABILITY

- ▶ Module redundancy
- ▶ Increased UPS bypass source reliability
- ▶ Individual battery systems
- ▶ Simplified operator interfaces and procedural safeguards
- ▶ IGBT PWM inverter technology
- ▶ Use of UL listed standard products

FACTORS THAT **DECREASE** UPS RELIABILITY

- ▶ Complicated sync tie switchgear systems
- ▶ System controls for module paralleling
- ▶ Common battery systems
- ▶ System complexity
- ▶ Poor environmental conditions
- ▶ UPS topologies with narrow input voltage and frequency windows or topologies that switch states to remain on-line (line interactive)

There are many ways to calculate UPS System Reliability. Some suppliers of UPS systems claim over 1,000,000 hours Mean-Time-Between-Failure (114 years) using self derived MTBF calculations. Unfortunately these methodologies have no statistical significance and favor vendors with the oldest/largest installed base.

A more realistic way to calculate UPS MTBF is to utilize industry standards, such as **MIL-HDBK-217**, which yield data on failure rates of electronic components based on field data observed over many years. Using this data, theoretical conclusions can be made on the reliability of different UPS configurations as shown in the table below.

Availability

The Availability of a UPS system is a function of the MTBF (Mean-Time-Between-Failure) and MTTR (Mean-Time-To-Repair). The MTTR of UPS Systems can range from 1/2 hour to 24 hours depending on the complexity and the self-diagnostic capability of the UPS system.

$$\text{Availability} = \text{MTBF} / (\text{MTBF} + \text{MTTR})$$

$$\text{Non-Availability} = 1 - \text{Availability}$$

UPS System Configuration	Reliability MTBF in Hours	Availability	Non Availability	Mean Downtime in 5 years
Single Module without Static Bypass	27,440 Hours	99.97813%	.0002187	9.58 Hrs
Single Module with Static Bypass	250,000 Hours	99.99760%	.0000240	1.05 Hrs
Shared Parallel-for-Capacity (2 Mod)	185,000 Hours	99.99567%	.0000433	1.90 Hrs
Conventional Parallel-for Capacity (2 Mod)	135,210 Hours	99.99408%	.0000591	2.59 Hrs
Shared Parallel-Redundant (2 Mod)	380,000 Hours	99.99789%	.0000210	0.92 Hrs
Conventional Parallel-Redundant (2 Mod)	345,000 Hours	99.99768%	.0000231	1.01 Hrs
Sync-Tie via Shared Paralleling (4 Mod)	190,000 Hours	99.99368%	.0000631	2.76 Hrs
Sync-Tie via Conventional Paralleling (4 Mod)	172,500 Hours	99.99304%	.0000695	3.05 Hrs
Isolated Redundant/Distributed Redundant	498,000 Hours	99.99919%	.0000080	0.35 Hrs

Companies protected by MGE

Information Technology

Abast Systems America Online Ameritrade Apple Bull Bull X Siracusa CERFnet Cisco Systems Coinfur Compaq	Cray Research DEC Discovery Net DoubleClick EDS Exodus Founder Group Fujitsu Gateway 2000 GLOBEX	GS1 HP HP China Ltd. Hyundai IBM IBM China Ltd. ICL Impsat Intel Internet Direct	IT Consulting JOS Legend Technology Group Look Communications Inc. Microsoft Motorola Netscape Communications Olivetti PSINet Sun Microsystems	Toshiba Unisys UUNET Shanghai Intel SemiConductorSiemens Nixdorf 3 Com Ltd Toshiba
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Banks and Insurance

American Express Athens Stock Exchange Banamex Banca Di Credito Banci Ganadero Banco Acac Banco del estado Bank of America	Bank of Montreal Bank of Tokyo Barclays Bank Belgian Bank BNP Charles Schwab Chase Manhattan Bank	CIBC (Canadian Imperial Bank of Commerce) Citibank Citicorp Crédit Agricole Ericsson Europay Norge As	Europe Assistance Fidelity Investments GE Capital Hong Kong Bank Lico Leasing Lloyd's Bank Merrill Lynch	Progressive Insurance Scottish Equitable Singapore Stock Exchange Thai Milstang Bank UNEDIC Visa Wells Fargo Bank
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Telecommunications

ABC Air Touch Alcatel AT&T Beijing Siemens Bell Atlantic Bell South British Telecom	CBS CDX Cable China Telecom Deutsche France Telecom FOCAL GTE Data Services Global Star Guangdong Nortel	Hong Kong Telecom Indosat Lucent Technologies MCI Telecommunications Media One Netcom Pacific Bell Radio Vaticano	ROGERS RTL Shanghai Bell Siemens SITA Southwestern Bell Telecom Malaysia Teleds Celular	Telefonwerke Televisa Telkom TESAM Transpac TV Ableca
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Industrial

AGIP Amoco Oil Benetton Boeing British Aerospace Capital Steel Co. Ltd.	Ciba-Geigy Cinzano Conoco Daqing Petroleum Group Dow Chemical EDF	ELF Enami Exxon Fiat Hughes Aircraft Co. Ikea	Michelin Mobil Oil Procter & Gamble Sautec Seagate Shanghai Baoshan Steel Group	Shell Oil Shell China Ltd. Southern Company Suez Canal Whirlpool
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Medical

Bayer Becton Dickinson Bergamo Barozzi Care Children's Hospital Chungshan Hospital Ciba-Geigia	Dow Chemical Hoechst Hoechst Hellas Hospital St. Germain Institut Pasteur JFK Hospital Kabi Pharmacia	Kaiser Genetic Testing L'Oreal Paris Mayo Clinic Merck-Medco Managed Merieux Miami Heart Institute and Medical Center	National Institute of Health Pacific Care Pharmabiotech Pharmacia Prince of Wales Hospital - Hong Kong	Queen Elizabeth Hospital - Hong Kong Royal Hospital of Riyad Wellcome Foundation
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High-tech

Applied Materials Intel Matsushita Technologies Micron Electronics	Motorola National Semiconductor Power Design Sony	TDK Semiconductor CERN Institut Léo Langevin Intel	Phillips Components SONY Sprint ST Microelectronics	Amcior Anam Intel
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Transportation

Air Canada Air China Air France Alitalia American Airlines Boeing	British Airways Canadair Capital Airport Cathay Pacific Chrysler Continental Airlines	Ford Motors Hong Kong Airport Iberia KLM Lockheed Nissan	Northwest Airlines Renault Renault Argentina Singapore Airlines Shanghai Metro Shanghai Volkswagen	SNCF Swissair Toyota Toyota Hellas Volvo Wuhan Citroen
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Government

Civil Aviation Authority - UK CNES EDF FBI GENIE Military Ministerio de Defensa	NASA NAV CANADA Royal Air Force Saudi Arabian Ministry of Interior	Secretaria de la defensa - Mexico Social Security System - Philippinas Swedish Air Force	The White House US Bureau of the Census US Dept of Energy US Dept of Public Safety UNAM	US Navy US Pentagon US Social Security Services
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