

Designing Resilience Into Secure Power Systems

By Leo Craig, Sales Manager for Riello Galatrek Ltd

Business continuity plans include an ever increasing reliance on secure power systems. Whilst the mean time between failure (MTBF) of uninterruptible power supplies continues to rise above 100,000 hours, more can be done at the design stage to increase their overall resilience and availability.

Uptime

The primary purpose of an Uninterruptible Power Supply (UPS) is to provide a continuous source of clean power when mains power fails. In a UPS a mains powered rectifier converts the incoming mains AC voltage to DC which then charges the battery and powers the inverter. The inverter continuously powers the load with a regenerated sine-wave supply.

Resilience is built into the UPS in the form of an automatic static transfer switch. A sensor monitors the output waveform of the inverter. Should the inverter fail due to a load short circuit, overload or fault condition, the static switch transfers the load to the mains supply without a break. Two further levels of resilience should be considered especially for larger kVA and MVA installations:

- UPS Power sources
- Redundancy

UPS Power Sources

UPS Inverter

The inverter constantly powers the load. For long mains failures it requires either a large battery from which to draw a DC supply or secondary external AC power sources to feed the rectifier to which it is connected. Three areas of resilience can be considered:

- Batteries – chemical process
- Standby Generators – mechanical process
- Dual inputs – electrical process

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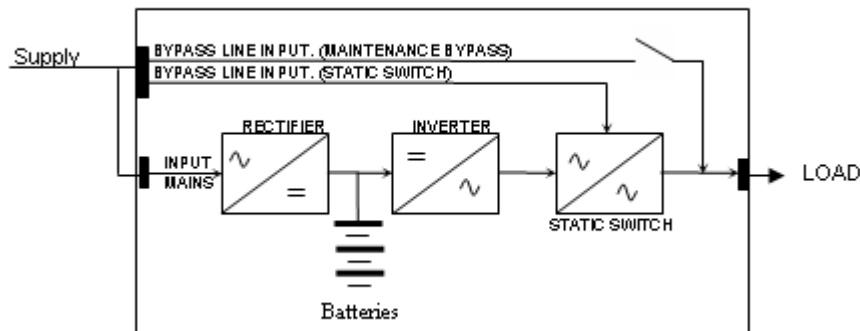


Figure 1

UPS Batteries

Batteries operate using a chemical process. The efficiency of this process is very much dependent upon the age, state and installation environment. The size of the battery is dictated by the load size in kW and the amount of autonomy time that the installation must be capable of working through during mains failure. Whilst it is possible to install battery packs that can last several hours key problems arise for project engineers in large kVA and MVA installations. Principally these centre on the physical size of the battery set and environmental considerations.

Plant room space is expensive and on most sites free space is a rarity. To provide an 800kVA UPS with an 8 minute battery supply would require over 8000kg of batteries with a typical cabinet foot print of 4500Wx1000Dmm. Further space around the battery must be left for air-flow, maintenance and general replacement access.

Such a battery set is best installed in its own secure area for health and safety, and security reasons. It may also be necessary to carry out structural reinforcement and provide sufficient ventilation or air conditioning to maintain a steady temperature within the room.

Therefore for large kVA and MVA installations the battery should only be considered as a short-term energy storage device and be augmented by external AC power sources. The battery must be sized to allow the transfer to a secondary AC power source if long mains failures are to be protected against. Alternatively sufficient time to instigate an emergency shutdown should be planned for should the second power source not be available.

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Standby Generators

A generator can be used to provide a secondary AC power source to a UPS rectifier.

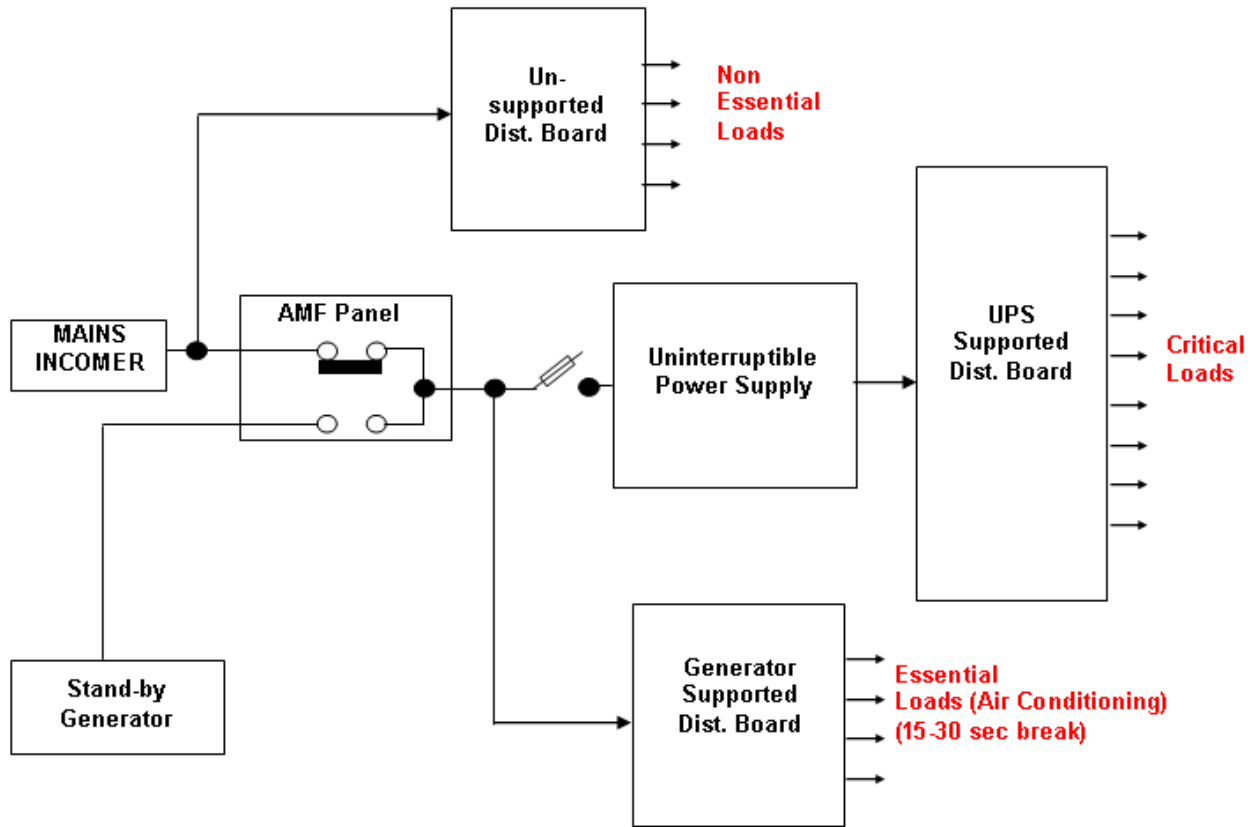


Figure 2

The installation of a generator helps to reduce the overall size (physically and electrically) of the battery installation but other considerations arise.

Firstly the generator will typically be fuelled by diesel. This will lead to environmental issues covering exhaust and heat emissions, vibration and noise levels.

For this reason generators are typically sited in the plant room with heat ducts and exhaust pipes taken to a dedicated exit point or a sited outside the building in acoustic weather-proof enclosures. Planning permission for the installation may be required from the local council for some installations.

Guidelines on generator sizing vary between manufacturers but an accepted rule of thumb starts from (1.6 x the size of the UPS being powered) as a minimum. Extra capacity can be built into the equation to provide power for air conditioning and local lighting which may be vital for some sites during a mains power failure.

The typical standard base/day fuel tank will last between eight and twelve hours. This can be increased with larger bulk tanks to give longer runtimes. However in addition to the possible need for planning permission, health and safety and environmental concerns can arise concerning access to the generator and storage of fuel on site.

Activation of the generator is controlled by an Automatic Mains Failure (AMF) panel. This monitors the mains for failure and signals the generator to start. As a mechanical device a generator on start up will take several seconds before it can deliver full power to the UPS. This means that the UPS battery must be at least sized to cater for the start up period and longer in case the generator has to be manually started.

The mechanical assemblies in a generator are inactive for the majority of their working life. They are only used in anger when needed to generate power. For this reason the reliability of a generator can only be guaranteed through a strict weekly test regime and regular maintenance. It is not uncommon for such tests to be performed out of hours and business continuity plans must take into account the potential for failures during such tests.

Dual Input Supplies

In a standard UPS configuration a single mains fed supplies the system with electrical power. In critical environments it is increasingly common for dual input supplies to be installed. These can be from separate distribution boards and even different substations. Dual input supplies can be used in two scenarios:

- Through a static transfer switch
- To the UPS and Bypass lines

Dual Input Supplies To a Static Transfer Switch

Dual supplies can feed a static transfer switch situated upstream of the UPS whose rectifier is supplied with either AC mains supply A or B dependent upon availability.

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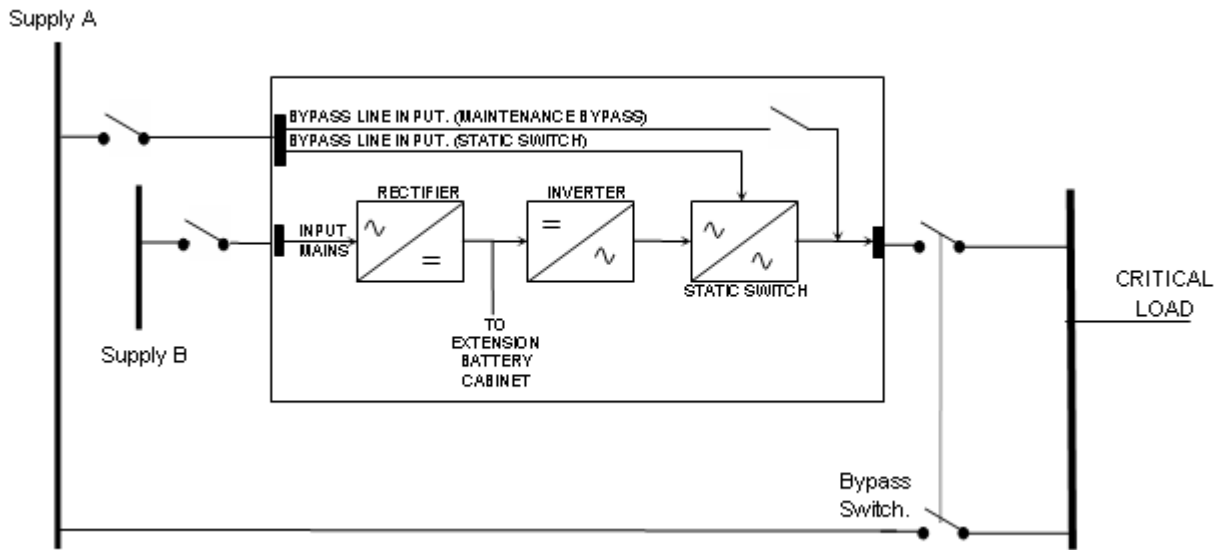


Figure 3

Dual Input Supplies To The UPS and Bypass Supply

Alternatively mains supply A can be connected to the UPS rectifier and mains supply B can be connected to the automatic bypass of the UPS. In this scenario should the mains power supply fail, the battery will power the load. If a generator fails to start and mains supply A is not restored the UPS will transfer the load to its bypass line. If this is powered from Supply B the load will not be dropped.

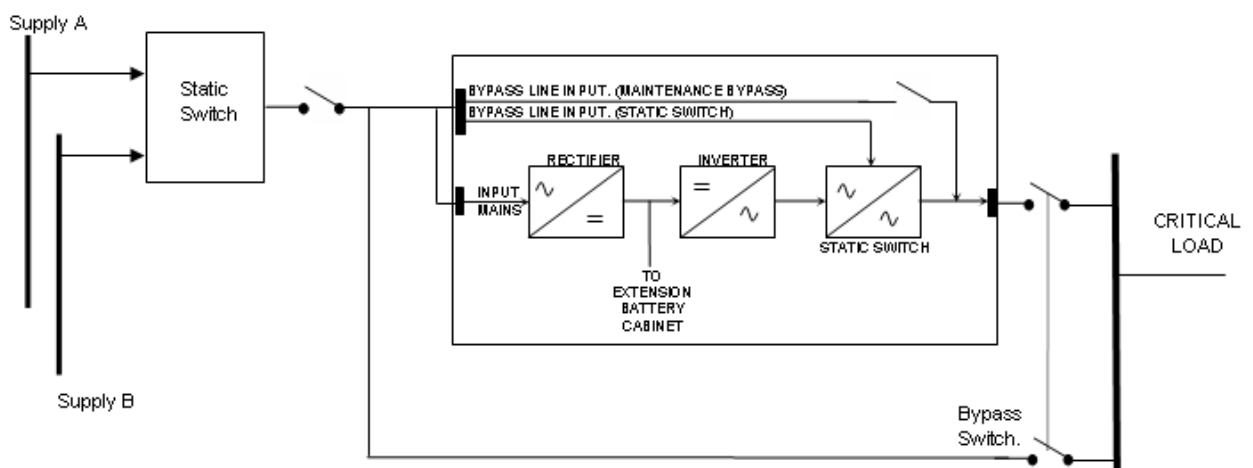


Figure 4

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Redundancy

Redundant and N+1 Configuration

Redundancy means extra investment in not only UPS hardware but switch gear, maintenance and future battery replacement. However it does improve availability.

Typically sites opt for a redundant N+1 configuration. Here should one UPS fail the other automatically supplies the distribution point. The N+1 configuration also provides UPS cover during planned maintenance. One UPS can be taken out of service whilst the other is there to protect the load.

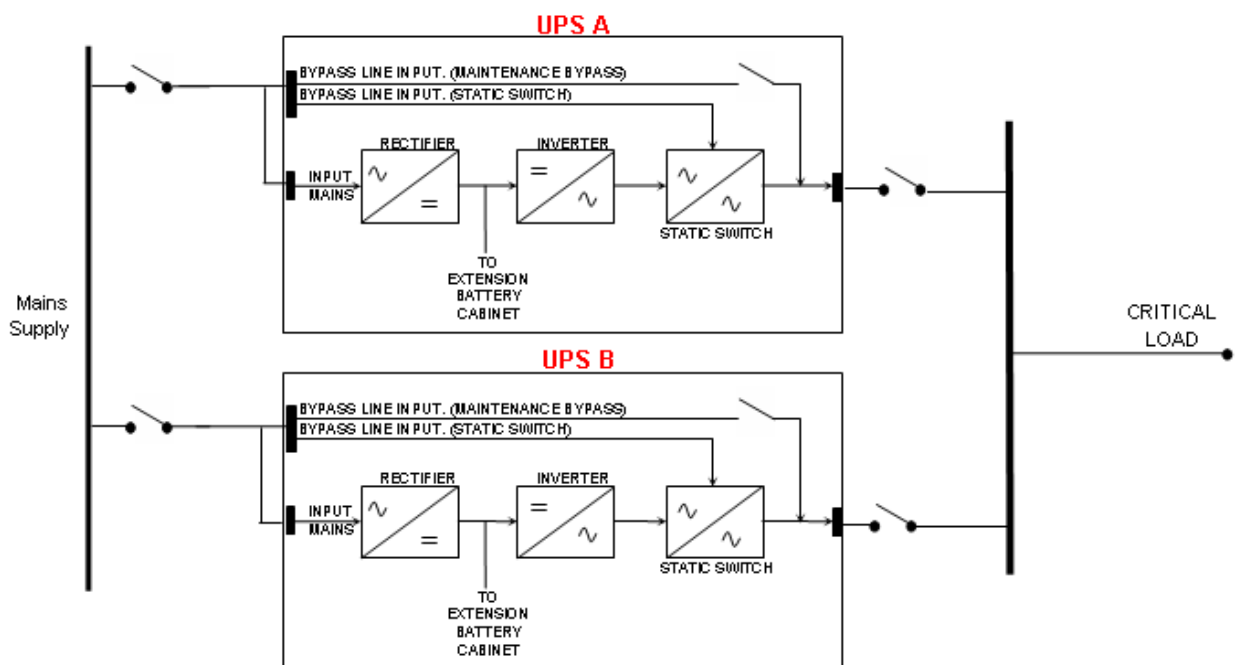


Figure 5

Most UPS incorporate a maintenance bypass to allow the UPS to be serviced without load disruption.

In multiple UPS installations e.g. a 4M8VA system where six 800kVA modules are used to achieve the total power rating, overall system bypass can be achieved through the installation of suitable control-switch gear with electrical and mechanical interlocks.

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Conclusion

Commissioning of a secure power system may only require the pressing of a few keypad push-buttons. The long-term resilience of the system requires a sound electrical engineering approach at the design, planning, installation and maintenance stages. Through this the overall reliability and MTBF of the entire power system can be increased to meet the requirements of the most stringent business continuity plans.

Ends