

Tier performance standards

The Uptime Institute tier performance standard system

	<u>Tier I</u>	<u>Tier II</u>	<u>Tier III</u>	<u>Tier IV</u>
Source	System	System	System	System + system
Distribution path	1	1	1 normal + 1 alternate	2 simultaneously active
Redundancy	1	N+1	N+1	Minimum of N+1
Compartmentalization	No	No	Yes	Yes
Concurrently maintainable	No	No	Yes	Yes
Fault tolerant (single fault)	No	No	No	Yes
Single point of failure	Many + human errors	Many + human errors	Some + human errors	None + fire and EPO
Site availability	99.67%	99.75%	99.98%	99.99%

General aspects

Power supply customers expect availability of “five nines” or 99.999%. Unfortunately, the substantial investment that a business makes to achieve five nines is unlikely to be sufficient unless matched with a complementary site infrastructure that can support their availability goals. The overall site tier rating is dependant on all aspects of the site infrastructure and will be the lowest of the individual sub system ratings covering such aspects as power, cooling and distribution etc.

It is important to be aware that sustainability (how the site is operated once constructed) also plays a significant role in what site availability is actually achieved. All too often people wrongly assume that installing a UPS is the end of their problems. However, if the overall design, installation and ongoing service support is handled badly, it could just be the beginning. For example, it is vital to ensure that the mean time to repair (MTTR) the system is kept to a minimum if the highest overall availability is to be achieved. Nowhere is this more important than with the design of data centers.

Each industry has a unique uptime need driving the site infrastructure tier level required. After careful alignment of business availability objectives with site infrastructure performance expectations, a company may select a site infrastructure based on any of the tier classifications.

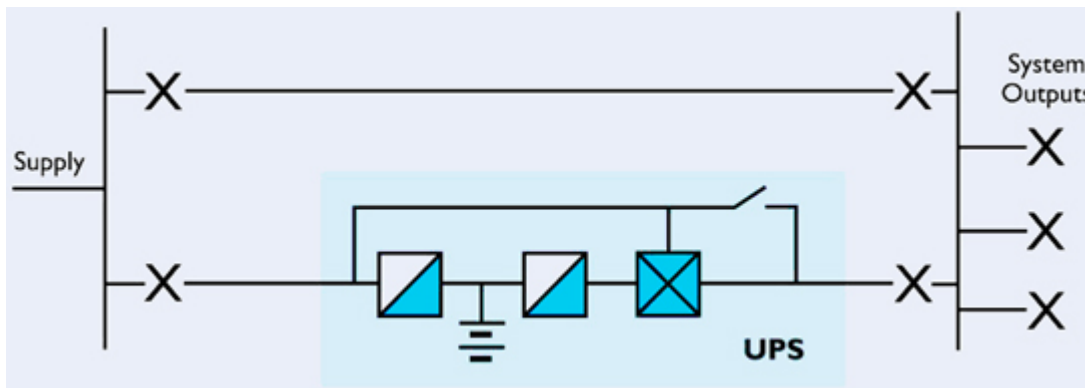
Management has the responsibility to determine what tier of functionality is appropriate or required for their sites. As such, it is a business decision to determine the tier classification necessary to support site availability objectives. Part of this decision is to balance the operational practices with the facility practices that support the operations. Once selected, however, the desired tier should be uniformly implemented.

Tier I is appropriate for firms such as:

The Uptime Institute fundamental classification of Tier I states:

A Tier I basic facility has non-redundant capacity components and single non-redundant path distribution paths serving the site's equipment.

Typical solution (diagram 1): Single UPS module



Summary

- A cost effective secure supply system that meets the requirements of Tier 1.
- The system is based on a single non-redundant UPS with static bypass to support critical loads.
- The system can be easily enhanced over and above the basic requirement by the addition of an external manual bypass to allow the UPS to be totally isolated for maintenance without loss of power to the system load.
- In order to allow for the possible failure of the normal incoming AC supply, the system will normally require a second AC supply source such as an automatically starting generator.

Organizations selecting Tier 1 infrastructure typically do not have an established revenue stream or identifiable financial impact of disruption due to power supply failure. Sometimes organisations with an established revenue stream will select Tier 1 topology because their applications have a low availability requirement such as a 5-day business week.

The performance confirmation test

Any capacity component or distribution path failure will impact the systems.

Planned work will require most or all of the systems to be shut down, impacting the business process.

The operational impact

The site is susceptible to disruption from both planned and unplanned activities.

The site infrastructure must be completely shut down on an annual basis to safely perform necessary preventive maintenance and repair work.

Urgent situations may require more frequent shutdowns. Failure to perform this maintenance work increases the risk of unplanned disruption as well as the severity of the consequential failure.

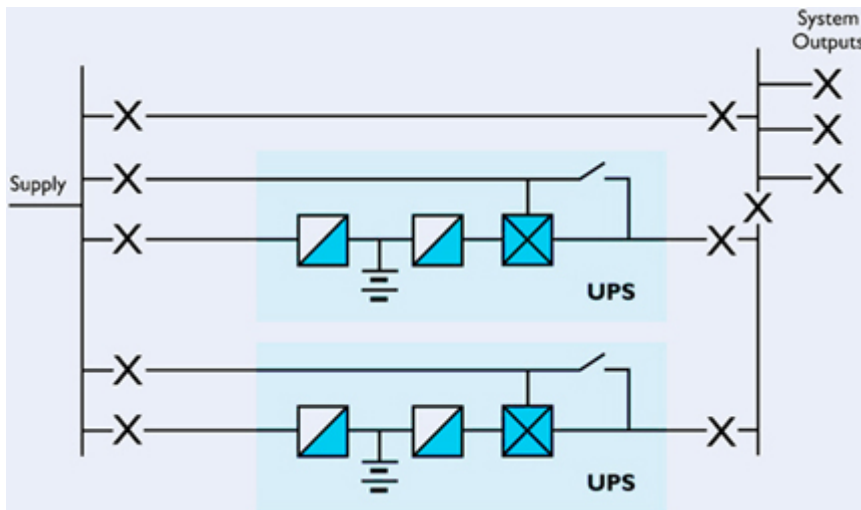
Operation errors or spontaneous failures of site infrastructure components will cause a data centre disruption.

Tier II is appropriate for firms such as:

The Uptime Institute fundamental classification of Tier II states:

A Tier II facility has redundant capacity components and single non-redundant distribution paths serving the site's equipment.

Typical solution (diagram 2): Modular N+I parallel UPS system

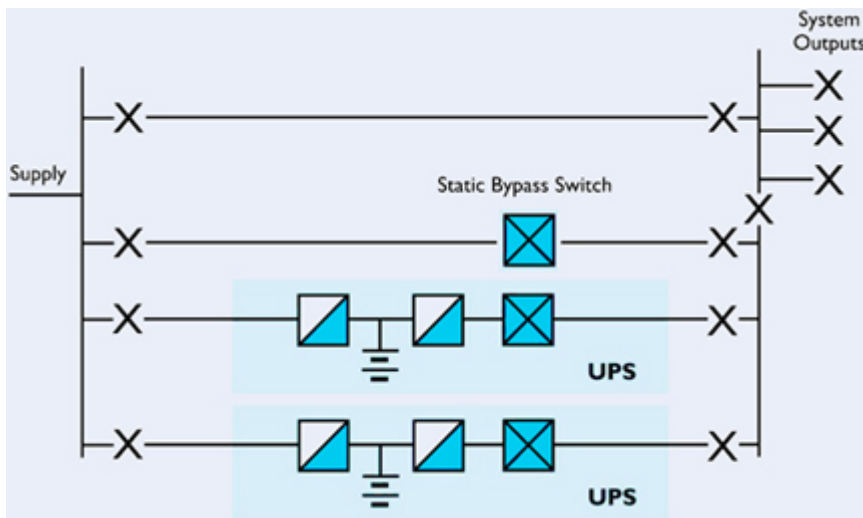


Summary

- Redundancy is provided by a second UPS module running in parallel.

- This configuration exceeds the basic Tier II requirement by enabling maintenance of each UPS module whilst the other is supporting the load, and therefore eliminates the need for total system shutdown for this purpose.
- Can be easily expanded to up to eight parallel modules for higher power or further levels of redundancy.
- Cost effective means of providing redundancy.
- If future requirements change, the system can be easily expanded or reduced and modules re-used elsewhere. Generators will normally meet the requirements for a second source of incoming AC supply.

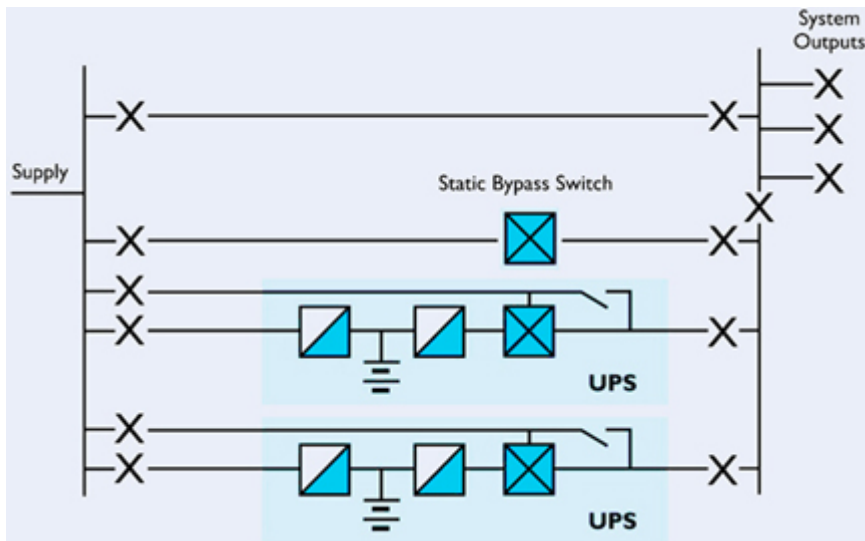
Typical solution (diagram 3): Centralized N+I parallel system



Summary

- System as per Modular Parallel System (diagram 2) but using a single “reserve static switch”, common to all UPS modules.
- Centralized static switch offers more flexibility in positioning UPS modules. Power cables to each UPS can be of different lengths because Vector Control UPS technology ensures correct parallel operation.
- Generators will normally meet the requirements for a second source of incoming AC supply.

Typical solution (diagram 4): High fault capacity N+I parallel system



Summary

- System as per Centralized Parallel System (diagram 3) but with an additional High Fault Capacity (HFC) “reserve static switch”, that is common to all UPS modules.
- The HFC static switch can be removed for service and the system will still function as in diagram 2.
- Combines the advantages of the modular and centralized parallel UPS configurations with high fault clearing capability.
- The HFC configuration permits more flexibility by enabling the external static bypass switch to be maintained without taking the whole UPS system offline.
- Centralized static switch also offers flexibility in positioning UPS modules. Power cables to each UPS can be of different lengths because Vector Control UPS technology ensures correct parallel operation.
- Generators will normally meet the requirements for a second source of incoming AC supply.

Organizations will typically select Tier II infrastructure if they do not depend on real-time delivery of products or services for a significant part of their revenue stream, or are contractually protected from damages due to lack of system availability. Organizations may select Tier II infrastructure if they have become burdened with impacts due to nuisance equipment outages associated with Tier I sites.

The performance confirmation test

A capacity component failure may impact the equipment.

A distribution path failure will cause the equipment to shut down.

The operational impact

The site is susceptible to disruption from both planned activities and unplanned events.

Redundant UPS modules and generators are required.

The site infrastructure must be completely shut down on an annual basis to safely perform preventive maintenance and repair work. Urgent situations may require more frequent shutdowns. Failure to perform this maintenance work increases the risk of unplanned disruption as well as the severity of the consequential failure.

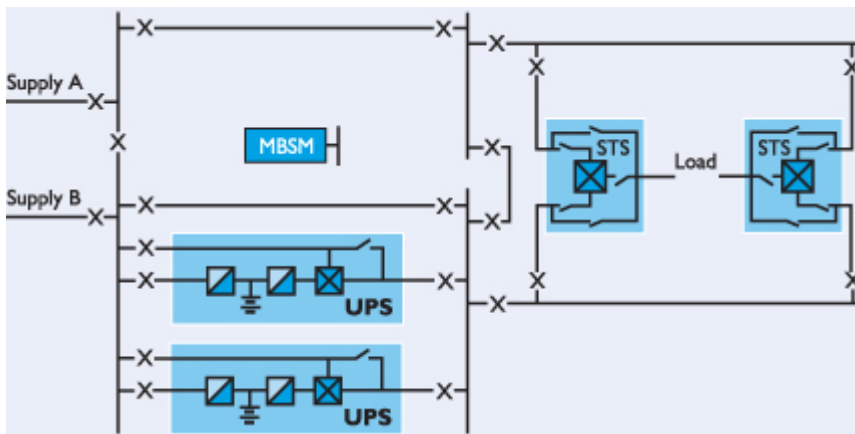
Operation errors or spontaneous failures of site infrastructure components may cause a data centre disruption.

Tier III

The Uptime Institute fundamental classification of Tier III states:

A concurrently maintainable facility has redundant capacity components and multiple distribution paths serving the site's equipment. Generally, only one distribution path serves the equipment at any time.

Typical solution (diagram 5): Redundant UPS module with dual static transfer switches



Summary

- The requirement for multiple distribution paths is satisfied by fitting multiple electronic Static Transfer Switches (STS) so that the critical loads can benefit from two different AC supplies.
- System output is maintained even if either one of the two incoming AC supply sources is shut down.
- The UPS system remains in synchronism with the alternative supply source even if its own incoming supply is not available.
- Alternative power paths ensure maintainability of the system.

- Main and Reserve auto-start generators will normally meet the requirements for a second source of incoming AC supply.

Organizations selecting Tier III infrastructure usually have high availability requirements for ongoing business or have identified a significant cost of disruption due to a planned data center shutdown. These organizations are willing to accept the impact of disruption risk of an unplanned event. However, Tier III is appropriate for organizations who expect the functionality requirements to increase over time. Some organizations design a Tier III site so that it can be upgraded to Tier IV at a later date.

The performance confirmation test

Each and every capacity component and element of the distribution paths can be removed from service on a planned basis without causing any of the equipment to be shut down.

The operational impact

The site is susceptible to disruption from unplanned activities.

Planned site infrastructure maintenance can be performed by using the redundant capacity components and distribution paths to safely work on the remaining equipment.

In order to establish concurrent maintainability of the critical power distribution system between the UPS and the equipment, Tier III sites require all hardware have dual power inputs.

During maintenance activities, the risk of disruption may be elevated.

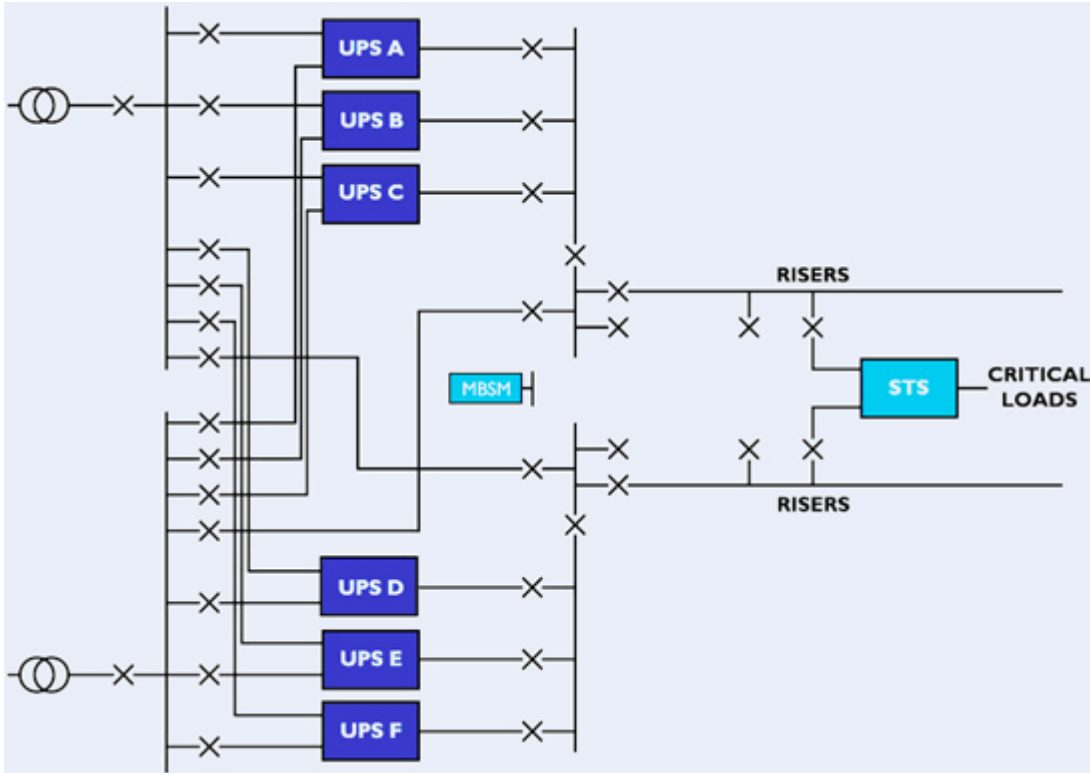
Operation errors or spontaneous failures of site infrastructure components may cause a facility disruption.

Tier IV:

The Uptime Institute fundamental classification of Tier IV states:

A fault tolerant data center has redundant capacity systems and multiple distribution paths simultaneously serving the site's equipment.

Typical solution (diagram 6): Dual bus 2x (N+1) UPS system with dual static transfer switches



Summary

- The principle of redundancy is extended further to include 2 x independent incoming supplies, 2 x (N+1) UPS systems and 2 x distribution.
- HFC option ensures maximum fuse clearing capability and helps to ensure flexibility and maintainability of the system.
- Load STS ensures that BOTH load power inputs remain powered even for load distribution fault.
- UPS systems remain in synchronism to ensure load bus synchronism even during mains failures.
- When either UPS is under maintenance the load still receives a protected AC supply from the alternative N+1 UPS with mains available as further back up.
- Main and reserve auto-start generators or dual incoming AC supplies will satisfy the requirements for a second source of incoming AC supply.
- The highest level of power availability for critical system loads.

Organizations will select Tier IV site infrastructure if they have an extremely high availability requirement for ongoing business or if there is a profound cost of disruption in the event of a data center shutdown. These organizations will know the cost of a disruption in both financial terms and impact on market share. The cost of disruption makes the case for investment in high availability infrastructure a clear business advantage.

The performance confirmation test

A single worst case failure of any capacity system, capacity component or distribution element will not impact the equipment.

Each and every capacity component and element of the distribution paths must be able to be removed from service on a planned basis without causing any of the equipment to be shut down.

In order to establish fault tolerance and concurrent maintainability of the critical power distribution system between the UPS and the equipment, Tier IV sites require all hardware have dual power inputs.

Complementary systems and distribution paths must be physically separated (compartmentalized) to prevent any single event from impacting on both systems and paths simultaneously.

The operational impact

The site is not susceptible to disruption from a single unplanned worst case event.

The site is not susceptible to disruption from any planned work activities.

The site infrastructure maintenance can be performed by using the redundant capacity components and distribution paths to safely work on the remaining equipment.

During maintenance activities, the risk of disruption may be elevated.

Operation of the fire alarm, fire suppression, or Emergency Power Off (EPO) may cause a data centre disruption.