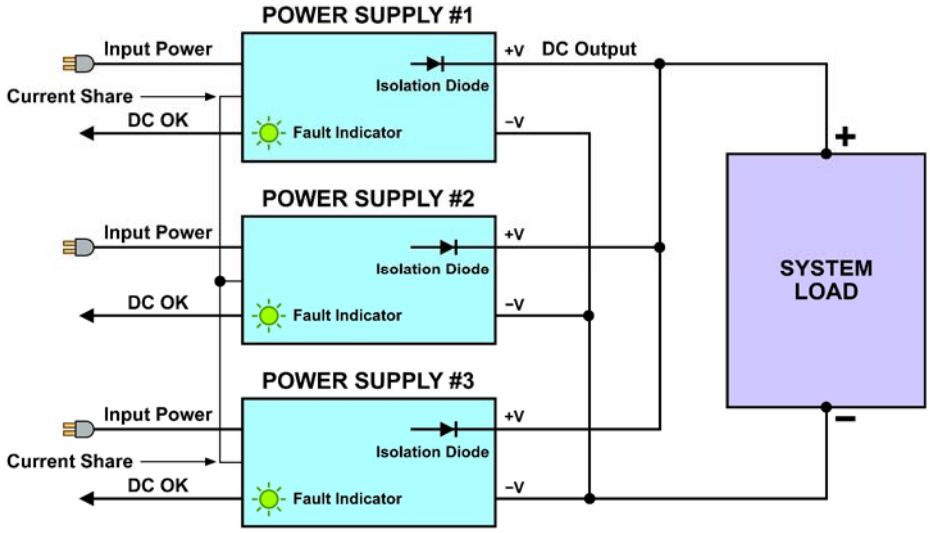
Eliminate System Downtime with Redundant Power Supplies

When designing systems or products that must have a minimum downtime, the power supply needs to be carefully selected. As a general rule, the longer the power supply's warranty, the longer the power supply, and the end product or system, will operate without a failure. Power supplies contain large electrolytic capacitors which over time will dry out and eventually fail. High quality industrial grade power supplies use higher grade and more expensive electrolytic capacitors that resist drying out and therefore ensure the longest power supply life possible. Also, many medium to high power supplies use fans to keep them at the correct operating temperature. Since fans are electro-mechanical devices, they have the shortest lifespan of any component in a power supply and will eventually fail.

In cases where an OEM product or system cannot tolerate any downtime, a redundant power supply configuration should be considered. Below is a schematic of a Redundant Power System. You'll notice there are three power supplies connected in parallel via internal isolation (ORing) diodes to the system load. The isolation diodes' function is to become back-biased (like an open-switch) in the event one of the power supplies fails. In this situation, the failed supply is isolated from the load, its fault indicator turns from green to red, and the System Load continues to receive full power from the remaining two redundant power supplies. The failed supply is designed to be replaced while the system input and output power remains ON (hot-swapped); therefore it can replaced when the user's convenience, without impeding the operation of the system.



One of the main reasons for using “Redundant Power Supplies” that are connected in parallel with isolation (ORing) diodes is to construct a "fault-tolerant" power system. This means that even if one of the paralleled supplies should fail, the system will continue to provide full power to its power bus. This is sometimes referred to as "power availability." In redundant power systems, each supply must include a circuit that automatically disconnects its output from the others should it malfunction. Typically this automatic disconnect is accomplished by having Isolation (ORing) Diodes or MOSFETs placed in series with the output of each paralleled supply. In the event one of the supplies develops a short circuit on its output (a worst case scenario) or shuts down for any reason, the isolation (ORing) diodes would become back-biased or the isolation-MOSFET switches would be turned off (high impedance state), thus preventing the output current from the other supplies from flowing into the shorted or defective output of the failed supply. In addition to having this automatic output "disconnect" feature, each supply must include a signal and visual indicator which can be used to alert the user or the monitoring external system that a specific redundant power supply has failed, so it can replaced and repaired in the future.

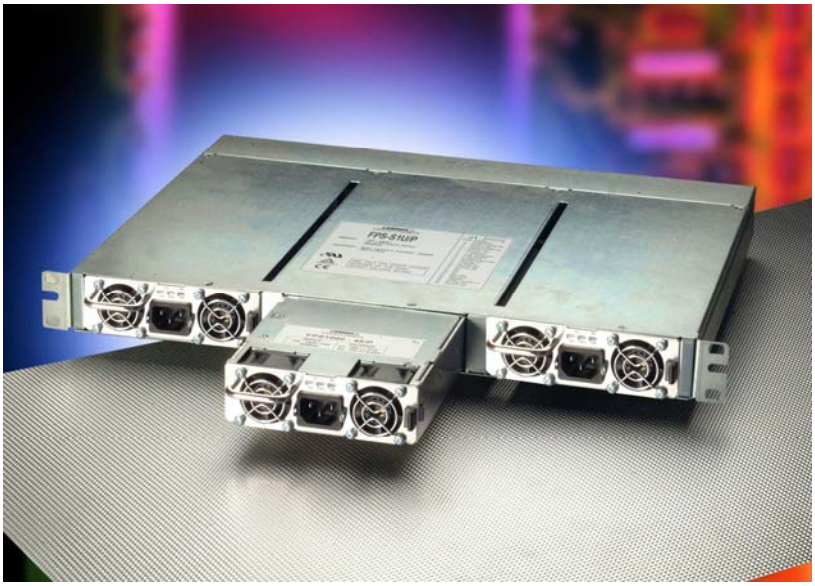


Photo of Redundant Power System with Three 1kW Hot-Swap Power Supplies (FPS1000 Series Shown)

What is N+1 Redundancy?

There are a number of ways to construct Redundant or Fault-Tolerant power systems. The most common method is to have at least one supply with sufficient output power to fully satisfy the system's power requirements. Then, a second power supply of the exact same ratings is provided as a "back-up" in the event one of the two supplies fails. This forms a basic N+1 Redundant and Fault-Tolerant power system (1+1 system). "N" equals the number of supplies required to fully power the system and "+1" equals one back-up or redundant supply that will take over for a failed supply. "N" could consist of two power supplies, each providing 50% of the total load power with "+1" supply having the same power rating as the

others. One advantage of this type of power system (2+1) is that under normal operating conditions each of the 3-paralleled supplies are only providing 33.3% of the total system power, thus reducing the thermal stress on each supply, and improving the Mean-Time-To-Repair (MTTR) of the power system.

What is N+2 Redundancy?
In some very critical applications, there may be a need for an N+2 redundant power system. As previously mentioned, the “N” is the number of supplies needed to support the system's load. But, in mission critical applications, like air control or life support systems, having 2 back-up supplies provides much better fault tolerance than if one is provided. However, there is an added expense to achieve to this improved degree of power availability and fault-tolerance.

What is meant by "Hot-Swap"?
It is best if all the Redundant and Fault-Tolerant supplies have the type of interface circuits and input/output connectors that allow the supplies to be replaced while the system's AC input and DC output power is still in the "ON" state. The ability to do this is called "Hot-Swap" and is an important feature to have. In this way, a maintenance person can replace the faulty power supply without interrupting the system's operation.

What is Active Current Share and why do I need it?
To properly parallel two or more power supplies, the supplies must include an "active current share" or "master/slave" feature. This function forces each of the paralleled supplies to contribute its share of current to the load. For example, two paralleled supplies would each provide 50% of the total load current and three supplies would each provide 33% of the total current, etc. These current share connections must be made between all the paralleled supplies. If active current share was not employed, one of the paralleled supply's outputs could drift higher than the others and can 'hog' most of the load current, which can be dangerous and can lead to the premature failure of the power supply, especially in high power applications.

Must I Use a Rack Mount Enclosure?
No. A rack mount enclosure provides a convenient means for paralleling supplies for expansion, and/or to form a redundant, hot-swap configuration. However, many power supplies have the necessary features for being connected in parallel with active current sharing and failure alarm signals. And, by adding external Isolation (ORing) Diodes many TDK-Lambda power supplies can be configured to form a Redundant Power System. Always check your power supply's instruction manual to be sure that your supplies can be connected in parallel, etc. The only feature that paralleling individual supplies will lack compared to the rack systems previously described, is the special mechanical aspects that allow the power supplies to be hot-swapped while the input and output power is active. However, in most situations there are scheduled “maintenance” times when a faulty power supply can be replaced.

Above is a photo of an HWS series power supply that can provide 1000 watts of output power and features alarm signals and active current sharing. Two or more of these supplies can be connected in parallel with external "ORing" diodes to form a redundant and fault tolerant power system.

In Summary

We have discussed when and how to consider using, or constructing, a Redundant Power System, plus the features required of the power supplies in order to accomplish this with the greatest amount of reliability and ease of system maintenance.

For more information about Rack Mounted and Redundant Power Supplies, please call TDK-Lambda Americas at 1-800-LAMBDA-4 or visit our website at: http://us.tdk-lambda.com/lp/

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