Power Supplies/Medical Applications

Preventing system failures *with* redundant power systems

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In cases where an end-product or system cannot tolerate any downtime, a redundant power supply or system configuration should be considered. In addition, when designing a system or end-product that must have a minimum downtime, the power source should be carefully selected.

In general, the longer the power supplies warranty, the longer the power supply and the end-product 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.

In addition, most 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 or system and will over time, fail.

Figure 1 is a schematic of a redundant power system. You'll notice there are three power supplies connected in parallel by means of internal Isolation (ORing) Diodes connected in series to the system load. The isolation diodes' function is to become back-biased (as an open-switch) in the event one of the power supplies fails. In this situation, the failed supply is automatically disconnected from the system 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 at the user's convenience without impeding the operation of the system.

One of the main reasons for using 'Redundant Power Supplies' 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 100% power availability. In redundant power systems, each supply must include a circuit that automatically disconnects its output from the others, should it malfunction.

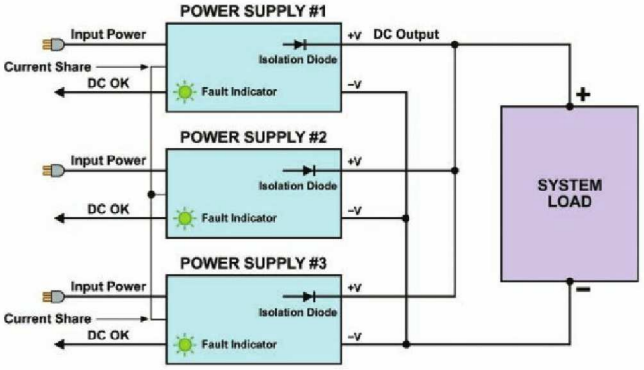

Fig. 1: Typical redundant power system.

Typically this automatic disconnect is accomplished by having isolation 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 diodes would become back-biased or the isolation-MOSFET switch 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.

The HFE1600 Series 19" rack mount redundant power system comes with five 1.6kW hot-swap power supplies installed. If fewer supplies are needed, blanking plates can be installed in the unused slots.

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 a remote monitoring station that a specific redundant power supply has failed, so it can replaced and repaired in the future.

Typical redundant configurations

There are a number of ways to construct redundant or fault-tolerant power system. 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 three-paralleled supplies are only providing 33.3% of the total system power, thus reducing the thermal stress on each supply and improving its Mean-Time-To-Repair (MTTR).

In some mission-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. However, in mission-critical applications like air traffic control, data back-up, or life support systems, having two back-up supplies provides much better fault tolerance than if one is provided. Nonetheless, there is an added expense to achieve this improved degree of power availability and fault-tolerance.

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.

Active current share is important

In order to properly parallel two or more power supplies, the supplies should 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 33.3% of the total current, etc. These current share connections must be

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Sealed power distribution module is compact hard-wired for 280 style

Cole Hersee HWB18 sealed power distribution module (PDM) is a compact PDM suitable for use in space-constrained vehicle battery compartments. The 18-slot device accepts plug-in circuit protection components with a 280 style footprint, including Delphi MetriPack 280 terminals, cable seals, and cavity plugs. Product stands up to road splash and salt spray, providing robust protection to devices. The compact sealed unit measures 60 x 38 x74 millimeters.

LITTELFUSE

http://ept.hotims.com/40519-74

2kW ac/dc power supply delivers PFC-input, inherent redundancy

PFH 2K series of rugged, industrial grade ac/dc switching power supplies with PFC-input deliver up to 2kW continuous output power. Several units may be paralleled for even higher power. Products convert a universal ac-input voltage (95-264Vac) to 36Vdc/60A, 48Vdc/40A, 54Vdc/37A, 110Vdc/18A or 125Vdc/16A. Custom input and output options are available. Product series is built with two PFH 65F internal modules which utilize field-proven design topology to provide 1kW each.

ABSOPULSE ELECTRONICS

http://ept.hotims.com/40519-75

Battery pack with integral charger drives mobile app

GS-1907 Battery Pack consists of 3 Samsung Li-Ion cells in a 3S-1P configuration provides 28.86WHr (2.6AHr) of power to mobile applications. Product includes battery charger circuits, thermal cut-outs and dedicated safety circuit and can run stand alone power. Device is configured in a soft pack with shrink wrap and is compliant with UL1642, UL 2054, UN38.3 and CE standards. Customizations including connectors, custom plastic enclosures, and alternate cell configurations and quantities are available.

GLOBTEK

http://ept.hotims.com/40519-76

Medical 65W switcher in small footprint is ITE-certified

MWS65 series 65-watt open-frame, medical/ITE ac-dc power supplies provide 4kVac reinforced input to output isolation and output to ground isolation of 1500Vac. All models comply with UL/EN60601-1 Editions 2 & 3 safety approvals for medical equipment and include onboard dual fusing making them Suitable for use in B (Body) and BF (Body Floating) type medical applications.

TDK-LAMBDA AMERICAS

http://ept.hotims.com/40519-77

Capacitive coupling device enables wireless charging systems

LXWS series wireless power transmission module enables wireless charging systems for tablet PCs, mobile devices, music players and other apps. Firm applied its circuit design and module manufacturing technologies to develop a capacitive coupling wireless charging module that is capable of charging at 10W, includes a high level of positioning freedom, and integrates removal and error detection to ensure optimal system operation. The incorporation of a very thin electrode (less than 0.1mm) with a miniaturized antenna structure decreases the thickness of the structure. Device generates limited heat in the wireless power transmission area, effectively suppresses noise, and is easy to integrate into almost any mobile device.

MURATA ELECTRONIC NORTH AMERICA

http://ept.hotims.com/40519-78

Compact battery holders connect solidly

Surface and through-hole mount battery holders provide solid electrical contact for CR1216, CR1225, CR2016, CR2025 and CR2032 lithium coin and button cells. Product's compact design assists space-constrained applications such as computers, remote controls and other handheld electronics. Device's nickel-plated phosphor bronze construction provides good conductivity and strength. Two metal arms secure the battery to the contact patch.

LINX TECHNOLOGIES

http://ept.hotims.com/40519-79

Preventing system failures

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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.

Economies of scale

Economic savings can be achieved where a system requires a specific power level when it is originally built and shipped to the end-user, but can be upgraded in the field to add more power as the system grows. For example, for data center servers the original power requirements for the system may require two or more power supplies in parallel. However, as more data handling capacity is added, more power will be required. The ability to add or reduce the total power provided to a system is referred to as 'scalable power'.

The advantage of a rack-mounted redundant power system is that the original configuration can consist of some number of power supplies with blanking plates covering the unused slots. Then, as more power is needed by the system, one or more blanking plates can be removed and additional hot-swap power supplies can be added to system to supply the additional power requirements.

Optional rack-mounting

A rack mount enclosure provides a convenient means for paralleling supplies for expansion (scalability) 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 diodes these 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-mounted 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. So, in non hot-swap applications, a scheduled maintenance shut-down period is required to allow time for replacing the faulty power supply.

The SWS1000L series power supply 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 isolation diodes to form a redundant and fault tolerant power system.

Summary

In summary, we have reviewed when and how to consider using a hot-swap, redundant and fault tolerant power system, plus the economics of scalable power and the features required of the power supplies in order to construct a redundant power system with the greatest amount of reliability and ease of system maintenance.

For more information on preventing system failures with redundant power systems from TDK-Lambda Americas Inc., go to http://ept.hotims.com/40519-80