EATON | Cutler-Hammer

Using a Spot Network for Mission Critical Applications

Application Note

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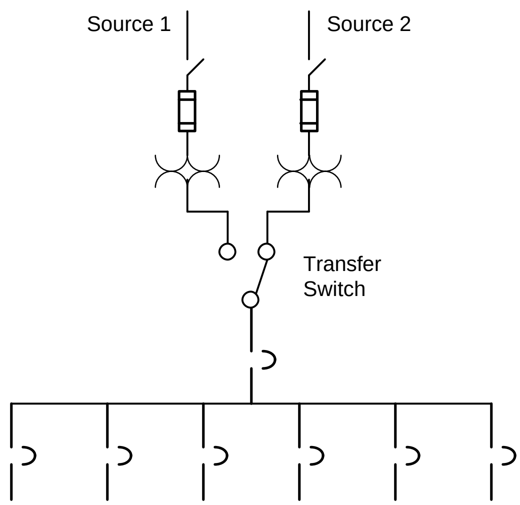

Figure 1: Transfer switch selects one of two sources. Operation of transfer switch from one source to the second leaves the loads without power during the transition time.

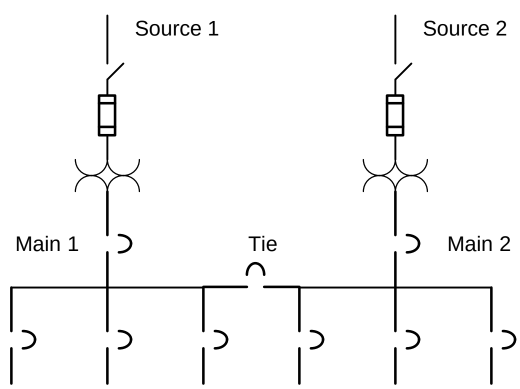

Figure 2: Primary selective system (main-tie-main) normally operates with either the tie open or one of the two mains open with the tie closed. If the primary source fails, the load is without power for the duration of time it takes to switch to the secondary source by either closing the tie or the second main.

General Description

There are ways of providing redundancy in an electrical system. These include obtaining utility power from more than one source. However, achieving bumpless switching from one source to another implies that there is a detection and switching system that connects the load to the good source *before* the load detects a problem.

Problem

Highly reliable systems require redundant sources of power since the nominal reliability of a utility distribution system is approximately 99.97% (2.63 hours per year of downtime).

Conventional transfer switches or main-tie-main systems cannot switch a load from one source to another fast enough to permit the load to continue without interruption.

This momentary outage cannot be tolerated in mission critical applications. As a result, battery or flywheel based local energy storage systems are used to ride through the momentary outage until the secondary source of ac power is connected to the loads.

Switching to battery power shortens the life of the batteries since the number of electrochemical discharge/charge cycles is limited. Accordingly, for each transfer of power to an alternate source, that battery's life is shortened.

Solution

To achieve bumpless transfer between two ac sources, there are two commonly used technologies, solid-state transfer switching or network.

A solid-state transfer switch transfers between sources using very high speed switching, but this solution is not as common due to its high cost.

A network parallels two or more transformers onto a common bus.

Since a network uses multiple sources of supply to simultaneously feed the load(s), the loss of one source does not interrupt power flowing to the load.

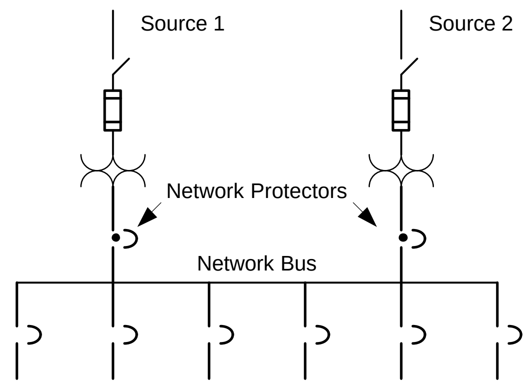

Figure 3: A network connects two or more transformers to a common bus, called the network bus. The loss of a single incoming source does not result in interruption to the load since the other source(s) are still providing power.

Issues

When connecting two sources onto a common bus, certain criteria must be met:

- Sources must have the same phase rotation (ABC or CBA)
- Instantaneous phase displacement between sources must be small (<2 deg). This implies that the sources originate from the same substation transformer and that the distribution wiring from the substation to the network approximately the same length
- The other loads connected to the two sources are approximately the same size, have the same load factor (ratio of peak load to average load) and that their peaks and minimum loads track each other

The concern is that if the two sources are not closely matched, energy from one source can travel in a reverse direction through the other source. This "out of network" power flow is undesirable.

For practical purposes, the most reliable networks are connected to what the utility calls "network grade feeders".

If your utility offers such a source, using a network instead of a transfer switch or primary selective system will provide approximately 5 times higher reliability.

Certification

For commercial or industrial applications, local authorities having jurisdiction typically require third party certification of electrical equipment. Equipment supplied in utility applications is typically certified by the utility only after extensive testing. As such, a utility does not rely on third party certification (such as UL). Be sure that the network protector you specify includes UL certification to insure approval by local inspectors.

Financial

As discussed in figure 4, nominal power system disturbances will remove from 2.3 to 6% of a battery's life per year. Based on a 10-year life cost, we can compute the life savings of using a network. Note since network protectors are priced comparably to a primary selective system, these savings represent true total project savings.

Based on battery costs listed at the right and the sensitivity setting of the UPS (which determines where in the 2.3-6% range you fall), your savings will range from $920 to $30000.

Battery	Savings	
Replace Cost	2.30%	6%
$4,000	$920	$2,400
$8,000	$1,840	$4,800
$30,000	$6,900	$18,000
$50,000	$11,500	$30,000

More Information

Contact Eaton Corporation at www.cutler-hammer.eaton.com and enter *spot network* in the search field to learn more about Cutler-Hammer Network Protector solutions.

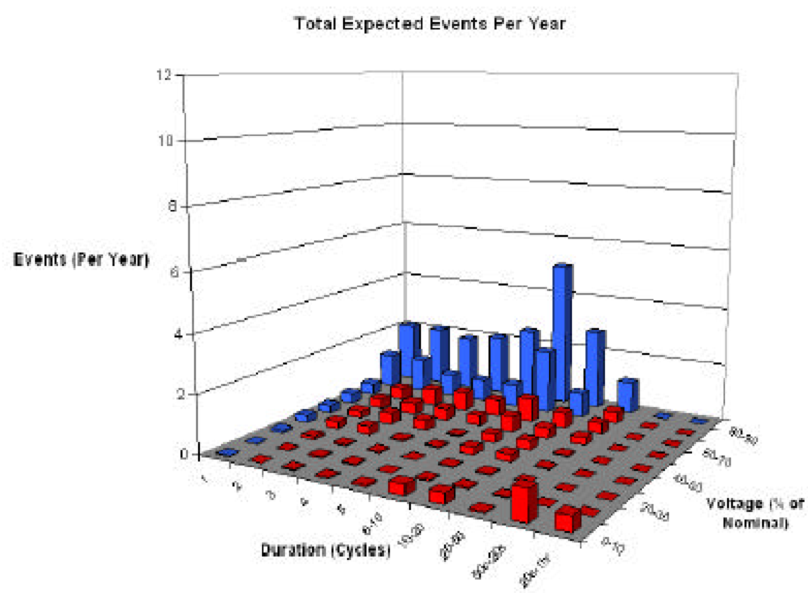

Figure 4: Electric Power Research Institute (EPRI) data on frequency of power quality events for a single utility source. The events in red are those events that exceed ITIC (CBEMA) limits and are most likely to cause equipment malfunction. Battery backed systems will supply the load during these events. For each battery use, there is a corresponding recharge. This discharge/recharge cycle reduces the life of the battery. Summing all the events, we have approximately 24 events per year, including 9 that exceed ITIC limits. Depending on the sensitivity of the battery backup system, you would have between 9 and 24 battery discharge/charge cycles per year, removing from 2.3% to 6% of the battery life per year.