TECHNICAL BULLETIN 1-09

MGE STATIC TRANSFER SWITCH ADVANTAGES
Fault Tolerant Distribution / Fault Isolation

Abstract*: Faults that occur downstream of the Static Transfer Switch (after the STS output) can cause a voltage sag on the entire distribution system. This voltage sag will affect the input power quality of all the STS's on the distribution system causing them to automatically transfer to the alternate source in search of better power quality. If the STS that has the down stream fault transfers to the alternate source, along with all of the other STS's in the system, it will continue to propagate the fault / voltage sag throughout the distribution system.*

MGE STS's can recognize the difference between voltage sag and a fault condition. This logic prevents the STS with the downstream fault from transferring to the alternate source, isolating the fault and voltage sag condition only to the loads connected to that specific STS. Meanwhile all other STS transfer to the alternate source, which is isolated from the fault induced voltage sag, and continue to supply quality power to critical loads.

One of the most important design features of any electrical distribution system is the ability to “sectionalize” or “isolate” load side faults. If not properly managed, load side faults can easily propagate their effects (usually in the form of a voltage sag) upstream and affect the entire critical power distribution system. As many data centers now host third party loads, Facilities Managers have less control over the type of loads and end user systems, thus increasing the risk of load side faults. By using distribution devices that inherently recognize and manage load side faults, distribution systems can be made “fault tolerant”, isolating faults to limited areas.

MGE’s *Digital Static Transfer Switch* (DSTS) is specifically designed to “sectionalize” or isolate faults, optimizing critical power reliability, and availability. To further explain this advantage of “fault sectionalization”, consider a typical distribution system with multiple static transfer switches being fed by two UPS systems [fig. 1]. Realizing that the main benefit of this system is to seamlessly transfer from UPS A (the preferred source) to UPS B (the alternate source) in the event of a deviation in power quality from UPS A, the configuration appears to be a bullet proof solution.

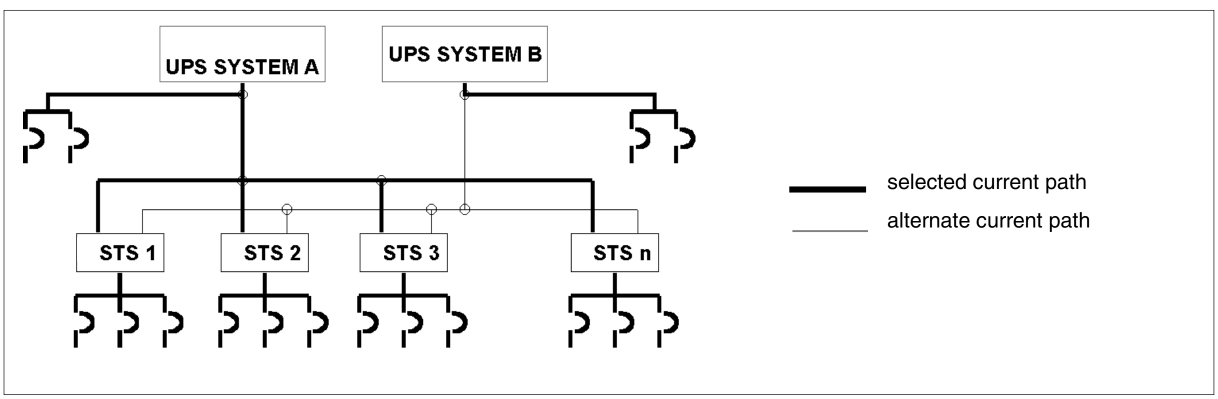

Figure 1: Typical STS distribution system configuration

The integrity of the system goes beyond the static transfer switch’s ability to detect poor power quality and perform a seamless transfer. To be truly bullet proof, the static transfer switch must have the ability to differentiate between a load side fault inducing a sag in the input voltage and a true deviation in power quality such as a drop in input voltage.

Consider what actually happens during load side fault, keeping in mind that it takes a breaker several cycles to trip during a dead short and many minutes or more to trip during a lesser fault.

Figure two illustrates a load failure/fault that occurs downstream of one of the STS's. During this time the preferred source (UPS A) is supplying power to the load. The fault induces a voltage sag that is propagated to all of the loads connected to "UPS A". The input voltage sag is now detected by all of the STS's. Acknowledging the sag, typical STS's will interpret the voltage drop as a "poor input voltage condition" and universally transfer to the alternate source "UPS B". With the fault still present at the output of STS 2, the voltage sag will still be present and continue to corrupt the entire critical power system.

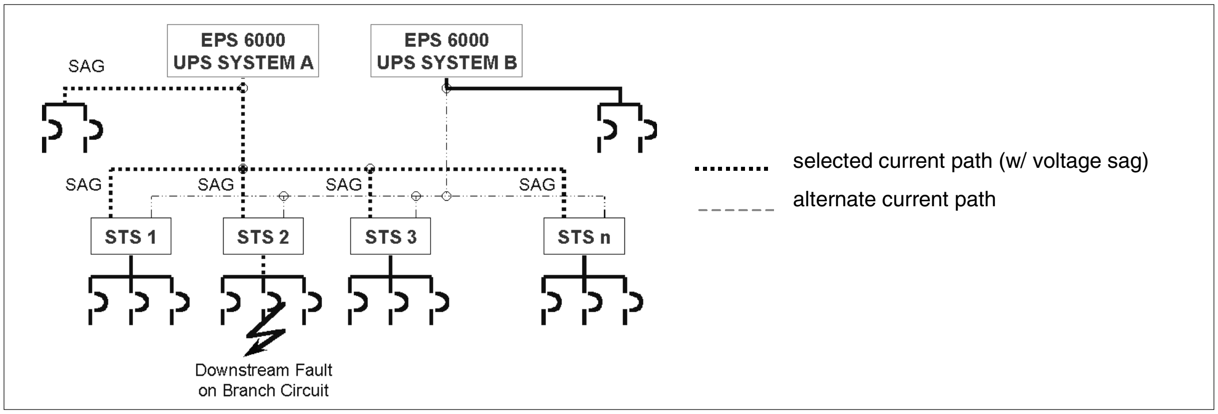

***Figure 2**:* The voltage sag effect caused by a single load downstream fault on a distribution system is propagated through the entire system.

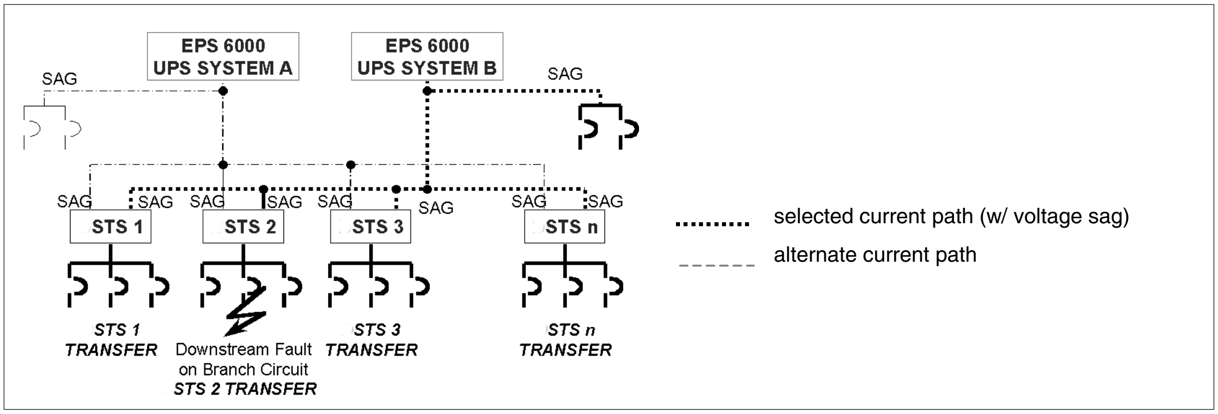

***Figure 2b**:* If STS 2 transfers to UPS B, then the fault will still be present and the voltage sag will still affect the entire distribution system.

The only way to prevent the single fault from propagating throughout the system is to ensure that the STS has the intelligence to distinguish between voltage sag due to deterioration in input power quality and voltage drop due to a load side fault. This would prevent the STS affected by the fault from transferring into a fault condition.

Looking at figure 3, STS 2 has recognized (using digital sampling techniques mentioned later) that it has been exposed to a fault condition, and not source voltage quality deterioration. The logic of the MGE switch (STS 2) inhibits the unit from transferring into a fault (transferring to UPS B). With STS 2 locked onto the UPS A, the fault and resulting voltage sag is isolated only to the path directly upstream of UPS A, and the output of STS 2. All other STS's (1,3,4) have interpreted the voltage drop correctly as a sag, not a downstream fault and transferred to the alternate source (UPS B) until such time as the preferred source (UPS A) is stable.

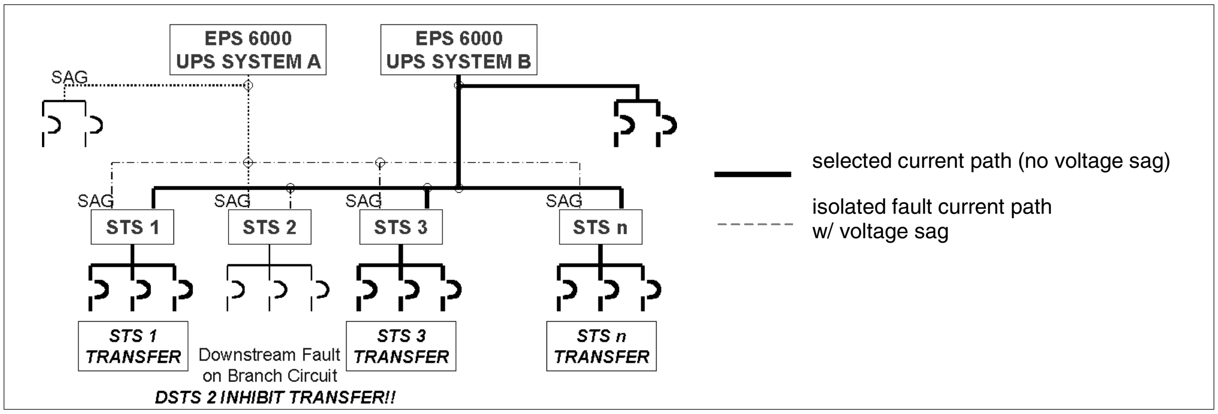

Figure 3: *Fault Sectionalization* – the MGE advantage: STS 2 has the intelligence to recognize a downstream fault and inhibits transferring to the alternate source (UPS B). This isolates the fault and associated voltage sag to UPS A's output and STS 2's load. Meanwhile all other STS's recognize the problem as a input voltage drop and not a sag and transfer "UPS B".

How the STS differentiates between a voltage sag and a fault condition: To differentiate between a downstream fault and voltage sags caused from poor input power quality the MGE STS employs advanced digital sampling techniques. Simplified, the STS monitors both fault current levels and voltage sags. However, the sampling rate for measuring fault current levels is much faster (2.5 times) than the sampling rate for voltage sags. This means that fast acting fault currents will be sampled three times for every single sampling of voltage sags. This higher sampling resolution allows the STS logic to recognize the profile of a fault current and inhibit transfer accordingly. When another leading STS system was tested on its ability to inhibit transferring into fault currents, the other STS transferred into the fault almost two thirds of the time causing a disruption of the entire critical power system, giving MGE's "intelligent" STS a clear advantage in system reliability.