Distributed Generator System Synchronization

Distributed Redundant is a common UPS system design used in the market today. This design uses multiple UPS modules that have their output busses cross-connected for multiple power sources to the critical load by static transfer switches. Each static transfer switch will have two inputs. One input will be set as the primary feed for the switch. The other input will be set as the secondary. In the event of a power failure on the primary input of the static transfer switch, it will automatically switch to the secondary source. The switching action is a short duration open transition, typically up to 4ms. The primary and secondary inputs of all the switches will be divided among the outputs of the UPS modules. This is done so that the load is balanced across the entire system. If any one UPS module were to fail, the static transfer switches that have their primary input fed by the failed UPS will switch input sources. The critical load is then transferred to the outputs of the other good UPS modules. Correct system design will ensure that the remaining good modules will not be overloaded at this time. Both inputs to the static transfer switches must be synchronized to minimize voltage transients during switching.

Delta Conversion Technology

As the largest single load on the engine generator, the UPS should be designed to both stabilize and enhance generator load capability. Delta Conversion Technology is designed to improve input power factor correction, reduce input current distortion to less than 5%, optimize system efficiency, and reduce heat dissipation. This results in smaller generator and air handling equipment requirements as well as lower utility costs. All of these positive operating characteristics are a direct result of Delta Conversion Technology, and do not require any additional filters or options.

To achieve these benefits the Delta Conversion topology does not frequency convert. It's output waveform will track its input reference within a preset window. During engine startup or other transitory the system will transfer to battery power. In battery operation the system will output 60Hz power +/- 0.1% and in a distributed redundant system with static-switch PDUs, all UPS input power sources are synchronized. An Inter-system Synchronization Unit (ISU) is used with each UPS module to synch its inverter during free-running operation.

After engine generator startup, generators are synchronized to the utility if any one of the sources is present, and to each other when there is no utility reference available. As soon as the generator output bus is within tolerance the Delta Conversion UPS soft loads the generator bus in a gradual linear increase designed to maintain engine generator speed and therefore frequency stability until the generator is fully loaded. During this time the free running UPS modules will be held in sync with the other UPSs whether they are in normal operation (synched to a utility reference) or free-running (no utility present). By assuring upstream synchronization (generator and utility) and the use of the ISU, synchronization at the static transfer switches can be assured.

Of greatest importance is that phase lock synchronization of the system from the generator bus is restored and maintained by the Delta Conversion UPS, which maximizes bypass availability for fault clearing or overloads. This is crucial since even while on generator the generator fault current capacity or overload capacity is at least four times that of the UPS bus. Overall system availability is maintained.

Generator Synchronization

Synchronization is essential for running generators on a parallel bus with other generators or the utility. The generator must be synchronized to the bus voltage reference before the paralleling switchgear will close it onto the bus. This is accomplished using a synchronizer unit, which drives the generator's governor to control its engine speed and output voltage frequency. A generator synchronizer is also used with all closed transition transfer switches. The synchronizer will sync the generator when a utility reference is presented to the line side of the transfer switch. This accommodates the closed transition from generator to utility. This technology has been used for many years and has evolved to greater speed of action with advancements in electronic synchronization control and governors over mechanical units.

A generator synchronizer unit can also be used to hold distributed generators in sync with the utility or each other. This assures the up-stream synchronization required in a distributed redundant design that utilizes Delta Conversion Technology. A PLC controller is used to sense each of the generator and utility voltage references. If a valid utility reference is available, the PLC will provide this reference to the synchronizer units that are connected to the distributed generators. If no utility is available, the PLC will pick an operating generator and use its output as the reference for the others. This will enable system synchronization in any operating condition. Examples of this system are shown in Figures 1 & 2.

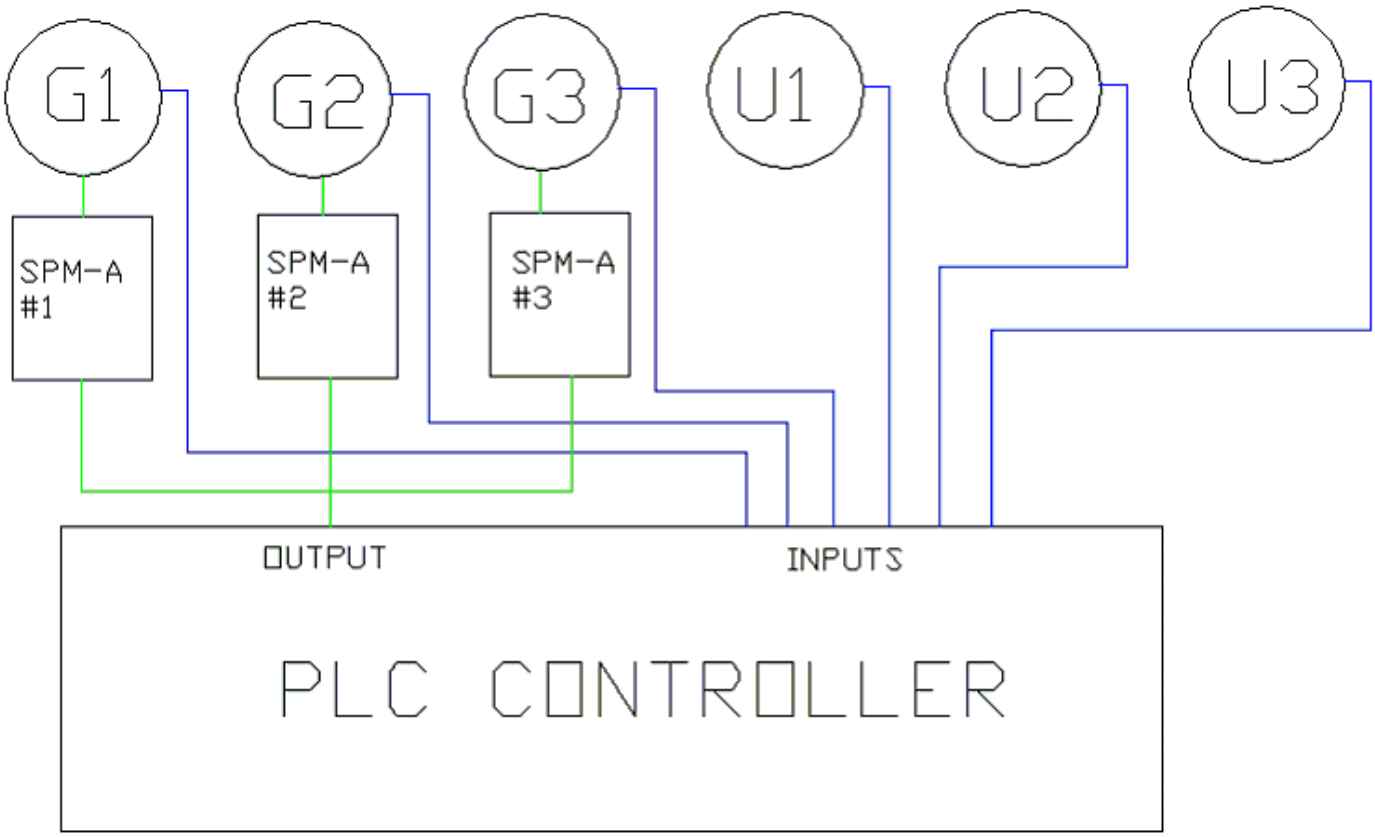

Figure 1 - *PLC Synchronization Control Circuit*

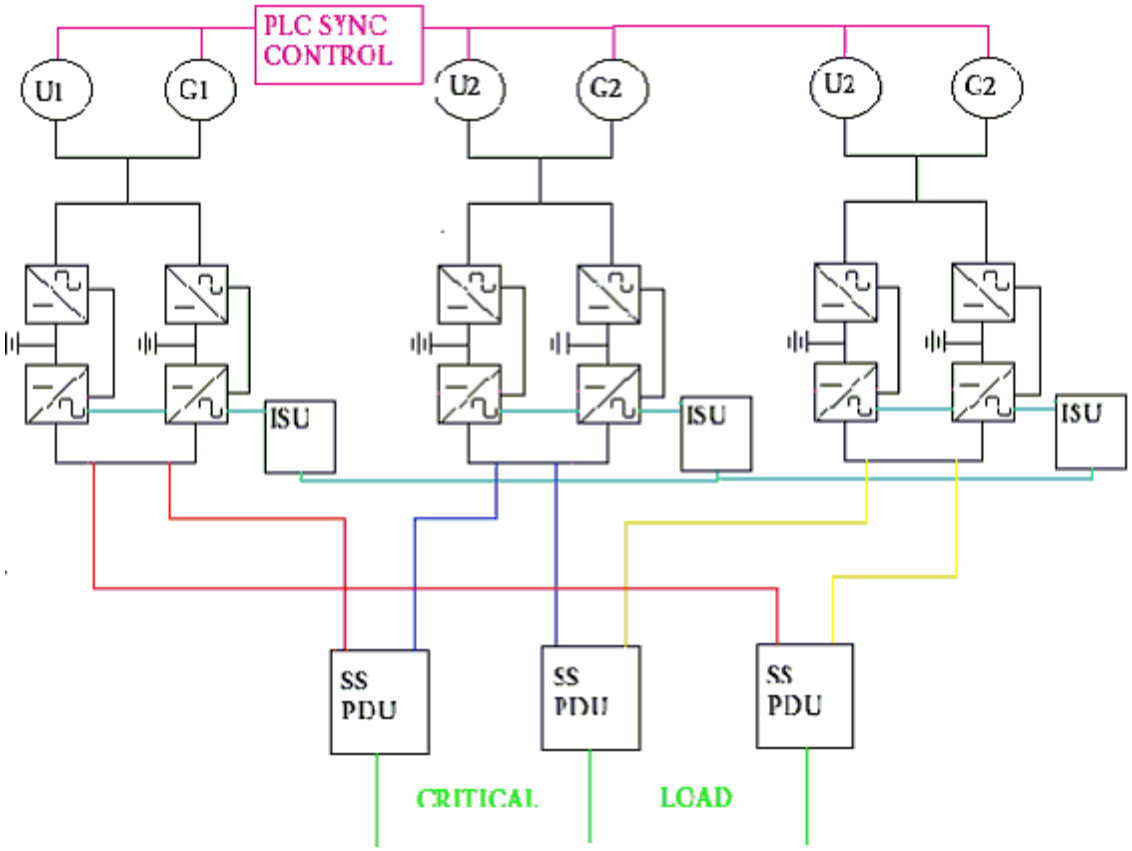

Figure 2 - *Distributed Redundant System Using Generator Synchronization*

Financial benefits to generator synchronization can be found by utilizing peak shaving and cogeneration. These benefits will only increase with the continued strain that is being placed on the utility grid. However, this subject is beyond the scope of this paper.

Conclusion

With today's technology it is possible to hold a distributed generation system in sync with the utility or other generators. This is accomplished using the same technology that allows us to parallel generators and perform closed transition transfers.

Several benefits will be seen when utilizing generator synchronization and Delta Conversion UPS modules in a distributed redundant power system design. Optimum system efficiency, input power factor correction, and less than 5% input current THD. The result will be lower utility bills, improved UPS/generator interaction, and reduced generator and air handler sizing requirements. For the critical power user, the greatest benefit will be the higher availability achieved with a Delta Conversion UPS and synchronized engine generator system.