

The Advantages of the APC UPSync™ Module

By John Collins

Abstract

This application note discusses the fundamental concepts of the UPSync™ system. Many common misconceptions promoted by competitors about APC's ability to synchronize UPS modules are dispelled. The subjects of 2N power distribution systems and power system synchronization are addressed. The various myths are described and criticized. The advantages of the APC design to the end-user or system designer are discussed.

Introduction

APC's major competitors have been actively promoting much industry misinformation about APC's ability to synchronize separate UPS modules and enable operation of downstream automatic transfer switch schemes for hybrid 2N distribution system designs. This application note addresses the APC UPSync™ module and its application, including the benefits to the end user in its application with APC Symmetra MW UPS systems. For more information about APC technologies and products see <http://www.apc.com>.

What is the UPSync module?

APC is the world's largest manufacturer of DC to AC inverters and UPS systems. APC manufactures single module three-phase UPS systems up to 1.6MW (Symmetra MW) and multi-module systems. APC also designs and manufactures customized large inverters and UPS systems for highly specialized applications. The APC UPSync™ module is an installation and operation-friendly synchronization module that allows two Symmetra MW UPS modules or two multi-module Symmetra MW UPS systems to be automatically synchronized to each other.

Figure 1 – APC UPSync™ module

2 U
Front view

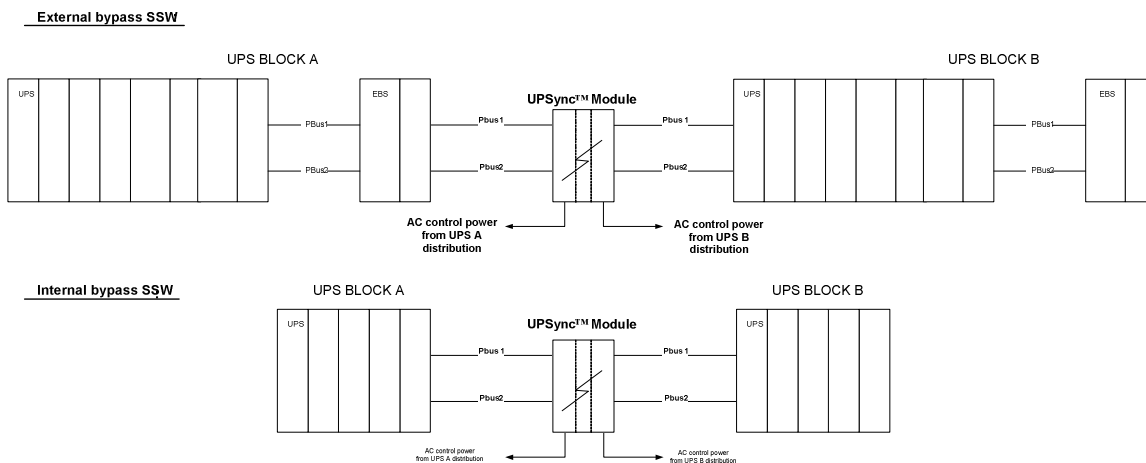


2 U
Rear View



The UPSync™ module is part of APC's InfraStruXure (ISX) pre-engineered solutions set for the Symmetra MW UPS family. The UPSync™ module installs in the same manner as an APC ISX Manager, i.e., an APC field service engineer (FSE) installs it in a customer rack and connects the UPSync power cord(s) to the rack PDU outlet(s). In the case of redundant Symmetra MW modules, as shown in **Figure 2**, the FSE connects four (4) UPSync™ control cables to the Symmetra MW UPS systems' parallel control bus (Pbus) which concludes the installation. There are no switches to set or programming of the UPSync™ module itself. The UPS modules can be located up to 500 meters (1,640 feet) from the UPSync™ module.

Figure 2 – APC UPSync™ installation

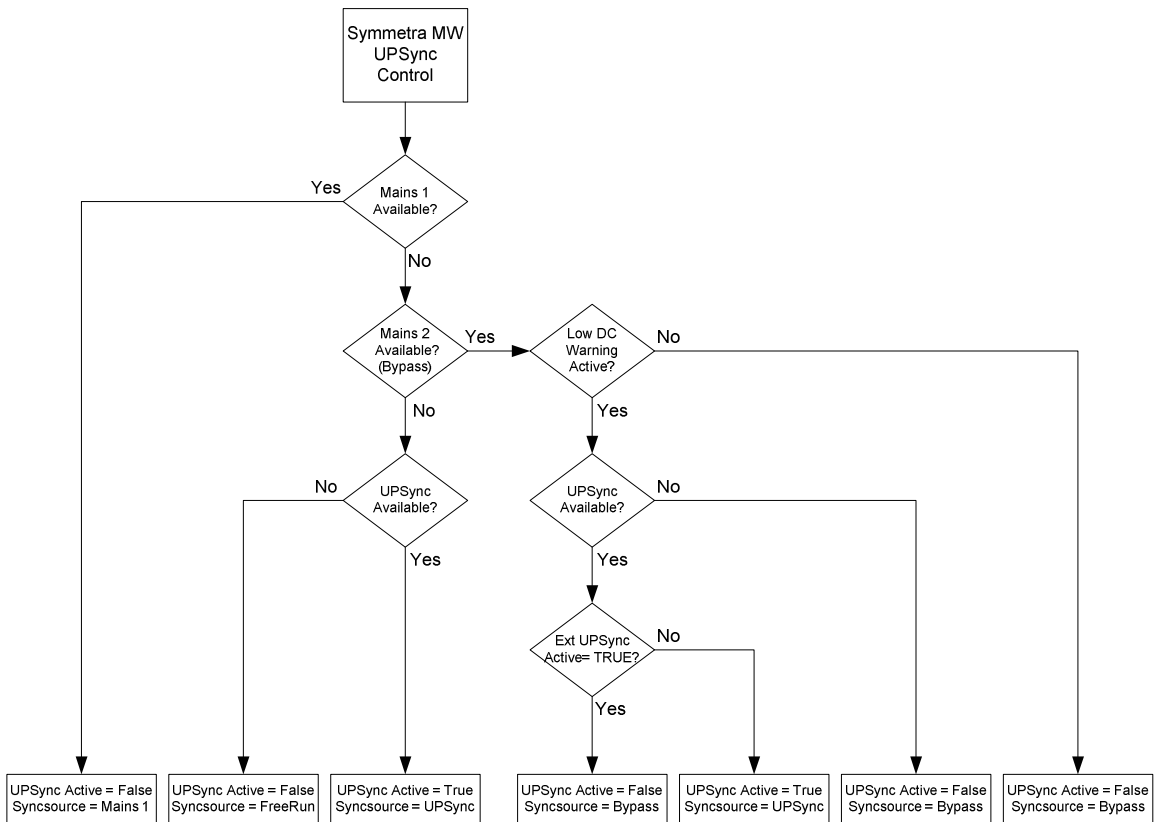


The APC FSE must program the Symmetra MW modules to use the UPSync™ synchronization signal. Once they have been programmed, the UPS modules themselves determine their own synchronization priority.

How does it work?

The UPSync™ module is purely a synchronization information translation box; it does not determine the UPS module synchronization priorities. The UPSync™ module takes the output bus synchronization signal from each UPS module and translates it to the other UPS module as a UPSync™ synchronization signal. It also translates the status of the UPS module synchronization to the other UPS module. Each UPS module uses the logic outlined in **Figure 3** to determine its own synchronization priorities

Figure 3 – APC UPSync™ UPS Module logic process with results



In normal operation where both mains 1 and mains 2 (bypass) are available, each UPS module is synchronized to its mains1 input.

Scenario analysis

The following nine scenarios provide a realistic look at the interactions between the UPSync™ module and the UPS modules.

1. Two modules both run normal operation. Neither module has bypass available. Mains disappear in module A.

Module A will go to battery operation and detect that it cannot synchronize to bypass so it starts synchronizing to module B and sets its UPSyncActive flag = TRUE.

2. Two modules both run normal operation. Neither module has bypass available. Mains disappear in both modules simultaneously.

Both modules will go to battery operation and set their UPSyncActive flag = TRUE. Both modules will then detect that they both have Ext UPSyncActive flag = TRUE and therefore both clear the flag and both start their UPSyncDelay timer. As the timer is very unlikely to expire at the same time in both modules, one will start tracking the other and indicate this by setting its UPSyncActive flag =TRUE. The other module will detect this before the timer runs out and remains free running with the other module tracking it.

3. Module A runs in normal operation, Module B runs in battery operation and is tracking Module A. Neither module has bypass available. Mains disappears in Module A.

Module A will go to battery operation and detect that it cannot synchronize to bypass. It then detects that Module B has the UPSyncActive flag = TRUE set, so it starts free running.

4. Module A runs normal operation, Module B runs battery operation and is tracking Module A. Neither Module has bypass available. Bypass becomes available in Module B.

Module B start synchronizing to bypass mains as it has higher priority and clears its UPSyncActive =TRUE flag.

5. Module A runs battery operation, Module B runs battery operation and is tracking Module A. Neither module has bypass available. Bypass becomes available in Module B.

Module B starts synchronizing to bypass mains as it has higher priority and clears its UPSyncActive flag. Module A detects that Module B has cleared its UPSyncActive flag and starts to sync to Module B and sets its UPSyncActive = True flag.

6. Module A runs normal operation, Module B runs battery operation and is tracking module A. Module A has bypass available. An output short circuit occurs in Module A.

Module A will go to bypass operation and Module B will continue to sync to Module A.

7. Two modules both run in battery operation with Module B tracking Module A. Neither module has bypass available and low dc shutdown occurs in Module A.

Module A's output will go off and Module A sets its UPSyncActive = TRUE flag to ensure that Module B stops synchronizing to Module A. Module B will start to free run.

8. Two modules both run in battery operation with Module B tracking Module A. Module A has bypass available and low dc shutdown occurs in Module A.

Module A will transfer to bypass (dual mains situations) and Module B continues to track Module A.

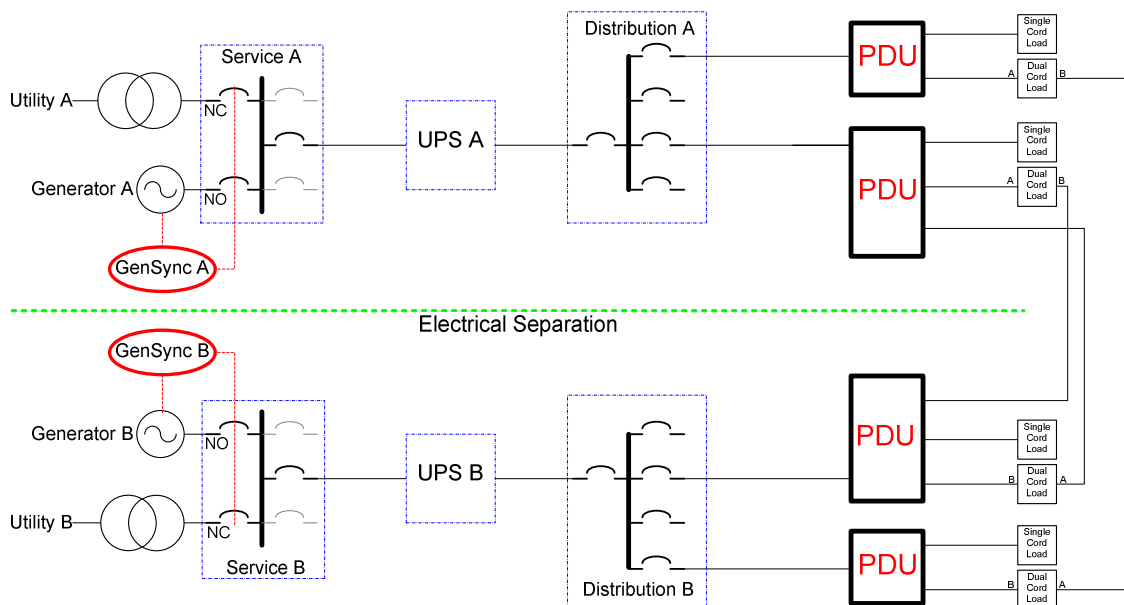
9. Two modules both run in battery operation with Module B tracking Module A. Neither module has bypass available and low dc shutdown occurs in Module B.

Module B's output will turn off but keeps its UPSyncActive=TRUE flag to ensure that Module A does not try to synchronize to Module B.

Why is it needed?

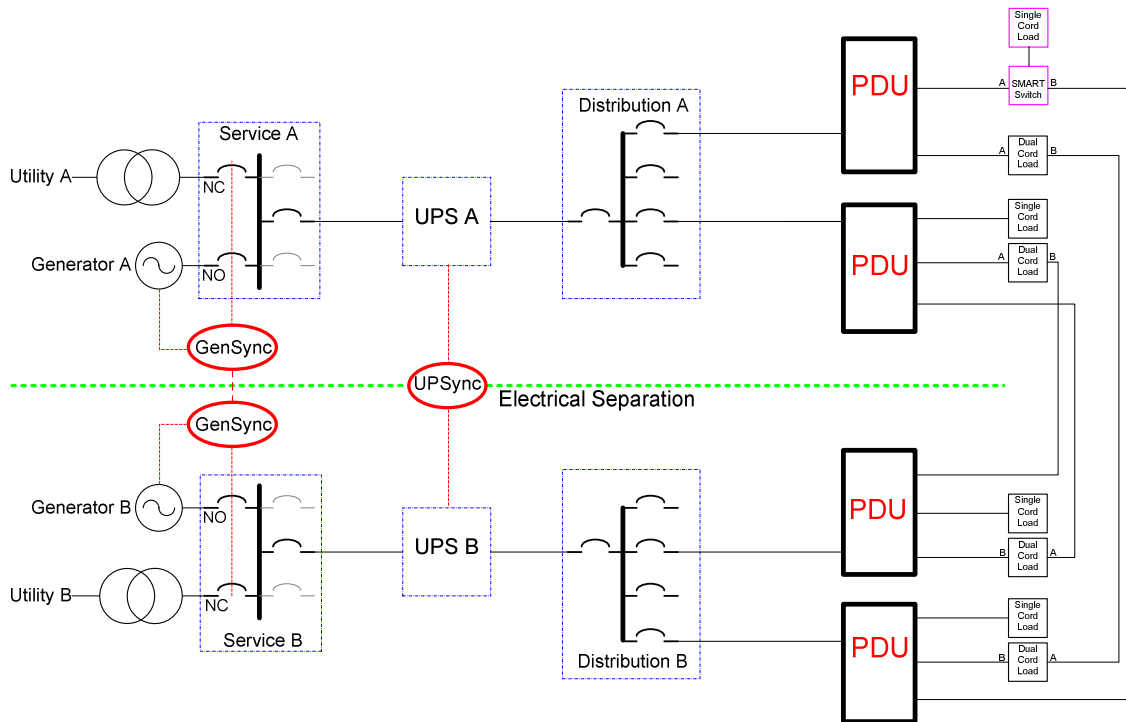
The predominant need for UPSync™ is the hybrid 2N power system. This type of power system uses either automatic static transfer switches or electro-mechanical switches to supply dual power paths to single-corded loads.

Figure 4 – Basic 2N power system with electrical separation to the load outlets



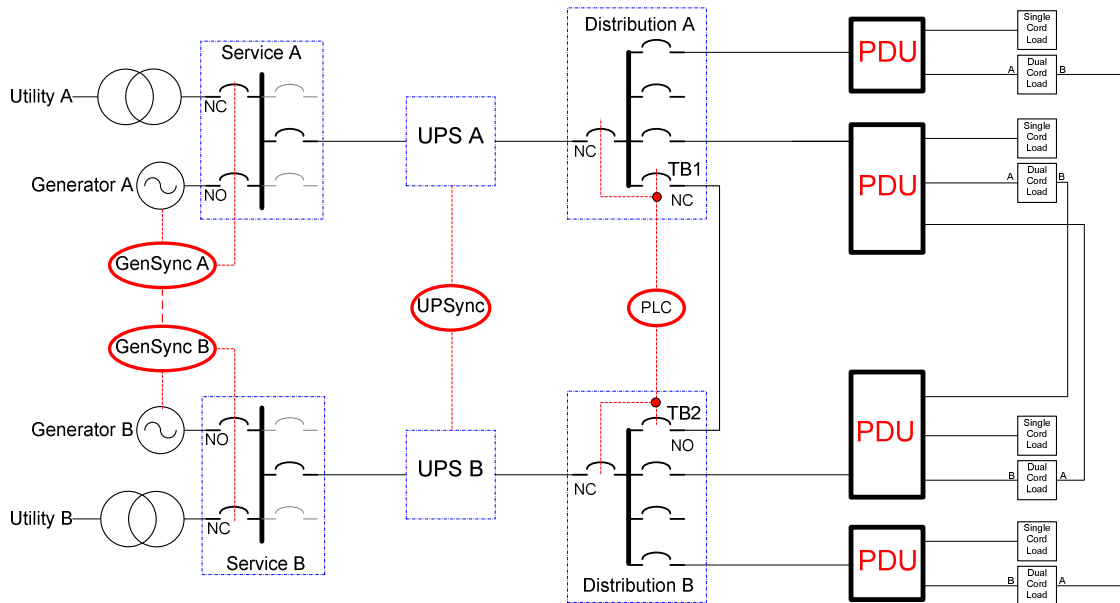
The basic 2N (dual power path) design above in **Figure 4** is the most reliable for powering dual-corded loads. This is due to the electrical separation between the two power paths, where a fault in one path cannot affect the other power path. It also offers the least number of components in the power paths, i.e., least number of links in the power chain, therefore higher reliability. Since single-corded loads can only plug into one of these power paths, an additional piece of equipment must be used to allow single-corded loads to reap the reliability benefits of this 2N design.

Figure 5 – 2N design with A-B transfer switch at the load and power path synchronization



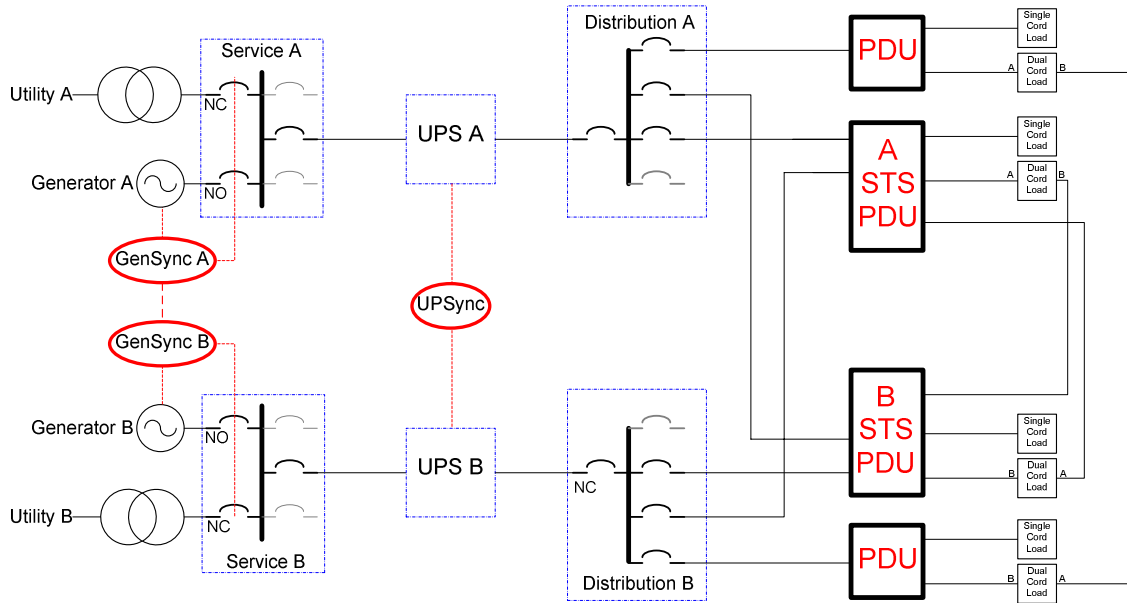
One preferred design is shown above in **Figure 5**. This design uses an A-B transfer switch such as the APC Rack Automatic Transfer Switch to connect the single corded loads. As shown, we can add 100% synchronization to the basic 2N design by using both the APC UPSync™ module and the generators' system synchronization controls (a standard feature on all new generators) i.e., via an external generator sync signal, that originates from one of the generators in order to control the others. As discussed previously, the UPSync™ module's synchronization signals are derived from each UPS module and translated via the UPSync™ module to maintain electrical separation. This allows complete electrical separation between the two power paths.

Figure 6 – Hybrid 2N design with UPS output bus tie



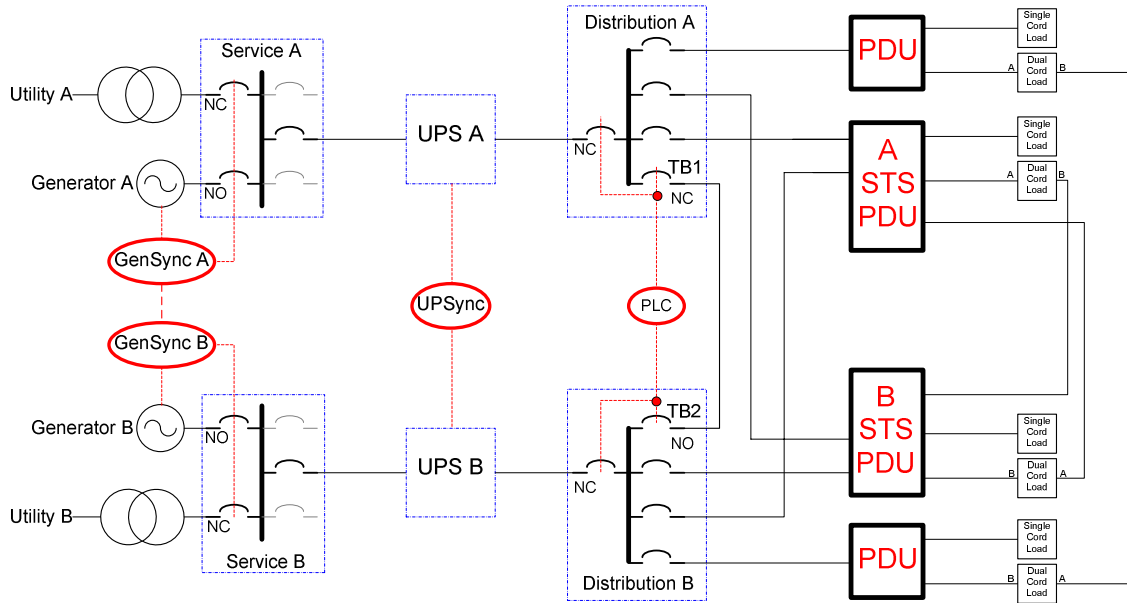
The design shown in **Figure 6** above is a fairly common industry practice. The advantage is that either UPS module can be taken off line without causing disruption to either the A or B inputs at the load outlets. The remaining UPS module can support both the A & B bus loads. This design requires 100% synchronization, i.e., including both the generator and the UPS modules. The primary disadvantage in this design is that the electrical separation is compromised when tie breakers TB1 and TB2 are closed. For example, if UPS Module A is offline for maintenance and the tie is closed, a fault on the Distribution A bus could take down both A & B buses. It's critical that a fault coordination study is done to determine the appropriate circuit breaker coordination settings. Some designs may be manually operated or may utilize a single tie breaker. In any case, the UPSync™ module and the UPS control logic are identical as discussed in the “How Does It Work” section. This is also true of all of the subsequent designs that follow.

Figure 7 – Hybrid 2N design with static transfer switch (STS) PDUs



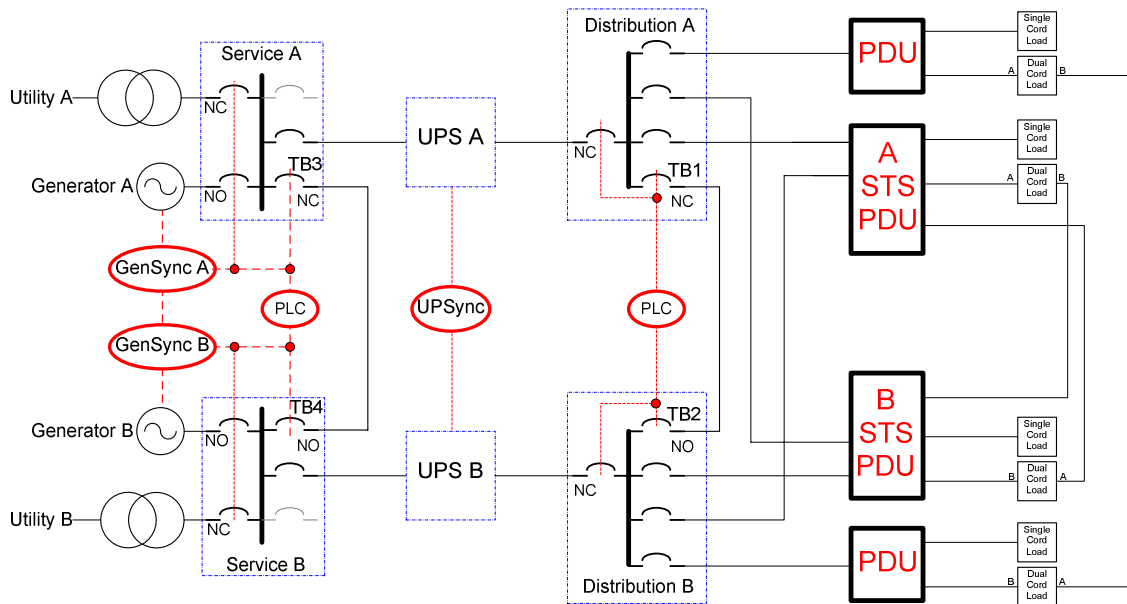
The design in **Figure 7** above utilizes static transfer switches (STS) in the power distribution units (PDU) to supply power to both single corded and dual corded loads. This design also requires 100% synchronization between the A & B power paths. Once again the electrical isolation between both power paths has been compromised, i.e., a single major fault in a STS PDU can affect both the A & B bus.

Figure 8 – Hybrid 2N design with UPS output bus tie and static transfer switch (STS) PDUs



The hybrid design in **Figure 8** above is a combination of the UPS output bus tie and the STS PDUs. The same advantages and disadvantages previously discussed apply here as well.

Figure 9 – Hybrid 2N design with mains bus tie, UPS output bus tie and STS PDUs



The hybrid 2N design in **Figure 9** above, adds the main bus tie which allows power delivery to both UPSs from either service bus. This can be of real practical value in the advent of either an extended outage on one of the utility supplies, a service transformer failure, or a generator failure. However, as with any design, a circuit breaker coordination study is mandatory for security of the design. There are numerous other design possibilities that are not included in this applications note. Please consult with your APC representative for detailed design support.

Please note that in all of these designs, there are no special switch gear modifications, extraneous signals, or communications other than the UPSync™ module required by the UPS modules to maintain synchronization of the A & B output buses. If forced synchronization is desired, it can be accomplished by opening the input circuit breaker(s) to one of the UPS modules, i.e., mains 1 on single input systems or both mains 1 and mains 2 (bypass) on dual input systems.

Conclusion

The APC UPSync™ module offers superior performance, increased system reliability and availability over a typical competitor synchronization system.

- APC's UPSync™ module is application design friendly. It's a single solution that fits all 2N electrical designs which use Symmetra MW modules
- APC's UPSync™ module is installation friendly. It's easily installed by an APC FSE, without modifications to any customer switchgear.
- APC's UPSync™ module is operator friendly: Operation does not require operator intervention to facilitate correct system synchronization.

List of other applicable white papers / application notes.

Application Note #46 – Distributed Generator System Synchronization

About the Author:

John Collins is a Product Line Manager for APC. He is responsible the Symmetra MW product line. John received a Bachelor's degree in Electrical Engineering from University of Rhode Island in 1992 and has been in the UPS industry for 15 years.