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INTELLIGENT PARALLELING AND CIRCULAR REDUNDANCY: TWO TECHNOLOGIES FOR HIGHER UPS EFFICIENCY

Executive Summary

In order to optimize the energy used by an Uninterruptible Power Supply (UPS), Vertiv™ has developed proprietary technologies named **Intelligent Paralleling** for monolithic UPS and **Circular Redundancy** for modular scalable UPS. Both technologies are capable of delivering higher operating system efficiency without compromising reliability and availability.

This white paper will focus on these particular technologies to improve the UPS operating efficiency when the unit is working at a reduced system capacity, which is the typical condition in a data center.

Through the Intelligent Paralleling and Circular Redundancy modes the UPS will automatically adapt and optimize the energy consumption improving the system's efficiency according to the actual load demand.

Intelligent Paralleling

The Intelligent Paralleling technology allows the UPS to optimize the double conversion efficiency when operating at partial load down to very low load percentages, achieving superior cost savings and reducing TCO.

Activating the Intelligent Paralleling mode allows the system to automatically adapt capacity to meet immediate load requirements by measuring the system output current and the real power needed by the load downstream, in order to switch excess units to standby mode, while ensuring continuous system availability. When units are running in an idle state, they are not completely switched off but they still have the inverter control active and synchronized, as well as the DC bus charged in order to be ready to start up in case of load increase. The activation time of idle units is <5 ms and during this quick transitory phase/step, the remaining active units will continue to supply the load without any interruption supporting a temporary overload condition. Obviously, the specific load thresholds and tolerances used by the Intelligent Paralleling algorithm can be customized to meet specific customer requirements in terms of available power, redundancy and reliability levels.

Furthermore, the Intelligent Paralleling mode allows each UPS unit to operate in standby for the same amount of time, ensuring an equal life-span of module components.

Here below in Fig. 1 and Fig. 2 is shown an example of the Intelligent Paralleling mode enabled on the Liebert® EXL model considering 400 kVA units. We can observe that through the Intelligent Paralleling mode, the difference in terms of average system operating efficiency brings a financial saving greater than 2,700 €* over the first year *(*with an energy cost of 0.1 €/kWh and an air conditioning coefficient equal to 20%).*

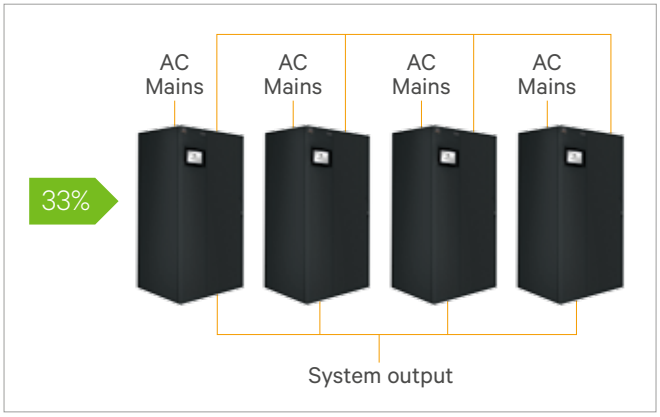

Figure 1: *Liebert EXL Intelligent Paralleling: distributed parallel UPS configuration with four 400 kVA units at 33% load each, achieving overall system efficiency around 95.8%.*

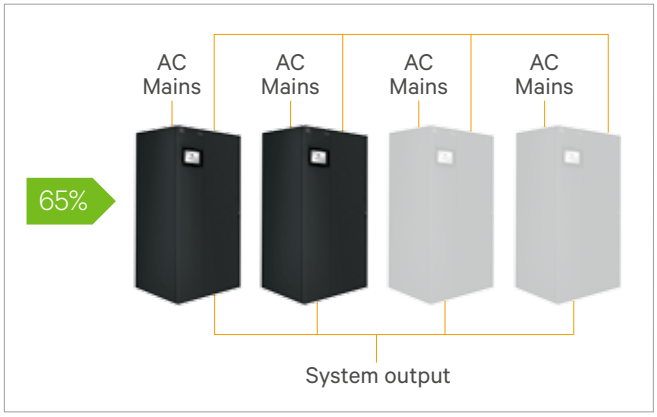

Figure 2: *Liebert EXL Intelligent Paralleling: two 400 kVA units at 65% load each, system efficiency around 96.7%.*

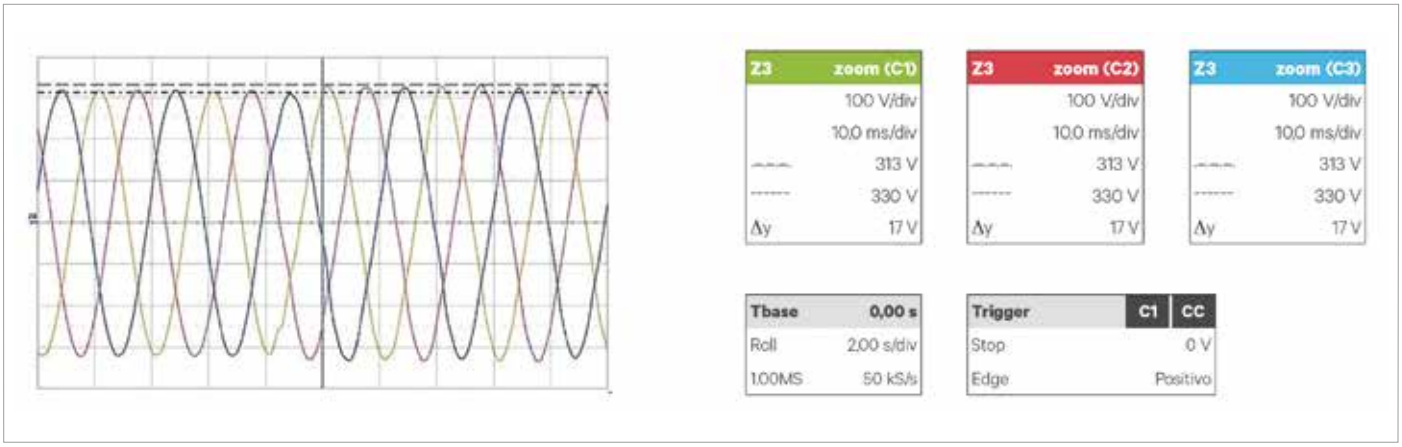

Figure 3: *Waveform of a system made of three (3) Liebert EXL 500 kW after two (2) idle units are activated.*

Circular Redundancy

For modular, scalable UPS such as Vertiv™'s Trinergy™ and the latest Liebert® Trinergy™ Cube, the Circular Redundancy mode works with the same philosophy of the Intelligent Paralleling technology for monolithic units.

Leveraging its modular architecture, the UPS unit defines the necessary number of modules (CORES) to supply the load and sets the remaining CORES in a special idle state, maintaining also the requested level of redundancy.

Similarly to the Intelligent Paralleling mode, also the Circular Redundancy technology ensures that the stand-by CORES have the inverter control active and synchronized, as well as the DC bus charged in order to be ready to start-up in case of load increase. Under this condition the time necessary to have one module activated, while the unit is in Circular Redundancy mode, is <5ms. As previously stated with regards to the Intelligent Paralleling on monolithic UPS, the remaining CORES will continue to supply the load with no interruption when starting-up the sleeping modules, while at the same time addressing specific capacity, redundancy and reliability needs of the critical infrastructure.

It is important to note that Circular Redundancy powers only the minimum number of inverters required at that load level, ensuring a periodic turnover of all the available CORES. Therefore, through an auto-detection feature which monitors the operating time of each module embedded within the UPS algorithm, the idle CORES are rotated in order to ensure the same ageing for all module components part of the system.

For example, in Fig. 3, the Circular Redundancy technology applied on a 1.6 MVA Liebert Trinergy Cube UPS is shown. Compared to a configuration with all CORES in operation, it allows a difference in terms of average system operating efficiency leading to a financial saving greater than 3,200 €* over the first year *(*with an energy cost 0.1 €/kWh and an air conditioning coefficient equal to 20%).*

Figure 4: *Example of Liebert Trinergy Cube Circular Redundancy for a 1.6 MVA UPS system.*

Conclusion

Vertiv's Intelligent Paralleling and Circular Redundancy technologies further improve UPS operating system efficiency at typical load conditions, without compromising system reliability and availability.

Other methods used to maximize system efficiency, as for example running UPS via ECO mode operation, have a very limited scope of application with modern mission critical load types and are not providing any power conditioning to the load downstream. On the contrary, energy saving technologies such as Intelligent Paralleling and Circular Redundancy offer the maximum level of load protection and power conditioning being a real alternative solution to the standard double conversion mode (VFI) or line interactive mode (VI), keeping financial and environmental costs associated to the energy consumption to a minimum optimal value, always in line with the actual load demand.

Within the medium and large UPS product portfolio, Vertiv™ offers different UPS platforms meeting specific customer and installation requirements, including both monolithic T-free and T-based models and modular scalable T-free UPS up to 3,4 MW (see Fig. 4 here below for product details).

All of these products are equipped with energy saving features as Intelligent Paralleling or Circular Redundancy to maximize efficiency at partial load operation to reduce the overall total cost of ownership (TCO).

	Liebert® EXL	Liebert® NXL	Liebert® Trinergy™ Cube
Product Architecture	Monolithic T-free	Monolithic T-based	Modular Scalable T-free
Power Range	100-1200 kW	400-800 kVA	150-3400 kW
Modular Energy saving System	**Intelligent Paralleling**	**Intelligent Paralleling**	**Circular Redundancy**
VFI Efficiency	Up to 96.8%	Up to 94%	Avg. 98.5%(1)
1 Year Saving(2) using the Modular Energy Saving System	>2,700 €	>2,000 €	> 3,200 €
Energy Saving Mode Advantages	• Higher system operating efficiency at partial load • System capacity automatically adapted to the real load requirement • Lower Opex and reduced TCO		

(1) Average operating efficiency as a result of the Liebert Trinergy Cube three functioning modes (VFI, VFD, VI)
(2) Four units/modules in parallel with two in idle state, energy cost 0.1 €/kWh, air conditioning coefficient equal to 20%.

Figure 5: *Vertiv's product offering with Intelligent Paralleling and Circular Redundancy energy saving technologies available as standard.*

Notes:

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