White paper: The impact of leading power factor of blade servers on derating of UPS systems

There is one solution to the power protection challenges posed by mixing new computer technologies with legacy IT equipment

Data centres are dynamic computer environments. In recent years the increasing mix of old and new computer technologies is causing the overall power factor of the computers/servers to shift towards unity. Furthermore with the introduction of powerful blade servers the overall power factor may even become leading.

This server evolution is becoming a big challenge for IT managers as most of the installed legacy UPS systems, with PWM (pulse width modulated) inverter switching, are designed to provide maximum power at lagging power factors. These UPS systems are approaching their kW power limits due to the change of loads from lagging to leading power factors, or may even shift into an overload condition. The majority of legacy UPS topologies that are installed in IT environments experience a typical derating up to 30% compared with modern transformerless topologies.

Power capabilities of UPS topologies with leading loads

Legacy UPS topologies are designed to provide maximum kW power for lagging loads, typically at PF = 0.8. If the load shifts from lagging to leading PF, legacy double-conversion UPSs will derate substantially and hence reach or exceed their rated power. The PWM inverter switching in most transformer-based UPS systems cannot avoid derating when supplying loads with leading power factors. Modern UPS topologies are designed to provide maximum kW power for lagging and leading loads, providing a full kW rating at unity power factor.

Transformerless UPS with adaptive inverter switching experience no derating at unity.

	300kVA Transformerless UPS	300kVA Legacy double -conversion UPS
Power Factor	kW Rating	kW Rating
0.80 lead	231kW	152kW
0.85 lead	249kW	166kW
0.90 lead	270kW	182kW
0.95 lead	285kW	214kW
1.00	300kW	240kW
0.95 lag	285kW	240kW
0.90 lag	270kW	240kW
0.85 lag	255kW	240kW
0.80 lag	240kW	240kW

Figure 1 UPS derating versus leading loads (300kVA)

Figure 1 shows typical values of power versus load power factor for both modern transformerless and legacy UPS topologies. Legacy UPS topologies (300kVA) typically provide 240kW between 0.8 lagging and unity power factor.

Transformerless UPSs (300kVA) typically can provide 240kw through a larger range of 0.8 lagging to 0.85 leading power factors.

Figure 2 shows that the transformerless UPS can provide substantially more power than equivalent legacy UPSs. The 300kVA transformerless UPS provides up to 71kW more power for a 200kW load with with 0.95 leading power factor, or up to 88kW more power with 0.90 leading power factor, than equivalent legacy UPSs. When new data centre power requirements are assessed it is very important to evaluate the power that the specified UPS can provide at leading power factors. The shift to leading power factors gives a clear advantage to transformerless UPS with respect to legacy UPS. Due to the substantial derating of legacy UPS when powering loads with leading power factors, in many cases it will be possible to specify a smaller transformerless UPS against a larger legacy double-conversion UPS.

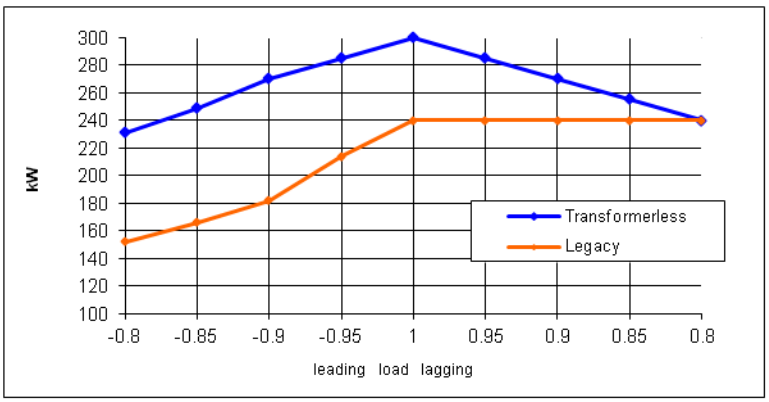

Figure 2 Power (kW) versus power factor

If a legacy UPS is supplying a load with traditional servers and the IT manager decides to introduce blade servers to achieve higher computing density, the power demand will grow and the legacy UPS may reach its power limits or may even be in overload. In this case, there are various ways to overcome the problem.

1. Replace existing legacy UPS with a legacy UPS of higher output power rating. This may cause changes in the power distribution and installation, and is a high cost solution.

2. Add another parallel UPS to the existing legacy UPS. This may cause changes in the power distribution and installation and is a very high cost solution.

3. Replace legacy UPS with a transformerless UPS which provides more power for leading loads. This is a lower-cost solution.

When new data centre power requirements are assessed it is very important to evaluate the power that the specified UPSs can provide at leading power factors. The shift to leading power factors gives a clear advantage to transformerless UPSs with respect to legacy UPSs. Due to the substantial derating of legacy UPSs when powering loads with leading power factors, it will be possible in many cases to specify a smaller transformerless UPS against a larger legacy double-conversion UPS.

Meeting the challenge

Figure 3 shows how two typical UPS topologies cope with blade servers with leading input power factor, which represents a major challenge for legacy double-conversion UPS.

	Transformerless UPS	Typical legacy UPS
UPS Rating	300kVA	300kVA
Effective power at PF = 0.9_{lead}	270kW **(UPS 74% loaded)**	182kW **(UPS 10% overloaded)**
Losses at full load of 200kW (0.9 lead, non-linear)	9kW **(95.5% efficiency)**	25kW **(89% efficiency)**
Generator over-sizing factor	1.5	2.5

Figure 3 Comparison of two UPS topologies' performance in relation to blade servers (assuming a 200kW load and PF = 0.9_{lead})

It should also be borne in mind that, irrespective of the UPS topology, should the UPS system operate in bypass mode, the blade server load with leading power factor will be presented directly to the output of the standby generator — there is a risk that leading power factor loads could result in the generator AVR losing full control of the output voltage. As data centre loads move towards leading power factors the technical advantages of transformerless UPS, particularly in the output power range from 60 to 500kVA become evident.

Uninterruptible Power Supplies Limited is currently involved in the development of data centres where the introduction of blade servers is presenting a challenge. With the company's PowerWAVE Transformerless UPS topology, the data centre manager can respond to most of the power growth demand that cannot always be accommodated by legacy equipment. PowerWAVE Transformerless UPS topology offers these advantages for data centres:

- low derating for leading computer power factors up to PF = 0.9_{lead}
- lower installation costs than those associated legacy UPS
- no need for over-sizing of the generator thanks to low THDi
- less energy loss and less heat dissipation (meaning lower air conditioning costs) thanks to high efficiencies.

Contact

Uninterruptible Power Supplies Ltd
Woodgate
Bartley Wood Business Park
Hook
Hampshire
RG27 9XA

Phone: 01256 386700
Email: sales@upspower.co.uk
Web: www.upspower.co.uk