



## White Paper

### OLDER UPS, NEWER IT LOADS

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As an Independent Service Provider we provide Corrective and Preventive Maintenance Services for a variety of UPS Manufacturers including systems that have been in service for years. These older UPS continue to provide excellent service and value to their users. Since these UPS do continue to provide reliable service, they are not typically replaced (refreshed) at the same rate as the IT loads they so often support. UPS have both kW and kVA nameplate ratings, indicating what they are capable of supplying in continuous operation. These ratings are based upon a specific load power factor, which depending on UPS model can range from .7 lagging all the way to .9 leading. In older UPS however the power factor rating is typically either .8 lagging or .9 lagging. These UPS will operate connected loads with power factors ranging from .7 lagging through 1.0 (unity).

Typically for connected loads with power factors ranging from .7 lagging to the name plate power factor rating of the UPS the full kVA of the UPS is available; however loads with power factors greater than the UPS nameplate power factor rating constrains the UPS to KW rating. Loads with power factors that are leading or below .7 lagging can cause operational instability, including overloads in older UPS. Inadvertently an IT equipment refresh may accidentally cause this instability.

Since the maintenance and supply of power quality products is our own business we are keenly aware of the type of loads these UPS support and the advances in technology that corresponds to these loads, especially with IT applications.

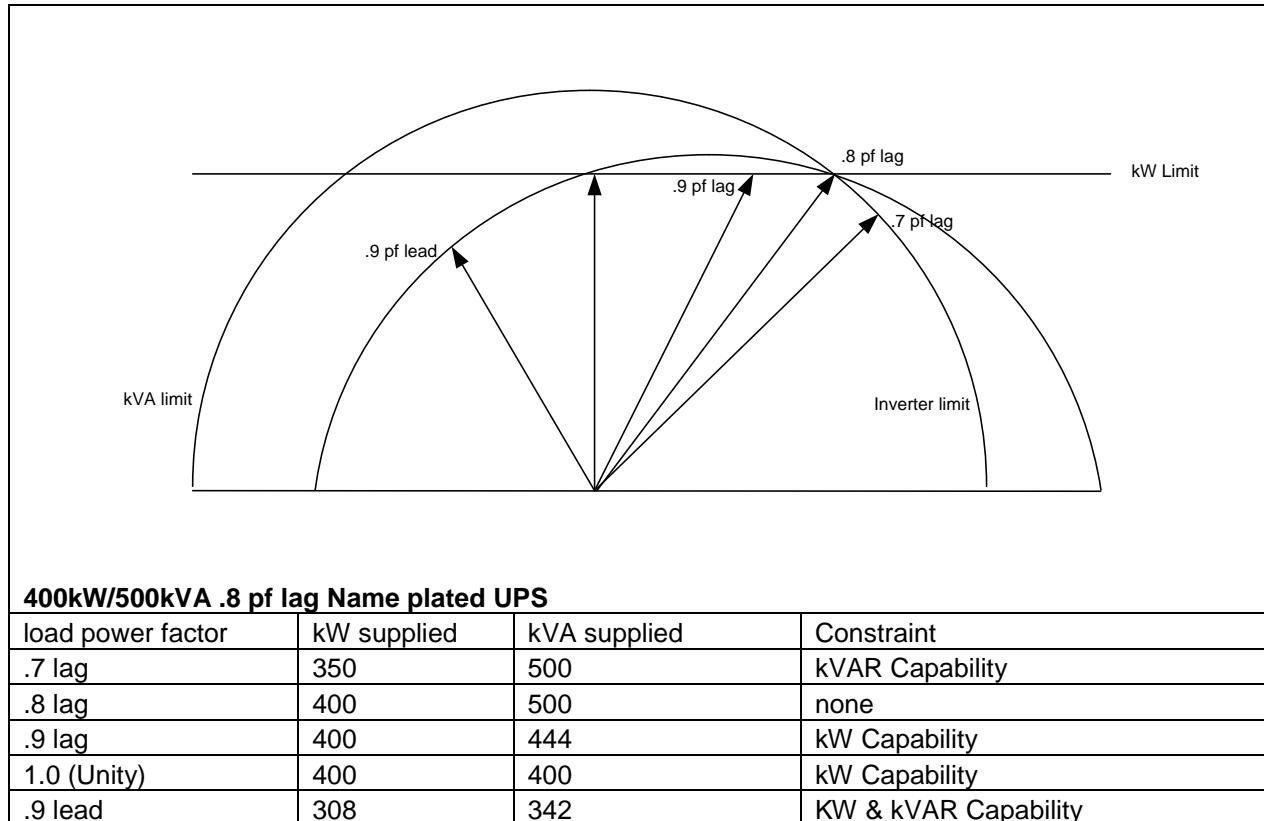
Ever increasing demands for data processing and communications, with corresponding increases in speed is prevalent in almost every data center and network operations center (NOC). Computer technology has rapidly advanced to meet these needs, especially servers, deployed in modular rack systems. For years servers have been powered by switch mode power supplies (SMPS); while these SMPS have many advantages, their original design produced high input current distortion, often as high as 30% THDi and operated with power factors that range from .7 lagging to .9 lagging. This increased demand for servers lead to a critical need to improve the input power characteristics of the SMPS, and today's design has resulted in power supplies with power factor correction (PFC), now typically rated at >.99 lagging at full load (Unity PF Rated) and reduced harmonic distortion typically less than 5% THDi. A consequence of these designs is that at light loads these power supplies often exhibit leading power factors in .9 to .95 range. The increased demand for data processing and communications has also increased the demand for reliability of the IT equipment, and it is increasingly common to employ redundant power supplies in the IT servers, especially in "Blade" configurations, which ensure that the power supplies are less than 50% loaded.

For many years, the load profile of IT equipment had power factors in .7 lag to .9 lag range and as a consequence almost all UPS manufacturers designed their UPS for a nominal kW/kVA rating using .8 lag power factor, with some later adjustment to a nominal kW/kVA rating of .9 lag power factor. (e.g.: 400kW/500kVA or 450kW/500kVA)

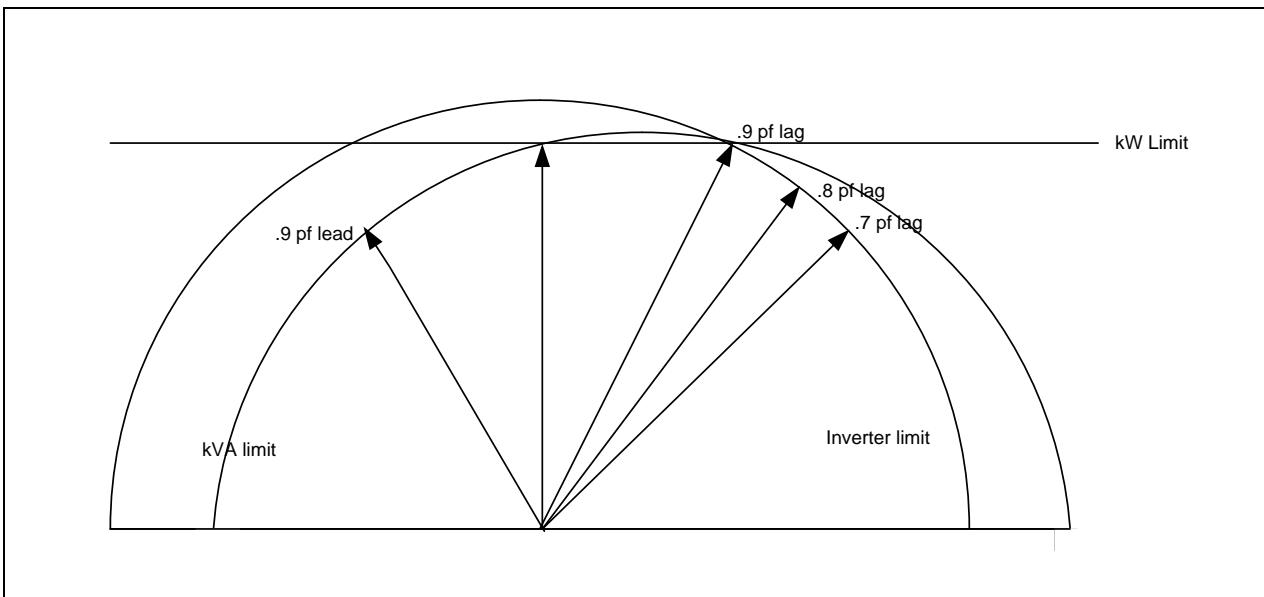
Selection of a load power factor is an important decision in UPS design, especially the inverter section since almost all UPS have an output filter comprised of inductors and large quantities of capacitors. The output filter was designed to build the inverter output into a sine wave and optimized for typical lagging power factor loads, the resulting design utilized a large capacitance, essentially in parallel with the load. Both power switching devices and control techniques have improved and changed through the years (from SCR's to Bi-Polar Transistors to Isolated Gate Transistors) with switching speeds of these components increasing, from as low as 360HZ to as high as 20kHz. Today the requirement for large filter components has significantly reduced and thus today's UPS are optimized to handle these new power factor loads.

## CIRCULAR DIAGRAMS

The first circular diagram illustrates the output capability of a 400 kW/ 500 kVA (.8pf lag) rated UPS. Both the diagram and the chart below indicate how the UPS power delivered is limited dependent upon the power factor of the load attached to it.



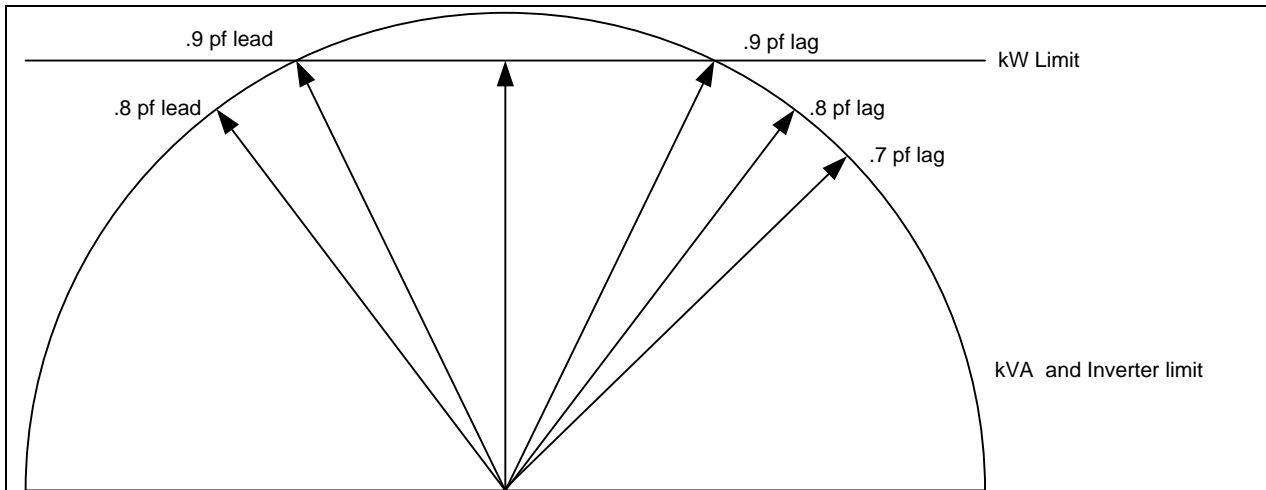
This circular diagram illustrates the slight improvement in power deliver when UPS were rerated to 450 kW/ 500 kVA (.9pf lag). Many time this improvement was done ‘in the field’ when an optional ‘field retrofit kit’ was purchased an installed. While this still offers an improvement compared to .8pf lag UPS it still not capable of handling today’s IT loads well.



#### **450kW/500kVA .9 pf lag Name plated UPS**

load power factor	kW supplied	kVA supplied	Constraint
.7 lag	350	500	kVAR Capability
.8 lag	400	500	kVAR Capability
.9 lag	450	500	none
1.0 (Unity)	450	450	kW Capability
.9 lead	372	413	KW & kVAR Capability

Newer UPS that rated .9pf lead lag do not lose their kW capability as the load starts to move toward a leading power factor.



#### 450kW/500kVA .9 pf lead to .9 pf lag Name plated UPS

load power factor	kW supplied	kVA supplied	Constraint
.7 lag	350	500	kW Capability
.8 lag	400	500	kW Capability
.9 lag	450	500	none
1.0 (Unity)	450	450	kW Capability
.9 lead	450	500	none
.8 lead	400	500	kW Capability

As indicated, there may become a time that your UPS, though still operational, becomes no longer suitable for the load it supports.