



# AI-load tolerant UPS for ultimate power reliability

Tested and validated products:

- Galaxy VX
- Galaxy VL
- Galaxy VXL



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## Background

With the emergence of accelerated compute clusters based on GPUs (Graphics Processing Unit), there is a noticeable deviation on power profiles when these clusters are executing AI (Artificial Intelligence) training workloads to create and fine tune LLMs (Large Language Model) versus when they are executing inferencing workloads or other high computationally demanding workloads. This AI training power dynamic profile has been characterized at the server level (power input to the single server) but less has been written on these impacts as multiple servers are operated as synchronous clusters and how this power dynamic will ripple back through rack, cluster, Power Distribution Units (PDUs), Uninterruptible Power Supplies (UPSs) and Genset/Utility power profiles.

The dynamic power nature of a GPU accelerated compute cluster running AI training workload as characterized by the following profile:

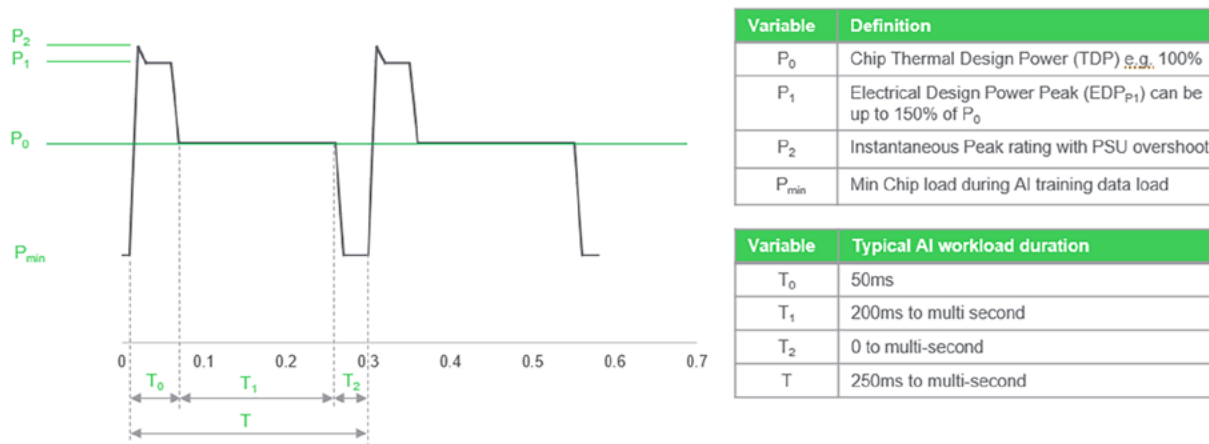


Figure 1 Characteristics of the AI Load profile in time domain

There are three key elements that all UPS and power trains must be properly rated and sized for.

1. The UPS must be sized such that its full load rating is greater than  $P_0$
2. The UPS must be tolerant of the instantaneous peak power bursts ( $P_1$ ,  $P_2$ ) without use or degradation of batteries, and lower than the limit for entering bypass operation
3. The UPS must tolerate the dynamics occurring at a fast rate as indicated by repetitive period  $T$  (typically on the range of 0.5 second to multi-seconds)



# AI load tolerant UPS ratings

The Schneider Electric robust UPS design is well suited to handle overload conditions and thus support AI loads. It is based on power topology with multiple AC/DC and DC/DC converters with peak shaving capability to operate with simultaneous AC and DC sources to support dynamics and peak levels of typical AI Load levels and going above nominal UPS rating.

AI Load tolerant Galaxy V UPSs have been validated in our labs by simulated load dynamics based on representative GPU load profiles and expected peak levels in next generation of GPU's. During testing, our UPS mainly operated in its PFC (Power Factor Correction) input stage to optimize the data center sizing, while the peak of the dynamic load was absorbed by the battery, ensuring it remained within a SOC (State of Charge) of 100%.

Schneider Electric's typical Galaxy V AI load tolerant UPS electrical design is based on following electrical key parameters:

- Load crest factor up to 3
- 110% steady state continuous overload capacity in double conversion mode
- "Instantaneous" load step rated from 0% up to 100% load without loading the battery
- 150% overload capability in double conversion mode for 1 min
- Typical Galaxy V UPS dynamic behavior is demonstrated in table 1 below, to be adjusted accordingly to the UPS selected as well as the customer application

Load Zone	Peak Load Level $T_0 = 100\text{ms}$	UPS Operating Mode			Recommended Battery Technology
		eConversion	Double Conversion	On battery	
Level 0	0 % ... 100 %	No limitations	No limitations	All Peak load levels supported with energy supplied by battery	Li-ion or VRLA
Level 1	100 % ... 110 %	Changes automatically to double conversion	Peak support and no use of batteries <sup>1</sup>		Li-ion or VRLA
Level 2	111 % ... 123 %		Peak support with incidental use of batteries to manage internal dynamics		Li-ion <sup>2</sup>
Level 3	124 % ... 150 %		Peak support and operationally use the battery to "make up" for PFC input stage power limit capped at 123%  Above 150% peak is on the limit of transferring to bypass operation		Li-ion <sup>2 &amp; 3</sup>

Table 1 Demonstrated Galaxy V UPS behavior.

For all peak load level conditions shown in the table 1: UPS is operating in double conversion and battery mode, with ensuring the output performance according to VFI-SS-11 classification from IEC 62040-3. According to VFI-SS-11, best performance for critical loads are ensured without interruptions.

<sup>1</sup> Schneider Electric's typical Galaxy V, AI load tolerant UPS electrical design is based on 110% continuous operation within double conversion. Table represents typical AI Loading curve within double conversion operation mode.

<sup>2</sup> Operating above the 110% peak load levels are recommended with Li-Ion or other high cycle battery technologies. The partial use of battery energy during peak dynamic regulation introduces battery micro discharge/charge cycles and for repetitive peak support, lead-acid battery technology in general is not recommended.

<sup>3</sup> For the UPS capability to maintain 100% battery SoC and battery degradation is dependent of period cycle time and lifetime repetitions that we suggest to further validate for the final customer application based on estimated loading curves with specific application.

Operating with peak levels higher than 100% is handled by UPS configuration for presence of alarms and warnings.

AI dynamic load is also supported by eConversion mode with same best in class output performance according to VFI-SS-11 classification. In eConversion mode supported peak load levels is limited to a maximum of 100%. At higher peak load levels the UPS will exit eConversion and change to double conversion mode without any interruptions to support the peak load levels listed in table 1.

# UPS sizing and specific impacts

UPS must always be sized so AI workload level P0 is within the nominal UPS rating, see figure 1.

For many AI data center solutions, the load capacity requires parallel UPS configuration either configured as N+0 or with N+1 UPS redundancy. Table 2 is showing examples of different UPS configurations and peak levels seen by individual UPSs as well as expected lifetime impact in typical application and loading curves. This table can be used by data center operators and designers to understand how the AI tolerance is enhanced when used in various N+1 configurations when all UPSs are in operation. This helps planning in operations, particularly in understanding that while battery life may be impacted with Level 3 mode when a UPS is off-line, this is generally a temporary situation, and any impact can be minimized with planned operations. In all modes in table 2, the output is properly supported according to VFI-SS-11 classification (IEC 62040-3).

Table 2 example of different UPS configurations and respective P1 Peak level support by individual UPS and battery.

UPS Configuration		Peak Load Level Support by individual UPS and battery			Expected Battery Lifetime Impact
		Level 1	Level 2	Level 3	
N + 0		110 %	123 %	150%	Possible battery lifetime impact to be further evaluated based on actual AI load curves and application
N + 1	4 + 1	88 %	98 %	120%	No battery lifetime impact except during loss of UPS redundancy
	3 + 1	83 %	92 %	113%	
	2 + 1	73 %	82 %	100%	
	1 + 1	55 %	62 %	75%	

## Conclusion

Galaxy V UPS robust designs are well suited to support dynamic AI loads when properly applied. In most redundant configurations, the UPS will operate well within its overload capability, stay online, and have minimal impact on the batteries.

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If you want to know more about Galaxy V Series visit:  
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