Highly Efficient, scalable, fault-tolerant power protection for large facilities, data centers and mission-critical applications

4-Level Inverter UPS

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4-Level Inverter Galaxy VM-VX Power Topology

Galaxy VM is based on modern transformer-less double-conversion topology:

This offers multiple **advantages** compared to “legacy” **transformer-based** solutions:

- Increased efficiency (96% at 30% load)
- Reduced footprint and weight
- Low input distortion (THDI)
- Generator friendly
- Longer & flexible battery (Li-Ion, NiCd, Lead Acid)

NEW Galaxy VM-VX Patents:
- 7,688,048
- 7,806,711
- 8,007,301
- 8,008,809
- 8,072,761
- 8,344,551
- 8,385,091
- 8,546,689
Benefits: 4 Level Inverter UPS reduces switching losses and increase reliability

**4-level conversion Technology**

This reduces switching losses and improves efficiency:
96% at 30% Load

**Benefit:** Reduced operational costs, smaller foot print

**Benefit:** Higher Reliability due to the reduced switching stress of each IGBT.

Competitor update

Most UPS manufacturers have already changed from simple (legacy) 2-level technology to more efficient 3-level converter technology.

Galaxy V-Series offers even further reduced switching losses and significantly less IGBT voltage stress by its **(patented) 4-level converter technology.**
How does it work – 2-level

2-level Inverter:

“Switching Voltage” = 100% * Vbus (e.g. 900V)
=> High switching loss.
How does it work – 3-level

3-level Inverter:

"Swichting Voltage" = 50% x Vbus (e.g. 450V)
=> Lower switching loss.
How does it work – 4-level

Upper Valve Voltage

AC Output Voltage

Lower Valve Voltage

Galaxy VM 4-level Inverter:

“Switching Voltage” = 33% x Vbus (e.g. 300V)
=> Lowest switching loss.
Galaxy VX Benefits: 4-Level Inverter reduces switching stress

2 Level Inverter

Switching voltage across the IGBTs: Full VDC across inverter = (480VDC x 2)

960V switching voltage

3 Level Inverter

Switching voltage across the IGBTs: ½ Full VDC across inverter = 1/2 (480VDC x 2)

480V switching voltage

4 Level Inverter

Switching voltage across the IGBTs: 1/3 Full VDC across inverter = 1/3 (480VDC x 2)

320V switching voltage
A second but very important advantage by reduced IGBT voltage stress is that it practically eliminates all known (over)voltage-related IGBT failures caused by:

- Switching transients, radiation impact (SEB : Single Event Burnout) bus over-voltages from grid voltage swells etc.

This increased design margin = increased reliability.  

Example of IGBT failure rate voltage stress dependency:

![Graph showing the relationship between voltage stress and probability of failure.](http://powerelectronics.com/mag/709PET21.pdf)

- 75% voltage stress on a 600V device: 3-Level Inverter
- 50% voltage stress on a 600V device: 4-Level Inverter

Fig. 3. These TO-247 MOSFET or IGBT failure rates at 100°C reveal the strong dependency of SEB on voltage stress.

Galaxy VX Benefits: ECOnversion Mode – How does it Work?

ECOnversion mode™

ECOnversion Mode

- Primary power path is through static bypass switch
- Inverter is ON, synchronized and parallel with static switch
- Bi-directional Inverter is charging the DC Bus, batteries charge
- Inverter acts as PFC
  - Corrects power factor
  - Filters harmonics
- If power to bypass is interrupted, Inverter seamlessly powers load
  (no break in output power)
- Bypass Switch SCRs can be controlled like ‘diodes’
  - Upstream faults can be mitigated by allowing current in one direction only (current flow to load)
Features at a glance

- **High efficiency in Double Conversion mode**
  - 96% efficiency at 30% load

- **Scalable**
  - Increase power capacity as needs grow
  - Add internal redundancy

- **Multiple Operating Modes – Optimize efficiency**
  - Double conversion Mode
  - ECOnversion Mode
  - ECO Mode

- **Modular, redundant design**
  - System scales using 250kW Power cabinets
  - Cabinets can be added after initial installation to allow for load growth or increased redundancy

  - Redundant cooling fans, swappable without transfer to bypass
  - Robust Static Bypass Switch, 125% continuous load rating

- **Flexible**
  - Single and Dual feed
  - Top and bottom cable entry, no additional hardware
  - Adjacent or Remote Maintenance Bypass Cabinet

Flexible energy Storage Options
- Lead Acid
- Flywheel
- Li ION
- NiCd

- **Facility Friendly**
  - 7-inch LCD touch screen provides graphical overview of systems layout, status, alarms, and event history

  - Input power factor corrected, limiting impact on facility infrastructure