

4-Level Inverter UPS

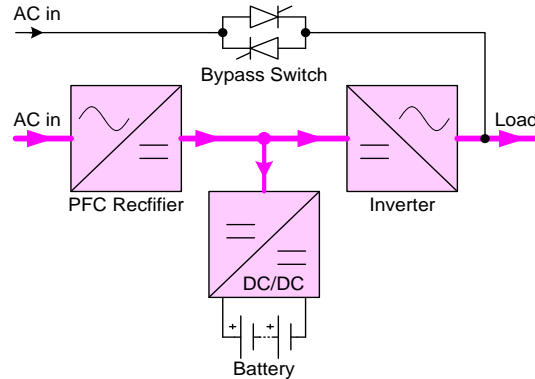
*Highly Efficient, scalable, fault-tolerant
power protection for large facilities, data
centers and mission-critical applications*



Presented by: Carsten Baumann

4-Level Inverter Galaxy VM-VX Power Topology

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



NEW Galaxy VM-VX
Patents:

•7,688,048

•7,806,711

•8,007,301

•8,008,809

•8,072,761

•8,344,551

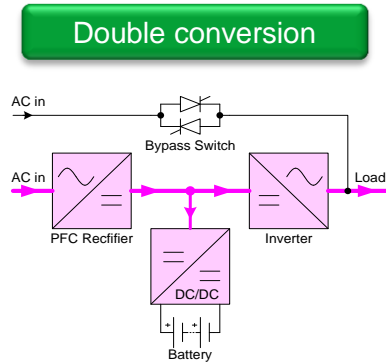
•8,385,091

•8,546,689

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)

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

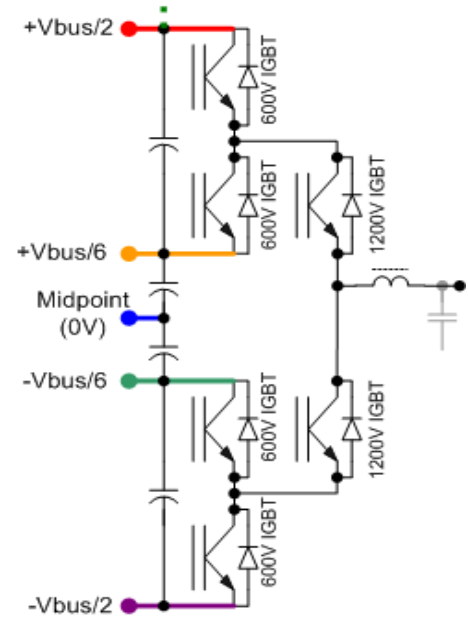
Benefit: Higher Reliability due to the reduced switching stress of each IGBT.

Competitor update

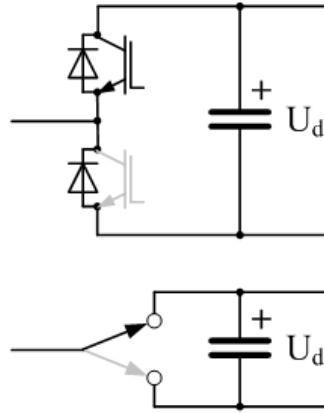
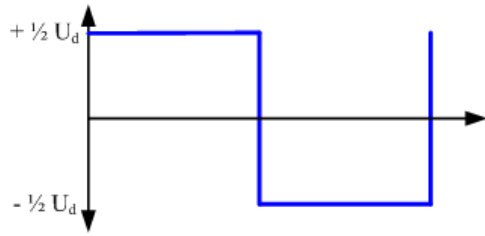
Most UPS manufacturers have already changed from simple (legacy) 2-level technology to more efficient 3-level converter technology.

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

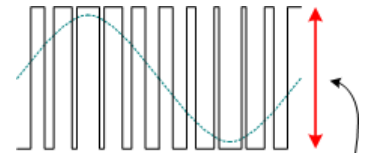
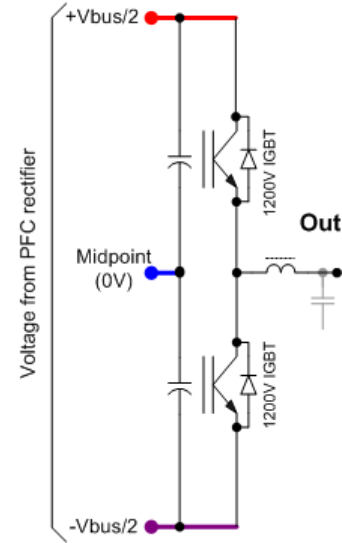
4-level Inverter:



How does it work – 2-level

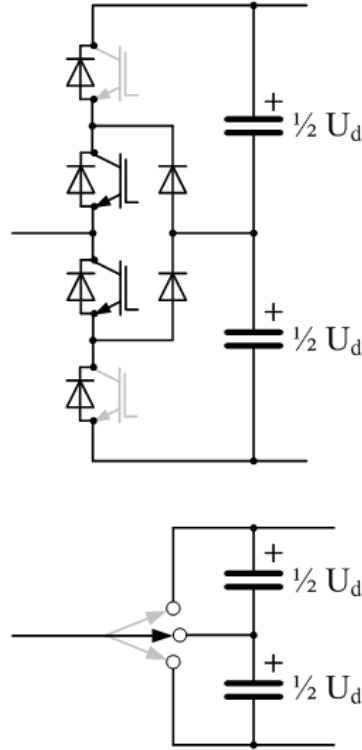
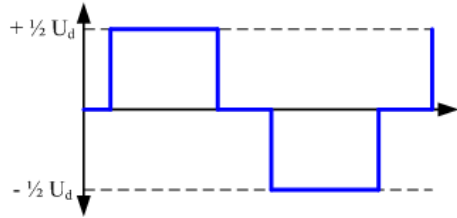


2-level Inverter:

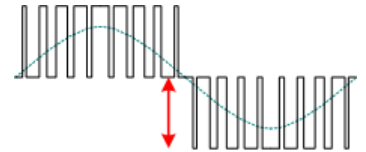
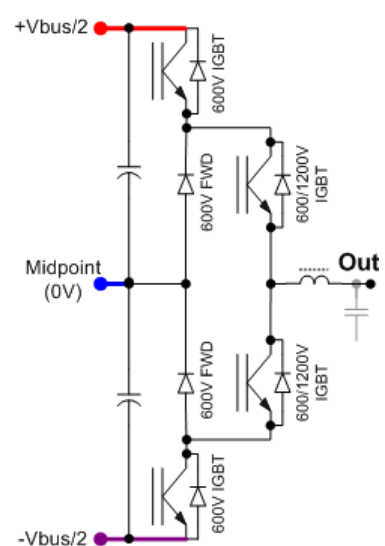


"Switching Voltage" =
 $100\% * V_{bus}$ (e.g. 900V)
=> **High switching loss.**

How does it work – 3-level

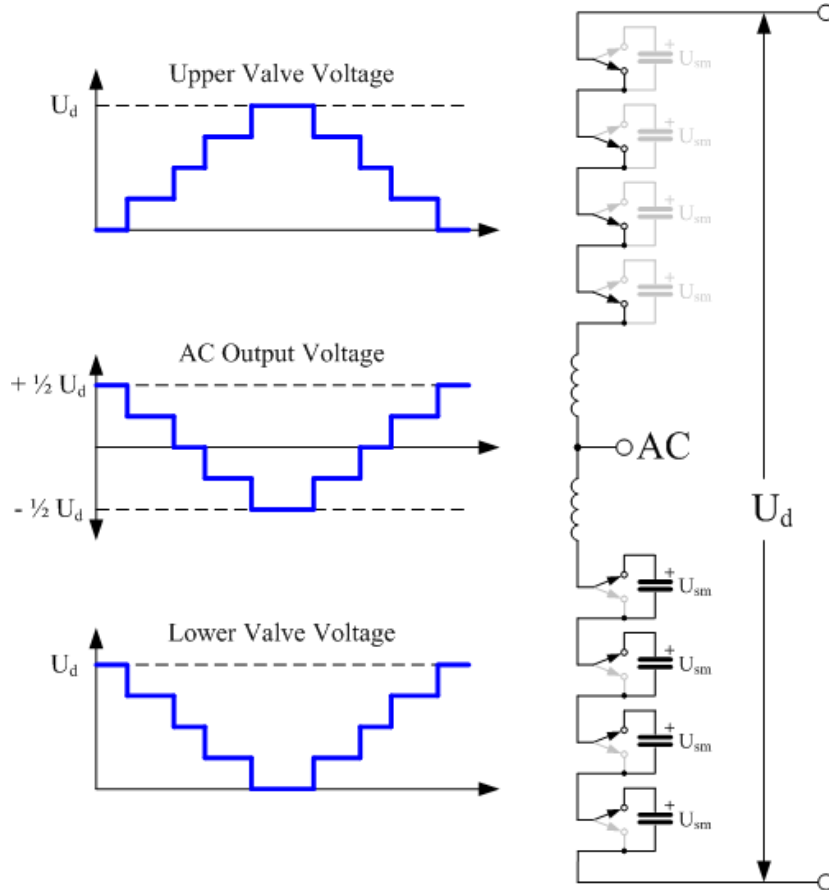


3-level Inverter:

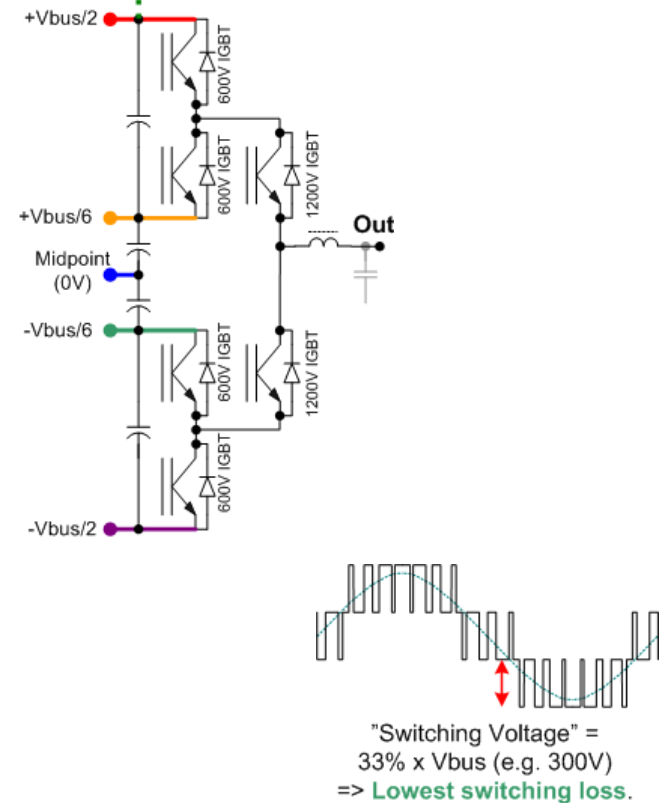


"Switching Voltage" =
50% x V_{bus} (e.g. 450V)
=> **Lower switching loss.**

How does it work – 4-level

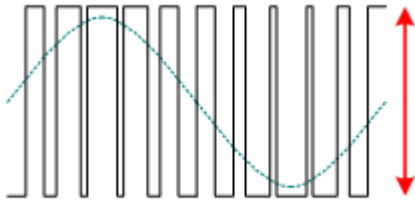
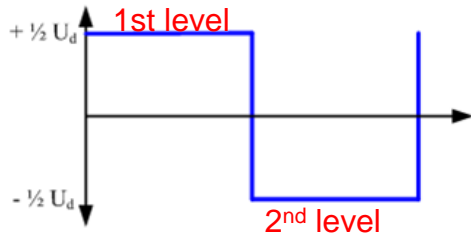


Galaxy VM 4-level Inverter:



Galaxy VX Benefits: 4-Level Inverter reduces switching stress

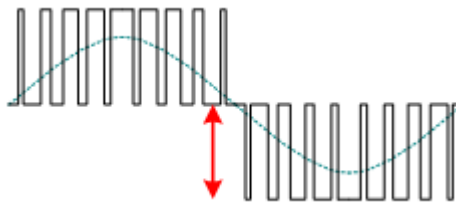
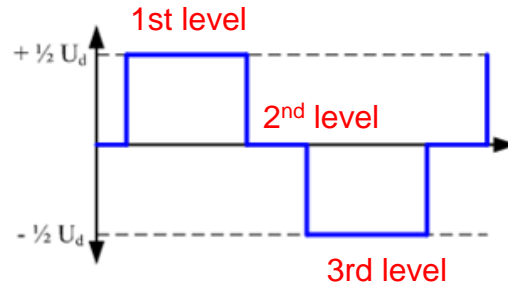
2 Level Inverter



Switching voltage across the IGBTs: Full VDC across inverter = $(480\text{VDC} \times 2)$

960V switching voltage

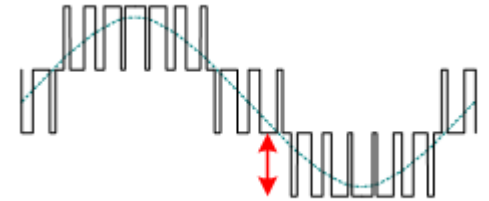
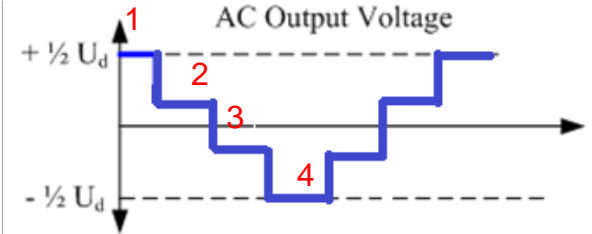
3 Level Inverter



Switching voltage across the IGBTs: $\frac{1}{2}$ Full VDC across inverter = $\frac{1}{2} (480\text{VDC} \times 2)$

480V switching voltage

4 Level Inverter



Switching voltage across the IGBTs: $\frac{1}{3}$ Full VDC across inverter = $\frac{1}{3} (480\text{VDC} \times 2)$

320V switching voltage

4-Level Inverter based UPS push IGBT reliability below the chart

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:

Probability of Failure

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

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

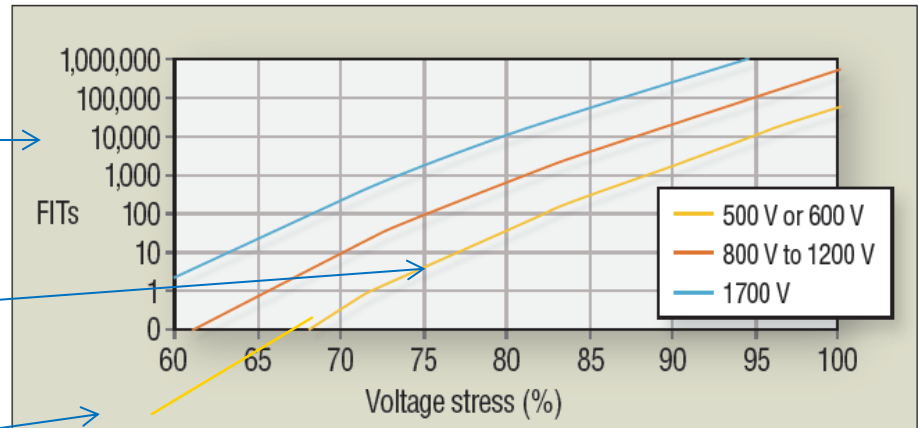
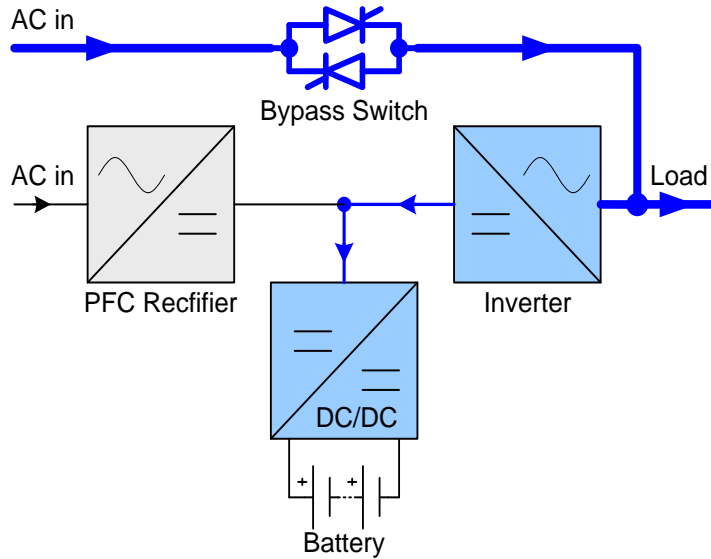


Fig. 3. These TO-247 MOSFET or IGBT failure rates at 100°C reveal the strong dependency of SEB on voltage stress.

Source: <http://powerelectronics.com/mag/709PET21.pdf>

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)

Life Is On

Schneider
Electric

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
- ECO Conversion 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