

Power Electronics Bundling Quiz 1

Power converters

Power converters are currently experiencing strong development due to the ever-increasing demand of energy. Lowering their cost, reducing their overall size, and achieving better efficiency are key requirements when developing new power converters.

Power semiconductor components are critical in achieving these new requirements. The benefits provided by these components are subject to certain constraints. For example, they operate at extremely high frequency, the heat they generate has to be dissipated, and they need to be protected against catastrophic failure.

There are four types of power converters:

- Rectifiers (AC to DC)
- Inverters (DC to AC)
- Choppers (DC to DC)
- Cycloconverters (AC to AC)

The most commonly used semiconductor for power converters is the Insulated Gate Bipolar Transistor, or IGBT. IGBTs offer:

- Ease of control (voltage gate drive)
- High frequency operation
- Large range of power (voltage and current ratings)
- Availability from various manufacturers

Question 1: Since an IGBT can work at high frequency, what needs to be limited when wired in a power converter?

- A. Wiring resistance
- B. The capacitor DC bank
- C. Stray inductance

Explanation

- With high switch frequency, any small parasitic inductance—or stray inductance—will create overvoltage when the IGBT is turned off.
- This overvoltage will increase IGBT's watt losses, but could lead to IGBT failure if the overvoltage is higher than its blocking voltage characteristic.

Question 2: Since an IGBT can cover a large range of power, what else needs to be limited when used in a power converter?

- A. The size of the capacitor bank
- B. The IGBT junction temperature
- C. The size of the heat sink

Explanation

Semiconductor devices like (but not limited to) IGBTs need to have strict control of the junction temperature or wafer temperature.

Today, the maximum operating junction temperature varies between 125°C to 150°C. Any junction temperature above this will result in certain catastrophic failure due to a shorted component.

Question 3: Since an IGBT can experience catastrophic failure, what else needs to be limited when used in a power converter to keep downtime and repair costs as low as possible?

- A. IGBT housing size
- B. IGBT housing rupturing
- C. The number of IGBTs installed

Explanation

Catastrophic failure is fact. When it occurs, the main goal is to contain it inside the IGBT housing (or case). This will avoid the propagation of the fault to surrounding components, thus limiting maintenance costs and downtime and making the power converter safer.

Question 4: What key surrounding components make an IGBT safer to use and maintain in operation?

- A. Fast-acting fuses
- B. Heat sinks
- C. Bus bars
- D. All of the above

Explanation

Fast-acting fuses will protect an IGBT against catastrophic failure by containing the fault within the housing.

Well-engineered heat sinks will limit IGBT junction temperature under the maximum operating value published by IGBT manufacturers.

Laminated bus bars will limit the stray inductance, thus limiting overvoltage during turn off.

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Power Electronics Quiz 1 (continued)

In Summary

Mersen is the go-to player for power electronics applications and has developed solutions to serve that market. Some examples of the uses of power converters are:

- ...in photovoltaic and wind energy systems, where power converters transform the source current and voltage waveforms before the energy is transferred to the grid
- ...in rail transportation, where power converters manage and supply energy to train motors and collect energy generated at braking
- ...in variable speed drives for controlling electric motors in industrial or commercial facilities

Mersen already has a key role in power converters. Mersen is well known as an expert in electrical protection, with industry-leading products that can improve efficiency and reliability. Mersen offers:

- Fast acting fuses that protect IGBTs against catastrophic failure by limiting the let thru energy under the max IGBT's housing rupturing energy

- Cooling devices that provide thermal protection for semiconductor components while enabling heat to dissipate
- Laminated bus bar that plays a key role in power converters, and laminated and insulated bus bar that provides connection between various components, limits parasitic inductance, and eases assembly and integration, leading to an improvement of the overall power converter reliability, performance, and efficiency while minimizing assembly costs
- A power electronic specification team that will help to select the right fast acting fuse, bus bar, and cooling device—one Mersen contact to help you select three critical components for your power converter application!

Additional Resources

- Power Electronics Brochure
- Cooling of Power Electronics Solutions Guide
- R-Tools 3D Heatsink Thermal Modeling Tool
- Select-A-Fuse® for Power Electronics, Version 4.2