System Solution Guide - Preview

Industrial Motor Drive

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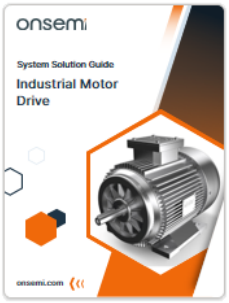

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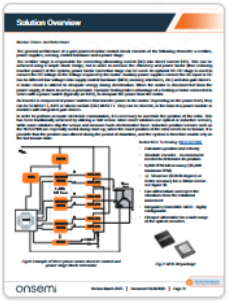

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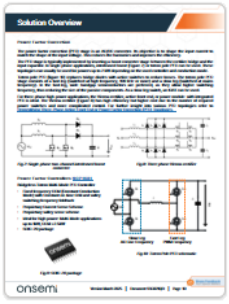

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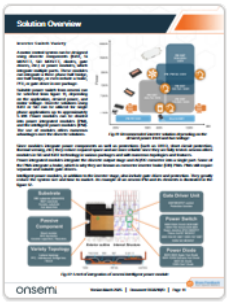

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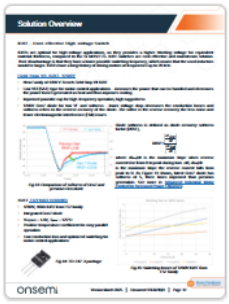

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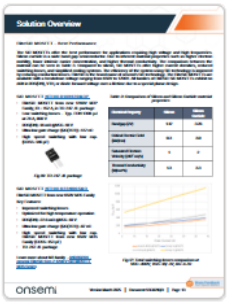

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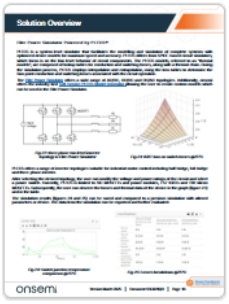

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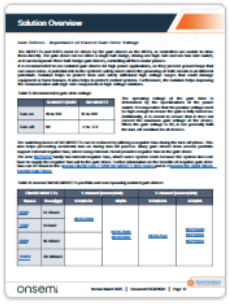

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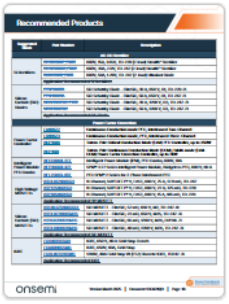

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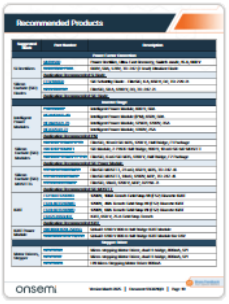

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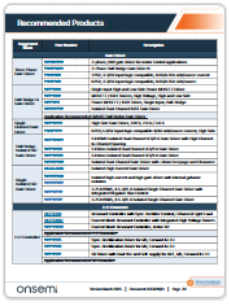

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Block Diagram

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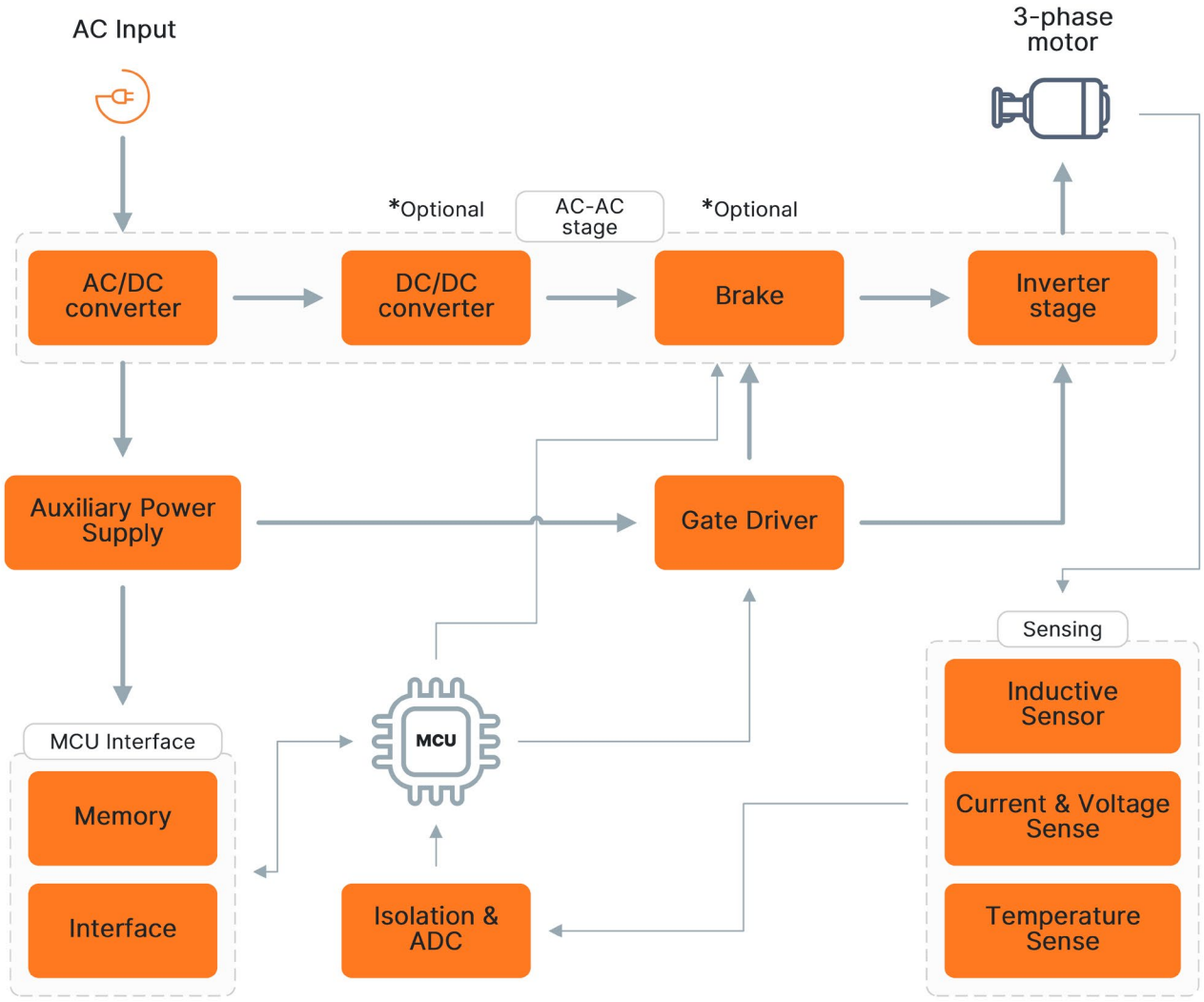
Motor Drive Top Level Topology

Block diagram below represents industrial motor drive solution recommended by **onsemi**. Most important building block is AC-AC stage. In the past considerable number of motors were directly powered from mains, but it is more efficient to use AC/DC converter and then inverter stage. Other important parts include control unit, which contains algorithm and controls whole system, sensing which delivers feedback and auxiliary power supply providing low voltage rails.



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Inverter Switch Variety

A motor control system can be designed using discrete components (IGBT, Si MOSFET, SiC MOSFET, diodes, gate drivers, etc.) or power modules, which integrate multiple parts. These modules can integrate a three-phase half bridge, one half bridge, or even include a brake, PFC, or gate driver in one package.

Suitable power switch from onsemi can be selected from figure 11, depending on the application, desired power, and motor voltage. Discrete solutions using IGBT or SiC can be utilized for single phase applications up to approximately 5 kW. Power modules can be divided into power integrated modules (PIM), and the intelligent power modules (IPM). The use of modules offers numerous advantages over the discrete solutions.

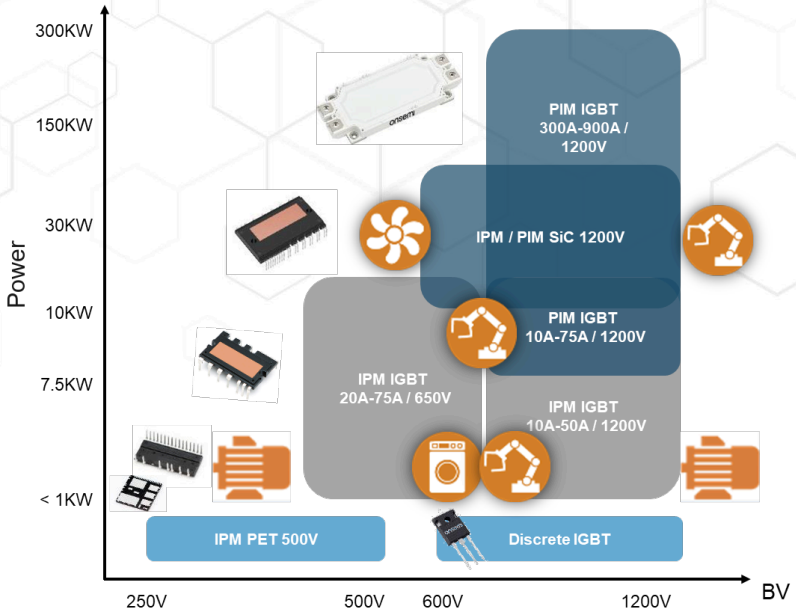

Fig.11: Recommended inverter solution depending on the desired power level and bus voltage

Since modules integrate power components as well as protections (such as UVLO, short-circuit protection, thermal sensing, etc.) they reduce required space and are more reliable since they are fully tested. onsemi offers modules in SiC and IGBT technology in various packages and with numerous topologies and features.

Power integrated modules integrate the discrete output stage and AC/DC converter into a single part. Some of the PIMs integrate a brake, which is why they are known as converter inverter brake (CIB) PIMs. PIMs still require separate and suitable gate drivers.

Intelligent power modules, in addition to the inverter stage, also include gate driver and protection. They greatly reduce the system size and time to market. An example of an onsemi IPM and its elements is illustrated in the figure 12.

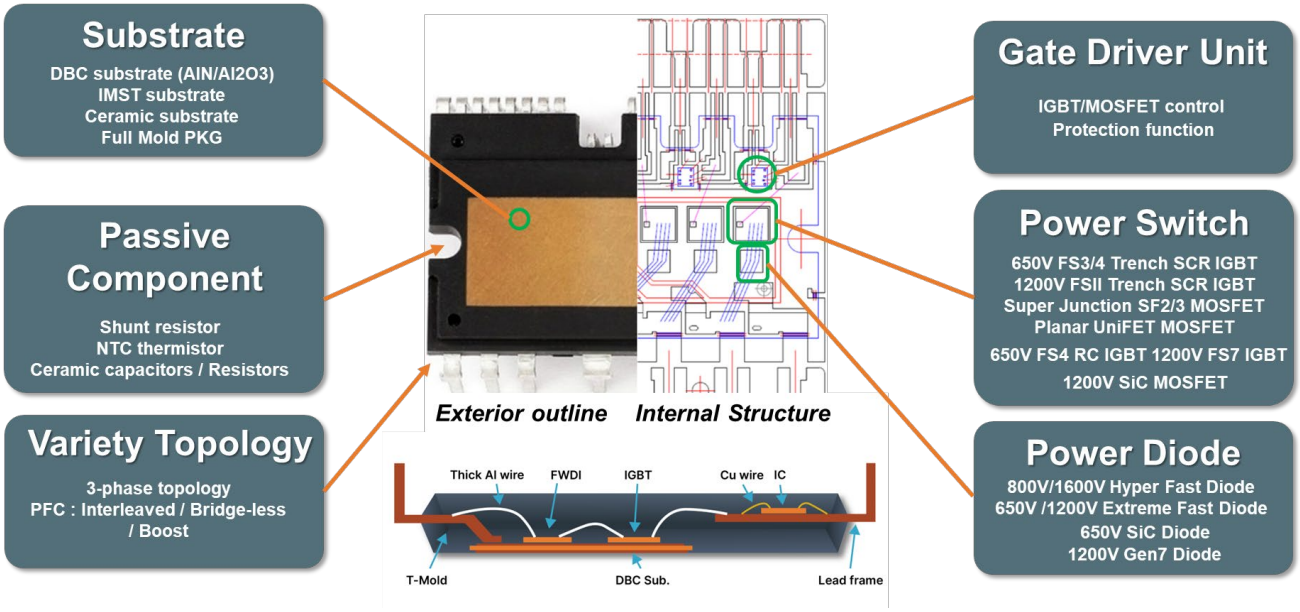

*Fig.12: Level of integration of **onsemi** Intelligent power module*

IGBT – Cost-effective High-voltage Switch

IGBTs are optimal for high-voltage applications, as they provides a higher blocking voltage for equivalent material thickness, compared to the Si MOSFETs. IGBT switches are cost-effective and mainstream solution. Their disadvantage is that they have a lower possible switching frequency, which means that the used inductors would be larger. IGBTs have a long history of driving motors at frequencies up to 20 kHz.

Field Stop VII, IGBT, 1200V

- New Family of 1200 V Trench Field Stop VII IGBT
- Low VCE(SAT) type for motor control applications – increases the power that can be handled and decreases the power losses generated as heat and thus improves cooling
- Improved parasitic cap for high-frequency operation, high ruggedness
- 1200V Gen7 diode for low VF and softness – lower voltage drop decreases the conduction losses and softness refers to the reverse recovery of the diode. The softer is the reverse recovery the less noise and fewer electromagnetic interference (EMI) issues

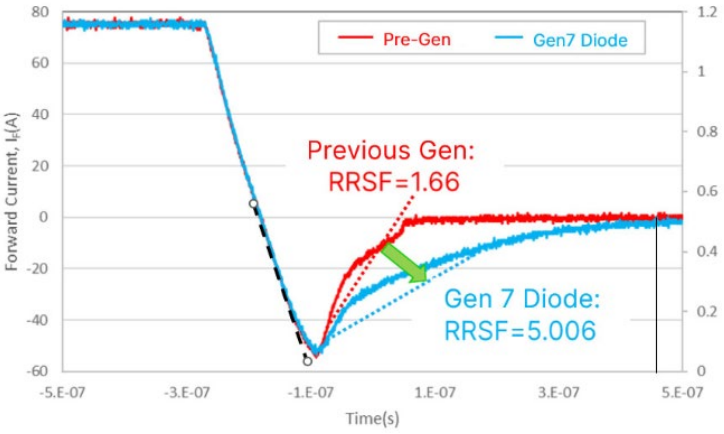

Fig.13: Comparison of softness of Gen7 and previous Gen diode

Diode softness is defined as diode recovery softness factor (RRSF),

$$RRSF = \frac{\left|\frac{dI_{rise}}{dt}\right|}{\left|\frac{dI_{fall}}{dt}\right|}$$

where dI_{rise}/dt is the maximum slope when reverse current rise from 0 to peak during turn–off, di_{fall}/dt is the maximum slope the reverse current falls from peak to 0. As Figure 13 shows, latest Gen7 diode has softness of 5, three times improved than previous generation. See more in Advanced Industrial Motor Control for Increased Power Efficiency.

IGBT FGY100T120RWD

- 1200V, 100A IGBT from FS7 family
- Integrated Gen7 diode
- VCE(SAT) = 1.4V, Tjmax = 175°C
- Positive temperature coefficient for easy parallel operation
- Low conduction loss and optimized switching for motor control applications

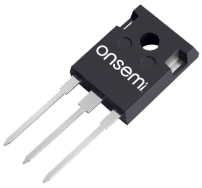

Fig.14: TO-247-3 package

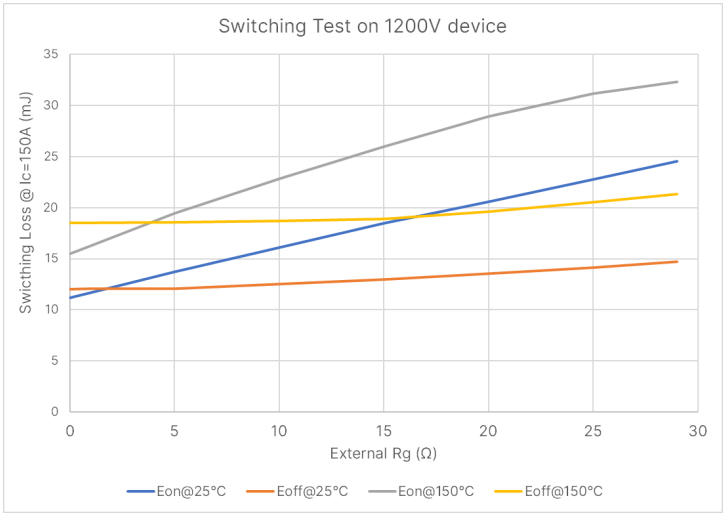

Fig.15: Switching losses of 1200V IGBT from FS7 family

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