



System Solution Guide - Preview

# Heat Pumps



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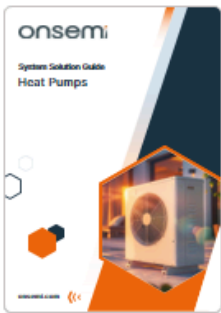
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The onsemi logo is displayed in a large, bold, dark blue font. To the right of the logo is a small trademark symbol (TM). The background of the logo area features a pattern of light gray hexagons.The image shows the cover of the 'onsemi System Solution Guide Heat Pumps'. The cover is white with a blue header containing the onsemi logo. Below the header, the title 'System Solution Guide Heat Pumps' is written in a smaller font. At the bottom of the cover, there is a photograph of a heat pump unit installed in a wall.

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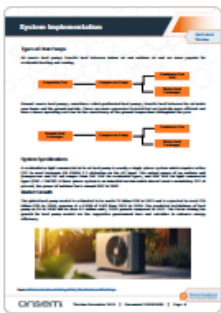
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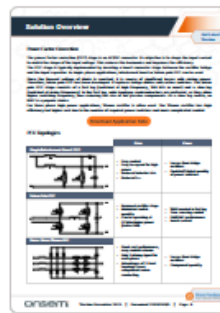
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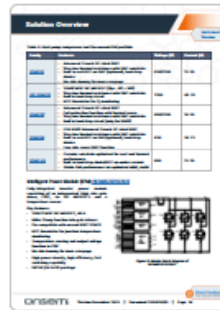
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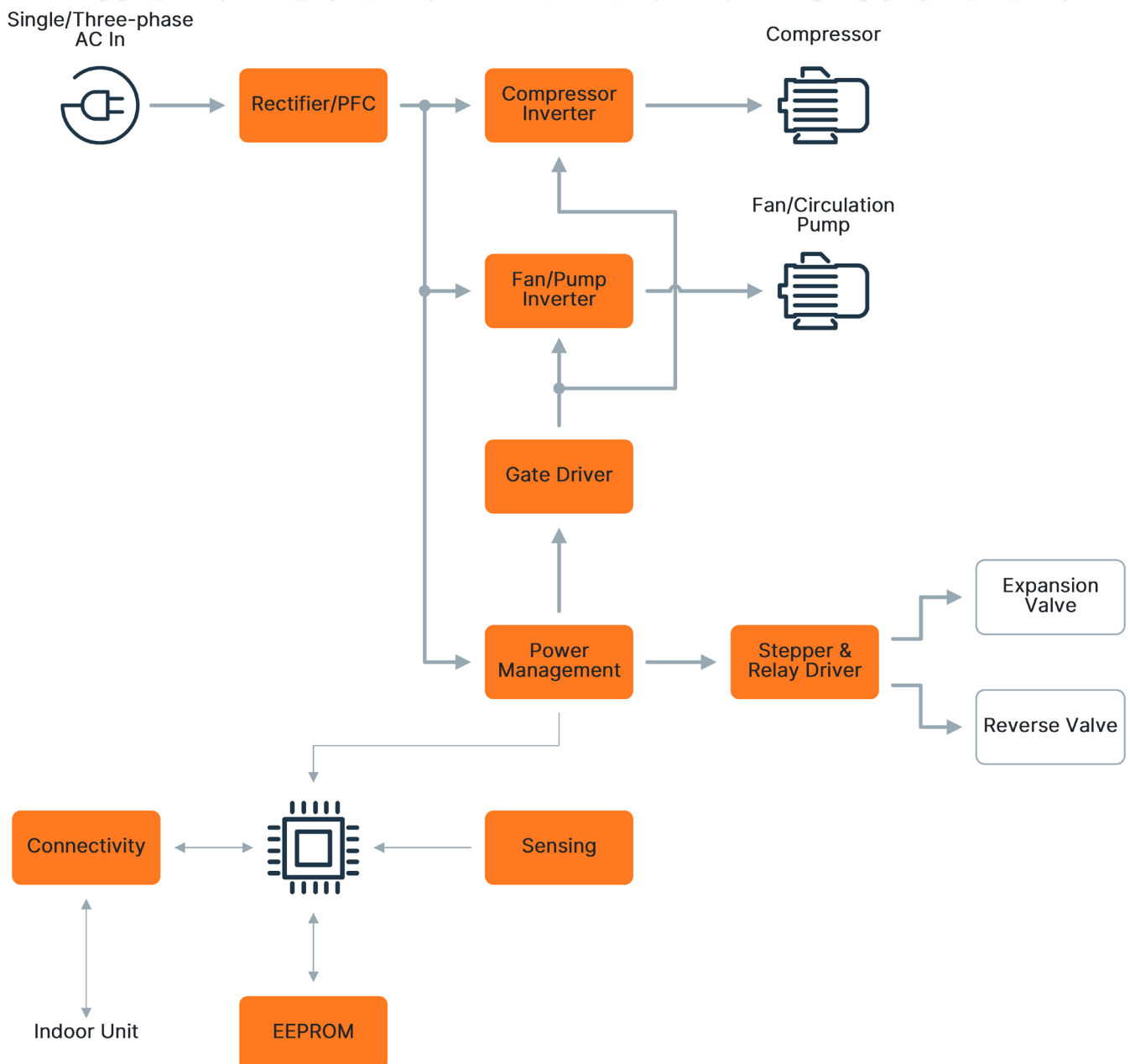
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# Block Diagram

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## Heat Pump Outdoor Unit Top Level Topology

Block diagram below represents heat pump outdoor unit solution recommended by **onsemi**. Outdoor unit of a heat pump system contains evaporator (in case of air-source heat pump) or ground heat exchanger (ground-source heat pump). Other main blocks are circulation pump, compressor and fan. All of the mentioned require inverter, which is usually satisfied by IGBT IPM. Other blocks are sensing (voltage, current, temperature), CPU and connectivity to the indoor unit.



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## Intelligent Power Modules (IPMs)

Intelligent Power Module is a highly integrated device used as a power switch with the highest degree of integration currently available. The switch is either an IGBT or a Si MOSFET. They are a popular choice for motor control application, fans, pumps and general-purpose drives. They can integrate not only power switch and gate driver, but also PFC stage and/or passive components (such as NTC) in a single package. Further advantages include EMI improvements, space optimization and reduced power losses and thus easier thermal design.

### IPM Features

- IPM contains inverter power stage, gate driver, NTC (optional), bootstrap diode and power switches
- Bring the power level up to 1-20kW for single and three-phase input AC drives
- Direct Bonded Copper:
  - Outstanding thermal conductivity:  $24(\text{Al}_2\text{O}_3)$  to  $170(\text{AlN})$  W/mK
  - Perfect isolation and no degradation:  $>20\text{kV/mm}$
  - Huge Resistivity  $>10\Omega\text{cm}$  @ $20^\circ\text{C}$
  - Broad temperature range
  - Common packages for P2P replacement

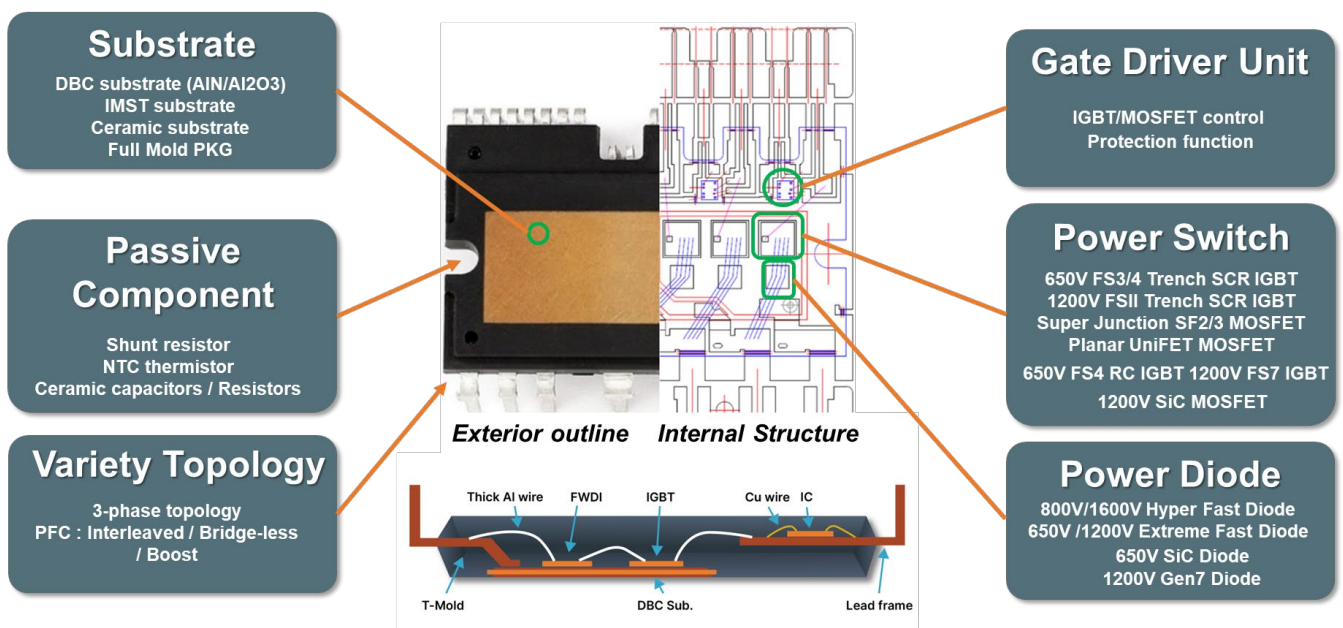


Figure 8: Level of integration of **onsemi** IPM

Heat pumps have different power ratings depending on the intended usage. Generally, consumer heat pumps will have between 2 to 7 kW and commercial three-phase ones from 8 to 15 kW.

IPMs are incredibly versatile and in the heat pump system can be used to control:

- Main compressor – 600/1200 V
- Indoor unit fan – 600 V single phase
- Circulation pumps – 600 V single phase, low power rating
- Outdoor unit fan – 600/1200 V

# Solution Overview

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Table 5: Heat pump compressor and fan **onsemi** IPM portfolio

Family	Features	Voltage (V)	Current (A)
<a href="#">SPM®31</a>	<ul style="list-style-type: none"> <li>Advanced Trench SC rated IGBT</li> <li>Very low thermal resistance with DBC substrate</li> <li>Built-in real NTC on DBC (optional), bootstrap diodes</li> <li>No side dummy for more creepage</li> </ul>	650/1200	15-50
<a href="#">SiC SPM®31</a>	<ul style="list-style-type: none"> <li>1200V M3P SiC MOSFET (V<sub>gs</sub> : 0V ~ 18V)</li> <li>Very low thermal resistance with DBC substrate</li> <li>Built in bootstrap circuit</li> <li>NTC thermistor for T<sub>j</sub> monitoring</li> </ul>	1200	40-70
<a href="#">SPM®3V</a>	<ul style="list-style-type: none"> <li>Advanced Trench SC rated IGBT</li> <li>Full protection function with thermal sense</li> <li>Very low thermal resistance with DBC substrate</li> <li>Built in bootstrap circuit (only for 600V)</li> </ul>	600/1200	10-50
<a href="#">SPM®49</a>	<ul style="list-style-type: none"> <li>FS4 650V Advanced Trench SC rated IGBT</li> <li>Very low thermal resistance with DBC substrate</li> <li>Built-in real NTC on DBC(optional), bootstrap diodes</li> <li>Low side sense IGBT function</li> </ul>	650	50-75
<a href="#">SPM® 45</a>	<ul style="list-style-type: none"> <li>Ceramic substrate optimized for cost and thermal performance</li> <li>Built-in bootstrap diode/NTC on under ceramic</li> <li>Stable EMI performance via optimized di/dt, dv/dt</li> </ul>	600	15-30

## Intelligent Power Module (IPM) [NFAM5312SCBUT](#)

Fully-integrated inverter power module consisting of an independent High side gate driver, LVIC, six SiC MOSFET's and a temperature sensor.

### Key features:

- 1200 V M3P SiC MOSFET, 40 A
- Miller Clamp function into gate drivers
- Pin compatible with **onsemi** IGBT SPM31
- NTC thermistor for junction temperature monitoring
- Temperature sensing and output voltage function in LVIC
- No side dummy for more creepage
- High power density, High efficiency, Fast switching capability
- DIP39 (54.5x31) package

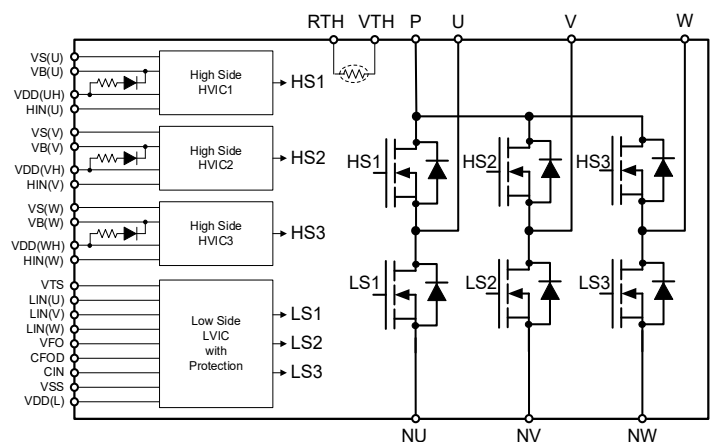





Figure 9: Interior block diagram of NFAM5312SCBUT

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