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IPM Overview and Product Selection Guide

AND90042/D

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APPLICATION NOTE

This application note provides an overview of the different IPM package families, to facilitate the module selection for a specific application and power range.

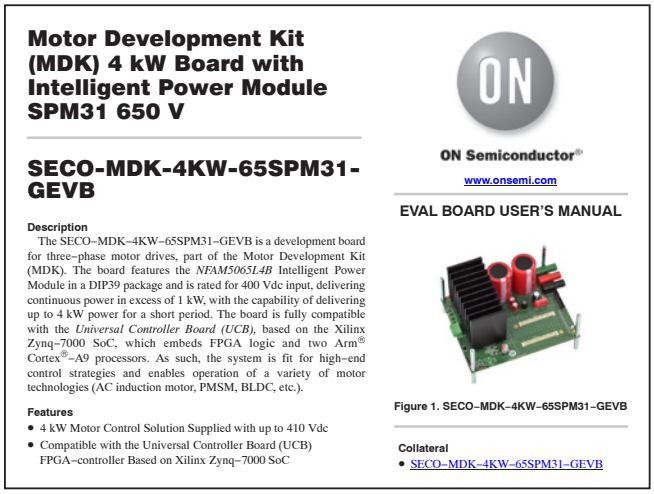
ON Semiconductor's IPM allows designers to:

- Reduce system cost thanks to high integration in small foot print packages with excellent cooling performance
- Reduce assembly cost with simple assembly concept
- Reduce time to market with a power stage already optimized to meet the best trade-off between switching characteristics and EMI performance
- Improve reliability with short circuit rated IGBTs driven by rugged gate driver ICs with key protection features, in a rugged transfer mold package

ON Semiconductor proposes different module topologies:

- 3-Phase Inverter modules
- 3-Phase Inverter with PFC (Combo) modules
- Interleave PFC with Input bridge rectifier modules
- Single boost PFC with input bridge rectifier modules
- Bridgeless PFC modules with built in shunt resistor

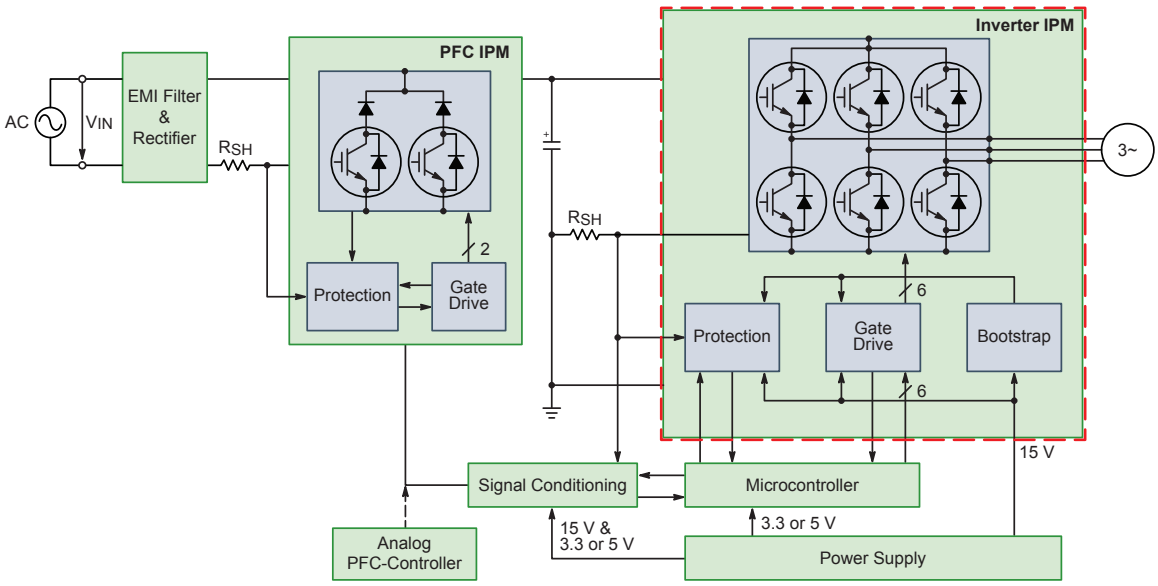
Reference designs and online simulation tool are available in ON Semiconductor website to facilitate the design and evaluation of IPMs.



Motor Development Kit

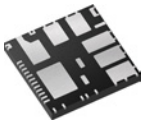
Online Simulation

3-Phase Inverter IPM



Application Diagram

SPM7 in PQFN for Up to 80 W Motors



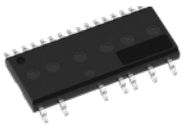
12.9 mm²

- MOSFET/IGBT module in small foot print 12.9 x 12.9 mm PQFN package
- Available in 250 V with $R_{DS(ON)}$ from 0.8 Ω to 1.4 Ω
- Available in 500 V with $R_{DS(ON)}$ from 1.85 Ω to 3.4 Ω
- Achieve high power density thanks to larger PCB land pattern with higher heat dissipation capability

SPM5 in SMD and Through-Hole Packages for Up to 200 W Motors

DIP (No Suffix)

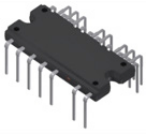
Double DIP (T Suffix)



Surface Mount (S Suffix)

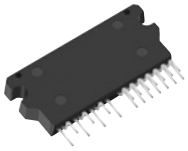
- MOSFET/IGBT module in SMD and Through-Hole package to drive motors up to 200 W
- Can be mounted with heatsink for enhanced heat dissipation (but no screw hole on the package)
- Available in 250 V using MOSFET with $R_{DS(ON)}$ from 0.37 Ω to 1.10 Ω
- Available in 500 V using MOSFET with $R_{DS(ON)}$ from 1.43 Ω to 5.50 Ω
  - FSB50x50**A** version is optimized for applications running at switching frequency below 10 kHz, for which conduction losses are predominant
  - FSB50x50**B** version is optimized for applications running at frequency above 10 kHz, for which switching losses are predominant
  - FSB50x50**BL** version is slow down compared to the B version for better EMI
- Available in 600 V using:
  - RC IGBT, provide higher efficiency at higher current, with good tradeoff between low switching loss, good EMI performance and cost benefit.
  - Super Junction MOSFETs with RDS(ON) from 0.45 Ω to 2.70 Ω for ultra-low conduction losses
- Used in various white good appliances such as dishwashers and washing machine drain pumps, refrigerators as well as in industrial motor drive such as fan, pumps.

SPM8 for 300 W Range Motors



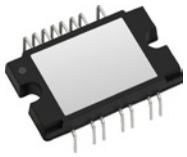
- IGBT module in fully molded package with screw hole for easy mounting on heat sink
- Available with 600 V IGBTs, from 4 A to 15 A
- Used in in white goods appliances such as compressors for refrigerators and fans

SIP-K for Up to 1 kW Range Motors



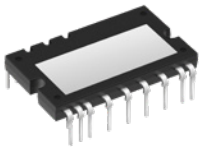
- IGBT module in a Single-In-Line package for vertical mounting on the PCB
- It is based on an IMS substrate for high mounting density and good heat spreading, fully over molded for enhanced electrical isolation
- SIPK is pin compatible with SIP1A and SIP05F. It also has same mounting hole position with SIP05F
- SIPK available in 600 V 5 A and 10 A

Compact IPM in DIP-S6 and DIP-S for 1 kW Range Motors



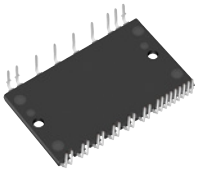
- 600 V IGBT module in a compact 29.6 x 18.2 mm package
- 3 A device based on IMST and full mold package
- From 5 A to 15 A with exposed Al2O3 substrate for enhanced heat dissipation and reliability
- NFAQ0560R43T/NFAQ1560R43T are 5 A and 15 A modules based on FS4 RC IGBTs, enabling a higher power density in compact sized package with cost optimization
- Used in white good appliance such as washing machines and in industrial motor drive such as fans, with power ranging from 700 W to 1 kW

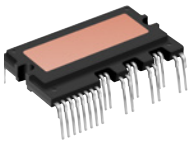
SPM45 for 1 kW to 3 kW Motors



- IGBT module with ceramic substrate for optimized heat dissipation and cost
- Available in 600 V, wide portfolio from 5 A to 30 A for scalable power class within the same foot print
- NFA41560R42 and NFA42060R42 are 15 A and 20 A modules based on FS4 RC IGBTs for cost optimization, good EMI performance
- Used in room air conditioning ranging from 1 horse power to 3 horse power

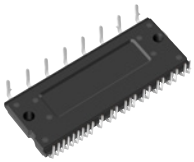
SPM31, SPM3V and ASPM27 for 7 kW Motors

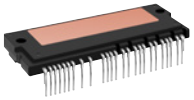




- IGBT modules with Al2O3 and AlN substrates for best heat dissipation
- Available in 1,200 V from 5 A to 20 A
- Available in 600 V from 15 A to 50 A, 650 V from 20 A to 60 A
- Used in large range of industrial motor drives such as variable frequency drives, servo, pumps, HVAC with powers up to 7 kW
- SPM31 is pin to pin compatible with other suppliers in the market, offering dual source capability
- SPM31 with FS4 IGBT offers a more cost effective solution for high performance applications. It offers higher efficiency than SPM3V for switching frequencies above 10 kHZ
- SPM3V is running at higher volume and offers a more cost effective solution for applications demanding less performance
- AQG324 Automotive version available under ASPM27 package family, for e-compressor and other auxiliary motor drives for EV/HEV
- ASPM27v3 based on FS4 IGBTs, optimized with lower switching losses for fast switching application with good EMI trade off:
  - NFVA33065L42 shows similar losses as NFVA33065L32 but better EMI
  - NFVA3-50/60-65L42 shows lower losses than the NFVA3-40/50-65L32, allowing faster switching or higher current rating for similar EMI performance

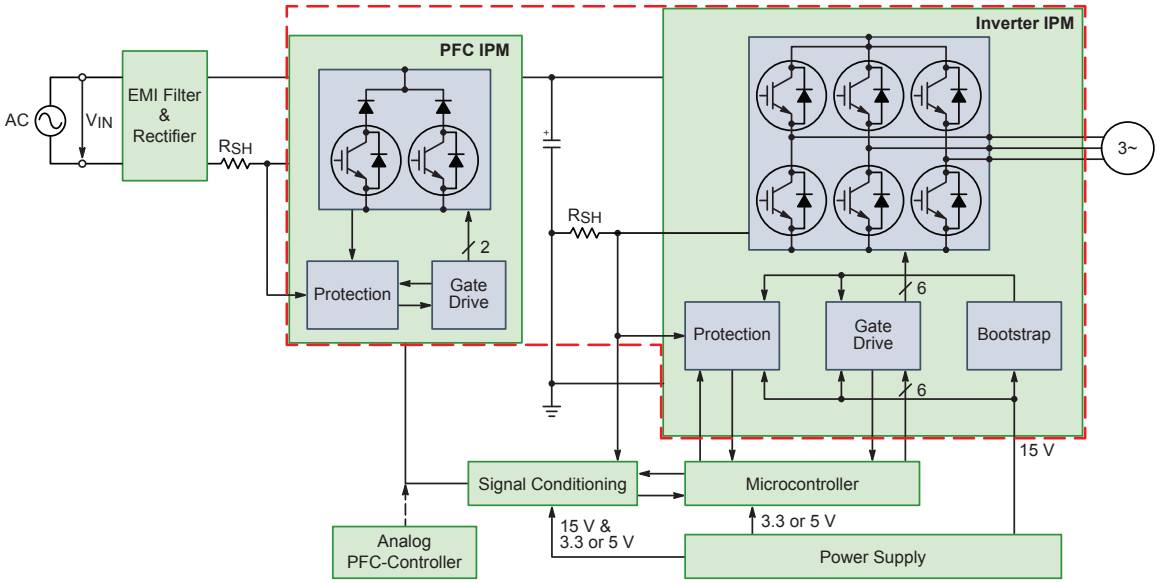
SPM49, SPM34 and ASPM34 for 10 kW Motors





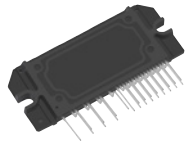
- IGBT modules with Al2O3 and AlN substrate for best heat dissipation
- Available in 1,200 V from 10 A to 50 A
- Available in 600 V from 30 A to 75 A, 650 V from 50 A to 75 A
- Used in large range of industrial motor drives such as variable frequency drives servo, pumps, HVAC with powers up to 10 kW
- AQG324 Automotive version available under ASPM34 package family, for e-compressor and other auxiliary motor drives for EV/HEV
- SPM49 is pin to pin compatible with other suppliers in the market, offering dual source capability
- SPM49 with FS4 IGBT offers a more cost effective solution for high performance applications. It offers higher efficiency than SPM34 for switching frequencies above 10 kHz

3-Phase Inverter with PFC Combo Module Overview



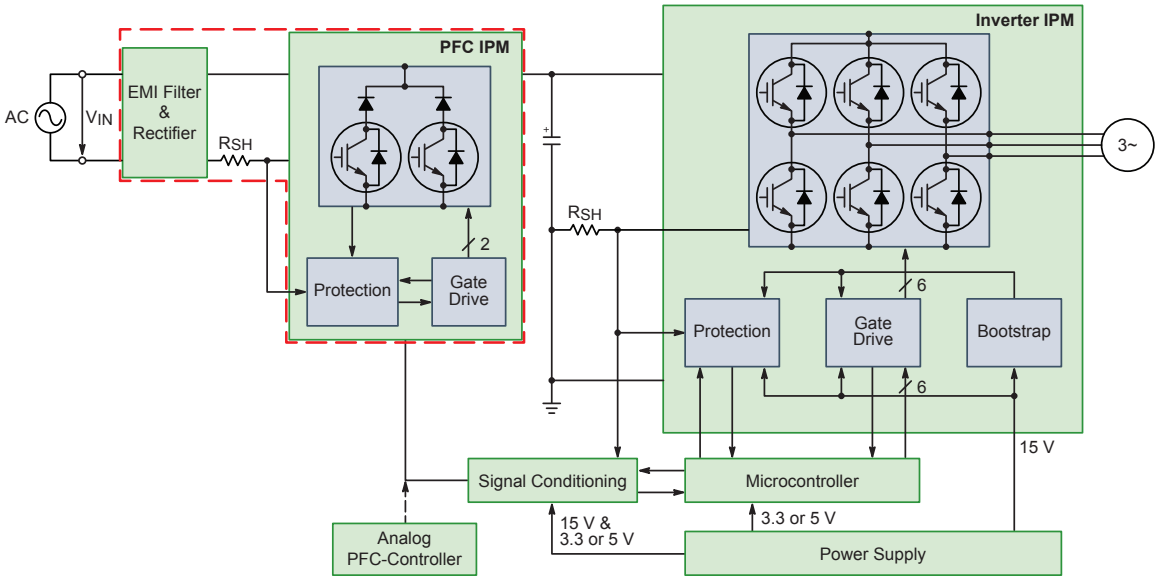
Application Diagram

SIP2A Combo Module



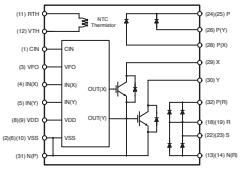
- IGBT inverter combined with PFC stage
- Available in 600 V 10 A with PFC based on Super Junction Mosfet and Silicon Carbide diode optimized for 100 kHz switching frequency range
- Available in 600 V 15 A with PFC based on IGBT and silicon diode, for 20 kHz ~ 40 kHz switching frequency
- In SIP2A Single In Line package is available with straight leads or 90deg bend leads for vertical and horizontal mounting on PCB

PFC Modules with/without Input Bridge Rectifier

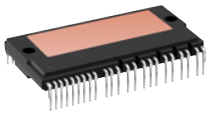


Application Diagram

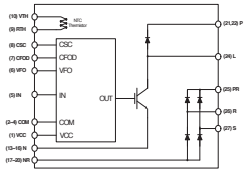
Interleave PFC with Input Bridge Rectifier



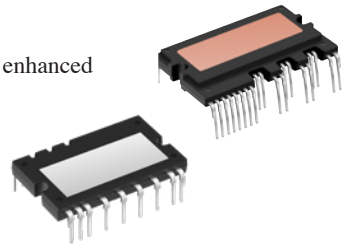
- SPM2V 32 with Al2O3 and AlN substrate for best thermal dissipation
- Available in 600 V from 30 A to 50 A
- Available with Silicon Carbide diode for enhanced thermal and EMI performance
- Optimized for 40 kHz ~ 60 kHz switching frequency



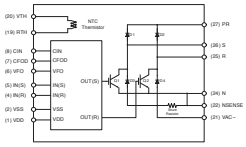
Single Boost PFC with Input Bridge Rectifier



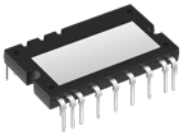
- SPM45 with ceramic substrate and SPM3V with Al2O3 substrate for enhanced heat dissipation
- Available in 600 V, from 20 A to 30 A



Bridgeless PFC Module with Built-In Shunt Resistor



- SPM3V package with Al2O3 and AlN substrate for best heat dissipation
- Available in 600 V from 40 A to 60 A



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