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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 (MDK) 4 kW Board with Intelligent Power Module SPM31 650 V



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**SECO-MDK-4KW-65SPM31-GEVB**

**EVAL BOARD USER'S MANUAL**

**Description**  
The SECO-MDK-4KW-65SPM31-GEVB is a development board for three-phase motor drives, part of the Motor Development Kit (MDK). The board features the *NEAMS065LAB* Intelligent Power Module in a DIP39 package and is rated for 400 Vdc input, delivering continuous power in excess of 1 kW, with the capability of delivering up to 4 kW power for a short period. The board is fully compatible with the *Universal Controller Board (UCB)*, based on the Xilinx Zynq-7000 SoC, which embeds FPGA logic and two Arm® Cortex®-A9 processors. As such, the system is fit for high-end control strategies and enables operation of a variety of motor technologies (AC induction motor, PMSM, BLDC, etc.).

**Features**

- 4 kW Motor Control Solution Supplied with up to 410 Vdc
- Compatible with the Universal Controller Board (UCB) FPGA-controller Based on Xilinx Zynq-7000 SoC




Figure 1. SECO-MDK-4KW-65SPM31-GEVB

**Collateral**

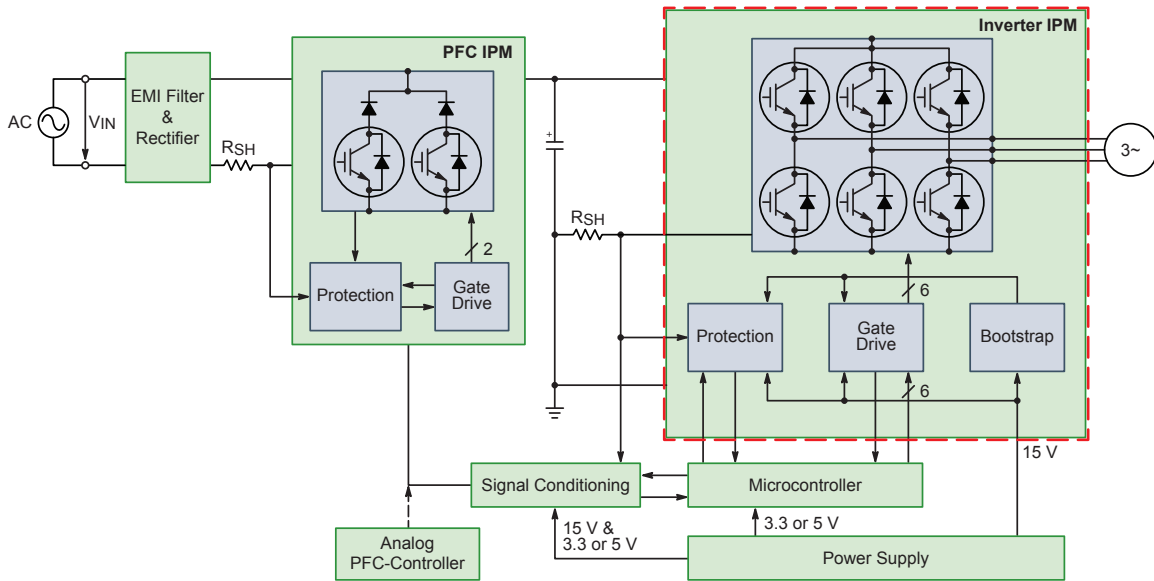
- [SECO-MDK-4KW-65SPM31-GEVB](#)

Motor Development Kit



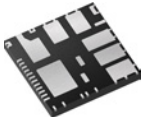
Online Simulation

### 3-Phase Inverter IPM



Application Diagram

#### SPM7 in PQFN for Up to 80 W Motors



12.9 mm<sup>2</sup>

- 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  $\Omega$  to 1.4  $\Omega$
- Available in 500 V with  $R_{DS(ON)}$  from 1.85  $\Omega$  to 3.4  $\Omega$
- Achieve high power density thanks to larger PCB land pattern with higher heat dissipation capability

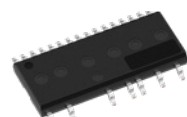
#### SPM5 in SMD and Through-Hole Packages for Up to 200 W Motors



DIP (No Suffix)



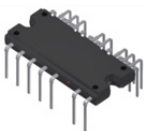
Double DIP (T Suffix)



Surface Mount (S Suffix)

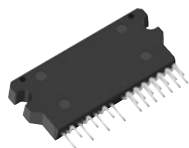
- MOSFET/IGBT module in SMD and Through-Hole package to drive motors up to 200 W
- Can be mounted with heatsink for enhanced heat dissipation (but no screw hole on the package)
- Available in 250 V using MOSFET with  $R_{DS(ON)}$  from 0.37  $\Omega$  to 1.10  $\Omega$
- Available in 500 V using MOSFET with  $R_{DS(ON)}$  from 1.43  $\Omega$  to 5.50  $\Omega$ 
  - FSB50x50A version is optimized for applications running at switching frequency below 10 kHz, for which conduction losses are predominant
  - FSB50x50B version is optimized for applications running at frequency above 10 kHz, for which switching losses are predominant
  - FSB50x50BL 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  $R_{DS(ON)}$  from 0.45  $\Omega$  to 2.70  $\Omega$  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



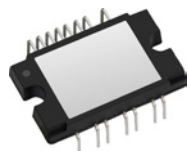
- IGBT module in fully molded package with screw hole for easy mounting on heat sink
- Available with 600 V IGBTs, from 4 A to 15 A
- Used in white goods appliances such as compressors for refrigerators and fans

## SIP-K for Up to 1 kW Range Motors



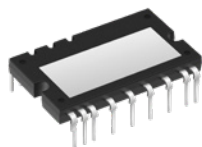
- IGBT module in a Single-In-Line package for vertical mounting on the PCB
- It is based on an IMS substrate for high mounting density and good heat spreading, fully over molded for enhanced electrical isolation
- SIPK is pin compatible with SIP1A and SIP05F. It also has same mounting hole position with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

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



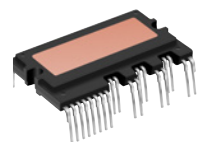
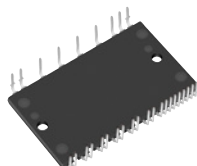
- 600 V IGBT module in a compact 29.6 x 18.2 mm package
- 3 A device based on IMST and full mold package
- From 5 A to 15 A with exposed Al<sub>2</sub>O<sub>3</sub> substrate for enhanced heat dissipation and reliability
- NFAQ0560R43T/NFAQ1560R43T are 5 A and 15 A modules based on FS4 RC IGBTs, enabling 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



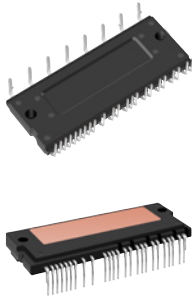
- IGBT module with ceramic substrate for optimized heat dissipation and cost
- Available in 600 V, wide portfolio from 5 A to 30 A for scalable power class within the same foot print
- NFA41560R42 and NFA42060R42 are 15 A and 20 A modules based on FS4 RC IGBTs for cost optimization, good EMI performance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

## SPM31, SPM3V and ASPM27 for 7 kW Motors



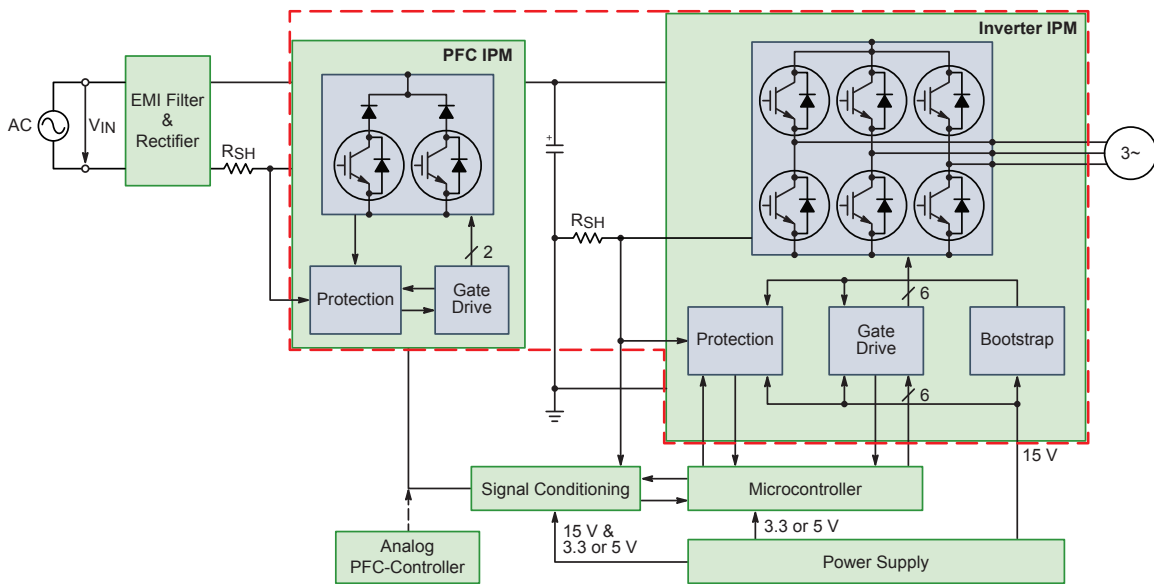
- IGBT modules with Al<sub>2</sub>O<sub>3</sub> and AlN substrates for best heat dissipation
- Available in 1,200 V from 5 A to 20 A
- Available in 600 V from 15 A to 50 A, 650 V from 20 A to 60 A
- Used in large range of industrial motor drives such as variable frequency drives, servo, pumps, HVAC with 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**



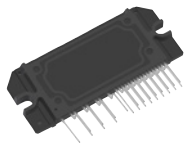
- IGBT modules with Al2O3 and AlN substrate for best heat dissipation
- Available in 1,200 V from 10 A to 50 A
- Available in 600 V from 30 A to 75 A, 650 V from 50 A to 75 A
- Used in large range of industrial motor drives such as variable frequency drives servo, pumps, HVAC with powers up to 10 kW
- 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



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