

## Introducing Intelligent Power Module (IPM) Family from ON Semiconductor



ON Semiconductor®

<http://onsemi.com>

### TECHNICAL NOTE

#### THE TECHNOLOGY

##### Insulated Metal Substrate Technology (IMST®)

ON Semiconductor became the first company in the world (in 1969) to develop IMST, or Insulated Metal Substrate Technology, which forms electronic circuits on plates of aluminum, that is to say, on metal substrates. IPMs that use this technology use these plates of aluminum with its high thermal conductivity for their base substrates. The company's IPMs, which enable power output circuits, control circuits, and their peripheral circuits to be mounted on the same substrate, are widely known as the STK brand.

The company has built up an impressive sales record and a reputation for reliability, particularly in the field of power electronics. We are living in an age of high-density mounting, which is developing at a rapid clip. IMST, which has succeeded in turning bare chip mounting into an element technology since the beginnings of its development, will continue to evolve as an outstanding mounting technology capable of delivery high density, high performance and high reliability.

#### *Insulated Metal Substrate Technology*

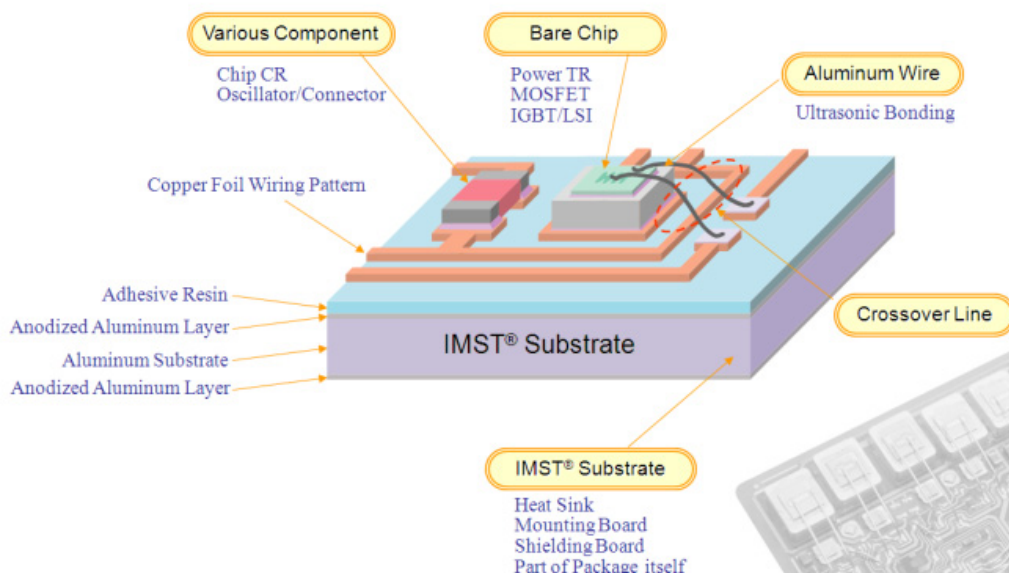


Figure 1. IMST Composition

IMST allows assembly of Discrete passive components (Resistors, Capacitors) Discrete active components

(Diodes, Transistors) and more complex IC s or ASICs (Gate drivers, DSP, Logic, etc.).



Figure 2. IMST Module Example

### Cross Section of an IMST

The typical cross section, front bottom to top is showing a High thermal conductive Aluminum substrate for

excellent thermal and mechanical performances, covered with an insulating layer and topped with a copper foil, for electrical routing.

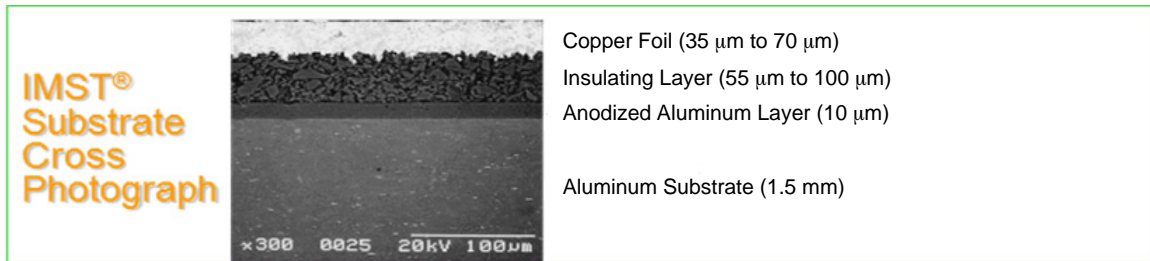


Figure 3. IMST Base Material Cross Section

### No Ceramic

The cross section of the IMST technology shows a unique feature: the absence of any ceramic layers as insulator or mechanical substrate. Hence, ON Semiconductor IMS Technology shows better grounding than any Ceramic based hybrid. IMST is also effective against EMC/EMI noise due to distributed capacitance generated from insulation resin between aluminum plate of metal substrate and copper foil pattern. Robustness to mechanical and temperature stress cycling is improved and thermal coefficient match with silicon is better.

### Over-Molding

When components are mounted in IPM technology, it is often seen that solder joints become a reliability problem: either at the passive-device-to-substrate interface or at the die-to-substrate interface.

For higher reliability we offer the over-molding of the IPM as a way to re-enforce mechanical cohesion. This further decreases the risk for mechanical stress at the solder joint, for example at the capacitor to substrate interface. The graphic below explains how far we go in this domain with various types of components.

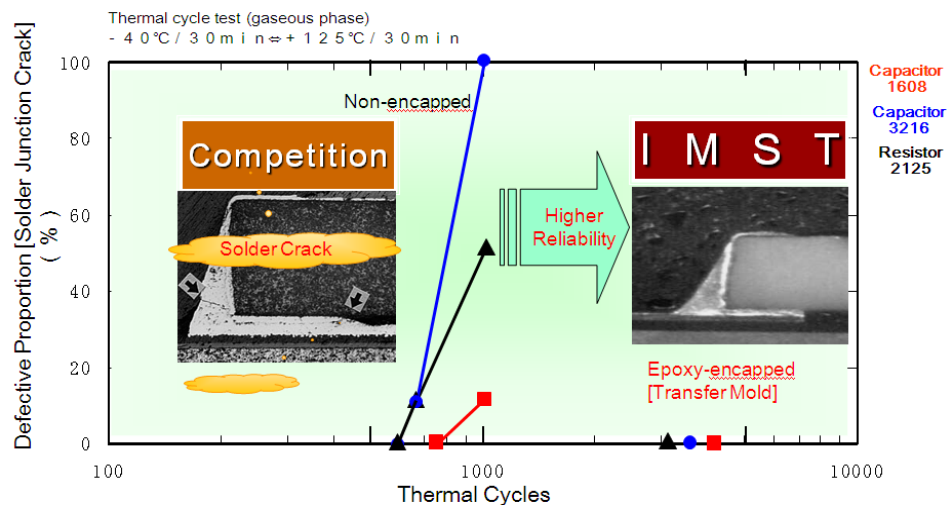


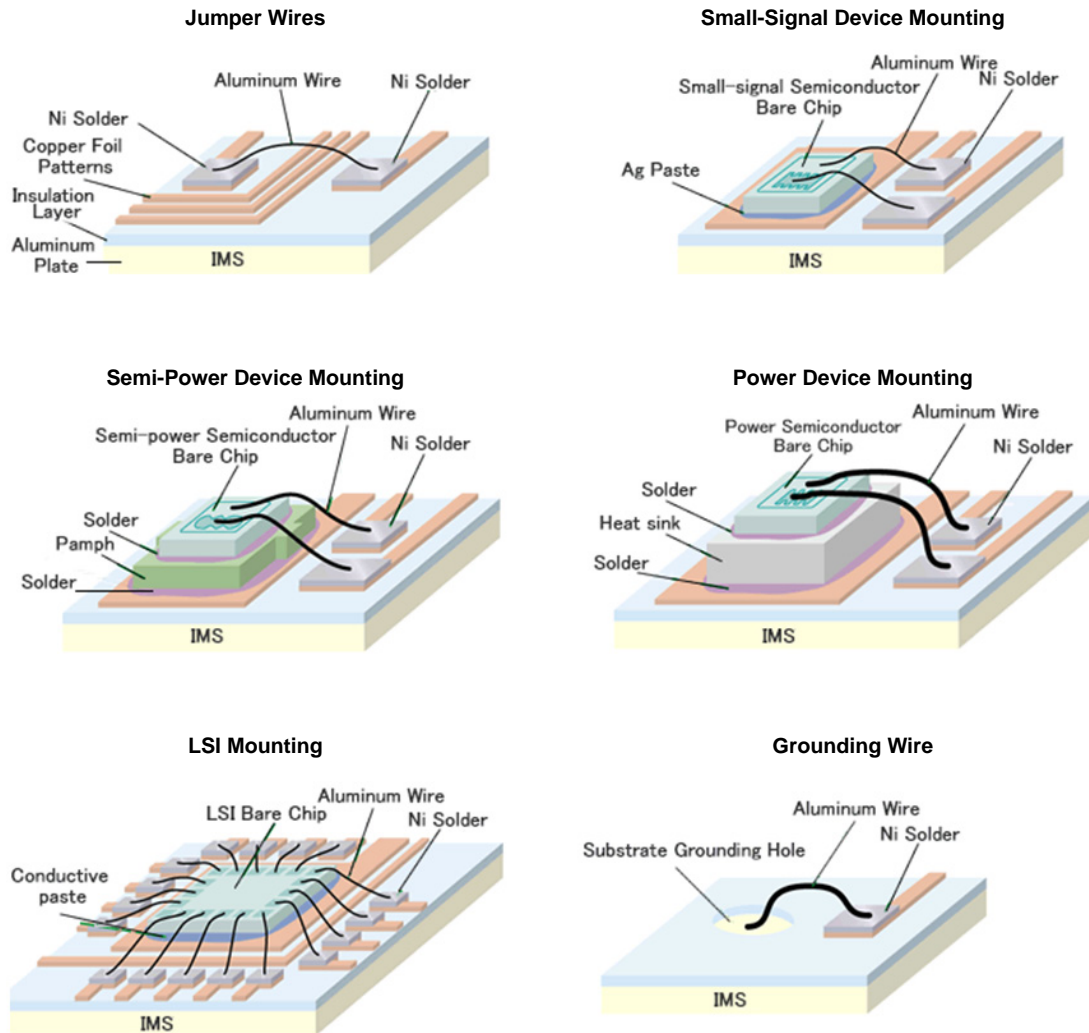
Figure 4. Thermal Cycling Robustness

### Thick Copper & Aluminum Bonding for Higher Current & Lower Noise

IMST (Insulated Metal Substrate Technology) is a method of mounting semiconductor devices (such as power transistors, ICs and diodes) using bare chips. Bare chip devices are connected to the copper foil patterns that form the circuits using ultrasonically bonded aluminum wires. ON Semiconductor has established this bonding

technology, which uses aluminum wires with a diameter ranging from 30  $\mu\text{m}$  to 500  $\mu\text{m}$ . The size is determined according to the level of the current flowing through the aluminum wires and purpose for which the wires are used (whether as jumper wires or grounding wires, for instance).

Structure Elements	Material	Thickness	Application Example
Conductor	Copper Foil	35 $\mu\text{m}$	Low Current
		70 $\mu\text{m}$	High Current
Insulating Resin	Filling of Inorganic Filler Epoxy	50 $\mu\text{m}$	Low Thermal Resistance
		80 $\mu\text{m}$	High Withstand Voltage
Base Plate	Aluminum Plate	1.5 mm	



Aluminum Wire Bonding: 30  $\mu\text{m}\varnothing$  to 500  $\mu\text{m}\varnothing$

Figure 5. IMST Bonding Schemes

## Integration

IMS Technology allows users to have integrated in one single module, Passive/Active components, Die or Packaged components, Sensors, ASICS or LSI chips.

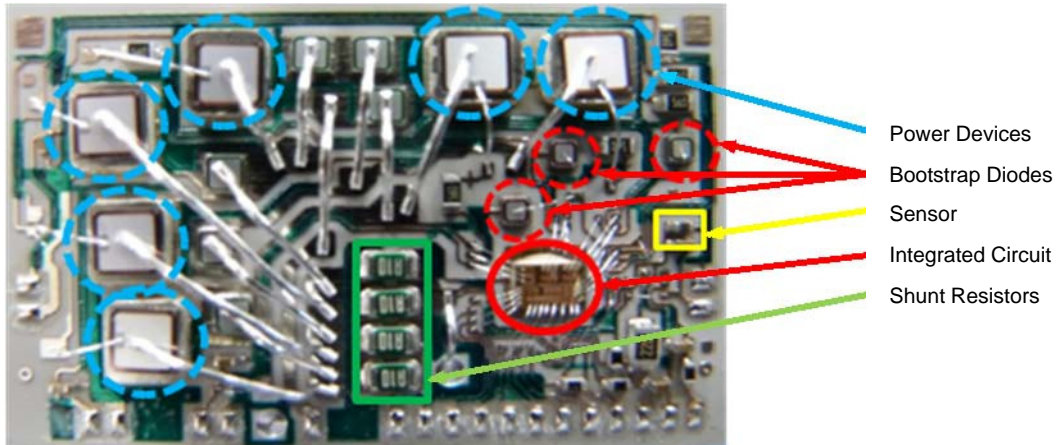


Figure 6. Integration IMST

## SIP/DIP

After molding is done several pin forming schemes are possible: Vertical SIP, bent SIP, DIP. This allows better

integration in mechatronic and several options of positions for the module.

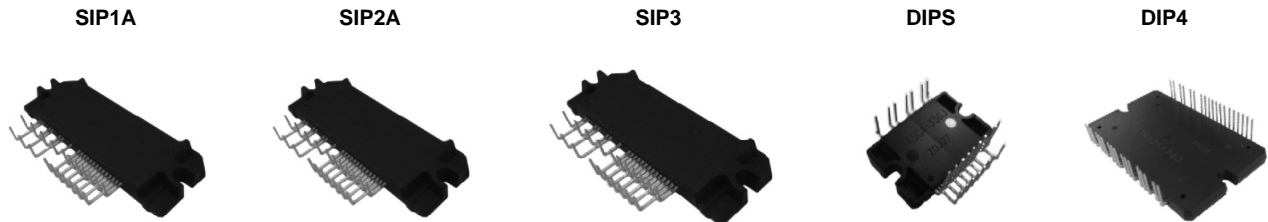


Figure 7. IMST Modules – Pinout Examples

## FEATURES/BENEFITS

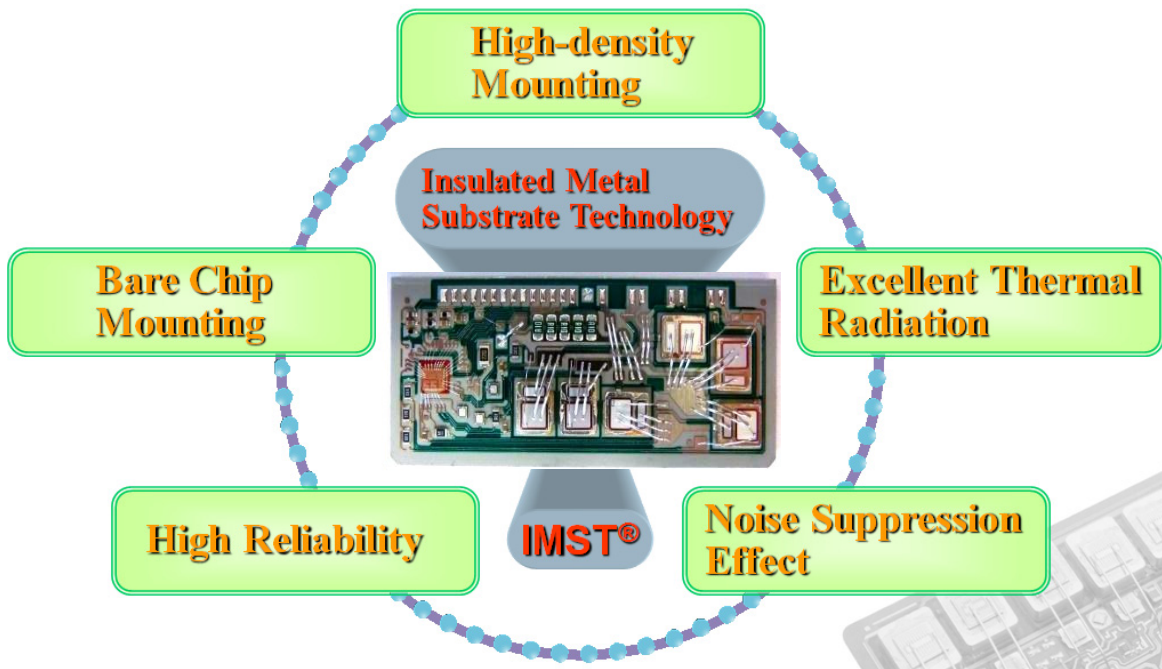


Figure 8. IMST Benefits

## A LEADING POSITION

ON Semiconductor has acquired a leading position in some highly competitive market places for IPMs in the field of Motor drivers.

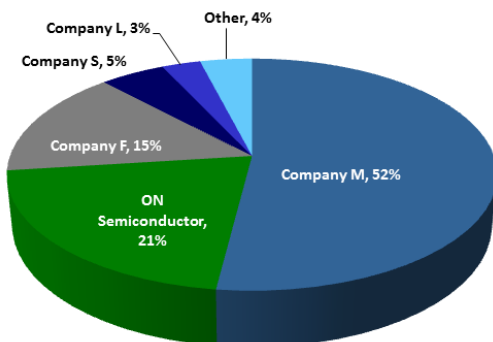
According to a recent Market study, Motor Driver inverters represent almost 50% of the Inverter market; this market is also showing growth projections over the next 5 years of more than 50%. IPM presence is justified by the higher demand of performance in motor drives, together with higher energetic efficiency, increased demand for noise reduction, and higher reliability.

These problems are easily solved by IMST and our customers acknowledge this fact.

Shown below is our market share in the White Goods motor driver IPM market.

One can also consider technology evolution and mastering as a key element for choosing a supplier of IPMs.

ON Semiconductor designs, manufactures, and monitors, technologies that represents now and for the coming years, the majority of the power market. Our serviceable market share is and will remain 90% of the power module market. This is a very interesting position for us.





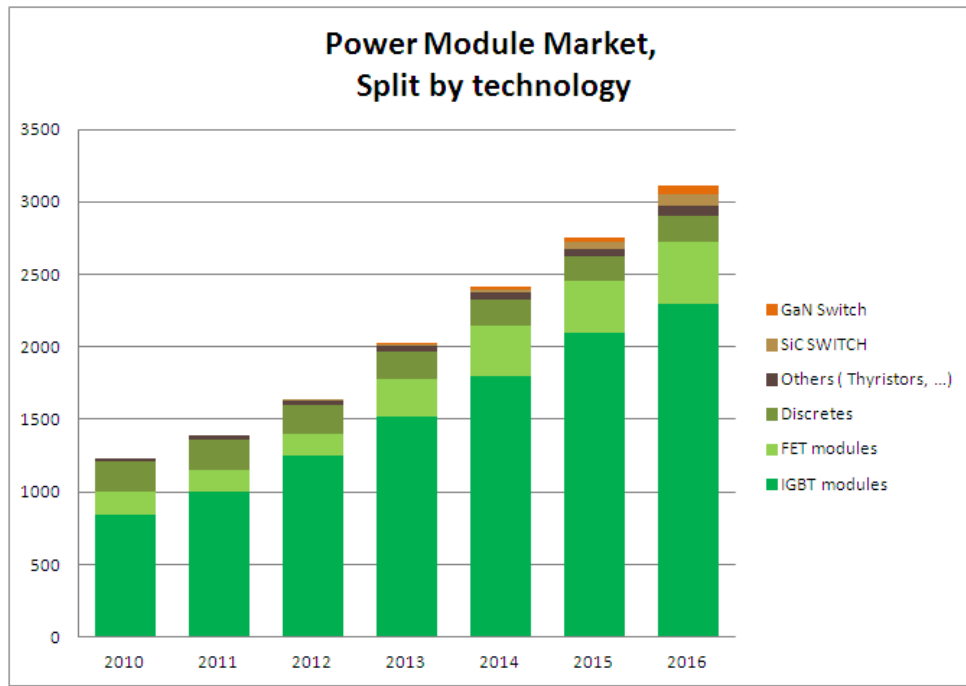


Figure 9. Power Module Market

This graph represents in green tones color the share of the Hybrid market ON Semiconductor is capable to address

with his technology. ON can see that wideband gap device based IPM is still very marginal.

## ONE-STOP SHOPPING

### Design and Manufacturing Made by ON Semiconductor

All the ON IPMs are designed and made in house with all inhouse key devices by ON Semiconductor experts.

ON Semiconductor has accumulated 30 years of IPM design, manufacturing, and selling experience. All the steps

of manufacturing are in house, from raw material purchase of Aluminum plate, copper foils, to packing before shipping to customer.

This includes: substrate to packing as below.

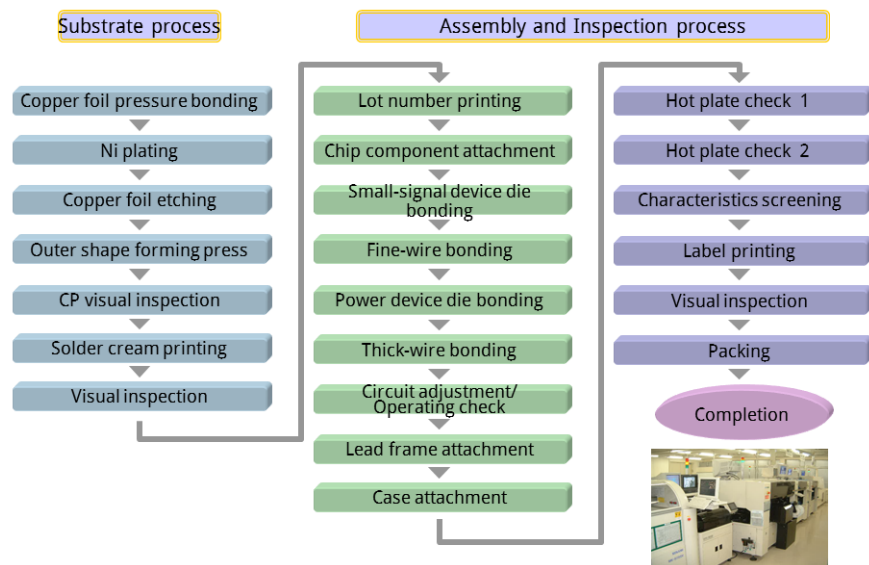


Figure 10. Fabrication Process Flowchart

## All Critical Components Are Made by ON

The ON IMS Technology takes benefit of the wide portfolio of discrete small signal, Buffers, Converters, LSI,

Drivers, and Power Stages that are in our catalogue, plus the new devices that are in development.


## CONCLUSION

ON Semiconductor is now positioned to offer to the market a IPM technology that fits the vast majority of the power market requirements ranging from 300 W to 5–6 kW. This technology is proven to be reliable, low noise emissions, high efficiency, and cost effective.

Several markets are benefitting from these features: White goods, Industrial and Automotive Motor control.

As a recognized semiconductor manufacturer of power discrete components, ON Semiconductor is also offering the vertical integration of its IPM family from active embedded components (power MOS FETs, power IGBTs, Diodes, ICs) to the full packaged Module.

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