Industry's first 1200 V SiC IPM CIPOS™ Maxi IM828-series

Alfred Hesener, Senior Director Technical Marketing IPM
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Global trends are driving demand for new power semiconductor solutions

Clean energy
Renewable energy sources like wind and sun are the vital part of new global energy mix

Energy efficiency
Reduction of energy consumed is needed, enabling systems that make the way we live and work greener

Electric mobility
Electrification of mobility is inevitable – in both, private and public transport segment
Silicon Carbide (SiC) can be an answer to these challenges

New requirements & challenges

- More energy from clean resources
- Get more out of less energy

Technical advantages of SiC lead to strong benefits for the system

- Increased performance
- Higher power density
- Reduced system size
- Lower system cost
Functional integration on system level is mainstream – even up to highest power.

System benefits translate to customer advantages.

IPMs improve **time to market**, **performance** and **reliability**.
Broad Intelligent Power Module portfolio – serving power ranges from 20 W to 4 kW

Main Applications
- Industrial Drives
- Major Home Appl.
- Small Home Appl.

Intelligent Power Module Portfolio
- CIPOS™ Nano
- POS™ Micro
- CIPOS™ Tiny
- CIPOS™ Mini
- CIPOS™ Maxi

CoolMOS™
FREDFET
CoolSiC™

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Industry's first 1200 V full SiC IPM: IM828-series at a glance

Products

DIP 36x23D package

- Fully isolated Dual In-Line molded module with 1200 V CoolSiC™ MOSFET
- Power capability over 8 kW
- Improved heat dissipation
- Rugged 1200 V SOI gate driver technology (6ED)
- Integrated bootstrap functionality
- Over current shutdown
- Independent temperature thermistor
- Under-voltage lockout at all channels
- Low side pins accessible for all phase current monitoring

Key Features

- Fully isolated Dual In-Line molded module with 1200 V CoolSiC™ MOSFET
- Power capability over 8 kW
- Improved heat dissipation
- Rugged 1200 V SOI gate driver technology (6ED)
- Integrated bootstrap functionality
- Over current shutdown
- Independent temperature thermistor
- Under-voltage lockout at all channels
- Low side pins accessible for all phase current monitoring

Product Line

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Package</th>
<th>Rds(on)</th>
<th>Voltage Rating</th>
<th>Ver.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM828-XCC</td>
<td>DIP 36x23D</td>
<td>55 mΩ</td>
<td>1200 V</td>
<td>CoolSiC™ MOSFET</td>
</tr>
</tbody>
</table>

Topology:
3 phase inverter

Value Proposition

- Offer very low loss by using the advanced CoolSiC™ MOSFET technology
- High power density and high efficiency
- High output power in one small package
- Provide wide switching speed range
- Minimize system size and reduce system costs
- Fast time to market

Application

- Commercial air conditioners
  - Active filter (PFC)/compressor
- Industrial motor drives
- Pumps

Dimension [mm]: 36 x 22.7 x 3.1 mm³ with 24 pins

Configuration: 3-phase inverter with open emitters

Voltage Rating: 1200 V

Rds(on): 55 mΩ

I_D DC drain current: 20 A
  (T_C = 80°C, T_J < 150°C)
IM828-XCC vs. reference A: Thermal performance comparison

IM828-MCC shows superior thermal performance compared to Reference A

<table>
<thead>
<tr>
<th>Test conditions</th>
<th>DUT</th>
<th>Measured value</th>
<th>Simulated data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ta [°C]</td>
<td>Tc [°C]</td>
</tr>
<tr>
<td>Case 1</td>
<td>IM828-XCC</td>
<td>26.1</td>
<td>54.4</td>
</tr>
<tr>
<td>(5 kHz, 25 Apeak, MI=0.58)</td>
<td>Reference A</td>
<td>26.6</td>
<td>68.2</td>
</tr>
<tr>
<td>Case 2</td>
<td>IM828-XCC</td>
<td>25.9</td>
<td>41.6</td>
</tr>
<tr>
<td>(30 kHz, 7 Apeak, MI=0.64)</td>
<td>Reference A</td>
<td>26.5</td>
<td>92.0</td>
</tr>
</tbody>
</table>

V<sub>DC</sub>=600 V, V<sub>DD</sub>=15 V, R<sub>shunt</sub>=10 mΩ, F<sub>0</sub>=60 Hz, PF=0.99, T<sub>dead</sub>=0.5 μs (SiC-MOSFET) / 3 μs (Si-IGBT)

Comments

Reference A is 1200 V 50 A IPM based on Si-IGBT technology

V<sub>DC</sub>=600 V, V<sub>DD</sub>=15 V, R<sub>shunt</sub>=10 mΩ, F<sub>0</sub>=60 Hz, PF=0.99, T<sub>dead</sub>=0.5 μs (SiC-MOSFET) / 3 μs (Si-IGBT)
IM828-XCC SiC IPM gives an excellent value to fit for various applications

<table>
<thead>
<tr>
<th>Key Features</th>
<th>Key Benefits</th>
<th>Value</th>
<th>To fit for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 phase inverter topology</td>
<td>Minimized PCB size</td>
<td>Reduced system costs</td>
<td></td>
</tr>
<tr>
<td>with smallest compact molded</td>
<td>Easy PCB footprint design</td>
<td>Fast time to market</td>
<td></td>
</tr>
<tr>
<td>package, up to 8 kW power</td>
<td>Less peripheral components</td>
<td>Wide range of application</td>
<td></td>
</tr>
<tr>
<td>rating</td>
<td>Wide switching speed range</td>
<td>High efficiency</td>
<td></td>
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<tr>
<td>Embedded single 1200 V SOI</td>
<td>Maintain stability against transient</td>
<td>High power density</td>
<td></td>
</tr>
<tr>
<td>gate driver technology</td>
<td>Lower switching losses</td>
<td>High output power</td>
<td></td>
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<tr>
<td>Built-in bootstrap</td>
<td>Monitoring system thermal status</td>
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<tr>
<td>Over current shutdown</td>
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<tr>
<td>Under-voltage lockout</td>
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<tr>
<td>All of 6 switches turn off</td>
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<td>during protection</td>
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<td>Enable pin</td>
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<tr>
<td>Excellent thermal performance</td>
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<td>with DCB substrate</td>
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<tr>
<td>Independent thermistor</td>
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<tr>
<td>Servo</td>
<td>Compact system design</td>
<td></td>
<td></td>
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<tr>
<td>PFC (Active filter) for pump</td>
<td>Dynamic and heavy load</td>
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<tr>
<td>or HVAC</td>
<td>High power dissipation requirement</td>
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<tr>
<td>CAC compressor</td>
<td>High efficiency requirement</td>
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<td></td>
<td>High switching frequency requirement</td>
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<td></td>
<td>Compact system design</td>
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<tr>
<td></td>
<td>Require harmonic current suppression</td>
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<tr>
<td></td>
<td>capability</td>
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<td></td>
<td>Minimize size and weight</td>
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<td></td>
<td>Improve system stable capability</td>
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<td></td>
<td>High power factor requirement</td>
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<td></td>
<td>High efficiency requirement</td>
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<td></td>
<td>High switching frequency requirement</td>
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<tr>
<td></td>
<td>Compact system design</td>
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<td></td>
<td>System simplify and easy design</td>
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<tr>
<td></td>
<td>High power rating requirement</td>
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To fit for:
- Servo
- PFC (Active filter) for pump or HVAC
- CAC compressor

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IM828-XCC in compact package with high output power and low heat dissipation for servo drive applications

**Advanced servo drive topology with SiC IPM technology**

**Comments**

- **Miniaturization of servo drive**
  - High power requirement for dynamic load condition
  - High power density and good thermal performance requirement based on the compact mechanical structure with heavy load
  - High efficiency and high switching frequency requirement

- **CIPOS™ Maxi offers the highest power density compact solution with SiC IPM**
  - High power rating with excellent protection functions
  - Small and compact design with good thermal performance
  - High efficiency and wide range for switching frequency
  - Highest power density of system
IM828-XCC with excellent performance for high frequency and low heat dissipation for PFC applications

Advanced motor drive topology for fan/pump with dual IPM solution

IM828-XCC

Converter (PFC)

Brake Stage

DC link Capacitor

Inverter

Motor

AC Source

Gate Driver

Power Flow

Control Signal

Sensing Signal

Micro Controller

IM818 series

Comments

PFC will be the trend in fan and pump applications

› Harmonic current suppression requirement
  - Regulatory requirement be strict
› Minimized losses and cost
  - The generation of the power and the capital equipment involved in the process

CIPOS™ Maxi offers a smaller compact solution with dual IPM: ①+②

› Wide range for switching frequency to fit for PFC requirement
› High efficiency and high power rating
› Highest power density of system
› Small and compact design
› Easy assembly with pin compatible package
High Power and High Performance IM828-XCC with Wide Speed Range for HVAC Application

Revolutionary HVAC topology with complete IPM Solution

- Miniaturized high performance HVAC
  - Require harmonic current suppression capability
    - IEC/EU 61000-3-2 standard requirement
  - Require high performance and stable capability
  - Minimized system cost such as size and weight

- CIPOS™ Maxi offers complete IPM revolutionary solution: ①+②+③
  - Excellent high frequency capability to achieve high power factor for suppress harmonic current to meet standard
  - High output power can be generated at low frequency to drive compressor
  - High efficiency and highest power density to provide system stable capability
  - Compact system design to reduce 70% inductor core size/PCB size and 75% weight for saving huge space

AC Source ➔ Inductor ➔ Converter (Active filter) ➔ DC link Capacitor ➔ IM828-XCC ➔ Inverter ➔ Compressor

- Power Flow
- Control Signal
- Sensing Signal

Micro Controller

Comments
EVAL-M1-IM828-A MADK evaluation board: IM828-XCC SiC IPM performance for 8 kW motor drive

Specifications

- Input voltage 380~480 V\textsubscript{AC}
- **Default 8 kW motor power output**
- Output current 15 A\textsubscript{rms} / 19 A\textsubscript{rms} (low speed)
- On board EMI filter
- Single shunt current sensing configured by default
- Auxiliary power supply with 15 V, 3.3 V
- Over-current protection
- Over-temperature protection
- Sensing of DC-link voltage
- Thermistor output
- Fault diagnostic output
- Measurement test-points compatible to standard oscilloscope probes
- PCB is 150 mm × 140 mm and has two layers with 70 μm copper each
- RoHS complaint

Power Board Picture

Control Board Picture

OPN: EVALM1101TT0BO1

Power Board Diagram

Tool and Software

MCEWizard and MCEDesigner: [http://www.infineon.com/imotion-software](http://www.infineon.com/imotion-software)
Thermal image of evaluation board: Output power 8.9 kW

Operating conditions:
550 V AC input,
11.5 A RMS output current
IM828 SiC IPM: next level of performance

› Infineon has a long and successful history with SiC diodes and power switches

› SiC represents a strong technology option for applications needing higher performance and efficiency

› IM828 full SiC intelligent power module is the latest and greatest addition to the portfolio of Infineon's CoolSiC products:
  - High power density and low losses enable system cost savings
  - High switching frequency enables high performance for systems requiring high load dynamics
  - High switching frequency enables significant system cost reductions in active filter applications

› Full industrial qualification, high reliability and robustness
Part of your life. Part of tomorrow.