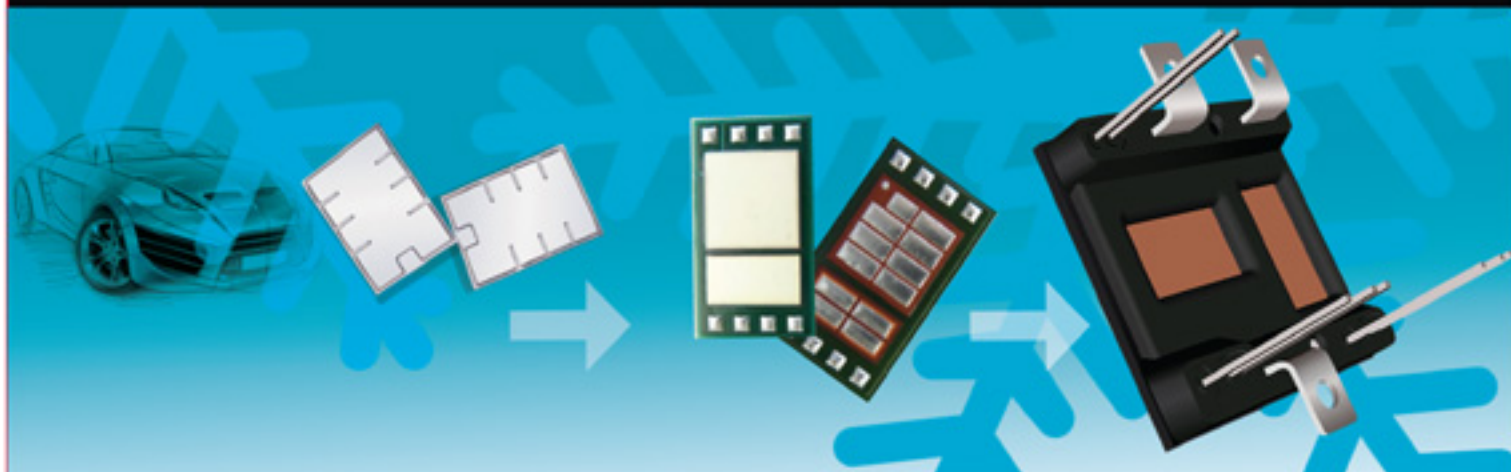


# COOLiR™ Advanced Automotive Power Management Solutions



International  
**IOR** Rectifier

AN INFINEON TECHNOLOGIES COMPANY

[WWW.IRF.COM](http://WWW.IRF.COM)

# COOLiR™ Advanced Automotive Power Management Solutions



## COOLiR™

### Power Switch Technologies

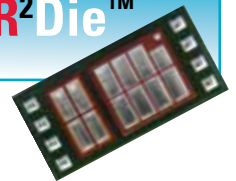
#### COOLiRIGBT™ Gen1

#### COOLiRIGBT™ Gen2

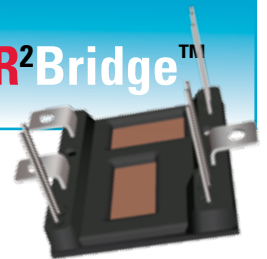
#### COOLiRDiode™ Gen2

### Performance Power Packaging Technologies

#### COOLiR²Die™



#### COOLiR²Bridge™



#### COOLiR FEATURES:

- Devices optimized for (H)EV applications
- Solderable Front Metal (SFM) and wireless bonding increase reliability and reduce size
- Flexible cooling configurations with low thermal resistance
- Automotive qualified

#### COOLiR ADVANTAGES:

- Exceptional power density
- Dramatically reduced size and cost
- Dual-sided cooling configurations lower  $R_{th}$  and improve  $Z_{th}$
- High switching frequency IGBTs up to 200kHz

International Rectifier's COOLiR silicon and advanced COOLiR² packaging technology provides a new power management platform approach for hybrid electric vehicles ((H)EV) to help address the need to reduce the size, weight and system cost of electric power train components while increasing system reliability for long lifetime, low maintenance and low warranty cost.

The portfolio features silicon capable of operating at 175°C and both slow and fast switching devices up to 200kHz offering incredible new possibilities for designing in automotive applications such as DC-DC converters, battery chargers, (H)EV main inverters or air conditioning compressors.

COOLiRIGBT and COOLiRDiode switches are manufactured on cost effective processes and equipment to improve the performance and ruggedness of the devices without increasing manufacturing complexity.

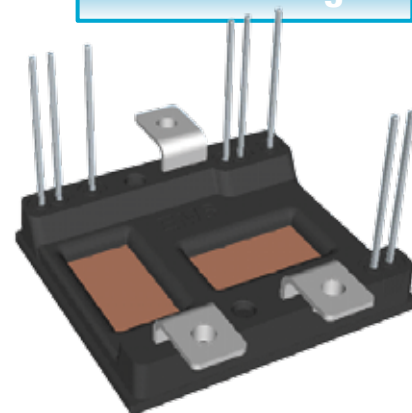
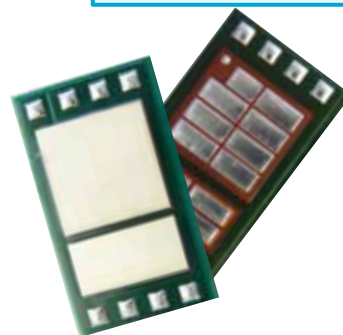
COOLiR²Die and COOLiR²Bridge packaging platforms complement the silicon technologies by eliminating handling of ultra-thin die as well as wire bonding, enabling double sided cooling, superior reliability and very compact system design.

COOLiRDiode™ & COOLiRIGBT™

COOLiR<sup>2</sup>Die™

COOLiR<sup>2</sup>Bridge™

IR's  
automotive  
sub-system  
building  
blocks for  
HEV solutions



#### COOLiR<sup>2</sup> ADVANTAGES:

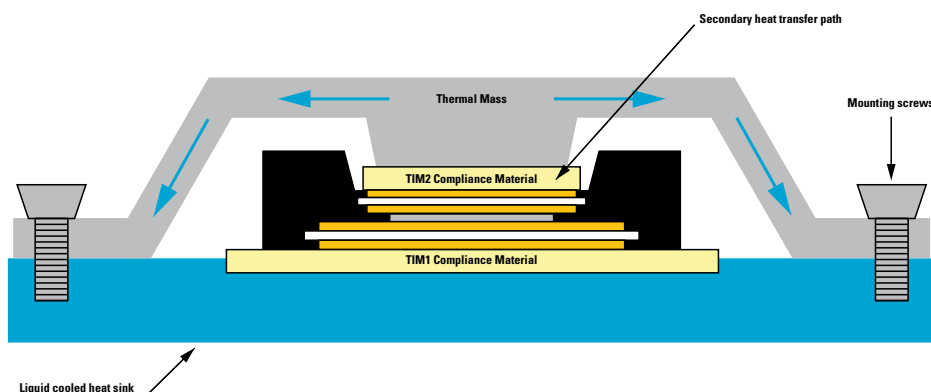
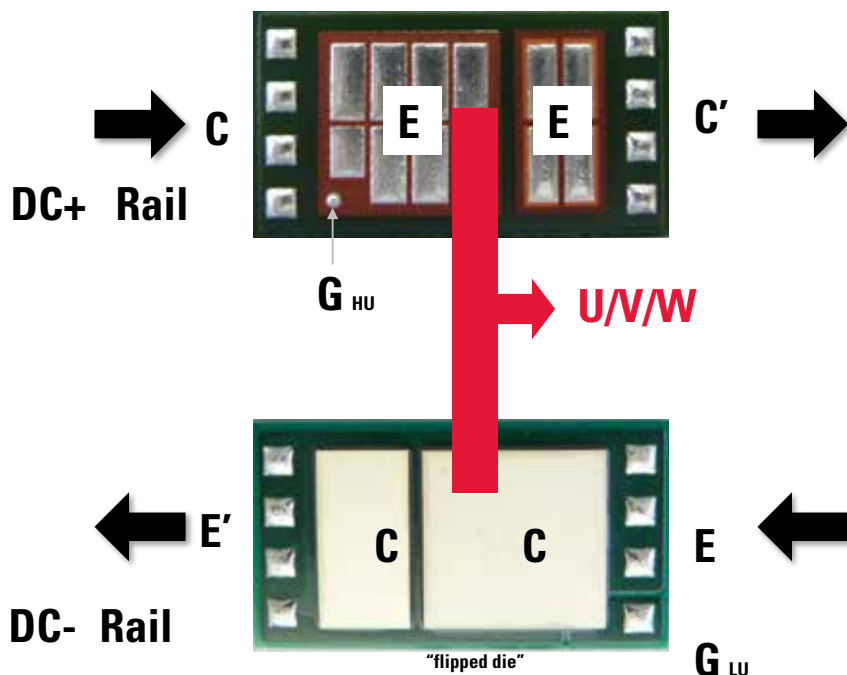
- Flexibility and scalability enable customized solutions and integration of electro-mechanics and power electronics (mechatronics)
- Dual-sided cooling, higher power density
- No wirebonds, improved reliability
- Low package and circuit resistance ( $< 100 \mu\Omega$ )
- Low package and circuit inductance

#### COOLiR<sup>2</sup>Die

Simplified substrate design and efficient signal routing give the freedom to mount the collector up ("die up") or down ("flipped die") adding new possibilities in designing compact circuits with ultra-low parasitics.

Using one flipped die and one die up builds a very compact and efficient half-bridge.

Flexible cooling arrangements including double sided cooling and a  $T_{jmax}$  of  $175^{\circ}\text{C}$  in both COOLiR<sup>2</sup>Die and COOLiR<sup>2</sup>Module enable up to 79% greater current handling capability over conventional wire bonded modules.



## COOLiRIGBT™ Gen.1

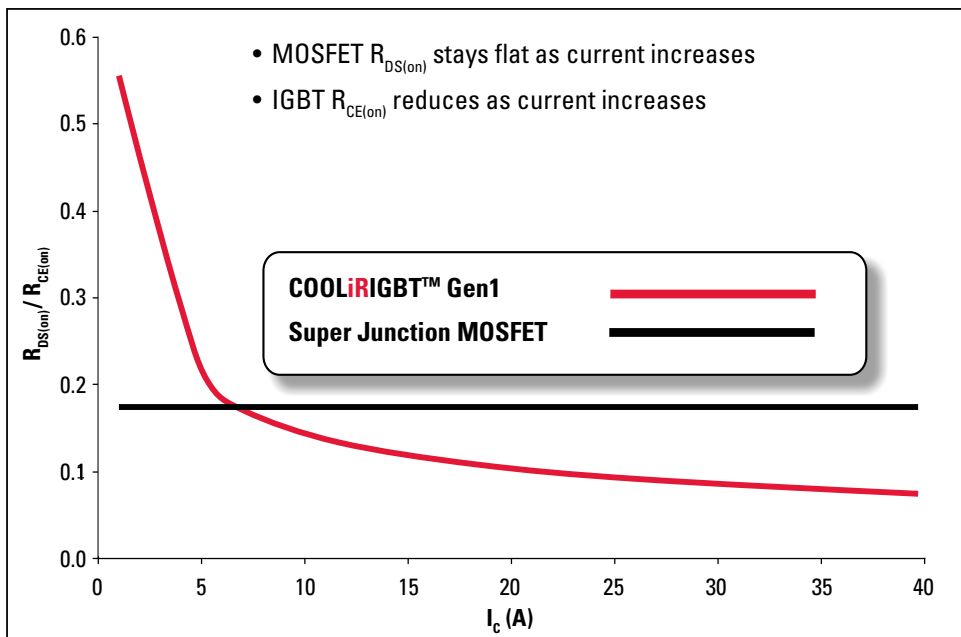
IR's ultrafast switching COOLiRIGBTs Gen1 are tailor-made according to the needs of fast switching, high power HEV/EV applications such as DC-DC converters and battery chargers.

By using ultra-fast COOLiRIGBTs International Rectifier has optimized cost and efficiency to simplify the development of automotive high power applications.

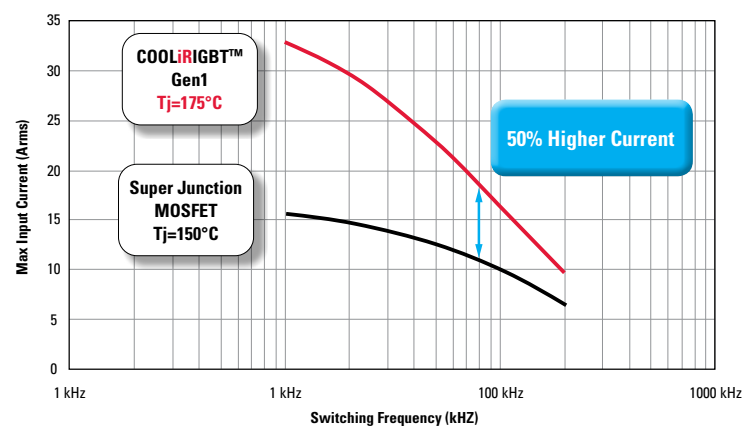
**IGBTs offer reduced conduction losses and greater efficiency at higher currents than a MOSFET.**

### COOLiRIGBT™ Gen.1 ADVANTAGES:

- Tj Max of 175°C
- Devices optimized for high frequency switching applications
- 600V rated devices with a short circuit rating of > 5μs
- Switching frequencies up to 200kHz
- Paired with an optimal diode
- $V_{CE(on)}$  typ. of 1.8V
- Large dies offering excellent efficiency at high currents



	Super Junction MOSFET	COOLiRIGBT™ Gen1
Tj Max	150°C	175°C
Manufacturability	Complex	Simple
Switching Frequency	High	High
Losses At High Currents	High	Low



**Super Junction MOSFETs have been the choice of switch in high frequency and high voltage applications, until now...**

**COOLiRIGBT with Tjmax=175°C offers a maximum current increased by 50% compared to leading SJMOSFETs on the market.**



# A COOLiR™ Solution

## MAIN INVERTER

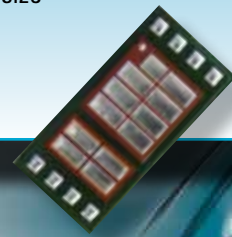
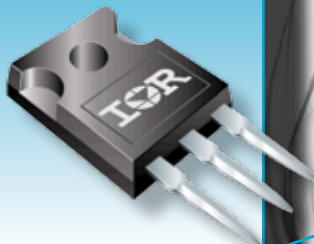
### COOLiR<sup>2</sup>Bridge™ + COOLiR<sup>2</sup>Die™

- Flexible cooling configurations (single/double sided) lowering  $R_{th}$
- High power density
- Superior electrical performance
- Package inductance of  $< 12nH$
- Package resistance  $< 0.5m\Omega$
- Elimination of wire bond dramatically improves reliability while reducing cost and size

## AC COMPRESSOR

### COOLiR<sup>2</sup>IGBT™ Gen.2

- Superior robustness and reliability
- Cost effective
- Superior efficiency
- $T_{jmax}$  175°C
- BV of 680V





## MAIN INVERTER

### COOLiRIGBT™ Gen.2

- Very high current density with good heat dissipation capability
- Reduced size and weight
- Cost effective
- Tsc of  $> 6\mu\text{s}$  at  $150^{\circ}\text{C}$
- Reduced power losses and switching losses due to wire bond elimination



## DC-DC CONVERTER

### COOLiRIGBT™ Gen.1

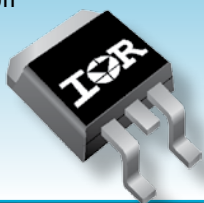
- Capable of frequencies up to 200kHz
- Diode with superior trr and no oscillation
- $T_{j\text{max}}$   $175^{\circ}\text{C}$



### BATTERY CHARGER

#### COOLiRIGBT™ Gen.1

- High efficiency, cost competitive IGBT technology
- IGBT capable of high power and high frequencies
- Optimal diode with low ringing and no oscillation



## COOLiRIGBT™ Gen.2

A new trench platform specifically designed for HEV/EV motor drive applications. Thin wafer technology enables very low  $V_{CE(on)}$  while being highly cost effective, offering outstanding performance in main inverter, AC compressors and other motor control applications.

#### COOLiRIGBT™ Gen.2 ADVANTAGES:

- Very low conduction losses
- $T_j$  max 175°C
- BV of 680V at 25°C
- Tsc of > 6μs at 150°C
- Available as bare die as well as in traditional and performance packages

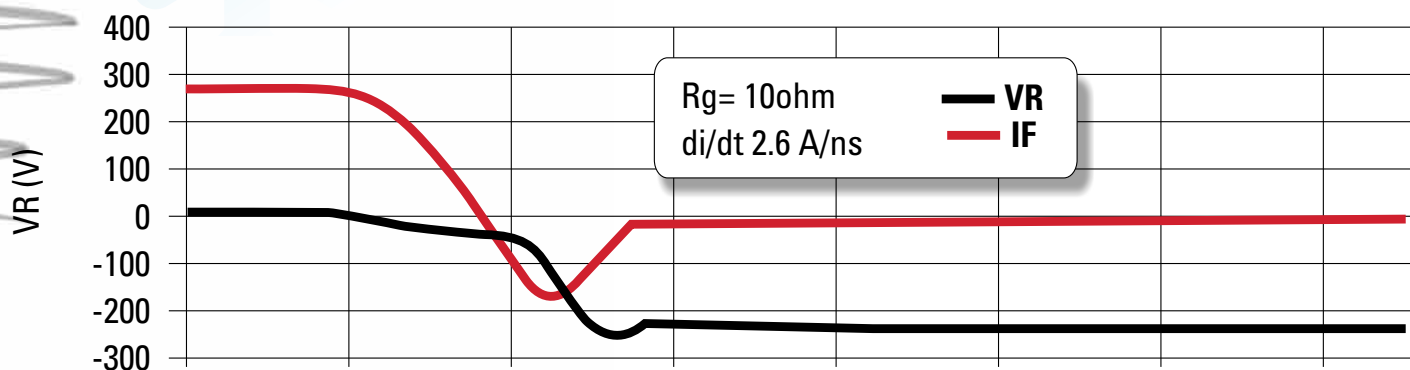
## COOLiRDiode™ Gen.2

The complementary COOLiRDiode was developed specifically for COOLiRIGBTs, offering excellent switching performance with minimal ringing and no oscillation even at low currents.

#### COOLiRDiode™ Gen.2 ADVANTAGES:

- $T_j$  max 175°C matching IGBT
- BV of 680V at 25°C
- Double sided cooling
- Soft recovery without oscillation
- Low  $V_f$  and low Err versions

Oscillation-Free, Soft Recovery of COOLiRDiode™ Gen.2





### Product Line

### Applications

### Key Products



#### Energy Saving Products

Integrated design platforms that enable customers to add energy-conserving features that achieve lower operating energy costs and manufacturing Bill of Material (BOM) costs.

- Appliances
- Audio
- Display
- Industrial
- Lighting
- SMPS

- Digital Control ICs
- High-Voltage ICs
- IGBTs
- IIRAM Integrated Power Modules
- MERs
- $\mu$ IPM™



#### Enterprise Power

Optimized power management system solutions that deliver benchmark power density, efficiency and performance in enterprise power.

- Servers
- Storage Networks
- Switchers & Routers
- Workstations
- Notebooks
- Game Stations
- Set-Top Box

- DirectFET®plus
- SupIRBuck®
- PowIRstage®
- CHiL Digital Controllers



#### Automotive

Automotive grade power management solutions qualified to meet the needs of 12V, 24V and HEV/EV applications with a zero defect goal.

- AC and DC Motor Drives
- Powertrain / Engine control
- Body Electronics
- Lighting
- Class D Audio
- Heavy Loads and Actuators

- Automotive Qualified:
- HEXFET® Power MOSFETs
  - Intelligent Power Switches
  - Driver ICs
  - IGBTs
  - DirectFET®2
  - COOLiR™



#### Benchmark MOSFETs

IR continues to lead the industry by offering power MOSFETs with the lowest  $R_{DS(on)}$  and widest range of packages up to 250V for a diverse range of applications.

- Audio
- Computing
- Communications
- Motor Control
- Power Supply
- Synchronous Rectification

- Discrete HEXFET® MOSFETs
- Dual HEXFET® MOSFETs
- FETKY®
- DirectFET®
- StrongIRFET™
- FastIRFET™



#### HiRel

Our discrete components, complex hybrid power module assemblies and rugged DC-DC converters utilize leading-edge power technology which, together with demanding environmental specifications help engineers to meet their toughest design challenges.

- Space
- Military
- Commercial Aviation
- Rugged Industrial
- Medical

- RAD-Hard MOSFETs
- Power Modules/Hybrid Solutions
- Motor Control Solutions
- DC-DC Converters