



# Power Management

Selection Guide 2015





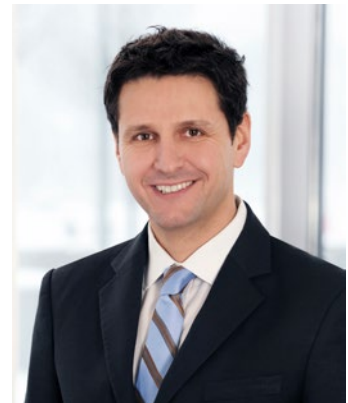
Dear Customer,

**Our world is facing huge challenges**

The world population is rising, energy demand is increasing rapidly and we are seeing alarming climate changes. It is essential to preserve our natural resources, choose renewable energy forms and put tremendous efforts into optimizing energy efficiency. Our solutions maximize electricity savings along the entire supply chain – from generation to distribution to consumption – setting benchmarks for energy efficiency and power density.

**Our passion is to understand your systems and offer the best solutions**

By using our products and systems, you gain in innovation and cost-performance in your applications – including Servers, Telecom Systems, Computers, Game Consoles, Smart Phones, Cellular Infrastructure and Lighting Solutions. Product families such as CoolMOS™, OptiMOS™ or the combination of power transistors and ICs in the most advanced packaging technologies as well as digital power platforms enable a completely new level of efficiency and compactness. We are proud that well-known customers trust our competence and use our solutions for their competitive advantage. Infineon is becoming even stronger and we are looking forward to unleashing great potential in the power industry – our experts combine Infineon semiconductors and control architecture in a unique way to make your products more efficient, more cost effective and altogether more successful. Please be invited to let our new Power Management Selection Guide 2015 inspire you to find the right energy efficient products and solutions for your purpose!



A stylized, handwritten signature in blue ink, consisting of a large 'U' followed by a horizontal line and a curved flourish.

**Andreas Urschitz**  
Division President of  
Power Management & Multimarket

电源管理及多元化市场事业部总裁

尊敬的用户,

**我们的世界正面临着巨大的挑战**

世界人口正在增长, 能源需求急剧增加, 我们面临着惊人的气候变化。我们必须保护我们的自然资源, 选择可再生能源, 并且在优化能源效率方面付出极大的努力。我们的解决方案是最大限度地在整个从发电、输送到用电的供应链中节省电力, 以此为能源效率和功率密度设定行业标杆。

**我们的动力是了解您的系统, 并提供最好的解决方案。**

通过使用我们的产品和系统, 你获得了创新和性价比高的应用, 包括服务器、电信系统、电脑、游戏机、智能手机、蜂窝通信基础设施和照明解决方案。产品系列如CoolMOS™ 或OptiMOS™, 以最先进的封装技术结合的功率晶体管和专用集成电路, 以及数字电源平台, 造就了全新水平的效率和紧凑。知名客户信任我们的能力, 使用我们的解决方案来提高其竞争优势, 为此我们感到很自豪。英飞凌日益强大, 我们期待着释放在电力行业的巨大潜力 – 我们的专家将英飞凌半导体和控制架构以一种独特的方式结合, 使得您的产品更高效, 更经济, 更成功。请让我们新版的2015电源管理选型指南带您找到符合您目标的正确的节能产品和解决方案。

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We shape Power Management -  
We live Energy Efficiency



# .dp digital power™ 2.0

## Simplify Innovation

Power supply development migrates from analog to digital design, to achieve smaller form factors and higher efficiency. Infineon is introducing .dp digital power™ 2.0 to simplify your innovations. The new digital IC family is the first all-in-one package solution that integrates a digital power controller with key peripherals.

**.dp digital power 2.0 will be introduced to the broader market by 2015.**

### Key Benefits of a digital switched mode Power Supply

- Technical enhancement and cost saving go hand-in-hand
- Firmware gives flexibility over fixed analog design
- Cost saving and faster time to market increase competitiveness

### Your advantage

- More flexibility through digital approach
- Simplify the management of product variation
- Shorten development cycles down by 70%
- Offer room for customer innovation and own IP
- Advanced energy efficiency
- Reduced system cost and BOM

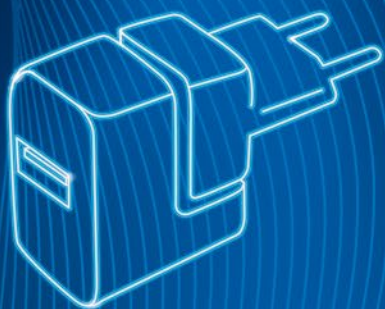
### The value added

For lighting market customers .dp helps to cope with the paradigm shift of LED requirements and to solve actual lighting challenges. For Power Supply customers in the mid-performance sector .dp helps to comply with energy efficiency criteria and provides a much better stand-by management.

[www.infineon.com/digitalpower](http://www.infineon.com/digitalpower)

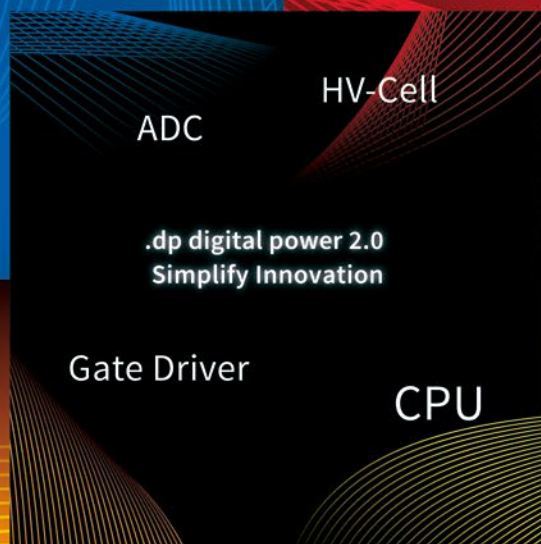
## Increase efficiency

.dp power supplies achieve smaller form factors and higher efficiency.



## Reduce costs

.dp cuts development cycles, OPEX and BOM considerably!



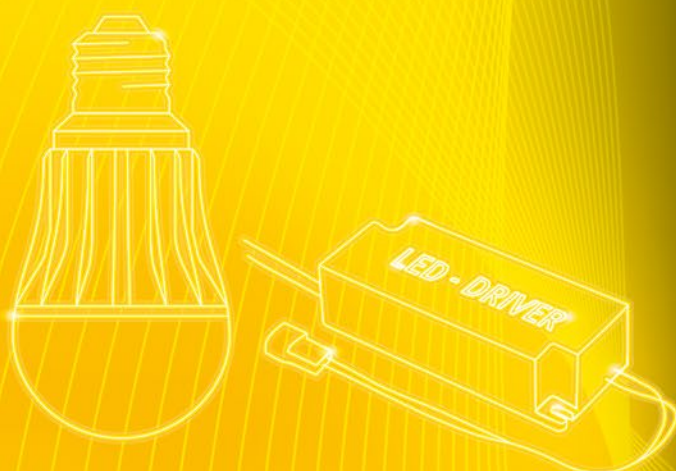
## Maximize flexibility

Adapters with .dp inside charge mobile devices significantly faster.



## Boost performance

LED drivers with .dp inside improve the lifetime of valuable LED components.

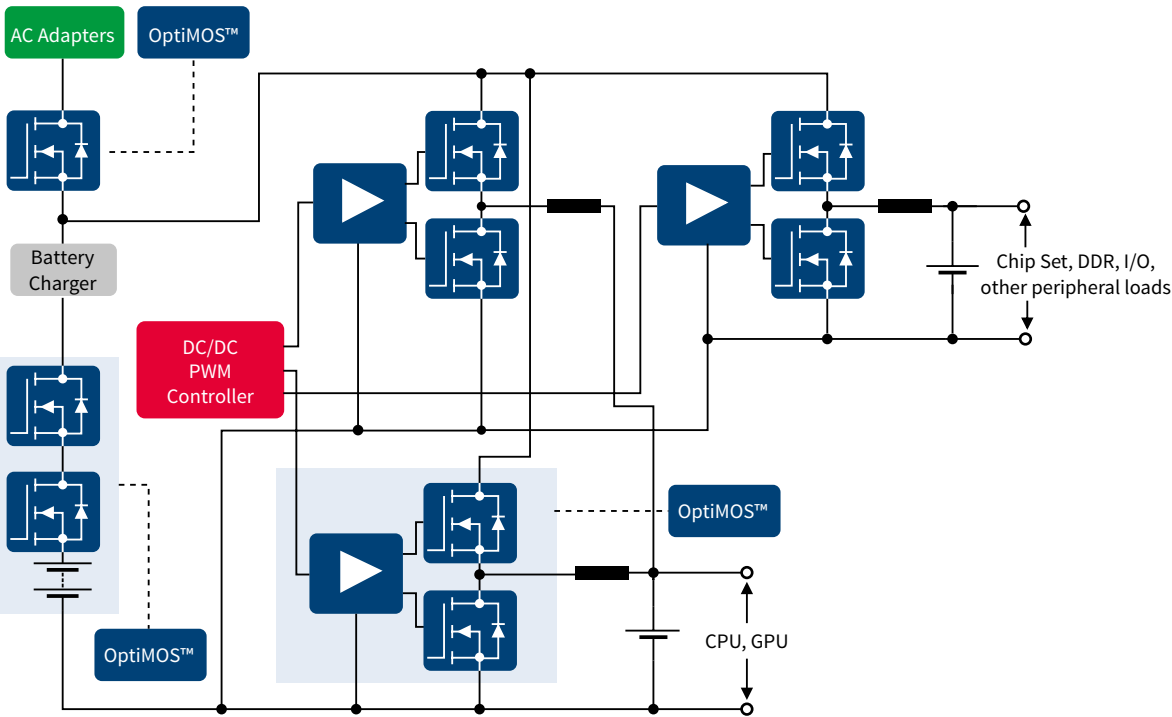




# DC/DC Computing

## Small and Cool System Power for Notebooks

Benchmark technologies significantly improve switching losses in power stages and drivers and thus improve battery lifetime and system reliability. Highest efficiency at all load conditions enables system designers to overcome thermal challenges to reach a new level of system miniaturization. Our latest portfolio of Notebook products is consequently optimized along the requirements of the next generation Notebook platforms and easy to design-in.



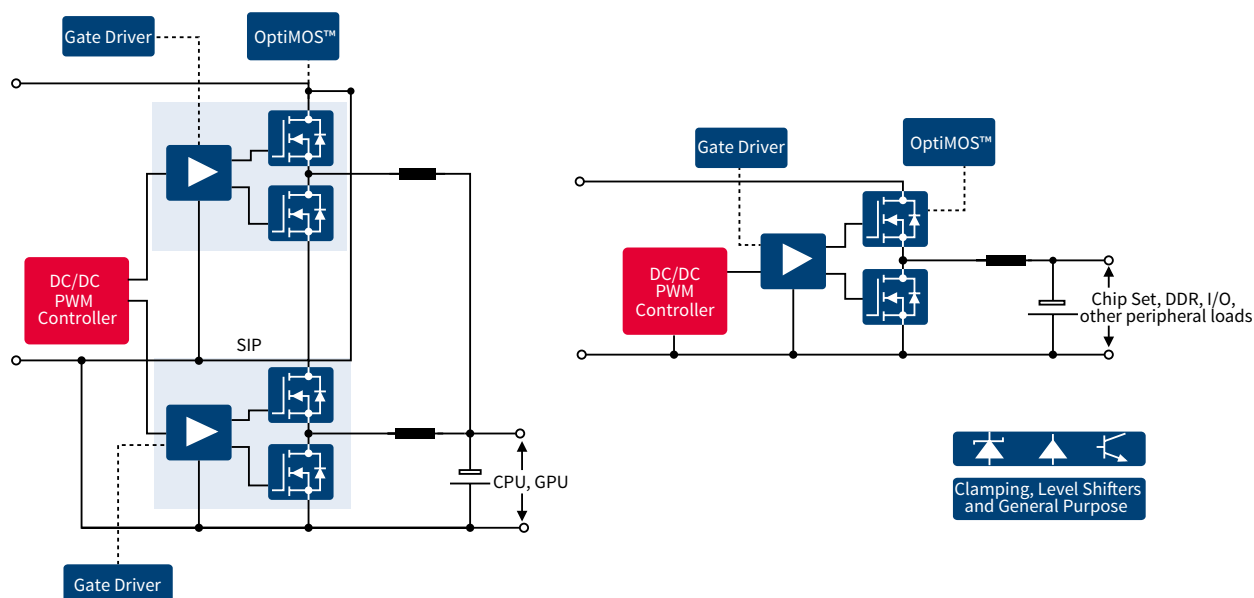
Notebook	Topology	Voltage Class	Technology	Selection
DC/DC	Buck Converter	30V	OptiMOS™	Recommendation
Controller	Buck Converter	See page 137 for further information		



# DC/DC Computing

## Highest Power Density for Server, Desktop and Graphic Cards

Power management system solutions based on OptiMOS™ technology increase Energy Efficiency in all load conditions, reduce required PCB real estate and are easy to use. Our benchmark solutions demonstrate greatly increased efficiency, even at high currents and high switching frequencies. This supports system designers to achieve efficiency as well as power and thermal requirements with a reduced number of phases and thus save overall system cost.



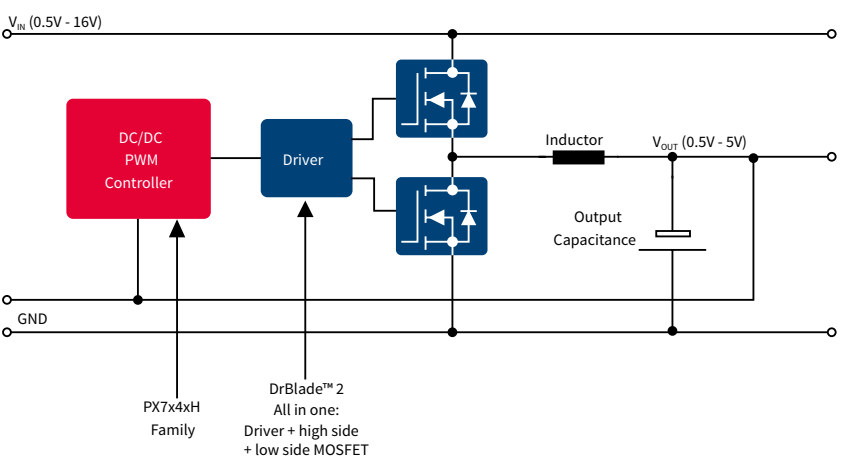
Server, Desktop and Graphic Cards	Topology	Voltage Class	Technology	Selection
DC/DC	Buck Converter	25V	OptiMOS™	Recommendation
	Buck Converter	30V	OptiMOS™	Reference
Gate Driver	Buck Converter	12V	PX3517	Recommendation
SIP	Buck Converter	16V	TDA21320	Recommendation
Controller	Buck Converter	See page 137 for further information		



# DC/DC Computing

## Point of Load Power Management for Superior Performance

Our power architectures address the need for more accurate and efficient power delivery to support increasingly challenging requirements of today’s microprocessors, memories, ASICs and FPGAs. The voltage regulators can be optimized and configured while actively regulating; the final configuration is then permanently stored inside the controller chip non-volatile memory eliminating the need for external configuration components. Combined with DrBlade™ 2 (TDA21320) the voltage regulators can achieve > 95% efficiency depending on operating conditions. Designs with output voltages of up to 5.0V are supported. Point of Load is used in Datacom, Computing and Telecom.



Point of Load	Topology	Technology	Selection
Controller	Buck Converter	Highly parameterized fully digital controller	Recommendation
Power Stage	Buck Converter	DrBlade™ 2 – SiP (driver and FETs)	Recommendation

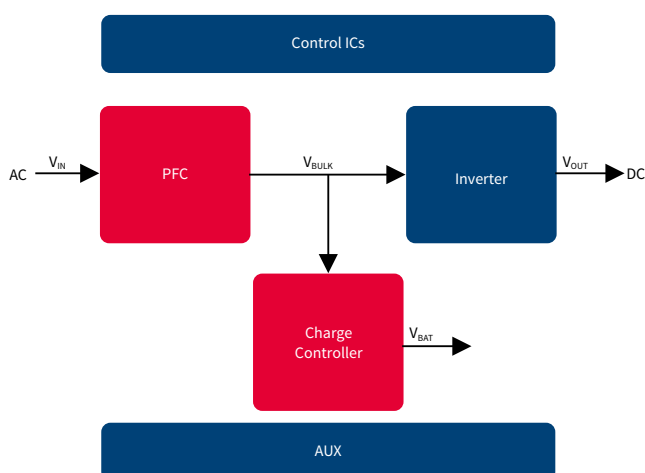


# Uninterruptable Power Supply (UPS)

Attractive Solutions for Highest Efficiency and Power Density

Infineon offers a wide range of cost-effective products for Uninterruptable Power Supply (UPS), for all its stages. This includes IGBTs, diodes and control ICs for AC/DC and DC/AC stages, as well as for the battery charge control circuitry and switches for the auxiliary Power Supply.

The recently launched 650V TRENCHSTOP™ 5 IGBTs in combination with Rapid diodes support the trends towards continuously increasing system efficiency, power density and reducing the cost of ownership for UPS users.



Stage	Topology	Voltage Class	Technology	Selection
PFC	Boost PFC	600V / 1200V	TRENCHSTOP™	Ease-of-use
	Boost PFC	600V / 1200V	HighSpeed 3	Efficiency
	Boost PFC	650V	TRENCHSTOP™ 5	Efficiency
	Boost PFC	650V	Rapid Diode	Efficiency
Inverter	NPC1	600V	TRENCHSTOP™	Ease-of-use
	NPC1	600V	HighSpeed 3	Efficiency
	NPC1	650V	TRENCHSTOP™ 5	Efficiency
	NPC1	650V	Rapid Diode	Efficiency
	NPC2	1200V	TRENCHSTOP™ 2	Ease-of-use
	NPC2	1200V	HighSpeed 3	Efficiency
	NPC2	650V	TRENCHSTOP™ 5	Efficiency
	NPC2	650V	Rapid Diode	Efficiency
Charger controller	Half bridge	1200V	HighSpeed 3	Efficiency
Driver IC	-	1200V	EiceDriver™ Compact	Recommendation
AUX	-	650V-800V	CoolSET™	Recommendation



# SMPS

## Charger

High power density and cost effective Power Supplies can be designed by operating the converter at a higher switching frequency to avoid a considerable increase in transformer and output capacitor size. In realizing the required thermal performance and EMI behavior, power devices with lower FOM ( $R_{DS(on)} * Q_g$ ) and controlled switching behavior enable effective and fast R&D development due to their lower losses and smoother waveforms. Semiconductor devices in SMD packages enable optimal PCB layout through minimal footprint and are very well fit for automatized large volume production.

The CoolMOS™ high voltage MOSFET and OptiMOS™ low voltage MOSFETs portfolios enable high power density designs whilst keeping your thermal requirements under control.

### High Voltage MOSFETs

An efficiency optimized solution can be achieved with CoolMOS™ C6/E6 families. Both families include a gate resistor which gives a good balance in ease-of-use, efficiency and reduced EMI. For cost sensitive Consumer applications we recommend CoolMOS™ CE family. This technology offers smoother waveforms, lesser dv/dt and RFI and an internal gate resistor for ease-of-use. Nevertheless, our technology still achieves better efficiency and thermal behavior than standard MOSFETs.

Topology	Voltage Class	Technology	Benefit
Flyback	600V/650V	CoolMOS™ C6/E6	<ul style="list-style-type: none"> <li>High efficiency due to lower <math>R_{g,int}</math> (E6)</li> <li>Easy control of switching behavior</li> </ul>
Flyback	600V/650V	CoolMOS™ CE	<ul style="list-style-type: none"> <li>Best price competitive CoolMOS™ family</li> <li>Lower switching losses vs. standard MOSFET</li> <li>Controlled dv/dt and di/dt for better EMI</li> </ul>

### Low Voltage MOSFETs

The OptiMOS™ 60V, 80V and 100V families have the lowest  $R_{DS(on)}$  when compared to other similar devices. This helps to keep conduction losses to a minimum, benefiting the thermal management of the charger. The lower output charge of the OptiMOS™ family reduces the overshoot in the Synchronous Rectification stage.

Topology	Voltage Class	Technology	Benefit
Flyback	60V - 100V	OptiMOS™ 5	<ul style="list-style-type: none"> <li>Low conduction losses, reduced overshoot</li> </ul>
Synchronous Rectification	60V - 100V	OptiMOS™ 5	<ul style="list-style-type: none"> <li>Low conduction losses, reduced overshoot</li> </ul>

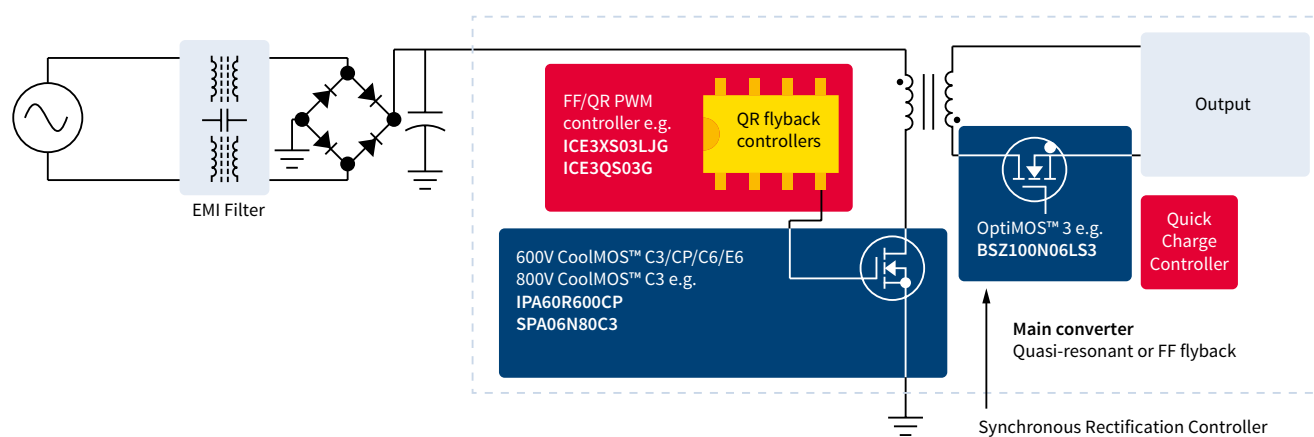


### Control ICs

Quasi-Resonant Flyback topology is known to have high efficiency and low EMI performance compared with the Fixed Frequency Flyback topology as the system is switching at the valley point for each switching cycle. ICE2QS03G inherits the QR topology and enhances performance through 7 valley switching points to reduce the switching frequency. Also, the patented active burst mode feature enhances the light load standby power.

Topology	Voltage Class	Technology	Benefit
QR Flyback IC	500V	ICE2QS03G	■ High efficiency, low standby power

### Discrete Solution Blockdiagram





# SMPS

## Adapter

Manufacturing of slimmer and lighter Adapters requires ICs enabling high efficiency with good EMI performance and low standby power and cost effective MOSFETs in small packages that feature good electromagnetic interference (EMI) and excellent thermal performance.

Infineon offers a wide range of products for Adapters including high voltage MOSFETs and control ICs for PFC and PWM stages, as well as low voltage MOSFETs for Synchronous Rectification. With these products, Infineon supports the trend towards a significantly higher efficiency level, especially in partial load conditions, as well as miniaturization of the Adapter. Especially versatile are the CoolMOS™ C6/E6 and P6 families which combine high efficiency with ease-of-use. For Synchronous Rectification, Infineon's OptiMOS™ series offers extremely low on-state resistance and low capacitances. New control ICs support topologies such as Quasi-Resonant Flyback and LLC, which have become increasingly significant within the Notebook Adapter segment. In order to offer a complete power electronics solution perfectly complementing Infineon's portfolio, the new hyperfast Rapid Silicon diode family has been introduced for the PFC stage.

Regional regulations and a general increased sensitivity toward the containment of electronic waste are pointing towards the adoption of universal Adapters. The implementations methodologies and protocols are not yet harmonized, however Infineon is already closely monitoring and partnering with the decision makers to timely insure the offer of a competitive semiconductor solution. The capability to efficiently manage different power classes and protocols will be key in this application and Infineon is getting ready for supporting Adapter makers in this challenge.

### High Voltage MOSFETs

For efficiency driven and high power density applications, CoolMOS™ P6 family is the recommended solution due to low switching losses even in high switching frequency operation. For standard Adapters, where ease of design and good EMI behavior are the main priorities, CoolMOS™ CE offers higher internal gate resistance for softer voltage and current transition.

Topology	Voltage Class	Technology	Benefit
DCM PFC	600V	CoolMOS™ P6	<ul style="list-style-type: none"> <li>Fast switching speed for improved efficiency and thermals</li> <li>Reduced gate charge for enhanced light load efficiency</li> <li>Optimized <math>V_{gs}</math> threshold for lower turn-off losses</li> </ul>
Flyback	600V	CoolMOS™ P6	
HB LLC	600V	CoolMOS™ P6	
DCM PFC	500V/600V	CoolMOS™ CE	<ul style="list-style-type: none"> <li>Easy control of switching behavior due to higher <math>R_{g,int}</math></li> <li>Better transition losses vs. standard MOSFET</li> </ul>
Flyback	500V/600V	CoolMOS™ CE	
HB LLC	500V/600V	CoolMOS™ CE	
DCM/CCM PFC	650V	CoolMOS™ C6/E6	<ul style="list-style-type: none"> <li>Easy control of switching behavior even in not optimized layout</li> <li>Better switching losses in comparison with its predecessor</li> <li>Rugged body diode which prevents device failure during hard commutation</li> </ul>
HB LLC	650V	CoolMOS™ C6/E6	

### Low Voltage MOSFETs

The OptiMOS™ 80V, 100V and 120V families have the lowest  $R_{DS(on)}$  when compared to other similar devices. This helps to keep conduction losses to a minimum, benefiting the thermal management. The lower output charge of the OptiMOS™ family reduces the overshoot in the Synchronous Rectification stage.

Topology	Voltage Class	Technology	Benefit
Flyback	80V - 120V	OptiMOS™	<ul style="list-style-type: none"> <li>Low conduction losses, reduced overshoot</li> </ul>

## Boost Diodes

For DCM PFC topologies, a low forward voltage diode is recommended. Rapid 1 diodes have a low and temperature-stable forward voltage to simplify design effort.

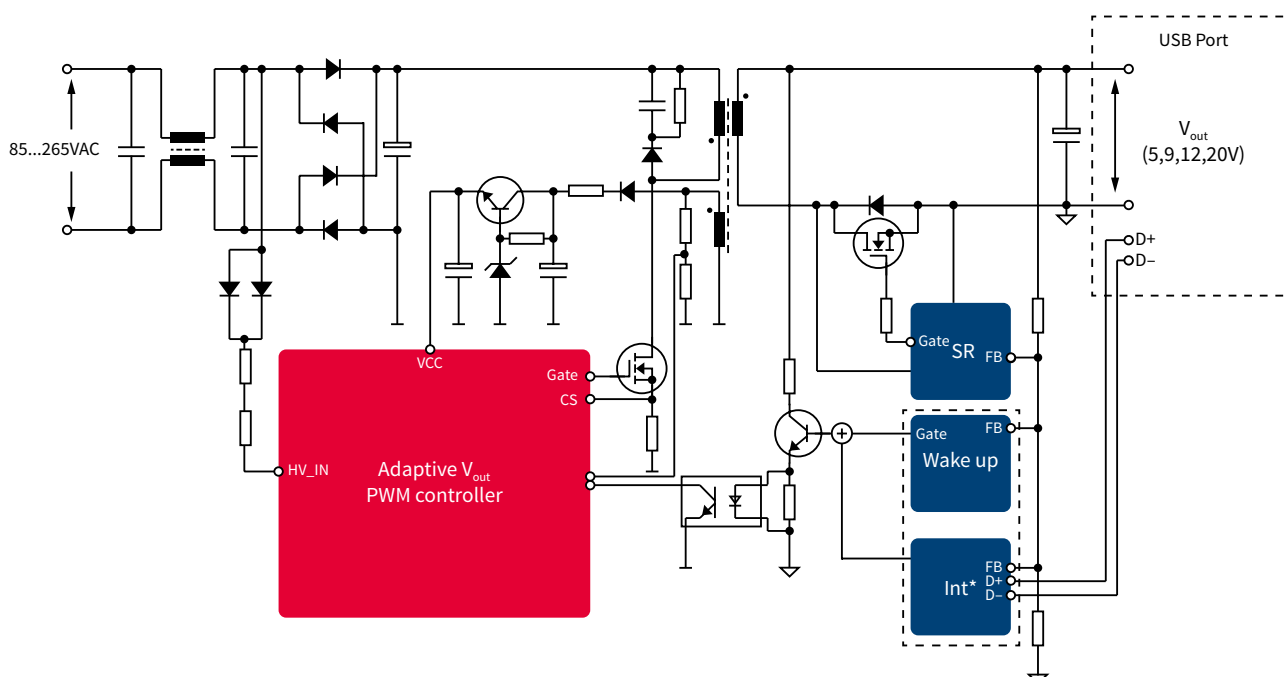
Topology	Voltage Class	Technology	Benefit
DCM PFC	650V	Rapid 1	■ Low conduction losses

## Control ICs

ICE2QS03G can achieve high efficiency and low standby power performance as it adopts the QR topology and Infineon's patented active burst mode feature. TDA486x (G) is a DCM PFC IC which can achieve a power factor close to 1 and low Total Harmonic Distortion (THD).

Topology	Voltage Class	Technology	Benefit
QR Flyback IC	500V	ICE2QS03G	■ High efficiency, high standby power
DCM PFC IC	650V	TDA486x(G)	■ High PFC, low THD

## Blockdiagram





# SMPS

PC Silverbox

Latest PC models dramatically cut active and standby energy consumption by implementing more efficient Power Supply Units (PSU) and low power processors and chipsets.

Today's requirement for OEM PC power is a small form factor with better performance and embedded diagnostics. An intelligent control scheme that enables the adaption of load variation to minimize power consumption, together with optimized power semiconductors, is the key in meeting market demands. Proven reference designs are available to help designers to develop the best-possible PC Power Supply solutions – from greater efficiency to lower overall system cost.

## High Voltage MOSFETs

CoolMOS™ P6 family is the recommended solution to achieve a compact form factor with the highest efficiency even at very light load conditions. This is due to its optimized  $E_{on}$  and  $E_{off}$  losses without the compromise in performance during hard commutation. CoolMOS™ CE is an alternative option for a price driven segment where the main concern is the maintenance of design robustness even if the board layout is not optimized.

Topology	Voltage Class	Technology	Benefit
DCM/CCM PFC, HB LLC	600V	CoolMOS™ P6	<ul style="list-style-type: none"> <li>Fast switching speed for improved efficiency and thermals</li> <li>Low gate charge for enhanced light load efficiency and low power consumption at no load condition</li> <li>Optimized <math>V_{gs}</math> threshold for lower turn-off losses</li> <li>Rugged body diode for HB LLC application</li> </ul>
DCM/CCM PFC, HB LLC	600V	CoolMOS™ C6/E6	<ul style="list-style-type: none"> <li>Easy control of switching behavior even in not optimized layout</li> <li>Better switching losses in comparison with its predecessor</li> <li>Rugged body diode which prevents device failure during hard commutation</li> </ul>
DCM/CCM PFC, HB LLC	500V	CoolMOS™ CE	<ul style="list-style-type: none"> <li>Easy control of switching behavior due to higher <math>R_{g,int}</math></li> <li>Better transition losses vs. standard MOSFET</li> </ul>

## Low Voltage MOSFETs

For Synchronous Rectification and DC/DC, we recommend our OptiMOS™ 40V and 60V families which combine extremely low on-state resistance with low capacitances.

Topology	Voltage Class	Technology	Benefit
HB LLC + center-tap	40V	OptiMOS™	Optimized cost/performance, layout tolerance
HB LLC + center-tap	60V	OptiMOS™	Layout tolerance, low thermals

## Boost Diodes

For DCM PFC topologies, a low forward voltage diode is recommended. Rapid 1 diodes have a low and temperature-stable forward voltage to simplify design effort. For CCM PFC topologies, a low reverse recovery charge diode is used to minimize diode switching losses. Rapid 2 diodes have a low peak reverse recovery current that lowers both diode switching losses and PFC switch turn-on losses.

Topology	Voltage Class	Technology	Benefit
DCM PFC	650V	Rapid 1	Low conduction losses
CCM PFC	650V	Rapid 2	Low reverse recovery losses and PFC switch turn-on losses

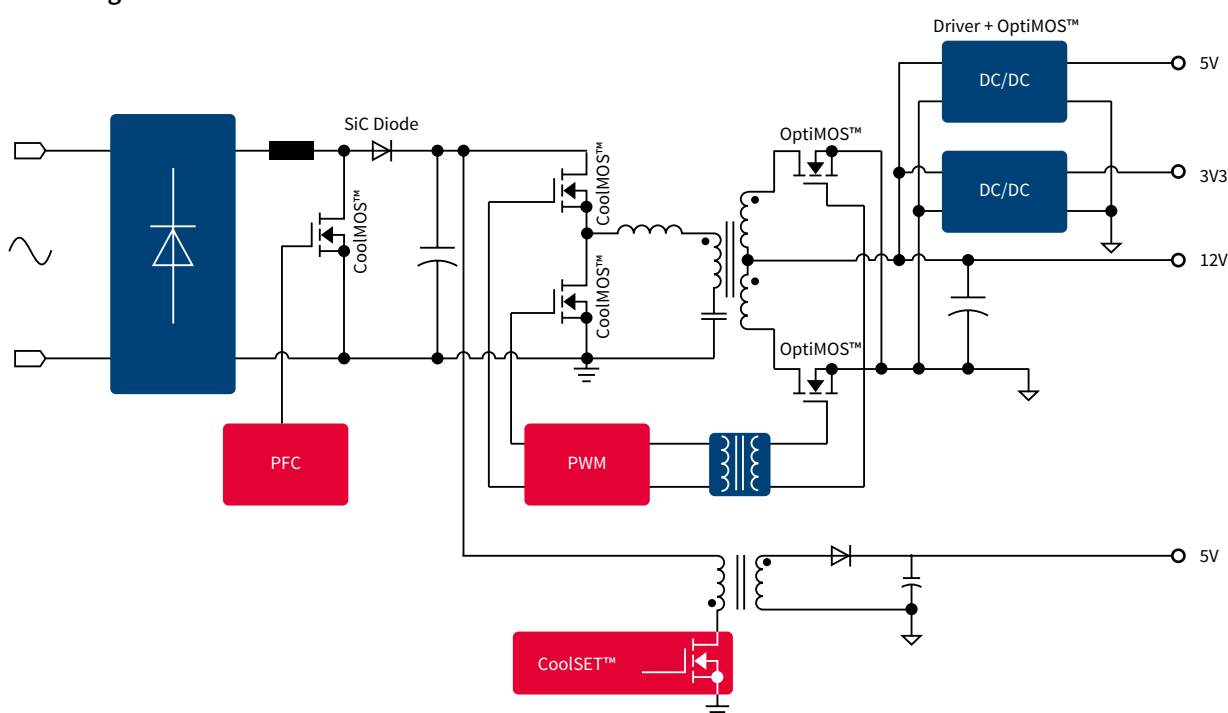


### Control ICs

QR/FF CoolSET™, either 650V or 800V, is the best choice for the auxiliary power. Most importantly it can achieve very low standby power. It is cost effective and easy to use. ICE3PCS0xG is the latest CCM PFC IC which implements digital control and can achieve high PFC, low THD and fast response. ICE1/2HS01G is the novel resonant LLC half-bridge controller IC which is easy to use and can achieve high efficiency and low EMI by ZVS switching.

Topology	Voltage Class	Technology	Benefit
QR/FF Flyback CoolSET™	650V/800V	ICE2QRxx65/80(Z)(G) ICE3xRxx65/80J(Z)(G)	■ Low standby power, high efficiency
CCM PFC IC	800V	ICE3PCS0xG	■ High PFC, low THD
HB LLC IC	650V	ICE1HS01G-1 ICE2HS01G	■ High efficiency, low EMI

### Blockdiagram





# SMPS

## TV Power

In addition to their outstanding image quality, new generation TVs gain attention for their user interface, low power consumption and for the slim silhouette. Power Supply Unit (PSU) with a high degree of embedded intelligence and a low profile to maintain the TV's slim appearance are required. Infineon's Power Supplies feature power metering and communication of diagnostics, characterized by high efficiency, good thermal and EMI performance while keeping short design cycles, avoiding R&D cost increase and still being highly cost-effective.

### High Voltage MOSFETs

A low profile Power Supply within a demanding thermal environment will require excellent thermal performance parts with low losses even at high switching frequencies. CoolMOS™ P6 family addresses this challenge with enhanced turn-on and turn-off losses which results in better efficiency. For applications that do not operate at high switching frequencies, CoolMOS™ CE/C6/E6 provide gentle switching behavior due to higher output capacitance ( $C_{oss}$ ) and internal gate resistor. This results in low RFI and minimal voltage oscillations resulting in unwanted parasitic due to PCB layout.

Topology	Voltage Class	Technology	Benefit
DCM PFC, HB LLC	600V	CoolMOS™ P6	<ul style="list-style-type: none"> <li>Fast switching speed for improved efficiency and thermals</li> <li>Low gate charge for enhanced light load efficiency and low power consumption at no load condition</li> <li>Optimized <math>V_{gs}</math> threshold for lower turn-off losses</li> <li>Rugged body diode which prevents device failure during hard commutation</li> </ul>
DCM PFC, HB LLC	500V/600V	CoolMOS™ CE	<ul style="list-style-type: none"> <li>Easy control of switching behavior even in not optimized layout</li> <li>Rugged body diode which prevents device failure during hard commutation</li> <li>Better switching losses in comparison with its predecessor</li> </ul>
DCM PFC, HB LLC	600V	CoolMOS™ C6/E6	<ul style="list-style-type: none"> <li>Easy control of switching behavior even in not optimized layout</li> <li>Rugged body diode which prevents device failure during hard commutation</li> <li>Better switching losses in comparison with its predecessor</li> </ul>

### Low Voltage MOSFETs

The OptiMOS™ 5 100V family, along with the OptiMOS™ 3 100V, with the lowest  $R_{DS(on)}$  when compared to other similar devices, help to keep conduction losses to a minimum, benefiting thermal management. The OptiMOS™ 5 family has reduced output charge, which reduces the overshoot in the Synchronous Rectification stage.

Topology	Voltage Class	Technology	Benefit
Flyback	100V	OptiMOS™ 3/5	<ul style="list-style-type: none"> <li>Low conduction losses, reduced overshoot</li> </ul>

### Boost Diodes

For DCM PFC topologies, a low forward voltage diode is recommended. Rapid 1 diodes have a low and temperature-stable forward voltage to simplify design effort.

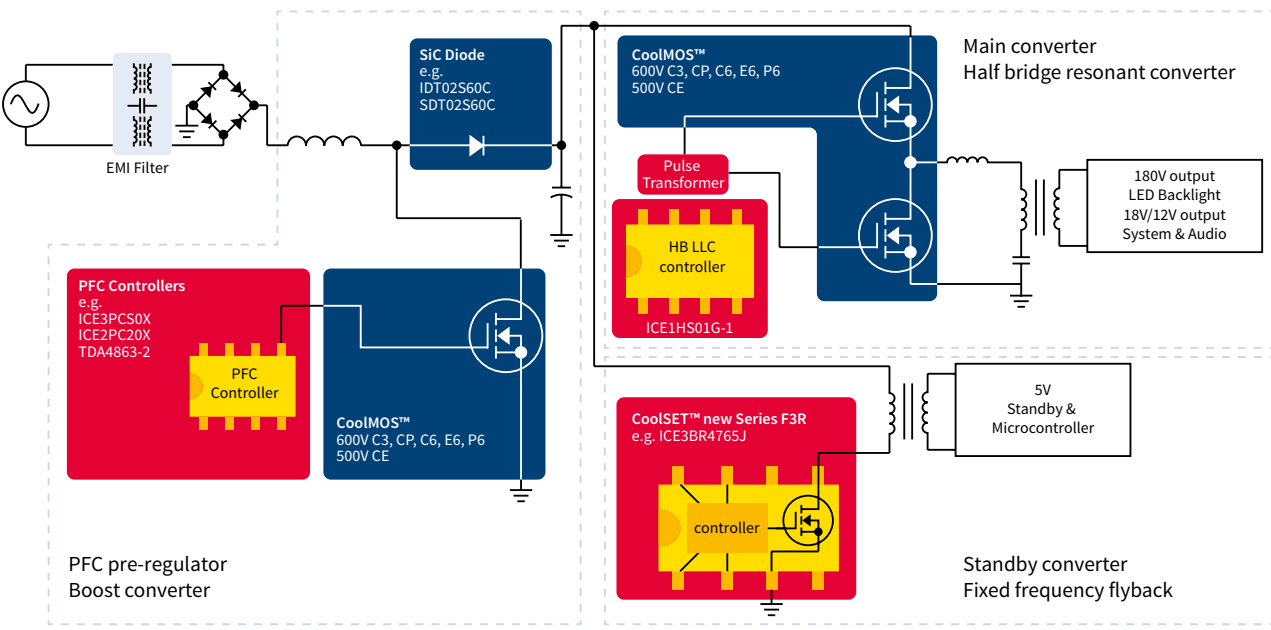
Topology	Voltage Class	Technology	Benefit
DCM PFC	650V	Rapid 1	<ul style="list-style-type: none"> <li>Low conduction losses</li> </ul>

# Control ICs

QR/FF CoolSET™ 650V is the best choice for the auxiliary power. Most importantly, it can achieve very low standby power. TDA486x(G) is a DCM PFC IC which can achieve a power factor close to 1 and low Total Harmonic Distortion (THD). ICE1/2HS01G is the novel resonant LLC half bridge controller IC which is easy to use and can achieve high efficiency and low EMI by ZVS switching. To address the market needs for lower system cost, the upcoming controller ICs will implement efficient digital control modes during standby. This enables the removal of the auxiliary Power Supply while meeting the stringent regulative requirements. A full set of protection features required in TV applications and flexible IC parameterization will complement these innovative IC solutions.

Topology	Voltage Class	Technology	Benefit
QR/FF Flyback CoolSET™	650V	ICE2QRxx65(Z)(G) ICE3xRxx65J(Z)(G)	■ Low standby power, high efficiency
DCM PFC IC	650V	TDA486x(G)	■ High PFC, low THD
HB LLC IC	650V	ICE1HS01G-1 ICE2HS01G	■ High efficiency, low EMI

# Blockdiagram





# SMPS

## Server Power Supply

The rising cost of energy and environmental concerns makes SMPS efficiency optimization a key requirement across the entire load range for Server and Data Center design. This challenging task is combined with the requirement for higher power. In the PFC stage and in general hard switching topologies used in Server applications, Infineon proposes CoolMOS™ C7 family with the lowest FOM  $R_{DS(on)} \cdot Q_g$  and  $R_{DS(on)} \cdot E_{oss}$ . This provides the lowest switching losses necessary in fast switching needed in high-end Server SMPS, optimizing the efficiency starting from very light load operation. The very compact SMD packages such as ThinPAK offer benefits in space and power density, and are used with Infineon's new industry standard non-isolated driver family 2EDN752x (available from mid 2015). Complementary to CoolMOS™ C7 in high efficiency PFC is the SiC diodes Generation 5 family.

The CoolMOS™ P6 family offers a good compromise between price and performance. This is valuable in both PFC and HV DC/DC stages where the low  $Q_g$  and turn-off losses are important benefits, especially in the case of high switching frequency operation and high light load efficiency requirements. In applications with a low output voltage and high output current, further efficiency improvements have been made possible by the continuous reduction of on-resistance by Infineon's low-voltage OptiMOS™ MOSFET series used in the Synchronous Rectification stage.

### High Voltage MOSFETs

The new C7 series offers Best-in-Class performance in CCM Mode PFC enabling highest efficiency to be achieved over the full load range. The world best  $R_{on} \cdot A$  enables smaller footprint packages to be used bringing benefits in power density. The low  $Q_g$  achieves better light load efficiency – an enhanced requirement in today's Server SMPS. Also, the CoolMOS™ C7 enables moving to higher switching frequencies without loss in efficiency, bringing benefits in power density by reducing the size of magnetic components. P6 is a well-balanced product family, which brings high efficiency in PFC topology, but due to its rugged body diode, can also be used in resonant DC/DC topologies such as LLC. The reduced  $Q_g$  leads to benefits in light load efficiency.

Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC; TTF	650V	CoolMOS™ C7	<ul style="list-style-type: none"> <li>Best FOM <math>R_{DS(on)} \cdot Q_g</math> and <math>R_{DS(on)} \cdot E_{oss}</math></li> <li>Lowest <math>R_{DS(on)}</math> per package</li> <li>Low dependency of switching losses from <math>R_{g,ext}</math></li> </ul>
PFC and PWM	CCM/interleaved PFC; TTF HB LLC	600V	CoolMOS™ P6	<ul style="list-style-type: none"> <li>Fast switching speed for improved efficiency and thermals</li> <li>Low gate charge for enhanced light load efficiency and low power consumption at no load condition</li> <li>Optimized <math>V_{gs}</math> threshold for lower turn-off losses</li> <li>Rugged body diode which prevents device failure during hard commutation</li> </ul>

### SiC Diodes

The recommended diode for CCM PFC applications is the 650V thinQ!™ SiC Schottky Diode Generation 5, which include Infineon's leading edge technologies, such as diffusion soldering process and wafer thinning technology. These Generation 5 products provide ~ 25% lower  $V_F$  over previous generations. The result is a new family of products showing improved efficiency over all load conditions, coming from both the improved thermal characteristics and an improved Figure-of-Merit ( $Q_c \times V_F$ ).

Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC	650V	SiC Generation 5	<ul style="list-style-type: none"> <li>Low FOM <math>V_F \cdot Q_c</math></li> </ul>

## Low Voltage MOSFETs

Functional Block	Topology	Voltage Class	Technology	Benefit
Synchronous Rectification	HB LLC + center-tap	40V	OptiMOS™	■ High efficiency over whole load range, layout tolerance
	ITTF	60V	OptiMOS™	■ High efficiency, low thermals, low $V_{DS}$ overshoot
	ZVS PS FB + center-tap	80V	OptiMOS™	■ High efficiency over whole load range, low $V_{DS}$ overshoot and oscillations

## Control ICs

Since the control has a crucial role in the optimal SMPS design, Infineon also proposes families of analog (ICEXX / TDAXX families) and digital controllers (XMC family) able to meet different needs, including power management and digital communication topics. QR/FF CoolSET™ 800V, is the best choice for the auxiliary power. Most importantly, it can achieve very low standby power. It is cost effective and easy to use. ICE3PCS0xG is the latest CCM PFC IC which implements digital control and can achieve high PFC, low THD and fast response. ICE1/2HS01G is the novel resonant LLC half bridge controller IC which is easy to use and can achieve high efficiency and low EMI by ZVS switching.

Functional Block	Topology	Voltage Class	Technology	Benefit
Auxiliary Power Supply	QR/FF Flyback CoolSET™	800V	ICE2QRxx80(Z)(G) ICE3xRxx80J(Z)(G)	■ Low standby power, High efficiency
PFC	CCM PFC IC	800V	ICE3PCS0xG	■ High PFC, Low THD
PWM	HB LLC IC	800V	ICE1HS01G-1 ICE2HS01G	■ High efficiency, low EMI
PFC and PWM	PFC/LLC/ZVS PS FB/TTF	800V	XMC	■ Flexibility, HR PWM, digital communication

## IGBTs

For price optimization, Infineon offers two excellent alternatives. The TRENCHSTOP™ 5 technology provides outstanding performance at excellent price point which is ideal for PFC and inverter stages addressing the Gold efficiency standard. The TRENCHSTOP™ 5 features a very low  $Q_g$  to achieve high light load efficiency. The H5 is suitable for plug & play replacement of MOSFET while F5 version is optimized for high efficiency solutions. Both the H5 and F5 include an ultra-fast discrete free-wheeling diode which has been optimized for improved ruggedness in ZVS and LLC topologies.

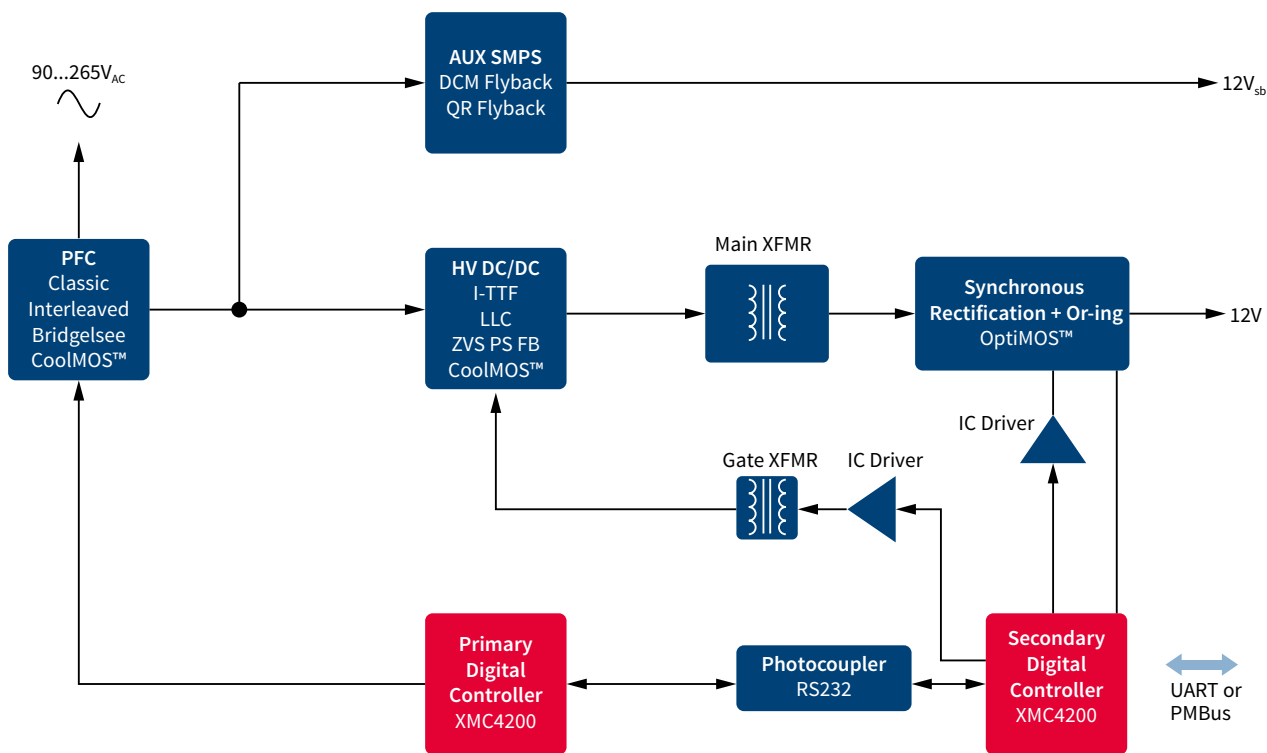
Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC	650V	TRENCHSTOP™ H5	■ Ease-of-use
	CCM/interleaved PFC	650V	TRENCHSTOP™ F5	■ High efficiency in low inductance designs
PWM	ZVS PS FB; LLC	650V	TRENCHSTOP™ H5	■ Improved ruggedness and ease-of-use
	ZVS PS FB; LLC, TTF	650V	TRENCHSTOP™ F5	■ Improved ruggedness and high efficiency in low inductance designs

### Boost Diodes

In CCM PFC topologies, a low reverse recovery charge diode is used to minimize diode switching losses. Rapid 2 diodes have a low peak reverse recovery current that lowers both diode switching losses and PFC switch turn-on losses. IGBT and Rapid diode together provide excellent efficiency up to 100kHz, particularly under light load conditions.

Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC	650V	Rapid 2	■ Low reverse recovery losses and PFC switch turn-on losses, common-cathode configuration

### Blockdiagram





# SMPS

## Telecom Power Supply

The telecommunication industry providing data, voice and video is nowadays continuously growing supported by the expansion into the new markets, especially in Asia, accelerated by the spread of the wireless and broadband technologies.

The outstanding improvements in Telecom SMPS performance achieved in the past 10 years have been primarily brought by the dramatic reduction of the on-resistance achieved in high voltage MOSFETs using the revolutionary Superjunction principle, introduced by Infineon at the end of the nineties in the CoolMOS™ series and equally impressive improvements in reverse-recovery characteristics of high voltage SiC (Silicon Carbide) diodes. In order to achieve the new challenging efficiency targets the Synchronous Rectification has become increasingly popular even in the typically high output voltage of telecom rectifiers.

### High Voltage MOSFETs

The CoolMOS™ C7 series offers Best-in-Class performance in CCM Mode PFC enabling highest efficiency to be achieved over the full load range. The world best  $R_{on} \cdot A$  enables smaller footprint packages to be used bringing benefits in power density. The low  $Q_g$  achieves better light load efficiency – an enhanced requirement in today's Server SMPS. Also, the CoolMOS™ C7 enables moving to higher switching frequencies without loss in efficiency, bringing benefits in power density by reducing the size of magnetic components. CoolMOS™ P6 is a well-balanced product family, which brings high efficiency in PFC topology, but due to its rugged body diode, can also be used in resonant DC/DC topologies such as LLC. The reduced  $Q_g$  leads to benefits in light load efficiency.

For ZVS topologies in the HV DC/DC Stages, Infineon has developed the CoolMOS™ CFD2 family, combining the requirements of high performance with the high reliability given by the Fast Body Diode concept.

Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC; TTF	650V	CoolMOS™ C7	<ul style="list-style-type: none"> <li>■ Best FOM <math>R_{DS(on)} \cdot Q_g</math> and <math>R_{DS(on)} \cdot E_{oss}</math></li> <li>■ Lowest <math>R_{DS(on)}</math> per package</li> <li>■ Low dependency of switching losses from <math>R_{g,ext}</math></li> </ul>
PWM	Resonant PFC; Resonant HV DC/DC stages HB LLC or ZVS PS	650V	CoolMOS™ CFD2	<ul style="list-style-type: none"> <li>■ Significant <math>Q_g</math> reduction compared CFD1 technology</li> <li>■ Defined <math>t_{r,max}</math> and <math>Q_{r,max}</math> values</li> <li>■ Lower price compared to CFD1 technology</li> </ul>
	CCM/interleaved PFC; TTF HB LLC	600V	CoolMOS™ P6	<ul style="list-style-type: none"> <li>■ Fast switching speed for improved efficiency and thermals</li> <li>■ Low gate charge for enhanced light load efficiency and low power consumption at no load condition</li> <li>■ Optimized <math>V_{gs}</math> threshold for lower turn-off losses</li> <li>■ Rugged body diode which prevents device failure during hard commutation</li> </ul>

## Driver ICs

Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC	1200V	1ED compact	■ Very high CMTI

## SiC Diodes

Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC	650V	SiC Generation 5	■ Low FOM $V_F \cdot Q_C$

## Low Voltage MOSFETs

Functional Block	Topology	Voltage Class	Technology	Benefit
Synchronous Rectification	Synchronous Rectification MOSFET	80V - 200V	OptiMOS™	<ul style="list-style-type: none"> <li>■ Industry's lowest FOM (<math>R_{DS(on)} \cdot Q_g</math>) leading to high efficiency at good price/performance</li> <li>■ Low voltage overshoots enabling easy design in</li> <li>■ Industry's lowest <math>R_{DS(on)}</math></li> <li>■ Highest system efficiency and power density</li> <li>■ Outstanding quality and reliability</li> <li>■ Reduces the need for a snubber circuit</li> </ul>
Or-ing	Or-ing MOSFET	60V - 150V	OptiMOS™	
Battery Protection	MOSFET	60V - 150V	OptiMOS™ Small Signal	
Isolated DC/DC	Primary Side PWM MOSFET	60V - 200V	OptiMOS™ Small Signal	
	Synchronous Rectification MOSFET	40V - 100V	OptiMOS™	
	Or-ing MOSFET	25V - 30V	OptiMOS™	<ul style="list-style-type: none"> <li>■ Driver and MOSFET in one package</li> <li>■ Double side cooling possibility</li> <li>■ Integrated sense feature (thermal and current)</li> </ul>
Non isolated PoL, Buck	MOSFET	20V - 30V	OptiMOS™ Small Signal	
	Power Stage	25V - 30V	DrMOS, DrBlade™	
	Digital DC/DC Controller		PRIMARION™	<ul style="list-style-type: none"> <li>■ Triple-rail &amp; multi-phase controllers with I2C/PMBus, integr. NVM</li> <li>■ Temp. range -40 to +125°C, power modes &lt;30, &lt;0.5, &lt;0.2mW</li> <li>■ Integr. ARM <math>\mu</math>-processor</li> <li>■ External temp. sense, digitally programmable PID &amp; current balancing</li> <li>■ Active Transient Response (ATR) modulation for optimum response to high di/dt load transients</li> </ul>

Since the control has a crucial role in the optimal SMPS design, Infineon also proposes families of analog (ICEXX / TDAXX families) and digital controllers (XMC family) able to meet different needs, including power management and digital communication topics.

## Control ICs

Functional Block	Topology	Voltage Class	Technology	Benefit
Auxiliary Power Supply	QR/FF Flyback CoolSET™	800V	ICE2QRxx80(Z)(G) ICE3xRxx80J(Z)(G)	■ Low standby power, high efficiency
PFC	CCM PFC IC	800V	ICE3PCS0xG	■ High PFC, low THD
PWM	HB LLC IC	800V	ICE1HS01G-1 ICE2HS01G	■ High efficiency, low EMI
PFC and PWM	PFC/LLC/ZVS-PSF/TTF	800V	XMC	■ Flexibility, HR PWM, digital communication

## IGBTs

For price optimization, Infineon offers two excellent alternatives. The TRENCHSTOP™ 5 technology provides outstanding performance at excellent price point which is ideal for PFC and inverter stages, addressing Gold Efficiency Standard. The TRENCHSTOP™ 5 features a very low  $Q_g$  to achieve high light load efficiency. The H5 is suitable for plug & play replacement of MOSFET while F5 version is optimized for high efficiency solutions. Both the H5 and F5 include an ultra-fast discrete free-wheeling diode which has been optimized for improved ruggedness in ZVS and LLC topologies.

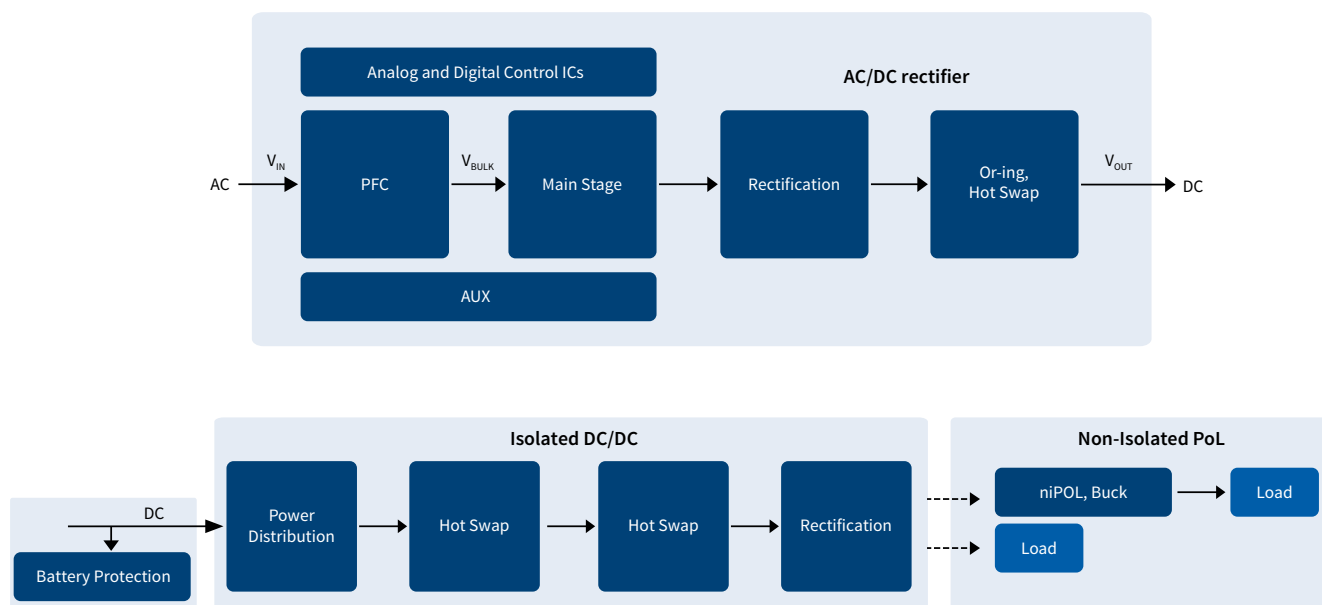
Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC; TTF	650V	TRENCHSTOP™ H5	■ Ease-of-use
PFC	CCM/interleaved PFC; TTF	650V	TRENCHSTOP™ F5	■ High efficiency, low gate drive losses in low inductance designs
PWM	ZVS PS FB; LLC	650V	TRENCHSTOP™ H5	■ Improved ruggedness and ease-of-use

In cost optimized PFC, Rapid 2 diode is able to provide low  $Q_{rr}$  and  $I_{rrm}$  at a very attractive price.

## Boost Diodes

Functional Block	Topology	Voltage Class	Technology	Benefit
PFC	CCM/interleaved PFC	650V	Rapid 2	■ Low reverse recovery losses and PFC switch turn-on losses, common-cathode configuration

## Blockdiagram





# E-Mobility

## Best Solutions for Battery Chargers

To recharge the battery of an electric or hybrid/electric car, a charger is needed. Chargers can be implemented on-board or off-board the vehicle. Electric energy may be transferred to the vehicle by wire or by wireless methods like resonant inductive power transfer. Power units on-board the vehicle require automotive-grade components, while the wider product selection of industrial-grade components can be used for off-board units.

### On-Board Chargers

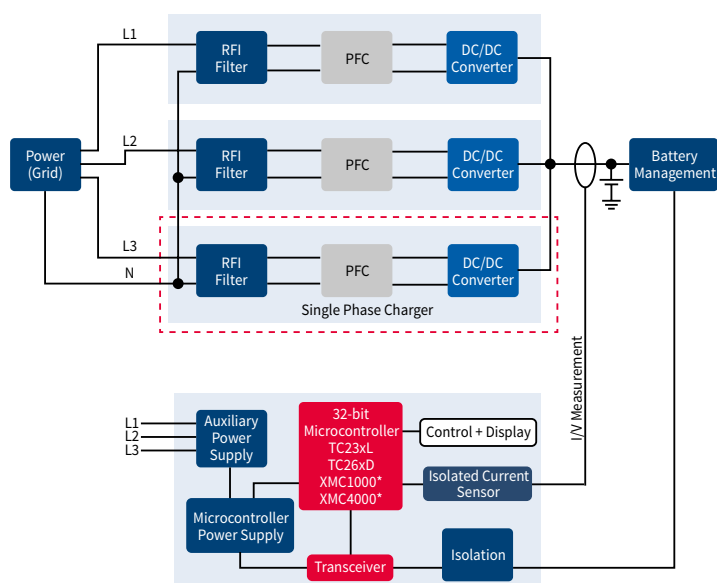
In cars with On-Board Chargers the batteries can be recharged from any standard AC power outlet which provides maximum power of 3.6kW best case (single phase 230V/16A). This standard charging at low power takes several hours (overnight). Battery charging via the power grid requires a flexible power converter topology to handle different voltage and power ratings wherever the car may go to and On-Board Chargers need to be as efficient and small as possible to stay cool at lowest possible weight.

### Off-Board Chargers

In Off-Board Chargers, the power conversion from AC grid voltage to DC battery voltage is done outside the car and the resulting DC power is transmitted by wire to the EV's DC-charging socket. Ultra-fast chargers with power ratings at 50kW and more have been designed in this way. As the power converter is off-board, automotive grade qualification is not required for the respective electronic components.

Apart from fast and ultra-fast chargers, there may be a market for Off-Board Chargers in the power range up to 10kW, for example to charge small and economic electric vehicles (LEVs). Also in case of the Off-Board Chargers, selecting the right topology to enable maximum conversion efficiency is an important design criterion.

#### Diagram of AC/DC Battery Chargers: Functional Blocks



\*For off-board chargers only

## Product Portfolio for On-Board & Off-Board Charger Applications

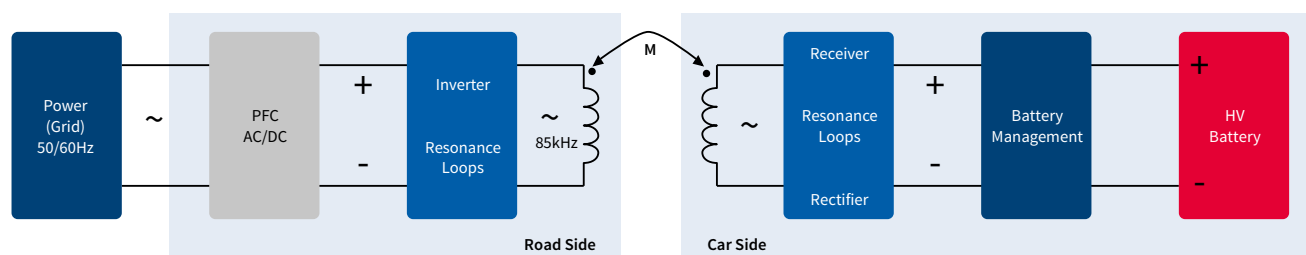
Infineon's comprehensive portfolio of semiconductors (sensors, Microcontrollers, power semiconductors, etc.) lends itself perfectly to designs of compact units for on-board, off-board and wireless charging. Our products in this sector support high switching frequencies at lowest possible  $R_{DS(on)}$  to enable compact and efficient designs : MOSFETs such as CoolMOS™, IGBTs TRENCHSTOP™ 5 and SiC Schottky Diodes like 650V thinQ!™ SiC Diode. In addition, integrated MOSFET and IGBT drivers, controller ICs for active CCM PFC high-performance Microcontroller solutions and high accurate current sensors complete our product portfolio.

Automotive Products for On-Board Units	Product Family	Description
1ED02012FA2	Automotive EiceDRIVER™	Single-channel isolated driver for 650V/1200V IGBTs and MOSFETs
1ED02012FTA	Automotive EiceDRIVER™	Single-channel isolated driver, two-level turn-off for 650V/1200V IGBTs
2ED02012FA	Automotive EiceDRIVER™	Dual-channel isolated driver for 650V/1200V IGBTs and MOSFETs
IPx65RxxCFDA	CoolMOS™	650V MOSFET with integrated Fast Body Diode
IKWxxN65F5A	TRENCHSTOP™ 5	650V fast IGBT with Rapid 1 Diode
IGWxxN65F5A	TRENCHSTOP™ 5	650V fast IGBT single
TC23xL, TC26xD	AURIX™	32-bit lockstep Microcontroller
TLF35584 <sup>1)</sup>	System Supply	New ISO26262-system-supply optimized for AURIX™
TLE7250G	Transceiver	High-speed automotive CAN transceiver
TLE6251D	Transceiver	High-speed automotive CAN transceiver, with wake-up

Industrial Products for Off-Board Units	Product Family	Description
IKWxxN65F5	TRENCHSTOP™ 5	650V fast IGBT with Rapid 1 Diode
IGWxxN65F5	TRENCHSTOP™ 5	650V fast IGBT single
IDWxxG65C5	thinQ!™	650V SiC Schottky Diode Generation 5
IPW65RxxC7	CoolMOS™	650V MOSFET, C7 series for hard switching topologies
HYBRIDPACK™ 1	Power Module	1200V/200A for fast & ultrafast charging (>10kW/phase)
XMC1000 <sup>2)</sup> , XMC4000 <sup>2)</sup>	XMC Microcontroller	32-bit ARM® Cortex™ M0/M4F Microcontrollers, up to 125°C ambient temperature (XMC4000)
IFX1763, IFX54441, IFX54211	Linear Voltage Regulator	Linear voltage regulator family with output current capability of 500mA/300mA/150mA respectively
IFX1050, IFX1021	Transceiver	High-speed CAN transceiver / LIN transceiver
TLI4970	Current Sensor	600V functional isolation, ± 50A

## Wireless Charging

Wireless methods for power transfer to charge the batteries of electric vehicles are gaining attention. Several concepts for wireless power transfer systems have been proposed, which in general seek to compensate the significant stray inductances on primary and secondary sides of the magnetic couplers by adaptive resonant methods. By the end of 2013, SAE announced a future standard for inductive charging which will define 3 power levels at 85kHz. Our TRENCHSTOP™ 5 IGBT and thinQ!™ SiC Diodes are perfectly suited for driving inductive power transfer systems (on the road side) which operate inside the 80kHz to 90kHz band.



1) in development  
2) for external chargers

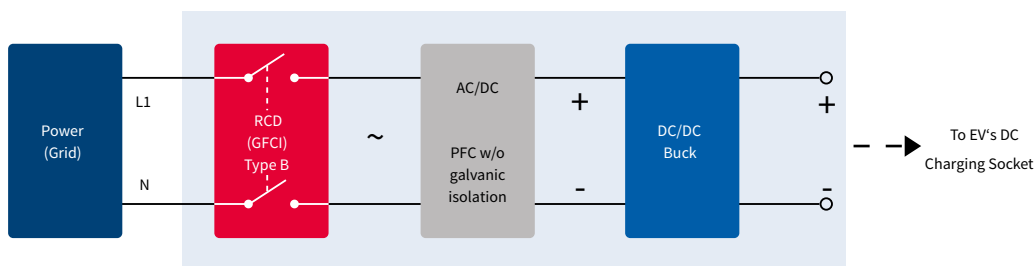
Automotive Products for the Car Side	Product Family	Description
1ED020112FA2	Automotive EiceDRIVER™	Single-channel isolated driver for 650V/1200V IGBTs and MOSFETs
1ED020112FTA	Automotive EiceDRIVER™	Single-channel isolated driver, two-level turn-off for 650V/1200V IGBTs
2ED020112FA	Automotive EiceDRIVER™	Dual-channel isolated driver for 650V/1200V IGBTs and MOSFETs
IPx65RxxCFDA	CoolMOS™	650V MOSFET with integrated Fast Body Diode
IKWxxN65F5A	TRENCHSTOP™ 5	650V fast IGBT with Rapid 1 Diode
IGWxxN65F5A	TRENCHSTOP™ 5	650V fast IGBT single
TC23xL, TC26xD	AURIX™	32-bit lockstep Microcontroller
TLF35584 <sup>1)</sup>	System Supply	New ISO26262-system-supply optimized for AURIX™

Industrial Products for the Road Side	Product Family	Description
IKW40N65F5	TRENCHSTOP™ 5	Fast IGBT with Rapid 1 Diode, 40A, TO-247
IGW40N65F5	TRENCHSTOP™ 5	Fast IGBT, single, 40A, TO-247
IDW40G65C5	thinQ!™	650V SiC Schottky Diode Generation 5, 40A, TO-247 <sup>2)</sup>
XMC4000	XMC Microcontroller	32-bit ARM® Cortex™ -M4F Microcontrollers, up to 125 °C ambient temperature
IFX1763, IFX54441	Linear Voltage Regulator	Linear voltage regulator family with output current capability of 500mA or 300mA respectively
TLI4970	Current Sensor	600V functional isolation, +/- 50A

Available in different current ratings too.

## Charger Concepts without Galvanic Isolation of the Power Stages

Transformerless design, without galvanic isolation inside the power stages, are economic and efficient. But enhanced safety measures may be required to operate such designs from standard AC-grid power outlets. There need to be Type-B RCD (GFCI) safety switches on the grid side to immediately break the circuit in case an unintended feedback of DC-voltage from the HV-battery into the AC-grid occurs under worst case failure conditions, but Type-B safety switches on the grid side are not standard by today. This is a main reason why non-isolated designs are currently not accepted for On-Board Chargers as the level of safety-measures on the grid side of the charging spot is uncertain. However, inside an Off-Board Charger installation with an integrated Type-B safety switch, the use of non-isolated concepts may be indicated. To highlight their opportunities, Infineon has investigated non-isolated concepts, built and evaluated laboratory-demonstrators of single-phase 3kW chargers without galvanic isolation inside the power stages.



### Concept Demonstrator of Lean and Efficient Off-Board DC-Charger w/o galvanic isolation

Input 230V/50Hz single phase AC

Output 220V – 390V<sub>DC</sub>, max. power 3.3kW at 350V with 96.2% efficiency

More detailed information about this demonstrator is available upon request.

Industrial Products for the Road Side	Product Family	Description
ICE3PCS01G	Integrated controller	For active CCM PFC, PG-DSO-14
IPW65R019C7	CoolMOS™	650V MOSFET, 19mΩ, TO-247
IDW30G65C5	thinQ!™	650V SiC Schottky Diode Generation 5, 30A, TO-247
TLI4970	Current sensor	600V functional isolation, ± 50A

<sup>1)</sup> in development

<sup>2)</sup> Automotive version under consideration

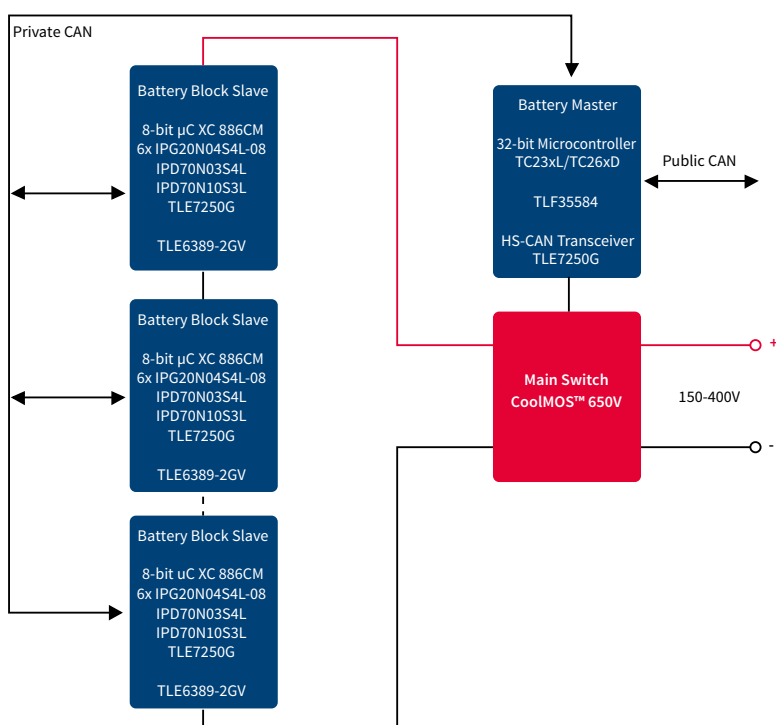
## Best Solution for Battery Management

An intelligent Battery Management System (BMS) is necessary to sustain battery performance throughout its entire lifetime - the challenge there is to tune the utilization of each battery cell individually. Passive cell balancing is the default approach where the weakest one of the cells sets the limits for battery lifetime and cruising range. Infineon's Microcontrollers and sensors in combination with our power devices enable active cell balancing while charging and discharging. An active cell balancing system helps to increase the effective cruising range and the battery's lifetime by 5 to 10 %, compared to passive balancing. In this context we want to mention our 8-bit XC886CM Microcontroller family for the slave blocks and the new 32-bit AURIX™ Microcontroller family for the master block, our OptiMOS™ low voltage MOSFETs, our automotive CAN transceivers TLE7250G, TLE6251D as well as step-down DC/DC controllers TLE6389-2GV and brand-new TLF35584.

Main Switch	Product Family	Description
IPx65RxxxCFDA	CoolMOS™	650V MOSFET with integrated Fast Body Diode

Battery Master	Description
TC23xL, TC26xD	New 32-bit AURIX™ lockstep Microcontroller
TLF35584 <sup>1)</sup>	New ISO26262-system-supply optimized for AURIX™
TLE7250G	High-speed automotive CAN transceiver
TLE6251D	High-speed automotive CAN transceiver, with wake-up

Battery Master	Description
XC886CM	8051 compatible 8-bit automotive Microcontroller
TLE6389-2GV	Step-down DC/DC controller
TLE7250G	High-speed automotive CAN transceiver
IPG20N04S4L	OptiMOS™ -T2 Power-Transistor, Logic Level, Dual, 40V/8.2mW
IPD70N03S4L	OptiMOS™ -T2 Power-Transistor, Logic Level, 30V/4.3mW
IPD70N10S3L	OptiMOS™ -T2 Power-Transistor, Logic Level, 100V/11.5mW



1) in development



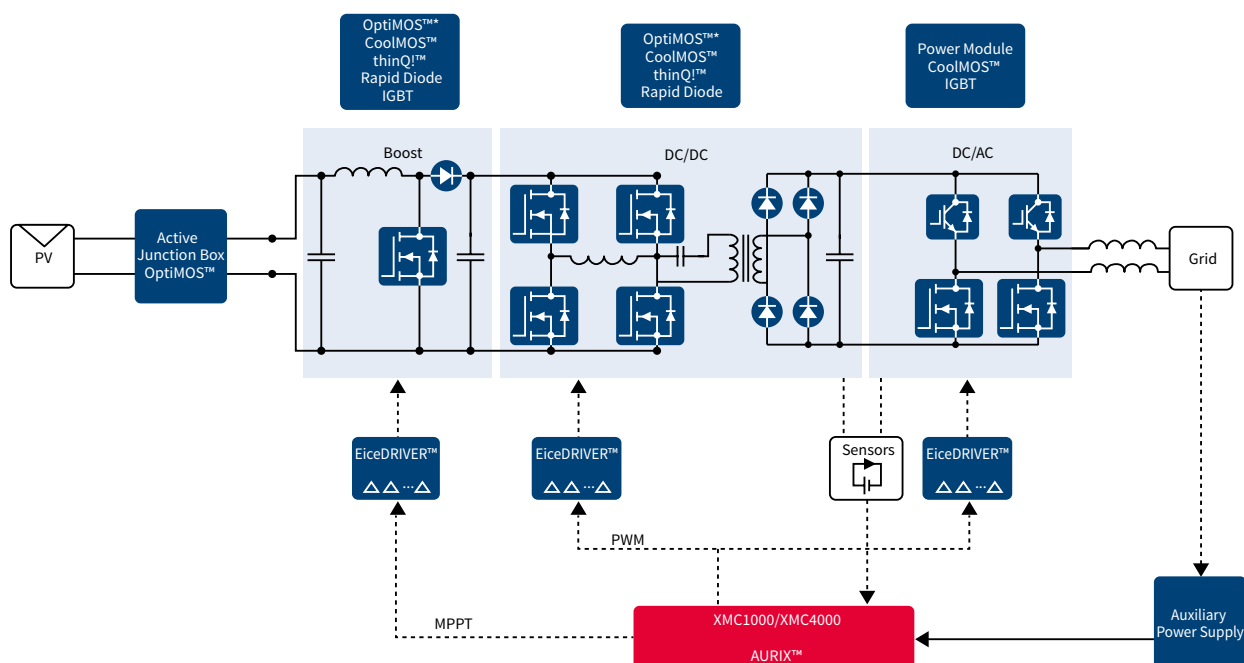
# Solar

## Leading Products for Solar Power Systems

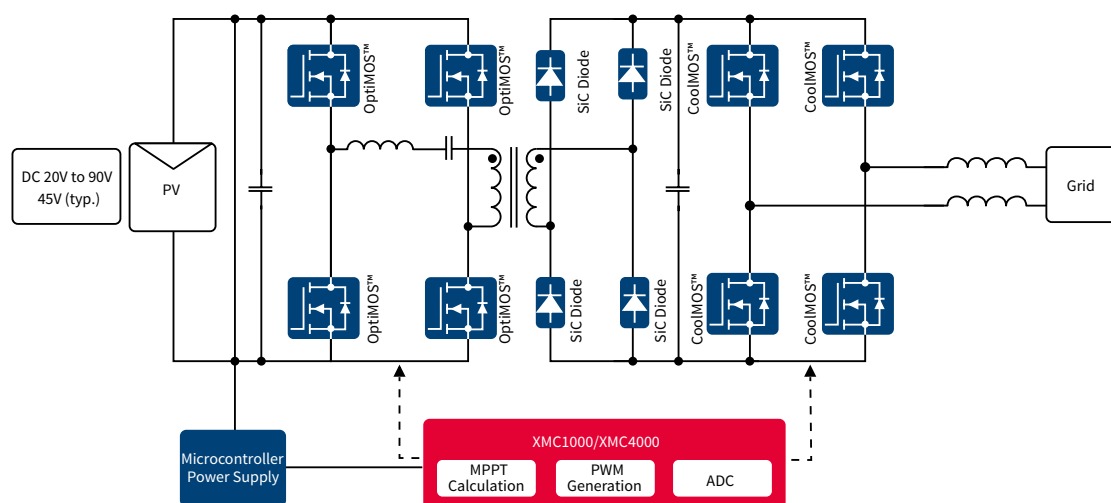
Infineon provides a comprehensive portfolio to deliver the best efficiency and reliability for Solar applications. Infineon's leading edge technology like Superjunction MOSFET, TRENCHSTOP™ and Fieldstop IGBT, Coreless transformer driver etc. combined with rich experience and highest quality, ensured our number 1 position in Solar application. The newest add ARM® Cortex™ -M4 based MCU enables easy and high efficiency design.

	Optimizer 250W - 750W	Single/Dual Micro Inverter 250W-600W; 900W	String Inverter 1kW - 30kW
MOSFET	OptiMOS™ SS08 CanPAK™   75V - 150V	OptiMOS™ SS08   60V-200V	CoolMOS™ TO-247   600V/650V   19mΩ-99mΩ
SiC Diode		thinQ!™ ThinPAK/DPAK   650V/1200V	thinQ!™ TO-220/TO-247   650V/1200V
IGBT			TRENCHSTOP™/HighSpeed 3 600V/650V/1200V TO-247 Single/Duo Pack
Power Module & Stack			EasyPACK 1B/2B Press FIT
Driver			IGBT Driver: 1ED020I12-F2, 2ED020I12-F2
Schottky Diode			BAT165 Schottky Diode
Auxiliary Power Supply			CoolSET™ 800V
Microcontroller	XMC 1xxx ARM® Cortex™-M0  XMC 45xx ARM® Cortex™-M4	XMC 1xxx ARM® Cortex™-M0  XMC 45xx ARM® Cortex™-M4	XMC 1xxx ARM® Cortex™-M0  XMC 45xx ARM® Cortex™-M4

## Infineon Leading Products for Complete Solar System



## Micro Inverter



### Infineon OptiMOS™ for Micro Inverter

Input Voltage	Topology	MOSFET Breakdown Voltage	SuperSO8 Suggestion	CanPAK™ Suggestion	D <sup>2</sup> PAK Suggestion
Up to 48V	Half bridge, full bridge, LLC and other resonant	60V	BSC014N06NS BSC016N06NS BSC028N06NS BSC039N06NS	BSB028N06NN3G	–
Up to 64V	Half bridge, full bridge, LLC and other resonant	80V	BSC030N08NS5 BSC052N08NS5	BSB044N08NN3G	–
Up to 80V	Half bridge, full bridge, LLC and other resonant	100V	BSC035N10NS5 BSC040N10NS5	–	IPB020N10N5
Up to 60V	Flyback	150V	BSC091N15NS5 BSC108N15NS5 BSC175N15NS5	BSB165N15NZ3	IPB041N15N5 IPB063N15N5 IPB108N15N3G
	Push pull	200V	BSC320N20NS3G	–	IPB107N20N3G

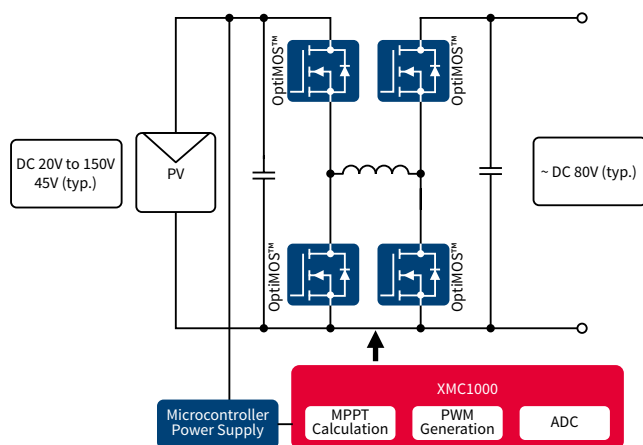
### Recommended Infineon CoolMOS™ for Micro Inverters

Topology	Package	Voltage Class	CoolMOS™
Current source	D <sup>2</sup> PAK	800V	SPB17N80C3
Current / voltage source	D <sup>2</sup> PAK	650V	IPB65R190C6
			IPB65R190C7
			IPB65R125C7
			IPB65R095C7
			IPB65R065C7
			IPB65R045C7
	ThinPAK 8x8	600V	IPL60R210P6
		650V	IPL65R195C7
			IPL65R130C7
			IPL65R099C7
			IPL65R070C7

### Recommended Infineon Microcontrollers for Micro Inverters

Topology	Package	Voltage Class	Technology
Microcontroller	All	All	XMC1000
Microcontroller Supply	Linear voltage regulator	Up to 20V	IFX1763, IFX54441, IFX54211
Microcontroller	All	All	XMC4000

## Optimizer



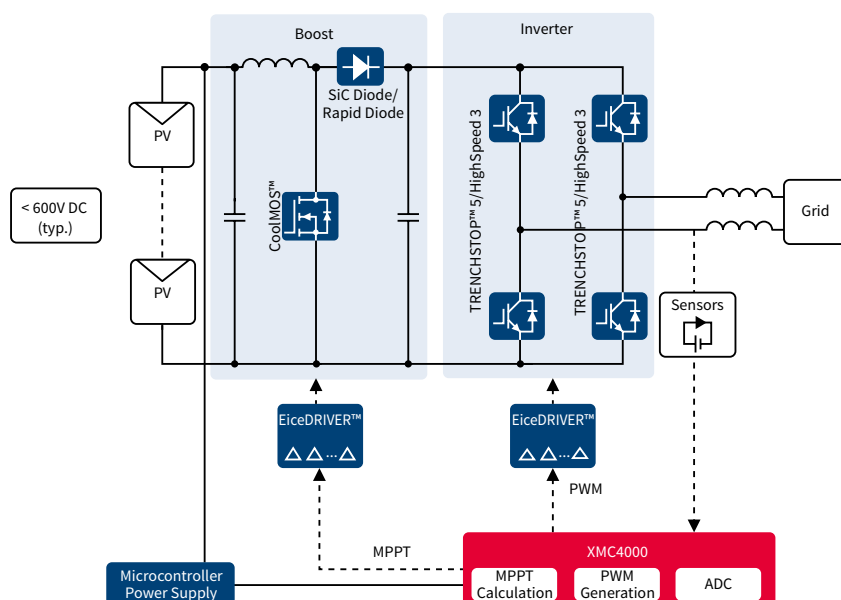
### Infinion OptiMOS™ for Optimizer DC/DC Power Conversion

Input Voltage	Topology	MOSFET Breakdown voltage	SuperSO8 Suggestion	S3O8 Suggestion	CanPAK™ Suggestion	D <sup>2</sup> PAK and DPAK Suggestion
Up to 48V	Buck-boost	60V	BSC016N06NS	BSZ042N06NS	BSB028N06NN3G	IPB026N06N
Up to 60V	Buck-boost	75V	BSC042NE7NS3G	–	–	IPB049NE7NS3G
Up to 64V	Buck-boost	80V	BSC027N08NS5 BSC052N08NS5 BSC117N08NS5	BSZ075N08NS5 BSZ084N08NS5 BSZ110N08NS5	BSB044N08NN3G BSF134N10NJ3G	IPB017N08N5 IPB031N08N5 IPB049N08N5
Up to 80V	Buck-boost	100V	BSC035N10NS5	BSZ097N10NS5	BSB056N10NN3	IPB020N10N5
Up to 125V	Buck-boost	200V	BSC320N20NS3G	BSZ900N20NS3 G	–	IPD320N20N3G

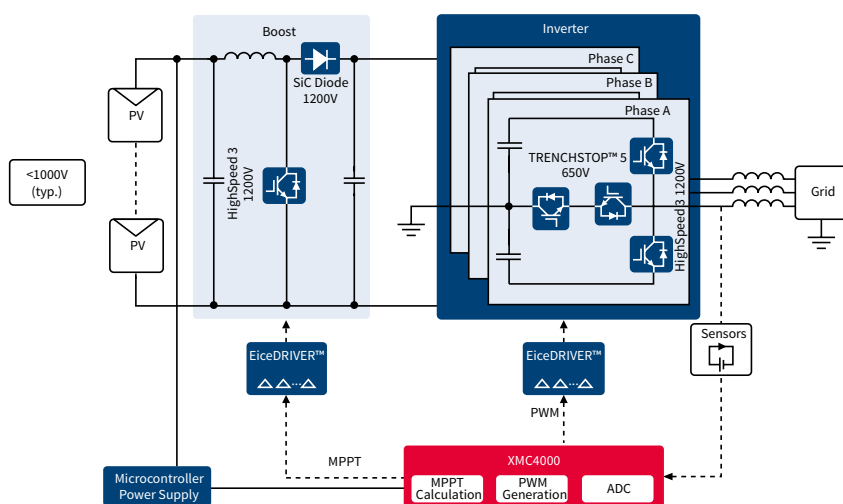
### Recommended Infineon Microcontrollers for Power Optimizers

Server Power Supply	Topology	Voltage Class	Technology
Microcontroller	All	All	XMC1000
MC Supply	Linear Voltage Regulator	Up to 20V	IFX1763, IFX54441
Microcontroller	All	All	XMC4000

## String Inverter (Non-Isolated)



## String Inverter (Three-Phase)



### Infinion Discrete Power Device for String Inverter

Inverter Type	Function	Product Series	Typical Part Number	Voltage Class
Single Phase	Boost	CoolMOS™ CP/C7	IPW65R045C7	650V
		thinQ!™ SiC Diode	IDW20G65C5	650V
	DC/DC	CoolMOS™ C6	IPW65R041C6	650V
		thinQ!™ SiC Diode	IDW20G65C5	650V
		Rapid Diode	IDW15E65D2	650V
	Inverter	HighSpeed 3	IKW40N60H3	600V
		TRENCHSTOP™ 5	IKW40N65H5	650V
		CoolMOS™ C6	IPW65R041C6	650V
	Three Phase	Boost	HighSpeed 3	IKW40N120H3
thinQ!™ SiC Diode			IDW40G120C5B	1200V
Inverter		HighSpeed 3	IKW40N120H3	1200V

### Infinion EiceDRIVER™ for String Inverter

Power Device	Driving Method	Voltage Class	Typical Part Number
IGBT	Single channel	1200V	1ED020112-F2/B2
IGBT	Half bridge	1200V	2ED020112-F1

### Infinion CoolSET™ for String Inverter

Voltage class	Typical Part Number
800V	ICE3AR2280JZ
650V	ICE3BR1765JZ

### Recommended Infineon Microcontrollers for String Inverters

Server Power Supply	Topology	Voltage Class	Technology
Microcontroller	All	All	XMC4000
Microcontroller Supply	Linear Voltage Regulator	Up to 20V	IFX1763, IFX54441



# Major Home Appliances

## Highest Performance and Efficiency for Induction Cooking Appliances

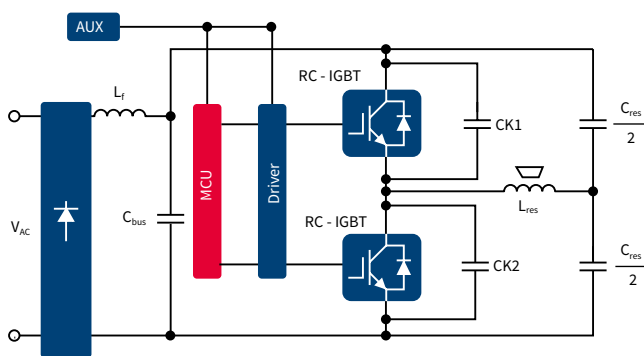
Resonant-switching applications such as induction cooktops and inverterized microwave ovens have unique system requirements. The consumer market place demands that they be cost effective, energy efficient and reliable. To achieve these goals, designers need devices that are created specifically for these applications.

Infineon's RC-H family of discrete IGBTs was developed for soft switching with a monolithically integrated reverse conducting diode. With this technology leadership and a broad portfolio of devices from 650V to 1600V, it is the market leader and provides the industry benchmark performance in terms of switching and conduction losses.

The newest generation in the family is the RC-H5, which extends the performance leadership for both half bridge and single ended designs. New 650V devices with higher blocking voltage offer higher reliability with improved performance even in designs which require higher frequencies or hard switching conditions. The updated RC-H5 1350V and 1200V offer the lowest switching losses across a broad range of operating conditions, allowing customers to develop the most efficient and reliable designs. Infineon also offers a range of complementary products which can be used with the IGBT, as well as in the central control and Power Supply subsystems of Induction Cooking appliances.

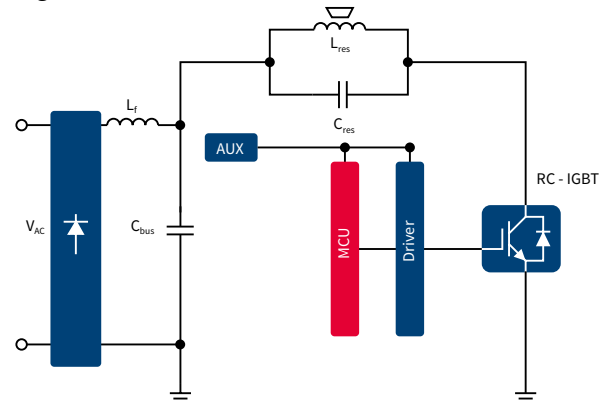
### Induction Heating Inverter (Current Resonance)

#### Half bridge



### Induction Heating Inverter (Voltage Resonance)

#### Single switch



Induction Heating	Topology	Voltage Class	Technology/Product Family	Selection
DC/AC	Series resonant half bridge	650V	RC-H5	Recommendation
	Quasi resonant single ended	1100V	RC-H3	Recommendation
	Quasi resonant single ended	1200V & 1350V	RC-H3, RC-H5	Recommendation
	Quasi resonant single ended	1600V	RC-H2	Recommendation
IGBT Driver	Single channel & half bridge	600V & 1200V	EiceDRIVER™	Recommendation
Microcontroller	-	-	XMC1000	Recommendation
Microcontroller Supply	Linear voltage regulator	Up to 20V	IFX54211	Efficiency
AUX	Flyback	650V	CoolSET™ QR	Efficiency
	Flyback	800V	CoolSET™ QR	Recommendation
	Buck Converter	800V	CoolSET™ F3	Recommendation

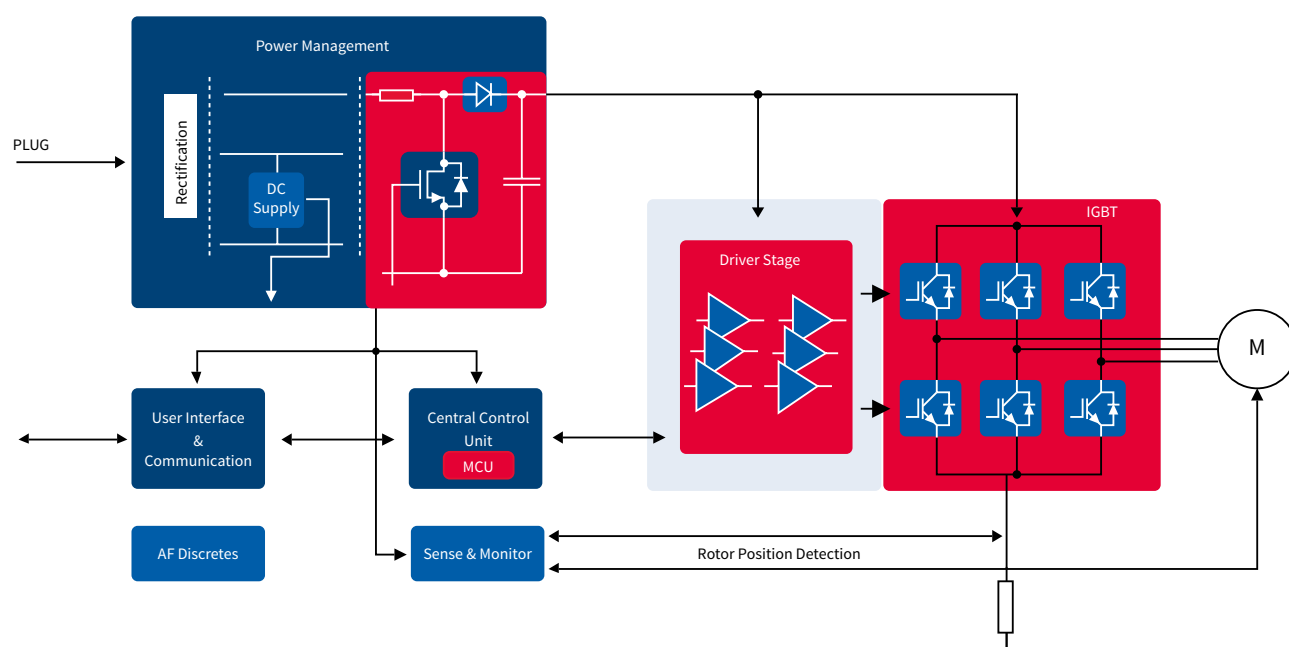


# Major Home Appliances

## Innovative Approach for Inverterized Drives

Product designers are facing the daunting challenge of delivering smaller, smarter, more powerful and more energy-efficient appliances. Based on industry-leading technology and manufacturing expertise, our line of innovative components for household appliances meets and exceeds even the most rigorous requirements for reliability and quality.

The block diagram of an air conditioning system together with the product selection table provides effective guidelines for engineers in selecting the right component for each power management stage inside Major Home Appliances.



Aircon	Topology	Voltage Class	Technology/Product Family	Selection
PFC AC/DC	PFC CCM (low frequency)	600V	TRENCHSTOP™	Recommendation
	PFC CCM (high frequency)	600V	HighSpeed 3	Recommendation
	PFC CCM	600V	CoolMOS™ P6	Reference
	PFC CCM	650V	Rapid 1 and Rapid 2	Recommendation
	PFC CCM	-	CCM PFC Controller ICE2PCS0xG, ICE3PCS0xG	Recommendation
DC/AC	B6-VSI	600V	RC-Drives IGBT	Recommendation
	B6-VSI	600V	TRENCHSTOP™	Efficiency
IGBT Driver	Driver for B6 bridge	600V	EiceDRIVER™ (6ED)	Recommendation
AUX	Buck converter	650V	CoolSET™ F3R	Recommendation
	Flyback	800V	CoolSET™ QR	Recommendation
	Buck converter	800V	CoolSET™ F3R	Recommendation
Microcontroller	-	-	XMC1000	Reference
	-	-	XMC4000	Recommendation
Microcontroller Supply	Linear voltage regulator	Up to 20V	IFX1763, IFX54441, IFX54211	Efficiency
Communication	CAN, LIN transceiver	-	IFX1050, IFX1021	Robustness
Position Sensing	Angle sensor	-	TLE5009, TLE5012B	Recommendation
	Hall switch	-	TLI496x	Recommendation
Angle Sensor	-	-	TLE5009, TLE5012B	Recommendation
Hall Switch	-	-	TLI496x	Recommendation



# Lighting

## Long Lifetime & High Efficiency for Street Lighting & High Bay Lighting

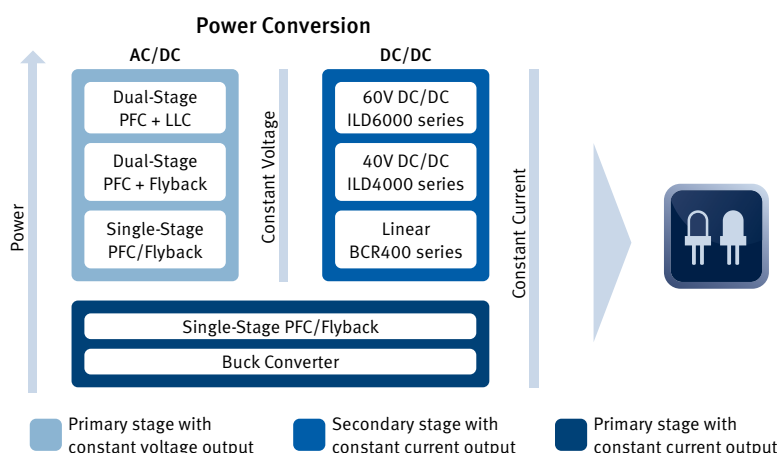
Street Lighting and High Bay Lighting for warehouses, factories and other applications where high light output is required are being converted into LED Lighting very fast.

### Key drivers

- Reduction of maintenance cost of LED systems due to longer lifetime
- Higher efficiency of LED systems including light load condition during dimming at night

### Infineon's Offering for LED Lighting

- Highly efficient AC/DC power conversion including light load condition
- Big choice of highly efficient and reliable high voltage MOSFETs
- Industry leading thermal protection provided by DC/DC LED driver IC's
- Modularity by selecting number of LED strings
- Scalability by offering same footprint for different LED currents



## High Voltage MOSFETs for Lighting

### CoolMOS™

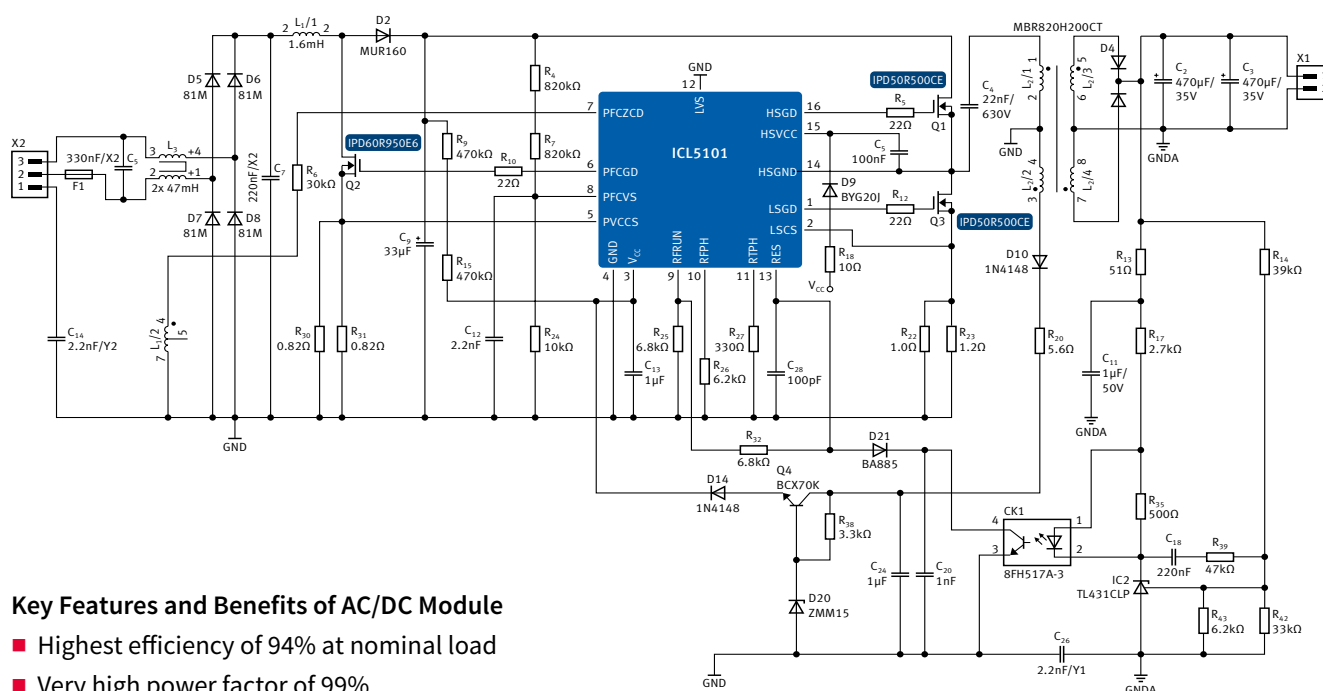
Due to its low cost and easy implementation, Quasi-Resonant Flyback is the most commonly used topology in LED drivers. This makes CoolMOS™ 800V CE the perfect fit for this application. In addition to this, other topologies, such as fixed-frequency Flyback topology, are supported by 600V or 650V-type MOSFETs. For high-power Lighting applications, where each percentage point counts, the P6-type for high performance and low  $R_{DS(on)}$  MOSFETs are the preferred choice.

Topology	Voltage Class	$R_{DS(on)}$	Selection
Quasi-Resonant Flyback	800V CE	1Ω ... 2.8Ω	DPAK, IPAK
Quasi-Resonant Flyback	800V C3	85mΩ ... 0.95Ω	TO-220, TO-220 FP
Quasi-Resonant Flyback	900V C3	340mΩ ... 1.2Ω	TO-220, TO-220 FP
PFC stage	600V C6	99mΩ ... 600mΩ	DPAK, TO-220 FP
LLC stage	500V CE, 600V C6, 600V P6	190mΩ ... 950mΩ	DPAK, TO-220 FP
Non-isolated Buck	500V CE	1Ω ... 3Ω	DPAK



## AC/DC Power Conversion (Dual Stage PFC+LLC)

Application example - 110W LED driver with constant voltage output



### Key Features and Benefits of AC/DC Module

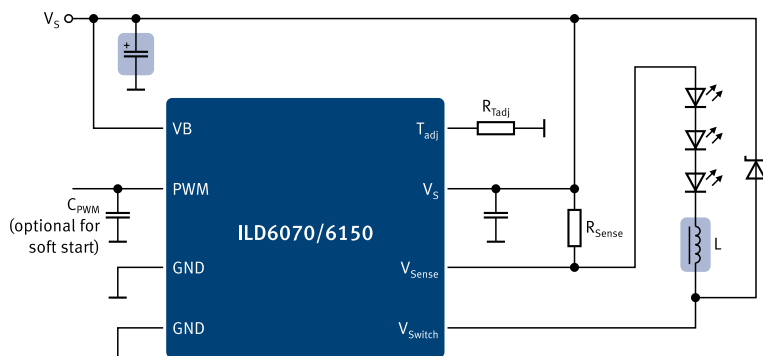
- Highest efficiency of 94% at nominal load
- Very high power factor of 99%
- Very low THD < 5% providing high margin to fulfill regulatory requirements
- Both high efficiency and low THD also at light load condition
- Low Bill of Material (BOM) due to
  - Combo IC combining PFC and LLC in one IC
  - Resistors can replace capacitors to adjust electrical parameters

Part Number	Details
ICL5101*	AC/DC off-line LED Driver IC
IPD50R500CE	CoolMOS™ 500V CE for LLC stage
IPD60R950E6	CoolMOS™ 600V E6 for PFC stage

\* coming Q2 2015

## DC/DC Power Conversion (60V DC/DC Buck Converter)

Application Example with ILD6070/6150 with constant current output



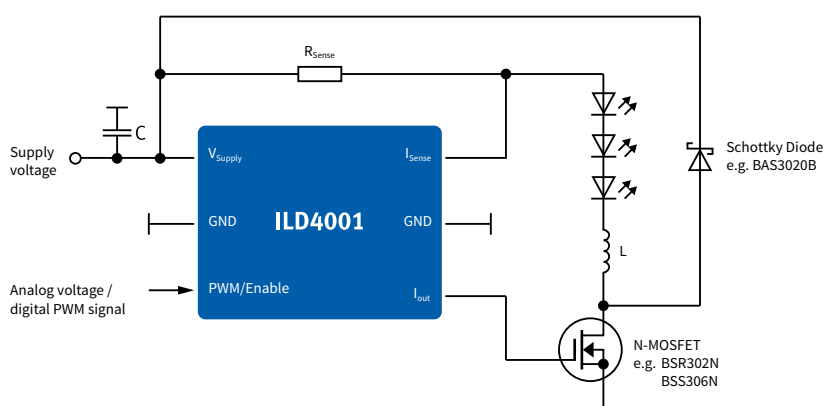
### Key Features & Benefits

- Wide input voltage from 4.5V – 60V
- Scalable for an output current up to 1500mA due to same footprint
  - Up to 700mA with ILD6070 in SO-8 exposed pad
  - From 700mA –1500mA with ILD6150 in SO-8 exposed pad
- Provides both PWM or analog dimming options
- High efficiency of up to 98%
- Advanced thermal protection including
  - Current reduction in a slope enables the protection of LED lifetime
  - Trigger point of thermal protection can be adjusted
  - No need for external NTC or PTC, thereby reducing system cost

Evaluation boards available: EVALLED-ILD6150

## DC/DC Power Conversion (40V DC/DC Buck Converter)

Application example with ILD4001 with constant current output



### Key Features & Benefits

- Wide input voltage from 4.5 - 40V
- Coverage of wide current range from 10 - 3000mA
- Cost can be optimized by selection of respective MOSFET
  - Low cost solution with BSR302
  - Lowest cost solution with BSS306
- High efficiency up to 98%
- Thermal protection included
  - No external NTC required
  - Smooth reduction of LED current at high temperature level
- Small SC-74 package

Evaluation boards available: ILD4001 1A



# Industrial Welding (MMA < 280A)

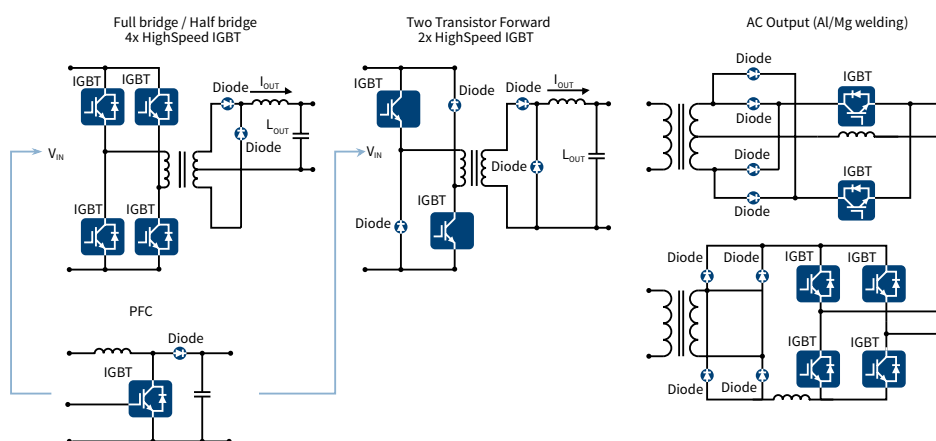
## Innovative Solutions for Your Applications

In the field of Industrial Welding machines, discrete IGBTs are used in small inverterized 1-phase hand-held welders from 120A to 200A and 3-phase welding machines with up to 300A  $I_{out}$  for industrial use. With the trend towards higher switching frequency, Infineon's portfolio perfectly supports customer requirements by offering 600V, 650V and 1200V discrete IGBTs at an excellent performance/price point.

For 2015, the new WR5 series based on the TRENCHSTOP™ 5 technology will be released, specifically for the price sensitive 1-phase welding machine market to offer a new benchmark in performance/price. The WR5 offers low switching losses coupled with low conduction losses plus excellent  $R_g$  controllability to provide customers with improved efficiency and outstanding thermal behavior.

Meanwhile for the Best-in-Class performance, where customers are striving for differentiation in the welding market, the H5 series offers the highest efficiency for optimized designs. Excellent dynamic response of the H5 series enables the arc-current to be reached in a shorter time contributing to better weld quality. Additionally, in-house application tests have shown the case temperature of the H5 to be 20% lower than the next Best-in-Class competitor device.

For 3-phase welders, Infineon's 1200V H3 family is the market's preferred device, due to its outstanding efficiency and controllability.



Industrial Welding	Topology	Voltage Class	Technology/Product Family	Selection
DC/AC	Full bridge/half bridge/TTF	650V	WR5 TRENCHSTOP™ 5	Recommendation
	Full bridge/half bridge	650V	TRENCHSTOP™ 5	Recommendation
	Full bridge/half bridge/TTF	1200V	HighSpeed 3	Recommendation
	Two Transistor Forward	650V	Rapid 1/Rapid 2	Recommendation
AC/DC: PFC	Boost converter/switch	650V	WR5 TRENCHSTOP™ 5	Recommendation
	Boost converter/switch	650V	TRENCHSTOP™ 5	Reference
	Boost converter/switch	1200V	HighSpeed 3	Reference
	Boost converter/diode	650V	Rapid 1/Rapid 2	Recommendation
IGBT Driver	Half bridge single channel	600V/1200V	EiceDRIVER™ (1ED)	Efficiency
	Half bridge dual channel	600V/1200V	EiceDRIVER™ (2ED)	Recommendation
Controller	Boost converter	650V	CoolSET™ F3	Recommendation
	Boost converter	-	XMC1000	Flexibility
Microcontroller Supply	Linear voltage regulator	Up to 20V	IFX54211	Efficiency



# Battery Powered Applications

## Highest Performance in your Drives Application

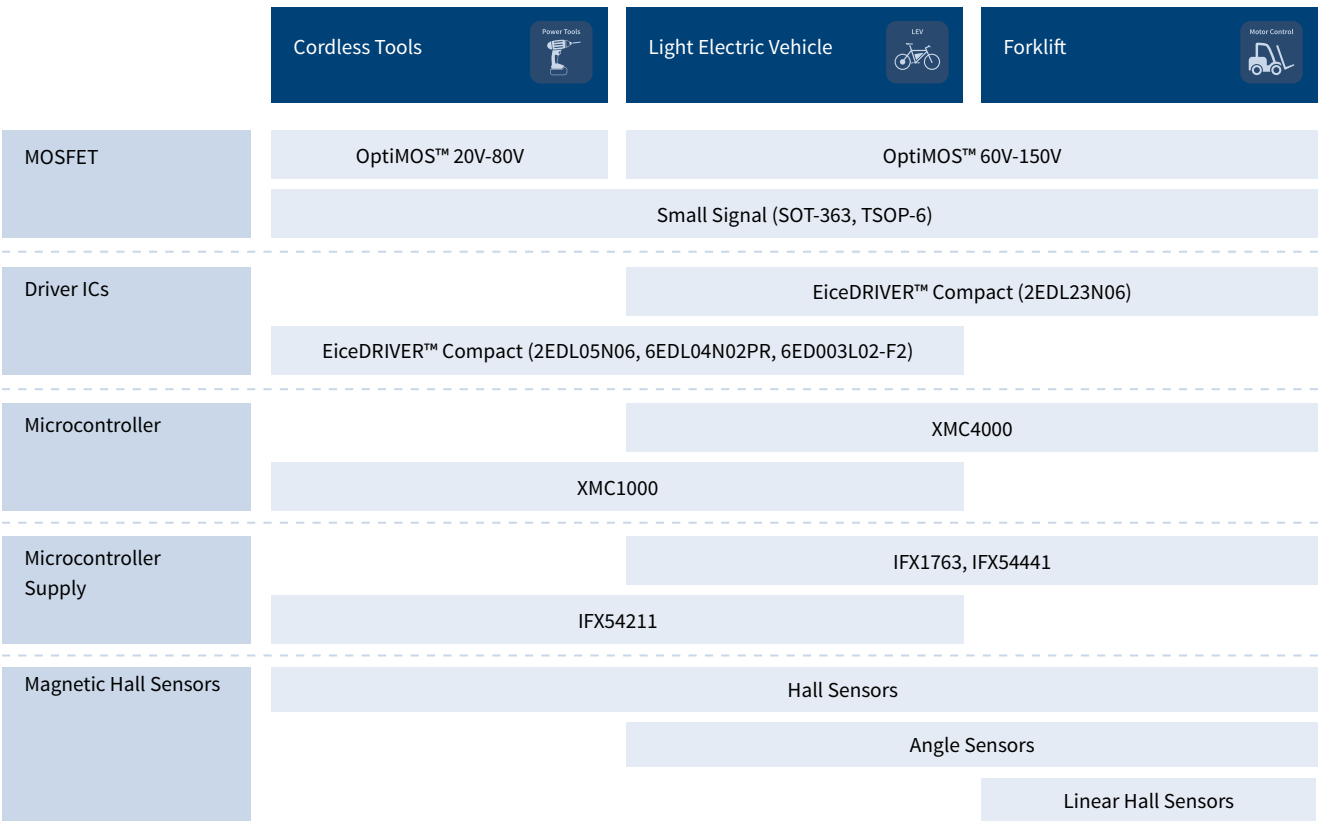
Based on industry leading technology, the highest quality and manufacturing expertise, Infineon provides a variety of innovative power semiconductors which enable designers to develop highly reliable and efficient solutions for all kinds of drive applications.

**Key enabling products**

- Low voltage power MOSFETs – OptiMOS™
- Small Signal products
- High voltage power MOSFETs – CoolMOS™
- Gate drivers – EiceDRIVER™ Compact
- Microcontrollers and supply – XMC and voltage regulators
- Magnetic sensors

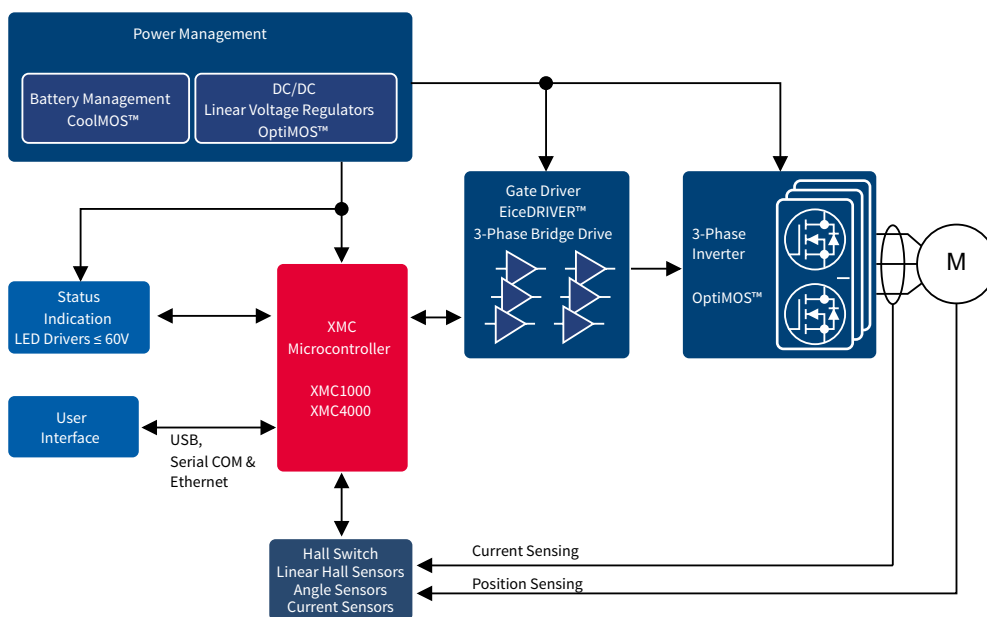
Infineon offers a comprehensive portfolio to address a broad range of Battery Powered Motor Control applications such as Forklift, E-Scooter, Pedelecs, Low Speed Cars and many others. For further information please explore our homepage.

**Infineon Solution Tree for Battery Powered Applications**





### Typical Low Voltage Application: Battery Powered 3-Phase System



To shorten customer development cycle time and cost we offer a complete portfolio of low voltage motor control application kits:

XMC1000 Motor Control Application Kit	XMC4000 Motor Control Application Kit	300W Motor Control Application Kit	Evaluation Board 5kW TO-Leadless	1kW Motor Control Application Kit
				

[www.infineon.com/motorcontrolapplicationkit](http://www.infineon.com/motorcontrolapplicationkit)  
[www.infineon.com/to-leadless-evaluationboard](http://www.infineon.com/to-leadless-evaluationboard)



# Light Electric Vehicles

Leading-Edge Innovation, Outstanding Reliability and Excellent Quality

Infineon's solutions for Light Electric Vehicles provide leading-edge innovation, outstanding reliability and excellent quality. We offer the full range of semiconductor solutions – from low voltage power MOSFETs to Microcontrollers. Key requirements for those applications like E-Bikes, Pedelecs, E-Scooters, Low Speed Cars, Forklifts, etc. are increasing the range of the vehicle, increasing battery lifetime and reducing charging time. Infineon offers the right set of devices for battery management and voltage regulation with highest possible efficiency. Besides power management, the power consumption is effectively controlled by XMC controllers, EiceDRIVER™ gate drivers, OptiMOS™ low voltage MOSFETs.

## Key Enabling Products for Light Electric Vehicles are:

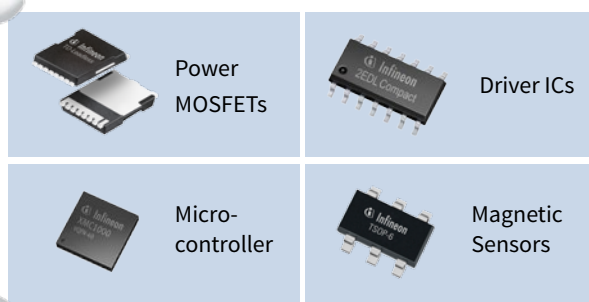
- Low voltage power MOSFETs – OptiMOS™
- High voltage power MOSFETs – CoolMOS™
- Gate drivers – EiceDRIVER™ Compact
- Microcontrollers and supply – XMC and voltage regulators, DC/DC converters
- Silicon Power Diodes – Rapid 1 and Rapid 2 Diode
- Magnetic Sensors

## Application Requirements

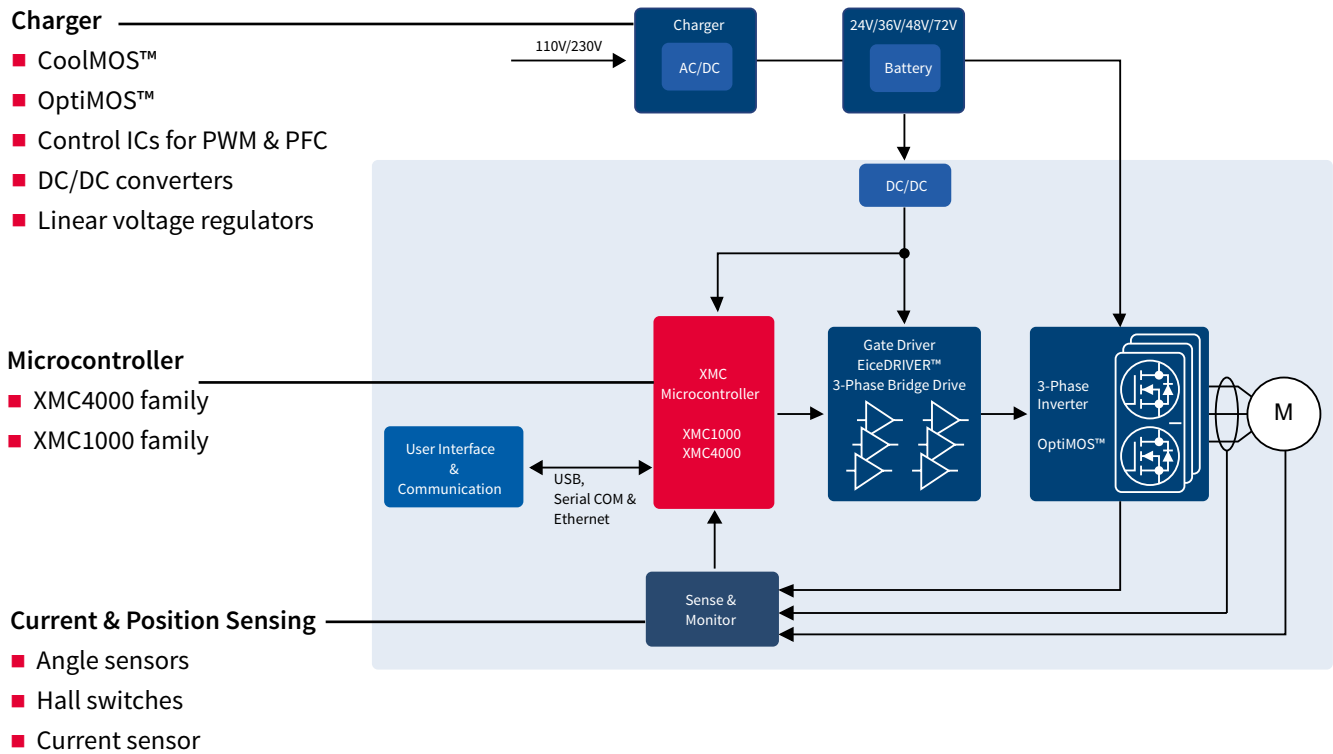
- Efficiency: reduction of overall system energy consumption, increasing the battery lifetime
- Reliability: reliable operation and avoiding system down time
- Maintenance: low maintenance and long lifetime of components
- Size and Cost: reduction of overall system size and cost
- Time to market: reduction of development time and cost

## Benefits of Infineon Components

- Complete portfolio from one source
- Increased lifetime due to Infineon reliability and quality
- Smallest area for highest power density
- BOM cost reduction due to lowest  $R_{DS(on)}$
- Complete support infrastructure: simulations, documentation and demoboard



## Application Diagram of Infineon Solution for Inverter and Charger



## Recommended Products for Inverter

	Battery Voltage	Standard Solution	High End Solutions
Low Voltage MOSFETs	24V	IPD034N06N3 G	BSC028N06NS
	36V	IPD053N08N3 G	BSC047N08NS3 G
	48V	IPP045N10N3 G	IPT020N10N3
		IPB042N10N3 G	
Gate Driver - EiceDRIVER™		2EDL05N06PF	
Microcontroller - XMC		XMC1302	XMC4400
Microcontroller Supply		Linear Voltage Regulator (IFX54211) DC/DC Converter (IFX90121)	Linear Voltage Regulator (IFX1763, IFX54441) DC/DC Converter (IFX90121, IFX91041)
Current & Position Sensors		Hall Switch (TLI496x)	
		Angle Sensor (TLE5009, TLE5012B)	
		Current Sensor (TLI4970)	
Communication			IFX1050G

## Recommended Products for LEV Charger

	Battery Voltage	AC/DC (PFC)	DC/DC (PWM)	Synchronous Rectification
High Voltage MOSFETs	600V	IPP60R125P6	IPP60R099C6	
		IPP60R160P6	IPP60R125C6	
		IPP60R190P6	IPP60R160C6	
		IPL60R180P6	IPP60R190C6	
	650V		IPP65R110CFD	
			IPP65R150CFD	
			IPL65R165CFD	
			IPP65R190CFD	
Low Voltage MOSFETs	40V - 100V			OptiMOS™ in TO-220, SuperS08 or D <sup>2</sup> PAK
Diodes	650V	Rapid Diodes in TO-220		



# Wireless Power

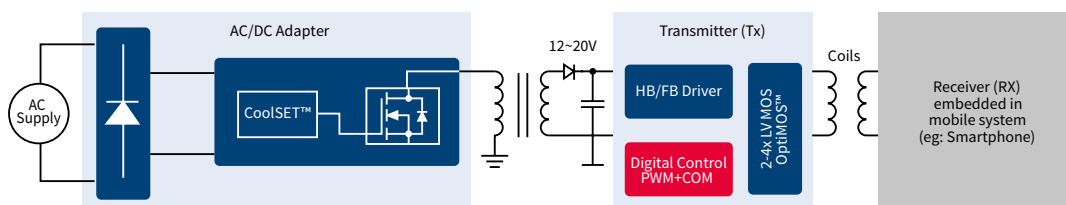
## Highest Efficiency for Wireless Charging

Now is the time when Wireless Power applications will enter the main stream. We will each have one or more applications of Wireless Charging in our daily lives in the coming years, starting with battery charging of Mobile Devices. That is on top of the electric toothbrush that seems to be around forever.

A typical wireless power transfer system consists of the AC/DC Adapter powering the charging station or mat, the transmitter in the station or mat and the receiver which usually is highly integrated and embedded in the mobile device or the back cover of a Smartphone.

Infineon's CoolSET™ series continues to deliver design agility and miniaturization. For example the F3 series combines a new feature-packed controller with the power of CoolMOS™ to give you the output power you desire. Alternatively a stand-alone PWM IC (Fix Frequency or Quasi Resonant) can be combined with a discrete 600V/650V CoolMOS™ C6 available in different packages including DPAK, IPAK and the newest ThinPAK 5x6.

Especially for emerging higher power (10W+) transmitter applications equipping your half or full bridge with components from the OptiMOS™ 30V product family with their ultralow gate and output charge, together with lowest on-state resistance in small footprint packages will pay off with superior power transfer performance. There are Half Bridge modules, dual N-Channel and single N-Channel OptiMOS™ versions available for your Wireless Power transmitter design.



AC/DC Adapter	Description
ICE3ARXX65JG	CoolSET™ F3 series with integrated switch for Fixed Frequency Flyback
ICE2QRXX65G	CoolSET™ F3 series with integrated switch for Quasi Resonant Flyback
ICE3BS03LJG	Stand-alone PWM IC for Fixed Frequency Flyback
ICE2QS03G	Stand-alone PWM IC for Quasi Resonant Flyback
IPL65R1K5C6S	650V CoolMOS™ MOSFET in ThinPAK 5x6
IPD65R1K4C6	650V CoolMOS™ MOSFET in DPAK
IPU60R1K4C6	600V CoolMOS™ MOSFET in IPAK

Transmitter	Description
XMC 1302 or XMC 4108	32-bit XMC Microcontroller (XMC 1302 for single standard, XMC 4108 for multi standard solution)
BSC0925ND	5x6 OptiMOS™ 30V/5mΩ half bridge Module SuperSO8
BSC150N03LDG	OptiMOS™ 3 Dual N-Channel, Logic Level, 30V/15mΩ SuperSO8
BSC072N03LDG	OptiMOS™ 3 Dual N-Channel, Logic Level, 30V/7.2mΩ SuperSO8
BSZ065N03LS	OptiMOS™ Power MOSFET, Logic Level, 30V/6.5mΩ S308
BSC0909NS	OptiMOS™ Power MOSFET, Logic Level, 34V/9.2mΩ SuperSO8
BSC120N03MSG	OptiMOS™ 3 Power MOSFET, Logic Level 5V opt., 30V/12mΩ SS08



# Expert Support for Applications

Easy Access and High Quality



**Block Diagrams, Documents, Videos, Evaluation Boards & More**

[www.infineon.com/smpps](http://www.infineon.com/smpps)

[www.infineon.com/emobility](http://www.infineon.com/emobility)

[www.infineon.com/solar](http://www.infineon.com/solar)

[www.infineon.com/industrial](http://www.infineon.com/industrial)

[www.infineon.com/consumer](http://www.infineon.com/consumer)

[www.infineon.com/lighting](http://www.infineon.com/lighting)

[www.infineon.com/motorcontrol](http://www.infineon.com/motorcontrol)

[www.infineon.com/automation](http://www.infineon.com/automation)



Applications

# OptiMOS™

## Leading-Edge Solutions

Infineon's innovative products serve the market needs throughout the whole energy supply chain. OptiMOS™ is the market leader in highly efficient solutions for power generation (e.g. Solar Micro Inverter), Power Supply (e.g. Server and Telecom) and power consumption (e.g. Electric Vehicle). In all these areas, engineers face the challenges of growing power demand, increasing efficiency and lowering cost. At the same time, the available space is constantly shrinking, leading to higher power density requirements.

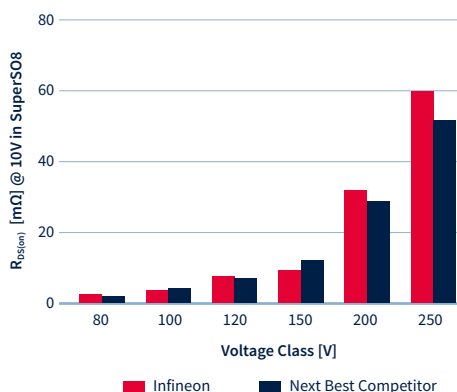
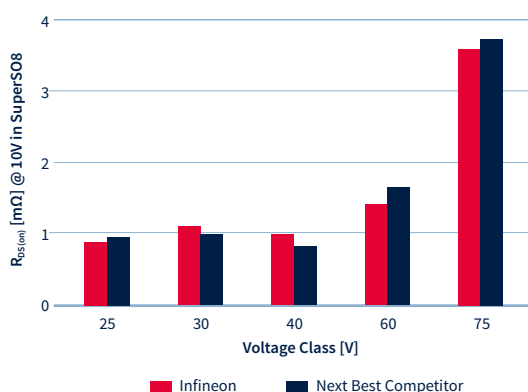
The solution can be found with Infineon's power MOSFET OptiMOS™ family. From 20V up to 300V, OptiMOS™ consistently sets the benchmark in key specifications for power system design. Leading on-state resistance and Figure of Merit characteristics enable reduced power losses and improved overall efficiency.

Lower power losses enable system cost improvement by reducing the need for device paralleling and allowing smaller heatsinks. The OptiMOS™ family also provides the opportunity for more compact Power Supply designs.

Available in innovative space saving packages such as TO-Leadless, CanPAK™, SuperSO8 or S3O8, power stage and Blade, these products reduce area consumption. TO-Leadless for example, allows a 60% space reduction compared to D²PAK 7pin. In addition, TO-Leadless improves switching noise and EMI for SMPS, as well as for other industrial applications.

### OptiMOS™ Products are Suitable for a Wide Range of Applications:

- VR-modules for Server
- Solar Micro Inverter and Maximum Power Point Tracker (MPPT)
- Synchronous rectification for AC/DC SMPS
- LED Lighting
- DC/DC converters
- Notebook and Desktop
- Motor Control 12V-110V systems



## Demonstrating > 93% Efficiency in Voltage Regulation for Power Applications

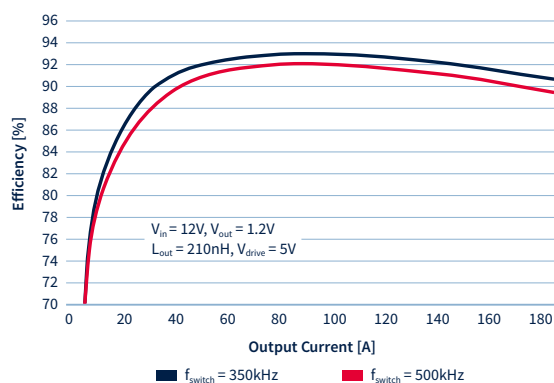
With the new OptiMOS™ 25V and 30V product family, Infineon sets new standards in power density and Energy Efficiency for discrete power MOSFETs and system in package. Ultra low gate and output charge, together with lowest on-state resistance in small footprint packages, make OptiMOS™ 25V the best choice for the demanding requirements of voltage regulator solutions in Servers, Datacom and Telecom applications. OptiMOS™ 30V products are tailored to the needs of power management in Notebook by improved EMI behavior, as well as increased battery life.



With the New OptiMOS™ Products, We Have the Best Solution to:

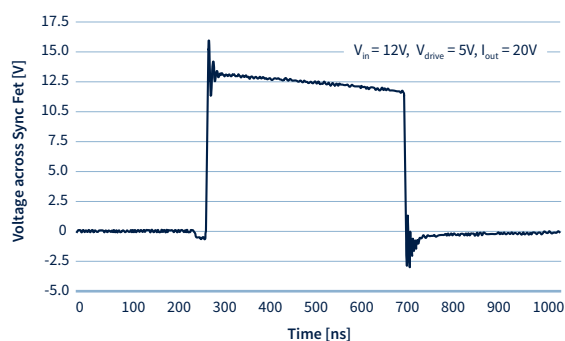
- Save overall system costs by reducing the number of phases in multiphase converters
- Reduce power losses and increase efficiency for all load conditions
- Save space with the smallest packages such as CanPAK™, S308 or system-in-package solution
- Minimize EMI in the system making external snubber networks obsolete and the products easy to design-in

#### Efficiency of OptiMOS™ 25V in a Six-Phase Server VRD



Outstanding performance of the new OptiMOS™ 25V and 30V products is exemplified on a six-phase Server  $V_{core}$  VRD. 93% peak efficiency and >90% full load efficiency is demonstrated with the new OptiMOS™ 25V products in SuperSO8 package.  
(high side: BSC050NE2LS; low side: BSC010NE2LS)

#### Clean Waveforms for Optimized EMI Behavior Make New OptiMOS™ 25V/30V Products Easy to Use

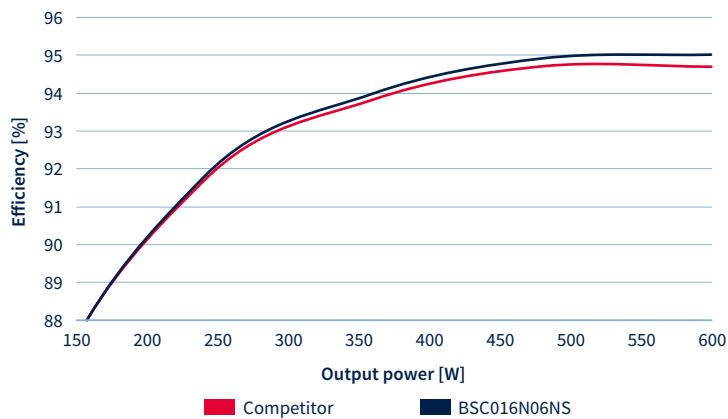


With the new OptiMOS™ 25V/30V products short switching times (rise and fall times <5ns) go in hand with excellent EMI behavior. An integrated damping network guarantees low over and undershoot and minimizes ringing without sacrificing efficiency.

## Always a Step Ahead with Infineon

With OptiMOS™ 40V-300V products, we set the benchmark in the industry. The leading on-state resistance ( $R_{DS(on)}$ ) and switching behavior reduce power losses and enable overall efficiency of 96%. With these products Infineon supports the market trend towards Energy Efficiency targets such as Energy Star Titanium Level. OptiMOS™ technology enables for the first time very low  $R_{DS(on)}$  values needed for high current applications in space saving packages such as SuperSO8, S3O8 and CanPAK™ and TO-Leadless, which were previously only possible in bulky packages.

### Efficiency



Using Infineon products in Synchronous Rectification of a 600W Server Power Supply with 12V output brings your peak efficiency 0.3% higher.

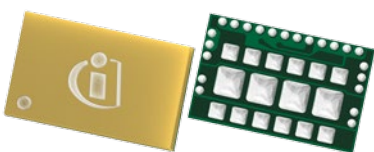
## TO-Leadless



**Optimized for  
High Power Applications**

TO-Leadless package is especially designed for high current applications with high power and reliability requirements such as Forklift, Light Electric Vehicles, e-fuse, PoL (Point of Load) and Telecom. The outstanding current capability up to 300A is an ideal feature for these applications. Furthermore, TO-Leadless offers benefits in terms of optimized board space. The significantly smaller package size, reduced by 60%, enables a very compact design. Compared to D<sup>2</sup>PAK 7pin, TO-Leadless shows a 30% reduction in footprint. This allows a board space reduction in Forklift applications and the 50% reduced height offers a significant advantage in narrow applications such as rack or blade Servers.

## DrBlade™



**The Revolutionary  
Next Packaging Generation**

DrBlade™ is the new ultra-compact integrated MOSFET half bridge with driver, realized in a revolutionary new packaging technology. It is an ideal solution for buck converter applications with highest efficiency and power density requirements. The Blade packaging technology realizes a low package resistance and inductance as well as high current handling capability. It replaces standard packaging processes such as bonding or molding which provide a 30% package footprint reduction. Additionally, the thermal resistances to the package bottom and top side are optimized, improving its thermal behavior. The new packaging technology is available in discrete products such as in the integrated DrBlade™ configuration including driver and MOSFETs.

## SuperSO8/S3O8

In applications like Synchronous Rectification in Server and Desktop, Motor Drives and DC/DC converters in Telecom, high power density and high efficiency are the major driving factors. The trend set by Infineon to move from TO-220 to SuperSO8 in Server reduces the area consumption drastically. With three times lower resistance parasitic compared to TO-220, SuperSO8 offers highest efficiency and lowest design efforts due to reduced spikes.



**The Intelligent Way to Highest Efficiency and Power Density**

## CanPAK™

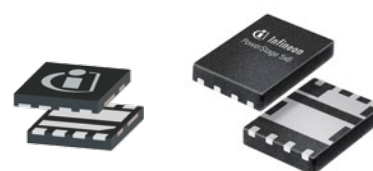
The CanPAK™ portfolio is the best fit for a broad number of industrial applications such as voltage regulator for Servers, DC/DC converters in Telecom, Solar Micro Inverters and Maximum Power Point Trackers (MPPT), low voltage drives and Synchronous Rectification in server and desktop. With only a 31mm<sup>2</sup> footprint, CanPAK™ M allows 79% space reduction in power components on the board compared to traditional D<sup>2</sup>PAK. In addition, the metal 'Can' enables double-sided cooling along with almost no package parasitic inductances, leading to a higher systems efficiency.



**Best Thermal Behavior in a Tiny Footprint**

## Power stage 3x3 and power stage 5x6

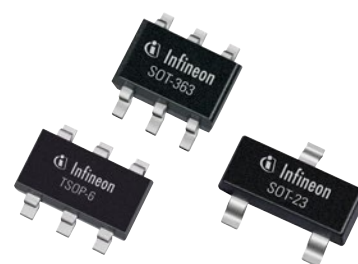
Dual FET power stages in a single leadless SMD package integrate the low side and high side MOSFET of a synchronous DC/DC converter into a 3x3mm<sup>2</sup> or 5x6mm<sup>2</sup> package outline. Designers are able to shrink their designs up to 85% by replacing two separate discrete packages such as SO-8 or SuperSO8 with this new package. Both the small outline and the interconnection of the two MOSFETs within the package minimize the loop inductance which boosts efficiency. With the new OptiMOS™ technology, power stage 3x3 and power stage 5x6 achieve a peak efficiency of 93.5%. Power stage 3x3 can handle an application current up to 12.5A and power stage 5x6 up to 30A.



**Save Space, Minimize Losses, Boost Efficiency**

## Small Signal

Small Signal MOSFETs from Infineon are available in 7 industry-standard package types ranging from the largest SOT-223 down to the smallest SOT-363 measuring 2.1mm x 2mm x 0.9mm. Products are offered in single, dual and complementary configurations and are suitable for a wide range of applications including Battery Protection, LED Lighting, low voltage drives and DC/DC converters. All Infineon Small Signal packages are qualified to Automotive AEC Q101.



**Automotive Qualified Packages**

## OptiMOS™ 20V Super Logic Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=4.5V$ [mΩ]	TO-251 / TO-251 SL	TO-252 (DPAK)	CanPAK™ S/M	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	SO-8
<2							BSC019N02KS G $R_{DS(on)}=1.9m\Omega$	
2-4							BSC026N02KS G $R_{DS(on)}=2.6m\Omega$	
4-10							BSC046N02KS G $R_{DS(on)}=4.6m\Omega$	

## OptiMOS™ 25V Logic Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-251 / TO-251 SL	TO-252 (DPAK)	CanPAK™ S/M	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	S308
<1.0			BSB008NE2LX $R_{DS(on)}=0.8m\Omega$				BSC009NE2LS $R_{DS(on)}=0.9m\Omega$	
1-2			BSB012NE2LX $R_{DS(on)}=1.2m\Omega$				BSC010NE2LS $R_{DS(on)}=1.0m\Omega$	
			BSB012NE2LXI $R_{DS(on)}=1.2m\Omega$				BSC010NE2LSI $R_{DS(on)}=1.05m\Omega$	
			BSB013NE2LXI $R_{DS(on)}=1.3m\Omega$				BSC014NE2LSI $R_{DS(on)}=1.4m\Omega$	
							BSC018NE2LS $R_{DS(on)}=1.8m\Omega$	BSZ18NE2LS $R_{DS(on)}=1.8m\Omega$
							BSC018NE2LSI $R_{DS(on)}=1.8m\Omega$	BSZ018NE2LSI $R_{DS(on)}=1.8m\Omega$
2-4							BSC024NE2LS $R_{DS(on)}=2.4m\Omega$	
			BSF030NE2LQ <sup>1)</sup> $R_{DS(on)}=3.0m\Omega$				BSC032NE2LS $R_{DS(on)}=3.2m\Omega$	
			BSF035NE2LQ <sup>1)</sup> $R_{DS(on)}=3.5m\Omega$					BSZ036NE2LS $R_{DS(on)}=3.6m\Omega$
4-6							BSC050NE2LS $R_{DS(on)}=5.0m\Omega$	
								BSZ060NE2LS $R_{DS(on)}=6.0m\Omega$
6-7								

<sup>1)</sup> CanPAK™ S



## OptiMOS™ 25/30V in power stage 3x3 and 5x6



Part Number	Monolithically integrated Schottky like diode	BV <sub>DSS</sub> (V)	R <sub>DS(on)max.</sub> [mΩ] @ V <sub>GS</sub> =4.5V max		Q <sub>g</sub> [nC] @ V <sub>GS</sub> =4.5V typ	
			High Side	Low Side	High Side	Low Side
BSC0910NDI	✓	25	5.9	1.6	7.7	25.0
BSC0911ND	–	25	4.8	1.7	7.7	25.0
BSC0921NDI	✓	30	7.0	2.1	5.8	21.0
BSC0923NDI	✓	30	7.0	3.7	5.2	12.2
BSC0924NDI	✓	30	7.0	5.2	5.2	8.6
BSC0925ND	–	30	6.4	6.4	5.2	6.7
BSG0811ND	–	25	4	1.1	5.6	20
BSG0813NDI	✓	25	4	1.7	5.6	12

## OptiMOS™ 30V Logic Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-251 / TO-251 SL	TO-252 (DPAK)	CanPAK™ M	TO-Leadless	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	SuperSO8	S308	Bare Die ( $R_{DS(on)}$ typ.)
1-2			BSB012N03LX3 G $R_{DS(on)}=1.2m\Omega$	IPT004N03L $R_{DS(on)}=0.4m\Omega$		IPB009N03L G $R_{DS(on)}=0.95m\Omega$		BSC011N03LS $R_{DS(on)}=1.1m\Omega$		IPC218N03L3 $R_{DS(on)}=0.5m\Omega$
								BSC011N03LSI $R_{DS(on)}=1.1m\Omega$		
								BSC014N03LS G $R_{DS(on)}=1.4m\Omega$		
			BSB017N03LX3 G $R_{DS(on)}=1.7m\Omega$					BSC016N03LS G $R_{DS(on)}=1.6m\Omega$	BSZ019N03LS $R_{DS(on)}=1.9m\Omega$	IPC055N03L3 $R_{DS(on)}=1.7m\Omega$
								BSC0901NS $R_{DS(on)}=1.9m\Omega$		
								BSC0901NSI $R_{DS(on)}=2.0m\Omega$	BSZ0901NS $R_{DS(on)}=2.0m\Omega$	
2-4								BSC020N03LS G $R_{DS(on)}=2.0m\Omega$	BSZ0901NSI $R_{DS(on)}=2.1m\Omega$	IPC042N03L3 $R_{DS(on)}=2.3m\Omega$
								BSC025N03LS G $R_{DS(on)}=2.5m\Omega$		
								BSC0902NS $R_{DS(on)}=2.6m\Omega$	BSZ0902NS $R_{DS(on)}=2.6m\Omega$	
								BSC0902NSI $R_{DS(on)}=2.8m\Omega$	BSZ0902NSI $R_{DS(on)}=2.8m\Omega$	
	IPS031N03L G $R_{DS(on)}=3.1m\Omega$	IPD031N03L G $R_{DS(on)}=3.1m\Omega$			IPB034N03L G $R_{DS(on)}=3.4m\Omega$		IPP034N03L G $R_{DS(on)}=3.4m\Omega$	BSC030N03LS G $R_{DS(on)}=3.0m\Omega$	BSZ035N03LS G $R_{DS(on)}=3.5m\Omega$	
								BSC034N03LS G $R_{DS(on)}=3.4m\Omega$		
4-6	IPS040N03L G $R_{DS(on)}=4.0m\Omega$	IPD040N03L G $R_{DS(on)}=4.0m\Omega$			IPB042N03L G $R_{DS(on)}=4.2m\Omega$		IPP042N03L G $R_{DS(on)}=4.2m\Omega$	BSC042N03LS G $R_{DS(on)}=4.2m\Omega$	BSZ0904NSI $R_{DS(on)}=4.0m\Omega$	
								BSC0906NS $R_{DS(on)}=4.5m\Omega$		
	IPS050N03L G $R_{DS(on)}=5.0m\Omega$	IPD050N03L G $R_{DS(on)}=5.0m\Omega$						BSC050N03LS G $R_{DS(on)}=5.0m\Omega$	BSZ050N03LS G $R_{DS(on)}=5.0m\Omega$	IPC028N03L3 $R_{DS(on)}=5.0m\Omega$
					IPB055N03L G $R_{DS(on)}=5.5m\Omega$		IPP055N03L G $R_{DS(on)}=5.5m\Omega$	BSC052N03LS $R_{DS(on)}=5.2m\Omega$		IPC022N03L3 $R_{DS(on)}=5.3m\Omega$
								BSC057N03LS G $R_{DS(on)}=5.7m\Omega$	BSZ058N03LS G $R_{DS(on)}=5.8m\Omega$	
									BSZ065N03LS $R_{DS(on)}=6.5m\Omega$	
6-8	IPS060N03L G $R_{DS(on)}=6.0m\Omega$	IPD060N03L G $R_{DS(on)}=6.0m\Omega$			IPB065N03L G $R_{DS(on)}=6.5m\Omega$					
	IPS075N03L G $R_{DS(on)}=7.5m\Omega$	IPD075N03L G $R_{DS(on)}=7.5m\Omega$			IPB080N03L G $R_{DS(on)}=8.0m\Omega$					
8-10								BSC080N03LS G $R_{DS(on)}=8.0m\Omega$	BSZ088N03LS G $R_{DS(on)}=8.8m\Omega$	
	IPS090N03L G $R_{DS(on)}=9.0m\Omega$	IPD090N03L G $R_{DS(on)}=9.0m\Omega$						BSC090N03LS G $R_{DS(on)}=9.0m\Omega$		
								BSC0909NS $R_{DS(on)}=9.2m\Omega$		
10-15									BSZ100N03LS G $R_{DS(on)}=10.0m\Omega$	
								BSC120N03LS G $R_{DS(on)}=12.0m\Omega$	BSZ0909NS $R_{DS(on)}=12.0m\Omega$	
		IPD135N03L G $R_{DS(on)}=13.5m\Omega$							BSZ130N03LS G $R_{DS(on)}=13.0m\Omega$	
2 x 7.2								BSC072N03LD G $R_{DS(on)}=7.2m\Omega$		
2 x 15								BSC150N03LD G $R_{DS(on)}=15.0m\Omega$		
50										IPC014N03L3 $R_{DS(on)}=50.0m\Omega$

## OptiMOS™ 30V Logic Level 5V Optimized



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-251 / TO-251 SL	TO-252 (DPAK)	TO-263 (D <sup>+</sup> PAK)	TO-263 (D <sup>+</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	S308	SO-8
<2							BSC014N03MS G $R_{DS(on)}=1.4m\Omega$		
							BSC016N03MS G $R_{DS(on)}=1.6m\Omega$		
2-6							BSC020N03MS G $R_{DS(on)}=2.0m\Omega$	BSZ035N03MS G $R_{DS(on)}=3.5m\Omega$	BSO033N03MS G $R_{DS(on)}=3.3m\Omega$
							BSC025N03MS G $R_{DS(on)}=2.5m\Omega$		BSO040N03MS G $R_{DS(on)}=4.0m\Omega$
							BSC030N03MS G $R_{DS(on)}=3.0m\Omega$		
							BSC042N03MS G $R_{DS(on)}=4.2m\Omega$	BSZ050N03MS G $R_{DS(on)}=5.0m\Omega$	
							BSC050N03MS G $R_{DS(on)}=5.0m\Omega$	BSZ058N03MS G $R_{DS(on)}=5.8m\Omega$	
							BSC057N03MS G $R_{DS(on)}=5.7m\Omega$		
6-10									
							BSC080N03MS G $R_{DS(on)}=8.0m\Omega$	BSZ088N03MS G $R_{DS(on)}=8.8m\Omega$	
							BSC090N03MS G $R_{DS(on)}=9.0m\Omega$		
10-20							BSC100N03MS G $R_{DS(on)}=10.0m\Omega$	BSZ100N03MS G $R_{DS(on)}=10.0m\Omega$	BSO110N03MS G $R_{DS(on)}=11.0m\Omega$
							BSC120N03MS G $R_{DS(on)}=12.0m\Omega$	BSZ130N03MS G $R_{DS(on)}=13.0m\Omega$	
>20									
2x15									BSO150N03MD G $R_{DS(on)}=15.0m\Omega$
2x22									BSO220N03MD G $R_{DS(on)}=22.0m\Omega$

## OptiMOS™ 40V Logic Level/Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	CanPAK™ S/M	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	S308	Bare Die ( $R_{DS(on)}$ typ.)
<2							BSC010N04LS $R_{DS(on)}=1.0m\Omega$		
							BSC010N04LSI $R_{DS(on)}=1.05m\Omega$		
							BSC014N04LS $R_{DS(on)}=1.4m\Omega$		
							BSC014N04LSI $R_{DS(on)}=1.45m\Omega$		
		BSB014N04LX3 G $R_{DS(on)}=1.4m\Omega$	IPB015N04N G $R_{DS(on)}=1.5m\Omega$	IPB011N04L G $R_{DS(on)}=1.1m\Omega$	IPP015N04N G $R_{DS(on)}=1.5m\Omega$		BSC016N04LS G $R_{DS(on)}=1.6m\Omega$		
		BSB015N04NX3 G $R_{DS(on)}=1.5m\Omega$	IPB015N04L G $R_{DS(on)}=1.5m\Omega$	IPB011N04N G $R_{DS(on)}=1.1m\Omega$			BSC017N04NS G $R_{DS(on)}=1.7m\Omega$		
							BSC018N04LS G $R_{DS(on)}=1.8m\Omega$		IPC218N04N3 $R_{DS(on)}=0.5m\Omega$
							BSC019N04NS G $R_{DS(on)}=1.9m\Omega$		IPC171N04N $R_{DS(on)}=1.1m\Omega$
2-3				IPB020N04N G $R_{DS(on)}=2.0m\Omega$	IPP023N04N G $R_{DS(on)}=2.3m\Omega$		BSC022N04LS $R_{DS(on)}=2.2m\Omega$	BSZ023N04LS $R_{DS(on)}=2.3m\Omega$	
			IPB023N04N G $R_{DS(on)}=2.3m\Omega$				BSC026N04LS $R_{DS(on)}=2.6m\Omega$	BSZ028N04LS $R_{DS(on)}=2.8m\Omega$	
							BSC027N04LS G $R_{DS(on)}=2.7m\Omega$		
							BSC030N04NS G $R_{DS(on)}=3.0m\Omega$		
3-4	IPD036N04L G $R_{DS(on)}=3.6m\Omega$				IPP039N04L G $R_{DS(on)}=3.9m\Omega$		BSC032N04LS $R_{DS(on)}=3.2m\Omega$	BSZ034N04LS $R_{DS(on)}=3.4m\Omega$	
							BSC035N04LS G $R_{DS(on)}=3.5m\Omega$	BSZ040N04LS G $R_{DS(on)}=4.0m\Omega$	
4-7					IPP041N04N G $R_{DS(on)}=4.1m\Omega$		BSC050N04LS G $R_{DS(on)}=5.0m\Omega$	BSZ042N04NS G $R_{DS(on)}=4.2m\Omega$	
					IPP048N04N G $R_{DS(on)}=4.8m\Omega$		BSC054N04NS G $R_{DS(on)}=5.4m\Omega$		
							BSC059N04LS G $R_{DS(on)}=5.9m\Omega$		
7-8									
8-10							BSC093N04LS G $R_{DS(on)}=9.3m\Omega$	BSZ097N04LS G $R_{DS(on)}=9.7m\Omega$	
10-11								BSZ105N04NS G $R_{DS(on)}=10.5m\Omega$	
13-17								BSZ165N04NS G $R_{DS(on)}=16.5m\Omega$	

## OptiMOS™ 60V Logic Level/Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	CanPAK™ S/M	TO-Leadless	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	S308	Bare Die ( $R_{DS(on)}$ typ.)
<3	IPD025N06N <sup>2)</sup> $R_{DS(on)}=2.5m\Omega$	BSB028N06NN3 G $R_{DS(on)}=2.8m\Omega$	IPT007N06N <sup>2)</sup> $R_{DS(on)}=0.7m\Omega$	IPI020N06N <sup>2)</sup> $R_{DS(on)}=2.0m\Omega$	IPB019N06L3 G $R_{DS(on)}=1.9m\Omega$	IPB010N06N <sup>2)</sup> $R_{DS(on)}=1.0m\Omega$	IPP020N06N <sup>2)</sup> $R_{DS(on)}=2.0m\Omega$	IPA029N06N <sup>2)</sup> $R_{DS(on)}=2.9m\Omega$	BSC014N06NS <sup>2)</sup> $R_{DS(on)}=1.4m\Omega$		
				IPI024N06N3 G $R_{DS(on)}=2.4m\Omega$		IPB014N06N <sup>2)</sup> $R_{DS(on)}=1.4m\Omega$	IPP024N06N3 G $R_{DS(on)}=2.4m\Omega$		BSC016N06NS <sup>2)</sup> $R_{DS(on)}=1.6m\Omega$		IPC218N06L3 $R_{DS(on)}=1.2m\Omega$
				IPI029N06N <sup>2)</sup> $R_{DS(on)}=2.9m\Omega$	IPB026N06N <sup>2)</sup> $R_{DS(on)}=2.6m\Omega$	IPB016N06L3 G $R_{DS(on)}=1.6m\Omega$	IPP029N06N <sup>2)</sup> $R_{DS(on)}=2.9m\Omega$		BSC028N06NS <sup>2)</sup> $R_{DS(on)}=2.8m\Omega$		IPC218N06N3 $R_{DS(on)}=1.3m\Omega$
					IPB029N06N3 G $R_{DS(on)}=2.9m\Omega$	IPB017N06N3 G $R_{DS(on)}=1.7m\Omega$			BSC028N06LS3 G $R_{DS(on)}=2.8m\Omega$		
3-5	IPD031N06L3 G $R_{DS(on)}=3.1m\Omega$			IPI032N06N3 G $R_{DS(on)}=3.2m\Omega$	IPB034N06L3 G $R_{DS(on)}=3.4m\Omega$		IPP032N06N3 G $R_{DS(on)}=3.2m\Omega$	IPA032N06N3 G $R_{DS(on)}=3.2m\Omega$	BSC031N06NS3 G $R_{DS(on)}=3.1m\Omega$	BSZ042N06NS <sup>2)</sup> $R_{DS(on)}=4.2m\Omega$	
	IPD034N06N3 G $R_{DS(on)}=3.4m\Omega$				IPB037N06N3 G $R_{DS(on)}=3.7m\Omega$		IPP037N06L3 G $R_{DS(on)}=3.7m\Omega$	IPA040N06N <sup>2)</sup> $R_{DS(on)}=4.0m\Omega$	BSC034N06NS <sup>2)</sup> $R_{DS(on)}=3.4m\Omega$		
				IPI040N06N3 G $R_{DS(on)}=4.0m\Omega$			IPP040N06N <sup>2)</sup> $R_{DS(on)}=4.0m\Omega$		BSC039N06NS <sup>2)</sup> $R_{DS(on)}=3.9m\Omega$		
	IPD038N06N3 G $R_{DS(on)}=3.8m\Omega$						IPP040N06N3 G $R_{DS(on)}=4.0m\Omega$				
	IPD048N06L3 G $R_{DS(on)}=4.8m\Omega$										
5-7	IPD053N06N <sup>2)</sup> $R_{DS(on)}=5.3m\Omega$						IPP052N06L3 G $R_{DS(on)}=5.2m\Omega$	IPA057N06N3 G $R_{DS(on)}=5.7m\Omega$	BSC066N06NS <sup>2)</sup> $R_{DS(on)}=6.6m\Omega$		
					IPB057N06N <sup>2)</sup> $R_{DS(on)}=5.7m\Omega$		IPP057N06N3 G $R_{DS(on)}=5.7m\Omega$	IPA060N06N <sup>2)</sup> $R_{DS(on)}=6.0m\Omega$	BSC067N06LS3 G $R_{DS(on)}=6.7m\Omega$	BSZ067N06LS3 G $R_{DS(on)}=6.7m\Omega$	
							IPP060N06N <sup>2)</sup> $R_{DS(on)}=6.0m\Omega$			BSZ068N06NS <sup>2)</sup> $R_{DS(on)}=6.8m\Omega$	
7-10	IPD079N06L3 G $R_{DS(on)}=7.9m\Omega$			IPI084N06L3 G $R_{DS(on)}=8.4m\Omega$	IPB081N06L3 G $R_{DS(on)}=8.1m\Omega$		IPP084N06L3 G $R_{DS(on)}=8.4m\Omega$	IPA093N06N3 G $R_{DS(on)}=9.3m\Omega$	BSC076N06NS3 G $R_{DS(on)}=7.6m\Omega$	BSZ076N06NS3 G $R_{DS(on)}=7.6m\Omega$	
	IPD088N06N3 G $R_{DS(on)}=8.8m\Omega$				IPB090N06N3 G $R_{DS(on)}=9.0m\Omega$		IPP093N06N3 G $R_{DS(on)}=9.3m\Omega$		BSC097N06NS <sup>2)</sup> $R_{DS(on)}=9.7m\Omega$	BSZ100N06LS3 G $R_{DS(on)}=10.0m\Omega$	
									BSC100N06LS3 G $R_{DS(on)}=10.0m\Omega$	BSZ100N06NS <sup>2)</sup> $R_{DS(on)}=10.0m\Omega$	
11-30		BSF110N06NT3 G <sup>1)</sup> $R_{DS(on)}=11.0m\Omega$							BSC110N06NS3 G $R_{DS(on)}=11.0m\Omega$	BSZ110N06NS3 G $R_{DS(on)}=11.0m\Omega$	
30-50	IPD350N06L G $R_{DS(on)}=35.0m\Omega$										
	IPD400N06N G $R_{DS(on)}=40.0m\Omega$										
	IPD640N06L G $R_{DS(on)}=64.0m\Omega$										

<sup>1)</sup> CanPAK™ S<sup>2)</sup> 6V rated ( $R_{DS(on)}$  also specified @  $V_{GS}=6V$ )

## OptiMOS™ 75V Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	CanPAK™ S/M	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperS08	S308	Bare Die ( $R_{DS(on)}$ typ.)
2-4				IPB020NE7N3 G $R_{DS(on)}=2.0m\Omega$		IPP023NE7N3 G $R_{DS(on)}=2.3m\Omega$		BSC036NE7NS3 G $R_{DS(on)}=3.6m\Omega$		IPC302NE7N3 $R_{DS(on)}=1.2m\Omega$
				IPB031NE7N3 G $R_{DS(on)}=3.1m\Omega$		IPP034NE7N3 G $R_{DS(on)}=3.4m\Omega$				
4-6				IPB049NE7N3 G $R_{DS(on)}=4.9m\Omega$		IPP052NE7N3 G $R_{DS(on)}=5.2m\Omega$		BSC042NE7NS3 G $R_{DS(on)}=4.2m\Omega$		
6-12						IPP062NE7N3 G $R_{DS(on)}=6.2m\Omega$				
12-45		BSF450NE7NH3 <sup>1)</sup> $R_{DS(on)}=45.0m\Omega$								

OptiMOS™ 80V Normal Level <sup>2)</sup>

$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	CanPAK™ S/M	TO-Leadless	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperS08	S308	Bare Die ( $R_{DS(on)}$ typ.)
1-3			IPT012N08N5 $R_{DS(on)}=1.2m\Omega$		IPB017N08N5 $R_{DS(on)}=1.7m\Omega$	IPB015N08N5 $R_{DS(on)}=1.5m\Omega$	IPP020N08N5 $R_{DS(on)}=2.0m\Omega$				IPC302N08N3 $R_{DS(on)}=1.2m\Omega$
					IPB025N08N3 G $R_{DS(on)}=2.5m\Omega$	IPB019N08N3 G $R_{DS(on)}=1.9m\Omega$	IPP023N08N5 $R_{DS(on)}=2.3m\Omega$	IPA028N08N3 G $R_{DS(on)}=2.8m\Omega$	BSC026N08NS5 $R_{DS(on)}=2.6m\Omega$		
					IPB020N08N5 $R_{DS(on)}=2.0m\Omega$		IPP027N08N5 $R_{DS(on)}=2.7m\Omega$		BSC030N08NS5 $R_{DS(on)}=3.0m\Omega$		
					IPB024N08N5 $R_{DS(on)}=2.4m\Omega$		IPP028N08N3 G $R_{DS(on)}=2.8m\Omega$				
3-4				IPI037N08N3 G $R_{DS(on)}=3.7m\Omega$	IPB031N08N5 $R_{DS(on)}=3.1m\Omega$	IPB030N08N3 G $R_{DS(on)}=3.0m\Omega$	IPP034N08N5 $R_{DS(on)}=3.4m\Omega$	IPA037N08N3 G $R_{DS(on)}=3.7m\Omega$	BSC037N08NS5 $R_{DS(on)}=3.7m\Omega$		
					IPB035N08N3 G $R_{DS(on)}=3.5m\Omega$		IPP037N08N3 G $R_{DS(on)}=3.7m\Omega$		BSC040N08NS5 $R_{DS(on)}=4.0m\Omega$		
4-6	IPD053N08N3 G $R_{DS(on)}=5.3m\Omega$	BSB044N08NN3 G $R_{DS(on)}=4.4m\Omega$			IPB049N08N5 $R_{DS(on)}=4.9m\Omega$		IPP052N08N5 $R_{DS(on)}=5.2m\Omega$	IPA057N08N3 G $R_{DS(on)}=5.7m\Omega$	BSC047N08NS3 G $R_{DS(on)}=4.7m\Omega$		
					IPB054N08N3 G $R_{DS(on)}=5.4m\Omega$		IPP057N08N3 G $R_{DS(on)}=5.7m\Omega$		BSC052N08NS5 $R_{DS(on)}=5.2m\Omega$		
									BSC057N08NS3 G $R_{DS(on)}=5.7m\Omega$		
									BSC061N08NS5 $R_{DS(on)}=6.1m\Omega$		
6-7					IPB067N08N3 G $R_{DS(on)}=6.7m\Omega$				BSC072N08NS5 $R_{DS(on)}=7.2m\Omega$		
7-11	IPD096N08N3 G $R_{DS(on)}=9.6m\Omega$	BSB104N08NP3 $R_{DS(on)}=10.4m\Omega$					IPP100N08N3 G $R_{DS(on)}=9.7m\Omega$	IPA100N08N3 G $R_{DS(on)}=10.0m\Omega$	BSC117N08NS5 $R_{DS(on)}=11.7m\Omega$	BSZ075N08NS5 $R_{DS(on)}=7.5m\Omega$	
										BSZ084N08NS5 $R_{DS(on)}=8.4m\Omega$	
11-20										BSZ110N08NS5 $R_{DS(on)}=11.0m\Omega$	
	IPD135N08N3 G $R_{DS(on)}=13.5m\Omega$								BSC123N08NS3 G $R_{DS(on)}=12.3m\Omega$	BSZ123N08NS3 G $R_{DS(on)}=12.3m\Omega$	
30-40									BSC340N08NS3 G $R_{DS(on)}=34.0m\Omega$	BSZ340N08NS3 G $R_{DS(on)}=34.0m\Omega$	

<sup>1)</sup> CanPAK™ S<sup>2)</sup> 6V rated ( $R_{DS(on)}$  also specified @  $V_{GS} = 6V$ )

## OptiMOS™ 100V Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	CanPAK™ S/M	TO-Leadless	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperS08	S308	Bare Die ( $R_{DS(on)}$ typ.)
1-3			IPD015N10N5 <sup>2)</sup> $R_{DS(on)}=1.5m\Omega$		IPB020N10N5 <sup>2)</sup> $R_{DS(on)}=2.0m\Omega$	IPB017N10N5 <sup>2)</sup> $R_{DS(on)}=1.7m\Omega$	IPP023N10N5 <sup>2)</sup> $R_{DS(on)}=3.0m\Omega$				IPC302N10N3 $R_{DS(on)}=1.7m\Omega$
			IPD020N10N3 <sup>2)</sup> $R_{DS(on)}=2.0m\Omega$	IPI030N10N3 G $R_{DS(on)}=3.0m\Omega$	IPB027N10N3 G $R_{DS(on)}=2.7m\Omega$	IPB025N10N3 G $R_{DS(on)}=2.5m\Omega$	IPP030N10N3 G $R_{DS(on)}=3.0m\Omega$	IPA030N10N3 G $R_{DS(on)}=3.0m\Omega$			
					IPB027N10N5 <sup>2)</sup> $R_{DS(on)}=2.7m\Omega$		IPP030N10N5 <sup>2)</sup> $R_{DS(on)}=3.0m\Omega$				
3-4									BSC035N10NSS <sup>2)</sup> $R_{DS(on)}=3.5m\Omega$		IPC26N10NR $R_{DS(on)}=3.2m\Omega$
						IPB039N10N3 G $R_{DS(on)}=3.9m\Omega$			BSC041N10NSS <sup>2)</sup> $R_{DS(on)}=4.1m\Omega$		IPC173N10N3 $R_{DS(on)}=3.6m\Omega$
4-6		BSB056N10NN3 G $R_{DS(on)}=5.6m\Omega$		IPI045N10N3 G $R_{DS(on)}=4.5m\Omega$	IPB042N10N3 G $R_{DS(on)}=4.2m\Omega$		IPP045N10N3 G $R_{DS(on)}=4.5m\Omega$	IPA045N10N3 G $R_{DS(on)}=4.5m\Omega$	BSC046N10NS3 G $R_{DS(on)}=4.6m\Omega$		
6-8	IPD068N10N3 G $R_{DS(on)}=6.8m\Omega$			IPI072N10N3 G $R_{DS(on)}=7.2m\Omega$					BSC060N10NS3 G $R_{DS(on)}=6.0m\Omega$		
							IPP072N10N3 G $R_{DS(on)}=7.2m\Omega$		BSC070N10NS3 G $R_{DS(on)}=7.0m\Omega$		
									BSC070N10NSS <sup>2)</sup> $R_{DS(on)}=7.0m\Omega$		
8-12	IPD082N10N3 G $R_{DS(on)}=8.2m\Omega$			IPI086N10N3 G $R_{DS(on)}=8.6m\Omega$	IPB083N10N3 G $R_{DS(on)}=8.3m\Omega$		IPP083N10N5 <sup>2)</sup> $R_{DS(on)}=8.3m\Omega$	IPA083N10N5 <sup>2)</sup> $R_{DS(on)}=8.3m\Omega$			
								IPA086N10N3 G $R_{DS(on)}=8.6m\Omega$	BSC098N10NSS <sup>2)</sup> $R_{DS(on)}=9.8m\Omega$		
							IPP086N10N3 G $R_{DS(on)}=8.6m\Omega$		BSC109N10NS3 G $R_{DS(on)}=10.9m\Omega$	BSZ097N10NSS <sup>2)</sup> $R_{DS(on)}=9.7m\Omega$	
12-18	IPD122N10N3 G $R_{DS(on)}=12.2m\Omega$	BSF134N10NJ3 G <sup>1)</sup> $R_{DS(on)}=13.4m\Omega$			IPB123N10N3 G $R_{DS(on)}=12.3m\Omega$		IPP126N10N3 G $R_{DS(on)}=12.6m\Omega$	IPA126N10N3 G $R_{DS(on)}=12.6m\Omega$		BSZ160N10NS3 G $R_{DS(on)}=16.0m\Omega$	
									BSC160N10NS3 G $R_{DS(on)}=16.0m\Omega$		
18-20	IPD180N10N3 G $R_{DS(on)}=18.0m\Omega$			IPI180N10N3 G $R_{DS(on)}=18.0m\Omega$			IPP180N10N3 G $R_{DS(on)}=18.0m\Omega$	IPA180N10N3 G $R_{DS(on)}=18.0m\Omega$	BSC196N10NS G $R_{DS(on)}=19.6m\Omega$		
20-40	IPD25CN10N G <sup>2)</sup> $R_{DS(on)}=25.0m\Omega$										
	IPD33CN10N G <sup>2)</sup> $R_{DS(on)}=33.0m\Omega$										
40-80									BSC440N10NS3 G $R_{DS(on)}=44.0m\Omega$	BSZ440N10NS3 G $R_{DS(on)}=44.0m\Omega$	
	IPD78CN10N G <sup>2)</sup> $R_{DS(on)}=78.0m\Omega$										
2 x 75									BSC750N10ND G $R_{DS(on)}=75.0m\Omega$		

<sup>1)</sup> CanPAK™ S<sup>2)</sup> 6V rated ( $R_{DS(on)}$  also specified @  $V_{GS} = 6V$ )

## OptiMOS™ 100V Logic Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-251 / TO-251 SL	TO-252 (DPAK)	CanPAK™ M	CanPAK™ S	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperS08	S308	Bare Die ( $R_{DS(on)}$ typ.)
4-6												
6-8												
8-12										BSC082N10LS G $R_{DS(on)}=8.2m\Omega$		
										BSC105N10LSF G $R_{DS(on)}=10.5m\Omega$		
							IPP12CN10L G $R_{DS(on)}=12.0m\Omega$					
12-18										BSC123N10LS G $R_{DS(on)}=12.3m\Omega$	BSZ150N10LS3 $R_{DS(on)}=15.0m\Omega$	IPC045010N3 $R_{DS(on)}=15.2m\Omega$
20-40												IPC020N10L3 $R_{DS(on)}=42.0m\Omega$
										BSC265N10LSF G $R_{DS(on)}=26.5m\Omega$		

## OptiMOS™ 120V Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-251 / TO-251 SL	TO-252 (DPAK)	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	SuperS08	S308	Bare Die ( $R_{DS(on)}$ typ.)
<4				IPB038N12N3 G $R_{DS(on)}=3.8m\Omega$	IPB036N12N3 G $R_{DS(on)}=3.6m\Omega$				IPC302N12N3 $R_{DS(on)}=2.6m\Omega$
4-5			IPI041N12N3 G $R_{DS(on)}=4.1m\Omega$			IPP041N12N3 G $R_{DS(on)}=4.1m\Omega$			IPC26N12N $R_{DS(on)}=3.0m\Omega$
						IPP048N12N3 G $R_{DS(on)}=4.8m\Omega$			
7-8			IPI076N12N3 G $R_{DS(on)}=7.6m\Omega$			IPP076N12N3 G $R_{DS(on)}=7.6m\Omega$	BSC077N12NS3 G $R_{DS(on)}=7.7m\Omega$		
10-13	IPS110N12N3 G $R_{DS(on)}=11.0m\Omega$	IPD110N12N3 G $R_{DS(on)}=11.0m\Omega$				IPP114N12N3 G $R_{DS(on)}=11.4m\Omega$			
13-20			IPI147N12N3 G $R_{DS(on)}=14.7m\Omega$	IPB144N12N3 G $R_{DS(on)}=14.4m\Omega$		IPP147N12N3 G $R_{DS(on)}=14.7m\Omega$	BSC190N12NS3 G $R_{DS(on)}=19.0m\Omega$		
20-25								BSZ240N12NS3 G $R_{DS(on)}=24.0m\Omega$	IPC300N15N3R $R_{DS(on)}=4.9m\Omega$

OptiMOS™ 150V Normal Level <sup>4)</sup>

$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	CanPAK™ M	TO-Leadless	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperS08	S308	Bare Die ( $R_{DS(on)}$ typ.)
3-7			IPT039N15N5 <sup>3)</sup> $R_{DS(on)}=3.9m\Omega$	IPI046N15N5 <sup>3)</sup> $R_{DS(on)}=4.6m\Omega$	IPB043N15N5 <sup>3)</sup> $R_{DS(on)}=4.3m\Omega$	IPB040N15N5 <sup>3)</sup> $R_{DS(on)}=4.0m\Omega$	IPP046N15N5 <sup>3)</sup> $R_{DS(on)}=4.6m\Omega$				IPC302N15N3 $R_{DS(on)}=4.9m\Omega$
			IPT059N15N3 $R_{DS(on)}=5.9m\Omega$		IPB065N15N5 <sup>3)</sup> $R_{DS(on)}=6.5m\Omega$	IPB065N15N3 G $R_{DS(on)}=6.5m\Omega$					
7-12				IPI069N15N5 <sup>3)</sup> $R_{DS(on)}=6.9m\Omega$	IPB072N15N3 G $R_{DS(on)}=7.2m\Omega$		IPP068N15N5 <sup>3)</sup> $R_{DS(on)}=6.8m\Omega$	IPA075N15N3 G $R_{DS(on)}=6.5m\Omega$	BSC093N15NS5 <sup>3)</sup> $R_{DS(on)}=9.3m\Omega$		
				IPI075N15N3 G $R_{DS(on)}=7.5m\Omega$	IPB108N15N3 G $R_{DS(on)}=10.8m\Omega$		IPP075N15N3 G $R_{DS(on)}=7.5m\Omega$	IPA105N15N3 G $R_{DS(on)}=10.5m\Omega$	BSC110N15NS5 <sup>3)</sup> $R_{DS(on)}=11m\Omega$		
				IPI111N15N3 G $R_{DS(on)}=11.1m\Omega$			IPP111N15N3 G $R_{DS(on)}=11.1m\Omega$				
16-30	IPD200N15N3 G $R_{DS(on)}=20.0m\Omega$	BSB165N15NZ3 G $R_{DS(on)}=16.5m\Omega$			IPB200N15N3 G $R_{DS(on)}=20.0m\Omega$		IPP200N15N3 G $R_{DS(on)}=20.0m\Omega$		BSC160N15NS5 <sup>3)</sup> $R_{DS(on)}=16.0m\Omega$	BSZ300N15NS5 <sup>3)</sup> $R_{DS(on)}=30m\Omega$	
		BSB280N15NZ3 G $R_{DS(on)}=28.0m\Omega$							BSC190N15NS3 G $R_{DS(on)}=19.0m\Omega$		
30-60									BSC360N15NS3 G $R_{DS(on)}=36.0m\Omega$		
	IPD530N15N3 G $R_{DS(on)}=53.0m\Omega$			IPI530N15N3 G $R_{DS(on)}=53.0m\Omega$	IPB530N15N3 G $R_{DS(on)}=53.0m\Omega$		IPP530N15N3 G $R_{DS(on)}=53.0m\Omega$		BSC520N15NS3 G $R_{DS(on)}=52.0m\Omega$	BSZ520N15NS3 G $R_{DS(on)}=52.0m\Omega$	
80-90										BSZ900N15NS3 G $R_{DS(on)}=90.0m\Omega$	

<sup>3)</sup> In development<sup>4)</sup> 8V rated ( $R_{DS(on)}$  also specified @  $V_{GS}=8V$ )

## OptiMOS™ 200V Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	S308	Bare Die ( $R_{DS(on)}$ typ.)
10-20									IPC300N20N3 $R_{DS(on)}=9.2m\Omega$
		IPI110N20N3 G $R_{DS(on)}=11.0m\Omega$	IPB107N20N3 G $R_{DS(on)}=10.7m\Omega$		IPP110N20N3 G $R_{DS(on)}=11.0m\Omega$				IPC302N20N3 $R_{DS(on)}=9.2m\Omega$
			IPB107N20NA <sup>5)</sup> $R_{DS(on)}=10.7m\Omega$		IPP110N20NA <sup>5)</sup> $R_{DS(on)}=11.0m\Omega$				
			IPB117N20NFD $R_{DS(on)}=11.7m\Omega$		IPP120N20NFD $R_{DS(on)}=12.0m\Omega$				
30-40	IPD320N20N3 G $R_{DS(on)}=32.0m\Omega$	IPI320N20N3 G $R_{DS(on)}=32.0m\Omega$	IPB320N20N3 G $R_{DS(on)}=32.0m\Omega$		IPP320N20N3 G $R_{DS(on)}=32.0m\Omega$		BSC320N20NS3 G $R_{DS(on)}=32.0m\Omega$		
40-50							BSC500N20NS3G $R_{DS(on)}=50.0m\Omega$		
80-100							BSC900N20NS3 G $R_{DS(on)}=90.0m\Omega$	BSZ900N20NS3 G $R_{DS(on)}=90.0m\Omega$	
100-200							BSC12DN20NS3 G $R_{DS(on)}=125.0m\Omega$	BSZ12DN20NS3 G $R_{DS(on)}=125.0m\Omega$	
200-300							BSC22DN20NS3 G $R_{DS(on)}=225.0m\Omega$	BSZ22DN20NS3 G $R_{DS(on)}=225.0m\Omega$	

## OptiMOS™ 250V Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	S308	Bare Die ( $R_{DS(on)}$ typ.)
10-20									IPC302N25N3A <sup>5)</sup> $R_{DS(on)}=16.0m\Omega$
20-30		IPI200N25N3 G $R_{DS(on)}=20.0m\Omega$	IPB200N25N3 G $R_{DS(on)}=20.0m\Omega$		IPP200N25N3 G $R_{DS(on)}=20.0m\Omega$				IPC045N25N3 $R_{DS(on)}=25.0m\Omega$
					IPP220N25NFD $R_{DS(on)}=22.0m\Omega$				
60-70	IPD600N25N3 G $R_{DS(on)}=60.0m\Omega$	IPI600N25N3 G $R_{DS(on)}=60.0m\Omega$	IPB600N25N3 G $R_{DS(on)}=60.0m\Omega$		IPP600N25N3 G $R_{DS(on)}=60.0m\Omega$		BSC600N25NS3 G $R_{DS(on)}=60.0m\Omega$		
100-200							BSC16DN25NS3 G $R_{DS(on)}=165.0m\Omega$	BSZ16DN25NS3 G $R_{DS(on)}=165.0m\Omega$	
400-500								BSZ42DN25NS3 G $R_{DS(on)}=425.0m\Omega$	

<sup>5)</sup> Part qualified according to AEC Q101



## OptiMOS™ 300V Normal Level



$R_{DS(on)} \text{ max}$ @ $V_{GS}=10V$ [mΩ]	TO-252 (DPAK)	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK 7pin)	TO-220	TO-220 FullPAK	SuperSO8	S308	Bare Die ( $R_{DS(on)}$ typ.)
40-50			IPB407N30N $R_{DS(on)}=40.7\text{m}\Omega$		IPP410N30N $R_{DS(on)}=41.0\text{m}\Omega$				

## Small Signal



Voltage [V]		SOT-223	TSOP-6	SOT-89	SC-59	SOT-23	SOT-323	SOT-363
P-Channel MOSFETs	- 250	BSP317P 4Ω, -0.43A, LL						
		BSP92P 12Ω, -0.26A, LL		BSS192P 12Ω, -0.19A, LL	BSR92P 11Ω, -0.14A, LL			
	- 100	BSP321P 900mΩ, -0.98A, NL						
		BSP322P 800mΩ, -1.0A, LL						
		BSP316P 1.8Ω, -0.68A, LL			BSR316P 1.8Ω, -0.36A, LL			
	- 60	BSP612P 120mΩ, 3A, LL						
		BSP613P 130mΩ, 2.9A, NL				BSS83P 2Ω, -0.33A, LL		
		BSP170P 300mΩ, -1.9A, NL				BSS84P 8Ω, -0.17A, LL	BSS84PW 8Ω, -0.15, LL	
		BSP171P 300mΩ, -1.9A, LL						
		BSP315P 800mΩ, -1.17A, LL			BSR315P 800mΩ, -0.62A, LL			
	- 30		BSL303SPE ~30mΩ, ~-6.6A, LL		BSR303PE <sup>1)</sup> ~30mΩ, ~-3.3A, LL			
			BSL305SPE ~50mΩ, ~-5.3A, LL		BSR305PE <sup>1)</sup> ~50mΩ, ~-2.7A, LL			
			BSL307SP 43mΩ, -5.5A, LL			BSS308PE 80mΩ, -2.1A, LL, ESD		
			BSL308PE 80mΩ, -2.1A, LL, dual, ESD			BSS314PE 140mΩ, -1.5A, LL, ESD		
			BSL314PE 140mΩ, -1.5A, LL, ESD, dual			BSS315P 150mΩ, -1.5A, LL		BSD314SPE 140mΩ, -1.5A, LL, ESD
							BSS356PWE <sup>1)</sup> ~560mΩ, ~-0.73A, LL	BSD356PE <sup>1)</sup> ~560mΩ, ~-0.73A, LL
	- 20		BSL207SP 41mΩ, -6A, SLL				BSS209PW 550mΩ, -0.58A, SLL	BSV236SP 175mΩ, -1.5A, SLL
			BSL211SP 67mΩ, -4.7A, SLL				BSS223PW 1.2Ω, -0.39A, SLL	BSD223P 1.2Ω, -0.39A, SLL, dual
						BSS215P 150mΩ, -1.5A, SLL		

<sup>1)</sup> Coming Q2 2015

All products are qualified to Automotive AEC Q101



## Small Signal



		Voltage [V]	SOT-223	TSOP-6	SOT-89	SC-59	SOT-23	SOT-323	SOT-363
Complementary	-20/20			BSL215C N: 140mΩ, 1.5A, SLL P: 150mΩ, -1.5A, SLL					BSD235C N: 350mΩ, 0.95A, SLL P: 1.2Ω, -0.53A, SLL
	-30/30			BSL316C N: 160mΩ, 1.4A, LL P: 150mΩ, -1.5A, LL					
				BSL308C N: 57mΩ, A, LL P: 80mΩ, A, LL,					BSD356C <sup>2)</sup> N: 350mΩ, 0.95A, LL P: ~560mΩ, ~0.73A, LL

<sup>2)</sup> Coming Q2 2015

All products are qualified to Automotive AEC Q101

## Small Signal



Voltage [V]		SOT-223	TSOP-6	SOT-89	SC-59	SOT-23	SOT-323	SOT-363
N-Channel MOSFETs	20		BSL802SN 22mΩ, 7.5A, ULL		BSR802N 23mΩ, 3.7A, ULL			
			BSL202SN 22mΩ, 7.5A, SLL		BSR202N 21mΩ, 3.8A, SLL	BSS806NE 57mΩ, 2.3A, ULL, ESD		
			BSL806N 57mΩ, 2.3A, ULL, dual			BSS806N 57mΩ, 2.3A, ULL		BSD816SN 160mΩ, 1.4A, ULL
			BSL205N 50mΩ, 2.5A, SLL, dual			BSS205N 50mΩ, 2.5A, SLL		BSD214SN 140mΩ, 1.5A, SLL
			BSL207N 70mΩ, 2.1A, SLL, dual				BSS816NW 160mΩ, 1.4A, ULL	BSD840N 400mΩ, 0.88A, ULL, dual
			BSL214N 140mΩ, 1.5A, SLL, dual			BSS214N 140mΩ, 1.5A, SLL	BSS214NW 140mΩ, 1.5A, SLL	BSD235N 350mΩ, 0.95A, SLL, dual
	30		BSL302SN 25mΩ, 7.1A, LL		BSR302N 23mΩ, 3.7A, LL	BSS306N 57mΩ, 2.3A, LL		
			BSL306N 57mΩ, 2.3A, LL, dual			BSS316N 160mΩ, 1.4A, LL		BSD316SN 160mΩ, 1.4A, LL
	55					BSS670S2L 650mΩ, 0.54A, LL		
	60	BSP318S 90mΩ, 2.6A, LL	BSL606SN 60mΩ, 4.5A, LL	BSS606N 60mΩ, 3.2A, LL	BSR606N 60mΩ, 2.3A, LL	BSS138N 3.5Ω, 0.23A, LL	BSS138W 3.5Ω, 0.28A, LL	
		BSP320S 120mΩ, 2.9A, NL				BSS7728N 5Ω, 0.2A, LL		
		BSP295 300mΩ, 1.8A, LL				SN7002N 5Ω, 0.2A, LL	SN7002W 5Ω, 0.23A, LL	
						2N7002 3Ω, 0.3A, LL		2N7002DW 3Ω, 0.3A, LL, dual
						BSS159N 8Ω, 0.13A, depl.		
	75	BSP716N 160mΩ, 2.3A, LL	BSL716SN 150mΩ, 2.5A, LL					

All products are qualified to Automotive AEC Q101 (except 2N7002)

## Small Signal



Voltage [V]		SOT-223	TSOP-6	SOT-89	SC-59	SOT-23	SOT-323	SOT-363
N-Channel MOSFETs	100	BSP373N 240mΩ, 1.8A, NL	BSL373SN 230mΩ, 2.0A, NL			BSS169 12Ω, 0.09A, depl.		
		BSP372N 230mΩ, 1.8A, LL	BSL372SN 220mΩ, 2.0A, LL			BSS119N 6Ω, 0.19A, LL $V_{GS(TH)}$ 1.8V to 2.3V		
		BSP296N 600mΩ, 1.2A, LL	BSL296SN 460mΩ, 1.4A, LL					
						BSS123N 6Ω, 0.19A, LL $V_{GS(TH)}$ 0.8V to 1.8V		
	200	BSP297 1.8Ω, 0.66A, LL						
		BSP149 3.5Ω, 0.14 A, depl.						
	240	BSP88 6Ω, 0.35A, 2.8V rated		BSS87 6Ω, 0.26A, LL		BSS131 14Ω, 0.1A, LL		
		BSP89 6Ω, 0.35A, LL						
		BSP129 6Ω, 0.05A, depl.						
	250					BSS139 30Ω, 0.03A, depl.		
	400	BSP179 24Ω, 0.20A, depl.*						
		BSP298 3Ω, 0.5A, NL						
		BSP324 25Ω, 0.17A, LL						
	500	BSP299 4Ω, 0.4A, NL						
	600	BSP125 45Ω, 0.12A, LL		BSS225 45Ω, 0.09A, LL		BSS127 500Ω, 0.023A, LL		
		BSP135 60Ω, 0.02A, depl.				BSS126 700Ω, 0.007A, depl.		
	800	BSP300 20Ω, 0.19A, NL						

\* In development

All products are qualified to Automotive AEC Q101

## Power P-Channel MOSFETs



$R_{DS(on)}$ @ $V_{GS}=10V$			TO-220	TO-252 (DPAK)	TO-263 (D <sup>2</sup> PAK)	SO-8	SuperSO8	S308
P-Channel MOSFETs	- 20V	7mΩ				BSO201SP H		
		21mΩ				BSO203SP H BSO203P H (dual)		
		30mΩ						
		45mΩ				BSO207P H (dual)		
		67mΩ				BSO211P H (dual)		
	- 30V	3mΩ					BSC030P03NS3 G	
		4,2mΩ		IPD042P03L3 G				
		5-7mΩ		SPD50P03L G <sup>1)</sup> * IPD068P03L3 G			BSC060P03NS3E G	
		~8mΩ				BSO080P03NS3 G BSO080P03NS3E G BSO080P03S H BSO301SP H	BSC080P03LS G BSC084P03NS3 G BSC084P03NS3E G	BSZ086P03NS3 G BSZ086P03NS3E G
		12mΩ						BSZ120P03NS3 G BSZ120P03NS3E G
		13mΩ				BSO130P03S H	BSC130P03LS G	
		18mΩ						BSZ180P03NS3 G BSZ180P03NS3E G
		20mΩ				BSO200P03S H BSO303SP H		
		21mΩ				BSO303P H (dual)		
		1,2Ω						
	- 60V	23mΩ	SPP80P06P H *		SPB80P06P G *			
		75mΩ		SPD30P06P G *				
		130mΩ	SPP18P06P H *	SPD18P06P G *	SPB18P06P G *	BSO613SPV G *		
		250mΩ		SPD09P06PL G *				
		300mΩ	SPP08P06P H *	SPD08P06P G *	SPB08P06P G *			
	- 100V	210mΩ	SPP15P10PL H *	SPD15P10PL G *				
		240mΩ	SPP15P10P H *	SPD15P10P G *				
		850mΩ		SPD04P10PL G *				
		1Ω		SPD04P10P G *				
Comp.	-60/ 60V	11-30mΩ				BSO612CV G *		
						BSO615C G *		

## Power P-Channel MOSFETs



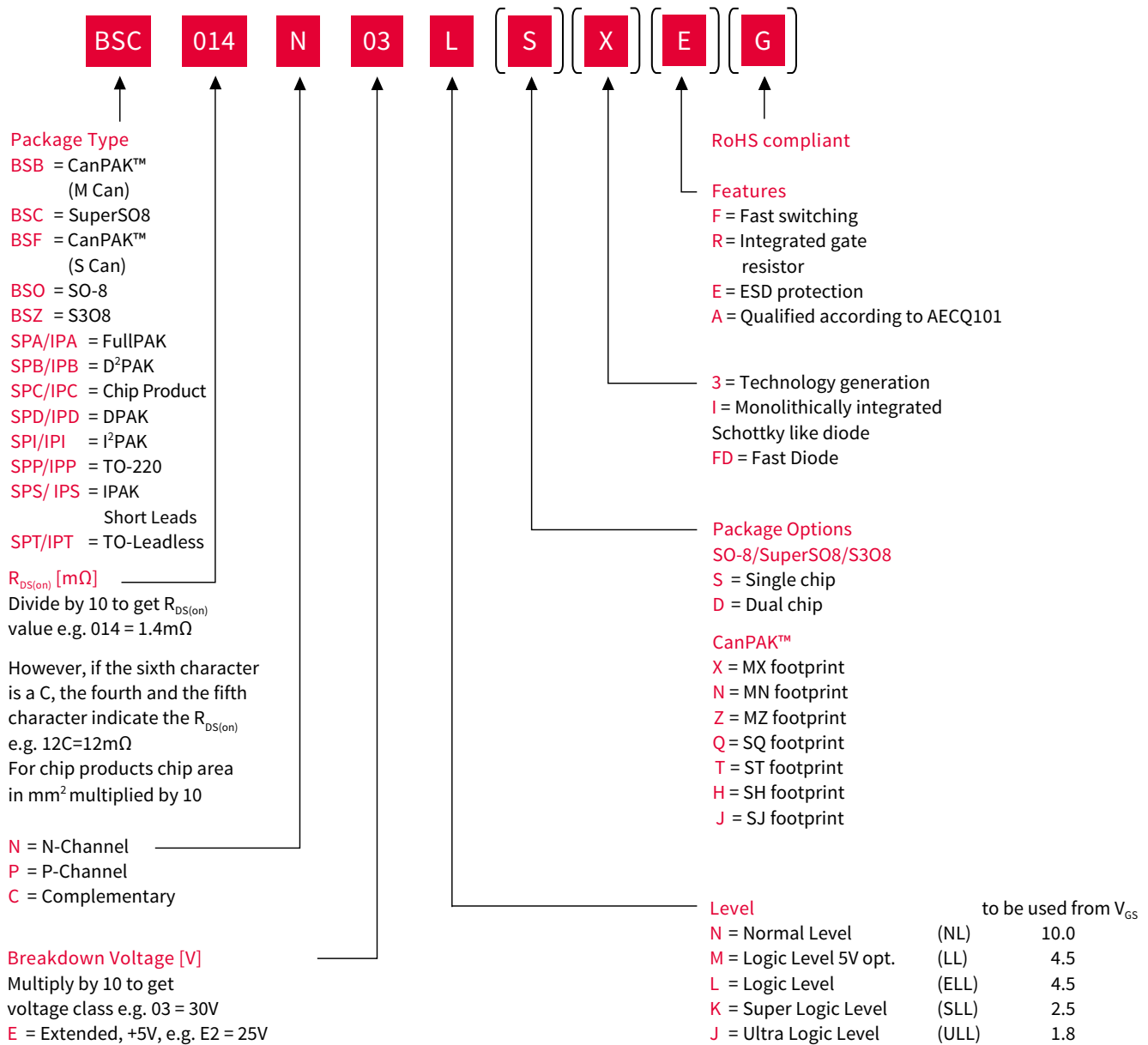
$R_{DS(on)}$ @ $V_{GS}=4.5V$			TO-220	TO-252 (DPAK)	TO-263 (D <sup>2</sup> PAK)	SO-8	SuperSO8	S308
Comp.	-20V/ 20V	55- 150mΩ						BSZ15DC02KD H*

<sup>1)</sup> 5-leg

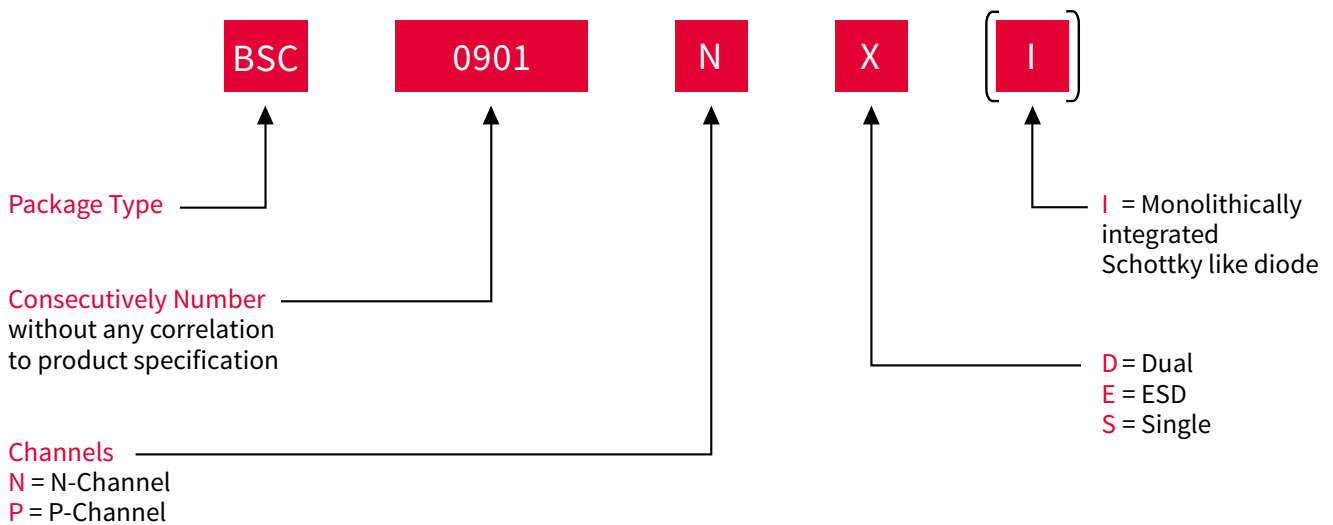
\* Products are qualified to Automotive AEC Q101

# Naming System

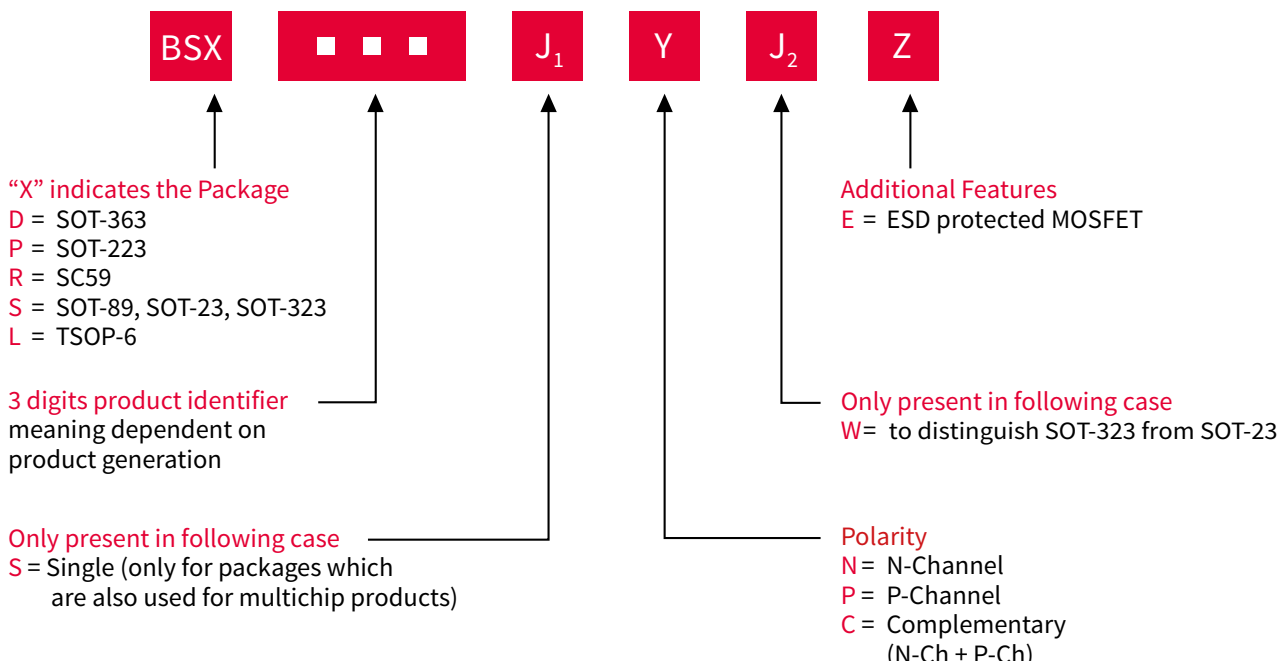
## OptiMOS™



## New OptiMOS™ 30V



## Small Signal





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## Application Notes, Datasheets & More

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Datasheets

# CoolMOS™

## Continuous Leadership in High Voltage MOSFETs

The revolutionary CoolMOS™ power family sets new standards in the field of Energy Efficiency. Our CoolMOS™ products offer a significant reduction of conduction, switching and driving losses and enable high power density and efficiency for superior power conversion systems. Especially, the latest state-of-the-art generation of high voltage power MOSFETs makes AC/DC Power Supplies more efficient, more compact, lighter and cooler than ever before.

Each application has its own requirements and optimization criteria which are reflected in the available technologies paired with innovative package solutions. Driving factors like efficiency, power density, controllability, EMI, layout resistance, commutation behavior and cost can not be fulfilled at the same time and leading to different technologies and solutions.

For instance, high full load efficiency can be the focus. This can be achieved with lower  $R_{DS(on)}$ , yet at a higher cost. The patented TO-247 4pin package using the Kelvin source concept helps to decrease the feedback inductance. This leads to lower switching losses for free and enables better gate drive and lower RFI at the same time.

A further design consideration is the handling of worst case conditions. The associated high  $dv/dt$  can trigger oscillations especially if the layout can not be optimized for the device behavior. Technologies like C6, E6, P6, CFD2 and the recently released CE series take this into account with intrinsic patented damping circuits that come without penalty in efficiency. At the same time the commutation behavior at commutation on the intrinsic body diode is improved, which enables resonant topologies.

### Best Solutions for Challenges Within Your Applications

- **EMI:** Higher efficiency leads to faster switching slopes and can not be optimized from technology point of view. Using fast parts the layout must be optimized by avoiding large areas in commutation and gate loops. Secondly parasitic should be minimized. This can be easily done via bifilar arrangements and small capacitive coupling areas on jumping potentials including coupling capacitances of magnetics. We have developed an in-depth understanding of these topics and our engineers are happy to support your design.
- **Efficiency:** Reflects the switching and gate drive losses. In hard switch topologies like PFC the turn-off and turn-on losses and in soft switched only the turn-off losses are reflected.
- **Commutation:** Reflects the behavior at hard commutation on the body diode. The intrinsic damping circuits or reverse recovery charge reduction lowers the overvoltage spike in the current cut-off phase.
- **Controllability:** Describes the layout resistance. Especially under worst case conditions high  $dv/dt$  and  $di/dt$  can be achieved. A good controllability is achieved if the part is limiting actively the slopes.

Our nomenclature guides through different optimization criteria and will help to select and find the perfect matching part for your application.



## High Power SMPS

In high power SMPS, we recommend the following products for Server, Telecom, TV, PC Silverbox and Solar applications:

- **CoolMOST™ P6:** Superior efficiency combined with ease-of-use and low design-in effort. P6 is recommended for most designs in high power SMPS applications (100W ... 3kW) as an “all-rounder” part with excellent performance. The P6 is suitable for both soft and hard switching applications due to its good body diode ruggedness. High efficiency well ahead of competitor products in both PFC and LLC completes its performance.
- **CoolMOST™ C7:** Best-in-Class efficiency and fastest switching performance in the industry. The C7 is a part optimized for the highest efficiency and for higher power density designs. For example, at 45mΩ the C7 allows for > 0.7% higher light load efficiency than CoolMOST™ CP.

## Low Power SMPS

In low power SMPS, we recommend the following products for Smartphone/Tablet Chargers, Notebook Adapters and TV sets:

- **CoolMOST™ C6/ E6:** Good efficiency, excellent ease-of-use and excellent EMI performance make C6/E6 the product of choice for many low power applications such as flyback-based Adapters and also PFC and LLC. It's switching behavior makes it a product of choice for fast design-in when better switching performance (and price) than the predecessor CoolMOST™ C3 is needed.
- **CoolMOST™ CE:** Product for lower switching frequencies or higher transformer coupling capacitances. This technology comes ahead with smoother waveforms, lesser dv/dt, a higher internal gate resistor and even better EMI. Offers better efficiency and thermal behavior than standard MOSFET.
- **CoolMOST™ C3:** For 800V and 900V, we recommend the well-established CoolMOST™ C3 800V and C3 900V.

# CoolMOS™ P6 Series

## Superior Efficiency Combined with Ease-of-Use

600V CoolMOS™ P6 is Infineon's answer to SMPS applications that require excellent performance yet also a high level of ease-of-use in the design-in process. P6 is suitable for both soft and hard switching applications due to its good body diode ruggedness. Optimizations such as  $Q_g$ ,  $V_{th}$ ,  $E_{on}$ , and  $E_{off}$  enable its superior efficiency, while its ease-of-use feature is attributed to the optimized  $dv/dt$  ( $di/dt$ ) controllability, internal  $R_g$ , and improved oscillation behavior. P6 achieves very low conduction and switching losses especially in light load condition enabling switching applications to work more efficient and be designed more compact, lighter and cooler. Moreover, with its granular portfolio, P6 addresses the specific needs of applications such as Server, PC Power, Telecom rectifiers and Consumer applications meanwhile offers the best price/performance ratio on the market today.

### Features

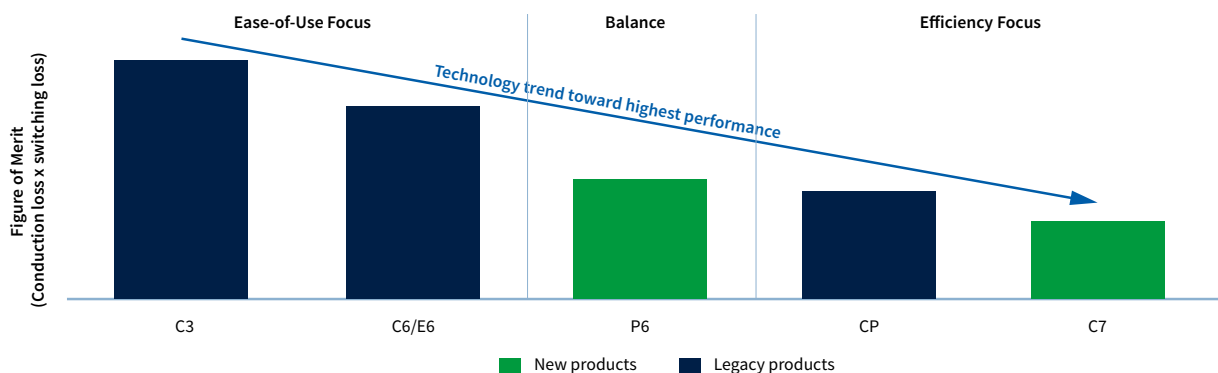
- Reduced gate charge ( $Q_g$ )
- Optimized  $V_{th}$  for soft switching
- Good body diode ruggedness
- Optimized integrated  $R_g$
- Improved  $dv/dt$

### Benefits

- Improved efficiency in light load condition
- Better efficiency in soft switching applications due to earlier turn-off
- Suitable for hard- and soft-switching topologies
- Excellent ease-of-use and good controllability of switching behavior
- High robustness, better efficiency
- Outstanding quality and reliability

### Applications

- PFC stages for Server, Telecom Rectifier, PC Silverbox, Gaming Consoles
- PWM stages (TTF, LLC) for Server, Telecom Rectifier, PC Silverbox, Gaming Consoles



P6 is optimized for ease-of-use and addresses typical design challenges in high power SMPS, while offering Best-in-Class efficiency on a level close to CoolMOS™ CP:

- P6 offers good **controllability** for managing  $dv/dt$  ( $di/dt$ ) and EMI: With an external gate resistor  $R_{g,ext}$  the switching speed can be controlled very well offering the power system designer high flexibility in balancing efficiency vs. EMI
- P6 is optimized for **improved oscillation**: parasitic capacitances and inductances in the PCB often lead to unstable designs. P6 comes with a moderate internal  $R_g$  providing ease-of-use in the design-in process, yet without reducing switching speed and efficiency (P6 is at the level of CoolMOS™ CP)
- P6 is **suitable for LLC due to its rugged body diode**: P6 has a commutation ruggedness sufficient for LLC applications. Combined with its Best-in-Class efficiency in LLC this makes P6 a premier choice for this topology

P6 is optimized for ease-of-use and addresses typical design challenges

#### Challenges in PFC

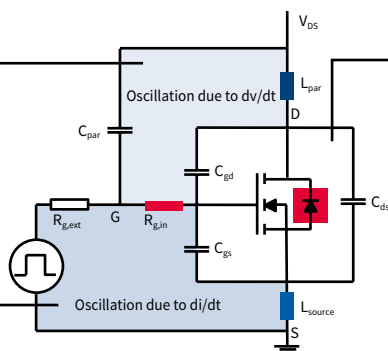
- $V_{GS}$  out of spec.
- High switching loss
- High device stress

→ P6 optimized for improved oscillation

#### Challenges from fast switching

- EMI and oscillations from high  $di/dt$

→ P6 with good controllability for ease-of-use



#### Challenges in LLC

- Body diode hard commutation
- High voltage overshoot
- High current spike
- High device stress

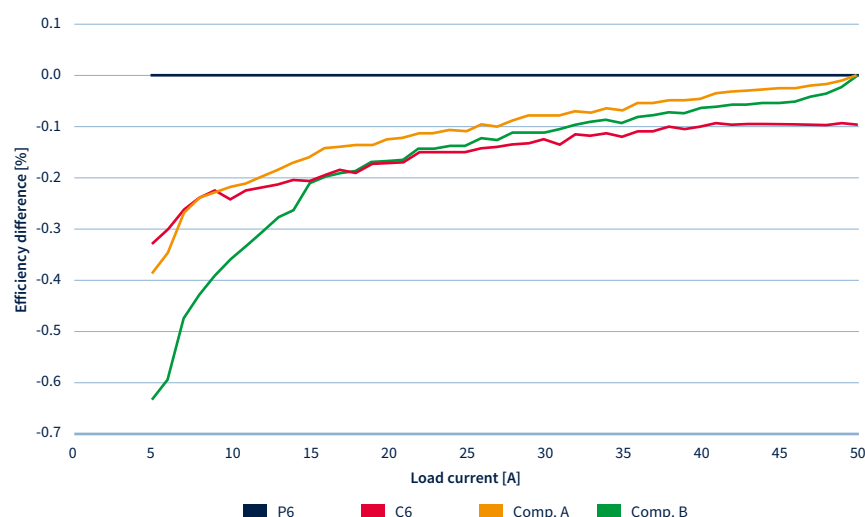
→ P6 with good commutation ruggedness

$L_{par}$ : Layout parasitic inductance

$C_{par}$ : Layout parasitic capacitance

## P6 for LLC Applications

Efficiency comparison of 190mΩ device tested on Infineon 600W LLC board



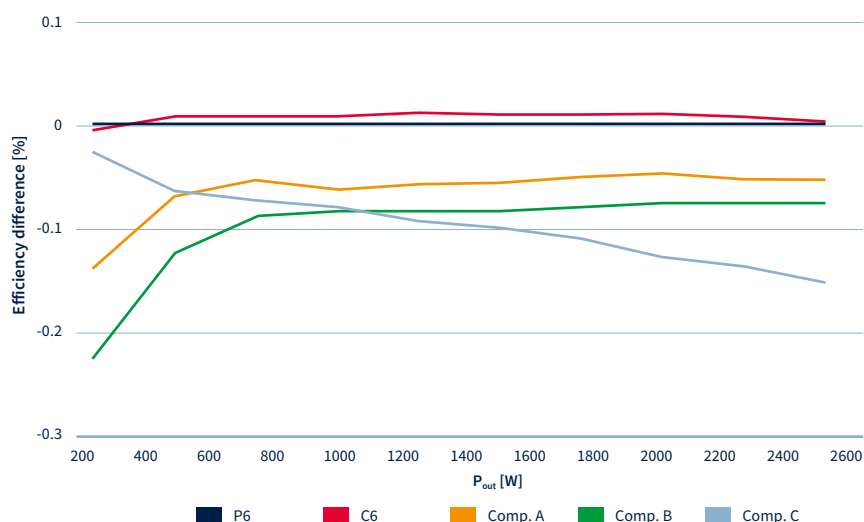
P6 shows the Best-in-Class efficiency over full load range especially at the light load conditions thanks to its low  $Q_g$  and higher  $V_{th}$ . Main competitor products are at the level of below CoolMOS™ P6 or lower than CoolMOS™ C6.

CoolMOS™ P6 sets benchmark in LLC efficiency

- Low  $Q_g$  improves the light load efficiency
- Higher  $V_{th}$  improves efficiency due to lower turn-off losses

## P6 for PFC Stages

Efficiency comparison of 41mΩ device @ 65kHz, highline



The efficiency of CoolMOS™ P6 is at the level of CoolMOS™ CP and well ahead of competitors while offering much better ease-of-use. This graph shows the PFC efficiency difference at highline for 41mΩ device tested on 2500W board.

- P6 reaches similar performance as CP
- P6 efficiency one step ahead of competitors



# New CoolMOS™ C7 Series

## Highest Efficient MOSFET in the Market

With the new CoolMOS™ C7 series Infineon brings a new level of performance in hard switching applications such as Power Factor Correction (PFC). It is the the successor to the CP series and provides efficiency benefits across the whole load range through balancing a number of key parameters. The Best-in-Class  $R_{DS(on)}$  leads to increased full load efficiency and enables power density benefits by using smaller packages for the same  $R_{DS(on)}$ .  $E_{oss}$  reduction brings efficiency benefits at light load and the low  $Q_g$  correlates to faster switching and lower  $E_{on}$  and  $E_{off}$  which gives efficiency benefits across the whole load range. The very low  $E_{oss}$  and  $Q_g$  are the two key parameters in enabling no efficiency loss when moving up in switching frequency. This also enables power density benefits by reducing the size of the circuits magnetic components.

### Key Features



- Revolutionary Best-in-Class  $R_{DS(on)}$  /package
- Reduced energy stored in output capacitance  $E_{oss}$
- Low gate charge  $Q_g$

### Key Benefits

- Lowest conduction loss/package
- Power density by use of smaller packages
- Low switching losses
- Enabler to power density by not losing efficiency at higher switching frequencies
- Improved light load efficiency

## Power Density – Increased Switching Frequency

C7 is an enabler technology that gives customers the stepping stone to new higher switching frequency technologies like GaN but with the proven reliability of Superjunction technology.

Paramter	Competitor A	Competitor B	CoolMOS™ C7
$R_{DS(on)}$ [mΩ]	45	36	45
$Q_g$ typ [nC]	143	218	93
$E_{oss}$ [μJ]	13	27,5	11,7
	 <p>80turns 602uH 65kHz</p>		 <p>64turns 340uH 120kHz</p>

Same losses at higher frequency leads to size reduction of magnetic components for improved power density

### Power Density with C7

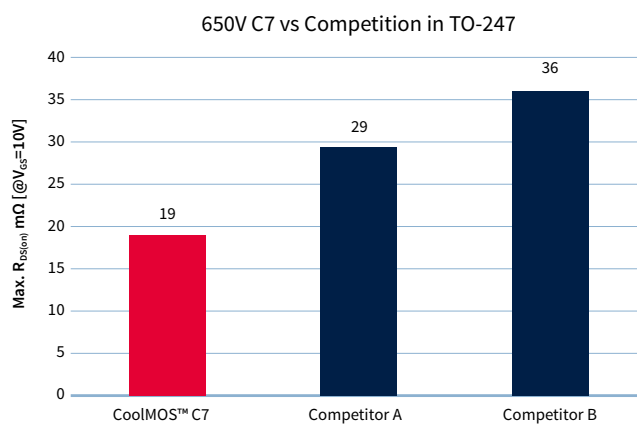
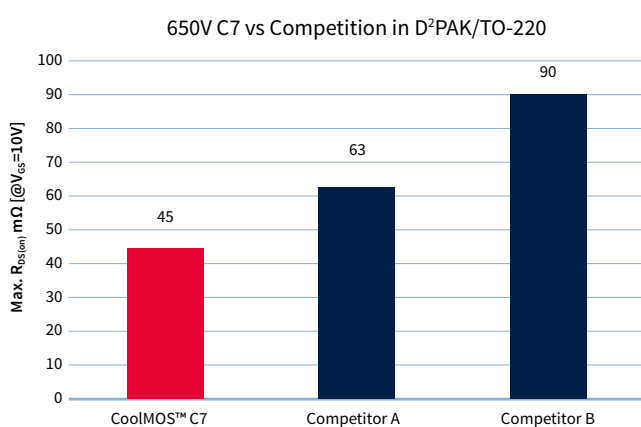
The higher up the switching frequency of an application goes, the more important parameters such as  $E_{oss}$  and  $Q_g$  become due to losses of efficiency. The very low values of these parameters in CoolMOS™ C7 minimize losses in a power factor correction (PFC) circuit – at 120kHz the same efficiency can be reached as with the predecessor series at 65kHz. This brings a benefit in power density because the sizes of magnetic components can be reduced.

## Best-in-Class Efficiency in the Industry

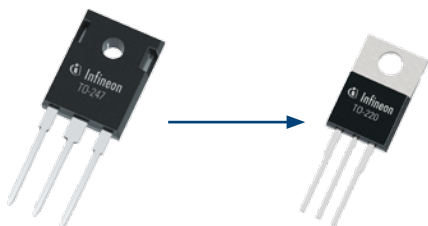
C7 offers the highest efficiency of competitor devices at the same  $R_{DS(on)}$ , especially at light load the difference is remarkable. The graph shows the high efficiency when switching at 100kHz in PFC, whereas older technologies such as CP and competitor technologies reduce in efficiency, C7 remains high. Our customers make use of this in 2 ways:

- Increasing power density – higher switching frequencies are enabled by C7 that enable even smaller magnetic components in circuit and thus allow for much improved form factors
- Reduced power losses – some customers use C7 for their highest efficiency designs and in order to reduce energy consumption

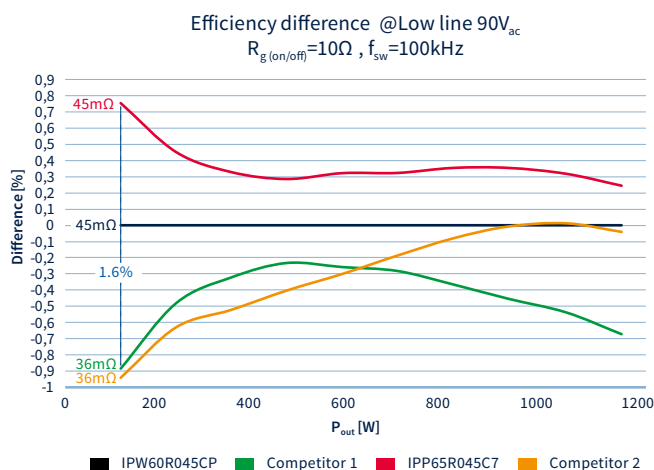
### World leading $R_{DS(on)}$ \*A Leading to Power Density Benefits



- Previous 45mΩ CP in TO-247 (IPW60R045CP)
- Now 45mΩ C7 in TO-220 (IPP65R045C7)



- World leading  $R_{DS(on)}$  package
  - TO-247 package with a 34% lower  $R_{DS(on)}$  than the nearest competitor
  - TO-220/D<sup>2</sup>PAK with 29% lower  $R_{DS(on)}$  than the nearest competitor
- As well as improving efficiency, the new  $R_{DS(on)}$  values mean a benefit in power density with the ability to now use smaller packages than ever before



### Measured CCM PFC Efficiency (Plug & Play)

C7 advantage enables the customer to:

- Improve efficiency with smaller footprint and enable higher switching frequency



# New CoolMOS™ TO-247 4pin

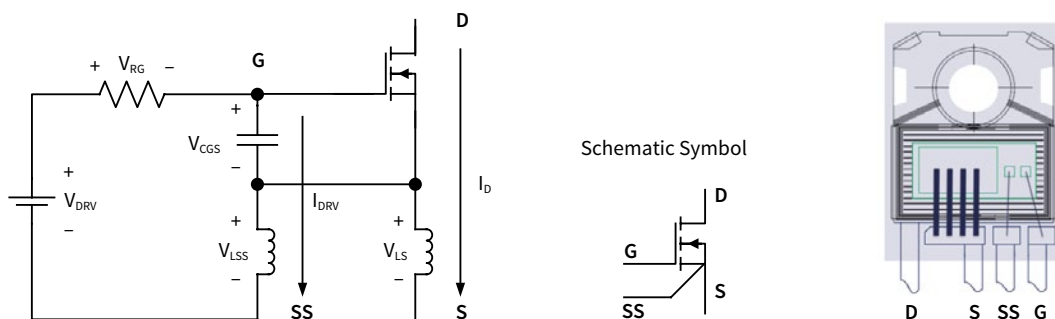
## Improved Full Load Efficiency via Package Innovation

Infineon has introduced the TO-247 4pin package – a package innovation leading to higher efficiency at very reasonable cost. The core idea of this package is to add a 4<sup>th</sup> pin that acts as a Kelvin Source reducing parasitic inductance, in order to improve efficiency.

### Motivation and Concept: Source-Sense Concept

The idea of the 4<sup>th</sup> pin, so-called "source sense", is to separate the drive circuit loop from the high current load:

- The issue with traditional high power through hole packages is that the voltage drop across the source pin (caused by the source inductance) counteracts the gate drive voltage and slows down the switching event. Efficiency loss is the consequence
- Solution with Infineon's new TO-247 4pin:
  - An additional source pin is added to separate the Source current (pin S) from the Source Sense signal (pin SS) that is used for driving the circuit. Doing so separates the parasitic voltage drop on the source inductance from the gate loop as can be seen in the figure.
  - The Source Sense or Kelvin Source connection will have its own parasitic inductance. But this does not play a big negative role, because of the relatively low currents flowing in this circuit.



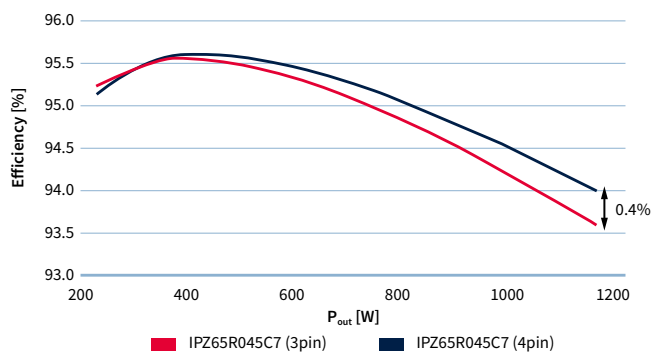
## Realization in a Package

How this can look like in reality can be seen in the package schematic diagram of the TO-247 4pin package:

The lead frame is direct connected to the very left pin, having high clearance and creepage distance to the source pin with its massive bond wires. The following pins for the gate driving do not having high voltage potential, so the distance can be held much smaller.

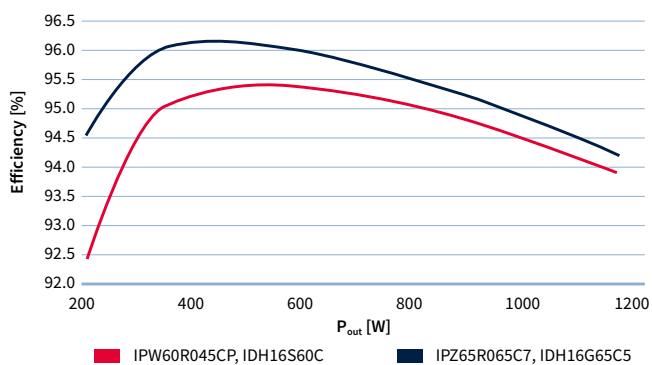


### Impact on the Application Performance: CCM PFC Efficiency @100kHz; 90V<sub>ac</sub>; 10Ω; IDH16G65C5



PFC efficiency comparison between 3pin and 4pin configuration for 90V<sub>ac</sub> (PFC CCM, R<sub>g</sub>=10Ω, IDH16G65C5 @100kHz; 5mm pin length). By connecting the same device (using the 4pin as a standard 3pin and then connecting in the Kelvin Source for a real like-for-like comparison), a benefit of 0.4% efficiency equaling 5W power saving can be seen

### Impact to the Application Performance: CCM PFC Efficiency @100kHz; 90V<sub>ac</sub>



The improved switching performance now offers new opportunities. For example, using a higher ohmic device in 4pin in order to improve efficiency and cost at the same time (in this case, using a 45mΩ device in standard 3pin TO-247 and a 65mΩ device in the TO-247 4pin). Furthermore, the light load efficiency is dramatically improved.

# New CoolMOS™ CE

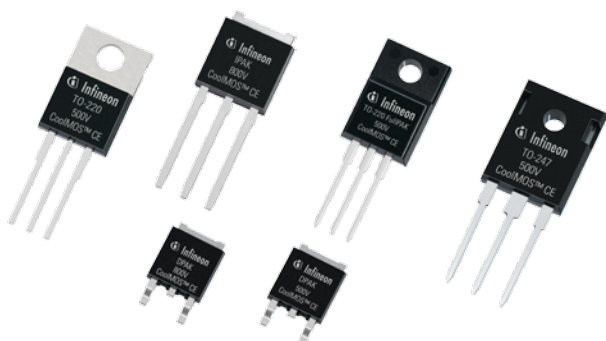
## Superjunction High Voltage MOSFETs Optimized for Consumer Electronics

### What is CoolMOS™ CE?

- CoolMOS™ CE is a technology platform of Infineon's market leading high voltage power MOSFET designed according to the Superjunction principle (SJ) and conceived to fulfill consumer requirements
- CoolMOS™ CE portfolio offers 500V, 600V, 650V and 800V devices targeting low Power Chargers, Adapters, LCD, LED TV and LED Lighting and Power Tools applications
- This new series of CoolMOS™ is cost optimized to meet typical requirements in consumer application
- CoolMOS™ CE is suitable for hard and soft switching applications and as modern SJ, it delivers low conduction and switching losses improving efficiency and ultimately reduces power consumption
- CoolMOS™ CE's ease-of-use enables customers to reduce the design-in cycle and compete in dynamic markets

Features	Technical Benefits	Customer Benefits
<ul style="list-style-type: none"> <li>■ Narrow margins between typical and max <math>R_{DS(on)}</math></li> <li>■ Reduced energy stored in output capacitance (<math>E_{oss}</math>)</li> <li>■ Good body diode ruggedness and reduced reverse recovery charge (<math>Q_{rr}</math>)</li> <li>■ Optimized integrated gate resistor (<math>R_g</math>)</li> </ul>	<ul style="list-style-type: none"> <li>■ Low conduction losses</li> <li>■ Low switching losses</li> <li>■ Suitable for hard and soft switching</li> <li>■ Easy controllable of switching behavior</li> </ul>	<ul style="list-style-type: none"> <li>■ Improved efficiency and consequent reduction of power consumption</li> <li>■ Less design-in effort</li> <li>■ Ease-of-use</li> </ul>

Topology	Voltage Class	Technology	Benefit
DCM/CCM PFC, HB LLC	500V	CE	Easy control of switching behavior due to higher $R_{g,int}$
			Better transition losses vs. standard MOSFET
DCM PFC, HB LLC	500V/600V	CE	Easy control of switching behavior even in not optimized layout
			Better switching losses in comparison with its predecessor
			Rugged body diode which prevents device failure during hard commutation
Flyback	600V/650V/800V	CE	Best price competitive CoolMOS™ family
			Lower switching losses vs. standard MOSFET
			Controlled $dv/dt$ & $di/dt$ for better EMI



# 600V CoolMOS™ CPA and 650V CoolMOS™ CFDA

## Automotive Technology in Pole Position

After launching the first series of high voltage Automotive MOSFET, the 600V CoolMOS™ CPA series, Infineon has launched its second generation of market leading Automotive qualified high voltage MOSFET, the 650V CoolMOS™ CFDA series. The 600V CoolMOS™ CPA portfolio and the broad 650V CoolMOS™ CFDA portfolio provide all benefits of a fast switching Superjunction MOSFET while fulfilling the enhanced reliability requirements for Automotive applications realized with special screening measures in front end and back end as well as qualification compliant to AEC Q100. The 650V CoolMOS™ CFDA series additionally caters to special application needs with its integrated Fast Body Diode. This Fast Body Diode is the key for addressing resonant switching topologies resulting in lower switching losses due to the low gate charge. The softer commutation behavior and consequent reduced EMI appearance gives the 650V CoolMOS™ CFDA series a clear advantage in comparison to competitor parts. Furthermore, limited voltage overshoot during hard commutation of the body diode enables easier implementation of layout and design. Therefore, the combination of both the 600V CoolMOS™ CPA and the new 650V CoolMOS™ CFDA technologies are the best choice for switching topologies in Automotive applications.

### Common Key Features CoolMOS™ "A"

- First 600V/650V Automotive qualified high voltage technologies for automotive market
- Compliant to AEC Q101 standard

### Key Features 600V CoolMOS™ CPA

- Lowest  $R_{DS(on)}$  per package
- Lowest gate charge value  $Q_g$

### Applications 600V CoolMOS™ CPA

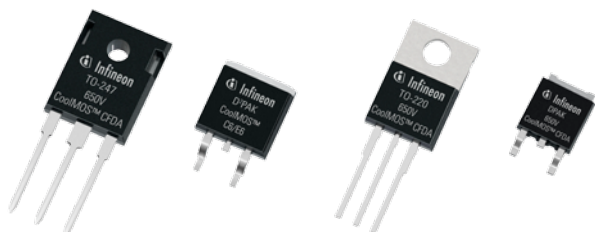
- Hard switching topologies
- PFC boost stages in On-Board Charger
- Active clamp or 2 transistor forward in DC/DC Converter

### Key Features 650V CoolMOS™ CFDA

- Limited voltage overshoot during hard commutation – self-limiting  $di/dt$  and  $dv/dt$
- Low  $Q_{rr}$  at repetitive commutation on body diode and low  $Q_{oss}$

### Applications 650V CoolMOS™ CFDA

- Resonant switching topologies
- LLC or full bridge ZVS in DC/DC Converter
- HID Lamp





## 500V CoolMOS™ CE



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-220 FullPAK	TO-247	TO-252 (DPAK)	TO-251 (IPAK)	TO-251 (IPAK SL)
18.5	190	IPP50R190CE	IPA50R190CE	IPW50R190CE			
7.5-13.0	280	IPP50R280CE	IPA50R280CE	IPW50R280CE	IPD50R280CE		
6.3-9.9	380	IPP50R380CE	IPA50R380CE		IPD50R380CE		
5.4-7.6	500	IPP50R500CE	IPA50R500CE		IPD50R500CE		
4.6-6.1	650		IPA50R650CE		IPD50R650CE		
4.1-5.0	800		IPA50R800CE		IPD50R800CE		
3.7-4.3	950		IPA50R950CE		IPD50R950CE	IPU50R950CE	
3.1	1400				IPD50R1K4CE	IPU50R1K4CE	
2.4	2000				IPD50R2K0CE	IPU50R2K0CE	
1.5	3000				IPD50R3K0CE	IPU50R3K0CE	

## 600V CoolMOS™ CE



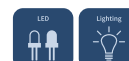
$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-220 FullPAK	TO-247	TO-252 (DPAK)	TO-251 (IPAK)	TO-251 (IPAK SL)
10.3	400		IPA60R400CE		IPD60R400CE		
9.1	460		IPA60R460CE		IPD60R460CE		
7.0	650		IPA60R650CE		IPD60R650CE		
5.6	800		IPA60R800CE		IPD60R800CE		
4.3	1000				IPD60R1K0CE	IPU60R1K0CE	
3.1	1500				IPD60R1K5CE	IPU60R1K5CE	
2.3	2100				IPD60R2K1CE	IPU60R2K1CE	

## 650V CoolMOS™ CE



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-220 FullPAK	TO-247	TO-252 (DPAK)	TO-251 (IPAK)	TO-251 (IPAK SL)
	400						IPS65R400CE <sup>1)</sup>
	650						IPS65R650CE <sup>1)</sup>
4.3	1000						IPS65R1K0CE
3.1	1500						IPS65R1K5CE

## 800V CoolMOS™ CE



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-220 FullPAK	TO-247	TO-252 (DPAK)	TO-251 (IPAK)	TO-251 (IPAK SL)
6.8	310		IPA80R310CE				
5.0	460		IPA80R460CE				
4.5	650		IPA80R650CE				
3.6-5.7	1000		IPA80R1K0CE		IPD80R1K0CE	IPU80R1K0CE	
2.8-3.9	1400		IPA80R1K4CE		IPD80R1K4CE	IPU80R1K4CE	
1.9	2800				IPD80R2K8CE	IPU80R2K8CE	

1) Coming Q3 2015

## 600V CoolMOS™ C6



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-252 (DPAK)	ThinPAK 5x6
77.5	41					IPW60R041C6		
53.0	70					IPW60R070C6		
57.7	74	IPP60R074C6						
38.0	99	IPP60R099C6		IPB60R099C6	IPA60R099C6	IPW60R099C6		
30.0	125	IPP60R125C6		IPB60R125C6	IPA60R125C6	IPW60R125C6		
23.8	160	IPP60R160C6		IPB60R160C6	IPA60R160C6	IPW60R160C6		
20.2	190	IPP60R190C6	IPI60R190C6	IPB60R190C6	IPA60R190C6	IPW60R190C6		
13.8	280	IPP60R280C6	IPI60R280C6	IPB60R280C6	IPA60R280C6	IPW60R280C6		
10.6	380	IPP60R380C6	IPI60R380C6	IPB60R380C6	IPA60R380C6		IPD60R380C6	
8.1	520	IPP60R520C6			IPA60R520C6		IPD60R520C6	
7.3	600	IPP60R600C6		IPB60R600C6	IPA60R600C6		IPD60R600C6	
4.4	950	IPP60R950C6		IPB60R950C6	IPA60R950C6		IPD60R950C6	
3.2	1400	IPP60R1K4C6					IPD60R1K4C6	
	1500							IPL60R1K5C6S
2.4	2000						IPD60R2K0C6	
	2100							IPL60R2K1C6S
1.7	3300						IPD60R3K3C6	

## 650V CoolMOS™ C6



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-252 (DPAK)	ThinPAK 5x6
83,2	37					IPW65R037C6		
53,5	70					IPW65R070C6		
57,7	74	IPP65R074C6						
38,0	99	IPP65R099C6	IPI65R099C6	IPB65R099C6	IPA65R099C6	IPW65R099C6		
20,2	190	IPP65R190C6	IPI65R190C6	IPB65R190C6	IPA65R190C6	IPW65R190C6		
16,1	250						IPD65R250C6	
13,8	280	IPP65R280C6	IPI65R280C6	IPB65R280C6	IPA65R280C6	IPW65R280C6		
10,6	380	IPP65R380C6	IPI65R380C6	IPB65R380C6	IPA65R380C6		IPD65R380C6	
7,3	600	IPP65R600C6	IPI65R600C6	IPB65R600C6	IPA65R600C6		IPD65R600C6	
	650							IPL65R650C6S
4,5	950						IPD65R950C6	
	1000						IPD65R1K0C6	IPL65R1K0C6S
3,2	1400						IPD65R1K4C6	IPL65R1K5C6S

## 600V CoolMOS™ E6



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-252 (DPAK)	ThinPAK 8x8
20.2	190	IPP60R190E6			IPA60R190E6	IPW60R190E6		
13.8	280	IPP60R280E6			IPA60R280E6	IPW60R280E6		
10.6	380	IPP60R380E6			IPA60R380E6		IPD60R380E6	
9.2	450	IPP60R450E6			IPA60R450E6		IPD60R450E6	
8.1	520	IPP60R520E6			IPA60R520E6		IPD60R520E6	
7.3	600	IPP60R600E6			IPA60R600E6		IPD60R600E6	
5.7	750	IPP60R750E6			IPA60R750E6		IPD60R750E6	

## 650V CoolMOS™ E6



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-252 (DPAK)	ThinPAK 8x8
20.2	190	IPP65R190E6			IPA65R190E6	IPW65R190E6		IPL65R190E6
16.1	250						IPD65R250E6	
13.8	280	IPP65R280E6	IPI65R280E6	IPB65R280E6	IPA65R280E6	IPW65R280E6		
13.1	310							IPL65R310E6
10.6	380	IPP65R380E6			IPA65R380E6		IPD65R380E6	
	420							IPL65R420E6
7.3	600	IPP65R600E6			IPA65R600E6		IPD65R600E6	
6.7	660							IPL65R660E6

## 800V CoolMOS™ C3



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-252 (DPAK)
54.9	85					SPW55N80C3	
17.0	290	SPP17N80C3		SPB17N80C3	SPA17N80C3	SPW17N80C3	
11.0	450	SPP11N80C3			SPA11N80C3	SPW11N80C3	
8.0	650	SPP08N80C3	SPI08N80C3		SPA08N80C3		
6.0	900	SPP06N80C3			SPA06N80C3		SPD06N80C3
4.0	1300	SPP04N80C3			SPA04N80C3		SPD04N80C3
2.0	2700	SPP02N80C3			SPA02N80C3		SPD02N80C3

## 900V CoolMOS™ C3



$I_D$ [A]	$R_{DS(on)}$ [mΩ]	TO-220	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-252 (DPAK)
36.0	120					IPW90R120C3	
10.0-15.0	340	IPP90R340C3	IPI90R340C3	IPB90R340C3	IPA90R340C3	IPW90R340C3	
11.0	500	IPP90R500C3	IPI90R500C3		IPA90R500C3	IPW90R500C3	
6.9	800	IPP90R800C3	IPI90R800C3		IPA90R800C3	IPW90R800C3	
5.7	1000	IPP90R1K0C3	IPI90R1K0C3		IPA90R1K0C3	IPW90R1K0C3	
3.1-5.1	1200	IPP90R1K2C3	IPI90R1K2C3		IPA90R1K2C3	IPW90R1K2C3	IPD90R1K2C3

## 600V CoolMOS™ P6



I <sub>D</sub> [A]	R <sub>DS(on)</sub> [mΩ]	TO-220	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-247 4pin	TO-252 (DPAK)	ThinPAK 5x6	ThinPAK 8x8
	41				IPW60R041P6	IPZ60R041P6 <sup>(1)</sup>			
53.5	70				IPW60R070P6	IPZ60R070P6 <sup>(1)</sup>			
37.9	99	IPP60R099P6		IPA60R099P6	IPW60R099P6	IPZ60R099P6 <sup>(1)</sup>			
30.0	125	IPP60R125P6		IPA60R125P6	IPW60R125P6	IPZ60R125P6 <sup>(1)</sup>			
10.4-23.8	160	IPP60R160P6	IPB60R160P6 <sup>(1)</sup>	IPA60R160P6	IPW60R160P6				
	180								IPL60R180P6
9.5-20.2	190	IPP60R190P6	IPB60R190P6 <sup>(1)</sup>	IPA60R190P6	IPW60R190P6				
19.2	210								IPL60R210P6
8.6-16.8	230	IPP60R230P6	IPB60R230P6 <sup>(1)</sup>	IPA60R230P6	IPW60R230P6				
15.9	255								IPL60R255P6
7.7-13.8	280	IPP60R280P6	IPB60R280P6 <sup>(1)</sup>	IPA60R280P6	IPW60R280P6				
7.0-12.0	330	IPP60R330P6	IPB60R330P6 <sup>(1)</sup>	IPA60R330P6	IPW60R330P6				
6.5-10.6	380	IPP60R380P6	IPB60R380P6 <sup>(1)</sup>	IPA60R380P6			IPD60R380P6		
4.9-7.3	600	IPP60R600P6	IPB60R600P6 <sup>(1)</sup>	IPA60R600P6			IPD60R600P6		
6.7	650							IPL60R650P6S	

## 650V CoolMOS™ C7



I <sub>D</sub> [A]	R <sub>DS(on)</sub> [mΩ]	TO-220	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-247 4pin	TO-252 (DPAK)	ThinPAK 8x8
75.0	19				IPW65R019C7	IPZ65R019C7		
18.0-46.0	45		IPB65R045C7	IPA65R045C7	IPW65R045C7	IPZ65R045C7		
15.0-33.0	65	IPP65R065C7	IPB65R065C7	IPA65R065C7	IPW65R065C7	IPZ65R065C7		
28.0	70							IPL65R070C7
12.0-24.0	95	IPP65R095C7	IPB65R095C7	IPA65R095C7	IPW65R095C7	IPZ65R095C7		
	99							IPL65R099C7
10.0-18.0	125	IPP65R125C7	IPB65R125C7	IPA65R125C7	IPW65R125C7			
15.0	130							IPL65R130C7
8.0-13.0	190	IPP65R190C7	IPB65R190C7	IPA65R190C7	IPW65R190C7		IPD65R190C7	
12.0	195							IPL65R195C7
7.0-11.0	225	IPP65R225C7	IPB65R225C7	IPA65R225C7			IPD65R225C7	
10.0	230							IPL65R230C7

## 650V CoolMOS™ CFD2



I <sub>D</sub> [A]	R <sub>DS(on)</sub> [mΩ]	TO-220	TO-262 (I <sup>2</sup> PAK)	TO-263 (D <sup>2</sup> PAK)	TO-220 FullPAK	TO-247	TO-252 (DPAK)	ThinPAK 8x8
68.5	41					IPW65R041CFD		
43.3	80					IPW65R080CFD		
31.2	110	IPP65R110CFD	IPI65R110CFD	IPB65R110CFD	IPA65R110CFD	IPW65R110CFD		
22.4	150	IPP65R150CFD	IPI65R150CFD	IPB65R150CFD	IPA65R150CFD	IPW65R150CFD		
21.3	165							IPL65R165CFD
17.5	190	IPP65R190CFD	IPI65R190CFD	IPB65R190CFD	IPA65R190CFD	IPW65R190CFD		
16.1	210							IPL65R210CFD
11.4	310	IPP65R310CFD	IPI65R310CFD	IPB65R310CFD	IPA65R310CFD	IPW65R310CFD		
10.9	340							IPL65R340CFD
8.7	420	IPP65R420CFD	IPI65R420CFD	IPB65R420CFD	IPA65R420CFD	IPW65R420CFD	IPD65R420CFD	
8.3	460							IPL65R460CFD
6.0	660	IPP65R660CFD	IPI65R660CFD	IPB65R660CFD	IPA65R660CFD	IPW65R660CFD	IPD65R660CFD	
5.8	725							IPL65R725CFD
3.9	950						IPD65R950CFD	
3.2	1400						IPD65R1K4CFD	

<sup>1)</sup> Coming Q3 2015

# CoolMOS™ Automotive

## 600V CoolMOS™ CPA Product Portfolio



Product Type	$R_{DS(on)}$ @ $T_J = 25^\circ\text{C}$ $V_{GS} = 10\text{V}$ [mΩ]	$I_{D(max)}$ @ $T_J = 25^\circ\text{C}$ [A]	$I_{D(puls)}$ (max) [A]	$V_{GS(th)}$ (min-max) [V]	$Q_g$ (typ) [nC]	$R_{thJC}$ (max) [K/W]	Package
IPB60R099CPA	105	31	93	-20 ... 20	60	0,5	TO-263
IPB60R199CPA	199	16	51	-20 ... 20	32	0,9	TO-263
IPB60R299CPA	299	11	34	-20 ... 20	22	1,3	TO-263
IPP60R099CPA	105	31	93	-20 ... 20	60	0,5	TO-220
IPW60R045CPA	45	60	230	-20 ... 20	150	0,29	TO-247
IPW60R075CPA	75	39	130	-20 ... 20	87	0,4	TO-247
IPW60R099CPA	105	31	93	-20 ... 20	60	0,5	TO-247
IPW60R099CPA	105	31	93	-20 ... 20	60	0,5	TO-262

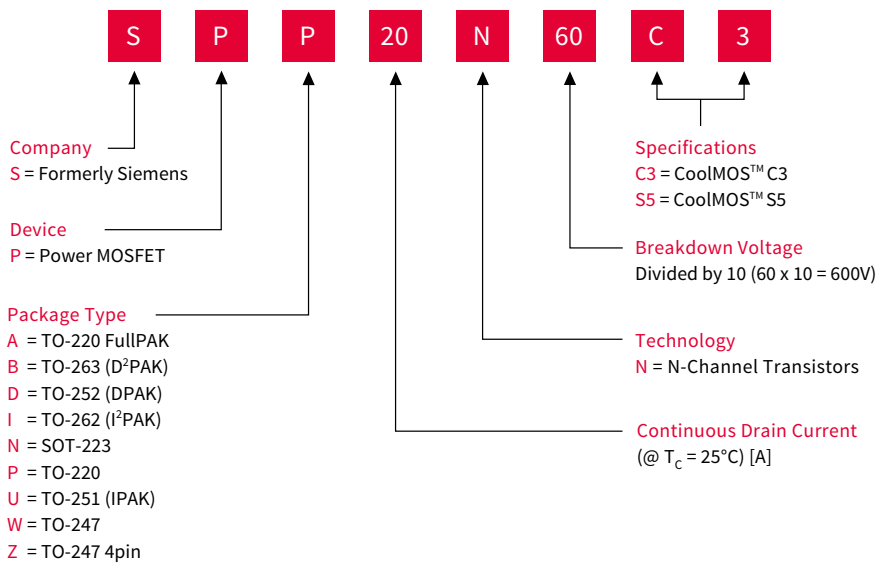
## 650V CoolMOS™ CFDA Product Portfolio



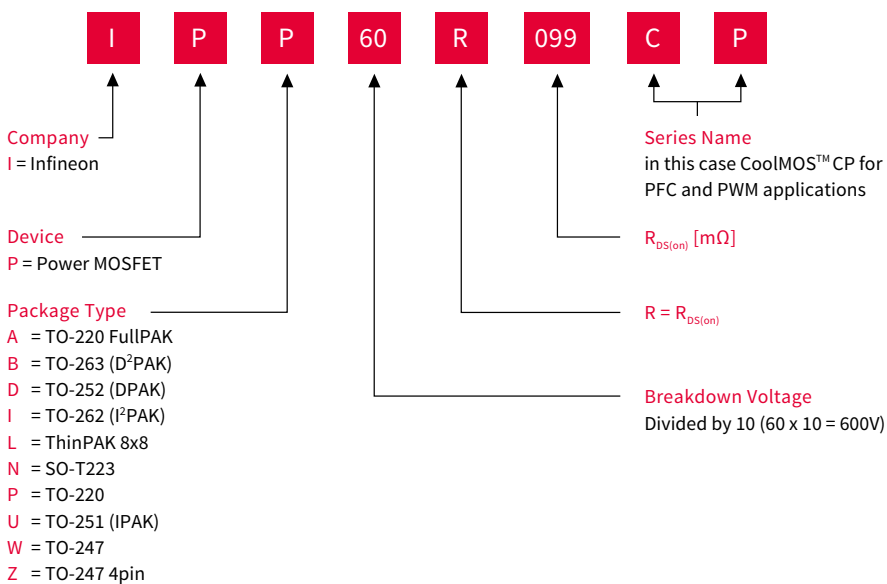
Product Type	$R_{DS(on)}$ @ $T_J = 25^\circ\text{C}$ $V_{GS} = 10\text{V}$ [mΩ]	$I_{D(max)}$ @ $T_J = 25^\circ\text{C}$ [A]	$I_{D(puls)}$ (max) [A]	$V_{GS(th)}$ (min-max) [V]	$Q_g$ (typ) [nC]	$R_{thJC}$ (max) [K/W]	Package
IPD65R420CFDA	420	8,7	27	3.5...4.5	32	1,5	TO-252
IPD65R660CFDA	660	6	17	3.5...4.5	20	2	TO-252
IPB65R110CFDA	110	31,2	99,6	3.5...4.5	11	0,45	TO-263
IPB65R150CFDA	150	22,4	72	3.5...4.5	86	0,64	TO-263
IPB65R190CFDA	190	17,5	57,2	3.5...4.5	68	0,83	TO-263
IPB65R310CFDA	310	11,4	34,4	3.5...4.5	41	1,2	TO-263
IPB65R660CFDA	660	6	17	3.5...4.5	20	2	TO-263
IPP65R110CFDA	110	31,2	99,6	3.5...4.5	11	0,45	TO-220
IPP65R150CFDA	150	22,4	72	3.5...4.5	86	0,64	TO-220
IPP65R190CFDA	190	17,5	57,2	3.5...4.5	68	0,83	TO-220
IPP65R310CFDA	310	11,4	34,4	3.5...4.5	41	1,2	TO-220
IPP65R660CFDA	660	6	17	3.5...4.5	20	2	TO-220
IPW65R048CFDA	48	63,3	228	3.5...4.5	27	0,25	TO-247
IPW65R080CFDA	80	43,3	127	3.5...4.5	16	0,32	TO-247
IPW65R110CFDA	110	31,2	99,6	3.5...4.5	11	0,45	TO-247
IPW65R150CFDA	150	22,4	72	3.5...4.5	86	0,64	TO-247
IPW65R190CFDA	190	17,5	57,2	3.5...4.5	68	0,83	TO-247

# Naming System

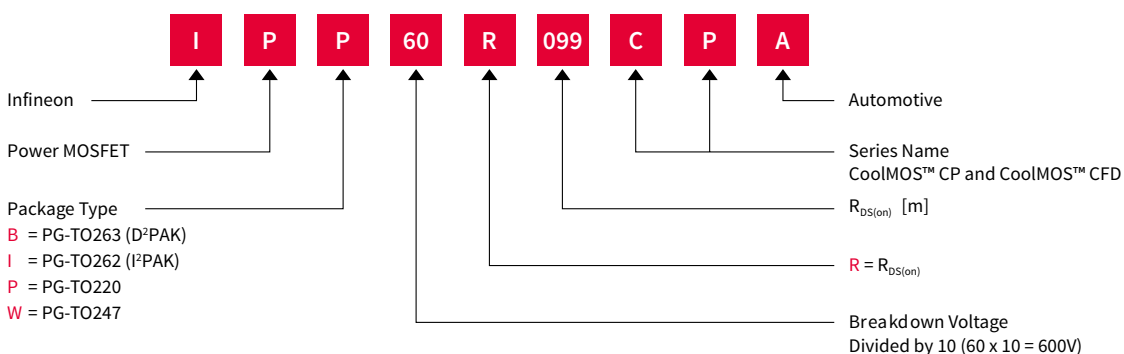
## Power MOSFETs (Naming System Until 2005)



## Power MOSFETs (Naming System From 2005 Onwards)



## Automotive MOSFETs





# Expert Support for CoolMOS™

Easy Access and High Quality



## Application Notes, Datasheets & More

[www.infineon.com/coolmos-500V-650V](http://www.infineon.com/coolmos-500V-650V)

[www.infineon.com/coolmos-800V-900V](http://www.infineon.com/coolmos-800V-900V)



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[www.infineon.com/600w-llc-evaluationboard-d](http://www.infineon.com/600w-llc-evaluationboard-d)



Datasheets

# Silicon Carbide Diodes

## Improve Efficiency and Solution Costs

Silicon Carbide (SiC) devices belong to the so-called wide band gap semiconductor group, which offers a number of attractive characteristics for high voltage power semiconductors when compared to commonly used Silicon (Si). In particular, the much higher breakdown field strength and thermal conductivity of SiC allow creating devices which outperform by far the corresponding Si ones, and enable reaching otherwise unattainable efficiency levels.

### Silicon Carbide Schottky Diodes

The differences in material properties between SiC and Silicon limit the fabrication of practical Silicon unipolar diodes (Schottky diodes) to a range up to 100V – 150V, with relatively high on-state resistance and leakage current. On the other hand, SiC Schottky barrier diodes (SBD) can reach a much higher breakdown voltage. Infineon offers products up to 1200V as discrete and up to 1700V in modules.

#### Features

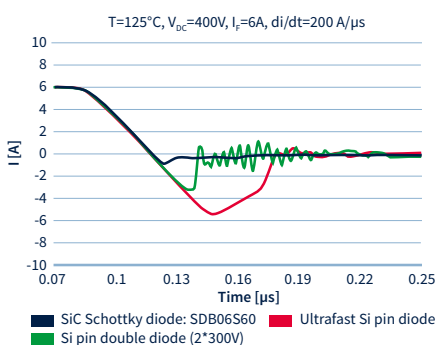
- Benchmark switching behavior
- No reverse recovery charge
- Temperature independent switching behavior
- High operating temperature ( $T_{j, \max}$  175°C)

#### Benefits

- System efficiency improvement compared to Si diodes
- Reduced cooling requirements
- Enabling higher frequency/ increased power density
- Higher system reliability due to lower operating temperature
- Reduced EMI

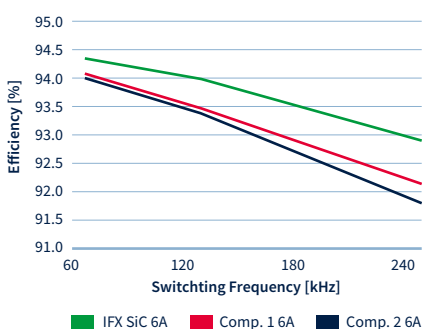
#### Applications

- Server
- Telecom
- Solar
- UPS
- PC Silverbox
- Motor Drives
- Lighting



#### Reverse Recovery Charge of SiC versus Silicon Devices

The majority carrier characteristics of the device imply no reverse recovery charge and the only contribution to the switching losses comes from the tiny displacement charge of capacitive nature. In the same voltage range, Silicon devices show a bipolar component resulting in much higher switching losses. Here the comparison between various 600V devices.



#### Improved System Efficiency (PFC in CCM Mode Operation, Full Load, Low Line)

The fast switching characteristics of the SiC diodes provide clear efficiency improvements at system level.

The performance gap between SiC and high-end Silicon devices increases with the operating frequency.

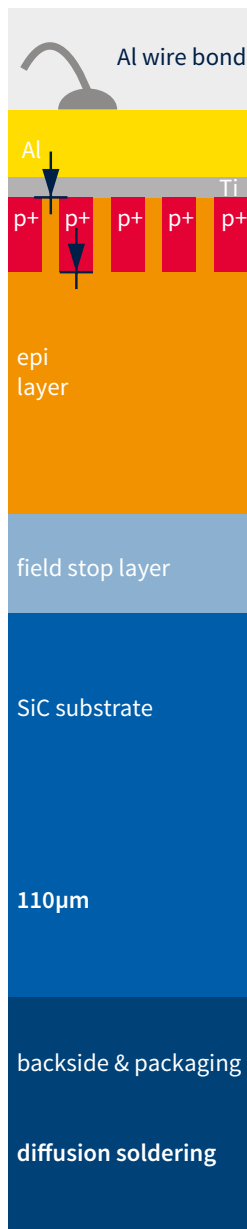
Infineon is the world's first SiC discrete power supplier. Long market presence and experience enable Infineon to deliver highly reliable, industry-leading SiC performance. With over 10 years pioneering experience in developing and manufacturing SiC diodes, Infineon's latest thinQ!™ SiC Schottky Diodes Generation 5 family sets benchmark in quality, efficiency and reliability.

## 650V SiC thinQ!™ Generation 5 Schottky Diodes: Best Price/Performance

This product family has been optimized from all key aspects including junction structure, substrate, and die attach. It represents a well-balanced product family which offers state of the art performance and high surge current capability at competitive cost level.

### Innovation: Optimized Junction, Substrate and Die Attach

Infineon Generation 5 SiC Schottky diode is optimized with regard to all key aspects relevant for high power and high efficiency SMPS applications.



#### Junction: Merged PN Structure

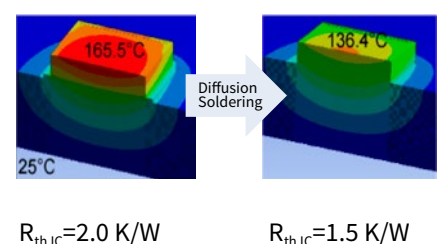
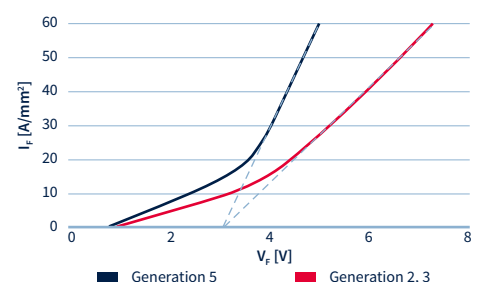
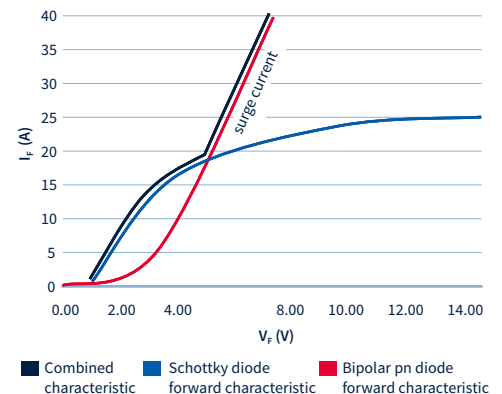
On the junction level, it has an optimized merged PN structure. Compared to competitors Infineon SiC diode has additional P doped area, together with the N doped EPI layer, it forms a PN junction diode. Thus it is a combination of Schottky diode and PN junction diode. Under normal conditions, it works like a standard Schottky diode. Under abnormal conditions, such as lighting, AC line drop-out, it works like a PN junction diode. At high current level, the PN junction diode has significantly lower  $V_F$  than Schottky diode, this leads to less power dissipation, thus significantly improving the surge current capability.

#### Substrate: Thin Wafer Technology

On the substrate level, Infineon introduced thin wafer technology, at the later stage of our SiC diode production thin wafer process is used to reduce the wafer thickness by about 2/3, this significantly reduces the substrate resistance contribution thus improve both  $V_F$  and thermal performance.

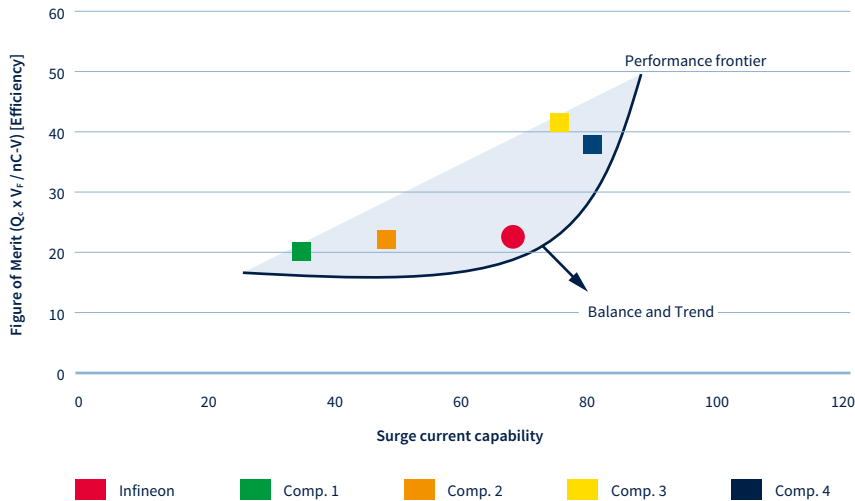
#### Die Attach: Diffusion Soldering

On the backside and package level diffusion soldering is introduced which significantly improves the thermal path between lead frame and the diode, enhancing the thermal performance. With the same chip size and power dissipation, the junction temperature is reduced by 30°C.



## Optimum Balance of Efficiency and Surge Current Capability

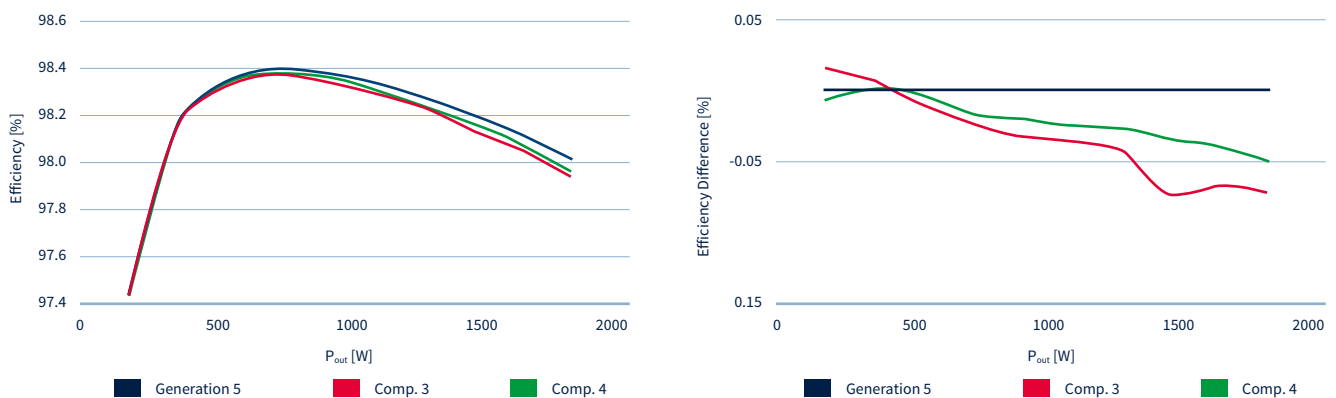
### 8A SiC Diode Comparison from Different Suppliers



Generation 5 SiC Schottky diode offers the optimum efficiency and ruggedness balance. Lower  $V_f$  means lower conduction loss and lower  $Q_c$  means lower switching loss.  $Q_c \times V_f$  is the Figure of Merit for efficiency and comparison indicates that Generation 5 matches the best competitors on the market. In addition, SiC Generation 5 offers a surge current robustness far better than that offered by the most efficient products. Thus under abnormal conditions this surge current capability offers excellent device robustness. All over, SiC Generation 5 offers excellent efficiency and surge current capability at the same time. No other SiC diode product on the market offers such good balance between efficiency and surge current capability. Some vendors offer better efficiency but weak surge current; while others offer better surge current but are less attractive in efficiency.

## Efficiency Comparison

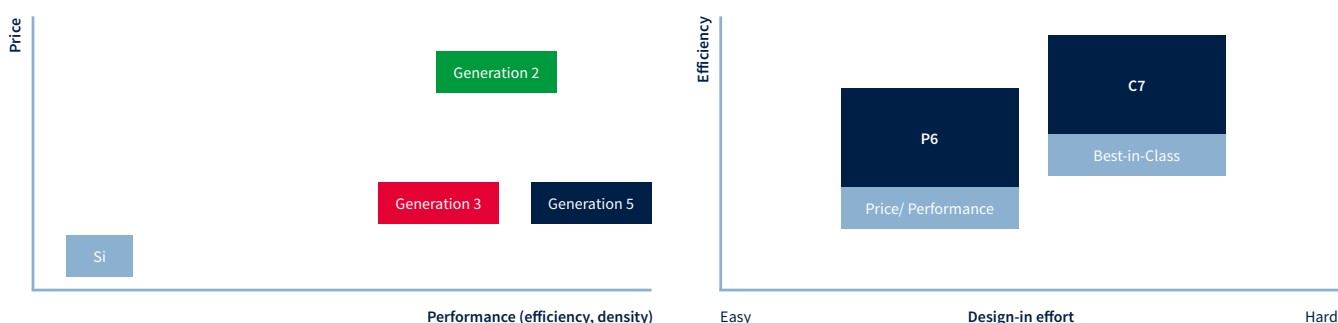
CCM mode PFC, high line,  $P_{max} = 1800W$ ,  $f_{sw} = 65kHz$ ; MOSFET: IPW65R095C7, SiC Diode: TO-220 8A



In terms of efficiency, 8A device has been tested in CCM PFC. The maximum output power is 1.8kW and switching frequency is 65kHz. The left figure shows the absolute efficiency as a function load power, while right figure shows efficiency difference compared to our Generation 5 SiC diode. It is obvious Infineon Generation 5 delivers better efficiency over full load range.

## System Solution for PFC

The thinQ!™ SiC Schottky diode Generation 5 is in perfect combination with Infineon's CoolMOS™ for best performance and efficiency in PFC stages. The target applications in this case are Telecom, Server, etc. We recommend thinQ!™ SiC Schottky diode Generation 5 for new designs. The selection of CoolMOS™ and thinQ!™ depends on target efficiency and cost.



### Infineon System Solution in PFC

CCM PFC Power [W]	CoolMOS™ $R_{DS(on)}$ [mΩ]		thinQ!™ SiC Diode $I_F$ [A]
	Server	Telecom	Server and Telecom
500	1 x 190	1 x 190	1 x (4~6)
750	1 x 99/2 x 190	2 x 190	1 x (6~8)
1200	2 x (70~99)		1 x (8~10)
2000		2 x 99	2 x (6~8)/1 x (12~16)
2700	3 x (41~80)		2 x (8~10)/1 x (16~20)
3000		2 x 65/1 x 19	2 x (8~10)/1 x (16~20)

- $R_{DS(on)}$  depends on target efficiency level, switching frequency and thermal management
- SiC diode current level depends on switching frequency, current limitation and thermal management

## New 1200V SiC thinQ!™ Generation 5 Schottky Diodes : High Efficiency/Compact

By using hybrid Si IGBT/SiC diode sets, designers of industrial applications will gain flexibility for system optimization compared to Silicon based solution. The keys are reduced cooling requirements, higher output power or higher switching frequency at high efficiency. In the new 1200V thinQ!™ Generation 5 SiC Schottky diodes, the zero reverse recovery charge comes with a reduction of forward voltage and extended surge current capability compared to previous generation. The ultra-low forward voltage, even at high operating temperature, results in 30% static loss gain versus previous generation during full-load condition. Implementing Generation 5 thinQ!™ diodes in combination with Infineon's 1200V HighSpeed 3 IGBT, designers can achieve outstanding system level performance and reliability.

**Key Features 1200V SiC vs. 1200V Si diodes**

- No reverse recovery charge
- No voltage overshoots due to zero forward recovery
- Switching behavior independent from forward current, switching speed and temperature

**Key Features 1200V Gen5 vs. 1200V Gen2**

- Low forward voltage ( $V_F$ )
- Mild positive temperature dependency of  $V_F$
- Extended surge current capability
- Excellent thermal performance
- Up to 40A rated diode

**Applications**

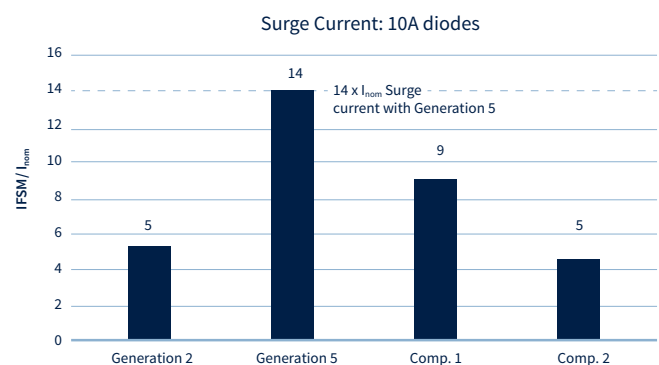
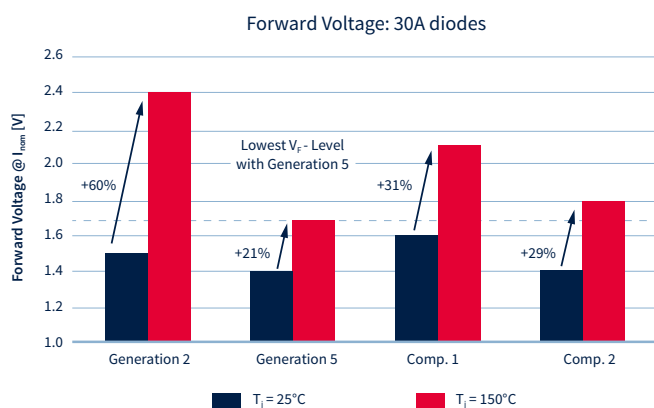
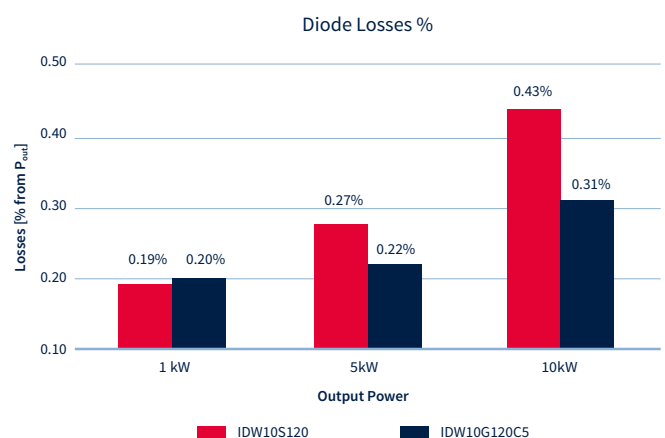
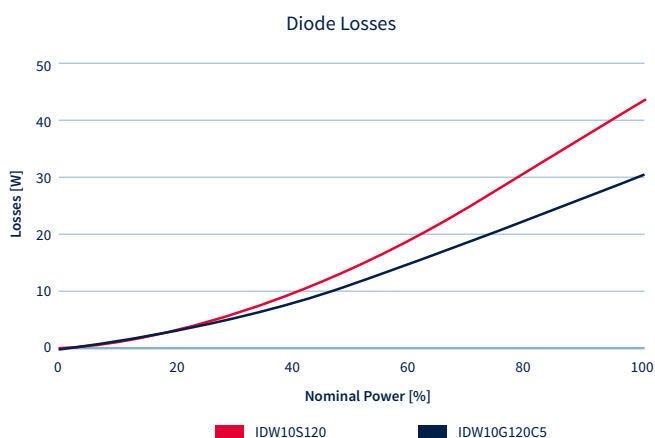
- Solar Inverters
- UPS
- 3-phase SMPS
- Motor Drives

**Key Benefits 1200V SiC vs. 1200V Si diodes**

- Virtually no diode switching losses and thereby lower Si IGBT losses → high system efficiency
- Reduced EMI
- Higher system reliability
- Higher switching frequency for high efficiency

**Key Benefits 1200V G5 vs. 1200V G2**

- Higher efficiency through up to 30% gain in diode losses
- Reduced cooling requirements through lower diode losses and lower case temperatures
- Better system reliability through extended surge current up to 14x nominal current

**Front-End Booster Stage of a Photovoltaic Inverter:  $V_{in} = 500\text{V}$ ,  $V_{out} = 800\text{V}$ , 20kHz,  $T_j = 125^\circ\text{C}$** 

CoolSiC™ 1200V SiC JFET family, in combination with the proposed Direct Drive JFET Topology, represents Infineon's leading edge solution to bring actual designs towards new and so far unattainable efficiency borders. The SiC JFET offers Best-in-Class switching loss behavior with respect to 1200V IGBT with comparable conduction losses available. Utmost efficiency at highest power density levels can be reached also thanks to Infineon CoolSiC™ monolithically integrated body diode, showing a switching performance comparable with that of an external SiC Schottky barrier diode. The Infineon SiC JFET, with its ultrafast SiC body diode and dedicated driver, represents the best solution in Solar, UPS and Industrial Drives applications by combining best performance, reliability, safety and ease-of-use.

- Extremely low and temperature independent switching losses
- Excellent high load efficiency compared to IGBTs
- Monolithically integrated SiC body diode
- Dedicated driver for direct JFET control
- High reliability due to missing gate oxide
- Structural elements similar to SiC diodes, with > 10 years proved experience in manufacturing

- Reduced cooling effort due to reduced losses
- Increase of the operating frequency with consequent shrink of passive components and savings at system level
- Increased power density
- Increase of output power, reduction of specific system cost

- Solar
- UPS
- Industrial Drives



Voltage	R <sub>DS(on)</sub> [mΩ]	Sales name	JFET Package	Driver	Driver Package	LV MOS	LV MOS Package
1200	70	IJW120R070T1	TO-247	1EDI30J12CL/CP	DSO-16-20/19-4	BSC030P03NS3 G	SuperSO8
	100	IJW120R100T1	TO-247	1EDI30J12CL/CP	DSO-16-20/19-4	BSC030P03NS3 G	SuperSO8
1200	70	IJC120R070T1	Bare die	1EDI30J12CL/CP	DSO-16-20/19-4	IPC099P03N	Bare die
	100	IJC120R100T1	Bare die	1EDI30J12CL/CP	DSO-16-20/19-4	IPC099P03N	Bare die

## 650V Generation 5



$I_F$ [A]	TO-220 R2L	TO-247 Dual Die	TO-247	DPAK DML	D <sup>2</sup> PAK R2L	ThinPAK 8x8
2	IDH02G65C5				IDK02G65C5	IDL02G65C5
3	IDH03G65C5				IDK03G65C5	
4	IDH04G65C5				IDK04G65C5	IDL04G65C5
5	IDH05G65C5				IDK05G65C5	
6	IDH06G65C5				IDK06G65C5	IDL06G65C5
8	IDH08G65C5				IDK08G65C5	IDL08G65C5
9	IDH09G65C5				IDK09G65C5	
10	IDH10G65C5		IDW10G65C5		IDK10G65C5	IDL10G65C5
12	IDH12G65C5		IDW12G65C5		IDK12G65C5	IDL12G65C5
16	IDH16G65C5		IDW16G65C5			
20	IDH20G65C5	IDW20G65C5B*	IDW20G65C5			
24		IDW24G65C5B*				
30/32		IDW32G65C5B*	IDW30G65C5			
40		IDW40G65C5B*	IDW40G65C5			

## 600V Generation 3



$I_F$ [A]	TO-220 R2L	TO-247 Dual Die	TO-247	DPAK DML	D <sup>2</sup> PAK	ThinPAK 8x8
3	IDH03SG60C			IDD03SG60C		
4	IDH04SG60C			IDD04SG60C		
5	IDH05SG60C			IDD05SG60C		
6	IDH06SG60C			IDD06SG60C		
8	IDH08SG60C			IDD08SG60C		
9	IDH09SG60C			IDD09SG60C		
10	IDH10SG60C			IDD10SG60C		
12	IDH12SG60C			IDD12SG60C		

## 600V Generation 2



$I_F$ [A]	TO-220 R2L	TO-247 Dual Die	TO-247	DPAK DML	D <sup>2</sup> PAK DML	ThinPAK 8x8
4	IDH04S60C**					
5	IDH05S60C**					
6	IDH06S60C**				IDB06S60C**	
8	IDH08S60C**					
10	IDH10S60C**				IDB10S60C**	
12	IDH12S60C**					
16	IDH16S60C**					

\*to be released in 2015

\*\*not for new designs



## 1200V Generation 5



$I_F$ [A]	TO-220 R2L	TO-247 Dual Die	TO-247	DPAK DML	D <sup>2</sup> PAK DML	ThinPAK 8x8
2	IDH02G120C5*			IDM02G120C5*		
5	IDH05G120C5*			IDM05G120C5*		
8	IDH08G120C5*			IDM08G120C5*		
10	IDH10G120C5*	IDW10G120C5B				
15	IDH15G120C5*	IDW15G120C5B				
20		IDW20G120C5B				
40		IDW40G120C5B				

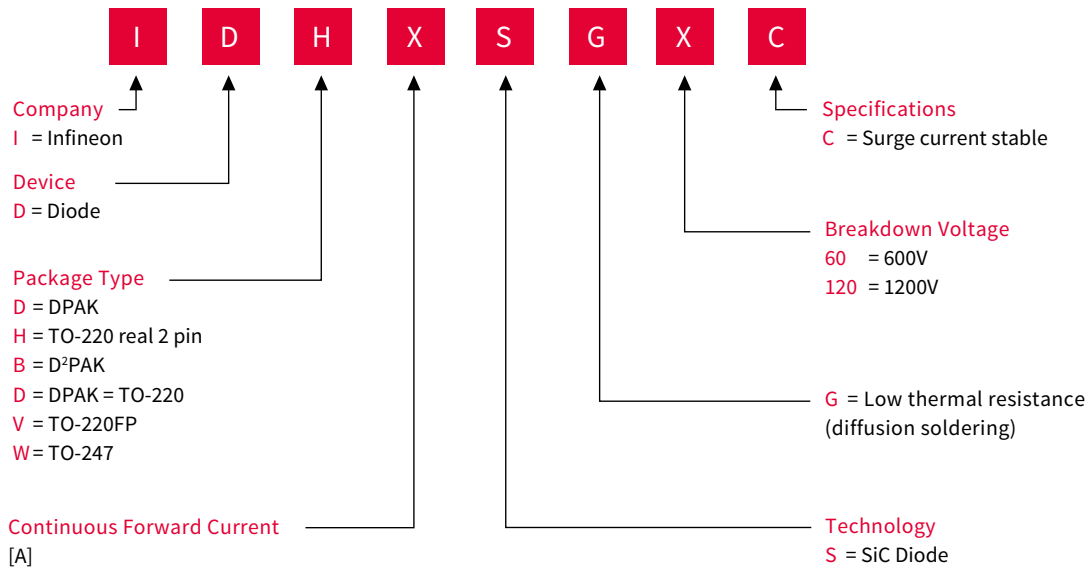
## 1200V Generation 2



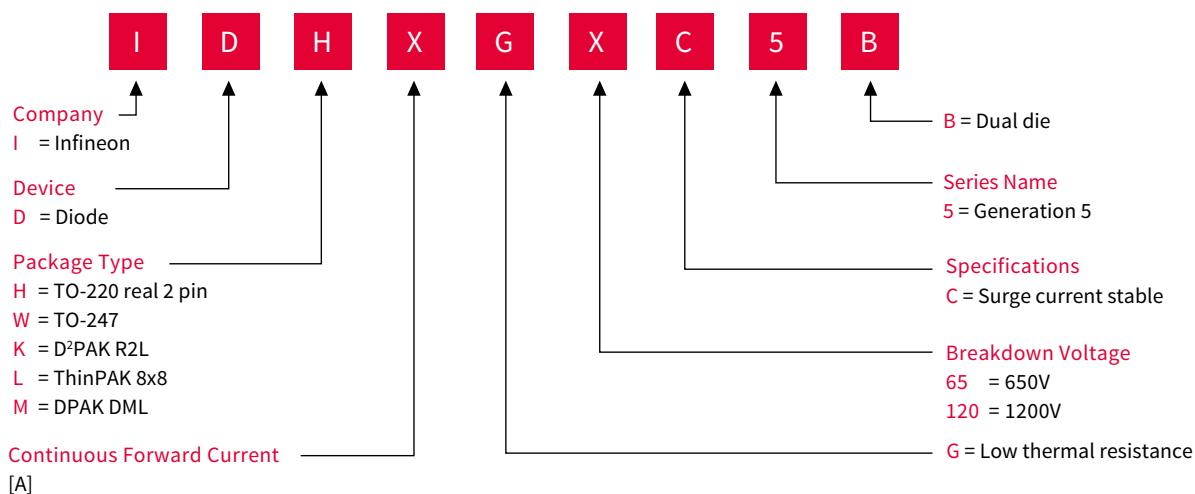
$I_F$ [A]	TO-220 R2L	TO-247 Dual Die	TO-247	DPAK DML	D <sup>2</sup> PAK DML	ThinPAK 8x8
2	IDH02SG120					
5	IDH05S120					
8	IDH08S120					
10	IDH10S120		IDW10S120**			
15	IDH15S120		IDW15S120**			
20		IDW20S120**				

# Naming System

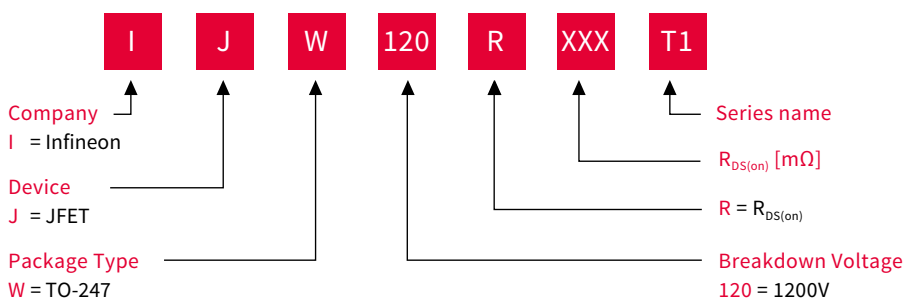
## thinQ!™ Silicon Carbide Schottky Diodes Generation 2 and 3



## thinQ!™ Silicon Carbide Schottky Diodes Generation 5



## CoolSiC™ Silicon Carbide JFET





# Expert Support for Silicon Carbide

Easy Access and High Quality



## Application Notes, Datasheets & More

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Datasheets








# IGBT

## Market Leadership Through Groundbreaking Innovation and Application Focus

Striving for the highest standards in performance and quality, Infineon offers a comprehensive application specific discrete IGBT portfolio that is second to none.


















### Overview Discrete IGBTs

#### Product Portfolio

	TO-252 DPAK	TO-263 D <sup>2</sup> PAK	TO-220	TO-220 FullPAK	TO-247	TO-247 4pin	TO-247PLUS
Package Options							
Voltage Class	600V, 650V, 1100V, 1200V, 1350V, 1600V						
Configuration	DuoPack (with diode), Single IGBT						
Continuous Collector Current $T_c = 100^\circ\text{C}$	2A - 120A						

New products are application specific developed to achieve highest value.

### New Best-in-Class Technologies and Applications

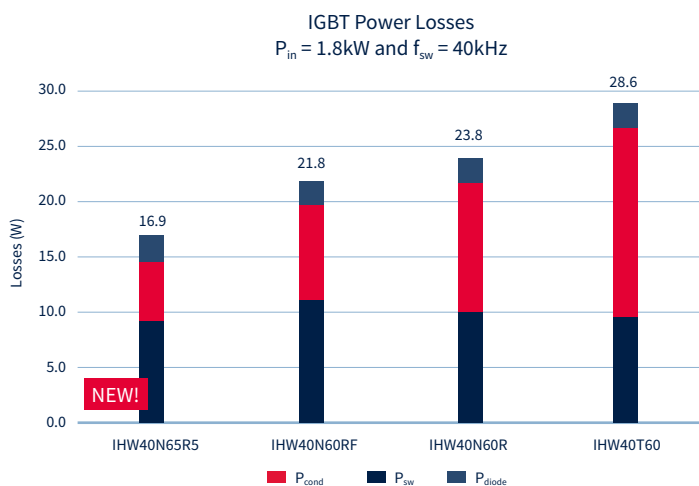
Technology	Application
TRENCHSTOP™ 5 H5 F5 650V	     
TRENCHSTOP™ 5 L5 650V	  
Rapid Diode 650V	   
RC-H5 650V/1200V/1350V	
WR5 650V	
RC-Drives RC-Drives Fast 600V	 

## New Generation Reverse Conducting IGBT

The newest generation of reverse conducting IGBTs has been optimized for the unique requirements of Induction Cooking applications. With a monolithically integrated reverse conducting diode, the RC-H5 family sets the industry standard for performance in soft switching applications.

For single switch systems, RC-H5 is available with 1200V and 1350V blocking voltage. These 20A devices are the next generation of the successful RC-H3 family, and once again set a new industry benchmark. With up to 30% reduction in switching losses, they allow for higher system switching frequencies and improved efficiency.

For half bridge designs, an entirely new family of RC-H5 650V devices was created by building on the industry leading performance of the TRENCHSTOP™ 5 and the application specific technology of earlier reverse conducting IGBTs. The result is a family of products optimized for the lowest  $V_{CE(sat)}$  for best efficiency and thermal performance, and additionally with low  $E_{off}$  for improved operation at switching frequencies up to 40kHz.



### Features

- Reduced losses up to 30%
- Soft current turn-off waveforms for low EMI
- Higher blocking voltages in 650V and 1350V devices
- $T_{j(max)} = 175^{\circ}C$
- 650V: Hard switching capable with commutation rugged diode

### Benefits

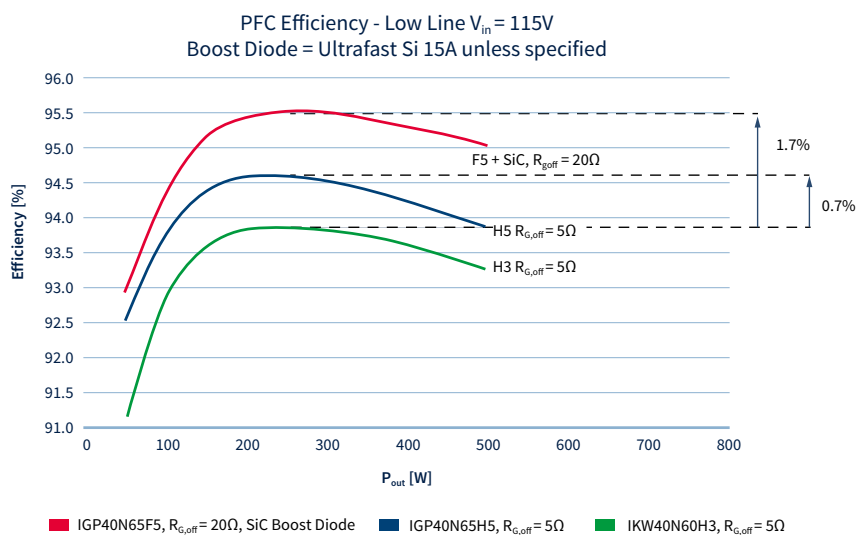
- Improved performance in systems with increased switching frequency
- Lowest power dissipation for best system efficiency
- Better thermal management for higher reliability
- Lower EMI filtering requirements

### Applications

- Induction Cooking Stoves
- Inverterized Microwave Ovens
- Induction Rice Cookers
- Induction Water Heaters
- Other Resonant Switching Applications

## TRENCHSTOP™ 5

In terms of switching and conduction losses, there is no other IGBT on the market that can match the performance of the TRENCHSTOP™ 5. TRENCHSTOP™ 5 is the next generation of thin wafer technology for applications switching >10kHz. Wafer thickness has been reduced by >25%, which enables a dramatic improvement in both switching and conduction losses, whilst providing a breakthrough voltage of 650V. Translating this Best-in-Class efficiency application tests show >25% reduction in package temperature when performing a plug and play approach with Infineon's previous Best-in-Class IGBT, the "HighSpeed 3". Even more revolutionary, when replacing a TO-247 HighSpeed 3 IGBT with the TRENCHSTOP™ 5 in a TO-220, case temperatures are >10% lower for the TRENCHSTOP™ 5. The quantum leap of efficiency improvement provided by the TRENCHSTOP™ 5 opens up new opportunities for designers to explore.



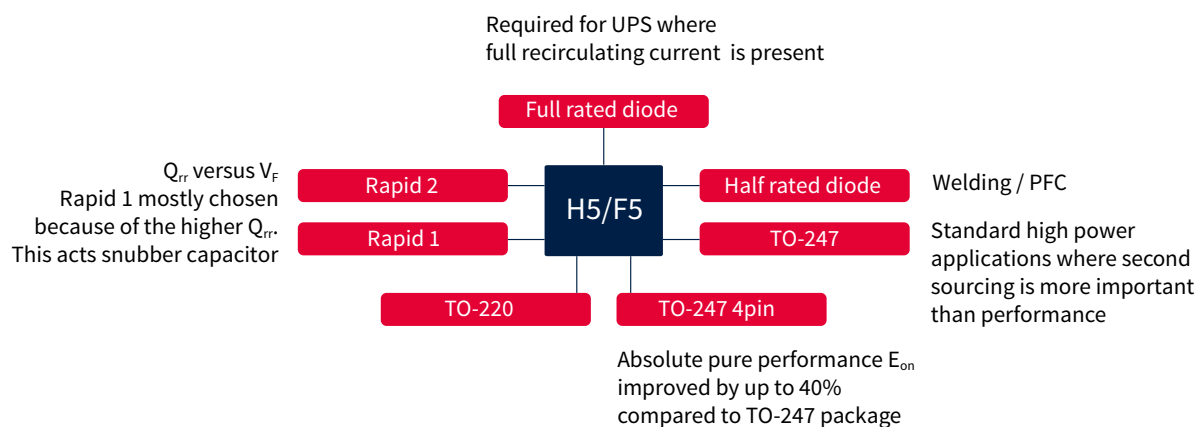
### Features

- 650V breakthrough voltage
- Compared to Infineon's Best-in-Class "HighSpeed 3" family
  - Factor 2.5 lower  $Q_g$
  - Factor 2 reduction in switching losses
  - 200mV reduction in  $V_{CE(sat)}$
- Co-packed with Infineon's new "Rapid" Si-diode technology
- Low  $C_{oss}/E_{oss}$
- Mild positive temperature coefficient  $V_{CE(sat)}$
- Temperature stability of  $V_F$

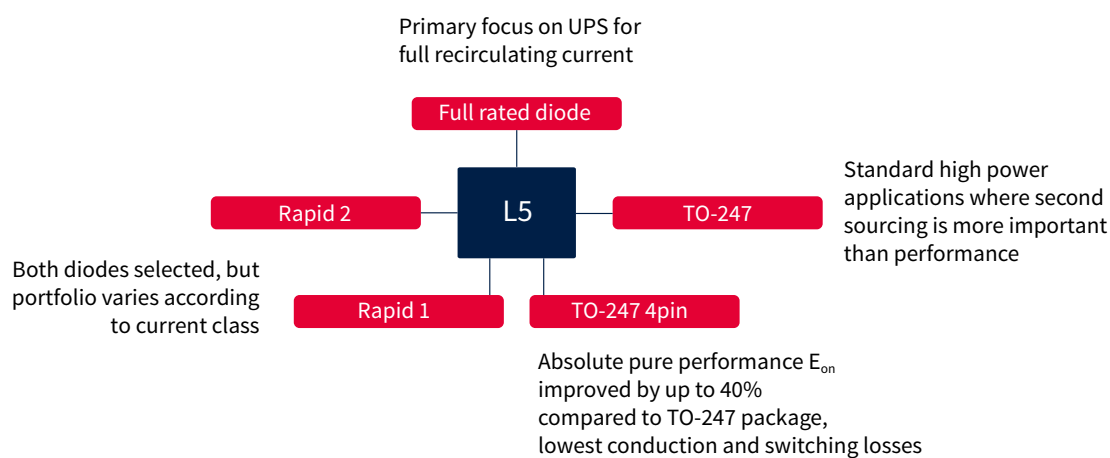
### Benefits

- Best-in-Class efficiency, resulting in lower junction and case temperature leading to higher device reliability
- 50V increase in the bus voltage possible without compromising reliability
- Higher power density designs

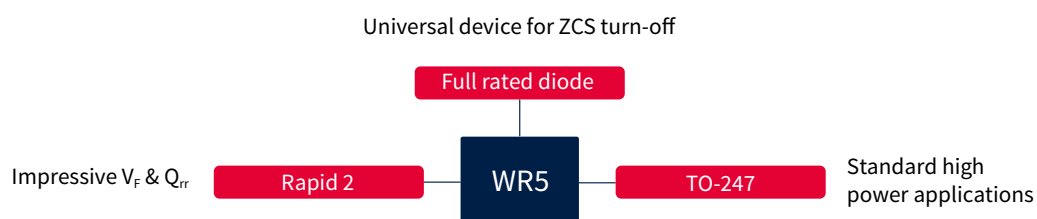
## First step H5 Variation – 10kHz → 100kHz



## Low $V_{CE(sat)}$ Variation – 50Hz → 20kHz



## Zero Current Switching Optimized Variation – 18kHz → 60kHz

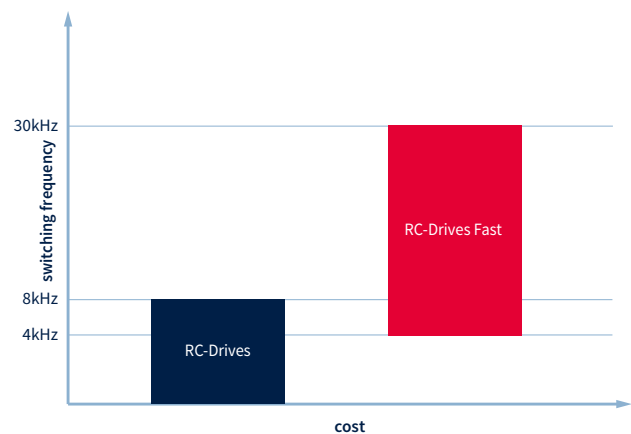
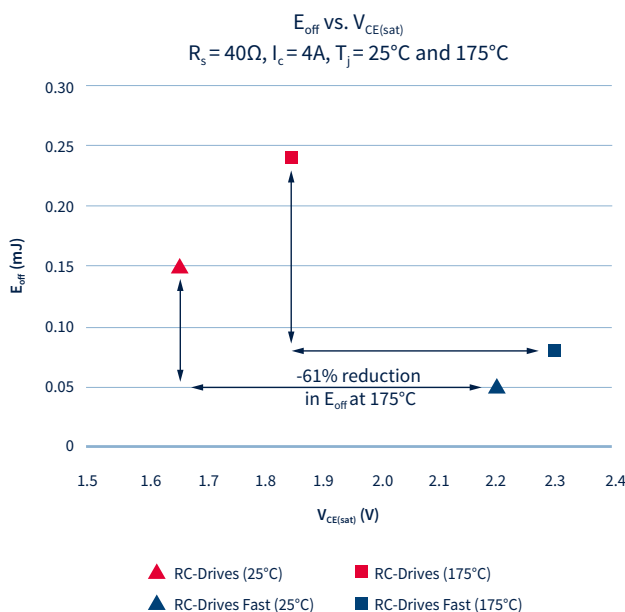


## RC-Drives and RC-Drives Fast

The RC-Drives (RC-D) IGBT technology is a cost optimized solution for permanent magnet synchronous and brushless DC motors in the price-sensitive consumer drives market. The RC-Drives Fast (RC-DF) family extension was developed to provide outstanding performance at switching frequencies above 8kHz

- IGBT and diode were optimized to reduce losses at frequencies of 18 - 30kHz
- Audible noise can be reduced to absolutely silent level for high efficiency inverters operating above 16kHz

Highly precise vector control techniques can be used to provide more torque in operation at low speed and high performance dynamics in the control at high speed. Furthermore, the small size of RC-Drives allows high power density designs with less system costs.



### Features

- Optimized  $E_{on}$ ,  $E_{off}$  and  $Q_{rr}$  for up to 20% lower switching losses
- Operating range from DC to 30kHz
- Max. junction temperature 175°C
- Short circuit capability of 5μs
- Very tight parameter distribution
- Best-in-Class current versus package size performance
- Smooth switching performance leading to low EMI levels
- Complete product portfolio and PSpice Models on the internet

### Benefits

- Excellent cost/performance for hard switching applications
- Outstanding temperature stability
- Very good EMI behavior

- Up to 60% space saving on the PCB
- Higher reliability due to monolithically integrated IGBT & diode due to less thermal cycling during switching

### Applications RC-Drives ( $f_{sw} < 4kHz$ )

- Fridge Compressors
- Pumps
- Fans
- Aircon Compressors

### Applications RC-Drives Fast ( $4kHz < f_{sw} < 30kHz$ )

- Washing Machines
- General Purpose Inverters
- Aircon Compressors
- Hard Switching Topologies up to 1.0kW



## TRENCHSTOP™ 60TA – Well Established and Known in the Automotive World (AEC-Q qualified)

Infineon TRENCHSTOP™ 60TA IGBT technology due to combination of trench top-cell and field stop concept leads to significant improvement of static as well as dynamic performance of the device. Combination of IGBT with soft recovery Emitter Controlled-Diode further minimizes the turn-on losses. The highest efficiency is reached due to the best compromise between switching and conduction losses.

### Features

- Low  $V_{CE(sat)}$  for low conduction losses
- Max. junction temperature 175°C
- Short circuit capability of 5μs
- Low EMI emissions
- Very soft, fast recovery anti-parallel diode
- Very tight parameter distribution
- Positive temp. coefficient in  $V_{CE(sat)}$

### Benefits

- Suitable for low switching frequencies
- High temperature capable
- Very good EMI behavior
- High ruggedness, temperature stable behavior
- High device reliability
- Applicable for high level of device paralleling

### Applications

- Main Inverter/Drive Train
- AUX Inverter (AirCon Compressor, PTC Heater)
- Motor Drives

### Product Portfolio TRENCHSTOP™ 60TA

Technology Continuous collector current @ TC=100°C	Current Rating	600V			
		TO-263 D <sup>2</sup> PAK	TO-220	TO-247	TO-247PLUS
IGBT + Diode	20 A	IKB20N60TA	IKP20N60TA	IKW20N60TA	-
	30 A	-	-	IKW30N60TA	-
	50 A	-	-	IKW50N60TA	-
	75 A	-	-	IKW75N60TA	-
	100 A	-	-	-	IKQ100N60TA
	120 A	-	-	-	IKQ120N60TA



## TRENCHSTOP™ 5 AUTO – A Revolution in the IGBT World

Infineon's brand new TRENCHSTOP™ 5 AUTO IGBT technology redefines “Best-in-Class” IGBT by providing unmatched performance in terms of efficiency for hard switching applications. It is a revolution in the IGBT world to match the market's highest efficiency demand of tomorrow, means when highest efficiency, lower system cost and increased reliability is required, TRENCHSTOP™ 5 is the only option. It provides drastic reduction in switching and conduction losses. The TRENCHSTOP™ 5 AUTO is available in two versions - H5 (high speed) and F5 (highest efficiency).

### Key Features

- 650V blocking voltage
- Max. junction temperature 175°C
- Very low conduction and switching losses
- Very low junction and case temperature
- High power density design
- Mild positive temperature coefficient in  $V_{CE(sat)}$

### Benefits

- 50V higher blocking voltage
- Highest efficiency
- High device reliability
- Low temperature leads to less cooling efforts
- Less system costs

### Applications

- DC/DC Converter
- DC/AC Converter
- On-Board Charger

### Product Portfolio TRENCHSTOP™ 5 Auto

Technology Continuous collector current @ $T_c=100^\circ\text{C}$	Current Rating	650V	
		H5 TO-247	F5 TO-247
Single IGBT	40A	IGW40N65H5A	IGW40N65F5A
	50A	IGW50N65H5A	IGW50N65F5A
IGBT+Diode	40A	IKW40N65H5A	IKW40N65F5A
	50A	IKW50N65H5A	IKW50N65F5A



## Reverse Conducting Drives and Drives Fast - Qualified According to AEC Q101

RC-Drives IGBT technology has been developed by Infineon as a cost optimized solution by offering space saving advantages due to monolithically integrated diode. Furthermore the technology provides outstanding performance for smooth switching behavior and low EMI levels even at the maximum junction temperature of 175°C. This variant enables high efficiency, especially at high speed switching up to 30kHz, while keeping the well known advantages of the RC-Drives family. It also reduces the audible noise to an absolute silent level. The complete product family offers high efficiency at reduced component size and high power density and leads to a reduction in terms of system costs.

### Features

- Optimized parameters for up to 20% lower switching losses
- Operating range from DC to 30kHz
- Max. junction temperature 175°C
- Short circuit capability of 5μs
- Very tight parameter distribution
- Best-in-Class current versus package size performance
- Smooth switching performance leading to low EMI levels

### Benefits

- Excellent cost/performance for hard switching applications
- Outstanding temperature stability
- Very good EMI behavior
- Up to 60% space saving on the PCB
- Higher reliability due to monolithically integrated IGBT and diode due to less thermal cycling during switching

### Applications RC-DA < 8kHz

- Piezo Injection
- HID Lighting
- Pumps
- Small Drives

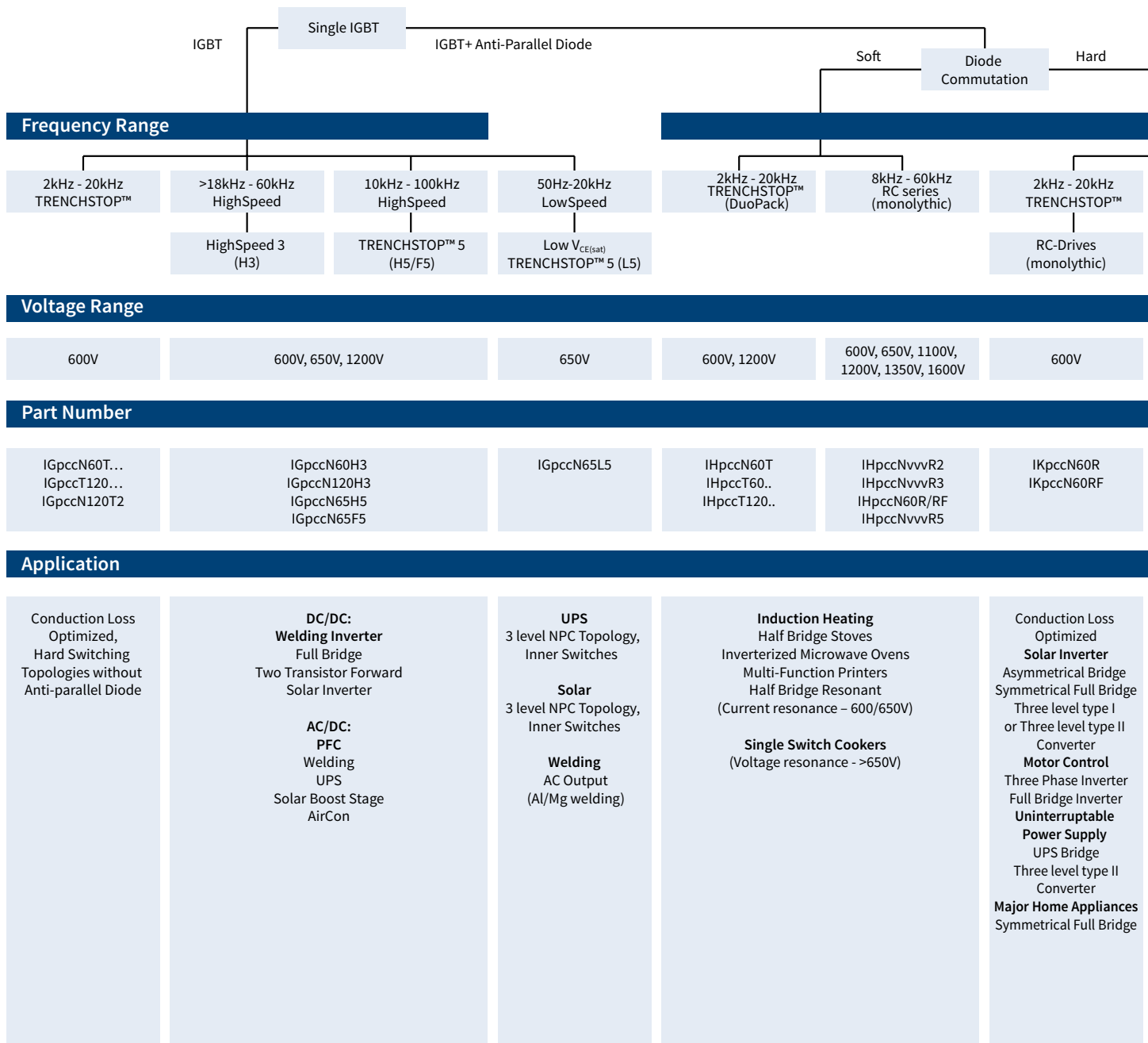
### Applications RC-DFA < 5kHz

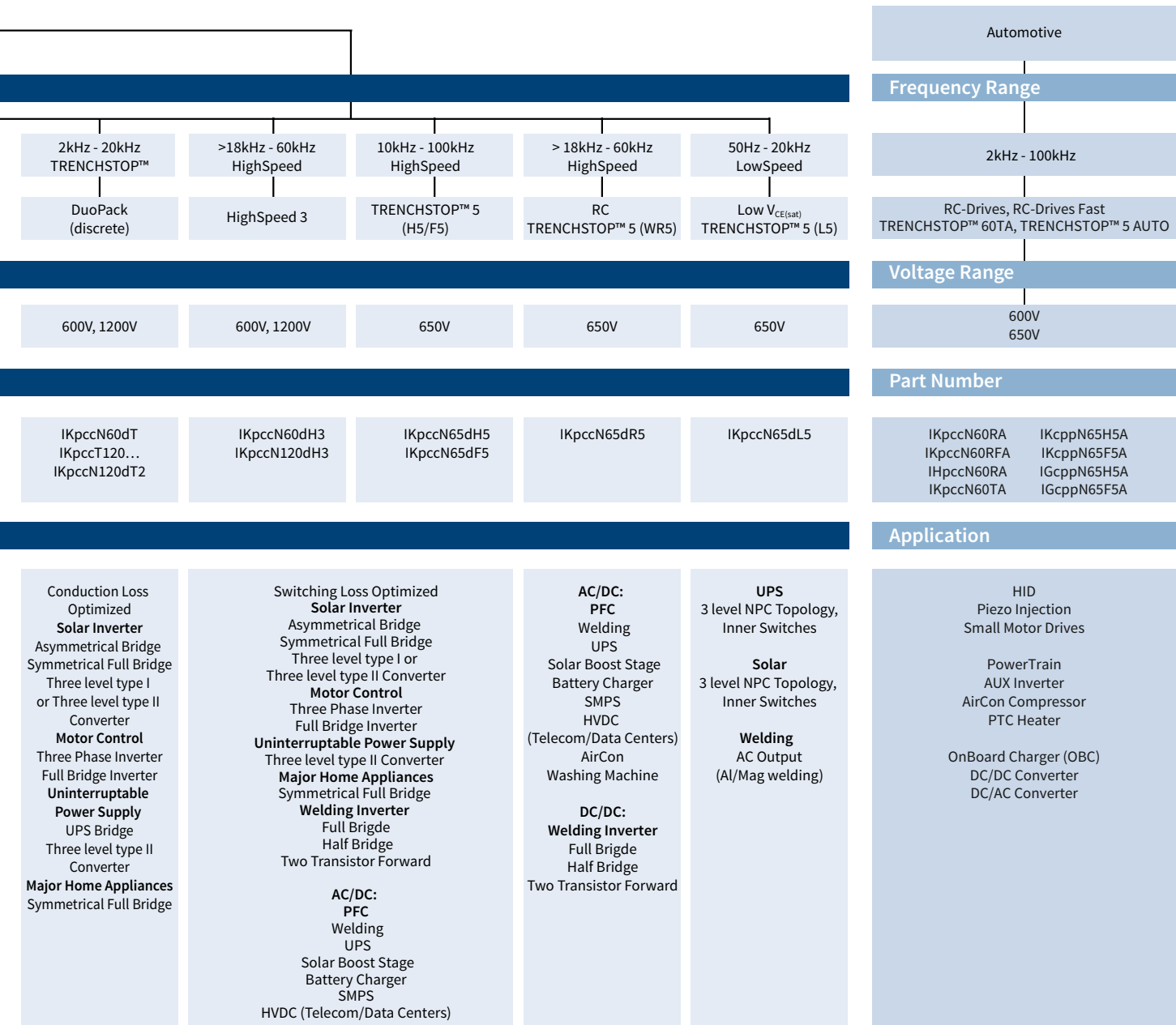
- Piezo Injection
- HID Lighting
- Low Power Motor Drives

### Product Portfolio Reverse Conducting Drives and Drives Fast

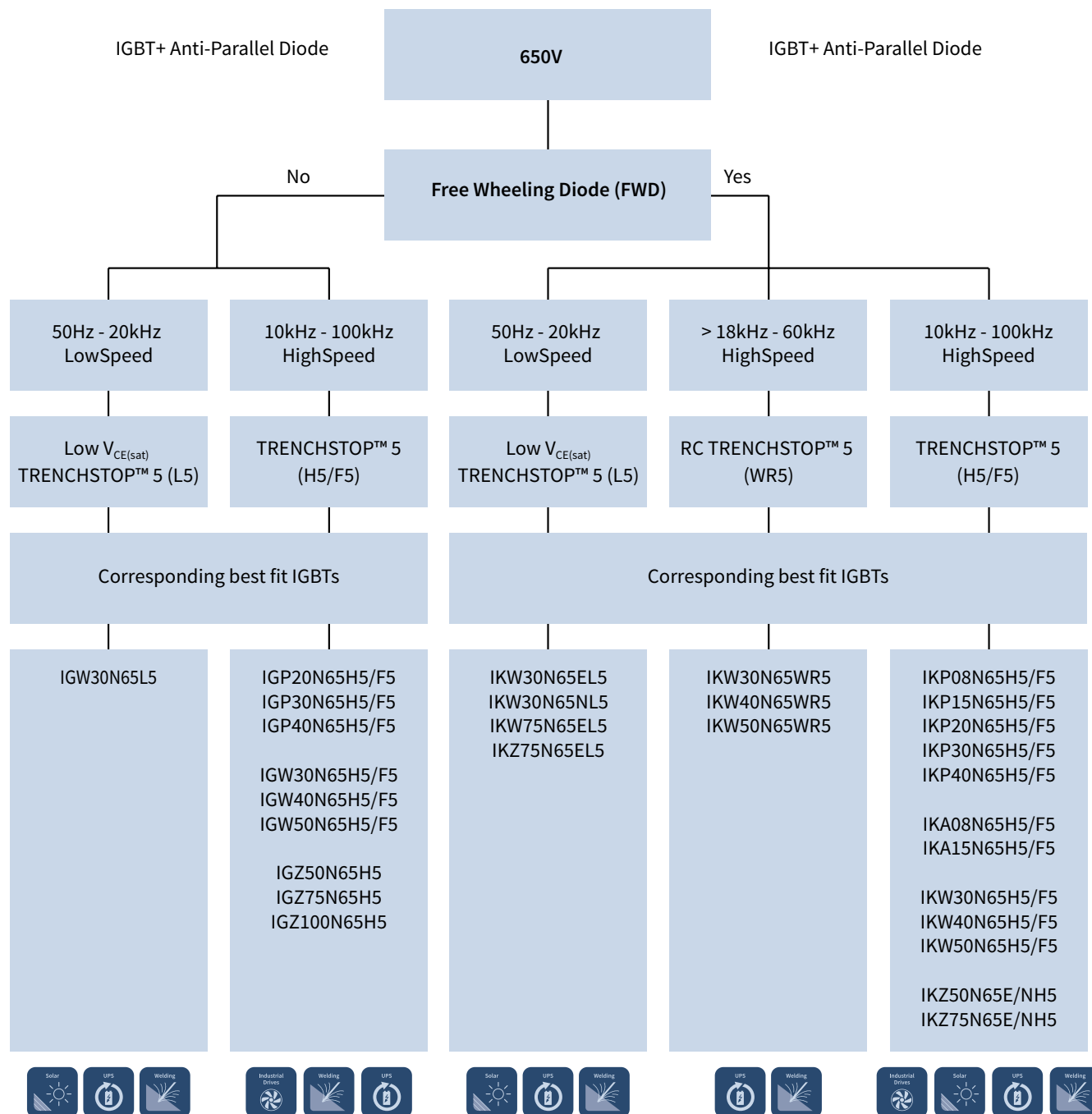
Technology Continuous collector current @ T <sub>c</sub> =100°C	Current Rating	600V	
		RC-DA TO-252 / DPAK	RC-DFA TO-252 / DPAK
IGBT + Diode	3A	--	IKD03N60RFA
	4A	IKD04N60RA	IKD04N60RFA
	6A	IKD06N60RA	IKD06N60RFA
	10A	IKD10N60RA	IKD10N60RFA
	15A	IKD15N60RA	IKD15N60RFA

# IGBT Selection Tree





## TRENCHSTOP™ 5 Selection Tree



## TRENCHSTOP™ and RC-Drives Product Portfolio



## 600V Product Family

Continuous collector current @ $T_c=100^{\circ}\text{C}$		TO-251 Halogen-Free	TO-252 DPAK Halogen-Free	TO-263 D <sup>2</sup> PAK Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-220 FullPAK Halogen-Free	TO-247 Halogen-Free	TO-247PLUS Halogen-Free
Single IGBT	4	IGU04N60T							
	6		IGD06N60T		IGP06N60T				
	10			IGB10N60T	IGP10N60T				
	15			IGB15N60T	IGP15N60T				
	30			IGB30N60T				IGW30N60T	
	50			IGB50N60T	IGP50N60T			IGW50N60T	
	75							IGW75N60T	
IGBT and Diode	3		IKD03N60RF/RFA						
	4		IKD04N60RF/RFA IKD04N60R/RA		IKP04N60T				
	6		IKD06N60RF/RFA IKD06N60R/RA	IKB06N60T	IKP06N60T		IKA06N60T		
	10		IKD10N60RF/RFA IKD10N60R/RA	IKB10N60T	IKP10N60T		IKA10N60T		
	15		IKD15N60RF/RFA IKD15N60R/RA	IKB15N60T	IKP15N60T		IKA15N60T		
	20			IKB20N60T/TA	IKP20N60T/TA			IKW20N60T/TA	
	30							IKW30N60T/TA	
	50							IKW50N60T/TA	
	75							IKW75N60T/TA	
	100								IKQ100N60T/TA
	120								IKQ120N60T/TA

Discrete IGBTs

## TRENCHSTOP™ Product Portfolio



## 1200V Product Family

Continuous collector current @ $T_c=100^{\circ}\text{C}$		TO-251	TO-252 DPAK Halogen-Free	TO-263 D <sup>2</sup> PAK Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-220 FullPAK	TO-247 Halogen-Free	
								TRENCHSTOP™	TRENCHSTOP™ 2
Single IGBT	8							IGW08T120	
	15							IGW15T120	
	25							IGW25T120	
	40							IGW40T120	
	60							IGW60T120	
Duo Pack	8							IKW08T120	
	15							IKW15T120	IKW15N120T2
	25							IKW25T120	IKW25N120T2
	40							IKW40T120	IKW40N120T2

## Induction Cooking Series Product Portfolio



600V, 1100V, 1200V, 1350V & 1600V Product Families

Continuous collector current @ T <sub>c</sub> =100°C		TO-251	TO-252 (DPAK) Halogen-Free	TO-263 (D <sup>2</sup> PAK) Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-247 Halogen-Free				
							600V/650V	1100V	1200V	1350V	1600V
IGBT & Diode	15								IHW15N120R3		
	20						IHW20N65R5		IHW20N120R3	IHW20N135R3	
	25								IHW20N120R5	IHW20N135R5	
	30						IHW30N65R5	IHW30N110R3	IHW30N120R3	IHW30N135R3	IHW30N160R2
	40						IHW40N65R5		IHW40N120R3	IHW40N135R3	
							IHW40N60R				
							IHW40N60RF				
	50						IHW50N65R5				
	60										
	75										

## HighSpeed 2 Product Portfolio



1200V Product Family

Continuous collector current @ T <sub>c</sub> =100°C		TO-251	TO-252 (DPAK) Halogen-Free	TO-263 (D <sup>2</sup> PAK) Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-220 FullPAK Halogen-Free	TO-247 Halogen-Free
IGBT	1		IGD01N120H2	IGB01N120H2	IGP01N120H2			
	3			IGB03N120H2	IGP03N120H2		IGA03N120H2	IGW03N120H2
Duo Pack	3			IKB03N120H2	IKP03N120H2		IKA03N120H2	IKW03N120H2

## HighSpeed 3 Product Portfolio



600V Product Family

Continuous collector current @ T <sub>c</sub> =100°C		TO-251	TO-252 (DPAK) Halogen-Free	TO-263 (D <sup>2</sup> PAK) Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-220 FullPAK Halogen-Free	TO-247 Halogen-Free
IGBT	20			IGB20N60H3	IGP20N60H3			IGW20N60H3
	30			IGB30N60H3	IGP30N60H3		IGA30N60H3	IGW30N60H3
	40							IGW40N60H3
	50							IGW50N60H3
	60							IGW60N60H3
	75							IGW75N60H3
	100							IGW100N60H3
Duo Pack	20			IKB20N60H3	IKP20N60H3			IKW20N60H3
	30							IKW30N60H3
	40							IKW40N60H3
	50							IKW50N60H3
	60							IKW60N60H3
	75							IKW75N60H3

## HighSpeed 3 Product Portfolio

### 1200V Product Family



Continuous collector current @ T <sub>c</sub> =100°C		TO-251	TO-252 (DPAK) Halogen-Free	TO-263 (D <sup>2</sup> PAK) Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-220 FullPAK Halogen-Free	TO-247 Halogen-Free
IGBT	15							IGW15N120H3
	25							IGW25N120H3
	40							IGW40N120H3
Duo Pack	15							IKW15N120H3
	25							IKW25N120H3
	40							IKW40N120H3

## TRENCHSTOP™ 5 Product Portfolio

### 650V Product Family



Continuous collector current @ T <sub>c</sub> =100°C		TO-251	TO-252 (DPAK) Halogen-Free	TO-263 (D <sup>2</sup> PAK) Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-220 FullPAK Halogen-Free	TO-247 Halogen-Free	TO-247 4pin Halogen-Free
IGBT	20				IGP20N65F5/H5				
	30				IGP30N65F5/H5				
	40				IGP40N65F5/H5			IGW40N65F5/5 IGW40N65H5A IGW40N65F5A	
	50							IGW50N65F5/5 IGW50N65H5A IGW50N65F5A	IGZ50N65H5
	75								IGZ75N65H5
	100								IGZ100N65H5
Duo Pack	8				IKP08N65F5/H5		IKA08N65F5/H5		
	15				IKP15N65F5/H5		IKA15N65F5/H5		
	20				IKP20N65H5/F5				
	30				IKP30N65H5/F5			IKW30N65H5 IKW30N65WR5	
	40				IKP40N65F5/H5			IKW40N65F5/H5 IKW40N65WR5 IKW40N65H5A IKW40N65F5A	
	50							IKW50N65F5/H5 IKW50N65WR5 IKW50N65H5A IKW50N65F5A	IKZ50N65EH5 IKZ50N65NH5
	65								IKZ75N65NH5 IKZ75N65EH5

## TRENCHSTOP™ 5 Low V<sub>CE(sat)</sub> Product Portfolio

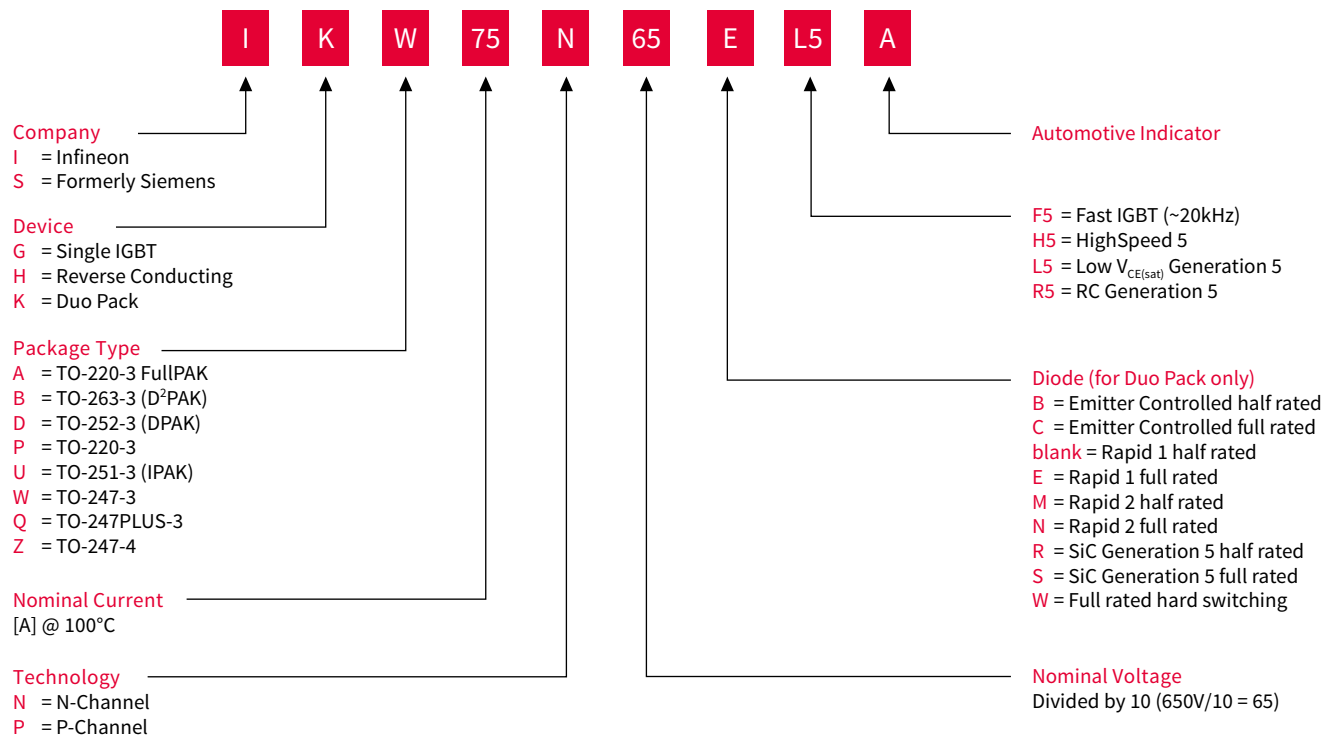
### 650V Product Family



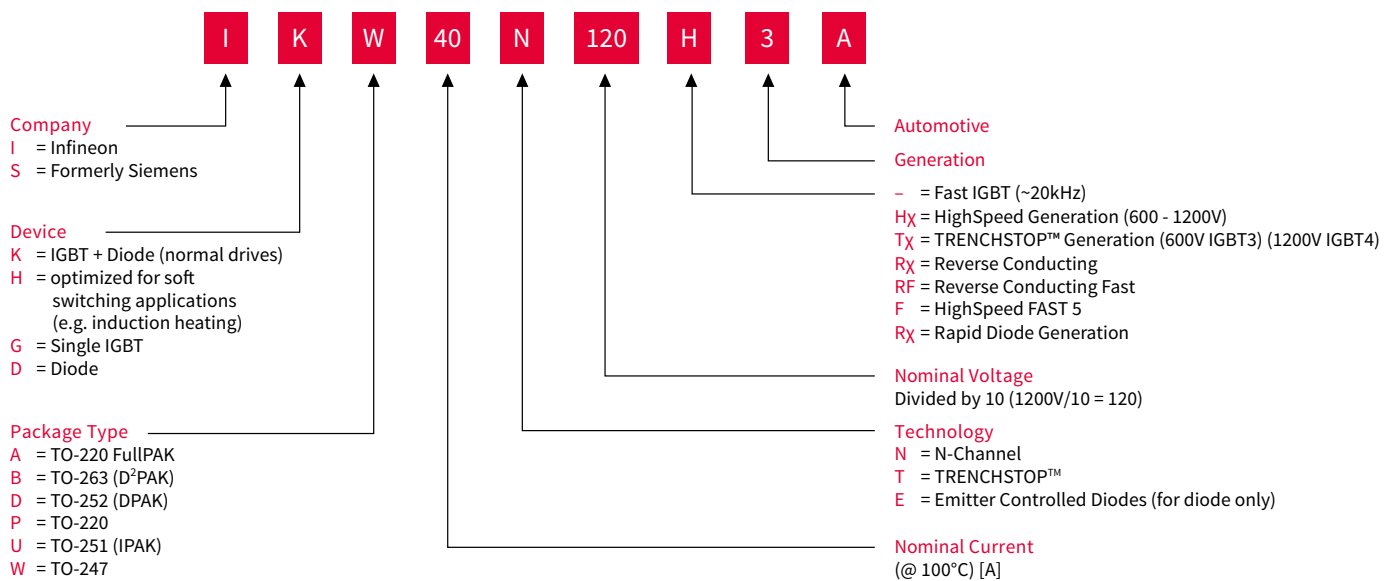
Continuous collector current @ T <sub>c</sub> =100°C		TO-251	TO-252 (DPAK) Halogen-Free	TO-263 (D <sup>2</sup> PAK) Halogen-Free	TO-220 Halogen-Free	TO-262 Halogen-Free	TO-220 FullPAK Halogen-Free	TO-247 Halogen-Free	TO-247 4pin Halogen-Free
IGBT	30							IGW30N65L5	
Duo Pack	30							IKW30N65EL5 IKW30N65NL5	
	75							IKW75N65EL5	IKZ75N75EL5

# Naming System

## IGBT (Products Launched After 03/2013)



## IGBT (Products Launched Before 03/2013)





# Expert Support for Discrete IGBT

Easy Access and High Quality



## Application Notes, Datasheets & More

[www.infineon.com/igbt-datasheets](http://www.infineon.com/igbt-datasheets)

[www.infineon.com/igbt-material](http://www.infineon.com/igbt-material)

[www.infineon.com/discrete-automotive-igbt](http://www.infineon.com/discrete-automotive-igbt)

[www.infineon.com/latest-discrete-packages](http://www.infineon.com/latest-discrete-packages)



## Latest Videos

[www.infineon.com/igbt-discretes](http://www.infineon.com/igbt-discretes)



## New Releases

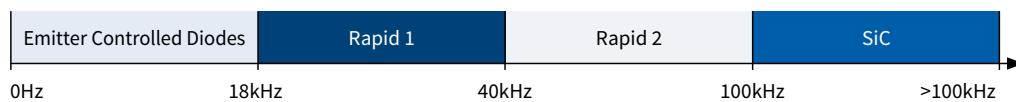
[www.infineon.com/igbt-newreleases](http://www.infineon.com/igbt-newreleases)



Datasheets

# Silicon Power Diodes

The Rapid Diode family complements Infineon's existing high power 600V/650V diode portfolio by filling the gap between SiC diodes and previously released emitter-controlled diodes. They represent a perfect cost/performance balance and target high efficiency applications switching between 18kHz and 100kHz. Rapid 1 and Rapid 2 diodes are optimized to have excellent compatibility with CoolMOS™ and high speed IGBT (Insulated Gate Bipolar Transistor) such as the TRENCHSTOP™ 5 and HighSpeed 3.



## The Rapid 1 Diode Family

Rapid 1 is forward voltage drop ( $V_F$ ) optimized to address low switching frequency applications:

Optimized for applications switching between 18kHz and 40kHz, for example Air Conditioner and Welder PFC stages

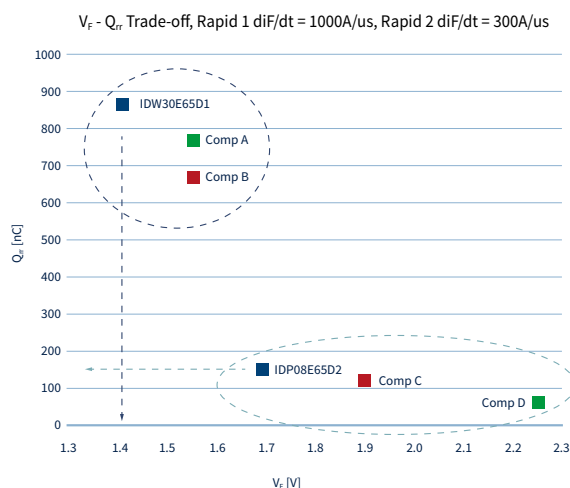
- 1.35V temperature-stable forward voltage ( $V_F$ )
- Lowest peak reverse recovery current ( $I_{rrm}$ )
- Reverse recovery time ( $t_{rr}$ ) < 100ns
- High softness factor

## The Rapid 2 Diode Family

Rapid 2 is  $Q_{rr}/t_{rr}$  optimized hyperfast diode to address high speed switching applications:

Optimized for applications switching between 40kHz and 100kHz typically found in PFCs in high efficiency Switch Mode Power Supplies (SMPS) and Welding Machines.

- Lowest reverse recovery charge ( $Q_{rr}$ ):  $V_F$  ratio for Best-in-Class performance
- Lowest peak reverse recovery current ( $I_{rrm}$ )
- $t_{rr}$  < 50ns
- High softness factor










## Rapid 1 Diodes

650V Product Family








Continuous Current $I_c$ $T_c=100^\circ\text{C}$	TO-220  Halogen-Free	TO-220 FullPAK  Halogen-Free	TO-220 (Common Cathode)  Halogen-Free	TO-247  Halogen-Free	TO-247 (Common Cathode)  Halogen-Free
8A	IDP08E65D1				
15A	IDP15E65D1				
20A		IDV20E65D1			
30A	IDP30E65D1			IDW30E65D1	IDW30C65D1
40A				IDW40E65D1	
60A					IDW60C65D1
75A					IDW75D65D1
80A					IDW80C65D1

## Rapid 2 Diodes

650V Product Family



Continuous Current $I_c$ $T_c=100^\circ\text{C}$	TO-220  Halogen-Free	TO-220 FullPAK  Halogen-Free	TO-220 (Common Cathode)  Halogen-Free	TO-247  Halogen-Free	TO-247 (Common Cathode)  Halogen-Free
8A	IDP08E65D2	IDV08E65D2			
15A	IDP15E65D2	IDV15E65D2		IDW15E65D2	
20A	IDP20E65D2		IDP20C65D2		IDW20C65D2
30A	IDP30E65D2	IDV30E65D2	IDP30C65D2		IDW30C65D2
40A	IDP40E65D2			IDW40E65D2	
80A					IDW80C65D2

## Emitter Controlled Diodes

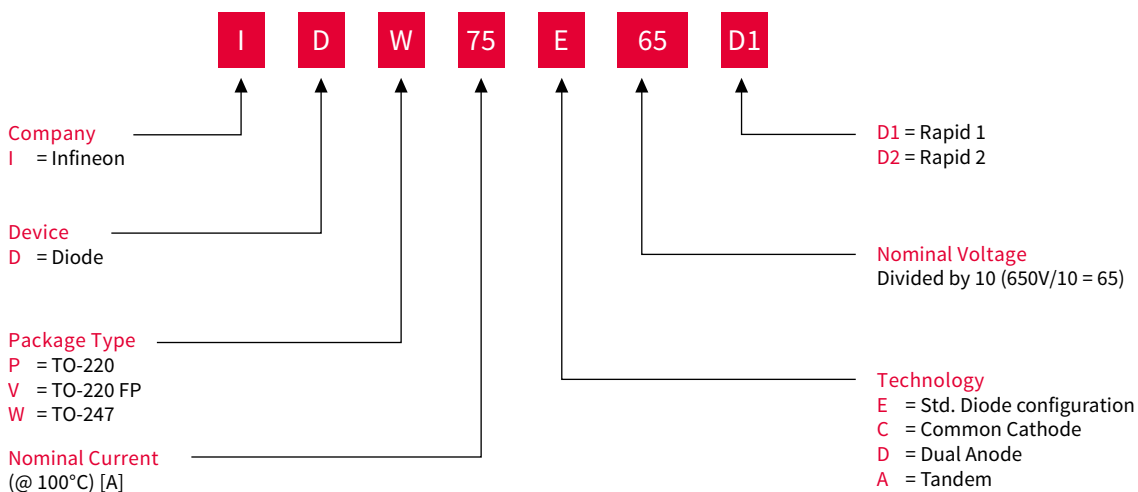


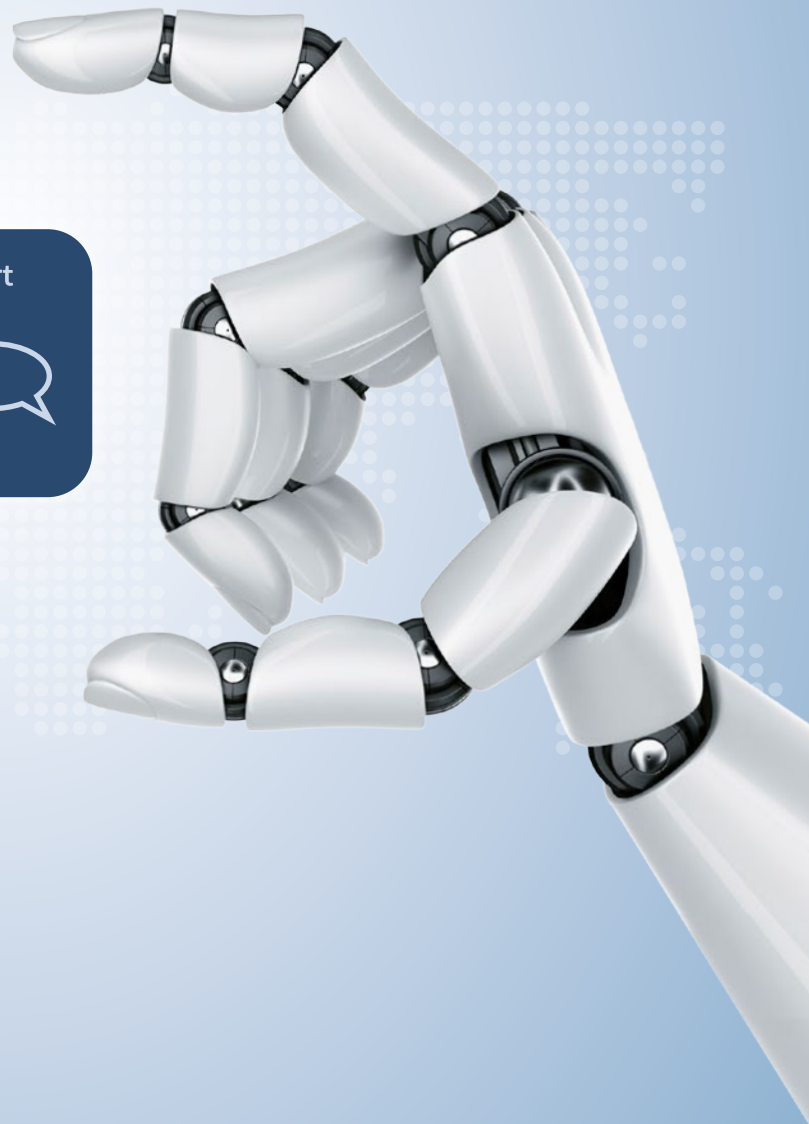
600V and 1200V Product Families

Continuous Current $I_c$ $T_c=100^\circ\text{C}$		TO-252 (DPAK) Halogen-Free	TO-263 (D <sup>2</sup> PAK) Halogen-Free	TO-220 Real 2pin Halogen-Free	TO-247
600V	6	IDD06E60			
	9	IDD09E60			
	15	IDD15E60	IDB15E60	IDP15E60	
	30		IDB30E60	IDP30E60	IDW30E60
	45			IDP45E60	
	50				IDW50E60
	75				IDW75E60
	100				IDW100E60
1200V	12			IDP12E120	
	18			IDP18E120	
	30		IDB30E120	IDP30E120	

## Naming System

### Silicon Power Diodes





# Expert Support for Si Power Diodes

Easy Access and High Quality



## Application Notes, Datasheets & More

[www.infineon.com/rapiddiodes-material](http://www.infineon.com/rapiddiodes-material)

[www.infineon.com/rapiddiodes-datasheets](http://www.infineon.com/rapiddiodes-datasheets)

[www.infineon.com/ultrasoftdiodes-material](http://www.infineon.com/ultrasoftdiodes-material)

[www.infineon.com/ultrasoftdiodes-datasheets](http://www.infineon.com/ultrasoftdiodes-datasheets)



## Latest Videos

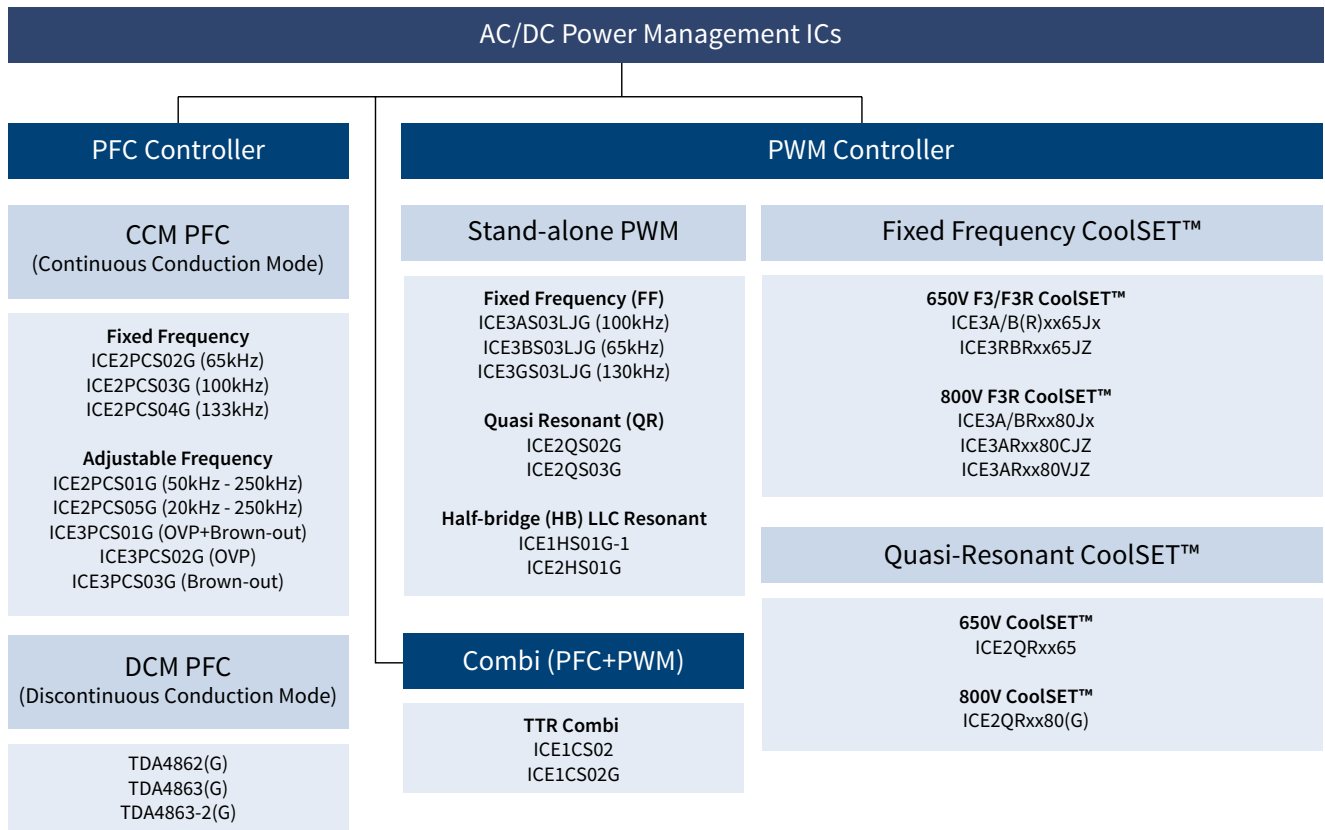
[www.infineon.com/rapiddiodes](http://www.infineon.com/rapiddiodes)



Datasheets

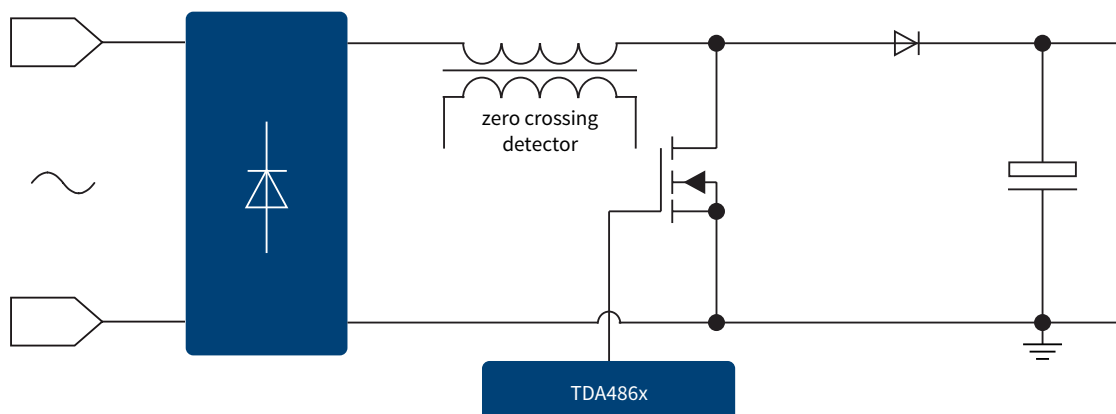
# Power Management ICs

Technology Leadership in Power Supply



## Power Factor Correction and Combo Controller

### Discontinuous Conduction Mode PFC ICs



#### TDA4862 / TDA4862G

Power Factor Controller (PFC) IC for high-power factor and active harmonic filter

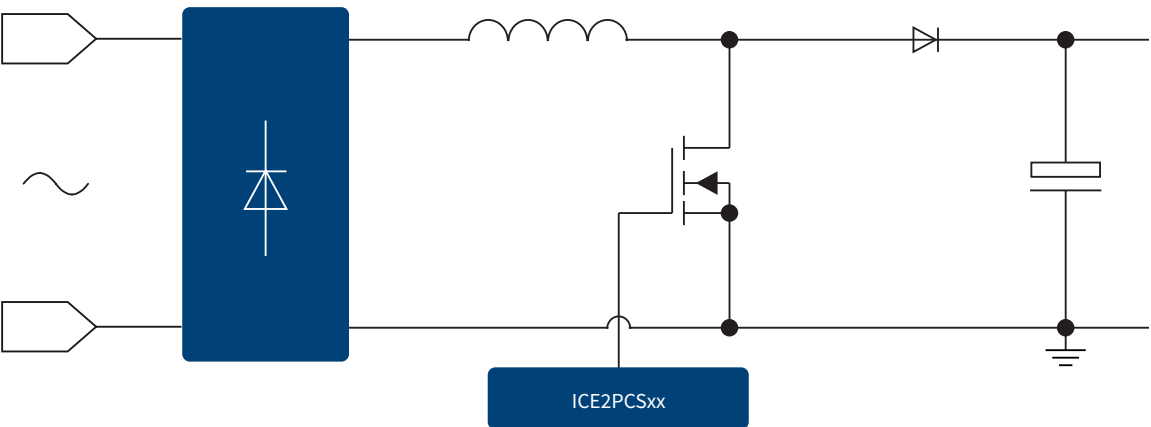
- IC for sinusoidal line-current consumption
- Power factor approaching 1
- Controls boost converter as an active harmonics filter
- Internal start-up with low current consumption
- Zero current detector for discontinuous operation mode
- High current totem pole gate driver
- Trimmed  $\pm 1.4\%$  internal reference
- Undervoltage lock out with hysteresis
- Very low start-up current consumption
- Pin compatible with world standard
- Output overvoltage protection
- Current sense input with internal low pass filter
- Totem pole output with active shutdown during UVLO
- Junction temperature range  $-40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$
- Available in DIP-8 and SO-8 packages

#### TDA4863-2/G

Power Factor Controller IC for high-power factor and low THD additional features to TDA4862

- Reduced tolerance of signal levels
- Improved light load behavior
- Open loop protection
- Current sense input with leading edge blanking LEB
- Undervoltage protection

Continuous Conduction Mode PFC ICs



2<sup>nd</sup> Generation Continuous Conduction Mode (CCM) Power Factor Correction IC Features

- Fulfills Class D requirements of IEC 61000-3-2
- Lowest count of external components
- Adjustable and fixed switching frequencies
- Frequency range from 20kHz to 250kHz
- Versions with brown-out protection available
- Wide input range supported
- Enhanced dynamic response during load jumps
- Cycle by cycle peak current limiting
- Integrated protections OVP, OCP
- DIP-8 and DSO8
- Leadfree, RoHS compliant

2<sup>nd</sup> Generation Continuous Conduction Mode (CCM) Power Factor Correction IC Product Portfolio

Product	Frequency – f <sub>sw</sub>	Current Drives	Package
ICE2PCS01G	50kHz-250kHz	2.0A	DSO-8
ICE2PCS02G	65kHz	2.0A	
ICE2PCS03G	100kHz	2.0A	
ICE2PCS04G	133kHz	2.0A	
ICE2PCS05G	20kHz-250kHz	2.0A	

## 3<sup>rd</sup> Generation Continuous Conduction Mode (CCM) Power Factor Correction IC Features

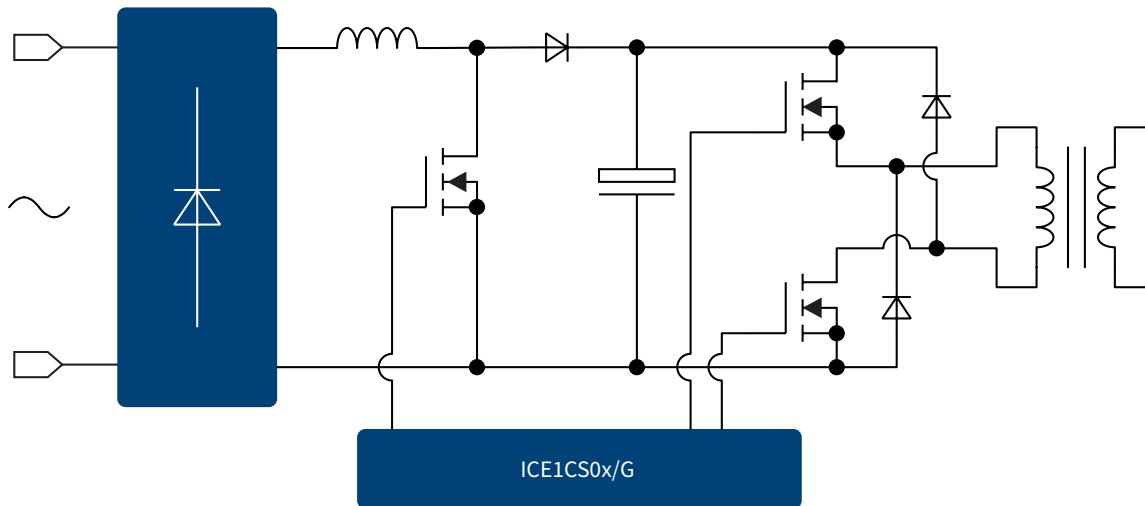
- Fulfills Class D requirements of IEC 61000-3-2
- Integrated digital voltage loop compensation
- Boost follower function
- Bulk voltage monitoring signals, brown-out
- Multi protections such as Double OVP
- Fast output dynamic response during load jump
- External synchronization
- Extra low peak current limitation threshold
- SO-8 and SO-14
- Leadfree, RoHS compliant

### Fixed Frequency PWM IC and CoolSET™ Product Portfolio

Product	Frequency – $f_{sw}$	Current Drives	Features	Package
ICE3PCS01G	Adjustable	0.75A	OVP+Brown-out	SO-14
ICE3PCS02G		0.75A	OVP	SO-8
ICE3PCS03G		0.75A	Brown-out	SO-8

CCM PFC by feature	ICE2PCS01(G) ICE2PCS05(G)	ICE2PCS02(G) ICE2PCS03(G) ICE2PCS04(G)	ICE3PCS03G	ICE3PCS02G	ICE3PCS01G
Digital control voltage loop	–		✓	✓	✓
Variable frequency	✓	–	✓	✓	✓
Synchronous frequency	–		✓	✓	✓
Open loop protection	✓	✓	✓	✓	✓
Low peak current limit	-1V	-1V	-0,4V	-0,4V	-0,2V
Brown out protection	–	✓	✓	–	✓
Over voltage protection	✓	✓	✓	✓	✓
Second over voltage protection		–		✓	✓
PFC enable function		–			✓
Boost follower mode		–			✓
5V regulator		–			✓

## Combination of Continuous Conduction Mode PFC with Two-Transistor Forward PWM IC



- Pre-short protection
- Trimmed reference voltage  $\pm 2.5\%$  ( $\pm 2\%$  at  $25^\circ\text{C}$ )
- BiCMOS technology for wider  $V_{CC}$  range

### Power Factor Correction Block

- Fulfills Class D requirements of IEC 61000-3-2
- Fixed switching frequency (sync to half PWM freq.)
- AC brown-out protection
- Average current control
- Max. duty cycle of 95%
- Enhanced dynamic response for fast load response
- Unique soft-start to limit start up current
- Over-voltage protection

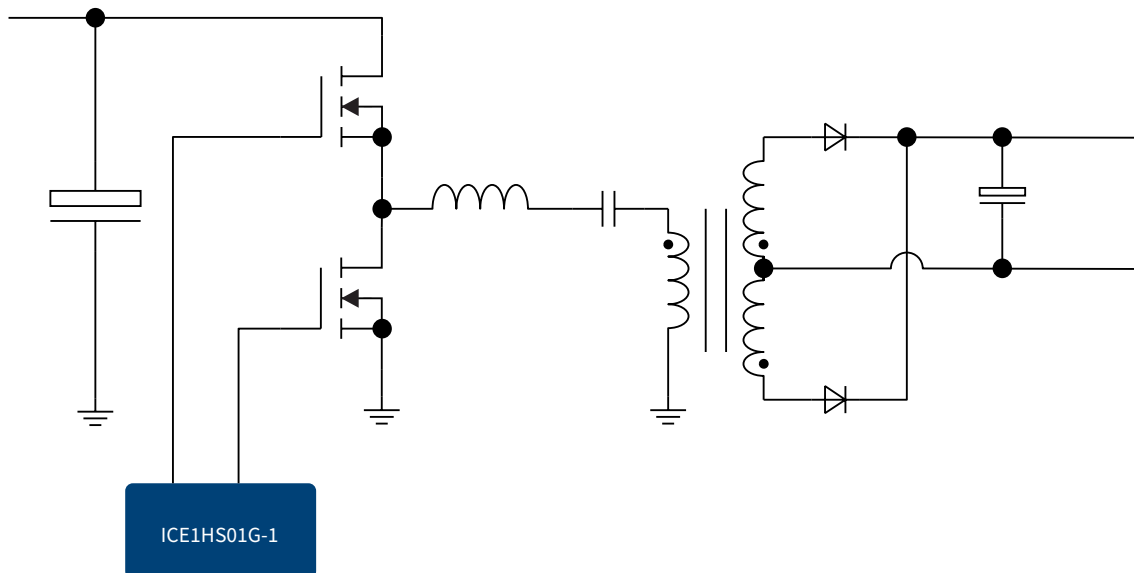
### Pulse-Width-Modulation Block

- Fixed switching frequency
- Option for external control synchronization
- Built in soft start for higher reliability
- Max duty cycle 47% or 60%
- Overall tolerance of current limiting  $\leq \pm 5\%$
- Internal leading edge blanking
- Slope compensation
- Fast, soft switching totem pole gate drive (2A)
- SO-16 and DIP-16
- Pb-free lead plating and RoHS compliant
- All protection features available

Product	Frequency - $f_{SW}$	Current Drives	Package
ICE1CS02	PFC=65kHz PWM=130kHz	2.0A	DIP-16
ICE1CS02G		2.0A	DSO-16

## Resonant LLC Half-Bridge Controller IC

LLC Resonant (No SR)

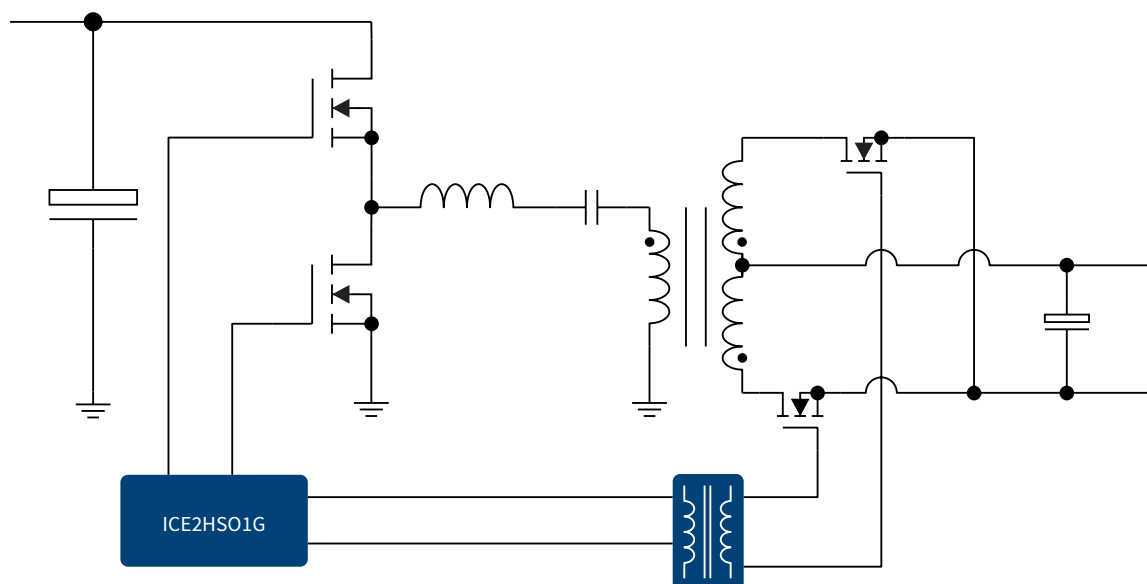


- Novel and simple design (12 components + HB driver)
- Minimum operating frequency is adjustable externally
- Burst mode operation for output voltage regulation during no load and/or bus over-voltage
- Multiple protections in case fault
- Input voltage sense for brown-out protection
- Open loop/over load fault detection by FB pin with auto-restart and adjustable blanking/restart time
- Frequency shift for over-current protection
- Lead Free, RoHS compliant package
- DSO-8 package

Product	Frequency - $f_{sw}$	Dead Time(ns)	Current Drives	Package
ICE1HS01G-1	30kHz~600kHz	380	1.5A	DSO-8

## Resonant LLC Half-Bridge Controller IC with Integrated Synchronised Rectifier Control

### LLC Resonant + SR



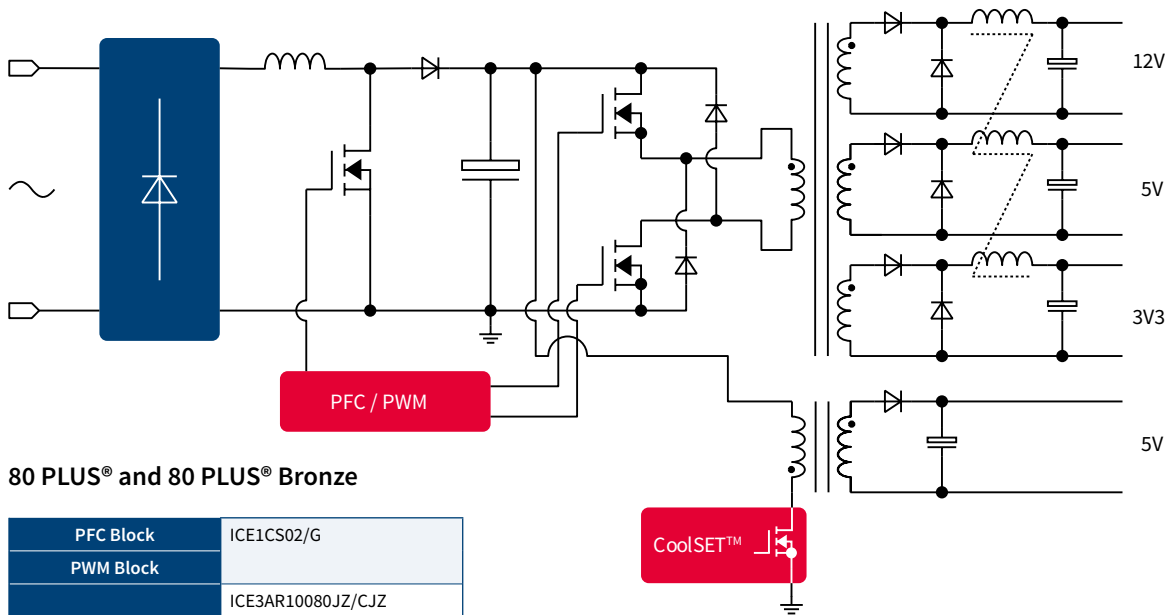
- Novel LLC/SR operation mode and controlled by primary side controller
- Multiple protections for SR operation
- Tight tolerance control
- Accurate setting of switching frequency and dead time
- Simple system design
- Optimized system efficiency
- Multiple converter protections: OTP, OLP, OCP, latch-off enable
- External disable for either SR switching or HB switching
- Lead free, RoHS compliant package
- DSO-20 package

Product	Frequency <sub>(SW)</sub>	Dead Time(ns)	Current Drives	Package
ICE2HS01G	30kHz~1MHz	100~1000	0.3A	DSO-20



LLC Half-Bridge Controller IC	ICE1HS01G-1	ICE2HS01G
Package	DSO-8	DSO-20
Switching frequency range	up to 600kHz	up to 1MHz
LLC softstart	✓	✓
LLC burst mode	✓	✓
Adjustable minium frequency	✓	✓
Over load/open loop protection	✓	✓
Mains undervoltage protection with hysteresis	✓	✓
Over current protection	2-level	3-level
Drive signal for Synchronous Rectification	-	✓
Adjustable deadtime	-	✓
External latch-off and OTP	-	✓
Target application	LCD-TV, Audio, etc.	Server, PC, LCD-TV, etc.

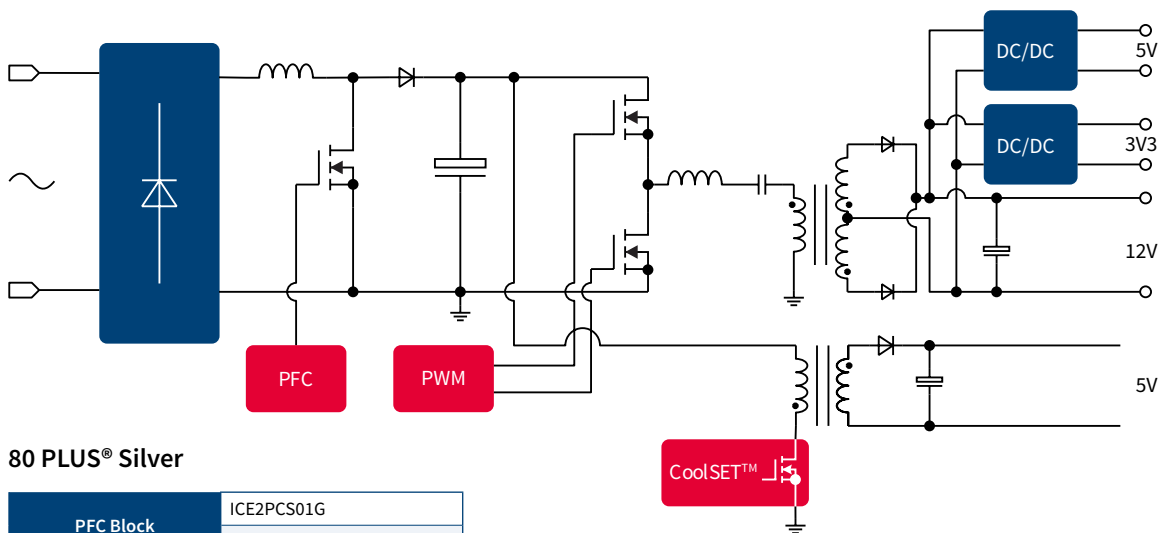
## Climate Saver 80 PLUS® and 80 PLUS® Bronze



80 PLUS® and 80 PLUS® Bronze

PFC Block	ICE1CS02/G
PWM Block	
Standby Block CoolSET™	ICE3AR10080JZ/CJZ
	ICE3AR4780JZ
	ICE3AR2280JZ/CJZ
	ICE3AR0680JZ
	ICE3AR4780CJZ

## Climate Saver 80 PLUS® Silver



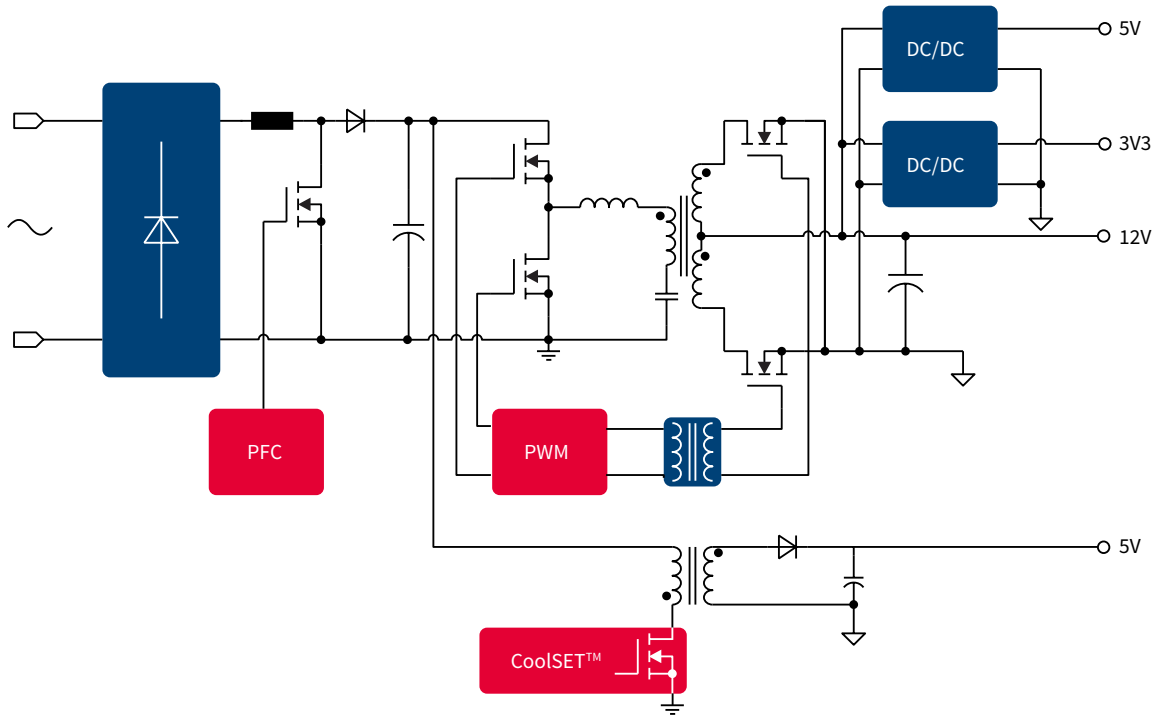
80 PLUS® Silver

PFC Block	ICE2PCS01G
PFC Block	ICE2PCS02G
PWM Block	ICE1HS01G-1
Standby Block CoolSET™	ICE3AR10080JZ/CJZ
	ICE3AR4780JZ
	ICE3AR2280JZ/CJZ
	ICE3AR0680JZ
	ICE2QR4765
	ICE2QR1765
	ICE2QR0665
	ICE3AR4780CJZ

## Climate Saver 80 PLUS® Gold

## Climate Saver 80 PLUS® Platinum

Certification for Infineon's Silverbox reference design



## 80 PLUS® Gold

PFC Block	ICE3PCS01G
	ICE3PCS02G
	ICE3PCS03G
PWM Block	ICE2HS01G
Standby Block CoolSET™	ICE3AR10080JZ/CJZ
	ICE3AR4780JZ
	ICE3AR2280JZ/CJZ
	ICE3AR0680JZ
	ICE3BR2280JZ
	ICE3BR0680JZ
	ICE3AR4780CJZ

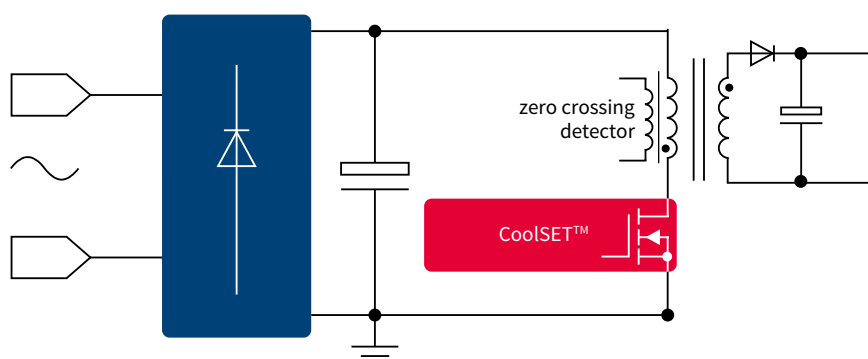
## 80 PLUS® Platinum

Certification for Infineon's Silverbox reference design

PFC Block	ICE3PCS01G
	ICE3PCS02G
	ICE3PCS03G
PWM Block	ICE2HS01G
Standby Block CoolSET™	ICE2QR4780Z
	ICE2QR2280Z - 1
	ICE2QR0680Z
	ICE2QR2280G-1

## Isolated AC/DC

### Quasi-Resonant PWM IC and CoolSET™ Features



- Integrated CoolMOS™ with startup cell
- Quasi-resonant operation with digital frequency reduction
- High average efficiency over wide load range
- Stable operation without jittering/audible noise problem
- Active burst mode operation for very low standby losses (to achieve standby power <50mW)
- Auto restart mode for  $V_{CC}$  under-voltage/over-voltage protection
- Auto restart mode for open-loop and output overload protection
- Auto restart mode for over-temperature protection
- Latch-off mode for output over-voltage, short-winding
- BiCMOS technology (controller) for wide  $V_{CC}$  operation and low IC power consumption
- Peak power limitation with input voltage compensation
- Minimum switching frequency limitation (no audible noise on power units on/off)
- DIP and DSO package (for controllers and CoolSET™)



Halogen-Free



RoHS

### Quasi-resonant PWM IC and 650V CoolSET™

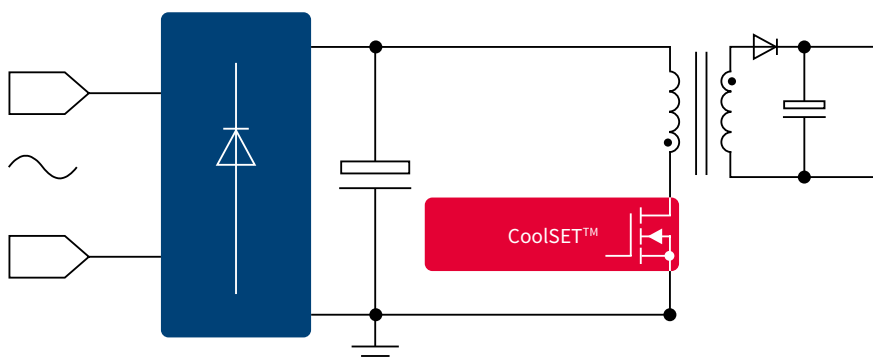
$P_{out}^{(1)}$ (85 ... 265V <sub>AC</sub> ) / $R_{DS(on)}$		14~15W	23~26W	34W	38~42W
		4.7Ω	1.7Ω	1.0Ω	0.6Ω
Package	PWM Only	650V Depletion CoolMOS™			
DIP-7		ICE2QR4765Z	ICE2QR1765Z	ICE2QR1065Z	ICE2QR0665Z
DIP-8		ICE2QR4765 ICE2QR4765-T	ICE2QR1765		ICE2QR0665
DSO-8	ICE2QS02G ICE2QS03G				
DSO-12		ICE2QR4765G	ICE2QR1765G		ICE2QR0665G

### Quasi-resonant CoolSET™ 800V

$P_{out}^{(1)}$ (85 ... 265V <sub>AC</sub> ) / $R_{DS(on)}$		18W	24W	47W
		4.7Ω	2.2Ω	0.6Ω
Package	800V Depletion CoolMOS™			
DIP-7	ICE2QR4780Z	ICE2QR2280Z ICE2QR2280Z-1	ICE2QR0680Z	
DSO-12		ICE2QR2280G ICE2QR2280G-1		

<sup>(1)</sup> Output power assume 78~83% efficiency.  $T_a=50^{\circ}\text{C}$ ,  $T_j=125^{\circ}\text{C}$  and no copper area for 650V device and 232mm<sup>2</sup> copper area for 800V device.

## Fixed Frequency PWM IC and CoolSET™ Features



- Active burst mode to achieve the lowest standby power requirements < 50mW
- Optional latched off mode (L) to increase robustness and safety of the system
- Adjustable blanking window for high load jumps to increase reliability
- DCM, CCM
- Startup cell switched off after start-up
- 65kHz/100kHz/130kHz internally fixed switching frequency
- Over-temperature, over-voltage, short-winding, overload and open-loop,  $V_{CC}$  under-voltage, brown-out protections, fast AC reset, input over-voltage protection
- Fixed softstart time
- Overall tolerance of current limiting < +/-5%
- Internal leading edge blanking time
- Max. duty cycle 72%
- DIP, DSO and FullPAK packages



Halogen-Free



RoHS

### Fixed Frequency PWM IC and CoolSET™ 650V

$P_{out}^{(1)}$ (85 ... 265V <sub>AC</sub> ) / $R_{DS(on)}$		11~12W	13~14W	18W	24~25W	34W	39~40W	61~138W
		6.5Ω	4.7Ω	3.0Ω	1.7Ω	1.0Ω	0.6Ω	2.5Ω/1.4Ω/1.0Ω/0.6Ω
Package	PWM Only	650V Depletion CoolMOS™						
DIP-7			ICE3RBR4765JZ		ICE3RBR1765JZ		ICE3RBR0665JZ	
DIP-8		ICE3B0365J ICE3B0365J-T	ICE3BR4765J	ICE3A1065ELJ	ICE3BR1765J	ICE3A2065ELJ ICE3BR1065J	ICE3BR0665J	
DSO-8	ICE3AS03LJG ICE3BS03LJG ICE3GS03LJG							
DSO-12		ICE3B0365JG	ICE3BR4765JG					
TO-220 FullPAK								ICE3BR2565JF (61W) (2.5Ω) ICE3BR1465JF (77W) (1.4Ω) ICE3BR1065JF (93W) (1.0Ω) ICE3BR0665JF (138W) (0.6Ω)

### Fixed Frequency PWM IC and CoolSET™ 800V

$P_{out}^{(1)}$ (85 ... 265V <sub>AC</sub> ) / $R_{DS(on)}$		11W	16W	22W	30W	37W	43W
		10.0Ω	4.7Ω	2.2Ω	1.5Ω	1.0Ω	0.6Ω
Package		800V Depletion CoolMOS™					
DIP-7	ICE3AR10080JZ ICE3AR10080JZ-T ICE3AR10080CJZ	ICE3AR4780JZ ICE3AR4780VJZ ICE3AR4780CJZ	ICE3AR2280JZ ICE3AR2280JZ-T ICE3AR2280CJZ ICE3AR2280VJZ ICE3BR2280JZ ICE3BR2280JZ-T	ICE3AR1580VJZ	ICE3AR1080VJZ	ICE3AR0680JZ ICE3AR0680VJZ ICE3BR0680JZ	

<sup>1)</sup> Output power assume 76~83% efficiency,  $T_a=50^\circ\text{C}$ ,  $T_j=125^\circ\text{C}$  and no copper area

## Fixed Frequency PWM IC

FF PWM IC	ICE3AS03LJG	ICE3BS03LJG	ICE3GS03LJG
Package	DSO-8		
Operating temperature	-25°C ~ 130°C		
Switching frequency	100kHz	65kHz	130kHz
Max V <sub>cc</sub> voltage	27V		
V <sub>cc</sub> on/off threshold	18V / 10.5V		
Soft start time	10ms	20ms	10ms
Gate drive capability	-0.17A / 0.39A		
Jitter feature for low EMI	✓		
Modulated gate drive	✓		
Active burst mode	✓		
Over load/Open loop	Auto restart		
V <sub>cc</sub> under voltage/ Short opto-coupler	Auto restart		
Short winding/Short diode	latch-off		
V <sub>cc</sub> over voltage	latch-off		
Over temperature	latch-off		
External protection enable pin	latch-off		

## Quasi-Resonant PWM IC

Feature	ICE2QS02G	ICE2QS03G
Package	DSO-8	DSO-8
Operating temperature	-25°C ~ 130°C	-40°C ~ 130°C
Startup cell	-	✓
V <sub>cc</sub> on/off	12V / 11V	18V / 10.5V
Power saving during standby	-	Active Burst Mode with f <sub>sb</sub> = 52kHz
Digital Frequency reduction for high average efficiency	✓	✓
OLP blanking time	Adjustable	Fixed
Auto restart timer	Setting with external components	Through V <sub>cc</sub> charging/discharging
Maximum input power limitation	Adjustable through ZC resistor	Adjustable through ZC resistor
Adjustable output overvoltage protection with Latch mode	Yes with V <sub>ZCOVP</sub> =4.5V	Yes, with V <sub>ZCOVP</sub> =3.7V
brown-out feature	✓	-
Target application	Aux-Power Supply to V <sub>cc</sub> Eg. LCD TV multi/main, Audio main, PDP TV multi/address	Self-Power Supply to V <sub>cc</sub> e.g. Notebook/Tablet Adapters, LCD TV Multit, CRT TV, Audio, DVD, Smart Meter, Industrial applications



### Quasi-Resonant CoolSET™

	650V CoolSET™		800V CoolSET™	
	ICE2QRxx65/Z/G	ICE2QRxx65-T	ICE2QRxx80Z/G	ICE2QRxx80Z/G-1
Package	DIP-8/DIP-7/DSO-16/12	DIP-8	DIP-7 / DSO-16/12	DIP-7 / DSO-16/12
CoolMOS™ rating	650V <sup>1)</sup>		800V	
$R_{D(on)}$	0.65/1.0/1.7/ 4.7Ω	4.7Ω	0.65/2.2/4.7Ω	2.2Ω
Output power <sup>2)</sup>	14 ~ 42W	15W	18 ~ 47W	24W
Operating temperature	-25°C ~ 130°C	-40°C ~ 130°C	-25°C ~ 130°C	
$V_{CC}$ on/off	18V / 10.5V			18V / 9.85V
Power Saving during standby	Active Burst Mode with $f_{sb} = 52kHz$			
Digital Frequency Reduction for high average efficiency	✓			
OLP blanking time	Fixed			
Auto restart timer	Through $V_{CC}$ charge/disscharge			
Maximum input power limitation	Adjustable through ZC resistor			
Adjustable output overvoltage protection with latch mode	Yes, with $V_{ZCOVP} = 3.7V$			
Product available	ICE2QR4765 ICE2QR4765Z ICE2QR4765G ICE2QR1765 ICE2QR1765Z ICE2QR1765G ICE2QR1065Z ICE2QR0665 ICE2QR0665Z ICE2QR0665G	ICE2QR4765-T	ICE2QR4780Z ICE2QR2280Z ICE2QR2280G ICE2QR0680Z	ICE2QR2280Z-1 ICE2QR2280G-1

DFR= Digital Frequency Reduction, PPR= Peak Power Limitation/Control

<sup>1)</sup> Output power assume 78~83% efficiency.  $T_a = 50^\circ C$ ,  $T_j = 125^\circ C$  and no copper area for 650V device and 232mm<sup>2</sup> copper area for 800V device.



## Fixed Frequency CoolSET™

	650V CoolSET™				
	F3(Jitter) ICE3Bxx65J(G)	F3( Latch & Jitter) ICE3Axx65ELJ	F3R ICE3BRxx65J(G)	F3R ICE3RBRxx65JZ	F3(Jitter) ICE3B0365J-T
Package	DIP-8, DSO-16/12	DIP-8	DIP-8, DSO-16/12	DIP-7	DIP-8
Output power range <sup>1)</sup>	11W ~ 12W	18W ~ 34W	13W ~ 40W	13W ~ 40W	11W
MOSFET (rugged avalanche capability)	650V				
Min. operating temperature	-25°C			-40°C	
Switching frequency	67kHz	100kHz	65kHz	65kHz	67kHz
Max V <sub>cc</sub> voltage	27V				
V <sub>cc</sub> on/off threshold	18V / 10.3V	18V / 10.5V			18V / 10.3V
Jitter feature for low EMI	✓ (by CSOFTS)	✓			✓ (by CSOFTS)
Modulated gate drive	–	✓			–
Soft start time	by CSOFTS	20ms			by CSOFTS
Active burst mode selection	1 level				
Over load/Open loop	Auto restart				
V <sub>cc</sub> under voltage/ short opto-coupler	Auto restart				
V <sub>cc</sub> over voltage	Auto restart	Latch	Auto restart		
Over temperature	Auto restart	Latch	Auto restart		
External protection enable pin	–	Latch	Auto restart		–
brown-out	–				
Input OVP	–				
Fast AC reset	–				
Slope compensation for CCM mode	–				
Product available	ICE3B0365J ICE3B0365JG	ICE3A1065ELJ ICE3A2065ELJ	ICE3BR4765J ICE3BR1765J ICE3BR1065J ICE3BR0665J ICE3BR4765JG	ICE3RBR4765JZ ICE3RBR1765JZ ICE3RBR0665JZ	ICE3B0365J-T

<sup>1)</sup> Output power assume 76~83% efficiency. T<sub>a</sub>=50°C, T<sub>j</sub>=125°C and no copper area



800V CoolSET™					
F3R 800V ICE3ARxx80JZ	F3R 800V ICE3BRxx80JZ	F3R CCM 800V ICE3ARxx80CJZ	F3R 800V ICE3ARxx80JZ-T	F3R 800V ICE3BRxx80JZ-T	F3R 800V ICE3ARxx80VJZ
DIP-7					
11W ~ 43W		11W ~ 22W	11W ~ 22W	11W	11W ~ 43W
800V					
-25°C			-40°C		
100kHz	65kHz	100kHz	100kHz	65kHz	100kHz
27V					
17V / 10.5V					
✓					
YES (with 50Ω gate turn-on resistor)					
10ms					
4 levels		3 levels		4 levels	
Auto restart					
Auto restart					
Auto restart					
Auto restart with hysteresis					
Auto restart		Latch	Auto restart		-
		✓			-
		-			✓
-		✓			-
-		✓			-
ICE3AR10080JZ ICE3AR4780JZ ICE3AR2280JZ ICE3AR0680JZ	ICE3BR2280JZ ICE3BR0680JZ	ICE3AR10080CJZ ICE3AR4780CJZ ICE3AR2280CJZ	ICE3AR10080JZ-T ICE3AR2280JZ-T	ICE3BR2280JZ-T	ICE3AR4780VJZ ICE3AR2280VJZ ICE3AR0680VJZ ICE3AR1080VJZ ICE3AR1580VJZ

## Non-Isolated DC/DC

### MOSFET Gate Driver IC

The new OptiMOS™ Driver products PX3517 and PX3519 are high speed Drivers, designed to drive a wide range of dual high side and low side n-channel power MOSFETs in applications such as Computing and Telecom Point-of-Load (PoL).

Combining the new devices with the Primarion/Infineon Digital Multi-Phase Controllers IC family and Infineon N-Channel MOSFETs, the new devices form a complete core-voltage regulator solution for advanced micro and graphic processors as well as Point-of-Load applications.

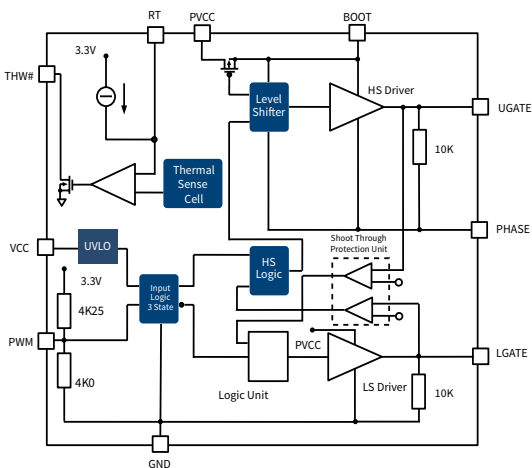
To tailor the efficiency of the system based on the customer conditions and needs, the OptiMOS™ Driver devices provide the capability of driving the high-side gate and low-side gate with a variable gate driving voltage ranging from 4.5V up to 8V.

#### General Features

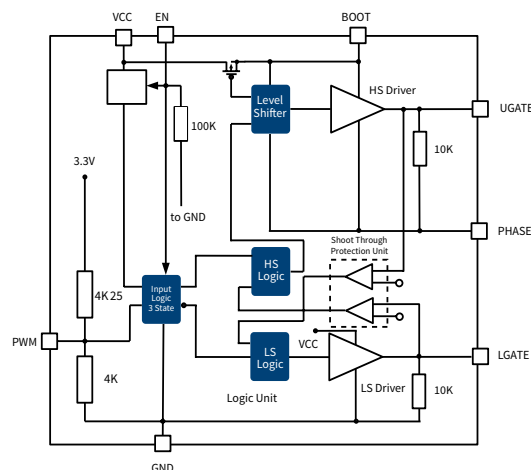
- High frequency operation up to 1.2MHz
- Wide  $V_{CC}$  input voltage range from 4.5V to 8V
- Capability to drive MOSFET at 50A continuous current per phase
- Wide input voltage range: up to 16V
- Low power dissipation
- Includes bootstrap diode
- Adaptive shoot through protection
- Compatible with standard + 3.3V PWM controller ICs
- Tri-state PWM input functionality
- RoHS compliant

#### Application Diagrams

PX3517 offers a thermal warning report function.



PX3519 features a gate disable pin (EN) for low power consumption.



Gate driver	PX3517	PX3519
Package	3mm x 3mm TDSO-10	3mm x 3mm VDSO-8
RoHS compliant	✓	✓
Max. junction temperature	-25°C to 125°C	-25°C to 125°C
Supply voltage and driving voltage, $V_{CC}$	+4.5V to 8V	+4.5V to 8V
Boot to GND	30	30
PWM inputs	tri-state compatibility	tri-state compatibility
Quiescent current $I_Q$	660μA	780μA
Features	thermal warning	driver enable pin

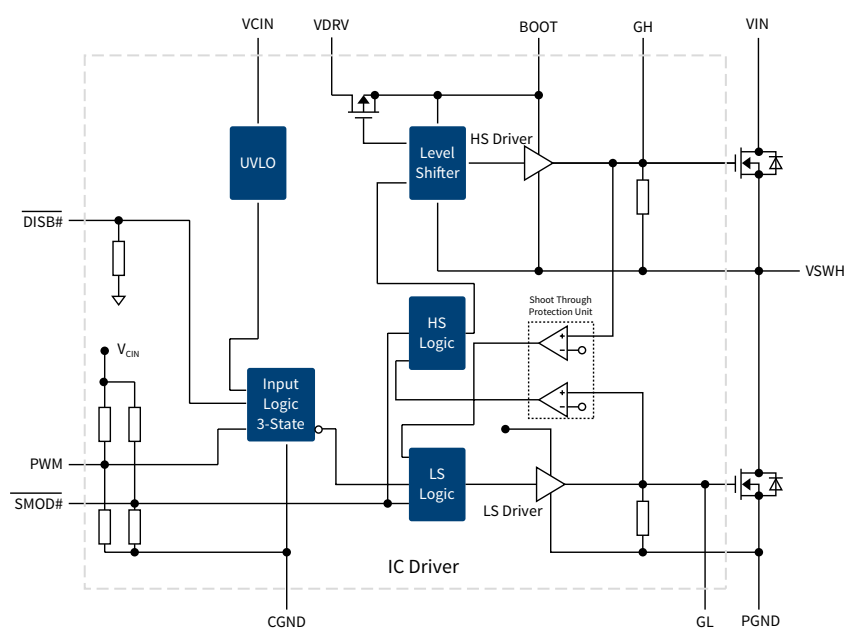
## 6 x 6 IQFN High-Performance DrMOS (Driver+MOS)

### TDA21220

#### Features

- Intel compliant DrMOS, Power MOSFET and Driver in one package
- For synchronous buck – step-down voltage applications
- Wide input voltage range from 5V to 16V
- High efficiency
- Extremely fast switching technology for improved performance at high switching frequencies
- Remote driver disable function
- SMOD-switching modulation of low side MOS
- Extremely robust switch node -10V ... 25V in noisy applications
- Includes active PMOS
- Adaptive gate drive for shoot through protection
- 5V high and low side driving voltage
- Compatible to standard PWM controller ICs with 3.3V and 5V logic
- Tri-State functionality
- Small package: IQFN-40 (6 x 6 x 0.8mm<sup>3</sup>)
- RoHS compliant (Pb Free)

#### DrMOS Application Diagram



	TDA21220
Input voltage range	5V to 16V
SMOD function	supported
Thermal warning/shutdown	-
Max. average load current	50A
MOSFET breakdown voltage	25V
PWM levels	compatible +3.3V / +5V (tolerant)
Shoot through protection	included

## DrBlade™

### The Revolutionary Next Packaging Generation

Infineon has launched the revolutionary Blade chip embedding technology. DrBlade™ contains the latest generation low voltage DC/DC Driver technology and OptiMOS™ MOSFET devices.

#### Features

- Compatible to Intel® VR12 Driver and MOSFETs module (DrMOS) functionality
- High current capability up to 60A
- Capable of operating up to 1.2MHz switching frequency
- Fast switching technology for improved performance (>95% peak efficiency)
- Small package size and low profile: 6.6x4.5x0.6m<sup>3</sup>
- Optimized footprint for DC/DC converter layout and improved cooling to the PCB
- Low thermal resistance to the top side
- RoHS compliant and halogen free
- Compatible to standard +3.3V PWM controller

#### Applications

- High performance Desktop, Notebook and Server DC/DC converters
- Single Phase and Multiphase DC/DC Point-of-Load (PoL) converters
- CPU/GPU voltage regulation in Desktop Graphics Cards, DDR Memory, Graphic Memory
- High Power Density Voltage Regulator Modules (VRM)
- Telecom VR

### TDA21320/ TDA21321

#### Features

- Temperature reporting and over temperature protection
- High side short protection
- Over-current protection
- Shoot-through protection
- Under voltage lockout
- Boot switch included
- Low side-off function

	TDA21320	TDA21321
Input voltage	16V	16V
SMOD function	included	included
Temperature reporting and overtemperature protection	included	included
Max average load current	60A	30A
Maximum MOSFET BVDSS voltage	25V	25V
PWM levels	+3.3V	+3.3V
Shoot through protection	included	included

## Digital Controllers for Point-of-Load Power Management

Infineon's Digital Multi-phase and Multi-rail controllers provide power for today's medium and high current PoL applications used in Telecom/Datacom and Server and Storage environments. Infineon's Digital Controller family enables OEMs and ODMs to improve efficiency and total cost of ownership while increasing power density and optimizing the total system footprint of the voltage regulator. The PX7247, PX7241, PX7143, PX7242 and PX7141 are the first products out of our 4<sup>th</sup> generation digital controller family and support up to 2 rails with 1-6 phases on individual rails. The I<sup>2</sup>C/PMBus interface connects the digital controllers to the application system and provides real time telemetry information, monitoring and control capabilities. The digital controllers are fully configurable through our PowerCode™ graphical user interface that allows for easy to use and simplified design optimization.

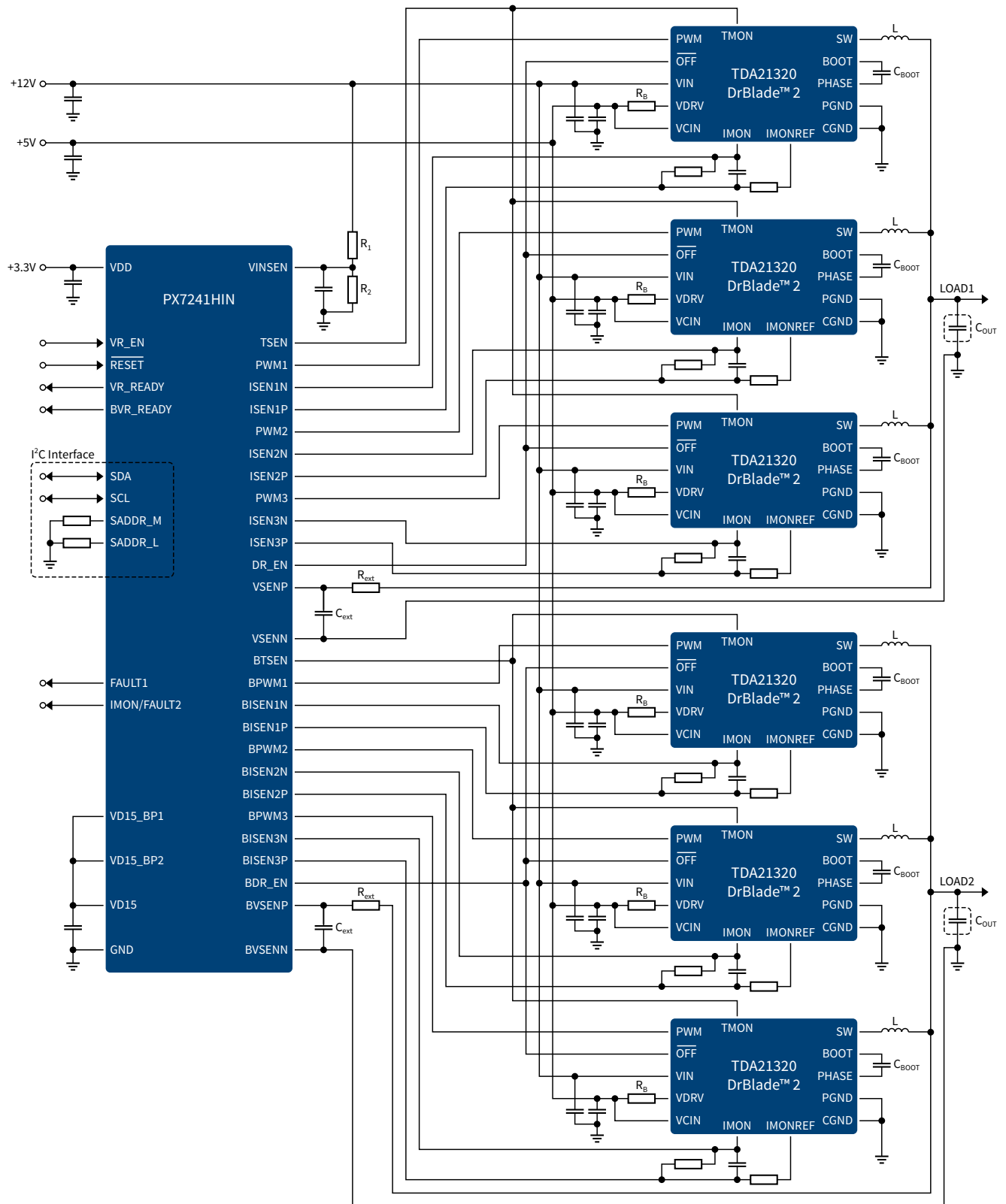
### Multiple Phase Configurations are Supported for Best Power Optimization:

Feature		Controller Family				
Configurable output rails		Dual /Single Rail	Dual Rail	Single Rail	Dual Rail	Single Rail
Part No.	PMBus	PX7247HDN	PX7241HDN	PX7143HDM	PX7242HDM	PX7141HDM
Phase configuration	Main	6+1	3+3	3ph	1+1	1ph
	Sub configurations	6+0, 5+1+, 5+0, 4+1	3+2, 3+1, 2+2+, 2+1	2ph	-	-
V <sub>out_max</sub>		5V	5V	5V	5V	5V
Switching frequency		Up to 2 MHz	Up to 2 MHz	Up to 2 MHz	Up to 2 MHz	Up to 2 MHz
Operating temperature range		-0...85°C	-0...85°C	-0...85°C	-0...85°C	-0...85°C
VQFN Package		48-lead (6 x 6) 0.4mm pitch	48-lead (6 x 6) 0.4mm pitch	40-lead (5 x 5) 0.4mm pitch	40-lead (5 x 5) 0.4mm pitch	40-lead (5 x 5) 0.4mm pitch

### Advantages of a Digital Controller

Protection features include a set of sophisticated over-voltage, under-voltage, over-temperature, and over-current protections. PX7247, PX7241, PX7143, PX7242 and PX7141 also detect and protect against an open circuit on the remote sensing inputs. These attributes provide a complete and advanced protection feature set for microprocessor, DSP, FPGA or ASIC power systems. Accurate current sense telemetry is achieved through internal calibration that measures and corrects current sense offset error sources upon startup. Programmable temperature compensation provides accurate current sense information even when using DCR current sense.

## Typical Point-of-Load Application





# Expert Support for Power ICs

Easy Access and High Quality



## Application Notes, Datasheets & More

[www.infineon.com/acdc](http://www.infineon.com/acdc)

[www.infineon.com/dcdc](http://www.infineon.com/dcdc)

[www.infineon.com/coolset](http://www.infineon.com/coolset)

[www.infineon.com/drblade](http://www.infineon.com/drblade)

[www.infineon.com/drmos](http://www.infineon.com/drmos)



## Power Management ICs Evaluation Boards

[www.infineon.com/powercontrol.evalboards](http://www.infineon.com/powercontrol.evalboards)

[www.infineon.com/coolset.evalboards](http://www.infineon.com/coolset.evalboards)

[www.infineon.com/coolsetqr.evalboards](http://www.infineon.com/coolsetqr.evalboards)



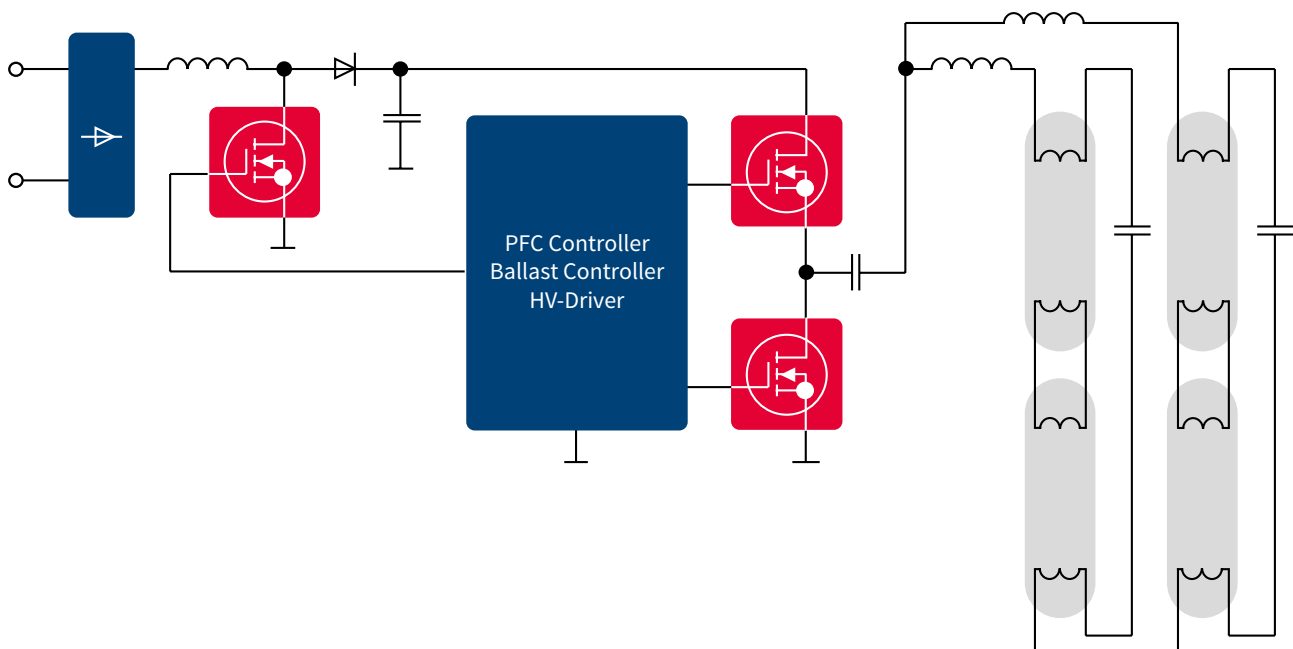
Datasheets

# Lighting ICs

## Ballast Control IC for Fluorescent Lamp

Ballast Control ICs from Infineon integrate all functions required to operate FL lamps such as preheat-, ignition- and run-mode and protection features. Digital mixed-signal power control is employed enabling speedy, cost effective and stable ballast designs with a minimum number of external components. Reliable and robust high voltage isolation is achieved using Infineon's proprietary Coreless Transformer Technology (CLT).

- Integrated high performance PFC stage
- Intelligent digital/mixed signal power control
- Integrated high voltage half bridge driver
- All parameters set using only resistors
- Highly accurate timing and frequency control over a wide temperature range





## ICB2FL01G

Infineon's 2<sup>nd</sup> Generation Ballast Controller ICB2FL01G is designed to control a fluorescent lamp ballast including

- Power Factor Correction (PFC)
- Lamp inverter control and
- High voltage level-shift half bridge driver  
with Coreless Transformer Technology

Short Form Data	min.	typ.	max.
Package	SO-19		
Operating voltage range	10V	–	17.5V
Turn-on threshold	–	14V	
Supply current during UVLO and fault mode	–	110μA	170μA
Operating frequency of inverter during RUN mode	20kHz	–	120kHz
Operating frequency of inverter during preheating mode	F <sub>RFRUN</sub>	–	150kHz
Preheating time	0ms	–	2500ms
Adjustable self-adapting dead time max between LS and HS gate drive	2.25μs	2.50μs	2.75μs
Adjustable self-adapting dead time min between LS and HS gate drive	1.00μs	1.25μs	1.50μs
Operating voltage range of floating HS gate drive	-900V	–	+900V
LS current limitation threshold: Ignition/start up/soft start/pre run	1.5V	1.6V	1.7V
LS current protection threshold during RUN mode and preheating	0.75V	0.80V	0.85V
End-of-life detection threshold	-40μA	–	+40μA
Detection of –n-ZVS operation CapMode 1 & 2	–	–	–
PFC preconverter control with critical and discontinuous CM	–	–	–
Maximum controlled on-time	18μs	22.7μs	26μs
Hysteresis of zero current detector	–	1.0V	–
PFC current limitation threshold	–	1.0V	–
Reference voltage for control of bus voltage	2.47V	2.5V	2.53V
Overvoltage detection threshold	2.68V	2.73V	2.78V
Undervoltage detection threshold	1.835V	1.88V	1.915V
Open loop detection	0.237V	0.31V	0.387V
Junction operating temperature range	-25°C	–	+125°C
Pb-free lead plating RoHS compliant	–	–	–

## Ballast Control ICs

### ICB2FL01G

#### Features

- Able to handle lamp chokes with higher saturation behavior
- Special in-circuit test mode for faster test time
- Excellent dynamic PFC performance enables very low THD across wide load ranges
- Separate adjustable levels of lamp overload and rectifier effect detection
- Adjustment of the preheat time
- No high voltage capacitor required for detection of lamp removal (capacitive mode operation)
- Automatically restarts by surge and inverter overcurrent events
- Skipped preheating when line interruption < 500ms
- Self adapting dead time adjustment of the half bridge driver
- One single restart at fault mode

#### Benefits

- Optimized lamp choke size and reduced BOM costs
- Dramatically reduced time for key tests such as end of life detection, preheat/ignition timeout and pre-run operation modes
- Suitable for dimming and multi-power ballasts
- Enables ballast compatibility with a wider range of lamp types
- Flexible support of both current and voltage mode preheating
- Reduced BOM costs
- Intelligent discrimination between surge & half bridge overcurrent events
- Meets standards for emergency lighting (according to DIN VDE 0108)
- Eases design of multi-power ballasts and reduces EMI
- Enhanced reliability of ballasts

### ICB2FL02G

The ICB2FL02G is functionality identical to the ICB2FL01G with adjustments to certain timings and parameters to further optimize performance in dimming ballasts.

Function	ICB2FL02G	ICB2FL01G
Cap load 1 protection	Deactivated	Activated
Suitable for dimming	Optimized	✓
Max. adjustable run frequency	140kHz	120kHz
Adjustable dead time	1.05µs	1.05µs to 2.5µs
Dead time detector level	-50mV	-100mV
Capacitive mode 2 detector level 3	-50mV	-100mV

### ICB2FL03G

Infineon's latest Ballast Controller ICB2FL03G in SO-16 offers very similar performance and feature set compared to the well established SO-19 product ICB2FL01G.

	ICB2FL03G	ICB1FL01G
Package	SO-16 small body	SO-19 wide body
Driver capability	650V	900V
Lamp connection	Single and series	Single, series and parallel

# LED Driver ICs for General Lighting

LED based Lighting sources are the best suited candidates to replace inefficient Lighting solutions such as incandescent or halogen lamps that are still widely used today. Current LED driver design and system cost are still a challenge to gain major consumer acceptance. Infineon offers benchmark solutions and represents an outstanding choice to overcome this hurdle.

## ICL8001G / ICL8002G

These devices are designed for off-line LED Lighting applications with high efficiency requirements such as replacement lamps (40/60/100W), LED tubes, luminaires and downlights. Infineon provides a single stage flyback solution with PFC functionality. Innovative primary control techniques combined with accurate PWM generation for phase cut dimming enable solutions with significant reduced component count on a single sided driver PCB for smallest form factor.

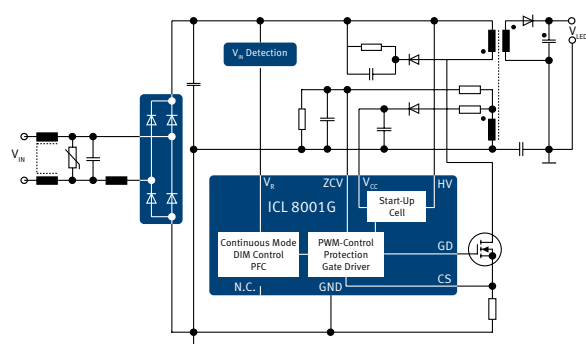
### Benefits

- ICL8001G simplifies LED driver implementation
- ICL8002G is optimized for best dimming performance

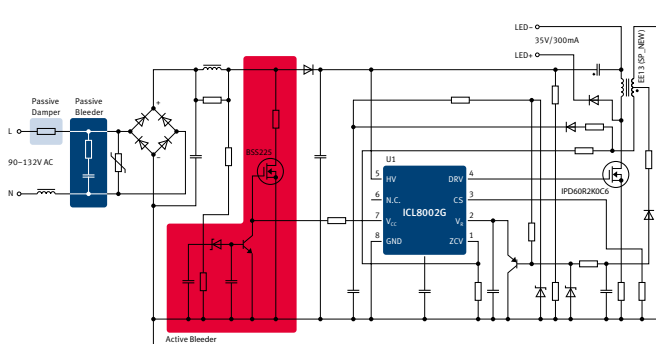
### Features

- Primary side flyback or buck control with integrated PFC and phase angle dimming
- Optimized for trailing- and leading-edge dimmers
- Integrated HV startup cell for short time to light
- Best-in-Class BOM for dimmable LED bulbs
- High and stable efficiency over wide dimming range
  - Good line regulation capabilities based on digital foldback correction
  - Low external part count for simplified designs and short-time to market
  - Cycle-by-cycle peak current limitation
- Built-in digital soft-start
- Auto restart mode for short circuit protection
- Adjustable latch-off mode for output overvoltage protection

ICL8001G



ICL8002G



## Linear Current Regulators

### BCR401W / BCR402W / BCR401U / BCR402U / BCR405U / BCR205W

The BCR40x family is the smallest size and lowest cost series of LED drivers. These products are perfectly suited for driving low power LEDs in general lighting applications. Thanks to AEC-Q101 qualification, it may also be used in Automotive applications such as brake lights or interior.

#### The advantage versus resistor biasing is:

- Long lifetime of LEDs due to constant current in each LED string
- Homogenous LED light output independent of LED forward voltage binning, temperature increase & supply voltage variations
- See Application Note AN182 for details on replacing resistors

#### The advantage versus discrete semiconductors is:

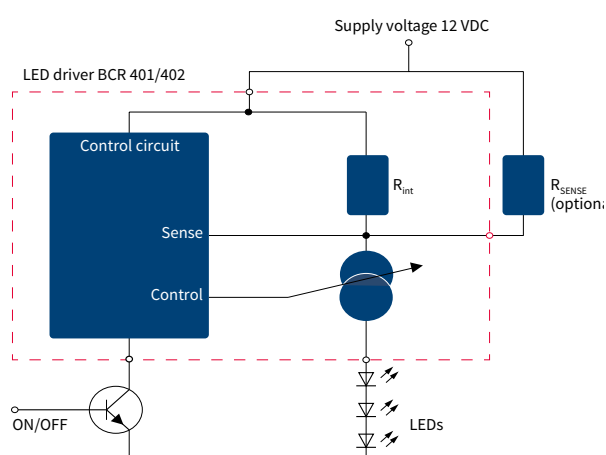
- Reduced part count and assembly effort
- Pretested output current
- Defined negative temperature co-efficient protection

#### Features and benefits

- Output current from 10mA to 65mA (adjustable by external resistor)
- Supply voltage up to 24V (BCR401W, BCR402W) and up to 40V (BCR401U, BCR402U, BCR405U)
- Reduction of output current at high temperature, contributing to long lifetime LED systems
- Ease-of-use
- Very small form factor packages with up to 750mW max. power handling capability

#### Low-Power LED Driver ICs (5–65mA)

Product Type	Group	Topology	$V_s$ (min) [V]	$V_s$ (max) [V]	$I_{out}$ (typ) [mA]	$I_{out}$ (max) [mA]	Dimming	Package	$P_{tot}$ (max) [mW]
BCR205W	LED controller	Linear	1.8	18	0.5	ext. Switch	no	SOT343	100
BCR401U	LED drivers for low-power LEDs	Linear	$1.4 + V_{fLED}$	40	10.0	65	Digital	SC74	750
BCR401W	LED drivers for low-power LEDs	Linear	$1.2 + V_{fLED}$	18	10.0	60	Digital	SOT343	500
BCR402U	LED drivers for low-power LEDs	Linear	$1.4 + V_{fLED}$	40	20.0	65	Digital	SC74	750
BCR402W	LED drivers for low-power LEDs	Linear	$1.4 + V_{fLED}$	18	20.0	60	Digital	SOT343	500
BCR405U	LED drivers for low-power LEDs	Linear	$1.4 + V_{fLED}$	40	50.0	65	Digital	SC74	750



## BCR420U / BCR321U / BCR420U / BCR421U / BCR450

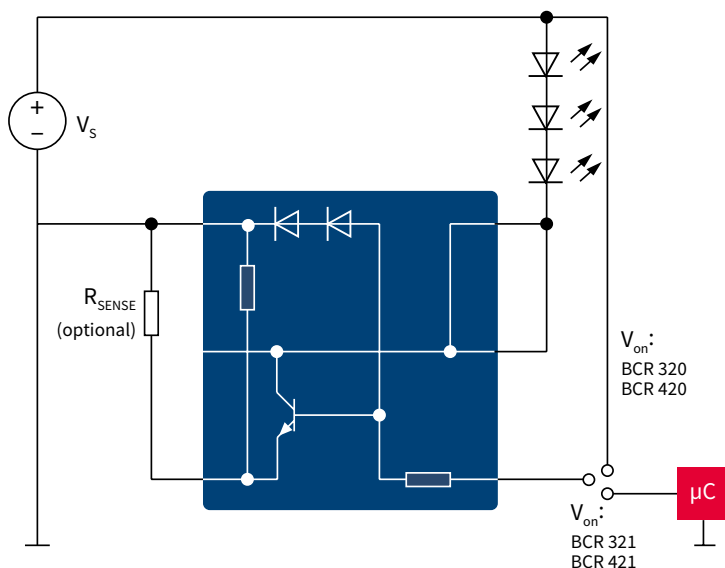
The BCR32x and BCR42x LED drivers are dedicated linear regulators for 0.5W LEDs with a maximum output current of 250mA. They are optimized in terms of cost, size and feature set for medium power LEDs in general Lighting applications. Thanks to AEC-Q101 qualification, it may also be used in Automotive applications such as brake lights or interior.

### Features and Benefits

- Output current from 10mA up to 300mA for BCR32x (200mA for BCR42xU), adjustable by external resistor
- Supply voltage up to 40V for BCR42x (24V for BCR32x)
- Direct Microcontroller interface for PWM dimming with BCR321U/BCR421U
- Reduction of output current at high temperature, contributing to long lifetime LED systems
- Ease-of-use
- Very small form factor packages with up to 1.000mW max. power handling capability

### Medium- & High-Power LED Driver ICs (65–500mA)

Product Type	Group	Topology	$V_i$ (min) [V]	$V_i$ (max) [V]	$I_{out}$ (typ) [mA]	$I_{out}$ (max) [mA]	Dimming	Package	$P_{tot}$ (max) [mW]
BCR320U	LED drivers for mid-power LEDs	Linear	$1.4 + V_{fLED}$	$24 + V_{fLED}$	250	300	No	SC74	1
BCR321U	LED drivers for mid-power LEDs	Linear	$1.4 + V_{fLED}$	$24 + V_{fLED}$	250	300	Digital	SC74	1
BCR420U	LED drivers for mid-power LEDs	Linear	$1.4 + V_{fLED}$	$40 + V_{fLED}$	150	200	No	SC74	1
BCR421U	LED drivers for mid-power LEDs	Linear	$1.4 + V_{fLED}$	$40 + V_{fLED}$	150	200	Digital	SC74	1
BCR450	LED controller	Linear	3.0	27	70	ext. switch	Digital	SC74	500



## DC/DC Switch Mode LED Driver ICs

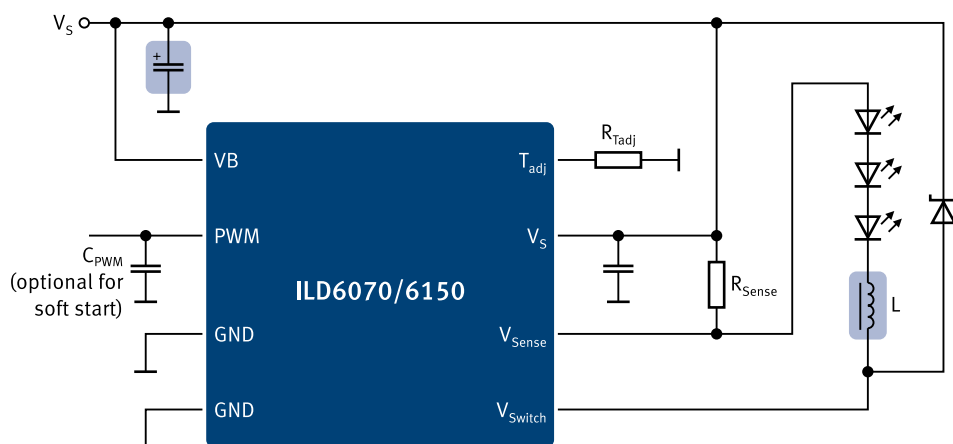
### ILD1151 / ILD4001 / ILD4035 / ILD4120 / ILD4180 / ILD6070 / ILD6150

The ILD series are switch mode LED driver ICs for high power LEDs. They combine protection features that contribute to the lifetime of LEDs with the flexibility in output current range from 150mA up to multiple amperes. The new ILD series include LED driver ICs with integrated power stage as well as with external MOSFET achieving up to 98% driver efficiency across a wide range of general Lighting applications. ILD4120, ILD4180, ILD6070 and ILD6150 are buck LED regulators. ILD4001 is a buck LED controller and ILD1151 is a multi-topology LED controller.

#### Features and Benefits

- Wide input voltage range
- Scalability in output current from 150mA up to multiple amperes
- Alternative dimming concepts: digital or analog
- Over voltage and over current protection
- Smart thermal protection for ILD2035, ILD4035, ILD4120, ILD6070 and ILD6150 contributing to longer LED lifetime
- ILD1151 supports boost, buck-boost and SEPIC topologies

	$V_i$ (min)	$V_i$ (max)	$I_{out}$ (typ)	$I_{out}$ (max)	Package	Dimming	Topology	$f_{sw}$	Features
ILD1151	4.5V	45V	90.0mA	3.000mA	SSOP-14	Analog/digital	Boost, buckboost SEPIC	Adjustable 100-500kHz	Multi topology controller, constant current or constant voltage mode, over-voltage, over-current, short on GND protection
ILD4001	4.5V	42V	10.0mA	3.000mA	DSO-8-27	Analog/digital	Hysteretic buck	< 500kHz	Thermal protection
ILD4035	4.5V	40V	350mA	400mA	SC74	Analog/digital	Hysteretic buck	< 500kHz	Smart thermal protection, over-voltage, over-current protection
ILD4120	4.5V	40V	1.200mA	1.200mA	DSO-8-27	Analog/digital	Hysteretic buck	< 500kHz	Smart thermal protection, over-voltage, over-current protection
ILD4180	4.75V	45V	1.800mA	1.800mA	DSO-8-27	Digital	Fixed frequency buck	370kHz	Over voltage, over-current protection, constant current or constant voltage mode
ILD6070	4.5V	60V	700mA	700mA	DSO-8-27	Analog/digital	Hysteretic buck	<1000kHz	Integrated switch rated up to 700mA, PWM or analog dimming, adjustable over temperature protection, over-current protection
ILD6150	4.5V	60V	1.500mA	1.500mA	DSO-8-27	Analog/digital	Hysteretic buck		Integrated switch rated up to 1.500mA, PWM or analog dimming, adjustable over temperature protection, over-current protection





# Expert Support for LED Driver ICs

Easy Access and High Quality



**Application Notes, Datasheets & More**

[www.infineon.com/led.appnotes](http://www.infineon.com/led.appnotes)

[www.infineon.com/led.documents](http://www.infineon.com/led.documents)

[www.infineon.com/lowcostleddriver](http://www.infineon.com/lowcostleddriver)

[www.infineon.com/ledoffline](http://www.infineon.com/ledoffline)



**LED Driver Online Design Tool**

[www.infineon.com/lightdesk](http://www.infineon.com/lightdesk)



**LED Driver Evaluation Boards**

[www.infineon.com/led.evalboards](http://www.infineon.com/led.evalboards)



Datasheets

# ISOFACE™

## Galvanic Isolated High Side Switches and Input ICs

Our ISOFACE™ product family provides robust and intelligent galvanic isolation for industrial control applications such as Programmable Logic Controllers, Sensor Input Modules, Control Panels and General Control Equipment. The output switches are compact in design, enabling robust and reliable operation at low system cost. Ideal for high speed applications, input ICs are equally robust, reliable and compact – also offering superior EMI robustness and diagnostics.

### Isolated Output Switches



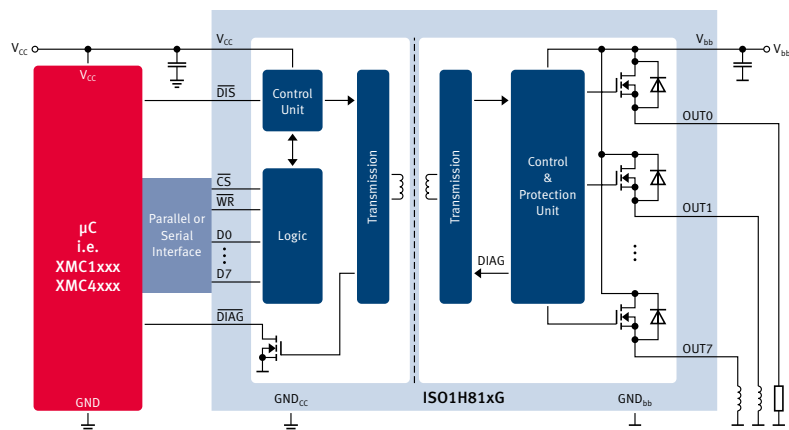
### Key Features

- Integrated galvanic isolation (500V)
- 8 channels (0.6 or 1.2A, each)
- Inductive load switching
- Diagnostic feedback (over-temperature, over-load)
- Serial and parallel MCU interface

### Key Benefits

- Robust and reliable
- Compact system solution
- Lower system cost
- System status feedback
- Directly interfacing with all MPUs and MCUs

### Typical Block Diagram Isolated Output Switch



Product Overview		ISO1H801G	ISO1H811G	ISO1H812G	ISO1H815G	ISO1H816G
Switch	V <sub>bb</sub> operational range: 11V to 35V	✓	✓	✓	✓	✓
	Max. continuous load current per channel	0.6A	0.6A	0.6A	1.2A	1.2A
	Load current increase by using outputs in parallel	✓	✓	✓	✓	✓
	Inductive clamping energy per channel: 1Joule	✓	✓	✓	✓	✓
µC Interface	Type	parallel	parallel	serial	parallel	serial
	Nominal voltages	5V	3.3V / 5V	3.3V / 5V	3.3V / 5V	3.3V / 5V
Safety Features	Isolation voltage: V <sub>ISO</sub> = 500V, UL508 & EN 61131-2 certified	✓	✓	✓	✓	✓
	Active current limitation	✓	✓	✓	✓	✓
	Thermal shut-down	✓	✓	✓	✓	✓
	Common output disable pin	✓	✓	✓	✓	✓
Diagnostics Feedback	Over-temperature		✓	✓	✓	✓
	V <sub>bb</sub> under-voltage		✓	✓	✓	✓
Package DSO-36 (16 x 14mm)		✓	✓	✓	✓	✓
Infineon Ordering Code		SP000722122	SP000413798	SP000413800	SP000555576	SP000555578

## Isolated Digital Input ICs



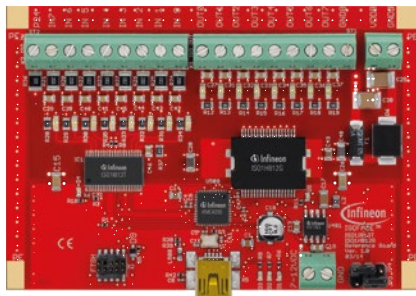
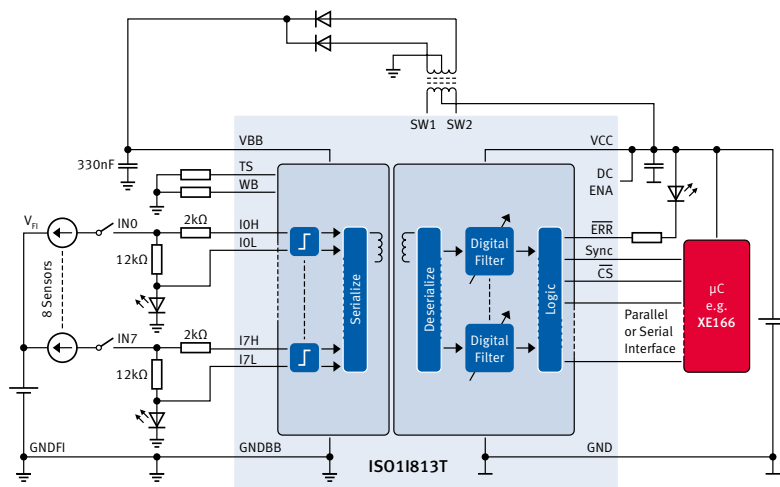
## Key Features

- Integrated galvanic isolation (500V)
- 8 channels (IEC Type 1/2/3)
- Up to 500kHz sampling speed
- Programmable input filters
- Channel-specific diagnostics (wire-break, undervoltage)

## Key Benefits

- Robust and reliable
- Compact system solution
- High-speed applications
- Superior EMI robustness
- System status feedback
- Valuable maintenance support

## Typical Block Diagram Digital Input Switch



## ISOFACE™ Reference Design with Microcontroller XMC

The EMI-tested reference design is a complete and proven template for product design and shortens development time:

- Layout proposal which meets IEC 61131-2 (Zone C) requirements
- Optimized bill-of-materials
- Example firmware

Ordering code: SP0012831904 (available as of April 2015)

Product Overview		ISO1811T	ISO1813T
Input Characteristics	IEC Type: I, II, III	✓	✓
	Input status LED	✓	✓
	Max sampling frequency	125kHz	500kHz
	Deglitching filter setting	Hard wired	Software, individual per channel
	Synchronous data acquisition	–	✓
μC Interface	3.3V/5V	✓	✓
	Serial & parallel	✓	✓
Safety Features	500V Isolation voltage	✓	✓
	Wire break, channel-specific	–	✓
	V <sub>bb</sub> undervoltage	–	✓
Support for external V <sub>bb</sub> supply		–	✓
Package TSSOP-48 (8 x 12.5mm)		✓	✓
Infineon ordering code		SP000876494	SP000876504

# EiceDRIVER™

## High Voltage Gate Driver ICs

### 1ED020I12-B2

Single channel isolated gate driver

- Basic isolation according to EN60747-5-2, recognized under UL1577
- Fully functional at transient +/- 1420V and static voltages of +/-1200V
- High voltage side status feedback
- 2A sink and source rail-to-rail output
- Max.  $T_j = 150^\circ\text{C}$
- Package SO-16 300mil
- Protection functions:
  - Enhanced desaturation detection
  - Active Miller clamp
  - Under-voltage lockout
  - Shut down
  - Watchdog timer

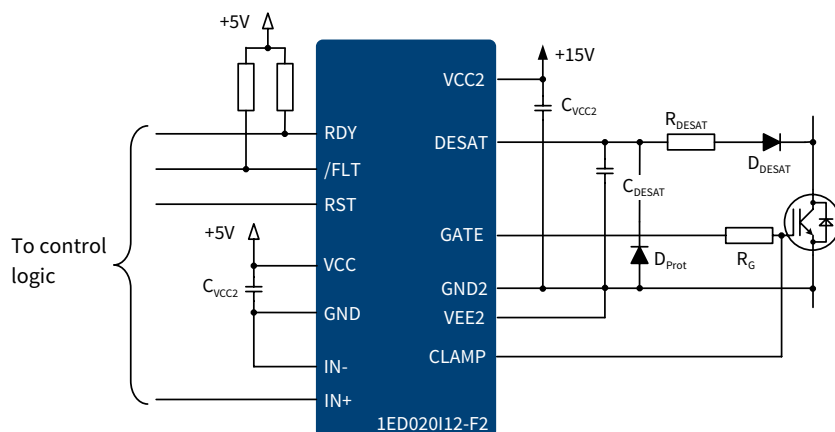
Evaluation board available EVAL-1ED020I12-B2

### 1ED020I12-F2

Single channel isolated gate driver

- Same functions and features as 1ED020I12-B2
- Functional isolation of 1200V
- Can be used with evaluation board EVAL-1ED020I12-B2

#### Typical Application 1ED020I12-F2



### 1ED020I12-BT

Single channel isolated gate driver

- Same functions and features as 1ED020I12-B2
- Basic isolation according to EN60747-5-2, recognized under UL1577
- Adjustable two level turn-off function
- Desaturation detection with 500μA

Evaluation board available EVAL-1ED020I12-BT

### 1ED020I12-FT

Single channel isolated gate driver

- Same functions and features as 1ED020I12-BT
- Functional isolation of 1200V
- Can be used with evaluation board EVAL-1ED020I12-BT

### 2ED020I12-F2

Dual channel isolated gate driver

- Same functions and features as two times 1ED020I12-F2
- Package SO-36 300mil

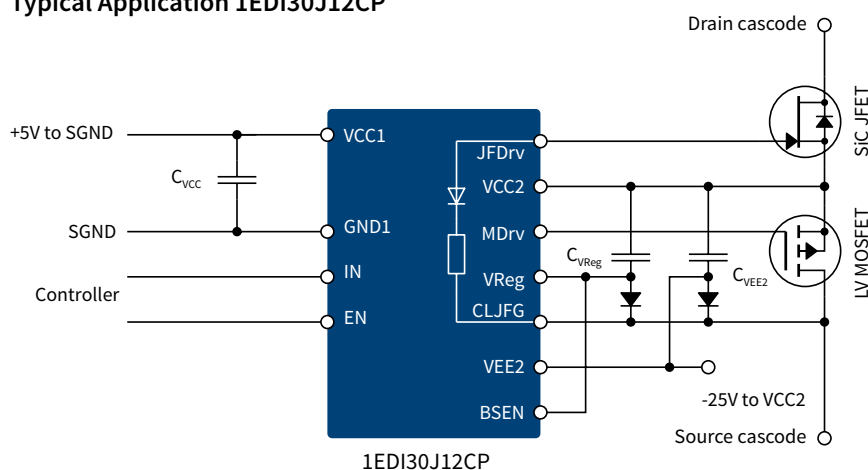
Evaluation board available EVAL-2ED020I12-F2

## 1EDI30J12CP

Infineon has developed the Direct Drive JFET Topology to enable normally-on SiC JFETs to be driven at best possible efficiency and as safe as normally-off switches. This isolated EiceDRIVER™ dedicated for normally-on SiC JFETs comes with special features and benefits:

- Single channel driver IC with Coreless Transformer (CT) technology
- Galvanic isolation, +/- 1200V
- UVLO 16-17V, optimized for Infineon's SiC JFET discretes and power modules
- Bootstrap mode (UVLO 8-9V, logic, MOS driver capability, indicator output)
- Safe turn-off during start up and power supply failures
- Minimum 3A rail-to-rail output
- Extremely low propagation delay of typ. 80ns
- Green package DSO-19-4 (300mil)

### Typical Application 1EDI30J12CP



### CoolSiC™ 1200V JFET Portfolio and Recommended Driver / LV MOS for Direct Drive Topology

Voltage	$R_{DS(on)}$	Sales name	JFET Package	Driver	Driver Package	LV MOS	LV MOS Package
1200	70	IJW120R070T1	TO-247	1EDI30J12CP	DSO-19-4	BSC030P03NS3 G	SuperSO8
	100	IJW120R100T1	TO-247	1EDI30J12CP	DSO-19-4	BSC030P03NS3 G	SuperSO8
1200	70	IJC120R070T1	Bare die	1EDI30J12CP	DSO-19-4	IPC099P03N	Bare die
	100	IJC120R100T1	Bare die	1EDI30J12CP	DSO-19-4	IPC099P03N	Bare die

## 2ED020I12-FI



1200V isolated high side half bridge gate driver

- Galvanic isolation of high side driver
- 2A sink current, 1A source current
- Fully functional at transient and static voltages of +/-1200V
- Integrated operational amplifier and comparator
- Matched delay times of high side and low side
- Max.  $T_j = 150^\circ\text{C}$
- Package SO-18 300mil
- Protection function:
  - Hardware input interlocking
  - Undervoltage lockout
  - Shut down function

## 2ED020I06-FI

650V isolated high side half bridge gate driver

- Galvanic isolation of high side driver
- 2A sink current, 1A source current
- Fully functional at transient and static voltages of +/-650V
- Matched delay times of high side and low side
- Max.  $T_j = 150^\circ\text{C}$
- Package SO-18 300mil
- Protection function:
  - Hardware input interlocking
  - Under voltage lockout

## 2EDL Compact Family



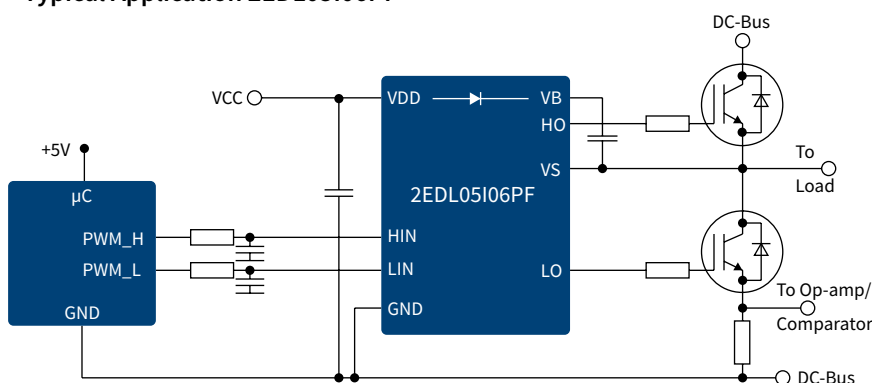
600V levelshift high side half bridge gate driver

- Ultra fast integrated bootstrap diode
- SO8 and SO14 package
- Enable function (2EDL23x only)
- Fault indication (2EDL23x only)
- Versions with and without interlock
- Protection functions:
  - Asymmetric undervoltage lockout
  - Active shut down
  - Undervoltage lockout levels for MOSFET and IGBT
  - Over-current protection (2EDL23x only)
  - Fixed HW dead time optional

**Evaluation boards available:**

- EVAL-2EDL05I06PF
- EVAL-2EDL23I06PJ
- EVAL-2EDL23N06PJ

### Typical Application 2EDL05I06PF



## 1EDI Compact Family



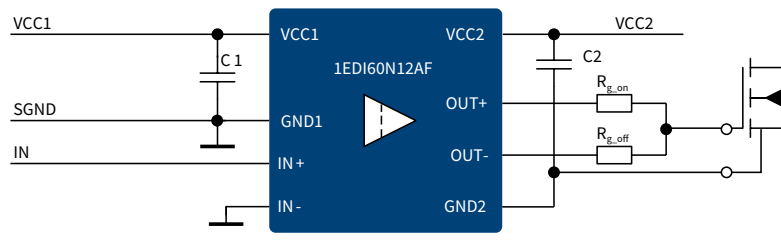
Single channel isolated gate driver

- Fully functional at static voltages of +/- 1200V
- High CMTI rating  $dv/dt = 100V/ns$
- Up to 6A min. output peak current
- Separated source/sink output or single output with Active Miller clamp
- Short propagation delay of 100ns or 240ns input filter time for Noise Suppression
- Compact SO-8 150mil package

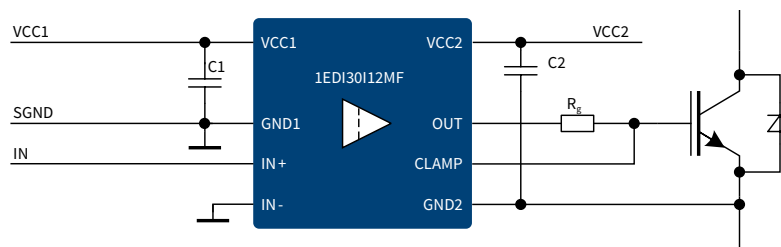
Evaluation board available

EVAL-1EDI60I12AF

### Typical Application 1EDI60N12AF



### Typical Application 1EDI30I12MF



## 6EDL Compact Family



200V and 600V 3-phase gate driver

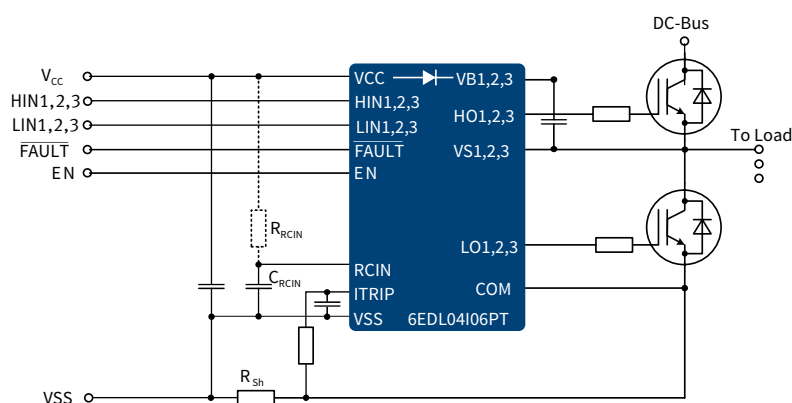
- Ultra fast integrated bootstrap diode
- Fully functional at neg. transient voltages down to -50V (500ns)
- Programmable restart after over current protection
- Shut down of all outputs in case of UVLO, OCP
- Package SO-28 300mil (600V) and package TSSOP-28 (200V)
- Protection functions:
  - Over-current protection (OCP)
  - Hardware input interlocking
  - Undervoltage lockout (UVLO)
  - Fixed hardware deadtime of high side and low side
  - Enable function
  - Pin compatible variants of first generation available

Evaluation boards available:

EVAL-6EDL04I06PT

EVAL-6EDL04N02PR

### Typical Application 6EDL04I06PT





## High Voltage Gate Driver ICs Product Type

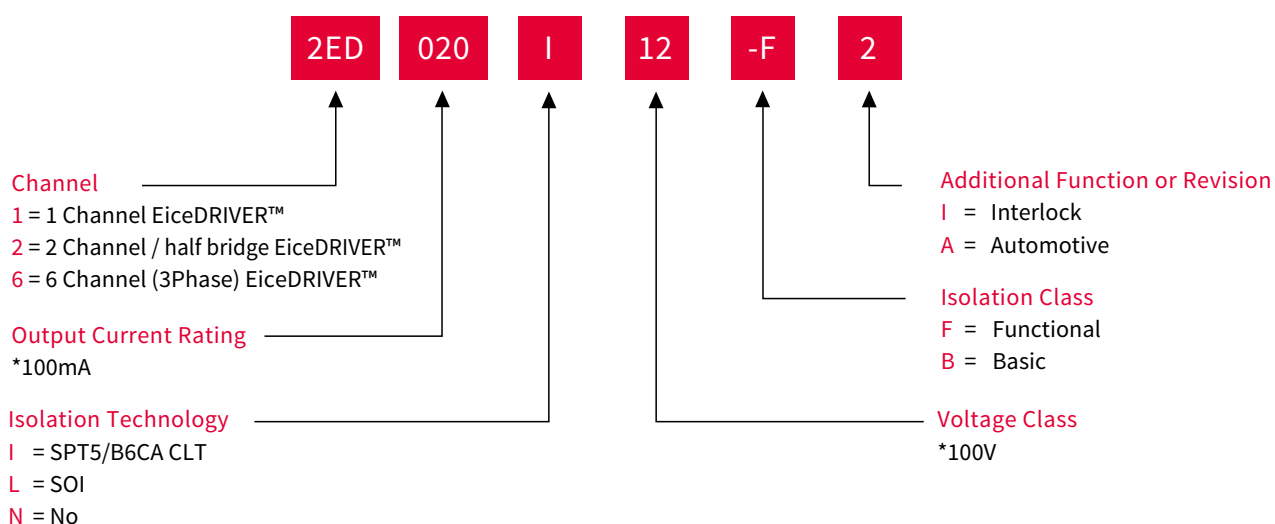
Products		Package	Topology	Voltage Class	Source/Sink Current I <sub>o</sub> +/-	Turn-On Propagation Delay (max)
	1EDI05I12AF	PG-DSO-8	Single	1200V	0.5 / -0.5A	330ns
	1EDI10I12MF	PG-DSO-8	Single	1200V	1.0 / -1.0A	330ns
	1EDI20I12AF	PG-DSO-8	Single	1200V	2.0 / -2.0A	330ns
	1EDI20N12AF	PG-DSO-8	Single	1200V	2.0 / -2.0A	115ns
	1EDI20I12MF	PG-DSO-8	Single	1200V	2.0 / -2.0A	330ns
	1EDI30I12MF	PG-DSO-8	Single	1200V	3.0 / -3.0A	330ns
	1EDI40I12AF	PG-DSO-8	Single	1200V	4.0 / -4.0A	330ns
	1EDI60I12AF	PG-DSO-8	Single	1200V	6.0 / -6.0A	330ns
	1EDI60N12AF	PG-DSO-8	Single	1200V	6.0 / -6.0A	115ns
	2EDL05I06BF	PG-DSO-8	Half Bridge	600V	0.25 / -0.5A	600.0ns
	2EDL05I06PF	PG-DSO-8	Half Bridge	600V	0.25 / -0.5A	600.0ns
	2EDL05I06PJ	PG-DSO-14	Half Bridge	600V	0.25 / -0.5A	600.0ns
	2EDL05N06PF	PG-DSO-8	Half Bridge	600V	0.25 / -0.5A	450.0ns
	2EDL05N06PJ	PG-DSO-14	Half Bridge	600V	0.25 / -0.5A	450.0ns
	2EDL23I06PJ	PG-DSO-14	Half Bridge	600V	1.5 / -2.3A	600.0ns
	2EDL23N06PJ	PG-DSO-14	Half Bridge	600V	1.5 / -2.3A	450.0ns
	6ED003L02-F2	PG-TSSOP-28	3-Phase	200V	180 / -380mA	800.0ns
	6ED003L06-F2	PG-DSO-28	3-Phase	600V	180 / -380mA	800.0ns
	6EDL04I06NT	PG-DSO-28	3-Phase	600V	180 / -380mA	800.0ns
	6EDL04I06PT	PG-DSO-28	3-Phase	600V	180 / -380mA	800.0ns
	6EDL04N02PR	PG-TSSOP-28	3-Phase	200V	180 / -380mA	800.0ns
	6EDL04N06PT	PG-DSO-28	3-Phase	600V	180 / -380mA	800.0ns
	1ED020I12-B2	PG-DSO-16	Single	1200V	2.0 / -2.0A	195.0ns
	1ED020I12-BT	PG-DSO-16	Single	1200V	2.0 / -2.0A	2,000.0ns
	1ED020I12-F2	PG-DSO-16	Single	1200V	2.0 / -2.0A	195.0ns
	1ED020I12-FT	PG-DSO-16	Single	1200V	2.0 / -2.0A	2,000.0ns
	2ED020I06-FI	PG-DSO-18	Half Bridge	650V	1.0 / -2.0A	105.0ns
	2ED020I12-F2	PG-DSO-36	Dual	1200V	2.0 / -2.0A	195.0ns
	2ED020I12-FI	PG-DSO-18	Half Bridge	1200V	1.0 / -2.0A	105.0ns

\* Certified according to DIN EN 60747-5-2

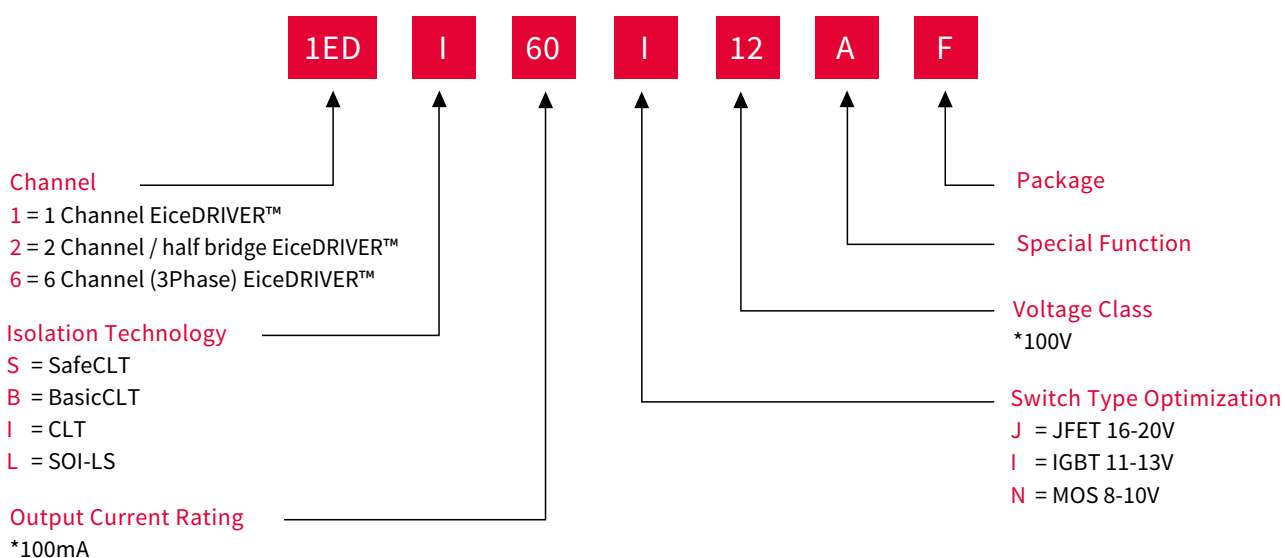
$T_{j(max)}$	Safety Isolation Type*	UVLO ON,max	Fault Reporting	Shutdown / Enable	Input Logic Type	Interlock	Two Level Turn-Off
150.0 °C	–	12.7V	–	–	pos/neg	–	–
150.0 °C	–	12.7V	–	–	pos/neg	–	–
150.0 °C	–	12.7V	–	–	pos/neg	–	–
150.0 °C	–	10.0V	–	–	pos/neg	–	–
150.0 °C	–	12.7V	–	–	pos/neg	–	–
150.0 °C	–	12.7V	–	–	pos/neg	–	–
150.0 °C	–	12.7V	–	–	pos/neg	–	–
150.0 °C	–	12.7V	–	–	pos/neg	–	–
150.0 °C	–	10.0V	–	–	pos/neg	–	–
150.0 °C	–	12.4V	–	EN	pos	–	–
150.0 °C	–	12.4V	–	EN	pos	✓	–
150.0 °C	–	12.4V	–	EN	pos	✓	–
150.0 °C	–	9.9V	–	EN	pos	✓	–
150.0 °C	–	9.9V	–	–	pos	✓	no
150.0 °C	–	12.4V	OCP	EN	pos	✓	–
150.0 °C	–	9.9V	OCP	EN	pos	✓	–
125.0 °C	–	12.5V	ITRIP	EN	neg	✓	–
125.0 °C	–	12.5V	ITRIP	EN	neg	✓	–
125.0 °C	–	12.5V	ITRIP	EN	neg	✓	–
125.0 °C	–	12.5V	ITRIP	EN	pos	✓	–
125.0 °C	–	9.8V	ITRIP	EN	pos	✓	–
125.0 °C	–	9.8V	ITRIP	EN	pos	✓	–
150.0 °C	Basic	12.6V	DESAT	/RST	pos/neg	–	–
150.0 °C	Basic	12.6V	DESAT	/RST	pos/neg	–	✓
150.0 °C	–	12.6V	DESAT	/RST	pos/neg	–	–
150.0 °C	–	12.6V	DESAT	/RST	pos/neg	–	✓
150.0 °C	–	13.5V	–	/SD	pos	✓	–
150.0 °C	–	12.6V	DESAT	/RST	pos/neg	–	–
150.0 °C	–	13.5V	OCP	/SD	pos	✓	–

# Naming System

## EiceDRIVER™ (Driver Boards and Existing Gate Driver)



## EiceDRIVER™ (Gate Driver ICs Since 2012)





# Expert Support for EiceDRIVER™

Easy Access and High Quality



**Application Notes, Datasheets & More**

[www.infineon.com/eicedriver](http://www.infineon.com/eicedriver)

[www.infineon.com/eicedriver-enhanced](http://www.infineon.com/eicedriver-enhanced)

[www.infineon.com/eicedriver-compact](http://www.infineon.com/eicedriver-compact)



**EiceDRIVER™ Boards**

[www.infineon.com/eicedriver-safe](http://www.infineon.com/eicedriver-safe)



Datasheets

# CAN/LIN Transceivers

## Proven Quality for Power Management Applications

Our CAN transceivers provide proven quality, reliable track records and high robustness in automation applications. Features include excellent electromagnetic performance and low levels of electromagnetic interference (EMI). They are also designed for ISO compliance. While our IFX1050G, IFX1050 GVIO and IFX1040SJ devices are optimized for high-speed communication, the IFX1054G variant is suited for fault tolerance at lower data rates, where a separate flag supports diagnostics.

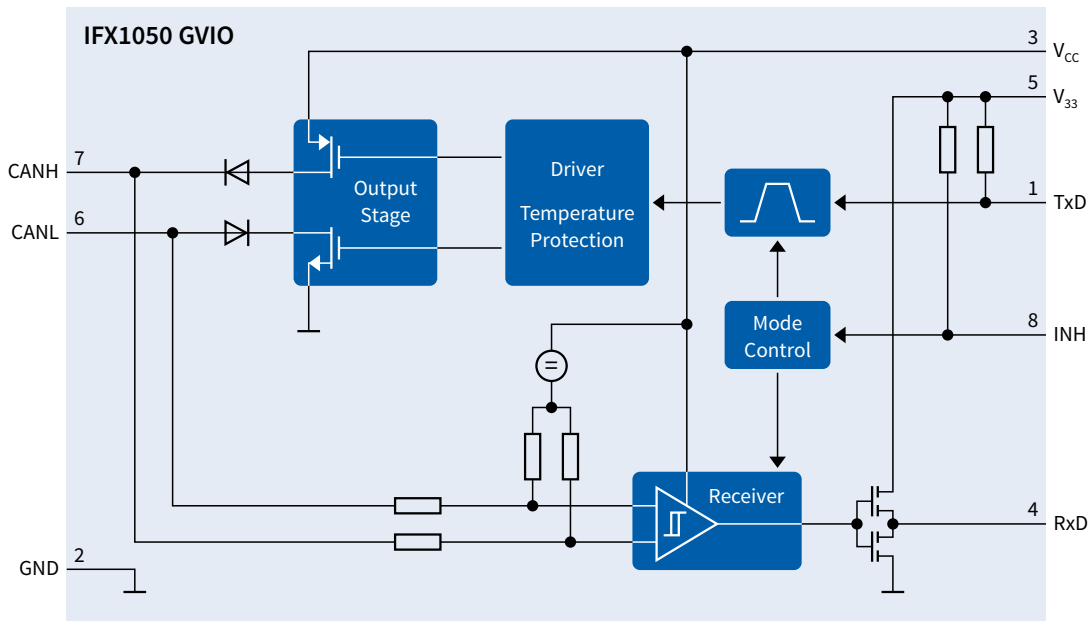
### Key Features

- Transmission rates up to 1Mbit/s
- ISO 11898 compliance
- Low-power modes
- Support of failure conditions
- Bus wake-up feature
- Receive-only mode
- Standby/sleep mode
- Thermal protection

### Key Benefits

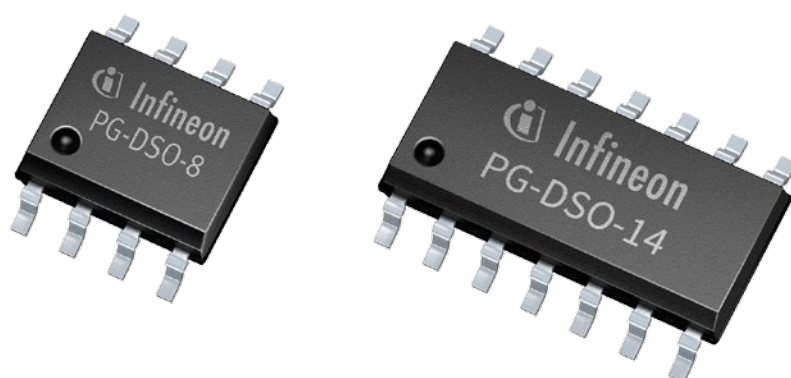
- Low current consumption
- Excellent EMC performance and EMI robustness
- Pin-to-pin replacements for industry-standard parts

Block Diagram IFX1050 GVIO



## Product Portfolio

Product Type	Transceiver Type	Transm. Rate (Max)	Quiescent Current	Bus Wake-Up Capability	Wake-Up Inputs	Package
IFX1050G	High-speed CAN, ISO11898-2	1MBaud	<10µA @ 5V standby	No	No	PG-DSO-8
IFX1050GVIO	High-speed CAN, ISO11898-2	1MBaud	<10µA @ 5V standby	No	No	PG-DSO-8
IFX1040SJ	High-speed CAN, ISO11898-2, ISO11898-5	1MBaud	<10µA @ 5V standby	Yes	Yes, STB	PG-DSO-8
IFX1054G	Fault tolerant CAN, ISO11898-3	125kBaud	<65µA sleep mode	Yes	Bus wake-up and wake-up pin	PG-DSO-14
IFX1021	LIN 1.3, 2.0, 2.1	20kBaud	<10µA sleep mode	Yes	Bus wake-up and wake-up pin	PG-DSO-8



# Voltage Regulators

## Energy-Efficient Voltage Regulators and Trackers

Our linear voltage regulators and trackers help to reduce energy consumption, extending operating time and minimizing operating costs across all kinds of systems. The wide supply voltage range, low quiescent current, rich protective feature set and choice of packages make our devices the perfect fit across a broad application spectrum, even beyond typical Automation designs. Our trackers are ideal as additional supplies for off-board loads to increase system reliability.

### Key Features

- Input voltage up to 60V
- Output current up to 1.5A
- Output voltage adjustable or fixed to specific values
- Quiescent current down to 20µA
- Overload, overtemperature, short-circuit and reverse-polarity protection
- Low current consumption
- Extended temperature range -40°C ... +125°C

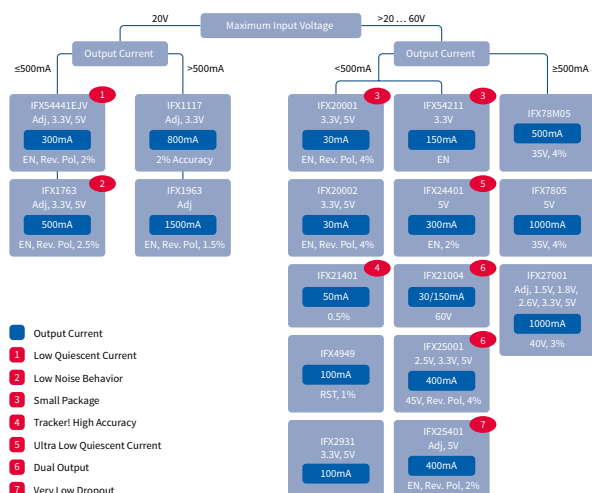
### Key Benefits

- Pin-to-pin compatibility with industry-standard parts
- Very low dropout voltage
- Trackers for optimized heat distribution and external protection
- Trackers for maximum system cost reduction
- Small robust packages

### Infinion Microcontroller Families and Industrial Voltage Regulators

Microcontroller Family	Input Voltage [V]	Input Current (max.) [mA]	Voltage Regulator
XMC1000 Family	1.8 ... 5.5	<100	IFX54211/IFX2931/IFX4949/IFX25001/IFX544xx
XMC4000 Family	3.3	<500/300	IFX1763/IFX544xx/IFX1117
XC8xx	3.3 ... 5.0	200	IFX20001/IFX24401/IFX2931/IFX21401/IFX4949/IFX544xx
XE166/XC2000	1.5 and 3.3 or 5.0	100	IFX25401/IFX24401/IFX2931/IFX4949
TriCore™	1.5 ... 3.3	>400	IFX27001/IFX8117/IFX91041/IFX80471/IFX25001/IFX1117

### Industrial Linear Voltage Regulator (Selection Tree)



[www.infineon.com/powersupply](http://www.infineon.com/powersupply)

# PROFET™ High-Side Switches

## Protected High-Side Switches

Our PROFET™ high-side switches sit between the supply and load in order to control the application. These high-side switches deliver a broad range of smart features, including various protective and diagnostic functions. Since PROFET™ devices can manage all kinds of resistive, capacitive and inductive loads, they can be used across a huge variety of industrial applications.

### Key Features

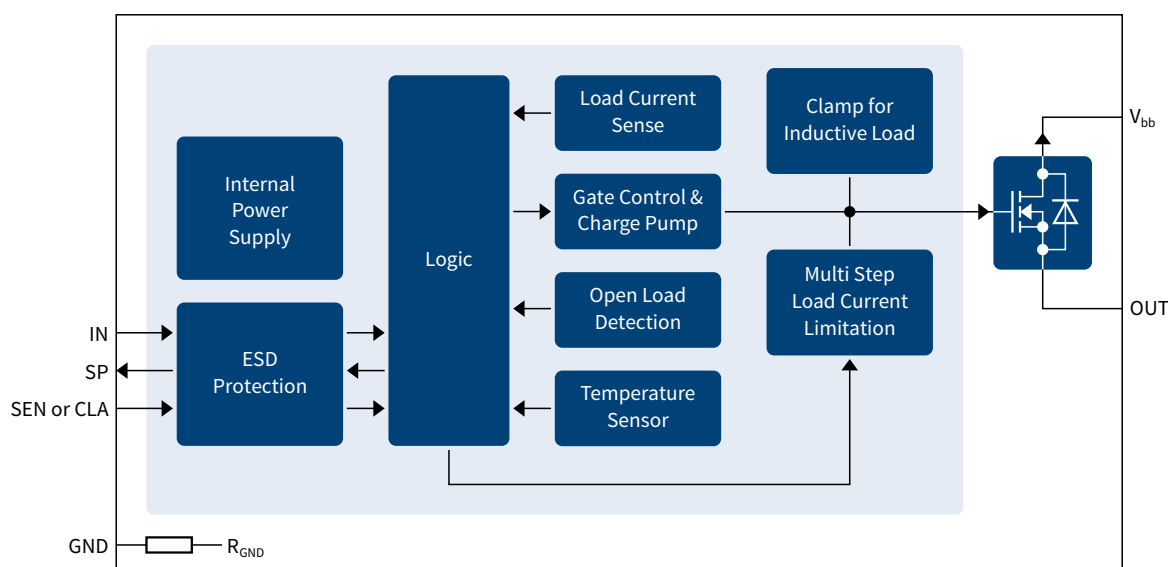
- RoHS compliance
- Very low stand-by current
- ESD protection, optimized EMC
- PWM capability
- Very low power DMOS leakage current in OFF
- 3.3V and 5V compatible logic inputs
- Protection features: load dump, current limitation, thermal shutdown, loss of ground/battery protection, stable behavior at undervoltage, overvoltage, reverse polarity
- Diagnostic features: open-load in on- and off-state, short-circuit to battery and ground, overtemperature sense
- Diagnosis: digital or as proportional load current sense

### Key Benefits

- Complete, built-in protection
- Flexible design for all kinds of resistive, capacitive and inductive loads



### Block Diagram



## Product Portfolio

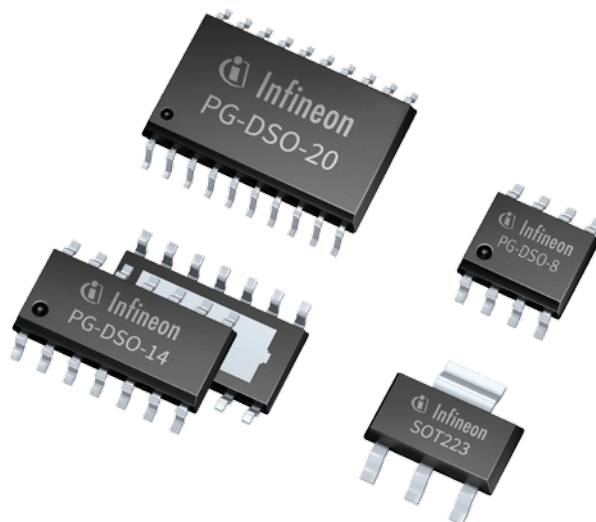
Product Type	Number of Channels	$R_{DS(on)}$ (typ) [mΩ]	Nominal Load Current [A]	EAS [mJ]	Recommended Operating Voltage Range [V]	$I_{L(SC)}$ (typ) [A]	Diagnosis N/A, Digital, Current Sense	Package
ITS4060S-SJ-N	1	50	3.1	900 @ 1.5A	5.0 ... 34.0	17.0	N/A	PG-DSO-8
ITS4100S-SJ-N	1	70	2.4	870 @ 1.0A	5.0 ... 34.0	10.0	N/A	PG-DSO-8
ITS4200S-ME-O	1	150	1.1	700 @ 0.5A	11.0 ... 45.0	3.0	N/A	PG-SOT223-4
ITS4141D	1	150	1.1	12,000 @ 0.5A	11.0 ... 45.0	3.0	N/A	PG-TO-252-5
ITS4200S-SJ-D	1	150	1.7	125 @ 1.0A	6.0 ... 52.0	6.5	Digital	PG-DSO-8
ITS4200S-ME-P	1	150	2.2	160 @ 1.0A	11.0 ... 45.0	3.0	N/A	PG-SOT223-4
ITS4200S-ME-N	1	160	1.2	500 @ 0.5A	5.0 ... 35.0	1.5	N/A	PG-DSO-8
ISP752T	1	200	1.7	125 @ 1.0A	6.0 ... 52.0	6.5	N/A	PG-DSO-8
ITS4300S-SJ-D	1	250	0.8	800 @ 0.3A	5.0 ... 34.0	1.2	Digital	PG-DSO-8
ITS41K0S-ME-N	1	1000	0.55	1,000 @ 0.15A	5.0 ... 34.0	0.9	N/A	PG-SOT223-4
ITS5215L	2	90	2 x 2.0	178 @ 3.5A	5.5 ... 40.0	15.0	Digital	PG-DSO-12
ITS42K5D-LD-F	2	2500	2 x 0.25	Freewheeling	4.5 ... 45V	600mA	Digital	PG-TSON-10
ITS724G	4	90	4 x 2.0	120 @ 3.3A	5.5 ... 40.0	15.0	Digital	PG-DSO-20
ITS716G	4	140	4 x 1.0	76 @ 2.3A	5.5 ... 40.0	9.0	Digital	PG-DSO-20
ITS711L1	4	200	4 x 1.0A	150 @ 1.9A	5.0 ... 35.0	7.5	Digital	PG-DSO-20
ITS42008-SB-D	8	200	8 x 0.6	10,000 @ 625mA	11.0 ... 45.0	3.0	Digital	PG-DSO-36

## Industrial PROFET™ Evaluation Board Plus Samples

The industrial PROFET™ universal evaluation kit enables you to test the performance of the industrial PROFET™ product family. The evaluation kit includes the board plus three samples of each of the new single channel products.

## Suitable for:

- ITS4060S-SJ-N
- ITS4100S-SJ-N
- ITS4200S-SJ-D
- ITS4300S-SJ-D
- ITS4200S-ME-N
- ITS4200S-ME-O
- ITS4200S-ME-P
- ITS41K0S-ME-N



[www.infineon.com/profet](http://www.infineon.com/profet)

# DC/DC Converters

## Robust Range of Converters for the Widest Application Spectrum

Our high-efficiency switching regulators and controllers help to reduce energy consumption. In addition to extending the operating time of battery-powered systems, they also significantly improve the thermal budget of the application. Overall, this translates into minimal operating costs. For your design flexibility, they are available as adjustable voltage variants as well as with dedicated fixed output voltage values.

### Key Features

- Input voltage up to 60V
- Output currents going from 500mA up to 10A
- Switching frequencies ranging from 100kHz to 2.2MHz
- Shutdown quiescent current down to below 2μA
- Current limitation and overtemperature protection
- Enable feature

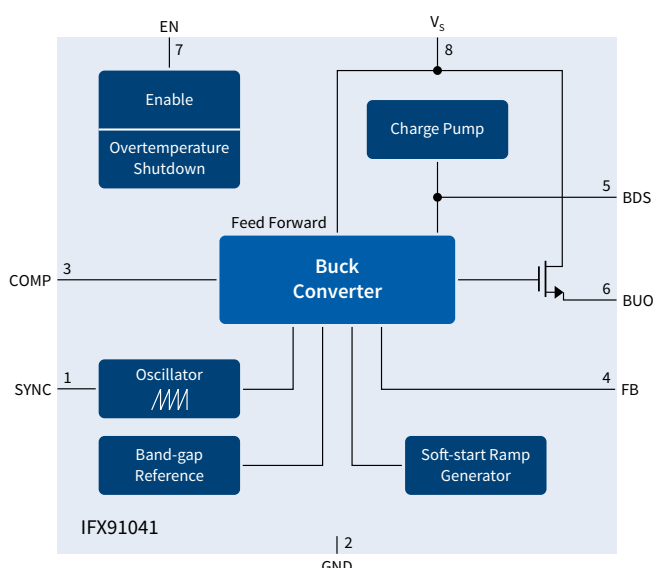
### Key Benefits

- High-efficiency regulation
- Only a few external components needed for stable regulation
- Perfectly suited for regulation in pre-/post-regulation Power Supply architectures

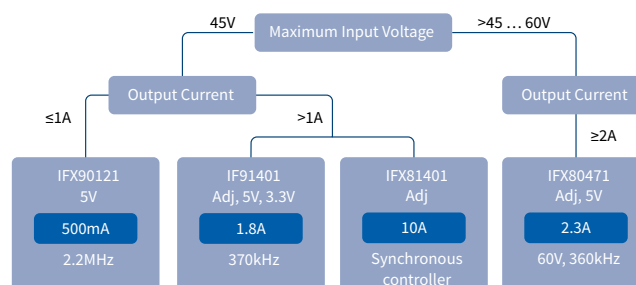
### DC/DC Converters

Product Type	V <sub>O</sub> (multiple)	Output Current Type	Output Current [A]	Product Features	Package
IFX81481ELV	Adjustable	Buck Controller	10.0	10A synchronous DC/DC adjustable Step Down Controller; f = 100 – 700kHz, N	PG-SSOP-14
IFX90121EL V50	5.0V	Buck Converter	0.5	V <sub>in</sub> up to 45V, 2.2MHz Step-Down Regulator with low quiescent Current	PG-SSOP-14
IFX80471SK V	Adjustable	Buck Converter	2.3	V <sub>in</sub> up to 60V; V <sub>O</sub> adjustable from 1.25V up to 15V; external MOS	PG-DSO-14
IFX80471SK V50	5.0V	Buck Converter	2.3	V <sub>in</sub> up to 60V; external MOS	PG-DSO-14
IFX91041EJV	Adjustable	Buck Converter	1.8	V <sub>O</sub> adjustable from 0.6V up to 16V; tolerance 2% up to 1000mA	PG-DSO-8
IFX91041EJ V33	3.3V	Buck Converter	1.8	V <sub>O</sub> fixed to 3.3V; tolerance 2% up to 1000mA	PG-DSO-8
IFX91041EJ V50	5.0V	Buck Converter	1.8	V <sub>O</sub> fixed to 5.0V; tolerance 2% up to 1000mA	PG-DSO-8

### Block Diagram IFX91041



### Industrial DC/DC Buck Regulators (Selection Tree)



[www.infineon.com/industrial-dcdc-converters](http://www.infineon.com/industrial-dcdc-converters)

# XMC – 32-bit Industrial Microcontrollers

One Microcontroller Platform. Countless Solutions.

---

Our XMC 32-bit Microcontroller family gives you a real competitive advantage. This wide and scalable portfolio offers excellent real-time performance. Designed for quality and robustness, it offers configurable and fast peripherals which operate largely autonomously. This means the XMC can be adapted to the specific needs of different target markets such as building and factory automation, power and energy, home and professional computing and transportation. Customers benefit from a wide portfolio and ecosystem powered by an ARM® Cortex™ -M0 (XMC1000 family) and Cortex™ -M4 (XMC4000 family).

## DAVE™ - Digital Application Virtual Engineer

A complete set of development tools, ready-to-use software solutions and supporting services are available for XMC Microcontrollers from Infineon and various third-party tool and software vendors. These tools and software products support the entire development cycle to ensure a highly efficient development process.

Infineon's free and revolutionary Eclipse-based IDE (Integrated Development Environment) enables a simple and straightforward development flow for less risk and effort. This is achieved thanks to an intuitive graphical interface and more than 350 application-optimized, configurable, tested and well documented apps and examples. Use of DAVE™ generated source code with other tools from the wide ARM ecosystem is supported.

### Key Features

- Integration of powerful peripherals
- Real-time and deterministic behavior
- Operation at up to 125°C ambient temperature

### Key Benefits

- Industrial, cross-market Microcontroller suited to widest application spectrum
- Excellent real-time performance
- Long-term product availability until 2027
- Easy design-in with DAVE™ IDE and DAVE™ Apps – advanced high-level GUI-based application-orientated programming using predefined, configurable and tested software components

## Infineon XMC 32-bit Microcontrollers Based on ARM® Cortex™ -M

	Infineon XMC MCUs	XMC1000			XMC4000				
	Parameter	XMC1100	XMC1200	XMC1300	XMC4100	XMC4200	XMC4400	XMC4500	
System	Core	ARM® Cortex™ -M0			ARM® Cortex™ -M4				
	Frequency	32MHz			80MHz		120MHz		
	Math coprocessor	–		64MHz	–				
	DSP instruction set	–			✓				
	Floating Point Unit (FPU)	–			✓				
	Peripherals speed	up to 64MHz			up to 80MHz		up to 120MHz		
	Programmable hardware interconnect matrix	1 x			2 x				
	DMA	–			8ch		12ch		
	MPU	Primitive Memory Protection (PAU)			Memory Protection Unit (8 Regions)				
	Watchdog	✓			✓				
	Real-time clock	✓			✓				
	Hibernate domain	–			✓				
	Number of I/Os	14 / 22 / 26 / 34 / 35			34 / 49		45 / 79 / 123		
	Supply voltage	1.8 to 5.5V			3.13 to 3.63V				
	Operating temperature	-40 ... 85°C / 105°C			-40 ... 85°C / 105°C / 125°C				
Memory	Flash	8 – 64KB	16 – 200KB	8 – 200KB	64KB	256KB	512KB	1MB	
	Error Correction Code (ECC)	✓			✓				
	RAM	16KB	16KB	16KB	20KB	40KB	80KB	160KB	
	Cache	–			1KB		4KB		
	Ext memory interface	–			– ✓				
Timer	SysTick	✓			✓				
	CCU4 (4 ch)	1 x			2 x		4 x		
	CCU8 (4 ch)	–	–	1 x	1 x		2 x		
Analog	12-bit ADC	up to 12ch, 1xADC (1 MSPS)	up to 12ch, 2x ADC (1 MSPS)		up to 9ch, 2 x ADC (2 MSPS)		up to 26ch, 4x ADC (2 MSPS)		
	12-bit DAC	–			2 x				
	Comparator	–	Up to 3 x		Programmable comparators built into Hi-Res PWM				
Communication	IEEE 1588 ethernet MAC	–			–		1x RMII & MII		
	USB	–			FS DEV		FS OTG		
	SDIO/SD/MMC	–			– ✓				
	USIC (UART, SPI, QSPI, I²C, I²S)	2ch, 1x FIFO (64 word)			4ch, 2 x FIFO (64 word) 6ch, 2 x FIFO (64 word)				
	CAN 2.0 B	–			2 nodes, 64 message objects 3 nodes, 64 message objects				
Application	Hi-Res PWM (150ps)	–			4ch –				
	ΔΣ Demodulator	–			–		4ch		
	POSIF	–	–	1 x	1 x		2 x		
	Capacitive touch control	–	Up to 16ch	–	Up to 7ch Up to 8ch				
	LED matrix control	–	Up to 128 LEDs	–	Up to 28 LEDs Up to 40 LEDs				
	Brightness control unit	–	Up to 9ch		–				
	DAVE™ apps	Code library with basic system, peripheral, and advanced application-oriented components for Motor Control, Power Conversion, Lighting, Communication, and many more applications.							
IDEs	Debug and trace	SWD, SPD			SWD, JTAG, Trace				
	Ecosystem (IDEs, compiler, debugger)	Infineon DAVE™ (free) and partner ARM®/KEIL™ (free up to 128KB, XMC1000), Atollic, IAR Systems, Rowley Associates, TASKING							
Other	Packages	PG-VQFN-24/40 PG-TSSOP-16/38	PG-VQFN-24/40 PG-TSSOP-16/28/38	PG-VQFN-24/40 PG-TSSOP-16/38	PG-VQFN-48 PG-LQFP-64	PG-VQFN-48 PG-LQFP-64	PG-LQFP-64/100	PG-LQFP-100/144 PG-LFBGA-144	

# AURIX™ – 32-bit Microcontrollers

## 32-bit Multi-Core TriCore™ – Safety Joins Performance

AURIX™ is Infineon's family of Microcontrollers serving exactly the needs of Industrial applications in terms of performance and safety. Its innovative multi-core architecture, based on up to three independent 32-bit TriCore™ CPUs @300MHz, has been designed to meet the highest safety standards while increasing the performance at the same time. The key strengths of the scalable AURIX™ family is to combine multiple worlds in one family, supporting safety and security as well as high-performance computing and the latest connectivity as well as innovative Power Supply concepts.

Using the AURIX™ platform, developers will be able to implement applications like Motor Control and Drives, PLC, or any other Automation application with the scalable MCU platform. Developments using AURIX™ will require less effort to achieve the SIL/IEC61508 standard based on its innovative safety concept and multiple HW safety features. The integrated hardware security module provides safety and also helps to prevent external interrupts. Furthermore, AURIX™ has enhanced communication capabilities to support communication between CAN, LIN, FlexRay™ and ethernet buses.

### Key Features


- TriCore™ with DSP functionality
- Best-in-Class real-time performance: triple TriCore™ with up to 300MHz per core
- Supporting floating point and fix point with all cores
- From single core to multi-core
- Encapsulation feature allows software development without interference for multiple applications
- HW accelerators
- Up to 2.75MB of internal RAM, up to 8MB of flash
- Innovative single supply 5V or 3.3V
- External memory interface
- IEC61508 conformance to support safety requirements up to SIL3
- Embedded EEPROM
- Advanced communication peripherals: CAN, LIN, SPI, FlexRay, ethernet

### Key Benefits

- High scalability gives the best cost-performance fit
- High integration leads to significant cost savings
- High integration leads to reduced complexity
- Innovative supply concept leads to Best-in-Class power consumption

## AURIX™ Family Package Scalability

	TQFP-80	TQFP-100	LQFP-144 TQFP-144	LQFP-176	LFBGA-292	BGA-416	LFBGA-516
<b>9x Series</b> up to 8MB Max. SRAM 2.75MB Triple-Core					TC297	TC298	TC299
<b>7x Series</b> up to 4MB Max. SRAM 472KB Triple-Core				TC275	TC277		
<b>6x Series</b> up to 2.5MB Max. SRAM 752KB Dual-Core			TC264	TC265	TC267		
<b>4x Series</b> up to 2MB Max. SRAM 96KB Single-Core			TC244				
<b>3x Series</b> up to 2MB Max. SRAM 708KB Lockstep-Core		TC233	TC234		TC237		
<b>2x Series</b> up to 1MB Max. SRAM 96KB Lockstep-Core	TC222	TC223	TC224				
<b>1x Series</b> up to 512KB Max. SRAM 56KB Lockstep-Core	TC212	TC213	TC214				

 Upgrade/Downgrade with pin-compatible packages

- Advanced package technologies deliver the best price/performance ratio
- Customers can choose between different devices in the same pin-compatible package

# Current Sensors

## The Miniaturization Advantage

TLI4970 is a high-precision current sensor based on our proven Hall technology. Its coreless concept supports the miniaturization trend defining today's sensor designs. It is a fully digital solution with the added bonus of ease-of-use. There is no need for any external calibration or other parts (such as A/D converters, Op-amps, reference voltage sources), reducing the overall implementation effort, PCB space and cost significantly.

TLI4970 provides superior accuracy compared with existing open- or closed-loop systems with magnetic cores. It has additional functionality such as overcurrent detection and programmable filters, while offering a significantly smaller footprint and lower power consumption. Key applications include AC/DC inverters, DC/DC converters and PFC Power Supplies and drives.

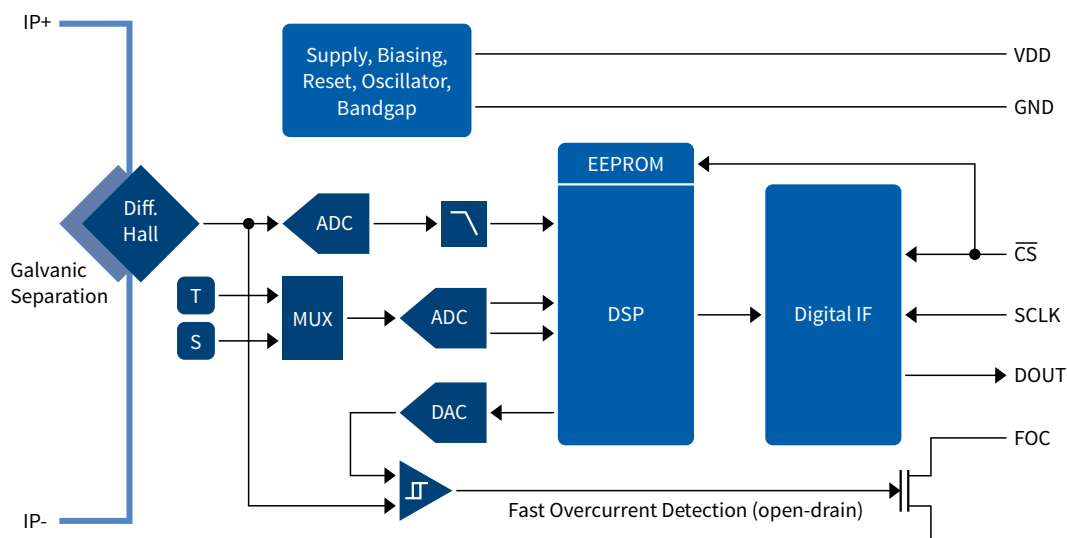
### Key Features

- AC & DC measurement range up to +/-50A
- Highly accurate over temperature range and lifetime (max. 1.0% (0 h), 1.6% (over lifetime) of indicated value)
- Low offset error (max. 75mA over temperature and lifetime)
- High magnetic stray field suppression
- Fast overcurrent detection with configurable threshold
- Galvanic isolation up to 2.5kV max. rated isolation voltage (UL1577)
- 16 bit digital SPI output (13 bit current value)
- Small 7.0 x 7.0mm<sup>2</sup> SMD package

### Key Benefits

- Ideal for Automation applications
- Plug and play solution – no external calibration needed
- Much smaller footprint than existing solutions
- Reduced implementation effort, PCB space and cost
- Small package size and weight for SMD mounting

### Block Diagram TLI4970



[www.infineon.com/tli4970](http://www.infineon.com/tli4970)

# Hall-Effect Switches

## The Energy-Saving Option with Excellent Accuracy and Robustness

Our portfolio of Hall switches comprises unipolar and omnipolar switches, bipolar latches and double Hall switches. They are suited to a wide range of applications such as Position Sensing, Index Counting, BLDC motor control, etc. These devices show excellent accuracy and robustness against electrical disturbances and are available in a variety of packages.

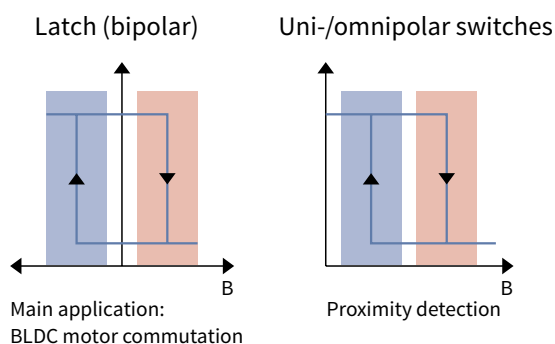
### Key Features

- Operating supply voltage 3–32V
- Reverse polarity protection (-18V)
- Overvoltage capability up to 42V without external resistor
- Low current consumption (1.6mA)
- Active error compensation
- High ESD performance, up to 7kV HBM
- Small SMD package SOT23
- Leaded package

### Key Benefits

- Reduction of system power consumption
- Reduced system size
- Removal of protection devices
- Reliable system operation
- Increased motor efficiency
- Broad range of switching thresholds available for all applications
- Special industrial versions available

### Hall Switch Types



# Linear Hall Sensors

## Highly Accurate Angular and Linear Position Measurement

All products of our linear Hall family measure the vertical component of a magnetic field. The output signal is directly proportional to the sensed magnetic field. Building on these principles, our TLE499x family of linear Hall ICs has been designed specifically to meet the requirements of highly accurate angular and linear position measurement. They are also suited to current measurement applications.

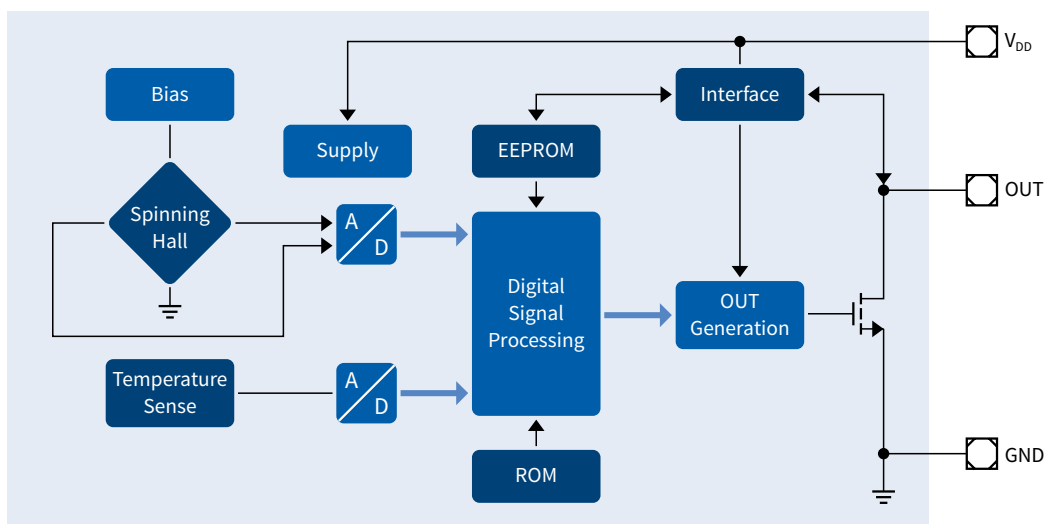
### Key Features

- Single supply voltage 4.5–5.5V
- Temperature range -40 ... +150°C
- Linear ratiometric output between -200mT and +200mT within three ranges
- Sensitivity offset and clamping programmable
- Digital temperature and stress compensation
- High-voltage capability and reverse polarity protection
- Low drift of output signal over temperature and lifetime
- 20-bit digital signal processing
- Analog and digital interfaces

### Key Benefits

- Wear-free operation
- Highly accurate contactless position sensing
- In-system calibration
- Flexible system implementation

Block Diagram TLE4998



# iGMR Angle Sensors

## Compact Designs in Small Outline Packages

Our angle sensor family is based on integrated Giant Magneto Resistance (iGMR) technology. These sensors detect the orientation of an applied magnetic field by measuring sine and cosine angle components with monolithically integrated magneto-resistive elements. This allows them to easily determine the absolute orientation of the magnetic field between 0° and 360°. Data processing and communication interfaces are integrated on the same silicon chip as the sensing elements, allowing a compact design using small outline packages. Our angle sensor family offers a broad variety of communication interfaces, as well as different levels of data processing and self-test capabilities. Ideal for functional safety-critical applications, our TLE5309D combines a TLE5009 iGMR with a TLE5109 iAMR chip, whereas the TLE5012BD combines two TLE5012B iGMR in one fully integrated dual-sensor package. Target applications of our iGMR sensors include Contactless Angle Measurement, Rotational Position Measurement, Steering Angle Measurement and BLDC motor commutation.

### Features

- Integrated GMR (iGMR) technology
- 0–360° angle measurement with sine and cosine bridge
- Supply voltage 3.3 or 5.0V
- On-chip temperature compensation of amplitude and offset
- Temperature range -40°C ... +150°C
- PG-DSO-8 package

### Product Portfolio

Sales Name	Description	Interface	Order Code
TLE5009 E1000	V <sub>DD</sub> : 3.3V; static offset compensation	Analog	SP000912764
TLE5009 E1010	V <sub>DD</sub> : 3.3V; TCO <sup>1)</sup>	Analog	SP000912774
TLE5009 E2000	V <sub>DD</sub> : 5.0V; static offset compensation	Analog	SP000912760
TLE5009 E2010	V <sub>DD</sub> : 5.0V; TCO <sup>1)</sup>	Analog	SP000912770
TLE5012B E1000	V <sub>DD</sub> : 3.3V & 5.0V	SPI <sup>2)</sup> , IIF <sup>3)</sup>	SP001166960
TLE5012B E3005	V <sub>DD</sub> : 3.3V & 5.0V	SPI <sup>2)</sup> , HSM <sup>4)</sup>	SP001166964
TLE5012B E5000	V <sub>DD</sub> : 3.3V & 5.0V	SPI <sup>2)</sup> , PWM <sup>5)</sup>	SP001166968
TLE5012B E9000	V <sub>DD</sub> : 3.3V & 5.0V	SPI <sup>2)</sup> , SPC <sup>6)</sup>	SP001166998
TLE5012BD E1200	V <sub>DD</sub> : 3.3V & 5.0V DualDie	SPI <sup>2)</sup> , IIF <sup>3)</sup>	SP001205296
TLE5012BD E9200	V <sub>DD</sub> : 3.3V & 5.0V DualDie	SPI <sup>2)</sup> , SPC <sup>6)</sup>	SP001205300
TLE5309D E1211	V <sub>DD</sub> : 3.3V (AMR & GMR), TCO <sup>1)</sup> , DualDie	Analog	SP001191262
TLE5309D E2211	V <sub>DD</sub> : 5.0V (AMR & GMR), TCO <sup>1)</sup> , DualDie	Analog	SP001191266
TLE5309D E5201	V <sub>DD</sub> : 5.0V (AMR) & 3.3V (GMR), DualDie	Analog	SP001145340
TLE5009 EVALKIT	Evaluation kit containing interface box (PGSISI-2) and evaluation board incl. magnet and software	–	SP000871462
TLE5009 EVALBOARD	Evaluation board incl. magnet and software (interface box is not included, but is required for operation)	–	SP000871466
TLE5012B EVALKIT	Evaluation kit containing interface box (PGSISI-2) and Evaluation board incl. magnet and software	–	SP000912902
TLE5012B EVALBOARD	Evaluation board incl. magnet and software (interface box is not included, but is required for operation)	–	SP000912898

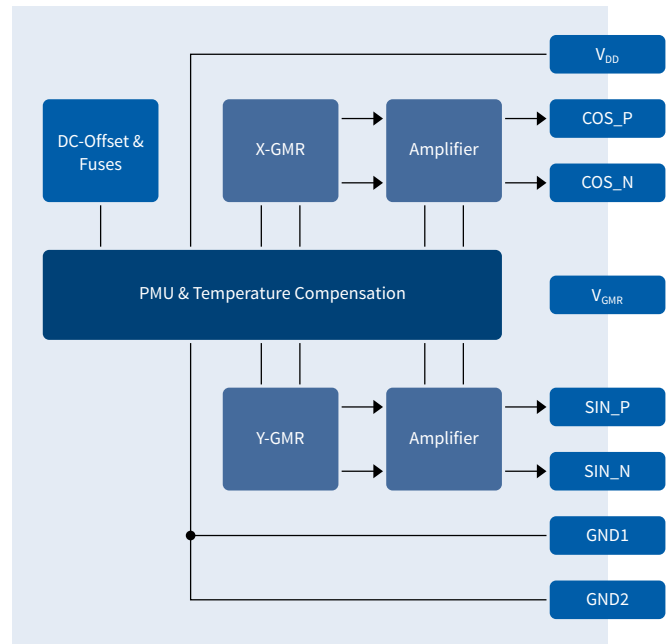
1) TCO = Temperature Compensation  
2) SPI = Serial Peripheral Interface

3) IIF = Incremental Interface  
4) HSM = Hall Switch Mode

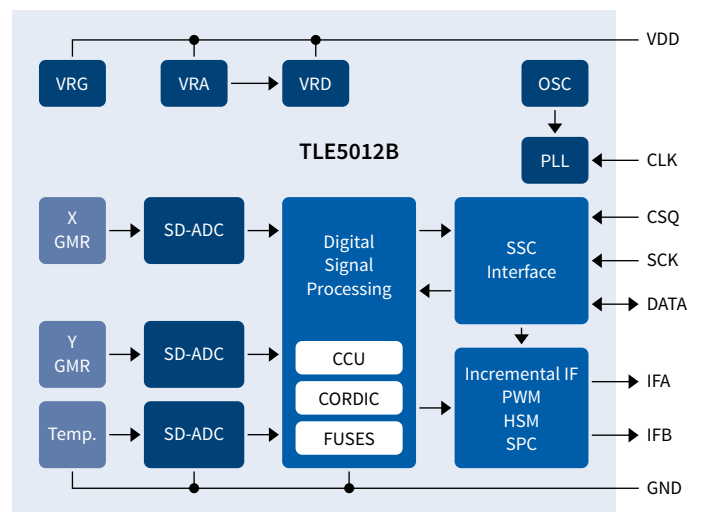
5) PWM = Pulse Width Modulation  
6) SPC = Short PWM Code

**Benefits TLE5009**

- The analog sensor output signals can be directly connected to the analog inputs of a Microcontroller
- The output signals are offset- and temperature-compensated
- Output signals can be read as single-ended or differential voltage
- Signal amplitudes are independent from supply voltage variations

**Block Diagram TLE5009****Benefits TLE5012B**

- Different digital interfaces available (SPI, PWM, HSM, IIF, SPC)
- Integrated angle calculation based on sine and cosine values
- Increased accuracy with auto-calibration functionality
- Prediction of output signal to compensate latency
- High-speed angle update rate up to 23.4kHz

**Block Diagram TLE5012B**



# Expert Support for ...

... Microcontrollers, Sensors and Power ICs



## Application Notes, Datasheets & More

[www.infineon.com/xmc](http://www.infineon.com/xmc)

[www.infineon.com/dave](http://www.infineon.com/dave)

[www.infineon.com/aurix](http://www.infineon.com/aurix)

[www.infineon.com/industrialtransceivers](http://www.infineon.com/industrialtransceivers)

[www.infineon.com/tli4970](http://www.infineon.com/tli4970)

[www.infineon.com/hall-switches](http://www.infineon.com/hall-switches)

[www.infineon.com/magnetic-sensors](http://www.infineon.com/magnetic-sensors)

[www.infineon.com/angle-sensors](http://www.infineon.com/angle-sensors)

[www.infineon.com/industrial-dcdc-converters](http://www.infineon.com/industrial-dcdc-converters)

[www.infineon.com/powersupply](http://www.infineon.com/powersupply)

[www.infineon.com/profet](http://www.infineon.com/profet)



Datasheets

# Packages
















## SMD Technology

TO-252-2 (DPAK)		DPAK (TO-252)		Reverse DPAK (Rev. TO-252)		DPAK 5pin (TO-252 5pin)		D <sup>2</sup> PAK (TO-263)		D <sup>2</sup> PAK 2pin (TO-263-2)															
2	9.9 × 6.5 × 2.3	3	9.9 × 6.5 × 2.3	3	9.7 × 6.6 × 2.34	5	9.9 × 6.5 × 2.3	3	15.0 × 10.0 × 4.4	2	15.0 × 10.0 × 4.4														
																									
D <sup>2</sup> PAK 7pin (TO-263 7pin)		SO-8/SO-8 dual		SO-16/12		SO-14		SO-16		SO-18															
7	15.0 × 10.0 × 4.4	8	5.0 × 6.0 × 1.75	12	10.0 × 6.0 × 1.75	14	8.75 × 6.0 × 1.75	16	10.0 × 6.0 × 1.75	18	12.8 × 10.3 × 2.65														
																									
SO-19		SO-20		SC59		SOT-23		SOT-89		SOT-223															
19	12.8 × 10.3 × 2.65	20	12.8 × 10.3 × 2.65	3	3.0 × 2.8 × 1.1	3	2.9 × 2.4 × 1.0	3	4.5 × 4.0 × 1.5	4	6.5 × 7.0 × 1.6														
																									
SOT-323		SOT-363		TSOP-6		S308		TISON (power stage 5x6)		WISON (power stage 3x3)															
3	2.0 × 2.1 × 0.9	6	2.0 × 2.1 × 0.9	6	2.9 × 2.5 × 1.1	8	3.3 × 3.3 × 1.0	8	5.0 × 6.0 × 1.0	8	3.0 × 3.0 × 0.8														
																									
SuperSO8		SuperSO8 dual		SuperSO8 fused leads		VSON (ThinPAK)		CanPAK™ S-Size		CanPAK™ M-Size															
8	5.15 × 6.15 × 1.0	8	5.15 × 6.15 × 1.0	8	5.15 × 6.15 × 1.0	4	8.0 × 8.0 × 1.0	6	4.8 × 3.8 × 0.65	7	6.3 × 4.9 × 0.65														
																									
TDSON-10-2		TDSON-10-7		TO-Leadless (TOLL)		TSSOP-48		DSO-36		IQFN-40															
10	3.0 × 3.0 × 0.9	10	3.0 × 3.0 × 0.9	8	11.68 × 9.9 × 2.3	48	12.5 × 6.1 × 1.1	36	15.9 × 11.0 × 3.5	40	6.0 × 6.0 × 0.8														
																									
TSSOP-28		DSO-28		VQFN-48		UIQFN-32 DrBlade™ 1.0		WIQFN-38 DrBlade™ 2.0		UIQFN-19 DrBlade™ 3															
28	9.7 × 6.4 × 1.2	28	18.1 × 10.3 × 2.65	48	6.0 × 6.0 × 0.9	32	5.0 × 5.0 × 0.6	38	6.6 × 4.5 × 0.8	19	5.0 × 4.0 × 0.7														
																									
TSOP-8 ThinPAK 5x6		Package (JEITA-code)																							
8	5.0 × 5.0 × 1.0	X	L × W × H																						
		pin-Count																							
		All Dimensions in mm																							

All products are available in green  
(RoHS compliant).



## THD Technology

IPAK (TO-251)		IPAK SL (TO-251 SL)		I <sup>2</sup> PAK (TO-262)		TO-220 real 2pin		TO-220 2pin		TO-220 3pin	
3	15.5 x 6.5 x 2.3	3	10.7 x 6.5 x 2.3	3	25.1 x 10 x 4.4	2	29.15 x 10.0 x 4.4	2	29.1 x 9.9 x 4.4	3	29.15 x 10.0 x 4.4
											
TO-220 FullPAK		TO-220-6-46		TO-220-6-47		TO-247		TO-247 4pin		DIP-7	
3	29.6 x 10.5 x 4.7	6	21.7 x 9.9 x 4.4	6	26.1 x 9.9 x 4.4	3	40.15 x 15.9 x 5.0	3	40.15 x 15.9 x 5.0	7	9.52 x 8.9 x 4.37
											
DIP-8		DIP-14		DIP-20		Package (JEITA-code)					
8	9.52 x 8.9 x 4.37	14	19.5 x 8.9 x 4.37	20	24.6 x 9.9 x 4.2	X	L x W x H				
						pin-Count					
						All Dimensions in mm					

All products are available in green  
(RoHS compliant).

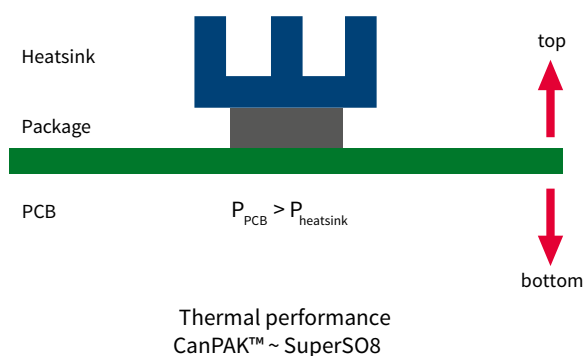


## Top and Bottom Side Cooling of SMD Devices

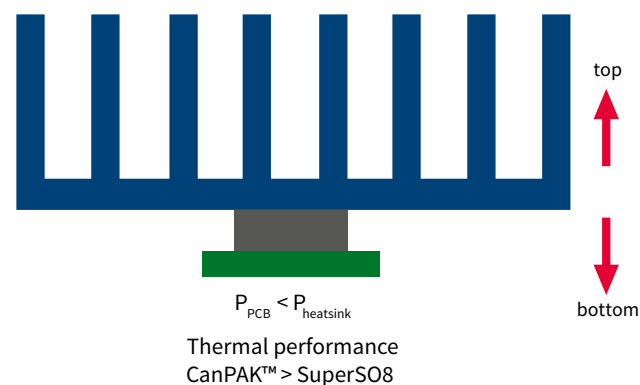
For LV MOSFETs different SMD packages such as SuperSO8, CanPAK™ and Blade are available. If the cooling system is designed for main heatflow to the PCB both packages will show similar thermal performance.

If the main heat flow is to the top side the CanPAK™ is the better choice since the thermal resistance to the top side is lower ( $R_{th\_top\_CanPAK™} \sim 1 \text{ K/W}$ ,  $R_{th\_top\_SuperSO8} \sim 20 \text{ K/W}$ ).

Bottom side cooling



Top side cooling



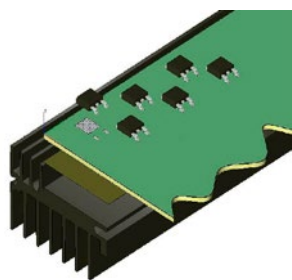
Example: High performance Server  
(PCB: 8 layer, 70μm)



Example: Motherboard (PCB 4 layer, 35μm) with  
high performance heatsink



## New IGBT Technology RCD Allows Highest Power Density with Small SMD Packages



The new IGBT RCD technology in combination with an efficient cooling system allows to use small SMD packages which enable to build compact systems with increased power density. In order to improve the heat dissipation, thermal vias are integrated in the PCB under the device case which results in a low thermal resistance to the opposite side of the PCB. A heatsink complements the cooling system. Isolation to the heatsink is realized with a thermal foil. With this cooling system power dissipation up to 7 to 10W / IGBT is achievable which corresponds to ~ 2kW application systems.

## OptiMOS™ in TO-Leadless

### A Package Optimized For High Current Applications

TO-Leadless has been designed for high currents up to 300A. In addition, latest OptiMOS™ Silicon technology in combination with reduced package resistance achieves lowest  $R_{DS(on)}$ . This enables a reduction in the number of parallel MOSFETs in a Forklift application and increases power density.

Further the 60% smaller package size enables a very compact design. Compared to D<sup>2</sup>PAK 7pin, TO-Leadless shows a substantial reduction in footprint of 30%. The 50% reduced height offers a significant advantage in applications where compact designs are key, such as Rack or Blade Servers.

Moreover low package parasitic inductances result in an improved EMI behavior and a 50% bigger solder contact area avoids electro migration at high current levels, which results in improved reliability.

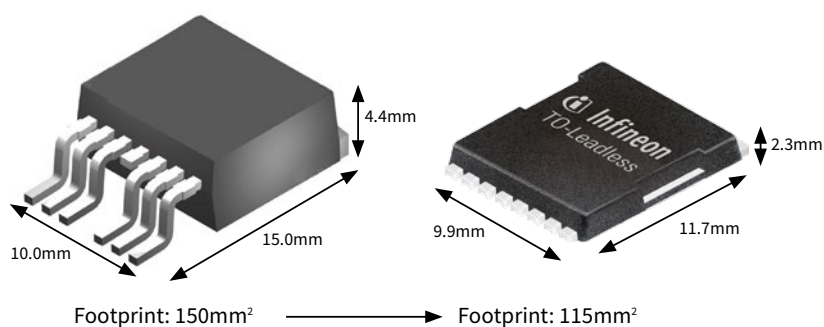
### Features

- Industry's lowest  $R_{DS(on)}$
- Highest current capability up to 300A
- Very low package parasitics and inductances
- Less paralleling and cooling required
- Highest system reliability
- System cost reduction
- Enabling very compact design



### Applications

- Forklift
- Light Electric Vehicles
- Point of Load (PoL)
- Telecom
- e-fuse





#### Benefits

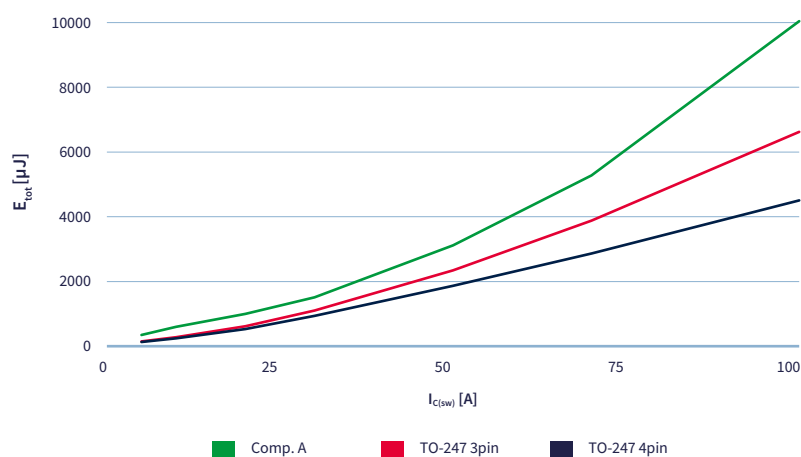
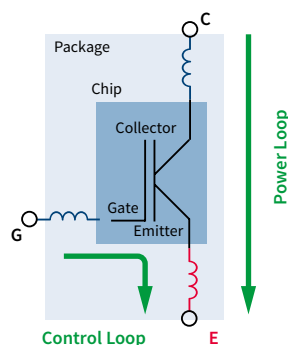
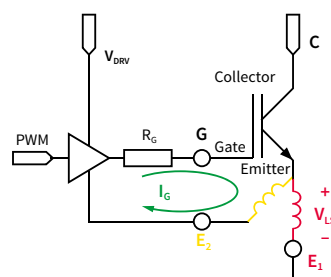
- Full load efficiency
- Improved EMI
- Better gate control
- Increased creepage

## TO- 247 4pin Full Load Efficiency for Free

### Package for High voltage switches with increased creepage and clearance

Infineon's TO-247 4pin package enables significant efficiency improvement in hard switched topologies and allows a better control at the same time. The fourth pin acts as kelvin source. The main current of the switch is placed outside of the gate loop and the feedback is eliminated. This leads especially at high currents to less switching losses. Secondly, the EMI will be reduced due to cleaner waveforms.

The benefit will be seen in various hard switching topologies used in AC/DC and DC/AC conversion. The package helps as well in designs where the next current or  $R_{DS(on)}$  class with a three pin approach must be chosen in high load operation. This is related to the improved efficiency by 5 to 8% at such operation condition.



## TO-247PLUS

Responding to the market requirement to accommodate ever increasing amounts of silicon in smaller, space saving packages, Infineon introduces the new package TO-247PLUS.

### Higher Current Capability - Improved Thermal Behavior

Infineon's new TO-247PLUS has the same outer dimensions as the industry standard TO-247, but due to the absence of the screw hole, allows up to 120A in 600V. Also the total backside active thermal pad area has been increased to improve heat dissipation capabilities of the package.

### Improved Thermal Management and Creepage Distances

Better heat dissipation through lower  $R_{th}$  improves thermal management, which means less heat sink and lower cost for the cooling infrastructure. TO-247PLUS package body has special "plastic trousers", that allows to increase the creepage distance to 4.25mm – 2mm bigger than the standard TO-247. Special cut-outs of the mold compound at the upper corners, increase creepage path at single clip mounting. Moreover, the TO-247PLUS plastic body has tighter tolerances to clip pressure comparing to the major competitors on the market, thus contributing for better reliability of the device use in application. A new bond wiring concept realized in TO-247PLUS package allows increase of the DC collector current from 80A to 160A (at  $T_c = 25^\circ\text{C}$ ) contributing to the better reliability and longer lifetime of the IGBT. TO-247PLUS 100A/120A is qualified according to industrial/automotive standards.

### Features

- Highest current rating co-pack 600V in 100A and 120A
- 35% bigger active thermal pad area for up to 20% lower thermal resistance  $R_{th(jh)}$
- Extended creepage distance of 4.25mm – 2mm bigger than TO-247

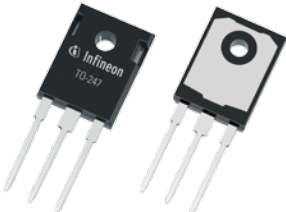
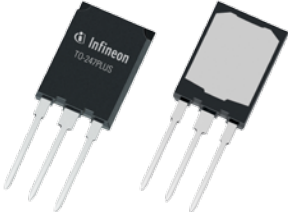
### Benefits

- Higher system power density –  $I_c$  increase keeping the same system thermal performance
- Lower thermal resistance  $R_{th(jh)}$  and improved by ~15% heat dissipation capability of TO-247PLUS vs TO-247
- Higher reliability, extended lifetime of the device



### Applications

- UPS
- Solar
- Welding
- Drives
- AirCon/ HVAC
- Automotive

TO-247	Major Differences	TO-247PLUS
	<ul style="list-style-type: none"> <li>■ Screw hole vs. no screw hole</li> <li>■ Maximum allowable chip area in single die ~70mm<sup>2</sup> vs 120mm<sup>2</sup></li> <li>■ Current capability (DuoPAK) 600V: 75A vs 120A (+60%)</li> <li>■ Increased creepage by 52% to 4.25mm</li> <li>■ Bond wire limit increased from 80A to 160A</li> <li>■ Bigger backside active thermal pad area due to missing hole 140mm<sup>2</sup> vs 190mm<sup>2</sup></li> <li>■ 20% lower thermal resistance <math>R_{th(jh)}</math></li> <li>■ 10%-15% better heat dissipation</li> </ul>	



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