

Power MOSFET and IGBT - Overview Brochure

Power Semiconductors

Efficient devices for a Green World



Renesas Power Semiconductors

Renesas understands the performance requirements of power semiconductors, for today and the future, taking advantage of renewable energy resources and also reducing power demands for consumer and industrial applications, achieving increased efficiency.

Renesas is a leading manufacturer of power semiconductors, merging the technology legacy of our founding companies Hitachi, Mitsubishi and NEC. This pool of knowledge enables us to offer high performance devices across the entire voltage range, from $V_{DSS} = 20\text{ V}$ to 1500 V for Power MOSFET and $V_{ces} = 600\text{ V}$ to 1350 V for IGBT.

The key benefits include:

- > Outstanding characteristics enabling highest efficiency circuit design based on exclusively owned technology, in-house IP and continuous new developments
- > Huge variety of packages for SMD and THD, allowing optimized circuit layouts
- > Complete control covering the entire manufacturing chain, from design to production processes to QA, leading to excellent logistics support including long term product availability
- > Full service customer support infrastructure

Power MOSFET

Low voltage	$V_{DSS} \leq 250\text{ V}$
Medium voltage	$250\text{ V} < V_{DSS} \leq 700\text{ V}$
High voltage	$700\text{ V} < V_{DSS} \leq 1500\text{ V}$
IGBT	$V_{ces} = 600\text{ V}, 1100\text{ V}, 1200\text{ V}, 1350\text{ V}$

Applications (typ.)

- Low voltage PSU, battery charger, small motor control, LED lighting
- Motor control inverter, consumer and industrial PSU, power conversion, solar inv., welding
- Motor control inverter, power conversion, PSU renewable energy

Requirements

- Low static and switching losses, low thermal resistance
- Low static and switching losses, high robustness, high switching speed
- Low $R_{ds(on)}$, high reliability, low thermal resistance

Solution

- Low $R_{ds(on)}$, low gate charge, UMOS tech, high performance packages
- Low $R_{ds(on)}$, low gate charge, including Super junction tech.
- Low $R_{ds(on)}$, low gate charge, no secondary breakdown

Product range

- Low voltage NP, uPA, RJK, ..series
- Medium voltage RJK, SJ, 2SK, .. series
- High voltage, 2SK series

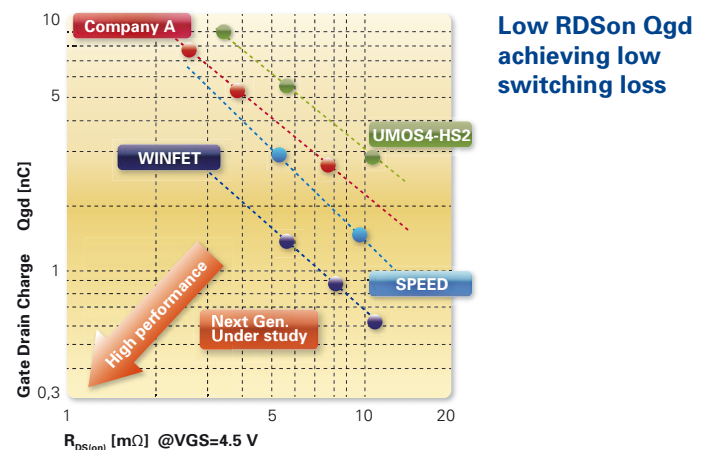
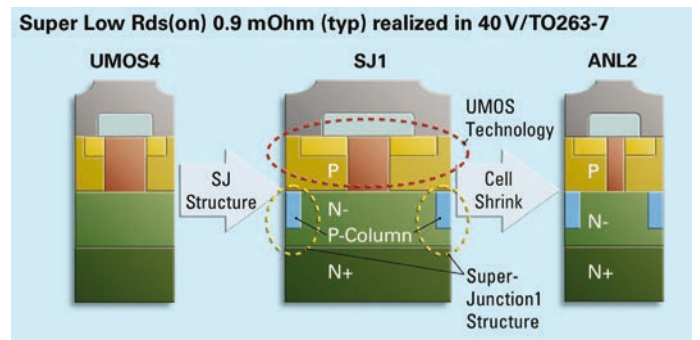
Efficient power designs

Low Voltage Power MOSFET $V_{DSS} \leq 250\text{ V}$

- > Wide range of voltage classes and current ratings
- > N-, P-channel, dual and complementary devices
- > Low $R_{ds(on)}$, low gate charge through proprietary IP such as UMOS & ANLx technology
- > Variety of standard and high performance packages, e.g. HVSON-8, Mini HVSON8, LFPK. Offering upgrade option to change eg. from SOP-8 to LFPK
- > Automotive qualification available on selected devices

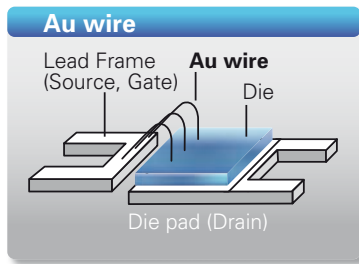
Over 1500 products in different voltage and current ratings

Voltage	20 V	250 V
Current	0,1 A	180 A

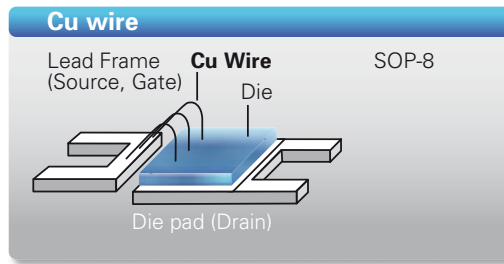


Minimized Package resistance

Low package resistance -> Reduction of conduction loss



~1.1 mOhm

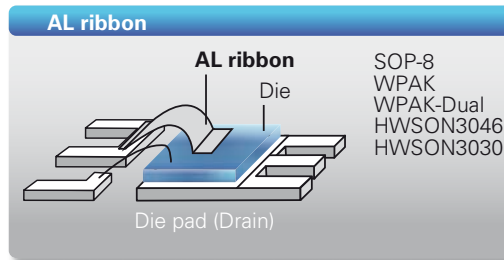


SOP-8

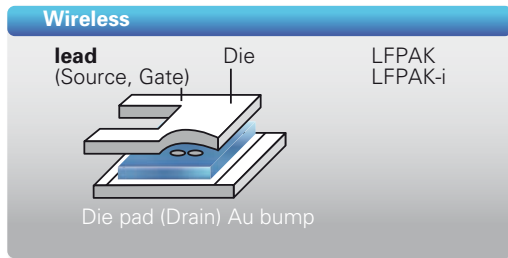
Advanced Assembly Technology

Package resistance

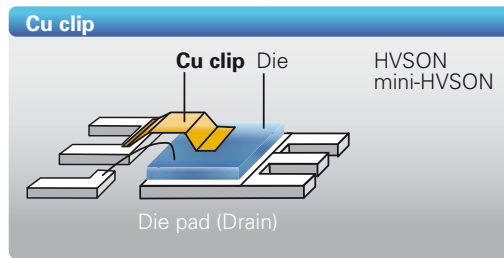
0.3-0.7 mOhm



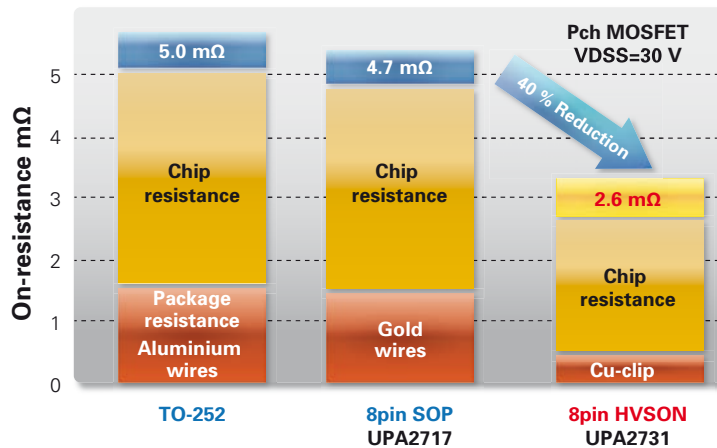
SOP-8
WPAK
WPAK-Dual
HWSON3046
HWSON3030



LPAK
LPAK-i



HVSON
mini-HVSON



Low Voltage Power MOSFET $V_{DSS} \leq 250V$

High performance packages

- > Small outlines,
- > low package resistance

Applied mounting and material technologies lead to outstanding performance



Dimensions in mm

Package examples
Power MOSFET
and IGBT

Power MOSFET

Medium Voltage Power MOSFET

250 V < V_{DS} <= 700 V

Increasing requirements in the range around $V_{DS} = 600$ V are covered by a large variety of products

- > Wide range of voltage and current ratings
- > THD and SMD package variety
- > Excellent efficiency through low $R_{DS(on)}$ and small gate drain charge Q_{gd}

New high performance product family:

Super Junction technology for 600 V

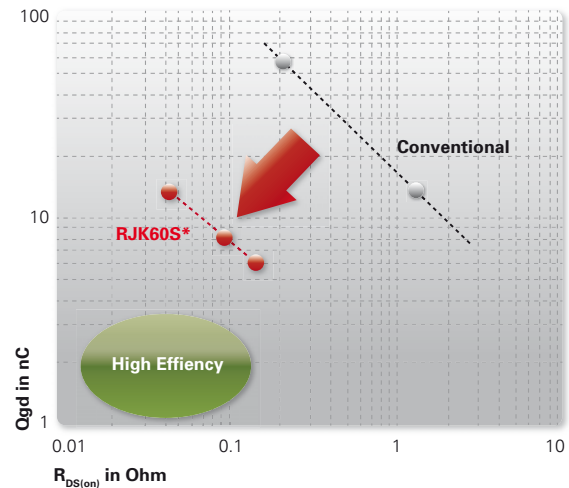
- > Outstanding low $R_{DS(on)}$ for low static losses down to 0.045 Ohm
- > Extremely low gate charge for high switching speeds
- > SMD and THD packages available

The ideal choice for power supply, welding, lighting, motor control and renewable energy applications.

Super Junction

$V_{DS} = 600$ V

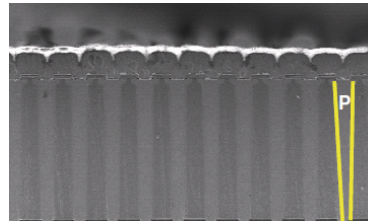
Outstanding performance in comparison to conventional design.



Medium and high Voltage Power MOSFET Overview

Over 250 products			
Voltage	250 V	600 V	1500 V
Current	0,1 A	12 A	55 A 88 A

Applied Deep trench structure for Super Junction

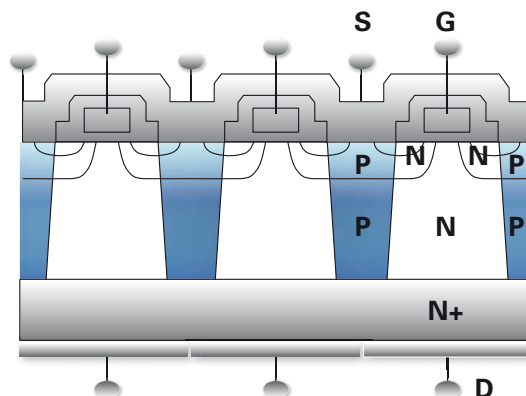


High Voltage Power MOSFET

700V <= V_{DS} <= 1500 V

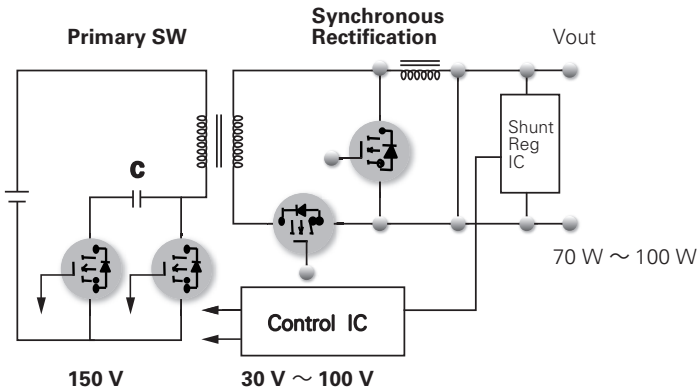
Renesas offers an attractive line up of discrete Power MOSFETs up to 1500 V. Along with increased efficiency requirements, several applications are moving from the "classic" range of 600 V to the high voltage area. Renesas can cover this with ideal products in several voltage classes: 900 V, 1000 V, 1500 V. Highest reliability and long term support gives the designer the right choice for leading-edge solutions.

Super Junction cross section



Application examples:

Brick converter, low voltage Power MOSFET Active Clamp Circuit topology

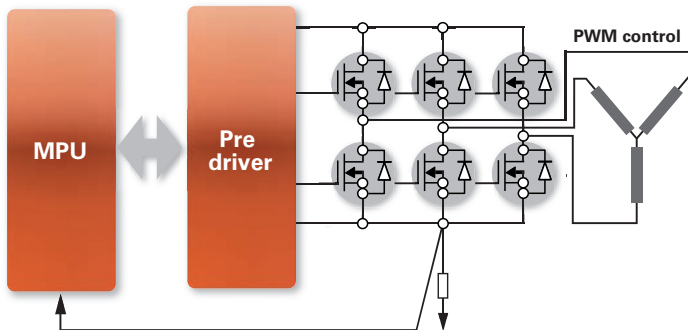


Advantages

- > Compact design through high performance packages
- > Minimum static and switching power losses through excellent $R_{DS(on)}$ and Q_{gd} values

Motor drive

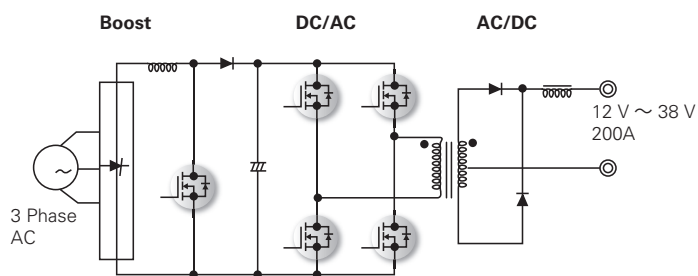
3 phase brushless motor-drive for Power tool



Advantages

High power density through high performance chip / package combination achieving minimum power losses and small footprint.

Welding (frequency 100 kHz)



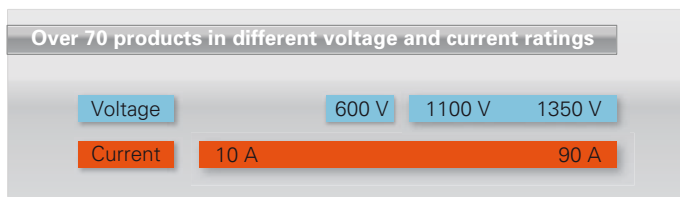
Advantages

High speed, minimum losses and robust design achieved by Super Junction technology.

IGBT

Renesas has a long experience in successfully designing IGBTs for various applications. This results in up to 70% global market share in specific application areas. These strengths are based on Renesas original technology, which has then been further developed and optimized for European customer requirements, for example in application areas such as inverters for motor control, renewable energy and induction heating

IGBT Product Range





Product highlights:


- > Full range within 600 V class, high voltage devices up to 1350 V, Easy to identify the best fitting product for an individual application*
- > Extremely low $V_{ce(sat)}$ for high efficiency and low static losses
- > Reliability through high short circuit capability up to 10 μ s, depending on product series* Gate emitter voltage rating +/- 30 V
- > Integrated fast recovery diode (FRD)** for compact design
- > SMD and THD packages, isolated and non isolated for full design flexibility

* Different product series offering application optimized characteristics
 **The majority of IGBT devices include a fast recovery diode (FRD) inside the same package for easy design, space and cost saving. Selected versions are also available without integrated FRD in order to further customize the characteristic within the circuitry.

Applications

IH Kitchen Appliances 

Inverter, solar inverter, welding 

PFC Circuits 

Requirements

High Output, Low Loss, All Metal

High-Frequency Operation, High Short Circuit Tolerance

Large Current, High Efficiency

Solution

High-Speed Trench IGBTs Composite Products with FRD applying HiGT***

HiGT*** with High Short Circuit Tolerance Composite Products with High-Speed FRD

Ultra-High-Speed IGBTs Composite Products with High-Speed FRD

Product series

F/BF/CF/DF-series

D/M/A8/CV/CD/CM-series

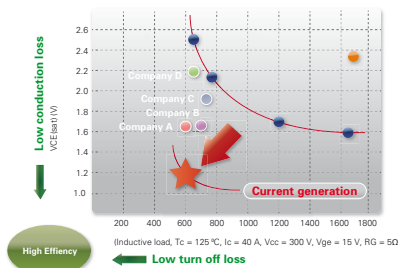
608-series

***HiGT: High conductivity IGBT
 Renesas Original Technology enables improvement of tradeoff between $V_{ce(sat)}$ vs. tail power loss.

IGBT technology

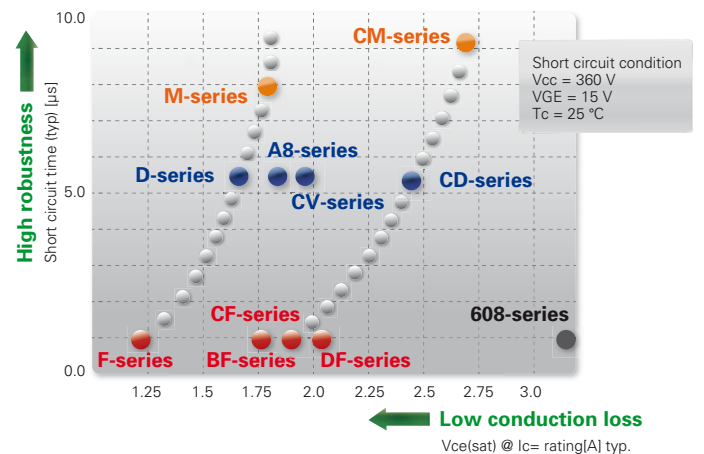


Applied thin wafer technology for low $V_{ce(sat)}$ resulting in lowest static losses



tsc vs. $V_{ce(sat)}$ for IGBT

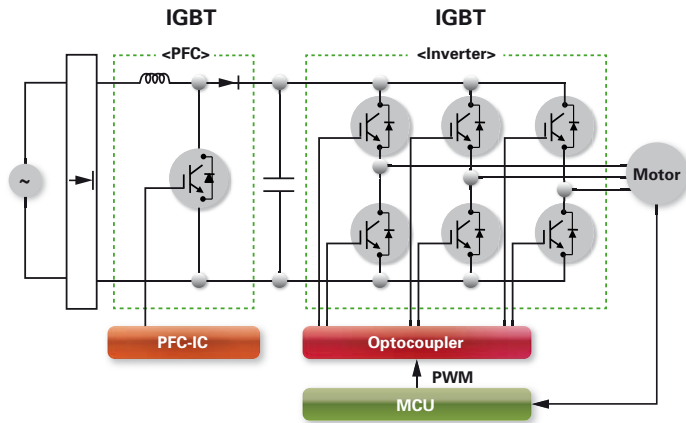
Application optimized characteristics



Application-optimized product families

Motor control inverter, solar inverter, welding

Product families in different voltage ranges **600 V** (D-, A8- and M-series) and **1200 V** (CV-, CD- and CM-series) offering a large variety. These products are the perfect choice for applications like motor control, solar inverter and welding. Robust characteristics combined with low power losses, are the key advantages of these IGBT product families.

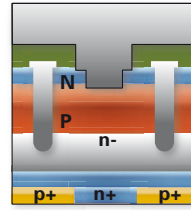


The optimum compromise between **low $V_{ce(sat)}$** and **short circuit withstand time t_{sc}** can be chosen by selecting **600 V class**

- > D-series and A8-series offering $t_{sc} = 5 \mu s$
- > M-series offering $t_{sc} = 8 \mu s$

1200 V class

- > CV-/CD-series offering $t_{sc} = 5 \mu s$
- > CM-series offering $t_{sc} = 10 \mu s$



IGBT
internal structure

Advantages

- > High output power with minimum losses through low $V_{DE(sat)}$
- > Robust design through high short circuit capability
- > Compact outlines through high current rated devices

Power Supply Unit

The 608-series product family was developed specifically for the requirements of high speed switching PSUs using PFC (Power Factor Correction). Recommended up to 100 kHz, with performing t_f (fall time) down to 40ns. The excellent performance of this IGBT product family is the cost down alternative to MOSFET designs.

Induction heating

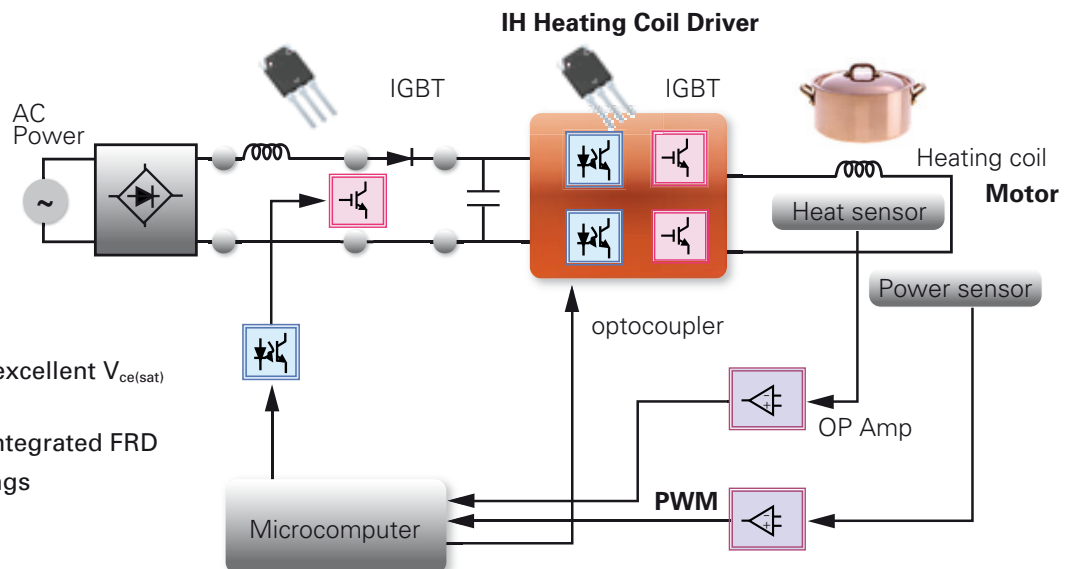
Highly efficient IGBT product family, based on Renesas' own HiGT** technology, achieving extremely low $V_{ce(sat)}$ for outstanding low static losses. Optimized characteristics for this application. Both topologies are supported:

- > Series resonant (half bridge) with a variety of 600 V IGBT -> F-series

and

- > Quasi resonant (single ended) are available 1100 V/1200 V/1350 V IGBT -> BF-, CF- and DF-series

IH Heating Coil Driver



Advantages

- > Low static losses through excellent $V_{ce(sat)}$ characteristics
- > Compact design through integrated FRD
- > Wide range of current ratings

Power Semiconductor – support infrastructure

Internet

<http://www.renesas.eu/products/discrete/index.jsp>

Catalog, line up information

General Catalog, “Discrete”:

http://documentation.renesas.com/doc/products/transistor/r07cs0003ej0200_discrete.pdf

Line up catalog “Status List”, full list of products and production status, updated quarterly

http://documentation.renesas.com/doc/products/transistor/r07cl0001ej0600_transistor.pdf

Application flyers eg.

http://documentation.renesas.com/doc/products/assp/r30ca0003xj0200_po-supply_je.pdf

Data, product selection

Cross reference search on internet:

<http://resource.renesas.com/AandP/crossreference/>

Online parametric search,

selection by parameters (e.g. voltage, current, $R_{DS(on)}$ / $V_{ce(sat)}$...)

<http://www.renesas.eu/>

Simulation, design support

http://www.renesas.com/products/analog_and_power/peer/support_tools.jsp

Including:

“Virtual Lab” design tool support for sync buck converter application

<http://www.renesas.eu/products/discrete/vp/index.jsp>

Before purchasing or using any Renesas Electronics products listed herein, please refer to the latest product manual and/or data sheet in advance.

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