Power & Discrete Semiconductor Highlights

Discretes, Drivers, Switch Mode Power Supply ICs, Voltage Regulators, AC/DC & DC/DC Converters, Power Supplies & Modules
Rutronik – Power Expertise meets Innovation

Many customers already know and appreciate Rutronik as a reliable partner with great expertise in power semiconductors and both an innovative and well-balanced portfolio. This brochure gives you an overview of our broad product portfolio as well as the latest, most advanced products in terms of power management and small signal devices.

The semiconductor market is still very dynamic with a high innovation rate due to the ever higher requirements of new applications with respect to regulation on the components. Regarding the manufacturers there is a lot of M&A actions, which is affecting as well the product innovation, the availability and the supply chain for the products.

**Power goes Efficient. Robust. Scalable.**

Today the markets requiring the most sophisticated solutions in terms of efficiency – growth drivers are e-mobility, power supplies as well as the renewable energy. Robustness is even mandatory in all safety functions and harsh environments, where you need the maximum of reliability for your system. To support fast time-to-market designs as well as modular systems, scalable solutions are hardly needed. Rutronik will offer you not only the state of the art components, Rutronik will offer you also innovative solutions and ideas for your application and design. So please be invited to join us and benefit from our expertise in Power Electronics.

**Consult** – Know-how. Built-in.

The technical competence from Rutronik Worldwide and individual consulting on the spot: by competent sales staff, application engineers and product specialists.

**Components** – Variety. Built-in.

The product portfolio from Rutronik Wide product range of semiconductors, passive and electromechanical components, storage, displays & boards and wireless technologies for optimum coverage of your needs.

**Logistics** – Reliability. Built-in.

The delivery service from Rutronik Innovative and flexible solutions: from supply chain management to individual logistics systems.


Quality management without compromise The integrated management system (IMS) encompasses quality control, environmental protection and occupational health and safety.
Power Supply Units

A power supply is a hardware component that supplies power to an electrical device. It converts main AC- to low regulated DC power for the internal components of an electrical system. The power supply is an integral part of electrical system and supports all the power that is needed for the electrical function of any system. The supplier portfolio has a wide range of different packages and power classes as well. Rutronik offers a large variation from leading suppliers like FSP, Murata Power Solutions, Recom and TDK-Lambda for applications in the field of Tele/Data communication, computer systems, industrial, office equipment, transportation, medical and power distribution applications. There are also options for redundancy and customized designed power supplies. Wah Hung is a specialist for customized solutions.

DC/DC & AC/DC Converter Modules

A DC/DC converter module is an electronic circuit which converts a source of direct current called DC from one voltage level to another one. The isolation of the DC/DC converter module allows the electronics design engineers to comply with the safety regulations and solve issues such as interferences and failure protection and helps to speed up any development and certification process. An AC/DC converter module converts main AC- to low regulated DC power for the internal components of an electrical system. It is an integral part of electrical system and supports all the power that is needed for the electrical function of any system. AC/DC and DC/DC converter modules offer a flexible and clean solution to Distributed Power Architecture systems in the lower range of power. Rutronik offers a strong portfolio of leading suppliers like RECOM, Murata Power Solutions and Delta for applications in the field of industrial, transportation, medical, energy, aerospace and communication segment.

Power Supply Units

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Housing</th>
<th>Power Range</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSP</td>
<td>-</td>
<td>25-400 W</td>
<td>3.3 V, 5 V, 12 V, 15 V, 24 V, 36 V, 48 V, 50-60 V</td>
</tr>
<tr>
<td></td>
<td>Open Frame</td>
<td>30-400 W</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Rack</td>
<td>1000-1000 W</td>
<td>x</td>
</tr>
<tr>
<td>Murata PS</td>
<td>-</td>
<td>250-400 W</td>
<td>3.3 V, 5 V, 12 V, 15 V, 24 V, 36 V, 48 V, 50-60 V</td>
</tr>
<tr>
<td></td>
<td>Open Frame</td>
<td>460-700 W</td>
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<tr>
<td>Recom</td>
<td>-</td>
<td>40-150 W</td>
<td>3.3 V, 5 V, 12 V, 15 V, 24 V, 36 V, 48 V, 50-60 V</td>
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<tr>
<td></td>
<td>Open Frame</td>
<td>40-150 W</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Rack</td>
<td>1000-1000 W</td>
<td>x</td>
</tr>
<tr>
<td>TDK-Lambda</td>
<td>-</td>
<td>10-1500 W</td>
<td>3.3 V, 5 V, 12 V, 15 V, 24 V, 36 V, 48 V, 50-60 V</td>
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<tr>
<td></td>
<td>Open Frame</td>
<td>10-1500 W</td>
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AC/DC Converter Modules

<table>
<thead>
<tr>
<th>Type</th>
<th>Power</th>
<th>Voltage</th>
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<tbody>
<tr>
<td>Kitce-GA</td>
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<td>5, 12</td>
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<td>Kitce-GB*</td>
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<td>3.3, 5, 9, 12, 15, 24</td>
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<td>Kitce-S/277**</td>
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<td>Kitce-S/277***</td>
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<td>Kitce-SC</td>
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<td>Kitce-SCA</td>
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<td>Kitce-SCB</td>
<td>5, 10, 20, 40, 50, 60</td>
<td>3.3, 5, 12, 15, 24, 48</td>
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<td>Kitce-SD</td>
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<td>Kitce-S/DC230</td>
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<td>Kitce-S/DC277</td>
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<td>Kitce-S/DC300</td>
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<td>Kitce-SC</td>
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<td>Kitce-S/DC</td>
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<td>5, 12, 15</td>
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*W = wired | **wired

DC/DC Converter Modules

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSP</td>
<td>-</td>
</tr>
<tr>
<td>Murata PS</td>
<td>-</td>
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<tr>
<td>Recom</td>
<td>-</td>
</tr>
<tr>
<td>TDK-Lambda</td>
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<table>
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<tr>
<th>Power [W]</th>
<th>Isolated</th>
<th>Non-Isolated</th>
<th>Standalone</th>
<th>Isolated</th>
<th>Non-Isolated</th>
<th>Micro DC-DC</th>
<th>Regulated</th>
<th>Unregulated</th>
<th>Non-Isolated</th>
<th>Isolated</th>
<th>Non-Isolated</th>
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<td>&gt; 1000</td>
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AC/DC: We Power your Products

Mains powered equipment requires universal input AC/DC converters if it is to be used globally, with full international certifications. RECOM specializes in on-board and off-board power supplies from 1W up to 480W with fully protected outputs and high efficiencies. The modules can be powered from as low as 80VAC up to 385VAC and come with 3kVAC/min or 4kVAC/1 min isolation.

Low Power AC/DC Modules

- RAC01, RAC02, RAC03, RAC04, RAC05, RAC06, RAC10

- Ultra-compact, low profile AC/DC module (class II) with 3kV AC isolation

- Space-saving 3”x2” or 4”x2” open-frame (class II) with 3kV AC isolation

- Fanless 40W, 65W, 100W or 135W

- RACM40, RACM65, RACM100, RACM150

- Less than 10mA leakage current (I2R rated output)

- Wide operating temperature range (-40°C to +85°C)

- UL/IEC/EN 60601-1 certified / 3 year warranty

AC/DC Power Supplies for Medical Applications

- REDIN4, REDIN60, REDIN120, REDIN240, REDIN480

- Boost power capability up to 150W

- Conformally coated and tested for high humidity environments

- UL/IEC/EN 60950 certified / UL 580 listed

- Side mount option for low-profile cabinets

- UL60601-1 certified, CB report

- 5 year warranty

DC/DC Converters for Every Application

When RECOM started to develop their first DC/DC converters more than 40 years ago, nobody could imagine their wide-spread use in electronics today. As one of the pioneers in this market, RECOM covers the entire power range from 0.25 - 240 Watts with a wide range of general purpose and application specific products. Whether regulated or unregulated, non-isolated or with very high isolation of up to 10kVDC, through-hole or SMD, industrial and medical grade, or designed for extremely low or high ambient temperature operation, RECOM offers a solution for every application.

Switching Regulator Module

- R-5xxx, R-6xxx, R-7xxx

- Asymmetric dual output

- 15V/3 / +20V/-5V / +15V/3

- Compact design

- High isolation up to 6kVDC

- Extreme low isolation capacity

- Efficiency up to 86%

- Operating temperature -40°C to +85°C

- EN / UL certified, CB report

- 3 year warranty

Low Power SMD DC/DC Converters


- 0.25 to 2 watt SMD converters

- Regulated and unregulated

- Very compact size

- Up to 3kV isolation

- Operating temperature -40°C to +100°C

- EN/UL certified

- CB report

- 3 year warranty

High Isolated DC/DC for IGBT/SIC

- RH, RP, RxxPxX/R, RxxPxx/R, RxxGZ, RV

- Ultra-compact design

- 1.8 to 2 watt in SIP7 package

- 2, 3.5 & 6 watt in DIP24 package

- Reinforced isolation up to 10kVDC

- Efficiency up to 86%

- Operating temp. -40°C to +85°C

- EN/UL certified, CB report

- IEC/EN/UL 60601-1

- 3 year warranty

DC/DC Converters for Cost-effective Applications

- R-78E, RP2078E, ROE, RSE, RSE/H, RKE, RKE/H, RSE, RSOE

- Ideal for the interface isolation in large numbers

- Pin-compatible with industry standard converter

- Operating temperature: -40°C to +85°C

- RISE suitable for vapor phase soldering

- RKE/H available with 3.7kVAC isolation

DC/DC LED Drivers

- For LED backlighting, LED display, LED lighting

- Wide input voltage range up to 72V

- Current and/or voltage feedback

- Full protection for LED and supply

- Extremely high isolation

- 3 to 120 watt in compact packages

- Industry standard pinouts

- Short circuit protection

- EN/UL certified, CB report

- 3 year warranty

Premium DC/DC for Industry Applications

- REC, REC3, REC5, REC3, REC4, REC6, REC8, REC10, REC10/M, REC15/M, REC20, RP02, RP20-AW, RP30-AW, RP40-AW, RP70-AW

- 3 to 120 watt in compact packages

- RKE/H available with 3.7kVAC isolation

- RKE/H available with 3.7kVAC isolation

Medical Grade DC/DC Converters

- REM1, REM3, REM6, REM10

- 250VAC working voltage – 2MOPP

- 2a patient leakage current

- 5kVDC/min isolation

- 8mm creepage and clearance

- Fully protected single / dual outputs

- IEC/EN/UL 60601-1

- 3 year warranty

- 5 year warranty
Power Supplies & DC-DC Converters
Highly Reliable Power Supplies for Industrial & Medical Equipment

TDK-Lambda, a subsidiary of the TDK Corporation, is a leading global power supply company providing highly reliable power supplies for industrial equipment worldwide. TDK-Lambda offers a broad product line of AC-DC power supplies, DC-DC converters and programmable power supplies from 1.5W to 15kW and meets the various needs of customers with entire range of activities, from research and development through to manufacturing, sales, and service with bases in five key areas, covering Japan, Europe, America, China, and Asia.

KMS-A – Series
Single Output, Medically Certified 15 - 60W Encapsulated Power Supplies
Designed for medical and industrial applications that require robust, encapsulated, lightweight and compact power supplies, these sealed AC-DC PCB mount KMS-A supplies resist dust and humidity.

- **Power**: 15, 30, 60W
- **Output Voltages**: 5, 9, 12, 15, 24Vdc

**Features:**
- EC 60601-1 & IEC 60950-1 approvals
- Input - Output isolation 4kVAC, 2 x MoPP
- Suitable for B & BF applications
- Enclosure leakage current less than 100μA
- Low off load power draw <0.3W
- Class II (no ground needed)
- Operating altitude 5,000m

KWS-A – Series
Class II Encapsulated Power Supplies Operate in High Ambient Temperatures
Featuring a wide operating temperature range of up to 85°C and start-up temperatures of –40°C, the single output encapsulated power module series KWS-A is ideal for harsh industrial applications.

- **Power**: 5, 10, 15, 25W
- **Output Voltages**: 5, 12, 15, 24Vdc

**Features:**
- Compact AC-DC supply with no need for external components
- 66% Footprint saving over previous generation KWS
- Improved efficiency values up to 88%
- No load power consumption less than 0.5 W
- Class II (no ground needed)

LS-Serie
25 -200W Single Output General Purpose Power Supplies
The LS series of 25W to 200W power supplies offers users both affordability and reliability with MTBF figures of up to 900,000 hours. Backed by a five year warranty, the LS has a superior operating performance in ambient temperatures up to +70°C.

- **Power**: 25, 50, 75, 150, 200W
- **Output Voltages**: 3.3, 5, 7.5, 12, 15, 24, 36, 48Vdc

**Features:**
- High MTBF up to 700,000 hours
- Superior operating temperature
- Performance up to 70 °C
- High efficiency up to 87%
- Low cost
- Compact
- Withstands 3000VAC surges (5x)
- Five year warranty

HWS-A
15-150W Industrial Power Supplies
Significantly upgraded in 2013, the HWS-A series now has a higher efficiency (up to 91%), a lighter weight and reduced no-load power consumption.

- **Power**: 15, 30, 50, 100, 150W
- **Output Voltages**: 3.3, 5, 12, 15, 24 and 48Vdc

**Features:**
- High efficiency up to 91%
- Wide range AC input
- Optional with or without cover
- Options: medical or heavy duty versions

DRB
15-480W Ultra Slim DIN Rail Power Supplies
The DRB series of single output DIN rail power supplies offers basic functionality with IEC/EN/UL 60950-1 and UL 508 certifications for power applications up to 480 W. The series combines low cost and extremely compact dimensions with efficiencies of up to 92%.

- **Power**: 15W, 30W, 50W, 100W, 150W, 200W, 350W, 480W
- **Output Voltages**: 5, 12-15, 24, 48Vdc

**Features:**
- Excellent efficiency – up to 92%
- ErP compliant up to 100W
- Single phase input
- 5 year warranty

CUS-S – Series
Single Output, Chassis Mount Medical & Industry Power Supplies
Convection cooled AC-DC series with full medical approvals and low profile – ideal for applications where audible noise cannot be tolerated.

- **Power**: 150, 200, 350W
- **Output Voltages**: 12, 18, 24, 36 or 48Vdc

**Features:**
- IEC 60601-1 (2x MoPP) & IEC 60950-1 Approvals
- Suitable for B & BF applications
- 200W convection cooled rating
- 350W convection (up to 420W rating with forced air )
- 5V Standby power (CUS200m, 5V & 12V Aux Power on board)
- Low profile (<1U)
- Operating altitude up to 5000m
- High efficiency up to 94%
- Low no-load power consumption (<0.5W)

CC-G
15 - 30W DC-DC Converters
The units are enclosed in a metal case with 6-sided shielding for lower noise and encapsulated for rugged shock and vibration performance.

- **Power**: 15, 30W
- **Output Voltages**: 3, 5, 12 or 15Vdc

**Features:**
- Industry Standard 1” x 1” Footprint
- Wide Range DC Input 9 - 36 or 18 - 76V
- High Efficiency - Up to 91%
- Adjustable output
- Remote on/off
- Six Sided Shielding

DRL
10-100W Low Profile, Ultra Slim DIN Rail Power Supplies
The low profile and ultra slim DRL series provide a reliable solution for many industrial applications and building automation.

- **Power**: 10, 30, 60, 100W
- **Output Voltages**: 12 or 24Vdc

**Features:**
- High Eff. up to 90% @ 230VAC
- UL510 class 2 compliant
- Low no load consumption
- “Fuse” shape design

EMC/EMI Filters
0.5A to 300 A Line Current

AC/DC Power Supplies

With design centers and ISO 9001:2000 registered manufacturing facilities on three continents, Murata is able to produce power supplies to the highest standards in terms of performance, efficiency, protection, approvals compliance and cooling for a multitude of application requirements. In addition to an expanding offering of standard models, Murata has a long and proud history of designing custom solutions to meet even the most stringent and challenging requirements.

PQC250 Series – 250W 3” x 5” Convection Cooled AC-DC Power

Features
- IEC60950-1 compliant, IEC62368-3 planned submission
- 250W compact high density, operation to 250W at +50°C
- Very low no load standby power; designed to meet ENERGY STAR® Program Requirements for Single Voltage
- External AC-DC Power Supplies
- Very low no load standby power; designed to meet 250W compact high density; operation to 250W at +50°C
- 60950-1 compliant, IEC62368 3 planned submission

Specifications
- Isolated 12W fan available and 10W standby
- Remote on-off and PS_OK (Aux output models)
- Remote sense
- 3rd ed. Medical and ITE safety approved
- Universal AC input with active PFC
- Remote sense, main output
- True zero load operation of the Main (V1) output; no minimum load requirements

Model Number Natural Connection Cooling Load Current Main Output (V1) Fan Output (V2) Aux Output (V2) Typical Efficiency
PQC250-12xx 250W 0 to 0.5A 12V 15W 94% High efficiency up to 95%
PQC250-15xx 24V 28W 93%
PQC250-24xx 24V 48W 93%
PQC250-36xx 36V 48W 93%
PQC250-48xx 48V 48W 93%
PQC250-54xx 54V 54W 93%

DC/DC Converter Highlights

Murata Power Solutions is one of the world’s largest suppliers of DC/DC converters. The main benefits of Murata Power Solutions are reliability, efficiency and cost-effectiveness. Their unique ability to blend proven circuit topologies, high-performance components, contemporary SMT construction and highly automated assembly brings you exceptional quality products, from standard off-the-shelf models to modified products and complete custom designs in a high grade of performance.

EMH-5A Series – Efficient Power-over-Ethernet for 24/48/60V Battery Systems

Isolated, 54Vdc, 3A, Ethernet Power Half-Brick DC-DC Converters
- PoE compliant
- 18V - 72V Vin Range
- 54Vout @ 3A (102W)
- 2250Vdc input to output isolation
- 97% efficiency
- Industry-standard Half Brick footprint
- Optional baseplate
- Datacom
- Networking applications

Applications
- Tele-communication
- Power-over-Ethernet
- Alternative Energy (wind power generators)
- Welding
- Motor Drives/Motion Control Medical
- Industrial/Railway

MGJ6HB, MGJ6FB, and MGJ63P- Gate Drive Power for Half, Full, and Three-phase Bridge Circuits

- Characterized dv/dt immunity 80kV/µs at 1.6kV
- Characterized partial discharge performance
- DC link voltage 3kVDC
- Reinforced insulation to 5kVAC
- 2250Vdc input to output
- PoE compliant
- 54Vout @ 3A (162W)
- 5V , 12V , & 24V input voltages
- 91% efficiency
- Industry-standard
- ANSI/AAMI ES60601-1 recognition pending
- 2 MOPP’s
- Gate Drive Power for Half, Full, and Three-phase Bridge Circuits

MGJ63P-12F24MC 9-18V 24V
MGJ63P-12F24MC 18-36V 24V
MGJ63P-12F24MC 54V 24V
MGJ63P-12F24MC 9-18V 48V
MGJ63P-12F24MC 54V 48V
MGJ63P-12F24MC 9-18V 24V

MVAC400 Series – Medically approved Highly Efficient Open Frame

Features
- 3rd ed. Medical and ITE safety approved
- Remote sense, main output
- Universal AC input with active PFC
- Less than 1U high

Specifications
- 3” x 5” industry standard footprint
- High efficiency 94% typical; excellent overall no load efficiency of circa 74%
- Current sharing option available
- Active inrush protection
- Convection-cooled operation up to 250W
- High efficiency up to 94%
- 3” x 5” x 1.4” standard footprint
- True zero load operation of the Main (V1) output; no minimum load requirements

Model Number Natural Connection Cooling Forced Air Cooling Main Output (V1) Fan Output (V2) Aux Output (V3) Typical Efficiency
MVAC400-12 250W w400W/550LPM 12V 15W 94%
MVAC400-24 24V 15W 93%
MVAC400-48 50W 12V 15W 94%

MVAC400-12 250W w400W/550LPM 12V 15W 94%
MVAC400-24 24V 15W 93%
MVAC400-48 50W 12V 15W 94%

IRx Series

Model Output Voltage Output Current Input Voltage Efficiency
IRH Series Encapsulated Half-Brick 150 Watt Isolated DC-DC Converter
IRH4.12T110 5 20 110
IRH4.12T110 24 6.25 110
IRH4.12T110 12 12.5 110
IRH4.12T110 24 6.25 110
IRH4.12T110 12 12.5 110
IRH4.12T110 24 6.25 110

ICQ Series: Wide Input 250 Watt Isolated Quarter Brick DC-DC
ICQ120V1PC 9 36 12 20.5
ICQ120V1PC 9 36 24 21
ICQ120V1PC 9 36 28 18

IHQ Series: Encapsulated Half-Brick 300 Watt Isolated DC-DC Converter
IHQ540V1PC 9 36 12 41
IHQ540V1PC 9 36 24 21
IHQ540V1PC 9 36 28 18

ICQ Series: Wide Input 250 Watt Isolated Quarter Brick DC-DC
ICQ120V1PC 9 36 12 20.5

Standard Power Modules

Isolated DC/DC Module

Open Frame DC/DC Brick
The power modules range all DOSA-compatible brick converter from 1/32 brick to ½ brick with industrial standard footprint and pinout. With 18 ~ 75V input voltage range, products output power up to 600W. Delta provides these high-density and high-efficiency converters with advance performance, flexibility and reliability, which are widely applied to the telecom, networking and datacenter marketplace.

<table>
<thead>
<tr>
<th>Package</th>
<th>1/32, 1/16, 1/8, ¼, ½ brick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>17~600W</td>
</tr>
<tr>
<td>Applications</td>
<td>Telecom, Networking, Datacenter</td>
</tr>
</tbody>
</table>

Encapsulated DC/DC Module
Delta’s expansive product portfolio provides solution capability to meet the specific requirements of industrial application. Products achieve extremely high efficiency, low power dissipation and greater reliability. These Modules housed in industrial standard footprint and pinout are easy to use and available in a fully encapsulated package for harsh environment applications.

<table>
<thead>
<tr>
<th>Package</th>
<th>SIP, SIP, SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>1~60W</td>
</tr>
<tr>
<td>Applications</td>
<td>Industrial, Railway, Healthcare</td>
</tr>
</tbody>
</table>

Panel Mount DC/DC Module
Panel-mounted DC/DC converter, a wide input range of 18~106V, can be provide 360W, regulated DC output voltage with high efficiency. It has an option for integrated fuse holder and enable on/off function. It also has parallel function; and allows a wide operation temperature range of -40° to +75°C with high reliability under extremely harsh operating conditions.

<table>
<thead>
<tr>
<th>Package</th>
<th>SIP, SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>3~30A</td>
</tr>
<tr>
<td>Applications</td>
<td>Telecom, Networking, Datacenter</td>
</tr>
</tbody>
</table>

Non-isolated POL
DOSA POL power modules are designed in an industry standard footprint and pinout. Each provides programmable output voltage by using an external resistor. Some series have flexible and programmable tracking and sequencing features to enable a variety of startup voltage as well as sequencing and tracking between power modules. Both DIP and SMD package are available.

<table>
<thead>
<tr>
<th>Package</th>
<th>SIP, SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>3~30A</td>
</tr>
<tr>
<td>Applications</td>
<td>Telecom, Networking, Datacenter</td>
</tr>
</tbody>
</table>

Panel Mount DC/DC Module
Delta offers a wide range of AC/DC power supplies in miniature, fully encapsulated plastic modules. All models provide universal input voltage 85~264VAC.

<table>
<thead>
<tr>
<th>Package</th>
<th>PCB Mount, Panel Mount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>2~60W</td>
</tr>
<tr>
<td>Applications</td>
<td>Industrial, Medical</td>
</tr>
</tbody>
</table>

Faster. Easier. Just more personal. rutronik24.com
Voltage Regulators

Rutronik offers a comprehensive portfolio of linear voltage regulators fitting a broad range of automotive, industrial and consumer applications from the world’s biggest and leading suppliers. We are an experienced long-term Distributor in power parts for all kinds of applications.

We are continuously expanding our portfolio to meet our customer’s present and future application requirements.

Small Package Automotive LDO
Smaller | Stronger | Faster

The world’s Smallest* Automotive-grade LDOs
The continued integration of cameras, sensor modules, and other devices that collect data in Advanced Driver Assist Systems (ADAS), which are experiencing rapid growth, has demanded increased miniaturization. To meet this need, the BUxxJA2MNVX-C series of 200mA output full CMOS regulators provide automotive-grade reliability in the industry’s smallest package (1.0mm x 1.0mm x 0.6mm). In addition, low power consumption with fast response is achieved, making them ideal for ADAS devices, power supplies for car radar/indicators, and similar applications.

World’s Smallest* Automotive-grade LDO Regulators

Ultra-Low Quiescent Current LDO Regulators

For MCU Applications in Body and Powertrain Systems

For Power Supplies in Information Systems (Various Output Levels/Package Types)

*April 2016 ROHM study
Infineon’s Power Supplies

Address a broad Range of Automotive Applications

Infineon offers a comprehensive portfolio of linear regulators and voltage trackers, fitting a broad range of automotive applications and is the global market leader with over 15 years of experience in the automotive regulator segment. Infineon continuously expands their portfolio to meet the customers present and future application requirements. Infineon automotive voltage regulators are especially designed for use in harsh environments and are offered in the highest quality level. The robust design approach ensures delamination-free ICs and long-term reliability.

Automotive Linear Voltage Regulators Portfolio

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Package</th>
<th>Maximum Input Voltage</th>
<th>Max Output Current</th>
<th>Output Voltage</th>
<th>Accuracy</th>
<th>Feature Set</th>
<th>Quiescent Current</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLE424xx-2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>TLE4255x</td>
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<td></td>
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<tr>
<td>TLS810x</td>
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<td>TLS850x</td>
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</tr>
<tr>
<td>TLF2051xx</td>
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<td>TLF2060xx</td>
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<td>TLF310xx</td>
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<td>TLF320xx</td>
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<td></td>
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<td></td>
<td></td>
</tr>
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<td>TLF419xx</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Infineon offers a comprehensive portfolio of linear voltage regulators fitting a broad range of consumer, computing, communications and industrial applications. By leveraging Infineon’s long standing and market leading experience in automotive power supplies application, they are expanding their portfolio to provide power supply solutions to customer’s current and future applications.

Linear Voltage Regulators for Industrial Applications

Infineon offers a comprehensive portfolio of linear voltage regulators fitting a broad range of consumer, computing, communications and industrial applications. By leveraging Infineon’s long standing and market leading experience in automotive power supplies application, they are expanding their portfolio to provide power supply solutions to customer’s current and future applications.

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Packages</th>
<th>Regulator Type</th>
<th>Output Voltage</th>
<th>Accuracy</th>
<th>Dropout Current</th>
<th>Typical Quiescent Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFX20002MB</td>
<td>Linear</td>
<td>5.0V</td>
<td>400mA</td>
<td>4.0%</td>
<td>50mA</td>
<td>1500µA</td>
</tr>
<tr>
<td>IFX20004MB</td>
<td>Linear</td>
<td>5.0V</td>
<td>400mA</td>
<td>4.0%</td>
<td>50mA</td>
<td>1500µA</td>
</tr>
<tr>
<td>IFX21401MB</td>
<td>Linear</td>
<td>5.0V</td>
<td>400mA</td>
<td>4.0%</td>
<td>50mA</td>
<td>1500µA</td>
</tr>
<tr>
<td>IFX21402MB</td>
<td>Linear</td>
<td>5.0V</td>
<td>400mA</td>
<td>2.0%</td>
<td>50mA</td>
<td>1500µA</td>
</tr>
<tr>
<td>IFX21403MB</td>
<td>Linear</td>
<td>5.0V</td>
<td>400mA</td>
<td>2.0%</td>
<td>50mA</td>
<td>1500µA</td>
</tr>
</tbody>
</table>

Recommended Infineon Industrial Voltage Regulators for Infineon Microcontroller Families

<table>
<thead>
<tr>
<th>MCU Family</th>
<th>MCU Input Voltage [V]</th>
<th>MCU Input Current (max) [mA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>INF1600 family</td>
<td>1.8V to 5.5V</td>
<td>100</td>
</tr>
<tr>
<td>INF4000 family</td>
<td>3.3V</td>
<td>550/300</td>
</tr>
<tr>
<td>INF560D family</td>
<td>3.3V</td>
<td>300</td>
</tr>
<tr>
<td>INF602D family</td>
<td>3.3V</td>
<td>300</td>
</tr>
<tr>
<td>INF607D family</td>
<td>3.3V</td>
<td>300</td>
</tr>
<tr>
<td>INF612D family</td>
<td>3.3V</td>
<td>300</td>
</tr>
<tr>
<td>INF616K/1000</td>
<td>1.5V and 3.3V or 5V</td>
<td>100</td>
</tr>
<tr>
<td>INF620K/1000</td>
<td>1.5V and 3.3V or 5V</td>
<td>100</td>
</tr>
</tbody>
</table>

www.infineon.com/voltage-regulators
ST's low dropout (LDO) regulators offer an optimal combination of low dropout voltage, low quiescent current, fast transient response, low noise and good ripple rejection. In particular, the ultra-low dropout (ULDO) regulators are ideal for battery-powered consumer applications as well as portable healthcare devices as a result of:

- Ultra-low quiescent current (down to 0.3 µA) which extends battery run time
- Tiny package options, including the 0.65 x 0.65 mm CSPs and 0.47 x 0.47 mm STSTAMPTM to achieve the smallest footprint

Signal fidelity is maintained over a wide range of input voltages and output currents all along the signal path, thanks to the high PSSR (power supply rejection rate) and low noise.

### Ultra Low Dropout

- **LD39200**:
  - 2A Ultra Low Dropout
  - 110mV of dropout @ 2A
  - Low startup voltage: 1.25V
  - Reverse current protection
  - High PSRR and low noise

### Low Dropout Current

- **STLQ020**: 200mA Very Low Dropout
  - 0.3 µA of quiescent current
  - 0.8x0.8 mm Flip Chip and DFN6 2x2mm package

- **LDLN025**: 250mA Very Low Dropout
  - 6.5µV Vrms of output noise
  - 75dB of PSRR
  - 0.65x0.65mm Flip Chip and DFN4 1x1mm package

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Maximum Current (mA)</th>
<th>Quiescent Current (µA)</th>
<th>Typ Vdrop at max load (mV)</th>
<th>Input Voltage Range (V)</th>
<th>PSRR typ @ 1kHz</th>
<th>Noise (uVrms)</th>
<th>Package</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>STLQ200</td>
<td>50</td>
<td>3.5</td>
<td>400</td>
<td>2.3-3.2</td>
<td>30</td>
<td>50</td>
<td>STS323SL</td>
<td>Ultra Low Iq</td>
</tr>
<tr>
<td>LDNQ15</td>
<td>85</td>
<td>5</td>
<td>550</td>
<td>4.3-4.4</td>
<td>45</td>
<td>95</td>
<td>STS323SL</td>
<td>Ultra Low Iq, High Vin</td>
</tr>
<tr>
<td>LD39015</td>
<td>85</td>
<td>3.8</td>
<td>500</td>
<td>2.5-2.4</td>
<td>45</td>
<td>95</td>
<td>STS323SL</td>
<td>Ultra Low Iq, High Vin</td>
</tr>
<tr>
<td>LD39015</td>
<td>150</td>
<td>18</td>
<td>80</td>
<td>1.5-5.5</td>
<td>65</td>
<td>29</td>
<td>STS323L</td>
<td>Flip Chip 4, High PSRR, Tiny Package</td>
</tr>
<tr>
<td>LD39015</td>
<td>150</td>
<td>20</td>
<td>80</td>
<td>1.5-5.5</td>
<td>74</td>
<td>30</td>
<td>Flip Chip 4, High PSRR, Tiny Package</td>
<td></td>
</tr>
<tr>
<td>LD39015</td>
<td>150</td>
<td>31</td>
<td>150</td>
<td>2.3-5.5</td>
<td>76</td>
<td>20</td>
<td>STS323L</td>
<td>Ultra Low Iq, Low Noise</td>
</tr>
<tr>
<td>LD39015</td>
<td>150</td>
<td>120</td>
<td>50</td>
<td>1.8-5.5</td>
<td>52</td>
<td>40</td>
<td>STS323L</td>
<td>Capsule</td>
</tr>
<tr>
<td>LD39015</td>
<td>150</td>
<td>15</td>
<td>35</td>
<td>2.5-5.5</td>
<td>93</td>
<td>6.3</td>
<td>DFN6 2x2</td>
<td>High PSRR, Ultra Low Noise</td>
</tr>
<tr>
<td>STQ015</td>
<td>150</td>
<td>1</td>
<td>115</td>
<td>1.5-5.5</td>
<td>40</td>
<td>75</td>
<td>STS323L</td>
<td>Ultra Low Iq</td>
</tr>
<tr>
<td>LD39020</td>
<td>200</td>
<td>20</td>
<td>200</td>
<td>1.5-5.5</td>
<td>80</td>
<td>45</td>
<td>STS323L</td>
<td>High PSRR, Tiny Package</td>
</tr>
<tr>
<td>LD39020</td>
<td>200</td>
<td>30</td>
<td>150</td>
<td>1.9-5.5</td>
<td>60</td>
<td>51</td>
<td>STS323L</td>
<td>High PSRR, Ultra Low Noise</td>
</tr>
<tr>
<td>LD39020</td>
<td>200</td>
<td>30</td>
<td>150</td>
<td>1.9-5.5</td>
<td>60</td>
<td>51</td>
<td>STS323L</td>
<td>High PSRR, Ultra Low Noise</td>
</tr>
<tr>
<td>LD39020</td>
<td>200</td>
<td>55</td>
<td>200</td>
<td>2.5-12.2</td>
<td>55</td>
<td>20</td>
<td>STS323L</td>
<td>Ultra Low Iq, High PSRR</td>
</tr>
<tr>
<td>LD39020</td>
<td>200</td>
<td>60</td>
<td>200</td>
<td>2.5-18.5</td>
<td>65</td>
<td>60</td>
<td>STS323L</td>
<td>Ultra Low Iq, High PSRR</td>
</tr>
<tr>
<td>STQ020</td>
<td>200</td>
<td>0.3</td>
<td>160</td>
<td>2.0-5.5</td>
<td>40</td>
<td>135</td>
<td>DFN4 2x2</td>
<td>Flip Chip 4, High PSRR, Tiny Package</td>
</tr>
<tr>
<td>LD39030</td>
<td>300</td>
<td>20</td>
<td>300</td>
<td>1.5-5.5</td>
<td>80</td>
<td>45</td>
<td>DFN4 2x2</td>
<td>High PSRR, Tiny Package</td>
</tr>
<tr>
<td>LD39030</td>
<td>300</td>
<td>20</td>
<td>300</td>
<td>1.5-5.5</td>
<td>62</td>
<td>30</td>
<td>Flip Chip 4, High PSRR, Tiny Package</td>
<td></td>
</tr>
<tr>
<td>LD39030</td>
<td>300</td>
<td>20</td>
<td>300</td>
<td>1.4-6.5</td>
<td>70</td>
<td>38</td>
<td>DFN4 1.2x1.3, Flip Chip 4, Ultra Low Noise</td>
<td></td>
</tr>
<tr>
<td>LD39030</td>
<td>300</td>
<td>1</td>
<td>300</td>
<td>1.4-6.5</td>
<td>70</td>
<td>38</td>
<td>DFN4 1.2x1.3, Flip Chip 4, Ultra Low Noise</td>
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<tr>
<td>LD39030</td>
<td>300</td>
<td>1</td>
<td>300</td>
<td>1.4-6.5</td>
<td>70</td>
<td>38</td>
<td>DFN4 1.2x1.3, Flip Chip 4, Ultra Low Noise</td>
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</tr>
<tr>
<td>LD39030</td>
<td>300</td>
<td>30</td>
<td>300</td>
<td>1.9-5.5</td>
<td>60</td>
<td>51</td>
<td>STS323L</td>
<td>High PSRR, Tiny Package</td>
</tr>
<tr>
<td>LD39030</td>
<td>300</td>
<td>120</td>
<td>125</td>
<td>2.5-6.5</td>
<td>62</td>
<td>45</td>
<td>DFN4 2x2, DFN4 3x3, DFN6 1.2x1.3, Low Noise</td>
<td></td>
</tr>
<tr>
<td>LD39030</td>
<td>300</td>
<td>125</td>
<td>125</td>
<td>2.5-6.5</td>
<td>62</td>
<td>45</td>
<td>DFN4 2x2, DFN4 3x3, DFN6 1.2x1.3, Low Noise</td>
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</tr>
<tr>
<td>STLQ08</td>
<td>800</td>
<td>35</td>
<td>70</td>
<td>1.6-5.5</td>
<td>80</td>
<td>45</td>
<td>STS323L</td>
<td>Flip Chip 4, High PSRR</td>
</tr>
</tbody>
</table>
Switching Regulators ICs

Rutronik’s unique switching regulator portfolio offers input-voltage capability up to 55 V, delivering output currents up to 4 A, with high switching frequency. This broad portfolio of ICs is composed of highly-specialized products to meet every market requirement: HV technology, together with high reliability and robustness for industrial applications, compactness, high efficiency at any load and a high level of performance for consumer and computer products. These devices embed a full set of protection functions (overcurrent, overvoltage, over-temperature) to increase the MTBF and reduce the number of external components. There are multiple package options, all offering compactness and high thermal performances to fit different applications.
LITIX™: Infineon® Auto LED Driver

The LITIX™ – Infineon® Auto LED Driver is an enabler of protected and high-performing lighting applications in the automotive industry. In particular, the constant current regulation secures the stable brightness of the LED over the whole automotive temperature and voltage range. Both the driver and LED are protected against overvoltage e.g. caused by voltage spikes or overtemperature. All kinds of load conditions are detected by its diagnostic features, such as open-load or shorted LED. All features are required to drive LEDs in harsh automotive environment conditions.

Key Features
- Constant output current, therefore constant brightness and extended LED lifetime
- Wide input voltage range
- Low drop voltage
- Open-load detection
- Overtemperature protection
- Short-circuit proof
- Reverse polarity proof
- Wide temperature range
- Very small SMD packages
- Automotive qualified

Applications
The Infineon automotive-optimized LED drivers address interior and exterior, low to high-power automotive LED applications such as: high and low beam, fog, DRL, position, tail, stop, CHMSL, RCL, reverse, turn indicator, dome, ambient lighting, status lamps etc.

LITIX™ – Infineon® Auto LED Driver consists of 4 sub-families:

- **LITIX™ Basic**: Flexible linear current source family with scalable feature set
- **LITIX™ Linear**: BCR400 series is the most cost effective solution to drive low-power LED
- **LITIX™ Power**: DC-DC converter and controller for medium to high-power applications
- **LITIX™ Power Flex**: Multiprofile DC-DC controller for highest flexibility/power applications

VIPerPlus HV Converters
Easy SMPS Design with Best Efficiency & Lowest Power Consumption: Where Every mW Counts

Today power supply units require more sophisticated methods for improving performance while energy saving regulations push for greater efficiency. VIPerPlus high voltage converters from STMicroelectronics address the challenge. They combine an 800 V avalanche rugged power switch with state-of-the-art PWM circuitry for control, and offering a comprehensive set of features and built-in protection. The result is a switched-mode power supply (SMPS) design that meets the most demanding energy-saving regulations and more: high reliability, flexibility and minimal component count.

Typical Topologies
- Isolated flyback
- Secondary-side reg. (SSR)
- Primary-side reg. (PSR)
- Non-isolated
- Buck / Buck-boost

Common Features
- PWM current mode
- Cycle-by-cycle OCP
- Light load management
- Soft start up
- Thermal shutdown
- Short-circuit protection
- Automatic restart after fault

Typical Applications
- Home automation
- Metering
- Lighting
- Home appliances
- IoT
- Consumer electronics

Simulation Tool
Design is also made easy thanks to the online simulation tool: www.st.com/eDesignSuite

New Families Highlights
- VIPer06, VIPer11 & VIPer1P: Optimized also for non-isolated topologies thanks to embedded E/A & self-supply (to remove auxiliary winding)
- VIPer11 & VIPer0P: Extended VCC (4.5 to 30 V)
- VIPer11: Low input voltage (18 VDC)
- VIPer0P: Zero power mode (ZPM)
Charge/Discharge Path 3 to 8 Cell Battery Pack Monitor
ISL94202 – Series

The ISL94202 is a Li-ion battery monitor IC that supports from three to eight series connected cells. It provides complete battery monitoring and pack control. The ISL94202 provides automatic shutdown and recovery from out-of-bounds conditions and automatically controls pack cell balancing. The ISL94202 is highly configurable as a stand-alone unit, but can be used with an external microcontroller, which communicates to the IC through an I2C interface.

Features
- Eight cell voltage monitors support Li-ion CoO2, Li-ion Mn2O4, and Li-ion FePO4 chemistries
- Stand-alone pack control – no microcontroller needed
- Multiple voltage protection options (each programmable to 4.8V, 12-bit digital value) and selectable overcurrent protection levels
- Programmable detection/recovery times for overvoltage, undervoltage, overcurrent, and short-circuit conditions
- Configuration/calibration registers maintained in EEPROM
- Open battery connect detection
- Integrated charge/discharge FET drive circuitry with built-in charge pump supports high-side N-channel FETs
- Cell balancing uses external FETs with internal state machine or external microcontroller
- Enters low power states after periods of inactivity
- Charge or discharge current detection resumes normal scan rates

Tools
Evaluation Board ISL94202EVKIT1Z

Applications
- Power tools
- Battery back-up systems
- Light electric vehicles
- Portable equipment
- Energy storage systems
- Solar farms
- Medical equipment
- Hospital beds
- Monitoring equipment
- Ventilators

High Voltage DC/DC Converter ICs

ROHM provides a complete line-up of High Voltage DC/DC-Converter ICs. In addition to the just released BD9G341, ROHM offers other solutions like BD9G101, with internal high-side 42V Power MOSFET, providing 0.5A DC output with small SOT23 package. ROHM’s DC/DC-Converter-ICs are built for power supplies, industrial distributed applications, automotive, battery powered equipment

BD9G341

Features
- Wide input voltage range: 12V to 76V (80V max.)
- Output current: up to 3A
- High efficiency under light and heavy load conditions

BD9G341 – Tiny 6-pin SOT23 / SSOP6 package

Features
- \( V_{\text{IN}} = 6V \) to 42V
- \( V_{\text{OUT}} = 1V \) to \( 0.7 \times V_{\text{CC}} \)
- \( I_{\text{OUT}} = 500mA \)
- Switching Frequency \( = 1.5MHz \)
- Under Voltage Lockout (UVLO), Thermal Shutdown (TSP), Over Current (OCP) Protection
- ENABLE pin
- Operating Temperature of -40°C to +105°C

Typical Application Circuit
The BCR4xxU family offer a simple means of driving multiple low power LEDs in single strings focussed on 12V, 24V and 48V systems. Supporting adjustable currents from 10 to 350mA, which allows an optimized LED current to be set giving a uniform brightness and extends the LED longevity. Available in SOT26 (SC-74) package for pin-compatibility with other sources and also DFN2020 for low profile edge lighting strips.

**Features**
- 1.4 to 40V Supply Voltage
- Low voltage overhead to increase efficiency with sufficient headroom for over-voltage conditions such as LEDs failing short
- 10mA to 350mA
- Adjustable CCR enables platform designs based on a single device to used across multiple LED strips – easing manufacturer’s qualification
- Negative Temperature Coefficient
- Self-protects and allows current sharing between parallel CCRs
- BCR421U with PWM
- PWM directly from MCU with up to 25kHz to adjust light output

**Applications**
Diodes Incorporated’s LED driving solutions are not only recognised for their high efficiency and simplicity; they are also renowned for their incredible versatility and are well suited to tackle a wide range of applications, such as:
- LED strip lights
- Automotive
- Signage and display

**Specifications**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Configuration</th>
<th>PWM from MCU</th>
<th>Max. Input Voltage</th>
<th>Max. Current</th>
<th>Adjustable Current</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCR420UW6/Q</td>
<td>NPN Low-side</td>
<td>No</td>
<td>40V</td>
<td>10mA</td>
<td>10 to 200mA</td>
<td>SOT26 (SC-74)</td>
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<tr>
<td>BCR421UW6/Q</td>
<td>NPN Low-side</td>
<td>Yes</td>
<td>40V</td>
<td>10mA</td>
<td>10 to 350mA</td>
<td>SOT26 (SC-74)</td>
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<tr>
<td>BCR401UW6/Q</td>
<td>PNP High-side</td>
<td>No</td>
<td>40V</td>
<td>10mA</td>
<td>10 to 65mA</td>
<td>SOT26 (SC-74)</td>
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<tr>
<td>BCR402UW6/Q</td>
<td>PNP High-side</td>
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<td>20 to 65mA</td>
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<td>BCR405UW6/Q</td>
<td>PNP High-side</td>
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<td>50mA</td>
<td>50 to 65mA</td>
<td>SOT26 (SC-74)</td>
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<tr>
<td>BCR420UFD/Q</td>
<td>NPN Low-side</td>
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<td>40V</td>
<td>10mA</td>
<td>10 to 200mA</td>
<td>DFN2020</td>
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<tr>
<td>BCR421UFD/Q</td>
<td>NPN Low-side</td>
<td>Yes</td>
<td>40V</td>
<td>10mA</td>
<td>10 to 350mA</td>
<td>DFN2020</td>
</tr>
</tbody>
</table>

Automotive Compliant products with a Q suffix are AECQ qualified and supported with a PPAP.

**Flexible Wireless Battery Charger Design for Standard & Custom Applications**

**STWBC/STWLC Families – Optimized for Wearable & Portable Devices**

Wireless battery chargers (WBC) are becoming more and more popular, especially for wearable devices, where the miniaturization makes the difference, and for portable devices, where a more frequent charging is required in order to avoid running on low battery. WBC transmitters are expected to become ubiquitous in hotels, airports, cafes and public places, allowing consumers to leave their cables at home and top up batteries in their devices wherever they are.

The STWBC transmitter family allows full compatibility with the Qi® standard. The STWBC performs all the essential functions for transmitter control: the detection of a valid receiver, the control of the amount of transmitted power matching with RX request, and the detection of metal objects close to the receiver (foreign objects detection, FOD). Uniquely, the STWBC family offers different firmware options, which allow customers to personalize their end products through an API libraries-based firmware and GUI or just take advantage of a turn-key design. The STWLC receiver family is compatible with Qi® & PMA standard protocol, allowing automatic detection of operating standard.

**Typical Applications**
- Wearable devices
- Charging accessories
- Cell Phones and Smartphones chargers

**Support and Development Tools**
A set of evaluation boards is available including Qi® A11 and A34 certified reference designs, and a custom kit for wearable applications.

**STWBC**
- STWBC: 5W Qi®1.1 A11 certified; API; turnkey SW
- STWBC-W A: optimized for low-BOM wearables
- STWBC-MC: 5W Qi®1.2 A34 multi-coil
- STWBC-EP*: 15W Qi®1.2 EPP applications

**Features & Package**
- Active object detection
- Transmitted power control
- Foreign object detection
- Low standby power
- QFN 5x5mm 32L

**STWLC**
- STWLC03: 1-12W Qi® 1.1 & PMA compatible
- STWLC04: Qi-based, optimized for 1W wearables

**Package**
- Flip Chip 77 bumps (3.12x4.73 mm)
SiC462 microBUCK®
First in a Family of 4.5 V to 60 V Input Buck Regulators

SiC462’s architecture delivers ultra-fast transient response with minimum output capacitance and tight ripple regulation at very light load. The device is stable with any capacitor and no external ESR network is required for loop stability. The device also incorporates a power saving scheme that significantly increases light load efficiency. The regulators integrates a full protection feature set, including over current protection (OCP), output overvoltage protection (OVP), short circuit protection (SCP), output undervoltage protection (UVP) and thermal shutdown (OTP). It also has UVLO for input rail and a user programmable soft start.

Features
- Scalable solution: 3 A, 6 A, and 10 A
- Stable with any output capacitor
- Low quiescent current – 250 μA
- Adjustable current limit, soft start, switching frequency
- Ability to start up into a pre-biased load
- Protection and monitoring: OVP, OCP, UVP, OTP, UVLO, power good
- -40˚C to +105˚C operating ambient temperature

Applications
- Base station power supplies
- Distributed supply regulation
- General purpose POL
- High-voltage single-board systems
- Industrial power supplies
- Wall transformer regulation

Minimum Solution Size
- < 20 mm x 30 mm

Technical Features
- Wide operating voltage up to 60V
- Up to 10A load (100W output power)
- Low operation current (<250μA)
- Full protections (OC, OV, OT and UV)
- Power Good / Enable
- Fast Transient Response

Efficiency at 300 kHz
- 24 VIN to 12 VOUT
- 24 VIN to 5 VOUT
- 48 VIN to 12 VOUT
- 48 VIN to 5 VOUT

Load Current (A)
Protected MOSFETs

Protected MOSFETs are known as low-side and high-side switches. High-side switches, with additional integrated features that can switch high currents into grounded loads safely and in compliance with the harsh automotive environment. High-side switches only require a simple TTL logic input, and incorporate a diagnostic output status to auto restart Thermal shutdown with restart/ protection against loss of battery and GND, reverse battery protection, short-circuit protection, voltage protection, latch, over-current and over-voltage protection. Optional features for inputs with mapping function, small 150 mil package only. 2 direct function, small 150 mil package.

Technical Facts

<table>
<thead>
<tr>
<th>Infineon</th>
<th>STMicroelectronics</th>
<th>Diodes</th>
<th>Renesas</th>
<th>Rohm</th>
<th>Toshiba</th>
<th>NJM</th>
<th>Intersil</th>
</tr>
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<tbody>
<tr>
<td><strong>Product Identification</strong></td>
<td><strong>High Side Switch</strong></td>
<td><strong>Low Side Switch</strong></td>
<td><strong>Diodes</strong></td>
<td><strong>Renesas</strong></td>
<td><strong>Rohm</strong></td>
<td><strong>Toshiba</strong></td>
<td><strong>NJM</strong></td>
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<td>BI32xx, BI33xx</td>
<td>B32Bxx, B33Bxx</td>
<td>B32Bxx, B33Bxx</td>
<td>BD54xx, BD55xx</td>
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<td>BD58xx, BD59xx</td>
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<td>BD62xx, BD63xx</td>
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<tr>
<td>BI32xx, BI33xx</td>
<td>B32Bxx, B33Bxx</td>
<td>B32Bxx, B33Bxx</td>
<td>BD66xx, BD67xx</td>
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<td>TLE88xx, TLE89xx</td>
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<tr>
<td><strong>Features</strong></td>
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<tr>
<td>MOSFET Technology</td>
<td>MOSFET Technology</td>
<td>MOSFET Technology</td>
<td>MOS7 Technology</td>
<td>MOS Technology</td>
<td>MOS Technology</td>
<td>MOS Technology</td>
<td>MOS Technology</td>
</tr>
<tr>
<td><strong>Logic Level input, switch clamp</strong></td>
<td><strong>Switching time optimized for low</strong></td>
<td><strong>Reverse battery protection</strong></td>
<td><strong>Over temperature shutdown</strong></td>
<td><strong>Optimized for USB and</strong></td>
<td><strong>Detecting a load short to power</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Microcontroller</strong></td>
<td><strong>Reverse battery protection</strong></td>
<td><strong>Protection against loss of battery and GND</strong></td>
<td><strong>Low voltage operation</strong></td>
<td><strong>250 - 1100 V</strong></td>
<td><strong>fail safe and full time</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Protected MOSFETs</strong></td>
<td></td>
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</tr>
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</table>
They offer protection against e.g. overload, overtemperature, short circuit for all kinds of automotive applications. The highly integrated PROFET™ family (Protected FET) incorporates a broad range of smart features like diagnose and protection. PROFET™ intelligent power high side switches consist of a DMOS power transistor and CMOS logic circuitry for complete built-in protection. They offer protection against e.g. overload, overtemperature, short circuit for all kinds of automotive applications.

### PROFET™ Smart High-Side Switches

The highly integrated PROFET™ family (Protected FET) incorporates a broad range of smart features like diagnose and protection. PROFET™ intelligent power high side switches consist of a DMOS power transistor and CMOS logic circuitry for complete built-in protection.

### Automotive Applications
- Lighting: Exterior and interior lighting (bulb/LED)
- Power Distribution: Relay & fuse replacement, solid state, relay, Smart Power Distribution Center (PDC)
- Heating: Seat, PTC, auxiliary, glow plug
- Motor Control: DC brush motor, pumps, fans
- Infotainment

### Industrial Applications
- Automation/robotics
- General load management
- Electric drives
- Control systems/energy saving

### PROFET™ families overview

<table>
<thead>
<tr>
<th>Family name</th>
<th>Basic features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classic PROFET™</td>
<td>- High-side switches for load currents between 0.25 and 12 A - Suitable for resistive, capacitive and inductive loads - Wide operating voltage range - On-state resistance between 2.5 and 10 m - Improved electromagnetic compatibility (EMC) - Protection: overtemperature, overvoltage, load dump, reverse polarity - Diagnosis: open load in OFF detection, current sense (partial)</td>
<td>- Diagnostic: load current sense output - Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit - PWM capability up to 200 Hz (PROFET™+ 12V) or 400 Hz (PROFET™+ 24V) - High-side switches for nominal load currents between 0.25 and 12 A - Especially suitable for capacitive loads - Operating voltage range: PROFET™+12V: 5 ~ 28 V PROFET™+24V: 5 ~ 36 V - 3.3 and 5V compatible logic input - PWM capability up to 1 kHz - Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit - Improved heat dissipation of DSO package</td>
</tr>
<tr>
<td>PROFET™+ 12V and 24V</td>
<td>- High-side switches for load currents between 0.5 and 10 A - Especially suitable for capacitive loads - Operating voltage range: - PROFET™+12V: 5 ~ 28 V PROFET™+24V: 5 ~ 36 V - 3.3 and 5V compatible logic input - PWM capability up to 1 kHz - Protection: current tripping, overtemperature, overvoltage, load dump, reverse polarity, short-circuit - Improved heat dissipation of DSO package</td>
<td>- 50% reduced current consumption - Simplified and cost efficient ground network only requiring small resistor while offering functional system safety - Outstanding current sense accuracy (KILIS) ≤ 5% @ nominal current - Benchmark cranking voltage capability able to work down to 3.1 V - 40% smaller package than previous generation offering - 60% smaller package than previous generation offering - Optimized for design flexibility across the family due to pin to pin compatibility - Very low output leakage current 'quiescent current' (≤ 0.5 µA up to 85°C)</td>
</tr>
<tr>
<td>PROFET™+2</td>
<td>- High-side switches for load currents up to 45 A - Suitable for resistive, capacitive and inductive loads - Optimized for 12 and 24 V supply voltages - Current-driven and voltage-driven input logic - On-state resistance from typically 20 to 2.5 m – 3.3 and 5V compatible logic input - PWM capability - Very high energy capability up to 3 joul - Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit - Improved heat dissipation of DSO package</td>
<td>- 50% reduced current consumption - Cost efficient ground network only requiring small resistor while offering functional system safety - Outstanding current sense accuracy (KILIS) ≤ 5% @ nominal current - Benchmark cranking voltage capability able to work down to 3.1 V - 40% smaller package than previous generation offering - 60% smaller package than previous generation offering - Optimized for design flexibility across the family due to pin to pin compatibility - Very low output leakage current 'quiescent current' (≤ 0.5 µA up to 85°C)</td>
</tr>
<tr>
<td>High-CURRENT PROFET™</td>
<td>- High-side switches for load currents up to 45 A - Suitable for resistive, capacitive and inductive loads - Optimized for 12 and 24 V supply voltages - Current-driven and voltage-driven input logic - On-state resistance from typically 20 to 2.5 m – 3.3 and 5V compatible logic input - PWM capability - Very high energy capability up to 3 joul - Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit - Improved heat dissipation of DSO package</td>
<td>- Efficient and robust drives for high-current loads - Monitoring of load current - Protection of device, wiring harness and load - Available in standard power packages, such as DPAK and QFN</td>
</tr>
<tr>
<td>Power PROFET™</td>
<td>- High-side switches for load currents up to 40 A - Suitable for resistive, capacitive and inductive loads - Optimized for 12 V supply voltage - Voltage-driven input logic (3.3 and 5V) - Stable behavior during cranking down to 3.2 V supply voltage - Low on-state resistance down to 1.0 m – - Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit - Improved heat dissipation of DSO package</td>
<td>- Efficient and robust drives for high-current loads - Monitoring of load current - Protection of device, wiring harness and load - High short-circuit robustness - Available in standard power package (QFN)</td>
</tr>
</tbody>
</table>
Infineon offers IR protected Mosfets qualified protected high-side switches to drive any kind of load connected to the ground. IR's high-side Intelligent Power Switch (IPS) family integrates into a single package a low RDS(on) output HEXFET® power MOSFET with protection and control circuits, making these ICs the most rugged, efficient and compact devices available for automotive loads in harsh environments. The embedded charge pump makes the interface to the microcontroller very simple with full logic-level compatibility.

Providing the ideal replacement for electro-mechanical relays, these devices suit applications including transmission and electronic stability controls, lighting, ABS, fuel injection systems, pump motors and radiator fans.

**Features**
- Protected high side switch
- AEC qualified
- Rdson from 3mΩ up to 120mΩ
- Packages:
  - D²pak – 5 leads, 7 leads
  - DPAK/SO8
- Voltage and current controlled
- High speed or high energy
- 12V and 24V applications

**Benefits**
- Over-current protection
- Over-temperature protection restart / latch
- Reverse battery protection
- Active clamp
- Digital diagnostic output
- Open load detection
- Proportional load current sensing
- ESD protected

**Applications**
- Suitable for resistive, inductive and capacitive loads
- Fuse replacement
- Relay replacement
- Small motors
- Solenoids

---

**HITFET™+ stands for highly integrated temperature protected MOSFET. These low-side switches offer a compelling feature set with protections against over temperature, short circuit and overload conditions as well as ESD robustness.**

HITFET™+ is a highly scalable portfolio based on new technology. In order to meet specific application requirements Infineon provides two different packages (TO252-x, TDSO-8) and two types of feature sets - standard versions (BTS3xxx) and fully featured devices (BTF3xxx).

Now available are 8 new RTSxxx HITFET™+ products with a standard feature set and different RDSon. BTS3035, BTS3050, BTS3080, BTS3125 are available in a DPAK and TDSO-8 package. With the new benchmark TDSO-8 package Infineon enables 50% footprint shrink compared to DPAK and 35% shrink compared to SOT223. package. At the same time the devices achieve an outstanding thermal capability. The devices are optimized to drive capacitive, inductive and resistive loads for 12V automotive and industrial applications.

---

**Features**
- Very low power DMOS leakage current in OFF state
- 3.3V and 5V compatible logic inputs
- Electrostatic discharge protection (ESD)
- Adjustable switching speed
- Handshaking digital feedback with autostart in power stage
- Green product (RoHS compliant)
- AEC qualified
- Packages: 3-pin and 5-pin DPAK

**Benefits**
- Increased robustness
- Selectable slew-rate
- 3.3V microcontroller compatible
- Low DMOS leakage current
- Suitable for resistive, inductive and capacitive loads
- Fuse replacement
- Relay replacement
- Small motors
- Solenoids

**Applications**
- Suitable for resistive, inductive and capacitive loads
- Fuse replacement
- Relay replacement
- Small motors
- Solenoids

---

**The New Low-side Switch Family HITFET™+ With Outstanding Design Flexibility**

IR Protected MOSFETs

Automotive Intelligent High Side Power Switch (IPS)

Infineon offers IR protected Mosfets qualified protected high-side switches to drive any kind of load connected to the ground.

IR’s high-side Intelligent Power Switch (IPS) family integrates into a single package a low RDS(on) output HEXFET® power MOSFET with protection and control circuits, making these ICs the most rugged, efficient and compact devices available for automotive loads in harsh environments. The embedded charge pump makes the interface to the microcontroller very simple with full logic-level compatibility.

Providing the ideal replacement for electro-mechanical relays, these devices suit applications including transmission and electronic stability controls, lighting, ABS, fuel injection systems, pump motors and radiator fans.

**Features**
- Protected high side switch
- AEC qualified
- Rdson from 3mΩ up to 120mΩ
- Packages:
  - D²pak – 5 leads, 7 leads,
  - DPAK/SO8
- Voltage and current controlled
- High speed or high energy
- 12V and 24V applications

**Benefits**
- Over-current protection
- Over-temperature protection restart / latch
- Reverse battery protection
- Active clamp
- Digital diagnostic output
- Open load detection
- Proportional load current sensing
- ESD protected

**Applications**
- Suitable for resistive, inductive and capacitive loads
- Fuse replacement
- Relay replacement
- Small motors
- Solenoids

---

**The New Low-side Switch Family HITFET™+ With Outstanding Design Flexibility**

<table>
<thead>
<tr>
<th>Product type</th>
<th>Rds(on) [mΣ]</th>
<th>I(BFSO) [A]</th>
<th>I(L) [A]</th>
<th>Protection</th>
<th>Package</th>
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</thead>
<tbody>
<tr>
<td>BTS3035TE</td>
<td>35</td>
<td>35</td>
<td>1</td>
<td>Auto-restart</td>
<td>TO252-3 (DPAK)</td>
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<tr>
<td>BTS3035TF</td>
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<td>TO252-3 (DPAK)</td>
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<td>BTS3050TE</td>
<td>50</td>
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<td>Auto-restart</td>
<td>TO252-3 (DPAK)</td>
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<tr>
<td>BTS3050TF</td>
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<td>100</td>
<td>4</td>
<td>Auto-restart</td>
<td>TO252-3 (DPAK)</td>
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<td>BTS3060TF</td>
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<td>TO252-3 (DPAK)</td>
</tr>
</tbody>
</table>

**IPS with current sense example: ALPS a**
Intelligent Power Switches

ISO8200B(8): The Market Smallest Octal Intelligent High-Side Driver

The ISO8200B is an isolated 8 channel monolithic power switch capable to drive any kind of load. It is designed to realize 0.5A Typ rated digital outputs in industrial automation applications compliant with IEC 61312-2 standard. Galvanic isolation between the logic & the power sides guarantees transient overvoltage immunity of 3.5kVPEAK in accordance with the IEC 60747-5-2 norm.

The two sections communicate with each other in both directions with certain level of redundancy in order to achieve reliable operation with feedback from the power side. Its power stage features very low Rsense fully protected MOSFETs (110mΩ). Together with its low supply consumption it makes the driver very efficient. The chip has a parallel interface which supports the two possible options: a) direct mode and b) synchronous mode.

Thanks to its tiny QFN housing and embedded isolation minimizing the amount of external components, the application becomes extremely compact.

Key Features
- Embedded galvanic isolation
- Low Rsense 110mΩ Typ
- Output current 0.7A min per channel
- Output synchronization capability
- Full set of protections
- Diagnostic feedback
- High robustness against EMC
- Tiny QFN 9x11 and PowerSSO-36 packages

IPS160H / 161H: Extreme Supply Voltage Range for Excellent Safety

The IPS160H and IPS161H are single channel high-side switches embedding a rich set of protections and diagnostics. Supply voltage range up to 65 V makes the devices ideally fitting in the applications with high safety requirements, such as safe outputs in Factory Automation. The chips are characterized and all parameters are guaranteed up to 60 V.

Both products are capable to drive any kind of loads (resistive, capacitive and inductive) with one side connected to ground. They are capable to handle very high switch-off energy. The drivers featuring power stages with low Rsense (60mΩ), which minimizes power dissipation. For enhanced system diagnostics, over-load, over-temperature as well as open-load detection features are implemented.

Embedded configurable cut-off function can disable the output in case of a long-term overload and eliminates excessive power dissipation.

Key Features
- Operating Supply up to 60 V / 65 V max
- Low Rsense 60mΩ Typ
- Output current
- IPS160H: 2.5 A min
- IPS161H: 0.7 A min
- Full set of protections
- Cut-off function to eliminate dissipation
- Rich diagnostics incl. load wire break
- High robustness against EMC
- Tiny housing PowerSSO-12

**Next-Generation VIPower M0-7® intelligent High-Side Switches**

ST’s new family of VIPower M0-7 intelligent power switches provide enhanced intelligent features, improve protection and reliability, and are up to 40% smaller than competing alternatives. Pioneered by ST, intelligent high-side switches provide a more reliable and efficient replacement for conventional relays, and can drive also all kind of inductive, capacitive and resistive loads. In the VIPower M0-7 series, 75% of family members are available in a 5 x 4 mm package, which is 40% smaller than the smallest competing devices. This allows car electronics designers to save PCB space and aim for smaller module sizes. Moreover, various internal design changes increase precision, enhance diagnostic feedback and improve reliability. Specifically, performance improvements include very low standby current (0.5µA max @85°C), greater protection against short-circuits, increased current-sense precision with new options (chip temperature, Vcc feedback) and best-in-class electromagnetic emission (EMI) performance. The VIPower M0-7 family operates at very low battery voltage, even down to 2.85V.

Diagnostic Functions
- Multiplexed analog feedback
  - load current with high precision proportional current mirror
  - TCHP device temperature
- Overload and short to ground (power limitation) indication
- Thermal shutdown indication
- Full ON- and OFF-state diagnostics capability
- Output short to VCC detection
- Multisense enable/disable

**Protections**
- Undervoltage shutdown
- Overvoltage clamp
- Two levels of load current limitation
- Self limiting of fast thermal transients
- Real-time configurable latch-off or auto-restart mode
- Overtemperature or power limitation
- Loss of GND and Vcc
- Reverse battery with and without external components
- Electrostatic discharge protection (ESD)

**Part Number**

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<th>Single-Channel Devices</th>
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New IPDs

The IPD (intelligent power device) series of the ROHM offers universal switches with automotive grade which integrated low on resistance MOSFET and various protection circuit into one chip. The devices provide high level protection against overheat, overcurrent, overvoltage and short circuit. The devices are suitable for different loads including resistant, capacitive and inductive making them suitable for various applications in the Automotive and Industrial area.

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BM2LB150FJ-C

**Specification**
- Grade: Automotive
- Channel Number: 2ch
- Drain-Source Voltage (Max.): 42.0V
- Output Current: 6.5A
- ON Resistance: 150mΩ
- Over Current Detect [A]: 6.5A
- Active Clamp Energy: 165.0mJ

**Features**
- Built-in overcurrent limiting circuit (OCP)
- Built-in thermal shutdown circuit (TSD)
- Direct control enabled from CMOS logic IC, etc.
- Low On resistance RDS(ON) up to 150 mΩ
- Monolithic power management IC with control block (CMOS) and power MOSFET mounted on a single chip
- Surface mount package SOP-J8
- AEC-Q100 qualified

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- Drive Train
- Body Electronics
- Comfort & Convenience
- Connected Car
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| automotive@rutronik.com | Tel. +49 (0) 7231 801-1552 |

Motor Driver ICs

The trend towards greater efficiency in automotive and industrial applications also concerns electric motors. Applications such as power steering, HVAC compressors and engine cooling fans and robotics will be controlled by electronic motors in the future. In general, there are three different types of Motor Drivers for Stepper, DC brush/brushless and 3Phase. Our portfolio includes Monolithic Driver ICs, Half-Bridges, Full-Bridges, Multi-Half-Bridges, Integrated Motor Driver ICs, 3Phase Driver + MOSFETS and 3Phase-Bridge Driver + MOSFETS.

Motor Driver ICs

ROHM offers a broad lineup Motor drivers supporting a wide range of supply voltages and output currents. Features like V_{DS}, PWM conversion for H-bridge drivers, integrated protection functions and their high reliability operation, making them ideal for many applications.

**BM2LB150F-J-C NEW**

The BD16952EFP is an AEC-Q100 automotive qualified 2-channel Half-Bridge Gate Driver, controlled by an external MCU through a 16-bit Serial Peripheral Interface (SPI). Independent control of low-side and high-side N-MOSFETS allows for several MCU controlled modes. A programmable drive current is available to adjust slew-rates, in order to meet EMI and power dissipation requirements. Diagnostics can be read and reset by an external MCU.

**Specifiation**
- Common Standard AEC-Q100
- V_{CC} (Max.) = 40.0V
- Power Supply Voltage (Max.) = 5.5V
- Power Supply Voltage (Min.) = 3.0V
- Output On Resistance (Typ.) (O) = 10.0Ω

**Features**
- AEC-Q100 Qualified
- 2ch Half-Bridge Gate Drivers
- 4 external MOSFETS are Controlled Independently
- Half-Bridge Control Modes are Selected by SPI
- Slew Rates are Controlled with Constant Source/Sink Current
- 500 kHz Oscillation for Charge Pump
- 16bit SPI

**BM637675-V NEW**

BM637675-V is a new 30A type Intelligent Power Module that integrates gate drivers, bootstrap diodes, fly wheel diodes and IGBTs into one package.

**Specifiation**
- Power Device IGBT
- V_{CEO} = 400V
- Current = 30A
- V_{CE(on)} = 1.7V
- Switching Frequency: ~20kHz
- Isolation Voltage: 1500V_{max}

**Features**
- 3phase DC/AC Inverter
- Low Side IGBT Open Emitter
- Built-in Bootstrap Diode
- High Side IGBT Gate Driver (HVIC)
- High Side IGBT Gate Driver (LVIC)
- Fault Signal (LVIC) Corresponding to SCP
- Low Side IGBT, TSD, UVLO Fault
- Input Interface 3.3V, 5V Line
Motor Driver ICs

Power bridges for all kinds of motors in automotive and industrial applications from 100mA up to 70A with different feature sets "scaled to your needs"

- High Power DC and BLDC motor bridges
- Scalable and flexible solutions with different functional options for all kind of motor drivers from 2A DC up to 70A peak currents. Usable in all kind of application areas.
- Smart power motor bridges
- Infineon low-current DC motor bridge family consists of a broad variety of bridges designed for use in automotive and industrial applications
- Our portfolio comprises complete end-to-end solutions for motor drivers from 2A DC up to 70A options for all kind of motor drivers from 2A DC up to 70A

Available Certificates
- TS16949 and ISO 9001 Certificates
- ISO 14001 and OHSAS 18001 Certificates
- IRIS Certificates
- TL9000 Certificates

Applications
- Automotive
- Industrial
- Truck
- Renewable energy

NovalithIC™ – Integrated High Current Half-Bridge Motor Drivers in D²PAK Package

Infineon’s series of NovalithIC™ devices extends the performance capabilities of integrated and protected motor drivers. This series brings the advantages of particularly compact designs to applications beyond 230 W without requiring increased cooling effort. Integrated features – such as overcurrent protection, undervoltage lockout and overtemperature protection – considerably reduce design work and, at the same time, keep system costs (BOM) at a low level. By extending the voltage range up to 40 V, NovalithIC™ is now the ideal fit for many industrial electronics applications in addition to the usual automotive electronics spectrum.

The internal 3-chip structure of the NovalithIC™ family comprises a half-bridge driver, an n-channel MOSFET and a p-channel MOSFET in chip-by-chip and chip-on-chip construction, which delivers maximum performance in the smallest space. The new family differs from the familiar BTN79xx series mainly in its use of the latest MOSFET technology for n- and p-channels. The integrated driver IC works in the same way as before with a logic level input, and can therefore be controlled directly by the µC. The use of p-channel technology on the high side switch of the motor eliminates the need to design a charge pump.

In this way, five chips (half-bridge driver and four MOSFETs) can be replaced by two Novalith IC™ devices in a conventional H-bridge configuration for controlling a bidirectional brushed DC motor (BDC), which reduces the component mounting effort. What is of greater importance in many applications, however, is the space saving of reduced EMI and reduced switching losses.

Key Features & Benefits
- Path resistance:
  - typ. 14.2 mΩ @ 25°C for BTN8962TA
  - typ. 10.0 mΩ @ 25°C for BTN8982TA
- Low quiescent current (typ. 7µA @ 25°C) for an extended battery life
- Capable of high PWM frequency (with active freewheeling in BTN8962TA, BTN-8982TA)
- Switched mode current limitation for reduced power dissipation in overcurrent condition
- Integrated over/undervoltage, overtemp., overcurrent protection and analog current sense to minimize the external components required
- Status flag diagnosis w. current sense capability
- Driver circuit with logic level inputs
- Option for on-board kilis offset calibration
- Operating voltage range up to 40V
- Enhanced switching speed with adjustable slew rate for optimized EMI and reduced switching losses
- Package D²PAK (TO263-7)
TLE986x & TLE987x Infineon® Embedded Power IC
2/3-Phase Motor Driver with integrated ARM® Cortex® M3 MCU

The TLE986x/TLE987x is a single chip 2/3-Phase motor driver that integrates the industry standard ARM® Cortex® M3 core, enabling the implementation of advanced motor control algorithms such as field-oriented control (3 Phase). It includes four/six fully integrated NFET drivers optimized to drive a 2/3-Phase motor via four/six external power NFETs, a charge pump enabling low voltage operation and programmable current along with current slope control for optimized EMC behavior. Its peripheral set includes a current sensor, a successive approximation ADC synchronized with the capture and compare unit for PWM control and 16-bit timers. A LIN transceiver is also integrated to enable communication to the device along with a number of general purpose I/Os. It includes an on-chip linear voltage regulator to supply external loads. It is a highly integrated automotive qualified device enabling cost and space efficient solutions for mechatronic DC/BLDC motor drive applications such as pumps and fans.

### Features
- ARM® Cortex® M3 MCU
- System clock up to 40MHz
- Up to 128KB Flash memory
- 4K EEPROM emulation
- NFET drivers with charge pump
- Current programmable NFET driver with patented slope control for optimized EMC behavior
- Integrated LIN transceiver compatible with LIN standard 2.2 and SAE J2602
- Support fast programming via LIN
- 10-bit SAR ADC for sensing
- Timers for PWM signal generation for 3-Phase motor control
- On-chip oscillator & PLL
- AEC-Q-qualified

### Benefits
- Complete system-on-chip for DC/BLDC motor control
- Minimum number of external components reduce BOM cost
- PG-VQFN package with 7 x 7mm footprint enable PCB space saving
- Integrated ARM® Cortex® M3 MCU
- System clock up to 40MHz
- Up to 128KB Flash memory
- 4K EEPROM emulation
- NFET drivers with charge pump
- Current programmable NFET driver with patented slope control for optimized EMC behavior
- Integrated LIN transceiver compatible with LIN standard 2.2 and SAE J2602
- Support fast programming via LIN
- 10-bit SAR ADC for sensing
- Timers for PWM signal generation for 3-Phase motor control
- On-chip oscillator & PLL
- AEC-Q-qualified

### Applications
- Fuel pump
- HV AC blower
- Engine cooling fan
- Water pumps
- High efficiency BLDC pumps and fans (TLE987x)
- Sensor-less and sensor-based BLDC motor applications controlled by the Local Interconnect Network (LIN) or PWM (TLE987x)
- Window Lift (TLE986x)
- Sunroof (TLE986x)

### TLE986x – Motor Drivers

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### TLE987x – Motor Drivers

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### TLE987x Block diagram

![TLE987x Block diagram](image-url)
A unique Motor Driver Product Portfolio

**PowerSTEP01**
Micro-stepping motor driver with advanced control logic and very low $R_{DS(on)}$ F7 series MOSFETs

PowerSTEP01 is a micro-stepping driver capable to drive both phases of a bipolar stepper motor. Thanks to the embedded low $R_{DS(on)}$ MOSFETs (16mΩ) it can deliver high power while keeping power dissipation at a very low level.

**Features**
- Intended for 2 phase bipolar stepper motor
- Voltage & current control modes supported
- Resolution up to 128µsteps
- Motion control engine for autonomous movement
- Speed and positioning commands
- Capable to drive 10A r.m.s. @ 85V (max.)
- Achievable power up to approx. 850W

**L62xx Series**
Robust, Reliable, Scalable

**A Family of STSPIN Motor Drivers**
Fully integrated motor driver ICs provide complete solutions for driving stepper, brush, and brushless DC motors, controllers and drivers combined in one chip.

**Features**
- Mixed signal DMOS power technology
- 5VDC to 32VDC operating voltage
- Output current 2.8A DC (5.6A Pk)
- L62xx Series, 1.4A DC (2.8A Pk)
- PowerSO, SO, DIP and tiny QFN packages
- Extended diagnostics
- Non-dissipative high side OC sensing and OC protection

**Applications**
- Automation
- Office automation
- Vending machines
- Industrial

---

**STSPINbattery**
Best in class products capable to drive any kind of motor

ST’s new STSPIN low-voltage monolithic motor drivers, with their 3 x 3 mm QFN package are the smallest ICs in the world that integrate a power stage to drive stepper, single and double DC as well as 3-phase brushless DC motors. Furthermore, they are optimized for the requirements of battery operated systems in terms of low input voltage, low noise, and minimal power consumption at full load as well as in standby conditions. Finally they provide accurate positioning and unprecedented smoothness of motion with up to 256 microsteps per full step.

**Features**
- Extremely low operating voltage 1.8 – 10 V, ideal for low-voltage, battery-operated motors
- High output current up to 1.3 ARMS for each full-bridge
- Energy saving and long battery life with best-in-class standby consumption down to 80 nA
- Extreme position accuracy and motion smoothness with up to 256 microsteps per full step (STSPIN220)
- Maximum reliability UVLO, over-current and thermal protection
- Ultra-miniaturized 3 x 3 mm QFN package

---

**STSPIN™ Family Positioning**

Monolithic low voltage drivers* STSPIN220, STSPIN230, STSPIN240

System-in-package drivers: POWERSTEP01

Monolithic drivers: L6470, L6472, L6474, L622x, L620x

Controllers: L6460, L6462

![Device](48)

**Applications**
- Toys
- Portable printers
- Robotics
- Point of sale (POS) devices
- Portable medical equipment
- Healthcare and wellness devices (shavers and toothbrushes)
3-Phase Motor Drive was Never Smaller

STSPIN32F0: 3-Phase Motor Pre-Driver with Embedded 32-bit Microcontroller

Combination of a well market proven STM32 microcontroller together with a specialized gate driver chip makes it possible to realize a very precise field-oriented control of the electric motor, 6-step sensor-less or other advanced driving algorithms, including the speed control loop. The integrated operational amplifiers allow maximum flexibility to design cost-effective sensor-less or Hall-effect sensor feedback systems. An internal 3.3 V DC-DC buck converter and 12 V LDO linear regulator provide the voltage rails to supply the MCU, the external circuitry and the gate drivers, further reducing the bill of materials and enhancing efficiency. The IC can be put into standby mode to disable all the internal circuitry apart from the DC-DC converter that supplies the MCU, thus reducing power consumption to a minimum.

A complete set of protection features is present including over-current, over-temperature and short-circuit, thus making it a bullet-proof solution for demanding applications, especially industrial ones, and further helping to reduce the number of external components, cost and complexity. All this comes in a miniaturized 7x7 mm QFN package that perfectly fits into compact devices and ensures a minimal footprint.

Features & Benefits

Three-phase Gate Driver for High Performance
- 600mA current capability to drive a wide range of power MOSFETs
- Real-time programmable over-current
- Integrated bootstrap diodes
- Cross-conduction, under-voltage and temp. protections

Integrated 32-bit STM32F0 MCU with ARM® Cortex®-M0 Core
- 48MHz, 4-Kbyte SRAM and 32-Kbyte Flash memories
- 12-bit ADC
- 1 to 3 shunt FOC supported
- Communication interfaces: I2C, UART, and SPI
- Complete development ecosystem available

Operational Amplifiers and Comparator
- Sensor-less or Hall-effect sensors supported for accurate control of 3-phase motors, with high efficiency

On-chip Generated Supplies for MCU, Driver and External Circuitry
- For maximum efficiency and flexibility

Typical Applications
- Portable vacuum cleaners
- Fans
- Drones and aeromodelling
- Power tools
- Air purifiers
- Industrial and educational robots

Applications
- AC and Brushless DC Motor Drives
- UPS-Systems
- Welding
- Home appliances
- Drones
- Fans, pumps
- General purpose drives
2EDN MOSFET EiceDRIVER™ Family
Reliable and Efficient Control of MOSFET, IGBT and GaN Switching Devices

Infineon’s 1EDN and 2EDN MOSFET EiceDRIVER™ gate driver ICs are the crucial links between control ICs and powerful MOSFET, IGBT and GaN switching devices. Gate driver ICs enable high system level efficiencies, excellent power density and consistent system robustness. Manufactured after industry standards and offered in different standard packages and pinout configurations, they offer full compatibility with existing designs, which eases drop-in replacements and upgrades. These flexible gate driver ICs are complementary to Infineon’s IGCTs, MOSFETS, SiC JFET and other power switches in discrete gate drive applications or as part of integrated power modules.

1EDN MOSFET EiceDRIVER™ Family

The new one-channel 1EDN MOSFET EiceDRIVER™ family is an industrial leader in low internal power consumption, with up to 200% higher efficiency of the output stages, compared to other 1-channel low-side gate driver ICs. The gate driver IC is capable to drive output reverse currents up to 5 A for both source and sink. The family serves PFC, synchronous rectification, DC-DC converters, telecom bricks, power tools, industrial SMPS, motor control and wireless charging applications, and is compatible to industrial standard pinout for 1:1 replacement.

The new two-channel 2EDN MOSFET EiceDRIVER™ family features two independent, non-isolated low-side channels, each capable of 5 A source and 5 A sink currents up to 5 A for both source and sink. The family serves PFC, synchronous rectification, DC-DC converters, telecom bricks, power tools, industrial SMPS, motor control and solar applications.

2EDN MOSFET EiceDRIVER™ Family

Key Features
- Single channel
- 4 A source/8 A sink
- Optional separate source/ sink outputs
- 19 ns propagation delay
- -10 V input robustness
- BoM costs. The family serves server, telecom, DC-DC converters, bricks, power tools, industrial SMPS, motor control, and solar applications.

DGxxxx Gate Drivers – Covering 50 V to 600 V

Provides a Simple Means of Switching Power MOSFETs and IGBTs in Half-bridge and Full-Bridge Configurations

Encompassing self-protection features: such as fixed dead-time delay to evade shoot-through issues, Schmitt triggered inputs to avoid false triggering; gate drive tolerance to negative transients caused during high dV/dt switching; and, undervoltage lockout (UVLO) protection on the VCC supply to avoid malfunction under low supply voltage.

DGxxxx Gate Drivers

<table>
<thead>
<tr>
<th>High-side / Low-side Gate Drivers</th>
<th>Integrated Booster Diode</th>
<th>Offset Voltage Max</th>
<th>Inputs</th>
<th>Output Current Per-Typ</th>
<th>Internal Delay Time Typ</th>
<th>tr / tf Typ</th>
<th>Package Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>DGD25057F6-13 Y</td>
<td>N 50 HIN, LIN, EN</td>
<td>1400 2200</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>Production</td>
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<tr>
<td>DGD25056F8-13 N</td>
<td>N 50 HIN, LIN</td>
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<td>-</td>
<td>Production</td>
</tr>
<tr>
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<td>N 100 HIN, LIN, SD</td>
<td>2500 2000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Production</td>
</tr>
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<td>N 60 HIN, LIN</td>
<td>290 600</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Production</td>
</tr>
<tr>
<td>DGD2106MS8-13 N</td>
<td>N 60 HIN, LIN</td>
<td>290 600</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Production</td>
</tr>
<tr>
<td>DGD2103MS8-13 N</td>
<td>N 60 HIN, LIN</td>
<td>290 600</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>Production</td>
</tr>
<tr>
<td>DGD21084S14-13 N</td>
<td>N 60 HIN, LIN*</td>
<td>290 600</td>
<td>-</td>
<td>420 680 / 150</td>
<td>70 / 35</td>
<td>-</td>
<td>Production</td>
</tr>
<tr>
<td>DGD2110S16-13 N</td>
<td>N 600 HIN, LIN</td>
<td>1900 2300</td>
<td>-</td>
<td>540 680 / 150</td>
<td>70 / 35</td>
<td>-</td>
<td>Production</td>
</tr>
<tr>
<td>DGD2136S28-13 N</td>
<td>N 600 HIN*</td>
<td>2500 2000</td>
<td>-</td>
<td>420 680 / 150</td>
<td>70 / 35</td>
<td>-</td>
<td>Production</td>
</tr>
<tr>
<td>DGD2118S8-13 N</td>
<td>N 600 HIN*</td>
<td>2500 2000</td>
<td>-</td>
<td>420 680 / 150</td>
<td>70 / 35</td>
<td>-</td>
<td>Production</td>
</tr>
<tr>
<td>DGD2184S8-13 N</td>
<td>N 600 HIN*</td>
<td>2500 2000</td>
<td>-</td>
<td>420 680 / 150</td>
<td>70 / 35</td>
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<td>Production</td>
</tr>
<tr>
<td>DGD21844S14-13 N</td>
<td>N 600 HIN*</td>
<td>2500 2000</td>
<td>-</td>
<td>420 680 / 150</td>
<td>70 / 35</td>
<td>-</td>
<td>Production</td>
</tr>
</tbody>
</table>

Key Features
- Dual-channel
- 4 A source/8 A sink
- Low ohmic output stages
- 19 ns propagation delay
- -10 V input robustness
- DSO, TSSOP, WSON

Key Features
- Single channel
- 4 A source/8 A sink
- Optional separate source/ sink outputs
- 19 ns propagation delay
- -10 V input robustness
- DSO, TSSOP, WSON

Figure Package Source / Sink Peak Current Separate Source/ Sink Output Typ. ULDO Part Number OPN CPN
5-pin SOT723 4 A / 8 A no 4 V 1EDN7512B 1EDN7512BXTMA1
6-pin WSON 4 A / 8 A no 4 V 1EDN7512G 1EDN7512GXTMA1

ManuFacts after industry standards and offered in different standard packages and pinout configurations, they offer full compatibility with existing designs, which eases drop-in replacements and upgrades. These flexible gate driver ICs are complementary to Infineon’s IGCTs, MOSFETS, SiC JFET and other power switches in discrete gate drive applications or as part of integrated power modules.

Manufactured after industry standards and offered in different standard packages and pinout configurations, they offer full compatibility with existing designs, which eases drop-in replacements and upgrades. These flexible gate driver ICs are complementary to Infineon’s IGCTs, MOSFETS, SiC JFET and other power switches in discrete gate drive applications or as part of integrated power modules.
Providing IGBTs (insulated gate bipolar transistors) for all switching frequencies and common voltage classes, Rutronik fulfills all demands of the industry. Due to the latest hard and soft switching technologies of leading suppliers we are able to offer a high efficiency portfolio for your application. The devices offer very low switching losses, optimized thermal performance and minimal conduction losses.

### M-Series 650 V IGBTs

**The 650 V IGBT M series combines the best trade-off between conduction and switch-off energy with outstanding robustness and EMI behavior.** They enable more efficient and reliable motor control, air conditioning compressors, HVAC motor drives, UPS, solar power converters and all power conversion applications working up to 20 kHz in hard-switching topologies. A 6 µs (min) short-circuit withstand time at 150 °C starting junction temperature, an extended operating junction temperature of 175 °C and a wide safe operating area extend service lifetime and boost reliability of applications requiring high power dissipation.

#### Features
- Wide Product Range up to 120 A in discrete package
- 175 °C max junction temperature
- Very low VCE(sat)
- 175 °C max junction temperature
- Very low VCE(sat)
- Self-ruggedness against short circuit events
- Low switch-off losses
- Safe paralleling
- Optimized very fast and soft recovery co-packed freewheeling diode option
- AEC-Q001 Qualified

#### Benefits
- M series is tailored to improve efficiency of targeted applications
- Longer lifetime
- Safe paralleling
- Soft and fast recovery
- Anti-parallel diode
- High robustness

### M-Series 650 V IGBTs

#### Features
- **Maximum junction temperature:** Tj = 175 °C
- **Very low & minimized tail in switching-off**
- **Positive derating of VCE(SAT) with temperature**
- **Tight parameters distribution**
- **Co-packed different feature diode**

#### Benefits
- Higher robustness and reliability
- **Increase system efficiency for energy saving**
- Safer paralleling operations
- **Specific diode option for different applications**
Field Stop Trench IGBTs –  
For High Voltage and High Current Applications

ROHM’s IGBTs (Insulated Gate Bipolar Transistors) contribute to high efficiency and low energy consumption of high voltage and high current applications enabling the realization of low operating loss and low switching noise. ROHM expands its portfolio of power devices.

For High Voltage and High Current Applications

Field Stop Trench IGBTs –

<table>
<thead>
<tr>
<th>Features &amp; Benefits</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built-in very fast &amp; soft recovery FRD (RFN-series)</td>
<td>General inverter</td>
</tr>
<tr>
<td>Low switching loss</td>
<td>UPS</td>
</tr>
<tr>
<td>Short circuit withstand time 80s</td>
<td>Power conditioner</td>
</tr>
<tr>
<td>Built-in very fast &amp; soft recovery FRD (RFN-series)</td>
<td>Welder</td>
</tr>
<tr>
<td>Low collector - Emitter Saturation Voltage</td>
<td>Igniter</td>
</tr>
</tbody>
</table>

ROHM’s IGBTs (Insulated Gate Bipolar Transistors) contribute to high efficiency and low energy consumption of high voltage and high current applications enabling the realization of low operating loss and low switching noise.

Features & Benefits

- Built-in very fast & soft recovery FRD (RFN-series)
- Low switching loss
- Low collector - Emitter Saturation Voltage
- Igniter
- Welder
- Power conditioner
- General inverter
- UPS
- Cooling fan

ROHM's IGBTs contribute to high efficiency and low energy consumption of high voltage and high current applications enabling the realization of low operating loss and low switching noise.

Series

- RG series are designed optimize to use converter
- RGT series are suitable for inverters
- RGP series is designed to ignite and it follows AEC-Q101

ROHM expands its portfolio of power devices.

ROHM expands its portfolio of power devices.

RGT series are designed to optimize converter and new S5 IGBT.

For 5 IGBT series - H5/F5/L5/WR5

The TRENCHSTOP™ 5 IGBTs deliver performance, outstanding efficiency and cost reduction and increased reliability. The family is a major breakthrough in IGBT innovation to match the market's high efficiency demands of tomorrow.

When high efficiency, lower system costs and increased reliability are demanded, TRENCHSTOP™ 5 is the only option.

The TRENCHSTOP™ 5 IGBTs deliver a dramatic reduction in switching and conduction losses.

The TRENCHSTOP™ 5 IGBT technology will be used as a basis for 5 IGBT series - HS/F5/L5/WR5 and new 55 IGBT.
Rutronik is a leading global provider for MOSFETs of the world’s well-known suppliers. MOSFETs (metal-oxide-semiconductor field-effect transistor) are usable for applications in the automotive segment as well as in the field of industrial and consumer. We provide you with a large product range including P-Channel, N-Channel and Dual MOSFETs for applications with voltage classes starting from -400V up to 1700V.

### Supplier Range / Series

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Description</th>
<th>Voltage Range</th>
<th>Conduction Losses</th>
<th>Switching Losses</th>
<th>Gate Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diodes</strong></td>
<td>P-CH, N-CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>P+CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
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</tr>
<tr>
<td><strong>Infineon</strong></td>
<td>P-CH, N-CH</td>
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<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>P+CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td><strong>Panjit</strong></td>
<td>P-CH*, N-CH*</td>
<td>-400 - 1700</td>
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<tr>
<td></td>
<td>2xP-CH*</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
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</tr>
<tr>
<td><strong>Renesas</strong></td>
<td>P-CH, N-CH</td>
<td>-400 - 1700</td>
<td>Low</td>
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<td>Low</td>
</tr>
<tr>
<td></td>
<td>P+CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td><strong>ROHM</strong></td>
<td>P-CH, N-CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td></td>
<td>P+CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td><strong>ST</strong></td>
<td>P-CH, N-CH</td>
<td>-400 - 1700</td>
<td>Low</td>
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<tr>
<td></td>
<td>P+CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td><strong>Toshiba</strong></td>
<td>P-CH, N-CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>P+CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Vishay</strong></td>
<td>P-CH, N-CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>P+CH</td>
<td>-400 - 1700</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

*Qualification for automotive: upon request*

### Our Power MOSFETs support high efficiency requirements in all necessary terms:
- Minimum conduction losses
- Extremely low Rds
- Low switching losses
- Optimized gate charge
40 V and 60 V StrongIRFET™
Logic level technology for battery powered applications

StrongIRFET™, Infineon’s MOSFET technology, offers higher max current ratings compared to the market and provides greater reliability in designs with high surge currents. The logic level gate drive allows designers to drive MOSFETs with only 5 V VGS. This is ideal in applications where standard gate drive is not available such as a battery powered circuits.

The family features low RDS(on) for reduced conduction losses, high current carrying capability for increased power capability and rugged silicon for robustness. The implemented enhanced wire-bond construction makes Infineon the unique supplier to offer a possibility of an upgrade of StrongIRFET™ to TO220, D2PAK, and D2PAK-7 packages. Such a wide and scalable offering enables the family to address a wider range of customer needs.

The newest upgrade to the family is 40 V StrongIRFET™ in D2PAK 7-pin package portfolio. Compared to the D2PAK 7-pin, it offers up to a 20 percent larger die leading to 15 percent lower RDS(on) and up to 39 percent lower thermal resistance from junction to PCB. These benefits, along with increased robustness, reliability, and power density, give designers better reliability when designing an application that could potentially see high current spikes.

Applications
- Power tools
- Light electric vehicles (LEV)
- Uninterruptible power supply
- Solar
- Industrial drives
- Electric toys
- DC/DC applications
- Battery powered applications

Features & Benefits
- Designed for industrial applications
- Ideal for low switching frequency (<100 kHz)
- High current carrying capability (>120 A)
- 4.5 V logic level optimized
- Rugged silicon
- Low RDS(on)

600 V CoolMOS™ P7 and 600 V CoolMOS™ C7 Gold (G7)
High voltage MOSFETs enabling highly efficient solutions for low and high power market

Infineon’s 600 V CoolMOS™ C7 Gold (G7) and 600 V CoolMOS™ P7 series are designed to operate at 600 V breakdown voltage and deliver improved superjunction MOSFET performance needed for target applications to achieve high power density.

600 V CoolMOS™ P7
offers a perfect balance between performance, ease of use, price and portfolio granularity. It brings efficiency gains of up to 1.5% in various topologies, and up to 4.2°C thermal benefits compared to the competition.

Features
- Outstanding commutation ruggedness
- Optimized balance between efficiency and ease-of-use
- Significant reduction of switching and conduction losses
- Excellent ESD robustness > 2 kV (HBM) for all products
- Better RDS(on)/package products compared to competition enabled by a low RDS(on) / A (<1 Ω x mm²)

Benefits
- Suitable for hard and soft switching (PFC and LLC)
- Ease-of-use and fast design-in through low ringing tendency and usage across PFC and PWM stages
- Simplified thermal management due to low switching and conduction losses
- Higher manufacturing quality due to > 2 kV ESD protection

600 V CoolMOS™ C7 Gold (G7)
for PFC & LLC circuits combines the benefits of the C7 Gold technology and superior thermal properties of the TOLL package resulting in new best in class products. The 4-pin Kelvin source configuration minimizes switching losses, offering efficiency gains of 0.6% at full load in PFC circuits.

Features
- Best-in-class FOM \(\frac{RDS(on) \times Qg}{I_{DSS}}\) and \(\frac{RDS(on) \times Qg}{I_{max}}\)
- Enables best-in-class RDS(on) in smallest footprint
- TOLL package
- Inbuilt 4th pin Kelvin source configuration and low parasitic source inductance (~1 nH)

Benefits
- FOM \(\frac{RDS(on) \times Qg}{I_{DSS}}\) is 16% better than previous 600 V C7 enabling higher efficiency
- Power density through best-in-class 28 mΩ in TOLL 115 mm² footprint
- Reducing parasitic source inductance by Kelvin source improves efficiency and ease-of-use
State-of-the-art MOSFETs Technologies

SiC MOSFET – The real breakthrough in high-voltage switching

Based on the advanced and innovative properties of wide bandgap materials, ST’s silicon carbide (SiC) MOSFET feature very low Rdson per area for the 1200 V rating combined with excellent switching performance, translating into more efficient and compact designs. ST is among the first companies to produce high-voltage SiC MOSFET. Compared to silicon MOSFET, SiC MOSFET also feature significantly reduced switching losses with minimal variation versus the temperature.

Features
- Very low switching losses
- Low power losses at high temperature
- Higher operating temperature (200°C)
- Body diode with no recovery losses
- Easy to drive

Benefits
- Smaller form factor and lighter systems
- Reduced size/cost of passive components
- Higher system efficiency
- Reduced cooling requirements and heatsink size
- Solar inverters
- High-frequency power supplies
- Motor drives

Applications
- Solar inverters
- High-frequency power supplies
- Motor drives

400/650 V MDmesh™ DM2
ST’s new MOSFET series with integrated fast-recovery body diode

The MDmesh™ DM2 is a new MOSFET silicon-based technology with a fast-recovery intrinsic diode. This new 400/650 V series achieves up to 40% better Rdson than earlier versions thanks to ST’s super-junction technology, combined with an excellent performance in terms of trr/Qrr and the industry’s best soft switching performance.

Features
- Higher BVdss: from 400 up to 650 V
- Fast recovery body diode
- Ultra-low gate charge (Qg)
- Very low Rdson
- Automotive AEC-Q101 qualified

Benefits
- Higher BVDSS: from 400 up to 650 V
- Fast recovery body diode
- Ultra-low gate charge (Qg)
- Very low Rdson
- Automotive AEC-Q101 qualified

Applications
- Telecom/Server
- Automotive
- Solar
- Motor Control

Part Number BVdss Type AECQ-101 Max Rdson (Ω) Max Vgs (V) Max Id (A) Total gate charge (nC) Package
STW50N60DM2 600 0.065 48 145 TO-247
STW48N60DM2 600 0.079 40 140 TO-247
STW45N60DM2 600 0.093 34 120 TO-220 / D2PAK
STx35N65DM2 600 0.11 32 115 D2PAK / TO-220FP / TO-220 / TO-247
STx24N60DM2 600 0.200/0.22 18 155 TO-220 / D2PAK / TO-247 / TO-220FP
STx18N60DM2 600 0.295/0.32 11 120 TO-220 / D2PAK / TO-247 / TO-220FP

Features
- Increased safety range & flexibility
- Excellent dynamic behavior
- Improved high load efficiency
- Lower conduction losses

Benefits
- Increased safety range & flexibility
- Excellent dynamic behavior
- Improved high load efficiency
- Lower conduction losses

Applications
- Telecom/Server
- Automotive
- Solar
- Motor Control

400-1050 V MDmesh™ K5 – ST’s first super-junction VHV MOSFET series to boost efficiency in high-voltage power supplies

ST’s latest-generation MDmesh™ K5 series enables flat-panel televisions, PC power supplies, LED lighting drivers and electronic ballasts for telecom, server, industrial and automotive applications. ST’s series of 800-1050 V STripFET™ F7 MOSFETs feature an enhanced trench-gate structure that lowers device on-state resistance while also reducing internal capacitances and gate charge for faster and more efficient switching. The devices also have high avalanche ruggedness making them ideal for rugged designs. Thanks to the new gate structure, high power design can be simplified by reducing the number of paralleled devices. Also, with the improved figure of merit and recovery diode, this technology is also ideal for high frequency switching applications.

Features
- High avalanche capability
- Optimized body diode
- High junction temperature (175 °C)

Benefits
- Low conduction losses
- Small form factor of final system
- Excellent behavior to EMI
- Robust design

Applications
- Automotive
- Industrial
- Motor control
- SMPS

800-1050 V MDmesh™ K5 – ST’s first super-junction VHV MOSFET series to boost efficiency in high-voltage power supplies

ST’s latest-generation MDmesh™ K5 series enables flat-panel televisions, PC power supplies, LED lighting drivers and electronic ballasts for high-intensity discharge (HID) lamps to establish the best efficiency and safety margin in the marketplace. These MOSFETs enable designers to meet increasingly strict limits on maximum power and minimum efficiency specified by eco-design standards such as Energy Star and the EU’s energy-related products (ErP) directive.

Features
- Extremely good Rdson at very high BVdss
- High switching speed
- 800-1050 V BVdss rated
- Available in slim I2PAKFP package
- 100% avalanche-tested
- Zener-protected

Benefits
- High efficiency with lower design complexity
- Especially targeted for flyback-based topologies
- Industry’s best figure of merit (FoM)
New SiHP065N60E
Fourth-Generation 600 V E-Series Power MOSFET

Vishay Intertechnology introduces the first device in its fourth generation of 600 V E-Series power MOSFETs. Providing high efficiency for telecom, industrial, and enterprise power supply applications, the Vishay Siliconix N-channel SiHP065N60E offers the industry’s lowest gate charge times on-resistance, a key FOM for 600 V MOSFETs used in power conversion applications.

Benefits
- Ultra-low on-resistance and gate charge reduce conduction and switching losses to save energy
- Gate charge times on-resistance figure of merit (FOM) of 2.8 Ω·nC
- Low effective output capacitance (Cot(e)) and (Cot(i)) improve switching performance
- Offered in the TO-220AB package
- RoHS-compliant, halogen-free
- Designed to withstand overvoltage transients in the avalanche mode with guaranteed limits through 100 % UIS testing

Applications
- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- High-intensity discharge (HID)
- Fluorescent ballast lighting
- Welding
- Motor drives
- Battery chargers
- PV inverters

Table: Single N-Channel | VGS = 600 V | VDS = 30 V

<table>
<thead>
<tr>
<th>Series</th>
<th>Package</th>
<th>RDS(On) (Ohms)</th>
<th>ID @ 100 mA</th>
<th>VDS @ 100 mA</th>
<th>Iq (nC)</th>
<th>PD (W)</th>
<th>Rthj @ 10 V (Therm)</th>
<th>Rthj @ 4.5 V (Therm)</th>
<th>Qg @ 10 V (nC)</th>
<th>Qg @ 4.5 V (nC)</th>
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PowerPAK® 8 x 8L
AEC-Q101-Qualified SQ Rugged Series MOSFETs

Vishay Intertechnology introduces a new 8 mm x 8 mm by 1.8 mm PowerPAK® 8x8L package designed to provide a high-current, space- and power-saving alternative to D²PAK and DPAK devices commonly used in automotive applications. Dedicated automotive processes ensure quality and robustness from design to manufacturing.

Benefits
- AEC-Q101-qualified
- Junction temperature up to 175 °C
- 75 % thinner and 60 % smaller than D²PAK
- Low on-resistance n- and p-channel trenchFET® technologies
- Gull-wing leads for mechanical stress relief

Applications
- All automotive applications requiring ruggedness and high reliability such as motor control, electric power steering, transmission control, injector drives, and coil drivers

Table: AEC-Q101 Series

<table>
<thead>
<tr>
<th>Series</th>
<th>Configuration</th>
<th>Package</th>
<th>Channel</th>
<th>VDS (V)</th>
<th>ID @ 100 mA (A)</th>
<th>RDS(On) @ 10 V (Ohms)</th>
<th>Rs @ 10 V (Ohms)</th>
<th>Qg @ 4.5 V (nC)</th>
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60 % smaller than D²PAK, similar Rs(On) 50 % lower Rs(On) than DPAK
SiC – MOSFET & Full SiC Power Modules

**SiC - MOSFET**
ROHM Semiconductor’s line-up of 650 V, 1200 V and 1700 V SiC MOSFETs are designed to deliver cost-effective and breakthrough performance in inverters and converters. The devices offer dramatically lower switching losses - up to 90% less compared to traditional Si IGBT.

**Applications:**
- Inverters, Converters for industrial equipment,
- High Voltage Motor Drives

**Key Features:**
- High-speed switching
- High temperature operation (Ej max=175°C) with low reverse recovery
- High reliability
- Low switching losses (e.g. Gate oxide)
- Low Vth shift

**Applications:**
- PFI/SMPs /Aux Power Supply
- Renewable Energy Inverter/Converter
- EV/HEV Inverter and Chargers
- Renewable Energy Inverter/Converter
- PFC/SMPS/ Aux Power Supply

**Full SiC Power Module**
Switching loss reduced by 85% (max.)
ROHM has developed low-surge-noise power modules integrating SiC devices produced in-house, maximizing high-speed performance. The result is significantly reduced switching loss compared with conventional Si IGITs.

**Applications:**
- High Voltage Motor Drives
- Inverters, Converters for industrial equipment, e-mobilities (EV, HEV, train, e-bike etc.)
- Solar/wind power generation, power supply unit, induction heating equipment

---

### DTMOS – High Voltage Mosfets

Toshiba has developed new generations of super junction 600 V, 650 V and 800 V DTMOS MOSFET series. Fabricated using the state-of-the-art single epilayer process, DTMOS IV provides a 30% reduction in Ron* A, a figure of merit (FOM) for MOSFETs, compared to its predecessor, DTMOS III. A reduction in Ron* A leads to smaller Rds(on) chips in the same packages. This helps users to improve efficiency and reduce the size of power systems. Fast switching X-type and fast body-diode W5-type versions are also available. The new DTMOS IV is designed to provide even better EMI performance.

#### Attractive Cost Effects
- Reduced heat system costs
- Less costs of field failure
- Less passive component costs
- Reduced BOM costs due to most effective solutions

#### Smart Performance Increases
- Easy design in for faster time to market and product launch
- Ready to support high volume markets with competitive prices

---

#### DTMOS IV 800 V Standard "W"-Series (NEW)

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#### DTMOS IV & V – Series (NEW)

**Applications**
- W-Series: Standard type For general switching
- WS-Series: With high speed body diode For bridge circuitry, like UPS or server SMPS
- X-Serie: High speed type (T-15um) For PFC circuit
- X5-Series: High speed type with high speed body diode For bridge circuitry, like UPS or server SMPS
- Y-Series: Low EMI For lighting, battery charger and AC/DC adapter

---

#### DTMOS IV & V 650 V Standard "W" & "Y" Series

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66 | 67

---

66 1. Tc is measured just below the chip. 2. The repetition rate shall be such that the switching loss of the element does not exceed 175°C. (Conditions: PW=1ms) 3. Vgs=18V 4. The repetition rate shall be such that the temperature rise of the element does not exceed 175°C. (Condition: PW=1ms, Vgs=18V, Vds=18V)

---

**Diagram**

[Diagram of DTMOS IV and V]
Triacs

Triacs are applied to control AC mains applications. They can be used as simple on/off switches, to replace electromechanical relays while providing a higher degree of flexibility (through electronic control) and superior reliability. Using a simple phase-control circuit, they can also control power level through AC loads.
T-Series Triacs offer on the same device 800 V capability with 125°C max Tj. With the 800 V T-Series Triacs family, ST is offering a series which exhibits superior dynamic performances (noise immunity and turn-off capability) and an extended temperature range up to 150°C. Moreover, the off-state voltage capability has been raised up to 800 V. This enables a downsizing of the Triac for a given load or higher load rating utilization.

Logic-level Gate ACS Series
STMicroelectronics has developed a series of overvoltage resistant AC switches. Their switching characteristics is immune to higher level surges than Triacs. The new logic level gate drive (such as the new ACS108-8TN with 5mA gate current) makes auxiliary loads and motor appliances drive an easy circuit design.

Benefits
- Enables equipment to meet IEC 61000-4-5 surge with overvoltage crowbar technology
- High noise immunity against static dV/dt and IEC 61000-4-4 burst
- Needs no external protection snubber or varistor
- -5 and 10 mA products interface directly with the microcontroller
- ECOPACK® 2 and RoHS compliant component

Features
- High commutation: 200 A/μs
- High off-state immunity: 1000 V/μs
- Gate trigger current: 50 mA
- Thermal cooling capability: Rth(j-c) = 0.3 °C/W
- AEC-Q101 compliant

Benefits
- Reduce BOM: extra power device no longer needed in the rectifier bridge
- Same efficiency and cooling size as diode bridge
- High PCB creepage distance above 4mm
- Control peak current at charger power up

Key Applications
- Auxiliary battery chargers
- Renewable energy inverters
- Motor drive
- Industrial welding system

High Temperature 30 and 40 A SCRs: TN30/TN4050H-12 Thyristors
This series make AC/DC converters safe by limiting the inrush current and providing insulation against AC line overvoltages.

Features
- High commutation: 200 A/μs
- High off-state immunity: 1000 V/μs
- Gate trigger current: 50 mA
- Thermal cooling capability: Rθ(j-c) = 0.3 °C/W
- AEC-Q101 compliant

Benefits
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- ECOPACK® 2 and RoHS compliant component

ACS type, current rating, and type of load

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<th>ACS Type</th>
<th>Current Rating</th>
<th>Type of Loads</th>
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<td>ACS308a &amp; ACS408a</td>
<td>2A</td>
<td>Main loads in Appliances</td>
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</table>

Teccor® Brand Thyristors
High Current Capability, High Reliability for Heating Control

Thyristors
Thyristors (TRIACS and SCR) give best balance in efficiency, simplicity, reliability and system costs in AC power applications such as heater and AC motor controls.

Schematic Symbol

Q6025PHS / Q6035PHS / Q6040PHS
25 / 35 / 40 A RMS High Commutation Triac for Heating Control in TO-218, TO-220 and the new FASTPAK.

MS0690J-DL1T (90A, 600V)
All new 90 A RMS Back-to-Back SCR for Robust Heating Control in SOT227B

800 V T-Series Triac Family

30-40 A Hi-Temp SCR

Key Applications
- Inrush current limiting circuits
- Home appliances & small appliances
- Fan & motor control
- Heater
- Lighting

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800 V T-Series Triac Family

30-40 A Hi-Temp SCR

Key Applications
- Inrush current limiting circuits
- Home appliances & small appliances
- Fan & motor control
- Heater
- Lighting
Schottky Diodes & Rectifiers

Any technology in the fields of high-voltage or small-signal needed for your application, Rutronik is able to provide it. No matter if it is Schottky, Standard-, Fast-, Superfast-, Ultrafast-Recovery or even Silicon Carbide Diodes we offer the solution for your need. Parts are available starting from 15V up to 4500V and give best performance caused by the technical characteristics.

- Optimized thermal behavior
- Low forward-drop voltage $V_F$
- Minimalized reverse leakage current
- Very fast reverse recovery times

| Voltage | 10  | 20  | 30  | 40  | 50  | 60  | 70  | 80  | 90  | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2500 | 3000 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----- |
SiC FERD Diodes

**Silicon Carbide Diodes – Drastic Reduction of Generated Losses**

Thanks to exceptional reverse recovery performance, the new Silicon Carbide (SiC) diodes of ST represent a key contributor to energy savings in SMPS applications and in emerging domains, such as solar energy conversion. The new SiC Diodes ST show an increased breakdown capability (650 V and 1200 V) and state-of-the-art surge current capability. These features, together with the exceptionally low forward-drop voltage VF, make this family the new reference in the market. Design, diffusion and packaging are made by ST.

**Benefits**

- **Permits reduction in associated filter size and cost**
- **Less EMI in application**
- **Efficiency increased by up to 2%**
- **Switching behavior independent**

**Applications**

- Photovoltaic inverter
- High performance SMPS
- High-frequency motor control drives
- Indispensable when power density increase is crucial
- Allows the use of smaller passive components
- Possibility to reduce the heatsink size
- Improved efficiency
- Low Vf

**Low Vf**

- Improved efficiency
- Possibility to reduce the heatsink size and reduce the cost to work at same Tj

**FERD (Field-Effect Rectifier Diodes)**

After the Silicon Schottky barrier diodes rectification method, the only way to achieve a breakthrough in efficiency and power density was to use expensive, complex synchronous rectification solutions, with MOSFETs and dedicated controllers. ST introduces a new generation of diodes, the FERD with a rectification performance in applications close to that of synchronous solutions yet with the lower complexity of traditional rectification techniques.

**FERD30065**

- STPS30UF
- TO-220AC
- 2
- 600
- 4 / 6 / 8 / 10 / 12

**Part Number Package Configurations**

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<td>STBR15U50P5</td>
<td>TO-220AC</td>
<td>Dual 15 400 0.78 300 150</td>
<td>15 0.78 250 150</td>
<td>15 0.72 160 150</td>
<td>15 0.65 120 150</td>
<td>15 0.60 80 150</td>
<td>15 0.55 60 150</td>
<td>15 0.50 45 150</td>
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<td>15 0.60 80 150</td>
<td>15 0.55 60 150</td>
<td>15 0.50 45 150</td>
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</table>

**For example:**

- **SBRT15U50P5** forward voltage of 0.47 V at 15 A and SBRT20U100SLP’s forward voltage of 0.5 V at 20 A, coupled with an operating temperature of +90°C, means conduction losses are minimized and charger efficiencies are increased.
SiC Schottky Barrier Diodes
Significantly Lower Switching Loss

SiDs were developed utilizing SiC, making them ideal for FPC circuits and inverters. Ultra-small reverse recovery time (impossible to achieve with silicon FRDs) enables high-speed switching. This minimizes reverse recovery charge (Qr), reducing switching loss considerably and contributes to end-product miniaturization. Rohm offers automotive-grade (AEC-Q001 qualified) products which have been adopted in a variety of charging circuits in electric/hybrid vehicles.

2nd Generation SiC Schottky Barrier Diodes – Industry-Leading Low VF SCS2 Series

| Features | Industry-leading low forward voltage (VF = 1.35 V, 650 V/10 A) | High-speed recovery characteristics | Dramatically lower switching loss |

Applications
- Power conditioners used in photovoltaic power generation
- Switching mode power supplies
- EV/HEV inverters and chargers

Power Rectifiers in Low-Profile SMPD (TO-263AC) & SlimDPAK Package

10 A to 30 A FRED Pt® Ultrafast Rectifiers in SMPD Package

- Offer increased power density and system efficiency for automotive and telecom applications.
- The rectifiers reduce switching losses and over-dissipation in automotive and telecom applications.
- With a footprint compatible with the D2PAK package, the FRED Pt Hyperfast and Ultrafast recovery rectifiers in the SMPD package offer a lower package height of < 1.7 mm for increased power density and efficiency to enable slimmer end products.

Features
- High operating temperature up to 175 °C
- Low forward voltage drop down to 0.75 V typical with fast recovery
- Soft recovery behavior over a temperature range of -40 °C up to 175 °C
- Low forward voltage drop of < 1.7 mm height SMDD (TO-263AC) package is foot-print-compatible to TO-263 (D2PAK) package

Benefits
- Provide a high-density alternative to the TO-263 (D2PAK) package
- Feature a planar structure and platinum-doped lifetime control to guarantee high overall performance, ruggedness, and reliability characteristics
- Offer an operating Tj from -65 °C to +175 °C over-dissipation in automotive and telecom applications. With a footprint compatible with the D2PAK package, the FRED Pt Hyperfast and Ultrafast recovery rectifiers in the SMDD package offer a lower package height of < 1.7 mm for increased power density and efficiency to enable slimmer end products.

Applications
- DC/DC converters
- DC/DC converters
- Battery-charger units
- Frequency inverters

High Current Density TMBS® Rectifiers – Industry-First TMBS® in SlimDPAK Package

- Very low-profile, surface-mount SlimDPAK package with typical height of 1.3 mm (57 % of DPAK package height)
- Better thermal performance (Rth-J = 1.5 °C/W) than DPAK (TO-252) due to 14 % larger heat sink area
- High current density up to 35 A (single chip) and 40 A (dual chip center-tap common cathode)
- PCB footprint compatible with DPAK (TO-252)

Applications
- SMPS
- DC/DC converters
- Frequency inverters

Example: Automotive Charging Circuit

1.35 V
10 mm
12.63 mm
10 A
TO-263AC

Power Rectifiers

High Current Density TMBS® Rectifiers – Industry-First TMBS® in SlimDPAK Package

- Very low-profile, surface-mount SlimDPAK package with typical height of 1.3 mm (57 % of DPAK package height)
- Better thermal performance (Rth-J = 1.5 °C/W) than DPAK (TO-252) due to 14 % larger heat sink area
- High current density up to 35 A (single chip) and 40 A (dual chip center-tap common cathode)
- PCB footprint compatible with DPAK (TO-252)

Applications
- SMPS
- Battery-charger units
- Frequency inverters
New Generation of Schottky

SiC Schottky

Compared with silicon schottky, PANJIT’s new silicon carbide (SiC) schottky delivers lower switching loss, higher breakdown voltage, and outstanding performance under high temperature condition (175 °C) due to its material characteristics. It is the optimal choice for customers who need high system efficiency, especially in the solar system, power management applications, and industrial fields.

Super Schottky

PanJIT’s Super Schottky is a new Schottky technology that utilizes a MOS manufacturing process to create a superior two terminal device that has a lower forward voltage and leakage current than Standard Schottky. With the implantation of an upgraded technology, this new family has an extremely low forward voltage drop, lower reverse current, lower power dissipation at high current and small footprint package for high current devices.

Features
- Low Trr
- High frequency operation
- Low EMI
- Good performance at high temperature operation

Applications
- Industrial equipment
- IT power supplies
- Solar inverter
- LED

Features
- Forward current loss reduction
- Low leakage current at high temperature
- Ultra low voltage drop
- High frequency switching

Applications
- Smart phone charger
- Adapter for Set-up box, TV box
- Power Supply for TV, LED, PC

<table>
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<tr>
<th>Part Number</th>
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<th>VRRM Max.</th>
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</table>

*R also available AEC-Q101 qualified

Applications
- Industrial equipment
- IT power supplies
- Solar inverter
- LED

Applications
- Smart phone charger
- Adapter for Set-up box, TV box
- Power Supply for TV, LED, PC

RUTRONIK POWER brings the latest knowledge, scalable solutions and efficient support for innovative power electronic components together – not only in the focus markets:
- Industrial
- eMobility
- Home Appliance

More information:
www.rutronik.com/power | power@rutronik.com
Bridge Rectifiers

A bridge rectifier consists of 4 individual diodes. The benefit of a bridge rectifier is the lower assembly cost. Rutronik offers a strong product portfolio of leading suppliers like Vishay, Fagor, Diotec, Panjit. These parts are dedicated to applications from low rated current until high power rated current (0.5 A until 50 A). General purpose use in AC/DC bridge full wave rectification for switching power supplies or home appliances.

Slim Profile SMD Bridge Rectifier

Space and Energy Saving AC to DC Conversion

Diotec offers a broad range of SMD bridge rectifier with slim profile and small footprints. They come with current ratings from 0.5 to 2.3 A, and maximum AC input voltages from 40 to 500V RMS. These devices feature high power density, high surge current ratings and low forward voltage drop, thus ensuring low power losses. The family comprises Standard Recovery, Fast Switching, Schottky and Low Capacitance bridges.

A smart new device family are the so-called Protectifiers®, combining extra low forward voltage with high reverse robustness.

Features
- Low profile package
- Low forward voltage
- Low capacitance
- High surge current
- High robustness
- Extra low forward voltage
- ESD rating (JESD22-A114 Method) - Class 3B
- Reverse avalanche energy rating ERSM - 20 mJ
- Forward surge current rating IFSM up to 75 A (1ms)

Benefits
- Help to reduce stand-by power consumption
- Lower heat generation
- Allows for smaller inrush current limiting resistor
- More robust against ESD pulses and short transients

Applications
- 50/60 Hz mains rectification
- Input power stages
- Offline power supplies
- Audio power supplies
- Steering and clamping circuits

Protector Family

Bridge-Protector® are based on innovative chip technology by Diotec. They offer what designers of power supplies nowadays are looking for: Energy savings and high robustness in reverse and forward. Its best-in-class forward voltage drop reduces power losses and allows for higher surge currents. Protective elements like inrush current limiting resistors can be kept small and thus save further energy. New requirements on stand-by power can be fulfilled by using these bridges.

In reverse direction, these parts feature an avalanche rating and are able to withstand ESD pulses. Rather than going higher and higher in reverse voltage, these parts offer a certain clamping capability for short transients.

Features
- Extra low forward voltage
- ESD rating (JESD22-A114 Method) - Class 3B
- Reverse avalanche energy rating ERSM - 20 mJ
- Forward surge current rating IFSM up to 75 A (1ms)

Benefits
- Help to reduce stand-by power consumption
- Lower heat generation
- Allows for smaller inrush current limiting resistor
- More robust against ESD pulses and short transients
Protection Diodes

Circuit protection devices interrupt overcurrent events (e.g. overload, short circuit) and divert overvoltage surges (e.g. inductive load switching, automotive load dump, ESD). They increase safety and enable end products to survive harsh conditions. Most electrical and electronic equipment require circuit protection devices. In many cases they must be installed to comply with safety standards before the end products can be sold or used.

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<th>Diotec</th>
<th>Fagor</th>
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<th>Littelfuse</th>
<th>Panjit</th>
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</table>

ESD

High Power TVS Diode Protection
AK / LTKAK Series

Littelfuse AK / LTKAK Series high energy TVS Diodes offer superior clamping performance over standard Silicon Avalanche Diode Technologies. LTKAK series also offer the highest power rating (8x20 μs waveform) among surface mount TVS available in the current market.

Key Advantages
- Innovative package (patent pending) design offers the highest power rating (8x20 μs waveform) among surface mount TVS available in current market
- SMT package is ideal for automatic pick and place assembly and reflow processes, allowing for a lower manufacturing cost and greater soldering quality than axial leads packages
- Because AK/LTKAK TVS Diodes can withstand multiple surge events, they will help equipment manufacturers extend their product warranties because, unlike passive MOVs, these semiconductor TVS Diodes do not wear out, which makes them ideal for protecting valuable loads

Applications
- Cell phone base stations
- Industrial transient voltage surge suppressors
- Defense and avionics
- Power grid and distribution systems
- AC/DC power line circuit protection

IGBT Protection
At times, providing voltage protection for an overall system can be very difficult to accomplish, especially for high power line voltage applications of 600V or higher. For these cases, Littelfuse suggests an additional (or secondary) high power TVS Diode that offers accurate low voltage clamping capability to provide differential protection to the rectifier diodes, capacitor, and IGBT.

The IGBT provides both power transistor and power MOSFET benefits. It works at high frequencies and is easy to drive and to shut off; however, it also has a weakness. Normally, two portions need be protected to achieve a robust design:
- Because the gate is a MOS structure, it can be easily damaged by electrostatic discharge (ESD), an electrical fast transient (EFT), or an overvoltage induced by the Miller effect.
- In high power/high current applications, high voltage inrush may occur at IGBT terminal C and terminal E when the device is turning on.

![Figure 3: IGBT gate protection](image-url)
Protection Repetitive Voltage Suppressor

STRVS Family
In applications, overvoltage constraints may not always come from lightning, electrical overvoltage or electrostatic discharge, but from the circuit itself. In such cases, standards do not apply. Repetitive surges may raise protection device temperature. The ST’s STRVS family is the first TVS to be specified against repetitive overvoltages in high temperature conditions. Protection devices must be selected according to their power capability at high junction temperatures and their clamping voltage specified at high temperature.

Benefits
• Lower leakage current:
• Stand-off voltage range: 85 to 188V
• Clamping voltage characteristics

Features
• Clamp voltage characteristics defined at 25 °C, 85 °C and 125 °C
• Stand-off voltage range: 85 to 188V
• Low leakage current: 0.2 μA at 25 °C

Applications:
• Smart metering
• Solar inverters
• Residential, commercial, architectural and street lighting

Suppressor

Vishay Intertechnology develops bidirectional symmetrical (BiSy) ESD protection diodes in the compact SOT-32, SOD-32 and SOT-323 packages. The single-line VLIN26A1-03G and the dual-line VCAN26A2-03G offer low capacitance and leakage current for the protection of automotive data lines against transient voltage signals. The VLIN26A1-03G is optimized for LIN-Bus applications, while the VCAN26A2-03G is ideal for CAN-Bus and FLEX-Bus applications.

These ESD protection devices which clamp positive and negative overvoltage transients to ground. Connected between the signal or data line and the ground the ESD Diodes offer a high isolation (low leakage current, small capacitance) within the specified working range of -16 V to +16 V or -26 V to +26 V. Due to the short leads and small package sizes the inductance is very low, so that fast transients like an ESD-strike can be clamped with minimal over- or undershoots.

As SOT-32 is leaded it is preferred for all production processes where an optical inspection is required.

ST offers protection devices for 5 V, 9 V, 12 V and 20 V charging voltage in the same micro-QFN package

Bidirectional ESD Protection Diodes
Offer Low Capacitance and Low Leakage Current

Part Numbers Tj Max Vf Wave Package
STRVS5182K02F 150°C 1.185 V typ @ 2A at 125°C SM06
STRVS5182K02F 150°C 1.185 V typ @ 2A at 125°C D0-15
VCAN26A2-03G SOT-323 26.5 0.05 4 200 16 30 Yes
VLIN26A1-03G SOT-323 26.5 0.05 3 150 15 30 Yes
VMSM26-02G SOD-223 26.5 0.05 3 150 15 30 Yes
VMSM26-02G 26.5 0.05 4 200 16 30 Yes

Applications
• LIN-, CAN-, and FLEX-Bus protection in automotive applications
Digital Transistors

Digital transistors were first invented and introduced to the market by Rohm. Today, Rohm is Rutronik’s main supplier for digital transistors, alongside Diodes Inc. Transistors of the conventional type are available with 100mA and 500mA, as both PNP and NPN type. This product is a combination of a bipolar transistor (SMD package) and base resistor(s) integrated into the package – called a “Resistor-equipped Transistor”. Also commonly known as Pre-Biased Transistor.

The resistor values are set to provide saturation of the transistor with a 5 Volt input. They are available with different configuration settings that can be selected according to the existing application’s conditions.

The idea is to further reduce the number of components needed in a product that needs to be small, and on the other hand to get more circuitry into a smaller PCB.

A major priority of Rutronik is to offer a wide range of products with AECQ qualification.

For more information, please visit our e-commerce platform: www.rutronik24.com
Bipolar Transistors

Our wide range of Bipolar Transistors are suitable for applications in automotive supported products as well as in the field of industrial and consumer products. With our suppliers, we are able to offer a variety of packages and a broad portfolio of small-signal to high-power bipolar transistors in order to cover the market extensively.

The packages range from micro-miniature surface-mount options of 0806 mm size up to high-voltage power package.

The broad portfolio of bipolar transistors that Rutronik offers include NPN, PNP, dual and complementary transistors for general purposes, as well as low saturation, fast switching and darlington transistors for various applications.

The majority of products available in Rutronik's bipolar transistors portfolio meet the stringent requirements of the Automotive Electronic Council specification AEC-Q101.

### Bipolar Transistors

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Series</th>
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*Note: AEC-Q101 qualification status.*
Bipolar Transistors

Diodes is the market leader when it comes to Bipolar transistors. By utilizing its wide line up of in-house packaging and superior silicon technology, Diodes is ideally positioned to meet your application needs for Bipolar transistors.

<table>
<thead>
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<th>Min @ IC</th>
<th>Max @ IC</th>
<th>Max @ IC/IB</th>
<th>VCE (sat) (mA)</th>
<th>hFE</th>
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<td>200</td>
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<tr>
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<td>2</td>
<td>250</td>
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<td>200</td>
<td>250</td>
<td>1</td>
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<td>200</td>
<td>0.5</td>
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<td>3</td>
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<td>1</td>
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<td>0.001</td>
<td>80</td>
<td>0.05</td>
<td>200</td>
</tr>
</tbody>
</table>

* Refer to data sheet for any differences to the NPN specs given

Continued Innovation

The Bipolar transistor portfolio is built on successive generations of our innovative matrix emitter process. Years of know-how, leading edge designs and process innovation have extended our leadership in building ultra-low saturation, fast switching transistors.

Application-Specific Products

Market demands for improved electronic systems solutions, whether in terms of improved efficiency, increased power density, just cost reduction, drive all our application specific products. Avalanche transistors, Gate drivers and H-bridge devices have all been developed to create dedicated solutions driven by customer needs and combine the benefits of the exceptional transistor die performance with Diodes packaging expertise.

Best-in-Class Performance

With focus on optimizing processes for the lowest saturation voltage, reduced die area and subsequently improved switching performance, the consequent reduction in power dissipation allows ever smaller surface mount packages, which still meet the demands of the target applications. The inherent ruggedness to ESD of the Bipolars along with their very low specific on-resistance also make them very cost effective alternatives to MOSFET technology in a wide range of circuit topologies.

Quality

The majority of the products in the Diodes’ Bipolar transistor portfolio are designed to meet the stringent requirements of the Automotive Electronic Council specification AEC-Q101.

RF / HF TRANSISTORS

In the fast growing market for wireless applications Rutronik offers a wide range of cost-effective, and high-end RF / HF transistors. Our comprehensive portfolio includes Low Noise Amplifiers (LNAs), Biased Low Noise Amplifiers, High Linearity Transistors, MMICs, RF MOSFET as well as LD MOS.

Find the most suitable device in our product catalogue and ask for samples respective design support via our e-commerce platform: www.rutronik24.com

Bipolar Transistors

- Market leading technologies from 10V to 800V
- NPN & PNP in single, duals, complementary, matched pairs, Darlington transistors, Pre-Bias (Digital)
- Very low VCE(SAT) for improved efficiency in saturated switching applications
- Excellent gain hold up at high peak currents for improved driving of MOSFETs
Modules

Rutronik offers a wide range of power module topologies, standard solder-pin connectors, press-fit technology, spring connections, innovative thermal interface material (TIM), and a broad power spectrum range. The offering encompasses Intelligent Power Modules (IPM), Power Integrated Modules (PIM, a combination of input rectifiers, inverter and brake chopper), six-pack inverters, and rectifier, PFC-, H-bridge, half-bridge, booster, as well as NPC, MNPC and AMNPC converter modules. Our experts work closely with yours to deliver solutions that fit your needs.

Applications
- Induction heating
- Microwave
- Multifunction printers
- Solar inverter
- Motor control
- UPS
- Airconditioning
- Washing machine
- Power supply
- Power tools
- Welding
- Pumps

SLLIMM™ 2nd Series
Small Low-Loss Intelligent Molded Module

IGBT Intelligent Power Module: Compact and high-performance. AC motor drive for simple and rugged designs up to 3kW

The SLLIMM 2nd series is ST’s new family of compact, high efficiency, dual-in-line intelligent power modules, with optional extra features. This family is designed using a new internal configuration with two gate drivers, one high-side driver and one low-side driver as well as an improved trench gate fieldstop IGBT. The best compromise between conduction and switching energy with an outstanding robustness and EMI behavior makes the new series ideal to enhance the efficiency of compressor, pumps, fans and motor drives working up to 20kHz in hard-switching circuitries and for applications with a power range from 300W to 3kW.

Key Features
- 600V DC rating from 8A to 35A at 25°C
- Low VoC(sat)
- Optimized driver and silicon for low EMI
- Lowest Rth value on the market for the DBC package versions
- Internal bootstrap diode
- 175°C max. operating junction temperature
- Separate open emitter outputs
- NTC on board
- Integrated temp. sensor on low-side driver
- Comparator for fault protection
- Shutdown input/fault output
- Isolation rating of 1500V/ICS max

Key Benefits
- Easy to drive through microcontroller
- 175°C maximum junction temperature for higher robustness and reliability
- Small Low-Loss Intelligent Molded Module

Key Applications
- Industrial motor drives
- 3-phase inverter for motor drives up to 3kW
- Home appliances

SLLIMM Rth

<table>
<thead>
<tr>
<th>Package</th>
<th>Part Number</th>
<th>L (mm)</th>
<th>W (mm)</th>
<th>H (mm)</th>
<th>Voltage (V)</th>
<th>Rthj-c (°C/W)</th>
<th>Min Tj (°C)</th>
<th>Max Vce(sat) (V)</th>
<th>ICN (A)</th>
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</thead>
<tbody>
<tr>
<td>SDIP2B-26L</td>
<td>STGIB10CH60TS-L(E) 15 (10)</td>
<td>16.18</td>
<td>15.8</td>
<td>5.7</td>
<td>10.25</td>
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<td>25</td>
<td>600</td>
<td>1.7 (1.5)</td>
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<td>SDIP2B-26L</td>
<td>STGIB30M60TS-L(E) 35 (30)</td>
<td>15.56</td>
<td>15.4</td>
<td>5.0</td>
<td>15.16</td>
<td>2.8</td>
<td>25</td>
<td>600</td>
<td>1.2 (1.0)</td>
</tr>
<tr>
<td>SDIP2B-26L</td>
<td>STGIF5CH60TS-L(E) 8 (5)</td>
<td>20.26</td>
<td>20.0</td>
<td>5.0</td>
<td>20.16</td>
<td>1.0</td>
<td>25</td>
<td>600</td>
<td>1.0</td>
</tr>
</tbody>
</table>

| Package and leads finish options: |
| Ta: NTC on board |
| F: Full enclosed |
| B: DBC (direct bond copper) |
| L: Long leads |

End Products
1 kW 200 W 2 kW 3 kW

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Room A/C

WM

End Products

WM
EconoDUAL™ 3
IGBT Modules

With the EconoDUAL™ 3 family, Infineon supports the complete current ranges from 100 A up to 600 A at 600 V / 650 V / 1200 V / 1700 V. Excellent mechanical robustness, power cycling capability, the option of PressFIT pins as well as the availability of TIM makes it a reliable, cost effective solution for applications in drives, CAV, wind turbines, solar, and hybrid vehicles. EconoDUAL™ 3 modules are available in 3-level, half bridge, H bridge and chopper topologies for efficient inverter designs.

EconoDUAL™ 3 modules are equipped with the state-of-the-art IGBT4 technology supporting junction temperatures of \( T_{\text{Jmax}} = 150 \, ^\circ\text{C} \) for highest power density and leading-edge art IGBT4 technology supporting junction temperatures of 

- **Features**
  - Best in class current rating: 650 V/1200 V/1700 V
  - Superb thermal performance to enable full power utilization
  - New advanced assembly technologies
  - Trench/Fieldstop IGBT4
  - Compact modules with only 17 mm height
  - Isolated base plate
  - Parallel operation enabled by symmetrical design
  - Standard housing
  - Optional pre-applied thermal interface material (TIM)

- **Benefits**
  - Highest power density for compact inverter designs
  - Trench/Fieldstop IGBT4
  - Compact modules with only 17 mm height
  - PressFIT contact technology
  - Emitter controlled diode
  - Integrated NTC temperature sensor
  - \( V_{\text{CER}} \) with positive temperature coefficient
  - Isolated base plate
  - Parallel operation enabled by symmetrical design
  - Standard housing
  - Optional pre-applied thermal interface material (TIM)

<table>
<thead>
<tr>
<th>( I_{\text{C}} ) [A]</th>
<th>650 V</th>
<th>1200 V</th>
<th>1700 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>F4100R17ME4_B11*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>F4150R17ME4_B11*</td>
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<td>250</td>
<td>F4250R17ME4_B11*</td>
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3-Level

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<th>1700 V</th>
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<tbody>
<tr>
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<td>F3L300R12ME4_B11</td>
<td></td>
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<tr>
<td>400</td>
<td>F3L400R07ME4_B22</td>
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<thead>
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<th>1700 V</th>
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<tbody>
<tr>
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<td>300</td>
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</tr>
<tr>
<td>630</td>
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</tr>
</tbody>
</table>

*Fourpack

New: EconoDUAL™ 3 for Medium Voltage Drives (MVD)

Infineon’s new EconoDUAL™ 3 H Bridge modules address the specific requirements of the Cascade H Bridge (CHB) topology, typically used in Medium Voltage Drives applications. One EconoDUAL™ 3 H Bridge module can replace two 62 mm modules, enabling for more compact inverter designs at reduced system costs for CHB drives.

EconoPACK™ 4
IGBT Modules

The EconoPACK™ 4 package perfectly fits into the well-known Econo portfolio. EconoPACK™ 4 features screw power terminal, providing excellent electric connection. DC and AC link are separated and distinguishable at one glance for ease of use. Control pins feature Infineon’s PressFIT technology for solderless assembly. A new and highly reliable ultrasonic welding process is used for all connections between the terminals and the DCBs within the module.

Optimized gate driver connection is possible by placing the driver on top of the module. Low parasitic stray inductance and optimized thermal resistance to heat sink contribute to excellent inverter solutions.

The EconoPACK™ 4 portfolio is available in current ratings from 100 A up to 400 A. Sixpack and half-controlled input rectifier configurations (available in 1600 V with current ratings of 240 A and 360 A) are tailor-made for industrial applications. Furthermore, three level one phase solutions are available with the 650 V, 1200 V and 1700 V IGBT Technology and current ratings of 200 A to 400 A, offering higher efficiencies, lower switching losses as well as savings in system costs, e.g. due to lower filter requirements.

1EDI EiceDRIVER™

EiceDRIVER™ solutions from Infineon are the expert’s choice. With its HV Gate Driver Board ICs and Gate Driver ICs, Infineon supports the complete current ranges from 100 A to 600 A with Infineon’s IGBT4 technologies. EiceDRIVER™ solutions provide a broad spectrum of solutions for reliable and efficient controls for IGBT and MOSFET products.

Main Features:
- Single channel isolated driver
- Input to output isolation voltage up to 1200 V
- For high voltage power MOSFETs and IGBTs
- Up to 6 A minimum peak rail-to-rail output
- Separate source and sink outputs or active Miller Clamp

Main Features:
- Robustness: rugged mechanical design with ultrasonic welded and injection moulded terminals
- Easy and most reliable assembly: PressFIT control pins and screw power terminals for completely solderless connections
- Efficiency: leading IGBT technologies with increased \( V_{\text{Jmax}} = 150 \, ^\circ\text{C} \), optimized module layout for high power densities
- Integration: compact rectifier, sixpack and three level one phase configurations with NTC

3-Level

<table>
<thead>
<tr>
<th>( I_{\text{C}} ) [A]</th>
<th>650 V</th>
<th>1200 V</th>
<th>1700 V</th>
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<tbody>
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2-Level

<table>
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<tr>
<td>100</td>
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Pack | \( I_{\text{C}} \) [A] | 650 V | 1200 V | 1700 V |
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>2-Level 650 V 1200 V 1700 V</td>
<td>2x chopper</td>
<td>2x chopper</td>
<td>half-controlled input rectifier</td>
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<td>200</td>
<td>FD200R12PT4 B6</td>
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<tr>
<td>300</td>
<td>FD300R12PT4 B6</td>
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<tr>
<td>400</td>
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Others

<table>
<thead>
<tr>
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<tr>
<td>200</td>
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</table>

*Pre-applied Thermal Interface Material (TIM) optionally available; _B26 NPC 2 topology; _B26 NPC-2}
Flexible Module Solutions for Motion Control
Power Modules

Vincotech is an established, reliable partner in designing and building semiconductor power modules for motion control, renewable energy and power supply applications, setting performance standards for both off-the-shelf and application-specific solutions. An independently operating affiliate of Mitsubishi Electric Corporation staffed with around 500 people worldwide, Vincotech delivers fast, flexible and customer-focused solutions, service and support to empower customer’s ideas. A major part of the power module portfolio is designed for standard motor drive applications featuring state-of-the-art chip technologies.

The **flow** module family is suited for a power range of below 1 kW and up to 50 kW. The name Vincotech stands for highest product reliability and excellent customer service resulting in outstanding customer satisfaction.

**Vincotech offers**

- Power semiconductor modules based on components from leading manufacturers (IGBT, MOSFET, thyristors and diodes, SiC MOSFET) as well as passive components (shunts, capacitors, NTC, PTC)
- Various topologies (e.g. Rectifier, Sixpack, PIM (CIB), PIM with PFC, IPM) all with low stray inductance
- 22 different housings in various contact options (solder, Press-fit, screw and spring terminals), flexible heat sink orientation (horizontal and vertical), with pre-applied thermal interface material, e. g. highly conductive phase change material.
- Standard Al₂O₃ and advanced AlN substrate for improved thermal connectivity
- Convex, pre-bent DCB to minimize thermal grease thickness
- Simulation tools that interactively calculate modules' electrical and thermal behavior based on fully measured parameters

**Available Topologies**

<table>
<thead>
<tr>
<th>Available Topologies</th>
<th>Package</th>
<th>Voltage [V]</th>
<th>Current [A]</th>
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<td>Flow 0B</td>
<td>600...1600</td>
<td>4...35</td>
</tr>
<tr>
<td>Rectifier, sixpack, 7pack, PM (CIB), PM with PFC, halfbridge, Halfbridge</td>
<td>Flow 0</td>
<td>600...1600</td>
<td>4...200</td>
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<tr>
<td>Sixpack</td>
<td>Flow 60</td>
<td>1200</td>
<td>8...35</td>
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<tr>
<td>Sixpack, 7pack, PM (CIB), Halfbridge</td>
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<td>600...1200</td>
<td>15...100</td>
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<tr>
<td>PM</td>
<td>Flow 1B</td>
<td>600...1200</td>
<td>4...10</td>
</tr>
<tr>
<td>Rectifier, sixpack, 7pack, PM (CIB)</td>
<td>Flow 2</td>
<td>600...1600</td>
<td>35...150</td>
</tr>
<tr>
<td>Rectifier, sixpack, PM (CIB), PM with PFC</td>
<td>Flow 10</td>
<td>600...1600</td>
<td>6...75</td>
</tr>
<tr>
<td>Sixpack, PM (CIB)</td>
<td>MiniSKiiP</td>
<td>600...1200</td>
<td>6...150</td>
</tr>
</tbody>
</table>

*MiniSKiiP™ is a trade mark of SEMIKRON Elektronik GmbH & Co KG*