We drive efficiency in drives
Our expertise for your optimal drive systems

May 2022
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### Overview of three major areas in low voltage drives

<table>
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<tr>
<th>General purpose drives</th>
<th>Servo drives</th>
<th>C-HVAC</th>
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<tbody>
<tr>
<td>370 W</td>
<td>370 W</td>
<td>3 kW</td>
</tr>
<tr>
<td>1250 kW</td>
<td>315 kW</td>
<td>75 kW</td>
</tr>
</tbody>
</table>

#### Requirements

- Performance and reliability
- Safety features
- Good price / performance ratio
- High positioning accuracy
- Fast response with no overshoot
- High reliability
- Good price / performance ratio

#### Key applications

- Pumps & fans
- Process automation
- Cranes
- Marine drives
- Robotics
- Material handling
- Machine tools
- Commercial Heating & Ventilation Air-Conditioning (C-HVAC)

#### Infineon products

- iMOTION™
- CIPOS™ IPM
- EiceDRIVER™ gate driver
- EasyPIM™
- EconoPIM™
- EconoDUAL™
- PrimePACK™
- CoolSiC™
- MOSFETs
- CIPOS™ IPM
- Discretes
- EiceDRIVER™ gate driver
- EconoPACK™
- EasyPACK™
- EconoDUAL™
- CoolSiC™
- MOSFETs
- EconoPIM™
- EasyPIM™
- EiceDRIVER™ gate driver
- OPTIGA™ Trust family
- CIPOS™ IPM
- iMOTION™
Overview of medium voltage drives

<table>
<thead>
<tr>
<th>Medium voltage drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kW</td>
</tr>
<tr>
<td>36 MW</td>
</tr>
</tbody>
</table>

Requirements

- Long life cycle
- Fast repair
- Redundancy
- High efficiency

Key applications

- Water pumps
- Material handling
- Power generation
- Oil & gas

Infineon products

- PrimePACK™
- PrimePACK™ .XT
- XHP™
- EconoDUAL™
- 62mm
- EiceDRIVER™ gate driver
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Key questions to design your drives inverter

- What is your specific application?
- What is the RMS current/motor power?
- What is the voltage AC/DC?
- What is the topology?
- What is the switching frequency?
Key questions to design your drives inverter

- **Application**
  - What is your specific application?

- **Power**
  - What is the RMS current/motor power?

- **Voltage**
  - What is the voltage AC/DC?

- **Topology**
  - What is the topology?

- **Frequency**
  - What is the switching frequency?
A closer look at a typical converter system
The levels of integration

<table>
<thead>
<tr>
<th>Power electronics</th>
<th>Gate drivers</th>
<th>Sensors &amp; Security</th>
<th>Microcontrollers</th>
<th>Wireless connectivity</th>
<th>External memory</th>
</tr>
</thead>
</table>
| › Discretes       | › Level shift driver  
                    | ➢ High side      | › Magnetic sensor for position and speed |
| › 3-phase PIM     | ➢ Half bridge    | › Current sensor   | › XMC™ controller family based on ARM® Cortex®-M |
| › Sixpack         | ➢ High and low side  
                    | ➢ Three phase    | › Countless possibilities for motor control |
| › Dual switch     | › Isolated driver (1 & 2 channel)  
                    | › Low side driver (1 & 2 channel) |
| › Single switch   |               |                   | › Wi-Fi MCUs      | › High-Performance Memories for Embedded Systems  
                    |               |                   | ➢ Flash          |
| › Thyristors & Diode Discs |             |                   |                  | ➢ RAM            |
## Application requirements for general purpose, servo and C-HVAC drives

<table>
<thead>
<tr>
<th></th>
<th>General purpose drives</th>
<th>Servo drives</th>
<th>C-HVAC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
<td>Broad portfolio (0.37... 1250 kW)</td>
<td>Less broad portfolio (... ~315 kW or customized current classes)</td>
<td>Portfolio (3 kW to 75 kW)</td>
</tr>
<tr>
<td></td>
<td>600 V, 1700 V and 1200 V switches (major)</td>
<td>600 V, 1200 V switches (major)</td>
<td>1200 V switches</td>
</tr>
<tr>
<td><strong>f&lt;sub&gt;sw&lt;/sub&gt;</strong></td>
<td>4 to 8 kHz &lt;100 kW</td>
<td>4 to 8 kHz, 16 kHz w/ derating</td>
<td>4 to 8 kHz</td>
</tr>
<tr>
<td></td>
<td>2 to 4 kHz &gt;100 kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>dv/dt</strong></td>
<td>≤ 5 kV/µs</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SC</strong></td>
<td>Fast short circuit detection (e.g. 8 µs for IGBT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>f&lt;sub&gt;out&lt;/sub&gt;</strong></td>
<td>a) Light duty – 50/60 Hz</td>
<td>Low f&lt;sub&gt;out&lt;/sub&gt; common down to 0 Hz (locked rotor)</td>
<td>30 Hz to 250 Hz</td>
</tr>
<tr>
<td></td>
<td>b) Heavy duty 1Hz w/ derating</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OL</strong></td>
<td>a) Light duty e.g. 110% I&lt;sub&gt;N&lt;/sub&gt; 60 sec 100% I&lt;sub&gt;N&lt;/sub&gt; 240 sec</td>
<td>a) High overload e.g. 200% I&lt;sub&gt;N&lt;/sub&gt; 3 sec 0% I&lt;sub&gt;N&lt;/sub&gt; 7 sec</td>
<td>No overload / light overload</td>
</tr>
<tr>
<td></td>
<td>b) Heavy duty e.g. 150% I&lt;sub&gt;N&lt;/sub&gt; 60 sec 100% I&lt;sub&gt;N&lt;/sub&gt; 240 sec</td>
<td>b) Very high overload e.g. 300% I&lt;sub&gt;N&lt;/sub&gt; 0.25 sec 70% I&lt;sub&gt;N&lt;/sub&gt; 3.75 sec</td>
<td></td>
</tr>
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</table>
Overload ratings for low-voltage drives are key for reliability

Overload capability is the property in which, during acceleration operations, the inverter temporarily delivers a higher current than the rated current. **There are two sorts of ratings used in industrial drives:**

**Light/Normal Duty (LD/ND)**
- Applied in fans and pumps, since they do not require high torque at low speed and have a 110% overload rating

**Heavy Duty (HD)**
- Applied in industrial automation and requires high torque at low speeds and a 150% overload rating
- The base load current is reduced when compared to normal duty

For servo drives the overload capability can increase up to 300% of rated current.
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Switching technologies for industrial drives – Mapping into motor drive types

**Low voltage drives**
100 V – 690 V

- General purpose
- Servo
- Commercial HVAC

**Medium voltage drives**
> 690 V

- IGBT 600, 650, 1200 V
- FET

- IGBT 1200 V+
- FET

**IGBT technologies**

- IGBT 600, 650, 1200 V

**MOSFET technologies**

- SiC MOSFET 650 V, 1200 V
- GaN HEMT 600 V
- SiC MOSFET 600 V – 650 V
- SiC MOSFET 100 V – 200 V – 300 V

**FET technologies**

- SiC MOSFET 1200 V, 1700 V+
Switching technologies for industrial drives – Technology positioning

IGBTs are the main stream technology for constant speed and standard frequency

**Si IGBT**
- Best $/Watt in low to mid frequency domains
- 650 V – 6.5 kV

**Si SJ MOSFET**
- Lower cost alternative for higher frequency and variable load
- 600 V / 650 V

**SiC MOSFET**
- High power – higher frequency
- 650 V – 2 kV+

**GaN HEMT**
- Medium/low power – highest switching frequency
- 600 V

**Load**
- Average high / constant load
  - Constant speed motors
  - General purpose drives
- Average low / variable load
  - Motors with frequent changes in speed/torque
  - Servo drives

**Frequency (kHz)**
- 1 MHz
- 10 MHz
- 1 MHz
- 10 kHz
- 100 kHz
- 1 kHz

**High inductance motors**
**Low inductance motors**

FETs enable variable speed and low inductance motors
Broad Intelligent Power Module portfolio – Serving power ranges from 20 W to 5 kW plus

Main Applications

- **Industrial Drives**
- **Major Home Appl.**
- **Small Home Appl.**

**CIPOS™ Nano**
- 7x8x0.9 mm
- 8x9x0.9 mm
- 12x12x0.9 mm
- For space constrained applications

**CIPOS™ Micro**
- Compact solution
- Optimized solution for low power fan & pump
- 7x8x0.9 mm
- 8x9x0.9 mm
- 12x12x0.9 mm

**CIPOS™ Tiny**
- New solution for RAC compressor
- Best optimized solution for RAC up to 1.5HP
- 34x15x3.8 mm

**CIPOS™ Mini**
- Broad range portfolio
- Proven solution for MHA/Industrial drives
- 36x21x3.1 mm

**CIPOS™ Maxi**
- Highest power density
- Ruggedized Industrial drives and CAC solution
- 36x23x3.1 mm

Power [W]

- 20 50 100 250 500 750 1500 3000 > 5000

Infineon Proprietary

2022-05-09
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CIPOS™ Mini provides fully featured compact inverter solution with wide current range up to 30 A

**Key features**

- Fully isolated dual-in-line transfer molded package
- Compact body size of 36x21x3.1mm and the smallest IPM with current rating up to 30 A
- One package platform covers wide current rating from 4 A to 30 A and it allows easy & fast platform design from small to larger power.
- Two kinds of package types: DIP 36x21 with fullpack and DIP 36x21D with DCB substrate to support excellent thermal performance
- Integrated 600V TRENCHSTOP™ IGBT and rugged SOI gate driver technology with advanced protection features
- UL certified

**Benefits**

- High integrations (bootstrap circuit, thermistor) for easy design and saving system space
- Single platform possible from 4 A to 30 A
- Enhanced robustness of the advanced IGBT, gate driver IC technology
- Smaller package and high power density
- Two kinds of substrates provide cost efficient solution for low to medium power motor drives.

**Internal schematic and products**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Related Current [A]</th>
<th>Package</th>
</tr>
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<tbody>
<tr>
<td>IKCM10L60GA</td>
<td>10 A</td>
<td>DIP 36x21</td>
</tr>
<tr>
<td>IKCM15L60GA</td>
<td>15 A</td>
<td>DIP 36x21D</td>
</tr>
<tr>
<td>IKCM20L60GA</td>
<td>20 A</td>
<td>DIP 36x21D</td>
</tr>
<tr>
<td>IKCM15L60GD</td>
<td>15 A</td>
<td>DIP 36x21D</td>
</tr>
<tr>
<td>IKCM20L60GD</td>
<td>20 A</td>
<td>DIP 36x21D</td>
</tr>
<tr>
<td>IM535-U6D</td>
<td>30 A</td>
<td></td>
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</tbody>
</table>
CIPOS™ Mini single boost PFC-integrated 3 phase inverter IPM enables system size reduction and cost improvement

Key features

- Fully isolated dual-in-line transfer molded package
- Excellent thermal performance with DCB substrate
- Inverter + single boost PFC in one package
- Inverter current rating: 10 / 15 / 20A
- Various PFC switching available: 20 kHz or 40 kHz (for 10 / 15 A)
- High PFC switching over 100kHz with CoolMOS™ Power MOSFET for PFC (for 20 A)
- Robust gate driver in SOI technology
- Power capability over 2 kW
- UL certified

Exemplary schematic/topology:

Benefits

- System size reduction with PFC integration into inverter module as well as significant inductor size reduction with high PFC switching
- Cost improvement from lower BOM count, reduced assembly cost, and smaller system size
- Smaller and cheaper heatsink
- Customer can design switching performance of PFC by using external driver circuit

<table>
<thead>
<tr>
<th>Rated current</th>
<th>PFC Fsw</th>
<th>20 kHz</th>
<th>40 kHz</th>
</tr>
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<tbody>
<tr>
<td>10 A</td>
<td>IFCM10S60GD</td>
<td>IFCM10P60GD</td>
<td></td>
</tr>
<tr>
<td>15 A</td>
<td>IFCM15S60GD</td>
<td>IFCM15P60GD</td>
<td></td>
</tr>
<tr>
<td>20 A</td>
<td>IM564-X6D (over 100 kHz with CoolMOS™ for PFC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CIPOS™ Maxi IPM provide excellent performance with highest power density in 1200 V class for 3-phase motor drive application

**Key features**

› Offers the smallest package in 1200 V IPM class
› Integrated 6 TRENCHSTOP™ IGBT 4 / CoolSiC™ MOSFET and a rugged 1200 V 6-channel SOI gate driver
› Integrated bootstrap functionality
› Over current shutdown
› Under-voltage lockout at all channels
› RFE pin with multi-functions
› An independent thermistor for temperature monitoring

**Exemplary schematic/topology:**

**Benefits**

› The smallest package size in 1200 V IPM class with high power density
› High output power up to 8 kW
› High efficiency up to 99.6%
› Enhanced robustness of gate driver technology for excellent protection
› Adapted to high switching application with lower power loss
› Simplified system design and manufacturing

---

**Part No.**  | **Package**  | **Rds(on)/Current Rating**  | **Voltage Rating**  | **Ver.**
--- | --- | --- | ---
IM818-SCC | DIP 36x23D | 5 A | 1200 V | IGBT 4
IM818-MCC | DIP 36x23D | 10 A | 1200 V | IGBT 4
IM818-LCC | DIP 36x23D | 15 A | 1200 V | IGBT 4
IM828-XCC | DIP 36x23D | 55 mohm / 20 A | 1200 V | CoolSiC™ MOSFET
Broad discrete IGBT & FET portfolio serving power ranges up to 20 kW

Discrete IGBT and CoolSiC™ MOSFET portfolio
# Discrete solutions for industrial drives – features and benefits

<table>
<thead>
<tr>
<th>Product type</th>
<th>Input Connection</th>
<th>Product name and Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>INV Switch IGBT</td>
<td>1-phase</td>
<td>IKW50N65ET7 TRENCHSTOP™ IGBT7</td>
</tr>
<tr>
<td></td>
<td>3-phase</td>
<td>IKW40N120CS7 TRENCHSTOP™ IGBT7</td>
</tr>
<tr>
<td>INV Switch SiC MOSFET</td>
<td>1-phase</td>
<td>IMW65R072M1H CoolSiC™ MOSFET</td>
</tr>
<tr>
<td></td>
<td>3-phase</td>
<td>IMW120R060M1H CoolSiC™ MOSFET</td>
</tr>
</tbody>
</table>

### Key features

- **IGBT7 T7** shows:
  - Improved humidity ruggedness
  - Low saturation and forward voltage
  - Optimized controllability below 5 kV/µs
  - Short circuit ruggedness

- **CoolSiC™ MOSFET** has:
  - Exclusive 3 µs short circuit withstand time
  - Reliability as Si power transistor by Infineon
  - Lowest total losses at the same EMI level as IGBT

### Benefits

- **CoolSiC™ MOSFET** provides:
  - Minimum switching losses, maximum cooling surface area, zero-voltage turn-off, minimized PCB board space and further power density improvements

- **TRENCHSTOP™ IGBT7** is best in class device in motor drive applications, where it shows:
  - up to 25% higher power density or up to 15% lower temperature rise
Discrete 600 V / 650 V CoolMOS™ assisted hard commutation solution – Making CoolMOS™ work in motor drives

A solution that enables the use of HV SJ MOSFETs (CoolMOS™) in hard commuting topologies, like half or full bridge topologies, so far addressable only by WBG devices or IGBTs

<table>
<thead>
<tr>
<th>Product type</th>
<th>Input Connection</th>
<th>Product name and Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJ MOSFET</td>
<td>3-phase</td>
<td>6 x IPT60R035CFD7 or 6 x IPDQ60R018CFD7*</td>
</tr>
<tr>
<td>Gate driver IC</td>
<td></td>
<td>6 x 2EDF7275F</td>
</tr>
<tr>
<td>SiC diode</td>
<td></td>
<td>6x IDL06G65C5 or 6x IDDD08G65C6</td>
</tr>
<tr>
<td>LV MOSFET</td>
<td></td>
<td>6x BSZ440N10NS3</td>
</tr>
</tbody>
</table>

Key features

› Low Qrr and Qoss solution: SJ MOSFET can be used in hard commuting topologies
› Similar performance as WBG
› Ohmic behavior

Exemplary schematic/topology:

Benefits

› Efficiency increase in hard commuting topologies
› BOM cost savings
› Power density improvement compared to state of the art solutions
› Large CoolMOS portfolio with a large choice of SMD packages
› Leverage CoolMOS 20 years track record
Broad IGBT package portfolio serving current ranges from 6 A to 3 kA
TRENCHSTOP™ IGBT7 with the Easy family –
A perfect fit for platform based design of industrial drives

Key features

› The latest TRENCHSTOP™ IGBT7 and EC7 diode technology
› Lower on state voltage VCE(sat) and Vf
› Overload capability at Tvj,op=175°C
› Enhanced controllability of dv/dt
› Optimized for simple driving
› All packages have same mechanical height

Benefits

› Higher power density and lower power losses
› Optimized for Drives application
› Reduced system size and lower system cost
› Power extension up to 45 kW, fit for platform based design and production

Exemplary schematic/topology:

Find more for IGBT7: www.Infineon.com/IGBT7
Easy modules with CoolSiCTM MOSFET chip technology for industrial drives

- Highest efficiency for reduced cooling effort
- Higher frequency operation
- Increased power density
- Optimized customer’s development cycle time and cost

Key features
- EasyPACK™ 1B 1200 V / 4 mΩ sixpack module with CoolSiC™ MOSFET in 1200 V, NTC and PressFIT contact technology
- High current density
- Best in class switching and conduction losses
- Low inductive design
- Integrated NTC temperature sensor
- PressFIT contact technology
- RoHS-compliant modules

Benefits
- Highest efficiency for reduced cooling effort
- Higher frequency operation
- Increased power density
- Optimized customer’s development cycle time and cost

Exemplary schematic/topology:

EasyPACK™ FS45MR12W1M1P_B11 also available with pre-applied TIM
Econo2 and Econo3 modules – established product for broad range of applications

- High reliability and quality
- Cost-efficient
- Fast, simplified, low-cost mounting
- Design flexibility and simple integration in power electronic applications
- High power density

Key features
- Established RoHS-compliant housing concept for high volume production
- Modules with base plate for increased robustness in standard solder pins or high reliability PressFIT pins
- Available with state-of-the-art IGBT7 technology
- Numerous topologies, voltages (600V-1700V) and currents (15A-200A) for broad range of applications
- Integrated configurations includes NTC, shunt, pre-applied Thermal Interface Material (TIM), Advance H2S protection

Exemplary schematic/topology:

PIM with NTC
EconoDUAL™ 3 – 1st choice for future system designs

Key features

- Highest power cycling capability
- Excellent mechanical robustness
- Screw-type power terminals and PressFIT control pins
- TIM – pre-applied thermal interface material
- Available with integrated shunts
- NTC integration for temperature control
- Evaluation Boards to reduce design-in effort
- $T_{v_{jop}}$ 150°C (TRENCHSTOP™ IGBT4)
- $T_{v_{jop}}$ 175°C overload (TRENCHSTOP™ IGBT7)

Benefits

- Optimized thermal resistance to heat sink
- Reduced mounting effort and increased interconnection reliability
- Compact configurations with only 17 mm height
- Parallel operation enabled by a symmetrical design
- Reduced system costs
- One module fits several applications

Exemplary schematic/topology:
EconoPACK™ 4

Key features

› Robustness: rugged mechanical design with ultrasonic welded and injection-molded screw terminals
› Easy assembly: pressFIT control pins and screw power terminals for completely solderless connections
› Integration: compact rectifier, chopper, 6-pack and 3-level single-phase configurations with NTC

Benefits

› **Cost advantage** compared to using 3 x 34mm modules / 62mm modules
› Allows **more compact inverters** compared to using 3 x 34mm / 3 x 62mm modules

Exemplary schematic/topology:

<table>
<thead>
<tr>
<th>Product</th>
<th>Ic (A)</th>
<th>Topology</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS100R12PT4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>FS150R12PT4</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>FS200R12PT4</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>
34mm and 62mm module family with its comprehensive portfolio offers more flexibility and highest reliability for successful inverter designs.

**Key features**

- IGBT7 and EC7 1200 V chipset
- Superior solution for frequency controlled inverter drives
- UL/ CSA certification with UL1557 E83336
- Operating temperature up to 150°C
- Optimized switching characteristic
- Softness
- Existing packages with high current capability
- RoHS compliant

**Benefits**

- Highest power density
- Allows to increase inverter output power with same frame size
- Reduced switching losses
- Improved humidity robustness

Exemplary schematic/topology:
IHV & XHPTM the perfect match with drives trends

Trends and requirements

- on drive level
- on drive converter level
- on module level

perfect match
reliable compact or even integrated drive

Features

- Low losses with high output RMS current on decreasing module dimensions
- Strict qualification tests and production test
- High TC (30,000 cycles @ ∆T_c=80K)
- PC capability at min. 2 Mio cycles @ ∆T_j=40K
  - Latest 3.3 kV generation (IGBT4) offer 200% PC
- Cosmic radiation stability (100FIT e.g. @ 2900V for 4.5 kV)
- Unbeatable Robustness

Benefits

- Above features enables more performant up to 50% smaller inverter design
- Higher PC allows lifetime conversion into higher output power and frequency (e.g. 200% PC = 12% higher I_{RMS} on same lifetime)
- Especially XHP™ 3 enables a very easy bus bar concept
- Robustness against overload and fault conditions and clean switching
- Assure required reliable lifetime of 5 to 30 years

The benefits of Infineon’s IGBTs & Diodes help >40% of the market, since 25 years
PrimePACK™ modules enable high system performance

- Multiple frame sizes on single platform
- Frame size scalability
- High life time in demanding applications
- High reliability and quality
- Optimized system based costs
- High Irms/ Area
- High current terminals
- Compact inverter size

**Key features**

- Ultrasonic Welding between DCB and terminals for optimal mechanical and electrical interconnection
- Equal distance between the chips and the mounting positions
- Homogenous temperature distribution between the chips
- Improved thermal resistance $R_{thjc}$ by optimized chip locations
- Fast switching (E4) and soft switching chips (P4)
- Modular design optimized for paralleling
- Pre-applied Thermal Interface Material (TIM) to achieve longest lifetime
- NTC integration for temperature control
- $T_{vop}$ 150°C

**Exemplary schematic/topology:**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Voltage</th>
<th>IC [A]</th>
<th>Package</th>
<th>Topology</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF450R12IE4</td>
<td>1200 V</td>
<td>450</td>
<td>PP2</td>
<td></td>
</tr>
<tr>
<td>FF600R12IE4/P4</td>
<td>600</td>
<td>PP2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF900R12IE4/P4</td>
<td>900</td>
<td>PP2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1400R12IP4</td>
<td>1400</td>
<td>PP3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1200R12IE5</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1500R12IE5/R</td>
<td>1500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1800R12IP5</td>
<td>1800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF450R17IE4</td>
<td>1700 V</td>
<td>450</td>
<td>PP2</td>
<td></td>
</tr>
<tr>
<td>FF650R17IE4</td>
<td>650</td>
<td>PP2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1000R17IE4</td>
<td>1000</td>
<td>PP3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1400R17IP4</td>
<td>1400</td>
<td>PP3</td>
<td></td>
<td></td>
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<tr>
<td>FF1200R17IP5</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1500R17IP5/R</td>
<td>1500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF1800R12IP5</td>
<td>1800</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Overview with performance classes for microcontroller

- **XMC1000**
  - ARM® Cortex®-M0
  - CPU up to 48 MHz
  - Flash: 8–200 kB
  - Package: 16–64 pins

- **XMC4000**
  - ARM® Cortex®-M4F
  - CPU up to 144 MHz
  - Flash: 64 k–2 MB
  - Package: 48–196 pins

- **AURIX™ 1st generation**
  - **AURIX™ TC2x¹**
    - TriCore™
    - Up to 3x multicore
    - CPU up to 300 MHz
    - Flash: 0.5–8 MB
    - Package: 80–516 pins

- **AURIX™ 2nd generation**
  - **AURIX™ TC3x¹**
    - TriCore™
    - Up to 6x multicore
    - CPU up to 300 MHz
    - Flash: 1–16 MB
    - Package: 100–516 pins

1) AURIX™ devices add safety and CAN FD
XMC4000 microcontroller units for industrial drives

Key features

› 32-bit ARM® Cortex™-M4 core with FPU running at 80MHz to 144MHz
› Dedicated Inverter PWM generators (CCU8)
› Fast and flexible 12-bit ADC
› Interfaces for HALL sensors, encoders and resolvers
› Event Request Unit (ERU)
› EtherCAT interface
› Wide temperature range from -40°C to 125°C

Benefits

› Real-time performance combined with enhanced connectivity
› Based on the robust technology going beyond usual industrial requirements
› Motor Control Libraries and DAVE Apps for fast software development
PSoC™, TRAVEO™ & AURIX™ Architectures meet broad set of application requirements and provide a strong portfolio.
Example of Synergy Application
Industrial Automation

AURIX™ Advantages:
› Multicore (up to 6 cores) to implement the various functions
› Safety IEC61508 up to SIL3 TÜV CERT.
› EtherCAT master / CANopen support
› TSN as the next fieldbus in industry

Traveo™ Advantages:
› ARM-based MCU for platform decision and tools / ecosystem reuse
› Multicore (up to 2 cores)
› Safety IEC61508 up to SIL2
› Up to CAN / SPI for communication
› AUDIO / Graphics capabilities for Display / HMI

HMI: TRAVEO™ & PSoC™

Traveo™ Advantages:
– Graphics Engine
– SIL2 Functional Safety
– Low Power Consumption
– Audio / Graphics Interfaces

PSoC® Advantages:
– Low Power
– Cap Sensor
– CapSense®
– MagSense™
– Multi-sense Converter
– HV LDO
– LIN TX
– Integration – Board Space

Communication: AURIX™, TRAVEO™ & PSoC™

AURIX™ Advantages:
– EtherCAT master / CANopen support
– TSN as the next fieldbus in industry (Aurix™ TC4xxx)
– HSSL support for AURIX connection to FPGA

Traveo™ Advantages:
– GbE – TSN in future devices
– SIL2 Functional Safety
– Low Power Consumption

PSoC® Advantages:
– Low Power
– Cap Sensor
– HV LDO
– LIN TX
– Integration – Board Space

Sensor: TRAVEO™ & PSoC™

Traveo™ Advantages:
– Graphics Engine
– SIL2 Functional Safety
– Low Power Consumption

PSoC® Advantages:
– Low Power
– Cap Sensor
– CapSense®
– MagSense™
– Multi-sense Converter
– HV LDO
– LIN TX
– Integration – Board Space

Motor Control: AURIX™ & TRAVEO™

AURIX™ Advantages:
– AURIX advanced Timer Unit
– Real time performance
– Scalability in Multicores & memory

Traveo™ Advantages:
– >256kB Flash
– PWM capability, High Resolution ADC
– 50µA stand-by current

Communication:

PLC: AURIX™ & TRAVEO™

HMI: TRAVEO™ & PSoC™

Sensor: TRAVEO™ & PSoC™
ISOFACE™ product family – Galvanic isolation & diagnostics integrated

8-channel switch IC
- 2.5 kV galvanic isolation
- 3.3 V µC interface (SPI, parallel)
- Diagnostics per channel:
  - Open load
  - Short to $V_{bb}$
  - Short to GND & overload
  - Over temperature
- 5-fold global diagnostics

8-channel switch ICs
- Integrated galvanic isolation
- Direct interface to µC
  - 3.3 V/5 V
  - Serial or parallel
- Short-circuit protection
- Inductive load switching
- Up to 1.2 A load current
- Integrated diagnostics:
  - Overload & short circuit

8-channel digital input ICs
- Integrated galvanic isolation
- Direct interface to µC
  - 3.3 V/5 V
  - Serial or parallel
- IEC-input types: 1/2/3

8-channel input ICs

8-channel switch ICs
- H823V 8x 0.6 A 12 x 12 VQFN

1st gen
- H811G 8x 0.6 A Parallel
- H812G 8x 0.6 A SPI
- H815G 8x 1.2 A Parallel
- H816G 8x 1.2 A SPI

2nd gen
- H811G 8x 0.6 A Parallel
- H812G 8x 0.6 A SPI
- H815G 8x 1.2 A Parallel
- H816G 8x 1.2 A SPI

8-ch. digital input ICs

Sampling speed | Filter settings | $V_{bb}$-monitor | Diagnostics | Wire-break
--- | --- | --- | --- | ---
125 kHz | 4 / IC | ✓ | ✓
500 kHz | 9 / channel | ✓ | ✓
ISOFACETM - Galvanic isolated high-side switches & input ICs

Key features

› Integrated galvanic isolation
› 8-channels
› Integrated clamping diode
› Programmable input filters
› Diagnostic feedback

Benefits

› Ideal for industrial applications operating at elevated temperatures
› Higher operational life-time
› Higher reliability
› Ideal for high-precision or high-speed applications
› At least 50% PCB area savings
› Inductive load switching
› Flexibility
› Over-load detection
› Strong maintenance support

Exemplary schematic/topology:
OPTIGA™ Trust Family
The security answer to our customer’s concerns

Security chip offering core functions to secure embedded systems

Security level
- High
- Low

Feature set
- Single function
- Advanced

Authentication
OPTIGA™
Authenticate S
- e.g. Authentication of accessories

OPTIGA™ Trust M
- e.g. secured communication to the cloud

Connected device security
OPTIGA™ Trust M SLS32AIA

Key features

- Based on CC EAL 6+ (high) certified security controller
- X.509 certificate supported
- TRNG AIS-31 certified
- CA certificate in-field update
- Cryptography ECC, RSA, AES, SHA
- Extended temperature range: -40° to 105°C
- Extended lifetime (20 years)

Benefits

- **Secured zero-touch provisioning** for leading cloud providers.
- **Easy integration** based on a range of turnkey use cases to minimize your integration efforts.
- **Future-proof security** provided by the most advanced cryptographic schemes.
- **Open Source** framework to benefit from direct support from developers.
# OPTIGA™ solutions and relevant use cases

<table>
<thead>
<tr>
<th>Use case</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand protection and authentication of accessories</td>
<td>OPTIGA™ Authenticate S can be used in accessories / consumables to verify that genuine parts are used.</td>
</tr>
<tr>
<td>Mutual authentication</td>
<td>OPTIGA™ Trust M can secure multiple secret keys and certificates. It can be used to perform mutual authentication with clouds and other systems. (e.g. a device can authenticate with commissioners, controllers, ecosystems, and other entities)</td>
</tr>
<tr>
<td>Secured communication</td>
<td>OPTIGA™ Trust M can be used to establish secured communication with a cloud or other service or device</td>
</tr>
<tr>
<td>Secured storage</td>
<td>OPTIGA™ Trust M adopts a Common Criteria EAL6+ certified hardware trust anchor which offers protection against various physical and reverse-engineering attacks. Data stored in the Trust M is protected against various extraction techniques as verified by the Common Criteria certification.</td>
</tr>
<tr>
<td>Secured firmware update</td>
<td>OPTIGA™ Trust M can be used to cryptographically verify and perform secured firmware updates.</td>
</tr>
</tbody>
</table>
XENSIV™ angle-sensors in electrification for drives

Key features

- Wide portfolio of magnetic position sensors
- Offering Hall, GMR, AMR and TMR sensors
- Digital and analog interfaces for angle sensors available

Benefits

- Suitable for all commutation types for motor control
- ISO ready and ISO compliant versions

Broad product portfolio for all kind of electric motor commutation types
XENSIV™ enablement examples: Infineon provides supportive material for a short time-to-market

Documentation
- Datasheets, product briefs, user manuals
- Updated product presentations

Application notes
- Joystick
- 3D Hall for multifunction knob
- 3D Hall for gearstick
- 3D Hall for linear movement
- 3D Hall for angle measurement
- And more…

Online simulation tools

Evaluation tools & SW
- Sensor-2-go kit for 3D Hall sensors incl. extensions
- Sensor-2-go kit for speed sensor & current sensor
- Shield2Go for 3D and current sensors
- Shield2Go for barometric pressure sensors
- Demo boards for radar

Sensing toolboxes
- Sensing toolbox for shaft sensing (end-of-shaft, integrated end-of-shaft) available
- Sensing toolbox for current sensing in work right now
- Main purpose: adapt fast to dedicated application
XENSIV™ TLI4971 - high precision coreless current sensor for industrial applications

Key features

› Magnetic coreless differential sensor
› Power package
› Best-in-class temperature and lifetime accuracy
› Easy system integration
› Protection capability for upcoming IGBT technologies

Benefits

› No hysteresis
› Overload capability
› Stray field immunity
› Very low power dissipation
› Superior system accuracy
› Support of ISO61508/ISO26262 requirements
› Simplified layout, reduced design risk
› Space and cost saving
Gate driver portfolio serving power ranges up to 200 kW and above

Note: Voltage class is defined base on different driver configurations for the Max Voltage class. 1. For high-side, high-and low-side, half bridge and three phase gate drivers, voltage class is defined as switch break down voltage in applications. 2. For low side drivers (N-ISO), voltage class is defined as maximum operating range supply voltage. 3. For special cases as 1EDN-TDI (N-ISO), voltage class is defined as maximum bus voltage (highest floating voltage it can manage).
EiceDRIVER™ gate driver IC technology overview
Wide portfolio to best fit with Drives application requirements

<table>
<thead>
<tr>
<th>Non-isolated GD</th>
<th>Level-shift GD</th>
<th>Isolated GD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low-side</strong></td>
<td><strong>Junction isolation (JI)</strong></td>
<td><strong>Silicon on insulator (SOI)</strong></td>
</tr>
<tr>
<td><img src="image1.png" alt="Non-isolated GD diagram" /></td>
<td><img src="image2.png" alt="Level-shift GD diagram" /></td>
<td><img src="image3.png" alt="Isolated GD diagram" /></td>
</tr>
<tr>
<td>› Monolithic construction of ground-reference gate drivers for 20 to 35 V supply voltage applications</td>
<td>› Monolithic construction of 1 to 6 gate drive channels up to 1200 V rating</td>
<td>› Monolithic construction of 2 to 6 gate drive channels up to 1200 V rating</td>
</tr>
<tr>
<td>› Comprehensive families of single- and dual-low-side drivers with flexible options for output current, logic configurations and UVLOs (plus non-isolated TDI)</td>
<td>› Industrial pioneering high-voltage IC (HVIC) technology used in all high-voltage gate drive applications</td>
<td>› VDE0884-11 isolation technology providing isolation up to 8 kV pk ViOTM and up to ±2300 V functional isolation</td>
</tr>
<tr>
<td>› Uses rugged and high-performance technologies of HVIC process or the latest state-of-the-art 130-nm process</td>
<td>› Optional Integrated bootstrap- FET circuit (200 Ω typ.)</td>
<td>› Two separate chips solution with magnetic coupling providing galvanically isolated single- and dual channel gate drivers</td>
</tr>
<tr>
<td>› Industry-standard DSO-8 and small form-factor SOT23, WSON and TSNP packages</td>
<td>› Negative transient immunity to prevent latch-up: -40 V for 100 ns</td>
<td>› VDE0884-11 isolation technology providing isolation up to 8 kV pk ViOTM and up to ±2300 V functional isolation</td>
</tr>
<tr>
<td>› Monolithic construction of ground-reference gate drivers for 20 to 35 V supply voltage applications</td>
<td>› Common mode transient immunity (CMTI): 50 V/ns, typ.</td>
<td>› Common-mode transient immunity (CMTI) of more than 300 V/ns</td>
</tr>
<tr>
<td>› Comprehensive families of single- and dual-low-side drivers with flexible options for output current, logic configurations and UVLOs (plus non-isolated TDI)</td>
<td>› Gen 2 technology (IR prefix): Industrial pioneering HVIC process</td>
<td>› Strongest gate-drive output currents (up to ±18 A) reducing need for external booster circuits</td>
</tr>
<tr>
<td>› Uses rugged and high-performance technologies of HVIC process or the latest state-of-the-art 130-nm process</td>
<td>› Gen 5 technology (IRS prefix): Cost-effective pin-to-pin versions of Gen 2</td>
<td>› Reliable protection options for each isolation rating in different packages</td>
</tr>
<tr>
<td>› Industry-standard DSO-8 and small form-factor SOT23, WSON and TSNP packages</td>
<td>› Negative transient immunity to prevent latch-up: -100 V for 300 ns</td>
<td></td>
</tr>
</tbody>
</table>
EiceDRIVER™ X3 Compact (1ED31xx) family
5.7 kV isolated driver with active Miller clamp or separate output

<table>
<thead>
<tr>
<th>Product highlights</th>
<th>Sample schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>› Single channel isolated gate driver with <strong>5.5 / 10 / 14 A</strong> (no booster required)</td>
<td></td>
</tr>
<tr>
<td>› Galvanic functional isolation voltages up to <strong>2300 V</strong></td>
<td></td>
</tr>
<tr>
<td>› <strong>90 ns</strong> propagation delay with <strong>30 ns</strong> input filter, <strong>7 ns</strong> propagation delay matching</td>
<td></td>
</tr>
<tr>
<td>› Active Miller Clamp or Separate outputs</td>
<td></td>
</tr>
<tr>
<td>› Exceptional CMTI robustness &gt; <strong>200 kV/µs</strong></td>
<td></td>
</tr>
<tr>
<td>› <strong>40 V absolute maximum</strong> output supply voltage</td>
<td></td>
</tr>
<tr>
<td>› Isolation capabilities &amp; certification</td>
<td></td>
</tr>
<tr>
<td>– 1ED31xxMU12F: UL 1577 certified $V_{iso}=3$ kV(rms)</td>
<td></td>
</tr>
<tr>
<td>– 1ED31xxMU12H: UL 1577 certified $V_{iso}=5.7$ kV(rms)</td>
<td></td>
</tr>
<tr>
<td>– 1ED31xxMC12H: UL 1577 &amp; VDE 0884-11 certified $V_{fom}=1767$ V (planned)</td>
<td></td>
</tr>
<tr>
<td>› DSO-8 150 mil (4 mm creepage) &amp; 300 mil package (8 mm creepage)</td>
<td></td>
</tr>
<tr>
<td>› Evaluation board available:</td>
<td></td>
</tr>
<tr>
<td>– EVAL-1ED3121MX12H; EVAL-1ED3122MX12H; EVAL-1ED3124MX12H</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>› Cost effective 8-pin gate driver (with <strong>150-mil and 300-mil</strong> bodies) enabling easy to design-in</td>
<td></td>
</tr>
<tr>
<td>› <strong>14 A driving capability &amp; 40 V output supply voltage range</strong></td>
<td></td>
</tr>
<tr>
<td>› Optimized specifications for driving SiC</td>
<td></td>
</tr>
<tr>
<td>› Fulfilling highest isolation standards</td>
<td></td>
</tr>
<tr>
<td>– UL1577 and VDE-11 (planned)</td>
<td></td>
</tr>
</tbody>
</table>

Typical Applications

- Lighting
- SMPS
- UPS
- EV charger
- Solar
- Drives
- Aircon

2022-05-09
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EiceDRIVER™ X3 Compact (1ED31xx) – Avoidance of parasitic turn-on based on Active Miller Clamp

- How to prevent parasitic turn-on during high dV/dt situation?
  - Negative VGE / VGS based on a bipolar power supply → Increase in design complexity
  - Active Miller Clamp (AMC) (i.e., bipolar power supply becomes obsolete)

- For SiC MOS and IGBT
  - For 0 V turn-off, Miller clamp function is highly recommended

EiceDRIVER™ 1ED Compact

- Active Miller clamp option
- VCC2 = 20 V (Max.)
- Unipolar power supply sufficient

EiceDRIVER™ X3 Compact

- Active Miller clamp option
- VCC2 = 40 V (Max.)
- Two options
  - Unipolar power supply only
  - Bipolar power supply & AMC
EiceDRIVER™ 2L-SRC Compact 1ED32xxMC12H – 5.7 kV isolated gate driver with 2-level slew rate control (2L-SRC)

**Product highlights**

- Single-channel isolated gate driver with 10 / 18 A
- 2-level slew rate control (EMI & switching losses optimization)
  - On-the-fly gate resistor change
- 100 ns propagation delay with 30 ns input filter
- 1 ns propagation delay matching (between OUT & OUTF)
- Standard output configuration and active Miller clamp option
- Exceptional CMTI robustness > 200 kV/µs
- 40 V absolute maximum output supply voltage
- Isolation capabilities & certification
  - 1ED32xxMC12H: UL 1577 & VDE 0884-11 (planned)
- 300-mil wide-body package (8 mm creepage)
- For IGBTs, MOSFETs, CoolSiC™ SiC MOSFETs up to 2300 V
- Evaluation board available:
  - EVAL-1ED3241MC12H, EVAL-1ED3251MC12H
  - [www.Infineon.com/gdcompact](http://www.Infineon.com/gdcompact)

**Sample schematic**

![Sample schematic diagram](image)

**Value proposition**

- 2-level slew rate control
  - Separate outputs for two-level (fast & slow) turn-on to reduce $dv/dt$
  - Reduction of switching losses
  - Tight propagation delay matching between outputs
- 8-pin gate driver (with 300-mil bodies) enabling easy to design-in
- Fulfilling highest isolation standards
  - UL1577 and VDE-11

**Typical Applications**

- Drives
- Solar
- UPS
- EV charger
EiceDRIVER™ Enhanced X3 Analog (1ED34xx) family
5.7 kV isolated driver with active Miller clamp, adjustable DESAT

Product highlights
› Single channel isolated gate driver with 3 / 6 / 9 A
› Galvanic functional isolation voltages up to 2300 V
› Active Miller clamp (clamp driver), DESAT, soft-off, Thermal shutdown
› Exceptional CMTI robustness > 200 kV/μs
› X3 Analog configurability
  › Adjustable DESAT filter time & blanking time and soft-off current with external resistor
› Isolation capabilities & certification
  › 1ED34×1M12M: UL 1577 certified $V_{\text{ISO}}=5.7$ kV(rms)
  › 1ED34×1MC12M: UL 1577 & VDE 0884-11 certified $V_{\text{FORM}}=1767$ V (planned)
› DSO-16 fine pitch, 300 mil wide-body package (8 mm creepage)
› For IGBTs, MOSFETs, CoolSiC™ SiC MOSFETs
› Evaluation board available:
  › EVAL-1ED3491MX12M www.Infineon.com/gdenhanced

Sample schematic

Value proposition
› Flexibility based on register-based configuration adjustments
› Reduction in hardware complexity with less customer product variants
› Reduction in the evaluation time with adjustable parameters for faster time-to-market.

Typical Applications

![Typical Applications Diagram]
EiceDRIVER™ Enhanced X3 Digital (1ED38xx) family
5.7 kV isolated driver with I2C bus configurability for DESAT

Product highlights
› Single channel isolated gate driver with 3 / 6 / 9 A
› Galvanic functional isolation voltages up to 2300 V
› Active Miller clamp (clamp driver), DESAT, soft-off, Thermal monitoring and shutdown
› Exceptional CMTI robustness > 200 kV/µs
› X3 Digital configurability
  - Full adjustable via I2C bus: 3 address configuration, 27 parameter configuration, 16 status
  - Configurable UVLO, DESAT², TLTO, Soft-off, Miller clamp
› Isolation capabilities & certification
  - 1ED38x0MU12M: UL 1577 certified $V_{ISO}=5.7$ kV(rms)
  - 1ED38x0MC12M: UL 1577 & VDE 0884-11 certified $V_{IORM}=1767$ V
› DSO-16 fine pitch, 300-mil wide-body package (8 mm creepage)
› For IGBTs, MOSFETs, CoolSiC™ SiC MOSFETs

Sample schematic

Value proposition
› Highest flexibility introduced by register-based adjustments via I2C
› Reduction in hardware complexity with less customer product variants
› Reduction in the evaluation time with adjustable parameters for faster time-to-market.

Typical applications

<table>
<thead>
<tr>
<th>EV charger</th>
<th>Solar</th>
<th>UPS</th>
<th>CAV</th>
<th>Aircon</th>
<th>Drives</th>
</tr>
</thead>
</table>

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EiceDRIVER™ Enhanced F3 (1ED332xMx12N) – Product overview

Product highlights

› Single-channel isolated gate driver with up to 6/8.5 A
› Active Miller clamp, DESAT, soft-off
› CMTI > ±300 kV/µs at 1.5 kV
› Propagation delay **85 ns typ.** (with 35 ns typ. input filter)
  › Prop. delay matching (part to part) +/- 15 ns
› DSO-16 300 mil package
  › 8 mm creepage distance, standard 1.27 mm pitch
  › Pin-compatible to 1ED020I12-F2/B2
› Isolation capabilities & certification
  › **UL 1577 certified** \( V_{ISO} = 5.7 \text{kV(rms)} \)
  › **VDE 0884-11 certified** \( V_{IORM} = 1767 \text{V(peak)} \) reinforced isolation
  For IGBTs, MOSFETs, CoolSiC™/SiC MOSFETs up to 2300 V
› Evaluation board available: EVAL-1ED3321MC12N

Sample schematic

Value proposition

› Accurate short-circuit protection (DESAT) & soft shutdown
› Up to 8.5 A driving capability & 40 V output supply voltage range
› Optimized specifications for driving SiC
› Fulfilling highest isolation standards
  › UL1577 and VDE-11
EiceDRIVER™ X3 Compact empower CoolSiC™ MOSFET
Avoid parasitic turn-on based on active Miller clamp

- How to prevent parasitic turn-on during high dV/dt situation?
  - Negative VGE / VGS based on a bipolar power supply  ➔ Increase in design complexity
  - Active Miller Clamp (AMC) (i.e., bipolar power supply becomes obsolete)

- For SiC MOS and IGBT
  - For 0 V turn-off, Miller clamp function is highly recommended

---

EiceDRIVER™ 1ED Compact

- Active Miller clamp option
- VCC2 = 20 V (Max.)
- Unipolar power supply sufficient

EiceDRIVER™ X3 Compact

- Active Miller clamp option
- VCC2 = 40 V (Max.)
- Two options
  - Unipolar power supply only
  - Bipolar power supply & AMC

---

www.Infineon.com/gdCompact

Copyright © Infineon Technologies AG 2022. All rights reserved.
EiceDRIVER™ 2L-SRC Compact empower IGBT7 in Drive application
Balancing efficiency vs. EMI by changing gate resistor on-the-fly

On-the-fly PWM cycle-to-cycle gate resistor change

Low load condition: Slow → Low switching losses

High load condition: Fast → Low switching losses

EMI PASS

Efficiency

EMI limit

Low load condition

High load condition

EMI

Efficiency

EMI PASS

Efficiency

EMI limit
## Infineon Bipolar portfolio

<table>
<thead>
<tr>
<th>Eco Line</th>
<th>Power Line</th>
<th>Prime Line</th>
<th>System Line</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>straight, efficient, functional</strong></td>
<td><strong>reliable, powerful, valuable</strong></td>
<td><strong>unique, optimized, leading</strong></td>
<td><strong>specific, complete, versatile</strong></td>
</tr>
</tbody>
</table>

**Eco Line**
- Modules
  - Eco Block
- Solder Bond
- Pressure Contact

**Power Line**
- Modules
  - Power Block
- Soft Starters
  - Power Start
- Diodes
  - Power Diode
- Discs
  - Power Disc

**Prime Line**
- Modules
  - Prime Block
- Diodes
  - Prime Soft
- Discs
  - Prime Disc
- Pressure Contact

**System Line**
- Stacks/Assemblies
  - Power Stack
- Accessories
  - Power Fit
- Press Pack IGBT
  - Prime Switch
Prime Switch portfolio

### Prime Switch Portfolio

<table>
<thead>
<tr>
<th>VSC HVDC 1)</th>
<th>MV-Drives and Wind turbines 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without internal FWD</td>
<td>Without internal FWD</td>
</tr>
<tr>
<td>› P3000ZL45X168</td>
<td>› P3000ZE45X168</td>
</tr>
<tr>
<td>› P3000ZL45X168APT³</td>
<td>› P2000DE45X168</td>
</tr>
<tr>
<td>With internal FWD</td>
<td>With internal FWD</td>
</tr>
<tr>
<td>› P2000DL45X168</td>
<td>› P2000DL45X168APT³</td>
</tr>
</tbody>
</table>

1) Nominal switching frequency <=300 Hz
2) Nominal switching frequency <=800 Hz
3) Application specific Power Transmission

---

On-state losses

MV-Drives/Wind turbines

VSC HVDC

Switching losses
The New Infineon Prime Switch – PPI offers outstanding features for best fit in target applications

### Description

New direct Press Pack IGBTs with 4.5 kV blocking voltage. 2000 A with and 3000 A without internal freewheeling diodes based on Infineon’s 4.5 kV trench IGBT chips. Using low-temperature sintering technology, the IGBT chips are sintered and directly connected to the pole pieces to enable double side cooling.

### Main features

- 4.5 kV trench IGBT chip
- Optimized loss trade off for MMC VSC and FACTS
- Full long-term short-on-fail; no springs inside
- Low temperature sintering; LTS-technology
- Hermetically sealed, explosion-proof housing

### Applications

- HVDC & FACTS
- DC breakers
- MV-Drives

---

<table>
<thead>
<tr>
<th>Description</th>
<th>Main features</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2000DL45X168</td>
<td>4.5 kV trench IGBT chip</td>
<td>HVDC &amp; FACTS</td>
</tr>
<tr>
<td>P3000ZL45X168</td>
<td>Optimized loss trade off for MMC VSC and FACTS</td>
<td>DC breakers</td>
</tr>
<tr>
<td>P3000ZL45X168APT</td>
<td>Full long-term short-on-fail; no springs inside</td>
<td>MV-Drives</td>
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<td>P2000DE45X168</td>
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<td>Hermetically sealed, explosion-proof housing</td>
<td></td>
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</tbody>
</table>
### Advantage of Press Pack IGBTs over IGCTs for MV-Drives

#### Press Pack IGBTs

<p>| | |</p>
<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>P3000ZE45X168</td>
<td></td>
</tr>
<tr>
<td>P2000DE45X168</td>
<td></td>
</tr>
</tbody>
</table>

- MV-Drives from 6 MW – 40 MW for applications with special demand of power cycling capability etc. rolling mills
- Mostly used in 3 level topology for 3.3 kV motors
- Diode Frontend and Active Fronted possible, regarding to the application demand

#### Benefits Press Pack IGBT – Prime Switch

- IGBT control well known from many applications
- No $di/dt$ limiting inductance is needed
- No snubber circuit needed
- Many driver boards for PPI are available
- Series connection of PPI possible
- 50% Smaller footprint of inverter is possible
**Broasted offering**
Infineon Prime Switch – Freewheeling Diodes for PPIs and IGCTs

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freewheeling Diodes with 4.5 and 6.5 kV blocking voltage for IGCT and modern IGBT applications such as HVDC voltage source converters and medium voltage drives (MV-Drives).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main features</th>
</tr>
</thead>
<tbody>
<tr>
<td>› Pulse turn off losses up to 9 MW</td>
</tr>
<tr>
<td>› Maximal junction temperature of 140°C</td>
</tr>
<tr>
<td>› Lowest thermal resistance</td>
</tr>
<tr>
<td>› Soft switching behavior optimized for IGCT or IGBT devices</td>
</tr>
<tr>
<td>› Current turn-off capability up to 5 kA/μs</td>
</tr>
</tbody>
</table>

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<td>› DC breakers</td>
</tr>
<tr>
<td>› MV-Drives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jens Przybilla</td>
</tr>
<tr>
<td>Chen Pan</td>
</tr>
</tbody>
</table>

› D1031SH45T  
› D1331SH45T  
› D1961SH45T  
› D931SH65T  
› D1131SH65T  

› D1600U45T122  
› D2700U45T122  
› D4600U45T172
Solution tree MV-Drives – The easy way to find best fitting products

Medium-Voltage Drives and High Power Wind Turbines

**Medium-Voltage Rectifier**

<table>
<thead>
<tr>
<th>Rectifier Diodes (N)</th>
</tr>
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<tbody>
<tr>
<td>D6001N50T</td>
</tr>
<tr>
<td>D711N60T</td>
</tr>
<tr>
<td>D1481N65T</td>
</tr>
<tr>
<td>D3001N68T</td>
</tr>
<tr>
<td>D3041N68T</td>
</tr>
<tr>
<td>D471N90T</td>
</tr>
<tr>
<td>D2601N90T</td>
</tr>
</tbody>
</table>

**Medium-Voltage IGCT Inverter**

<table>
<thead>
<tr>
<th>Freewheeling Diodes (SH)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generation 1</strong> (1kA/µs)</td>
</tr>
<tr>
<td>4.5 kV Diodes</td>
</tr>
<tr>
<td>D1031SH45T</td>
</tr>
<tr>
<td>D1331SH45T</td>
</tr>
<tr>
<td>D1961SH45T</td>
</tr>
<tr>
<td>6.5 kV Diodes</td>
</tr>
<tr>
<td>D931SH65T</td>
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<tr>
<td>D1131SH65T</td>
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**Medium-Voltage Press Pack IGBT Inverter**

<table>
<thead>
<tr>
<th>Press Pack IGBT (PPI) (With and without internal FWD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation 2 (5kA/µs)</td>
</tr>
<tr>
<td>4.5 kV Trench</td>
</tr>
<tr>
<td>P2000DE45X168</td>
</tr>
<tr>
<td>P3000ZE45X168</td>
</tr>
<tr>
<td>4.5 kV Diodes</td>
</tr>
<tr>
<td>D1600U45T122</td>
</tr>
<tr>
<td>D2700U45T122</td>
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<tr>
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**Medium-Voltage Press Pack IGBT Inverter**

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<tr>
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<td><strong>Generation 2</strong> (5kA/µs)</td>
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</tr>
<tr>
<td>D4600U45T172</td>
</tr>
</tbody>
</table>

Motor

Motor
Overview Power Block, Prime Block & Eco Block Modules (SC & PC)

<table>
<thead>
<tr>
<th>Power Block - PC</th>
<th>Prime Block – PC/SC</th>
<th>Eco Block - SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT,DD,TD,ND 150..380 A</td>
<td>TZ,DZ 175..600 A</td>
<td>TT,DD,TD 140..240 A</td>
</tr>
<tr>
<td>TZ,DZ 240..710 A</td>
<td>TZ,DZ 530..1100 A</td>
<td>TT,DD,TD 370 / 390 A</td>
</tr>
<tr>
<td>TT,TD 280..340 A</td>
<td>TT,TD 700..820 A</td>
<td>TT,DD,TD 60..120 A</td>
</tr>
</tbody>
</table>

V_{RRM}(V)

<table>
<thead>
<tr>
<th>New</th>
<th>New</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT,TD 700..820 A</td>
<td>eTT,eDD,eTD 540..630 A</td>
<td>TT,TD 340..470 A</td>
</tr>
</tbody>
</table>

SC solder contact: PC pressure contact
Prime Modules outperform the current market standards
1800 V coming for PC modules in next months

Prime Block
- TT/TD370N18KOF
- TT/TD390N18SOF
- TT/TD820N16KOF
- TT/TD780N18KOF
- TT/TD700N22KOF

Power Block
- TT/TD330N16KOF
- TT/TD330N18AOF
- TT/TD370N18KOF
- TT/TD320N18SOF
- eTT/TD630N16P60
- eTT/TD630N18P60

Eco Block
- TT/TD390N22S
- TT/TD390N18SOF
- DD390N22S
- TT/TD600N16KOF
- TT/TD570N18KOF

50 mm
- TT/TD330N16KOF
- TT/TD330N18AOF
- TT/TD320N18SOF

60 mm
- TT/TD370N18KOF
- TT/TD390N18SOF
- TT/TD820N16KOF
- TT/TD780N18KOF
- TT/TD700N22KOF

New
S25FL-L serial NOR Flash memories stores the boot code and application critical parameters even in rush environment

S25FL064L
S25FL128L
S25FL256L
Quad SPI
NOR Flash

Key features

- Densities 64Mb to 256Mb – voltage level 3.3V (2.7V-3.6V)
- Easy to design in due to industrial standard floating gate technology
- 4KB Uniform Sector Size / Easy to connect to most microcontrollers
- 100,000 Program/Sector Erase Cycles, minimum
- 0.30-ms Program time per 256 bytes and a 50-ms Sector Erase time
- 20 Year Data Retention, minimum
- Temperature range up to 125°C, multiple packages

Exemplary schematic/topology:

Benefits

- Easy to use and compliant due to Industrial Standard QSPI Interface
- Robust design with high temperature grade products
- Available in different packages and scalable densities

<table>
<thead>
<tr>
<th>Series</th>
<th>Density</th>
<th>Device</th>
<th>SOIC-8  208 mil</th>
<th>SOIC-16 300 mil</th>
<th>WSON 4 x 4 mm</th>
<th>WSON 6 x 5 mm</th>
<th>WSON 8 x 6 mm</th>
<th>BGA24 8 x 6 mm 5 x 6 Ball</th>
<th>BGA24 8 x 6 mm 4 x 6 Ball</th>
</tr>
</thead>
<tbody>
<tr>
<td>FL-L</td>
<td>64Mb</td>
<td>S25FL064L</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>128Mb</td>
<td>S25FL128L</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>256Mb</td>
<td>S25FL256L</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
SemperFlash serial NOR Flash offers most flexibility, highest performance and functional safety with densities 256 Mb to 4 Gb

S25HL-T  
S25HS-T  
S26HL-T  
S26HS-T  
S28HL-T  
S28HS-T  
NOR Flash

**Key features**

- ASIL-B / SIL-2 Functional safety compliance on component level
- Enhanced reliability (ECC and CRC)
- EnduraFlex™ Architecture – integrated wear leveling to optimize endurance and data retention
- Integrated diagnostic features for a safe and reliable operation
- High Speed Read Bandwidth up to 400MB/s – instant on feature
- xSPI compliant – easy to adopt to microcontroller (QSPI, OctalSPI, Hyperbus – perfect match to use with HyperRAM)

**Benefits**

- Cortex M0 offers enhanced diagnose and safety features
- High speed reading for instant on
- EnduraFlex™ allows to partition the NOR Flash, reduced component count and increase reliability
- Functional safety compliant reduces certification time and shorten time-to-market
- Designed for high reliability in rough and higher temperature
- Longevity >10 years
Broad RAM product portfolio to meet performance requirements

**Volatile**
- **F-RAM**
  - 4Kbit to 16Mbit
  - Serial and Parallel interface
  - Instant non-volatility
  - Optimized solution for low-power data-logging

- **MoBL® SRAM**
  - 256Kbit to 64Mbit
  - Access time: 45 ns – 70 ns
  - SER < 0.1 FIT/Mbit
  - Ultra-low standby currents for extending battery life

- **nvSRAM**
  - 64Kbit to 16Mbit
  - Access time: 20 ns – 45 ns
  - Unlimited endurance
  - Optional features including RTC, timer and alarm

**Persistent**
- **FAST SRAM**
  - 256Kbit to 32Mbit
  - Access time: 10 ns – 15 ns
  - SER < 0.1 FIT/Mbit
  - Unlimited endurance
  - Optional features including RTC, timer and alarm

- **HyperRAM™**
  - 64Mbit to 128Mbit
  - Serial HyperBus™ & xSPI
  - Up to 400 MB/s speeds
  - Ideal solution for a high-speed serial buffer memory

**Performance (MB/s)**
- nvSRAM
  - Parallel x8
  - Parallel x16
  - Parallel x32

- MoBL® SRAM
  - Parallel x8
  - Parallel x16
  - Parallel x32

- F-RAM
  - Parallel x8
  - Parallel x16

- **FAST SRAM**
  - Parallel x8
  - Parallel x16
  - Parallel x32

- **HyperRAM™**
  - HyperBus
  - xSPI
Persistent RAM Solutions for Industrial Motor Drives: NVRAM

Key features

› **nvSRAM**
  › 256Kbit to 16Mbit in density
  › Parallel asynchronous interface with access speeds ≤ 45 ns
  › Unlimited read/write cycles
  › Optional RTC, watchdog timer, and clock alarm

› **F-RAM**
  › 4Kbit to 16Mbit in density
  › Serial interface 40/50 MHz SPI and 108 MHz QSPI
  › $10^{14}$ read/write cycles – virtually unlimited endurance
  › Instant non-volatility with NoDelay Write

Benefits

› Eliminate battery for power back-up from the system
› Capture real-time, mission-critical system data at high speeds
› Retain data instantly on power-loss or system shutdown
› Log data continuously over a 15-year product lifespan
› Enhance system reliability with on-chip ECC and CRC
› Design with parallel or low-pin-count serial SPI and QSPI interface
› Support wide operating voltages and temperature grades

Additionally, F-RAM technology is immune to data corruption due to magnetic fields and radiation exposure.
Persistent RAM Solutions for Industrial Motor Drives: MoBL® SRAM

Key features

- MoBL® SRAM with ECC
- 4Mbit to 64Mbit in density
- Access times: 45 ns – 55 ns
- Parallel asynchronous interface
- Bus-width configurations: x8, x16 and x32
- Standby current (at 85°C) of 6.5 µA for 8Mbit, 8.0 µA for 16Mbit
- Wide operating voltage range: 1.8V - 5.0V
- High reliability with on-chip ECC
- Industrial and Automotive temperature grades

Benefits

- Capture real-time, mission-critical system data at high speeds
- Extend system battery life with best-in-class standby currents
- Log data continuously over a 15-year product lifespan
- Realize reliable systems with soft-error rates (SER) < 0.1 FIT/Mbit
- Support wide operating voltages and temperature grades
- Design with asynchronous interface compatible with 32-bit MCUs
Volatile RAM Solutions for Industrial Motor Drives: FAST SRAM

Key features

- FAST Asynchronous SRAM with ECC
  - 2Mbit to 16Mbit in density
  - Fast access times: 10 ns – 15 ns
  - Parallel asynchronous interface
  - Bus-width configurations: x8, x16 and x32
  - Wide operating voltage range: 1.8V - 5.0V
  - High reliability with on-chip ECC
  - Industrial and Automotive temperature grades

Exemplary schematic/topology:

Benefits

- Achieve data throughput up to 3.2Gb/s with a fast, expansion RAM
- Ideal for systems requiring high-speed expansion RAMs for use as a scratch-pad memory to execute control algorithms
- Realize reliable systems with soft-error rates (SER) < 0.1 FIT/Mbit
- Support wide operating voltages and temperature grades
- Design with asynchronous interface compatible with 32-bit MCUs

FAST asynchronous SRAMs with on-chip ECC have an optional PowerSnooze™ feature with a Deep-Sleep mode to save on idle currents ($I_{DS} = 15\mu A$) while operating at 10 ns access time.
Volatile RAM Solutions for Industrial HMI Systems: HyperRAM™

Key features

- **HyperRAM™**
  - 64 Mbit to 128 Mbit in density
  - 200 MHz DDR, JEDEC-compliant (JESD251A) HyperBus™ and xSPI interface
  - Operating voltage support of 1.8 V and 3.0 V
  - High reliability with automotive AEC Q100 qualification
  - Industrial and Automotive temperature grades (up to 105 °C)
  - Provides Hybrid Sleep Mode, Deep Power Down Mode and Partial Memory Array Refresh to minimize power consumption

Benefits

- Achieve data throughput up to 3.2 Gb/s
- Ideal for systems requiring high-speed expansion RAMs for use as a display buffer for smooth graphics rendering
- Access both the HyperFlash™ and HyperRAM™ with only 11 control pins
- Support wide operating voltages and temperature grades
- Leverage HyperBus™ ecosystem to access IP for leading platforms
Modular Application Design Kit (MADK)  
**CoolSiC™ MOSFET evaluation board for industrial drives**

- Compact and flexible 3-phase motor drive evaluation platform
- CoolSiC™ MOSFET in EasyPACK™ 1B can easily tested
Modular Application Design Kit (MADK)
CoolSiC™ MOSFET evaluation board for industrial drives

Parameters | Values | Conditions / Comments
--- | --- | ---
Including FS45MR12W1M1_B11 & FEDJ20H12AH

**Input**
- **Voltage**
  - 340 – 480 $V_{\text{rms}}$
- **Current**
  - 16 $A_{\text{rms}}$
  - Input 400 $V_{\text{AC}}$, $T_a = 25 \degree C$
- **DC bus voltage**
  - 530 V – 670 V typ.
- **Switching frequency**
  - 18 kHz nom
  - 100 kHz max

**Output**
- **3ph $P_{\text{out}}$ with mains line choke**
  - 11 kW max
  - Input 400 $V_{\text{AC}}$, $f_{sw} = 18$ kHz, $T_a = 25 \degree C$,
  - $T_h = 70 \degree C$, forced convection cooling
- **3ph $P_{\text{out}}$ without mains line choke**
  - 6 kW
  - Input 400 $V_{\text{AC}}$, $f_{sw} = 18$ kHz, $T_a = 25 \degree C$,
  - $T_h = 70 \degree C$, forced convection cooling, limited by input current
- **$I_{\text{rms, nom}}$**
  - 16 $A_{\text{rms}}$
  - Input 400 $V_{\text{AC}}$, $f_{sw} = 18$ kHz, $T_a = 25 \degree C$,
  - $T_h = 70 \degree C$, forced convection cooling
- **$I_{\text{rms, max}}$**
  - 8 $A_{\text{rms}}$
  - Input 400 $V_{\text{AC}}$, $f_{sw} = 100$ kHz, $T_a = 25 \degree C$,
  - $T_h = 70 \degree C$, forced convection cooling

- 3 ph AC-connector, EMI filter, bridge rectifier, inrush current limiter, 3 ph voltage source inverter and a 3 ph output for connecting the motor
- Isolated current, voltage sensing unit using $\Delta \Sigma$-ADC (digital/analogue output)
- Temperature sensing circuitry
- Auxiliary power supply

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Benefits with SiC solutions for industrial drives

**Increased performance**
- Reduction of power losses lead to higher performance
- 60% reduction @ 8 kHz compared to IGBT-based

**Higher robustness**
- 10 K lower operating temperature of heatsink
- Cooling efforts significantly reduced

**Higher power density & lower system cost**
- Heatsink can be reduced by 2/3 compared to IGBT
- Leads to a much higher system power density

Note: Measurements based on drive demonstrator (22 kW; 50 Hz output freq.; dv/dt <5 kV/µs; IGBT system under same conditions)
CoolSiC™ MOSFET powers the next generation of servo drives design

**Advantages of SiC**

› Up to 80% of total loss reduction is enabled by more than 50% switching loss reduction
› 80% reduction of low current conduction loss by resistive behavior
› CoolSiC™ enables motor and drive integration and hence, reduces the complexity of cabling

**CoolSiC™ MOSFET**

› Enables new levels of power density and performance
› Highest thermal conductivity
› Simpler topologies possible
› Smaller device footprint

---

No more need for a cooling fan since passive cooling is sufficient, therefore reducing your maintenance effort to a minimum.
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Features and benefits of TRENCHSTOP™ IGBT7

Features:
- Enhanced controllability
- Lower on state voltage
- Overload capability

Benefits:
- Improved diode
- Increased power
- Frame size jump
- Low losses
- Optimized driving
Technical features of TRENCHSTOP™ IGBT7

Overload capability

TRENCHSTOP™ IGBT7 allows a maximum junction temperature of 175°C whereas TRENCHSTOP™ IGBT4 is limited to 150°C. It is beneficial for drives application due to the need of repetitive short overload operation.

On state voltage

Compared to TRENCHSTOP™ IGBT4, IGBT7 lowers on-state voltage by around 20%. This brings a significant reduction in losses to target applications, especially to industrial drives, which usually operate with moderate switching frequencies.

Controllability

The TRENCHSTOP™ IGBT7 offers a high level of controllability to match the motor insulation requirements or EMI limitations. The controllability corresponds to the device’s ability to vary the dv/dt by adjusting the value of the gate resistor (RG).

Improved diode

The EC7 emitter-controlled diode reduces the forward voltage by 100 mV relative to the previous generation EC4. This also lowers the reverse recovery losses. In addition, it improves softness, which benefits the inverter’s EMI behavior.
Technical benefits of TRENCHSTOP™ IGBT7

Increased power

The EconoDUAL™ 3 with TRENCHSTOP™ IGBT7 can reach up to 900 A. Benefit from higher inverter output current for the same frame size, reduced system cost by avoiding paralleling of modules.

Low losses

The conduction losses at the given dv/dt limitation are significantly decreased. Moreover, there is a reduction in diode losses which leads to overall 15% lower power losses.

Frame size jump

An application example for general-purpose drives (GPD) compares modules built with IGBT4 and IGBT7 technologies. This illustrates how power density can be increased while lowering system cost.

Optimized driving

CGE and CGC are balanced to give the IGBT7 full control over the dv/dt, and to optimize the switching waveform. CGE is designed to avoid parasitic turn-on effects, zero voltage supply for turn-off is feasible (unipolar gate driver power supply).

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Infineon Proprietary
Customer benefits of IGBT7 solutions

Plug and play

- Pin to pin compatibility with IGBT4 module
- Lower losses
- Higher robustness

Reduction of heatsink

- System cost saving
- Compact inverter design

Package Jump

- Cost saving on module side
- Compact inverter design
- Higher flexibility on inverter frame size
- Reduction of heatsink

Broad portfolio

- Will be available in a broad power range
- High volume production
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Key take-aways

**Infineon offers optimized technologies**
- IGBT7 perfectly matched to the needs of drives applications like overload and switching speed control
- SiC-MOSFETs enabling a high degree of integration due to low losses

**Infineon has a unique one shop offering for industrial drives**
- The right fit package for the inverter in power range from W with IPM’s and 100’s of kW with EconoDUAL™
- Gate Driver solutions with enhanced functionalities
- Current sense solutions
- Peripherals like industrial interface IC’s, security solutions and microcontrollers

**Infineon is the right partner for customized solution and high volume products**
- With outstanding quality standards and production capability
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## Useful information material and tools

### Product page links

- **CoolSiC MOSFETs**
- **TRENCHSTOP™ IGBT7**
- **CoolMOS MOSFETs**
- **CoolGaN HEMTs**
- **CIPOS™ IPM**
- **iMOTION™**
- **IGBT7 Discretes**
- **Easy power modules**
- **EconoPIM™ 2 & 3**
- **EconoDUAL™ IGBT modules**
- **EconoPACK™ 4**
- **PrimePACK™ IGBT modules**
- **32-bit XMC™ microcontroller**
- **ISOFACE™ digital input ICs**
- **OPTIGA™ security solutions**
- **Magnetic sensors**
- **Current sensor**
- **EiceDRIVER™ gate driver**
- **External memory**
- **Wireless connectivity**

### Application pages

- **Overview**
- **Induction motor**
- **Permanent magnet synchronized motor**
- **Servo motor**
- **Motor control for industrial automation**
- **Robotics**

### MADK

- **iMOTION™ Modular Application Design Kit MADK**

### Online simulations

- **IPOSIM**
- **Discrete IGBT Motor Drive Simulator**
- **IPM 3-phase Inverter Simulator**

### Online forums

- **Silicon Carbide forum**
- **IGBT modules forum**
- **IGBT discretes forum**
Part of your life. Part of tomorrow.