# Solutions for Wind Energy Systems

Energy-efficient components and subsystems for high system reliability

www.infineon.com/windenergy

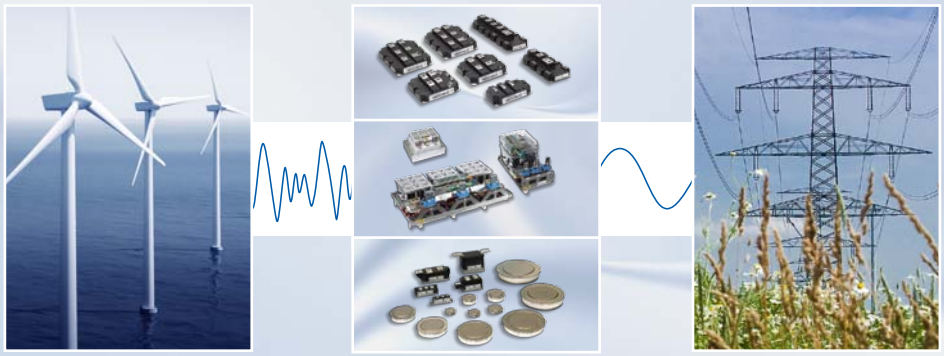
# Contents

# Introduction

Power semiconductors play a key role to produce energy from renewable sources. In wind turbines, power semiconductors are used to convert power and to couple the generator with the grid. They are also built into various auxiliary drives such as yaw drives, pitch drives, pumps and into protection circuits like crowbars.

Wind power converters control a number of vital functions and applications and therefore require power semiconductors of the highest quality standards. This applies in particular to offshore wind converters, which operate in exceptionally harsh environments exposed to salt, humidity etc. Rapid growth is projected for the offshore segment.

Wind energy turbines must also be designed to deliver maximum levels of availability in order to contribute to grid stability. This applies not only to the converter, but also to the various auxiliary drives mounted in different positions. Grid stability therefore depends on power semiconductor assemblies offering dynamic capabilities, outstanding functionality and superior reliability.

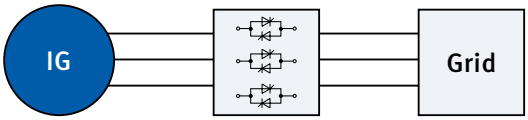


**Power semiconductors:**
From generator to grid

# Topologies

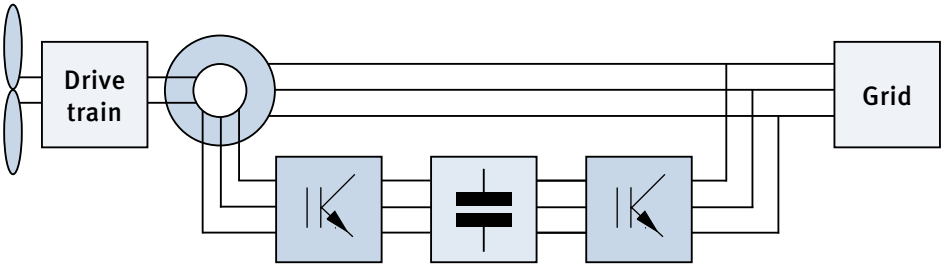
**Fixed-speed generators**

Fixed-speed designs are suited to generators up to 400 kW. New designs are usually based on semiconductor solutions to fulfill grid code requirements. Nevertheless, Infineon delivers the full range of grid coupling components, with thyristors and other bipolar semiconductors available as modules, discs and stacks.



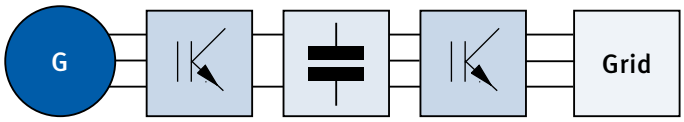

**Doubly Fed Induction Generator (DFIG)**

This speed-adjustable design is typically deployed in the power range between 400 kW and 2.500 kW. To control the full load only up to one third of the energy needs to be converted over power semiconductors in both directions. Infineon's IGBTs support optimum performance even at the limits of the operating range. High quality design, low voltage ride through (LVRT) capability and very low output frequencies meet high availability needs.



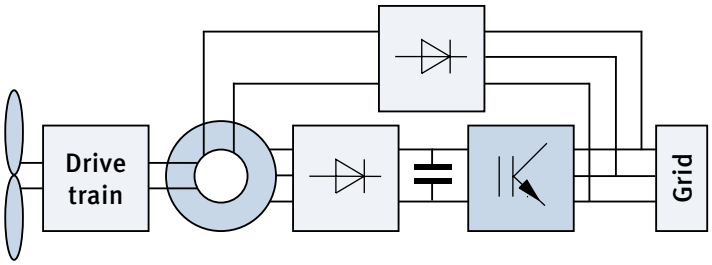
**Permanent Magnet (PM) generators**

Full converters for low-, medium- and high-speed generators provide maximum flexibility to meet LVRT and other grid stability requirements. High efficiency is mandatory and an active front-end inverter adapts variable power and frequency. This design reduces inductive component effort. Infineon's IGBTs enable modular and scalable system designs.



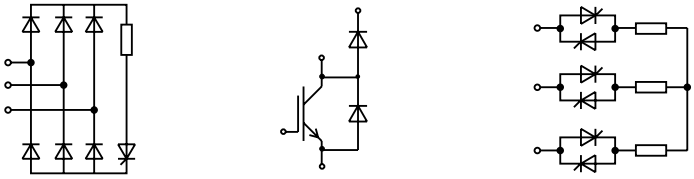

**Electrical Excited (EE) generators**

An EE generator feeds the inverter via a bipolar rectifier, with the generator voltage controlled by excitation. The grid inverter is controlled by an IGBT as the effect of excitation. This design is an established solution already successfully deployed in modern systems.



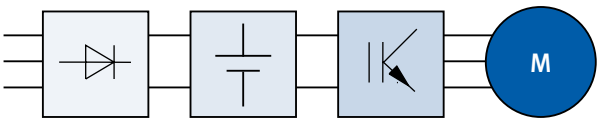

**Protection circuits**

Crowbars, choppers and active filters are important elements in wind turbine designs. Even though these components are not actively involved in feeding energy, they are needed to manage external impacts and fulfill grid stability requirements.



**Auxiliary drives**

Several drives are needed for a wind turbine design to function safely and properly. Yaw drives, pitch drives and pumps can be controlled by small inverters. An energy storage solution must be connected to the DC link in pitch control drives to enable emergency shutdown.



# Overview of products supplied by Infineon

## **Inverter** (p. 4/5)

| Application | Stacks (p. 8) | IHM (p. 14) | PrimePACK™ (p. 12) | IHV (p. 16) | EconoDUAL™ 3 (p. 18) | EconoPACK™ + (p. 20) | Bipolar (p. 10) | Driver boards 2ED300C17 (p. 24) |
|---|---|---|---|---|---|---|---|---|
| PM (p. 5) | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | – | ✔ |
| DFIG (p. 4) | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | – | ✔ |
| EE (p. 5) | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |

## **Protection circuits** (p. 5)

| Application | Stacks (p. 8) | IHM (p. 14) | Bipolar (p. 10) |
|---|---|---|---|
| Choppers | ✔ | ✔ | – |
| Crowbars | ✔ | – | ✔ |

## **Auxiliary drives** (p. 5)

| Application | Low Power Econos (p. 22) | EconoDUAL™ 3 (p. 18) | Driver ICs 1ED020I12-B2 (p. 26) |
|---|---|---|---|
| Pitch control | ✔ | ✔ | ✔ |
| Yaw control | ✔ | ✔ | ✔ |
| Pump control | ✔ | ✔ | ✔ |

# Highest energy efficiency

**Wide portfolio designed for the highest energy efficiency levels.**
Our TRENCHSTOP™ IGBT with its trench gate and field stop concept has dramatically improved the static and dynamic losses of IGBT designs. This improved performance has made our power switches more efficient, increasing power density up to 50 percent. In addition, our zero defect strategy, coupled with the experience gained producing more than 1 million TRENCHSTOP™ IGBT wafers to date, is the best guarantee of lowest failure rates and highest reliability.

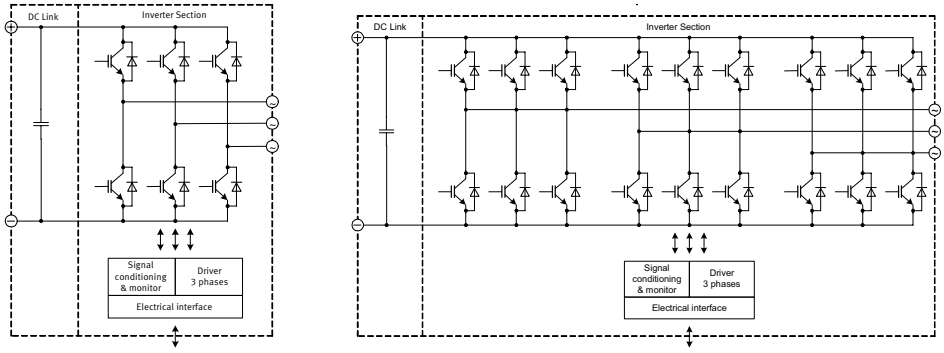
**Key benefits:**
- Industry-leading maximum operating junction temperature of 150°C
- Improved performance with lower electrical losses
- IGBT power modules offering highest quality and reliability

We have a global team of experienced application engineers providing advanced and cost-effective reference solutions and design support for our customers, thereby facilitating and shortening their time-to-market.

**Environmental sustainability**
- We have integrated environmental sustainability in our daily business and our strategy.
- We constantly reduce our environmental footprint.
- We enable energy-efficient end-products and applications.
- We enable a sustainable society by providing net environmental benefits.

# Stacks

Our ModSTACK™ HD family is a complete power electronic switch assembly including our standard PrimePACK™ high-power IGBT half-bridge modules. The family supports nominal chip currents from 1000 A up to 3000 A at 1700 V.
The standard switch assemblies are equipped with the necessary components for current, voltage and temperature measurement. Features include monitoring functions for self-protection and liquid cooled heat sinks for thermal management with optimized performance. Vertically arranged AC power terminals are mechanically decoupled from the power terminals of the modules to give our customers maximum flexibility when connecting the power bus system.




**Key benefits**

- Highest power density with PrimePACK™ IGBT4 modules
- Wide product range supporting all applications
- Suited to standardized cabinet frame size
- High reliability and robust design
- Parallel operation possible
- Increased operating temperature $T_{vjop}$ = 150°C with new IGBT4
- Low stray inductance
- Improved power cycling and thermal cycling capability
- Enlarged clearance and creepage distances
- Internal NTC sensor

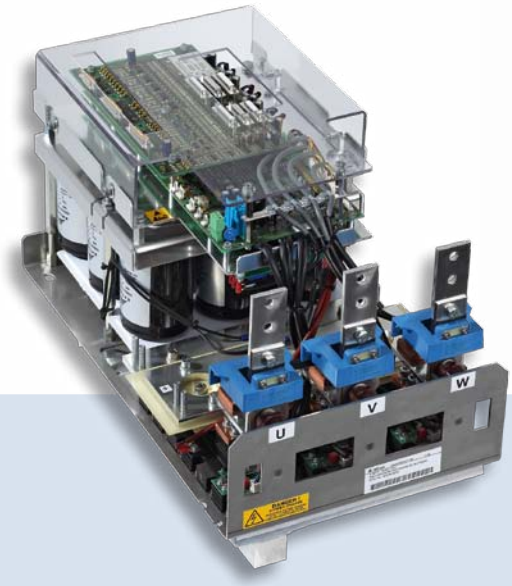
The ModSTACK™ HD stack works as a sub-assembly in a full converter system. The general control signals are supplied by a higher-level control unit provided by the customer. The ModSTACK™ HD family provides proven industry-standard electrical interfaces for regular operation and fault signal management.
The ModSTACK™ HD can work in stand-alone or parallel mode (master/slave configuration). Up to 8 MW is possible by paralleling up to 4 sub-assemblies. Symmetrical power layout and PWM control has to be provided by the end user.
Our ModSTACK™ HD family provides reliable and outstanding stack quality with optimized thermal management. The latest IGBT4 chip technology, combined with an in-built electronic controller and an optimized cooling concept, make this innovative solution ideal for a broad range of wind power systems.

## IGBT4 1700 $V_{CES}$

## $V_{AC}$ = 690 $V_{RMS}$ / $V_{DC}$ = 1100 V

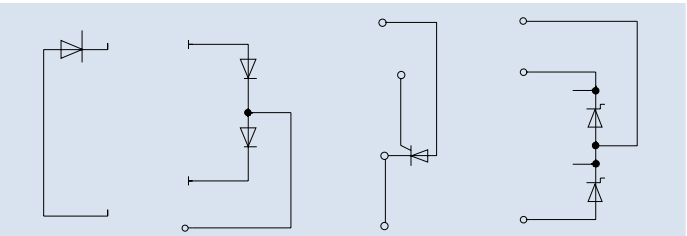
| $P_{max}$ [3] [kW] | $I_{RMS}$ [1] [A] | $f_{SW}$ [kHz] | $f_{SWmax}$ [2] [kHz] | Stack type | Implemented IGBT4 modules | Topology | Case cooling | Width x depth x height [mm] |
|---|---|---|---|---|---|---|---|---|
| 609 | 600 | 3 | 5 | 6MS10017E41W36460 | 3 x FF1000R17IE4 | B6I | MS HD1 liquid (copper) | 338 x 590 x 350 |
| 691 | 680 | 3 | 5 | 6MS10017E41W36775 | 3 x FF1000R17IE4 | B6I | MS HD1 liquid (aluminum) | 338 x 590 x 375 |
| 1219 | 1200 | 3 | 4 | 6MS20017E43W37032 | 6 x FF1000R17IE4 | B6I | MS HD3 liquid (copper) | 1090 x 596 x 342 |
| 1219 | 1200 | 3 | 4 | 6MS20017E43W38170[4] | 6 x FF1000R17IE4 | B6I | MS HD3 liquid (copper) | 1090 x 596 x 342 |
| 1828 | 1800 | 3 | 3 | 6MS30017E43W35613 | 9 x FF1000R17IE4 | B6I | MS HD3 liquid (copper) | 1090 x 596 x 342 |
| 1828 | 1800 | 3 | 4 | 6MS30017E43W38169[4] | 9 x FF1000R17IE4 | B6I | MS HD3 liquid (copper) | 1090 x 596 x 342 |
| 1828 | 1800 | 3 | 3 | 6MS30017E43W33015 | 9 x FF1000R17IE4 | B6I | MS HD3 liquid (aluminum) | 1090 x 596 x 342 |
| 2082 | 2050 | 3 | 3 | 6MS30017E43W34404 | 9 x FF1000R17IE4 | B6I | MS HD3 liquid (aluminum) | 1090 x 596 x 366 |
| 691<br>1382 | 680<br>1360 | 3<br>3 | 8<br>4 | 12MS20017E43W35155 | 3 x FF1000R17IE4<br>6 x FF1000R17IE4 | B6I +<br>B6I | MS HD3 liquid (aluminum) | 1090 x 596 x 342 |

[1] Typical output current at $V_{DC}$=1100V, $V_{AC}$=690V, $f_{SW}$= 3 kHz, $f_0$=50Hz, cos(φ)=0.85, $T_A$=40°C, $T_{vjmax}$≤150°C.
[2] Current derating may be required
[3] $P_{max}$ for 3-phase system similar to B6I types
[4] Optical interface included




# Bipolar modules and discs

The availability and reliability of power semiconductors incorporated in wind power applications are key success factors for the overall design. Our bipolar modules and discs are ideal for these harsh environments with their rugged, highly reliable pressure contact technologies. In today's windmill systems, they are used as input thyristors and generator voltage rectifiers, in auxiliary power supplies and in protective crowbar applications. The low-maintenance design, high quality and exceptional reliability of our bipolar devices ensure profitable operation over a long lifetime.



Bipolar modules

Bipolar discs

**Key benefits**

- Short on fail
- High overload capability
- High reliability and long lifetime
- Lowest maintenance costs

| Type | $V_{RRM}$ [V] | $I_{FSM}$ [A] @10 ms, $T_{vj\ max}$ | ∫i2dt [$A^2s \cdot 10^3$] @10 ms, $T_{vj\ max}$ | $I_{FAVM}/T_c$ [A] @180° el sin | $V_{(TO)}$ [V] $T_{vj\ max}$ | $r_T$ [mΩ] $T_{vj\ max}$ | $R_{thjc\ max}$ [K/W] @180° el sin | $R_{thch}$ [K/W] @180° el sin | $T_{vj\ max}$ [°C] |
|---|---|---|---|---|---|---|---|---|---|
| DZ 540 N26 K | 2600 | 14000 | 980 | 540/100 | 0.78 | 0.31 | 0.078 | 0.02 | 150 |
| DD 700 N22 K | 2200 | 21000 | 2205 | 700/100 | 0.78 | 0.19 | 0.065 | 0.02 | 150 |
| DZ 1070 N26 K | 2600 | 35000 | 6125 | 1070/100 | 0.80 | 0.17 | 0.045 | 0.01 | 160 |

| Type | $V_{DRM}$, $V_{RRM}$ [V] $V_{DSM} = V_{DRM}$ $V_{RSM} = V_{RRM} + 100$ V | $I_{TSM}$ [A] @10ms. $T_{vj\ max}$ | ∫$i^2$dt [$A^2s \cdot 10^3$] 10 ms. $T_{vj\ max}$ | $I_{TAVM}/T_c$ [A/°C] @180° el sin | $V_{(TO)}$ [V] @$T_{vj\ max}$ | $r_T$ [mΩ] @$T_{vj\ max}$ | $(di/dt)_{cr}$ [A/µs] @DIN IEC 747-6 | $t_q$ [µs] typ. | $R_{thJC\ max}$ [K/W] @180° el sin | $R_{thCK}$ [K/W] @180° el sin | $T_{vj\ max}$ [°C] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TZ 749 N22 KOF | 2200 | 26500 | 3500 | 740/85 | 0.90 | 0.21 | 200 | 350 | 0.042 | 0.01 | 125 |
| TZ 800 N18 KOF | 1800 | 30000 | 4500 | 800/85 | 0.85 | 0.17 | 200 | 240 | 0.042 | 0.01 | 125 |
| TT 425 N18 KOF | 1800 | 12500 | 781 | 425/85 | 0.90 | 0.30 | 120 | 250 | 0.078 | 0.02 | 125 |
| TT 430 N22 KOF | 2200 | 12000 | 720 | 430/85 | 0.95 | 0.45 | 150 | 300 | 0.065 | 0.02 | 125 |
| TT 500 N18 KOF | 1800 | 14500 | 1051 | 500/85 | 0.90 | 0.27 | 200 | 250 | 0.065 | 0.02 | 125 |
| TT 520 N22 KOF | 2200 | 14500 | 1051 | 520/85 | 0.85 | 0.35 | 200 | 250 | 0.058 | 0.02 | 125 |

| Type | $V_{DRM}$, $V_{RRM}$ [V] $V_{DSM} = V_{DRM}$ $V_{RSM} = V_{RRM} + 100$ V | $I_{TSM}$ [kA] @10 ms. $T_{vj\ max}$ | ∫$i^2$dt [$A^2s \cdot 10^3$] @10 ms. $T_{vj\ max}$ | $V_T/I_T$ [V/kA] $T_{vj\ max}$ | $I_{TAVM}$ [A] @180 ° el sin $T_c = 85$ °C | V(TO) [V] @$T_{vj\ max}$ | rT [mΩ] @$T_{vj\ max}$ | $(di/dt)_{cr}$ [A/µs] @DIN IEC 747-6 | tq [µs] typ. | $R_{thJC\ max}$ [K/kW] @180 ° el sin | $T_{vj\ max}$ [°C] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T 1190 N18 TOF VT | 1800 | 22.5 | 2530 | 2.05/5.4 | 1190 | 0.90 | 0.190 | 200 | 240 | 23.0 | 125 |
| T 1500 N18 TOF VT | 1800 | 33.5 | 5611 | 2.10/7.0 | 1500 | 0.90 | 0.150 | 200 | 240 | 18.4 | 125 |
| T 2180 N18 TOF VT | 1800 | 36.0 | 6480 | 2.05/8.0 | 2180 | 0.90 | 0.106 | 200 | 250 | 12.5 | 125 |
| T 3160 N18 TOF VT | 1800 | 57.0 | 16245 | 1.37/6.0 | 3160 | 0.85 | 0.082 | 200 | 250 | 8.5 | 125 |

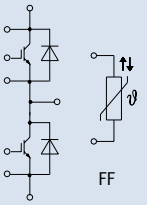
# PrimePACK™

Our PrimePACK™ IGBT modules in half-bridge and chopper configurations (1200 V & 1700 V, 450 A to 1400 A) with internal NTC have been optimized for modern converters. Key highlights include improved thermal properties, low stray inductance and a wide range of operating temperatures up to 150°C.

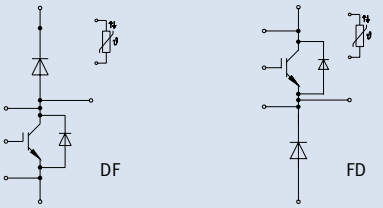
This family is designed to support inverter designs across a broad power range. The excellently placed DC terminal screw connections (all terminals are screw-connected) ensure high parallel design flexibility.

Two chopper variants (high side and low side) give design engineers even greater flexibility when choosing the inverter topology.

Many years of experience, a proven track record in driving innovation and a selection of the most recent chip generations optimized for high power applications mean that customers can always rely on us for the best converter solutions for wind applications.




Halfbridge with NTC




chopper modules with NTC

Our PrimePACK™ housing enjoys broad market acceptance and has established itself as an industry standard, used by all well-known manufacturers across countless applications worldwide.

**Key benefits**

- High power density for compact inverter designs
- Modular design optimized for paralleling
- Improved power cycling and thermal cycling capability
- Homogenous temperature distribution between the chips
- High clearance and creepage distance
- High reliability and robust module construction
- Standardized housing

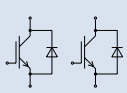
| Type | $V_{CES}$<br>V | $I_C$<br>A | $V_{CEsat}$<br>V<br>$T_{vj}$= 25°C typ. | $E_{on}/E_{off}$<br>mWs<br>$T_{vj}$=125°C typ. | $R_{thjC\ max}$<br>K/W<br>per arm |
|---|---|---|---|---|---|
| FF1000R17IE4 | 1700 | 1000 | 2 | 390/295 | 0.024 |
| FF1000R17IE4D_B2 | 1700 | 1000 | 2 | 365/315 | 0.024 |
| FF1400R17IP4 | 1700 | 1400 | 1.75 | 500/625 | 0.015 |
| FD1000R17IE4 | 1700 | 1000 | 2 | 390/295 | 0.024 |
| DF1000R17IE4 | 1700 | 1000 | 2 | 390/295 | 0.024 |
| FD1000 R17IE4D_B2 | 1700 | 1000 | 2 | 365/315 | 0.024 |
| DF1000 R17IE4D_B2 | 1700 | 1000 | 2 | 365/315 | 0.024 |

# IHM

Our well-known IHM (IGBT High-power Modules) are extremely robust, operating with supreme reliability at temperatures from -40 to +150°C. These devices enjoy widespread market acceptance with more than 2 million IHMs deployed in different applications around the globe.

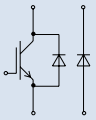
Highlights include superior power cycling with the latest IGBT technology and optimized switching losses. IHMs are available in 1200 V and 1700 V variants in half-bridge, single switch, chopper and diode topologies, covering a range from 400 A to 3600 A. This gives engineers the freedom to design high-power inverters of varying sizes. Electrical separation between the power and auxiliary terminals reduces the stray inductance influence on the sense contacts and makes these modules both easy to control and safe to use.

Backed by our global design support, our IHM solutions are the preferred choice for powerful, compact and modular converter designs. Customers can also rely on us to continually enhance IHM thermal properties and performance.

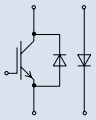


Half Bridge (FF)

Single Switches (FZ)



Chopper Modules (FD)



Chopper modules with inverted diode (FD ...-K)

Dual Diode (DD)

**Key benefits**

- Low $V_{CEsat}$ and $R_{thj-c}$
- Superior power cycling with IGBT4
- Optimized switching losses combined with soft switching
- Widest product portfolio available in the market
  - Two housings: IHM A and IHM B
  - Two footprints: 190 x 140 mm, 130 x 140 mm
  - Two base-plate materials: AlSiC and Cu
  - $I_{Cmax}$ from 400 A to 3600 A in voltage category 1200 V and 1700 V
  - Various topologies (half bridge-, single switch-, chopper- and diode modules)

| Modul name | Green | Modul type | C-E-blocking-voltage | max. DC-rated current | Base plate | Housing |
|---|---|---|---|---|---|---|
| DD1200S17H4_B2 | RoHS | Dual Diode | 1700 V | 1200 A | AlSiC | 130 x 140 mm |
| DD800S17H4_B2 | RoHS | Dual Diode | 1700 V | 800 A | AlSiC | 130 x 140 mm |
| FD1200R17HP4-K_B2 | RoHS | Chopper | 1700 V | 1200 A | AlSiC | 130 x 140 mm |
| FD1600/1200R17HP4_B2 | RoHS | Chopper | 1700 V | 1600 A | AlSiC | 190 x 140 mm |
| FF800R17KP4_B2 | | Half bridge | 1700 V | 800 A | AlSiC | 130 x 140 mm |
| FF1200R17KP4_B2 | | Half bridge | 1700 V | 1200 A | AlSiC | 130 x 140 mm |
| FZ1200R12HP4 | | Single switch | 1200 V | 1200 A | Cu | 130 x 140 mm |
| FZ1600R12HP4 | | Single switch | 1200 V | 1600 A | Cu | 130 x 140 mm |
| FZ2400R12HP4 | | Single switch | 1200 V | 2400 A | Cu | 130 x 140 mm |
| FZ3600R12HP4 | | Single switch | 1200 V | 3600 A | Cu | 190 x 140 mm |
| FZ1200R17HP4 | | Single switch | 1700 V | 1200 A | Cu | 130 x 140 mm |
| FZ1600R17HP4 | | Single switch | 1700 V | 1600 A | Cu | 130 x 140 mm |
| FZ2400R17HP4 | | Single switch | 1700 V | 2400 A | Cu | 130 x 140 mm |
| FZ2400R17HP4_B9 | | Single switch | 1700 V | 2400 A | Cu | 190 x 140 mm |
| FZ3600R17HP4 | | Single switch | 1700 V | 3600 A | Cu | 190 x 140 mm |
| FZ1600R17HP4_B2 | RoHS | Single switch | 1700 V | 1600 A | AlSiC | 130 x 140 mm |
| FZ1600R17HP4_B21 | RoHS | Single switch | 1700 V | 1600 A | AlSiC | 130 x 140 mm |
| FZ2400R17HP4_B2 | RoHS | Single switch | 1700 V | 2400 A | AlSiC | 130 x 140 mm |
| FZ2400R17HP4_B28 | RoHS | Single switch | 1700 V | 2400 A | AlSiC | 190 x 140 mm |
| FZ2400R17HP4_B29 | RoHS | Single switch | 1700 V | 2400 A | AlSiC | 190 x 140 mm |
| FZ3600R17HP4_B2 | RoHS | Single switch | 1700 V | 3600 A | AlSiC | 190 x 140 mm |

# IHV

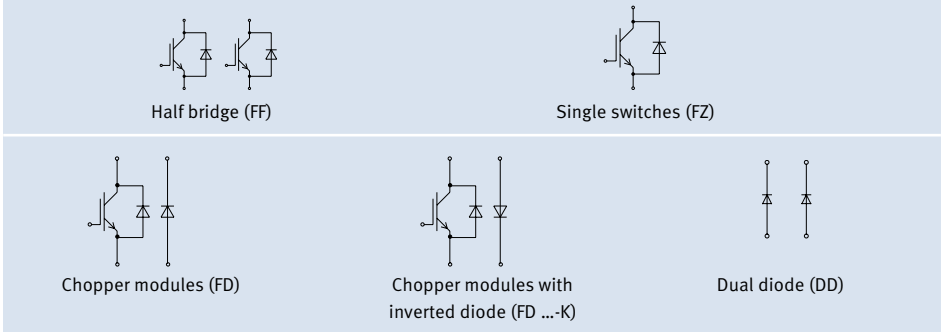
Our IHV (IGBT High-Voltage) modules are ideal for full inverter solutions in the power range above 2 MW. They enable significant cabling savings in turbine designs where the transformer is installed at the base of the tower. Our IHV devices offer blocking voltages of 3300 V, 4500 V or 6500 V. These devices have been successfully deployed in traction applications and industrial medium-voltage inverters for many years.

Our broad portfolio supports a wide range of nominal currents, topologies (chopper, diode) and designs. Multilevel inverters such as the popular NPC (Neutral Point Clamped) model can be built with good scalability. Internal isolation enables designs with grounded heat sinks, eliminating the need for deionized cooling fluids.

Our application support team provides assistance anywhere in the world, helping in particular to resolve your paralleling, Low Voltage Ride Through (LVRT) and lifetime challenges.

**Key benefits**

- Low $V_{CEsat}$ and $R_{thj\text{-}c}$
- Good thermal cycling capability due to AlSiC baseplate
- Optimized switching losses
- Widest portfolio on the market
  - Two housings for different isolation requirements
  - Two footprints 190x140 mm² 130x140 mm²
  - $I_{Cmax}$ from 200 A to 1500 A
  - Various topologies (half bridge-, single switch-, chopper- and diode modules)



| Modul name | Green | Modul type | E-blocking-voltage | max. DC-rated current | Base plate | Housing |
|---|---|---|---|---|---|---|
| DD500S33HE3 | RoHS | Dual diode | 3300 V | 500 A | AlSiC | 130 x 140 mm |
| DD800S33K2C | | Dual diode | 3300 V | 800 A | AlSiC | 130 x 140 mm |
| DD1200S33K2C | | Dual diode | 3300 V | 1200 A | AlSiC | 130 x 140 mm |
| DD400S45KL3_B5 | | Dual diode | 4500 V | 400 A | AlSiC | 130 x 140 mm |
| DD1200S45KL3_B5 | | Dual diode | 4500 V | 1200 A | AlSiC | 130 x 140 mm |
| DD400S65K1 | | Dual diode | 6500 V | 400 A | AlSiC | 130 x 140 mm |
| DD600S65K1 | | Dual diode | 6500 V | 600 A | AlSiC | 130 x 140 mm |
| DD750S65K3 | | Dual diode | 6500 V | 750 A | AlSiC | 130 x 140 mm |
| FF400R33KF2C | | Half bridge | 3300 V | 400 A | AlSiC | 130 x 160 mm |
| FZ800R33KF2C | | Single switch | 3300 V | 800 A | AlSiC | 130 x 140 mm |
| FZ1000R33HE3 | RoHS | Single switch | 3300 V | 1000 A | AlSiC | 130 x 140 mm |
| FZ1000R33HL3 | RoHS | Single switch | 3300 V | 1000 A | AlSiC | 130 x 140 mm |
| FZ1200R33HE3 | RoHS | Single switch | 3300 V | 1200 A | AlSiC | 190 x 140 mm |
| FZ1500R33HE3 | RoHS | Single switch | 3300 V | 1500 A | AlSiC | 190 x 140 mm |
| FZ1500R33HL3 | RoHS | Single switch | 3300 V | 1500 A | AlSiC | 190 x 140 mm |
| FZ800R45KL3_B5 | | Single switch | 4500 V | 800 A | AlSiC | 130 x 140 mm |
| FZ1200R45KL3_B5 | | Single switch | 4500 V | 1200 A | AlSiC | 190 x 140 mm |
| FZ400R65KF2 | | Single switch | 6500 V | 400A | AlSiC | 130 x 140 mm |
| FZ600R65KE3 | | Single switch | 6500 V | 600A | AlSiC | 190 x 140 mm |
| FZ750R65KE3 | | Single switch | 6500 V | 750A | AlSiC | 190 x 140 mm |

# EconoDUAL™ 3

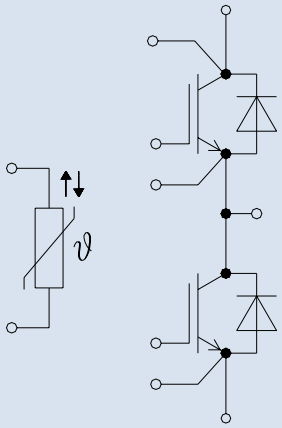
Our EconoDUAL™ 3 devices meet growing demands for compact inverter designs, flexibility and optimized electrical performance at highest reliability. These modules combine 17 mm housing with screw power terminals and easy assembly. The gate driver can be easily connected by placing it on top of the module. Low parasitic stray inductance and optimized thermal resistance to the heat sink contribute to excellent inverter designs.

All modules are available with our established PressFIT technology for reliable, solderless mounting. They are equipped with state-of-the-art IGBT4 technology up to $T_{vjop}$ = 150°C for highest power densities and leading-edge power cycling capability – making these devices ideal for wind inverters. Symmetrical module design facilitates parallel operation, optimizing current sharing between IGBT half-bridges. This makes EconoDUAL™ 3 the compact solution of choice for 690 V drives.

The FF600R17ME4/_B11 is our new flagship product in the EconoDUAL™ 3 family. It was developed with a view to maximizing power density within a given footprint. Copper bonding technology and an improved DCB combine to increase the output power by more than 30 % compared with the 450 A 1700 V version.

**Key benefits**

- Compact modules measuring only 17 mm in height
- Easy and most reliable assembly: PressFIT controls pins and screw power terminals for completely solderless connections
- Easy separation of DC and AC link
- No plugs or cables required
- Optimized thermal resistance to heat sink
- Ideal for low inductive system designs
- Highest power density for compact inverter designs



## IGBT4

| Product type | Product status | Green | $I_C$ | $V_{CE(sat)}$ (typ) | Configuration | Technology | Housing |
|---|---|---|---|---|---|---|---|
| FF600R17ME4 | In production | RoHS | 600.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |
| FF600R17ME4_B11 | In production | RoHS | 600.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |
| FF450R17ME4 | In production | RoHS | 450.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |
| FF450R17ME4_B11 | In production | RoHS | 450.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |
| FF300R17ME4 | In production | RoHS | 300.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |
| FF300R17ME4_B11 | In production | RoHS | 300.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |
| FF225R17ME4 | In production | RoHS | 225.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |
| FF225R17ME4_B11 | In production | RoHS | 225.0 A | 1.95 V | dual | IGBT4 | EconoDUAL™ 3 |

# EconoPACK™ +

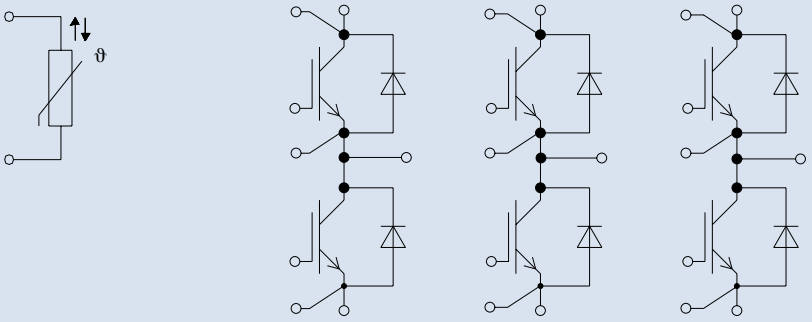
Our EconoPACK™ + D series meets growing market demands for compact inverter designs, flexibility and optimized electrical performance at highest reliability. These modules combine 17 mm housing with screw power terminals and easy assembly. The gate driver can be easily connected by placing it on top of the module. Low parasitic stray inductance and optimized thermal resistance to the heat sink contribute to excellent inverter designs.

All modules are available with our established PressFIT technology for reliable, solderless mounting. They are equipped with the state-of-the-art IGBT4 technology up to Tvjop = 150°C for highest power densities and leading-edge power cycling capability – making these devices ideal for wind inverters. Symmetrical module design facilitates parallel operation, optimizing current sharing between IGBT half-bridges. This makes EconoPACK™ + D the compact solution of choice for wind inverters.

The EconoPACK™ + D series is also available with our innovative pre-applied thermal interface material (TIM) solution. It fulfills the most stringent quality standards for power modules, offering the highest system reliability and output power.

**Key benefits**

- Compact modules measuring only 17 mm in height
- Easy and most reliable assembly: PressFIT controls pins and screw power terminals for completely solderless connections
- Easy separation of DC and AC link
- No plugs and cables required
- Optimized thermal resistance to heat sink
- Ideal for low inductive system designs
- Highest power density for compact inverter designs



## IGBT4

| Product type | Product status | Green | $I_C$ | $V_{CE(sat)}$ (typ) | Configuration | Technology | Housing |
|---|---|---|---|---|---|---|---|
| FS500R17OE4D | In production | RoHS | 500.0 A | 1.95 V | sixpack | IGBT4 | EconoPACK™ + |
| FS500R17OE4DP | In production | RoHS | 500.0 A | 1.95 V | sixpack | IGBT4 | EconoPACK™ + |
| FS450R170E4 | In production | RoHS | 450.0 A | 1.95 V | sixpack | IGBT4 | EconoPACK™ + |
| FS300R170E4 | In production | RoHS | 300.0 A | 1.95 V | sixpack | IGBT4 | EconoPACK™ + |
| FS225R170E4 | In production | RoHS | 225.0 A | 1.95 V | sixpack | IGBT4 | EconoPACK™ + |

# EconoPACK™

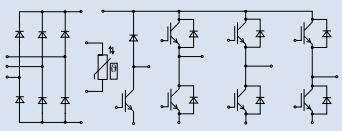
Our EconoPIM™/EconoPACK™ family was developed to give customers the option of cost-effective, compact designs with the added bonus of simplified, reliable mounting. This optimized family is targeted at low- and medium-power industrial drives used for pitch control in modern windmills.

The Econo family extends the power range from 15 A up to 200 A at 600 V/650 V/1200 V/1700 V. Devices are available in the well-known EconoPIM™ and EconoPACK™ packages. The Econo housing comes with a copper baseplate for optimized heat spread and greater reliability. It also includes a thermistor (NTC) for internal temperature measurement. Econo modules are available with solder or PressFIT pins.

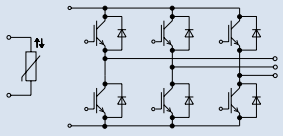
The Econo family features state-of-the-art IGBT4 650 V/1200 V/1700 V chip technology for low switching losses, low saturation voltage and high switching frequency. For ease of design, IGBTs with 10 µs short-circuit robustness are available in the same mechanical layouts for 650 V, 1200 V and 1700 V.

**EconoBRIDGE™ 2 rectifier modules**

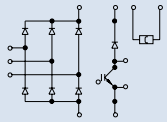
EconoBRIDGE™ 2 rectifier modules are available in the current range from 104 A to 180 A at 1600 V/1800 V. The available configurations are uncontrolled or half-controlled rectifier bridges including brake chopper IGBT and thermal resistor (NTC).



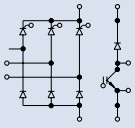
EconoPIM™



EconoPACK™



EconoBRIDGE™ 2 with Chopper IGBT and NTC



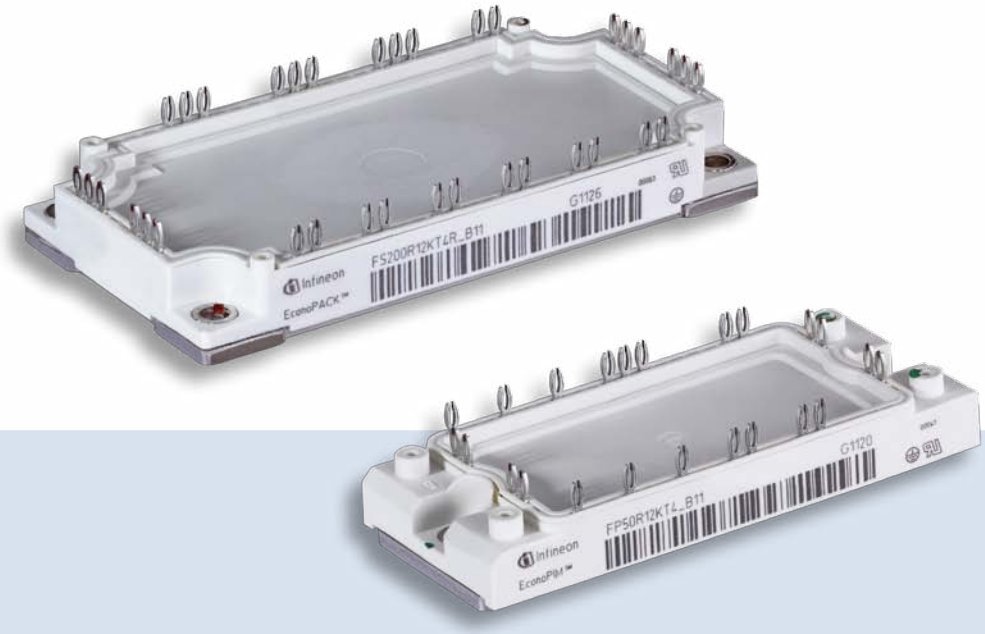
EconoBRIDGE™ 2, half-controlled with Chopper IGBT

**Key Benefits**

- Compact, well established module concept
- Optimized development cycle time and cost
- Configuration flexibility
- High power density
- Low stray inductance
- RoHS-compliant/UL recognized

| | Article | IGBT inverter | | | | Rectifier diodes | | | | Brake chopper | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CE}$ [V] | $I_C$ [A] | $R_{thJC\ max}$ [K/W] | $V_{CEsat}$ $T_{vj}$= 25C° [V] | $V_{RRM}$ [V] | $I_d/T_c$ [A]/ [C°] | $R_{thJC\ max}$ [K/W] | $V_F$ $T_{vj}$= 150C° [V] | $V_{CES}$ [V] | $I_{c,IGBT}$ $T_c$= 80C° [A] | $R_{thJC\ max}$ [K/W] |
| **EconoPACK™** | | | | | | | | | | | | |
| 650V | FS75R07N2E4 | 650 | 75 | 0.60 | 1.55 | | | | | | | |
| | FS100R07N2E4 | 650 | 100 | 0.45 | 1.55 | | | | | | | |
| | FS150R07N3E4 | 650 | 150 | 0.35 | 1.55 | | | | | | | |
| | FS200R07N3E4R | 650 | 200 | 0.25 | 1.55 | | | | | | | |
| 1200V | FS75R12KT4_B15 | 1200 | 75 | 0.39 | 1.85 | | | | | | | |
| | FS100R12KT4G | 1200 | 100 | 0.29 | 1.75 | | | | | | | |
| | FS150R12KT4 | 1200 | 150 | 0.20 | 1.75 | | | | | | | |
| | FS200R12KT4R | 1200 | 200 | 0.15 | 1.75 | | | | | | | |
| 1700V | FS100R17N3E4 | 1700 | 100 | 0.25 | 1.95 | | | | | | | |
| | FS150R17N3E4 | 1700 | 150 | 0.18 | 1.95 | | | | | | | |
| **EconoPIM™** | | | | | | | | | | | | |
| 650V | FP75R07N2E4 | 650 | 75 | 0.60 | 1.55 | 1600 | 80/80 | 0.65 | 1.00 | 650 | 50 | 0.80 |
| | FP100R07N3E4 | 650 | 100 | 0.45 | 1.55 | 1600 | 100/80 | 0.50 | 1.10 | 650 | 75 | 0.60 |
| | FP150R07N3E4 | 650 | 150 | 0.35 | 1.55 | 1600 | 150/80 | 0.40 | 1.10 | 650 | 100 | 0.45 |
| 1200V | FP75R12KT4 | 1200 | 75 | 0.39 | 1.85 | 1600 | 140/80 | 0.65 | 1.15 | 1200 | 50 | 0.54 |
| | FP100R12KT4 | 1200 | 100 | 0.29 | 1.75 | 1600 | 150/80 | 0.40 | 1.00 | 1200 | 50 | 0.54 |
| **EconoBRIDGE™** | | | | | | | | | | | | |
| 1600V | DDB6U104N16RR | | | | | 1600 | 105/100 | 1.08 | 1.30 | 1200 | 50 | 0.38 |
| | DDB6U134N16RR | | | | | 1600 | 134/100 | 0.70 | 1.35 | 1200 | 70 | 0.25 |
| | TDB6HK124N16RR | | | | | 1600 | 125/85 | 0.63 | 1.35 (125C°) | 1200 | 70 | 0.25 |
| | TDB6HK180N16RR | | | | | 1600 | 180/80 | 0.35 | 1.20 | 1200 | 100 | 0.29 |
| 1800V | DDB6U104N18RR | | | | | 1800 | 105/100 | 1.08 | 1.30 | 1200 | 50 | 0.38 |

Extract from our Econo 2/3 product portfolio suitable for pitch-control drives. All modules also available in PressFIT technology (EconoBRIDGE™ ‹180A on request)

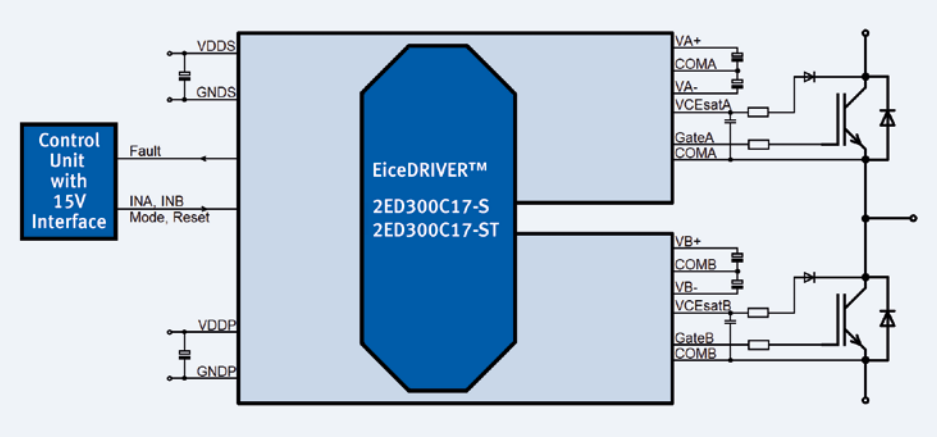


# EiceDRIVER™ boards

Our EiceDRIVER™ board 2ED300C17-S/-ST is a dual-channel, high-voltage gate driver for all Infineon IGBT modules up to 1700 V. These boards are ideally equipped to meet the high safety and reliability demands of wind energy systems.

This driver offers outstanding protection features and integrated fault management functionality to ensure safe operation. Desaturation monitoring is used to detect short circuits. A soft shut-down function prevents high switching overvoltages . Undervoltage lock-out (UVLO) is avoids operation with gate voltages that are too low. Another important safety function is the reinforced isolation between the primary and secondary side.

Featuring two galvanically isolated channels, these devices can support two operating modes: direct mode and half-bridge mode. In half-bridge mode, an interlocking logic prevents cross-currents. In addition, the integrated isolated power supply allows simple paralleling of modules.




**Key benefits**

- Reinforced isolation according to EN 50178/ IEC 61800-5-1
- Reliable operation, also in harsh environments
- Patented paralleling of modules

# EiceDRIVER™ Safe

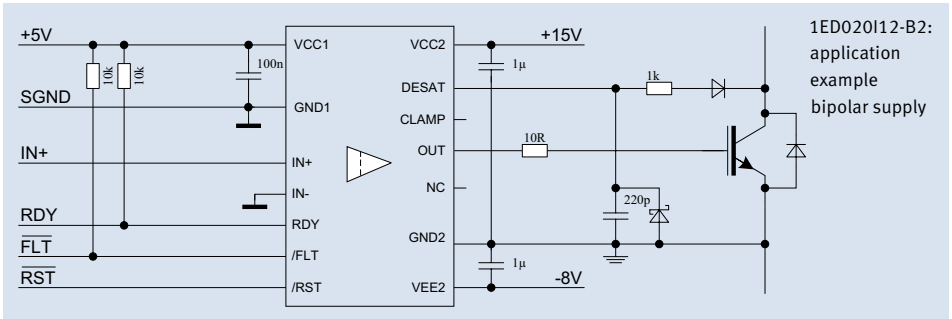
| Type | Channels | Control interface | IGBT max $V_{CE}$ V | $V_{ISO}$ kV | $I_{GM}$ A | $P_{OUT}$ W | $T_{OP}$ °C | Size mm x mm | Mounting method | For modules |
|---|---|---|---|---|---|---|---|---|---|---|
| 2ED300C17-S | 2 | 15V CMOS logic | 1700 | 5 | ±30 | 8 | -25/85 | 60.5 x 72 | Soldering | EconoPACK™+, 62 mm, IHM, EconoDUAL™, PrimePACK™ |
| 2ED300C17-ST | 2 | 15V CMOS logic | 1700 | 5 | ±30 | 8 | -40/85 | 60.5 x 72 | Soldering | EconoPACK™+, 62 mm, IHM, EconoDUAL™, PrimePACK™ |

# EiceDRIVER™ ICs for pitch control units

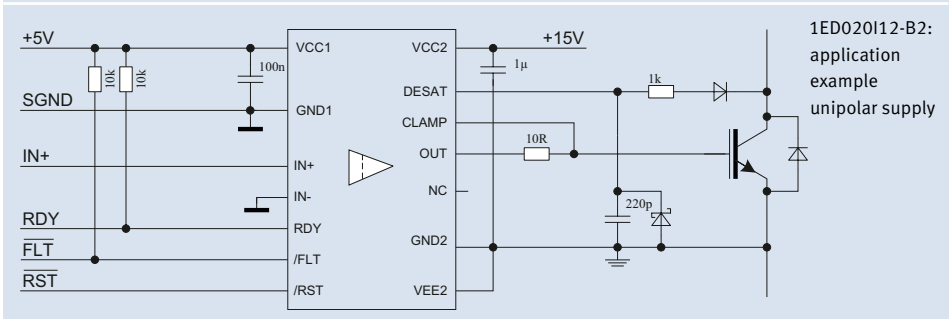
Our new enhanced EiceDRIVER™ family contains highly reliable, high-voltage driver ICs. By using advanced signal isolation technology, EiceDRIVER™ IGBT driver ICs overcome the temperature and lifetime restrictions associated with typical integrated IGBT driver solutions such as level-shifters and optocouplers. This makes them an ideal choice for demanding applications in wind turbine auxiliary drives like pitch control units.

The EiceDRIVER™ single-channel products 1ED020I12-F2 and 1ED020I12-B2 provide features such as desaturation detection (DESAT), active Miller Clamp, undervoltage lockout (UVLO) and shut-down in functional or basic isolation. Both devices 1ED020I12-FT and 1ED020I12-BT also support two-level turn-off (TLTO) for safe overcurrent shut-down. In 2ED020I12-F2, two independent channels are implemented in a compact package providing the same functions as 1ED020I12-F2.

Our EiceDRIVER™ high-voltage driver IC family covers a wide power range and enables customers to build reliable and efficient drive applications.




1ED020I12-B2: application example bipolar supply




1ED020I12-B2: application example unipolar supply

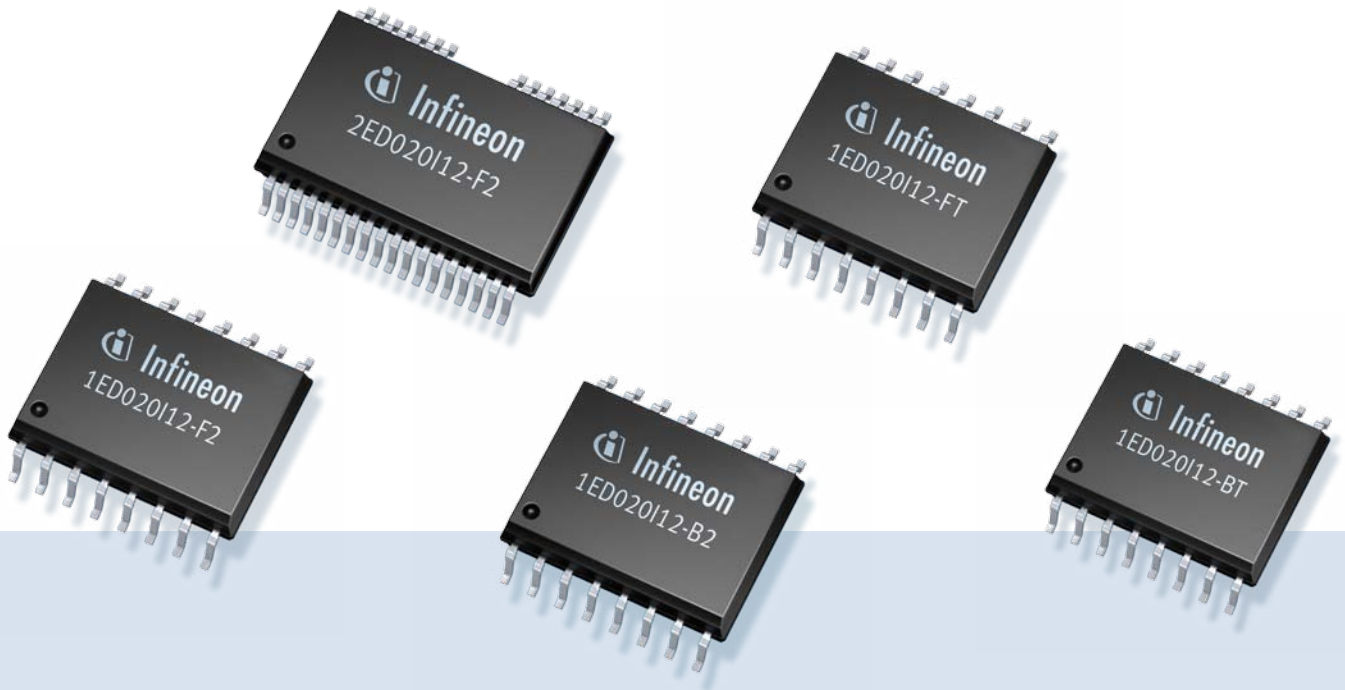
**Key benefits**

- Coreless transformer isolated driver
- Basic insulation according to DIN EN 60747-5-2
- Integrated protection features
- Suitable for operation at high ambient temperatures

# EiceDRIVER™ Enhanced

| Product List | Technology | Max. voltage [V] | Input logic | Features | Basic * isolation | Typ. UVLO [V] | Package |
|---|---|---|---|---|---|---|---|
| 1ED020I12-F2 | 1channel CLT | 1200 | Pos & neg | RST, DESAT, RDY | – | 11 / 12 | DSO-16 |
| 1ED020I12-B2 | 1channel CLT | 1200 | Pos & neg | RST, DESAT, RDY | X | 11 / 12 | DSO-16 |
| 1ED020I12-FT | 1channel CLT | 1200 | Pos & neg | RST, DESAT, RDY, TLTO | – | 11 / 12 | DSO-16 |
| 1ED020I12-BT | 1channel CLT | 1200 | Pos & neg | RST, DESAT, RDY, TLTO | X | 11 / 12 | DSO-16 |
| 2ED020I12-F2 | 2channel CLT | 1200 | Pos & neg | RST, DESAT, RDY | – | 11 / 12 | DSO-36 |

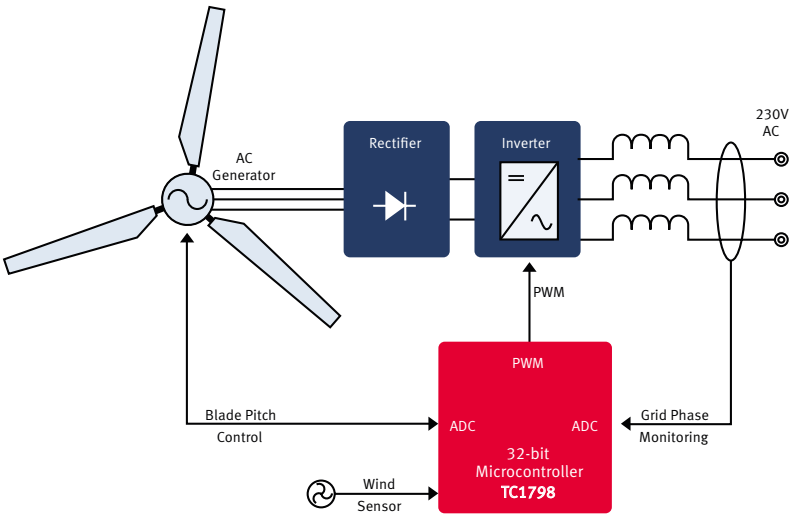
* Certified according to EN 60747-5-2



# Microcontrollers

We offer a broad range of microcontrollers scaling from 8-bit models to multiple 32-bit cores targeted at embedded real-time applications. Our microcontrollers combine our fast embedded flash with an industry-leading peripheral set optimized for motor control and power conversion. By offering extended temperature ranges and outstanding reliability and quality, we can support all applications from touch control through blade pitch control to power conversion.

Our XMC4000 and latest TriCore™ families feature an integrated delta sigma demodulator for isolated current and voltage measurements. In combination with best-in-class PWM timers, this feature lineup supports all current and future power conversion topologies.




**Key benefits**

- Performance from ~10 to >1500 MIPS
- Embedded flash up to 4 MByte
- Temperature range up to +150°C
- High performance ADCs
- Integrated delta sigma demodulator
- Best-in-class PWM timer
- High-resolution PWM units

Our XMC4000 series benefits from the real-time control and signal-processing capabilities of the ARM® Cortex™-M4 CPU. It provides a set of modern communication interfaces such as Ethernet and USB plus HMI peripherals.

Auxiliary functions such as touch control or LED signage can be implemented using our cost-efficient microcontroller series XMC1000. The XMC1000 microcontrollers are based on the ARM® Cortex™-M0 and offer 32-bit performance at 8-bit pricing.

## Power conversion & inverter control

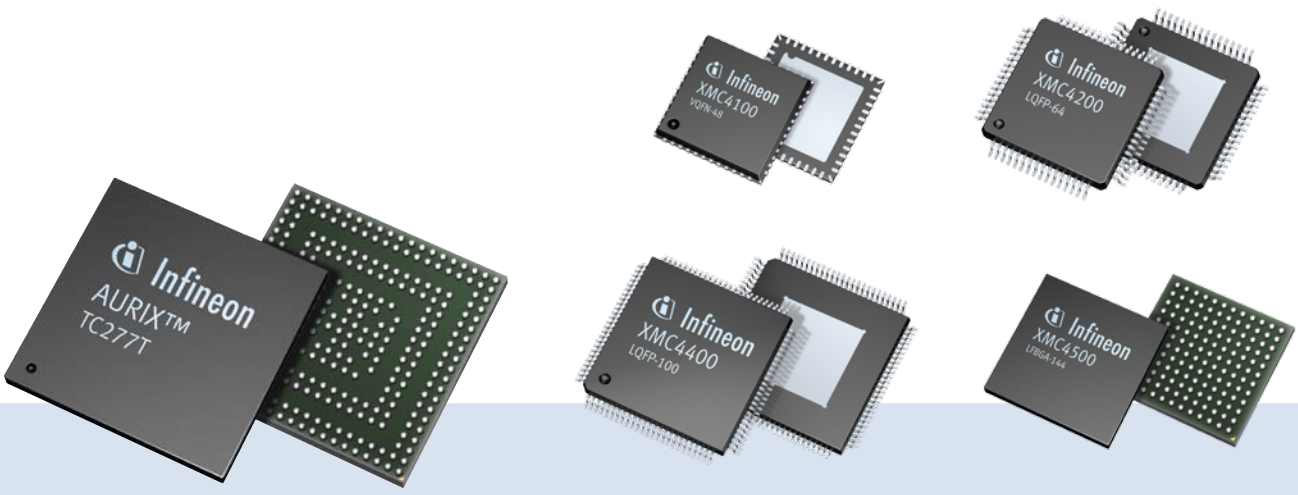
| Part numbers | Core | Clock frequency | Memory flash/SRAM | Description |
|---|---|---|---|---|
| TC277, TC275 | TriCore™ | 3x 200 MHz | 4.4 MByte/472 KByte | AURIX™ series of multi-core MCUs, integrated DSP & lockstep functionality, highly accurate ADC & delta sigma ADC, programmable PWM timer, functional safety package |
| TC1793, TC1798 | TriCore™ | 300 MHz | 4.2 MByte/288KByte | Single-core MCUs, integrated DSP functionality, highly accurate & fast ADCs, >100 PWM outputs |
| XMC4000 | ARM® Cortex™-M4 | 120 MHz | 1 MByte/160 KByte | Integrated DSP, highly accurate ADC & delta sigma ADC, programmable PWM timer, high-resolution PWM unit, motor control library available |

## Blade pitch control

| Part numbers | Core | Clock frequency | Memory flash/SRAM | Description |
|---|---|---|---|---|
| XMC4000 | ARM® Cortex™-M4 | 120 MHz | 1 MByte/160 KByte | Integrated DSP, highly accurate ADC & delta sigma ADC, programmable PWM timer, motor control library available |
| XMC1300 | ARM® Cortex™-M0 | 32/64 MHz | 200 KByte/16 KByte | Cost-effective MCU for FOC motor control, 64 MHz MATH co-processor for advanced control loops (CORDIC / DIVIDE), programmable PWM, timer & fast ADC |
| XC800 | 8051 | 24 MHz | 64 KByte/3 KByte | Cost-effective MCU for FOC motor control, integrated MATH co-processor, up to 150°C temperature range |

## HMI & communication

| Part numbers | Core | Clock frequency | Memory flash/SRAM | Description |
|---|---|---|---|---|
| XMC4000 | ARM® Cortex™-M4 | 120 MHz | 1 MByte/160 KByte | Touch & LED control, display control library available, Ethernet, USB, SPI, etc. |
| XMC1200 | ARM® Cortex™-M0 | 32 MHz | 200 KByte/16 KByte | Cost-effective MCU with integrated touch & LED control, LED control unit for brightness & color control |
| XC800 | 8051 | 24 MHz | 64 KByte/3 KByte | Low-cost MCU with integrated touch & LED control |



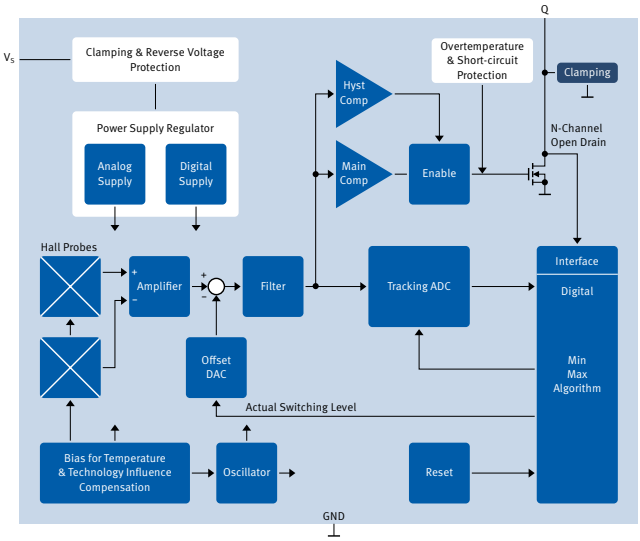
# High-precision integrated sensors

We develop sensors for a wide range of industrial applications, including renewable energy, industrial automation and e-mobility. Our offering here includes products such as magnetic position and speed sensors as well as linear Hall sensors. We offer a full range of energy-saving sensors for the fast-growing wind power sector.

**Highly accurate & robust speed sensors**

Our differential Hall sensor families TLE4957C(B) and TLE4951/54C(B) are the ideal choice for designers who need a robust speed sensor with high accuracy, air gap performance and vibration robustness. All devices in these families provide precise switching algorithms, dynamic self-calibration and excellent jitter and sensitivity levels, thus ensuring accurate speed measurements for both fine and coarse target wheels in the harshest of environments.

All of our sensors are designed to measure speed over a broad frequency range and come with sophisticated protective functionality. The TLE4957 family is a three-wire sensor with a voltage interface and is available with adaptive hidden or adaptive visible hysteresis. The TLE4951/54 family is a two-wire sensor with a current interface. In addition, TLE4954 provides direction information in four different protocol options. All sensors in the TLE4957,TLE4951 and TLE4954 families are available in our innovative iBB package and are ideal for industrial and automotive speed sensing applications.




AEC Qualified

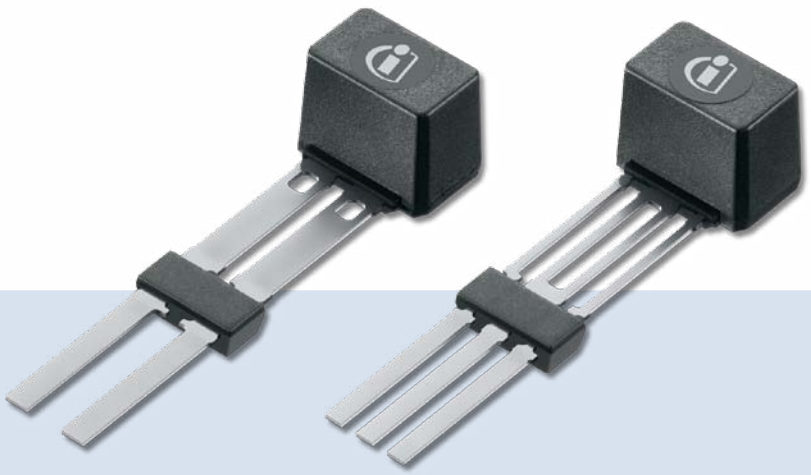
**Key benefits**

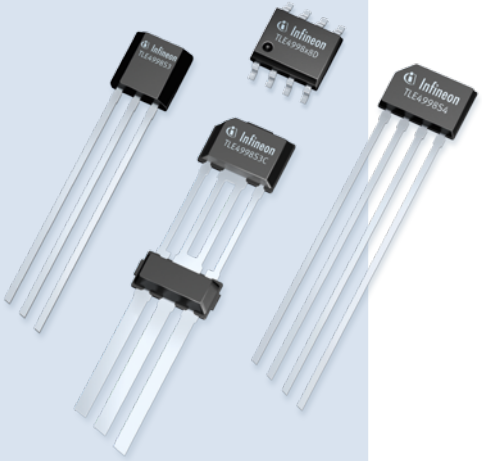
Greater robustness against vibrations

- Highly accurate speed measurements from 1 Hz to 12 kHz over large operating air gaps
- Broad operating temperature range
- High EMC robustness
- Reverse polarity protection
- AEC-Q100 qualified

| | Icon/ Description | TLE4921 | TLE4924 | TLE4926 | TLE4927 | TLE4928 | TLE-4941plusC | TLE4942 | TLE4951[3] | TLE4953 | TLE4954[3] | TLE4957 | TLE5025 | TLE5027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Automotive | Wheel speed | | | | | | Yes | Yes | | | | | | |
| | Camshaft | | Yes | | Yes | | | | | | | | Yes | |
| | Crankshaft | Yes | Yes | Yes | Yes | Yes | | | | | | Yes | Yes | Yes |
| | Transmission | Yes | Yes | | Yes | Yes | | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industrial | | Yes | Yes | | Yes | | | | Yes | | Yes | Yes | | |
| Sensor technology |  | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | Diff. Hall | iGMR | iGMR |
| Improved air gap/jitter performance | | | | | | | | | | | | | Yes | Yes |
| Direction information available |  | | | | | | | Yes | Yes | Yes | Yes | | | Yes |
| vibration suppression algorithm Incl. |  | | | | | | | | Yes | Yes | Yes | Yes | | |
| Type of hysteresis[1] |  | V | V | H | H | H | H | H | V | V | V | V/H | H | H |
| | | F | A/F | F | A | F | F | F | A | A | A | A | A | A |
| Interface[2] | # of pins | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| | Interface | V | V | V | V | V | C | C | C | C | C | V | V | V |
| | Protocol | S | S | S | S | S | S | P | P | P | P | S | S | P |
| Package without integrated capacitor |  | Yes | | | | Yes | | | | Yes | | | | |
| Package with integrated capacitor |  | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| iBB-Package |  | | Yes | | Yes | | Yes | | Yes | | Yes | Yes | | |

[1] H = Hidden; V = Visible; F = Fixed; A = Adaptive; P = Programmable | [2] C = Current; V = Voltage interface; S = Single pulse; P = PWM protocol; A = AK protocol | [3] Coming soon





# Linear Hall sensors

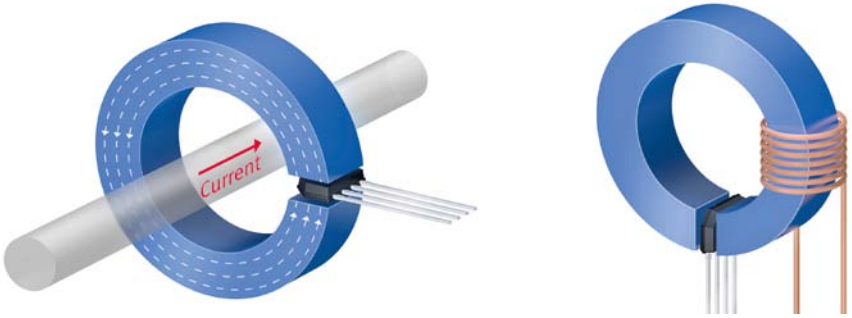
**High-precision linear Hall sensors for current sensing**

Our TLE4997/98 family of linear Hall ICs is tailored to the needs of highly accurate angular and linear position detection and current measurement applications. Each product measures the vertical component of a magnetic field and outputs a signal that is directly proportional to the magnetic field. Thanks to digital signal processing based on a 20-bit DSP architecture plus digital temperature compensation, these sensors deliver outstanding temperature stability compared with similar compensation methods. The TLE4998x products also come with a stress compensation feature to extend stability over lifetime and significantly reduce performance degradation.

The TLE4997/98 family offers a broad range of packages (including leaded and SMD options) and interface variants, giving engineers a large degree of design flexibility.

**Key benefits**

- Best-in-class accuracy with low drift of output signal over temperature and lifetime (including stress compensation in TLE4998)
- Programmable transfer function (gain, offset), clamping, bandwidth and temperature characteristics
- Broad range of interfaces (analog, PWM, SENT and SPC) and especially thin packages (SMD and leaded) available
- High reliability of sensors due to proven automotive zero-defect program



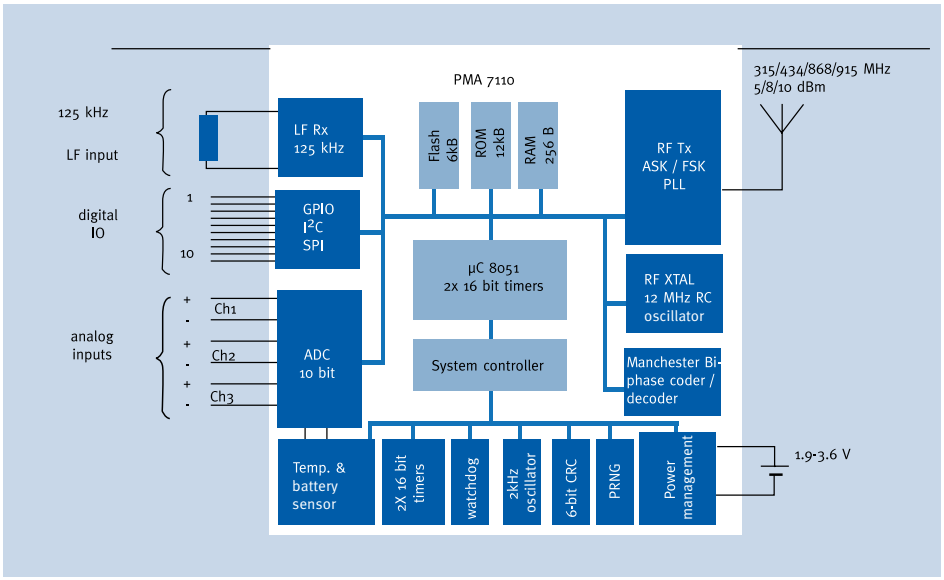

Flux concentrator (blue) surrounding the conductor. A Hall sensor is inserted in the air gap (left). The flux can be further boosted by using multiple windings on the principal conductor (right).

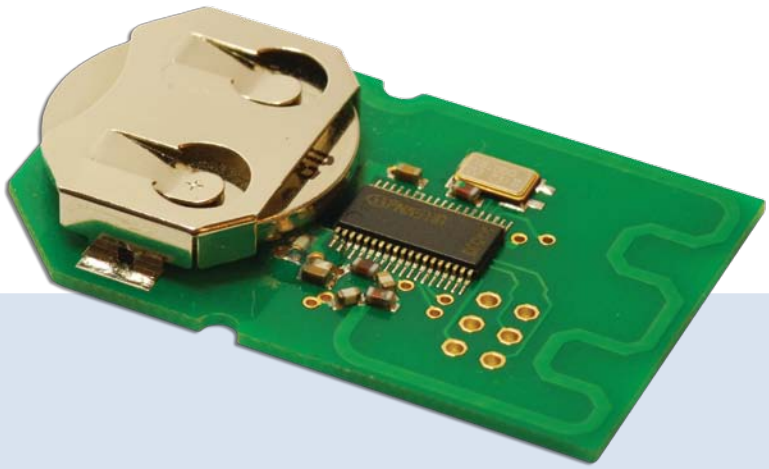
| Product program | Memory | Number of pins | Magnetic sensitivity | Offset | Supply voltage (extended range) | ATV | Industrial | Package |
|---|---|---|---|---|---|---|---|---|
| TLE4997 | EEPROM | 3 | ±12.5 to ±300 mV/mT | < ±400 µT | 5V ±10 % (7V) | • | • | PG-SSO-3-10 PG-TDSO-8 |
| TLE4998P | EEPROM | 3 | ±0.2 to ±6 %/mT | < ±400 µT | 5V ±10 % (16V) | • | • | PG-SSO-3-10 PG-SSO-4-1 PG-SSO-3-9 (2 capacitors) PG-TDSO-8 |
| TLE4998S | EEPROM | 3 | ±8.2 to ±245 LSB/mT | < ±400 µT | 5V ±10 % (16V) | • | • | PG-SSO-3-10 PG-SSO-4-1 PG-SSO-3-9 (2 capacitors) PG-TDSO-8 |
| TLE4998C | EEPROM | 3 | ±8.2 to ±245 LSB/mT | < ±400 µT | 5V ±10 % (16V) | • | • | PG-SSO-3-10 PG-SSO-4-1 PG-SSO-3-9 (2 capacitors) PG-TDSO-8 |

# SmartLEWIS™ MCU

**SmartLEWIS™ – transmitters with embedded microcontrollers**

Our SmartLEWIS™ family of PMA51xx/PMA71xx microcontrollers comprises an ASK/FSK transmitter for sub-1GHz ISM frequency bands plus an embedded 8051 microcontroller, on-chip flash memory and other exciting peripherals. These highly optimized, single-chip ICs are ideal, for example, for remote control designs, requiring only eleven components to create a key FOB. An associated software library provides powerful functions such as AES encryption, thus enabling fast software development and reduced user code size. The PMA family also offers an optional integrated 125 kHz LF receiver, which can be used for wireless wake-up, or an integrated 10-bit ADC to directly connect an analog sensor.



**Key Benefits**

- Highest functionality and performance
- Multiband transmitter plus embedded 8051 microcontroller with 6 KByte flash for user code and 2 x 128 Byte RAM for EEPROM emulation
- Comprehensive software library in ROM including license-free encryption algorithms such as AES-128
- Programmable transmitter power levels of 5, 8 and 10 dBm
- 125 kHz LF ASK receiver for wireless wake-ups
- 3-channel, 10-bit ADC
- Integrated temperature and supply voltage sensors

**Easy design**

- Quick-start development kit with USB interface
- Key FOB reference design with example software (PMA FOB)

# IPOSIM

The Infineon POwer SIMulation (IPOSIM) program is designed to help customers select the right Infineon bipolar products for their rectifier (B2, B6, M3.2 and M6) or AC switch (W1C and W3C) applications. It also helps engineers select suitable IGBT modules for inverter (single- & three-phase in 2-level as well as 3-level) or DC converter (buck and boost) applications.

IPOSIM calculates switching and conduction losses for active components in power semiconductor modules by taking into account static and dynamic module parameters as well as thermal ratings. Cooling conditions are custom-specified, but default values are also available. Junction temperatures as a result of applied loads for specific inverter operation points are calculated. IPOSIM also runs calculations for complete load cycles. Results are shown in tables and plotted as charts. Both can be saved for later review or printed as PDF files. For optimum accuracy and convenience, different control algorithms can be applied.

IPOSIM is quick and easy to use, enabling each engineer to select the best Infineon product for their application, also working out the applicable semiconductor power losses to establish the expected service life.

Visit the website and run a sample calculation yourself.

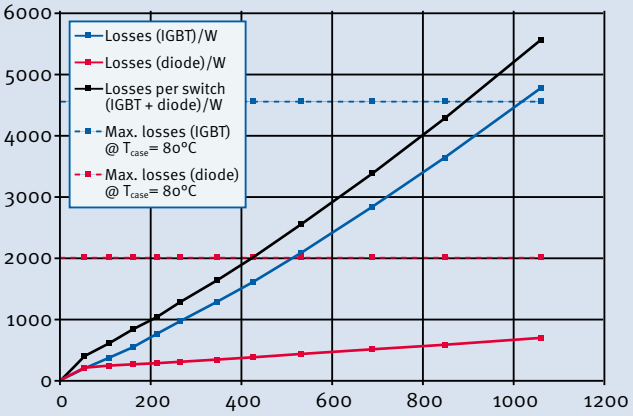
**web.transim.com/Infineon-IPOSIM**

# IPOSIM calculation results

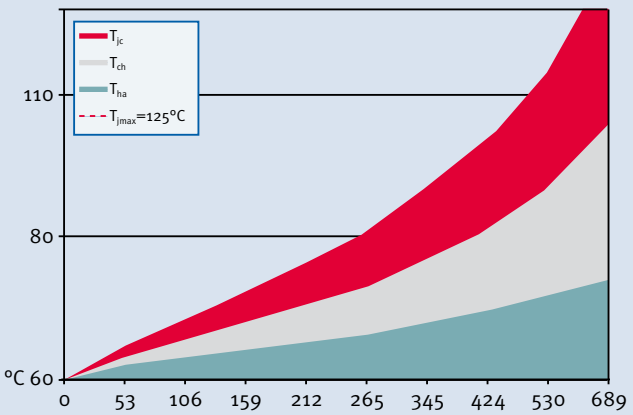
| Selected module IHV 6.5 kV 140 x 190 | FZ750R65KE3 |
|---|---|
| **Input** | |
| DC link voltage Vdc | 3600 V |
| Frequency $f_0$ | 50 Hz |
| Switching frequency $f_s$ | 400 Hz |
| Modulation factor m | 1 |
| Cos φ | 1 |
| Operation point current Irms | 600 A |
| **Thermal input** | |
| Max. junction temperature $T_j$ | 125°C |
| Max. ambient temperature $T_a$ | 60°C |
| Rth heat sink per arm | 0,006 K/W |

| Losses at 600 A | IGBT | Diodes |
|---|---|---|
| Static losses | 859 W | 74 W |
| Dynamic losses | 1541 W | 405 W |
| Total losses | 2400 W | 478 W |
| **Temperatures at 600 A** | **IGBT** | **ripple Δ $T_j$ [K]** |
| $T_{jmax}$ | 122.3° C | |
| $T_{jmin}$ | 116.7° C | 5,5 K |
| $T_c$ | 98.6° C | |
| $T_{hs}$ | 77.4° C | |

IGBT power simulation




Average losses for sinusoidal output current at 400 Hz switching frequency




Temperature distribution across IGBT junction-to-case, case-to-heat sink and heat sink-to-ambient for Ta = 60° C and a given heat sink

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