



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

General purpose drives

370 W

1250 kW

Requirements

- › Performance and reliability
- › Safety features
- › Good price / performance ratio

Key applications

- › Pumps & fans
- › Process automation
- › Cranes
- › Marine drives

Infineon products

- › iMOTION™
- › CIPOS™ IPM
- › EiceDRIVER™ gate driver
- › EasyPIM™
- › EconoPIM™
- › EconoDUAL™
- › PrimePACK™
- › CoolSiC™ MOSFETs

Servo drives

370 W

315 kW

Requirements

- › High positioning accuracy
- › Fast response with no overshoot
- › High reliability

Key applications

- › Robotics
- › Material handling
- › Machine tools

Infineon products

- › CIPOS™ IPM
- › Discretes
- › EiceDRIVER™ gate driver
- › EconoPACK™
- › EasyPACK™
- › EconoDUAL™
- › CoolSiC™ MOSFETs

C-HVAC

3 kW

75 kW

Requirements

- › Good price / performance ratio

Key applications

- › Commercial Heating & Ventilation Air-Conditioning (C-HVAC)

Infineon products

- › EconoPIM™
- › EasyPIM™
- › EiceDRIVER™ gate driver
- › OPTIGA™ Trust family
- › CIPOS™ IPM
- › iMOTION™

Overview of medium voltage drives

Medium voltage drives

250 kW

36 MW

Requirements

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

Key applications

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

Infineon products

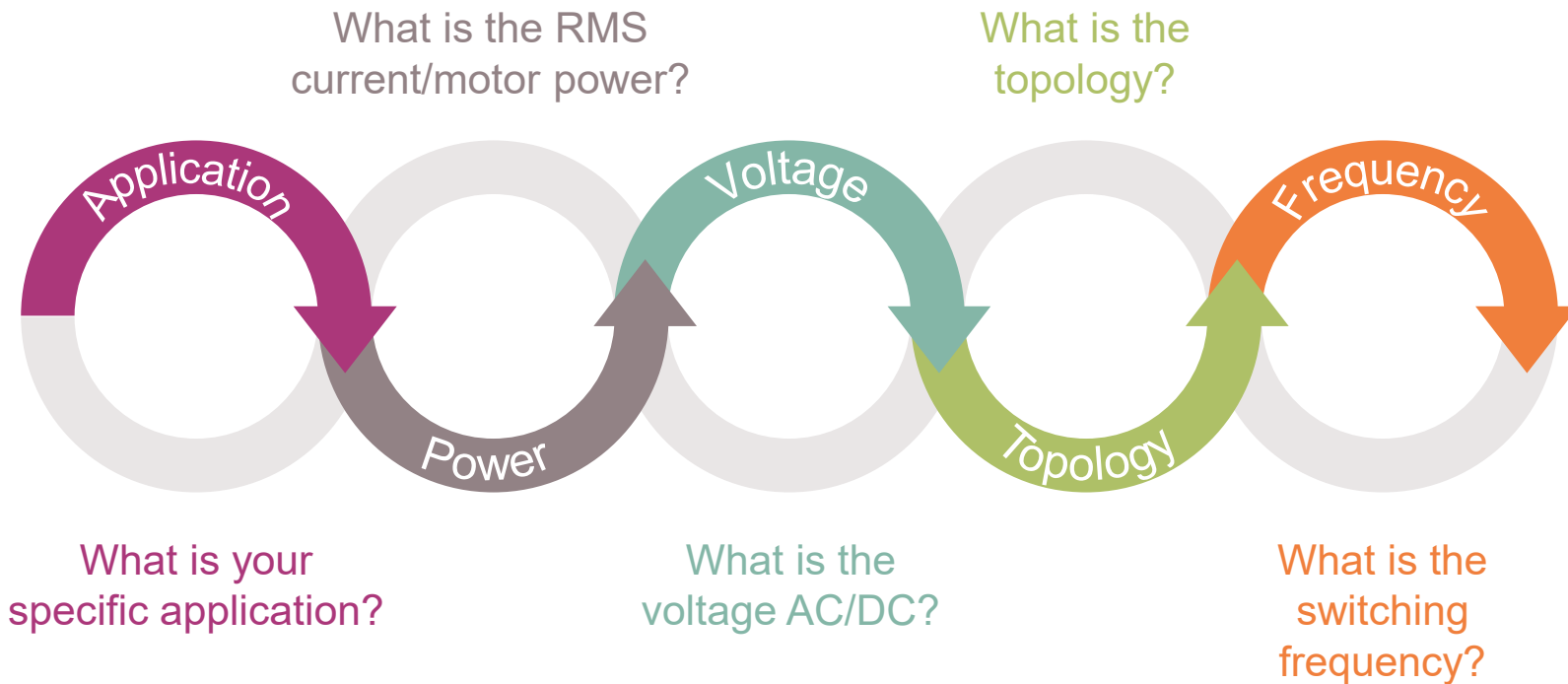
- › PrimePACK™
- › PrimePACK™ .XT
- › XHP™
- › EconoDUAL™
- › 62mm
- › EiceDRIVER™ gate driver



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Key questions to design your drives inverter



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



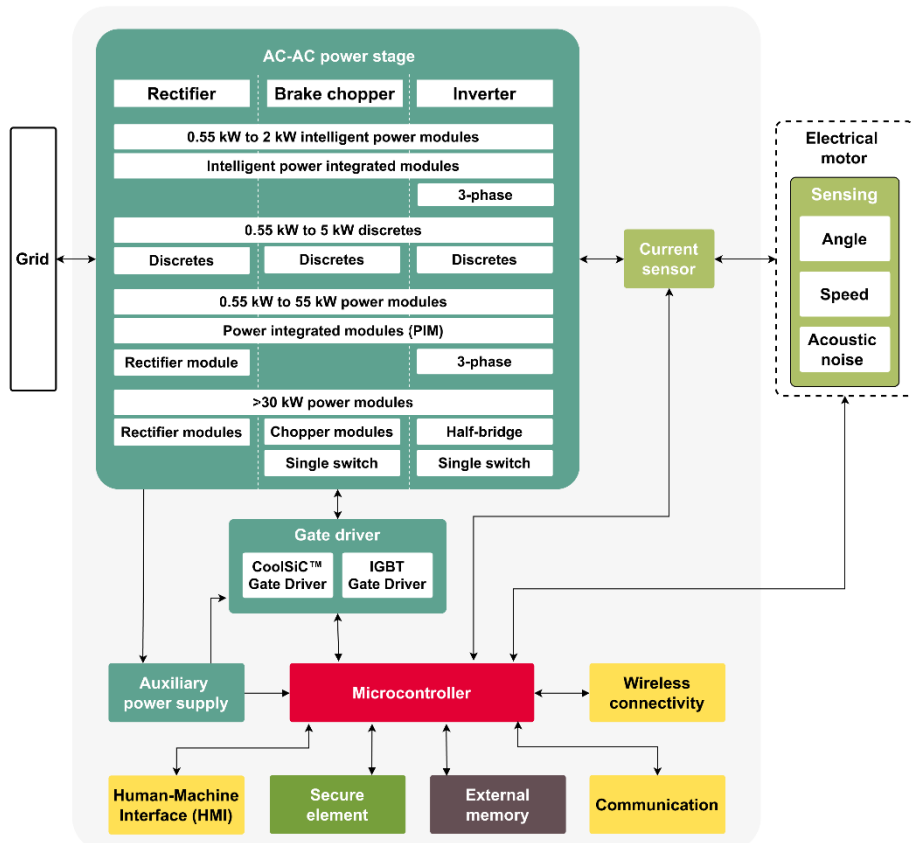
What is the topology?



Frequency

What is the switching frequency?

A closer look at a typical converter system



The levels of integration

Power electronics

- › Discretes
- › 3-phase PIM
- › Sixpack
- › Dual switch
- › Single switch
- › Thyristors & Diode Discs

Gate drivers

- › Level shift driver
 - High side
 - Half bridge
 - High and low side
 - Three phase
- › Isolated driver (1 & 2 channel)
- › Low side driver (1 & 2 channel)

Sensors & Security

- › Magnetic sensor for position and speed
- › Current sensor
- › OPTIGA™ Trust family

Microcontrollers

- › XMC™ controller family based on ARM® Cortex®-M
- › Countless possibilities for motor control







Wireless connectivity

- › Wi-Fi MCUs

External memory

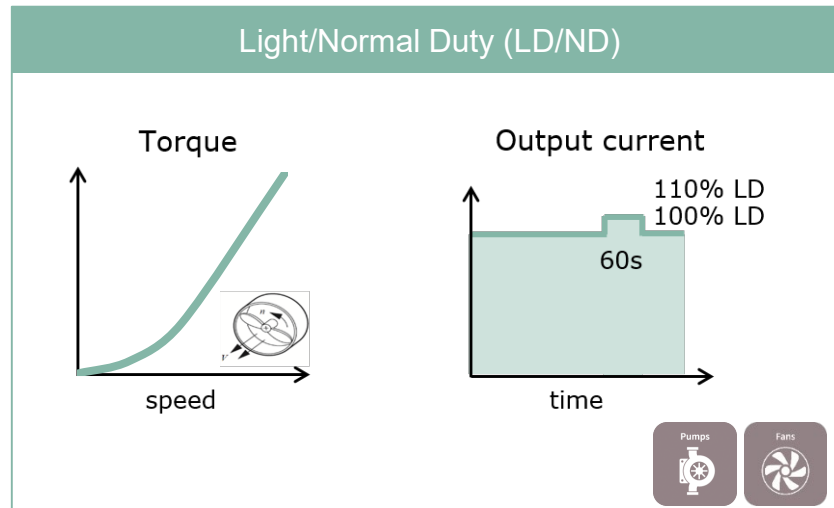
- › High-Performance Memories for Embedded Systems
 - Flash
 - RAM

Application requirements for general purpose, servo and C-HVAC drives

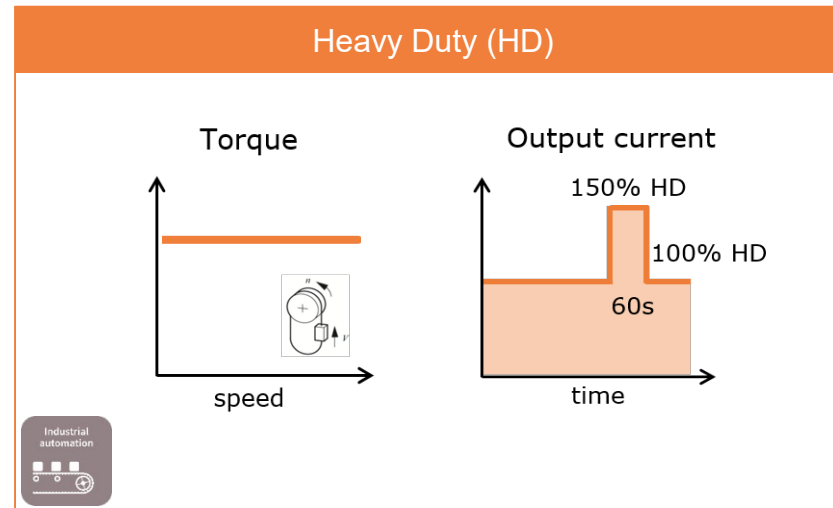
	General purpose drives	Servo drives	C-HVAC	
Power	Broad portfolio (0.37... 1250 kW) 600 V, 1700 V and 1200 V switches (major)	Less broad portfolio (... ~315 kW or <u>customized current classes</u>) 600 V, 1200 V switches (major)	Portfolio (3 kW to 75 kW) 1200 V switches	
f_{sw}	4 to 8 kHz <100 kW 2 to 4 kHz >100 kW	4 to 8 kHz, 16 kHz w/ derating	4 to 8 kHz	
dv/dt	$\leq 5 \text{ kV}/\mu\text{s}$			
SC	Fast short circuit detection (e.g. 8 μs for IGBT)			
f_{out}	a) Light duty – 50/60 Hz b) Heavy duty 1Hz w/ derating	Low f_{out} common down to 0 Hz (locked rotor)	30 Hz to 250 Hz	
OL	a) Light duty e.g. 110% I_N 60 sec 100% I_N 240 sec b) Heavy duty e.g. 150% I_N 60 sec 100% I_N 240 sec	a) High overload e.g. 200% I_N 3 sec 0% I_N 7 sec b) Very high overload e.g. 300% I_N 0.25 sec 70% I_N 3.75 sec	No overload / light overload	

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:**



- › Applied in fans and pumps, since they do not require high torque at low speed and have a 110% overload rating



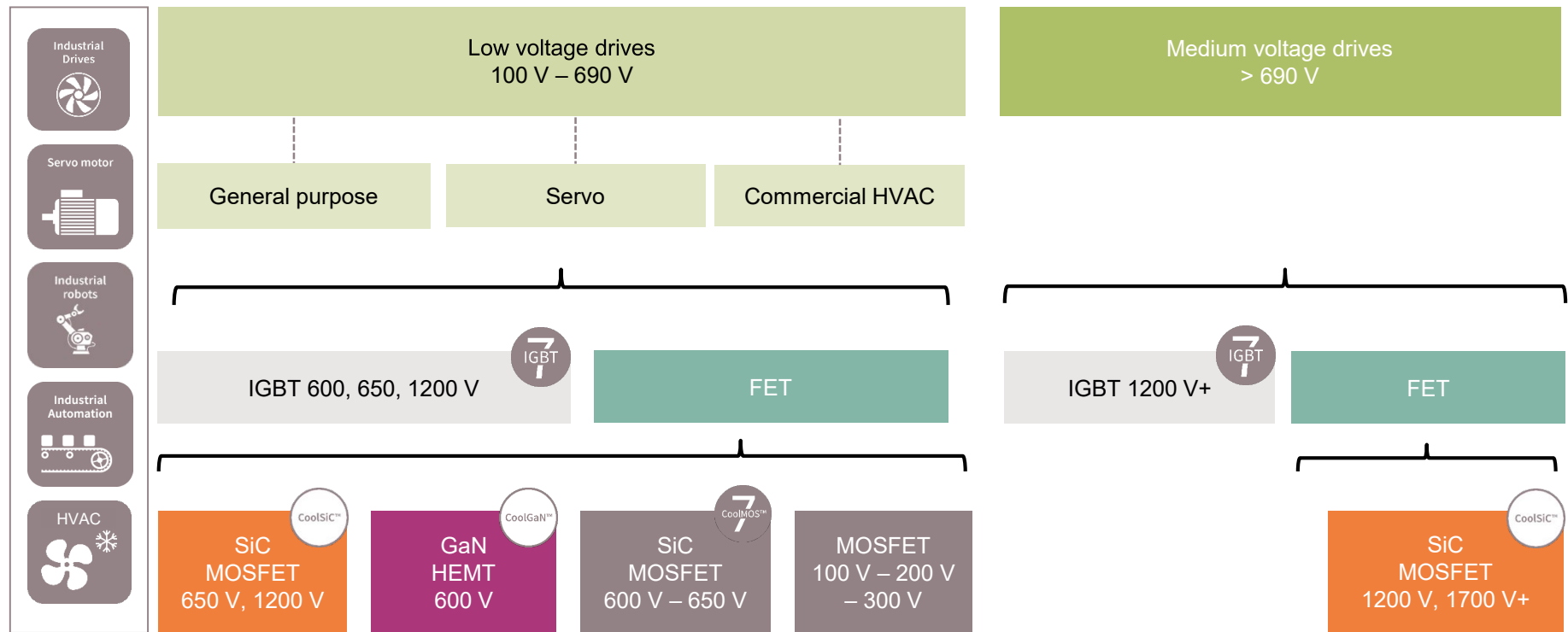
- › Applied in industrial automation and requires high torque at low speeds and a 150% overload rating
- › The base load current is reduced when compared to normal duty

For servo drives the overload capability can increase up to 300% of rated current.

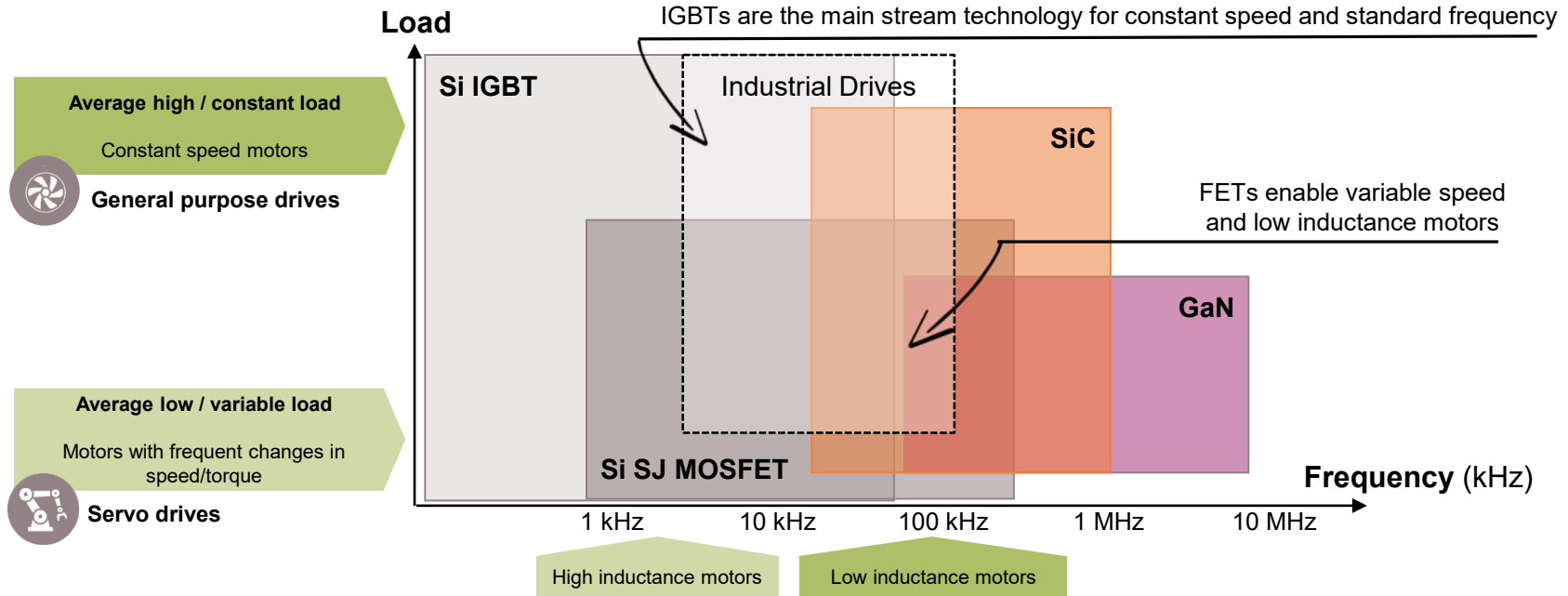
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Switching technologies for industrial drives – Mapping into motor drive types



Switching technologies for industrial drives – Technology positioning



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

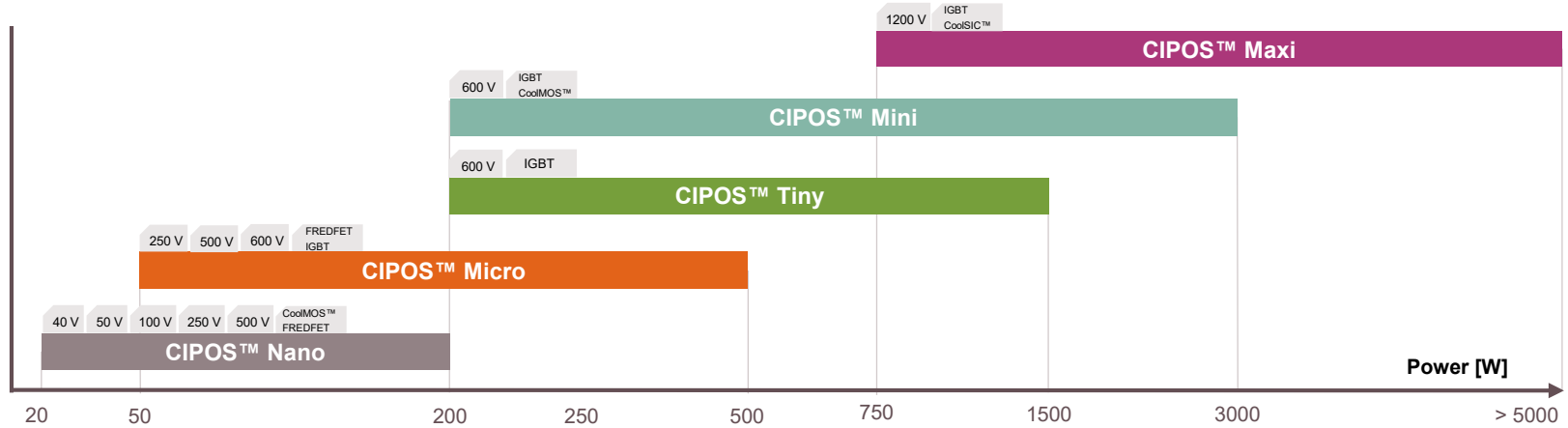
Broad Intelligent Power Module portfolio – Serving power ranges from 20 W to 5 kW plus

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

Powering millions of personal cares and low power application

CIPOS™ Micro

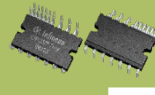


29x12x2.9 mm

Compact solution

Optimized solution for low power fan & pump

CIPOS™ Tiny

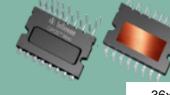


34x15x3.8 mm

New solution for RAC compressor

Best optimized solution for RAC up to 1.5HP

CIPOS™ Mini



36x21x3.1 mm

Broad range portfolio

Proven solution for MHA/Industrial drives

CIPOS™ Maxi

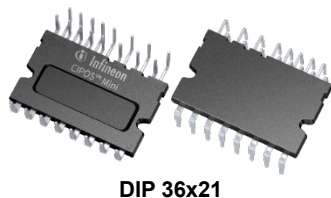


36x23x3.1 mm

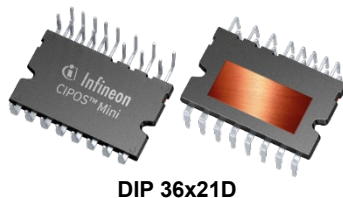
Highest power density

Ruggedized Industrial drives and CAC solution

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



DIP 36x21



DIP 36x21D

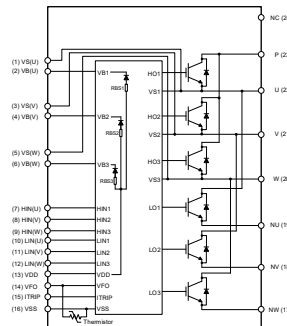


Key features

- › 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



Internal schematic and products



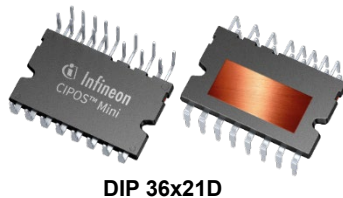
Product name	Related Current [A]	Package
IKCM10L60GA	10 A	DIP 36x21
IKCM15L60GA	15 A	
IKCM20L60GA	20 A	
IKCM15L60GD	15 A	DIP 36x21D
IKCM20L60GD	20 A	
IM535-U6D	30 A	



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.

CIPOS™ Mini single boost PFC-integrated 3 phase inverter IPM enables system size reduction and cost improvement



DIP 36x21D

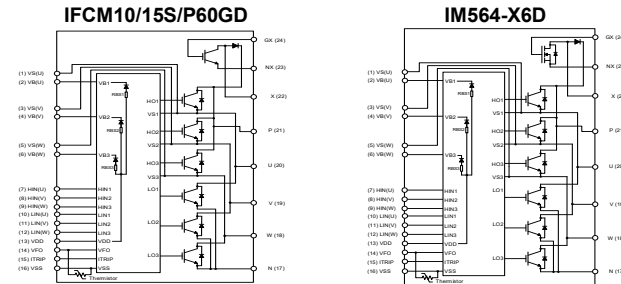


Key features

- › 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:



Rated current	PFC Fsw	
	20 kHz	40 kHz
10 A	IFCM10S60GD	IFCM10P60GD
15 A	IFCM15S60GD	IFCM15P60GD
20 A	IM564-X6D (over 100 kHz with CoolMOS™ for PFC)	

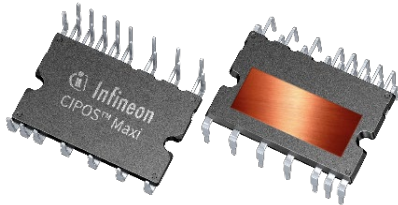


Benefits

- › 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

CIPOS™ Maxi IPM provide excellent performance with highest power density in 1200 V class for 3-phase motor drive application

DIP 36x23D



Key features

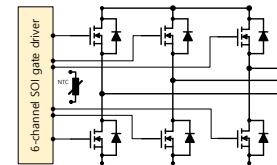
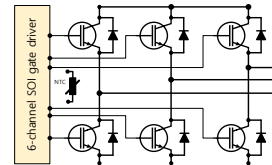
- › Offers the smallest package in 1200 V IPM class
- › Integrated 6 TRENCHSTOP™ IGBT 4 / CoolSiC™ MOSFET and a rugged 1200 V 6-channel SOI gate driver
- › Integrated bootstrap functionality
- › Over current shutdown
- › Under-voltage lockout at all channels
- › RFE pin with multi-functions
- › An independent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



Exemplary schematic/topology:

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

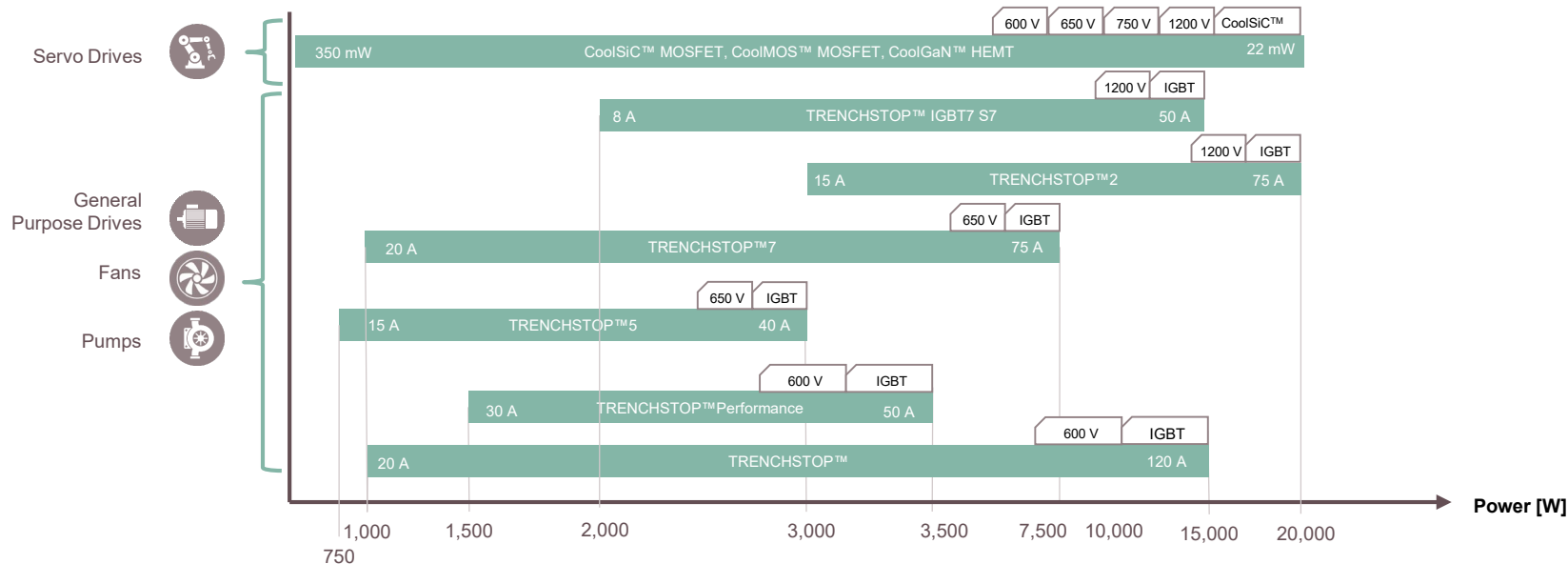
› 3-phase inverter



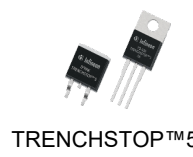
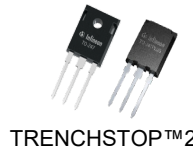
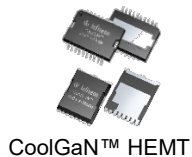
Benefits

- › 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

Broad discrete IGBT & FET portfolio serving power ranges up to 20 kW



Discrete IGBT and CoolSiC™ MOSFET portfolio

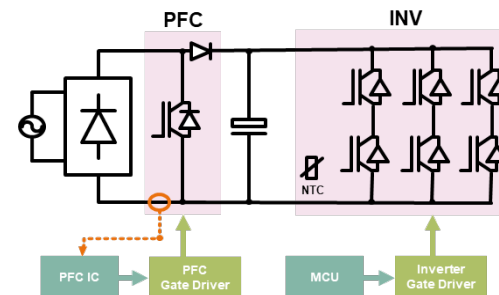


Discrete solutions for industrial drives – features and benefits

Product type	Input Connection	Product name and Family
INV Switch IGBT	1-phase	IKW50N65ET7 TRENCHSTOP™ IGBT7
	3-phase	IKW40N120CS7 TRENCHSTOP™ IGBT7
INV Switch SiC MOSFET	1-phase	IMW65R072M1H CoolSiC™ MOSFET
	3-phase	IMW120R060M1H CoolSiC™ MOSFET



Exemplary schematic/topology:



Key features

- › **IGBT7 T7** shows:
 - Improved humidity ruggedness
 - Low saturation and forward voltage
 - Optimized controllability below 5 kV/ μ s
 - Short circuit ruggedness
- › **CoolSiC™ MOSFET** has:
 - Exclusive 3 μ s 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

Product type	Input Connection	Product name and Family
SJ MOSFET	3-phase	6 x IPT60R035CFD7 or 6 x IPDQ60R018CFD7* *coming soon
Gate driver IC		6 x 2EDF7275F
SiC diode		6x IDL06G65C5 or 6x IDDD08G65C6
LV MOSFET		6x BSZ440N10NS3



Bottom side cooling



Top side cooling

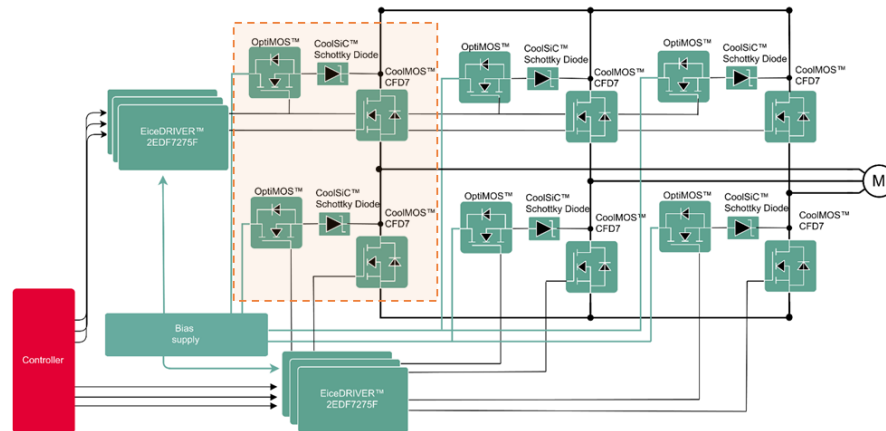


Key features

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



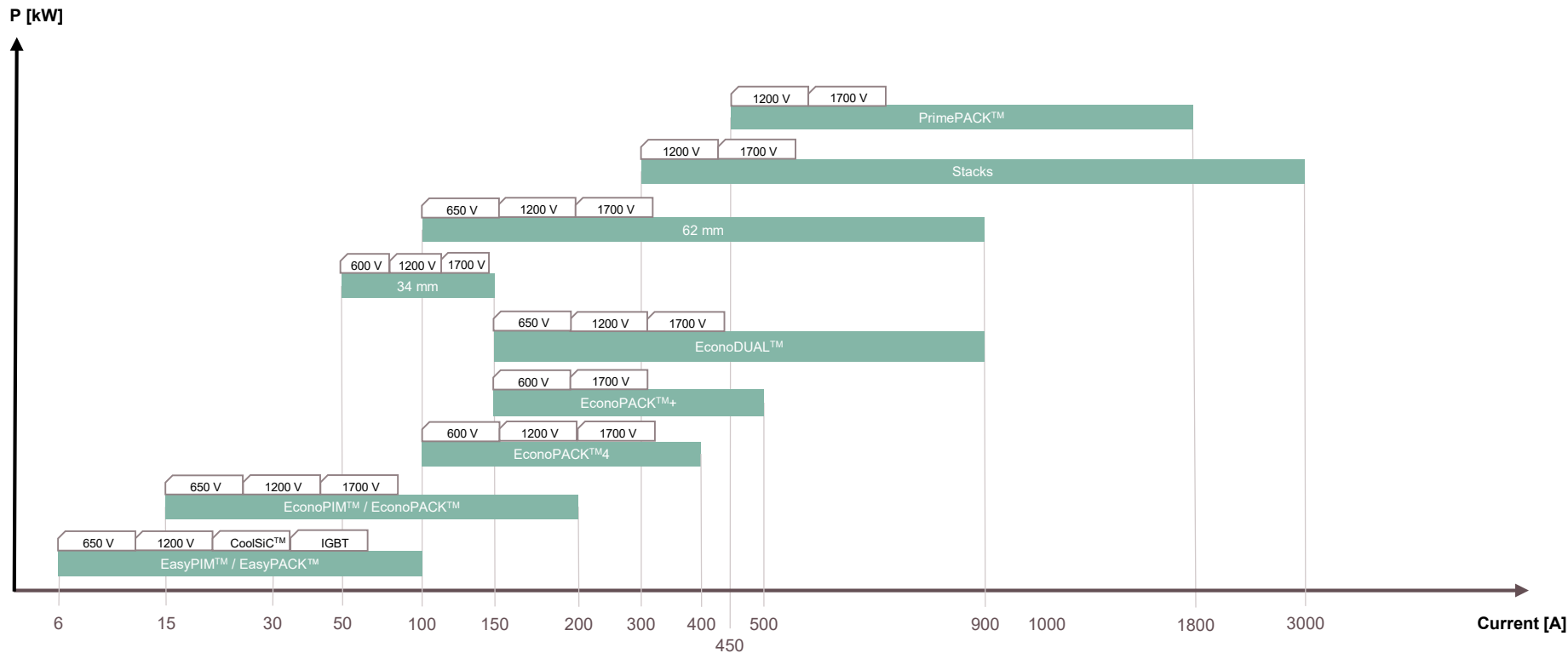
Exemplary schematic/topology:



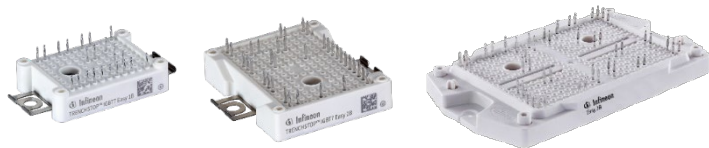
Benefits

- › 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

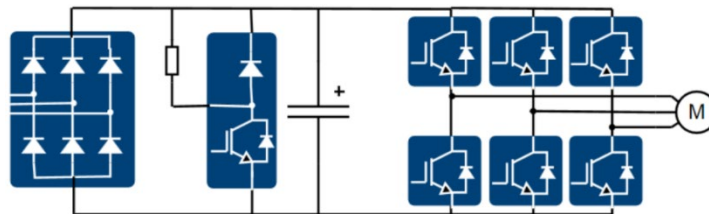
Broad IGBT package portfolio serving current ranges from 6 A to 3 kA



TRENCHSTOP™ IGBT7 with the Easy family – A perfect fit for platform based design of industrial drives



Exemplary schematic/topology:



Key features

- › The latest TRENCHSTOP™ IGBT7 and EC7 diode technology
- › Lower on state voltage $V_{CE(sat)}$ and V_f
- › Overload capability at $T_{vj,op}=175^{\circ}C$
- › Enhanced controllability of dv/dt
- › Optimized for simple driving
- › All packages have same mechanical height

Find more for IGBT7: www.infineon.com/IGBT7

Find more for Easy modules: <https://www.infineon.com/cms/en/product/power/igbt/igbt-modules/easy/>



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

Easy modules with CoolSiCTM MOSFET chip technology for industrial drives



EasyPACK™ FS45MR12W1M1P_B11 also available with pre-applied TIM

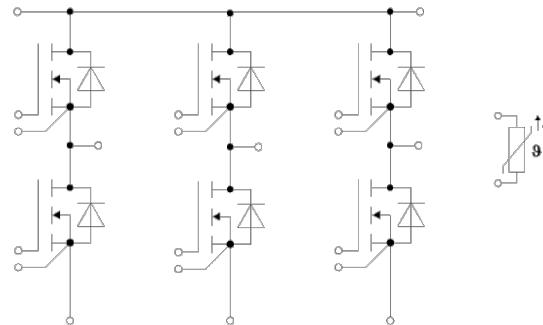


Key features

- › 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



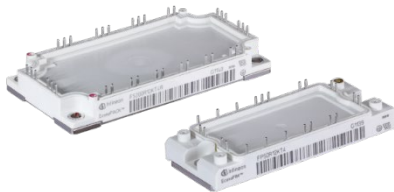
Exemplary schematic/topology:



Benefits

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

Econo2 and Econo3 modules – established product for broad range of applications

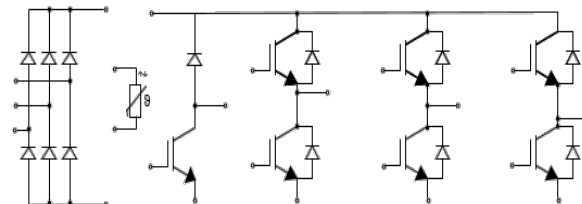


Key features

- › 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:



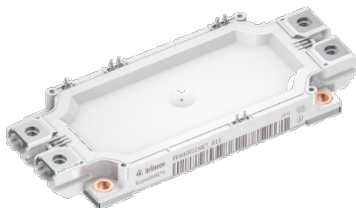
PIM with NTC



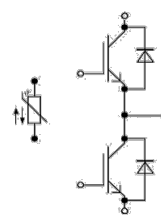
Benefits

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

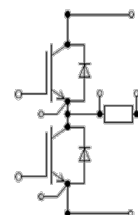
EconoDUAL™ 3 – 1st choice for future system designs



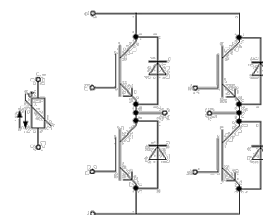
Exemplary schematic/topology:



Half-bridge



Half-bridge with shunts



H-bridge



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_{vjop} 150°C (TRENCHSTOP™ IGBT4)
- › T_{vjop} 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

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



Exemplary schematic/topology:

Product	I _c (A)	Topology
FS100R12PT4	100	
FS150R12PT4	150	
FS200R12PT4	200	



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

34mm and 62mm module family with its comprehensive portfolio offers more flexibility and highest reliability for successful inverter designs

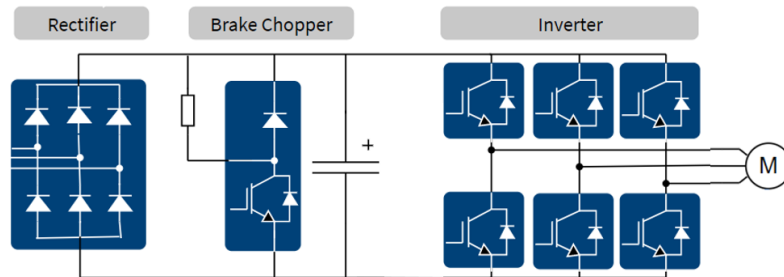


Key features

- › 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



Exemplary schematic/ topology:



Benefits

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

IHV & XHPTM the perfect match with drives trends

Trends and requirements

on drive level

on drive converter level

on module level



Cost and size

Compact designs

Power density increase
Low stray inductance
Clean switching

No interruptions in operation

Long lifetime of the converters
With low FIT rate

Up to 200% PC capability
at low FIT rate

Efficiency

High efficient designs

Low static and dynamic losses

Infineon
3.3 &
4.5 kV

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 @ $\Delta T_c = 80K$)
- › PC capability at min. 2 Mio cycles @ $\Delta T_j = 40K$
 - 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



PrimePACK™ 2: 172 x 89 mm



PrimePACK™ 3: 250 x 89 mm



PrimePACK™ 3+: 250 x 89 mm



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_{vjop} 150°C



Exemplary schematic/topology:

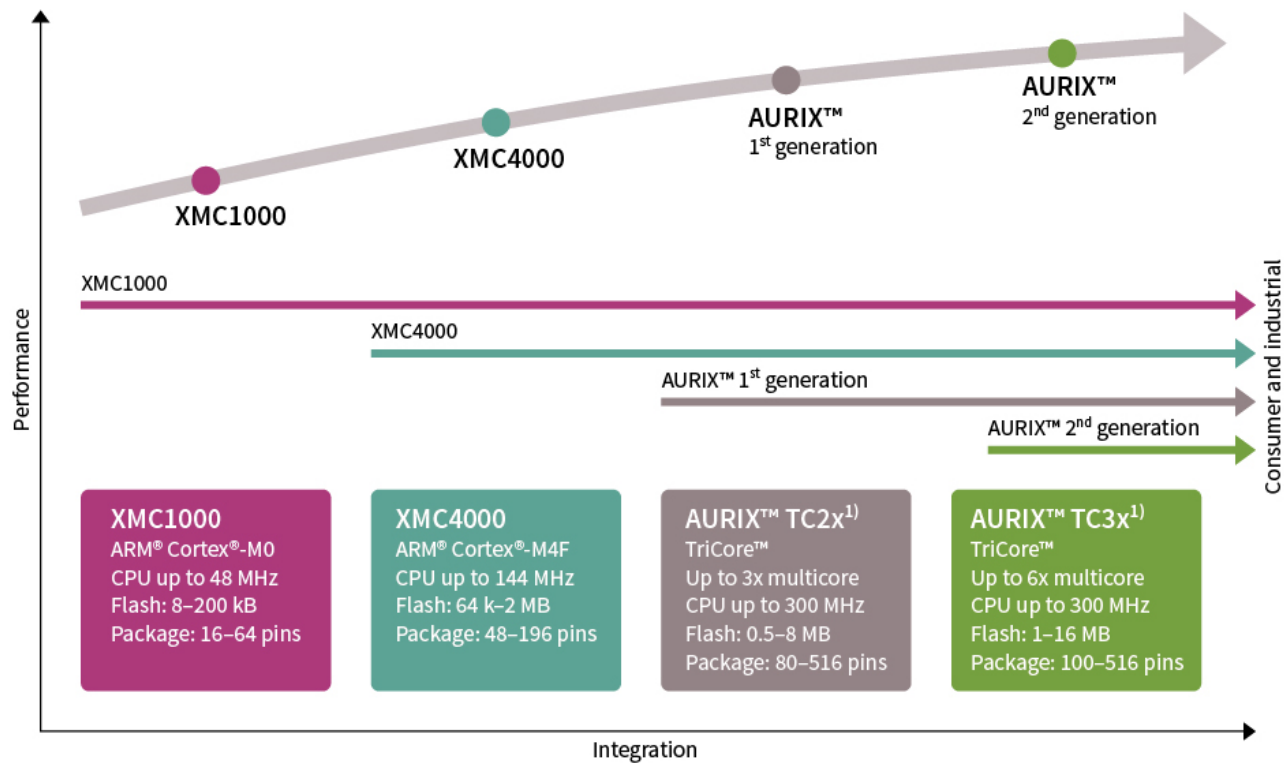
Part Number	Voltage	IC [A]	Package	Topology
FF450R12IE4	1200 V	450	PP2	
FF600R12IE4/P4		600	PP2	
FF900R12IE4/P4		900	PP2	
FF1400R12IP4		1400	PP3	
FF1200R12IE5		1200		
FF1500R12IE5/R		1500		
FF1800R12IP5		1800		
FF450R17IE4	1700 V	450	PP2	
FF650R17IE4		650	PP2	
FF1000R17IE4		1000	PP3	
FF1400R17IP4		1400	PP3	
FF1200R17IP5		1200		
FF1500R17IP5/R		1500		
FF1800R12IP5		1800		



Benefits

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

Overview with performance classes for microcontroller



1) AURIX™ devices add safety and CAN FD

XMC4000 microcontroller units for industrial drives

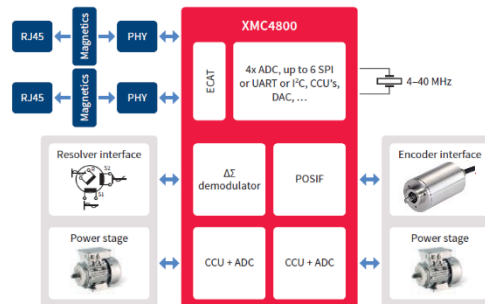


Key features

- › 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



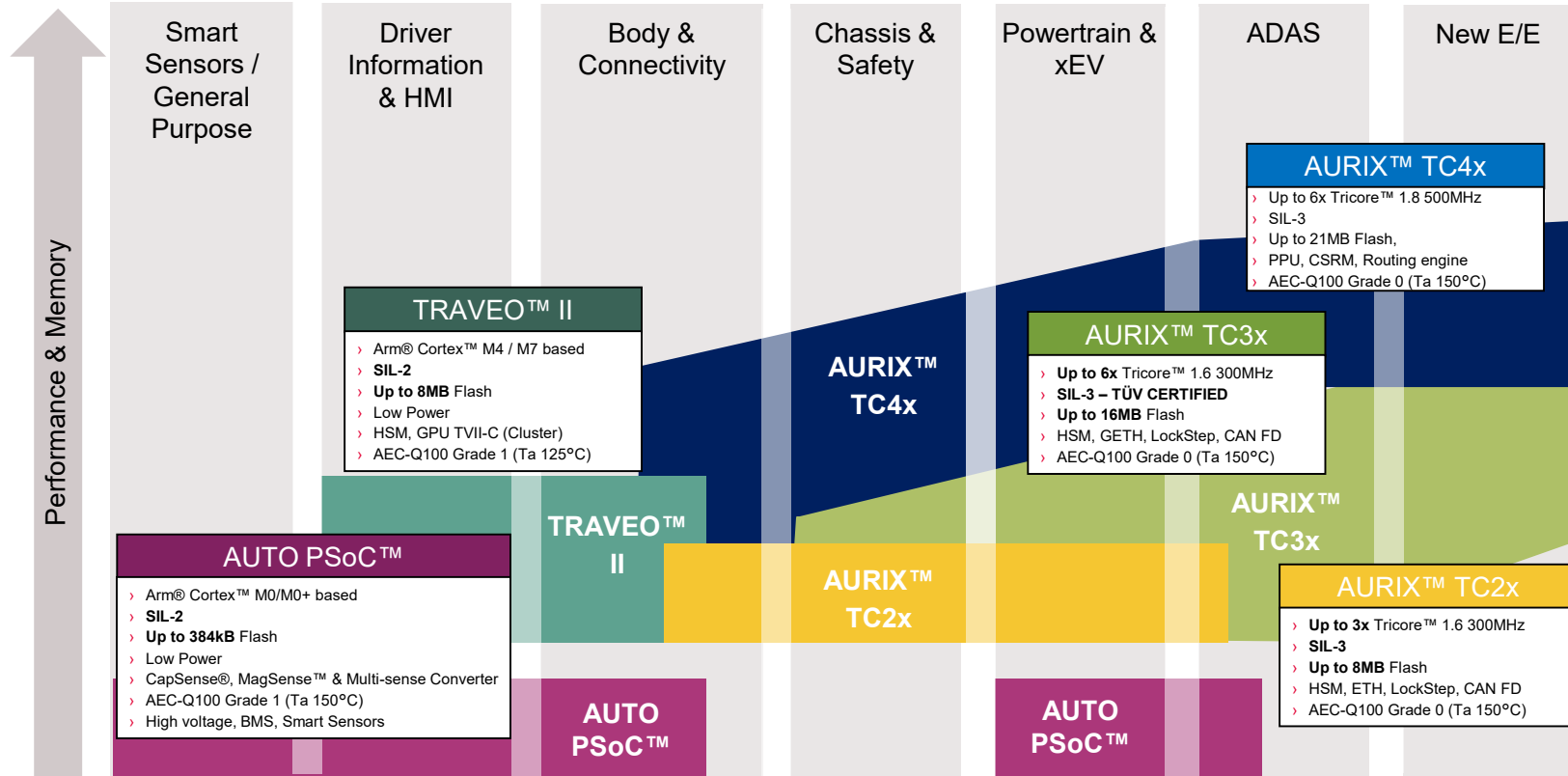
Exemplary schematic/topology:



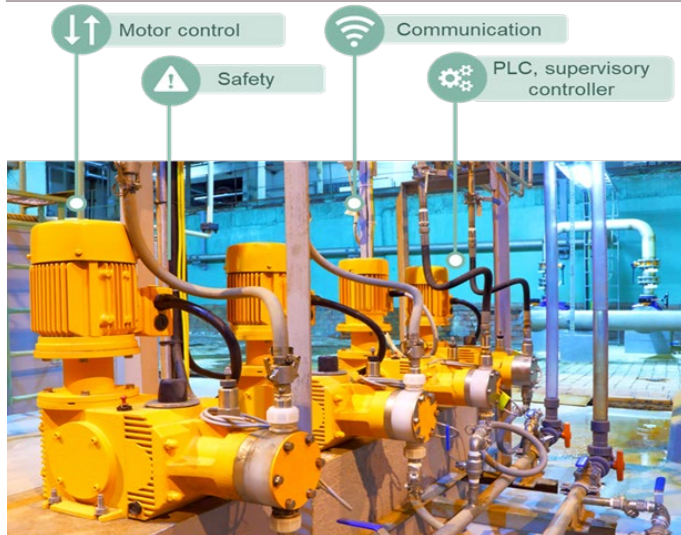
Benefits

- › 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



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

PLC: *AURIX™* & *TRAVEO™*

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 Touch Interface
- Inductive Sensor – Touch with Metal
- LCD Driver
- **SIL2**

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

ISOFACE™ product family – Galvanic isolation & diagnostics integrated

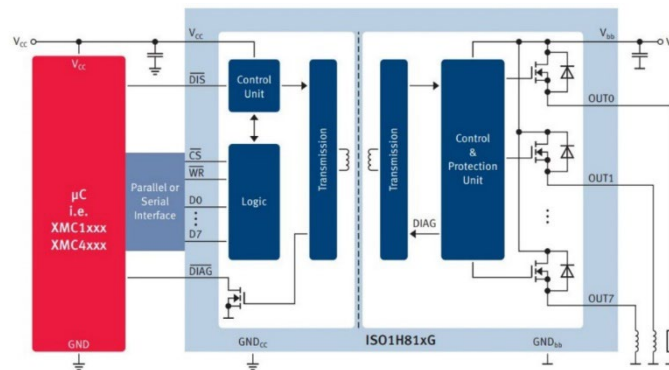
2nd
gen



- › H823V 8x 0.6 A
12 x 12 VQFN

8-channel switch IC

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



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

8-channel switch ICs

- › Integrated galvanic isolation
- › Direct interface to μ C
 - 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-ch. digital input ICs

- › Integrated galvanic isolation
- › Direct interface to μ C
- › 3.3 V/5 V
- › Serial or parallel
- › IEC-input types: 1/2/3

	Sampling speed	Filter settings	Diagnostics	
			V_{bb} -monitor	Wire-break
› I811T	125 kHz	4 / IC		
› I813T	500 kHz	9 / channel	✓	✓

8-channel switch ICs

8-channel input ICs

ISOFACTM - Galvanic isolated high-side switches & input ICs

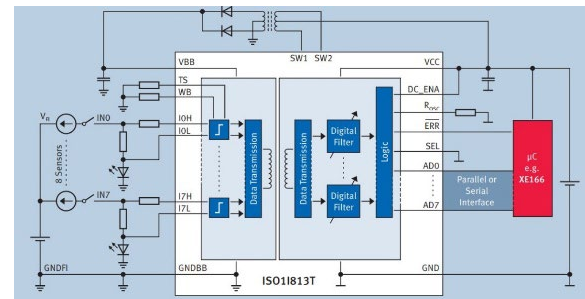


Key features

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



Exemplary schematic/topology:

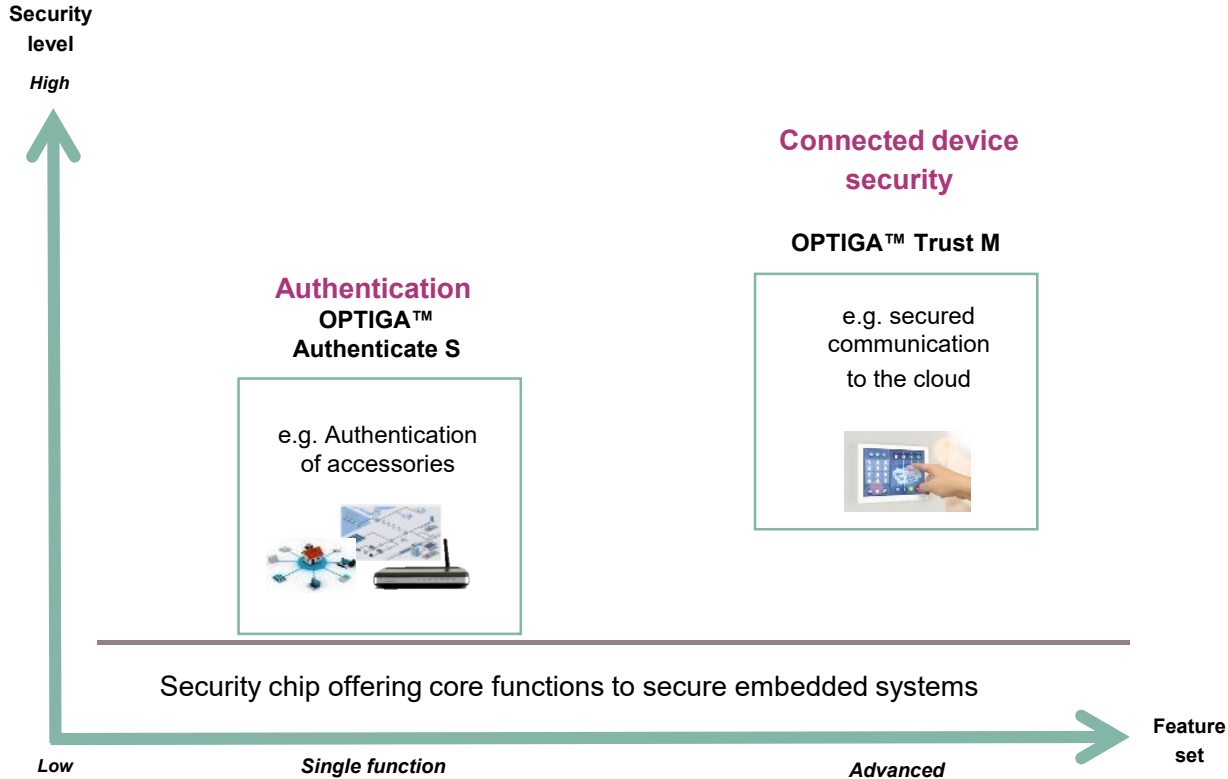


Benefits

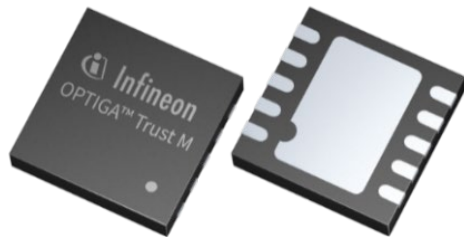
- > Ideal for industrial applications operating at elevated temperatures
- > Higher operational life-time
- > Higher reliability
- > Ideal for high-precision or high-speed applications
- > At least 50% PCB area savings
- > Inductive load switching
- > Flexibility
- > Over-load detection
- > Strong maintenance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

OPTIGA™ Trust Family

The security answer to our customer's concerns



OPTIGA™ Trust M SLS32AIA

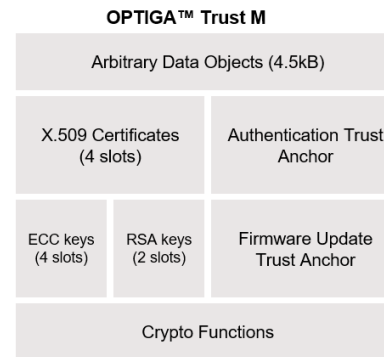


Key features

- › 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)



Exemplary schematic/topology:



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

Use case	Description
Brand protection and authentication of accessories	OPTIGA™ Authenticate S can be used in accessories / consumables to verify that genuine parts are used.
Mutual authentication	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)
Secured communication	OPTIGA™ Trust M can be used to establish secured communication with a cloud or other service or device
Secured storage	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.
Secured firmware update	OPTIGA™ Trust M can be used to cryptographically verify and perform secured firmware updates.

XENSIV™ angle-sensors in electrification for drives



Key features

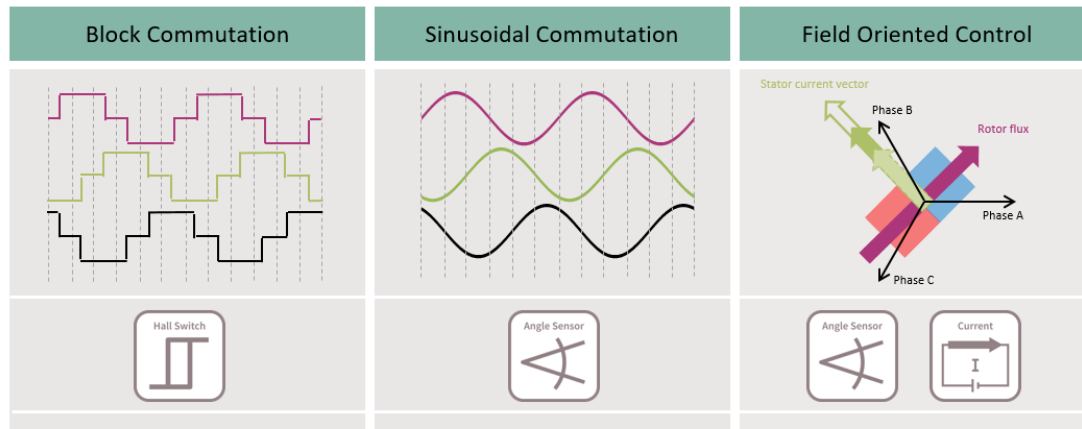
- › Wide portfolio of magnetic position sensors
- › Offering Hall, GMR, AMR and TMR sensors
- › Digital and analog interfaces for angle sensors available



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



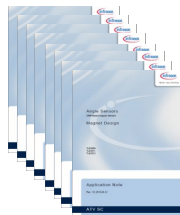
XENSIV™ enablement examples: Infineon provides supportive material for a short time-to-market

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



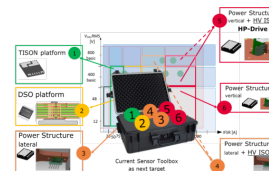
Evaluation tools & SW

- › 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

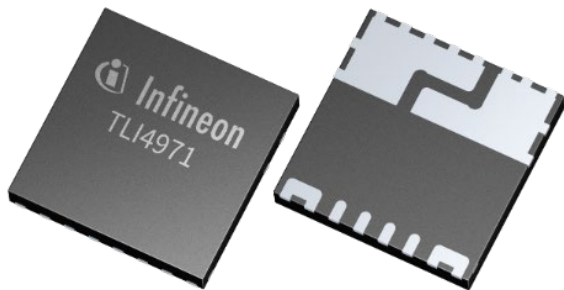


Sensing toolboxes

- › 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

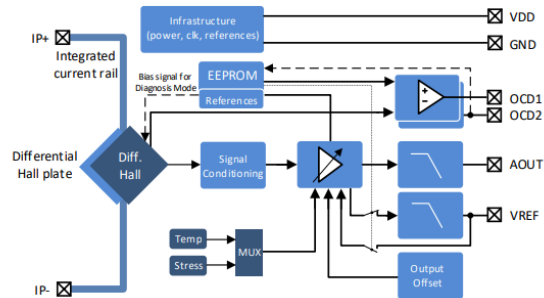


Key features

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



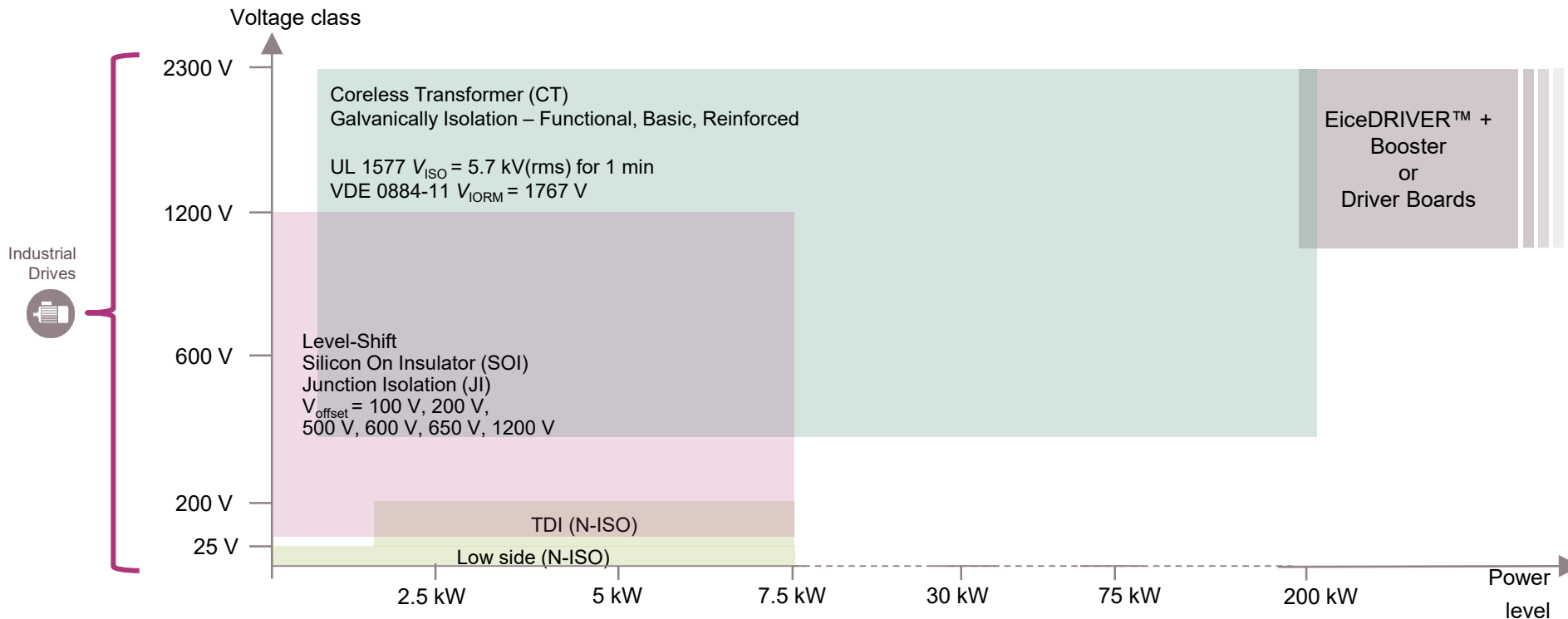
Exemplary schematic/topology:



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



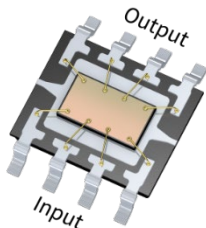
Note: Voltage class is defined base on different driver configurations for the Max Voltage class. 1. For high-side, high-and low-side, half bridge and three phase gate drivers, voltage class is defined as switch break down voltage in applications. 2. For low side drivers (N-ISO), voltage class is defined 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

Non-isolated GD

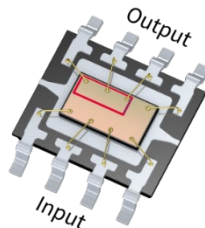
Low-side



- Monolithic construction of ground-reference gate drivers for 20 to 35 V supply voltage applications
- Comprehensive families** of single- and dual-low-side drivers with flexible options for output current, logic configurations and UVLOs (plus non-isolated TDI)
- Uses **rugged and high-performance technologies** of HVIC process or the latest **state-of-the-art 130-nm** process
- Industry-standard** DSO-8 and small form-factor SOT23, WSON and TSNP packages

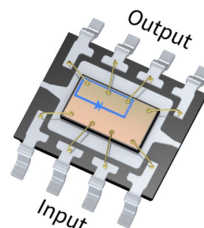
Level-shift GD

Junction isolation (JI)



- Monolithic construction of 1 to 6 gate drive channels up to 1200 V rating
- Industrial pioneering high-voltage IC (**HVIC**) **technology** used in all high-voltage gate drive applications
- Optional Integrated bootstrap- FET circuit (200 Ω typ.)
- Negative transient immunity** to prevent latch-up: -40 V for 100 ns
- Common mode transient immunity (CMTI): 50 V/ns, typ.
- Gen 2** technology (**IR** prefix): Industrial pioneering HVIC process
- Gen 5** technology (**IRS** prefix): Cost-effective pin-to-pin versions of Gen 2

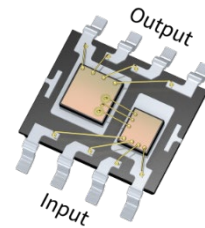
Silicon on insulator (SOI)



- Monolithic construction of 2 to 6 gate drive channels up to 1200 V rating
- Infineon SOI technology** for high-voltage applications
- Built-in **PN-based bootstrap diode** (36 Ω typ.) for simplified bootstrap operation & reduced PCB area
- Negative transient immunity** to prevent latch-up: -100 V for 300 ns
- Common mode transient immunity (CMTI): 50 V/ns, typ
- >50% lower level-shift losses** allowing for higher efficiency, higher frequency operation, smaller heat sinks, and higher reliability

Isolated GD

Coreless transformer



- Two separate chips solution with **magnetic coupling** providing **galvanically isolated** single- and dual channel gate drivers
- VDE0884-11 isolation technology** providing **isolation up to 8 kV_{pk} V_{IoTM}** and up to **± 2300 V functional isolation**
- Common-mode transient immunity (CMTI) of **more than 300 V/ns**
- Strongest gate-drive output currents** (up to ± 18 A) reducing need for external booster circuits
- Reliable protection options** for each isolation rating in different packages

EiceDRIVER™ X3 Compact (1ED31xx) family

5.7 kV isolated driver with active Miller clamp or separate output



Product highlights

- › Single channel isolated gate driver with **5.5 / 10 / 14 A** (no booster required)
- › Galvanic functional isolation voltages up to **2300 V**
- › **90 ns** propagation delay with **30 ns** input filter, **7 ns** propagation delay matching
- › **Active Miller Clamp or Separate outputs**
- › Exceptional CMTI robustness > **200 kV/μs**
- › **40 V absolute maximum** output supply voltage
- › Isolation capabilities & certification
 - 1ED31xxMU12F: **UL 1577 certified** $V_{ISO}=3$ kV(rms)
 - 1ED31xxMU12H: **UL 1577 certified** $V_{ISO}=5.7$ kV(rms)
 - 1ED31xxMC12H: **UL 1577 & VDE 0884-11 certified** $V_{ORM}=1767$ V (planned)
- › DSO-8 150 mil (4 mm creepage) & 300 mil package (8 mm creepage)
- › **Evaluation board available:**
 - EVAL-1ED3121MX12H; EVAL-1ED3122MX12H; EVAL-1ED3124MX12H
 - REF-22K-GPD-INV-EASY3B

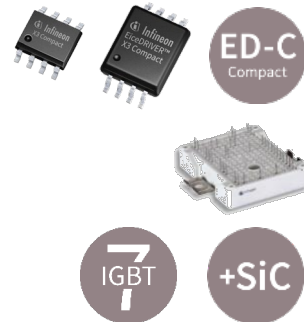
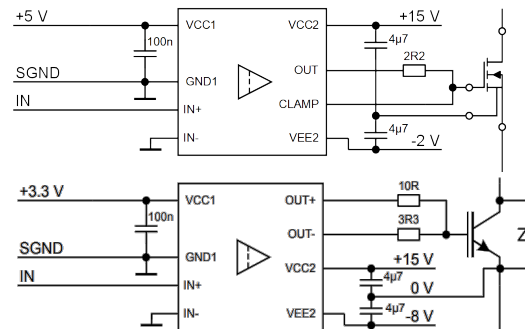


www.infineon.com/gdcompact

Typical Applications



Sample schematic



Value proposition

- › **Cost effective 8-pin** gate driver (with **150-mil** and **300-mil** bodies) enabling **easy to design-in**
- › **14 A driving capability** & **40 V** output supply voltage range
- › **Optimized specifications** for driving **SiC**
- › Fulfilling **highest isolation standards**
 - UL1577 and VDE-11 (planned)

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 V_{GE} / V_{GS}** 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 IGBT7

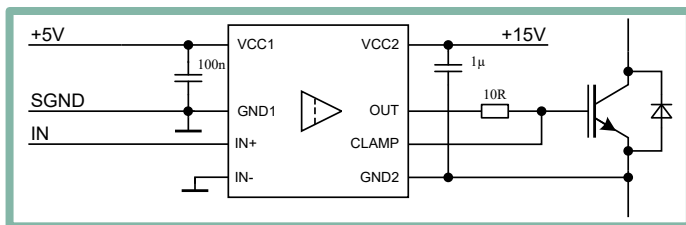


› For 0 V turn-off, Miller clamp function is highly recommended

ED-C
Compact

EiceDRIVER™ 1ED Compact

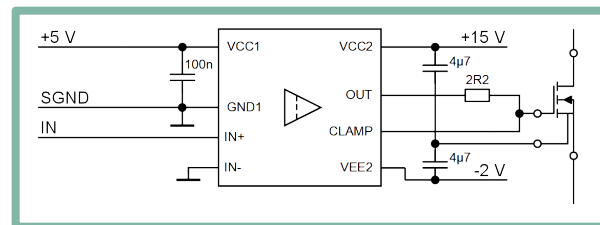
- › Active Miller clamp option
- › $V_{CC2} = 20\text{ V (Max.)}$
- › **Unipolar power supply sufficient**



ED-C
Compact

EiceDRIVER™ X3 Compact

- › Active Miller clamp option
- › $V_{CC2} = 40\text{ V (Max.)}$
- › 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

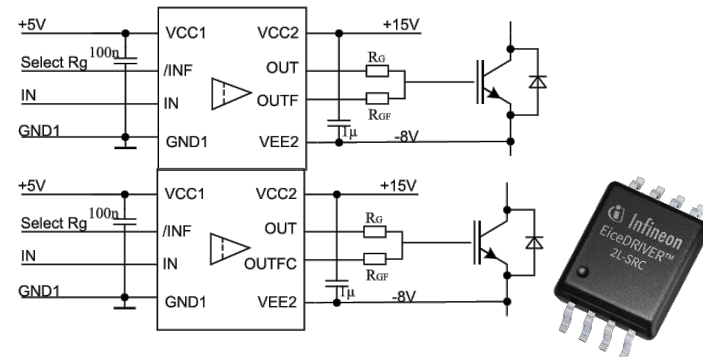


www.infineon.com/gdcompact

Typical Applications



Sample schematic



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

EiceDRIVER™ Enhanced X3 Analog (1ED34xx) family

5.7 kV isolated driver with active Miller clamp, adjustable DESAT

Product highlights

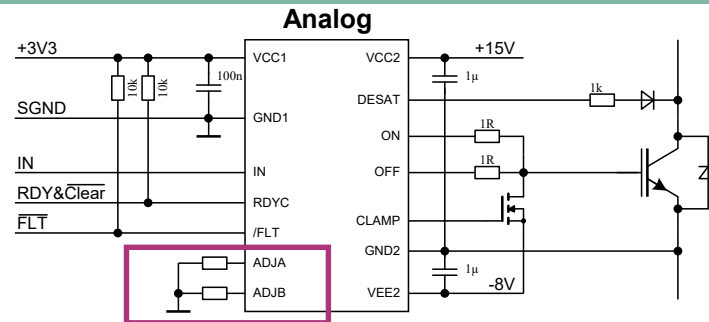
- › Single channel isolated gate driver with **3 / 6 / 9 A**
- › Galvanic functional isolation voltages up to **2300 V**
- › Active Miller clamp (clamp driver), DESAT, soft-off, Thermal shutdown
- › Exceptional CMTI robustness **> 200 kV/μs**
- › **X3 Analog configurability**
 - › Adjustable **DESAT filter time** and **blanking time** and **soft-off current** with external resistor
- › Isolation capabilities & certification
 - › 1ED34x1MU12M: **UL 1577 certified** $V_{ISO}=5.7 \text{ kV(rms)}$
 - › 1ED34x1MC12M: **UL 1577 & VDE 0884-11 certified** $V_{ORM}=1767 \text{ V (planned)}$
- › **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

Typical Applications



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**.



EiceDRIVER™ Enhanced X3 Digital (1ED38xx) family

5.7 kV isolated driver with I2C bus configurability for DESAT

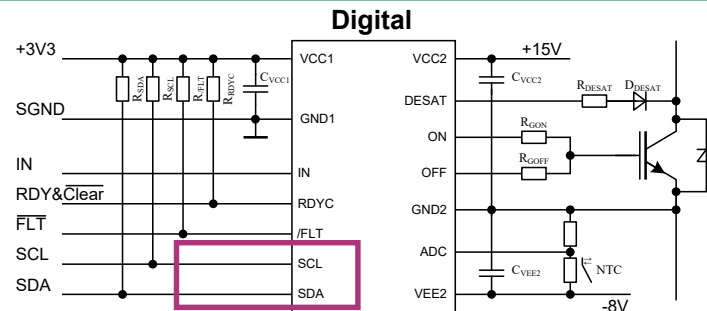
Product highlights

- › 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

Typical applications

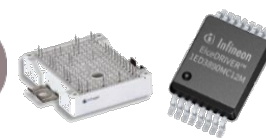
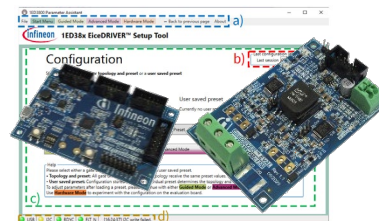


Sample schematic



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**.



EiceDRIVER™ Enhanced F3 (1ED332xMx12N) – Product overview

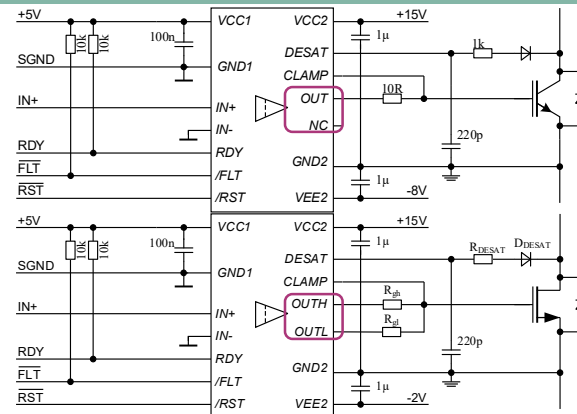


Product highlights

- › 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 1ED02012-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 IGBT7

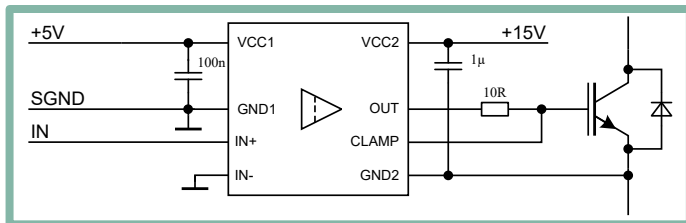


› For 0 V turn-off, Miller clamp function is highly recommended

ED-C
Compact

EiceDRIVER™ 1ED Compact

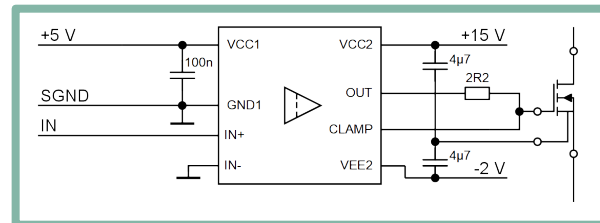
- › Active Miller clamp option
- › VCC2 = 20 V (Max.)
- › **Unipolar power supply sufficient**



ED-C
Compact

EiceDRIVER™ X3 Compact

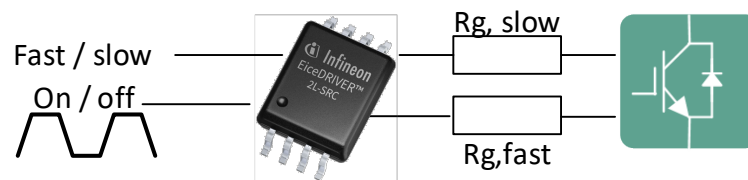
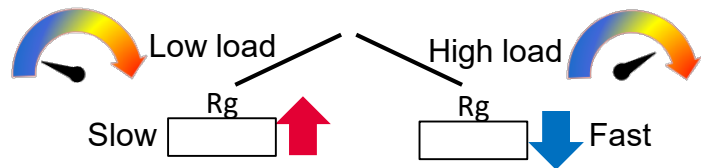
- › Active Miller clamp option
- › VCC2 = 40 V (Max.)
- › Two options
 - › **Unipolar power supply only**
 - › **Bipolar power supply & AMC**



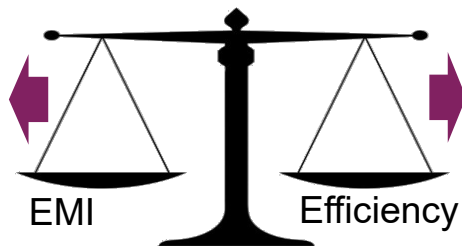
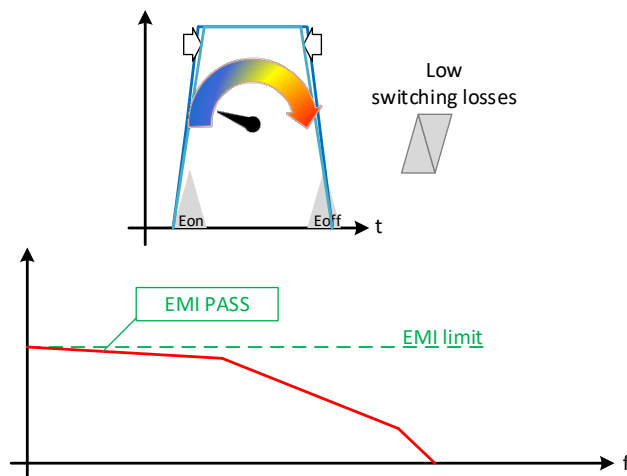
EiceDRIVER™ 2L-SRC Compact empower IGBT7 in Drive application

Balancing efficiency vs. EMI by changing gate resistor on-the-fly

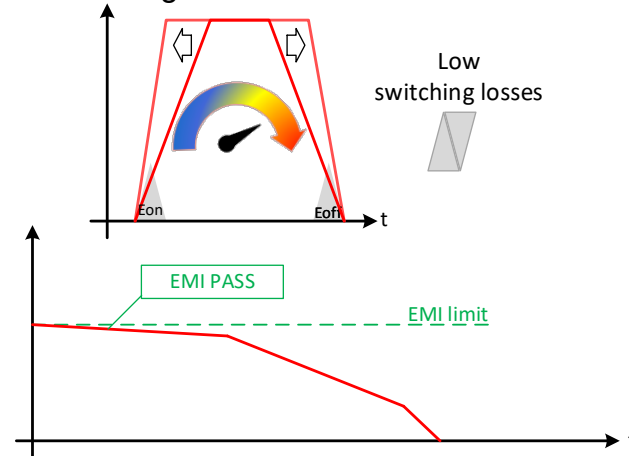
> On-the-fly PWM cycle-to-cycle gate resistor change








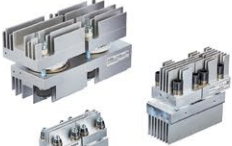





Low load condition



High load condition



Infineon Bipolar portfolio

Eco Line	Power Line	Prime Line	System Line
straight, efficient, functional	reliable, powerful, valuable	unique, optimized, leading	specific, complete, versatile
<p>Modules Eco Block</p>  <p>Solder Bond</p>  <p>Pressure Contact</p> 	<p>Modules Power Block</p>  <p>Diodes Power Diode</p> 	<p>Soft Starters Power Start</p>  <p>Diodes Prime Disc</p>  <p>Discs Prime Disc</p>  <p>Press Pack IGBT Prime Switch</p> 	<p>Stacks/Assemblies Power Stack</p>  <p>Accessories Power Fit</p> 

Prime Switch portfolio

Prime Switch Portfolio

VSC HVDC ¹⁾

Without internal FWD

› P3000ZL45X168

› P3000ZL45X168APT³⁾

With internal FWD

› P2000DL45X168

› P2000DL45X168APT³⁾



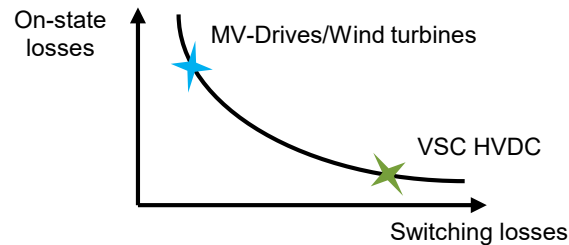
MV-Drives and Wind turbines ²⁾

Without internal FWD

› P3000ZE45X168

With internal FWD

› P2000DE45X168



- 1) Nominal switching frequency ≤ 300 Hz
- 2) Nominal switching frequency ≤ 800 Hz
- 3) Application specific Power Transmission

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.

P2000DL45X168
P3000ZL45X168
P3000ZE45X168
P2000DE45X168
P3000ZL45X168APT
P2000DL45X168APT



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

Advantage of Press Pack IGBTs over IGCTs for MV-Drives

Press Pack IGBTs

P3000ZE45X168

P2000DE45X168

- › 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

Broadest offering

Infineon Prime Switch – Freewheeling Diodes for PPIs and IGCTs



Description

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).

- › D1031SH45T
- › D1331SH45T
- › D1961SH45T
- › D931SH65T
- › D1131SH65T
- › D1600U45T122
- › D2700U45T122
- › D4600U45T172



Main features

- › Pulse turn off losses up to 9 MW
- › Maximal junction temperature of 140°C
- › Lowest thermal resistance
- › Soft switching behavior optimized for IGCT or IGBT devices
- › Current turn-off capability up to 5 kA/μs

Applications

- › HVDC & FACTS
- › DC breakers
- › MV-Drives

Contact

Jens Przybilla

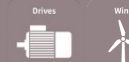


Chen Pan

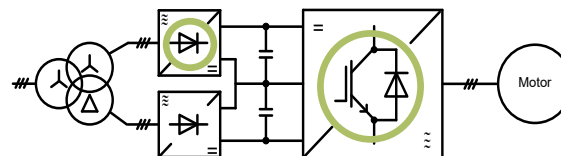
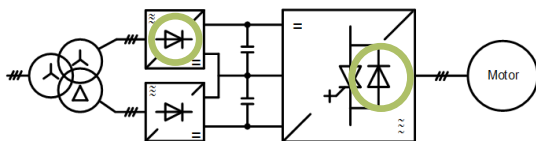


Solution tree MV-Drives – The easy way to find best fitting products

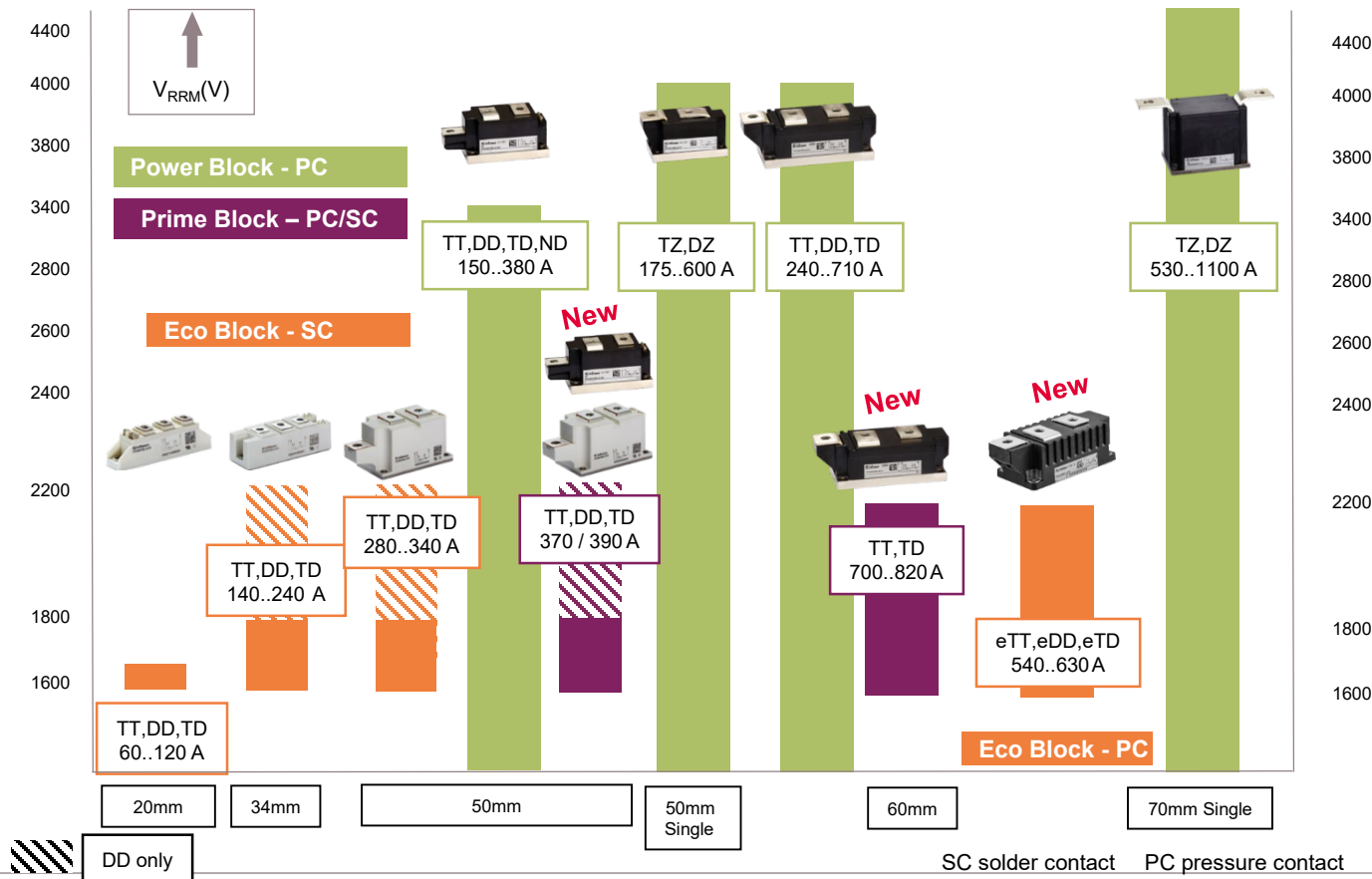
Medium-Voltage Drives and High Power Wind Turbines



Medium-Voltage Rectifier	Medium-Voltage IGCT Inverter	Medium-Voltage <u>Press Pack</u> IGBT Inverter	
Rectifier Diodes (N)	Freewheeling Diodes (SH) Generation 1 (1kA/μs)	Press Pack IGBT (PPI) (With and without internal FWD)	Freewheeling Diodes (U) Generation 2 (5kA/μs)
<ul style="list-style-type: none"> > D6001N50T > D711N60T > D1481N65T > D3001N68T > D3041N68T > D471N90T > D2601N90T 	4.5 kV Diodes <ul style="list-style-type: none"> > D1031SH45T > D1331SH45T > D1961SH45T 6.5 kV Diodes <ul style="list-style-type: none"> > D931SH65T > D1131SH65T 	4.5 kV Trench <ul style="list-style-type: none"> > P2000DE45X168 > P3000ZE45X168 	4.5 kV Diodes <ul style="list-style-type: none"> > D1600U45T122 > D2700U45T122 > D4600U45T172

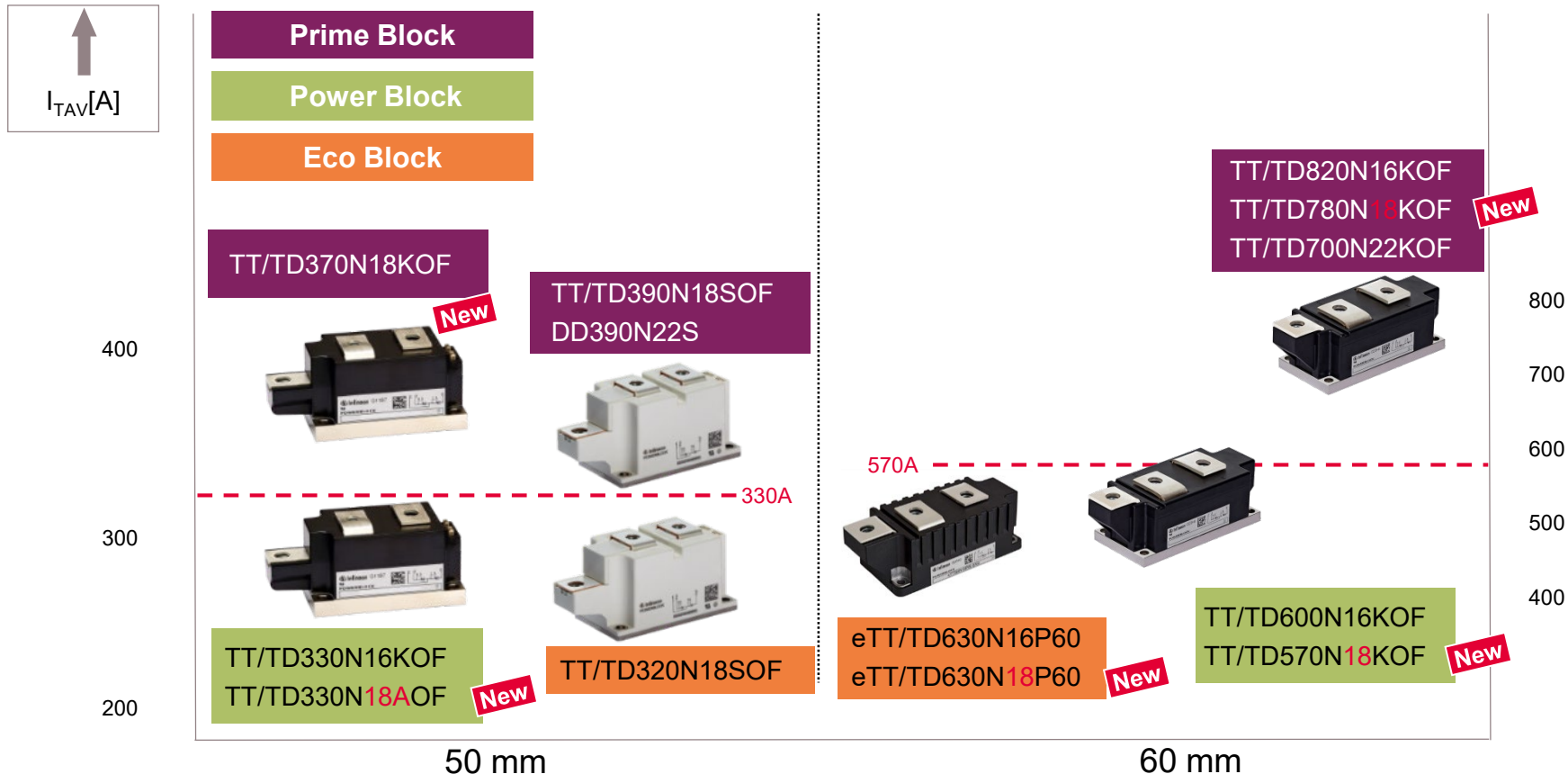


Overview Power Block, Prime Block & Eco Block Modules (SC & PC)



Prime Modules outperform the current market standards

1800 V coming for PC modules in next months



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

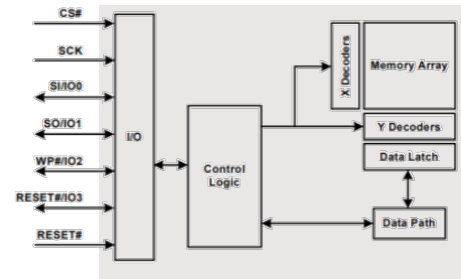


Key features

- 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

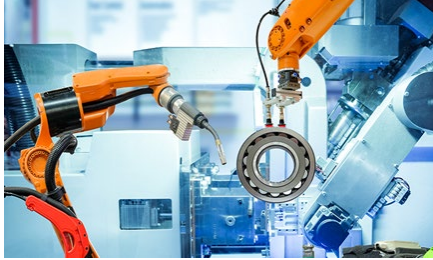
- Easy to use and compliant due to Industrial Standard QSPI Interface
- Robust design with high temperature grade products
- Available in different packages and scalable densities

Series	Density	Device	SOIC-8 208 mil	SOIC-16 300 mil	WSON 4 x 4 mm	WSON 6 x 5 mm	WSON 8 x 6 mm	BGA24 8 x 6 mm 5 x 5 Ball	BGA24 8 x 6 mm 4 x 6 Ball
FL-L	64Mb	S25FL064L	✓	✓	✓	✓		✓	✓
	128Mb	S25FL128L	✓	✓		✓		✓	✓
	256Mb	S25FL256L		✓			✓	✓	✓

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

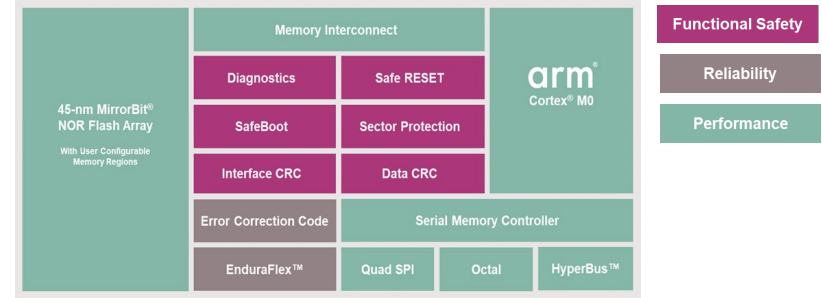


Key features

- 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)



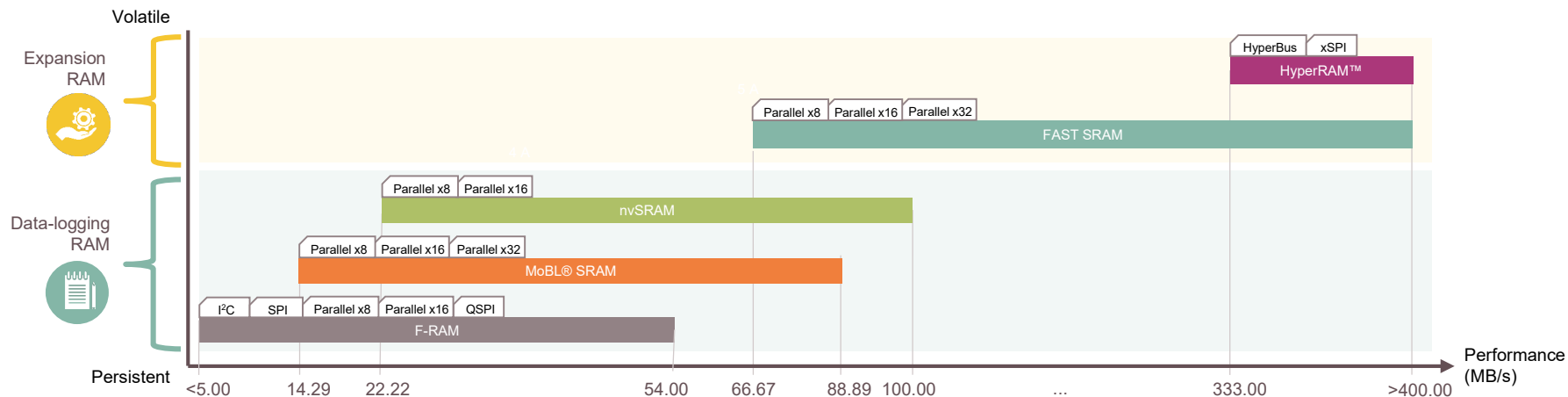
Exemplary schematic/topology:



Benefits

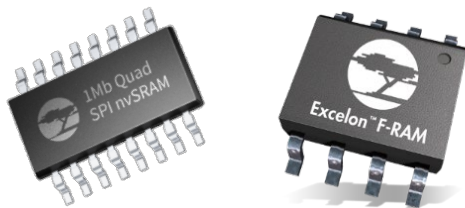
- Cortex M0 offers enhanced diagnose and safety features
- High speed reading for instant on
- EnduraFlex™ allows to partition the NOR Flash, reduced component count and increase reliability
- Functional safety compliant reduces certification time and shorten time-to-market
- Designed for high reliability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

Broad RAM product portfolio to meet performance requirements



F-RAM	MoBL® SRAM	nvSRAM	FAST SRAM	HyperRAM™
<ul style="list-style-type: none"> 4Kbit to 16Mbit Serial and Parallel interface Instant non-volatility Optimized solution for low-power data-logging 	<ul style="list-style-type: none"> 256Kbit to 64Mbit Access time: 45 ns – 70 ns SER < 0.1 FIT/Mbit Ultra-low standby currents for extending battery life 	<ul style="list-style-type: none"> 64Kbit to 16Mbit Access time: 20 ns – 45 ns Unlimited endurance Optional features including RTC, timer and alarm 	<ul style="list-style-type: none"> 256Kbit to 32Mbit Access time: 10 ns – 15 ns SER < 0.1 FIT/Mbit Optimized solution for a high-speed cache memory 	<ul style="list-style-type: none"> 64Mbit to 128Mbit Serial HyperBus™ & xSPI Up to 400 MB/s speeds Ideal solution for a high-speed serial buffer memory

Persistent RAM Solutions for Industrial Motor Drives: NVRAM

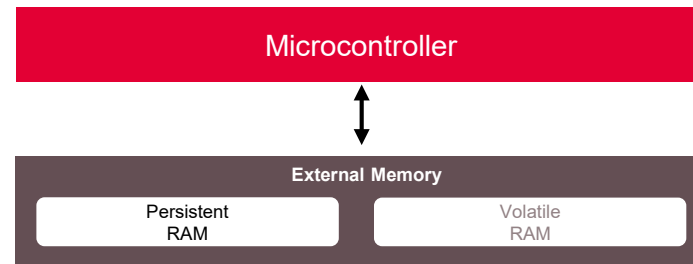


Key features

- › **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



Exemplary schematic/topology:



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

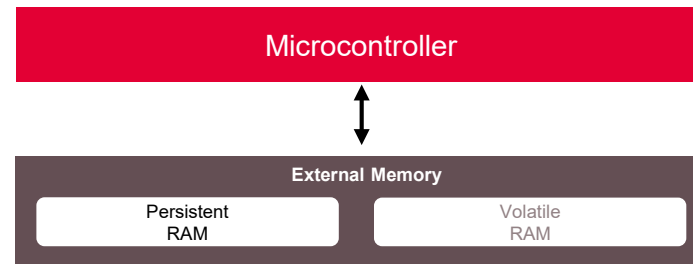


Key features

- › **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



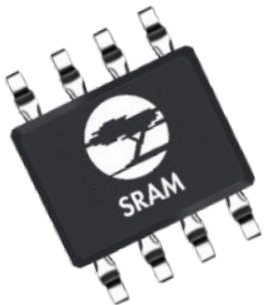
Exemplary schematic/topology:



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

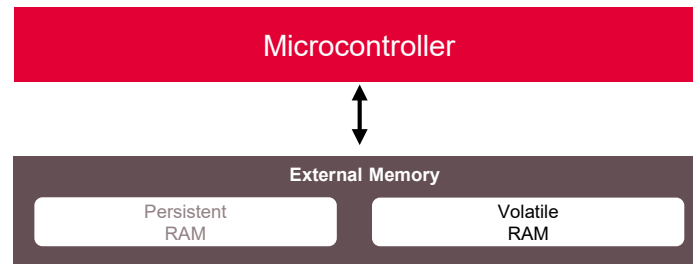


Key features

- › **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™

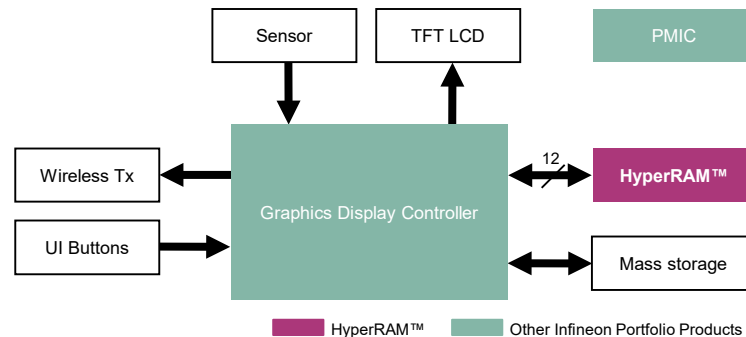


Key features

- › **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

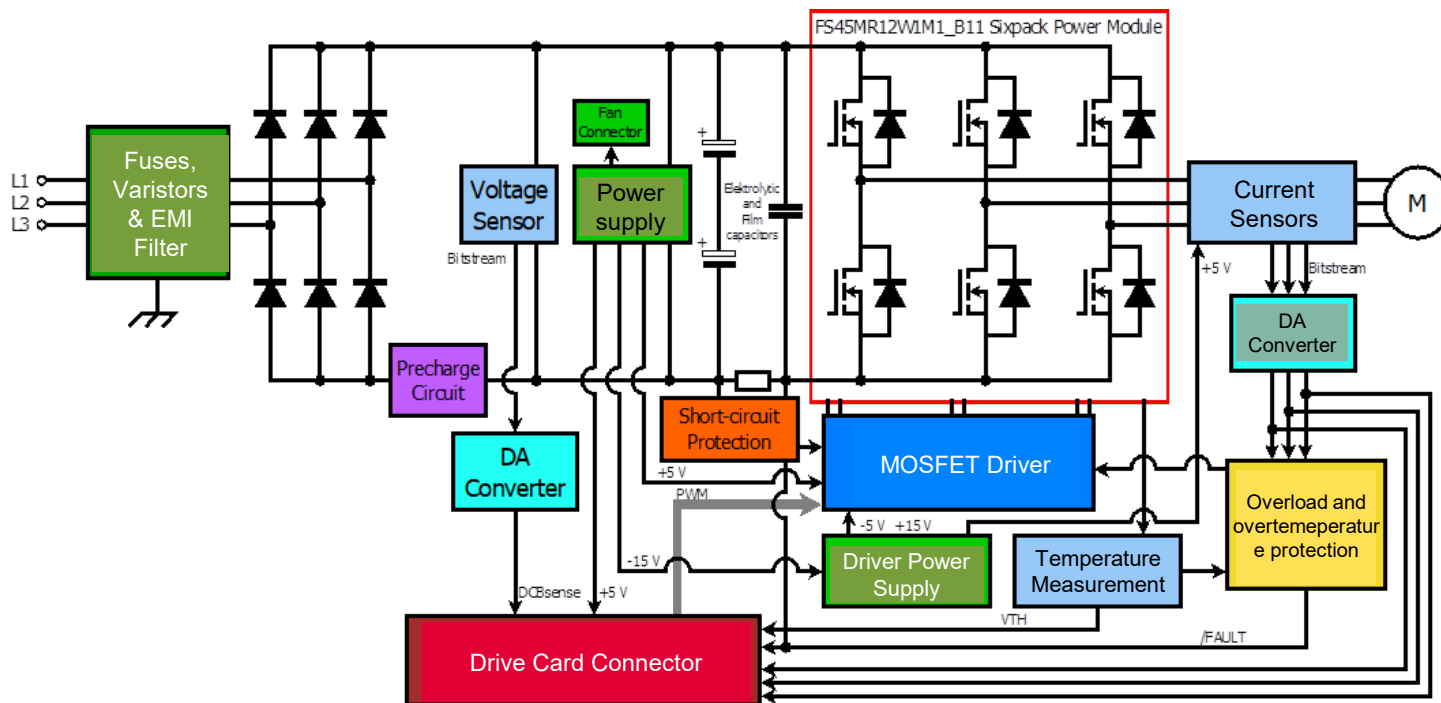


Exemplary schematic/topology:



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

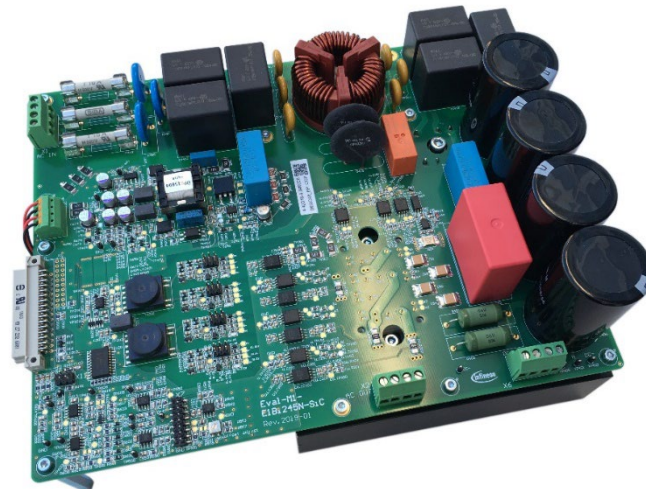


Modular Application Design Kit (MADK)

CoolSiC™ MOSFET evaluation board for industrial drives

Parameters	Values	Conditions / Comments
Including FS45MR12W1M1_B11 & 1EDI20H12AH		
Input		
Voltage	340 – 480 V _{rms}	
Current	16 A _{rms}	Input 400 V _{AC} , T _a = 25 °C
DC bus voltage	530 V – 670 V typ.	
Switching frequency	18 kHz nom 100 kHz max	
Output		
3ph P _{out} with mains line choke	11 kW max	Input 400 V _{AC} , f _{sw} = 18 kHz, T _a = 25 °C, T _h = 70 °C, forced convection cooling
3ph P _{out} without mains line choke	6 kW	Input 400 V _{AC} , f _{sw} = 18 kHz, T _a = 25 °C, T _h = 70 °C, forced convection cooling, limited by input current
Current per leg at f _{sw_nom}	16 A _{rms}	Input 400 V _{AC} , f _{sw} = 18 kHz, T _a = 25 °C, T _h = 70 °C, forced convection cooling
Current per leg at f _{sw_max}	8 A _{rms}	Input 400 V _{AC} , f _{sw} = 100 kHz, T _a = 25 °C, T _h = 70 °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

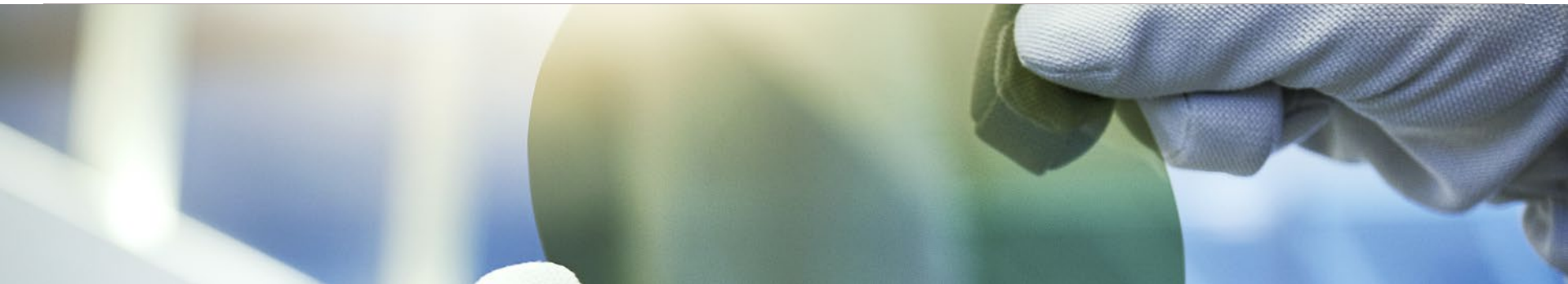


[Link to product page](#)

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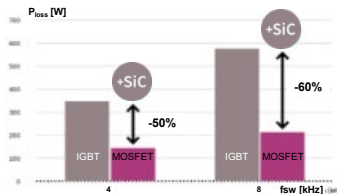
1	Introduction	3
2	A closer look on inverter solutions	6
3	Product solutions overview	13
4	Benefits with Silicon Carbide solutions (SiC)	71
5	IGBT7 technology – features and benefits	74
6	Key take-aways	79
7	Further information and links	81

Benefits with SiC solutions for industrial drives



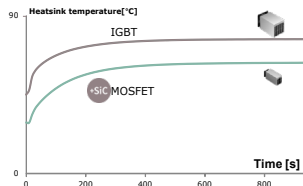
Increased performance

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



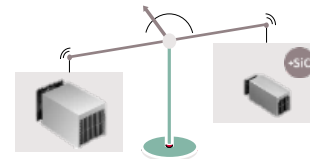
Higher robustness

- › 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



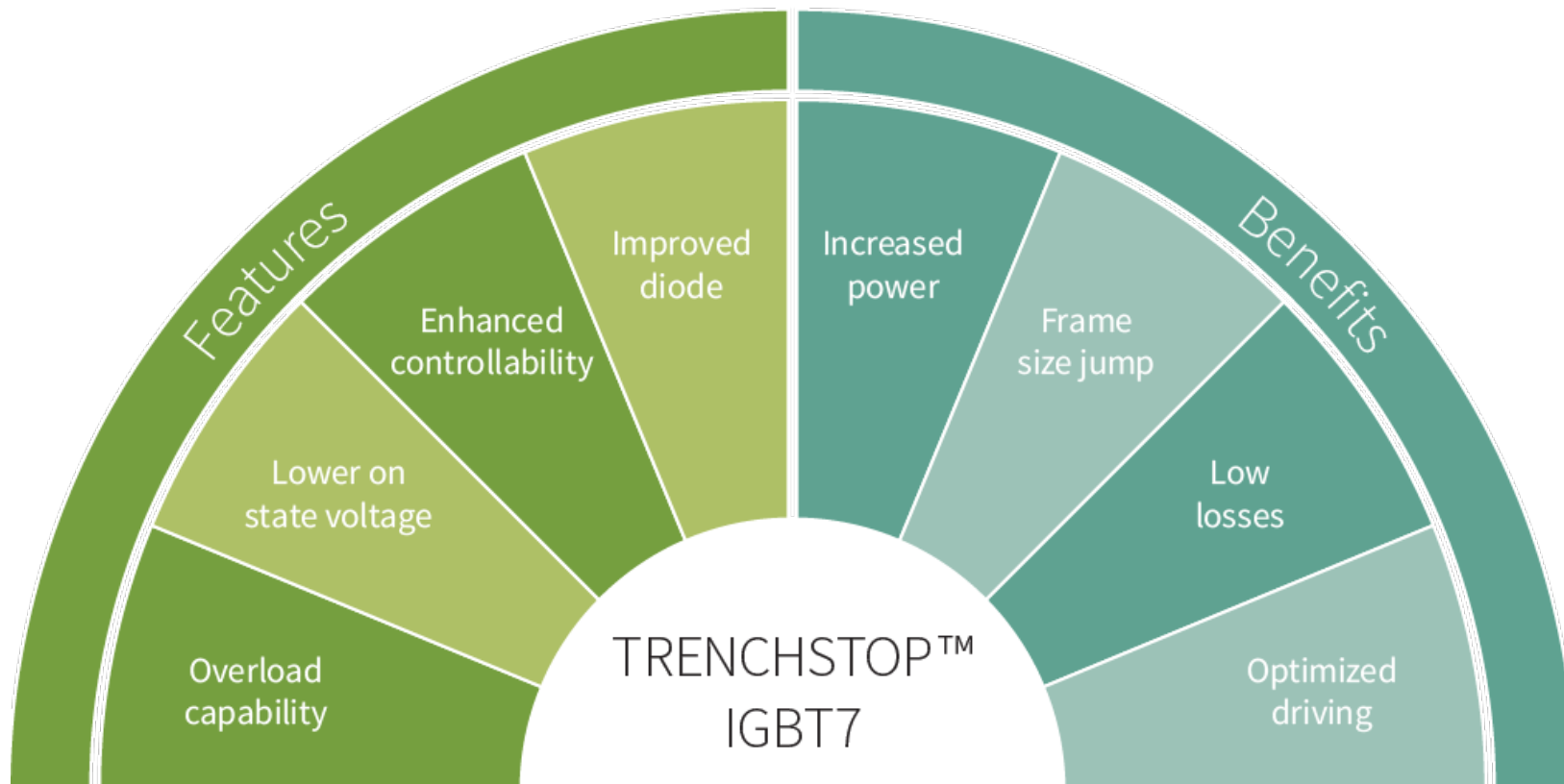
No more need for a cooling fan since passive cooling is sufficient, therefore reducing your maintenance effort to a minimum.



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3	Product solutions overview	13
4	Benefits with Silicon Carbide solutions (SiC)	71
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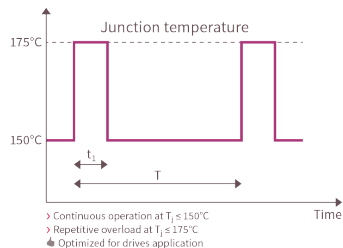
Features and benefits of TRENCHSTOP™ IGBT7



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.



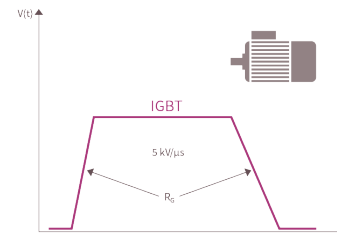
On state voltage

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.



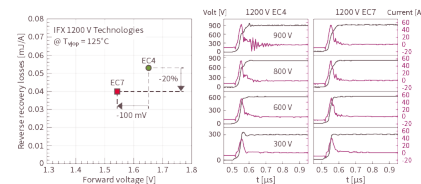
Controllability

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).

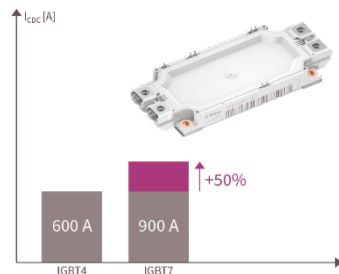


Improved diode

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

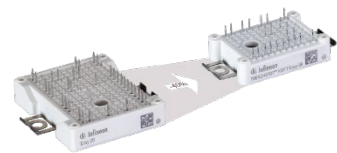


Increased power

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.

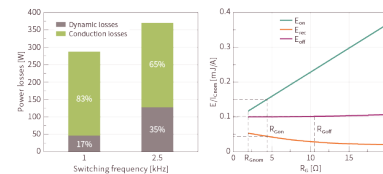
Frame size jump

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.



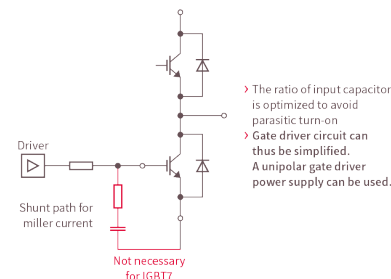
Low losses

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.



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).



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](#)



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