IFX solution for consumer robotics

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Agenda

1. Market overview
2. Infineon´s system solution
3. Product highlights
4. Summary
5. Support material

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Vacuum cleaners in the past…

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Vacuum cleaners nowadays…

Now, owing to my little helper - the robotic vacuum cleaner, I can spend my time enjoying the important things of life!

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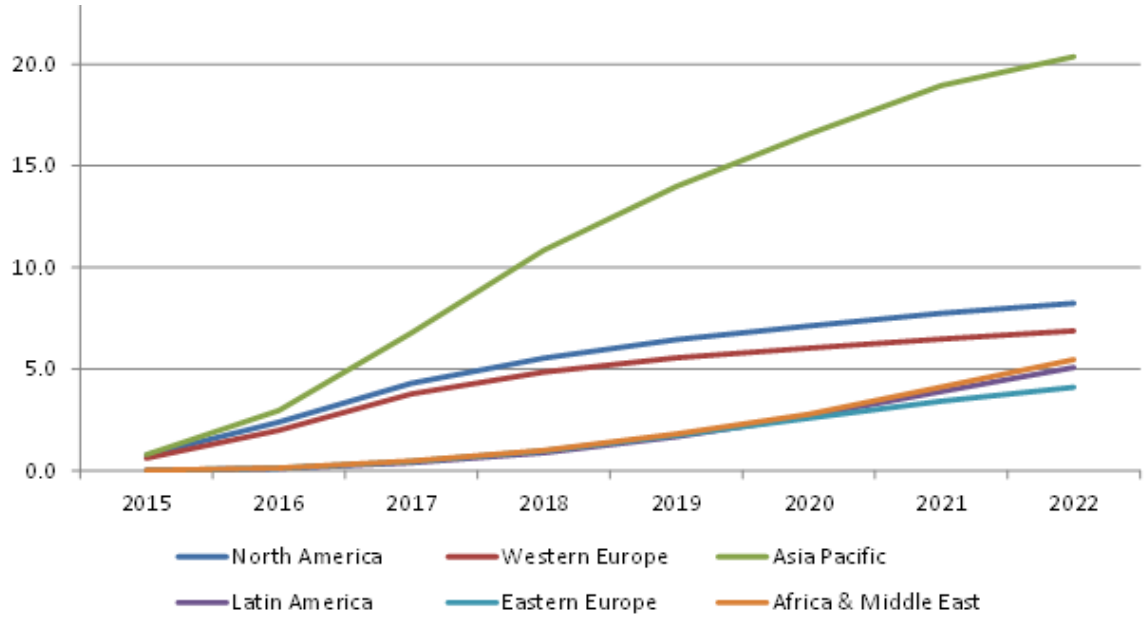
Total global drone shipments

Global drone shipments 2015 – 2022 (in Millions of units)



Strategy Analytics: Drones: Total Global Consumer & Enterprise Drone Shipments by Region: 2015 to 2022

- Sales have more than tripled form 2015 to 2016
- Shipments will more than double in 2017
- Drone shipments to exceed 50 million globally by 2022
- Double-digit annual growth rates

Total Global Drone* Shipments by Region (in Millions of units)	2015	2016	2017	2018	2019	2020	2021	2022
North America	0,76	2,38	4,30	5,54	6,45	7,12	7,75	8,23
Western Europe	0,61	1,99	3,77	4,85	5,55	6,03	6,48	6,88
Asia Pacific	0,78	2,96	6,77	10,85	13,99	16,57	18,96	20,37
Latin America	0,01	0,10	0,39	0,88	1,67	2,69	3,89	5,07
Eastern Europe	0,02	0,12	0,45	0,96	1,73	2,58	3,41	4,10
Africa & Middle East	0,02	0,13	0,47	1,00	1,81	2,78	4,12	5,47
Total	2,21	7,68	16,16	24,09	31,19	37,76	44,60	50,12
YtY Growth		**248%**	**110%**	**49%**	**29%**	**21%**	**18%**	**12%**

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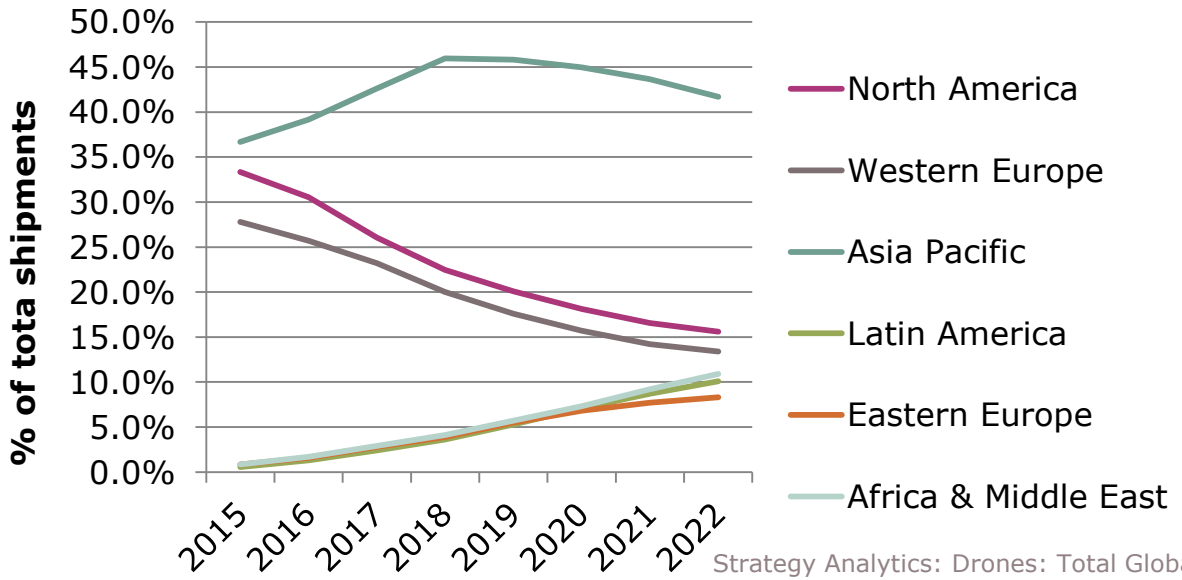
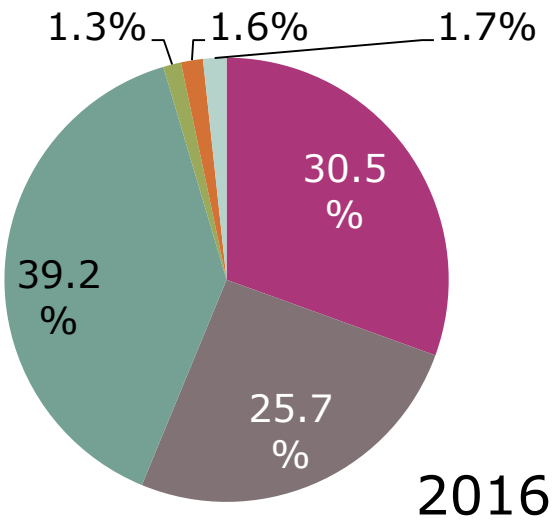
Consumer drones – Regions

- About 8 million consumer drones globally sold in 2016
- Asia Pacific, North America and Western Europe together account for 95 % of drone shipments in 2016
- By 2020, Asian Pacific shipments will account for nearly 42 % of total global volumes
- By 2019, Central & Latin America, Eastern Europe and Africa Middle East will each account for more than 5% of total consumer drone volumes

Consumer drone shipments by region





Strategy Analytics: Drones: Total Global Consumer & Enterprise Drone Shipments by Region: 2015 to 2022

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Drones trends in general

Agriculture

Air delivery drones

Drone racing and adoption of photography drones

Virtual and augmented reality

Multirotor drones for law enforcement

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Personal service robots

1

North America:

- 39% market share
- 14% CAGR (2016-2022)

Japan:

- Market leader for humanoid personal robots

2

Asia Pacific:

- Quickly growing
- 2017: 44% market share surpassing North America
- 35% CAGR (2016-2022)
- Market drivers: edutainment robots, but also household robots

3

Western Europe:

- 22% market share
- 16% CAGR (2016-2022)

Strong growth comes from edutainment robots

Global Personal Service Robot Sales (Millions of Units)	2014	2015	2016	2017	2018	2019	2020	2021	2022
North America	2,6	3,0	3,4	3,9	4,4	5,0	5,7	6,5	7,5
Western Europe	1,4	1,6	1,9	2,2	2,6	3,0	3,4	4,0	4,6
Asia Pacific	1,2	2,2	3,4	5,0	7,0	9,6	12,6	16,2	20,1
Central & Latin America	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,2	0,4
Central & Eastern Europe	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,2	0,4
Africa Middle East	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,2
Total	5,3	6,8	8,7	11,1	14,0	17,7	22,1	27,3	33,2

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Personal service robots
Market overview

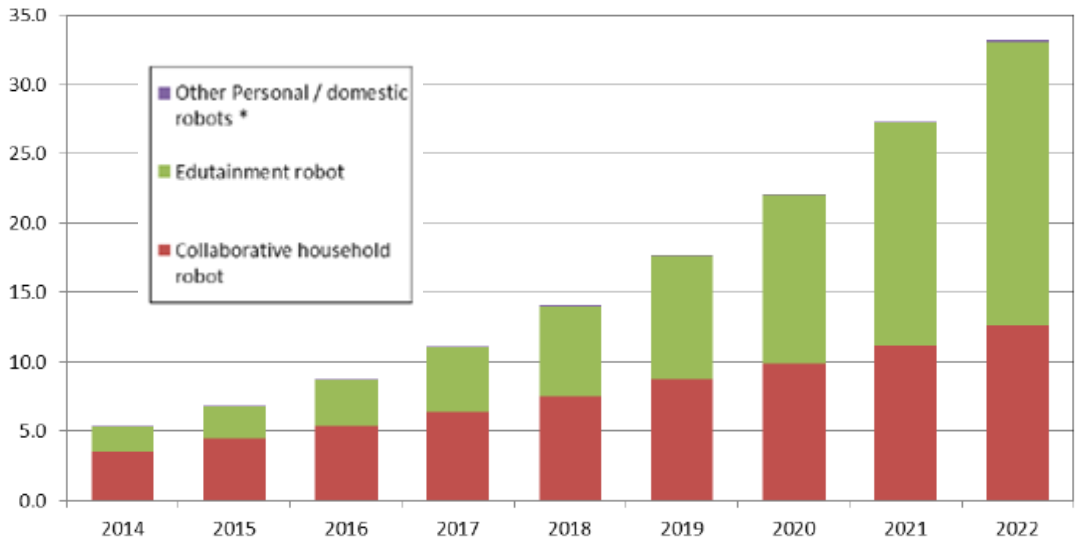
Personal service robots = 99% of all service robots in 2016

Global personal service robot sales by type (millions of units)

Personal service robots
- 99% of all service robots in 2016 (8.8 million sales)
- 26% CAGR
- 30 million units by 2022

Collaborative household robots
- biggest sub segment (62% global share)
- 16% CAGR
- 5.4 million sales in 2016
- >12 million sales by 2022

Edutainment robots
- surpass collaborative household robots in 2019
- 3.3 million sales in 2016
- > 20 million sales by 2022



Source: Emerging Device Strategies (EDS) service

Global Personal Service Robot Sales (YoY Growth)	2014	2015	2016	2017	2018	2019	2020	2021	2022
Collaborative household robot (excl DVADs)	~	28,6 %	20,0 %	18,5 %	17,2 %	16,7 %	13,1 %	13,1 %	12,5 %
Edutainment robot	~	30,7 %	43,5 %	41,8 %	38,9 %	36,9 %	36,0 %	32,2 %	28,1 %
Other Personal / domestic robots *	~	140,0 %	66,7 %	65,0 %	36,4 %	31,1 %	25,4 %	18,9 %	17,0 %
Total	~	29,4 %	28,0 %	27,4 %	26,4 %	26,1 %	24,6 %	23,6 %	21,7 %

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Trends and market drivers

Primary accelerators

Artificial Intelligence
Smartphone control
Cloud connectivity

Companion/assistant/humanoid robots

- powered by advanced AI
- Provide entertainment, social networking, telepresence, voice controlled web searching
- Act as a music player, fitness tracker, kitchen helper…
- High potential: new facial recognition algorithms to tell what mood the robot´s owner is in

Edutainment robots:

- New interactive educational companion robots
- Increasingly popular among children and young adults
- An entire industry of programs and apps will grow around these devices to download and add extra features

Other sub segments

- like robotized wheelchairs, personal aid and assistance for elderly, home security and surveillance rather small but growing at a combined CAGR of 31% until 2022.

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Infineon's industrial microcontrollers, power and sensor components complement each other

Power MOSFETs
Microcontroller
Driver ICs
Sensors

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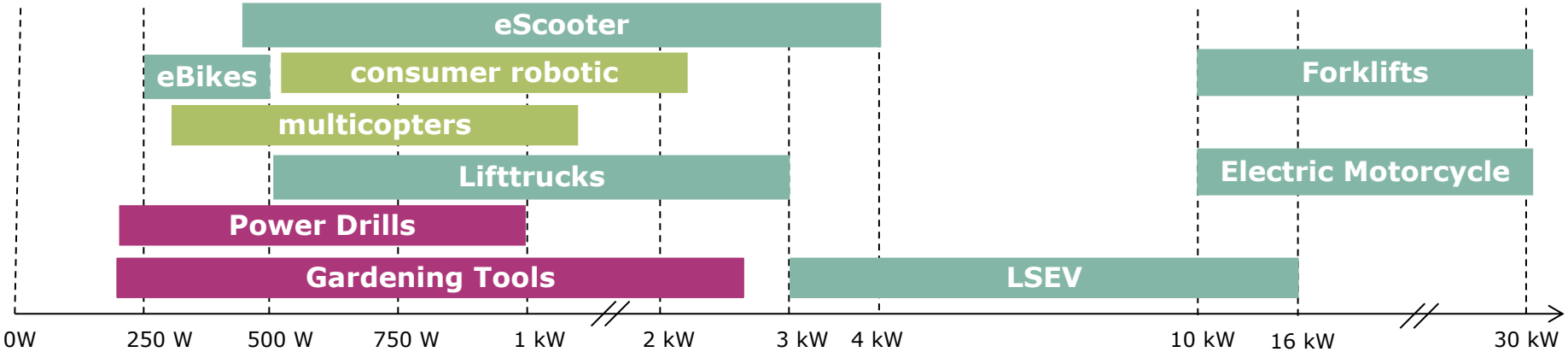
Scope
Battery powered applications

Low Power		High Power
Home & Professional	**Consumer Robotics**	**Light Electric Vehicle**
power tools, gardening tools, commercial multicopters, cordless home appliance, cordless vacuum cleaners, healthcare equipment	Consumer multicopters, vacuum robots, RC toys, service robotics, household robotics and other consumer robots	eScooter, eBike, electric wheelchair, electric forklift, low speed cars (LSEV), electric motorcycle, other battery vehicles



Continuous power

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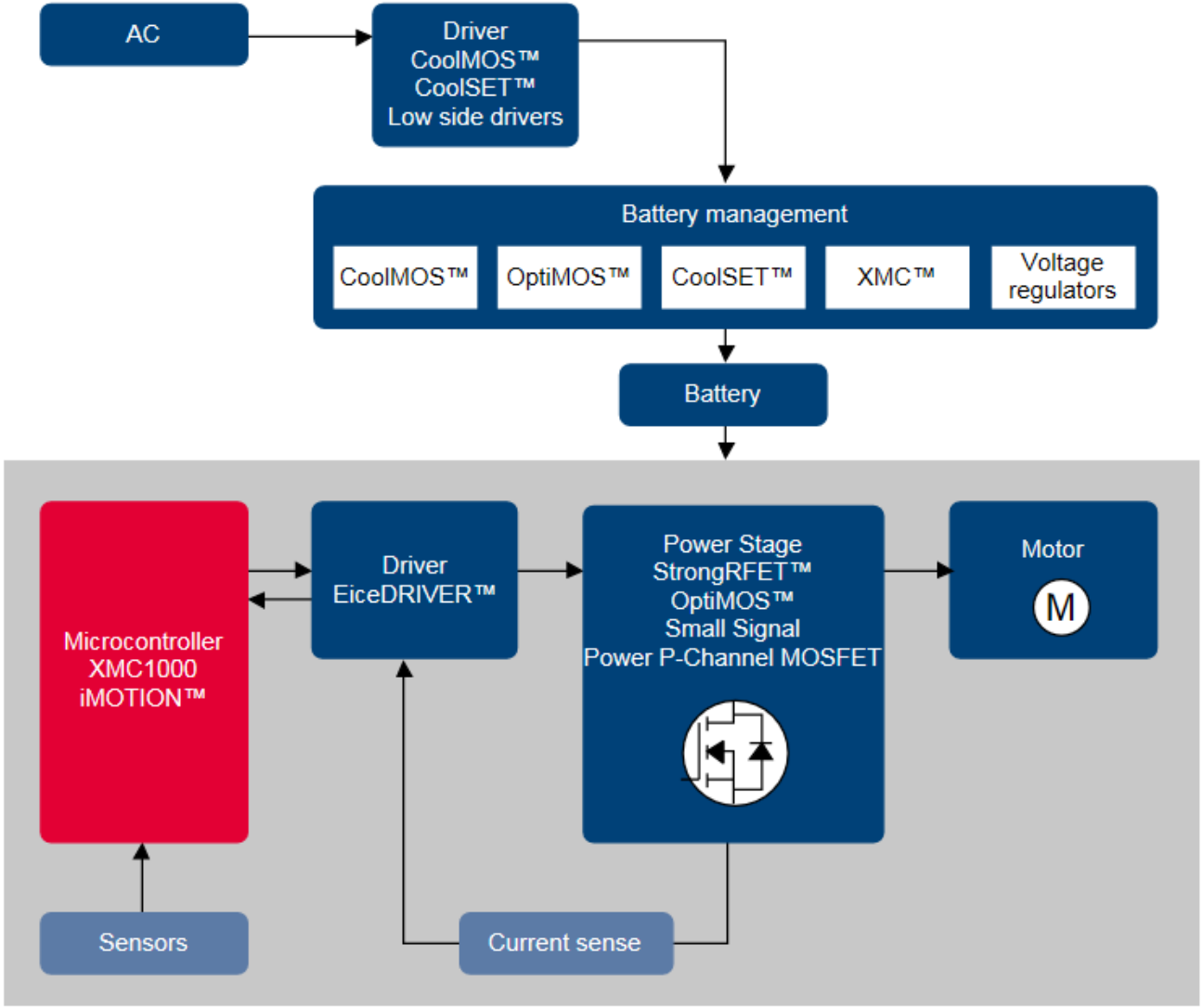
Typical system solution for service robotics



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Infineon´s product solutions for robotic vacuum cleaners and lawn mowers

Infineon Product Offering		Robotic Vacuum Cleaners	Robotic Lawn Mowers
Supply Voltage		7.2 V - 24 V	18 V – 36 V
MOSFET OptiMOS™ StrongIRFET™	**Voltage**	25 V - 40 V	30 V – 60 V
	Package	PQFN 3x3 SuperSO8 5x6 DPAK DirectFET™ S/M-Can	SuperSO8 DPAK DirectFET™ S/M/L-Can D2PAK
CoolMOS™ CE / P6	**Voltage**	500 V – 650 V	500 V – 650 V
	Package	TO220, TO220FP	TO220, TO22FP
Driver ICs EiceDRIVER™C		6EDL04N02PR, 2EDL05N06*, 2EDL23N06, IRS200x, IRS2187, IRS2301, IR2136x	6EDL04N02PR, 2EDL05N06*, 2EDL23N06, IRS200x, IRS2187, IRS2301, IR2136x
Microcontroller XMC iMotion		XMC 1000 IRMCK099M	XMC 1000 XMC 4000
Sensors		TLI496x, TLV4961, TLE5009, TLI5012B	TLI496x, TLV4961 TLE5009, TLI5012B
Battery charger (primary side)		CoolSET .dp	CoolSET .dp
Voltage regulators		IFX1763, IFX54211	IFX1763, IFX54211
Small Signal MOSFET (Both P & N channels)	**Voltage**	20 V,30 V & 60 V	30 V & 60 V
	Packages	TSOP6, SC59/SOT23, SOT363	SOT223,TSOP6,SC59/SOT23
Power P-channel	**Voltage**	20 V, 30 V & 60 V	30 V & 60 V
	Packages	PQFN 3x3, SuperSO8, DPAK	PQFN 3x3, SuperSO8, DPAK

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DirectFET™
The optimum power MOSFET package

Strong	More power with OptiMOS™ and StrongIRFET™
Easy	Control method enabled by microcontrollers (XMC™) & GUI quick software implementation through DAVE™ apps
Quiet	Motor control by powerful microcontrollers (XMC™) and sensors
Light	Lowest $R_{DS(on)}$ allows for the highest power density and reduces weight of cooling elements. Small Signal & PowerFETs
Design	Low overshoot, high current capabilities, compact packaging enabled by Small Signal & PowerFETs

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Infineon's industrial microcontrollers, power and sensor components complement each other

Small signal MOSFET

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Small signal MOSFETs

Typical small signal MOSFET application areas

Packages

4.5 x 4.0 x 1.5 mm

6.5 x 7.0 x 1.6 mm

2.9 x 2.5 x 1.1 mm

3.0 x 2.8 x 1.1 mm

2.9 x 2.4 x 1.0 mm

2.0 x 2.1 x 0.9 mm

2.0 x 2.1 x 0.9 mm

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Small signal MOSFET overview

Polarity	**N-Channel Enhancement / N-Channel Depletion** **P-Channel Enhancement with and without ESD protection**						
V_{DS} range	from -250 V up to 800 V						
Configuration	Single, dual and complementary						
Gate drive voltage	1.8 V (ULL), 2.5 V (SLL), 4.5 V (LL), 10 V (NL)						
Packages	SOT-223	SOT-89	TSOP-6	SC59	SOT-23	SOT-323	SOT-363
Qualification	Automotive AEC Q101 (except where indicated)						

ULL: Ultra Logic Level
SLL: Super Logic Level
LL: Logic Level
NL: Normal Level

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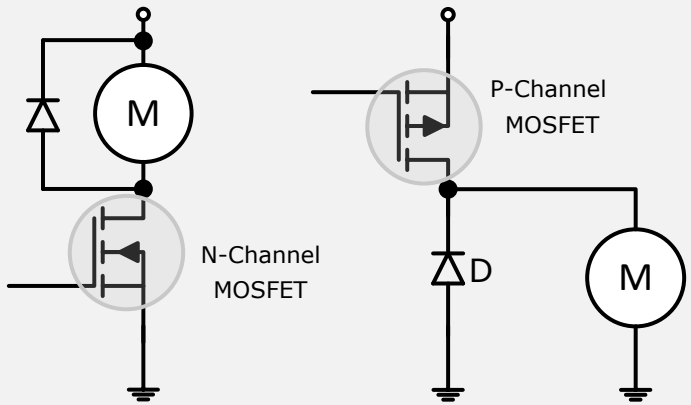
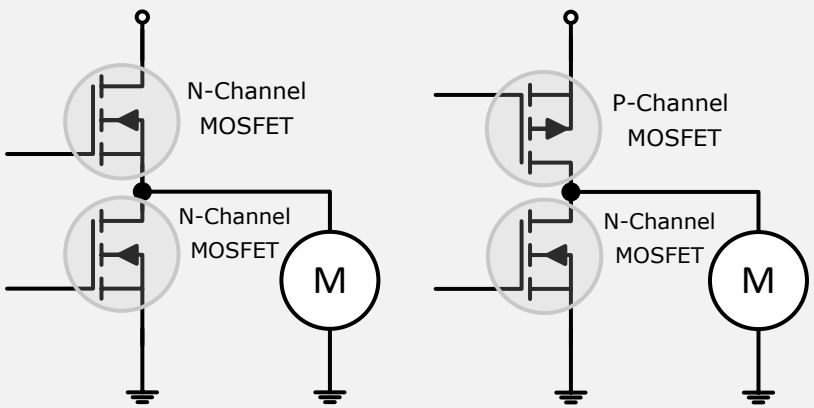
Low voltage drives



N-Channel Examples		
IFX Part	Package	Parameters
IRLML6244	SOT-23	20 V LL 21.0 mΩ
BSL202SN	TSOP-6	20 V SLL 22.0 mΩ
BSR802SN	SC59	20 V ULL 23.0 mΩ
BSS606N	SOT-89	60 V LL 60.0 mΩ
BSP373N	SOT-223	100 V NL 240.0 mΩ



P-Channel Examples		
IFX Part	Package	Parameters
BSL207SP	TSOP-6	-20 V LL 41.0 mΩ
IRLML2244	SOT-23	-20 V LL 54.0 mΩ
BSS308PE	SOT-23	-30 V LL 80.0 mΩ
BSP612P	SOT-223	-60 V LL 130.0 mΩ

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Small signal MOSFETs
Features and benefits

Key features

- Most products qualified to AEC Q101
- Four $V_{GS(th)}$ classes
- ESD protected P-Channel parts
- V_{DS} range -250 V to 800 V
- RoHS compliant and halogen free

Technical benefits

- Easy interface to MCU
- Improved efficiency at low loads due to low Q_g
- Fast switching

Customer benefits

- Suitable for automotive and high quality demanding applications
- Reduction of design complexity
- Industry standard small outline packages

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Infineon's industrial microcontrollers, power and sensor components complement each other

Low Voltage MOSFETs
OptiMOS™ & StrongIRFET™

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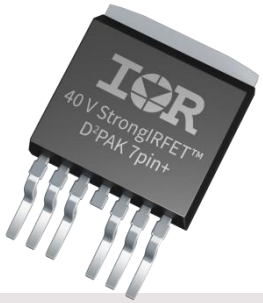
OptiMOS™ and StrongIRFET™ family attributes

OptiMOS™	StrongIRFET™
Designed for high performance applications	Designed for industrial applications
Ultra-low $R_{DS(on)}$	Low $R_{DS(on)}$
Ideal for high switching frequency	Ideal for low switching frequency
Provide best-in-class and price/performance products	3.0 V Threshold voltage 4.5 V Logic level available
Industry's best figure of merit	High current carrying capability
High efficiency and power density	Rugged silicon



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A powerful MOSFET combination

Best in class technology **OptiMOS™**

Robust, price/performance ratio **StrongIRFET™**

- **Expanded product portfolio 20 V – 300 V**
- **Able to address a larger range of customer needs**

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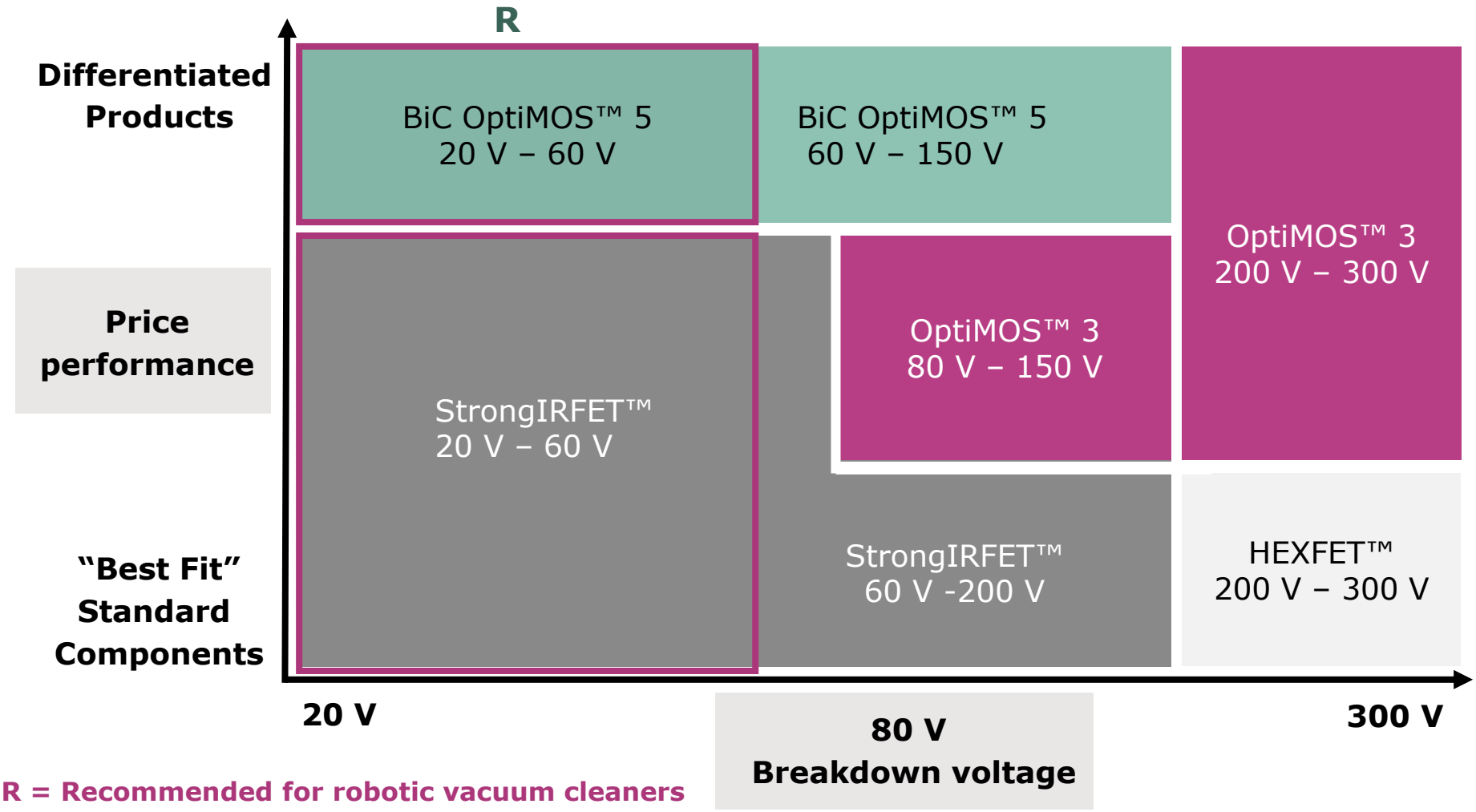
OptiMOS™ vs. StrongIRFET™ positioning low frequency applications < 100 kHz



R = Recommended for robotic vacuum cleaners

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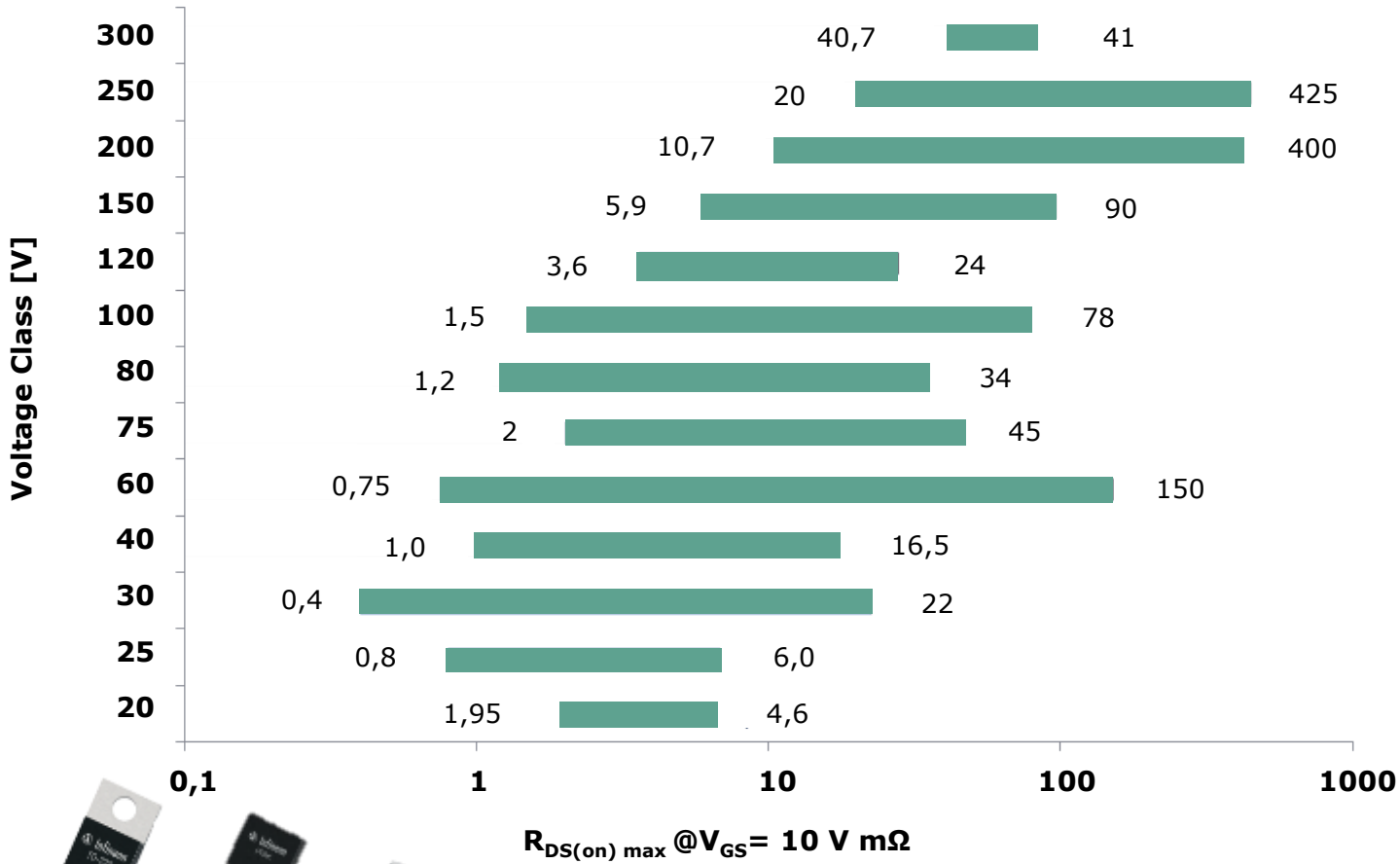
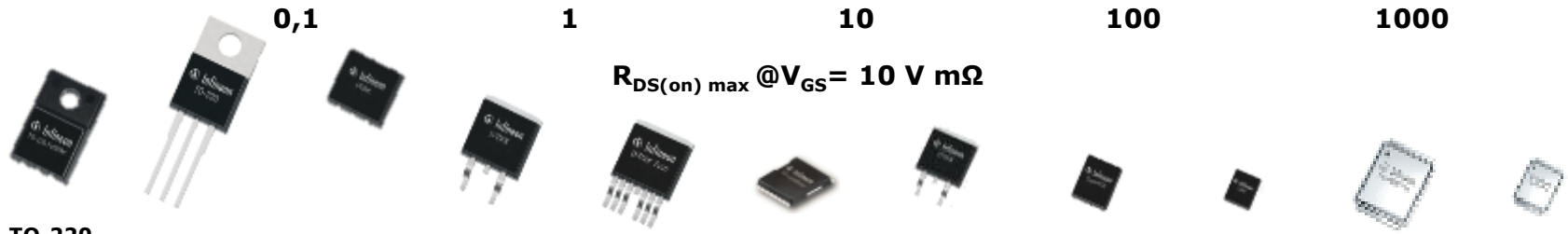
OptiMOS™ products by voltage class & $R_{DS(on)}$ max. in various packages





TO-220 FullPAK	TO-220	I²PAK	D²PAK	D²PAK 7Pin	TO-Leadless	DPAK	SuperSO8	PQFN 3.3x3.3	CanPAK™ M	CanPAK™S
202 mm²	201 mm²	155 mm²	153 mm²	153 mm²	115.8 mm²	66 mm²	31.7 mm²	10.9 mm²	30.9 mm²	18.2 mm²

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OptiMOS™ 5 40 V and 60 V Features and benefits

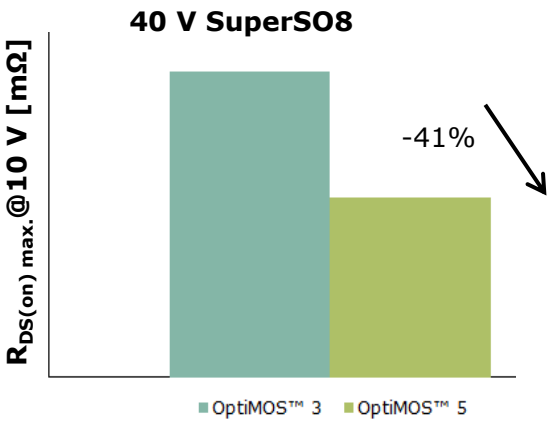
Features

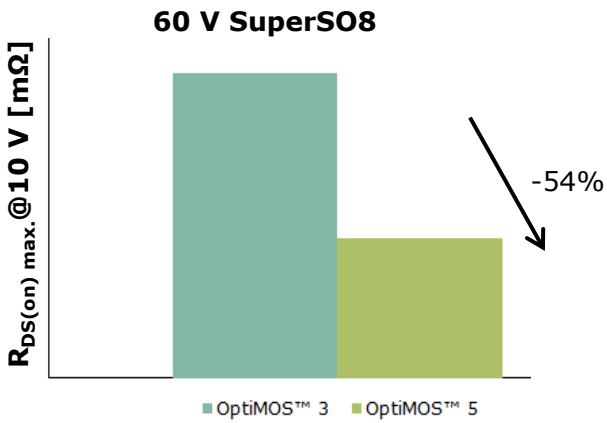
- Optimized for synchronous rectification
- $R_{DS(on)}$ up to 54% lower than OptiMOS™ 3
- FOM_g up to 55% lower than OptiMOS™ 3
- Integrated Schottky-like diode
- RoHS compliant, halogen free
- MSL1 rated

Key benefits

- Highest system efficiency
- Less paralleling required
- Increased power density
- Very low voltage overshoot
- Reduced need for a snubber circuit
- System cost reduction
- Reduction of engineering costs and effort

Lower $R_{DS(on)}$ in OptiMOS™ 5 compared to previous generation





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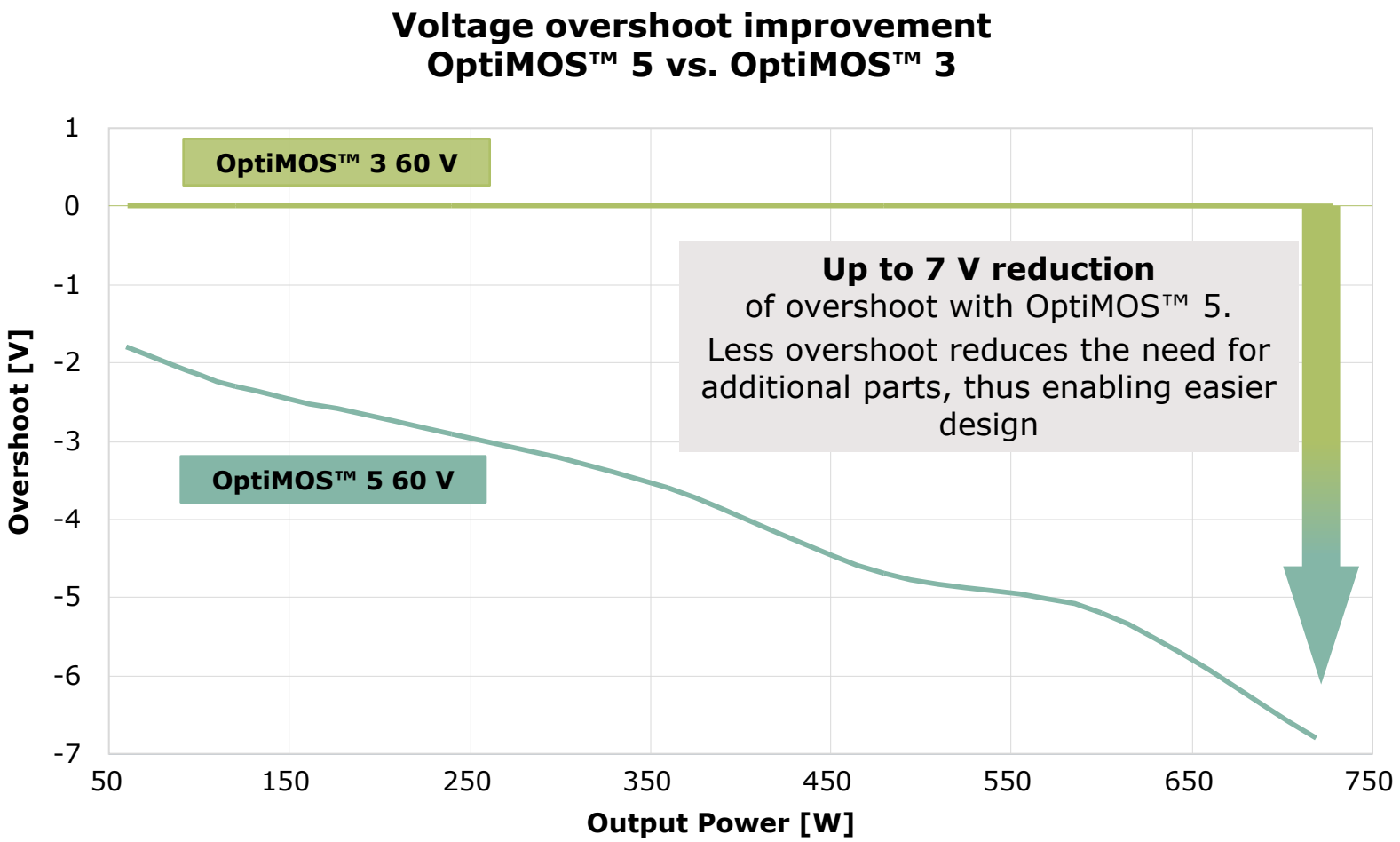
OptiMOS™ 5 60 V easy-to-use products



IPP032N06N3
IPP029N06N5

Conditions: 12 V-750 W server PSU, 140 kHz switching frequency, phase shifted full bridge, current doubler rectifier

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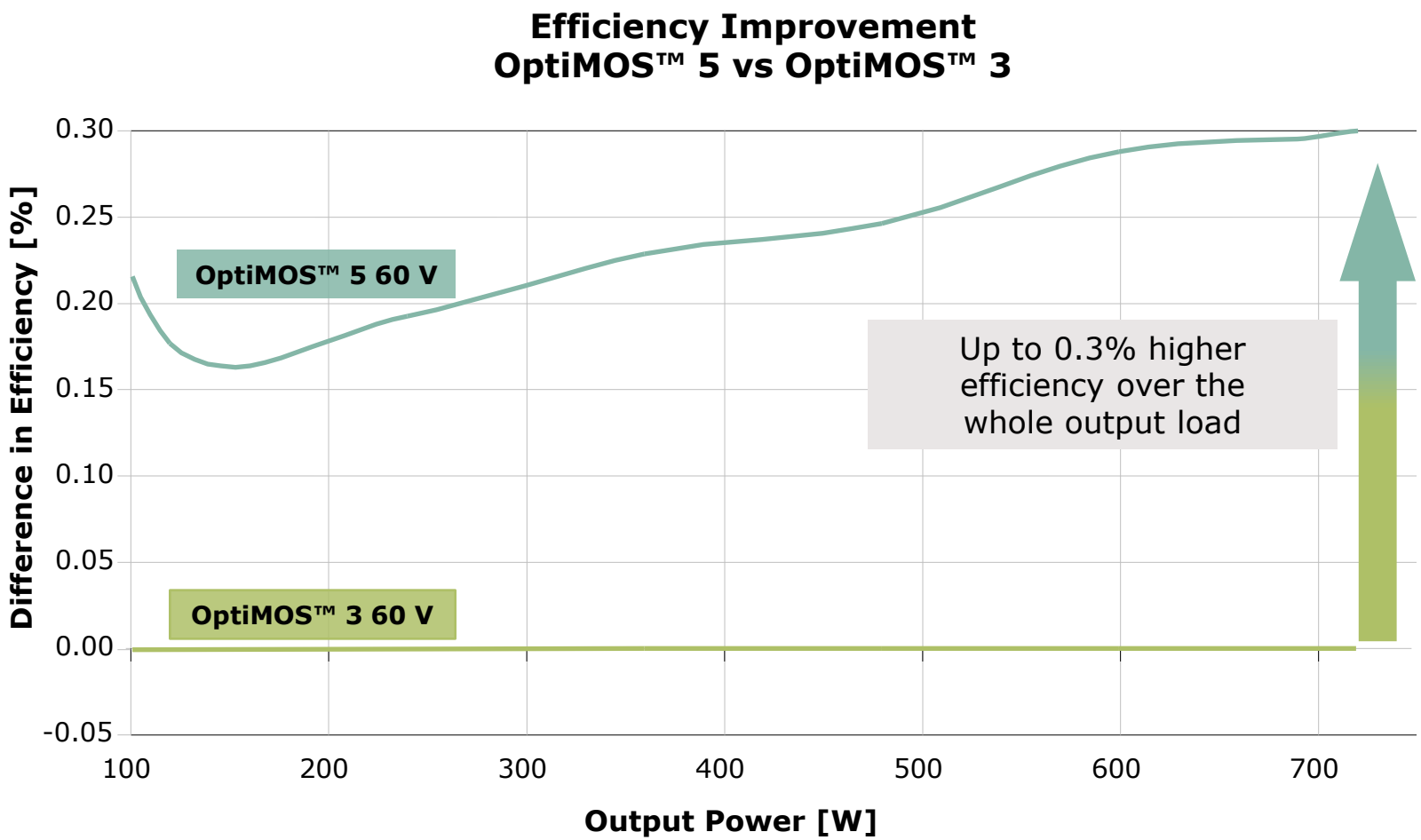
OptiMOS™ 5 60 V highest efficiency



IPP032N06N3
IPP020N06N5

Conditions: 12 V-750 W server PSU, 140 kHz switching frequency, phase shifted full bridge, current doubler rectifier

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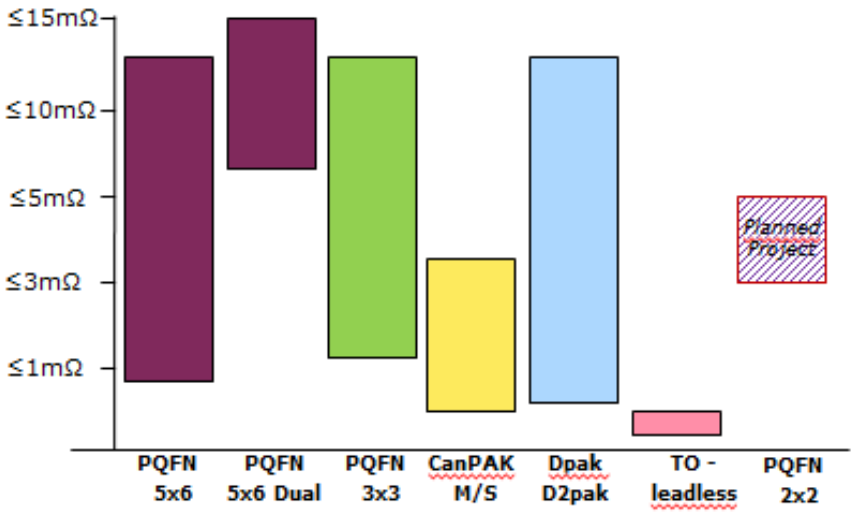
New low voltage OptiMOS™5 (25 V/ 30 V)

- Industrial benchmark **highest efficiency** (from 0.7% to 1.5% better than OptiMOS™)
- Best-in-class **on-state resistance** S3O8 and **highest power density** (0.5 mOhm better than OptiMOS™)
- **Power block** (new package technology) with **optimized layout and thermal capability** (source down) products available (not available in OptiMOS™)
- **Benchmark switching performance** (lowest Figure of Merits Ron x Q_g and Ron x Q_{gd}) 30% better than OptiMOS™

PL12 Product Portfolio (25 V/ 30 V)



Reduction of performance relevant figure of merits (Q_g, Q_{gd},..) up to 30%	Reduces power losses -> significant improvement in efficiency
Reduction of switching losses (Qswitch) of ~50%	Enables operation at high switching frequencies without compromises in efficiency
OptiMOS™ 5 Power block products: source down orientation for low side MOSFET	Big GND pad for better thermal connection to the PCB and higher current capability
Integrated damping network	Optimized EMI behavior and reduction of voltage overshoot

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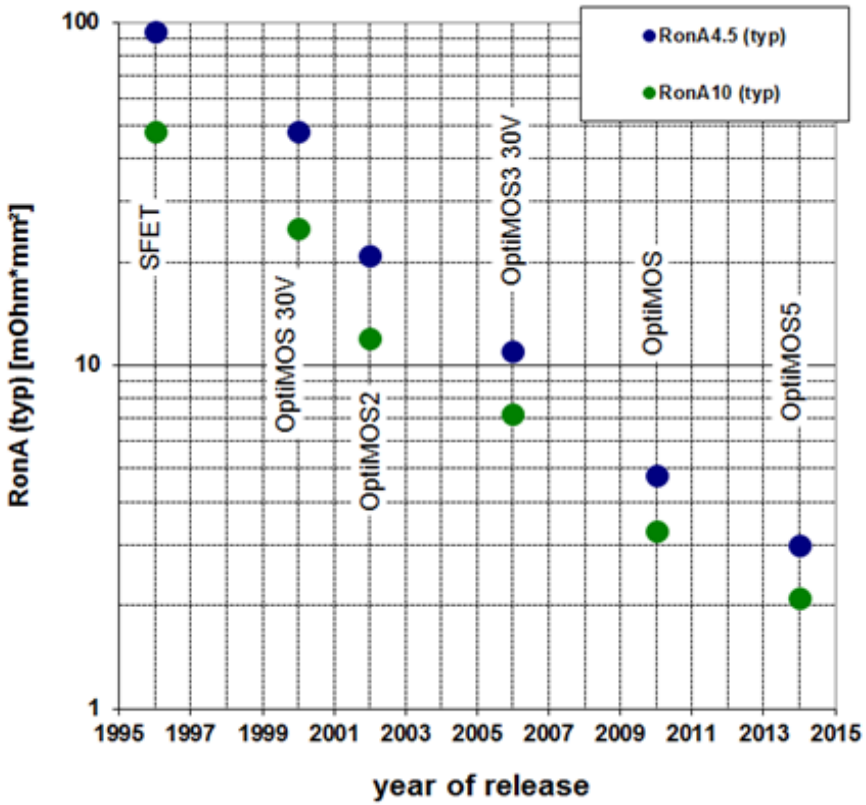
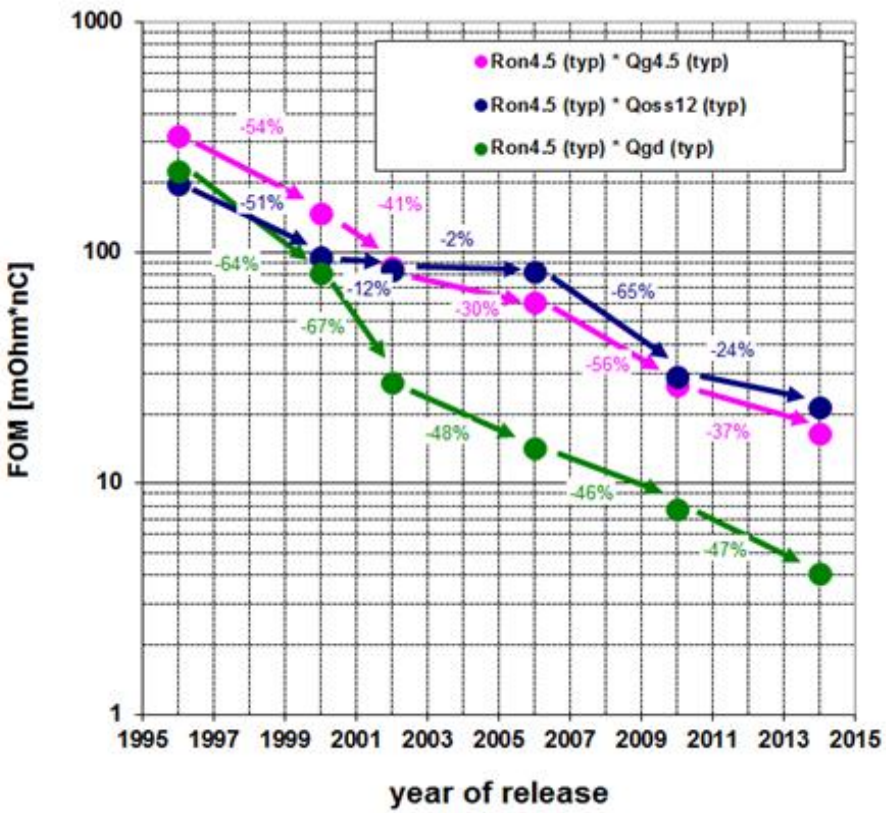
Advancements in OptiMOS™ technology

Specific On-resistance



Gate (QG) and output charge (Qoss)



Enables **smallest devices** to save PCB space and delivers highest efficiency for **best thermal performance and lowest power consumption**

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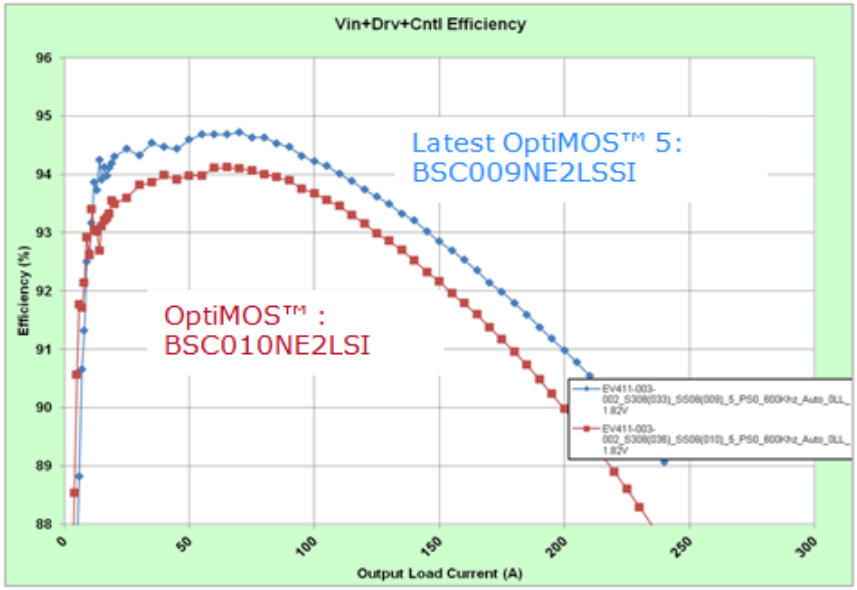
Extended discrete portfolio

Portfolio Outlook OptiMOS™ 5

RDS(on) max @V_{GS}=10V[mΩ]	SuperSO8 25V	S3O8 25V	SuperSO8 30V	S3O8 30V
<2	BSC009NE2LS5 $R_{DS(on)}$=0.9mΩ	BSZ013NE2LS5I $R_{DS(on)}$=1.3mΩ	BSC0500NSI $R_{DS(on)}$=1.3mΩ	BSZ0500NSI $R_{DS(on)}$=1.55mΩ
	BSC009NE2LS5I $R_{DS(on)}$=0.95mΩ	BSZ014NE2LS5IF ** $R_{DS(on)}$=1.45mΩ	BSC0501NSI $R_{DS(on)}$=1.9mΩ	
	BSC015NE2LS5I RDS(on)=1.5mΩ	BSZ017NE2LS5I $R_{DS(on)}$=1.7mΩ		
2-4.4	BSC026NE2LS5 RDS(on)=2.6mΩ	BSZ031NE2LS5 RDS(on)=3.1mΩ	BSC0502NSI $R_{DS(on)}$=2.4mΩ	BSZ0501NSI $R_{DS(on)}$=2.0mΩ
		BSZ033NE2LS5 $R_{DS(on)}$=3.3mΩ	BSC0503NSI $R_{DS(on)}$=3.2mΩ	BSZ0502NSI $R_{DS(on)}$=2.8mΩ
			BSC0504NSI $R_{DS(on)}$=3.7mΩ	BSZ0503NSI $R_{DS(on)}$=3.4mΩ
				BSZ0506NSI $R_{DS(on)}$=4.4mΩ

** optimized for resonant applications (e.g.. LLC converter)

Efficiency comparison OptiMOS™ vs. latest OptiMOS™ 5



Latest MOSFET technology improves efficiency relevant figures of merits by **>30%**
All OptiMOS™5 products do have mass production readiness

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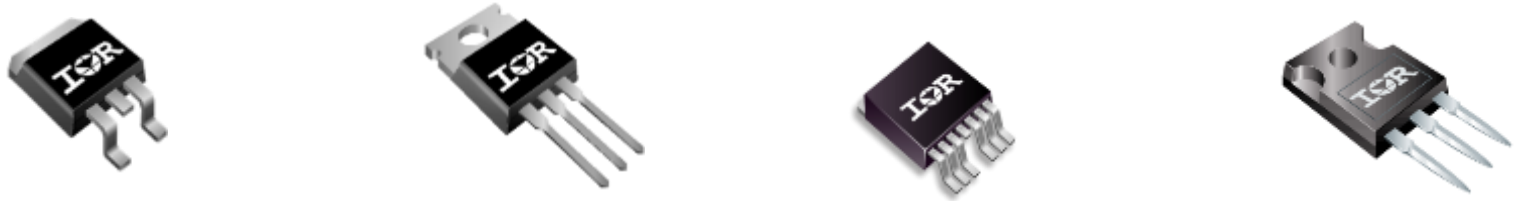
StrongIRFET™ current ratings = reliability

Package	StrongIRFET™ Max Id @ 25C (A)	Comp #1	Comp # 2	Comp # 3
TO220	195	120	120	120
TO247			156	
D2PAK			120	
D2PAK-7	240	180		180

StrongIRFET™ is the only MOSFET Technology that offers **higher max current ratings** than the rest of the market

Benefit: can provide better reliability in designs with high surge currents



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Infineon's industrial microcontrollers, power and sensor components complement each other

High Voltage MOSFETs
CoolMOS™

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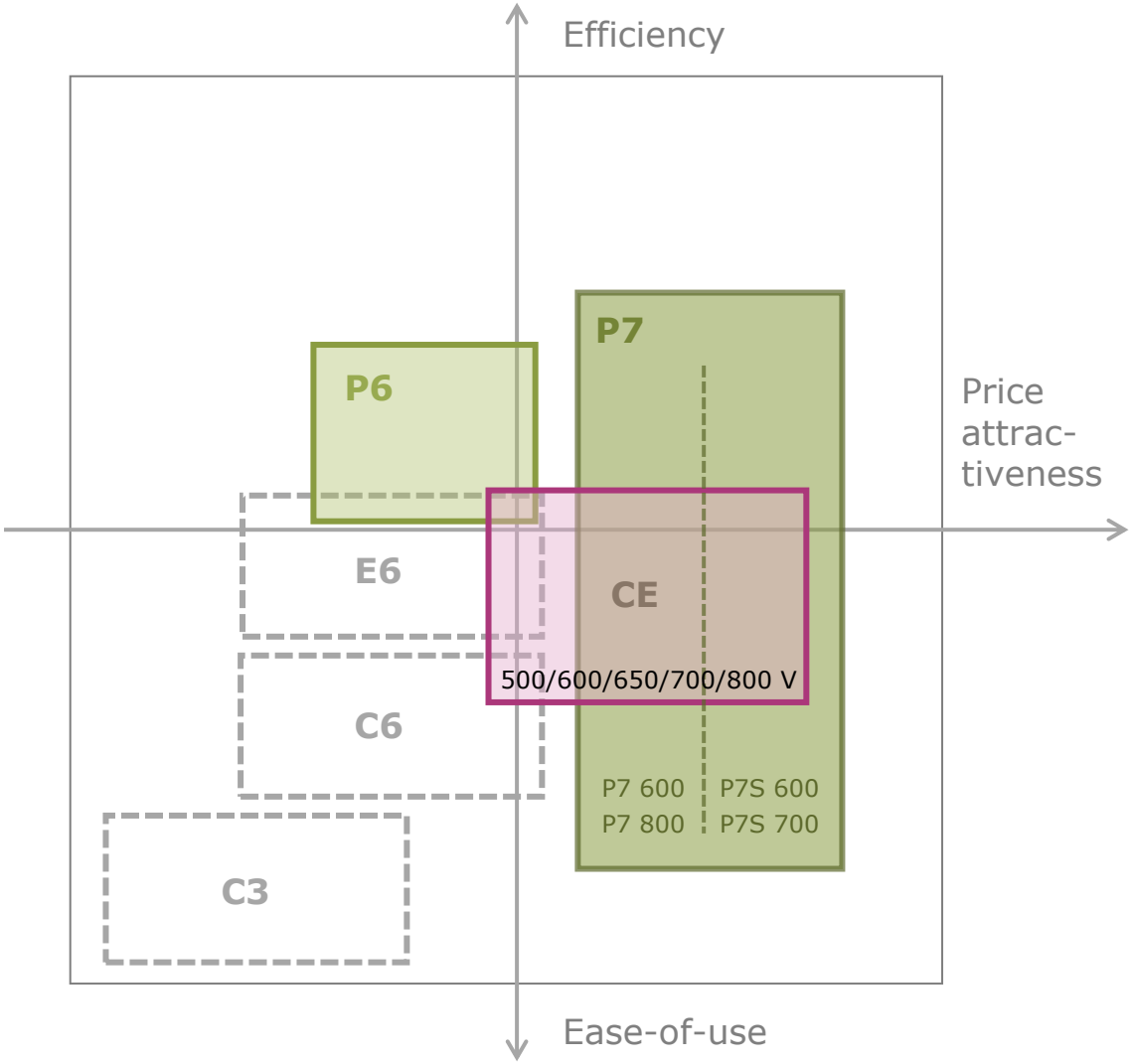
CoolMOS™ product families low power



Why CoolMOS™ CE ?

- **Superjunction device** (SJ): as such it delivers low conduction and switching losses, improves efficiency and ultimately reduces power consumption
- **Attractive price position:** with no compromise on proven CoolMOS™ quality and reliability
- **Fast design-in:** ease of use enables customers to reduce the design in cycle and compete in dynamic markets

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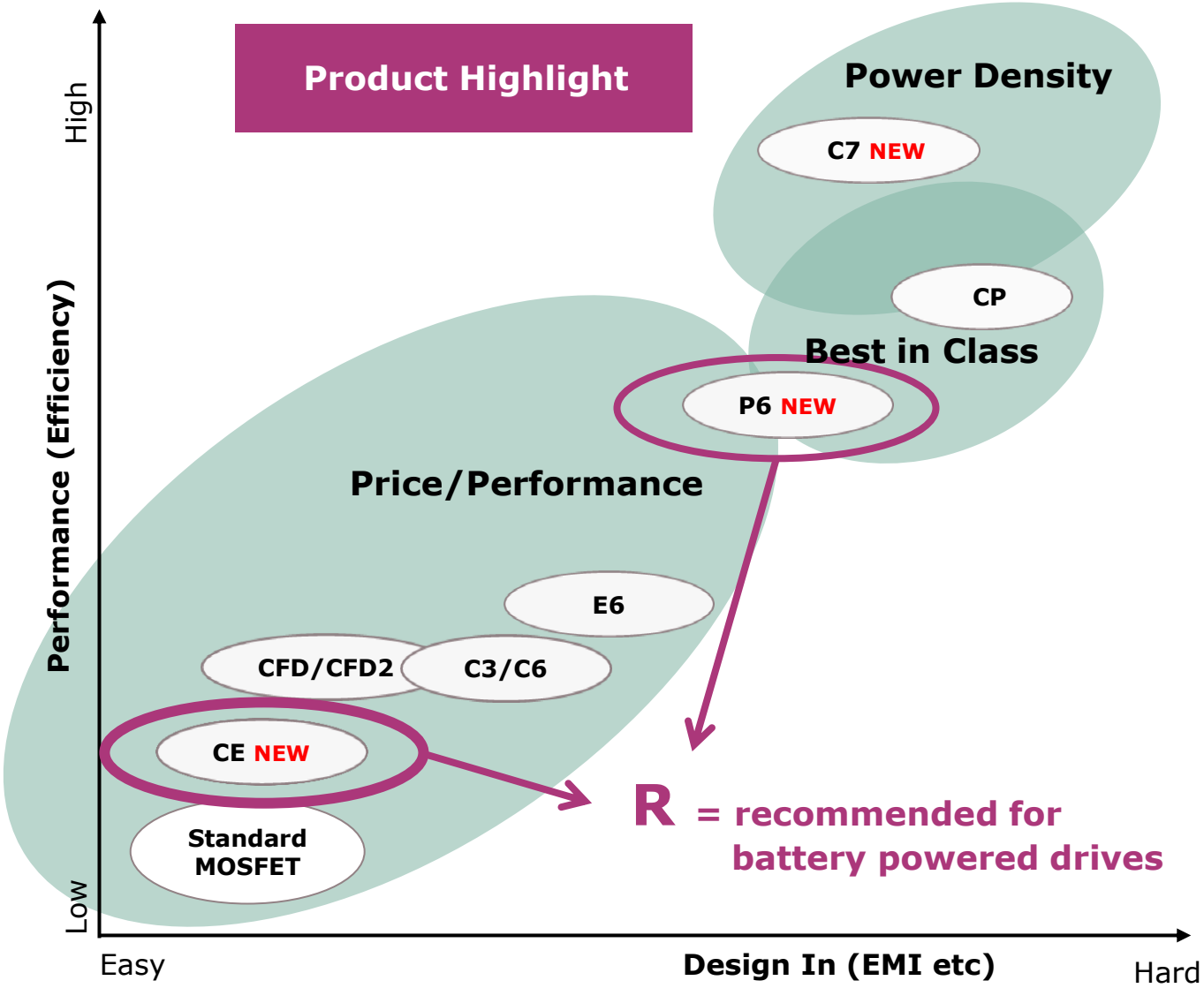
CoolMOS™ CE and P6 – the right fit for all kind of chargers used for battery powered drives



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CoolMOS™ CE

What is CoolMOS™ CE?

- **CoolMOS™ CE** is a technology platform of Infineon´s market leading high voltage power MOSFET designed according to the superjunction principle (SJ) and conceived to fulfill **consumer requirements**
- **CoolMOS™ CE** portfolio offers 500 V, 600 V, 650 V and 800 V devices targeting low power chargers, adapters, LCD, LED TV and LED lighting and power tools applications
- This new series of CoolMOS™ is **cost optimized** to meet typical **requirements in consumer** with no compromise on proven CoolMOS™ quality and reliability while still been price attractive
- **CoolMOS™ CE** is suitable for hard and soft switching applications and as modern SJ, it delivers low conduction and switching losses improving efficiency and ultimately reduces power consumption
- **CoolMOS™ CE ease of use** enables customers to reduce the design in cycle and compete in dynamic markets

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Top 5 reasons for choosing CoolMOS™ CE

Benefits	Provided by our CE solution…
1 **Price competitiveness**	› Economy of scale and improved cost structure from 300 mm production
2 **Lead time and supply flexibility**	› We understand consumer and lighting market dynamics and offer a lead time for middle-sized orders of 4-6 weeks
3 **Supply security**	› 3 frontend and 5 backend facilities (incl. subcons) secure supply › ≥ 96% of all orders shipped before commit date
4 **Portfolio breadth**	› Granular portfolio in 500, 600, 650, 700 and 800 V allows for the tuning of $R_{DS(ON)}$ and package
5 **Design-in support**	› We have a large field application engineering team to provide professional & flexible support for your design

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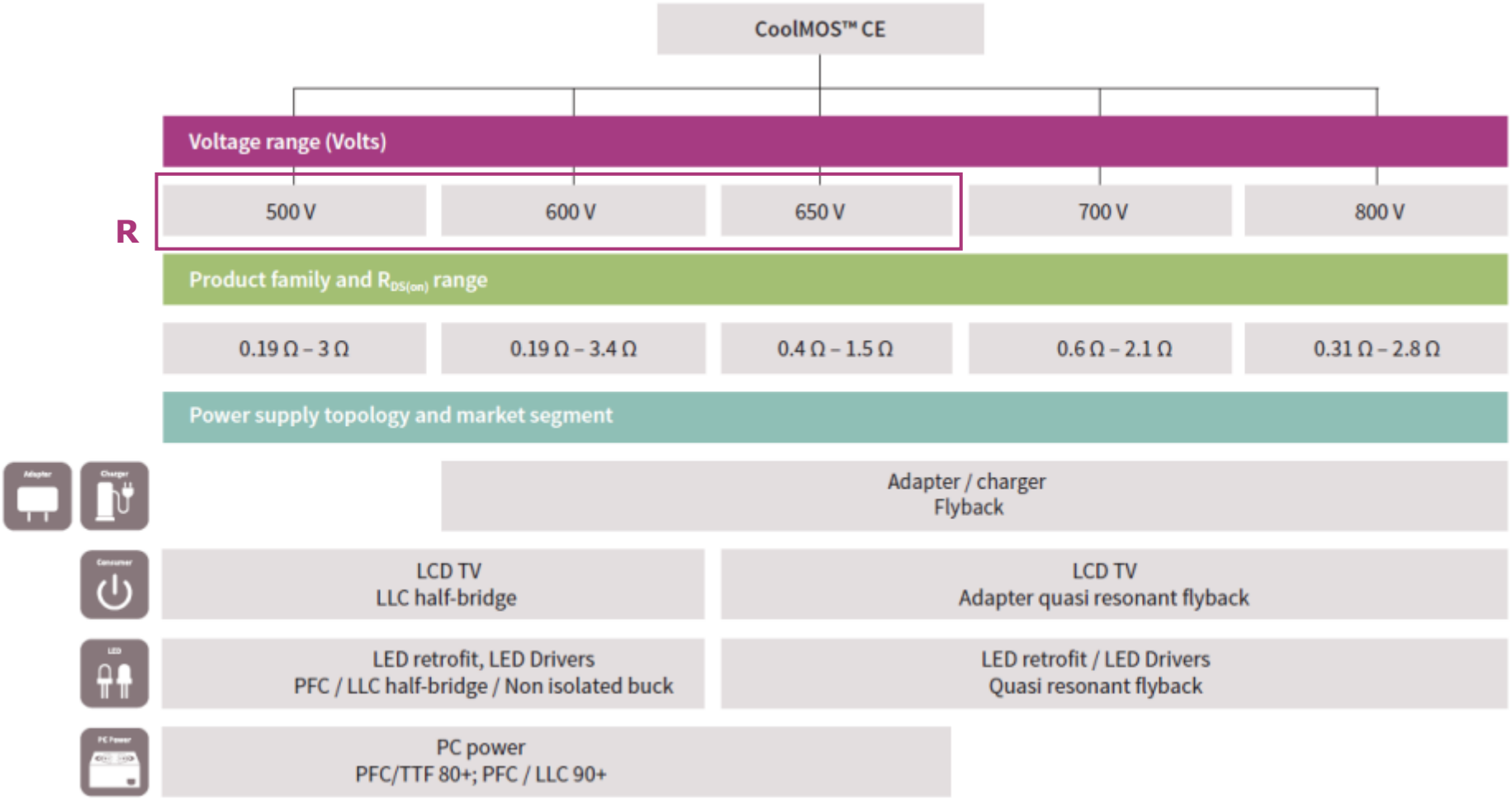
CoolMOS™ CE targets a broad range of applications



R = Recommended for battery powered applications

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CoolMOS™ CE: optimized platform addressing and meeting chargers customer needs

Customer concerning factors charger/ flyback in low power	CoolMOS™ value proposition (600 V and 650 V for flyback)
Thermal behavior ≤ 90°C on device, open case ≤ 50°C/70°C close case temperature	Low conduction losses from large margin between $R_{DS(on)}$ typ to nom Low switching losses from optimized E_{oss}
EMI within EN55022B standard	Optimized EMI to balance switching speed and EMI behavior
EMI within EN55022B standard	Good controllability given the integrated R_g

Customer benefits
High efficiency and consequent reduction of power consumption within large safety thermal margins Reduced design-in effort

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Infineon's industrial microcontrollers, power and sensor components complement each other

Microcontrollers
XMC™ & iMOTION™

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Microcontroller solutions from Infineon

Industrial µController - XMC™

- **XMC1000 – Family:** arm based µController (ARM Cortex™ - M0)
  - XMC1300: up to 200 kB Flash / 16 – 40 pins
  - XMC1400: up to 200 kB Flash / 40 – 64 pins
  - all products **are available until min. 2031**

Hardware Solution

iMOTION™ Controller

- **IRMCK099M**
  - 8 bit high speed 8051 microcontroller, 64 KB Flash
  - Motion Control Engine (MCETM) 16 bit RISC for motor control algorithm execution
  - sensorless Field Oriented Control block, including flux estimator, angle PLL
  - Speed loop customizable

Turnkey Solution

Embedded Power

- **Space optimized solution: entire motor control solution fits in 33 mm X 33 mm**
- **Programmable** FET driver enables an **easy** design for **wide range of power loads**
- Enables **decentralized intelligent motor control architecture**

ASP

Turnkey Solution	Software from IFX, Parametrization only
Hardware Solution	Software developed by customer
ASP	MC Software from IFX, combined with customer application code

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XMC™ MCUs powered by ARM® Cortex™ M0 one microcontroller platform

ARM Cortex™ - M0
- Core 32 MHz / Peripherals up to 64 MHz
- Capture Compare Units (CCU4)
- 2x Serial Channels
- **12Bit ADC**
- **Interconnect Matrix**
- **Secure Bootloader**
- **1.8 V – 5.5 V Supply Voltage Range**
- **TA = -40C to 105C**

	XMC1100	Up to 64 kB Flash TSOP16/38, VQFN24/40	
	XMC1200	Up to 200 kB Flash TSOP16/28/38, VQFN24/40	9 ch LED Control (BCCU) 3 x Analog comparators
R	**XMC1300**	Up to 200 kB Flash TSOP16/28/38, VQFN24/40	Math Co-Processor CCU8 PWM Timer Hall & Encoder I/F
R	**XMC1400**	Up to 200 kB Flash **VQFN40/48/64, TQFP64**	48 MHz Core / 96 MHz Peripherals 2x CAN FD 2x CCU8 / Up to 4 Serial Channels

R = recommended for robotic vacuum cleaner and lawn mowers

PRODUCT DIFFERENTIATORS

MATH co-processor
speeds up your arithmetic calculations by up to 94% - enables sensorless FOC motor control on M0 class device

Event Request Unit (ERU)
enables interconnection between analog, PWM and sensor interface peripherals

Supply Voltage Range
wide Supply Voltage Range from 1.8 V – 5.5 V

Secure boot loader
embedded code can be programmed to flash memory in a protected way using AES 128-bit cryptography. Protects IP if manufacturing is outsourced

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XMC4000 MCUs powered by ARM® Cortex® - M4F

ARM® Cortex®-M4F

- CPU Frequency up to 144 MHz
- **High performance flash technology**
- Timers CCU4, CCU8, POSIF
- USB / Up to 3 x CAN / Up to 6 x Serial channels
- Up to 4 x 12 Bit ADC / 2 x DAC

XMC4100/4200
Up to 256 kB Flash / 40 kB RAM
48-64 pins

XMC4400
Up to 512 kB Flash / 80 kB RAM
64-100pins

- 120 MHz Core
- **Ethernet**
- ΔΣ Demodulator

XMC4500
Up to 1MB Flash / 160 kB RAM
100 – 144 pins

- EBU
- SD Card

XMC4300
256 kB Flash / 128 kB RAM
100 pins

- EtherCAT

XMC4700
Up to 2 MB Flash / 352 kB RAM
100 – 196 pins

- 144 MHz Core
- 6 ch CAN

XMC4800
Up to 2 MB Flash / 352 kB RAM
100 – 196 pins

- EtherCAT

QFN 48 – 64-144 LQFP – 196 BGA

Long product life cycle (min. 2027)

Extended temperature range – up to Ta 125°C + continues up time of 20years@Tj 110C

Application specific peripherals

EtherCAT	Event request unit (ERU)	CSG - High-speed comparators + high resolution PWM	Timer for inverter control (CCU8)	Delta Sigma demodulator
Enable RT-Ethernet without the need of an external ASIC / FPGA → System Cost Saving	enables interconnection between analog, PWM and sensor interface peripherals → improves real-time behavior and reduces CPU load	reaching analog control performance with all the flexibility of digital control	dedicated timer for motor and inverter based designs → helps to reduce software workarounds + reduces CPU load	with integrated filters for cost- and size-efficient galvanic isolated current measurement.

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XMC1000 success story

XMC1000 Microcontrollers
32 MHz ARM® Cortex® - M0

XMC1100

XMC1200
LED Lighting, SMPS

XMC1300
Motor Control, SMPS

XMC1000 **customers** are **market leaders** in our **target applications**

Some Examples

Power Tools
Drives

Fans

LED Power
Supplies

XMC1000 is **award winning**

„Product of the Year 2013
electronic industry"

„Infineon High Performance
Award 2013"

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XMC1400: NEW opportunities in new and existing markets

Value proposition

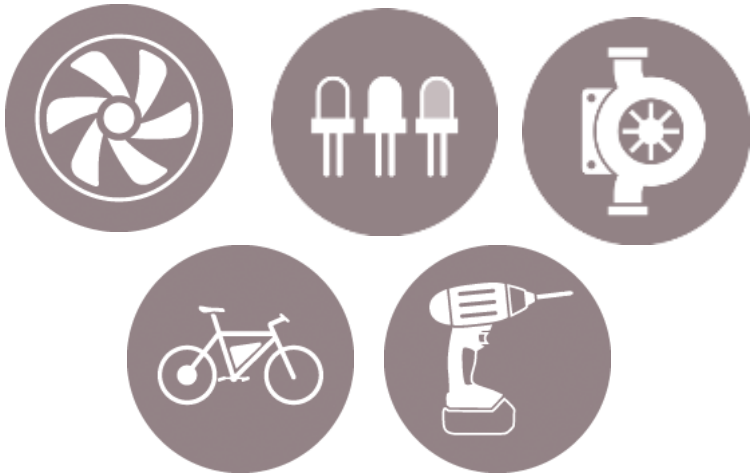
- **70%+ performance** over XMC1300
- Peripherals and on-chip-connectivity for **dual-motor control** and **dual-channel buck converters**

+

- 2 nodes **MultiCAN**
- **PWM timer** for **combustion engine control**
- Application know how as **#1 in Powertrain MCUs**

NEW opportunities in EXISTING markets

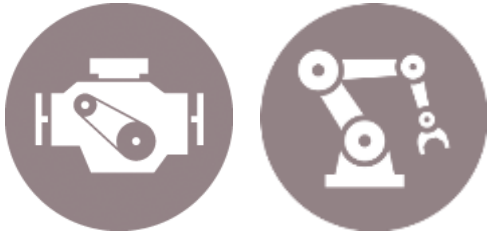
Power Tools, e-Bikes, Fans, Pumps, LED ballasts



NEW opportunities in NEW markets

I/O Modules Factory Automation

Small combustion engines



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The value proposition of XMC1400 lies in its taylored features and broad scalability

Taylored features (some examples)

MATH Co-processor

- Trigonometric operations and divisions allow control algorithms impossible with standard Cortex® M0 Microcontrollers

Motor Position Interface

- Direct interfacing to Hall sensors eliminates costly additional ICs

On-chip interconnects

- Peripherals like timers, ADCs or comparators can be directly connected
- This allows fast and deterministic control loops

Scalability

- Reuse of peripherals across XMC1000 family
- Pin-compatible VQFN-40 products to scale from XMC1300
- 32KB to 200KB Flash memory derivatives
- DAVE™ Development environment
- XMC™ Lib (peripheral driver)
- DAVE™ Apps

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TinyMCE (IRMCK099M) features

iMOTION™

Integrated Design Platform

- Sensorless motor control
- Simplified system solution
- Sinusoidal
- Robust algorithm
- Hardware accelerators
- Flexibility
- Fast time to market
- 10+ years of application know how in home appliances

- 32 bit MCE computation engine
- 100 MIPS by internal calibrated 100 MHz system clock
- Hardware accelerator (multiply, divide, Cordic vector rotate, ATAN) for fast FOC algorithm execution
- Zero offset/gain 8-channel 12-bit ADC (0-1.2 V)
- Integrated OP amps and comparator for current sensing
- 31 times re-writable parameters with 16 K byte OTP memory
- Low power standby mode, wake up by analog input (Vsp.)
- Internal temperature sensor
- Configurable digital IO
- Internal overcurrent hardware comparator
- UART, I2C, analog (PWM) output and capture input

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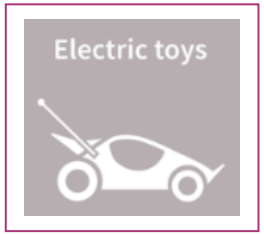
Benefits of iMOTION™

iMOTION™

Integrated Design Platform



- No hall sensors – this **lowers system cost** and increases reliability
- No active components

- **Higher efficiency** due to IPM reluctance torque.
- Smooth operation and **low acoustic noise**

- **High performance** with FOC
- Control 1 motor, 1 motor & PFC or 2 motors & PFC
- Integrated digital PFC

- **Save time and money** in motor control development
- Zero risk, yet **innovative architecture**

- Can control 3 phase permanent magnet motor/ IPM and BLDC motors
- **Large speed range operation**
- Vibration suppression control

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Infineon's industrial microcontrollers, power and sensor components complement each other

Industrial Gate Driver ICs EiceDRIVER™

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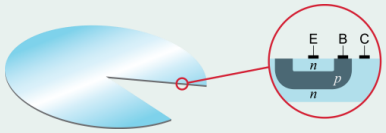
Choose the technology that fits your needs
Key technology performance parameters

Level-shift

Junction isolation

R

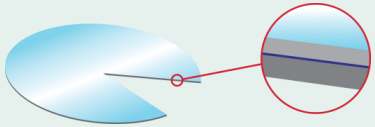


- Largest product lineup with industry standard gate driver portfolio
- Many drivers are tailored towards specific application needs at best price performance

- FET-based bootstrap circuit (typically 200 Ω)
- Active negative transient immunity (typically -90 V for a period of 1 µs) to prevent latch-up
- Common mode transient immunity (CMTI) typically 50 V/ns
- Resilient against positive voltage spikes

Silicon on insulator

R

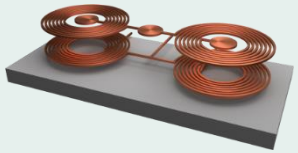


- Total system cost oriented, enabled through higher level of integration
- Increased robustness, e.g. against negative voltage transients

- PN-based bootstrap diode (typically 40 Ω)
- Negative transient immunity (-200 V for 1 µs) to prevent latch-up
- Common mode transient immunity (CMTI) typically 50 V/ns

Galvanic isolation

Coreless transformer



- Performance oriented
- Competitive alternative to optocoupler solutions
- Enables innovative applications and caters to early adopters (market leaders)

- Galvanic isolation
- Continuous immunity against negative and positive transients due to floating output chip, up to ±1200 V
- Exceptional common-mode transient immunity (CMTI) of more than 150 V/ns
- 6 kV basic isolation capabilities

R = Recommended for battery powered drives

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Infineon offers a wide variety of driver types for a large range of voltage classes

Driver Configuration	5 V	25 V	100 V	200 V	500 V	600 V	700 V	1200 V
Single channel high side					●	●		●
Single channel low side	●	●						
Dual channel high side						●		●
Dual channel low side		●						
High and low side				● ●	●	● ●	●	●
Half bridge			●	●		● ●	●	● ●
Half bridge plus single low side						●		
H bridge			●			●		
3-phase bridge				●		● ●		●
Current sense						●		●

● Non-isolated
● Junction Isolation (JI)
● Silicon On Insulator (SOI)
● Coreless Transformer (CT)

= Recommended for battery powered drives

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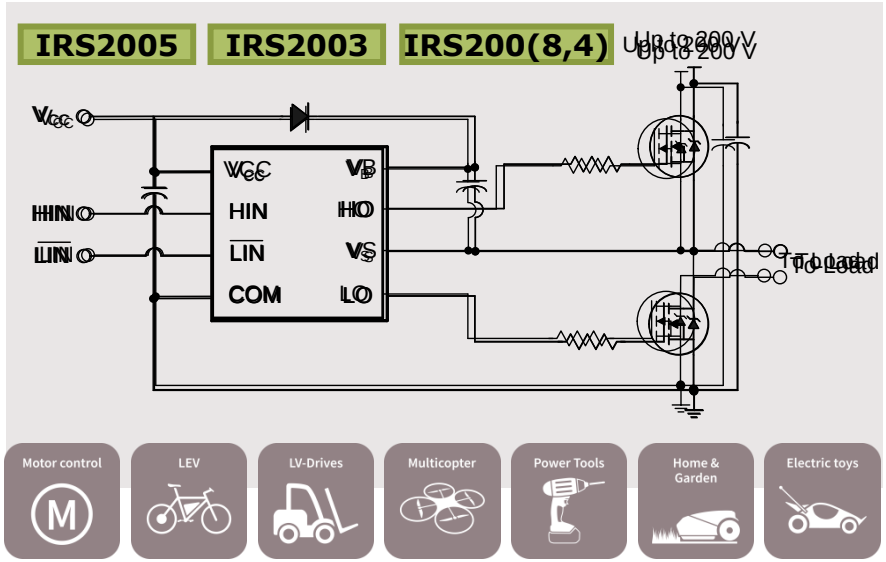
IRS200x 200 V Gate Drivers at a Glance

Now including new IRS2008 half-bridge driver

Features

- Fully operational up to +200 V offset voltage
- Designed for use with bootstrap power supplies
- Gate drive supplies up to 20 V per channel
- 3.3 V, 5 V, 15 V input logic compatible
- VCC and VBS undervoltage lockout (UVLO) protection
- Integrated deadtime & cross-conduction prevention logic (IRS2008, IRS2004, IRS2003)
- Matched propagation delays for all channels
- Tolerant to negative transient voltage, dV/dt immune

Typical Connection



Part Number	Voltage Class [V]	$I_{O+/-}$ (typ) [mA]	Ton/off (typ) [ns]	MT (max) [ns]	DT (typ) [ns]	Tr/f (typ) [ns]	Control Inputs	VCCUV typ. [V]	VBSUV typ. [V]	Package
IRS2008S	200	290/600	680/150	50	520	70/35	IN, /SD	8.2-8.9	8.2-8.9	SOIC-8
IRS2005S IRS2005M	200	290/600	160/150	50	-	70/30	HIN, LIN	8.2-8.9	8.2-8.9	SOIC-8 MLPQ4x4
IRS2004S IRS2004	200	290/600	680/150	60	520	70/35	IN, /SD	8.2-8.9	-	SOIC-8 PDIP-8
IRS2003S IRS2003	200	290/600	680/150	60	520	70/35	HIN, /LIN	8.2-8.9	-	SOIC-8 PDIP-8

For more information visit www.infineon.com/200VHVIC

*Note: IRS2008 can replace IRS2004. IRS2005 replaces IRS2001.

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Infineon Solution Finder
www.infineon.com/driver-finder

Visit Infineon's online **Solution Finder**. To simplify the gate driver selection process, Infineon offers an online easy-to-use tool. By selecting a few key switch or driver parameters, the tool quickly guides you in finding the right driver for your application.

Switch based selection

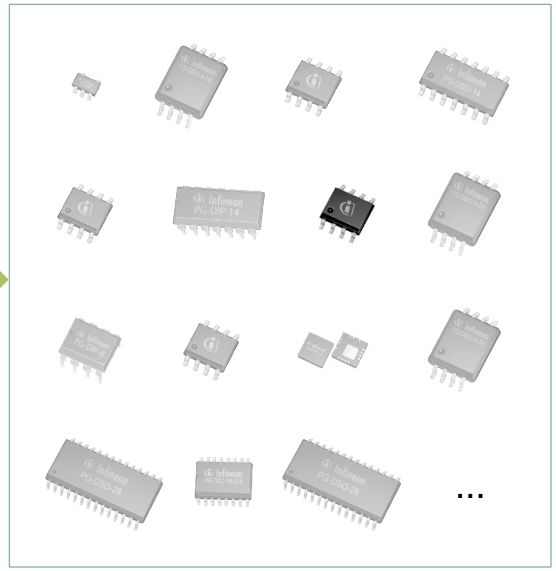
1. Switch Type or Product
2. Voltage Class
3. Gate Resistance
4. VGE/VGSS

-or-

Driver based selection

1. Driver Current
2. Voltage Class
3. Switching Frequency
4. Driver Topology
5. Isolation Requirement
6. Qualification Level
7. Package

Infineon Gate Driver IC Portfolio



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Agenda

1. Market overview
2. Infineon´s system solution
3. Product highlights
4. Summary
5. Support material

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Benefits of Infineon components

FAST TIME TO MARKET

- **Complete system solution** including Microcontroller – DAVE™, power stage and sensors are included
- **Evaluation boards for fast prototyping and testing** and in-depth system support enable reduction of development time and cost

ROBUSTNESS AND QUALITY

- **Infineon provides reliable and robust products for highest system durability and reliability, increasing life time and MTBF**

TECHNOLOGY LEADERSHIP

- **Lowest $R_{DS(on)}$ of e.g. 1.4 mΩ in 60 V SuperSO8 and highest current** capability of 300 A in TO-Leadless for highest system efficiency

SIZE AND COST

- **Saving space on the board:**
  Small form factors for compact design – SuperSO8 package

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Agenda

1 Market overview

2 Infineon´s system solution

3 Product highlights

4 Summary

5 Support material

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Support Material

Collaterals and Brochures	› Product Briefs › Selection Guides › Application Brochures › Presentations › Press Releases, Ads	› www.infineon.com/EiceDRIVER™ › www.infineon.com/driver-finder › www.infineon.com/OptiMOS™ › www.infineon.com/XMC™ › www.infineon.com/sensors › www.infineon.com/CoolMOS™ › www.infineon.com/CoolSET™
Technical Material	› Application Notes › Technical Articles › Simulation Models › Datasheets, MCDS Files › PCB Design Data	
Evaluation Boards	› Evaluation Boards › Demoboards › Reference Designs	› www.infineon.com/evaluationboards
Videos	› Technical Videos › Product Information Videos	› www.infineon.com/mediacenter

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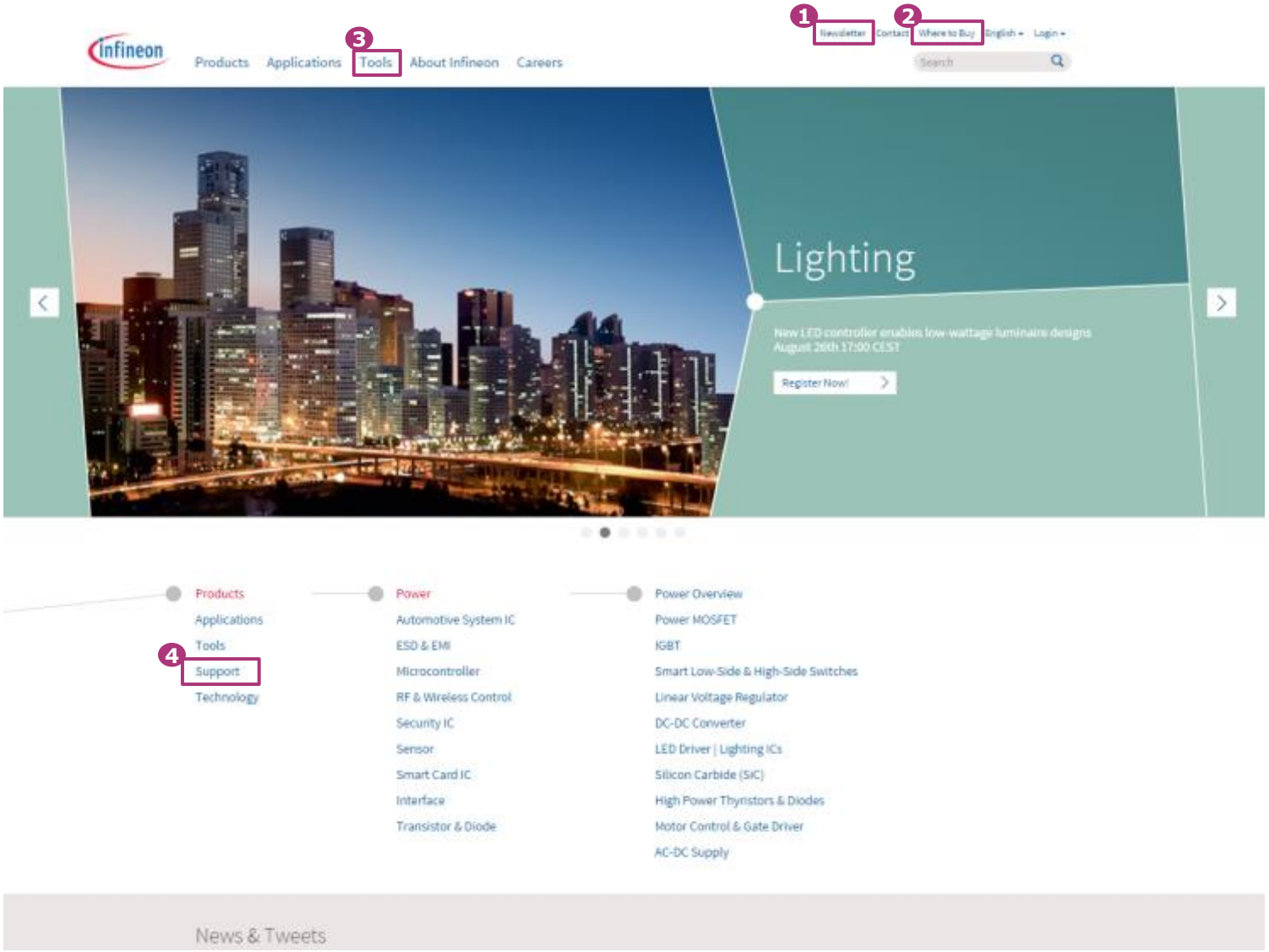
Support
Online tools and services



1. **Subscribe to Newsletter**
2. **Where to Buy**
3. **Tools, Finders and Selectors**
4. **Support**

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Low-voltage motor control application kits

To shorten customer development cycle time and cost we offer a complete portfolio of motor control kits:

1 40 V Medium Can ME/MF DirectFET™ 3-phase BLDC Motor Drive Demo Board

TOP **BOTTOM**

- Nominal input battery voltage: 18 V
- Output power:
  - Opt. 1: Single FET solution: 200 W
  - Opt. 1: 2 FETs in parallel: 400 W
- Top-side cooling using aluminum heatsink.
- Die temperature measurement via openings on the PCB.
- Latched shut-down overcurrent protection.
- Programmable overtemperature protection.
- To be Used with XMC1300 Drive Card.

XMC1000 Motor Control Application kit	XMC4000 Motor Control Application kit

2 XMC1000 & XMC4000 motor control application kits

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Part of your life. Part of tomorrow.

Infineon