High power density in battery powered motor driving system solution

2014-05-13

Contents

- Market overview for LV Drives
- LV Drives system overview
- Solution for high power density with OptiMOS™
- EiceDriver™, XMC microcontroller, Rotor position sensor
- Selection guide for each application
- Online support and summary

Contents

Key Applications

Forklift

Electric forklift
Handpallet trucks

Highest current capability & reliability

Light Electric Vehicles

Electric scooter
Pedelecs
Low-speed cars

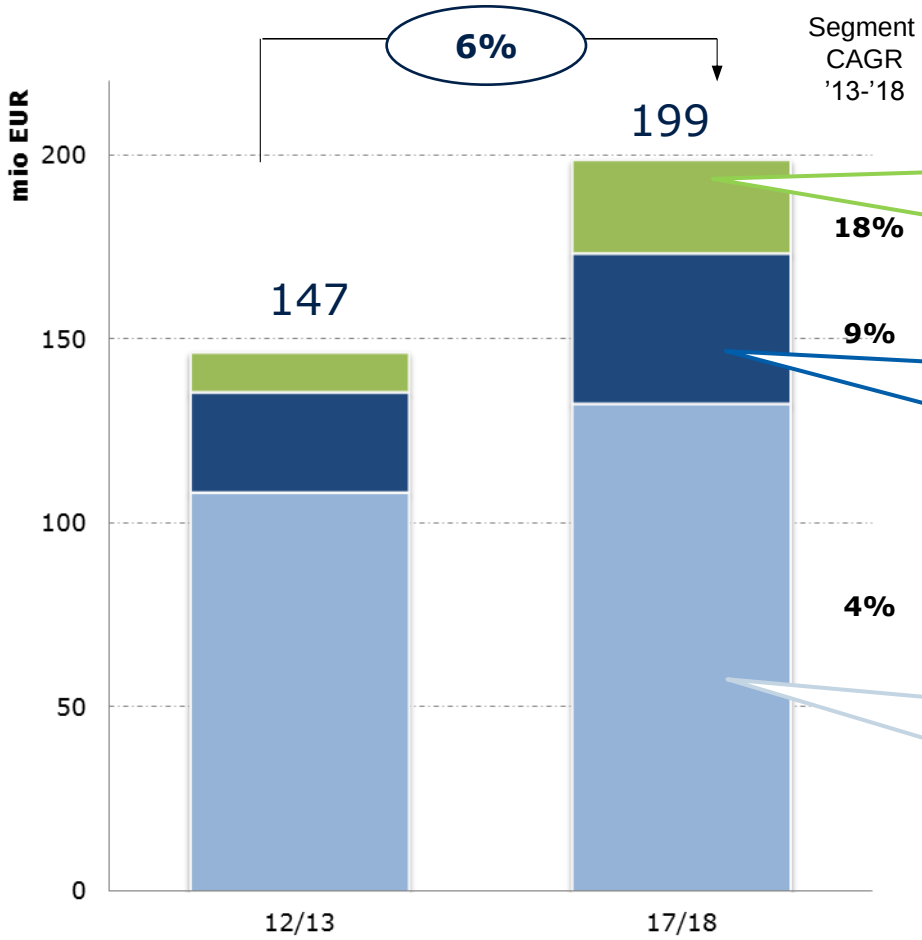
Lowest $R_{D(on)}$ for highest power density

Cordless Tools

Cordless power tools
Cordless gardening tools

Space reduction
Price/performance

Market Development of Focus Applications in LV Drives



Light Electric Vehicles - growth driven by µ-cars

Enabler: - improved battery technologies
Driver: - biggest growth potential is coming from µ-cars in China
- CO_2 reduction program

Forklift - stable industry drives further growth in electric forklifts

Enabler: - improved battery technologies
Driver: - lower total cost of ownership
- trend of "green" technology
- increasing demand of BRIC countries

Power Tools – high volume market

Enabler: - increasing share of Li-Ion batteries and BLDC motors
Driver: - higher flexibility and reduced weight increases share of cordless tools

Cordless Tools | Forklift | Light Electric Vehicles e.g. pedelecs, µ-cars

Source:
IMS - Motor Control (non-industrial) 2010; GIA – Press Release of Global Industry Analysts, 2011; Pike Research 2011, 2012
Freedonia – World Power Lawn and Garden Equipment, 2010, 2011; Industrial Truck Association – 20 top lift truck supplier – Report 2009, 2010, 2011, 2012
EBWR – Electric Bike Worldwide Reports 2011, 2012; IHS – Topical Report 2011; IDTech – World Market for EV 2010, own assumptions

Contents

Infineon's Industrial Microcontrollers, Power and Sensor Components Complement Each Other

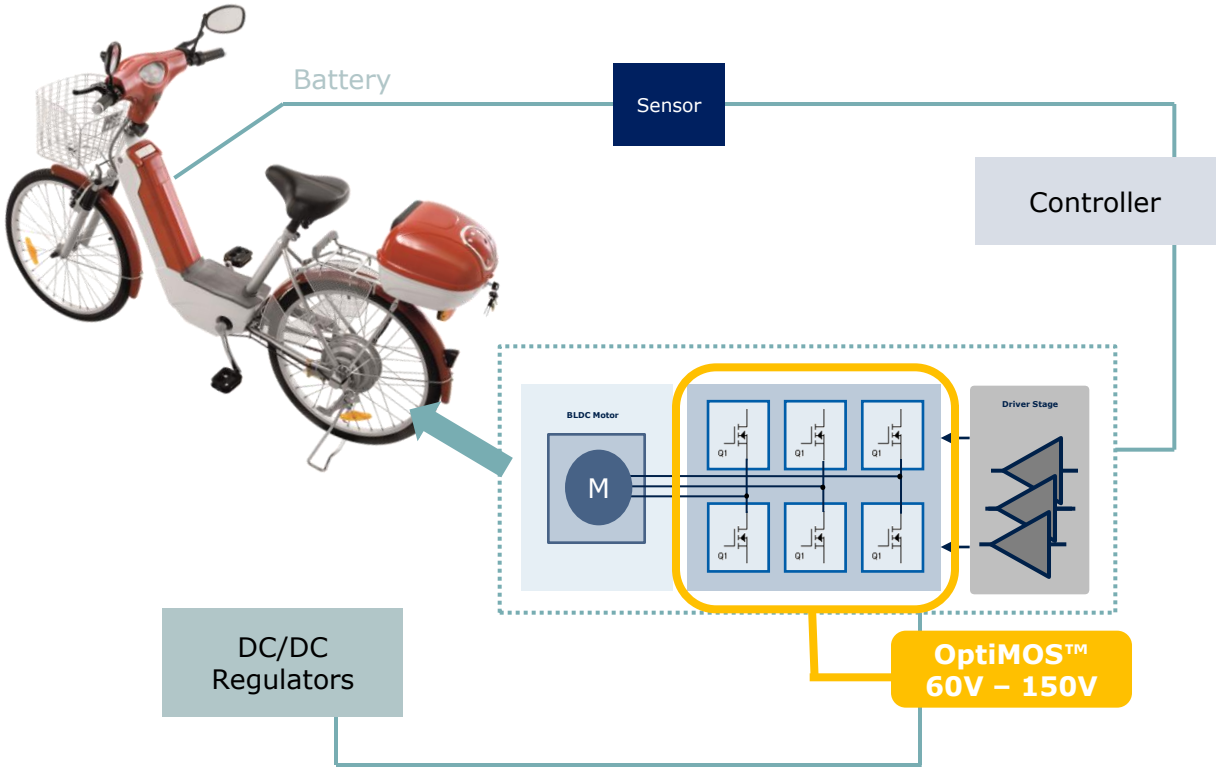
Source: IMS. 2010

System Overview LEV, Forklift

Light Electric Vehicles
Fork lift

- Electric scooter
- Pedelecs
- Low-speed cars
- Fork lift

Lowest $R_{DS(on)}$ for highest power density



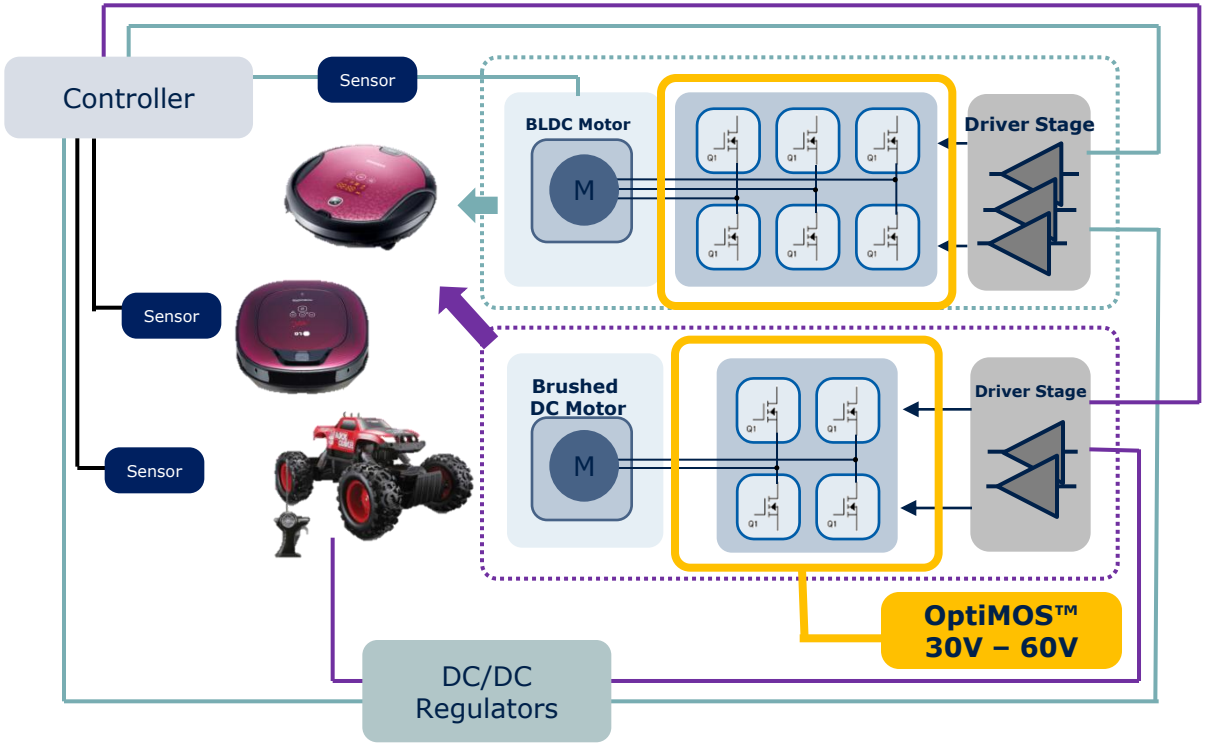
Low Voltage MOSFET Selection Criteria:

- Voltage class pending on system voltage (60V – 150V)
- Package type (TO-220, D²PAK, D²PAK 7pin, TOLL)

System Overview
- Cordless tools, Vacuum cleaner, RC Toy, etc

Cordless Tools
Vacuum cleaner
RC Toy, etc

Space reduction
Price/performance

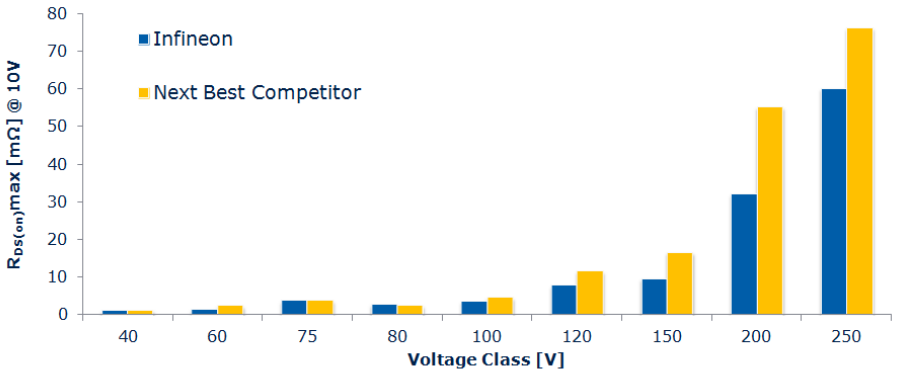


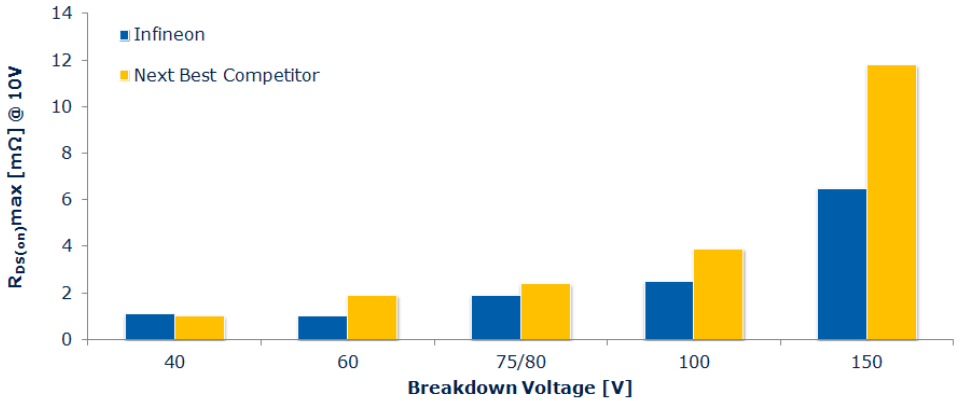
Low Voltage MOSFET selection criteria:

- Voltage class pending on system voltage (30V - 60V)
- Package type (TO-220, SuperSO8)

Contents

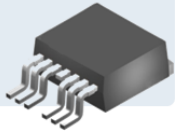
Infineon provides Lowest $R_{DS(on)}$ for Low Voltage Drives Application





Highest Efficiency and Power Density with SuperSO8 products

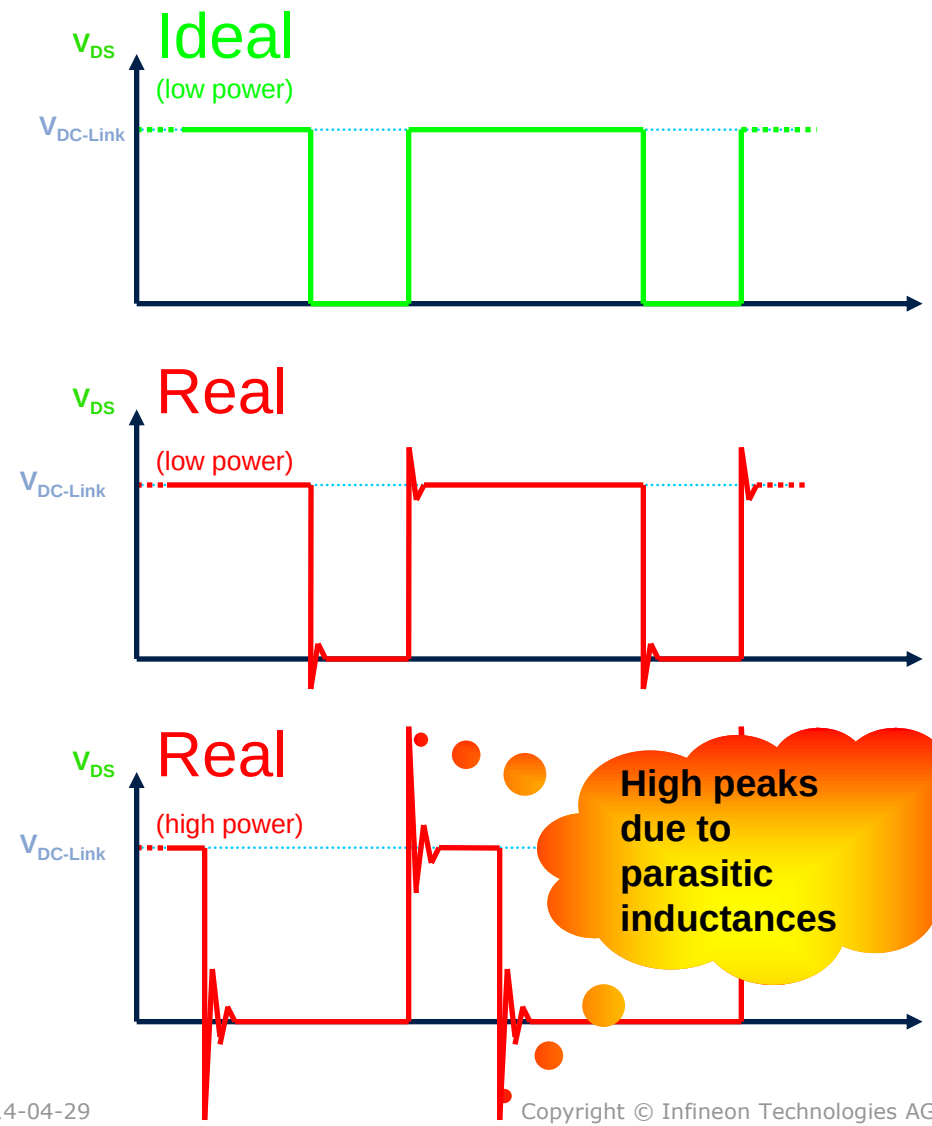
Industries Lowest $R_{DS(on)}$ in D²PAK 7pin

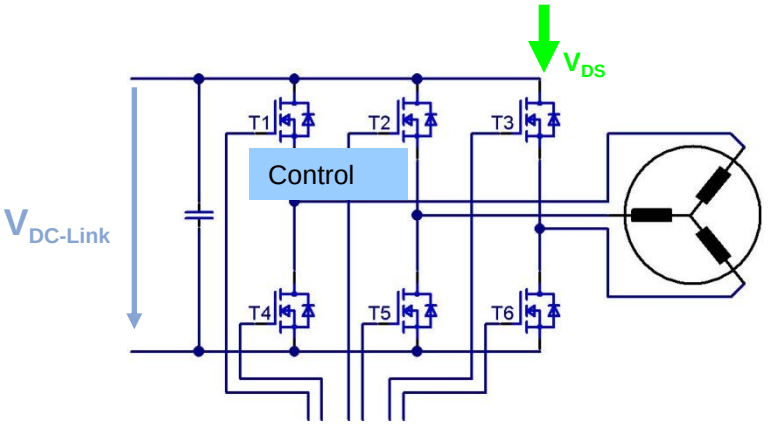


OptiMOS™ – Technology leader in low voltage MOSFETs

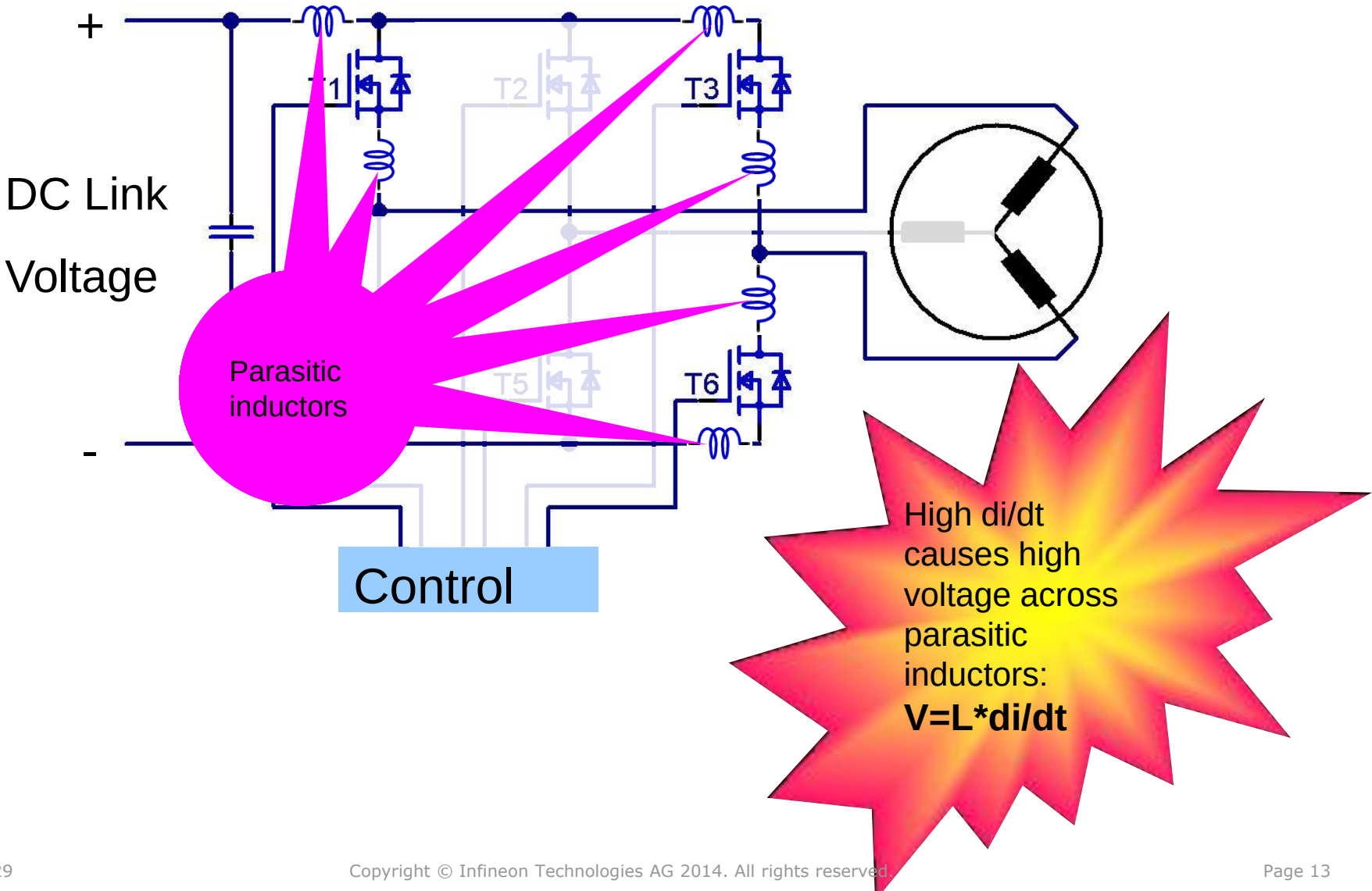
With **Lowest $R_{DS(on)}$** (=>reduced parallelization) in all required voltage classes, and **Best Quality** (=>high reliability) Infineon offers the right products for Low Voltage Drives

Ideal/Real waveforms of Drain-Source-Voltage V_{DS}





Voltage **Spikes** due to parasitic inductances

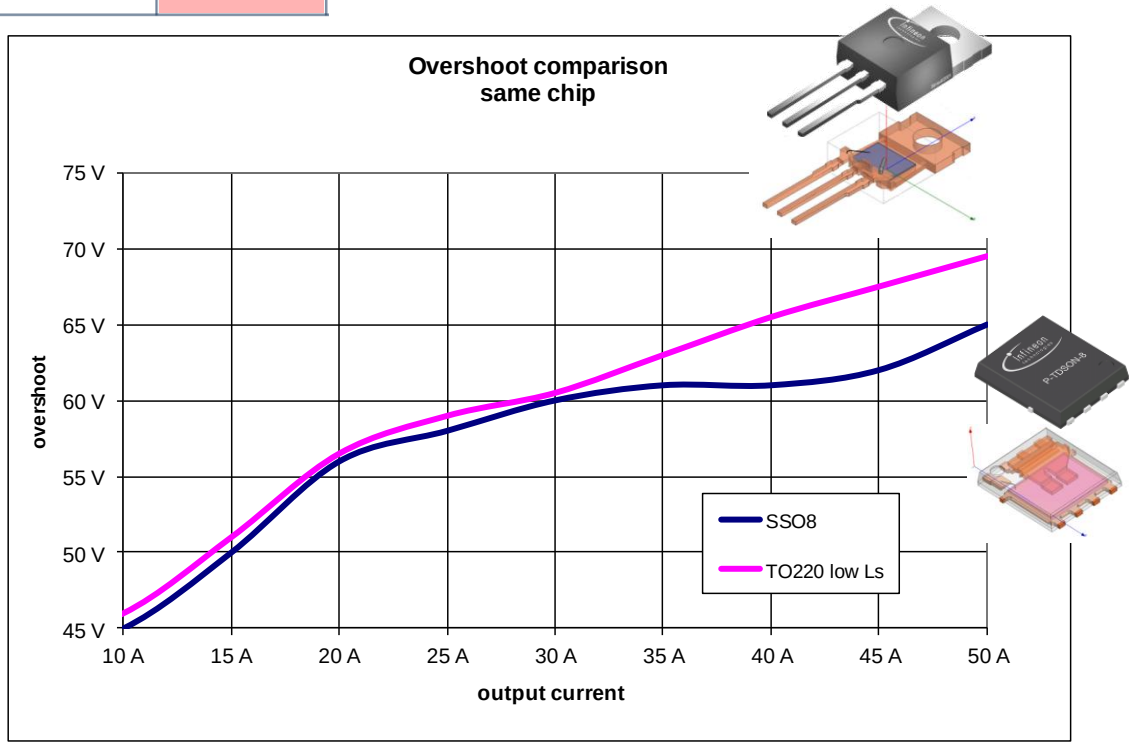


Minimizing the effect of voltage overshoot by package

	TO220	SSO8	D²PAK	D²PAK 7pin
Package Resistance	0.74 mΩ	0.5 mΩ	0.74 mΩ	0.44 mΩ
Current Capability	120A	100A	120A	180 A
Footprint	-	30 mm²	150 mm²	150 mm²
Inductivity	>10 nH	1-2 nH	>5 nH	<5 nH

- **Lower Package Resistance** can obtain more optimized price-performance ratio
- **Smaller Footprint** achieves to higher power density
- **Less Stray Inductivity** performs better switching behavior and control

- package inductance: low package inductance reduces ringing
  - → **Super SO8** has significantly lower ringing than TO-220 solution



TO-Leadless Packaging Technology

worlds lowest ohmic MOSFET:
IPT004N03L

0.4mOhmmax; 30V

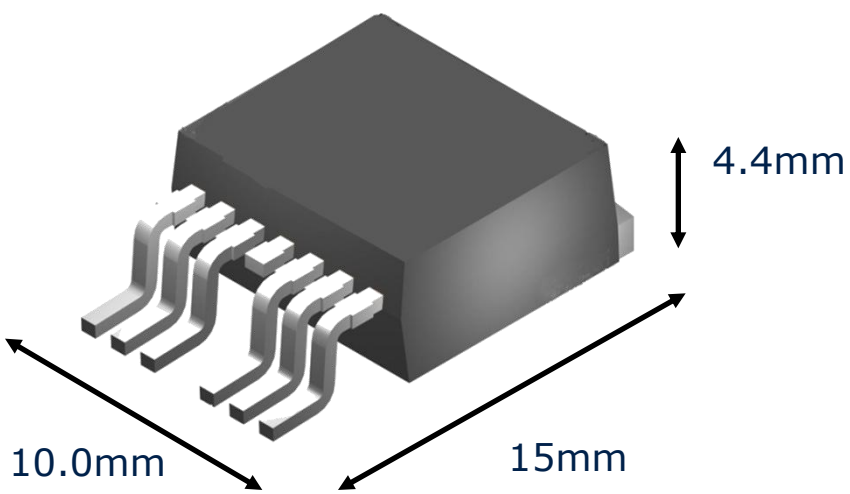
Size
- **60% space reduction** of standard D^2-Pak size

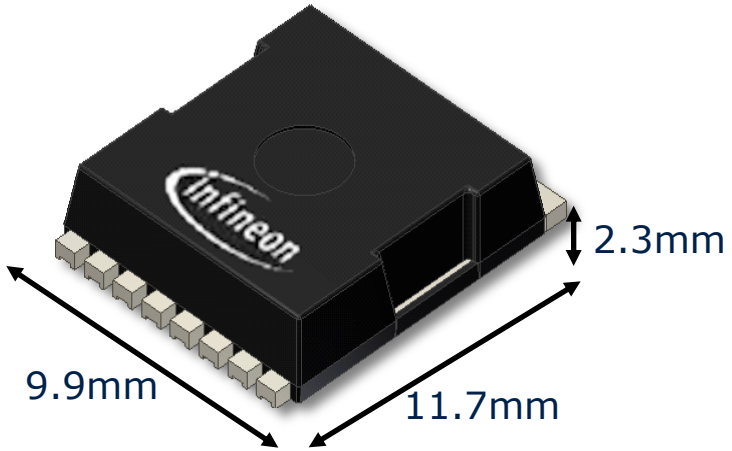
Interconnect
- up to 5*500um Al-bondwire
- <0.25mOhm package resistance

Electrical performance
- up to 300A I_d-dc

Reliability
- very low R_{th} – **up to 30% lower $R_{DS(on)}$**
- **Enables a visual inspection** due to Tin plated grooved leads
- **Better EMI** due to reduced parasitic inductances (cut by half)
- **High reliability** due to improved solder contact area – reduced electro migration

TO-Leadless Packaging Technology





Footprint: 150 mm²

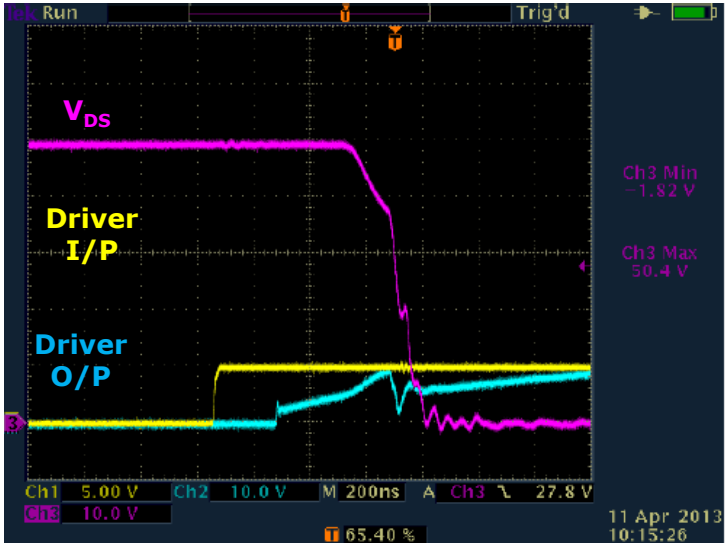
Footprint: 115 mm²

30% Footprint Reduction	50% Height Reduction	60% Space reduction

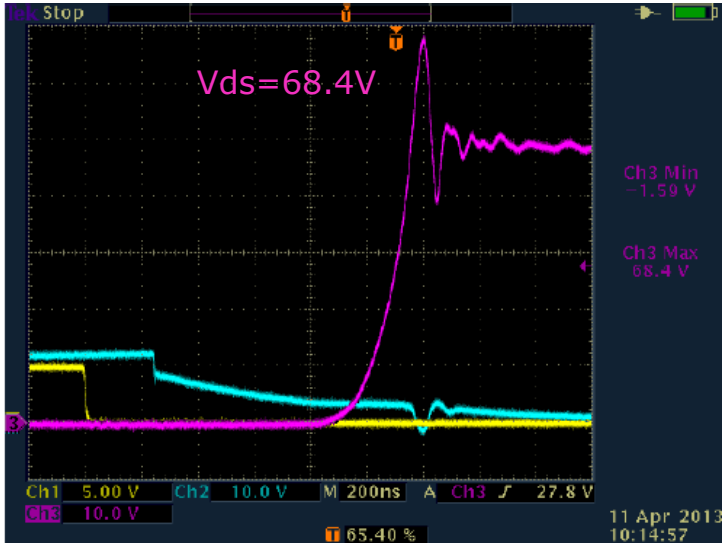
Measurement Data:
TO-Leadless vs. D2PAK 7Pin, $48V_{in}$, $80A_{rms}$

IPB025N10N3 G

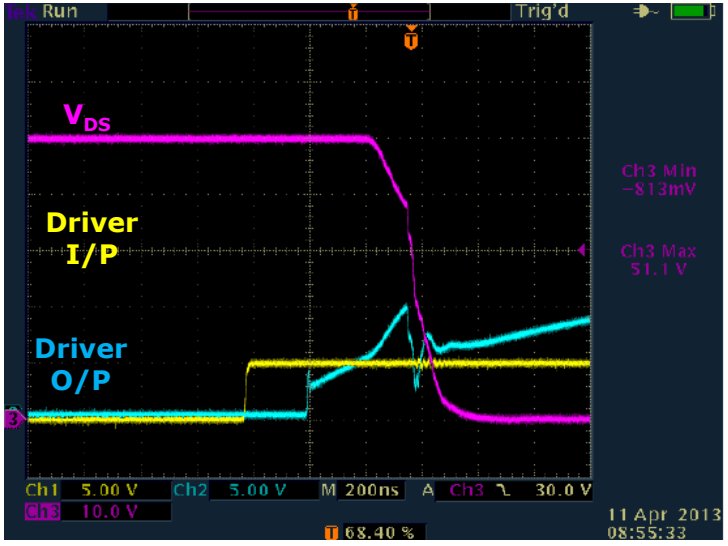
Turn-on

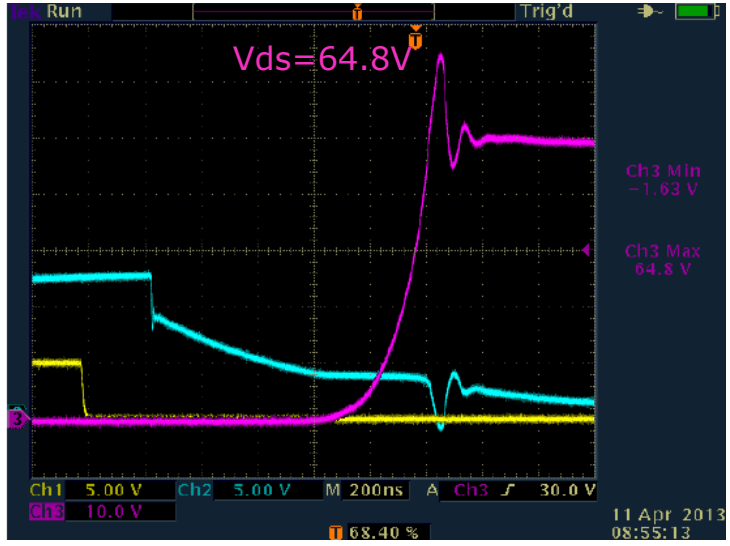


Turn-off



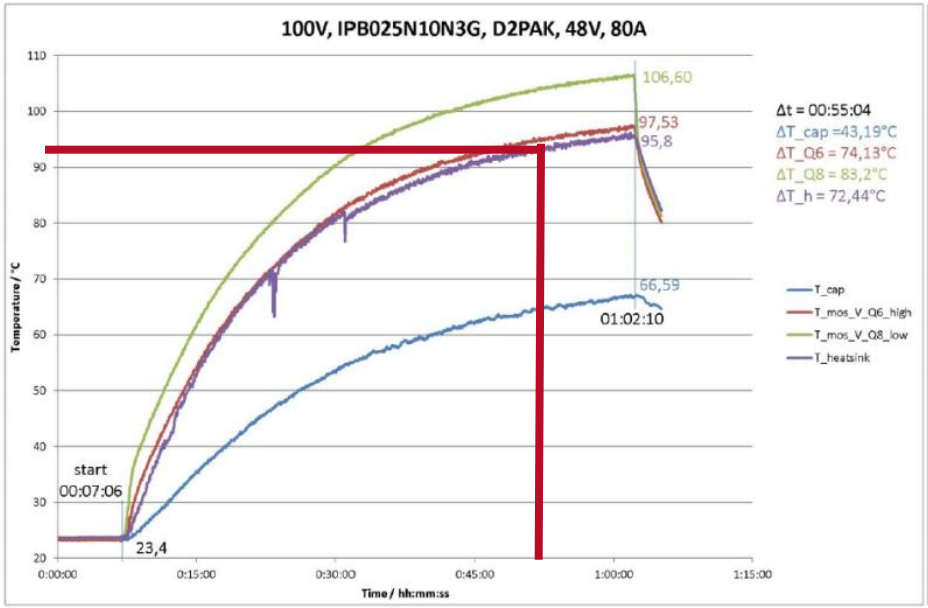
IPT020N10N





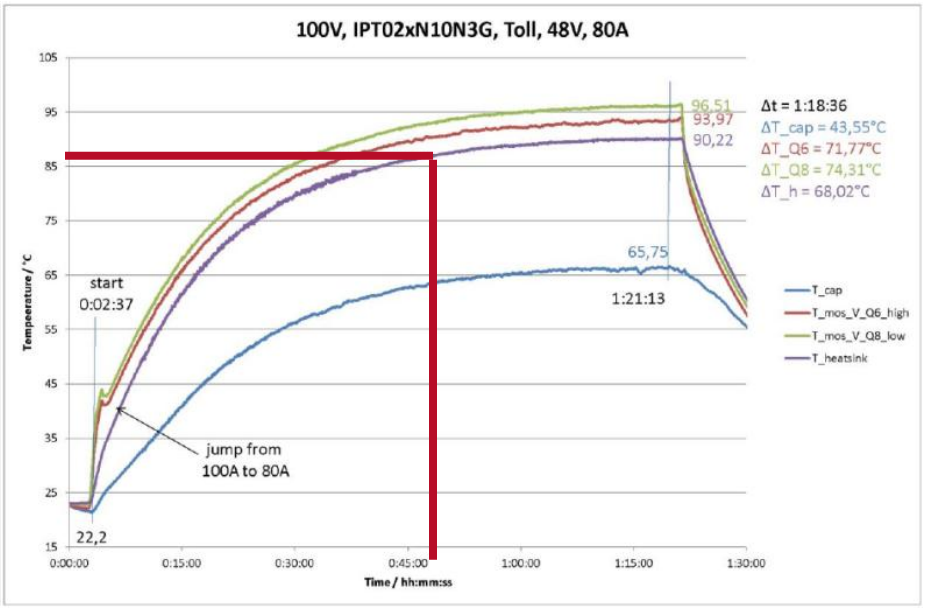
Measurement Data:
TO-Leadless vs. D2PAK 7Pin, $48V_{in}$, $80A_{rms}$

IPB025N10N3 G



$\Delta T_{@45min}$~70°C

IPT020N10N3



$\Delta T_{@45min}$<59°C

More than 15% reduction in losses with TO-Leadless (IPT020N10N3)

Parasitic parameters of high current packages

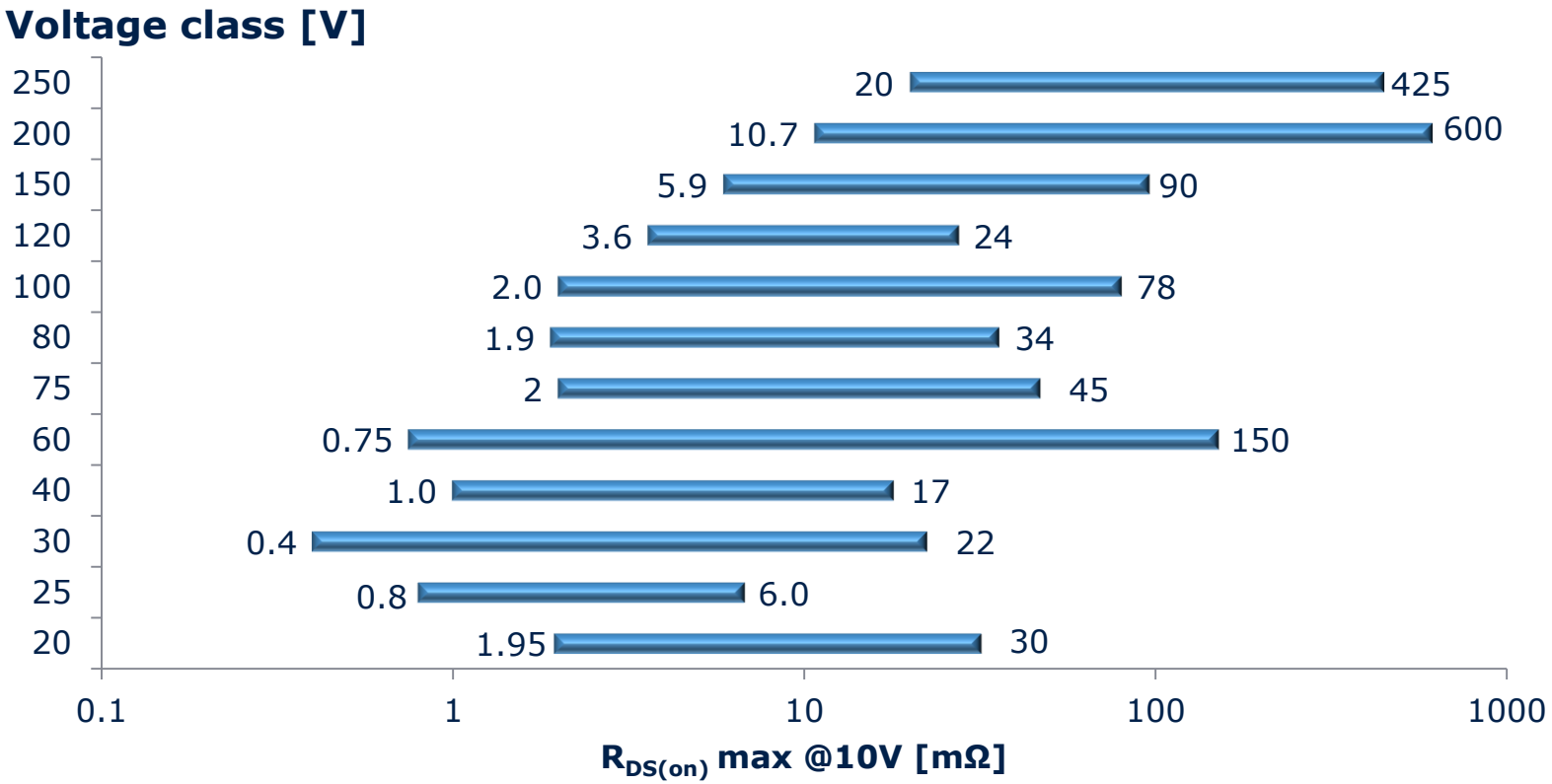




	TO220	SSO8	D²PAK	D²PAK 7pin	TOLL
Package Resistance	0.74 mΩ	0.5 mΩ	0.74 mΩ	0.44 mΩ	0.25 mΩ
Current Capability	120A	100A	120A	180 A	300 A
Footprint	-	30 mm²	150 mm²	150 mm²	115 mm²
Inductivity	>10 nH	1-2 nH	>5 nH	<5 nH	1-2 nH

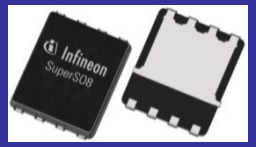
OptiMOS™ Product Portfolio

Products by Voltage Class and $R_{DS(on)}$ in Various Packages



Infineon Best in Class OptiMOS™ Products

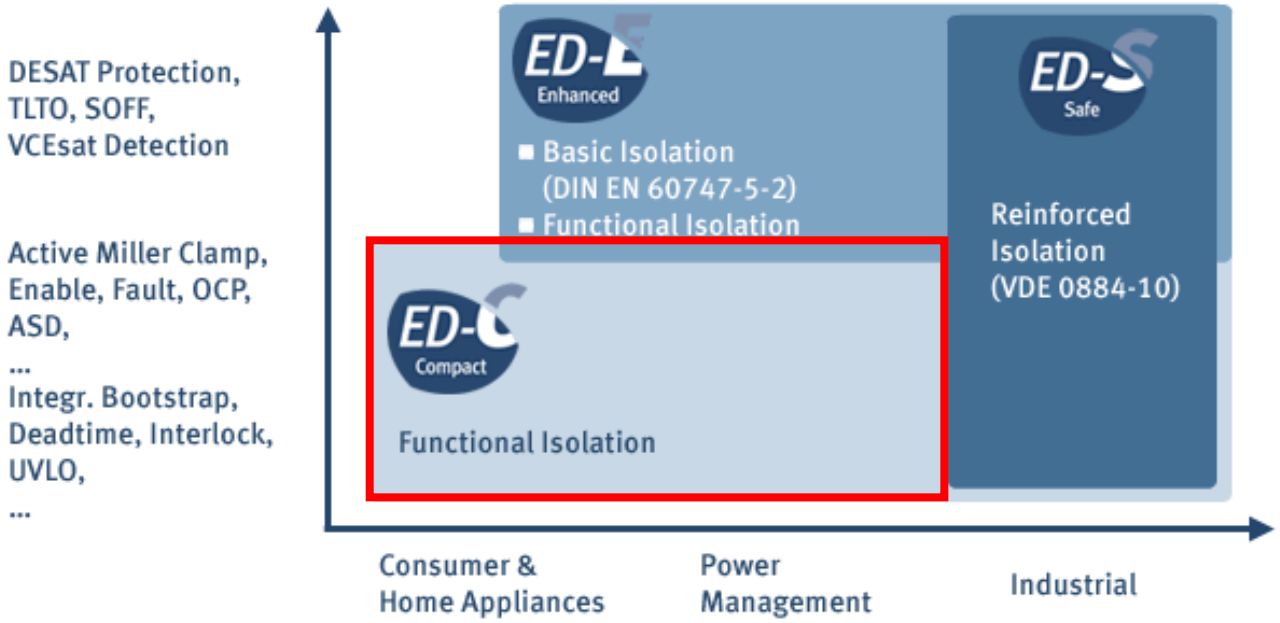
Best in Class

	 TOLL	 D²PAK-7	 D²PAK	 TO-220	 SSO8
30V LL	IPT004N03L (0.4mΩ)	IPB009N03L G (0.95mΩ)	IPB034N03L G (3.4mΩ)	IPP034N03L G (3.4mΩ)	BSC011N03LS (1.1mΩ) BSC011N03LSI (1.1mΩ)
40V LL		IPB011N04L G (1.1mΩ)	IPB015N04L G (1.5mΩ)	IPP039N04L G (3.9mΩ)	BSC010N04LS (1.0mΩ) BSC010N04LSI (1.0mΩ)
40V NL		IPB011N04N G (1.1mΩ)	IPB015N04N G (1.5mΩ)	IPP015N04N G (1.5mΩ)	BSC017N04NS G (1.7mΩ)
60V LL		IPB016N06L3 G (1.6mΩ)	IPB019N06L3 G (1.9mΩ)	IPP037N06L3 G (3.7mΩ)	BSC028N06LS3 G (2.8mΩ)
60V NL	IPT007N06N (0.7mΩ)	IPB010N06N (1.0mΩ)	IPB014N06N3 G (1.4mΩ)	IPP020N06N (2.0mΩ)	BSC014N06N (1.4mΩ)
75V			IPB020NE7N3 G (2.0mΩ)	IPP023NE7N3 G (2.3mΩ)	BSC036NE7NS3 G (3.6mΩ)
80V		IPB019N08N3 G (1.9mΩ)	IPB025N08N3 G (2.5mΩ)	IPP028N08N3 G (2.8mΩ)	BSC047N08NS3 G (4.7mΩ)
100V	IPT020N10N (2.0mΩ)	IPB025N10N3 G (2.5mΩ)	IPB027N10N3 G (2.7mΩ)	IPP030N10N3 G (3.0mΩ)	BSC046N10NS3 G (4.6mΩ)
120V		IPB036N12N3 G (3.6mΩ)	IPB038N12N3 G (3.8mΩ)	IPP041N12N3 G (4.1mΩ)	BSC077N12NS3 G (7.7mΩ)
150V	IPT059N15N (5.9mΩ)	IPB065N15N3 G (6.5mΩ)	IPB072N15N3 G (7.2mΩ)	IPP075N15N3 G (7.5mΩ)	BSC190N15NS3 G (19mΩ)
200V			IPB107N20N3 G (10.7mΩ)	IPP110N20N3 G (11mΩ)	BSC320N20NS3 G (32mΩ)
250V			IPB200N25N3 G (20mΩ)	IPP200N25N3 G (20mΩ)	BSC600N25NS3 G (60mΩ)

New OptiMOS™ technology

Contents

EiceDRIVER™ Compact - the Right Gate Driver for all Motor Drives

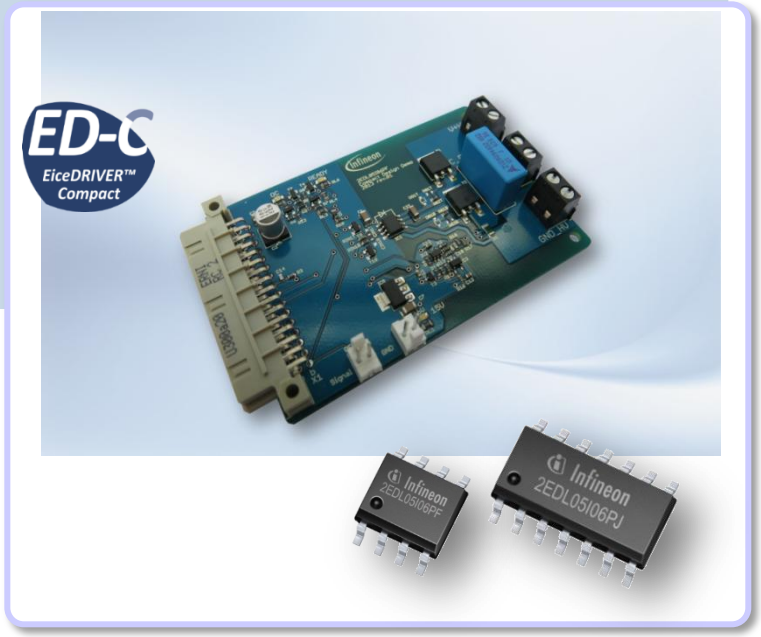


- **highly reliable** driver ICs with **functional isolation**
- **small packages** e.g. DSO-8 or TSSOP-28
- offers highest **cost-efficiency** & **ease-of use**

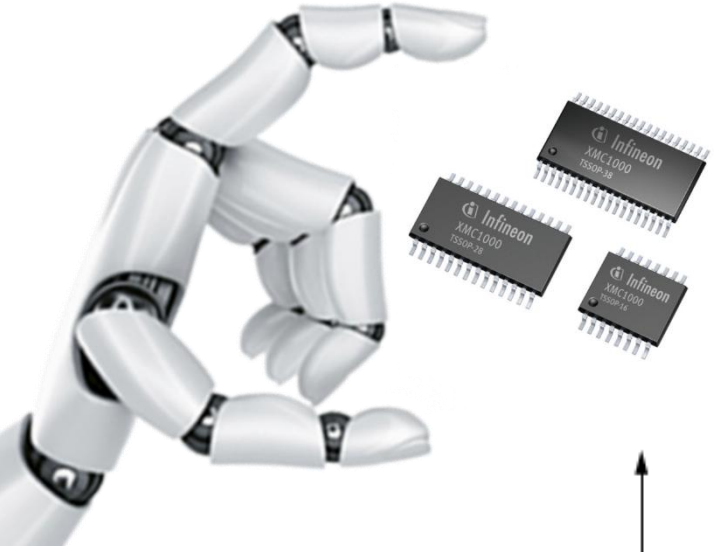
System cost reduction in drives using OptiMOS™ and EiceDRIVER™ C – 2EDL

Using OptiMOS™ & EiceDRIVER™ C – reduces your system costs by saving …

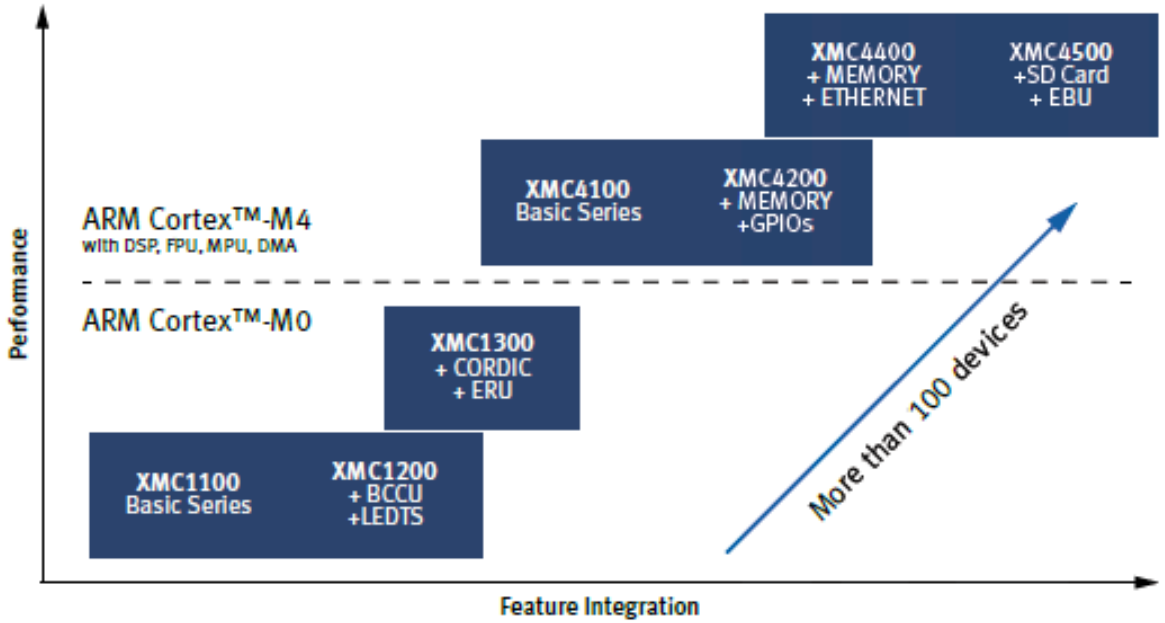
- HV bootstrap diode and current limiter
- external comparator and biasing for SC protection
- enable circuit
- gate emitter resistors



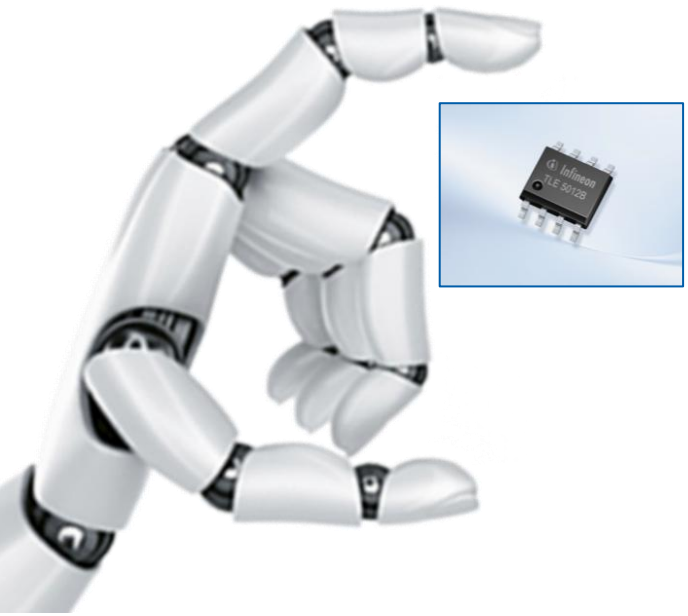
The new XMC 32-bit MCU based on ARM® Cortex™-M Characterized by …



- Performance
- Real-Time and Process Parallelization
- Application specific Integration
- Quality and Robustness

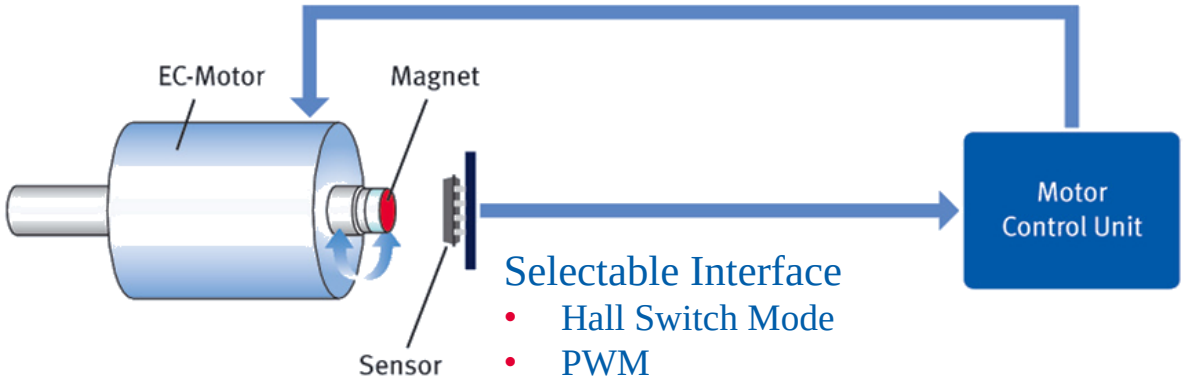


TLE5012B for BLDC rotor position sensing with best in class delay time



TLE5012B Customer advantages

- Reduction of µC load – angle calculation and auto calibration
- Easy implementation - multiple selectable interfaces
- High dynamic systems – best in class update rate and delay time
- Failsafe operation – active status monitoring

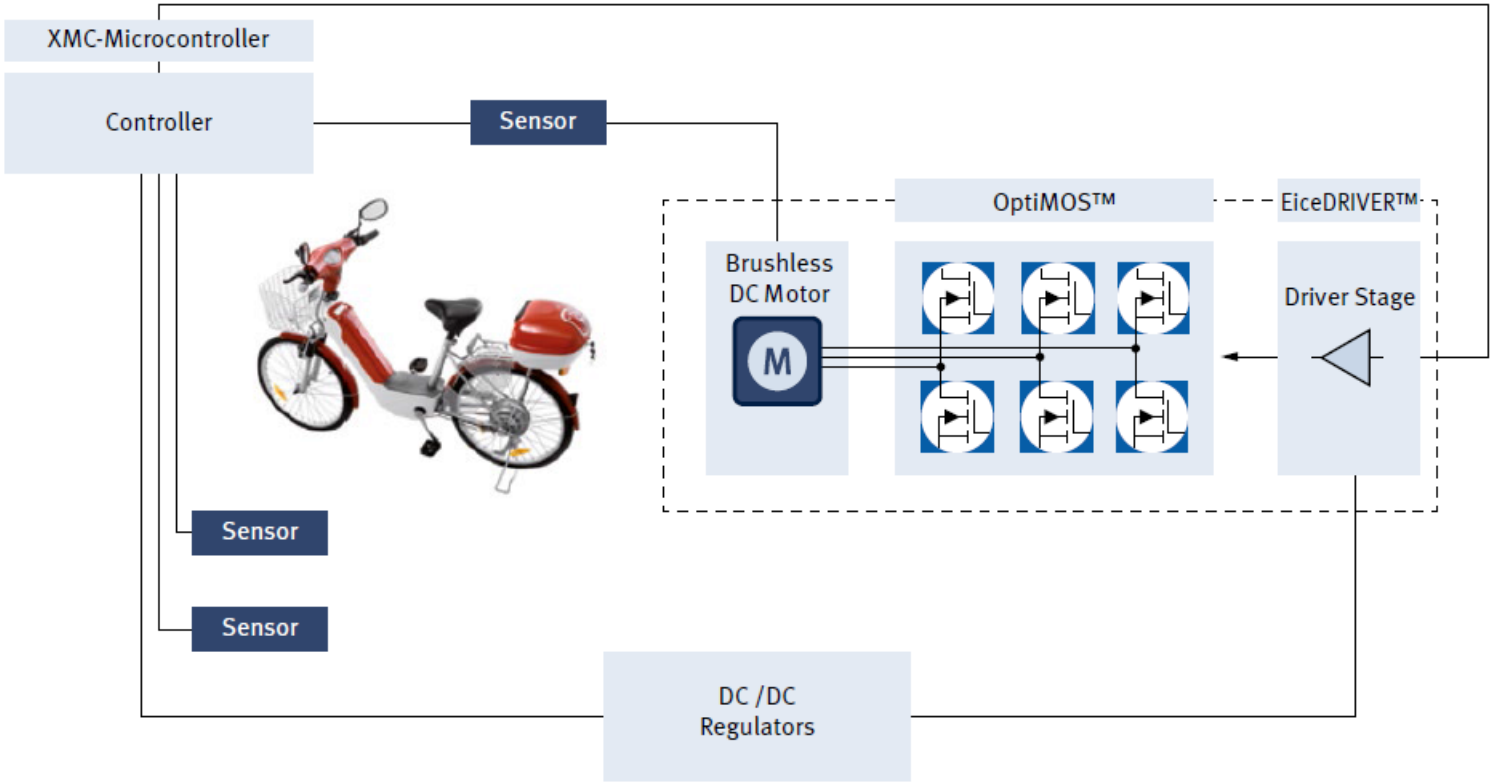


Selectable Interface

- Hall Switch Mode
- PWM
- Incremental Interface
- SPI

Contents

Selection guide for LEV



Infineon's OptiMOS™ for Light Electric Vehicles

System Voltage Class	Voltage Class	D²PAK	D²PAK 7pin	TO-Leadless	TO-220
24V	60V				IPP032N06N3 G
	75V	IPB020NE7N3			IPP034NE7N3
36V	80V	IPB025N08N3 G	IPB019N08N3 G		IPP037N08N3
48V	100V	IPB027N10N3 G	IPB025N10N3 G	IPT020N10N3	IPP045N10N3
72V	150V	IPB072N15N3 G	IPB065N15N3 G	IPT059N15N3	

Selection guide for LEV

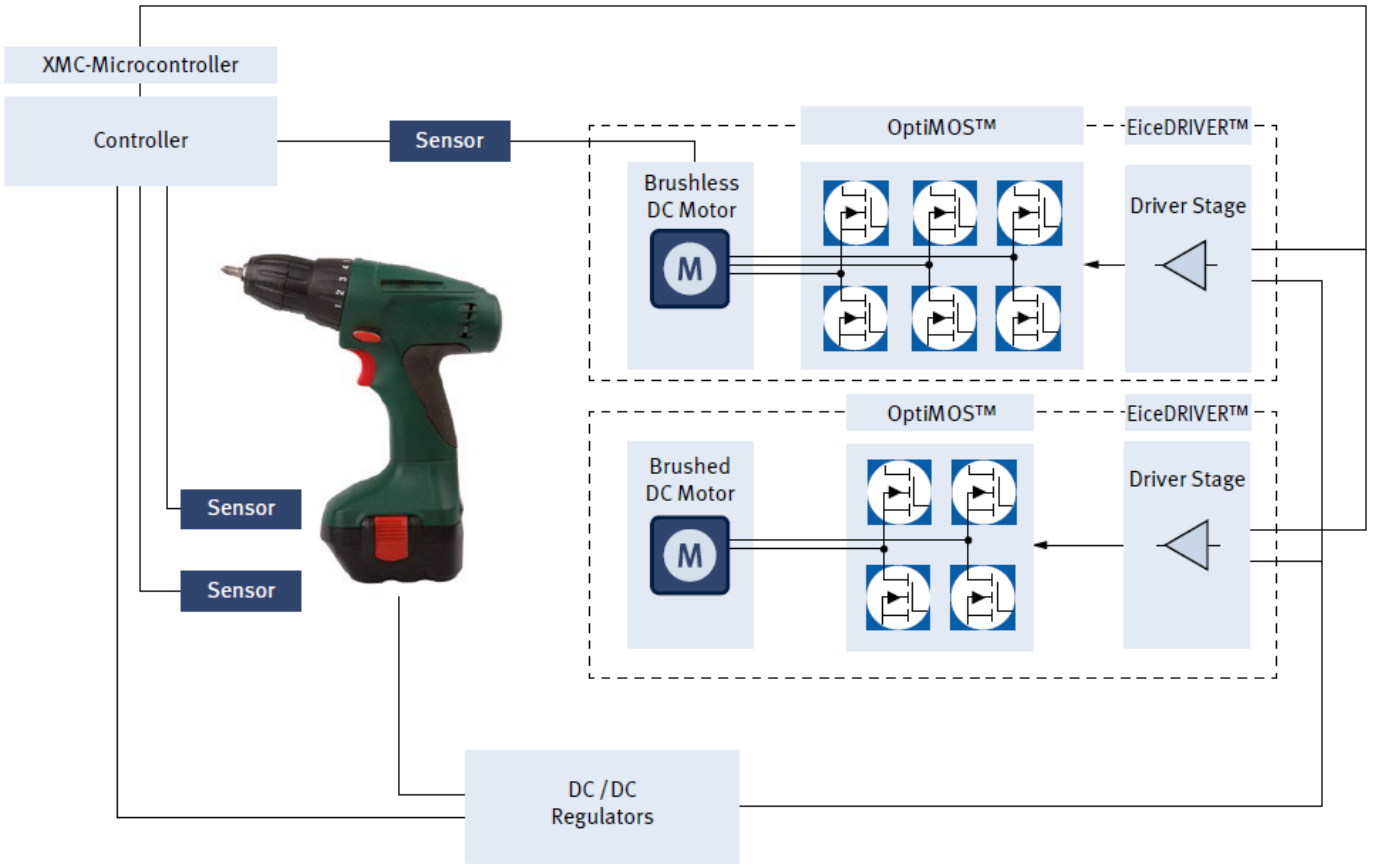
Infineon's EiceDRIVER™ for Light Electric Vehicles

Topology	DSO-8	DSO-14	TSSOP-28
Halfbridge	2EDL05N06PF	2EDL05N06PJ	
3-Phase (B6)			6EDL04N02PR
			6ED003L06-F2

Infineon's ARM® Cortex™ based Microcontroller Family

		XMC4100	XMC4200	XMC4400	XMC4500
System	Core	ARM® Cortex™ M4			
	CPU Frequency	80MHz	80MHz	120MHz	120MHz
	Co-Processor	Floating Point Unit			
	Flash Size	128kB	256kB	512kB	1MB
	RAM Size	20kB	40kB	80kB	160kB
	Cache	4kB	4kB	4kB	4kB
Timers	POSIF	1x	1x	2x	2x
	CCU4 (4ch)	2x	2x	4x	4x
	CCU8 (4ch)	1x	1x	2x	2x
	High-resolution PWM (150ps) Channels	4x	4x	4x	-
Signal Processing	ADC 12-bit	2x	2x	4x	4x
	ΔΣ Demodulator	-	-	4x	4x
	DAC	2x	2x	2x	2x
Communication	IEEE 15BB Ethernet MAC	-	-	1x	1x
	USB	FS DEV	FS DEV	FS OTG	FS OTG
	SDIO/SD/MMC	-	-	-	✓
	Serial Channels (UART, SPI, I^2C, I^2S)	4x	4x	4x	6x
	External Memory I/F	-	-	-	✓
	CAN	2x	2x	2x	3x
Application Specific	Touch Control / LED Display Matrix	✓	✓	✓	✓

Selection guide for Power tools



Infineon's OptiMOS™ for Cordless Tools

System Voltage Class	Voltage Class	TO-220	SuperSO8	CanPAK™
< 18V	30V		BSC011N03LS	BSB012N03LX3 G
≥ 18V - 24V	40V	IPP015N04N G	BSC010N04LS	BSB014N04LX3 G
36V	60V	IPP024N06N3 G	BSC014N06NS	BSB028N06NN3 G

Selection guide for Power tools

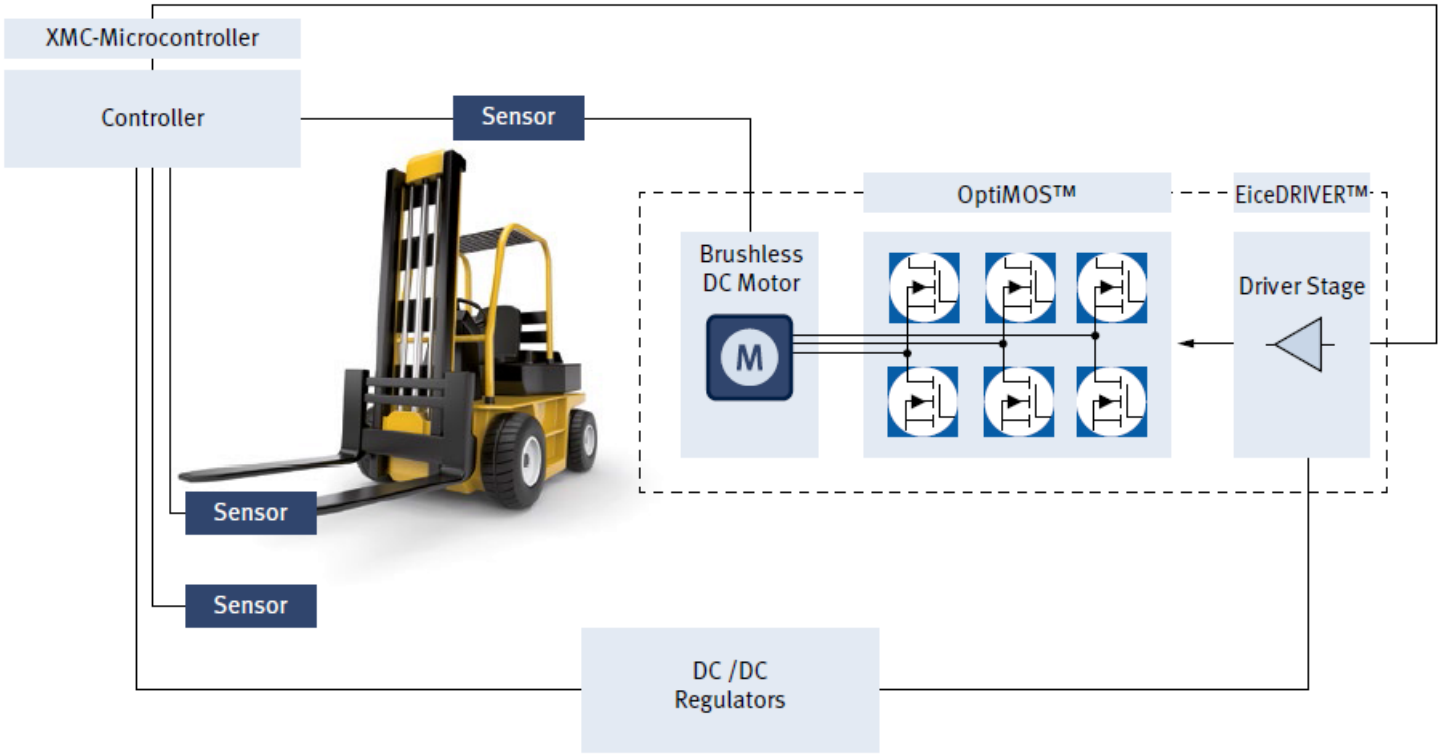
Infineon's EiceDRIVER™ for Cordless Tools

Topology	DSO-8	DSO-14	TSSOP-28
Halfbridge	2EDL05N06PF	2EDL05N06PJ	
3-Phase (B6)			6EDL04N02PR
			6ED003L06-F2

Infineon's ARM® Cortex™ based Microcontroller Family

		XMC1300
System Performance	Core	ARM® Cortex™ M0
	CPU Frequency	32 MHz
	Co-Processor	MATH
	Flash Size	8-200kB
	RAM Size	16kB
	POSIF	1x
Timers	CCU4 (4ch)	1x
	CCU8 (4ch)	1x
Signal Processing	ADC 12-bit	1x (2x S&H)
	Coparator	3x
Communication	Serial Channels (UART, SPI, I^2, I^2S)	2 Channel
Application Specific	LED Dimming & Color Control	✓

Selection guide for Forklift



Infineon's OptiMOS™ for Forklift Applications

System Voltage Class	Voltage Class	D²PAK	D²PAK 7pin	TO-Leadless
24V	60V	IPB029N06N3 G	IPB010N06N	IPT007N06N
36V	80V	IPB025N08N3 G	IPB019N08N3 G	
48V	100V	IPB027N10N3 G	IPB025N10N3 G	IPT020N10N3
72V/ 80V	150V	IPB 072N15N3 G	IPB065N15N3 G	IPT059N15N3

Selection guide for Forklift

Infineon's EiceDRIVER™ for Forklift Applications

Topology	DSO-8	DSO-14
Halfbridge	2EDL05N06PF	2EDL23N06PJ

Infineon's ARM® Cortex™ based Microcontroller Family

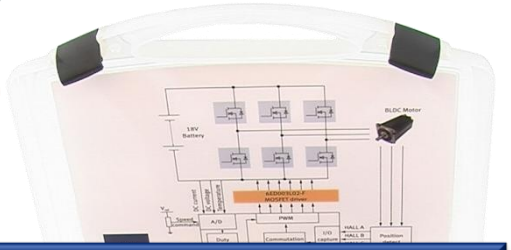
		XMC4100	XMC4200	XMC4400	XMC4500
System	Core	ARM® Cortex™ M4			
	CPU Frequency	80MHz	80MHz	120MHz	120MHz
	Co-Processor	Floating Point Unit			
	Flash Size	128kB	256kB	512kB	1MB
	RAM Size	20kB	40kB	80kB	160kB
	Cache	4kB	4kB	4kB	4kB
Timers	POSIF	1x	1x	2x	2x
	CCU4 (4ch)	2x	2x	4x	4x
	CCU8 (4ch)	1x	1x	2x	2x
	High-resolution PWM (150ps) Channels	4x	4x	4x	-
Signal Processing	ADC 12-bit	2x	2x	4x	4x
	ΔΣ Demodulator	-	-	4x	4x
	DAC	2x	2x	2x	2x
Communication	IEEE 15BB Ethernet MAC	-	-	1x	1x
	USB	FS DEV	FS DEV	FS OTG	FS OTG
	SDIO/SD/MMC	-	-	-	✓
	Serial Channels (UART, SPI, I^2C, I^2S)	4x	4x	4x	4x
	External Memory I/F	-	-	-	✓
	CAN	2x	2x	2x	3x

Contents

Low Voltage Drives Demoboards

300W Motor Control SSO8

300W INVERTER KIT featuring Infineon's OptiMOS™, µcontroller & EiceDRIVER™ technology



Key applications:
power tools & pedelecs

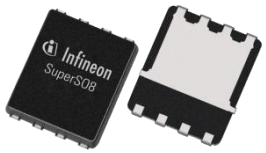
Features:
- Graphical User Interface (GUI)
- Topology: B6 inverter

Available to order at
www.infineon.com/motorcontrolapplicationkit

Benefits of Infineon Components

Reliable and robust products for highest system durability and reliability

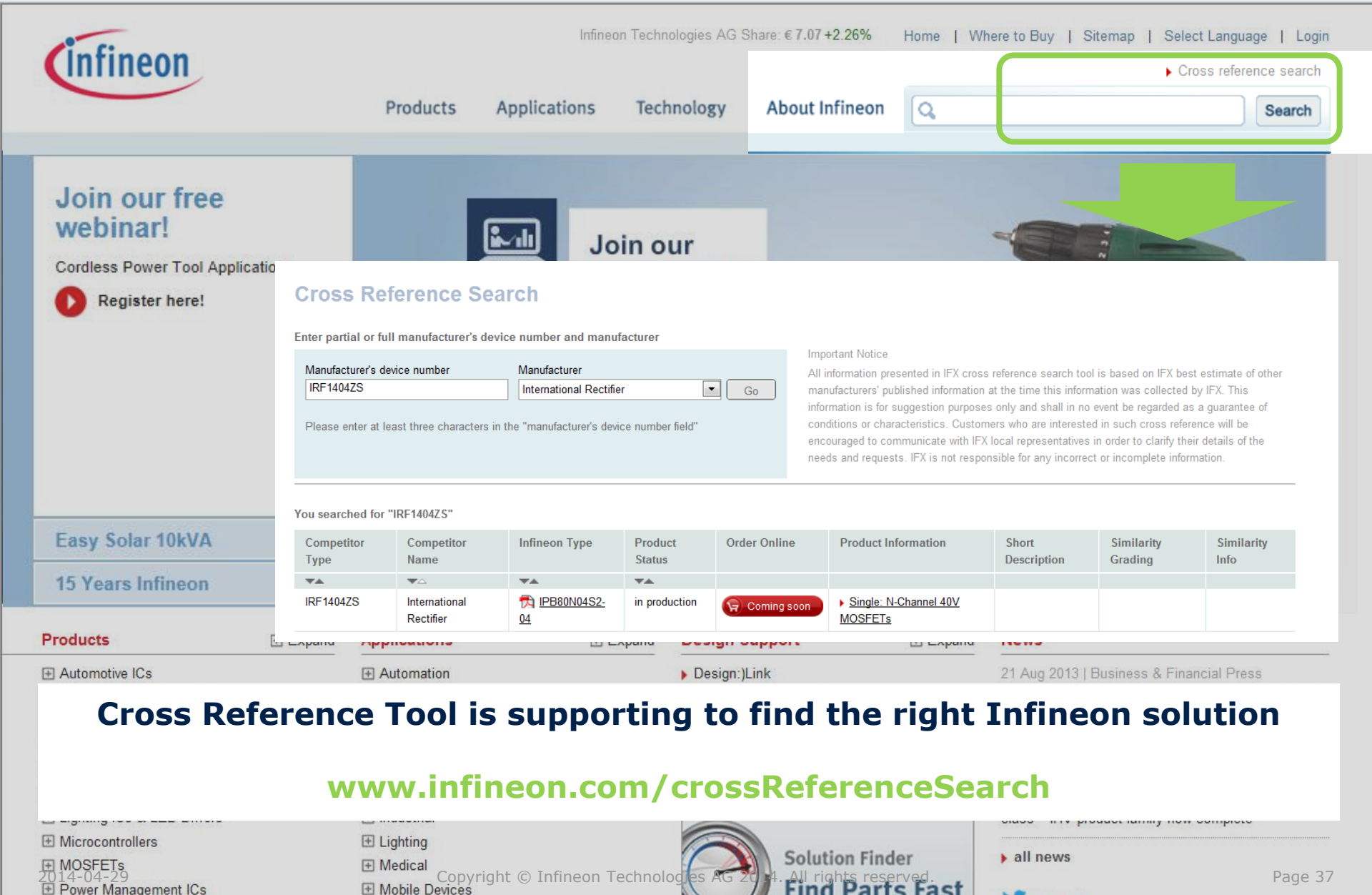
Lowest $R_{DS(on)}$) 1.0mΩ, 40V in SuperSO8 and **highest current capability** up to 300A in TO-Leadless for highest system efficiency and best thermal performance



Small form factors for compact design e.g. SuperS08 30mm² leading to reduction of overall system size and cost

Evaluation boards for fast prototyping and testing and in-depth system support enable **reduction of development time and cost.**

Online Support: Cross Referencing on Infineon Internet

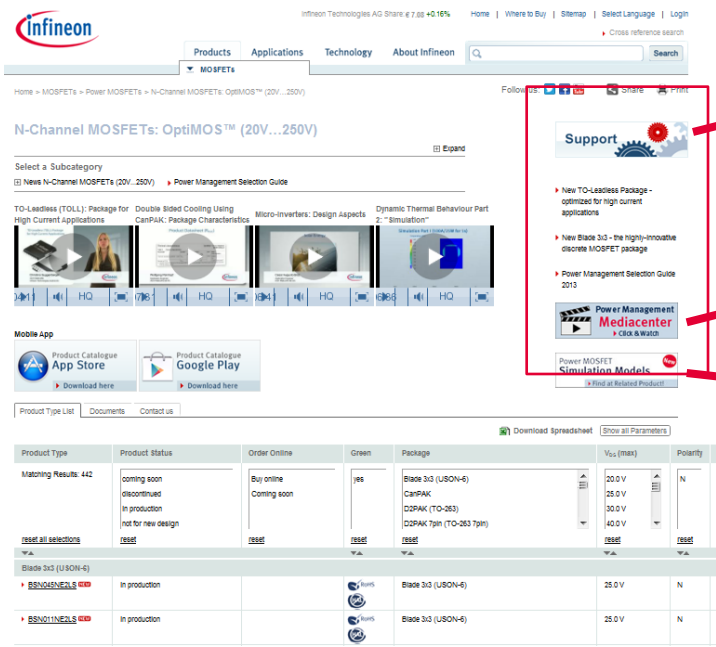


Cross Reference Tool is supporting to find the right Infineon solution

www.infineon.com/crossReferenceSearch

Online Support: Product Pages

Browse our Product Page for ad. information: www.infineon.com



- Online Chat
- E-Mail
- Call Center

- Tutorials
- E-Learnings

- Pspice
- Intusoft Spice
- Saber

Re-directs to product pages

1. MOSFETs: www.infineon.com/optimos; www.infineon.com/smallsignal
2. Microcontroller: www.infineon.com/xmc
3. Gate Driver: www.infineon.com/eicedriver

Always a Step Ahead with Infineon's Products

Contact point

- ( )

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ENERGY EFFICIENCY
MOBILITY
SECURITY

Innovative semiconductor solutions for energy efficiency, mobility and security.