

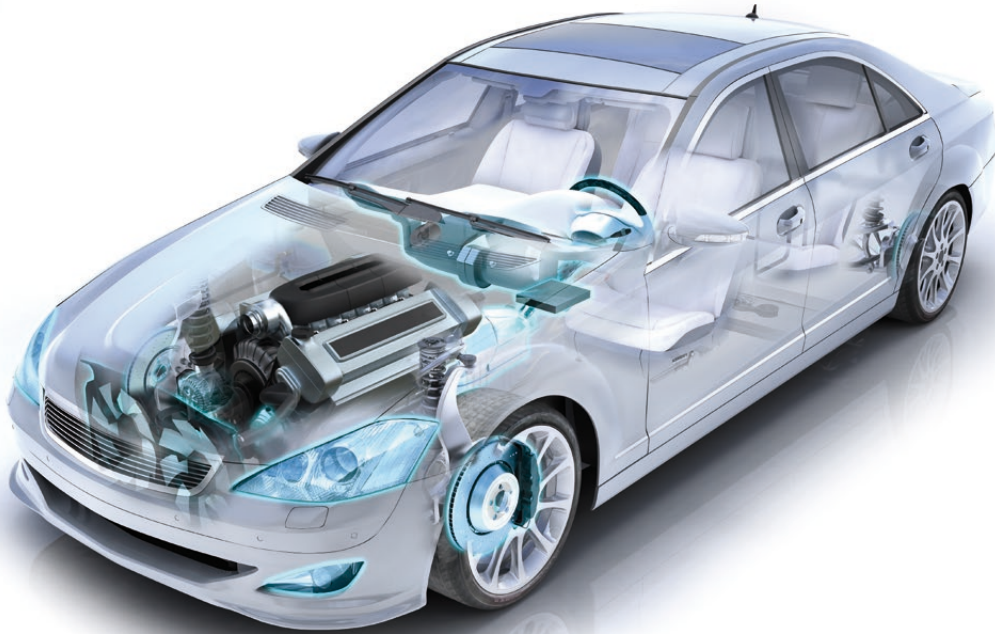


# Automotive Power MOSFET Selection Guide 2016

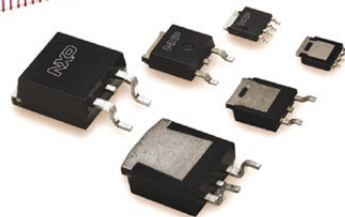
Performance, Quality, Reliability



# Automotive Power MOSFETs



- ▶ Semiconductor components play an increasingly important role in a vehicle's **performance, comfort and reliability**. Only suppliers with specialist knowledge and experience can create the solutions that meet and exceed the current and future demands of automotive electronics modules and systems.
- ▶ NXP is a clear leader in the area of power MOSFETs for automotive applications. Our dedicated focus on **low-voltage MOSFET solutions**, focused technical capability and in-depth understanding of automotive system requirements enables us to provide power semiconductor solutions that meet a wide spectrum of applications. From driving a simple lamp to the sophisticated needs of power management and control in engine, body or chassis applications, NXP power conductors can provide the answer to many automotive system power problems.
- ▶ NXP's power products are designed and manufactured around the key themes of **performance, quality and reliability** and are built to withstand long-term operation in some of the harshest environments within a typical vehicle.
- ▶ In addition, by providing a complete **technology, device and service capability**, NXP helps you meet the diverse and rigorous technical demands of today's automotive power switching and control applications, driving the development of tomorrow's vehicles and keeping you ahead of the rest.
- ▶ Put simply, NXP gives you the power to meet the challenges of automotive power system design, every step of the way.



# Commitment to Quality

Designed with automotive in mind

## AEC-Q101

- ▶ NXP Automotive Power MOSFETs are commonly deployed in many critical applications such as braking, power steering and engine management, where quality and reliability requirements go beyond mere compliance with **AEC-Q101** standards.
- ▶ Product qualification strategies start with a baseline of AEC-Q101, but far exceed its requirements to reflect real automotive mission profiles.
- ▶ NXP has more than 15 years experience qualifying automotive-grade Trench MOSFETs in such applications, resulting in an impressive track record of reliability.



- ▶ All processes and plants are subject to regular internal audits, as well as **TS16949, VDA** and specific customer audits.
- ▶ Our rigorous attention to detail and commitment to automotive quality has resulted in a **sub-ppm combined line, field and 0 Km failure rate for automotive customers.**

## DfX EXCELLENCE

- ▶ NXP's **Design for Excellence (DfX)** program ensures each new development builds on past learning and that best practices are always employed, resulting in continual product improvement.

## ZD ZERO DEFECT

- ▶ Our dedicated team of product quality, failure analysis and process engineers supports **our zero-defects** culture at all stages of development and production. We're determined to find real root causes and eliminate failure modes with widespread adoption of quality analysis tools and methodologies. Failure analysis is supported by a determination to find real Root Causes and eliminate failure modes with widespread adoption of quality analysis tools and methodologies.
- ▶ Dedicated design and manufacturing facilities focused on providing superior automotive quality are at the heart of NXP's manufacturing setup. From silicon and package design, through diffusion, and over to assembly and test, we carry out every process step for automotive products within our internal and qualified partner facilities.

# 4 Steps to select an Automotive MOSFET

1

Select a voltage (e.g., 40 V)

2

Select a package (e.g., LFPAK56)

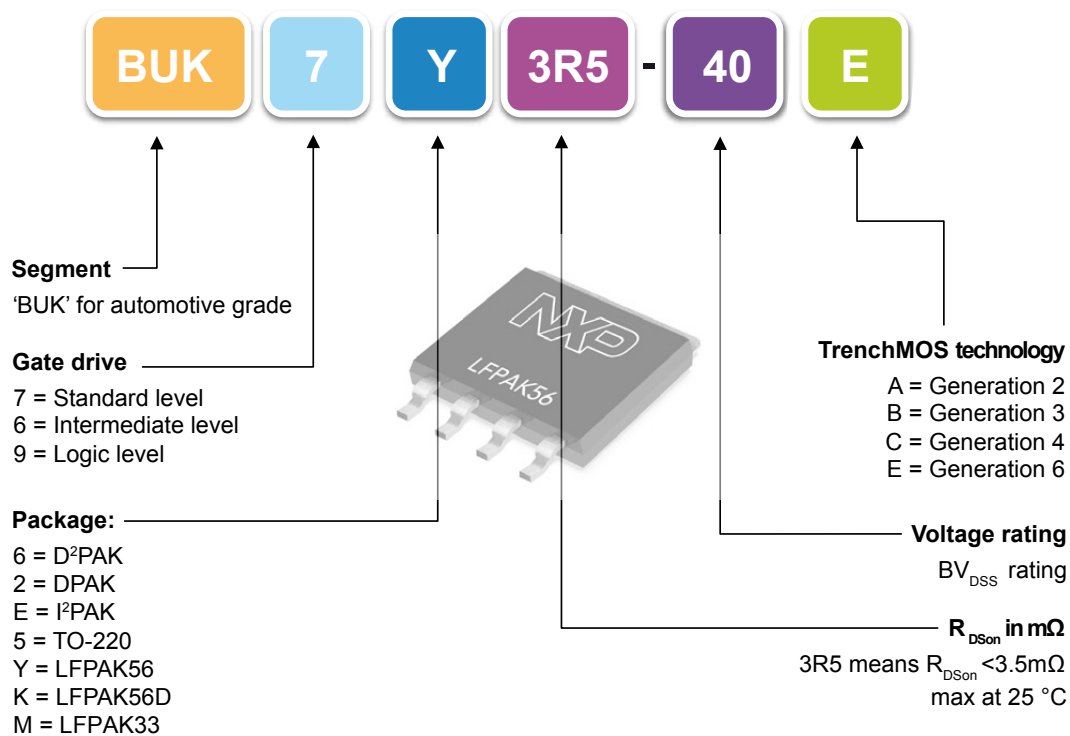
3

Choose an  $R_{DSon}$  from our extensive range

4

Select a 'BUK' type and visit [www.nxp.com/automotivemosfets](http://www.nxp.com/automotivemosfets) to download datasheets, models and order samples

## Automotive-Grade MOSFET Naming Convention





# High-Performance Automotive MOSFETs

## MOSFET Package Selection

### Through Hole

#### TO220

- ▶ Industry standard
- ▶ 120 A



#### I<sup>2</sup>PAK

- ▶ Industry standard
- ▶ 120 A



### Premium Performance

#### D<sup>2</sup>PAK

- ▶ Industry standard
- ▶ 120 A

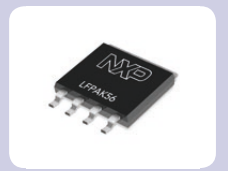


### Surface Mount

### Space Saving

#### LFAK56

- ▶ Power-SO8
- ▶ Copper clip technology
- ▶ 100 A



#### LFAK56D

- ▶ Dual Power-SO8
- ▶ 40 A Per channel
- ▶ Copper clip technology



#### LFAK33

- ▶ Power33
- ▶ Copper clip technology
- ▶ 70 A



#### DPAK

- ▶ Industry standard
- ▶ Proven reliability
- ▶ 100 A



#### SOT223

- ▶ Industry standard
- ▶ Proven reliability

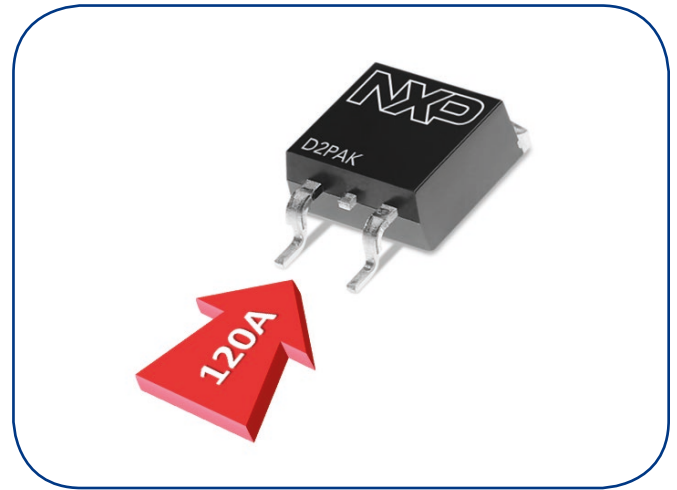


All packages are Automotive AEC-Q101 qualified to 175 °C and RoHs compliant.

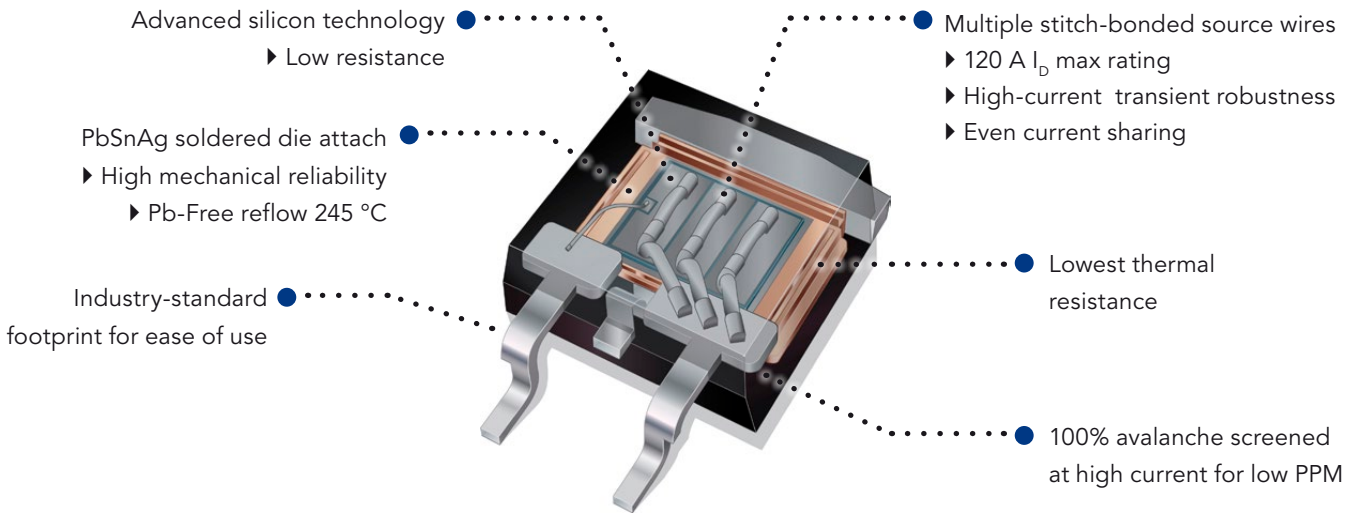
# D<sup>2</sup>PAK

## D<sup>2</sup>PAK—premium performance SMD products

The NXP D<sup>2</sup>PAK portfolio is ideally suited for high-power automotive application areas such as powertrain, chassis and safety. Combining advanced TrenchMOS technology with high-current packaging enables a product that delivers ultra-low on-state resistance and thermal performance within an industry-standard footprint.



Fully AEC-Q101 qualified to 175 °C



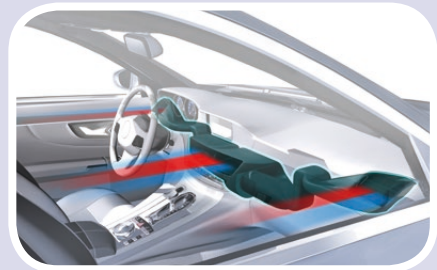
### POWERTRAIN

- ▶ Engine control
- ▶ Gearbox clutch
- ▶ Engine fan
- ▶ Electric vehicle
- ▶ Micro-Hybrid drive
- ▶ DC-DC converters



### CHASSIS & SAFETY

- ▶ Electric power steering (EPS)
- ▶ Vehicle stability (ESP)
- ▶ Braking systems (ABS)
- ▶ Electric parking brake (EPB)



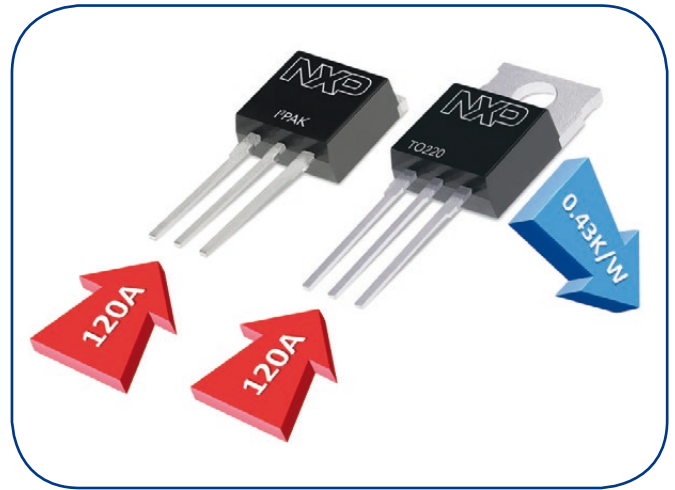
### BODY & SECURITY

- ▶ Climate control (HVAC)
- ▶ Wiper systems

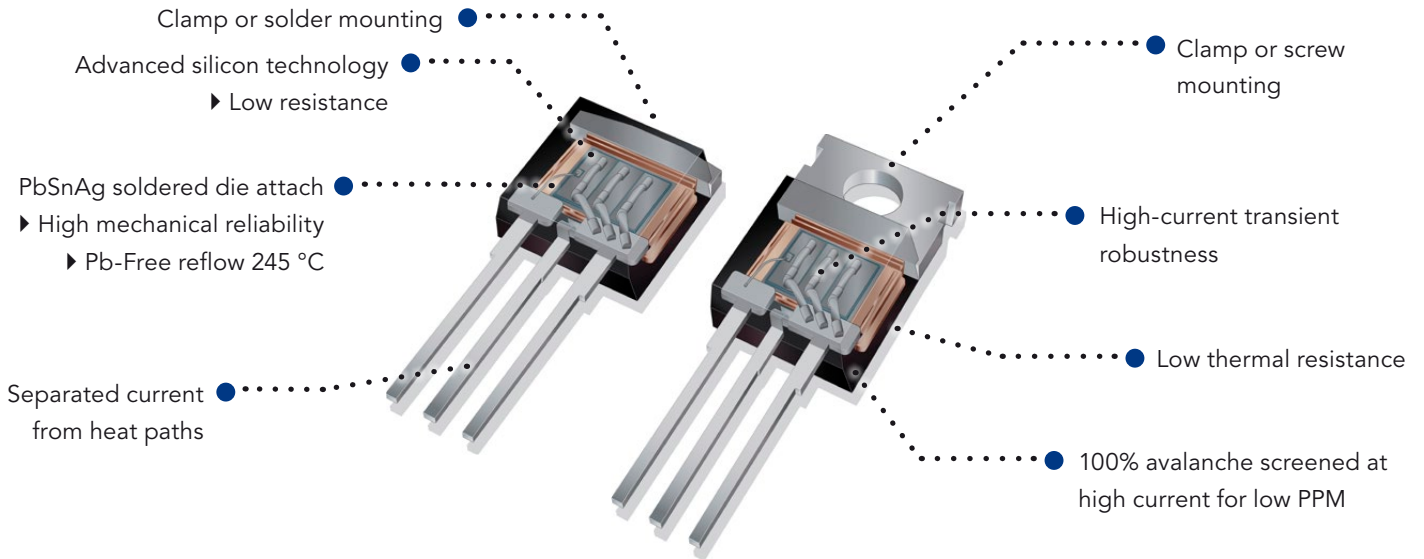
# I<sup>2</sup>PAK/TO-220

## I<sup>2</sup>PAK/TO-220—High-performance through-hole products

Providing industry-leading performance for through-hole products NXP's I<sup>2</sup>PAK/TO-220 portfolio enables the separation of the electrical and thermal pathways to optimise module performance. The convenience of the tab for screw mounting on the TO-220 is complemented by the industry-standard footprint and excellent current handling performance. Similarly the I<sup>2</sup>PAK can be readily soldered down to form a low resistance path.



Fully AEC-Q101 qualified to 175 °C



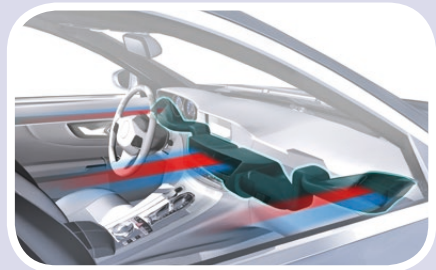
### POWERTRAIN

- ▶ Engine control
- ▶ Engine fan
- ▶ Electric vehicle
- ▶ Micro-Hybrid drive
- ▶ DC-DC converters



### CHASSIS & SAFETY

- ▶ Electric power steering (EPS)
- ▶ Braking systems (ABS)
- ▶ Electric parking brake (EPB)



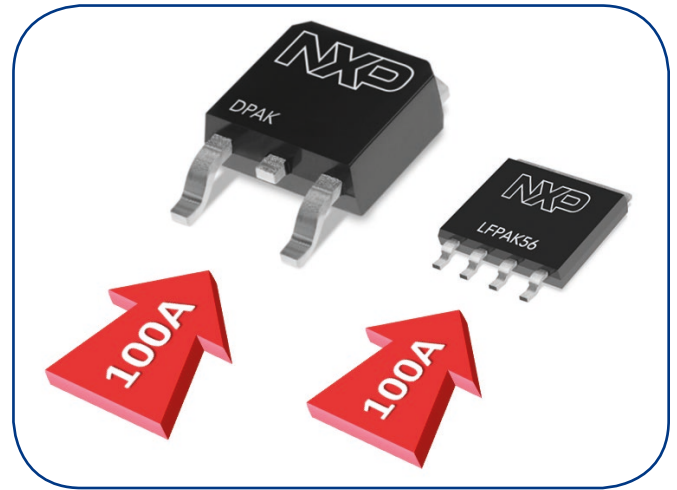
### BODY & SECURITY

- ▶ Climate control (HVAC)
- ▶ Wiper systems
- ▶ Electric horn

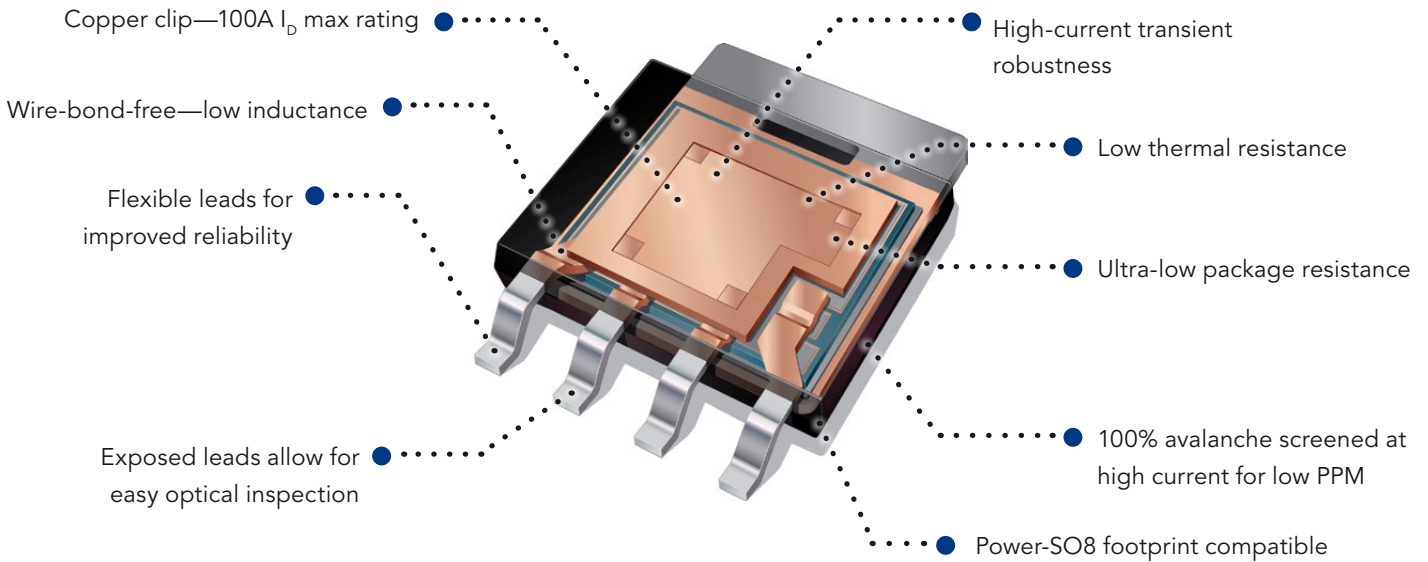
# LFAK56

## LFAK56—the Power-SO8 that packs a punch

Providing a true alternative to DPAK, NXP’s LFAK56 portfolio gives industry-leading performance in a truly innovative automotive grade package. Saving a considerable amount of space compared to traditional DPAK solutions the LFAK56 offers designers flexibility and reliability without compromising thermal performance.



Fully AEC-Q101 qualified to 175 °C



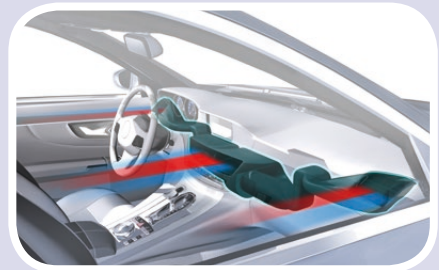
### POWERTRAIN

- ▶ Engine management
- ▶ Gearbox/clutch
- ▶ Engine fan
- ▶ Fuel/Water pump
- ▶ Auxiliary valves



### CHASSIS & SAFETY

- ▶ Vehicle stability (ESP)
- ▶ Braking systems (ABS)
- ▶ Airbag
- ▶ Electric parking brake (EPB)



### BODY & SECURITY

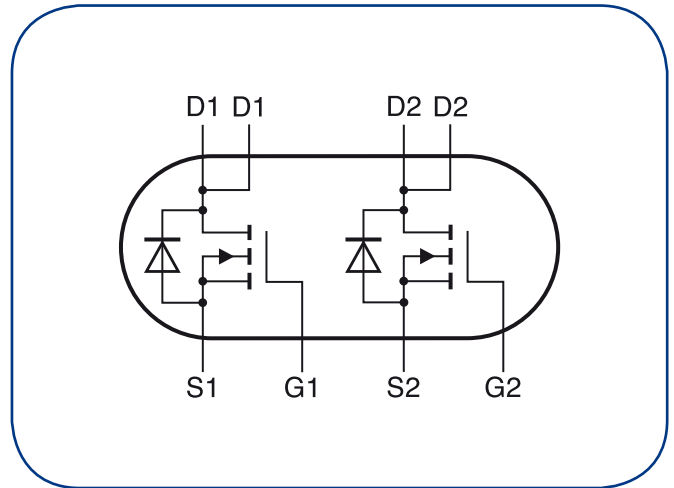
- ▶ Body control module
- ▶ Climate control (HVAC)
- ▶ Wiper systems
- ▶ Electric windows
- ▶ Electric mirrors
- ▶ Electric seats
- ▶ Sunroof
- ▶ Lighting



# LFAK56D

## LFAK56D—the ultimate dual MOSFET

Packing even more into the Power-SO8 footprint, the LFAK56D fits two MOSFETs into one robust package without compromising on performance. NXP's cutting-edge copper clip technology allows for exceptional current handling, ultra-low package resistance and supreme robustness and reliability. Perfect for situations where space is at a premium the LFAK56D offers power performance.

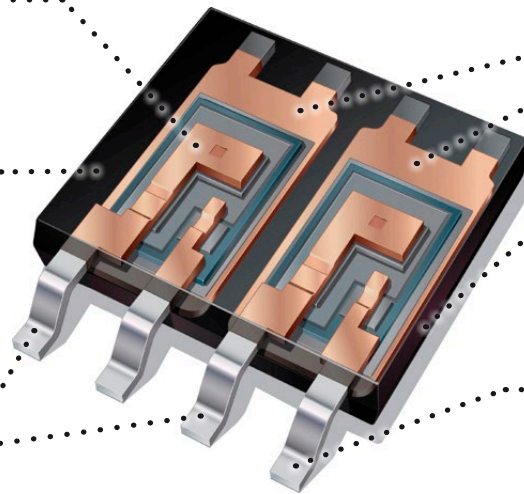


Fully AEC-Q101 qualified to 175 °C

Copper clip technology for low  $R_{DS(on)}$  and high robustness

100% avalanche screened at high current for low PPM

Up to 40 A per channel



Separate drain connections

Dual Power-SO8 footprint compatible

Flexible leads for improved manufacturability, inspectability and reliability

## LFAK56D Footprint Comparison

Product



Pad Layout



Footprint Area

31 mm<sup>2</sup>

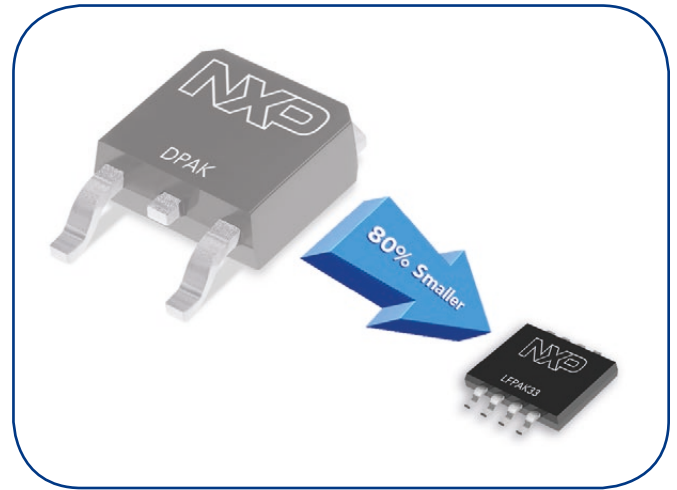
62 mm<sup>2</sup>

140 mm<sup>2</sup>

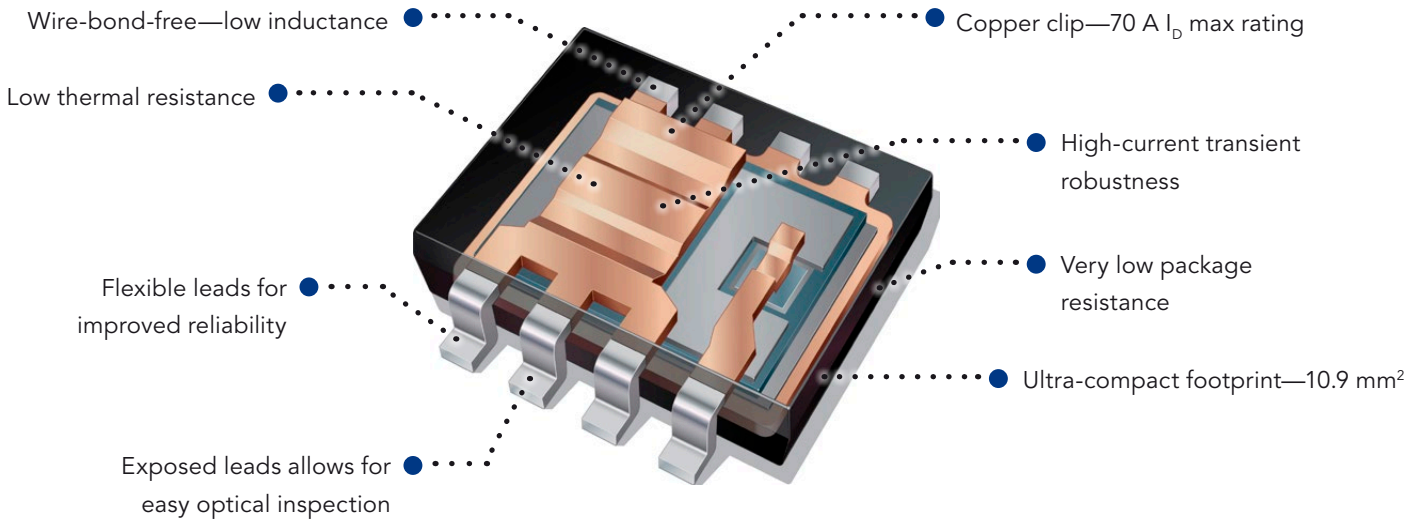
# LFAK33

## LFAK33—Shrinking the power footprint

With ever increasing pressure to reduce the size of modules while at the same time increasing their functionality, LFAK33 provides the benchmark in low-resistance, small-footprint packaging. The LFAK33 brings NXP's robust and reliable copper clip technology to the Power33 (3.3 mm x 3.3 mm) footprint.



Fully AEC-Q101 qualified to 175 °C



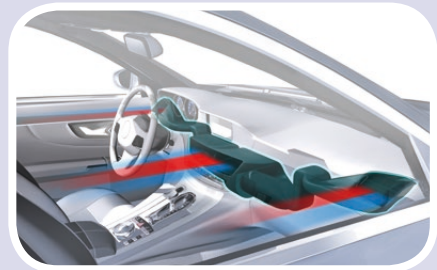
### POWERTRAIN

- ▶ Engine management
- ▶ Transmission
- ▶ Fuel/Water pump
- ▶ Auxiliary valves



### BODY CONTROL



- ▶ Body control module
- ▶ Wiper systems
- ▶ Electric windows
- ▶ Electric seating
- ▶ Electric mirrors
- ▶ Lighting



### CHASSIS AND SAFETY



- ▶ Vehicle stability (ESP)
- ▶ Braking systems (ABS)
- ▶ Electric parking brake (EPB)
- ▶ Airbag

## 30 V Automotive MOSFET

PACKAGE NAME	TYPE NUMBER	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ $V_{GS} = 10$ V (m $\Omega$ )	$R_{DS(on)}$ [max] @ $V_{GS} = 5$ V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
LFPAK56; Power-SO8 	BUK9Y07-30B	30	6	7	75	1.42
	BUK7Y07-30B	30	7		75	1.42
	BUK9Y11-30B	30	9	11	59	2
	BUK7Y10-30B	30	10		67	1.76
	BUK9Y22-30B	30	19	22	38	2.53
	BUK7Y20-30B	30	20		40	2.53
LFPAK56D; Dual Power-SO8 	<b>BUK9K5R1-30E</b>	<b>30</b>	<b>4.4</b>	<b>5.3</b>	<b>40</b>	<b>2.21</b>
	<b>BUK9K5R6-30E</b>	<b>30</b>	<b>4.7</b>	<b>5.8</b>	<b>40</b>	<b>2.36</b>
	<b>BUK7K5R1-30E</b>	<b>30</b>	<b>5.1</b>		<b>40</b>	<b>2.21</b>
	<b>BUK7K5R6-30E</b>	<b>30</b>	<b>5.6</b>		<b>40</b>	<b>2.36</b>
LFPAK33; Power33 	<b>BUK9M5R2-30E</b>	<b>30</b>	<b>4.1</b>	<b>5.2</b>	<b>70</b>	<b>1.89</b>
	<b>BUK9M6R6-30E</b>	<b>30</b>	<b>5.3</b>	<b>6.6</b>	<b>70</b>	<b>2</b>
	<b>BUK9M10-30E</b>	<b>30</b>	<b>7.8</b>	<b>10</b>	<b>59</b>	<b>2.75</b>
	<b>BUK9M17-30E</b>	<b>30</b>	<b>14</b>	<b>17</b>	<b>39</b>	<b>3.4</b>
D <sup>2</sup> PAK 	BUK962R8-30B	30	2.4	2.8	75	0.5
	BUK762R7-30B	30	2.7		75	0.5
	BUK763R4-30B	30	3.4		75	0.59
	BUK9607-30B	30	5	7	75	0.95
	BUK7607-30B	30	7		75	0.95
DPAK 	BUK9207-30B	30	5	7	75	0.95
	BUK7207-30B	30	7		75	0.95

Products in **bold** are Trench 6—latest generation technology. Products in **bold green** are new products.






## 40 V Automotive MOSFET

PACKAGE NAME	TYPE NUMBER	$V_{DS}$ [max] (V)	$R_{DSon}$ [max] @ VGS = 10 V (mΩ)	$R_{DSon}$ [max] @ VGS = 5 V (mΩ)	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
LFPAK56; Power-SO8 	BUK9Y3R0-40E	40	2.5	3	100	0.77
	BUK7Y3R5-40E	40	3.5		100	0.9
	BUK9Y3R5-40E	40	3.6	3.8	100	0.9
	BUK9Y4R4-40E	40	3.7	4.4	100	1.02
	BUK7Y4R4-40E	40	4.4		100	1.02
	BUK9Y7R6-40E	40	6	7.6	79	1.58
	BUK7Y7R6-40E	40	7.6		79	1.58
	BUK9Y12-40E	40	10	12	52	2.31
	BUK7Y12-40E	40	12		52	2.31
	BUK9Y21-40E	40	17	21	33	3.33
	BUK7Y21-40E	40	21		33	3.33
	BUK9Y29-40E	40	25	29	25	4.03
	BUK7Y29-40E	40	29		26	4.03
	LFPAK56D; Dual Power-SO8 	BUK7K6R2-40E	40	5.8		
BUK9K6R2-40E		40	6	6.2	40	2.21
BUK9K6R8-40E		40	6.1	7.2	40	2.36
BUK7K6R8-40E		40	6.8			2.36
BUK9K8R7-40E		40	8	9.4	30	2.84
BUK7K8R7-40E		40	8.5			2.84
BUK9K18-40E		40	16	19.5	30	3.96
BUK7K18-40E		40	19		24	3.96
BUK9K25-40E		40	24	29	18	4.68
BUK7K25-40E		40	25			4.68

Products in **bold** are Trench 6—latest generation technology.







## 40 V Automotive MOSFET

PACKAGE NAME	TYPE NUMBER	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ VGS = 10 V (m $\Omega$ )	$R_{DS(on)}$ [max] @ VGS = 5 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
LFAK33; Power33 	BUK7M6R3-40E	40	6.3		70	1.89
	BUK9M7R2-40E	40	5.8	7.2	70	1.89
	BUK7M8R0-40E	40	8		70	2
	BUK9M9R1-40E	40	7.3	9.1	66	2
	BUK7M10-40E	40	10		60	2.43
	BUK9M11-40E	40	9	11	56	2.43
	BUK7M12-40E	40	12		52	2.75
	BUK9M14-40E	40	11	14	48	2.75
	BUK7M21-40E	40	21		35	3.4
	BUK9M24-40E	40	20	24	31	3.4
	BUK7M45-40E	40	45		21	4.8
	BUK9M52-40E	40	40	52	19	4.8
D <sup>2</sup> PAK 	BUK961R6-40E	40	1.4	1.6	120	0.43
	BUK761R6-40E	40	1.57		120	0.43
	BUK761R7-40E	40	1.6		120	0.46
	BUK762R0-40E	40	2		120	0.51
	BUK962R6-40E	40	2.4	2.8	100	0.57
	BUK762R6-40E	40	2.6		100	0.57
	BUK963R1-40E	40	2.7	3.1	100	0.64
	BUK762R9-40E	40	2.9		100	0.64
	BUK964R1-40E	40	3.5	4.1	75	0.82
	BUK764R0-40E	40	4		75	0.82
	BUK965R4-40E	40	4.4	5.4	75	1.09
	BUK765R3-40E	40	4.9		75	1.09
DPAK 	BUK9209-40B	40	7	9	75	0.95
	BUK7208-40B	40	8		75	0.95
TO-220AB 	BUK751R8-40E	40	1.8		120	0.43
	BUK752R3-40E	40	2.3		120	0.51
	BUK753R1-40E	40	3.1		100	0.64
	BUK758R3-40E	40	7.4		75	1.56
I <sup>2</sup> PAK 	BUK7E1R8-40E	40	1.8		120	0.43
	BUK7E1R9-40E	40	1.9		120	0.46
	BUK7E2R3-40E	40	2.3		120	0.51
	BUK7E3R1-40E	40	3.1		100	0.64
	BUK7E8R3-40E	40	7.4		75	1.56






Products in **bold** are Trench 6—latest generation technology. Products in **green bold** are new products.

## 55–60 V Automotive MOSFET

PACKAGE NAME	TYPE NUMBER	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ VGS = 10 V (m $\Omega$ )	$R_{DS(on)}$ [max] @ VGS = 5 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
LFPAK56; Power-SO8 	BUK9Y4R8-60E	60	4.1	4.8	100	0.63
	BUK7Y4R8-60E	60	4.8		100	0.63
	BUK9Y6R0-60E	60	5.2	6	100	0.77
	BUK9Y7R2-60E	60	5.6	7.2	100	0.9
	BUK7Y6R0-60E	60	6		100	0.77
	BUK7Y7R2-60E	60	7.2		100	0.9
	BUK9Y8R7-60E	60	7.5	8.7	86	1.02
	BUK7Y8R7-60E	60	8.7		87	1.02
	BUK9Y15-60E	60	13	15	53	1.58
	BUK7Y15-60E	60	15		53	1.59
	BUK9Y25-60E	60	22	25	34	2.31
	BUK7Y25-60E	60	25		34	2.31
	BUK9Y43-60E	60	38	43	22	3.33
	BUK7Y43-60E	60	43		22	3.33
	BUK9Y59-60E	60	52	59	17	4.03
BUK7Y59-60E	60	59		17	4.03	
LFPAK56D; Dual Power-SO8 	BUK7K12-60E	60	9.3			2.21
	BUK7K13-60E	60	10		40	2.36
	BUK9K12-60E	60	11	12	35	2.21
	BUK9K13-60E	60	11	13	40	2.36
	BUK7K17-60E	60	14		30	2.84
	BUK9K17-60E	60	16	17	26	2.84
	BUK7K35-60E	60	30		21	3.96
	BUK9K35-60E	60	32	35	22	3.96
	BUK9K35-60E	60	32	35	22	3.96
	BUK7K52-60E	60	45		15	4.68
BUK9K52-60E	60	49	55	16	4.68	
LFPAK33; Power33 	<b>BUK7M9R9-60E</b>	60	<b>9.9</b>		<b>60</b>	<b>1.89</b>
	BUK7M12-60E	60	12		54	2
	BUK9M12-60E	60	11	12	54	1.89
	BUK7M15-60E	60	15		46	2.43
	BUK9M15-60E	60	13	15	49	2
	BUK7M19-60E	60	19		39	2.75
	BUK9M19-60E	60	17	19	40	2.43
	BUK9M24-60E	60	21	24	34	2.75
	BUK7M33-60E	60	33		26	3.4
	BUK7M42-60E	60	42		21	4.17
	BUK9M42-60E	60	37	42	23	3.4
	BUK9M53-60E	60	46	53	19	4.17
	BUK7M67-60E	60	67		16	4.8
BUK9M85-60E	60	73	85	14	4.8	
D <sup>2</sup> PAK 	BUK7610-55AL	55	10		75	0.5
	BUK7610-55AL	55	10		75	0.5
	BUK9620-55A	55	18	20	54	1.2
	BUK7620-55A	55	20		54	1.2
	BUK9624-55A	55	22	24	46	1.4
	BUK7624-55A	55	24		47	1.4
	BUK9628-55A	55	25	28	42	1.5
	BUK7628-55A	55	28		42	1.5
	BUK9635-55A	55	32	35	34	1.8
	BUK7635-55A	55	35		35	1.7
	BUK9675-55A	55	68	75	20	2.4
BUK7675-55A	55	75		20	2.4	







Products in **bold** are Trench 6—latest generation technology. Products in **green bold** are new products.

## 55–60 V Automotive MOSFET

PACKAGE NAME	TYPE NUMBER	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ VGS = 10 V (m $\Omega$ )	$R_{DS(on)}$ [max] @ VGS = 5 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
D <sup>2</sup> PAK 	BUK962R5-60E	60	2.3	2.5	120	0.43
	BUK762R4-60E	60	2.4		120	0.43
	BUK962R8-60E	60	2.5	2.8	120	0.46
	BUK762R6-60E	60	2.6		120	0.46
	BUK963R3-60E	60	3	3.3	120	0.51
	BUK763R1-60E	60	3.1		120	0.51
	BUK763R9-60E	60	3.9		100	0.57
	BUK964R2-60E	60	3.9	4.2	100	0.57
	BUK964R8-60E	60	4.4	4.8	100	0.64
	BUK764R4-60E	60	4.5		100	0.64
	BUK966R5-60E	60	5.9	6.5	75	0.82
	BUK766R0-60E	60	6		75	0.82
	BUK969R0-60E	60	8	9	75	1.09
	BUK768R3-60E	60	8.3		75	1.09
	BUK9614-60E	60	13	14	56	1.56
	BUK7613-60E	60	13		58	1.56
	DPAK 	BUK9215-55A	55	14	15	62
BUK7215-55A		55	15		62	1.3
BUK9219-55A		55	18	19	55	1.3
BUK7219-55A		55	19		55	1.3
BUK9222-55A		55	20	22	48	1.5
BUK7222-55A		55	22		48	1.5
BUK9225-55A		55	22	25	43	1.6
BUK7225-55A		55	25		43	1.6
BUK9230-55A		55	27	30	38	1.7
BUK7230-55A		55	30		38	1.7
BUK9237-55A		55	33	37	32	1.94
BUK7237-55A		55	37		32	1.9
BUK9245-55A		55	40	45	28	2.1
BUK9277-55A		55	69	77	18	2.93
BUK7277-55A		55	77		18	2.9
BUK92150-55A		55	125	140	11	4.1
BUK72150-55A		55	150		11	4.1
BUK9210-55B		55	10		75	0.95
BUK9212-55B		55	10	12	75	0.95
BUK7212-55B		55	12		75	0.95
<b>BUK929R1-60E</b>		<b>60</b>	<b>8.1</b>	<b>9.1</b>	<b>75</b>	<b>1.08</b>
<b>BUK9213-60E</b>		<b>60</b>	<b>12</b>	<b>13</b>	<b>58</b>	<b>1.53</b>
<b>BUK9223-60E</b>		<b>60</b>	<b>20</b>	<b>23</b>	<b>36</b>	<b>2.29</b>
SC-73 	BUK9832-55A/CU	55	29	32		
	BUK9880-55A/CU	55	73	80		
	BUK7880-55A/CU	55	80			
	BUK98150-55A/CU	55	137	150		
	BUK78150-55A/CU	55	150			
TO-220AB 	<b>BUK953R5-60E</b>	<b>60</b>	<b>3.4</b>	<b>3.7</b>	<b>120</b>	<b>0.51</b>
	<b>BUK954R8-60E</b>	<b>60</b>	<b>4.5</b>	<b>4.9</b>	<b>100</b>	<b>0.64</b>
I <sup>2</sup> PAK 	<b>BUK7E2R6-60E</b>	<b>60</b>	<b>2.6</b>		<b>120</b>	<b>0.43</b>
	<b>BUK7E3R5-60E</b>	<b>60</b>	<b>3.5</b>		<b>120</b>	<b>0.51</b>
	<b>BUK7E4R6-60E</b>	<b>60</b>	<b>4.6</b>		<b>100</b>	<b>0.64</b>
	<b>BUK7E13-60E</b>	<b>60</b>	<b>13</b>		<b>58</b>	<b>1.56</b>

Products in **bold** are Trench 6—latest generation technology. Products in **green bold** are new products.









## 75-80 V Automotive MOSFET

PACKAGE NAME	TYPE NUMBER	V <sub>DS</sub> [max] (V)	R <sub>DSon</sub> [max] @ 10 V (mΩ)	R <sub>DSon</sub> [max] @ 5 V (mΩ)	I <sub>D</sub> [max] @ 25 °C (A)	R <sub>th(j-mb)</sub> [max] (K/W)
LFPAK56; Power-SO8 	BUK7Y7R8-80E	80	7.8		100	0.63
	BUK9Y8R5-80E	80	8	8.5	100	0.63
	BUK7Y9R9-80E	80	9.9		89	0.77
	BUK7Y9R9-80E	80	9.9		89	0.77
	BUK9Y11-80E	80	10	11	84	0.77
	BUK9Y14-80E	80	14	15	62	1.02
	BUK7Y14-80E	80	14		65	1.02
	BUK9Y25-80E	80	25	27	37	1.58
	BUK7Y25-80E	80	25		39	1.58
	BUK9Y41-80E	80	41	45	24	2.33
	BUK7Y41-80E	80	41		25	2.31
	BUK9Y72-80E	80	72	78	15	3.33
	BUK7Y72-80E	80	72		16	3.33
	BUK9Y107-80E	80	98	107	12	4.03
LFPAK56D; Dual Power-SO8 	BUK9K19-80E	80	17	19	38	2.21
	BUK7K19-80E	80	19		38	2.21
	BUK9K21-80E	80	19	21	35	2.36
	BUK7K21-80E	80	21		35	2.36
	BUK9K29-80E	80	21	29	27	2.84
	BUK7K29-80E	80	29		27	2.84
LFPAK33; Power33 	BUK7M17-80E	80	17		43	1.89
	BUK7M22-80E	80	22		38	2
	BUK9M23-80E	80	20	23	37	1.89
	BUK7M27-80E	80	27		32	2.43
	BUK9M28-80E	80	25	28	34	2
	BUK9M35-80E	80	31	35	28	2.43
D <sup>2</sup> PAK 	BUK7613-75B	75	13		75	0.95
	BUK9616-75B	75	14	16	67	0.95
	BUK7623-75A	75	23		53	1.1
	BUK763R8-80E	80	3.8		120	0.43
	BUK964R2-80E	80	4	4.2	120	0.43
	BUK764R2-80E	80	4.2		120	0.46
	BUK964R7-80E	80	4.5	4.7	120	0.46
	BUK769R6-80E	80	9.6		75	0.82
	BUK9611-80E	80	10	11	75	0.82
DPAK 	BUK7214-75B	75	14		69	0.95
	BUK9217-75B	75	15	17	64	0.95
	BUK9226-75A	75	25	26	45	1.3
	BUK7226-75A	75	26		45	1
	BUK9214-80E	80	13	14	63	1.08
	BUK9230-80E	80	28	30	32	1.99
TO-220AB 	BUK753R8-80E	80	4		120	0.43

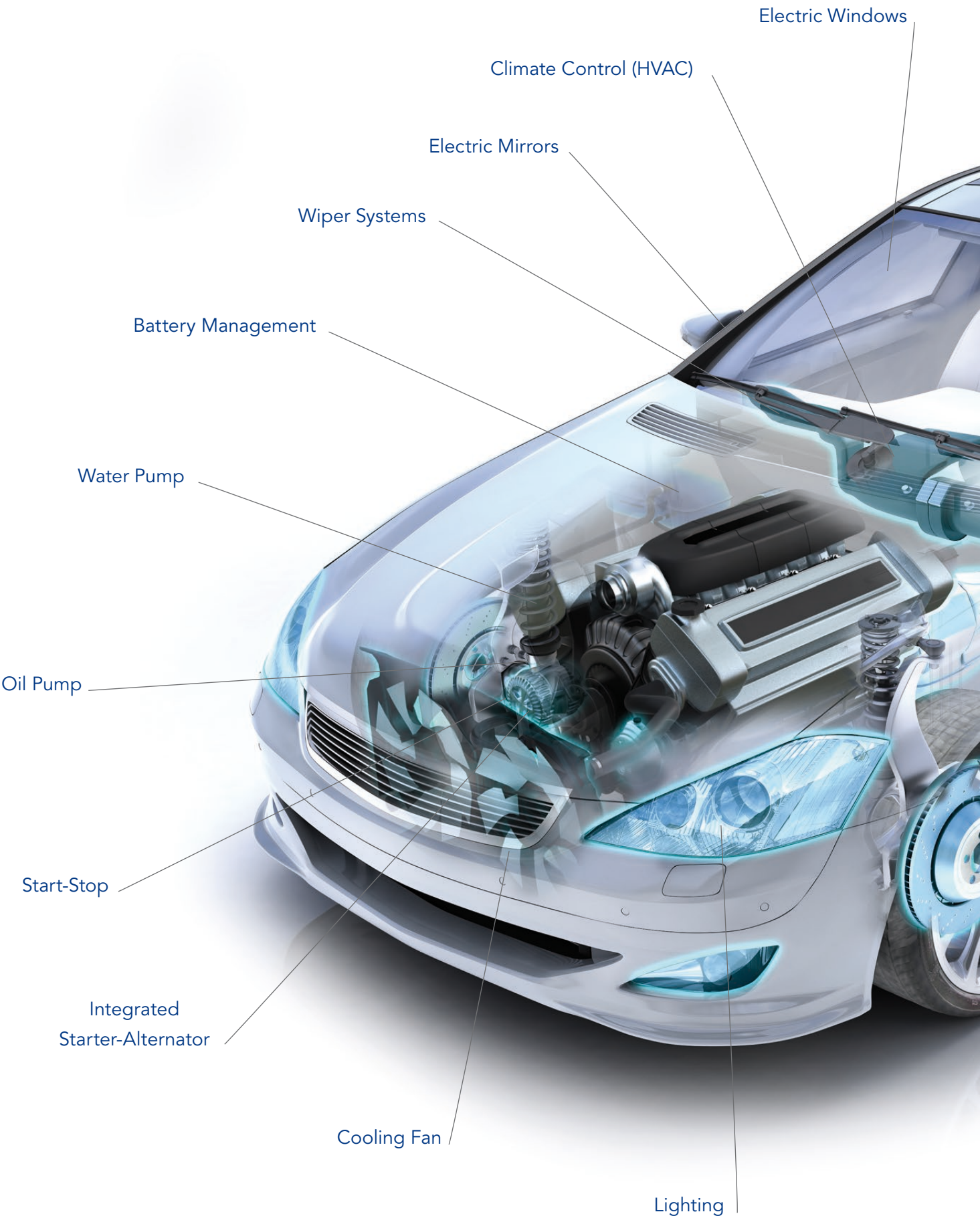
Products in **bold** are Trench 6—latest generation technology. Products in **bold green** are new products. Products in **bold grey** are in development



# 100 V Automotive MOSFET

PACKAGE NAME	TYPE NUMBER	V <sub>DS</sub> [max] (V)	R <sub>DSon</sub> [max] @ 10 V (mΩ)	R <sub>DSon</sub> [max] @ 5 V (mΩ)	I <sub>D</sub> [max] @ 25 °C (A)	R <sub>th(j-mb)</sub> [max] (K/W)
LFAK56; Power-SO8 	BUK9Y12-100E	100	12	12	85	0.63
	BUK7Y12-100E	100	12		85	0.63
	BUK9Y15-100E	100	15	15	69	0.77
	BUK7Y15-100E	100	15		68	0.77
	BUK9Y19-100E	100	18	19	56	0.9
	BUK7Y19-100E	100	19		56	0.9
	BUK9Y22-100E	100	22	22	49	1.02
	BUK7Y22-100E	100	22		49	1.02
	BUK9Y38-100E	100	38	38	30	1.58
	BUK7Y38-100E	100	38		30	1.58
	BUK9Y65-100E	100	63	65	19	2.31
	BUK7Y65-100E	100	65		19	2.31
	BUK9Y113-100E	100	110	113	12	3.33
	BUK7Y113-100E	100	113		12	3.33
BUK9Y153-100E	100	146	153	9	4.03	
BUK7Y153-100E	100	153		9	4.03	
LFAK56D; Dual Power-SO8 	BUK7K29-100E	100	25		30	2.21
	BUK9K29-100E	100	27	29	30	2.21
	BUK7K32-100E	100	28		26	2.36
	BUK9K32-100E	100	31	33	26	2.36
	BUK7K45-100E	100	38		21	2.84
	BUK9K45-100E	100	42	45	21	2.84
	BUK7K89-100E	100	83		13	3.96
	BUK9K89-100E	100	85	89	13	3.96
	BUK7K134-100E	100	121		9	4.68
	BUK9K134-100E	100	154	159	9	4.68
LFAK33; Power33 	<b>BUK9M34-100E</b>	100	34	35	28	1.89
	<b>BUK9M43-100E</b>	100	43	44	26	2
	<b>BUK9M120-100E</b>	100	119	120	12	3.4
	<b>BUK9M156-100E</b>	100	150	156	10	4.17
D <sup>2</sup> PAK 	BUK765R0-100E	100	5		120	0.43
	BUK965R8-100E	100	5.6	5.8	120	0.43
	BUK768R1-100E	100	8.1		100	0.57
	BUK969R3-100E	100	8.9	9.3	100	0.57
	BUK7613-100E	100	13		72	0.82
	BUK9615-100E	100	14	15	66	0.82
	BUK7631-100E	100	31		34	1.56
	BUK9637-100E	100	36	37	31	1.56
	BUK9660-100A	100	58	60	26	1.4
	BUK7660-100A	100	60		26	1.4
	BUK9675-100A	100	72	75	23	1.5
	BUK7675-100A	100	75		23	1.5
	BUK96180-100A	100	173	180	11	2.8
DPAK 	<b>BUK9222-100E</b>	100	22	22	48	1.08
	BUK7227-100B	100	27		48	0.95
	BUK9230-100B	100	28	30	47	0.95
	<b>BUK9234-100E</b>	100	33	34	32	1.53
	BUK9240-100A	100	39	40	33	1.3
	BUK7240-100A	100	40		34	1.3
	BUK9275-100A	100	72	75	22	1.7
SC-73 	BUK7275-100A	100	75		22	1.7
	BUK9875-100A	100	72	75	7	
SC-73	BUK98180-100A	100	173	180	5	
TO-220AB 	BUK755R4-100E	100	5.2		120	0.43
I <sup>2</sup> PAK 	BUK7E5R2-100E	100	5.2		120	0.43

Products in **bold** are Trench 6—latest generation technology. Products in **bold green** are new products.



Electric Windows

Climate Control (HVAC)

Electric Mirrors

Wiper Systems

Battery Management

Water Pump

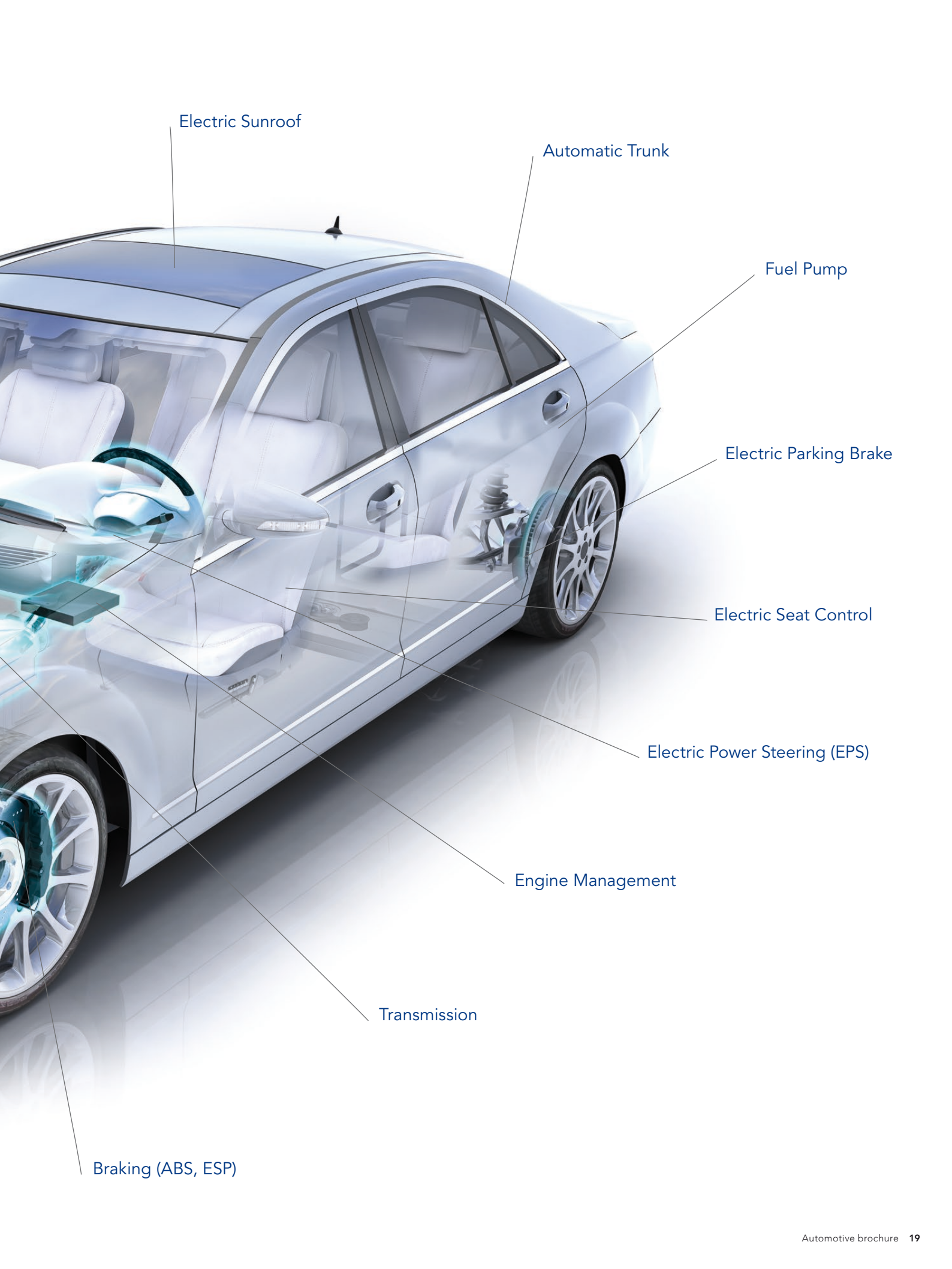
Oil Pump

Start-Stop

Integrated Starter-Alternator

Cooling Fan

Lighting



Electric Sunroof

Automatic Trunk

Fuel Pump

Electric Parking Brake

Electric Seat Control

Electric Power Steering (EPS)

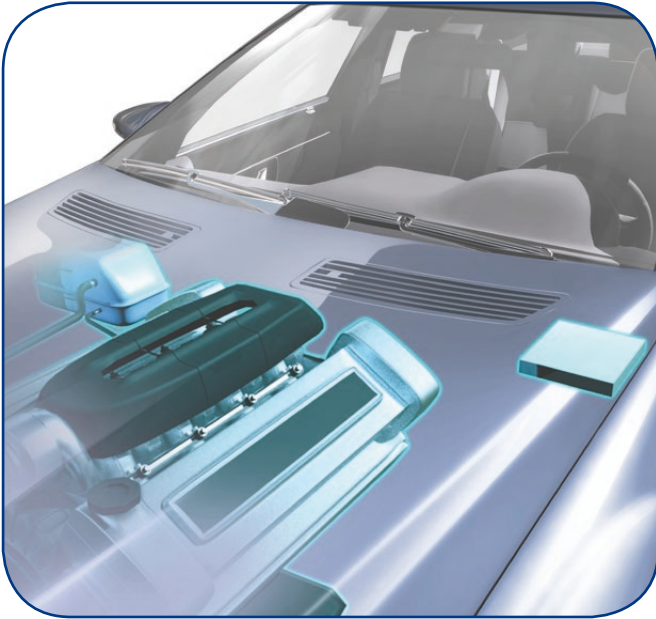
Engine Management

Transmission

Braking (ABS, ESP)



# Engine Management



## Application considerations

Injector/valve controllers form a building block within both diesel and gasoline engine control modules to deliver optimum fuel consumption. The injectors are controlled by a complex 'peak and hold' current control. The 'peak' current opens the valve and the 'hold' current maintains the valve in the open position.

**Diesel injection:** Various topologies are used, but are usually differentiated by those that apply a boost voltage and those that don't.

**Gasoline injection:** The main configurations are 'multi-point' and 'direct' injection. The circuit topology is similar to that of diesel injectors.

## Key MOSFET requirements:

- ▶ High lifetime reliability
- ▶ High-current transient robustness
- ▶ Good thermal performance
- ▶ Small footprint
- ▶ Guaranteed repetitive avalanche capability

## The LPAK family (LPAK56, LPAK56D, LPAK33)

of MOSFETs are ideally suited to provide compact and thermally stable solutions for injection applications.

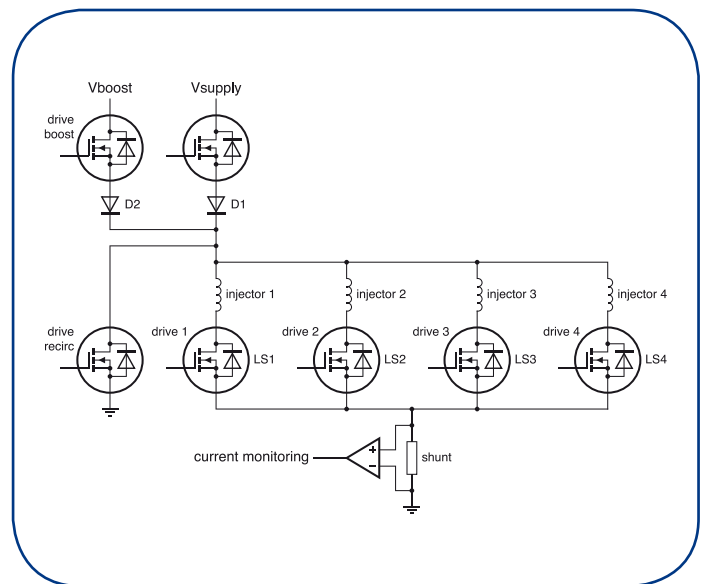
### Main benefits:

- ▶ Robust product using advanced copper clip technology
- ▶ Excellent current handling
- ▶ Compact footprint
- ▶ Repetitive avalanche rated

### Example products in LPAK56, LPAK56D and LPAK33

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-amb)}$ [max] (K/W)
BUK9K52-60E	60	49	16	4.68
BUK9M24-60E	60	21	34	2.75
BUK9M42-60E	60	37	23	3.4
BUK9Y41-80E	80	41	24	2.33
BUK9M23-80E	80	20	37	1.89
BUK9K29-100E	100	27	30	2.21
BUK9Y38-100E	100	38	30	1.58
BUK9M34-100E	100	34	28	1.89

## Typical diesel injector drive





# Braking (ABS)



## Application considerations

Anti-locking braking systems are used on most vehicles to maintain contact with the road surface and prevent skidding in poor braking conditions such as icy or wet roads.

**A pump motor** is used to re-pressurize the systems when the ABS system operates. Typically a single MOSFET is used for one direction ON-OFF pump motor control with PWM used to give speed control. No freewheel diode is used in high-side version with the MOSFET clamping (linear mode) when the motor is switched off.

**Solenoids** are used for controlling brake pressure. Low-side MOSFETs are used for solenoid driving and the body diode is avalanched to improve solenoid drop out time. The MOSFET must be avalanche rugged.

**Reverse polarity protection** can be added using another single MOSFET with a simple gate drive.

**The safety switch** MOSFET is normally continuously ON.

The **LPAK family (LPAK56, LPAK56D, LPAK33)** of MOSFETs are ideally suited to provide compact and thermally stable solutions for braking systems.

## Main benefits:

- ▶ Robust product using advanced copper clip technology
- ▶ Excellent current handling
- ▶ Compact footprint

## Example products in LPAK56, LPAK56D and LPAK33

PRODUCT	$V_{DS}$ [max] (V)	$R_{DSon}$ [max] @ $V_{GS} = 10$ V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK9Y3R0-40E	40	2.5	100	0.77
BUK7K6R2-40E	40	5.8	40	2.21
BUK9Y59-60E	60	5.2	16.7	4.03
BUK9M24-60E	60	20	34	2.75

**D<sup>2</sup>PAK** MOSFETs can provide solutions for several power handling tasks, such as driving the main pump motor as the safety switch or handling reverse polarity protection tasks. The pump motor drive device could be a 40 V low  $R_{DSon}$  MOSFET.

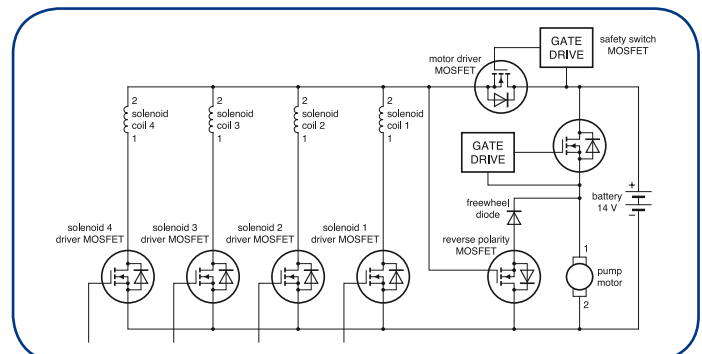
## Main benefits:

- ▶ Low on-resistance
- ▶ Low thermal resistance
- ▶ Highest current handling capability

## Example Products in D<sup>2</sup>PAK

PRODUCT	$V_{DS}$ [max] (V)	$R_{DSon}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK762R0-40E	40	2	120	0.51
BUK762R9-40E	40	2.9	100	0.64
BUK762R4-60E	60	2.4	120	0.43
BUK763R1-60E	60	3.1	120	0.51

## Typical solenoid driver circuit



# Electric Power Steering (EPS)



## Application considerations

Electric power steering (EPS) systems amplify the driver's steering responses to make steering easier.

EPS systems often use brushless DC motors. These motors provide the additional torque to the steering system for their compact size and lower system cost compared to equivalent mechanical solutions. They also improve performance, increase vehicle component lifetimes, reduce noise, increase reliability and make the installation process easier.

Motor power depends on vehicle size and performance. MOSFETs are configured in three-phase bridge arrangements to drive the BLDC motor. The system must be capable of handling worst-case current and thermal surges caused by the torque assistance pulses.

## Key MOSFET requirements:

- ▶ Low on-resistance
- ▶ Low thermal resistance
- ▶ High surge current capacity
- ▶ Flexible packaging solutions
- ▶ Guaranteed repetitive avalanche capability

**D<sup>2</sup>PAK** is ideally suited to provide high power density and surge current capability required for power steering systems.

## Main benefits:

- ▶ Lowest on-resistance
- ▶ Lowest thermal resistance
- ▶ Highest current handling capability
- ▶ Guaranteed repetitive avalanche rating

## Example products in D<sup>2</sup>PAK

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK761R6-40E	40	1.57	120	0.43
BUK761R7-40E	40	1.6	120	0.46
BUK762R0-40E	40	2	120	0.51
BUK762R9-40E	40	2.9	100	0.64
BUK764R0-40E	40	4	75	0.82
BUK763R8-80E	80	3.8	120	0.43

**I<sup>2</sup>PAK & TO-220** provide flexible solutions for power steering systems where through-hole mounting is adopted.

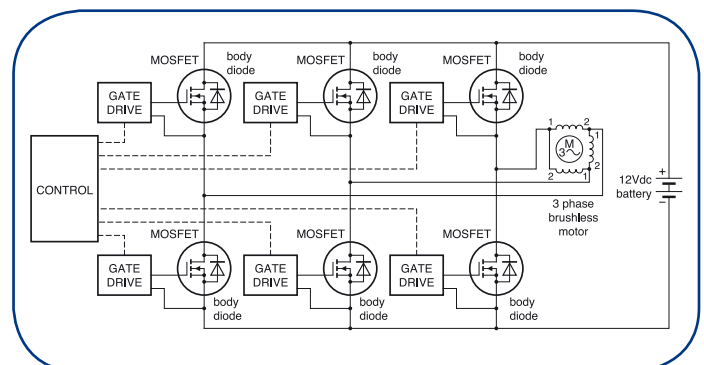
## Main benefits:

- ▶ Separate current and thermal paths
- ▶ Clamp, screw or solder mounting
- ▶ Low on-resistance
- ▶ High-current handling capability

## Example Products in I<sup>2</sup>PAK & TO-220

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK7E1R9-40E	40	1.9	120	0.46
BUK753R1-40E	40	3.1	100	0.64

## Typical three-phase motor controller



# Transmission



## Application considerations

Transmission systems distribute the power from the engine to the wheels. The system consists of a clutch, gearbox (manual or automatic), differential and final drive shaft. The actuators used in these systems are either solenoids or brushless DC motors.

**Gear selectors:** MOSFETs are used to drive solenoids that control electro-hydraulic valves or light linear mechanical loads within the gearbox to operate gear changes.

**Clutch control:** Modern clutch systems such as dual clutch control typically use brushless DC motors controlled by MOSFETs. Electric motors for transmission control often need accurate speed, direction and position control. The control MOSFETs are often situated in the gearbox.

## Key MOSFET Requirements:

- ▶ Stable performance at elevated temperatures
- ▶ Compact package
- ▶ Good current handling capability
- ▶ Low on-resistance

## The LPAK Family (LPAK56, LPAK56D and LPAK33)

of MOSFETs are ideally suited to provide compact and thermally stable solutions for transmission applications.

### Main benefits:

- ▶ Robust product using advanced copper clip technology
- ▶ Excellent current handling
- ▶ Compact footprint

### Example products in LPAK56, LPAK56D and LPAK33

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ $V_{GS} = 10$ V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK7Y3R5-40E	40	3.5	100	0.9
BUK7Y4R4-40E	40	4.4	100	1.02
BUK9K52-60E	60	49	16	4.68
BUK9M53-60E	60	46	19	4.17

**D<sup>2</sup>PAK** MOSFETs can provide solutions for motor drive tasks within transmission systems.

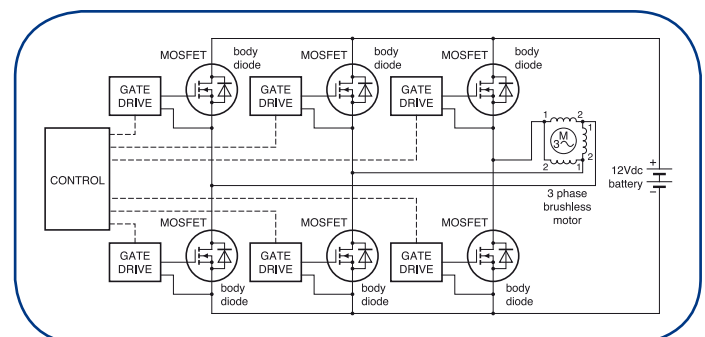
### Main benefits:

- ▶ Low on-resistance
- ▶ Low thermal resistance
- ▶ Guaranteed repetitive avalanche rating

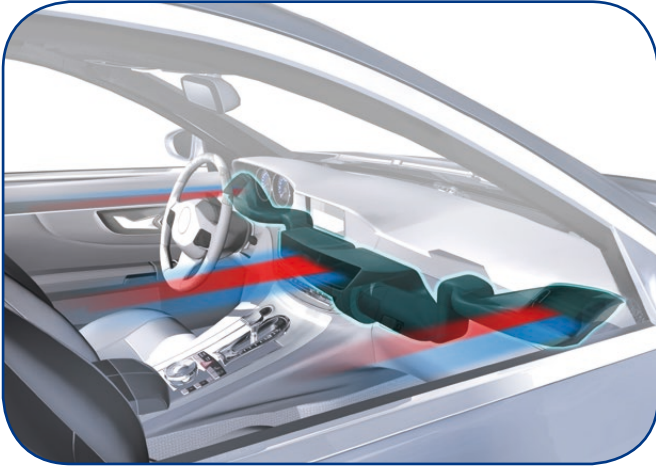
### Example products in D<sup>2</sup>PAK

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK761R6-40E	40	1.57	120	0.43
BUK762R0-40E	40	2	120	0.51
BUK762R6-60E	60	2.6	120	0.46
BUK763R8-80E	80	3.8	120	0.43
BUK764R2-80E	80	4.2	120	0.46

## Typical three-phase motor controller



# Climate Control (HVAC)



## Application considerations

The heating, ventilation, and air conditioning (HVAC) system regulates the temperature and quality of the air inside the vehicle cabin. This is often referred to as climate control.

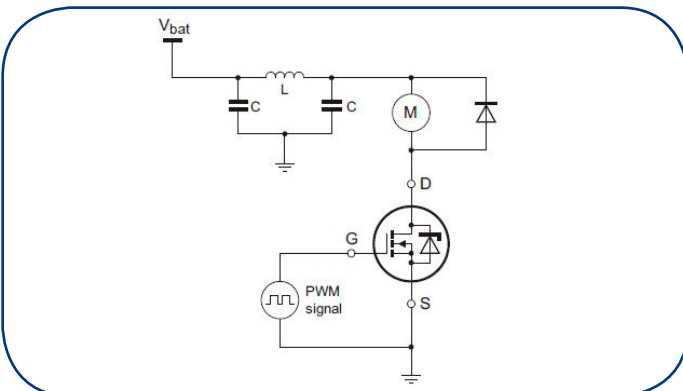
The electrically controlled elements are the blower fan motor and flap valves that divert the airflow.

The blower fan motor is usually a simple brushed DC motor, with its speed controlled by a MOSFET operating in PWM or linear mode. The flap valves are usually controlled by an integrated IC.

## Key MOSFET requirements:

- ▶ Switching capability for PWM control
- ▶ Low package thermal resistance
- ▶ Low on-resistance
- ▶ Good current handling

## Typical linear mode fan controller



**LFPAK56** is well suited to HVAC applications due to excellent current handling and thermal performance.

## Main benefits:

- ▶ Robust product using advanced copper clip technology
- ▶ Excellent current handling
- ▶ Low on-resistance

## Example products in LFPAK56 (single and dual)

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK7Y3R5-40E	40	3.5	100	0.9
BUK7Y4R4-40E	40	4.4	100	1.02
BUK7Y4R8-60E	60	4.8	100	0.63
BUK7Y7R8-80E	80	7.8	100	0.63

**I<sup>2</sup>PAK & TO-220** are ideal solutions for HVAC systems where through-hole mounting optimizes thermal performance and current handling.

## Main benefits:

- ▶ Separate current and thermal paths
- ▶ Clamp, screw or solder mounting
- ▶ Low on-resistance
- ▶ High-current handling capability

## Example products in I<sup>2</sup>PAK & TO-220

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK753R1-40E	40	3.1	100	0.64
BUK753R8-80E	80	3.8	120	0.43
BUK7E3R1-40E	40	3.1	100	0.64
BUK7E4R6-60E	60	4.6	100	0.64



# Integrated Starter Generator



## Application considerations

Integrated starter generator systems provide start-stop functionality and torque boost capability to reduce the emissions of modern vehicles.

In alternator mode, the system acts as a regenerative brake. While in motor mode, it starts the engine and provide torque assistance.

MOSFETs are used to drive highly reliable brushless DC motors.

## Key MOSFET requirements:

- ▶ Ultra-low on-resistance
- ▶ Low thermal resistance
- ▶ Safe high temperature operation
- ▶ Excellent current handling
- ▶ Guaranteed repetitive avalanche capability

**D<sup>2</sup>PAK** is ideal for integrated starter generator applications with ultra-low on-resistance and high current transient robustness.

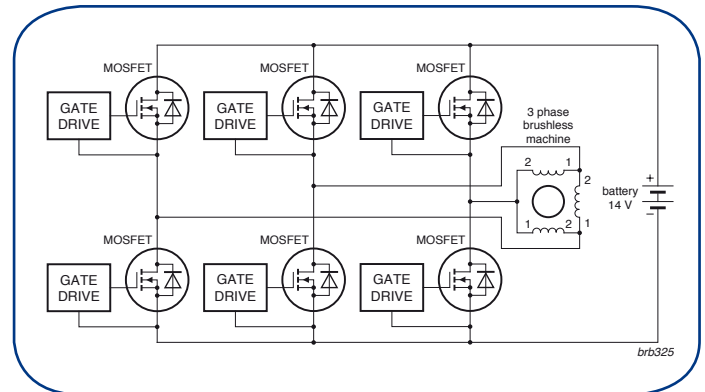
## Main benefits:

- ▶ Lowest on-resistance
- ▶ Lowest thermal resistance
- ▶ Highest current handling capability
- ▶ Guaranteed repetitive avalanche rating

## Example products in D<sup>2</sup>PAK

PRODUCT	$V_{DS}$ [max] (V)	$R_{DS(on)}$ [max] @ 10 V (m $\Omega$ )	$I_D$ [max] @ 25 °C (A)	$R_{th(j-mb)}$ [max] (K/W)
BUK761R6-40E	40	1.57	120	0.43
BUK761R7-40E	40	1.6	120	0.46
BUK763R8-80E	80	3.8	120	0.43
BUK765R0-100E	100	5	120	0.43

## Typical three-phase motor controller



# Automotive Lighting



## Application considerations

Headlights deliver a variety of functions for the driver, including high beam, low beam, fog lights, daylight running, indicators and parking lights. Similarly, rear clusters provide illumination for braking, reversing, fog lights or indicators.

Light emitting diodes (LEDs) are becoming more widespread in modern vehicles to deliver exterior and interior illumination.

The key advantages of LEDs over conventional halogen bulbs are their high luminance/watt, small size and reliability which has opened up design possibilities for engineers.

**Headlight and rear light clusters** can be illuminated by strings of LEDs controlled by a dedicated driver configured in a boost or boost/buck DC-DC converter topology. The power dissipation of individual LED strings can reach >40 W in a confined space, so MOSFETs with good switching performance combined with low on-state losses are required. Due to the space constraints and often limited heat sinking, products with low thermal impedance are also desirable. The longer the string of series-connected LEDs, the greater the  $V_{DS}$  of the MOSFET required to control them.

**Interior lights and backlit LCDs** where the power requirements are lower can be addressed by our large portfolio of LFPAK56, LFPAK56D and LFPAK33 devices.

## The LFPAK family (LFPAK56, LFPAK56D and LFPAK33)

of MOSFETs are ideally suited to provide compact and thermally stable solutions for automotive lighting applications.

### Main benefits:

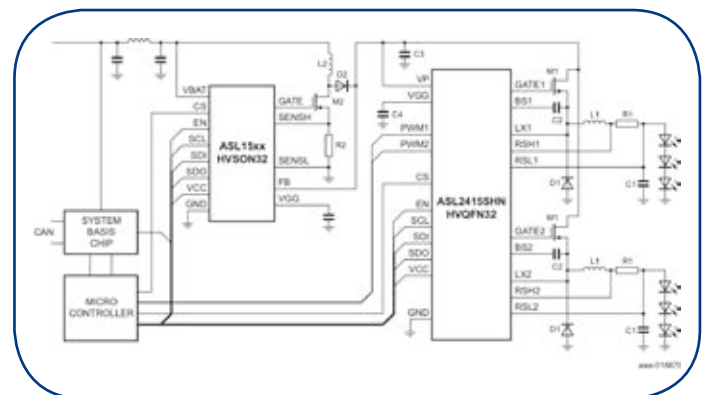
- ▶ Robust product using advanced copper clip technology.
- ▶ Low on-state losses
- ▶ Low switching losses
- ▶ Compact footprint

### Example products in LFPAK56, LFPAK56D and LFPAK33

To provide flexibility to designers, NXP offers a broad range of automotive grade MOSFETs in the LFPAK56 footprint beyond what is shown in the table below.

PRODUCT	$V_{DS}$ [max] [V]	$R_{DS(on)}$ [max] @ $V_{GS} = 10$ V [m $\Omega$ ]	$I_D$ [max] @ 25 °C [A]	$R_{th(j-amb)}$ [max] [K/W]
BUK9K25-40E	40	24	18	4.68
BUK9Y29-40E	40	25	25	4.03
BUK9Y59-60E	60	52	17	4.03
BUK9Y38-100E	100	38	30	1.58
BUK9K45-100E	100	42	21	2.84
BUK9K29-100E	100	27	30	2.21
BUK9M23-80E	80	20	37	1.89
BUK9M35-80E	80	31	28	2.43

## Typical two-channel controller













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