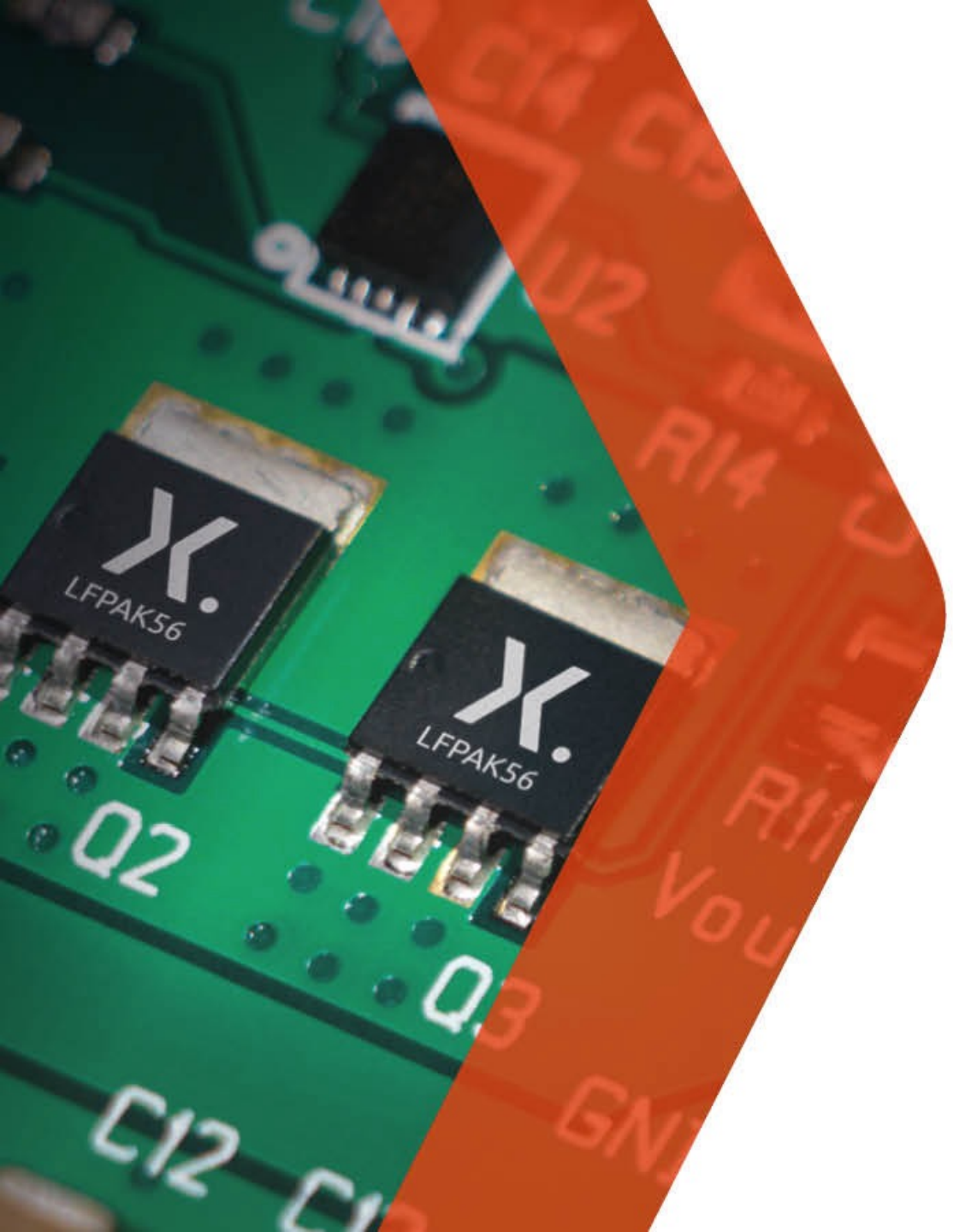


nexperia

Why would you need a 500Amp MOSFET?

September 2021

Introduction

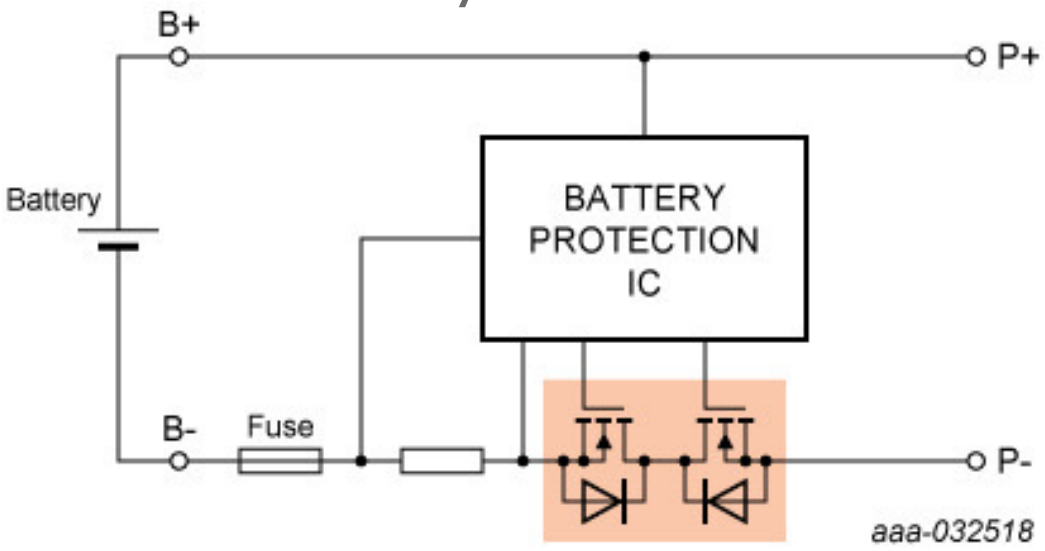
- Steven Waterhouse
- International Product Marketing Manager

- Stein Hans Nesbakk
- Application Engineer

Applications with high current requirements

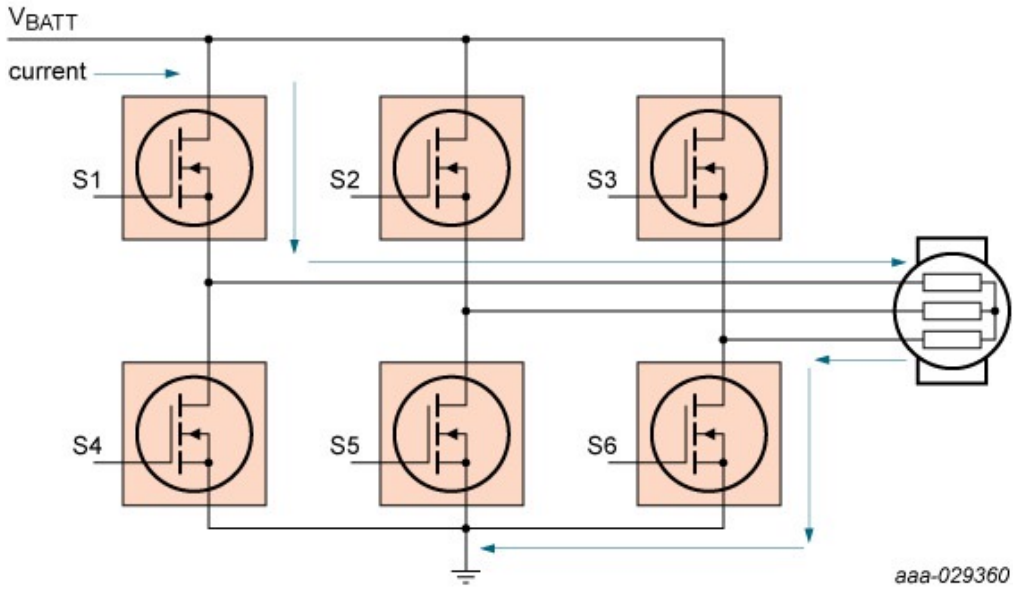
We’re listing two, but more exist: E-Fuse, load switch, USB VBUS-switch etc…

Battery Isolation



Condition: over-current, short circuit …

Motor Drive



Condition: Locked rotor

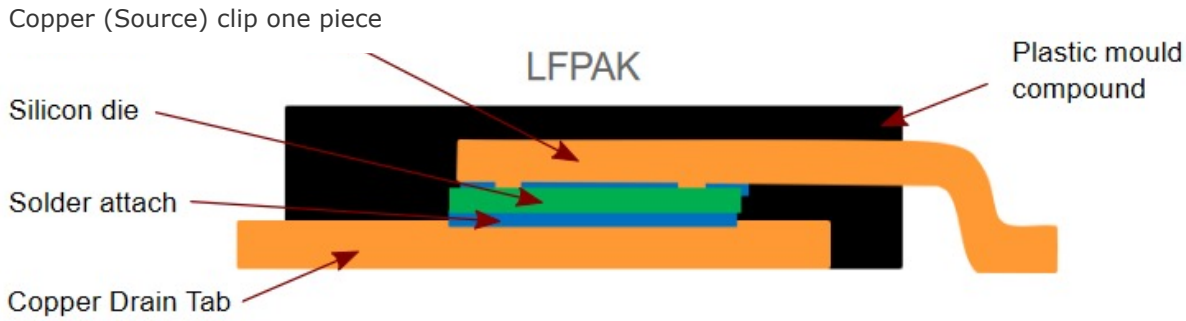
How power applications are evolving

- Power applications are becoming more demanding
  - Larger voltages
  - Larger currents
- Increased impact of application failures
  - Product reliability
  - Legal reliability
  - Safety
  - Brand reputation

What is ID rating?

- Maximum continuous Drain-Source current the MOSFET can sustain while fully enhanced at T_{mb}=25°C and die at max junction temperature

- A single parameter that captures:
  - Thermal performance
  - Temperature rating
  - $R_{DS(on)}$
    - Silicon die resistance
    - Package resistance



What is considered continuous current?

- When MOSFET reaches thermal stability (>100ms)
- Nexperia tests to ≥30s
- Mounting base @25C (use of heatsink is necessary)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Fig. 5		-	0.35	0.4	K/W

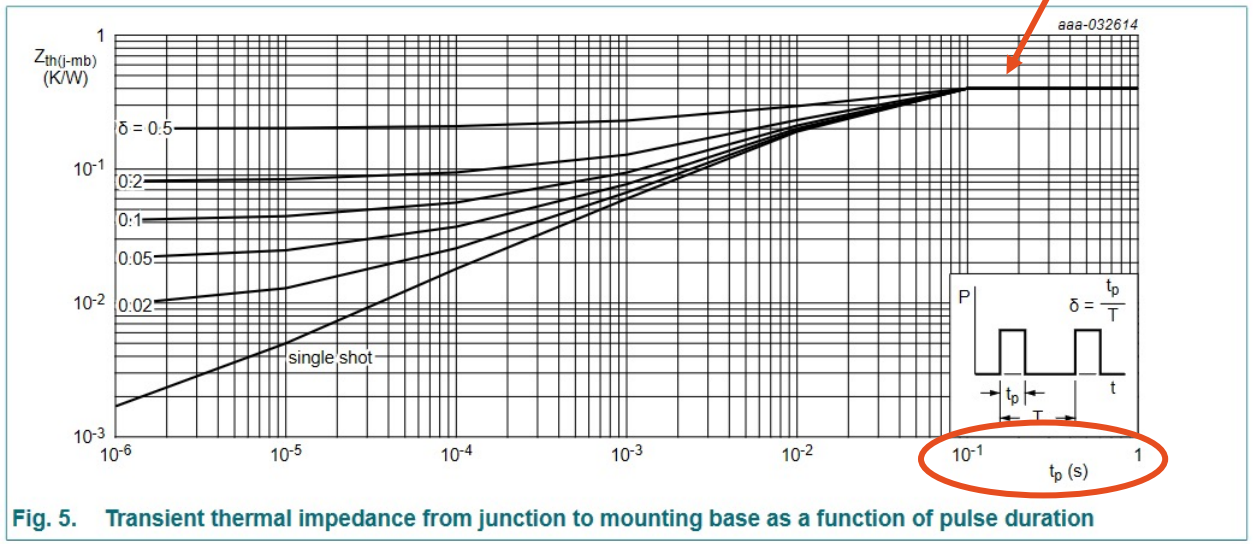
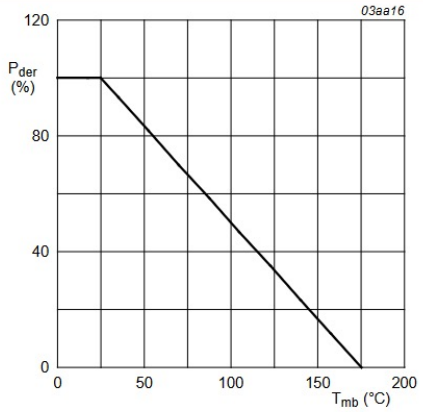


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

Drain current as a datasheet parameter

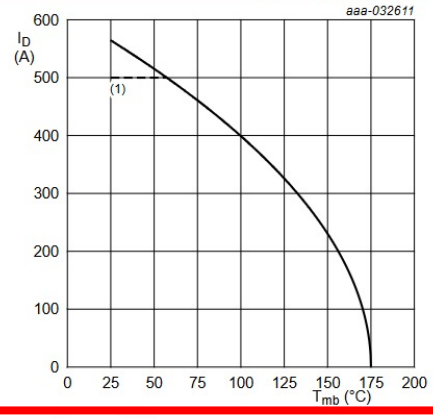
I_D	drain current	V_{GS} = 10 V; T_{mb} = 25 °C; Fig. 2	[1]	-	500	A
I_{DM}	peak drain current	pulsed; $t_p \leq$ 10 µs; T_{mb} = 25 °C; Fig. 3		-	2237	A

R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 25 A; T_j = 25 °C; Fig. 10	-	0.49	0.57	mΩ
		V_{GS} = 4.5 V; I_D = 25 A; T_j = 25 °C; Fig. 10	-	0.65	0.82	mΩ



$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\,\%$$

Fig. 1. Normalized total power dissipation as a function of mounting base temperature



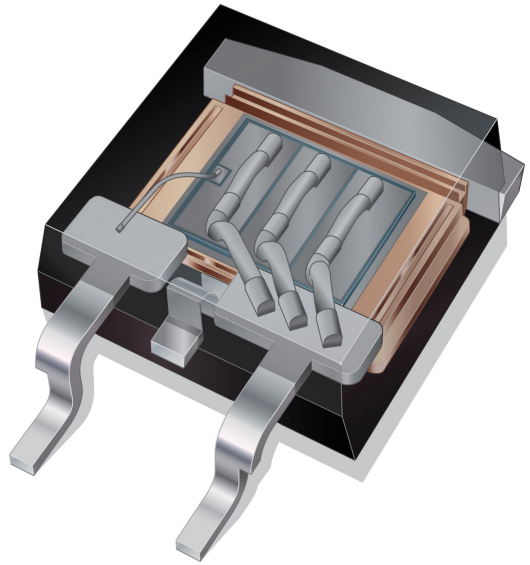
$V_{GS} \geq 10$ V

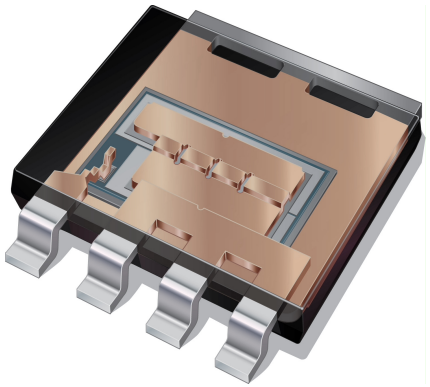
(1) 500A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

Fig. 2. Continuous drain current as a function of mounting base temperature

Device technologies and their impact

- ID max involves MOSFET parameters such as
  - Low R_{DSon}
  - Low R_{th}
  - $T_{j(max)}$ 175^{O}C
  - Bond-wires & Cu-clip
  - Current spreading
  - Package thermals
  - Reduced manufacturing steps
  - Improves reliability
- ID captures these parameters directly and indirectly





From lab to application

How is this representative of a real circuit?

- Lab measurement conditions are consistent
- "Ideal" heatsink (T_{mb}) kept at 25°C
- T_j max can be reached
- Lab ≥30 seconds
- Measurement is verified in the lab
  - I_D max rating is determined when junction temperature reaches T_j max (175°C)
- Application conditions may vary
- ID capability in applications is T_{mb} dependent
  - Application max current can be calculated from I_D max rating
- In an application, exceeding T_j max is not recommended
- System/application large surge current
  - 0.1-1sec considered DC for MOSFET
  - May not be considered DC for system
- Application will have safety margins and de-rating

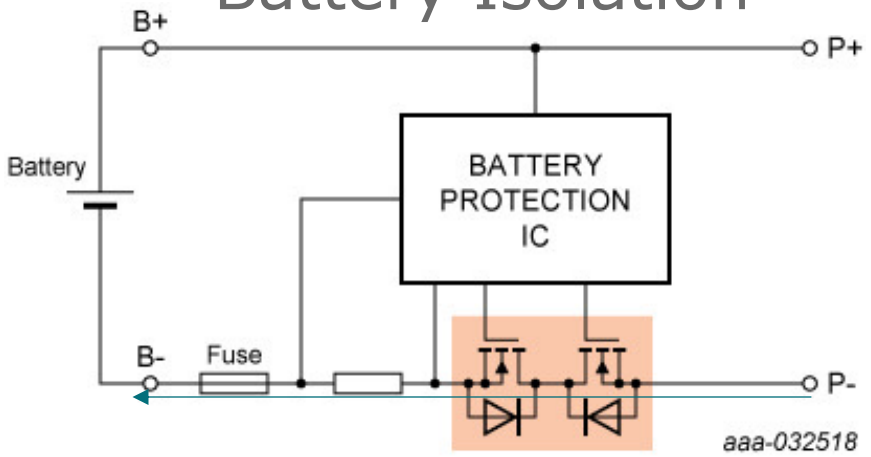
I_D - Application benefit

- Fully tested ID rating on the datasheet
- ID max rating is underpinned by:
  - Package technology
  - Silicon technology
  - Thermal performance
  - Manufacturing quality
- Gives a direct way of understanding complex MOSFET performance in an application when it matters the most

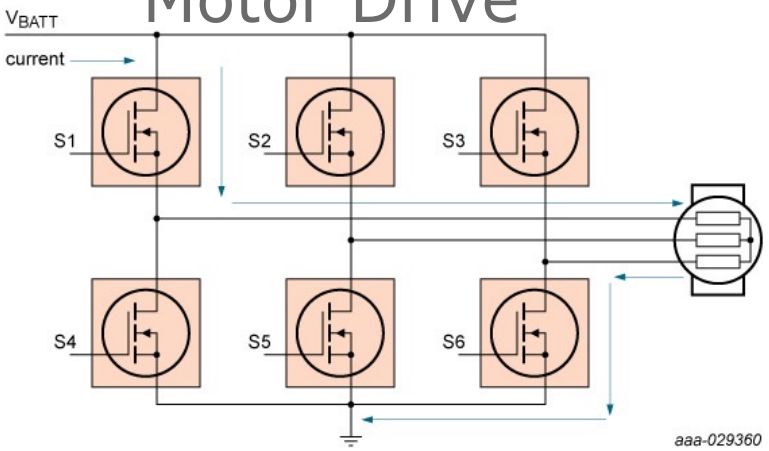
I_D in an application

- E-fuse/Battery isolation
  - Time between, over-current situation, its detection and reaction
- Motor Drive applications
  - Time between rotor locks and control system reacts becomes critical
- I_D Max capability becomes critical in the time between high system current occurring and the system reacting
  - Needs to switch off reliably
  - Cable inductances - strong ruggedness (avalanche)
  - Passes though linear mode when switching - Safe Operating Area

Battery Isolation

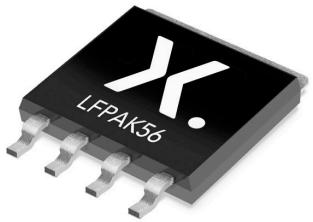


Motor Drive



Nexperia products

LFPAK88	Current rating (DC)	Pulse current rating, I_{DM}
PSMNR55-40SSH	**500A**	**2,237A**
PSMN2R0-100SSF	267A	1,070A



LFPAK56	Current rating (DC)	Pulse current rating, I_{DM}
PSMNR51-25YLH	380A	2,174A
PSMN1R5-50YLH	200A	1159A
PSMN3R9-100YSF	120A	690A

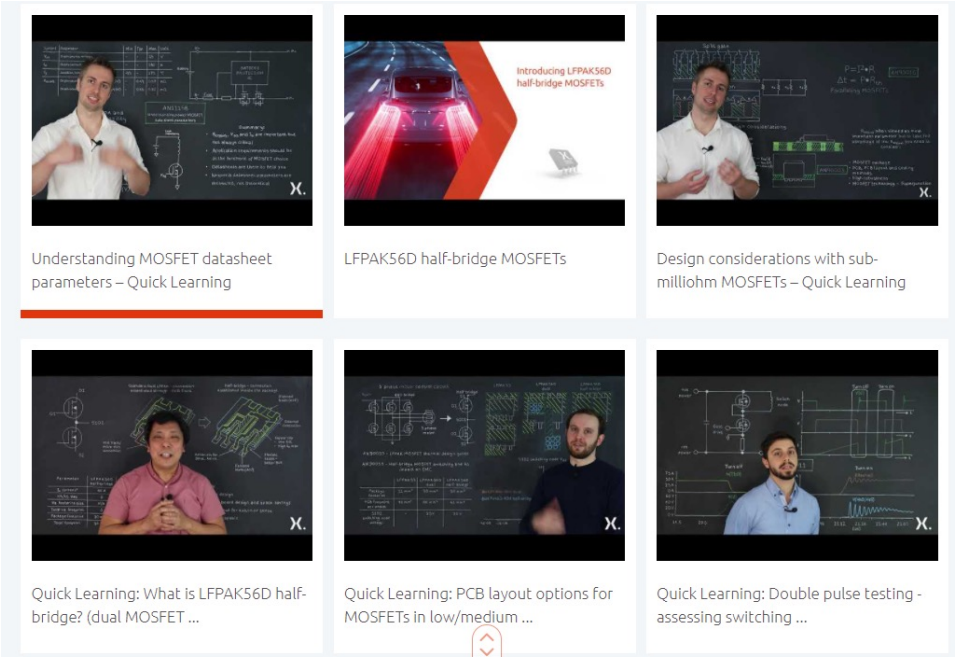
Nexperia Resources

- Please visit nexperia.com/mosfets

- Request Samples
  - Contact your local sales representative or distributor
  - Buy online from nexperia.com/shop

Application Notes

Videos



Please share your questions and insights

EFFICIENCY WINS.