

Rad hard P-channel FETs: a simpler & more reliable solution for space PMAD designs

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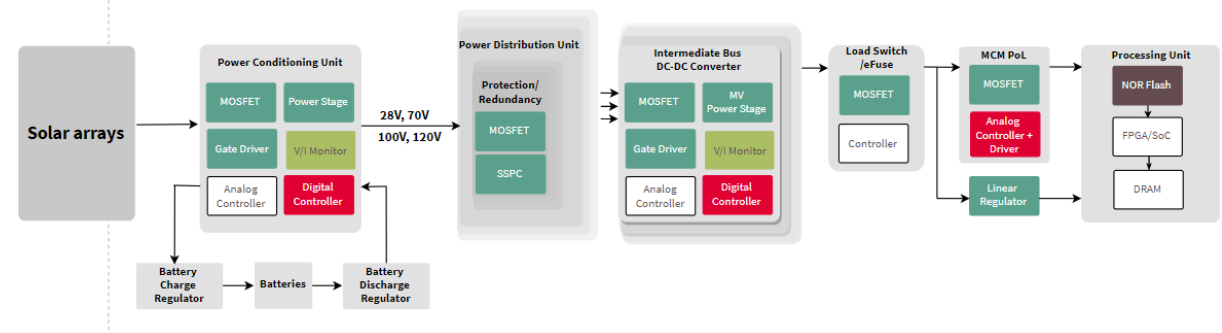
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MOSFETs are critical to PMAD reliability



- › Overall system reliability remains crucial in space applications.
 - This is especially true for the power management and distribution (PMAD) needed to keep spacecraft operational
- › With space systems only as capable as their weakest parts, reliability starts at the discrete component level
 - This includes power MOSFETs used in power converter, power stages and power distribution



Latest generation rad hard power solutions improve system efficiency

- › For a typical satellite, the mix of power FETs needed is approximately 60% N-channel and 40% P-channel

Applications ideal for P-channel MOSFETs include

- › Better $R_{DS(ON)}$ and SOA performance of IR HiRel's latest generation R9 rad hard P-channel devices may allow some PMAD applications to move away from using N-channel MOSFETs and take advantage of the simpler gate drive requirements of P-channel MOSFETs

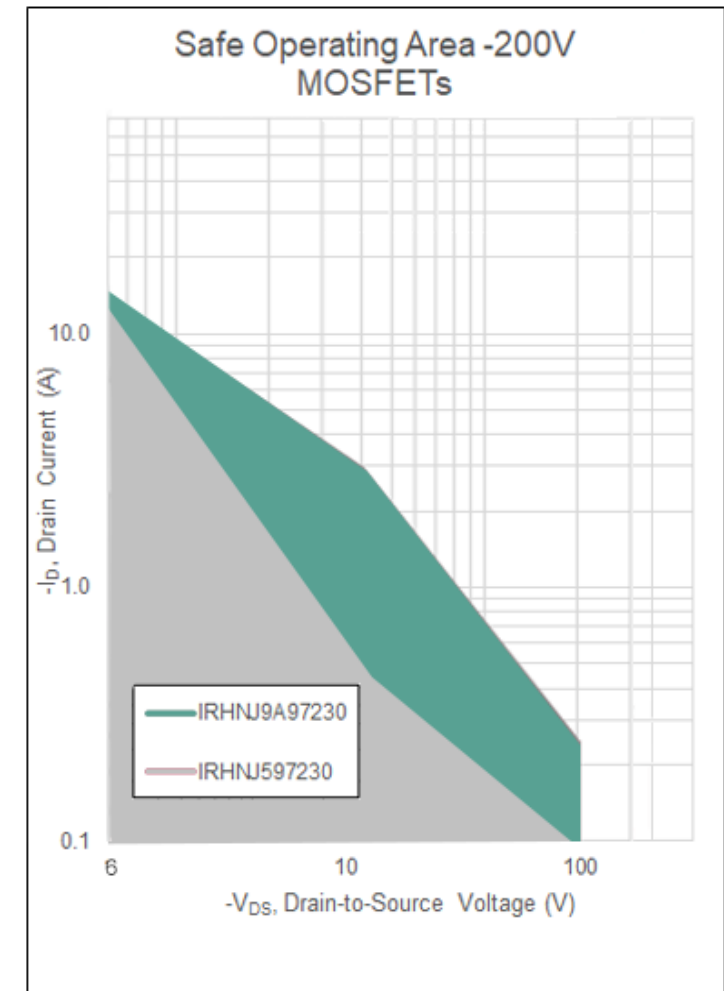
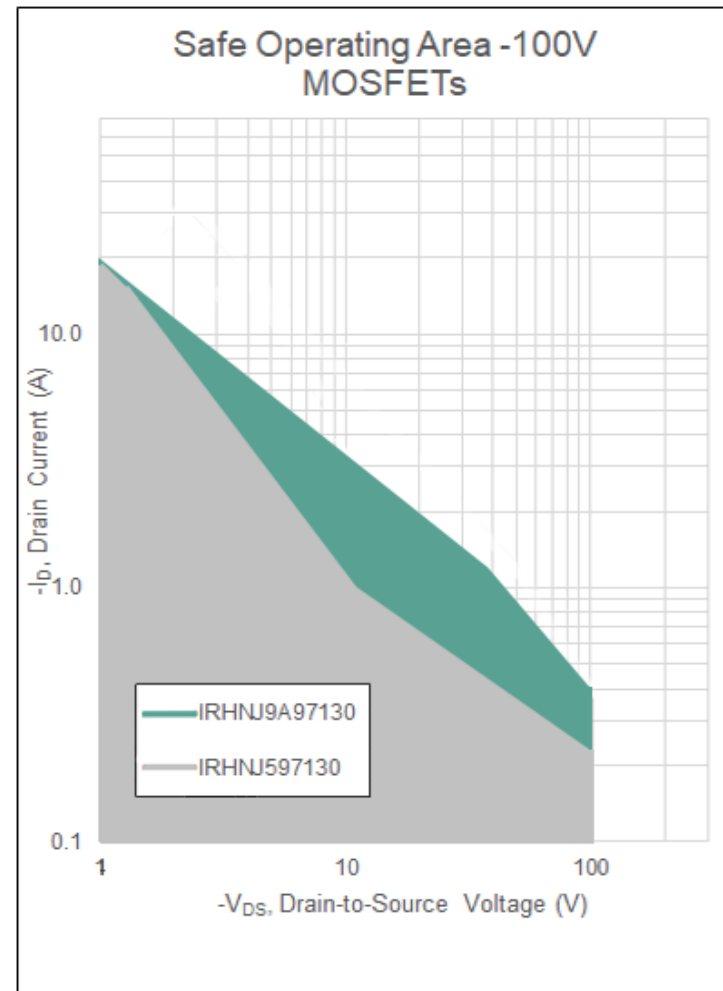
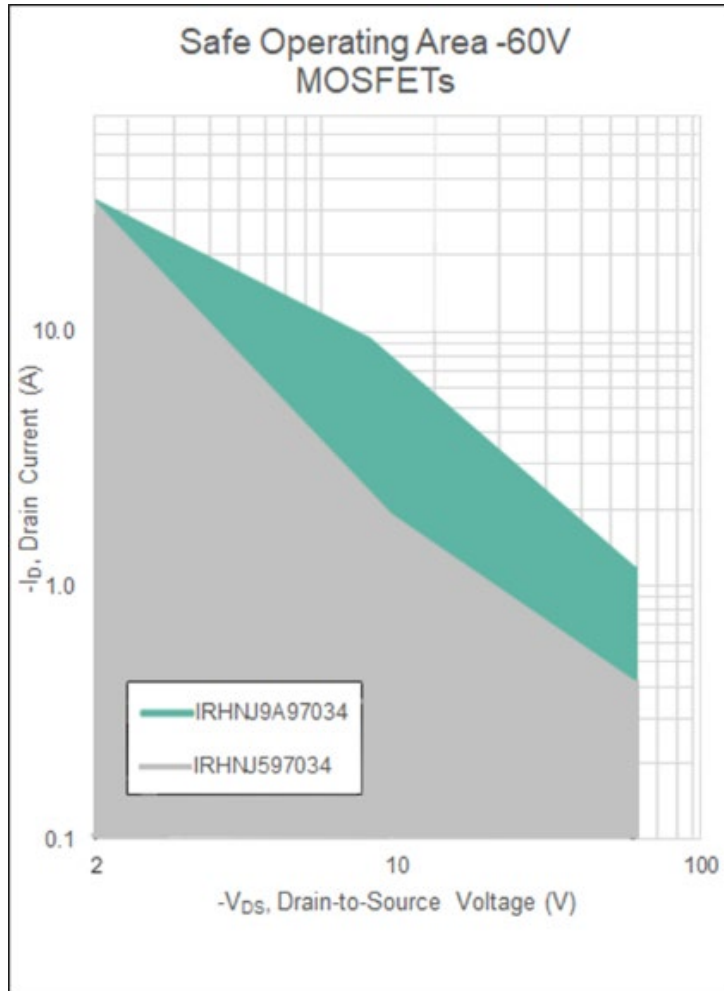
Load switching

Load sequencing

Redundancy for power sources and loads

Inrush current limiting

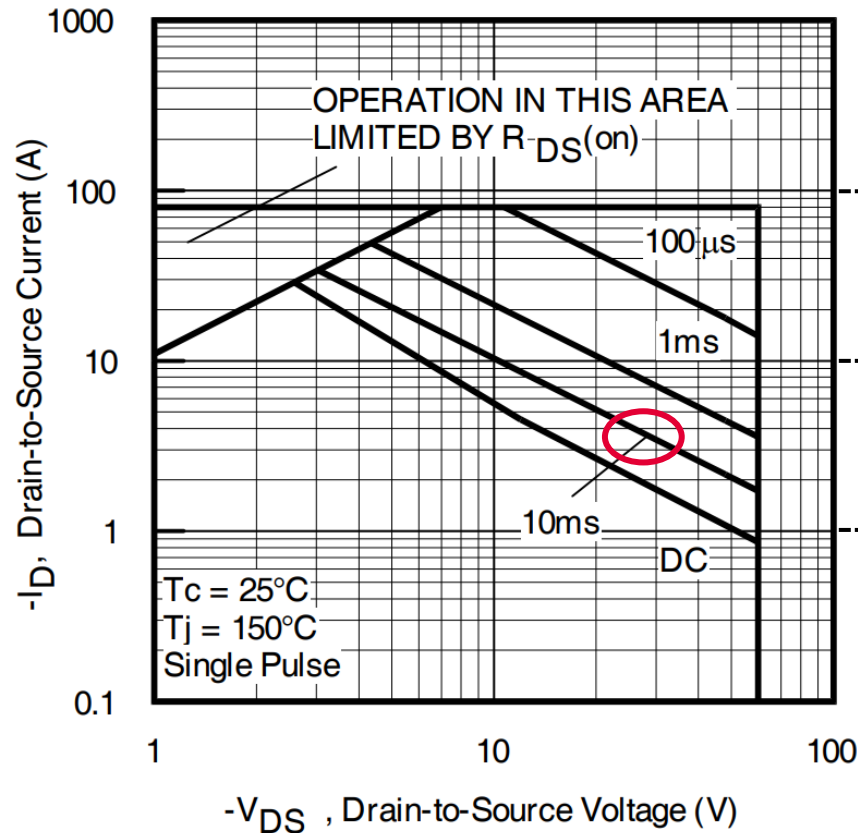
SOA improvements increase power capability by 250%



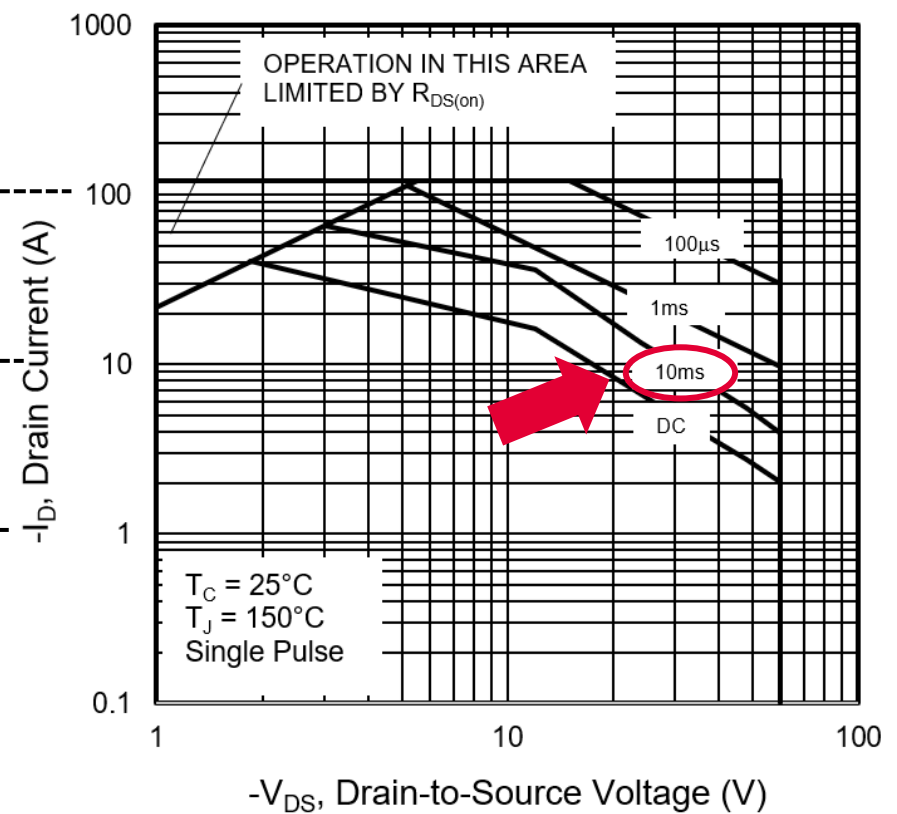
→ IR HiRel's R9 P-channel MOSFETs expand the envelope for DC safe operating area when compared with the company's legacy R5 devices. Three voltage classes of R9 and R5 MOSFETs are compared here.

R9 60 V P-channel devices have 3x higher current capability

R5 60 V P-channel MOSFET
(IRHYS597034CM)



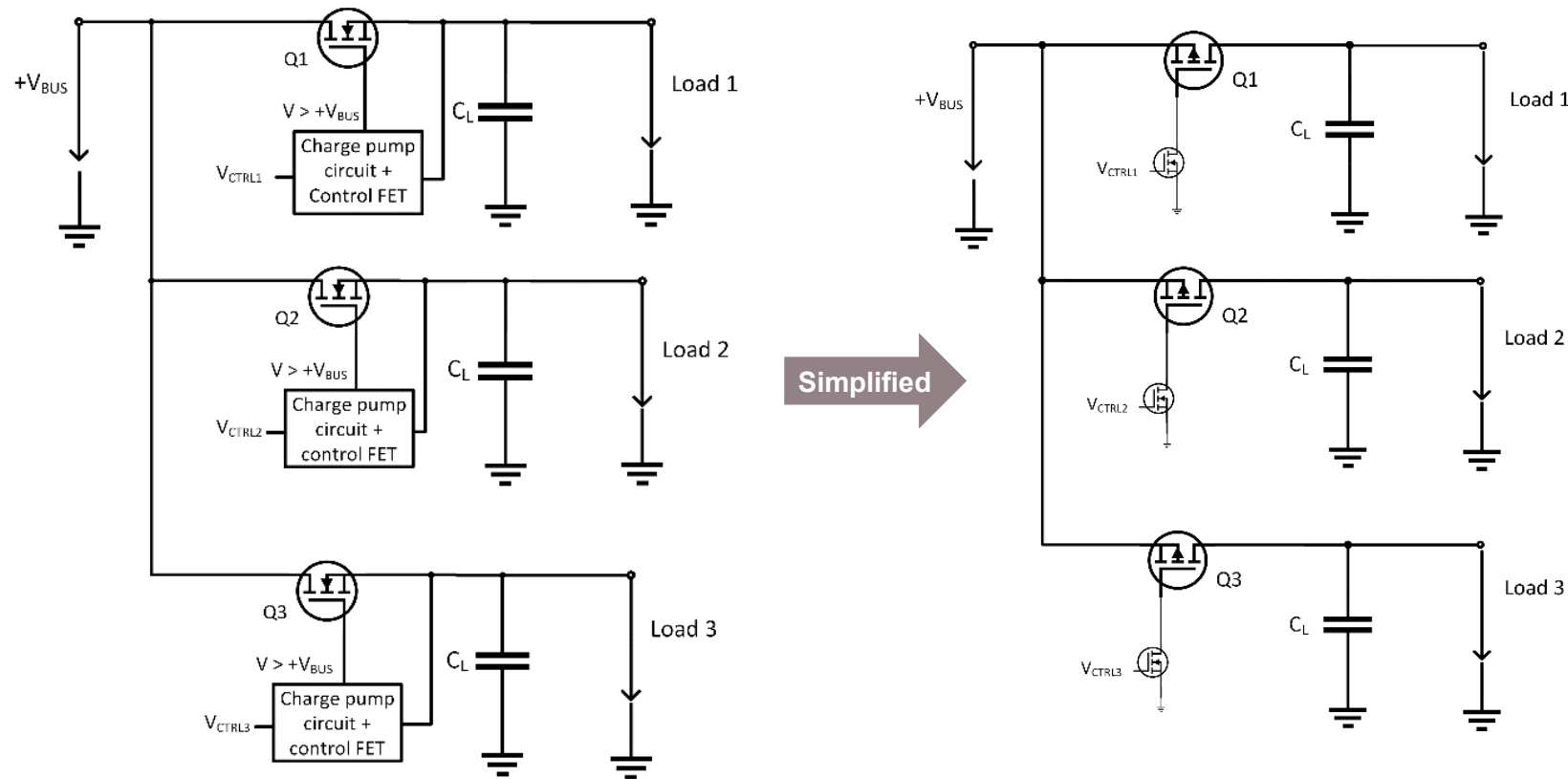
R9 60 V P-channel MOSFET
(IRHYS9A97034CM)



As T_a increases, inrush current peak is to be reduced

➔ **Comparing the SOA of an R5 60 V P-channel MOSFET (IRHYS597034CM on left) with that of an R9 60 V P-channel MOSFET (IRHYS9A97034CM on right). The R9 device has 250% higher current capability.**

Simplify gate driving with P-channel FETs



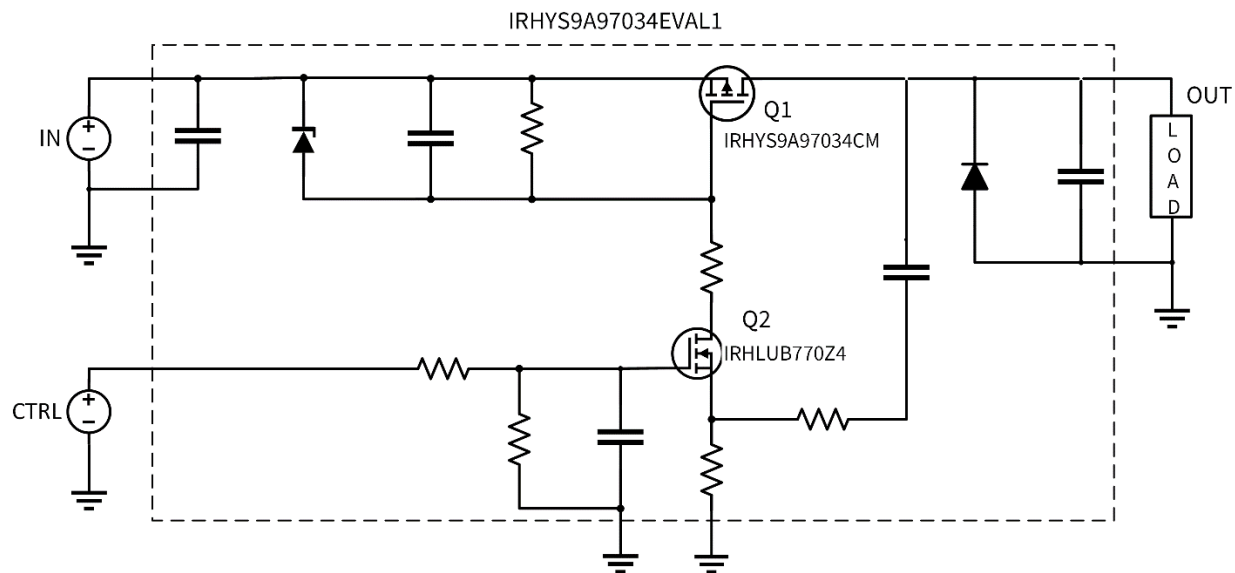
Benefits of coupling the simpler gate driver with low R_{DS(ON)} performance:

- increases system efficiency
- reduces design complexity
- decreases overall system cost

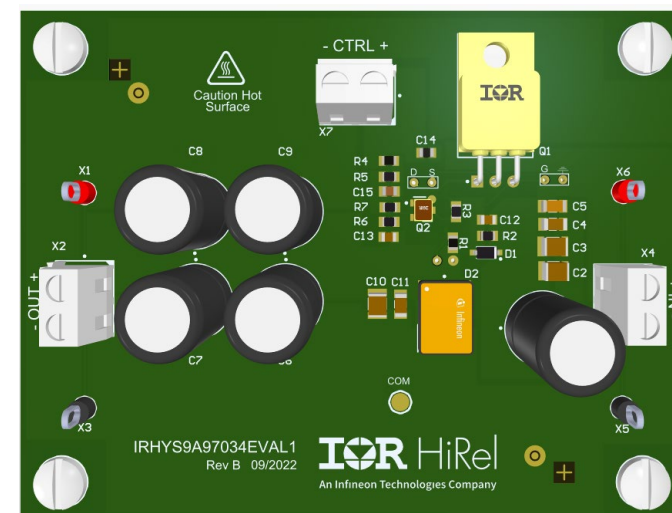
Simplified gate driving with P-channel (right) versus N-channel MOSFETs in a load sequencing circuit (left).

Save time and board space with P-channel devices

Typical inrush current limiter implementation

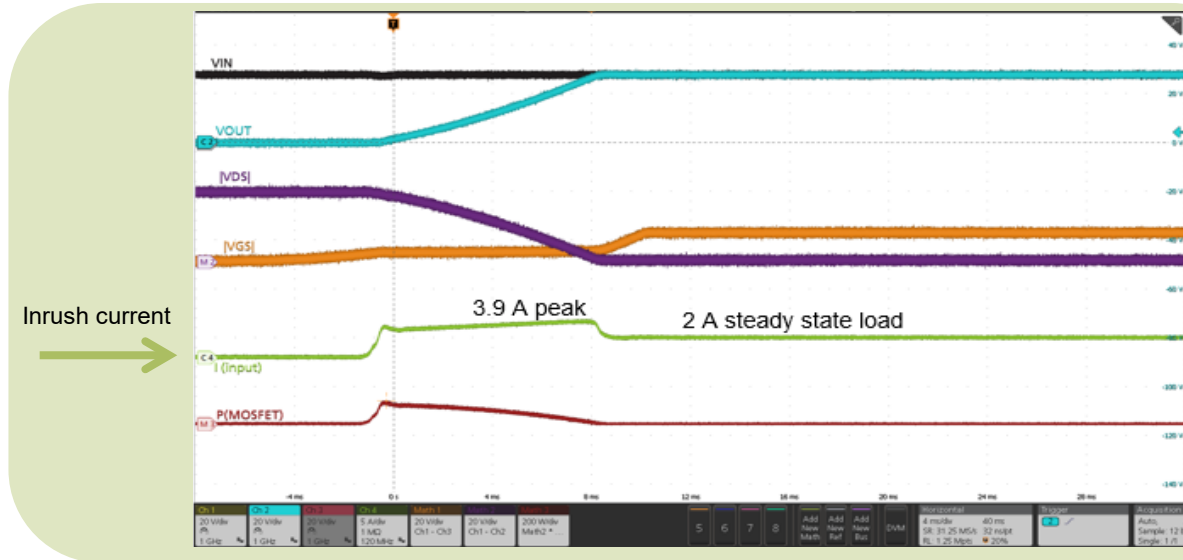


Inrush current limiter evaluation board using the IRHYS9A97034CM and IRHLUB770Z4



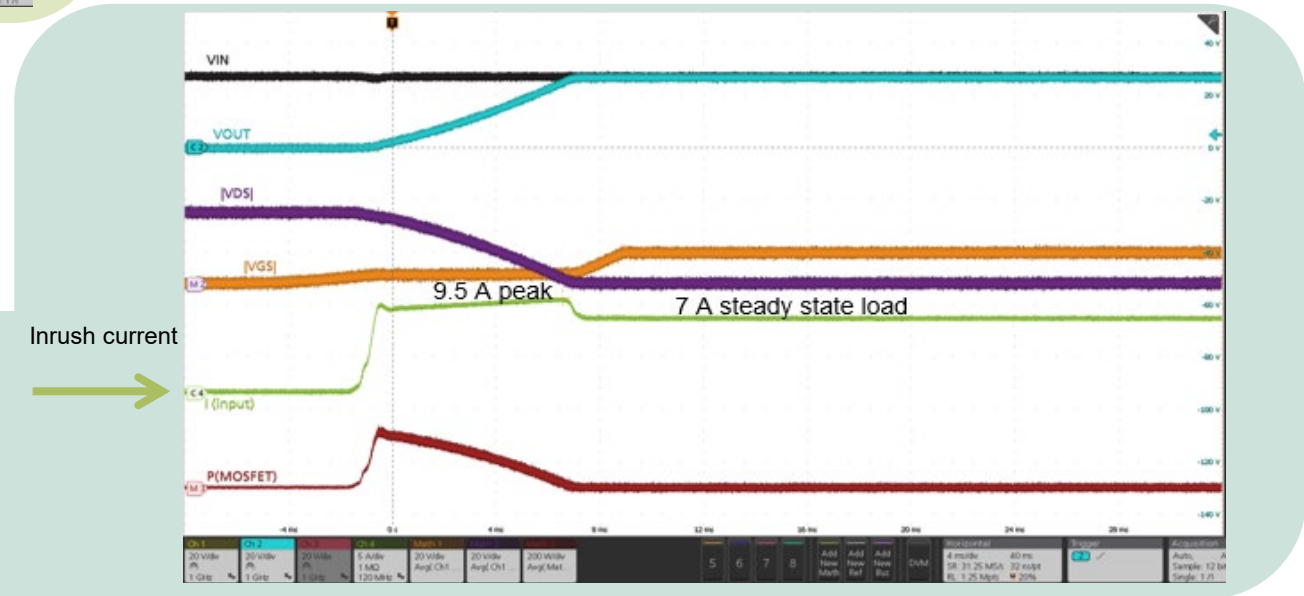
High side implementation	Benefits	Tradeoffs
N-channel	Lower $R_{DS(ON)}$	More complex design Larger board footprint Higher system cost
Latest gen R9 P-channel with improved FoM, SOA and $R_{DS(ON)}$	Simplified design Higher efficiency, reliability Board space savings Lower system cost	Higher $R_{DS(ON)}$

R9 devices support higher power dissipation in linear mode



R5 SOA performance in the TO-257AA package limits use to <50-W converters in inrush current limiting applications.

R9 performance in the same package can support >100 W of power dissipation in inrush current limiting applications.



R9 rad hard MOSFET technology platform

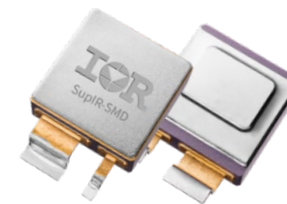
- › Improved SEE radiation performance
- › Increase power density and higher efficiency
- › Drop-in replacement for existing MOSFET
- › Smaller footprint and lower mass with innovative packaging

N-channel platform				P-channel platform			
Size \ Volt	60V	100V	250V	Size \ Volt	60V	100V	200V
6	✓	✓	✓	6	✓	✓	✓
3	✓	✓	✓	3	✓	✓	✓
1.7	✓	✓	✓	✓	fully released		
1	✓	✓	✓	✓	development		

Features

- › Increased I_D capability
- › Lower $R_{DS(on)}$
- › TID levels – 100krad and 300krad
- › SEE tolerant to LET 90 MeV·cm²/mg
- › Best Figure of Merit (FoM = $R_{DS(ON)}^* Q_G$)

Direct-to-PCB packaging solutions



(NS)
SupIR-SMD™
Size 6 die



(NKC)
SMD-0.5e
Size 3 die

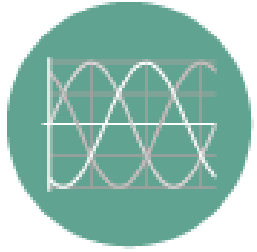


(NKC)
SMD-0.2
Size 2 die



(NPC)
SMD-0.1
Size 1 die

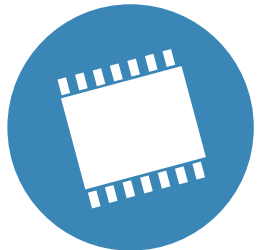
Enable higher power density and higher reliability of power distribution



- › Latest generation rad hard P-channel devices deliver higher current capability and can support higher current in linear mode applications



- › They also offer simplified board design, higher reliability for space PMAD systems



- › System designers can forego larger die sizes or packages, and device paralleling, saving solution size and weight



- › With improved figure of merit (FoM), electrical linear mode and SEE Safe Operating Area, new R9 P-channel FETs enable higher power density and higher reliability of power distribution circuits in space power systems

Questions?



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