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

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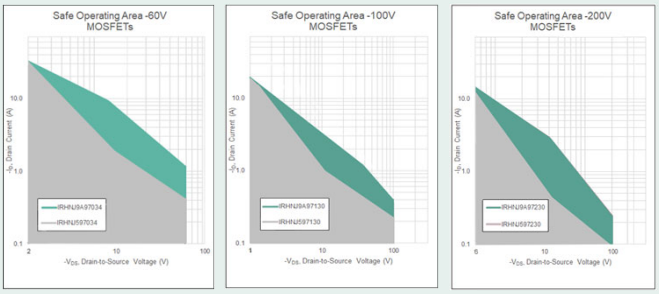
Background

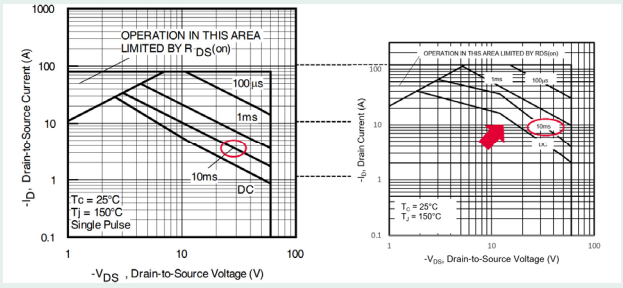
Overall system reliability remains crucial in space applications. This is especially true for the power management and distribution (PMAD) needed to keep spacecraft operational. With space systems only as capable as their weakest parts, reliability starts at the discrete component level. That includes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

For a typical satellite, the mix of power FETs needed is approximately 60% N-channel and 40% P-channel. Better $R_{DS(ON)}$ 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. Such applications ideal for P-channel MOSFETs include load switching, load sequencing, redundancy for power sources and loads, and inrush current limiting.

SOA improvements increase P-channel transistor power handling by 250% for given package size



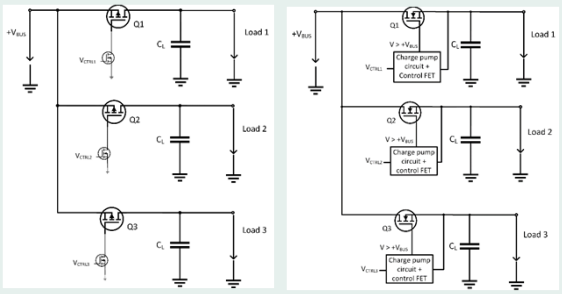
IR HiRel's R9 P-channel MOSFETs expand the envelope for DC safe operating area when compared with the company's legacy R5 devices. Three voltage classes of R9 and R5 MOSFETs are compared here.



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.

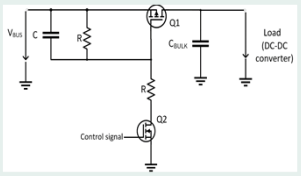
Simplified board design with P-channel devices

A P-channel FET's main advantage in the high-side switch position lies in the simplified gate driving technique. Coupling the simpler gate driver with low $R_{DS(ON)}$ performance increases system efficiency, reduces design complexity and decreases overall system cost. P-channel FETs are also ideal for point of loads or low-voltage drives in space-constrained systems.



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

In older generation FETs, the SOA performance delta was not great enough to warrant use of a P-channel to avoid a complex gate driver design needed with an N-channel in linear mode applications. However, with the robust SOA performance and significantly lower RDS(ON) of latest generation P-channel devices, simplifying the gate driver translates into greater efficiency, board space savings, and lower system costs.



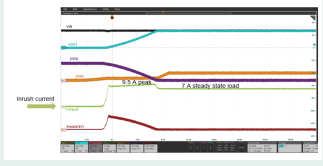
Typical inrush current limiter implementation.



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



Inrush current limiter evaluation board using the IRHYS9A97034CM.



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

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

Latest gen rad hard P-channel FETs offer simplified board design, higher reliability for space PMAD systems

Latest generation rad hard P-channel devices deliver higher current capability and can support higher current in linear mode applications. With improved figure of merit (FoM), electrical linear mode and SEE Safe Operating Area, new P-channel FETs enable higher power density and higher reliability of power distribution circuits in space power systems. System designers can forego larger die sizes or packages, and device paralleling, saving solution size and weight.

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