

New Product Update

Power switches for crucial monitoring and protection in satellites

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Product marketing engineer

Agenda

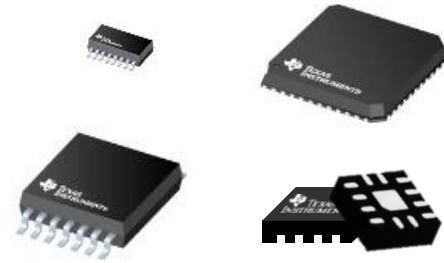
- Space grade product offerings
 - Radiation tolerant space enhanced plastic and radiation hardened QML Class V
- Power Switches Overview
 - Inrush Current Control
 - Reverse Current Protection
 - Current Limiting
 - Unique Fault Response Recovery
- Summary of Space Rated Power Switches
- Resources

Space product grades



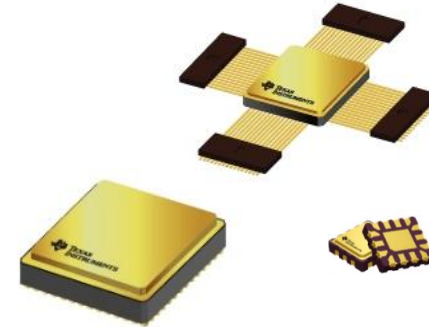
Rad Tolerant Plastic

TI Space EP



Rad Hard Plastic

QML Class P Precursor



Rad Hard Hermetic

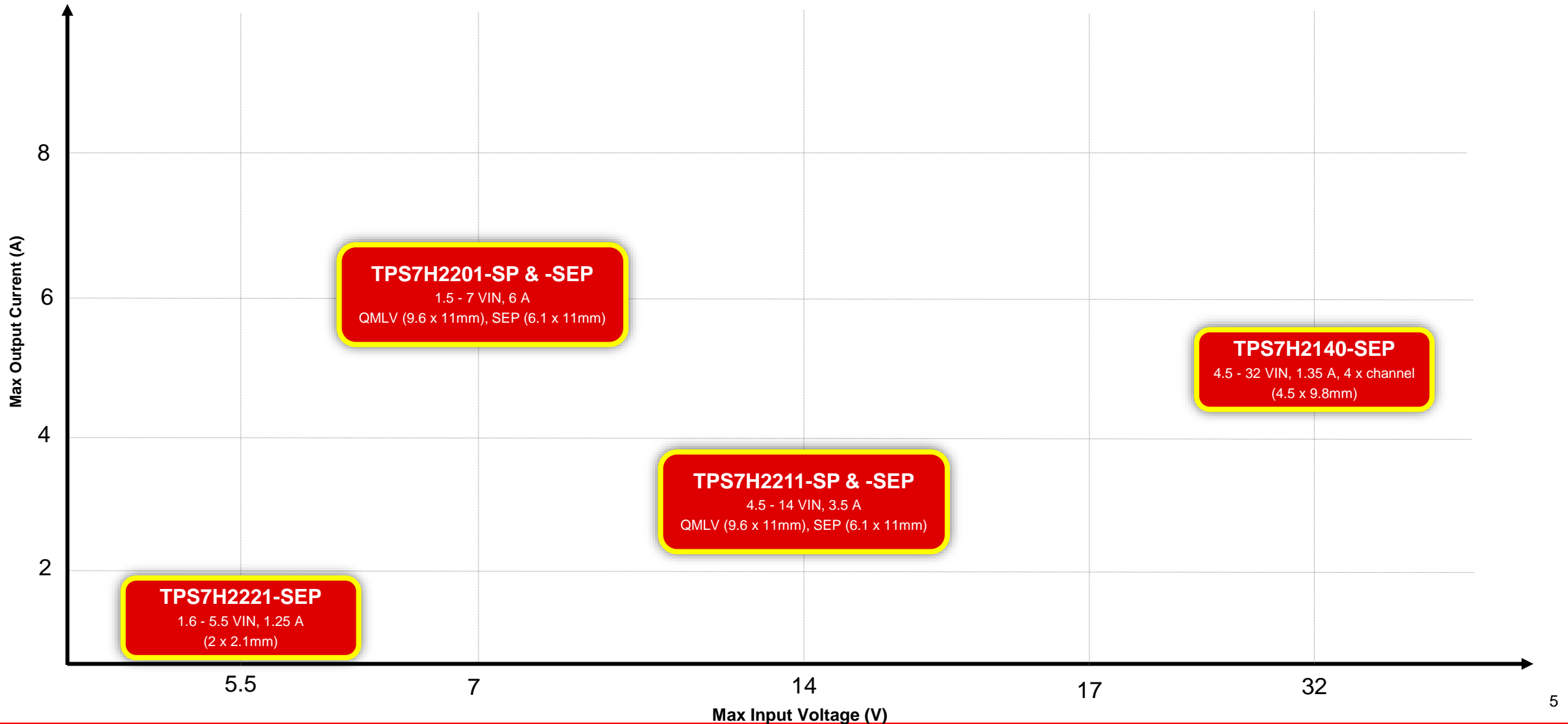
QML Class V

Packaging	Plastic	Plastic	Ceramic / Metal Can
Mil. Spec	VID	VID/SMD*	SMD
Burnin	No	Yes	Yes
TID Char	30 – 50 krad(Si)	<-----50krad(Si) – 300 krad(Si)----->	
TID RLAT	20, 30, or 50 krad(Si)	<----- Non-RHA, 50, 100, or 300 krad(Si) ----->	
SEL	43 MeV·cm ² /mg	<----- ≥ 60 MeV·cm ² /mg ----->	

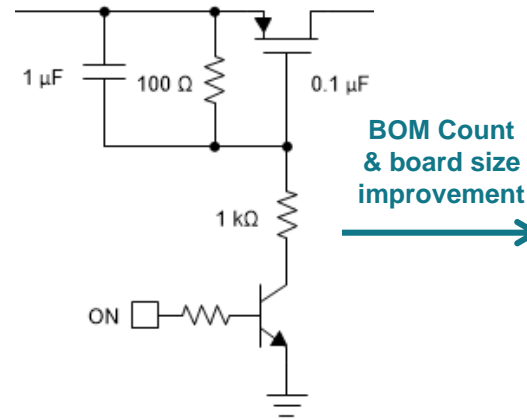
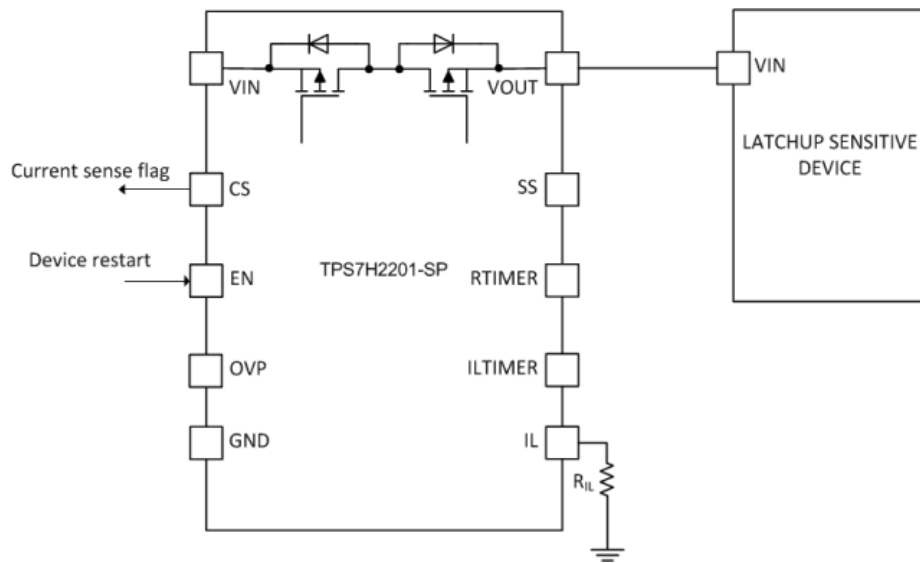
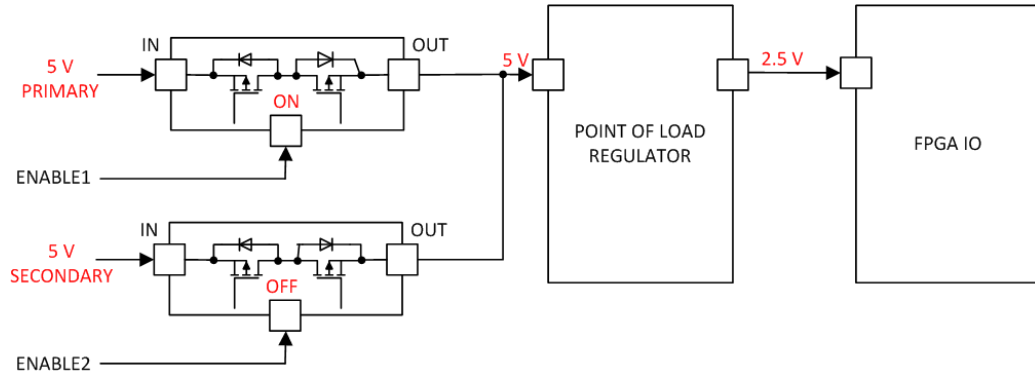
TI's space-grade manufacturing flows

	TI defined Space Enhanced Product (-SEP) flow	MIL-SPEC-38535 defined QML Class-P (-SP) flow	MIL-SPEC-38535 defined QML Class-V (-SP) flow
Part Number	TI defined TPS7HxxxxSEP	5962xxxxxxPxx	5962xxxxxxVxx
Packaging	Plastic	Plastic	Ceramic-Hermetic
Single Controlled Baseline	Yes	Yes	Yes
Bond Wires	Au	Au	Al
Meets DLA spec for less than 2% Sn	Yes	Yes	Yes
Production Burn-in	No	Yes	Yes
Typical Temperature Range	-55°C - 125°C	-55°C - 125°C	-55°C - 125°C
Characterized Radiation Performance	Yes	Yes	Yes
Per lot TID Radiation Lot Acceptance Testing (RLAT)	Yes	Yes	Yes
Outgassing tested per ASTM E595	Yes	Yes	N/A
Lot Level Temp Cycle	Yes	Yes	Yes
Per tube, tray or reel single lot date code	Yes	Yes	Yes
Life Test Per Wafer Lot	No	Yes	Yes
Group reports	Basic PCR report & Group E & P reports	PCR report & Group B, C, D, E, WLA reports	PCR report & Group B, C, D, E, WLA reports

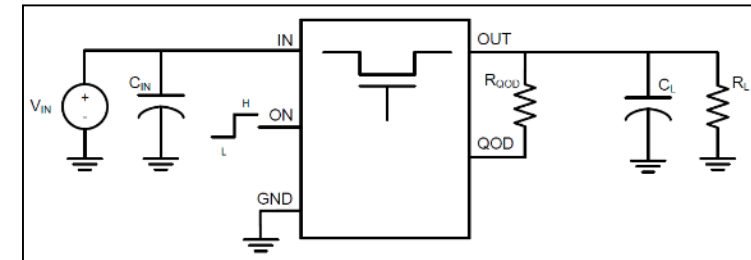
Radiation qualified | power switches



Smart load switch | eFuse use cases



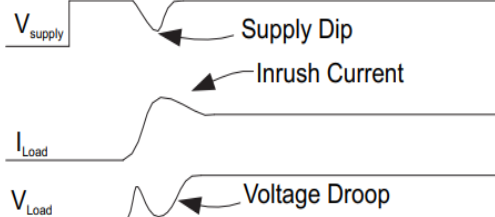
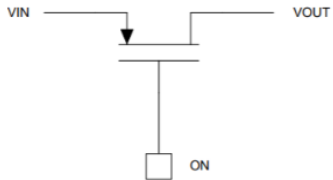
Integrated LS



- Smaller PCB
- Less components to manage, pick & place

Inrush current control

Discrete PMOS



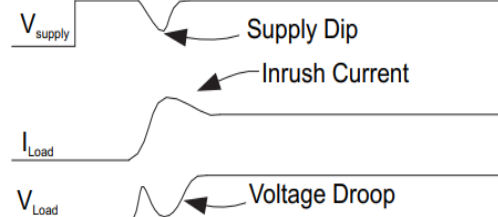
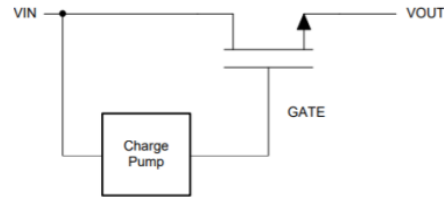
Advantages

- Simple
- Low cost and BOM count

Disadvantages

- Uncontrolled turn-on
- Large inrush current
- Active low

Discrete NMOS



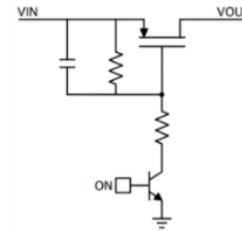
Advantages

- Simple
- Lower on-resistance

Disadvantages

- Requires a charge pump or high voltage rail
- Large solution size
- Increased BOM count

Discrete Load Switch



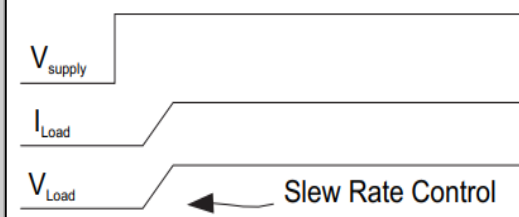
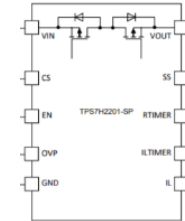
Advantages

- Active high
- Controlled turn-on

Disadvantages

- Nonlinear inrush current control
- Complicated discrete controls

TI Power Switch IC



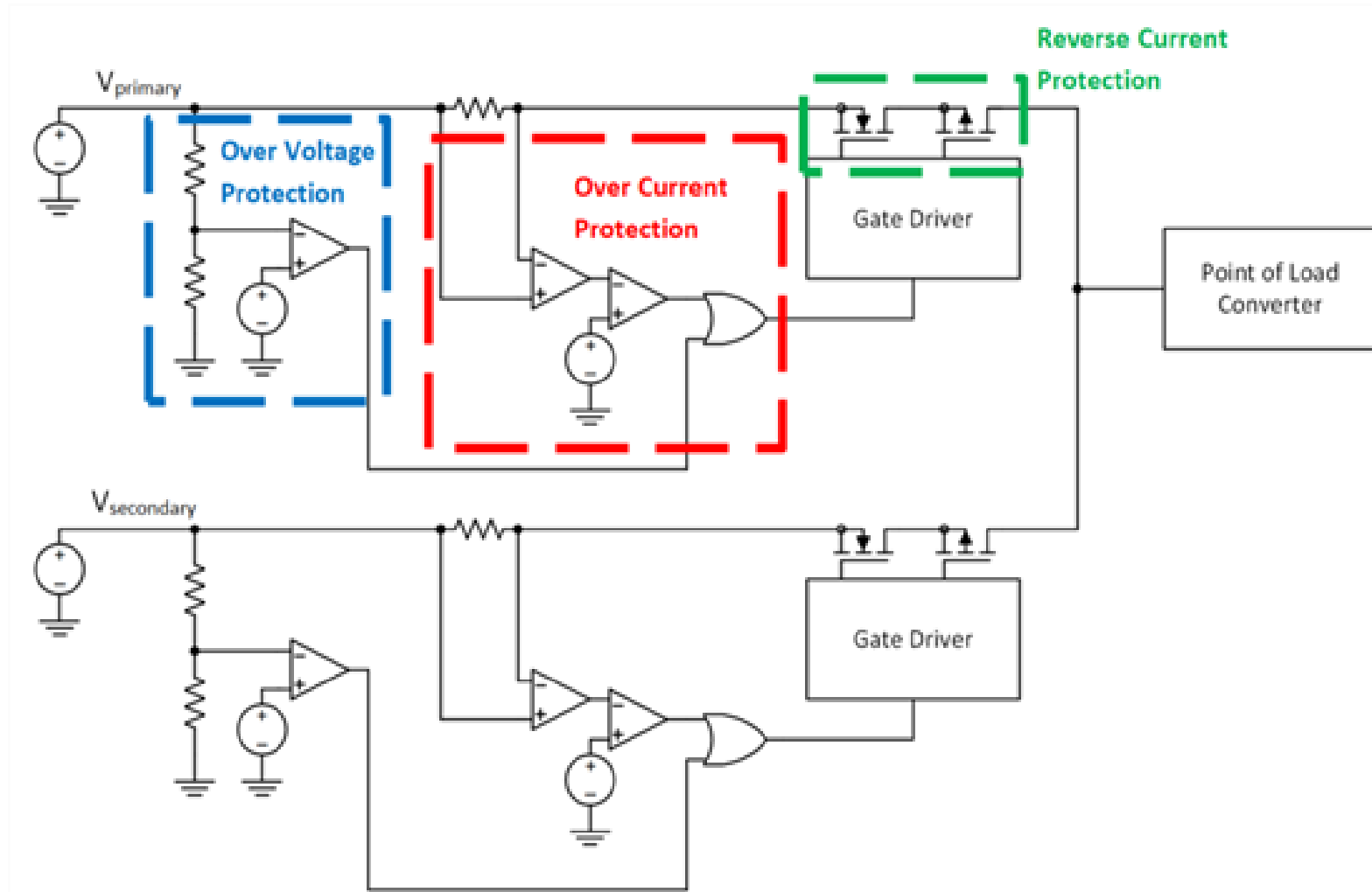
Advantages

- One chip solution
- Small solution size
- Linear inrush current control with adjustable rise time configured by an external capacitor
- Added protection features

Disadvantages

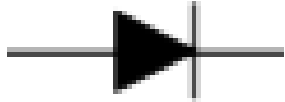
- Integration at the cost of flexibility

Expanding size with added protection



Reverse current protection for cold sparing

Diode



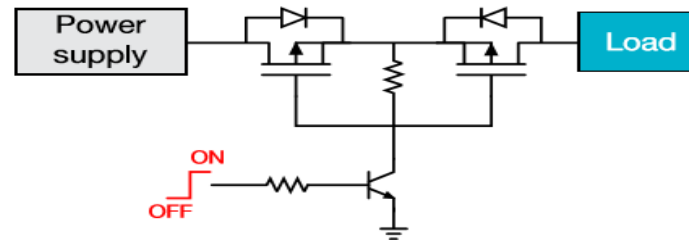
Advantages

- Simple
- Low cost and BOM count

Disadvantages

- Highly inefficient due to large voltage drop across the diode

Back-to-back MOSFETs



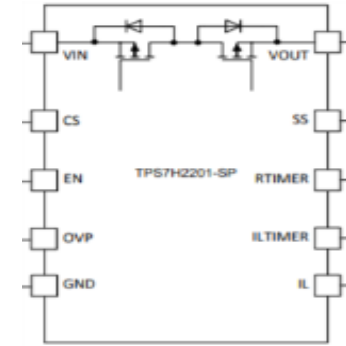
Advantages

- Current blocking in both directions
- Higher power efficiency

Disadvantages

- Larger solutions size and BOM count
- Only provides reverse current protection
- Increased R_{dson} value due to dual FETs

TPS7H2201/2211



Advantages

- One chip solution, reduced board space
- Integrated back-to-back MOSFETs for reverse current protection in a small solution size
- Added protection features

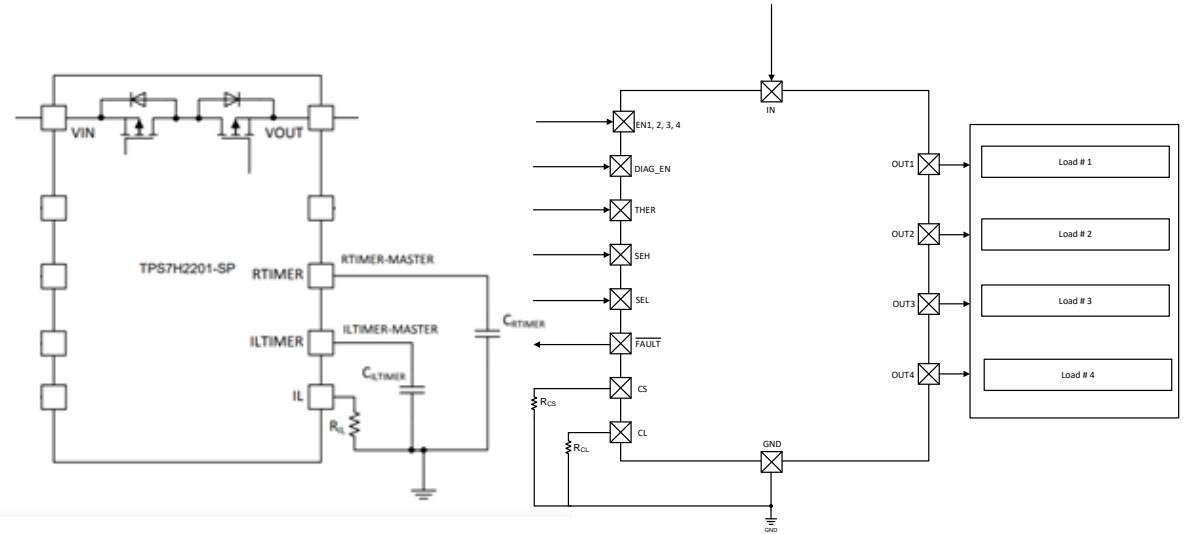
Disadvantages

- Increased R_{dson} value due to dual FETs
- Increased cost

Current limiting

Discrete challenges

- Additional complexity added due to current sense amplifier, without one, there would be decreased power efficiency and lower current-limiting accuracy
- Need careful consideration of the current sense resistor's value, tolerance, and temperature coefficient
- When opting for an integrated current sense amplifier, due to the precision element, it can greatly increase cost
- **Without a current limit feature or short circuit protection, load is left unprotected against transient current spikes and hard shorts**

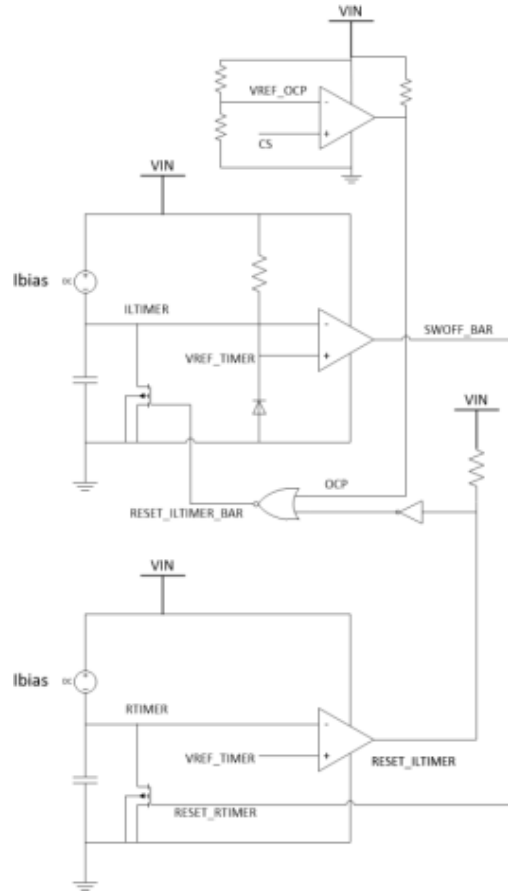


Both **TPS7H2201** & **TPS7H2140** support programmable current limit

TPS7H2201 fault response recovery

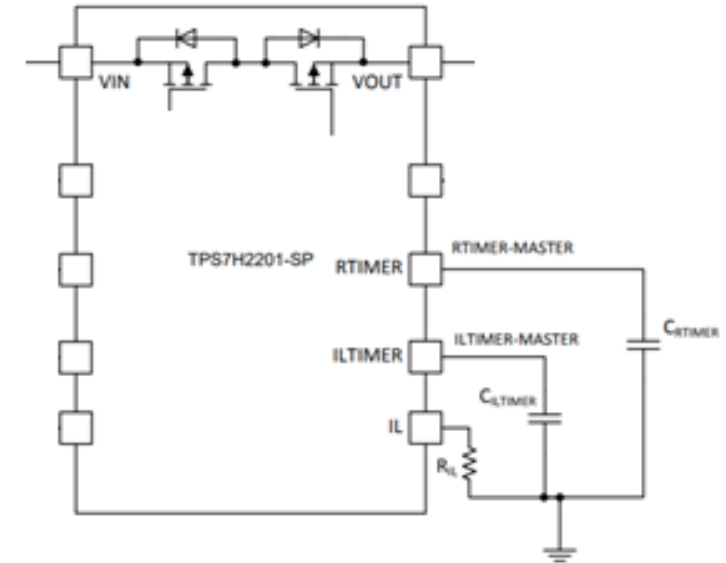
Discrete

- Typically not built due to the increase in solution size and varying degrees of complexity including timing factors
- Complexity in programmability
- **Without fault timers, the device is unable to be automatically restarted in a controlled manner**



TPS7H2201-SP

- Simplifies the design complexity to only two capacitors
- The programmable current limit fault time is defined by the capacitor at the ILTIMER pin
- The capacitor connected to the RTIMER pin defines how long the device stays in retry mode
- Min off time of 20 μ sec before going into retry mode



Overview of space-rated power switches

Device	V_{in}	I_{out}	Size	Feature capability
TPS7H2201	1.5 – 7V	6A	Ceramic: 9.6 x 11mm Plastic 6.1 x 11mm	Highly integrated switch with reverse current protection, programmable current limit, OVP, and retry timers
TPS7H2211	4.5 – 14V	3.5A	Ceramic: 9.6 x 11mm Plastic: 6.1 x 11mm	Highly integrated switch with higher input voltage for 12V rail, reverse current protection, and integrated OVP
TPS7H2140-SEP	4.5 – 32V	1.35A x 4	4.5 x 9.8mm	High voltage eFuse to interface with bus voltage supporting programmable current limit and flexibility for switching independent channels or paralleling for higher current
TPS7H2221-SEP	1.6 – 5.5V	1.25A	2 x 2.1mm	Smallest form factor load switch

Getting started

You can start evaluating these devices leveraging the following:

Content type	Content title	Link to content or more details
Selection Guide	TI Space Products Guide	https://www.ti.com/lit/sg/slyt532i/slyt532i.pdf
Application Note	Reduce the Risk in Low-Earth Orbit Missions with Space Enhanced Plastic Products	https://www.ti.com/lit/an/sboa344a/sboa344a.pdf
Parametric Table	List of Space Rated Power Switches	https://www.ti.com/power-management/power-switches/products.html#1498=Space&

Visit www.ti.com/npu

For more information on the New Product Update series, calendar and archived recordings



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