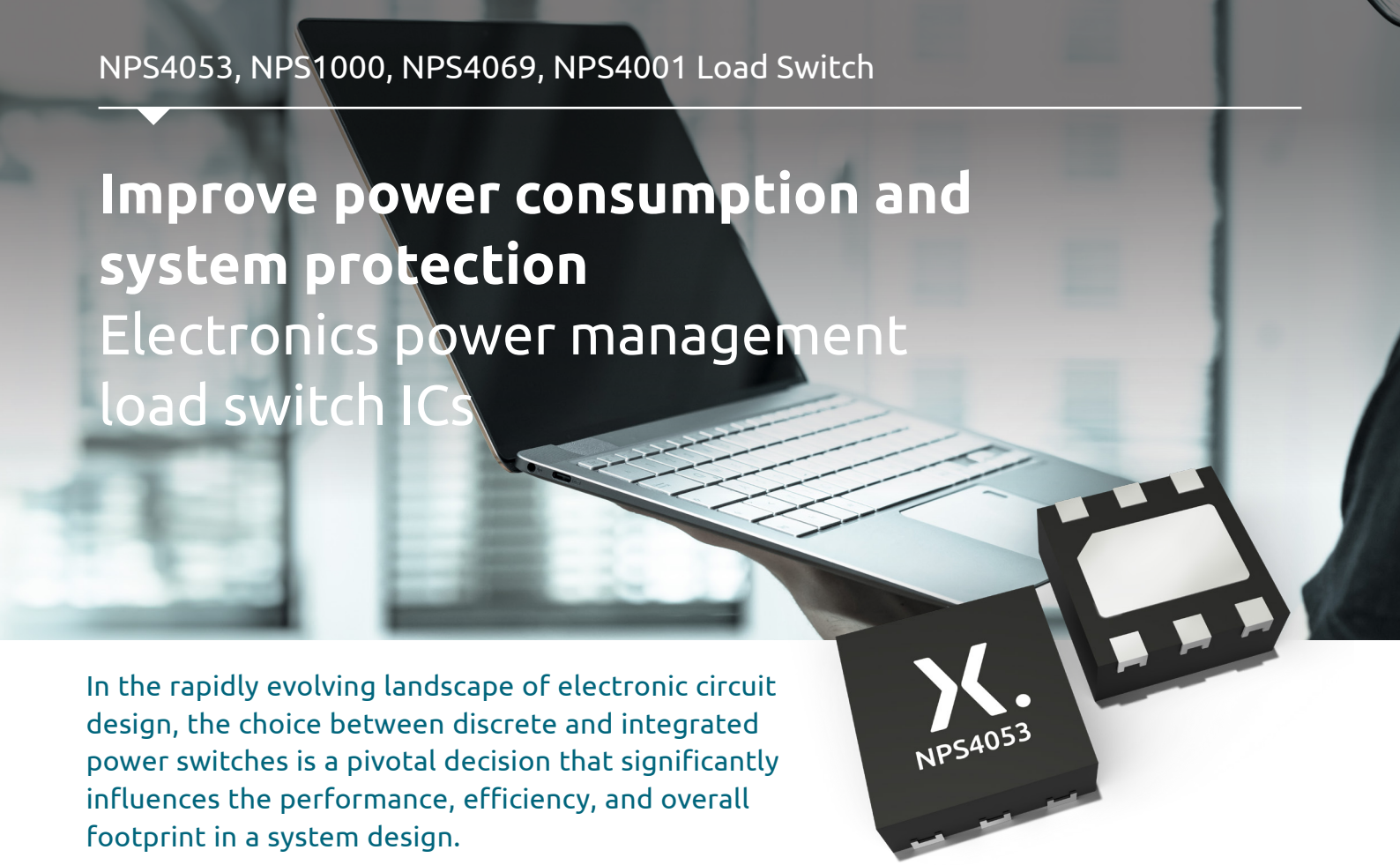
Improve power consumption and system protection

Electronics power management load switch ICs



In the rapidly evolving landscape of electronic circuit design, the choice between discrete and integrated power switches is a pivotal decision that significantly influences the performance, efficiency, and overall footprint in a system design.

A typical system design will likely be comprised of a DC power source and one or more loads that need to meet varying current requirements. Typically, the system needs to manage the activation, timing, and speed of each load dynamically. This can either be done using discrete components, or with an integrated load switch. Fig 1. shows an example of how a system with a power switch would be necessary to control the load to an external port, like a USB, HDMI, or display ports.

Nexperia Load Switches

Nexperia load switch ICs are highly integrated Power Management Integrated Circuits (PMICs) designed to efficiently control power rails within electronic systems. Load switches serve as indispensable components for managing power distribution and enabling the smooth operation of various loads.

Integrated load switches offer a consolidated solution with built in features such as undervoltage lockout, thermal shutdown, reverse current blocking, quick output discharge, and much more. This integration facilitates space-efficient designs and simplified implementation, contributing to overall system reliability. While discrete solutions can also include these features along with a high degree of customization, they may require more intricate designs and lack the streamlined features inherent in integrated load switches.

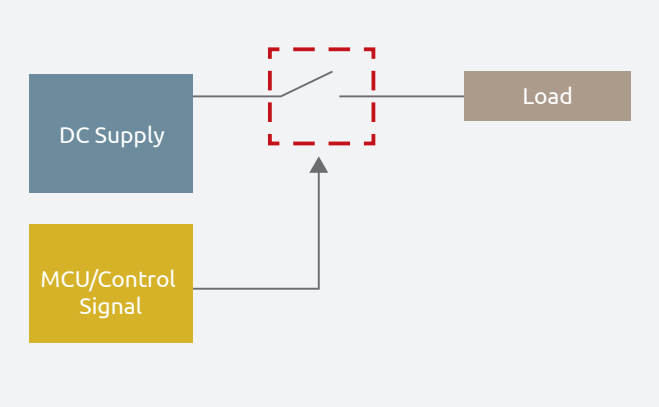


Fig. 1 Power switch in a system design

nexperia

EFFICIENCY WINS.

NPS40XX series

The NPS40XX series encompasses a suite of 5.5V, 55mΩ load switches, engineered to provide precise current limitation within system architectures. These switches are designed to enforce a constant-current mode, activating when the output load current surpasses a predefined current limit threshold or encounters a short circuit. The current limit threshold can either be adjustable (NPS4053) or fixed (NPS4001/NPS4069) depending on preference for the system design.

Furthermore, the NPS40XX series integrates active reverse voltage protection, activating when the output voltage exceeds the input voltage by a set threshold, as detailed in the product datasheets. In addition, this family incorporates a FLG pin, which is a dedicated pin for signaling fault conditions such as over-temperature, reverse voltage, or over-current scenarios. This ensures enhanced system safety and reliability.

NPS40XX Features and Benefits

- Wide Input voltage: 2.5 V to 5.5 V
- 110 mA to 2.5 A adjustable current limit to meet multiple applications (NPS4053)
- Fixed current limit versions 1.5A (NPS4069) and 2A (NPS4001)
- Enhances system robustness by providing protection against ILIM pin open or short to GND
- 6% current limit accuracy at 1.2 A
- Active reverse current blocking to prevent previous System from damage

Applications

- Laptops, notebooks and PCs
- USB ports/hubs, docking station and desktops
- Set top box
- Printers
- Optical socket protection
- Current limiting circuits

NPS1000 load switch

The NPS1000 load switch is a low voltage, single-channel load switch with a low on-resistance (11mΩ) to minimize the voltage drop and power loss across the pass FET when ON. To achieve low input voltage levels on the input pins and a low on-resistance, the device features a bias pin to power the internal control blocks of the device.

The NPS1000 is available in an ultra-small, space saving, 1.42mm x 0.72mm 8-pin WLCSP package. Additionally, it supports up to 0.6A RMS current and a peak current of 1.5A.

NPS1000 Features and Benefits

- Input voltage: 0.5 V to 1.0 V
- Low RDSON: 11mΩ typ at 25°C, 16mΩ max at 85°C
- Enable logic supports 1.2V logic levels
- Controlled Startup
  - <200us from enable to full enhancement of power FET
- Output short tolerant
  - When supplied by a 4.5A current limited power supply
- Over-Temperature Shutdown and Input UVLO Protection
- 8Ω Discharge While Disabled
- Small package footprint

Applications

- Wearable devices
- Mobile phones

Soft Start

A soft start circuit in an integrated load switch refers to a feature designed to control the inrush current when the load switch is first turned on. It minimizes large startup currents from flowing to the load by turning on of the pass FET slowly to avoid stressing connected loads. For integrated switches that have a soft start feature, the output voltage will rise at a linear rate, reducing the amount of inrush current that flows through the device. Integrated load switches such as the NPS1000, NPS4053, NPS4001 and NPS4069 have this feature built into the device.

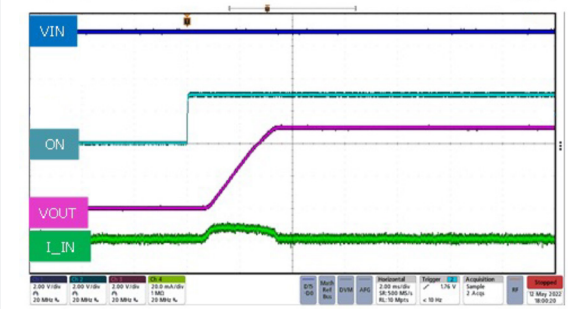


Fig. 2 Integrated load switch with soft start

Under Voltage Lockout

Under-voltage lockout (UVLO) is a critical safety and efficiency feature integrated into load switches that is designed to prevent the load switch from turning on or off until it has reached certain threshold levels. This function ensures that the system is protected from operating in conditions that could lead to inefficient performance or damage due to insufficient power. The UVLO feature is particularly important in scenarios where a consistent power level is crucial for the operation of sensitive electronic components. Among the variety of load switches that incorporate this feature, the NPS1000, NPS4053, NPS4001, and NPS4069 stand out. These specific models are equipped with UVLO to safeguard against under-voltage conditions, ensuring that the devices only operate within their optimal voltage range. This inclusion enhances the overall reliability and stability of the systems they are integrated into, by preventing the ICs from attempting to function in potentially harmful low-voltage scenarios, thus maintaining system integrity and prolonging the lifespan of the electronic components they control.

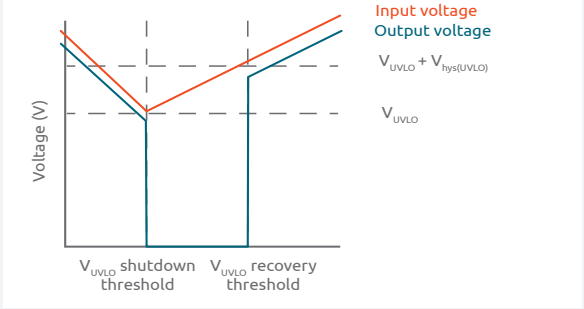


Fig. 3 Undervoltage lockout input vs output

Controlled Power Down (Quick Output Discharge)

The NPS4001, NPS4069, and NPS1000 offer controlled power down through the use of an internal pull-down that is enabled when the device is turned off. This feature is commonly referred to as quick output discharge, which rapidly discharges the output when the device is in its off state. This feature is particularly useful in electronic systems where precise control over the power supply is crucial, such as in portable devices, computing systems, and digital circuits. This feature facilitates quick power cycling and system resets, enhancing the overall reliability and performance of the system. Moreover, quick output discharge will eliminate floating voltages at the input of the load and ensure that the load remains in a defined power state.

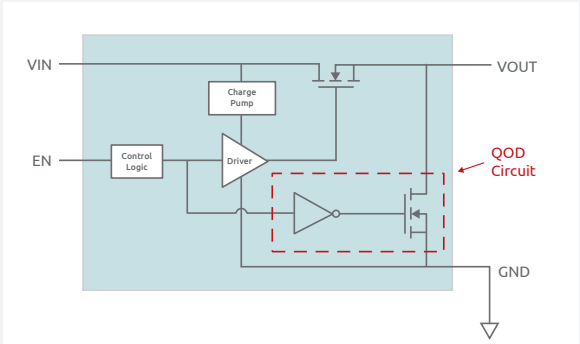


Fig 4. Simplified load switch IC with quick output discharge functionality

Reverse Voltage Protection

Reverse voltage protection is a crucial feature in load switch Integrated Circuits (ICs) that safeguards electronic components from damage due to reverse flow of current from the output of the device to the input. This protection mechanism prevents the flow of current when the voltage at the output exceeds the voltage at the input, which could otherwise lead to severe component failure or reduced functionality. The NPS4053, NPS4001, and NPS4069 load switches are exemplary models that incorporate reverse voltage protection, ensuring that devices remain protected against the adverse effects of reverse voltage when the output exceeds the input by a set threshold. By integrating this feature, these ICs enhance system reliability and durability, particularly in environments where the power supply delivering power to the load needs to be preserved and protected.

Device	NPS1000	NPS4053	NPS4069/NPS4001
Vin (V)	0.5 - 1.0	2.5 - 5.5	2.5 - 5.5
Rds(on) (mQ)	11	55	55
Rated Current (A)	0.6 RMS, 1.5 peak	2	1.5 (NPS4069) 2 (NPS4001)
Current limit	N/A	Adjustable	Fixed
Output short protection	When supplied by a 4.5A current limited power supply	√	√
Over Temperature Protection	√	√	√
Quick Output Discharge	√		√
Reverse voltage blocking		√	√
Fault Indicator		√	√
Package	WLCSP8	HWSON6, TSOP6	TSOP5

Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
NPS4053GH	-40 °C to +125 °C	HWSON6	Plastic thermal enhanced very very thin small outline packages, no leads; 6 terminals; 0.65 mm pitch; 2.0 mm x 2.0 mm x 0.75 mm body	SOT8044-1
NPS4001GV	-40 °C to +125 °C	TSOP5	Plastic surface-mounted package; 5 leads	SOT753
NPS4069GV	-40 °C to +125 °C	TSOP5	Plastic surface-mounted package; 5 leads	SOT753
NPS1000UP	-40 °C to +85 °C	WLCSP8	Wafer level chip-scale package; 8 bumps	SOT8068

Date of release:
March 2024