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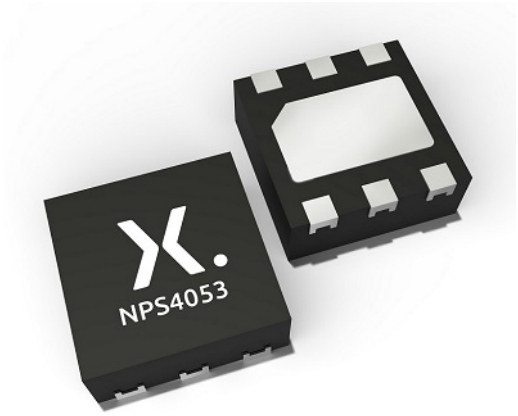
Application note

How to configure the fault and current limit pins of Nexperia NPS40XX load switch ICs



Abstract: This application note provides comprehensive guidance on configuring the fault and current limit pins of Nexperia NPS40XX family of load switch ICs for optimized performance and enhanced reliability in various electronic systems. Load switches play a crucial role in modern electronic devices, offering efficient power management and protection against overcurrent and fault conditions. Proper configuration of fault detection and current limit features ensures the safety and longevity of electronic systems, while also enhancing their overall performance.

Keywords: Load switch, NPS4053, NPS4069, NPS4001

nexperia

1. Introduction

Efficient power management including current limitation and protection against fault conditions, are essential requirements in the design of modern electronic systems. Load switches offer a versatile solution for achieving these objectives.

Central to Nexperia's NPS40XX family of load switches are their fault detection and current limiting features, which play a critical role in safeguarding downstream components and ensuring reliable operation. Configuring these features requires a good understanding of system requirements, load characteristics, and application-specific considerations.

This application note provides comprehensive details of the configuration of the fault, (/FLT), and current limit, (ILIM), pins in the NPS40XX family of load switches, offering practical guidance to enhance system reliability, efficiency, and performance. Through a detailed explanation of fault detection mechanisms, current limiting techniques, and practical implementation strategies, this application note equips designers and engineers with the knowledge needed to effectively tailor load switch configurations to the unique demands of their applications.

1.1. Fault pin (flag pin, /FLG) in a load switch IC

In the NPS40XX family of load switch ICs (Integrated Circuits), the fault pin, or flag (/FLG) pin, is an open-drain, active-low output signal that indicates a fault condition. In normal operation, a pull-up resistor is connected between the /FLG pin and VIN, or an external voltage. When a fault condition occurs, such as over-current, short circuit, over-temperature, reverse current, or other fault conditions, the fault pin is pulled low via an internal MOSFET, indicating the presence of the fault.

The fault pin functions by monitoring parameters such as voltage, current, or temperature, depending on the specific fault detection mechanism implemented in the load switch IC. Once a fault is detected, the fault pin may be configured to respond in various ways, such as signaling the occurrence of the fault to a microcontroller, activating protective measures, or initiating shutdown sequences to prevent damage to the load switch or connected components.

Fig. 1 shows the system block diagram of the NPS4053, and how the fault pin operates internally. When the IC experiences an over current, over temperature, or reverse voltage condition, the fault block will pull the /FLG pin low to indicate a fault event.

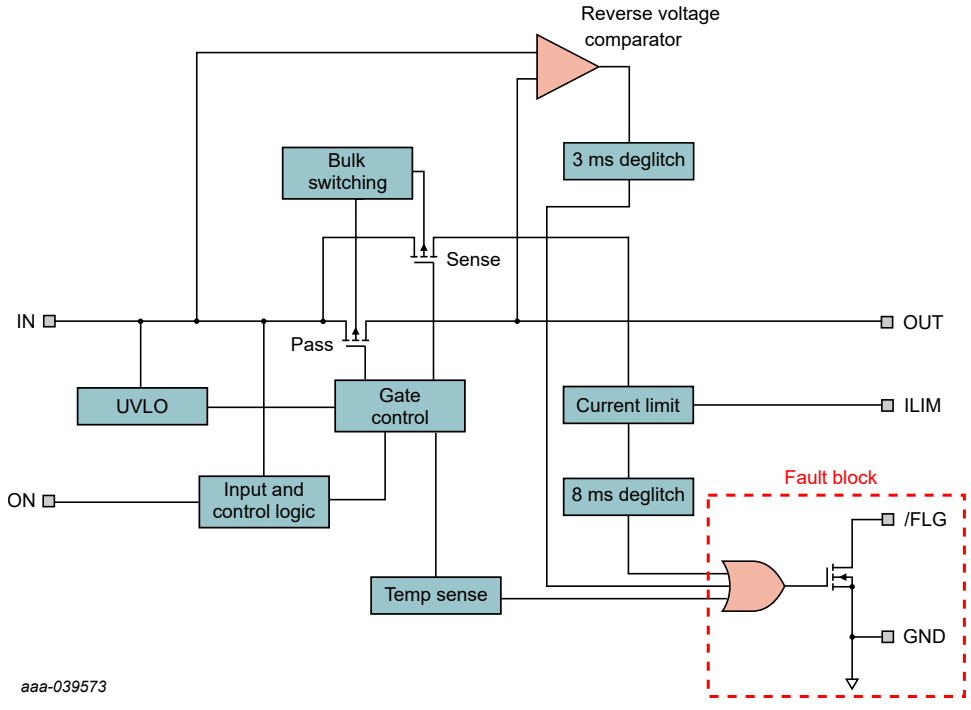


Fig. 1. Fault control block of NPS4053

1.2. Current limit (ILIM) pin in a load switch IC

The current limit pin (ILIM) in a load switch IC allows the designer to set the maximum output current for the load switch. By configuring this pin with a resistor to ground, you can adjust the threshold at which the load switch will limit the output current to protect the connected downstream loads. The NPS4053 features this unique function at the pin labeled “ILIM” as shown in Fig. 2. By adjusting the value of resistor R_{ILIM} from 9.31 kΩ to 210 kΩ, the maximum allowable output current can be set from 2.5 A to 0.11 A; see Fig. 3 and Table 1.

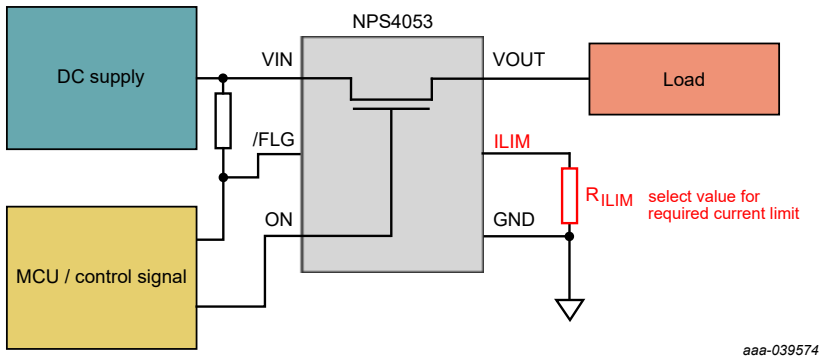


Fig. 2. ILIM pin of NPS4053, connected to ground via R_{ILIM}

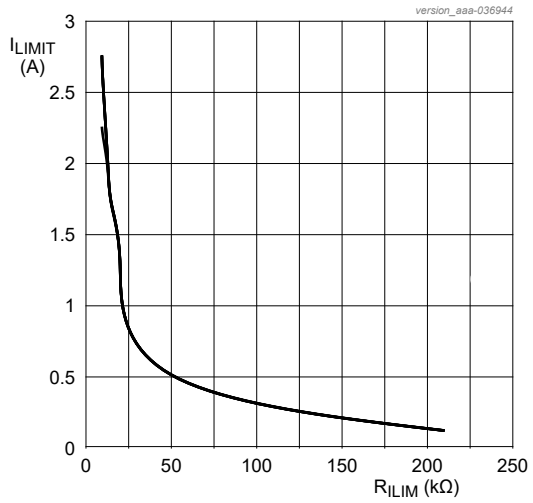


Fig. 3. Current limit vs R_{ILIM} for NPS4053

Table 1. R_{ILIM} values and corresponding output current limits

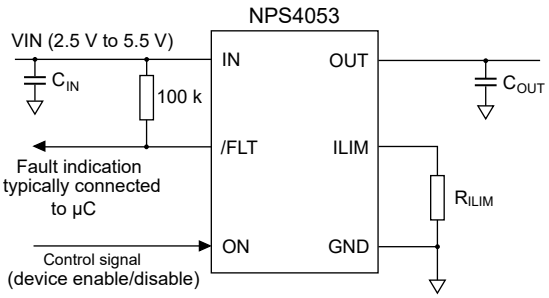
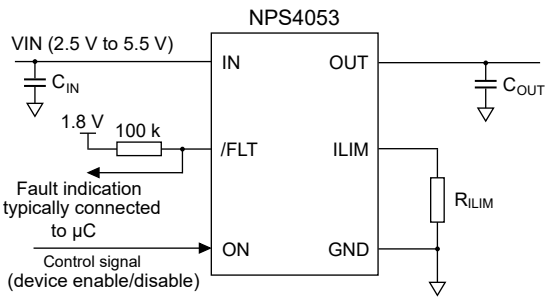
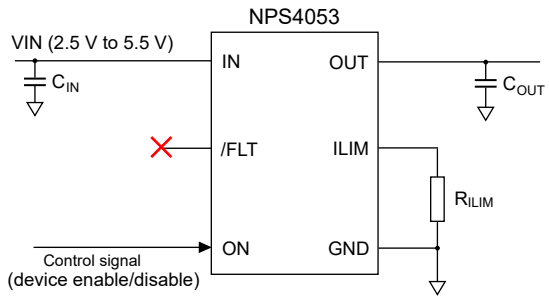
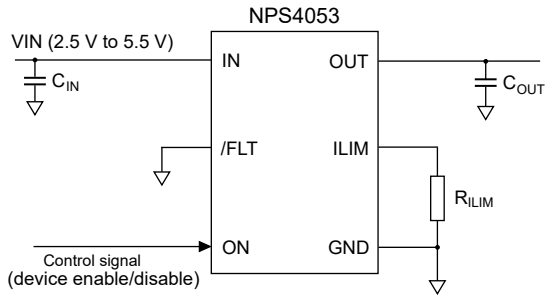
Symbol	Parameter	Conditions	T_{amb} = -40 °C to +125 °C			Unit
			Min	Typ	Max	
I_{LIMIT}	current-limit threshold	V_{IN} - V_{OUT} = 1.0 V				
		R_{ILIM} = 9.31 kΩ; T_j ≤ 125 °C	2.25	2.5	2.72	A
		R_{ILIM} = 10.2 kΩ; T_j ≤ 125 °C	2.06	2.3	2.50	A
		R_{ILIM} = 12.7 kΩ; T_j ≤ 125 °C	1.68	1.85	2.01	A
		R_{ILIM} = 15.0 kΩ; T_j ≤ 125 °C	1.48	1.57	1.67	A
		R_{ILIM} = 20.0 kΩ; T_j ≤ 125 °C	1.09	1.18	1.25	A
		R_{ILIM} = 49.9 kΩ; T_j ≤ 125 °C	0.42	0.47	0.51	A
		R_{ILIM} = 210.0 kΩ; T_j ≤ 125 °C	0.08	0.11	0.14	A
		pin LIMIT shorted to GND	-	2.46	-	A
		pin LIMIT open	-	0.11	-	A

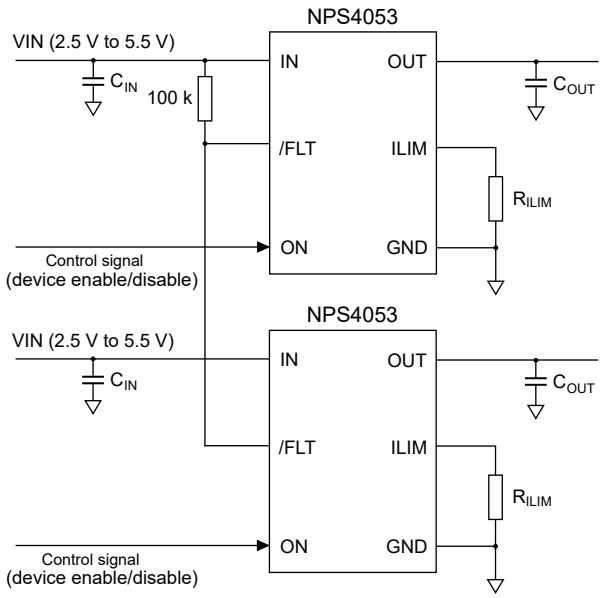
2. How to configure the fault (/FLT) pin

Configuring the /FLT pin in a load switch IC is essential for protecting the connected loads, ensuring system safety, and enhancing overall reliability. It provides an important layer of protection against over-current and thermal issues, while also enabling valuable diagnostic capabilities.

Table 2 shows a number of common /FLT pin configurations.

Table 2. Common fault (/FLT) pin configurations of the NPS40XX family of load switch ICs

Configuration	Comments
	• Typical application, since /FLT is active low, this pin is pulled up to VIN through external resistor • /FLT pin will be pulled low when NPS4053 enters over current limit mode, over temperature protection mode and reverse voltage blocking mode
	• /FLT pin is pulled up to another power rail (i.e. 1.8 V as shown) through external resistor • /FLT pin will be pulled low when NPS4053 enters over current limit mode, over temperature protection mode and reverse voltage blocking mode.
	• /FLT pin can be floating if not used
	• FLT pin can be shorted to GND if not used

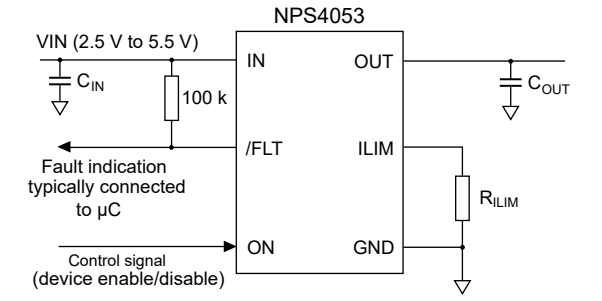
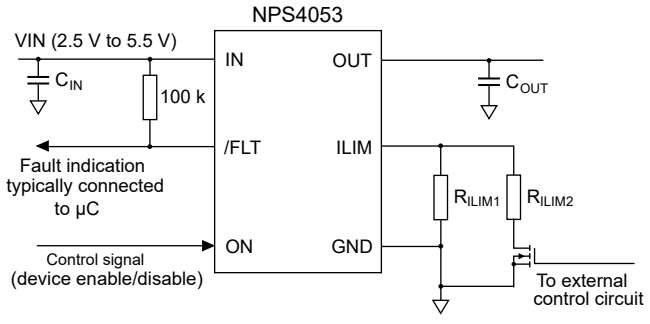
Configuration	Comments
	• /FLT pin can be set up into ORíng configuration for multiple load switches • Eliminates the need for multiple pull up resistors

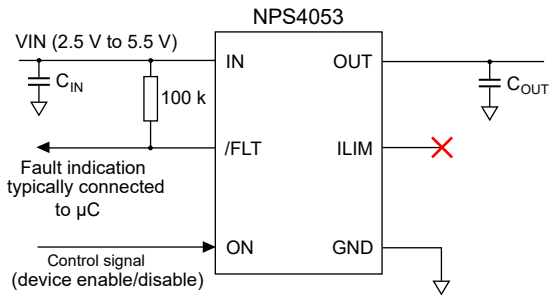
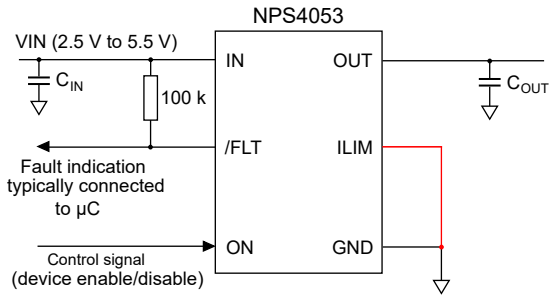
3. How to configure the current limit (ILIM) pin

Configuring the ILIM pin on a load switch IC is vital for ensuring the protection of the load, the load switch IC itself, and the overall system stability. It allows for customization based on application requirements, which ultimately contributes to the reliability and longevity of the system.

Table 3 shows a number of common ILIM pin configurations.

Table 3. Common current limit (ILIM) pin configurations of the NPS40XX family of load switch ICs

Configuration	Comments
	• C_{IN} at least 0.1 µF. • C_{OUT} at least 120 µF at output for USB port application, other applications except USB choose output capacitor according to actual transient requirements. • The maximum output current can be set by selecting the value of resistor R_{ILIM} (9.31 kΩ to 210 kΩ). The current limit threshold is hence programmable from 2.5 A to 0.11 A.
	• C_{IN} at least 0.1 µF. • Choose C_{OUT} according to actual transient requirements. • R_{ILIM1} to set first current limit threshold, R_{ILIM1}/R_{ILIM2} to set second current limit threshold. • One load switch to achieve multiple current limit thresholds with different R_{ILIM} in parallel.

Configuration	Comments
	• C_{IN} at least 0.1 µF. • Choose C_{OUT} according to actual transient requirements. • I_{LIM} pin floating to set a fixed 0.11 A current limit threshold. • Saves on BOM cost by eliminating extra resistor.
	• C_{IN} at least 0.1 µF. • Choose C_{OUT} according to actual transient requirements. • I_{LIM} pin shorted to GND to set a fixed 2.5 A current limit threshold. • Saves on BOM cost by eliminating extra resistor.

4. Revision history

Table 4. Revision history

Revision number	Date	Description
1.0	2024-04-24	Initial version.

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