MIC2526

Dual USB High-Side Power Switch

Advance Information

General Description

The MIC2526 is a dual integrated high-side power switch designed for self-powered and bus-powered Universal Serial Bus (USB) applications conforming to USB requirements.

The MIC2526 satisfies the following USB requirements: the switch's low on-resistance meets USB voltage drop requirements, load current is limited to typically 750mA, well below the UL25VA safety requirement, and flag outputs are available to transmit overcurrent conditions to the local USB controller. The low current limit also makes these devices very suitable in portable PC applications where low current consumption is required. Inrush current limiting eliminates the momentary voltage drop on the upstream port that may occur when the switch is enabled in bus-powered applications.

Additional features include thermal shutdown to prevent catastrophic switch failure from high-current loads, undervoltage lockout (UVLO) ensuring that the device remains off unless there is a valid input voltage present, and an enable input that is compatible with both 3.3V and 5V logic.

The MIC2526 is available in active-high and active-low enable versions in 8-pin DIP and 8-pin SOIC packages.

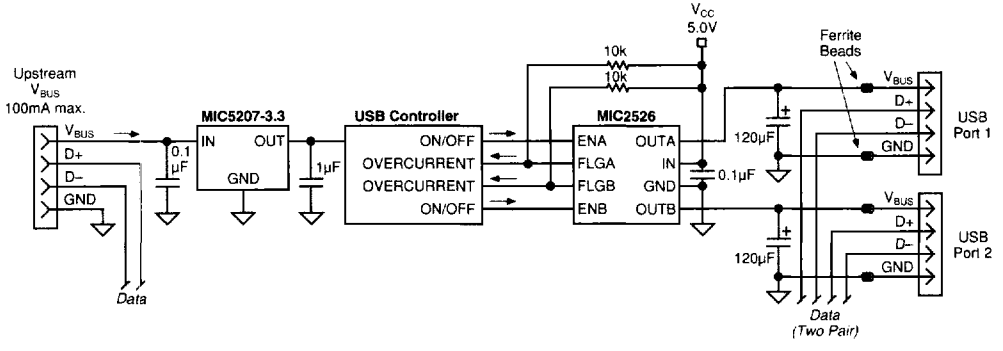
Features

- Compliant to USB specification 1.0 (Jan. 15, 1996)
- Low MOSFET on resistance at 5.0V
  140mΩ max. per channel
- 500mA minimum continuous load current per channel
- 4V to 5.5V input
- 110µA typical on-state supply current
- 1µA typical off-state supply current
- Output can be forced higher than input (off-state)
- Current limit
- Thermal shutdown
- Undervoltage lockout (UVLO)
- Open-drain fault flag
- 1ms (slow) turn-on and fast turnoff
- Available with active-high or active-low enable

Applications

- USB power management
- Hot plug-in power supplies
- Battery-charger circuits

Typical Applications

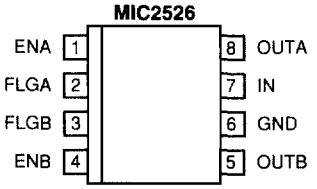


Dual-Port Self-Powered Hub Application

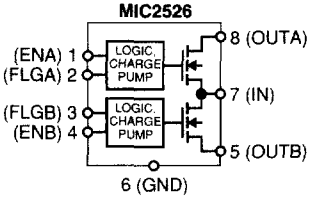
Ordering Information

Part Number	Enable	Temperature Range	Package
MIC2526-1BM	Active High	–40°C to +85°C	8-Pin SOIC
MIC2526-2BM	Active Low	–40°C to +85°C	8-Pin SOIC
MIC2526-1BN	Active High	–40°C to +85°C	8-pin DIP
MIC2526-2BN	Active Low	–40°C to +85°C	8-pin DIP

Pin Configuration



8-Pin SOIC (M)
8-Pin DIP (N)



Pin Description

Pin Number	Pin Name	Pin Function
1 / 4	EN(A/B)	Enable (Input): Logic-compatible enable input. High input > 2.1V typical. Low input <1.9V typical
2 / 3	FLG(A/B)	Fault Flag (Output): Active-low, open-drain output. Indicates overcurrent, UVLO, and thermal shutdown.
6	GND	Ground: Return.
7	IN	Supply Input: Output MOSFET drain. Also supplies IC's internal circuitry. Connect to supply.
8 / 5	OUT(A/B)	Switch Output: Output MOSFET source. Typically connect to switched side of load.

Absolute Maximum Ratings

Supply Voltage (V_{IN}) ..... +8.0V
Fault Flag Voltage (V_{FLG}) ..... +8.0V
Fault Flag Current (I_{FLG}) 50mA
Output Voltage (V_{OUT}) ..... +8.0V
Output Current (I_{OUT}) ..... Internally Limited
Control Input (V_{EN}) ..... –0.3V to 12V
Storage Temperature (T_S) ..... –65°C to +150°C
Lead Temperature (Soldering 5 sec.) ..... 260°C

Operating Ratings

Supply Voltage (V_{IN}) ..... +4V to +5.5V
Ambient Operating Temperature (T_A) ..... –40°C to +85°C
Thermal Resistance
SOIC (θ_{JA}) ..... 160°C/W
DIP(θ_{JA}) ..... 105°C/W

Electrical Characteristics

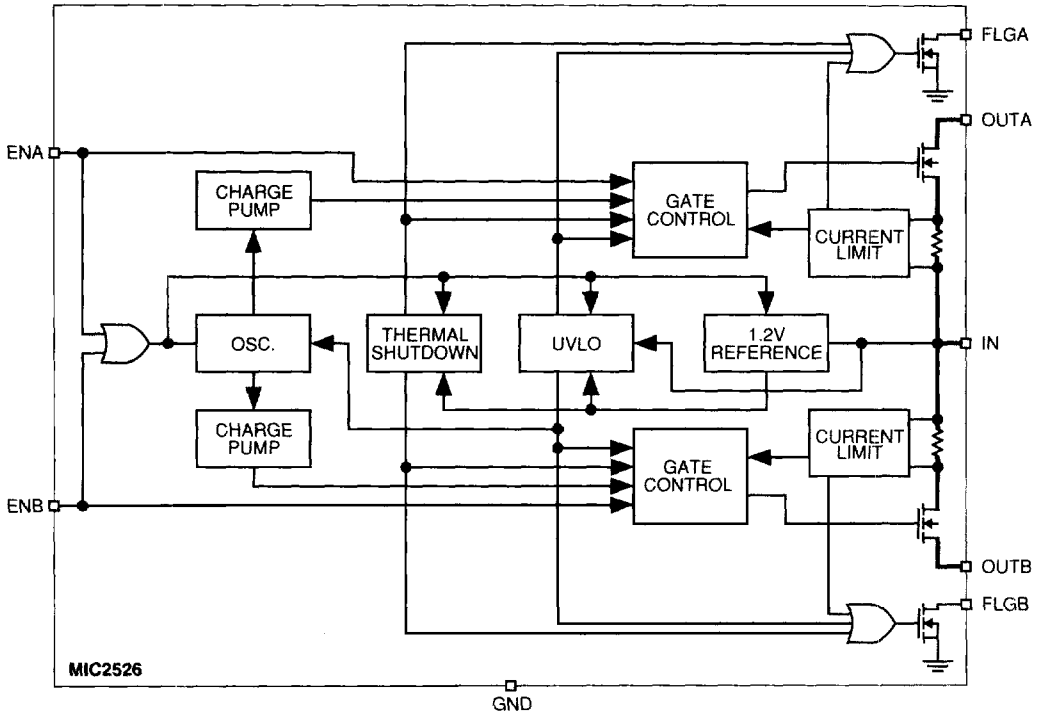
V_{IN} = +5V; T_A = 25°C.

Parameter	Condition	Min	Typ	Max	Units
Supply Current	**Note 1**, switch off, OUT = open		0.75		µA
	Note 1, switch on, OUT = open		110		µA
Enable Input Threshold	low to high transition high to low transition, **Note 1**	 0.8	2.1 1.9	2.4	V V
Enable Input Current	$V_{EN} = V_{OH(min)} = 2.4V$ $V_{EN} = V_{OL(max)} = 0.8V$		0.01 0.01	1 1	µA µA
Enable Input Capacitance			1		pF
Output MOSFET Resistance	each MOSFET		100		mΩ
Output Turn-On Delay	R_L = 10Ω each output		0.5		ms
Output Turn-On Rise Time	R_L = 10Ω each output		0.1		ms
Output Turn-Off Delay	R_L = 10Ω each output		1	20	µs
Output Turn-Off Fall Time	R_L = 10Ω each output		1	20	µs
Output Leakage Current	each output			10	µA
Current Limit Threshold	each output	0.5	.75	1.25	A
Overtemperature Shutdown Threshold	T_J increasing T_J decreasing		135 125		°C °C
Error Flag Output Resistance	V_{IN} = 5V, I_L = 10mA V_{IN} = 3.3V, I_L = 10mA		10 15		Ω Ω
Error Flag Off Current	V_{FLAG} = 5V		0.01	1	µA
UVLO Threshold	V_{IN} = increasing V_{IN} = decreasing		2.5 2.3		V V

General Note: Devices are ESD protected, however, handling precautions recommended.

Note 1: Off is ≤ 0.8V and on is ≥ 2.4V for the MIC2526-1. Off is ≥ 2.4V and on is ≤ 0.8V for the MIC2526-2. The enable input has approximately 200mV of hysteresis.

Block Diagrams



MIC2526 Block Diagram

Functional Description

The MIC2526-1 and MIC2526-2 are dual high-side switches with active-high and active-low enable inputs, respectively. Fault conditions turn off or inhibit turn-on one or both of the output transistors, depending upon the type of fault, and activate the open-drain error flag transistors making them sink current to ground.

Input and Output

IN (input) is the power supply connection to the logic circuitry and the drain of the output MOSFET. OUT (output) is the source of the output MOSFET. In a typical circuit, current flows through the switch from IN to OUT toward the load. Both OUT pins must be connected to the load.

The output MOSFET and driver circuitry are also designed to allow the MOSFET source to be externally forced to a higher voltage than the drain ($V_{OUT} > V_{IN}$) when the output is off. In this situation, the MIC2525 avoids undesirable drain-to-body diode current flow by grounding the body when the switch is off. (The conventional method for optimum turn on threshold has the source connected to the body. This would allow a large current to flow when $V_{source} > V_{drain} + 0.6V$.)

Thermal Shutdown

Thermal shutdown shuts off the output MOSFET and signals the fault flag if the die temperature exceeds 135°C. 10°C of hysteresis prevents the switch from turning on until the die temperature drops to 125°C. Overtemperature detection functions only when the switch is on.

Undervoltage Lockout

UVLO (undervoltage lockout) prevents the output MOSFET from turning on until IN (input voltage) exceeds 2.5V typical. After the switch turns on, if the voltage drops below 2.3V typical, UVLO shuts off the output MOSFET and signals the fault flag. Undervoltage detection functions only when the switch is on.

Current Limit

The current limit threshold is preset internally. The preset level prevents damage to the output MOSFET and external load but allows a minimum current of 0.5A through the output MOSFET. For further protection, there is typically 150mA foldback in the output current after the current limit threshold is exceeded.

Fault Flag

FLG is an N-channel, open-drain MOSFET output. The fault-flag is active (low) for one or more of the following conditions: undervoltage, current limit, or thermal shutdown. The flag output MOSFET is capable of sinking a 10mA load to typically 100mV above ground.

Applications Information

Supply Filtering

A 0.1µF to 1µF bypass capacitor from IN to GND, located at the MIC2526, is strongly recommended to control supply transients. Without a bypass capacitor, an output short may cause sufficient ringing on the input (from supply lead inductance) to damage internal control circuitry.

Input or output transients must not exceed the absolute maximum supply voltage ($V_{IN\ max}$ = 8V) even for a short duration.

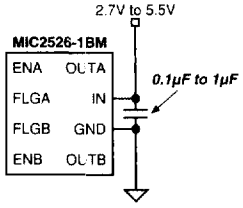


Figure 1. Supply Bypassing

Enable Input

EN must be driven logic high or logic low, or be pulled high or low for a clearly defined input. Floating the input may cause unpredictable operation.

Current Limit Induced Thermal Shutdown

Internal circuitry increases the output MOSFET on-resistance until the series combination of the MOSFET on-resistance and the load impedance limit current to typically 750mA. The increase in power dissipation, in most cases, will cause the MIC2526 to go into thermal shutdown, disabling both channels. When this is undesirable, thermal shutdown can be avoided by externally responding to the fault and disabling the current limited channel before the shutdown temperature is reached. The delay between the flag indication of a current limit fault and thermal shutdown will vary with ambient temperature, board layout, and load impedance, but is typically serval hundred milliseconds. The USB controller must therefore recognize a fault and disable the appropriate channel within this time.

Soft Start

The MIC2526 presents a high impedance when off, and slowly becomes a low impedance as it turns on. This reduces inrush current and related voltage drop that results from charging a capacitive load, satisfying the USB voltage droop requirements, for bus-powered applications as shown in Figure 2.

The soft start circuit can also be utilized to meet USB transient regulation specifications, shown in Figure 3, when the USB device has large load capacitance (>10µF). The MIC2526 will provide inrush current limiting for these applications.

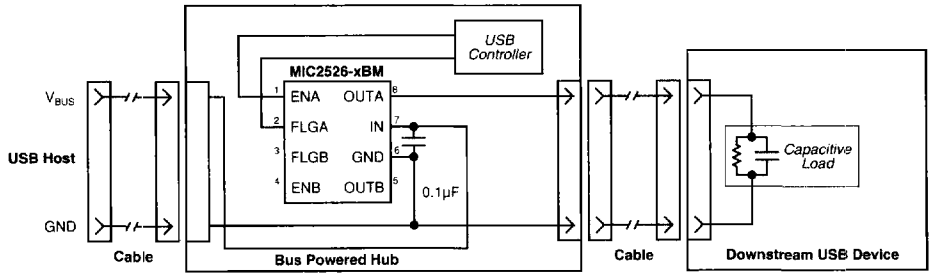


Figure 2. Soft Start (Single Channel)

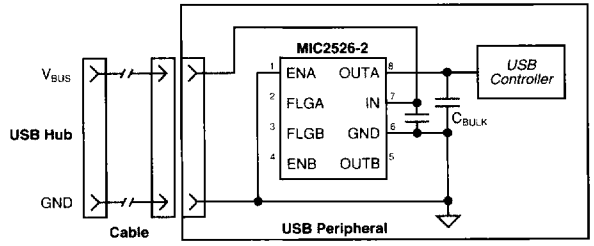


Figure 3. Inrush Current-Limit Application (one channel shown)