General Description

The ILC7526 contains dual high side power control switches, with independent enable and flag functions, integrated into a single 8-pin SOIC package. With just a few external components, the ILC7526 can be easily configured to meet requirements for either self powered or bus powered USB (Universal Serial Bus) applications. The ILC7526 has active high ENABLE inputs, while the ILC7536 ENABLE inputs are active low.

With a maximum R_{DSON} value of 140mΩ per switch, the USB voltage drop requirements can be achieved. Each switch can also supply up to 500mA, with internal circuitry limiting the fault current to 750mA. Fault conditions are also reported to the USB controller via one of the independent flag pins. Internal circuitry provides a soft-start that eliminates momentary upstream voltage drops when the switch is enabled, especially in bus powered applications.

Additional features include undervoltage lockout (2.4V), fast turn-off, 2.8V to 5.8V input voltage range, thermal shutdown to prevent switch failure from high current loads, and 3.3V and 5V logic compatible enable inputs.

The ILC7526 and ILC7536 are available in both 8-pin SOIC and 8-pin mini-DIP packages.

Features

- 2 independent switches with ENABLE and FLAG
- 500mA continuous load current per switch (channel)
- 140mΩ maximum R_{DSON} (switch on-resistance)
- 1.25A maximum short circuit current limit
- Thermal shutdown
- 110µA typical on-state supply current
- 0.75µA typical off-state supply current
- 2.4V typical undervoltage lockout
- 2.8V to 5.8V input voltage range
- 1 ms turn-on (soft-start)
- Fast turn-off
- Outputs can be forced higher than inputs (off-state)
- USB specification compliant
- Active-high or active-low ENABLE versions
- 8-pin SOIC or 8-pin mini-DIP packages

Applications

- USB host and self powered hubs
- USB bus-powered hubs
- USB monitors, printers, cameras and other USB controlled peripherals
- Hot plug-in power supplies
- Battery charger circuits

Ordering Information* (T_A = -40°C to =85°C)	
ILC7526-IK	Active High Enable, SO-8 package
ILC7526-IN	Active High, DIP-8 package
ILC7536-IK	Active Low, SO-8 package
ILC7536-IN	Active Low, DIP-8 package

Figure 2: Pin Configuration

```
          ┌─────────────┐
ENA   1 ──┤ ●           ├── 8  OUTA
FLGA  2 ──┤             ├── 7  IN
FLGB  3 ──┤             ├── 6  GND
ENB   4 ──┤             ├── 5  OUTB
          └─────────────┘
```
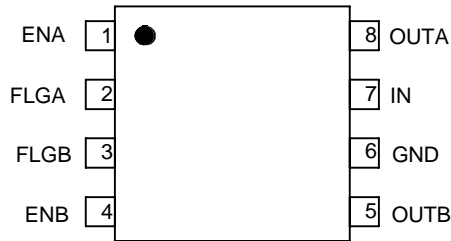
Pin Number	Pin Name	Pin Description
1	ENA	Enable A (input): Logic-compatible enable input. (7526 active-high, 7536 active-low). Do not float.
2	FLGA	Fault Flag A (Output): Active-low, open-drain output. Indicates overcurrent, UVLO, or thermal shutdown.
3	FLGB	Fault Flag B (Output): Active-low, open-drain output. Indicates overcurrent, UVLO, or thermal shutdown.
4	ENB	Enable B (Input): Logic-compatible enable input. (7526 active-high, 7536 active-low). Do not float.
5	OUTB	Switch Output B: Output MOSFET source. Typically connect to switched side of load.
6	GND	Ground: Supply return.
7	IN	Supply Input: Output MOSFET drain. Also supplies IC's internal circuitry. Connect to positive supply.
8	OUTA	Switch Output A: Output MOSFET source. Typically connect to switched side of load.

ILC7526

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         ┌──────────────────────┐
         │                      │─○ (OUTA)8
(ENA)1 ○─┤  ┌────────┐          │
         │  │ LOGIC  │     ║    │
         │  │ CHARGE │──────╢   │
(FLGA)2 ○┤  │ PUMP   │     ║    │
         │  └────────┘       ○──●─ (IN)7
(FLGB)3 ○┤  ┌────────┐     ║    │
         │  │ LOGIC  │     ║    │
         │  │ CHARGE │──────╢   │
(ENB)4 ○─┤  │ PUMP   │     ║    │
         │  └────────┘          │─○ (OUTB)5
         │          ○           │
         └──────────────────────┘
                 (GND)6
```
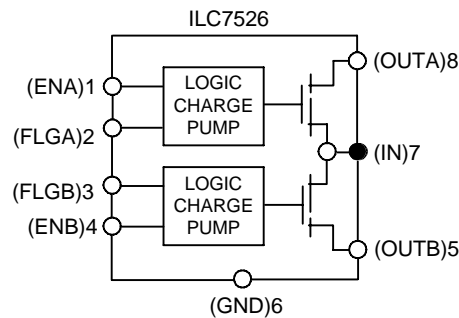
Absolute Maximum Ratings (Note 1, notes on next page)

Parameter	Symbol	Ratings	Units
Input Supply Voltage	V_{IN}	+6	V
Fault Flag Voltage	V_{FLG}	+6	V
Fault Flag Current	I_{FLG}	50	mA
Output Voltage	V_{OUT}	+6	V
Output Current	I_{OUT}	Internally Limited	mA
ENABLE Input Voltage	V_{EN}	-0.3 to +12	V
Storage Temperature	T_{STG}	-40 to +125	°C
Operating Ambient Temperature	T_A	-40 to +85	°C
Package Thermal Resistance SOIC 8-Pin DIP	θ_{JA}	120 130	°C/W °C/W
Lead Temperature (soldering 5 sec)	θ_{JA}	260	°C

Electrical Characteristics ILC7526IK

Test circuit shown in Fig. 2. **BOLDFACE** type indicates limits that apply over the full operating temperature range **(Note 2).**

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Current	I_{SS}	Switch off, OUT = Open All switches on, OUT = Open		0.75 110		µA µA
ENABLE Input Threshold	V_{ENTH}	Low to high transition High to low transition (Note 3)	0.8	2.1 1.9	2.4	V V
ENABLE Input Current	I_{EN}	V_{EN} = 0V to 5.8V	-1	+0.01	1	µA
ENABLE Input Capacitance	C_{EN}			1		pF
Switch resistance	R_{DSON}	V_{IN} = 5V, I_{OUT} = 500mA each switch V_{IN} = 3.3V, I_{OUT} = 500mA each switch		100 140	140 180	mΩ mΩ
Output Turn-on Delay	T_{ON}	R_L = 10Ω each output		0.5		ms
Output Turn-on Rise Time	T_{OR}	R_L = 10Ω each output		1		ms
Output Turn-off Delay	T_{OFD}	R_L = 10Ω each output		1	20	µs
Output Turn-off Fall Time	T_{OFF}	R_L = 10Ω each output		1	20	µs
Output Leakage Current	I_{OL}	Output disabled, each output			10	µA
Continuous Load Current	I_{OUT}	Each output	0.5			A
Short Circuit Current Limit	I_{SCL}	ENABLE into load, V_{OUT} = 4.0V	0.5	0.75	1.25	A
Current Limit Threshold	I_{LTH}	Ramped load to enabled output V_{OUT} < 4.0V, Note 2		1.6	2.2	A
Over Temperature Shutdown Threshold	O_{TTH}	T_J (Junction temperature) increasing T_J (Junction temperature) decreasing		135 125		°C °C
Error Flag Output Resistance	R_{FLG}	V_{IN} = 5V, I_L = 10mA V_{IN} = 3.3V, I_L = 10mA		10 15	25 40	Ω Ω
Error Flag Off Current	I_{FLG}	V_{FLG} = 5V		0.01	1	µA
Under Voltage Lockout Threshold	UVLO	V_{IN} = increasing V_{IN} = decreasing		2.5 2.3		V

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Note 1. Stresses above those listed under ABSOLUTE MAXIMUM RAT-INGS may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability. Operating ranges define those limits between which the functionality of the device is guaranteed.

Note 2. Specified min/max limits are production tested or guaranteed

through correlation based on statistical control methods. Measurements are taken at constant junction temperature as close to ambient as possible using low duty pulse testing.

Note 3. Off is $\leq$ 0.8V and On is $\geq$ 2.4V for the ILC7526. Off is $\geq$ 2.4V for the ILC7536. The enable input has approximately 200mV of hysteresis.
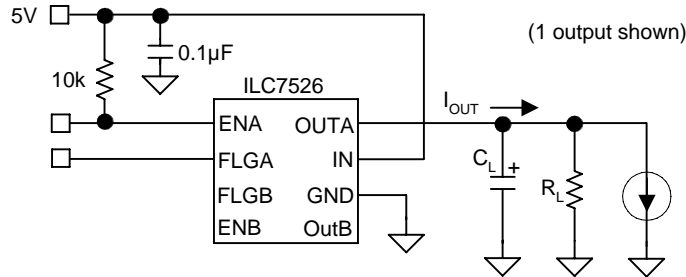
Functional Description

The ILC7526 and ILC7536 are dual high-side switches with active-high and active-low enable inputs, respectively. Fault conditions turn-off or inhibit turn-on of one or more of the output transistors, depending upon the type of fault, and also activate the open-drain error flag transistors which sink current to ground.

Input and Output
IN (input) is the power supply connection to the logic circuitry and the drains of both of the output MOSFET's. OUTx (output) is the source of each MOSFET. In a typical circuit, current flows through the switch from IN to OUT toward the load. If V_{OUT} is greater than V_{IN} when a switch is enabled, current will flow from OUT to IN since the MOSFET is bidirectional when on.

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 ILC7526 avoids undesirable current flow from OUT to IN. If V_{IN} < 2.5V, UVLO disables both switches.

Thermal Shutdown
Thermal shutdown shuts off the affected output MOSFET's and signals all fault flags 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 at least one switch is enabled.

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 850mA. The increase in power dissipation, in most cases, will cause the ILC7526 to go into thermal shutdown, disabling affected 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 several hundred milliseconds. The USB controller must therefore recognize a fault and disable the appropriate channel within this time. If the fault is not removed or the switch is not disabled within this time, the device will enter into a thermal oscillation of about 2Hz. This does not cause any damage to the device.

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Undervoltage Lockout

UVLO (undervoltage lockout) prevents the output MOS-FET from turning on until V_{IN} exceeds approximately 2.5V. In the undervoltage state, the FLAG will be low. After the switch turns on, if the voltage drops below approximately 2.3V, UVLO shuts off the output MOSFET and signals fault flag. Undervoltage detection functions only when at least one switch is enabled.

Current Sensing and Limiting

The current-limit threshold is preset internally. The pre-set level prevents damage to the output MOSFET and external load but allows a minimum current of 0.5A through the output MOSFET of each channel. The current-limit circuit senses a portion of the output FET switch current. The reaction to an overcurrent condition varies with three scenarios:

Switch Enabled into Short Circuit

If a switch is powered on or enabled into a heavy load or short circuit, the switch immediately goes into a constant-current mode, reducing the output voltage. The fault flag goes low until the load is reduced.

Short Circuit Applied to Output

When a heavy load is applied, a large transient current may flow until the current limit circuitry will respond. Once this occurs, the device limits current to less than the short-circuit current limit specification.

Current-Limit Response

The ILC7526 current-limit profile exhibits a small foldback effect of approximately 500mA. Once this current-limit threshold is exceeded the device enters constant-current mode. This constant current is specified as the short circuit current limit in the "Electrical Characteristics" table. it is important to note that the device will deliver load current up to the current-limit threshold which is typically 1.6A

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 (while $2V < V_{IN} < 2.7$), current limit, or thermal shutdown. The flag output MOSFET is capable of sinking a 10mA load to typically 100mV above ground. Multiple FLG pins may be wired "NORed" to a common pull-up resistor.

Supply Filtering

A 0.1µF to 1µF bypass capacitor from IN to GND, located at the device, 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 output supply voltage ($V_{IN\ MAX} = 6V$) even for a short duration.
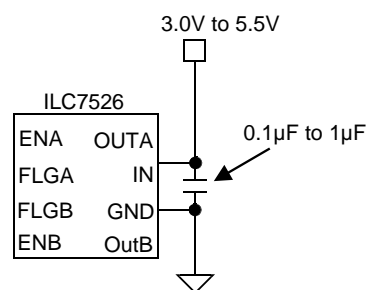
Enable Input

EN must be driven logic high or logic low for a clearly defined input. Floating the input may cause unpredictable operation. EN should not be allowed to go negative with respect to GND.
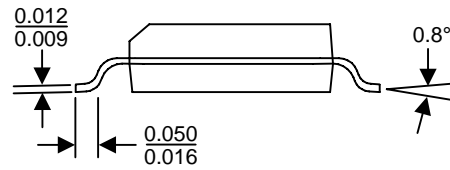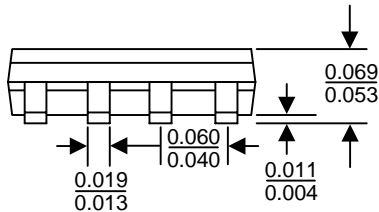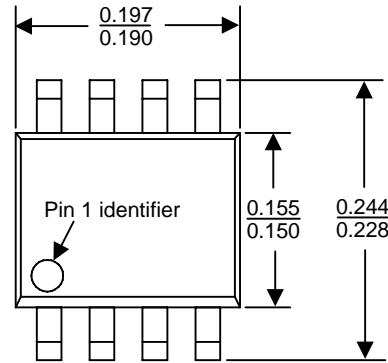
Soft-Start

The ILC7526 presents a high impedance when off, and slowly becomes a low impedance as it turns on. This reduces in rush current and related voltage drop that results from charging a capacitive load, satisfying the USB voltage drop requirements for bus-powered applications.
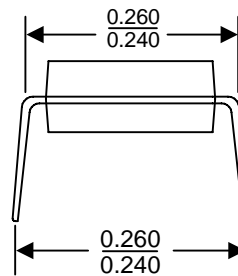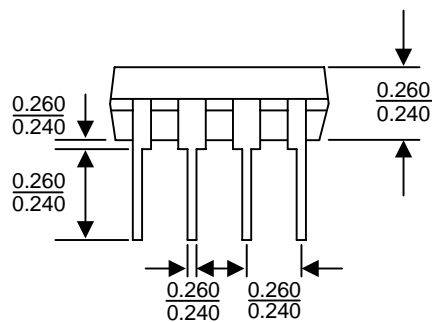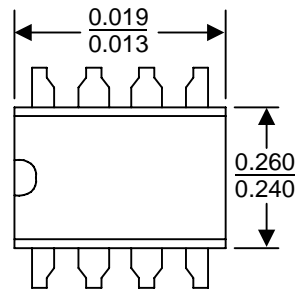
Package Dimensions

All dimensions in inches

8-Pin SOIC

8-Pin DIP

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