Dual USB High-Side Power Switch

– Dual switch
– 0.14Ω /0.1Ω "ON" resistance at 3/5V
– MIC2526 pin compatible

The IMP2526 dual high-side power switch IC is designed for self-powered and bus-powered Universal Serial Bus (USB) power supply and general purpose power management applications. ON resistance is a low 100mΩ at 5V input and 140mΩ at 3V input.

The IMP2526 conforms to the new USB Revision 1.1 standard. Fault current is limited to 750mA typically, and a flag output for each switch conveys fault information to the local USB controller. The IMP2526 "Soft-Start" function ramps the ON-current to eliminate any excessive voltage drop on the input side that could occur when capacitive loads are charged.

Self-monitoring features include thermal shutdown to prevent catastrophic switch failure from high-current loads and undervoltage lockout (UVLO) that insures that the device remains OFF unless there is a sufficient supply voltage present.

The switch Enable input logic can interface with both 3.3V and 5V logic. Both active-HIGH (-1 devices) and active-LOW (-2 devices) enable logic versions are available. Supply current is a low 0.75µA when disabled and just 110µA when enabled.

The IMP2526 devices are available in 8-pin DIP and 8-pin SO packages and are pin compatible replacements for the Micrel MIC2526-1/-2. IMP offers a complete family of USB power management products. For single-switch applications see the IMP2525 and IMP2525A data sheets. The single-switch IMP2525A features a 50% lower switch resistance, 0.07Ω. For quad-switch applications, refer to the IMP2524 data sheet.

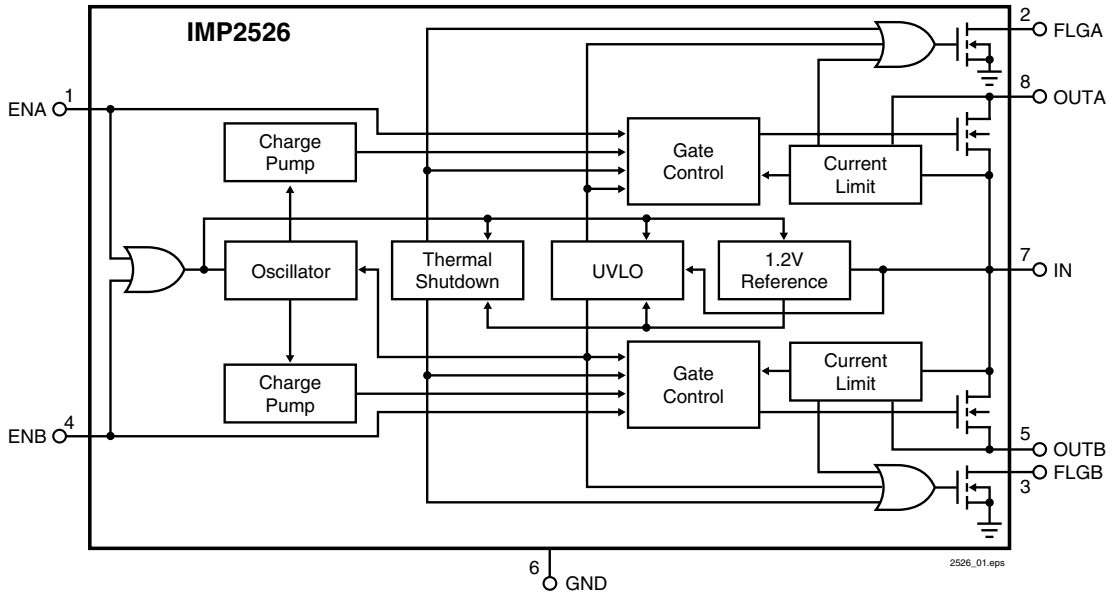
Key Features

- USB Rev. 1.1 compliant
- 2.7V to 5.5V input operation
- Low MOSFET ON resistance (0.1Ω at 5V)
- Low supply current
  - 110µA ON state current, 1µA OFF state current
- 500mA continuous load current per switch
- 1.25A maximum current limit, 750mA typical
- Thermal shutdown 2.4V undervoltage lockout (UVLO)
- Open-drain flag output
  - Undervoltage
  - Current limit
  - Thermal shutdown
- Active HIGH(-1) and active LOW(-2) enable
- Pin compatible with the Micrel MIC2526

Applications

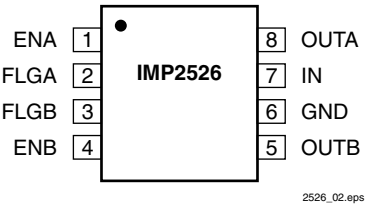
- USB host and self-powered hubs
- Bus-powered hubs
- Hot plug-in power supplies
- Battery chargers

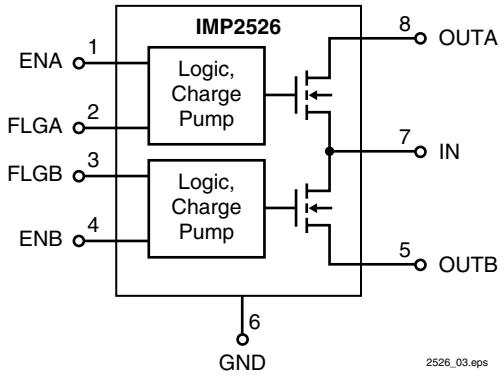
Block Diagrams



Pin Configuration

SO/DIP





Pin Descriptions

Pin Number	Name	Function
1, 4	ENA, ENB	Enable input. This pin is the MOSFET switch driver logic input. Both active-HIGH (-1 suffix) and active-LOW (-2 suffix) logic devices are available.
2, 3	FLGA, FLGB	Fault flag output. This open-drain output goes into an active-LOW state in response to undervoltage, current limit or thermal shutdown conditions.
6	GND	Ground. Power supply return for the internal circuitry of the IC.
7	IN	Positive power supply voltage input. This is the switching MOSFET drain connection as well as the positive supply for the IC.
8, 5	OUTA, OUTB	MOSFET source. The output pin supplies power to the load.

Ordering Information

Part Number	Enable Logic	Temperature Range	Pins-Package
IMP2526-1BM	Active HIGH	–40°C to +85°C	8-SO
IMP2526-2BM	Active LOW	–40°C to +85°C	8-SO
IMP2526-1BN	Active HIGH	–40°C to +85°C	8-DIP
IMP2526-2BN	Active LOW	–40°C to +85°C	8-DIP

Absolute Maximum Ratings

Supply Voltage . . . . . +6.0V
Fault Flag Voltage . . . . . +6.0V
Fault Flag Current 50mA
Output Voltage . . . . . +6.0V
Output Current . . . . . Internally Limited
Enable Input . . . . . –0.3V to 12V
Storage Temperature . . . . . –65°C to +150°C
Lead Temperature (Soldering, 5 sec.) . . . . . 260°C
Package Thermal Resistance
SO (θ_{JA}) . . . . . 120°C/W
DIP(θ_{JA}) . . . . . 130°C/W

Note: All voltages are referenced to GND.

These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time periods may affect device reliability.

Electrical Characteristics

Unless otherwise noted, V_{IN} = 5V and T_A = 25°C.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage Range	V_{IN}	T_A = –40°C to +85°C	2.7		5.5	V
Operating Temperature Range	T_A		–40		85	°C
Supply Current Switch OFF	$I_{IN\ OFF}$	Switch OFF, No load $V_{ENOFF} \le 0.8V$, $V_{ENON} \ge 2.4V$ IMP2526-1 $V_{ENON} \le 0.8V$, $V_{ENOFF} \ge 2.4V$ IMP2526-2		0.75	5	µA
Supply Current Switch ON	$I_{IN\ ON}$	Switch ON, No load $V_{ENOFF} \le 0.8V$, $V_{ENON} \ge 2.4V$ IMP2526-1 $V_{ENON} \le 0.8V$, $V_{ENOFF} \ge 2.4V$ IMP2526-2		110	160	µA
Enable Input Threshold	V_{ENH}	LOW to HIGH (“0” to “1”) Enable Voltage, Note 1		2.1	2.4	V
	V_{ENL}	HIGH to LOW (“1” to “0”) Enable Voltage, Note 1	0.8	1.9		
Enable Input Current	I_{EN}	V_{EN} = 0V to 5.5V	–1	±0.01	1	µA
Enable Input Capacitance	C_{EN}			1		pF
Switch ON Resistance	R_{ON}	V_{IN} = 5V, I_{OUT} = 500mA		0.10	0.14	Ω
		V_{IN} = 3.3V, I_{OUT} = 500mA		0.14	0.18	
Output Turn-On Delay	T_{DON}	R_L = 10Ω each output		0.25		ms
Output Turn-On Rise Time	T_{RON}	R_L = 10Ω each output		1		ms
Output Turn-Off Delay	T_{DOFF}	R_L = 10Ω each output		1	20	µs
Output Turn-Off Fall Time	T_{FOFF}	R_L = 10Ω each output		1	20	µs
Output Leakage Current	I_{OFF}				10	µA
Short-circuit Current Limit	I_{SC}		0.50	0.75	1.25	A
Overtemperature Shutdown Threshold		T_J increasing		135		°C
		T_J decreasing		125		
Error Flag Output Resistance	R_{FLAG}	V_{IN} = 5V, I_L = 10mA		10	25	Ω
		V_{IN} = 3.3V, I_L = 10mA		15	40	
Error Flag Output Current	I_{FLAG}	V_{FLAG} = 5V		0.01	1	µA
UVLO Threshold	V_{UVLO}	V_{IN} Increasing		2.5		V
		V_{IN} Decreasing		2.3		

Notes 1. Switch OFF is $V_{EN} \le 0.8V$ and Switch ON is $V_{EN} \ge 2.4V$ for the IMP2526-1. Switch OFF is $V_{EN} \ge 2.4V$ and Switch ON is $V_{EN} \le 0.8V$ for the IMP2526-2. The Enable input has approximately 200mV of hysteresis.

Detailed Descriptions

The IMP2526 dual high-side N-channel MOSFET switch interfaces with a USB controller by means of a Switch-Enable input and a Fault-Flag output. The Enable input, with either a logic "1" for the IMP2526-1 or logic "0" for the IMP2526-2, turns the power MOSFET ON. Any one of three fault conditions will activate the open-drain Fault-Flag Output to alert the controller that the power MOSFET has been turned OFF.

Input and Output

The IN (input) pin is the power supply connection to the logic circuitry and the "High-Side" of the switch (the Drain of the power MOSFET). The OUTA/B (output) pin is the "Low-Side" of the switch (the Source of the power MOSFET). In a typical circuit, current flows through the switch from IN to OUT toward the load. The switch is referred to as a "High-Side" switch since it drives the positive (or high) side of the load. The output MOSFET source can be forced to a higher voltage than the drain ($V_{OUT} > V_{IN}$) when the output is OFF with little leakage current. If, however, V_{IN} drops below 2.3V, reverse current may flow out the IN pin regardless of the enable state. When the power switch is ON, current can flow in either direction.

Fault Flag - FLG Pin

The Fault Flag pin, FLGA/B, connects to an N-channel, open-drain MOSFET and goes LOW ("0") for an occurrence of one or more of three conditions: undervoltage, current limit, or thermal shutdown. The FLG output MOSFET is capable of sinking a 10mA load to typically 100mV above ground. Both flags may be wire-NORed to a common pull-up resistor.

Table 1 gives the states of the FLG and OUT pins when a fault condition is detected.

Thermal Shutdown

Thermal shutdown is active when the output switch is enabled (turned ON). Thermal shutdown shuts off the output MOSFET and sets the Fault Flag if the on-chip temperature sensor exceeds 135°C. The switch is held OFF until the die temperature drops to 125°C or below. This 10°C of hysteresis will result in ON-OFF short-circuit cycling if the short-circuit condition is not removed or the bus-controller does turn off the switch with the Enable input. Over temperature detection is active only if the chip is enabled.

Undervoltage Lockout

The Undervoltage lockout (UVLO) prevents the output MOSFET from being put into the ON state until the positive supply voltage, V_{IN}, exceeds 2.5V. When the output switch is in the ON state and the positive supply voltage drops below 2.3V, the UVLO circuitry will assert the Fault Flag, FLG, and shut OFF the output MOSFET. The FLG output will only assert an active LOW state when the MOSFET switch is in the ON state. Undervoltage detection is active only if the chip is enabled.

Current Limiting

Current limiting is achieved by sensing the voltage drop from Drain-to-Source of the power MOSFET. When the internal threshold is exceeded the power MOSFET is turned OFF.

Table 1. Fault Flag Conditions - Switch Enabled

Condition	Cause	FLG pin "0" Until	Switch State (FLG = "0")
Thermal Shutdown	$T_J > 135°C$	$T_J \leq 125°C$	Turns OFF
Undervoltage Lockout (UVLO)	$V_{IN} < 2.3V$	$V_{IN} > 2.5V$	Turns OFF
Current Limiting	$I_O > 0.5A$ (step load) $I_O > 0.63A$ (ramped load)	Enable off or Thermal Shutdown	Stays ON*

** The switch and Fault Flag behavior during current-limiting is more complex than shown by this table. The detailed discussion on each of these fault conditions gives additional information.*

Application Information

Supply Filtering

IMP strongly recommends the use of a 0.1µF to 1µF bypass capacitor to control transients on the power supply pin. This capacitor, connected from IN to GND, should be in close proximity to the IMP2526 for maximum transient suppression. The lack of suitable bypassing can result in ringing on the IN input when transients occur. This ringing, due to supply lead inductance, could damage IMP2526 control circuitry if the 8V maximum input rating is exceeded.

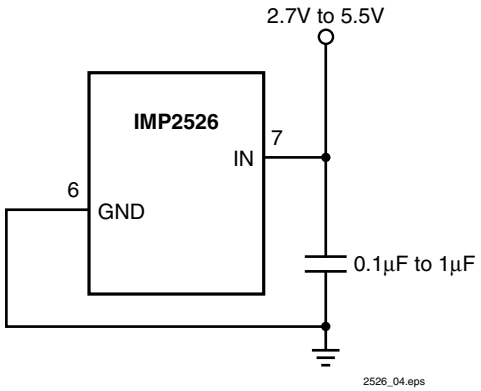


Figure 1. Supply Bypassing

Enable Input

As with any logic input, the enable pins, ENA/ENB, must be driven to a definitive logic state at all times. Floating the input can result in spurious operation. Do not drive ENA/ENB below GND.

Fault Flag Output

Soft Start

The IMP2526 provides a "Soft-Start" function that ramps up the ON-current to eliminate any excessive voltage drop that could occur due to charging a capacitive load in bus-powered applications. The "Soft-Start" results from a switch ON resistance, R_{ON}, that is ramped down from a high impedance to 0.14Ω in milliseconds. This R_{ON} ramping reduces the inrush current and related transients occur when charging capacitive loads; a requirement for meeting the USB voltage drop standards for bus-powered applications (see *Figure 2*). In circuits with large load capacitances, C_{BULK}, exceeding 10µF, the soft-start circuit shown in *Figure 3* can be used to limit the inrush start-up current to USB transient specifications. The current limiting feature of the IMP2526 provides this high-load, soft-start operation.

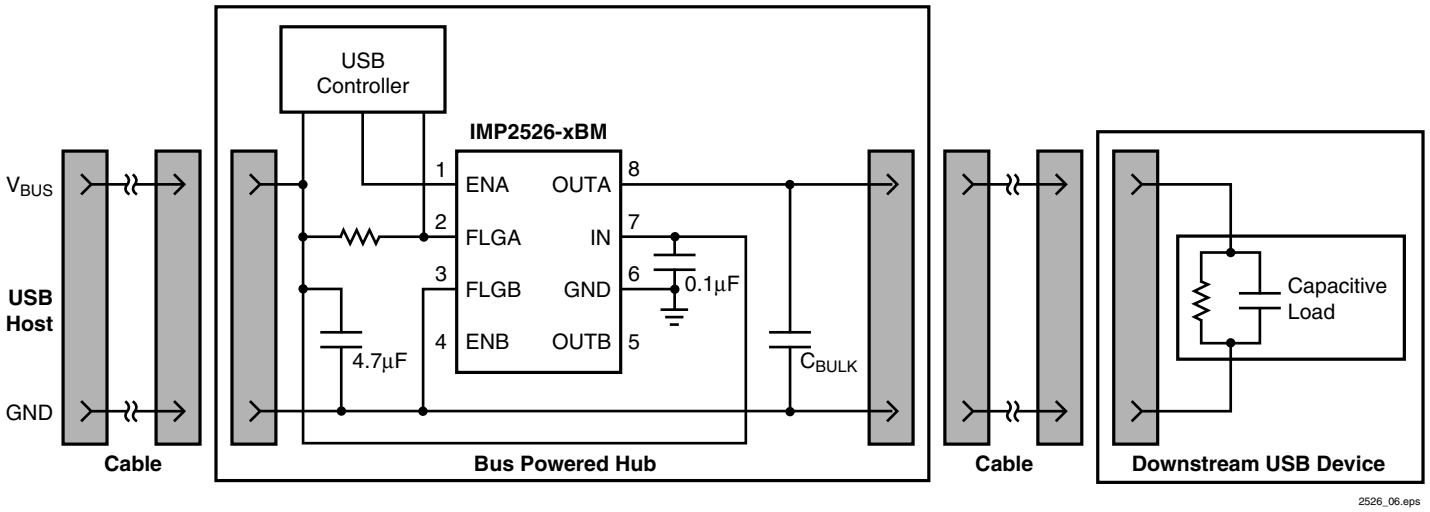


Figure 2. Soft-Start Application

Application Information

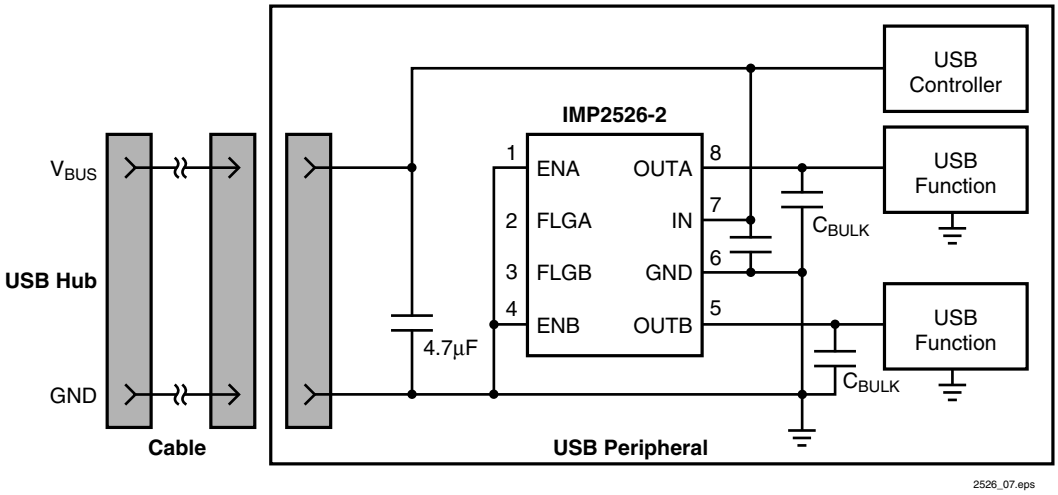


Figure 3. Inrush Current-Limit Application

Transient Overcurrent Filter

If a heavy capacitive load is suddenly connected to the output, the switch current-limiting function may cause the fault-flag to go low for 10µs to 200µs as the switch, in a constant current mode, charges the capacitance. If this transient over-current fault reporting is not wanted, a simple 1ms RC low-pass filter in series with the fault flag circuit will prevent this momentary flag (*Figure 4*).

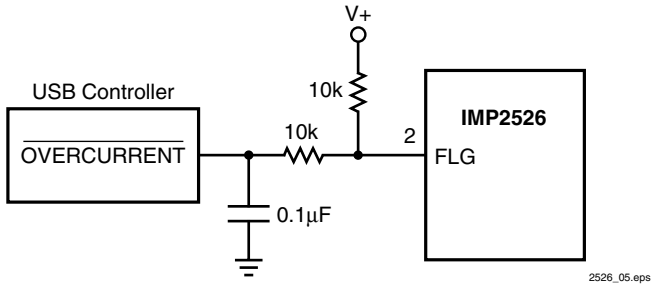


Figure 4. Transient Filter

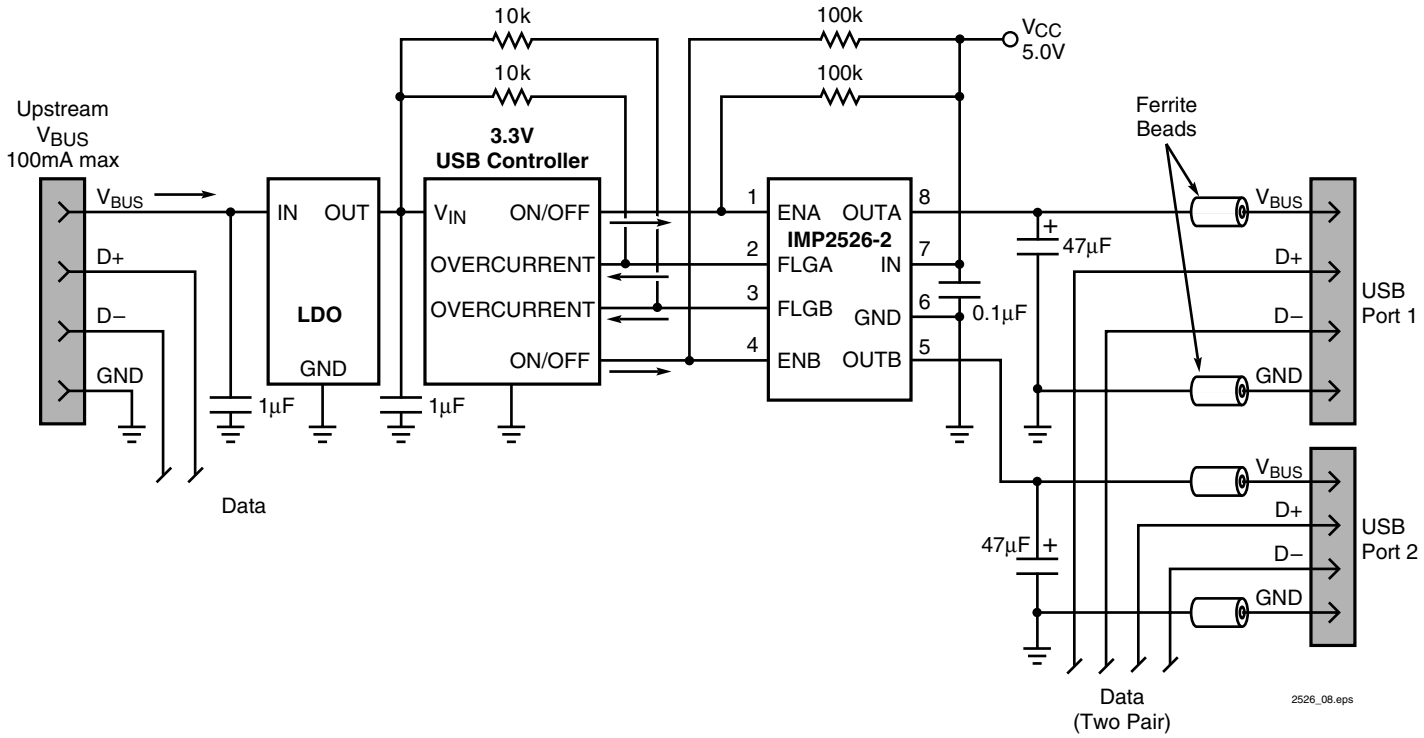
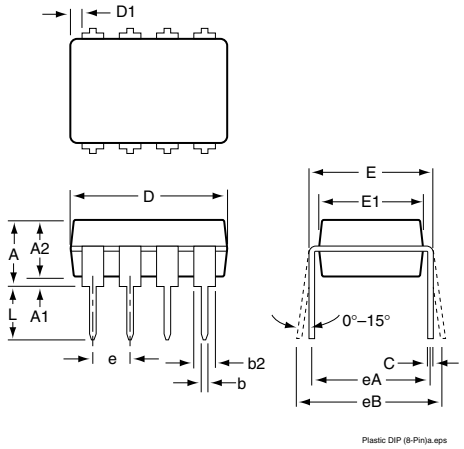


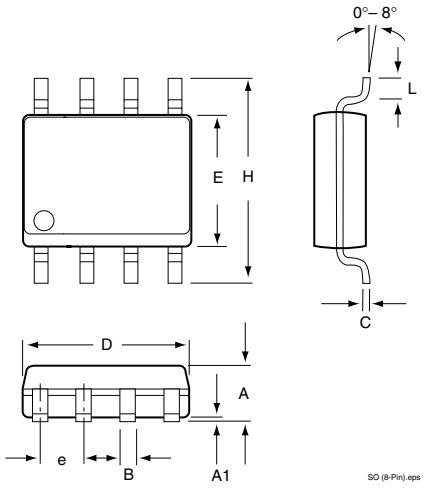
Figure 5. Single-Port Self-Powered Hub Application

Package Dimensions

Plastic DIP (8-Pin)



SO (8-Pin)



	Inches		Millimeters	
	Min	Max	Min	Max
Plastic DIP (8-Pin)*				
A	———	0.210	———	5.33
A1	0.015	———	0.38	———
A2	0.115	0.195	2.92	4.95
b	0.014	0.022	0.36	0.56
b2	0.045	0.070	1.14	1.78
b3	0.030	0.045	0.80	1.14
D	0.355	0.400	9.02	10.16
D1	0.005	———	0.13	———
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100	———	2.54	
eA	0.300	———	7.62	
eB	———	0.430	———	10.92
eC	———	0.060		
L	0.115	0.150	2.92	3.81
SO (8-Pin)**				
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.013	0.020	0.33	0.51
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27
D	0.189	0.197	4.80	5.00

* *JEDEC Drawing MS-001BA*
** *JEDEC Drawing MS-012AA*

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