

# 0.5A Dual USB High-Side Power Switch

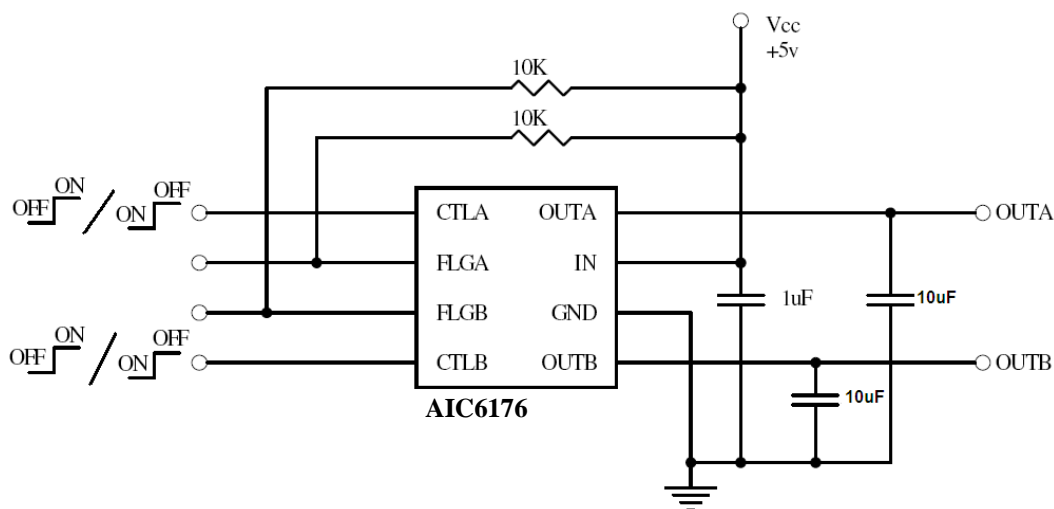
## FEATURES

- 2.7V to 6.5V Input Voltage Range
- 0.5A Dual Continuous Load Current
- 100mΩ High-Side P-MOSFET Switch
- 20Ω Open-Drain Over-Current Flag Output
- 80uA Quiescent Supply Current
- 150°C Thermal Shutdown Protection
- Short Circuit Current Fold-back Protection
- 2.3V Under Voltage Lockout
- Soft Start prevents large Inrush Current
- 9ms Error Flag Delay Time (AIC6176D)
- Reverse Current Blocking
- Enable Active-High or Active-Low Version

## APPLICATIONS

- USB Power Management.
- Notebook PCs
- Battery-Charger Circuit.

## TYPICAL APPLICATION CIRCUIT



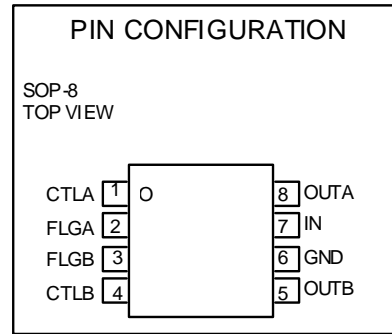
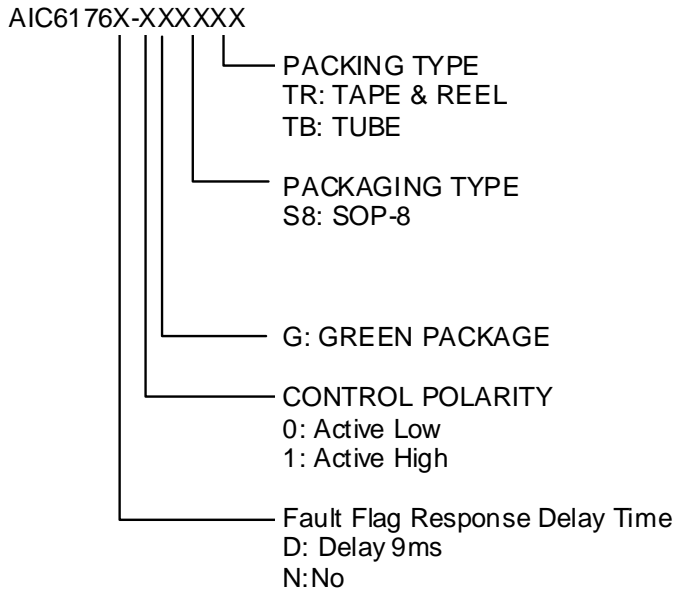
## DESCRIPTION

The AIC6176 integrates dual 100mΩ high-side power switches for self-powered and bus-powered Universal Serial Bus (USB) applications. It operates with inputs ranging from 2.7V to 6.5V, making it ideal for both 3 V and 5V systems.

The protection includes current limiting with fold-back, short circuit and thermal shutdown under over-current occurs. Fault current is limited to typically 1A in accordance with the USB power requirements. The AIC6176 is ideal for any system where current limiting and power control are desired.

Guaranteed minimum output rise time limits inrush current during hot plug-in as well as minimizing EMI and prevents the voltage at upstream port from dropping excessively.

■ ORDERING INFORMATION



Example: AIC6176N-0GS8TR  
 → No Delay, Active Low Version,  
 in SOP-8 Green Package  
 & Taping & Reel Packing Type

■ ABSOLUTE MAXIMUM RATINGS

Supply Voltage ( $V_{IN}$ )	.....	7.0V
Fault Flag Voltage ( $V_{FLG}$ )	.....	7.0V
Control Input ( $V_{CTL}$ )	.....	-0.3V ~7V
Operating Temperature Range	.....	-40°C~85°C
Junction Temperature	.....	150°C
Storage Temperature Range	.....	-65°C ~ 150°C
Lead Temperature (Soldering, 10sec)	.....	260°C
Thermal Resistance, $\theta_{JA}$ (Junction to Ambient)	SOP-8.....	160°C/W
(Assume no Ambient Airflow, no Heatsink)		
Thermal Resistance, $\theta_{JC}$ (Junction to Case)	SOP-8.....	40°C /W

**Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.**

**■ ELECTRICAL CHARACTERISTICS**

( $V_{IN}=5V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT}=1\mu F$ ,  $T_A=25^\circ C$ , unless otherwise specified.) (Note 1)

PARAMETERS	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply Voltage		2.7		6.5	V
Supply Current	Switch On, OUT=Open Switch Off, OUT=Open		80 0.2	160 2	$\mu A$
EN Input Threshold		0.8	1.3	1.8	V
Control Input Current	$V_{CTL} = \text{Logic "0"}$ $V_{CTL} = \text{Logic "1"}$		0.01 0.01	0.1 0.1	$\mu A$
Switch On Resistance			100		$m\Omega$
Output Turn-On Rise Time	$R_L = 10\Omega$ each Output		1000	2500	$\mu S$
Output Turn-Off Fall Time	$R_L = 10\Omega$ each Output		0.7	20	$\mu S$
Output Leakage Current	Switch Off, $R_L=0\Omega$		0.5	1	$\mu A$
Current Limit Threshold		0.6	1.0	1.25	A
Short Circuit Current Fold-back	$V_{OUT}=0V$		0.38		A
Over Current Flag Response Delay	From fault condition to FLG assertion	4	9		ms
Over Temperature Shutdown Threshold	$T_J$ Increasing $T_J$ Decreasing		150 120		$^\circ C$
Error Flag Output Resistance	$I_{SINK} = 1\text{ mA}$		20		$\Omega$
Error Flag Off Current	$V_{FLG} = 5V$		0.01	1	$\mu A$
UVLO Threshold	$V_{IN}$ Increasing $V_{IN}$ Decreasing	1.8	2.3 2.1	2.65	V

Note 1: Specifications are production tested at  $T_A=25^\circ C$ . Specifications over the  $-40^\circ C$  to  $85^\circ C$  operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

**TYPICAL PERFORMANCE CHARACTERISTICS**

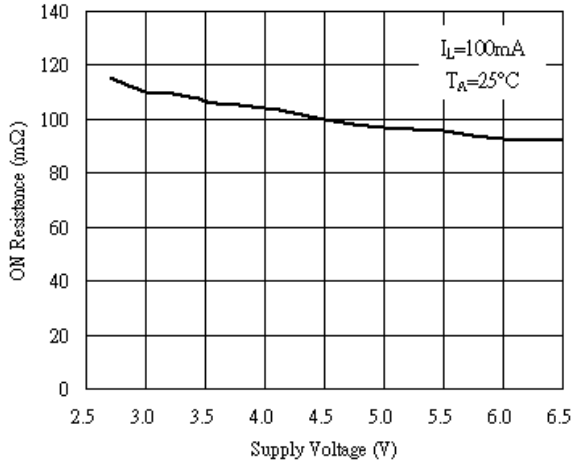


Fig. 1 ON Resistance vs. Supply Voltage

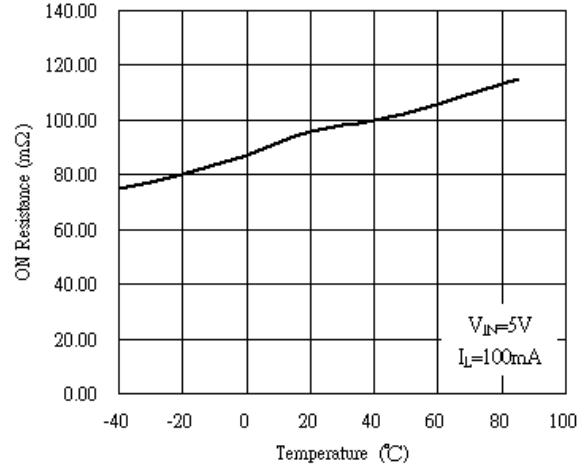


Fig. 2 ON Resistance vs. Temperature

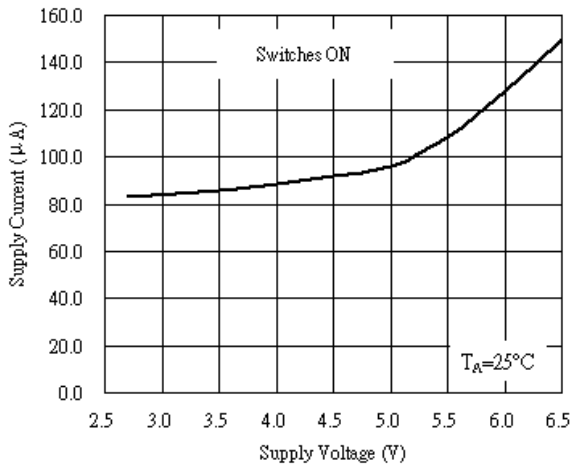


Fig. 3 ON-State Supply Current vs. Supply Voltage

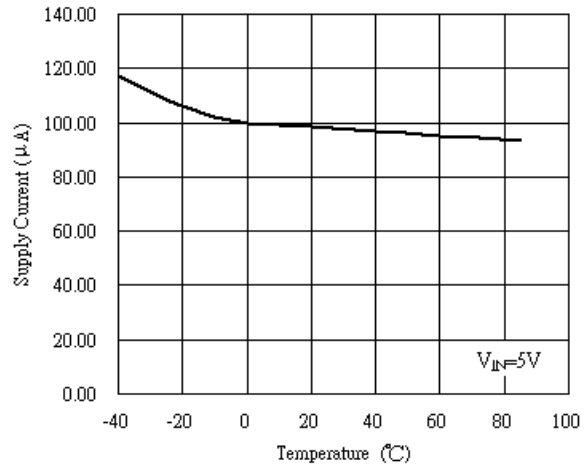


Fig. 4 ON-State Supply Current vs. Temperature

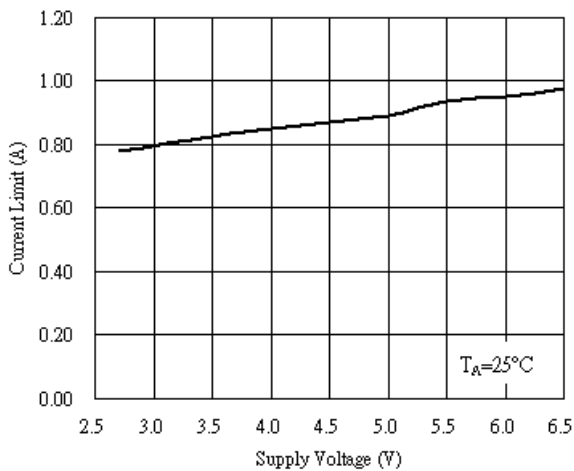


Fig. 5 Current Limit vs. Supply Voltage

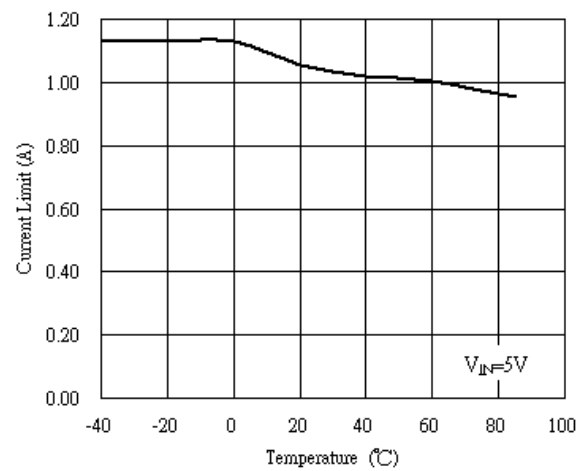


Fig. 6 Current Limit vs. Temperature

**TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

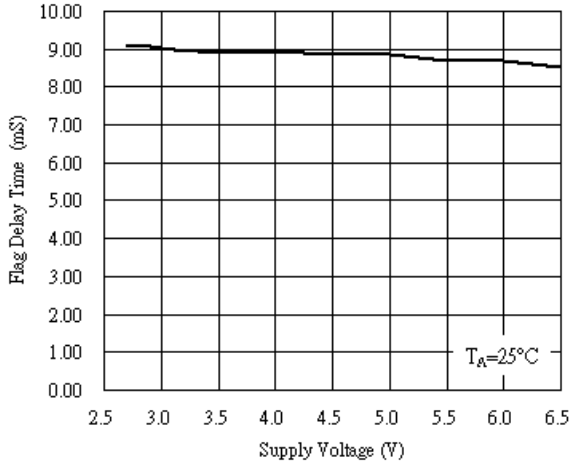


Fig. 7 Flag Delay Time vs. Supply Voltage

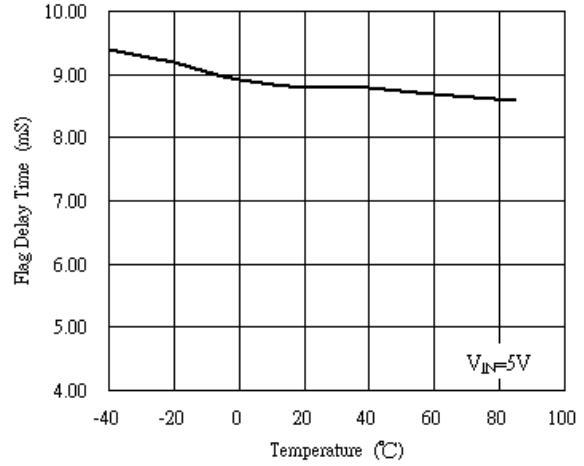


Fig. 8 Flag Delay Time vs. Temperature

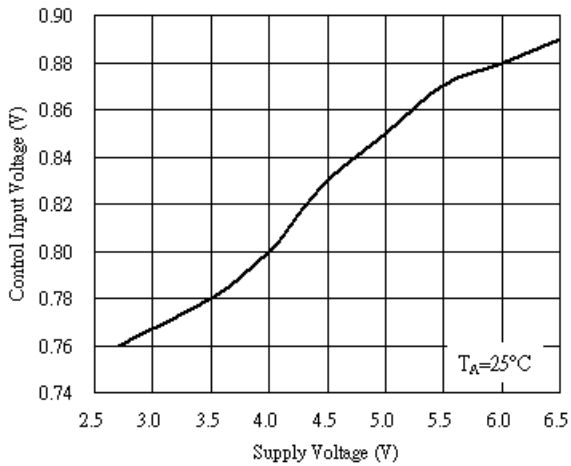


Fig. 9 Control Input Voltage vs. Supply Voltage

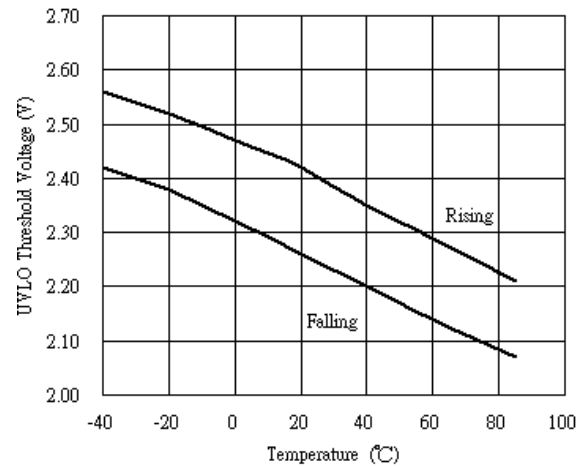


Fig. 10 UVLO Threshold Voltage vs. Temperature

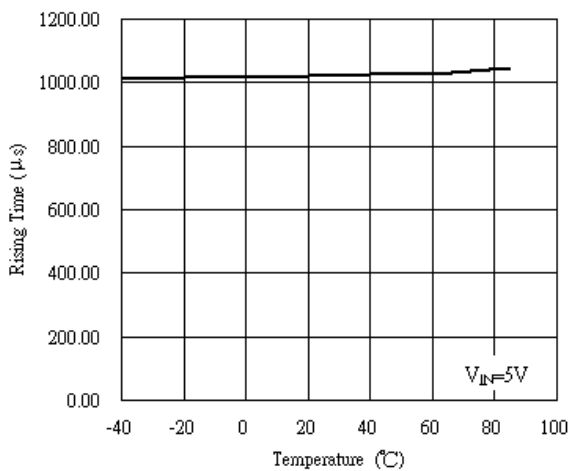
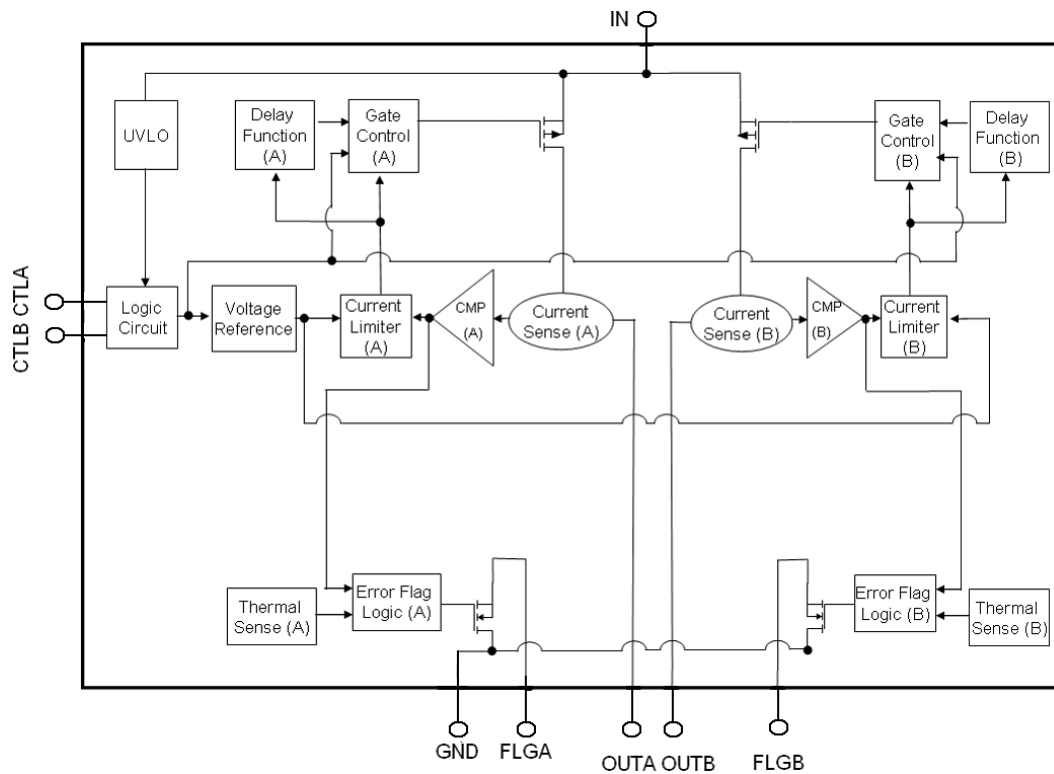


Fig. 11 Rising Time vs. Temperature

## ■ BLOCK DIAGRAM



## ■ PIN DESCRIPTIONS

PIN 1: CTLA - Controls the turn-on/turn-off of channel A MOSFET with TTL as a control input. Active high for AIC6176-1 and active low for AIC6176-0.

PIN 2: FLGA - An active-low and open-drained fault flag output for channel A. FLGA is an indicator for current limit or thermal shutdown when CTLA is active.

PIN 3: FLGB - An active-low and open-drained fault flag output for channel B. FLGB is an indicator for current limit or thermal shutdown when CTBL is active.

PIN 4: CTBL - Controls the turn-on/turn-off of channel B MOSFET with TTL as a control input. Active High for AIC6176-1 and active low for AIC6176-0.

PIN 5: OUTB - Channel B MOSFET switch output.

PIN 6: GND - Power ground.

PIN 7: IN - Power supply input.

PIN 8: OUTA - Channel A MOSFET switch output.

## ■ APPLICATION INFORMATION

### ● Flag Output

An error Flag is an open-drained output of an N-channel MOSFET. Flag output is pulled low to signal the following fault conditions: input undervoltage, output current limit, and thermal shutdown. The current limit flag response delay time is 9ms.

### ● Current Limit

The current limit threshold is preset internally. It protects the output MOSFET switches from damage resulting from undesirable short circuit conditions or excess inrush current, which is often encountered during hot plug-in. The error flag signals when any current limit conditions occur.

### ● Thermal Shutdown

When temperature of AIC6176 exceeds 150°C for any reasons, the thermal shutdown function turns MOSFET switch off and signals the error flag. A hysteresis of 30°C prevents the MOSFETs from turning back on until the chip temperature drops below 120°C.

### ● Enable Control

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

### ● Under-voltage Lockout

UVLO (undervoltage lockout) prevents the output MOSFET from turning on until input voltage exceeds 2.3V typically. After the switch turns on, if the input voltage drops below 2.1V typically, UVLO shuts off the output MOSFET.

### ● Supply Filtering

A 1 $\mu$ F bypass capacitor from USB IN to GND, located near 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.

### ● Transient Requirements

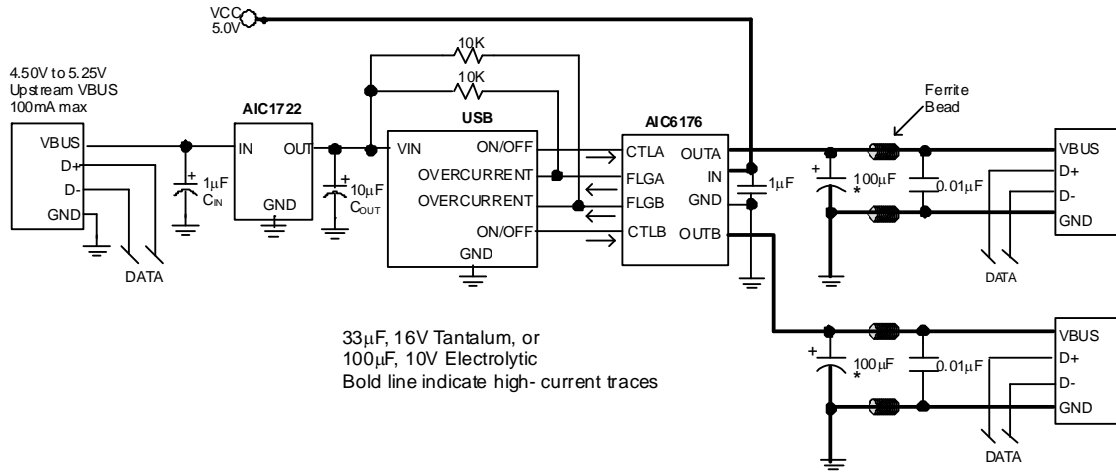
USB supports dynamic attachment (hot plug-in) of peripherals. A current surge is caused by the input capacitance of downstream device. Ferrite beads are recommended in series with all power and ground connector pins. Ferrite beads reduce EMI and limit the inrush current during hot-attachment by filtering high-frequency signals.

### ● Short Circuit Transient

Bulk capacitance provides the short-term transient current needed during a hot-attachment event. A 10 $\mu$ F/10V ceramic capacitor mounted close to downstream connector each port should provide transient drop protection.

### ● Printed Circuit Layout

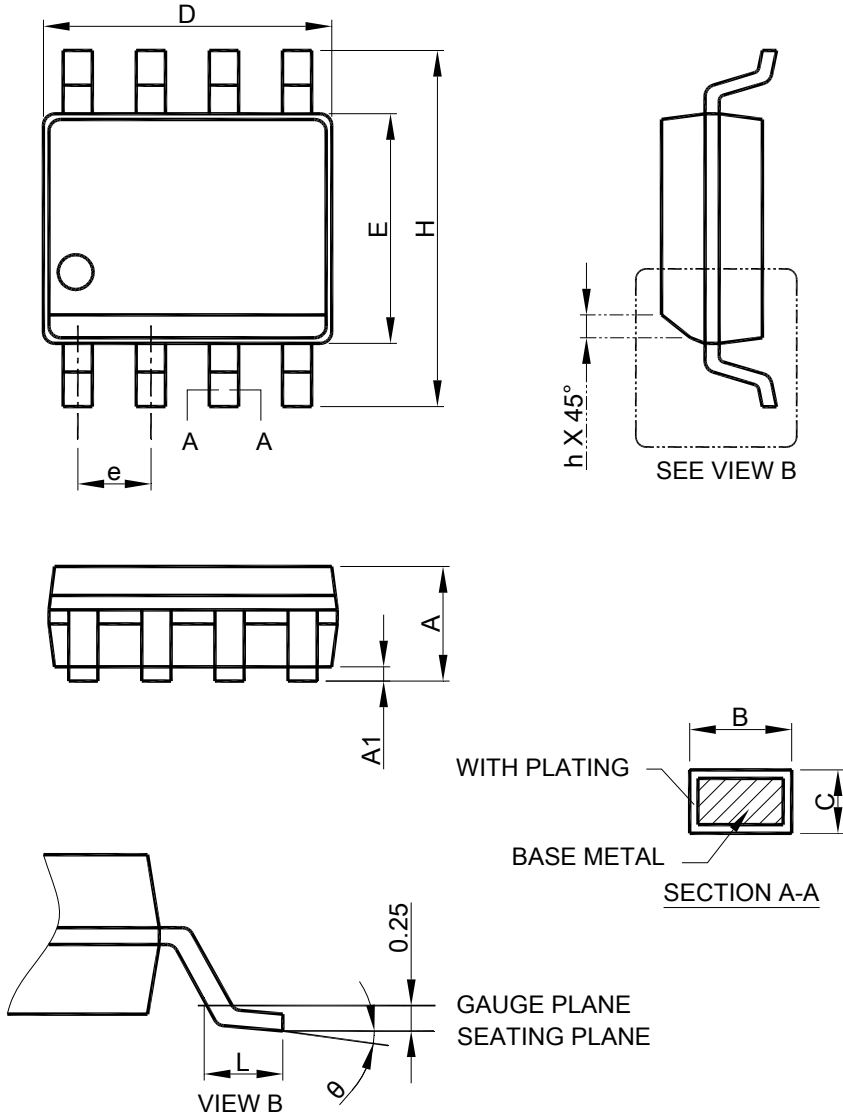
The power circuitry of USB printed circuit boards requires a customized layout to maximize thermal dissipation and to minimize voltage drop and EMI.

**TYPICAL APPLICATION CIRCUIT**

**Two-Port Self-Powered Hub**



■ **PHYSICAL DIMENSIONS** (unit: mm)

● **SOP-8 PACKAGE OUTLINE DRAWING**



SYMBOL	SOP-8	
	MILLIMETERS	
	MIN.	MAX.
A	1.35	1.75
A1	0.10	0.25
B	0.33	0.51
C	0.19	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.27
$\theta$	0°	8°

- Note:
1. Refer to JEDEC MS-012AA.
  2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .
  3. Dimension "E" does not include inter-lead flash or protrusions.
  4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

**Note:**

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