

Single Channel USB Switch with Adjustable Current Limit

■ FEATURES

- 60m Ω High-Side MOSFET Switch.
- 85 μ A Quiescent Supply Current.
- 1 μ A Maximum Shutdown Supply Current.
- 3.5V to 5.5V Input Voltage Range.
- Open-Drain Over-Current Flag Output.
- Under-Voltage Lockout.
- Thermal / Short Circuit Protection.
- Fast Short Circuit Protection Response.
- Adjustable Current Limit : 0.5A ~ 3.5A
- Under Voltage Lockout Ensures that Switch is off at Start Up.
- Soft Start prevents large Inrush Current.
- Discharge function when shutdown active.
- No Reverse Current when Power off.
- Enable Active-High or Active-Low Version.
- Available in SOP-8 Exposed Pad Package and SOT23-6 Package.
- 2kV ESD Rating (Human Body Model)

■ APPLICATIONS

- USB Power Management
- High-Side Power Protection Switch
- Hot Plug-In Power Supplies
- Battery-Charger Circuits
- Portable Application.
- Digital televisions

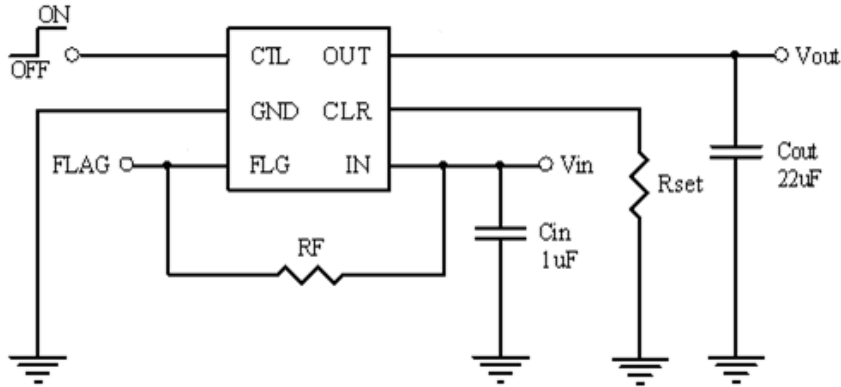
■ DESCRIPTION

The AIC6156 is integrated 60m Ω high-side power switch for self-powered and bus-powered Universal Serial Bus (USB) applications. This switch operates with input ranging from 3.5V to 5.5V, making it ideal for 5V system.

The protection includes programmable current limiting with foldback, short circuit protection and thermal shutdown. The AIC6156 is ideal for any system where current limiting and power control are desired. The AIC6156 has low quiescent current and small package, which is particularly suitable in battery powered portable application.

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.

TYPICAL APPLICATION CIRCUIT



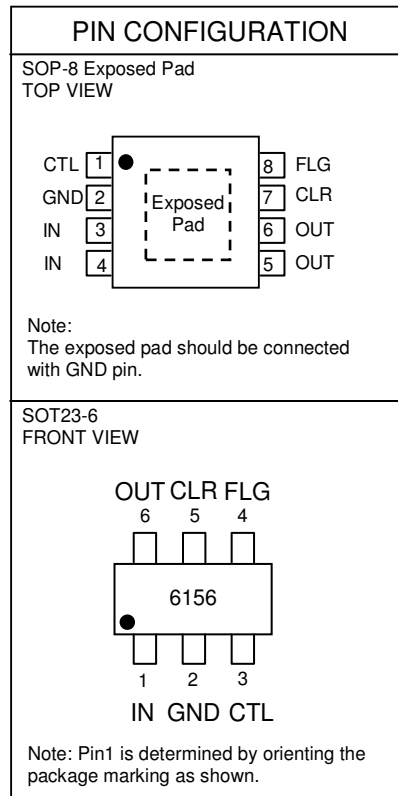
Typical Application Circuit

ORDERING INFORMATION

AIC6156XXXXXXXX

- PACKING TYPE
TR: TAPE & REEL
TB: TUBE
BG: BAG
- PACKAGING TYPE
S8E: SOP-8 Exposed Pad
U6: SOT23-6
- G: Green Package
- CONTROL POLARITY
L: Active Low
H: Active High

Example: AIC6156HGS8ETR
 → Active High Version, in SOP-8 Exposed Pad
 Green Package and Tape & Reel Packing Type



SOT23-6 Marking

Part No.	Package Code	Marking	Control Polarity
AIC6156xG	GU6	ILDxG	x=L for active low, x=H for active high

■ ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{IN}).....		-0.3V ~ 6.5V
CTL Input (V_{CTL}).....		-0.3V ~ 6.5V
CLR, OUT Voltage.....		-0.3V ~ 6.5V
Fault Flag Voltage (V_{FLG}).....		-0.3V ~ 6.5V
Fault Flag Current (I_{FLG}).....		25mA
Operating Temperature Range.....		-40°C ~ 85°C
Junction Temperature.....		125°C
Storage Temperature Range.....		-65°C ~ 150°C
Lead Temperature (Soldering, 10sec).....		260°C
Thermal Resistance Junction to Case	SOP-8 Exposed Pad*.....	15°C/W
	SOT23-6.....	115°C/W
Thermal Resistance Junction to Ambient	SOP-8 Exposed Pad*.....	60°C/W
	SOT23-6.....	250°C/W

(Assume no Ambient Airflow)

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

*The package is place on a two layers PCB with 2 ounces copper and 2 square inch, connected by 8 vias.

■ ELECTRICAL CHARACTERISTICS

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

PARAMETERS	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply Current			85	170	μA
Shutdown Supply Current			0.1	1	μA
Input Voltage Range		3.5		5.5	V
Output MOSFET Resistance			60	80	$m\Omega$
Output Turn-On Rise Time	$R_L = 10\Omega$ each Output		250		μS
Output Turn-Off Fall Time	$R_L = 10\Omega$ each Output		0.7	20	μS
Control Input Threshold		0.4	0.8	1.2	V
Current Limit	$R_{SET} = 583\Omega$	3060	3600	4140	mA
	$R_{SET} = 1.06k\Omega$	1700	2000	2300	
	$R_{SET} = 4.3k\Omega$	425	500	575	
Response time to short circuit	$V_{IN} = 5.0V$, $I_{CL} = 0.5A$		1.5		μS
Response time to short circuit	$V_{IN} = 5.0V$, $I_{CL} = 3.6A$		3.7		μS
Output Leakage Current	CTL='0', $V_{OUT} = 0V$		0.5	1	μA
Over Temperature Shutdown Threshold	T_J Increasing		145		$^\circ C$
	T_J Decreasing		125		
Under Voltage Lockout	V_{IN} Rising	2.6	2.8	3.0	V
Under Voltage Lockout Hysteresis		50	200	400	mV
Over Current Flag Response Delay	Apply $V_{OUT} = 0V$ until FLG low	4	9	25	ms
FLG Output Low Voltage	$I_{FLG} = 5mA$		0.1	0.5	V
FLG Off-State Current				1	μA

Note1: 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

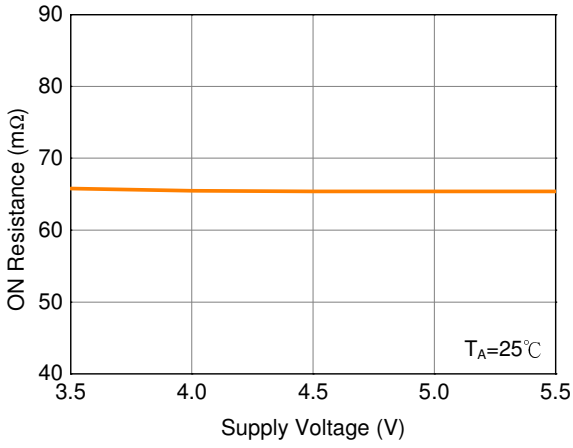


Fig. 1 ON Resistance vs. Supply Voltage

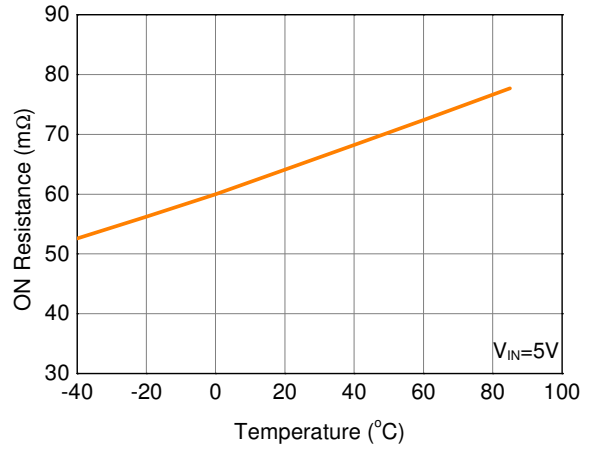


Fig. 2 ON Resistance vs. Temperature

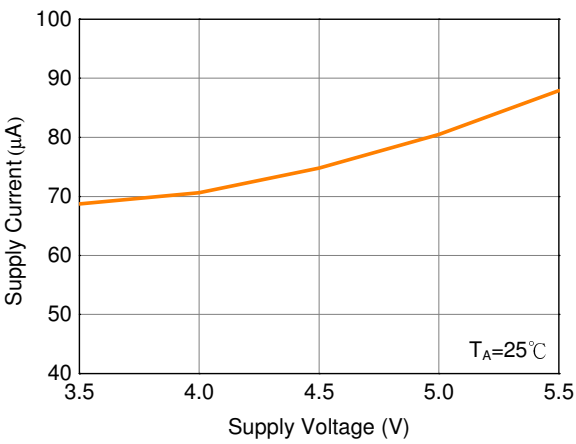


Fig. 3 Supply Current vs. Supply Voltage

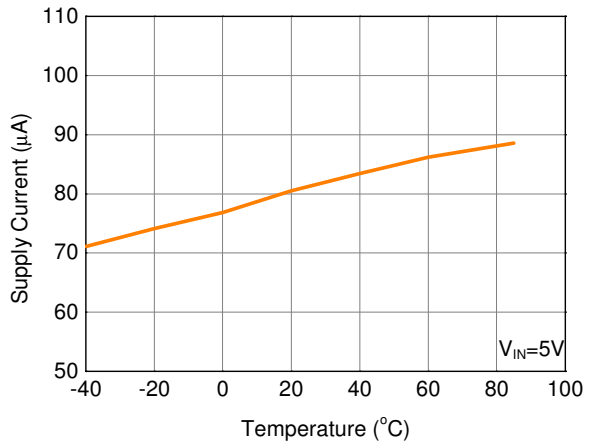


Fig. 4 Supply Current vs. Temperature

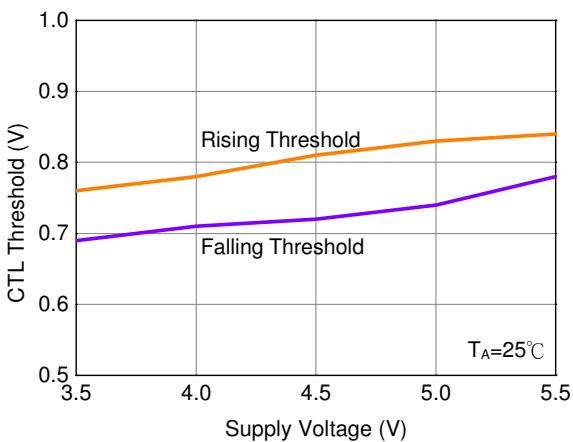


Fig. 5 CTL Threshold vs. Supply Voltage

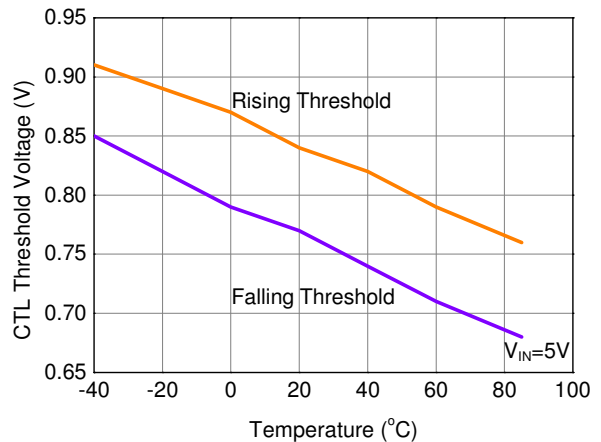


Fig. 6 CTL Threshold vs. Temperature

■ TYPICAL PERFORMANCE CHARACTERISTICS(Continued)

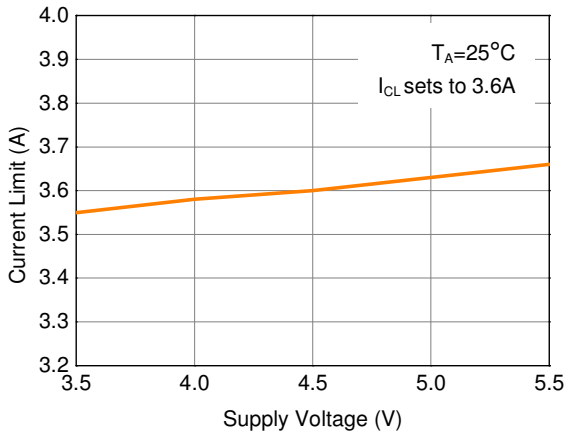


Fig. 7 Current Limit vs. Supply Voltage

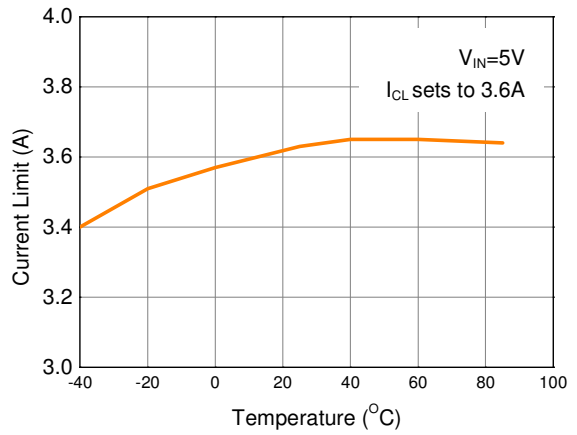


Fig. 8 Current Limit vs. Temperature

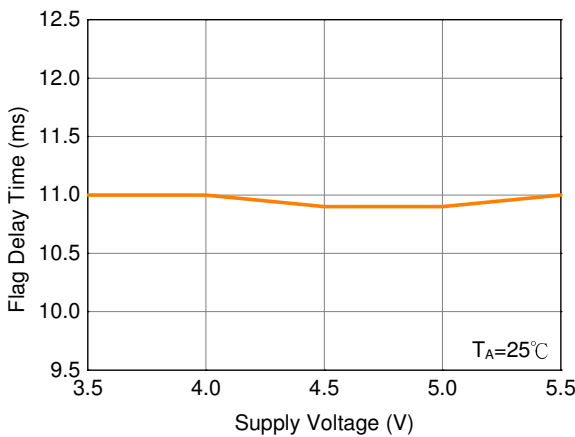


Fig. 9 Flag Delay Time vs. Supply Voltage

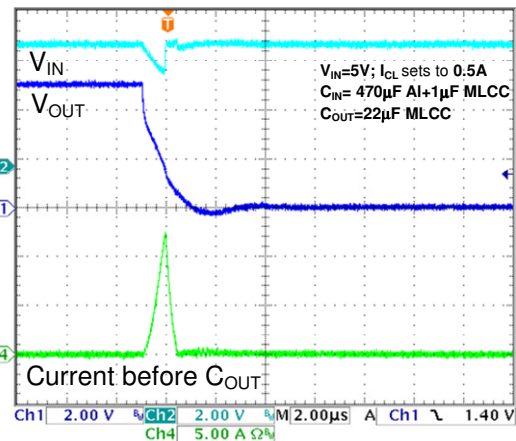


Fig. 10 Short Circuit Protection Response (I_{CL} sets to 0.5A)

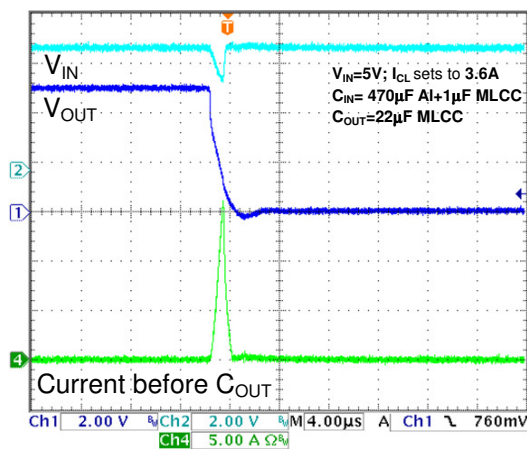
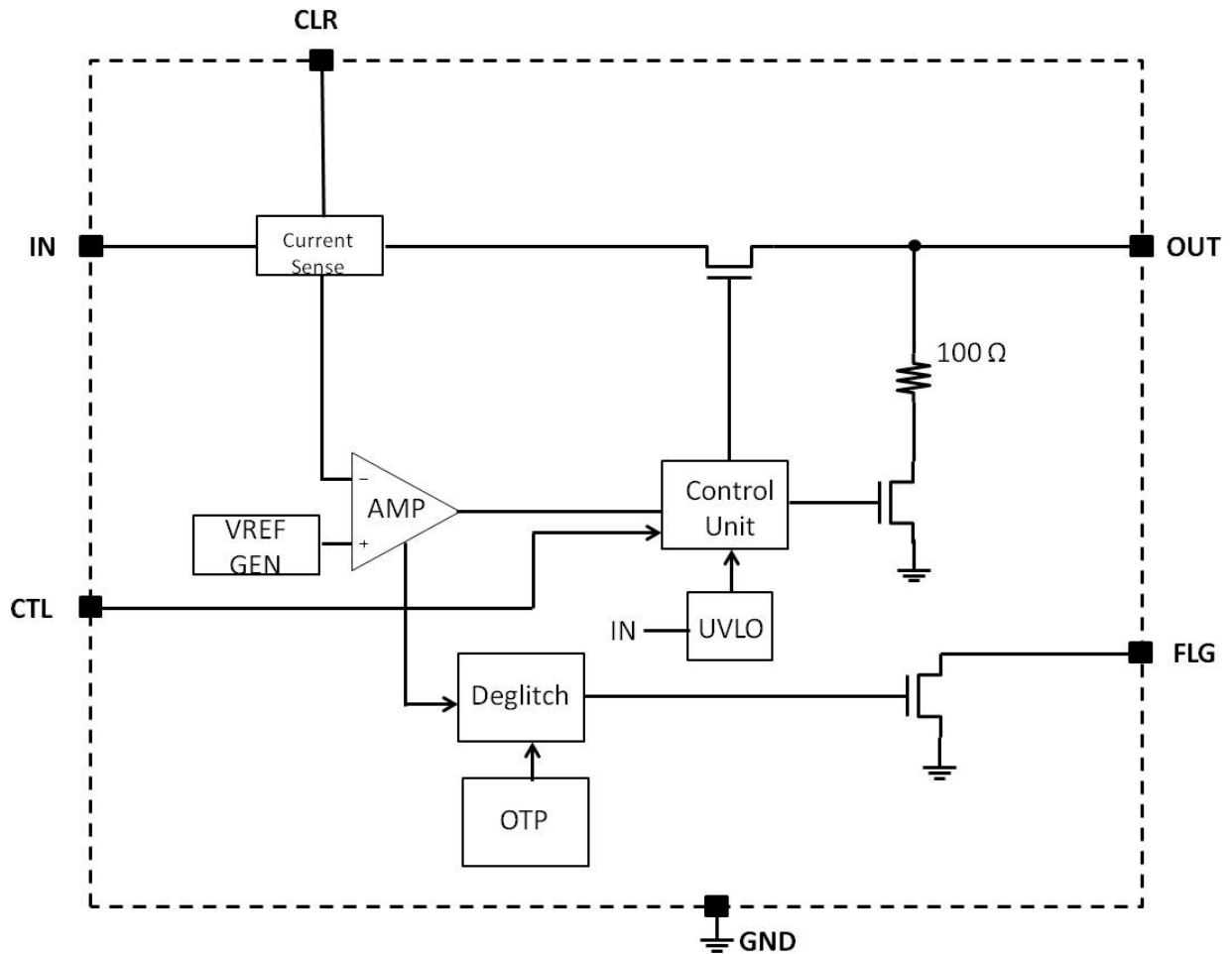


Fig. 11 Short Circuit Protection Response (I_{CL} sets to 3.6A)

FUNCTIONAL BLOCK DIAGRAM



Functional Block Diagram of AIC6156

PIN DESCRIPTIONS

- IN PIN : Power supply input.
- GND PIN : Chip power ground.
- CTL PIN : Switch Enable.
- FLG PIN : Fault status. A logic low on this pin indicates the switch is in current limit, or has been shutdown by the thermal protection circuit.
- CLR PIN : Sets the current limit threshold via a resistor connected between CLR and GND.
- OUT PIN : 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: output current limit and thermal shutdown. The current limit flag response delay time is about 9ms.

Current Limit

The AIC6156 has current limit function. 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. The current limit threshold can be set by the resistor, R_{SET} , connecting between CLR pin and GND pin and can be approximated by the following equation.

$$I_{LIMIT(yp)} = 2.1136 \times [R_{SET} (k\Omega)]^{-0.9858}$$

Thermal Shutdown

The AIC6156 includes an over temperature protection circuit, which is designed to protect the device. The over temperature shutdown threshold can change according to the state of the current limit protection function. If the current limit protection function does not be activated, the over temperature shutdown threshold is about 145°C. In the current limit protection condition, the over temperature shutdown threshold can reduce to about 125°C. When the junction temperature exceeds the over temperature shutdown threshold, the over temperature protection function turns off the power switch and signals the error flag. The over temperature protection hysteresis prevents the power switch from turning on until the junction temperature has dropped about 20°C.

CTL Control

CTL (Control input) must be driven logic high or logic

low for a clearly defined input. Floating the input may cause unpredictable operation.

Under-Voltage Lockout

UVLO (under voltage lockout) prevents the output MOSFET from turning on until input voltage exceeds 2.8V typically. After the switch turns on, if the input voltage drops below 2.6V typically, UVLO shuts off the output MOSFET.

Supply Filtering

A 1μF 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

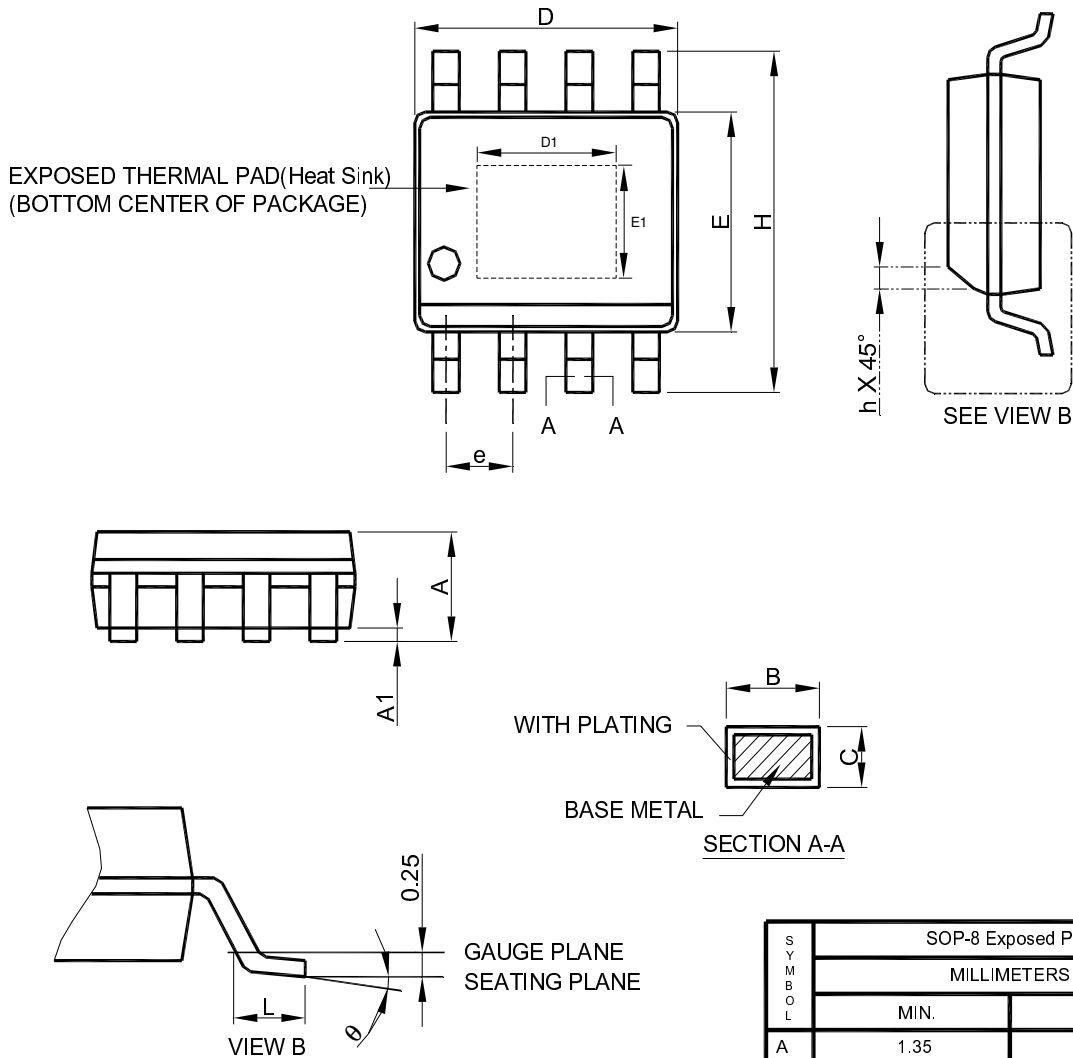
USB supports dynamic attachment (hot plug-in) of peripherals. A current surge is caused by the input capacitance of downstream device. Ferrite beads are recommended in series with all power and ground connector pins. Ferrite beads reduce EMI and limit the inrush current during hot-attachment by filtering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

Short Circuit Transient

Bulk capacitance provides the short-term transient current needed during a hot-attachment event. A 22μF/10V ceramic capacitor mounted close to downstream connector each port should provide transient drop protection.

Printed Circuit Layout

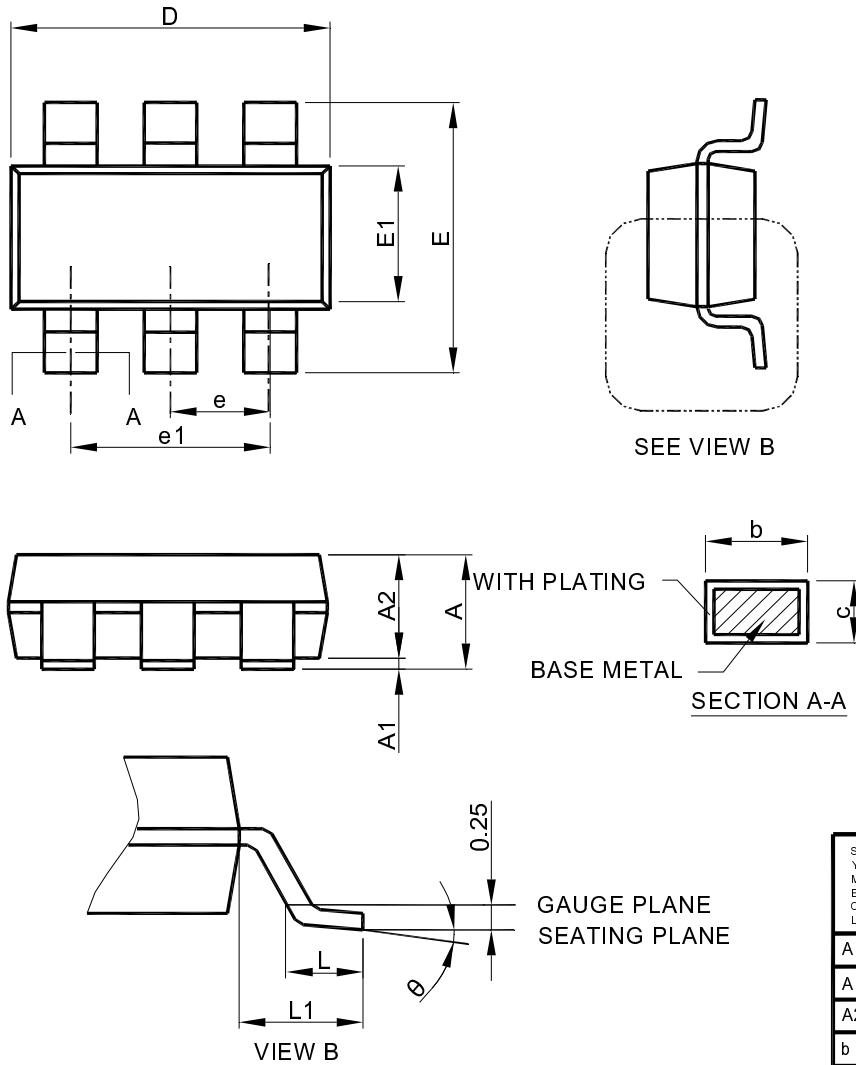
1. The power circuitry of USB printed circuit boards requires a customized layout to maximize thermal dissipation and to minimize voltage drop and EMI.
2. R_{SET} should be set as close to CLR pin as possible.

PHYSICAL DIMENSIONS (unit: mm)
SOP-8 Exposed Pad


- Note : 1. Refer to JEDEC MS-012E.
 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.

SYMBOL	SOP-8 Exposed Pad	
	MILLIMETERS	
	MIN.	MAX.
A	1.35	1.75
A1	0.00	0.15
B	0.31	0.51
C	0.17	0.25
D	4.80	5.00
D1	1.50	3.50
E	3.80	4.00
E1	1.0	2.55
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.27
θ	0°	8°

• SOT23-6



SYMBOL	SOT23-6	
	MILLIMETERS	
	MIN.	MAX.
A	0.95	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.30	0.50
c	0.08	0.22
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.95 BSC	
e1	1.90 BSC	
L	0.30	0.60
L1	0.60 REF	
θ	0°	8°

- Note :
1. Refer to JEDEC MO-178AB.
 2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.
 3. Dimension "E1" 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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