

# Regulatory USB High-Side Power Switch

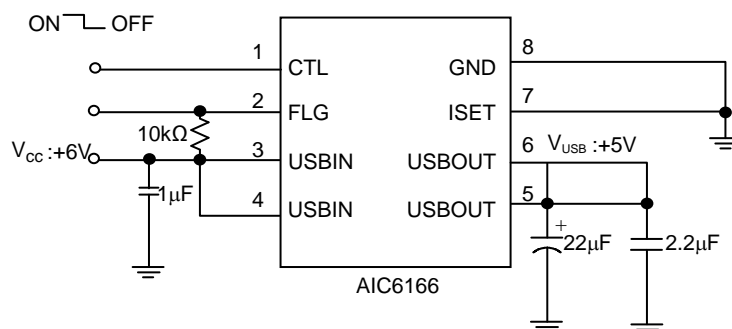
## FEATURES

- 150m $\Omega$  (6V Input) High-Side MOSFET Switch
- 0.62A/1.25A Continuous Load Current of USB switch
- 140 $\mu$ A Typical On-State Supply Current of USB switch
- 0.75 $\mu$ A Typical Off-State Supply Current of USB switch
- Fault Flag with 8ms filter eliminates false assertions
- Under voltage Lockout Ensures that Switch is off at Start Up
- USB Switch Output can be Forced Higher than USB Switch Input (Off-State)
- Open-Drain Fault Flag
- Slow Turn ON and Fast Turn OFF
- Control Active-High or Active-Low
- Constant Current Limit / Short Circuit Protection
- Thermal Shutdown Protection (latching)
- Available in SOP-8 Exposed Pad Package

## APPLICATIONS

- USB Power Management
- Hot Plug-In Power Supplies
- Battery-Charger Circuit

## TYPICAL APPLICATION CIRCUIT



## DESCRIPTION

The AIC6166 is a power switch IC integrated a low dropout linear regulator for bus-powered Universal Serial Bus (USB) applications.

The high-side switch of USB power switch is MOSFET with 150m $\Omega$  R<sub>DS(ON)</sub>, which meets USB voltage drop requirements for maximum transmission wire length.

Multi-purpose open-drain fault flag output indicates over-current limiting, thermal shutdown, or undervoltage lockout. The output current of USB power switch is typical limited to 0.62A / 1.25A (control by select pin).

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

AIC6166X-XXXXXX

PACKING TYPE  
TR: TAPE & REEL  
TB: TUBE

PACKAGING TYPE  
R8: SOP-8 Exposed Pad

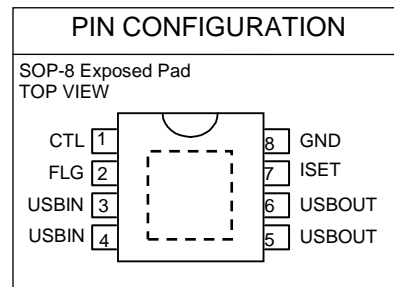
G: Green Package

CONTROL POLARITY  
0: Active Low  
1: Active High

Fault Flag Response Delay Time  
D: Delay 8ms

Example: AIC6166D-0GR8TR

→ With Fault Flag Response Delay Time,  
Active Low Version, in SOP-8 Exposed  
Pad Green Package & Tape & Reel  
Packing Type



## ■ ABSOLUTE MAXIMUM RATINGS

USB Power Switch Supply Voltage ( $V_{USBIN}$ )	7.0V
Fault Flag Voltage ( $V_{FLG}$ )	7.0V
Fault Flag Current ( $I_{FLG}$ )	50mA
Control Input ( $V_{CTL}$ , $V_{ENLDO}$ )	-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 Junction to Case      SOP-8 Exposed Pad*	15°C/W
Thermal Resistance Junction to Ambient      SOP-8 Exposed Pad*	60°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 placed on a two layers PCB with 2 ounces copper and 2 square inch, connected by 8 vias.

## ■ ELECTRICAL CHARACTERISTICS

( $C_{USBIN} = 1\mu F$ ,  $C_{USBOUT} = 2.2\mu F$ ,  $V_{USBIN} = 6V$ ,  $T_A = 25^\circ C$ , unless otherwise specified.) (Note 1)

PARAMETERS	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>USB POWER SWITCH</b>					
Supply Current	Control Active High, USB switch output OFF, USBOUT=Open Control Active Low, USB switch output OFF, USBOUT=Open		0.75	5	$\mu A$
	Control Active High, USB switch output ON, USBOUT=Open Control Active Low, USB switch output ON, USBOUT=Open		140	190	$\mu A$
Control Input Threshold	Control Active High, USB switch output ON Control Active Low, USB switch output OFF	2.4			V
	Control Active High, USB switch output OFF Control Active Low, USB switch output ON			0.8	V
USB Input Voltage	$V_{USBIN}$	5.3		7	V
Control Input Current	$V_{CTL} = V_{USBIN}$ or GND		0	100	nA
Control Input Capacitance			1		PF
Dropout Voltage	$V_{USBOUT} = 5V$ , $I_{USBOUT} = 0.5A$		90	190	mV
Dropout Voltage	$V_{USBOUT} = 5V$ , $I_{USBOUT} = 1A$		280	380	mV
Output Turn-On Rise Delay	$R_L = 10\Omega$		2.2	3.2	mS
Output Turn-On Rise Time	$R_L = 10\Omega$	2	3.8	7	mS
Output Turn-Off Delay	$R_L = 10\Omega$		0.8	20	$\mu S$
Output Turn-Off Fall Time	$R_L = 10\Omega$		0.7	20	$\mu S$
Output Leakage Current				10	$\mu A$
Current Limit Threshold	$I_{SET} > 2.4V$	0.5	0.62	0.75	A
Current Limit Threshold	$I_{SET} < 0.8V$	1.0	1.25	1.5	A
Over Current Flag Response Delay	Apply $V_{OUT} = 0V$ until FLG low	3	8	12	mS
Error Flag Output Resistance	$V_{USBIN} = 6V$ , $I_L = 10mA$		10	25	$\Omega$
Error Flag Off Current	$V_{FLG} = 5V$		0.01	1	$\mu A$
Undervoltage Lockout Threshold	$V_{USBIN}$ rising	2.2	2.6	3	V
Undervoltage Lockout Hysteresis			200		mV
<b>Thermal Protection</b>					
Thermal Shutdown Temperature (Note 2)			135		$^\circ C$

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).

The AIC6166 requires minimum  $C_{USBIN} = 0.8\mu F$  and  $C_{USBOUT} = 1\mu F$  to maintain stability. For best performance, typically use  $C_{USBIN} = 1\mu F$ ,  $C_{USBOUT} = 2.2\mu F$  (ceramic) +  $22\mu F$  (aluminum).

Note 2: When thermal shutdown, the IC performs the function of latching in OFF state. It can resume operation by turning off once (min. 1 $\mu S$ ) and then turn on using the CTL pin (with Typ.  $25^\circ C$  Thermal Shutdown Hysteresis), or by restoring power to the USBIN pin.

## ■ TYPICAL PERFORMANCE CHARACTERISTICS

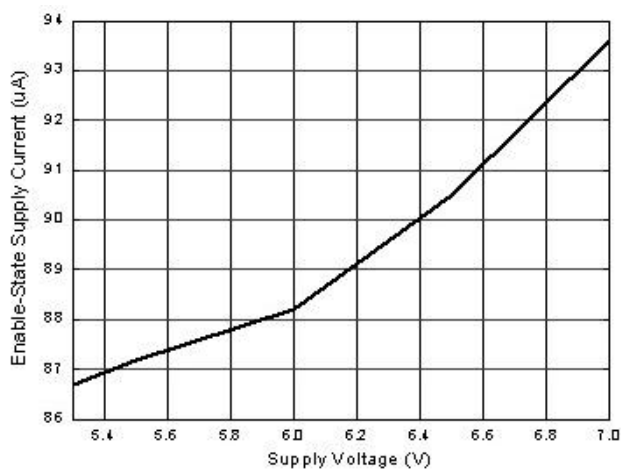


Fig. 1 Quiescent Current VS Input Voltage

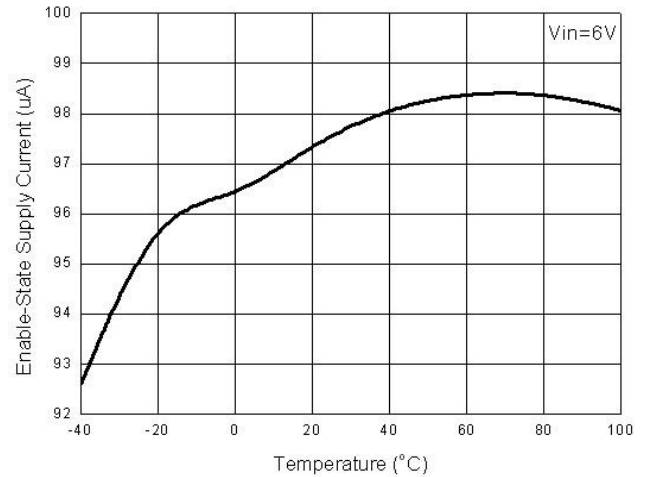


Fig. 2 Quiescent Current VS Temperature

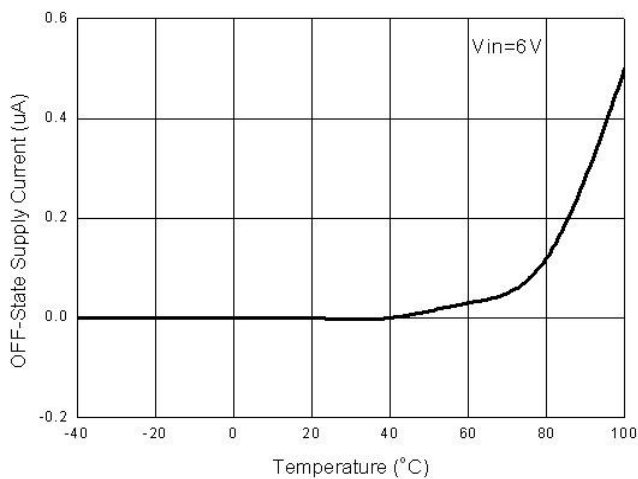


Fig. 3 Shut-down Current VS Temperature

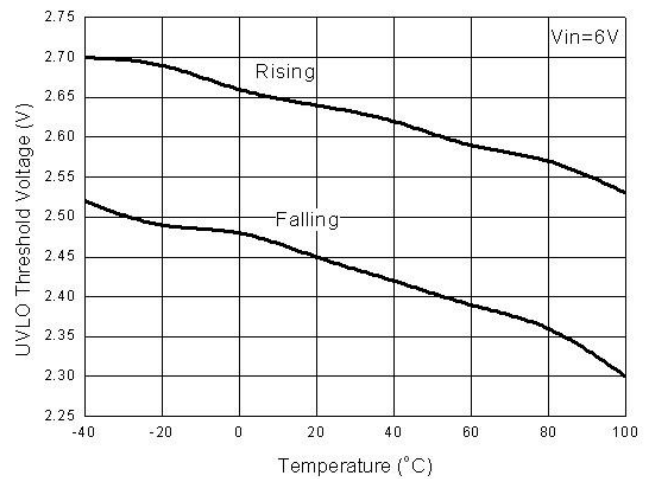


Fig. 4 UVLO Threshold Voltage VS Temperature

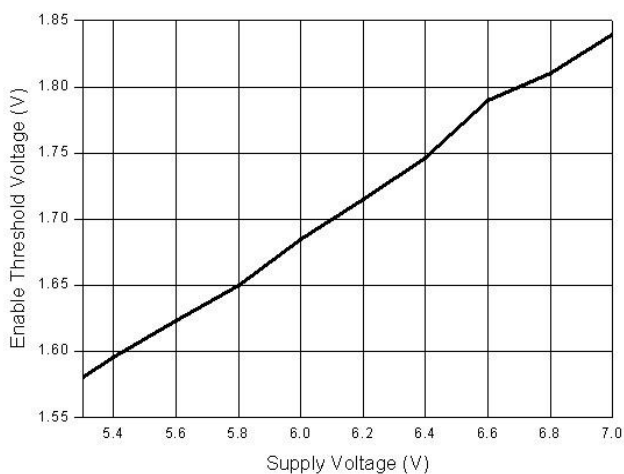


Fig. 5 Enable Threshold Voltage VS Input Voltage

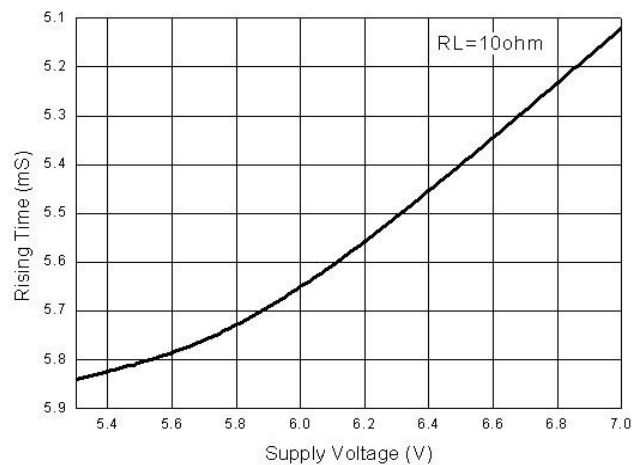


Fig. 6 Rising Time VS Input Voltage

## ■ TYPICAL PERFORMANCE CHARACTERISTICS

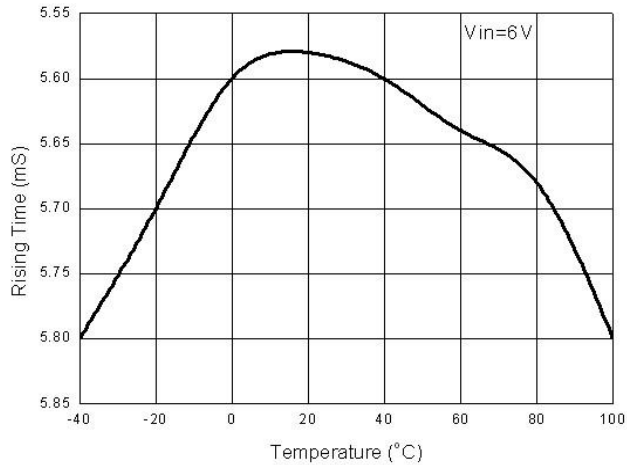


Fig. 7 Rising Time VS Temperature

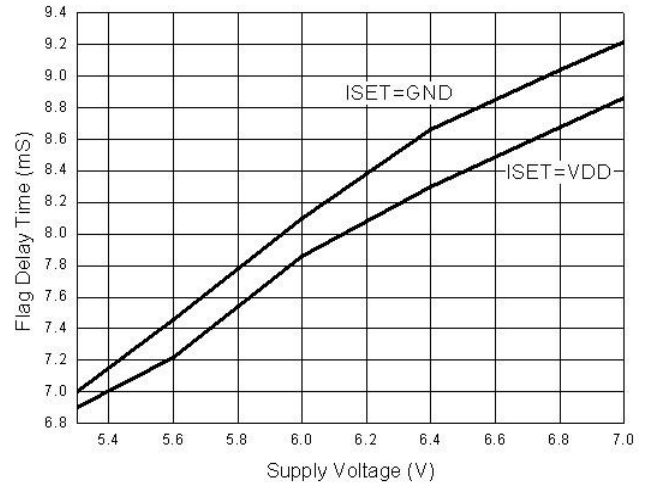


Fig. 8 Flag Delay Time VS Input Voltage

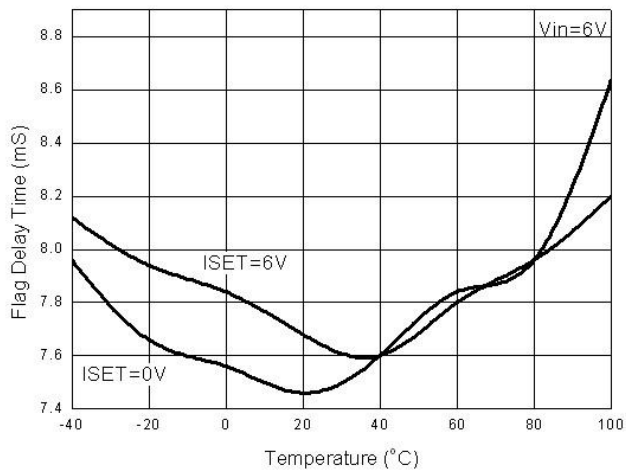


Fig. 9 Flag Delay Time VS Temperature

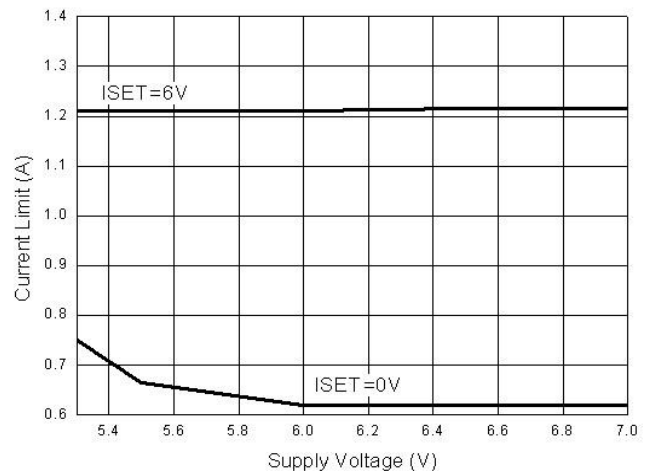


Fig. 10 Current Limit VS Input Voltage

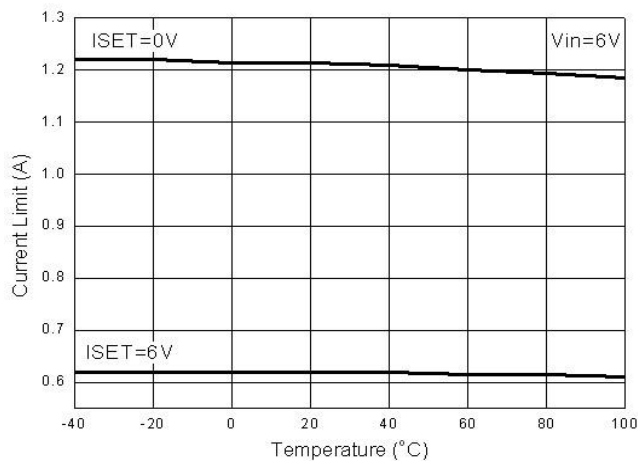


Fig. 11 Current Limit VS Temperature

## ■ TYPICAL PERFORMANCE CHARACTERISTICS

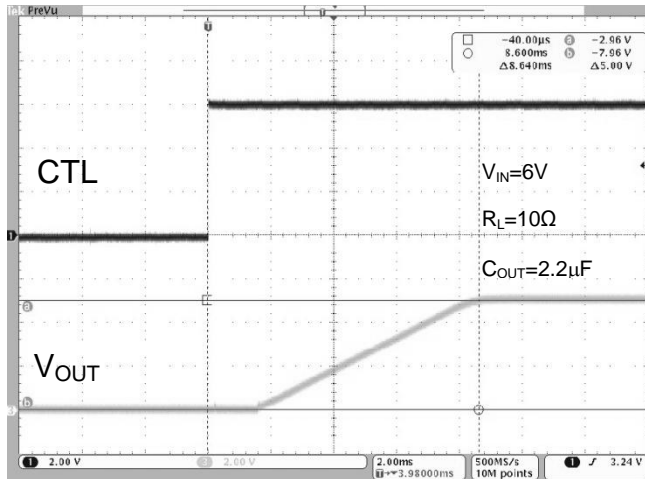


Fig. 12 Turn-On Time

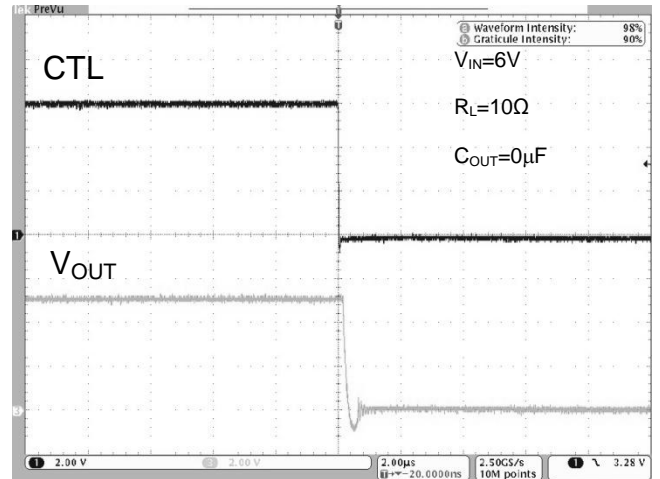


Fig. 13 Turn-Off Time

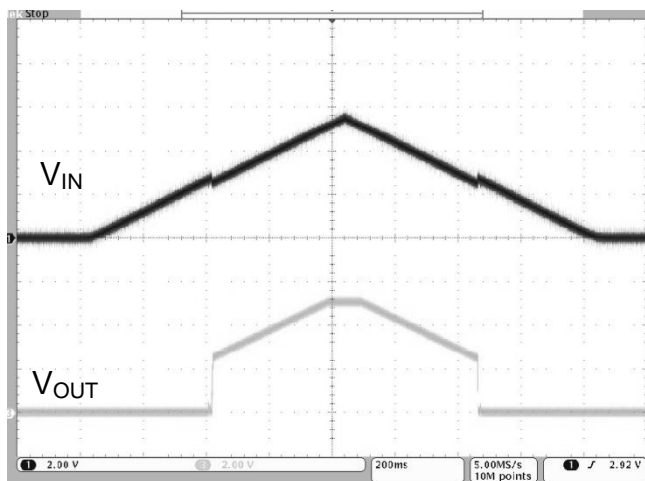


Fig. 14 UVLO Protection

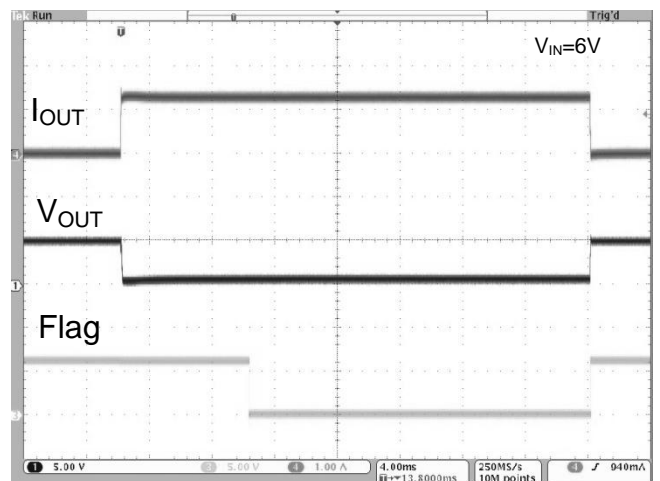


Fig. 15 Current Limit Event (I<sub>set</sub>=GND)

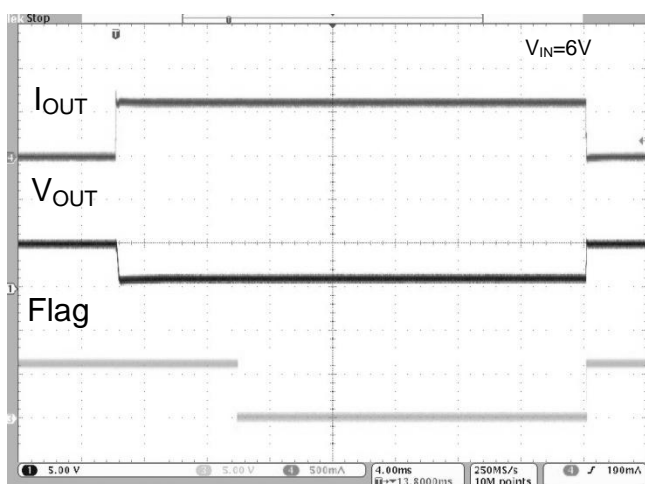


Fig. 16 Current Limit Event (I<sub>set</sub>=V<sub>IN</sub>)

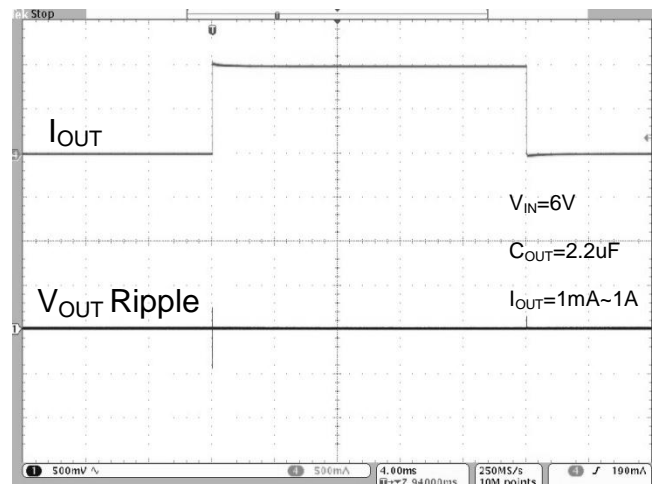
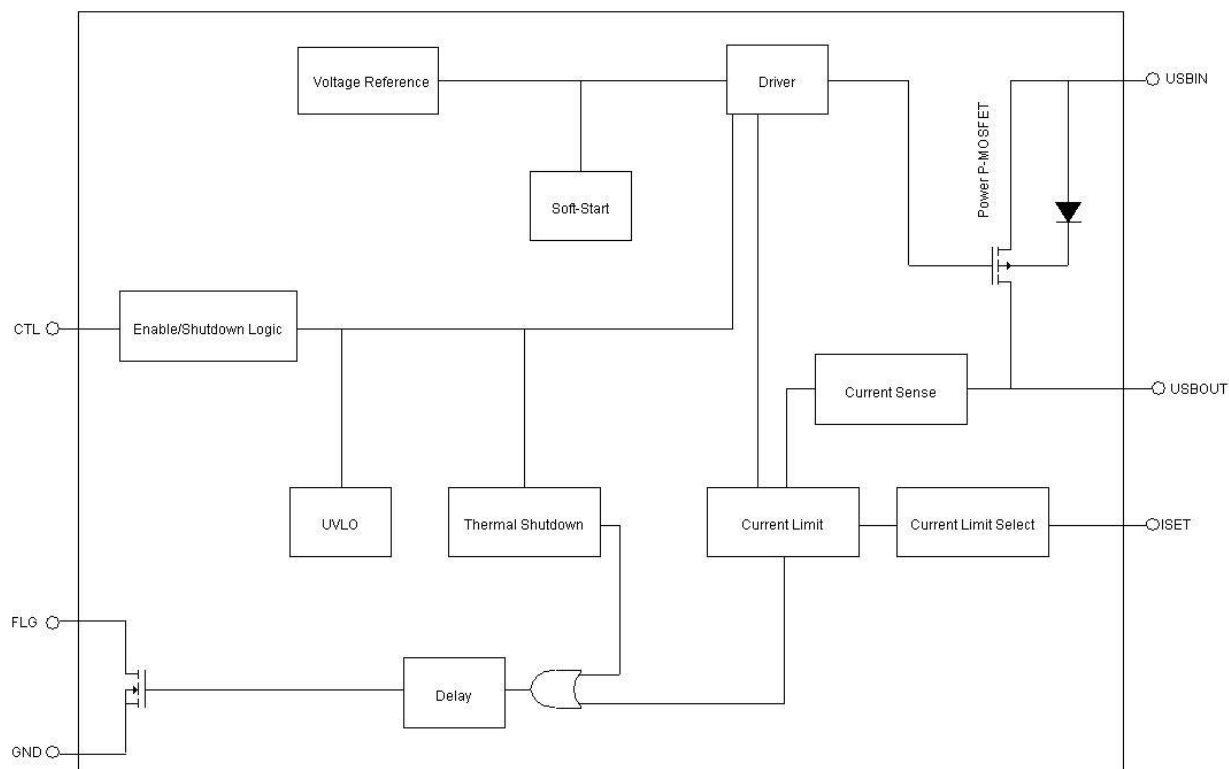


Fig. 17 Load Transition

## ■ BLOCK DIAGRAM



## ■ PIN DESCRIPTIONS

**PIN 1: CTL** - Controls the turn-on/turn-off of USB power switch with TTL as a control input. Active high for AIC6166-1 and active low for AIC6166-0.

**PIN 2: FLG** - An active-low and open-drained fault flag output. FLG is an indicator for current limit when CTL is active. In normal mode operation (CTL is active), it also can indicate thermal shutdown.

**PIN 3: USBIN** - USB power supply input pin.

**PIN 4: USBIN** - USB power supply input pin.

**PIN 5: USBOUT** - USB switch output.

**PIN 6: USBOUT** - USB switch output.

**PIN 7: ISET** - Current limit setting pin. Connect to GND for 1.25A current limit. Connect to USBIN for 0.62A current limit

**PIN 8: GND** - Chip power ground.

## ■ APPLICATION INFORMATION

### ● Error Flag

An error Flag is an open-drained output of an N-channel MOSFET. FLG output is pulled low to signal the following fault conditions: output current limit and thermal shutdown. The Fault Flag response delay time is 8ms.

### ● 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 AIC6166 exceeds 150°C for any reasons, the thermal shutdown function turns the MOSFET switch off and signals the error flag. When thermal shutdown, the IC performs the function of latching in OFF state. It can resume operation by turning off once (min. 1μS) and then turn on using the CTL pin, or by restoring power to the USBIN pin.

### ● Supply Filtering

A 1μF bypass capacitor from USBIN 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.

### ● Output Capacitance

Linear regulators require output capacitors to maintain stability and transient response. A 2.2μF output capacitor can satisfy most AIC6166 applications. For getting better load transient, a 4.7μF output capacitor is recommended.

### ● Dropout Voltage

The dropout voltage is defined as the difference between input voltage and output voltage at which the output voltage drops 100mV. Below this value, the output voltage will fall while the input voltage reduces. It depends on the load current and junction temperature.

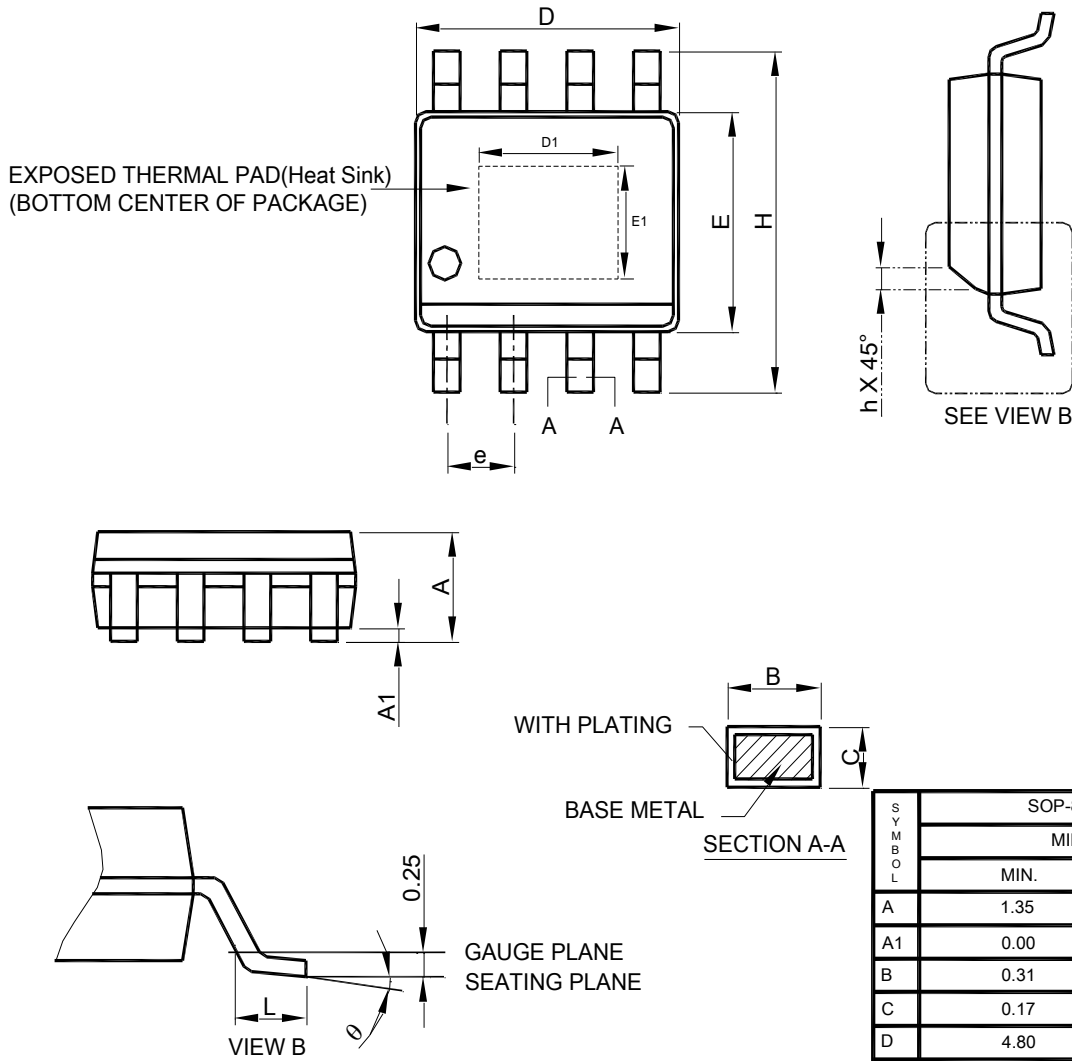
### ● Printed Circuit Layout

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



## ■ PHYSICAL DIMENSIONS

### ● 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°

### Note:

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