Precision Power Distribution Switch

FEATURES

- Integrated 60mΩ Power MOSFET
- Low Supply Current
- 30μA Typical at Switch On State
- 1μA Typical at Switch Off State
- Wide Input Voltage Range: 2.5V to 5.5V
- Fast Transient Response: 8μs
- 0.1ms Typical Rise Time
- Reverse Current Flow Blocking
- Deglitched Open-Drain Over-Current Flag Output
- Thermal Shutdown Protection
- Hot Plug-In Application (Soft-Start)
- SOT23-5 Package.

APPLICATIONS

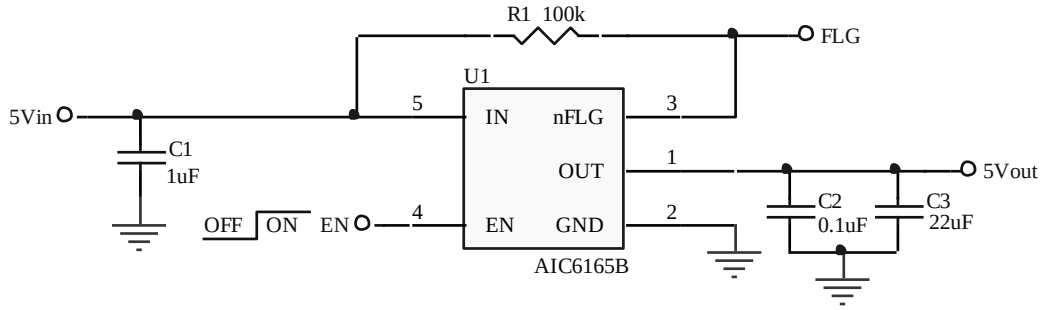
- USB Bus/Self Powered Hubs
- Battery-Charger Circuits
- Personal Communication Devices
- Notebook Computers

DESCRIPTION

The AIC6165B is a cost-effective, low voltage, single P-MOSFET load switch, optimized for self-powered and bus-powered Universal Serial Bus (USB) applications. This switch operates with inputs ranging from 2.5V to 5.5V, making it ideal for both 3V and 5V systems. The switch's low $R_{DS(ON)}$, 60mΩ, meets USB voltage drop requirements. A built-in P-channel MOSFET with true shutdown function to eliminate any reversed current flow across the switch when it is powered off. When the output voltage is higher than input voltage, the power switch is turned off by internal output reverse-voltage comparator.

nFLG is an open-drain output to signal over-current or over temperature event. In addition, nFLG also has typical 2.5ms deglitch timeout period and signals output reverse-voltage condition.

APPLICATION CIRCUIT

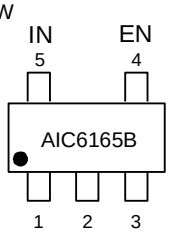


Typical Application Circuit

■ ORDERING INFORMATION

AIC6165BXXXXX

- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  U5: SOT23-5
- G: Green Package

Package Type	Pin Configuration
U5 (SOT23-5)	FRONT VIEW 

Example: AIC6165BGU5TR

→ in SOT23-5 Green package and
TAPE & REEL packing

● Marking

Top Mark: TXXXXX (TXX: Device Code, XXX: Inside code)

Part No.	Package Code	Package Type	Marking
AIC6165B	GU5	SOT23-5	T16AXX

■ ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage (V_{IN}) ..... -0.3V to 7V
EN Pin Voltage ..... -0.3V ~V_{IN}+0.3V
OUT Pin Voltage ..... -0.3V ~V_{IN}+0.3V
Junction Temperature(Note2) ..... 160°C
Storage Temperature Range ..... -65°C ~ 150°C
Lead Temperature (Soldering, 10sec) ..... 260°C
(Assume no Ambient Airflow, no Heatsink)

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

ELECTRICAL CHARACTERISTICS

(V_{IN}= 5V, C_{IN}= C_{OUT} = 1μF, T_A=25°C, unless otherwise specified.) (Note 1)

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
IN Section						
Input Voltage		V_{IN}	2.5		5.5	V
Supply Current, Enable	V_{IN}=5.5V, No load on OUT	I_{IN_ON}		30	60	μA
Shutdown Current, Disable	V_{IN}=5.5V, No load on OUT	I_{IN_OFF}		0.1	1	μA
Reverse Leakage Current	V_{OUT}=5.5V, V_{IN}=0V	I_{REV}		2	5	μA
Under Voltage Lockout Exit	V_{IN} rising from 0V to 5V	V_{UVLO_ON}		2	2.3	V
UVLO Hysteresis		V_{UVLO_HY}		100		mV
EN Section						
High-Level Enable Voltage	V_{IN}=5.5V	V_{EN_H}	1.5			V
Low-Level Disable Voltage	V_{IN}=2.5V	V_{EN_L}			1.0	V
EN Input Current	V_{EN}=5.5V or 0V	I_{EN}	-0.5	5	10	μA
Turn On Time	CL=1μF, RL=100Ω	T_{ON}		0.2		ms
Turn Off Time	CL=1μF, RL=100Ω	T_{OFF}		0.1		ms
OUT Section						
Over Current CC Regulation	V_{IN}=5V, V_{OUT}=3.5V	I_{OC}	1.6	2.1	2.3	A
Reverse Voltage Protection	V_{OUT}-V_{IN}	$V_{REVERSE}$	5	20	50	mV
Output Rise Time	CL=1μF, RL=100Ω	T_{RISE}		0.1		ms
Output Fall Time	CL=1μF, RL=100Ω	T_{FALL}		0.3		ms
Response Time to Short Circuit		T_{IOS}		12		μs
FLG(Fault flag) Section						
Output Low Voltage	I_{FLG}=1mA	V_{OL}			180	mV
Continuous FLG Sink		I_{FLG}			10	mA
Off-State Current	Off-state leakage	I_{FLG_LEAK}			1	μA
Fault Flag Deglitch Time	V_{OUT}=100%	T_{FLG}		2.5		ms

ELECTRICAL CHARACTERISTICS (Continued)

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Power Switch						
Output MOSFET Resistance	I_{OUT}=1A	R_{DS_ON}		60		mΩ
Thermal Shutdown						
Thermal Shutdown Temperature		T_{NORMAL}		150		°C
Thermal Shutdown Threshold Hysteresis		T_{NORMAL_HY}		20		°C

Note1: Specifications are production tested at T_A=25°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

Note2: T_J is calculated from the ambient temperature T_A and power dissipation PD according to the following formula: $T_J = T_A + (PD) \times (250°C/W)$.

Note3: To exactly identify the short circuit characteristic of IC, avoid the test result interfered by parasitic inductor, output capacitor, and contact resistor. It is necessary to follow the recommendation as follows.

Please,

1. Add 1000μF of capacitor between VIN and GND, and close to IC.
2. Remove output capacitor.
3. Shorter the short circuit device wire.
4. Measure output current (I_{OUT}).

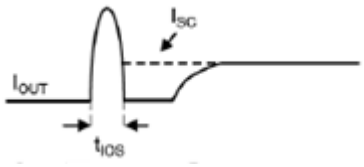


Fig. 1 Short Circuit Response Time

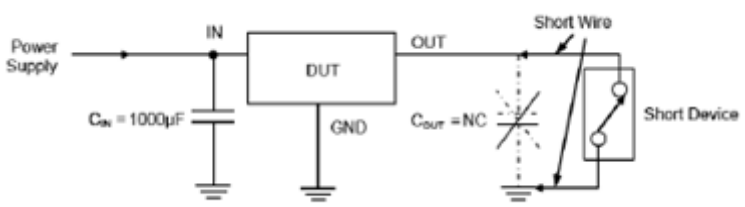
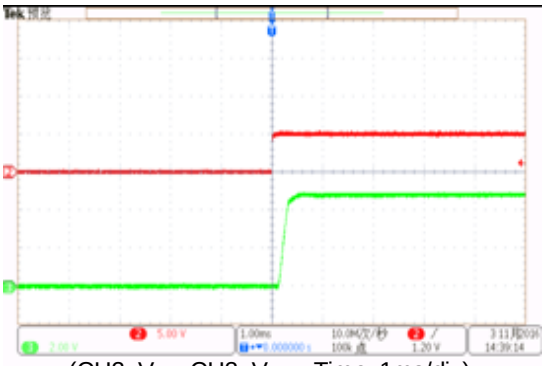


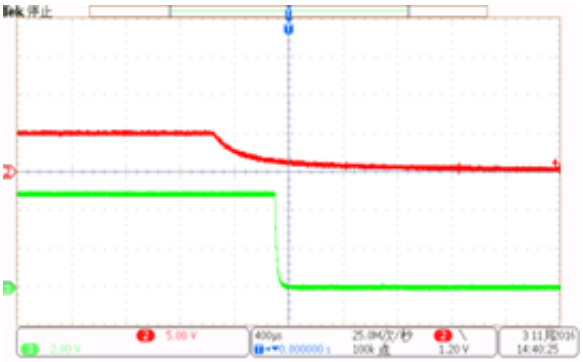
Fig. 2 Test Circuit

TYPICAL PERFORMANCE CHARACTERISTICS



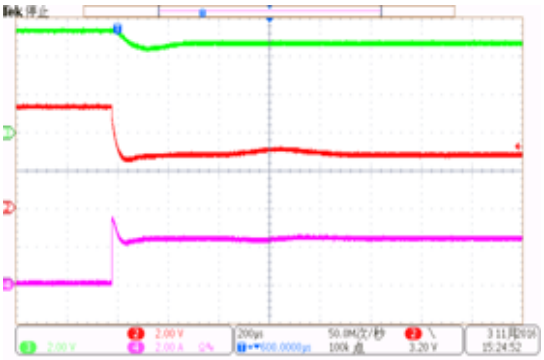
(CH2: V_{EN}; CH3: V_{OUT}; Time: 1ms/div)

Fig. 3 Turn on Delay Time and Rise Time



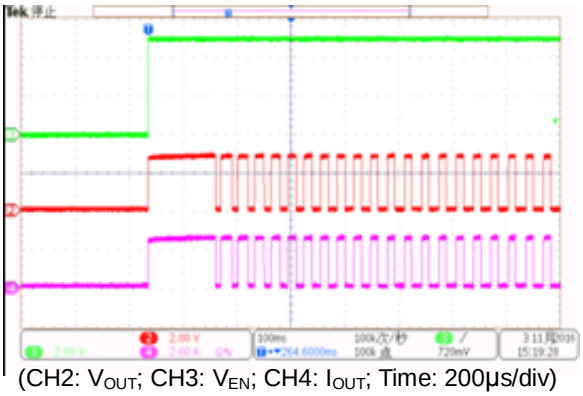
(CH2: V_{EN}; CH3: V_{OUT}; Time: 400µs/div)

Fig. 4 Turn off Delay Time and Fall Time



(CH2: V_{OUT}; CH3: V_{IN}; CH4: I_{OUT}; Time: 200µs/div)

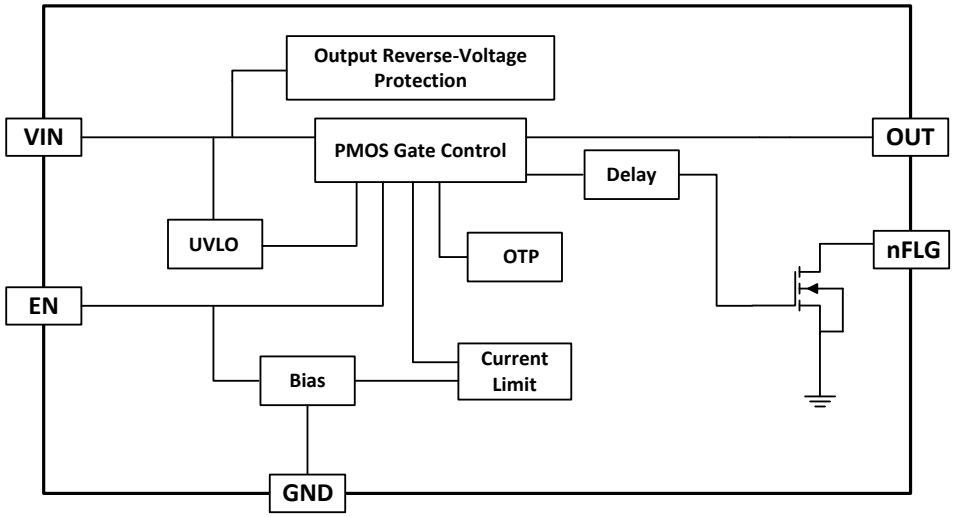
Fig. 5 Resistance Load Inrush Response



(CH2: V_{OUT}; CH3: V_{EN}; CH4: I_{OUT}; Time: 200µs/div)

Fig. 6 Over Current Response

BLOCK DIAGRAM



Functional Block Diagram of AIC6165B

PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Function
1	OUT	Switch Output: Output MOSFET Source of switch.
2	GND	IC ground connection.
3	nFLG	Over-Current: Open-Drain Fault Flag Output.
4	EN	Enable: Logic level enable input. Do not floating.
5	IN	Input Supply: Output MOSFET Drain, which also supplies.

APPLICATION INFORMATION

The AIC6165B is current-limited, power distribution switches using P-channel MOSFETs for applications where short circuits or heavy capacitive loads will be encountered and provide up to 1.6A of continuous load current. Additional device shutdown features include over temperature protection and reverse-voltage protection. The driver controls the gate voltage of the power switch. The driver incorporates circuitry that controls the rise and fall times of the output voltage to limit large current and voltage surges and provides built-in soft-start functionality. The AIC6165B enters constant current mode when the load exceeds the current-limit threshold

Input and Output

IN(input) is the power supply connection to the logic circuitry and the drain of the output MOSFET. OUT(output) is the source of the output MOSFET. In a typical application, current flows through the switch from IN to OUT toward the load. OUT pin must be connected together to the load.

Soft Start for Hot Plug-In Applications

In order to eliminate the upstream voltage droop caused by the large inrush current during hot-plug events, the “soft-start” feature effectively isolates the power source from extremely large capacitive loads, satisfying the USB voltage droop requirements.

FLG Function

The nFLG open-drain output is asserted (active low) when an over current condition is encountered after a 2.5ms deglitch timeout. The nFLG output remains asserted until the over-current condition is removed. Over temperature condition is also reported by nFLG open-drain output. In addition, nFLG is also asserted (active low) in output reverse-voltage condition until the output reverse-voltage condition is removed. The input voltage range from 4V to 5.25V is recommended for FLG function application.

Thermal Shutdown

The AIC6165B has internal over temperature protection to shut down the device when its junction temperature exceeds 150°C with over load current condition, then after the device is disabled, if the junction temperature drops 20°C hysteresis typically the device will resume and restart to work. The switch continues to cycle off and on until the over current fault is removed.

EN, the Enable Input

EN must be driven logic high or logic low for a clearly defined input. Floating the input may cause unpredictable operation, so please do not float EN input pin.

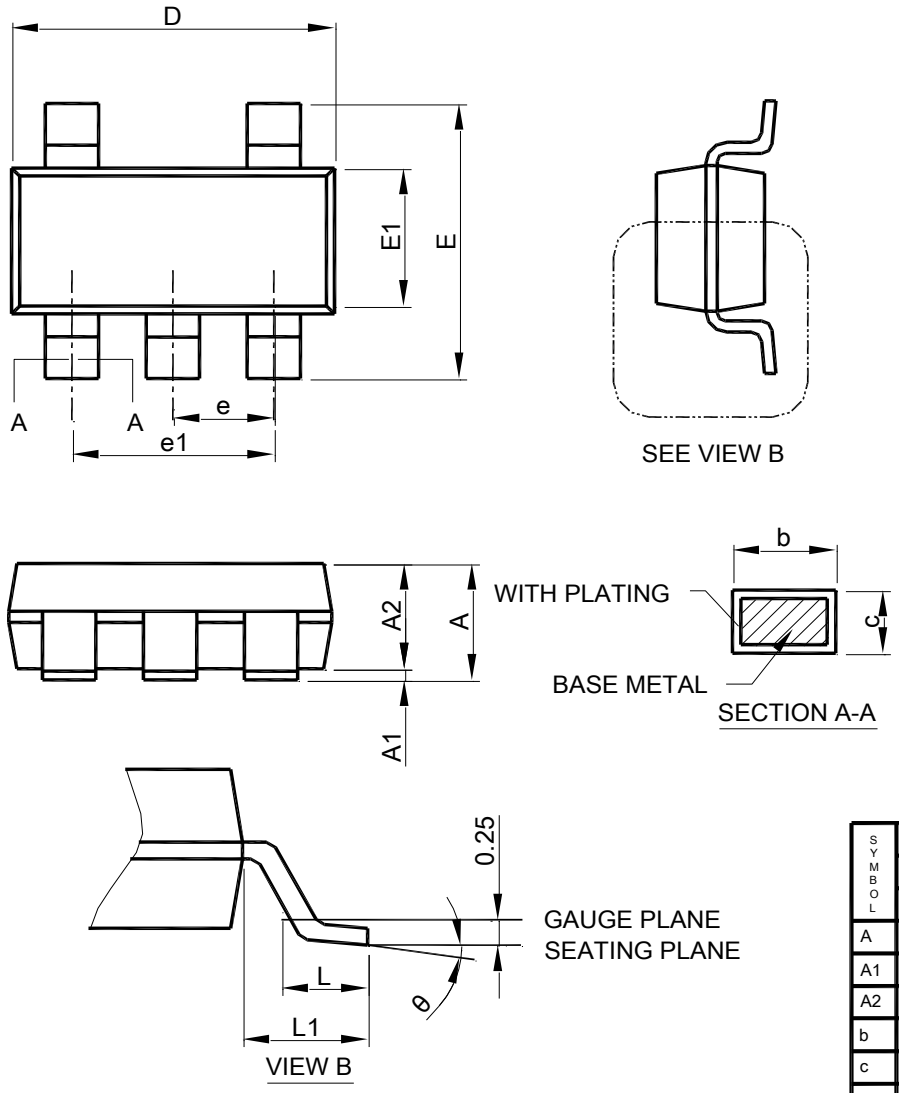
Layout Consideration

For best performance of the AIC6165B, the following guidelines must be strictly followed.

1) Input and output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
2) The GND should be connected to a strong ground plane for heat sink.
3) Keep the main current traces as possible as short and wide.

PHYSICAL DIMENSIONS (unit: mm)

- **SOT23-5**



SYMBOL	SOT23-5	
	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-178AA.
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.