60mΩ, 2.0A/1.5A/1A/0.5A High-Side Power Switches

Features

- Integrated 60mΩ Power MOSFET
- Low Supply Current
- 30uA Typical at Switch On State
- 1uA Typical at Switch Off State
- Wide Input Voltage Range:2.4V to 5.5V
- Fast Transient Response:8us
- 0.1mS Typical Rise Time
- Reverse Current Flow Blocking
- Deglitched Open-Drain Over-Current Flag Output($\overline{FLG}$)
- Continuous Load Current
- Thermal Shutdown Protection
- Hot Plug-In Application (Soft-Start)
- Output discharge function
  TP606X: No output discharge function
  TP606XF: Auto output discharge function
- SOT23-5 Package

Applications

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

General Description

The TP606X is a low voltage,single P-MOSFET high-side power switch, optimized for self-powered and bus-powered Universal Serial Bus (USB) applications. This switch operates with inputs ranging from 2.4V to 5.5V, making it ideal for both 3V and 5V systems. The switch's low RDS(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.

$\overline{FLG}$ is an open-drain output report over-current or over temperature event. In addition, $\overline{FLG}$ also has typical 2.5ms deglitch timeout period and reports output reverse-voltage condition.

Typical Application

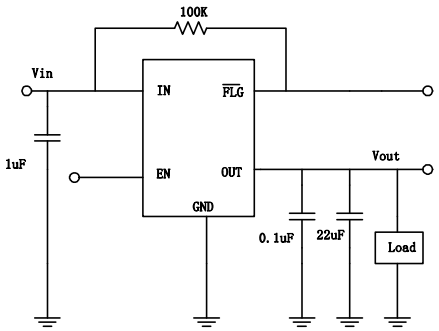

Figure 1. Basic Application Circuit

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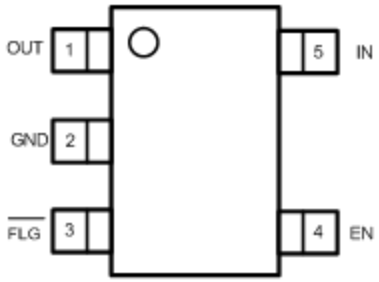
Pin Configuration

SOT23-5



Part Number	Mark	Description
TP606X	TP606X	Active High
TP606XF	TP606XF	Active High
TP606XL	TP606XL	Active Low
TP606XFL	TP606XFL	Active Low

X:1-4

Pin Functions

PIN No.	NAME	FUNCTION
1	OUT	Switch Output: Output MOSFET Source of switch. Typically connect to switched side of load.
2	GND	IC ground connection
3	$\overline{FLG}$	Over-Current: Open-Drain Fault Flag Output.
4	EN	Enable: Logic level enable input. Make sure EN pin never floating.
5	IN	Input Supply: Output MOSFET Drain, which also supplies IC's internal circuitry. Connect to positive supply.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage ……..-0.3V to 7V
EN Voltages……..... -0.3V to Vin+0.3V
VOUT Voltage..... .....-0.3V to (Vin+0.3V)
Lead Temperature(Soldering,10s) ….…+300°C
Operating Temperature Range .. -40°C to +85°C
Junction Temperature ……..…...125°C
Storage Temperature Range ..-65°C to 150°C

Electrical Characteristics

VIN = 5V, CIN=1μF, COUT=1μF, TA = 25°C.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
IN section						
Vin	Input voltage		2.5		5.5	V
Iin_on	Supply current, Enable	Vin=5.5V, No load on OUT		30	60	uA
Iin_off	Shutdown current, Disable	Vin=5.5V, No load on OUT		0.1	1	uA
IREV	Reverse leakage current	Vout=5.5V, Vin=0V		2	5	uA
VUVLO_ON	Under voltage lockout exit	Vin rising from 0-5V		2	2.3	V
VUVLO_hys	UVLO Hysteresis			100		mV
EN section						
VEN_H	High-level enable voltage	Vin=5.5V	1.5			V
VEN_L	High-level disable voltage	Vin=2.5V			1.0	V
IEN	EN input current	VEN=5.5V or 0V	-0.5	5	10	uA
ton	Turn on time	CL=1uF, RL=100ohm		0.2		ms
toff	Turn off time	CL=1uF, RL=100ohm		0.1		ms
OUT section						
IOC	Over Current CC Regulation	TP6063	1.9	2.1	2.25	A
VReverse	Reverse voltage protection	Vout-Vin	5	20	50	mV
IReverse	Reverse-current protection		0.1	0.4	1	A
tRise	Output rise time	CL=1uF, RL=100ohm		0.1		ms
tFall	Output fall time	CL=1uF, RL=100ohm		0.3		ms
tios	Response time to short circuit			12		us

Output Turn-On Rise Time		10% to 90% of Vout rising	400			us
Rated Current	TP6061		0.5			A
	TP6062		1			
	TP6063		1.5			
	TP6064		2			
Current Limit	TP6061	Current Ramp(< 0.1A/ms) On Vout	0.72	0.85	0.97	A
	TP6062		1.27	1.5	1.73	
	TP6063		1.9	2.1	2.25	
	TP6064		2.2	2.9	3.5	

FLG(Fault flag) section						
VOL	Output low	IFLG=1mA		180		mV
IFLG	Continuous FLG sink				10	mA
IFLG_leakage		Off-state leakage			1	uA
tFLG	Fault flag deglitch time			2.5		ms
Power switch						
RDS_ON		Iout=1A		60		mohm
Thermal Shutdown						
Tnormal	Thermal shutdown threshold			150		℃
Tnormal hys	Thermal shutdown threshold hysteresis			20		℃

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = TA + (PD) \times (250°C/W)$.

Note 3: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

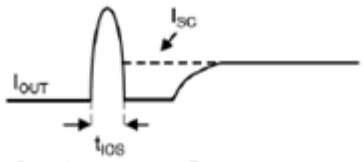


Figure 3

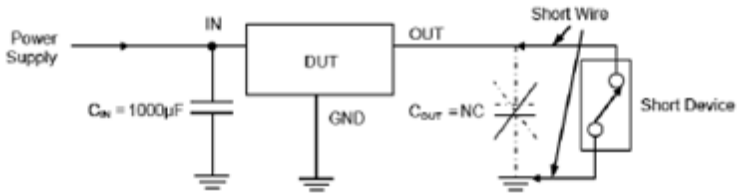


Figure 4

Note:

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 (IOUT).

Functional Block Diagram

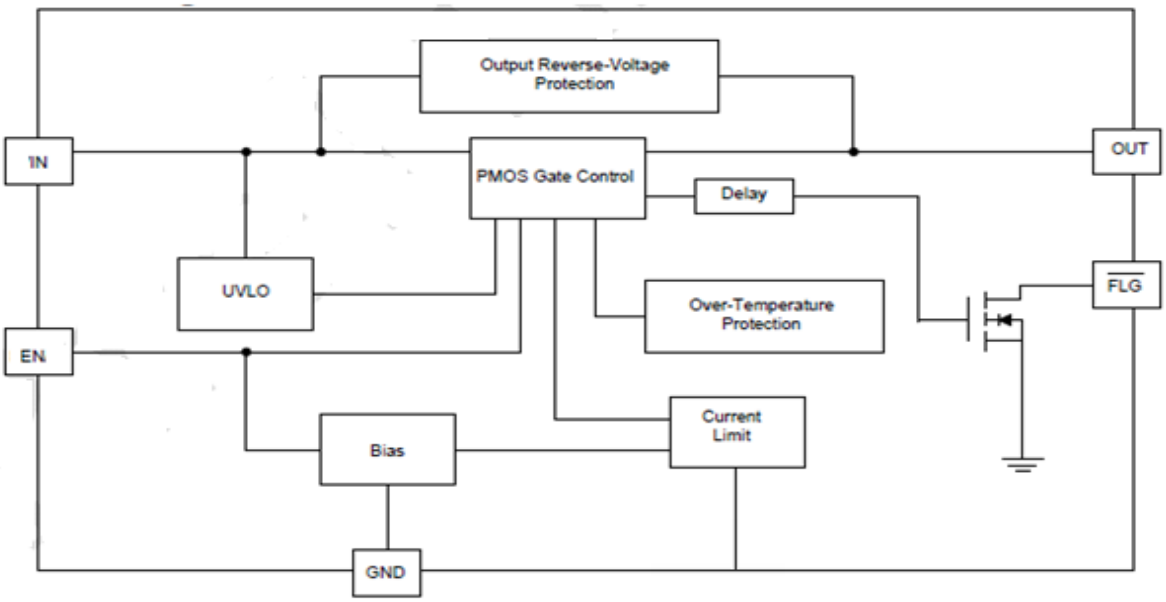


Figure 5. TP606X Block Diagram

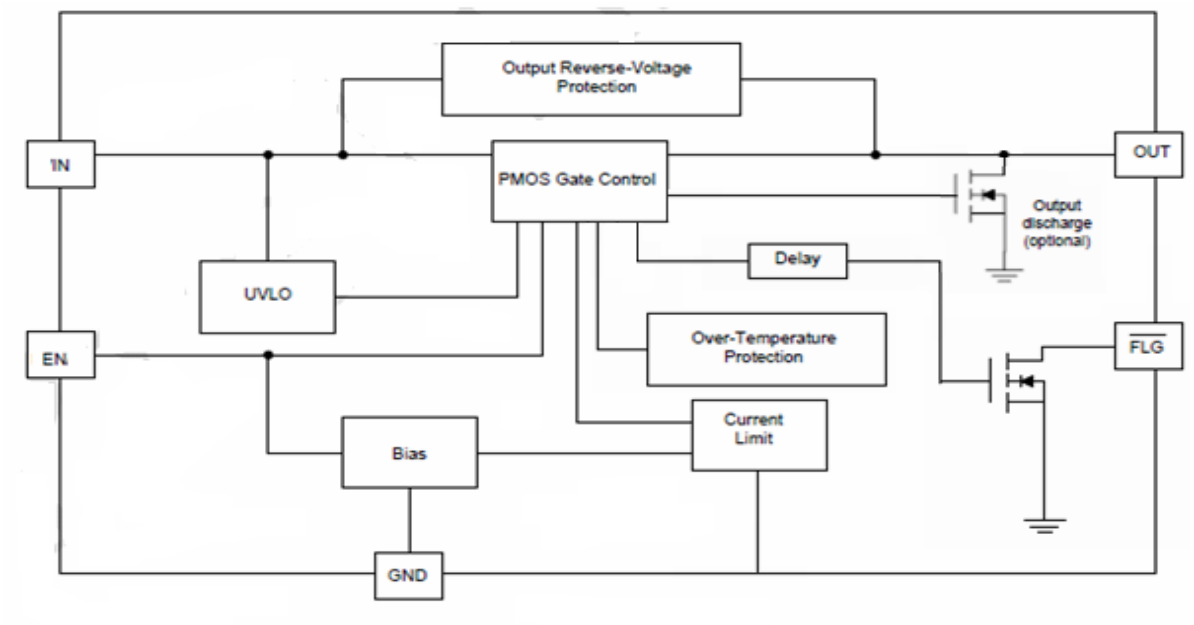
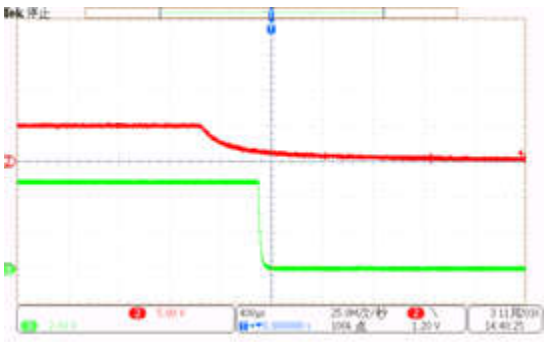


Figure 6. TP606XF Block Diagram

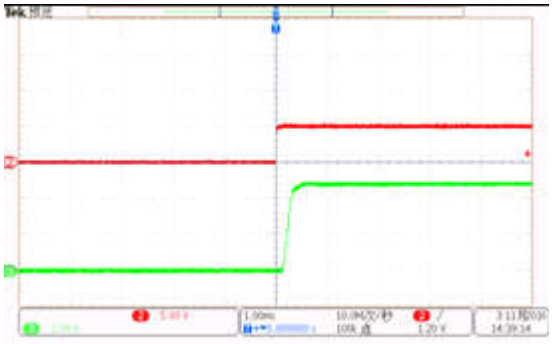
TYPICAL PERFORMANCE CHARACTERISTICS

Turn off Delay Time and Fall Time



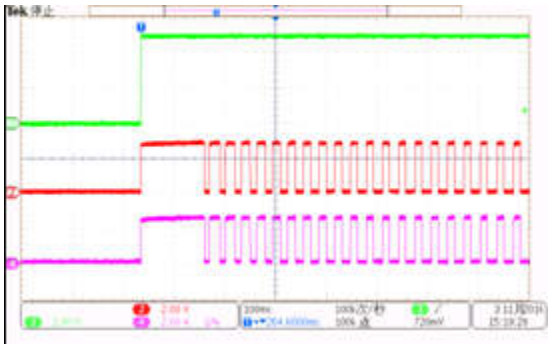
CH2:EN CH3:VOUT

Turn on Delay Time and Rise Time



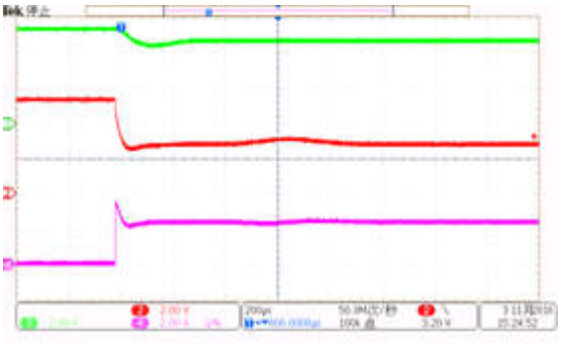
CH2:EN CH3:VOUT

Thermal Shutdown Response



CH2:VOUT CH3:EN CH4:IOUT

Resistance Load Inrush Response



CH2:VOUT CH3:VOUT CH4:IOUT

APPLICATION INFORMATION

The TP606X 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 rated 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 TP606X 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.

FLG Function

The $\overline{\text{FLG}}$ open-drain output is asserted (active low) when an over current condition is encountered after a 2.5ms deglitch timeout. The $\overline{\text{FLG}}$ output remains asserted until the over-current condition is removed. Over temperature condition is also reported by $\overline{\text{FLG}}$ open-drain output. In addition, $\overline{\text{FLG}}$ is also asserted (active low) in output reverse-voltage condition when the output reverse-voltage condition is removed.

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.

Thermal Considerations

The TP606X protects itself with two independent thermal sensing circuits that monitor the operating temperature of the power-switch and disables operation if the temperature exceeds recommended operating conditions. The device operates in constant-current mode during an over-current conditions, which increases the voltage drop across power-switch. The power dissipation in the package is proportional to the voltage drop across the power-switch, so the junction temperature rises during an over-current condition. The first thermal sensor turns off the power-switch when the die temperature exceeds 130°C and the part is in current limit. The second thermal sensor turns off the power-switch when the die temperature exceeds 150°C regardless of whether the power-switch is in current limit. Hysteresis is built into both thermal sensors, and the switch turns on after the device has cooled approximately 20°C(Thermal shutdown threshold hysteresis in current-limit is 20°C). The switch continues to cycle off and on until the fault is removed. The open-drain $\overline{\text{FLG}}$ is asserted (active low) immediately during an over temperature shutdown condition.

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. EN should not be allowed to go negative with respect to GND.

Layout Consideration

For best performance of the TP606X, the following guidelines must be strictly followed.

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

Package Information

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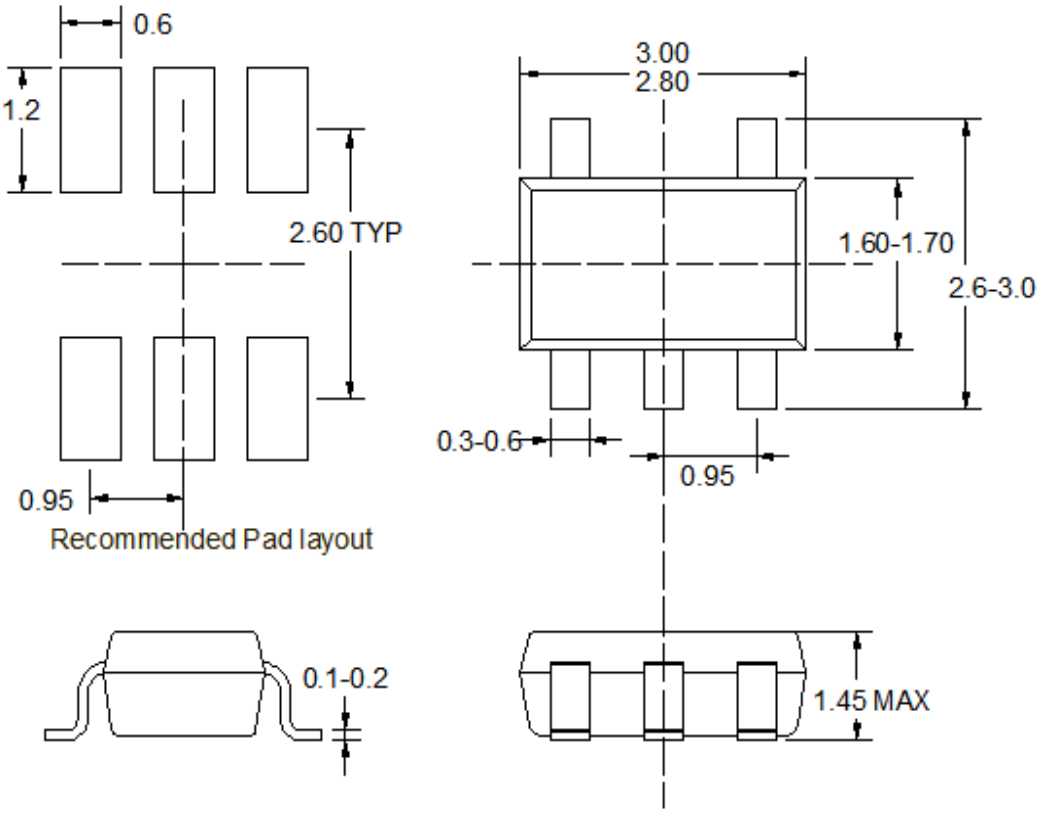
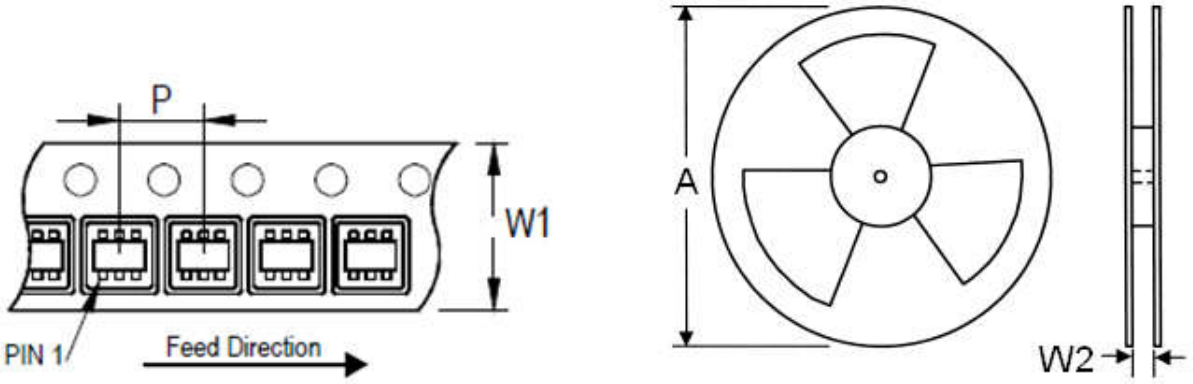


Carrier Dimensions



Tape Size (W1) mm	Pocket Pitch (P) mm	Reel Size (A)		Reel Width (W2) mm	Empty Cavity Length mm	Units per Reel
		in	mm			
8	4	7	180	8.4	300~1000	3,000