

Precision Power Distribution Switch

FEATURES

- Integrated 60mΩ Power MOSFET
- Adjustable Current Limit, 400mA to 2.4A
- 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
- Thermal Shutdown Protection
- Hot Plug-In Application (Soft-Start)
- SOT-23-5 Package

GENERAL DESCRIPTION

The TP6033EL 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.

The TP6033EL offers a programmable current limit threshold between 400mA to 2.4A via an external resistor.

APPLICATIONS

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

TYPICAL APPLICATION

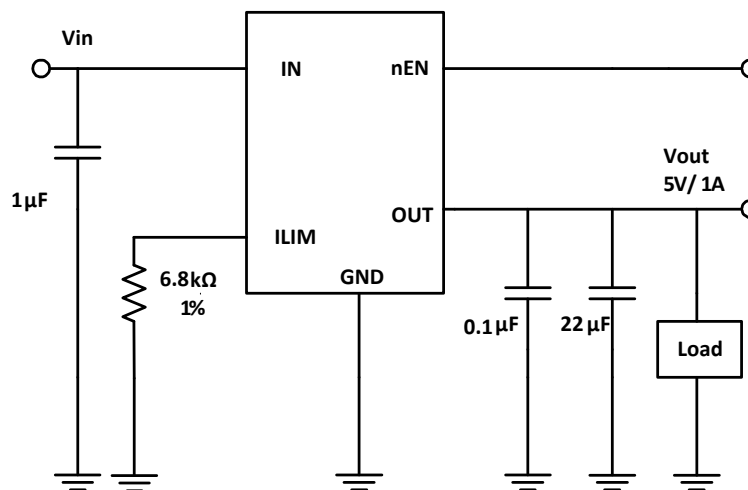
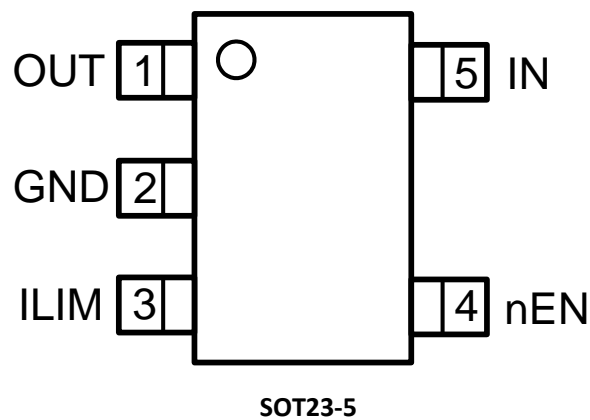


Figure 1. TP6033EL Application Circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

Parameter	Value	Unit
Input Supply Voltage	-0.3~7	V
All other pins Voltages	-0.3~ $V_{IN}+0.3$	V
Junction Temperature (Note2)	-40~160	°C
Storage Temperature Range	-65~150	°C
Junction-to-ambient Thermal Resistance	260	°C/W
Junction-to-case Thermal Resistance	120	°C/W
Lead Temperature(Soldering,10s)	260	°C

PIN CONFIGURATION



Top Mark: TPXXXXX (TPXXXXX: Device Code)

Part Number	Package	Top mark	Quantity/ Reel
TP6033EL	SOT23-5	TP6033E	3000

PIN FUNCTIONS

Pin	Name	Function
1	OUT	Switch Output: Output MOSFET Source of switch. Typically connect to switched side of load.
2	GND	Ground Pin
3	ILIM	External resistor used to set current-limit ILIM threshold
4	nEN	Enable: Logic level enable input. Make sure EN pin never floating. Pull low to enable IC.
5	IN	Input Supply: Output MOSFET Drain, which also supplies IC's internal circuitry. Connect to positive supply.

ESD RATINGS

Items	Description	Value	Unit
V_{ESD}	Human Body Model for all pins	±2000	V

JEDEC specification JS-001

RECOMMENDED OPERATING CONDITIONS

Items	Description	Min	Max	Unit
Voltage Range	IN	2.5	5.5	V
T_J	Operating Junction Temperature Range	-40	125	°C

ELECTRICAL CHARACTERISTICS
($V_{IN}=5V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, $T_A = 25^\circ C$.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
IN section						
V_{IN}	Input voltage		2.5		5.5	V
I_{IN_ON}	Supply current, Enable	$V_{IN}=5.5V$, No load on OUT		30	60	μA
I_{IN_OFF}	Shutdown current, Disable	$V_{IN}=5.5V$, No load on OUT		0.1	1	μA
I_{REV}	Reverse leakage current	$V_{OUT}=5.5V$, $V_{IN}=0V$		2	5	μA
V_{UVLO_ON}	Under voltage lockout exit	V_{IN} rising from 0-5V		2	2.3	V
V_{UVLO_HY}	UVLO Hysteresis			100		mV
EN section						
V_{nEN_H}	High-level enable voltage	$V_{IN}=5.5V$	1.5			V
V_{nEN_L}	Low-level disable voltage	$V_{IN}=2.5V$			0.8	V
I_{nEN}	EN input current	$V_{EN}=5.5V$ or $0V$	-0.5	5	10	μA
OUT section						
I_{OC}	Over Current CC Regulation	TP6033EL $R_{LIM}=6.8k\Omega$ $V_{IN}=5V$, $V_{OUT}=3.5V$	0.8	1	1.2	A
$V_{REVERSE}$	Reverse voltage protection	$V_{OUT}-V_{IN}$	5	20	50	mV
T_{RISE}	Output rise time	$CL=1\mu F$, $RL=100\Omega$		0.1		ms
T_{FALL}	Output fall time	$CL=1\mu F$, $RL=100\Omega$		0.3		ms
T_{IOS}	Response time to short circuit			12		μs
Power switch						
R_{DS_ON}		$I_{OUT}=1A$		60		m Ω
Thermal Shutdown						
T_{NORMAL}	Thermal shutdown temperature			150		$^\circ C$
T_{NORMAL_HY}	Thermal shutdown threshold hysteresis			20		$^\circ C$

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 PD according to the following formula: $T_J = T_A + (PD) \times \theta_{JA}$.

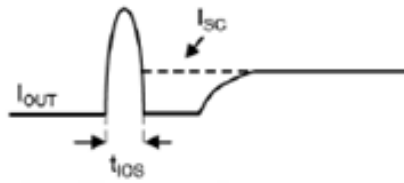


Figure 2. Short Circuits Response time

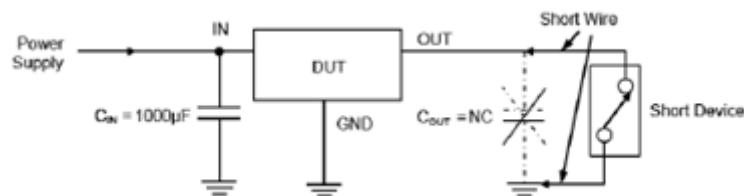


Figure 3. test circuits

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 (I_{OUT}).

FUNCTIONAL BLOCK DIAGRAM

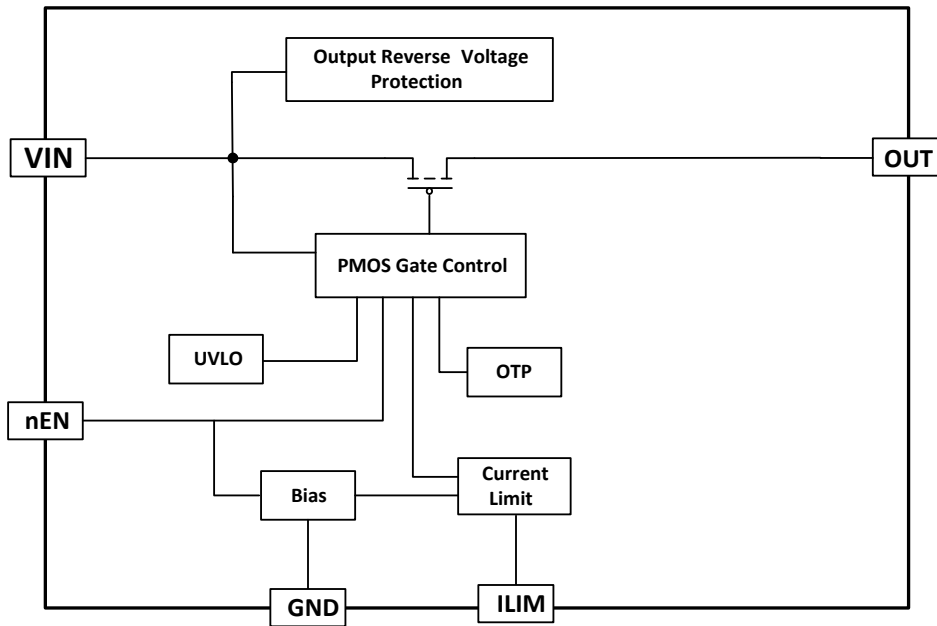
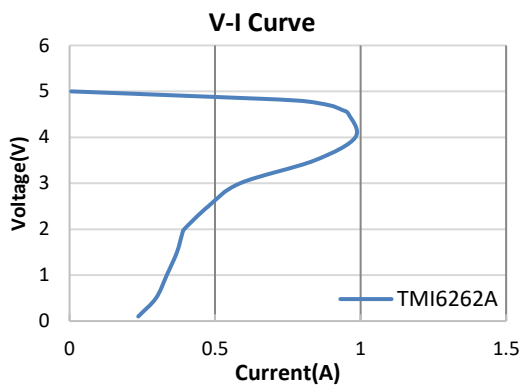


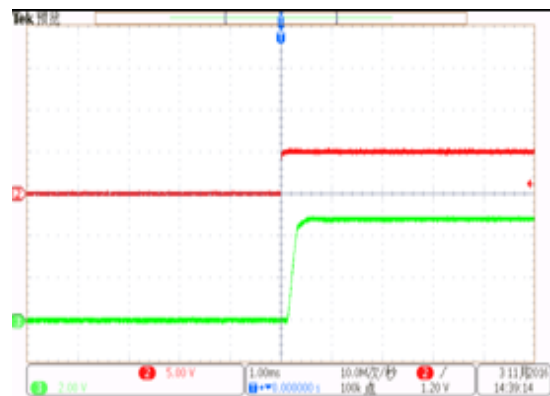
Figure 4. TP6033EL Block Diagram

TYPICAL PERFORMANCE CHARACTERISTICS

Over current Protection Characteristics

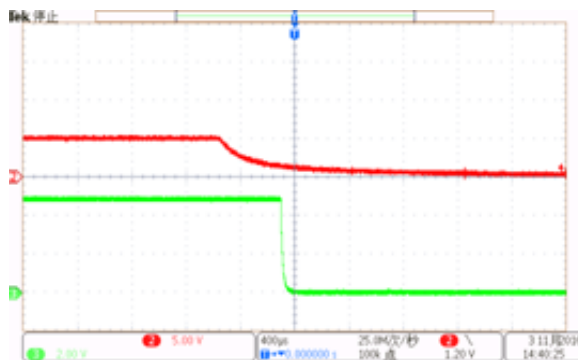


Turn on Delay Time and Rise Time



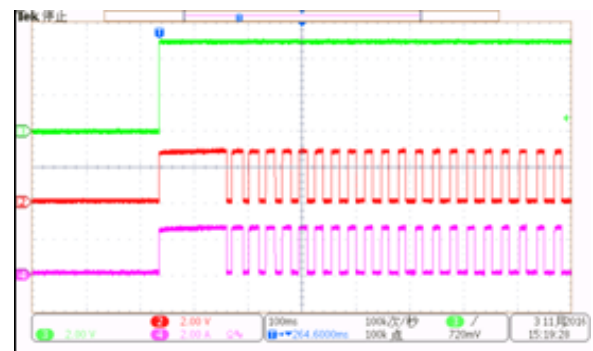
CH2:EN CH3:V_{OUT} 1mS/div

Turn off Delay Time and Fall Time



CH2:EN CH3:V_{OUT}400uS/div

Thermal Shutdown Response



CH2:V_{OUT} CH3:EN CH4:I_{OUT}200uS/div

APPLICATION INFORMATION

The TP6033EL 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 2.4 A 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 TP6033EL 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.

Setting Current Limit

The over-current threshold is user programmable via an external resistor. The TP6033EL use an internal regulation loop to provide a regulated voltage on the ILIM pin. The current-limit threshold is proportional to the current sourced out of ILIM. The recommended 1% resistor range for R_{ILIM} is $1k\Omega \leq R_{ILIM} \leq 30k\Omega$ to ensure stability of the internal regulation loop. Many applications require that the minimum current limit is above a certain current level or that the maximum current limit is below a certain current level, so it is important to consider the tolerance of the over current threshold when selecting a value for R_{ILIM} . The following Figure 6 can be used to select the resulting type over-current threshold for a given external resistor value (R_{ILIM}).

$$I_{LIMIT} = 6800 / R_{ILIM}$$

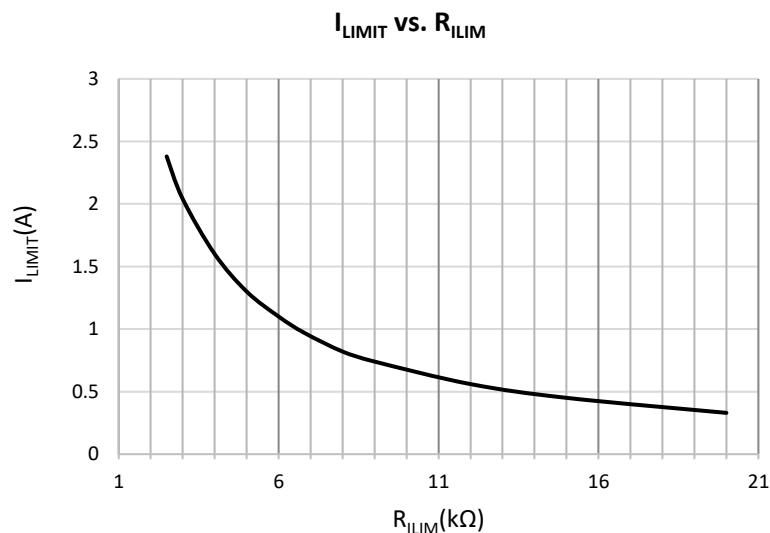


Figure 5. I_{LIMIT} vs. R_{ILIM}

Thermal Shutdown

The TP6033EL 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.

nEN, the Enable Input

nEN 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 nEN input pin.

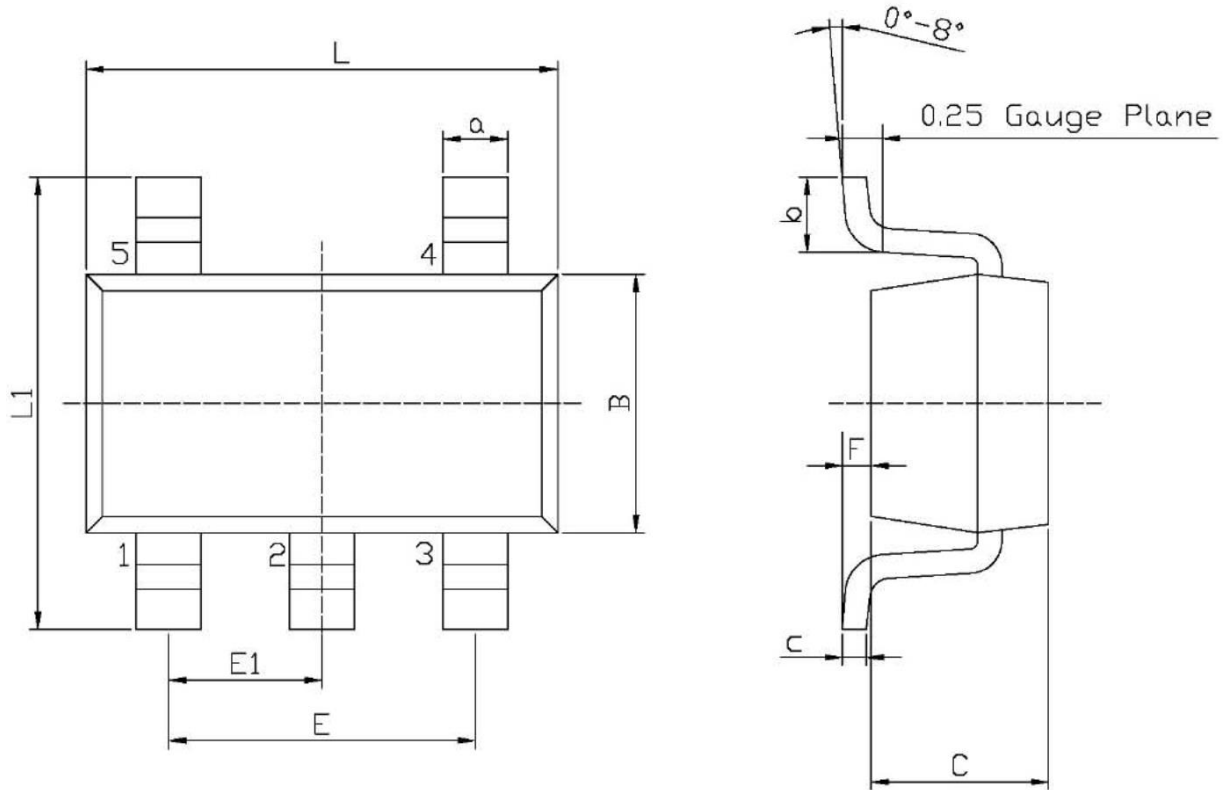
Layout Consideration

For best performance of the TP6033EL , 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.

PACKAGE INFORMATION

SOT23-5



Unit: mm

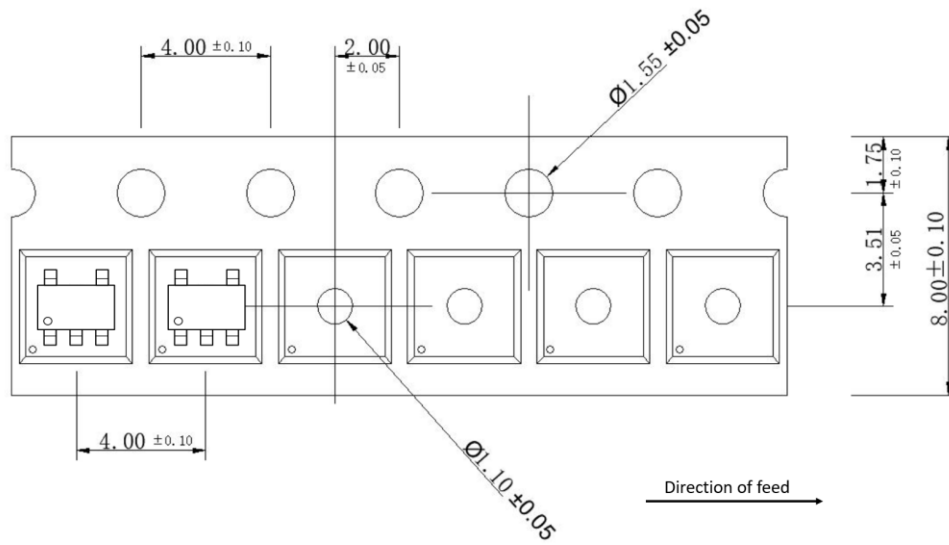
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

Note:

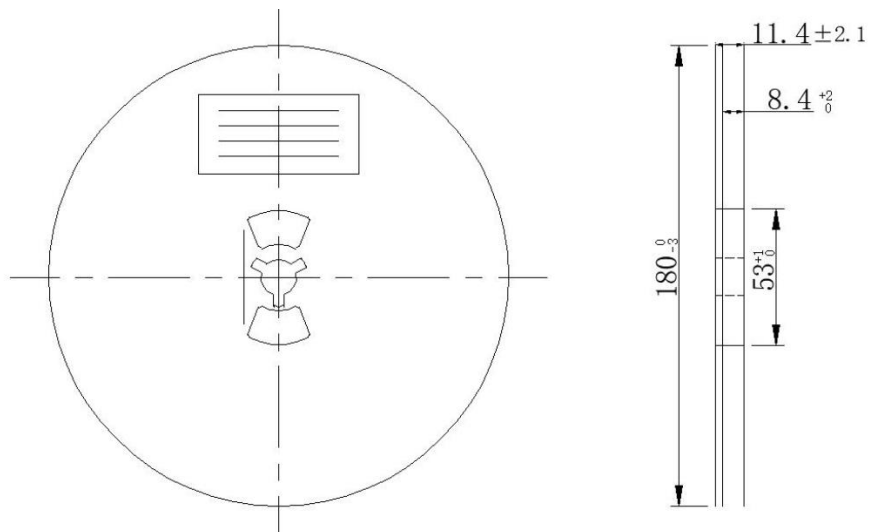
- 1) All dimensions are in millimeters.
- 2) Package length does not include mold flash, protrusion or gate burr.
- 3) Package width does not include inter lead flash or protrusion.
- 4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
- 5) Pin 1 is lower left pin when reading top mark from left to right.

TAPE AND REEL INFORMATION

TAPE DIMENSIONS:



REEL DIMENSIONS:



Note:

- 1) All Dimensions are in Millimeter
- 2) Quantity of Units per Reel is 3000
- 3) MSL level is level 3.