

# Precision Power Distribution Switch

## FEATURES

- Integrated 60mΩ Power MOSFET
  - 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
  - Automatic output discharge at shutdown
  - Deglitched Open-Drain Over-Current Flag Output (TMI6263AH, TMI6263AL)
  - Thermal Shutdown Protection
  - Hot Plug-In Application (Soft-Start)
  - Two Enable polarities and four current levels
- TMI6263AH: 2.0A/Enable High  
TMI6263AL: 2.0A/Enable Low  
TMI6263CH: 1.5A/Enable High  
TMI6263BH: ADJ /Enable High
- SOT23-5 package

## GENERAL DESCRIPTION

The TMI6263 is a cost-effective, single P-MOSFET load switch with ultra-low  $R_{DS(ON)}$ , optimized for self-powered and bus-powered Universal Serial Bus (USB) applications. Input voltage from 2.5V to 5.5V, making it ideal for both 3V and 5V systems. A built-in P-channel MOSFET with true shutdown function to eliminate any reversed current flow across the switch. When output voltage is higher than input voltage, power switch is turned off. The TMI6263BH offers a programmable current limit threshold between 200mA to 2.4A via an external resistor.

## APPLICATIONS

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

## TYPICAL APPILCATION

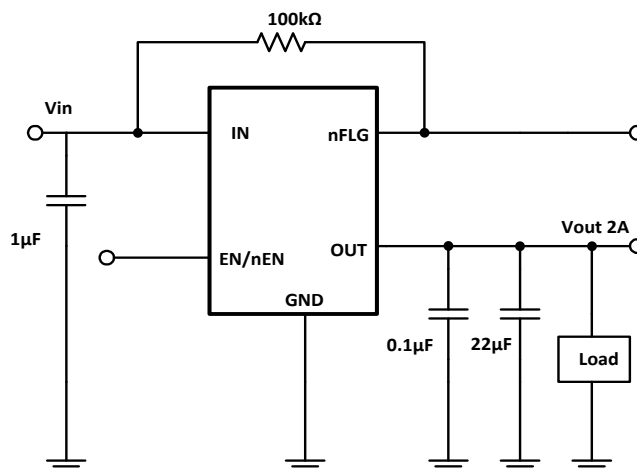


Figure 1. TMI6263AH/AL Application Circuit with EN/nEN and nFLG

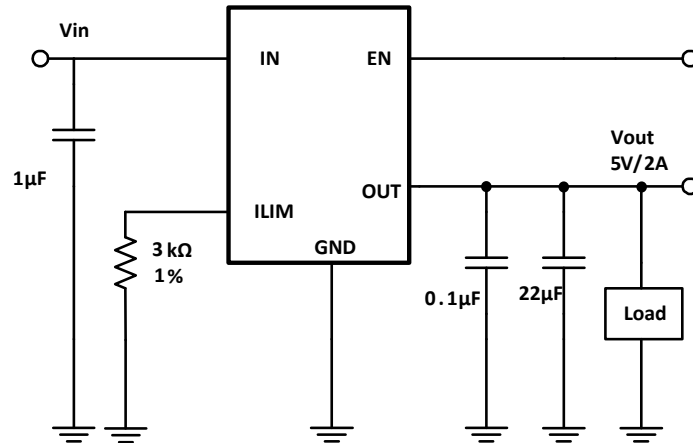


Figure 2. TMI6263BH Application Circuit with Adjustable ILIMIT and EN.

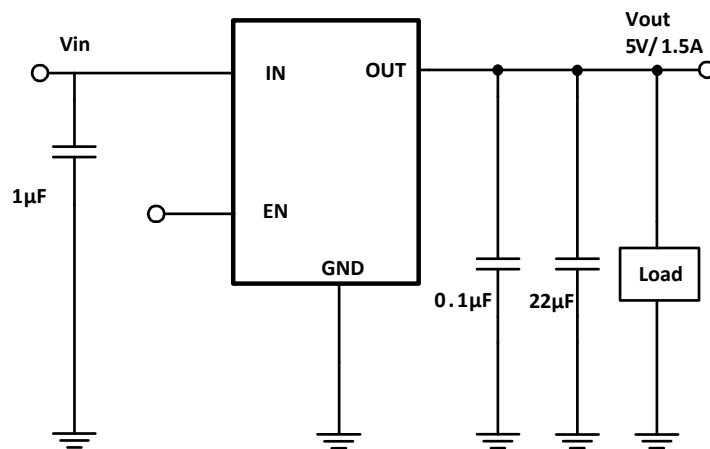
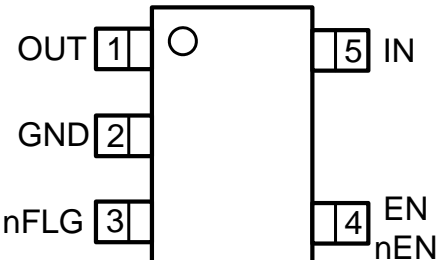
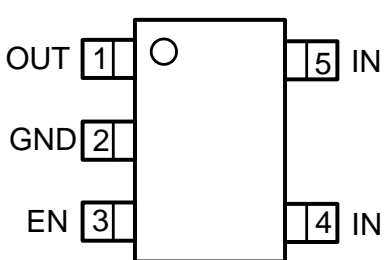
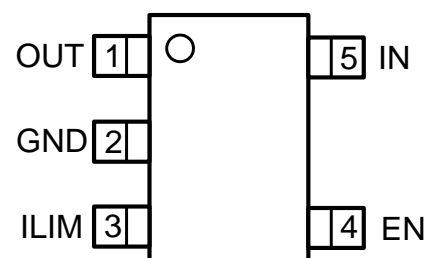


Figure 3. TMI6263CH Application Circuit with EN.

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

Description	Value	Unit
IN Input Voltage Range	-0.3~7	V
All other pins Voltage Range	-0.3 to (VIN+0.3)	V
Junction Temperature	-40~160	°C
Storage Temperature Range	-65~150	°C
Junction-to-ambient Thermal Resistance (Note 2)	260(SOT23-5)	°C/W
Junction-to-case Thermal Resistance (Note 2)	120(SOT23-5)	°C/W
Lead Temperature Soldering, 10Sec	260	°C

**PIN CONFIGURATION**

Package Type	Pin Configurations	Package Type	Pin Configurations
TMI6263AH TMI6263AL SOT23-5		TMI6263CH SOT23-5	
TMI6263BH SOT23-5			

**Top Mark: TXXXXXX (TXXX: Device Code, XXX: Inside code)**

Part Number	Package	Top mark	Quantity/ Reel
TMI6263AH	SOT23-5	T17BXXX	3000
TMI6263AL	SOT23-5	T19AXXX	3000
TMI6263CH	SOT23-5	T17AXXX	3000
TMI6263BH	SOT23-5	T18AXXX	3000

TMI6263AH/TMI6263AL/TMI6263CH/TMI6263BH devices are Pb-free and RoHS compliant.

## PIN FUNCTIONS

TMI6263AH TMI6263AL SOT23-5	TMI6263BH SOT23-5	TMI6263CH SOT23-5	Name	Function
1	1	1	OUT	Switch Output Pin.
2	2	2	GND	Ground Pin
3	-	-	nFLG	Open-Drain Fault Flag Output.
4	4	3	EN/nEN	EN: High Enable. Not floating. nEN: Low Enable. Not floating.
5	5	4,5	IN	Power Input Pin
	3		ILIM	Current limit Set Pin

## ESD RATINGS

Items	Description	Value	Unit
V <sub>ESD</sub>	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 <sub>J</sub>	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
$V_{IN}$	Input Voltage		2.5		5.5	V
$I_Q$	Quiescent Supply Current	$V_{IN}=5.0V$ , $nEN=L$ , No load		30	60	$\mu A$
$I_{SHDN}$	Shutdown Input Current	$V_{IN}=5.0V$ , $nEN=H$ , No load		0.1	1	$\mu A$
$I_{REV}$	Reverse Leakage Current	$V_{OUT}=5.0V$ , $V_{IN}=0V$		2	5	$\mu A$
$V_{UVLO}$	UVLO Threshold	$V_{IN}$ rising		2	2.3	V
$V_{UVLO\_HY}$	UVLO Hysteresis	$V_{IN}$ falling		100		mV
<b>EN/nEN Section</b>						
$V_{EN\_H}/V_{nEN\_H}$	EN/nEN Rising Threshold	$V_{IN}=5.5V$	1.0	1.2	1.5	V
$V_{EN\_H}/V_{nEN\_H}$	EN/nEN Rising Threshold	$V_{IN}=2.5V$	0.6	0.8	1.0	V
$V_{EN\_Hys}/V_{nEN\_Hys}$	EN/nEN Hysteresis			60		mV
$I_{EN}/I_{nEN}$	EN/nEN Input Current	$V_{EN}=5.0V$ or $0V$	-0.5	5	10	$\mu A$
<b>OUT Section</b>						
$I_{LIM}$	Limit Current	$R_{LIM}=6.8k\Omega$ (TMI6263BH)	0.8	1	1.2	A
		TMI6263AH/AL	2.1	2.5	3	A
		TMI6263CH	2	2.4	3	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
$T_{ON\_DELAY}$	EN/nEN On Delay Time	EN Rising to $10\% \cdot V_{OUT}$ $V_{IN}=5V$ , $CL=1\mu F$ , $RL=100\Omega$	100	165	230	$\mu s$
$T_{OFF\_DELAY}$	EN/nEN Off Delay Time	EN Falling to $90\% \cdot V_{OUT}$ $V_{IN}=5V$ , $CL=1\mu F$ , $RL=100\Omega$	4.5	7	10	$\mu s$
$T_{IOS}$	Short Circuit Response time			12		$\mu s$
$R_{DIS}$	OUT Discharge Resistance			10		$\Omega$
<b>FLG(Fault flag) section(TMI6263AH/TMI6363AL)</b>						
$V_{OL}$	Output low voltage	$I_{FLG}=1mA$			180	mV
$I_{FLG}$	Continuous FLG sink				10	mA
$I_{FLG\_LEAK}$		Off-state leakage			1	$\mu A$
$T_{FLG}$	Fault flag deglitch time			2.5		ms
<b>Power Switch</b>						
$R_{DS\_ON}$		$I_{OUT}=1A$		60		m $\Omega$
<b>Thermal Shutdown</b>						
$T_{OTP}$	Thermal Shutdown Threshold			150		$^{\circ}C$
$T_{OTP\_HY}$	Thermal Shutdown 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:  $T_J = T_A + (PD) \times \theta_{JA}$ .

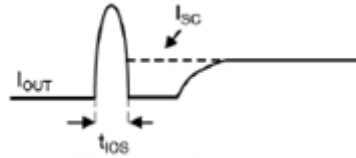


Figure 4. Short Circuits Response time

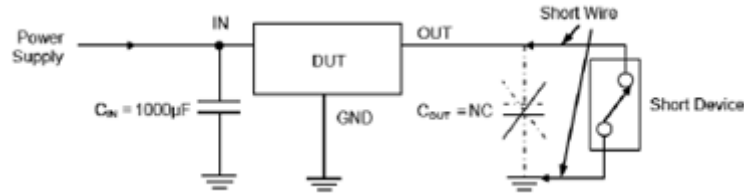


Figure 5. test circuits

**Note:**

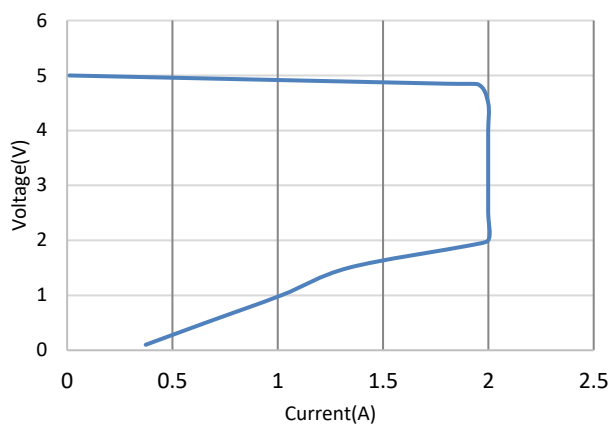
To exactly identify the short circuit characteristic of IC, avoid the test result interfered by parasitic inductor, output capacitor, and contact resistor. It is necessary to follow the recommendation as follows. Please,

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<sub>OUT</sub>).

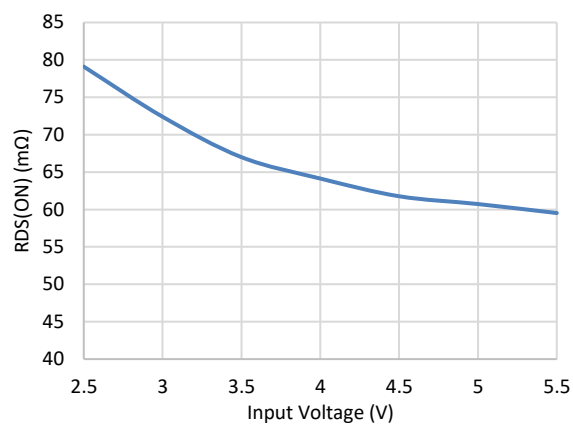
## TYPICAL PERFORMANCE CHARACTERISTICS

(Condition:  $V_{IN}=5V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT}=10\mu F$ , unless otherwise noted.)

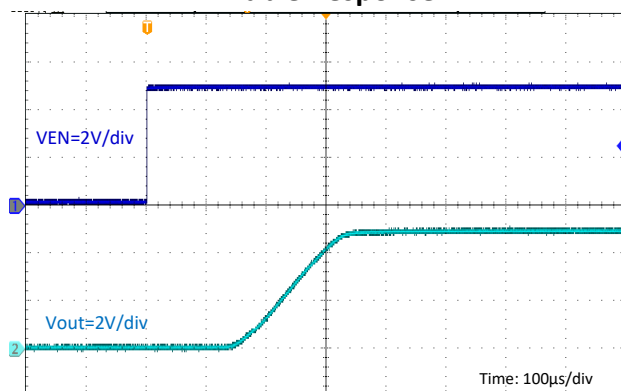
**Output V-I Curve (TMI6263BH)**



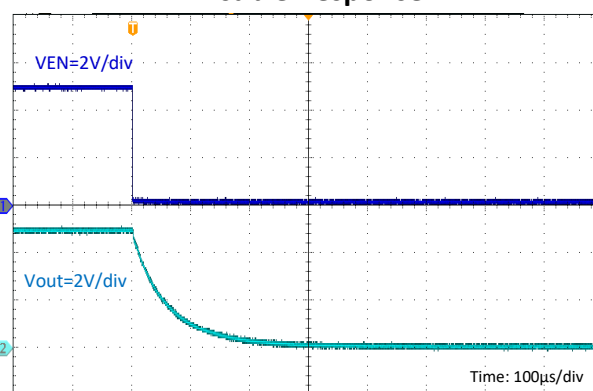
**$R_{DS(ON)}$  VS. Input Voltage**



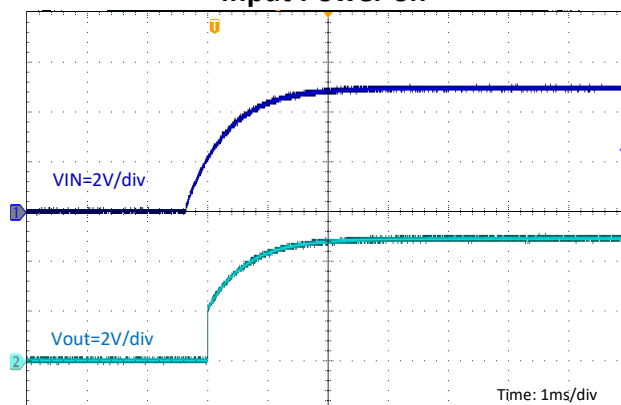
**Enable Response**



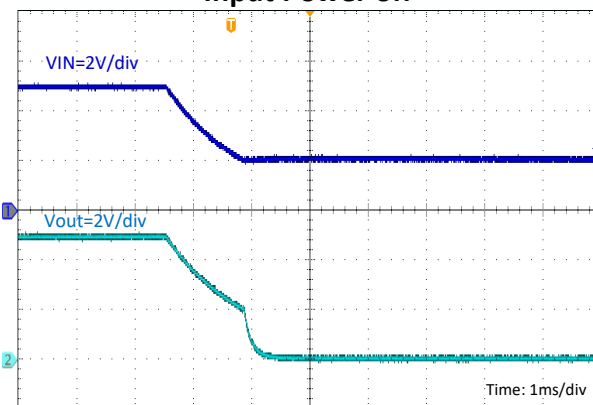
**Disable Response**



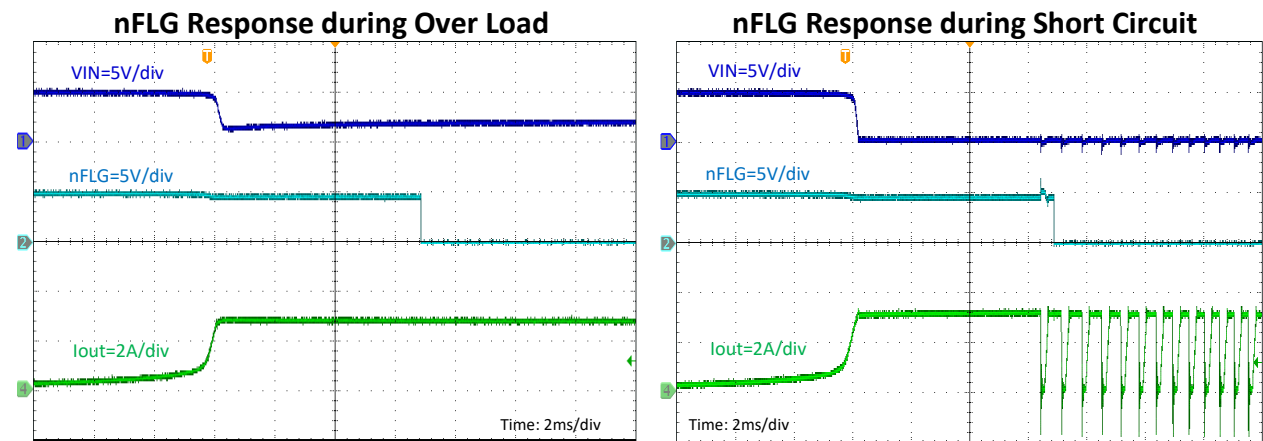
**Input Power on**



**Input Power off**



TYPICAL PERFORMANCE CHARACTERISTICS (continued)



FUNCTIONAL BLOCK DIAGRAM

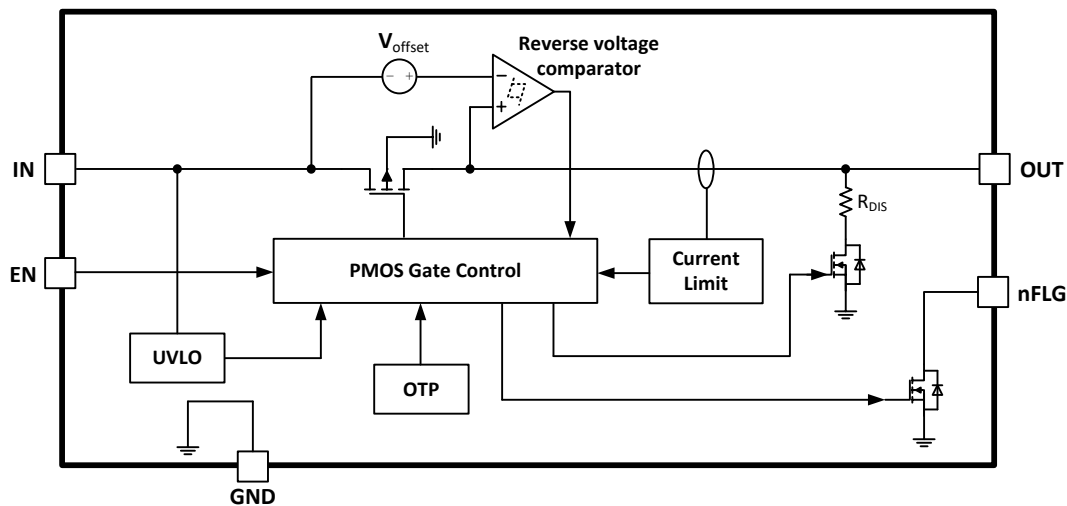


Figure 6. TMI6263AH Block Diagram

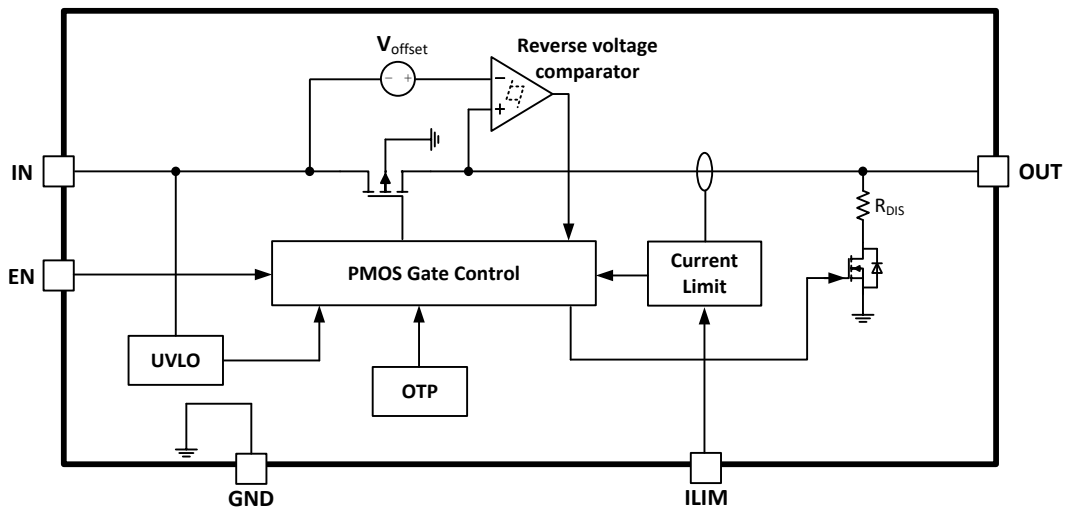


Figure 7. TMI6263BH Block Diagram



## APPLICATION INFORMATION

The TMI6263 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 2.4A 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 TMI6263 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 (TMI6263BH Only)

The over-current threshold is user programmable via an external resistor. The TMI6263BH 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  $2.8k\Omega \leq R_{ILIM} \leq 34k\Omega$  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 overcurrent 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 ( $R_{ILIM}$ ).

$$I_{LIM}(A) = \frac{6.8}{R_{ILIM}(k\Omega)}$$

TMI6263BH ensure that maximum Current Limit threshold is below 3A, it is important to avoid current limiting upstream power supplies causing the input voltage bus to drop

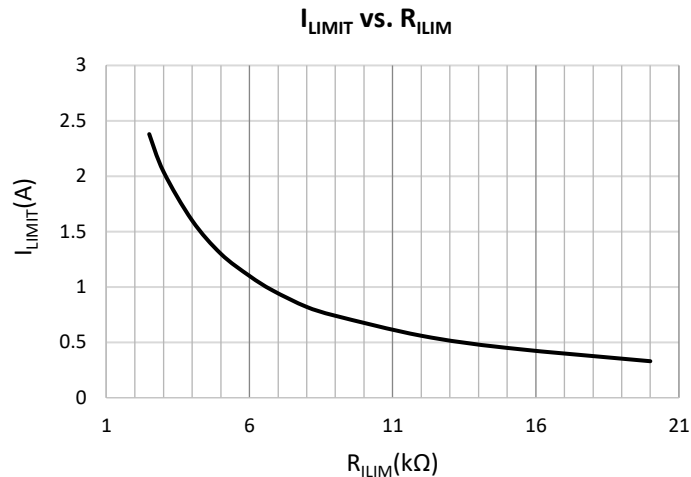


Figure 6.  $I_{LIMIT}$  vs.  $R_{LIMIT}$

### FLG Function (TMI6263AH/AL only)

The nFLG open-drain output is asserted (active low) when an over current condition is encountered after a 7ms 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 when the output reverse-voltage condition is removed.

### Thermal Shutdown

The TMI6263 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/nEN, the Enable Input

EN/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 EN/nEN input pin.

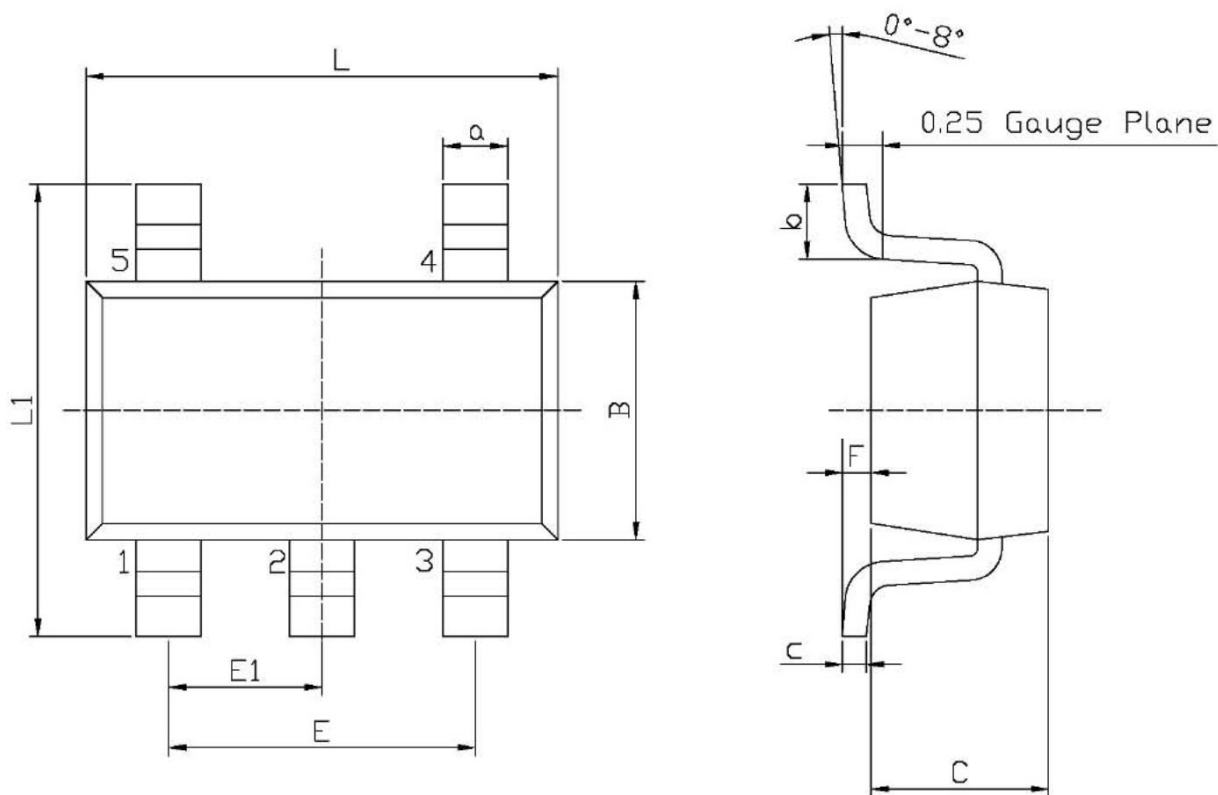
### Layout Consideration

For best performance of the TMI6263, 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	Typ	Max		Min	Typ	Max
L	2.82	2.92	3.02	E1	0.85	0.95	1.05
B	1.50	1.60	1.70	a	0.35	0.425	0.50
C	0.90	1.10	1.30	c	0.10	0.15	0.20
L1	2.60	2.80	3.00	b	0.35	0.45	0.55
E	1.80	1.90	2.00	F	0	0.075	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 DIMENSIONS:**



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