

## 300mA, Low I<sub>Q</sub>, High PSRR LDO Regulators

### FEATURES

- 2.5V to 5.5V Input Voltage Range
- 380mV @300mA Dropout Voltage
- Excellent Transient Response
- Stable with 1μF Ceramic Output Capacitor
- 70dB PSRR at 1kHz
- Low 37μA Quiescent Current
- Low Shutdown Current: <1μA
- Output Accuracy: ±2%
- Fixed Output Voltage: 1.2V~3.3V (0.1V per step)
- Current Limit Protection
- Thermal Shutdown
- Output Auto-Discharge in Shutdown
- RoHS Compliant and 100% Lead (Fb)-Free Halogen-Free

### APPLICATIONS

- Cellular Phones
- Bluetooth portable radios and Accessories
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computer
- PDAs
- Digital still Camera and Video Recorders

### TYPICAL APPLICATION

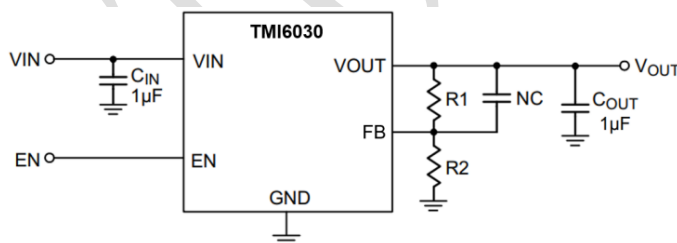


Figure 1. TMI6030 adjustable output Circuit

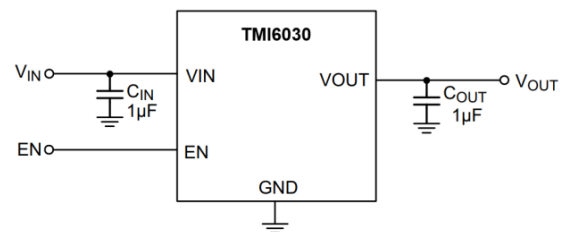


Figure 2. TMI6030 fixed output Circuit

### GENERAL DESCRIPTION

The TMI6030 is a 300mA, low-dropout (LDO) linear regulator with fast transient response and high PSRR. It offers high output accuracy, low dropout voltage and low quiescent current as well as fast start-up time. This regulator is based on a CMOS process.

The TMI6030 is designed to work with low-ESR ceramic capacitors, reducing the amount of the PCB area necessary for power applications. Only a 1μF ceramic output capacitor can make the device stable over the whole load range current (0mA to 300mA).

The output voltage of TMI6030 can be set by an external resistors divider. When the FB pin is connected to an external resistors divider, its output can be adjusted from 1.2V to 5V. Other key features include over-current protection and thermal shutdown. The TMI6030 is packaged in DFN-1×1-4L, SOT23-5 packages.

## BLOCK DIAGRAM

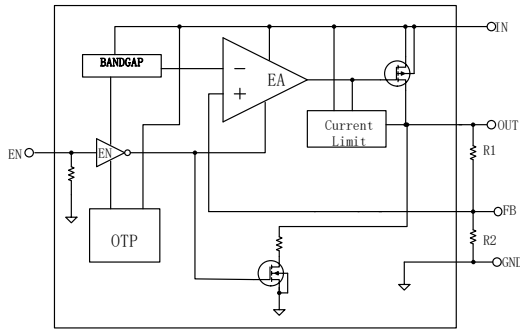


Figure 3. TMI6030 adjustable function block

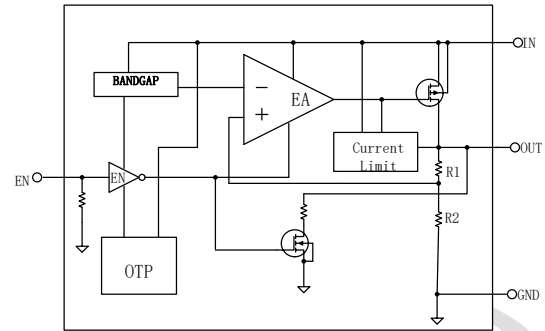


Figure 4. TMI6030 fixed function block

## ABSOLUTE MAXIMUM RATINGS

Description	Value	Unit
VIN, EN Input Voltage Range	-0.3~6	V
All other pins Voltage Range	-0.3 to (VIN+0.3)	V
Junction Temperature	160	°C
Storage Temperature Range	-65~150	°C
Junction-to-ambient Thermal Resistance	250 (SOT23-5) 239 (DFN1x1)	°C/W
Lead Temperature Soldering, 10Sec	260	°C

## ESD RATINGS

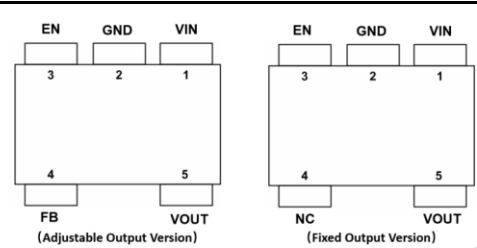
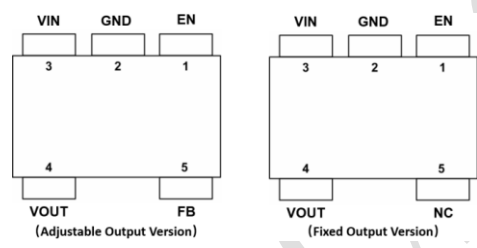
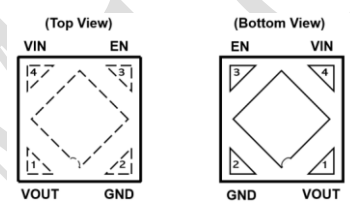
Items	Description	Value	Unit
V <sub>ESD</sub>	Human Body Model for all pins	±2000	V

JEDEC specification JS-001

## RECOMMEND OPERATING CONDITIONS

Items	Description	Min	Max	Unit
Voltage Range	IN	2.5	5.5	V
T <sub>J</sub>	Junction Temperature	-40	125	°C

**PIN CONFIGURATION**

Package Type	Pin Configurations
TMI6030 / SOT23-5	
TMI6030B / SOT23-5	
TMI6030D / DFN1x1	

**PIN FUNCTIONS**

TMI6030	TMI6030B	TMI6030D	Name	Function
1	3	4	VIN	Input Supply of the LDO.
2	2	2	GND	Signal Ground.
3	1	3	EN	Enable Pin. Connect this pin to ground or less than 0.4V to disable the device, connect EN to 1.5V or above to enable the device. This pin should not be floated.
4	5		NC/FB	Feedback Pin for adjustable output version NC for fixed output version
5	4	1	VOUT	Output of the LDO

## ORDER INFORMATION

TMI6030X-XX

Output Voltage

Blank: Adj

12 : 1.2V

18 : 1.8V

25 : 2.5V

28 : 2.8V

30 : 3.0V

33 : 3.3V

.... : Voltage

Package

Blank: SOT23-5

B : SOT23-5

D : DFN1x1

Part Number	Package	Top Mark	Quantity/ Reel
TMI6030	SOT23-5	TAAxxx	3000
TMI6030-12	SOT23-5	TABxxx	3000
TMI6030-18	SOT23-5	TACxxx	3000
TMI6030-25	SOT23-5	TADxxx	3000
TMI6030-28	SOT23-5	TAExxx	3000
TMI6030-30	SOT23-5	TAFxxx	3000
TMI6030-33	SOT23-5	TAGxxx	3000
TMI6030B	SOT23-5	TBAxxx	3000
TMI6030B-12	SOT23-5	TBBxxx	3000
TMI6030B-18	SOT23-5	TBCxxx	3000
TMI6030B-25	SOT23-5	TBDxxx	3000
TMI6030B-28	SOT23-5	TBExxx	3000
TMI6030B-30	SOT23-5	TBFxxx	3000
TMI6030B-33	SOT23-5	TBGxxx	3000
TMI6030D-12	DFN1x1	TDBxxx	3000
TMI6030D-18	DFN1x1	TDCxxx	3000
TMI6030D-28	DFN1x1	TDExxx	3000
TMI6030D-30	DFN1x1	TDFxxx	3000

Top Mark: TxAxxx (TxA: Device Code, xxx: Inside code)

**ELECTRICAL CHARACTERISTICS**
 $T_A=25^{\circ}\text{C}$ ,  $V_{IN}=V_{OUT}+1\text{V}$ , or  $V_{IN}=2.5\text{V}$  for  $V_{OUT}<1.5\text{V}$  unless otherwise specified.

Symbol	Parameter	conditions	Min	Typ	Max	Unit
<b>Input Voltage</b>						
$V_{IN}$	Input Voltage Range		2.5		5.5	V
$I_Q$	Quiescent Current	$V_{EN}=2.5\text{V}$ , $I_{OUT}=0\text{mA}$	35		70	$\mu\text{A}$
$I_{SHDN}$	Shutdown Current	$V_{EN}=0\text{V}$		0.1	1	$\mu\text{A}$
PSRR	Power Supply Ripple Rejection	$V_{IN}=V_{nom}+1V_{P-P}$ , $f=1\text{kHz}$ , $I_{LOAD}=10\text{mA}$		70		dB
<b>Enable</b>						
$V_{ENH}$	Enable High Voltage	All temperature range	1.5			V
$V_{ENL}$	Enable Low Voltage	All temperature range			0.4	V
$I_{EN}$	EN Input Current	$V_{IN}=3.5\text{V}$ , $V_{EN}=3.5\text{V}$ or $0\text{V}$	-1	0.2	1	$\mu\text{A}$
$T_{ST}$	Start-up Time	$V_{IN}=3.5\text{V}$ , $V_{OUT}=2.5\text{V}$		40		$\mu\text{s}$
<b>Output Voltage</b>						
$V_{OUT}$	Output Voltage Accuracy	$V_{IN}=V_{OUT}+1\text{V}$ , $I_{OUT}=10\text{mA}$	-2		+2	%
		$V_{IN}=V_{OUT}+1\text{V}$ , $I_{OUT}=10\text{mA}$ , $T_A=-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	-3		+3	%
$V_{FB}$	FB Pin Voltage		1.176	1.2	1.224	V
$V_{LNR}$	Output Line Regulation	$V_{OUT}+0.5\text{V}<V_{IN}<5.5\text{V}$ , $I_{OUT}=10\text{mA}$		0.01	0.1	%/V
$V_{LDR}$	Output Load Regulation	$1\text{mA}<I_{OUT}<300\text{mA}$ , $V_{IN}=V_{NOM}+1.0\text{V}$		3	6	mV
$V_{DROP}$	Dropout Voltage <sup>(3)</sup>	$I_{OUT}=300\text{mA}$ (Applied for $V_{OUT}\geq 2.3\text{V}$ )		320	350	mV
$I_{OUTMAX}$	Maximum Output Current		300			mA
<b>Protection</b>						
$I_{limit}$	Current Limit		350	470		mA
$R_{AD}$	Resistance of Auto-Discharge			130		$\Omega$
$T_{SD}$	Thermal Shutdown Temperature	No Load, $V_{IN}=V_{EN}=5\text{V}$		155		$^{\circ}\text{C}$
$T_{SDHYS}$	Thermal Shutdown Hysteresis	No Load, $V_{IN}=V_{EN}=5\text{V}$		30		$^{\circ}\text{C}$

Note (3): Dropout is defined as  $V_{IN}-V_{OUT}$  when  $V_{OUT}$  is 2% below the value of  $V_{OUT}$  for  $V_{IN}=V_{OUT}+0.5\text{V}$ .

**TYPICAL PERFORMANCE CHARACTERISTICS**

**Load Transient**

Vin=3.8V, Vo=2.8V, Io=10mA to 300mA

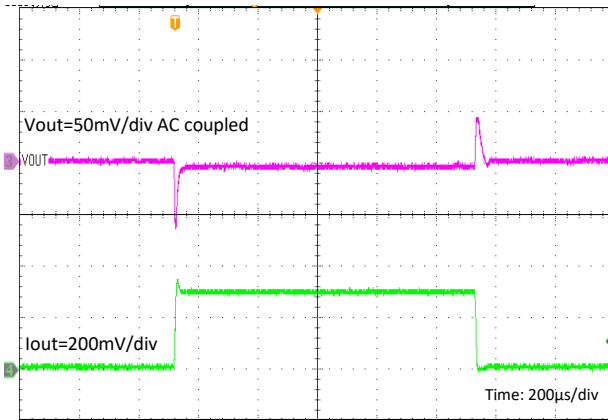


Figure 5. Load Transient

**Line Transient**

Vo=2.8V, Io=10mA, Vin=3.3V to 4.3V

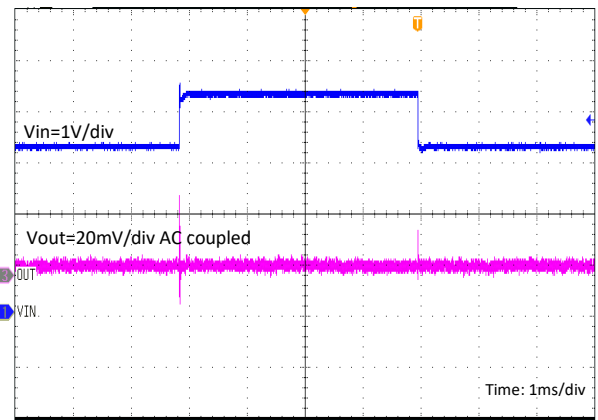


Figure 6. Line Transient

**Over Temperature Protection**

Vin=3.8V, Vo=2.8V, Ro=5.1Ω

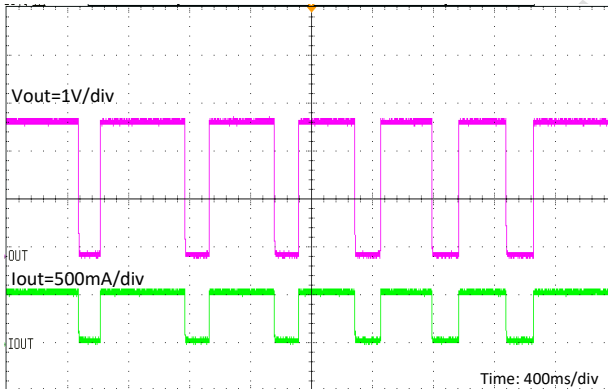


Figure 7. Over Temperature Protection

**Dropout vs. Iout**

Vin=3.8V, Ta=25°C

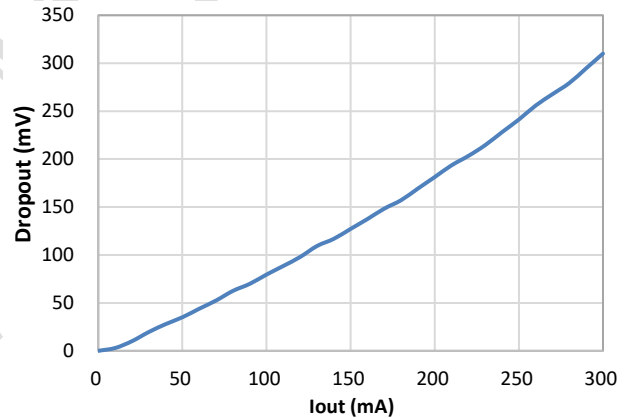


Figure 8. Dropout vs. Iout

**Over Current Protection**

Vin=3.8V, Vo=2.8V, Ta=25°C

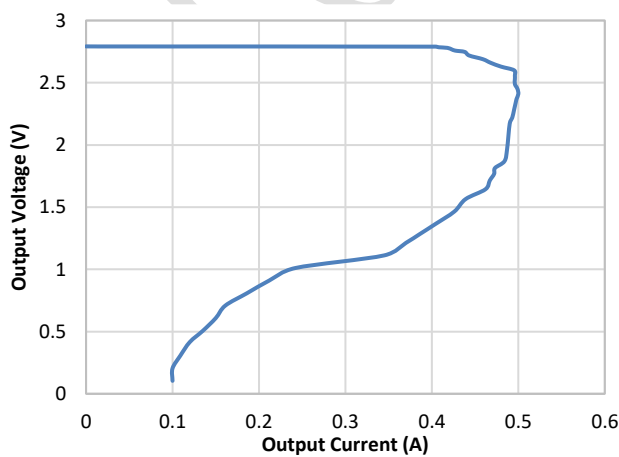


Figure 9. Over Current Protection

**PSRR vs. Frequency**

Vin=3.8V, Vo=2.8V, Io=10mA, Ta=25°C

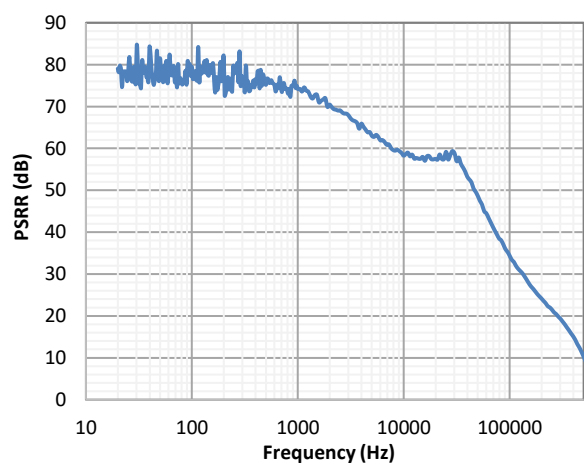


Figure 10. PSRR vs. Frequency

## Detailed Function Description

The TMI6030 is a high output current, low dropout linear regulator with fast transient response and high PSRR. It offers high output accuracy, low quiescent current and fast start-up time. It is designed to work with low-ESR ceramic capacitor, reducing the amount of the PCB area. Only a 1 $\mu$ F ceramic output capacitor can make the device stable over the whole load range.

As shown in the function block diagram, the TMI6030 is composed of the bandgap reference voltage, the error amplifier, P-channel MOSFET pass transistor, external resistor divider and some additional protection circuits. The reference voltage, connected to the cathode terminal of the error amplifier, compares with the feedback voltage to regulate the output voltage to make it constant over the whole load current range. If the feedback voltage is lower than the reference voltage, the pass transistor gate is pulled lower to increase its conductivity. This allows more current to flow to the output and increase the output voltage. If the feedback voltage is higher than the reference voltage, the pass transistor gate is pulled higher to decrease its conductivity. This allows less current to flow to the output and decrease the output voltage. The feedback point is the output of the external resistor divider connected to the V<sub>OUT</sub> pin.

### Enable/Shutdown

The TMI6030 is disabled when the EN pin is connected to ground or the voltage less than 0.4V, and the quiescent current is less than 1 $\mu$ A. Connect EN pin to 1.5V or higher voltage to enable the device. This pin cannot be floated.

### Output Auto Discharge

When the regulator is disabled, an internal 130 $\Omega$  resistor is connected between V<sub>OUT</sub> and GND to discharge output capacitor C<sub>OUT</sub>.

### Current Limit

The TMI6030 includes a current limit circuit to monitor the gate voltage of the pass transistor to limit the output current. When the output current is higher than the over-current limit, the circuit will clamp the gate voltage of the pass transistor to limit the output current. The typical output current limit is 450mA.

### Adjustable Output Voltage

TMI6030 has a wide output voltage range. The output voltage is programmed by an external resistor divider as shown in Figure 1. The output can be calculated by the following equation:

$$V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) \times V_{REF} \quad (\text{EQ.1})$$

Where V<sub>REF</sub> is the internal reference voltage, which is 1.2V in TMI6030.

### Short Circuit Protection

When V<sub>OUT</sub> pin is short-circuit to GND, short circuit protection will be triggered and clamp the output current to approximately 90mA. This feature protects the regulator from over current condition and damage due to overheating.

## Thermal Shutdown

The TMI6030 monitors internal temperature. When the junction temperature exceeds 155°C, the over temperature protection (OTP) circuit turn off the pass transistor until the device is cooled down by 30°C. Then the pass transistor resumes. For continue operation, do not exceed absolute maximum junction temperature.

## Application Information

### External capacitor

The TMI6030 requires external capacitor for stability. It is specifically designed to work with low-ESR capacitors requiring minimum PCB area. Place the external capacitors as close as possible to the device.

### Input capacitor

A 1 $\mu$ F or higher capacitance value ceramic capacitor is required between the VIN pin and the GND pin. Place it as close as possible to the device. There are no requirements for the ESR on the input capacitor, but the tolerance and temperature coefficient must be capacitance is 1 $\mu$ F over the whole operating temperature range.

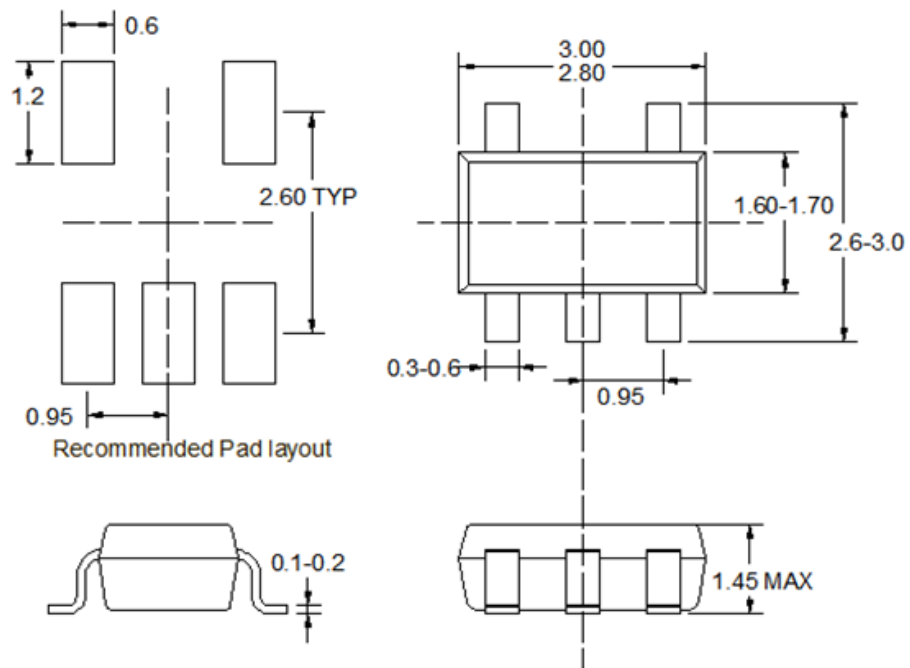
### Output capacitor

An output capacitor ( $C_{OUT}$ ) is needed to improve transient response and maintain stability. The TMI6030 is stable with very small ceramic output capacitors. A 1 $\mu$ F to 10 $\mu$ F capacitor is suitable for the most TMI6030 applications.

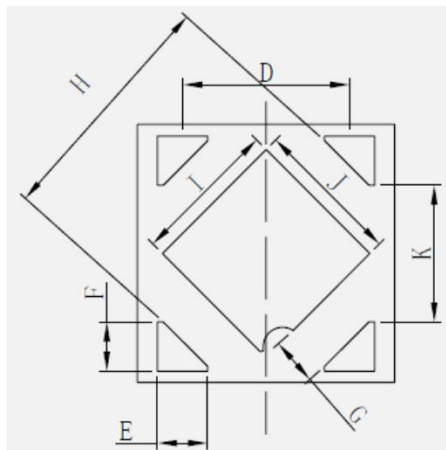


**PACKAGE INFORMATION**

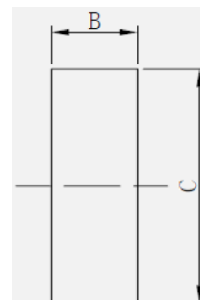
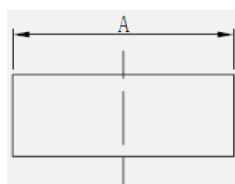
SOT23-5



DFN1x1-4



Dimensions In Millimeterer			
Symbol	MIN	TYP	MAX
A	0.950	1.000	1.050
B	0.320	0.370	0.420
C	0.950	1.000	1.050
D	0.600	0.650	0.700
E	0.145	0.195	0.245
F	0.140	0.190	0.240
G	0.134	0.184	0.234
H	0.890	0.940	0.990
I	0.520	0.570	0.620
J	0.520	0.570	0.620
K	0.480	0.530	0.580



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