TC1017

150 mA, Tiny CMOS LDO With Shutdown

Features

- Space-saving 5-Pin SC-70 and SOT-23 Packages
- Extremely Low Operating Current for Longer Battery Life: 53 µA (typ.)
- Very Low Dropout Voltage
- Rated 150 mA Output Current
- Requires Only 1 µF Ceramic Output Capacitance
- High Output Voltage Accuracy: ±0.5% (typ.)
- 10 µs (typ.) Wake-Up Time from $\overline{SHDN}$
- Power-Saving Shutdown Mode: 0.05 µA (typ.)
- Overcurrent and Overtemperature Protection
- Pin-Compatible Upgrade for Bipolar Regulators

Applications

- Cellular/GSM/PHS Phones
- Battery-Operated Systems
- Portable Computers
- Medical Instruments
- Electronic Games
- Pagers

General Description

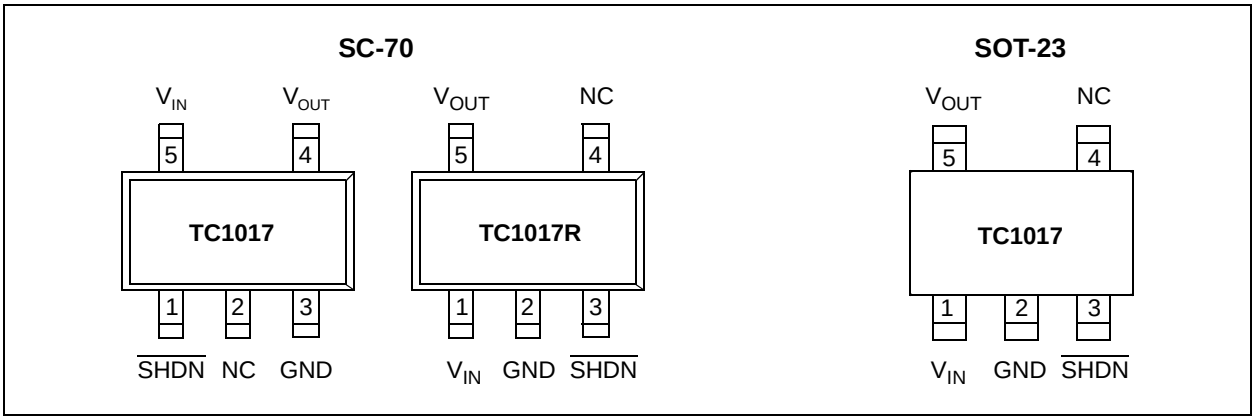
The TC1017 is a high-accuracy (typically ±0.5%) CMOS upgrade for bipolar Low Dropout regulators (LDOs). It is offered in a SC-70 or SOT-23 package. The SC-70 package represents a 50% footprint reduction versus the popular SOT-23 package and is offered in two pinouts to make board layout easier.

Developed specifically for battery-powered systems, the TC1017's CMOS construction consumes only 53 µA typical supply current over the entire 150 mA operating load range. This can be as much as 60 times less than the quiescent operating current consumed by bipolar LDOs.

The TC1017 is designed to be stable, over the entire input voltage and output current range, with low-value (1 µF) ceramic or tantalum capacitors. This helps to reduce board space and save cost. Additional integrated features, such as shutdown, overcurrent and overtemperature protection, further reduce the board space and cost of the entire voltage-regulating application.

Key performance parameters for the TC1017 include low dropout voltage (285 mV typical at 150 mA output current), low supply current while shutdown (0.05 µA typical) and fast stable response to sudden input voltage and load changes.

Package Types



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage 6.5V

Power Dissipation ..... Internally Limited (**Note 7**)

Maximum Voltage On Any Pin .....V_{IN} + 0.3V to -0.3V

† **Notice:** Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

PIN FUNCTION TABLE

Name	Function
$\overline{SHDN}$	Shutdown control input.
NC	No connect
GND	Ground terminal
V_{OUT}	Regulated voltage output
V_{IN}	Unregulated supply input

ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, $V_{IN} = V_R + 1V$, I_L = 100 µA, C_L = 1.0 µF, $\overline{SHDN} > V_{IH}$, T_A = +25°C
Boldface type specifications apply for junction temperatures of –40°C to +125°C.

Parameter	Sym	Min	Typ	Max	Units	Test Conditions
Input Operating Voltage	V_{IN}	**2.7**	—	**6.0**	V	**Note 1**
Maximum Output Current	I_{OUTMAX}	**150**	—	—	mA	
Output Voltage	V_{OUT}	**V_R – 2.5%**	V_R ±0.5%	**V_R + 2.5%**	V	**Note 2**
V_{OUT} Temperature Coefficient	TCV_{OUT}	—	**40**	—	ppm/°C	**Note 3**
Line Regulation	$\|(\Delta V_{OUT}/\Delta V_{IN})\| / V_R$	—	0.04	**0.2**	%/V	$(V_R + 1V) < V_{IN} < 6V$
Load Regulation **(Note 4)**	$\|\Delta V_{OUT}\| / V_R$	—	0.38	**1.5**	%	I_L = 0.1 mA to I_{OUTMAX}
Dropout Voltage **(Note 5)**	$V_{IN} – V_{OUT}$	— — — —	2 90 180 285	**—** **200** **350** **500**	mV	I_L = 100 µA I_L = 50 mA I_L = 100 mA I_L = 150 mA
Supply Current	I_{IN}	—	53	**90**	µA	$\overline{SHDN} = V_{IH}$, I_L = 0
Shutdown Supply Current	I_{INSD}	—	0.05	2	µA	$\overline{SHDN}$ = 0V
Power Supply Rejection Ratio	PSRR	—	58	—	dB	f =1 kHz, I_L = 50 mA
Wake-Up Time (from Shutdown Mode)	t_{WK}	—	10	—	µs	V_{IN} = 5V, I_L = 60 mA, $C_{IN} = C_{OUT}$ =1 µF, f = 100 Hz

Note 1: The minimum V_{IN} has to meet two conditions: $V_{IN} \geq 2.7V$ and $V_{IN} \geq (V_R + 2.5\%) + V_{DROPOUT}$.

2: V_R is the regulator voltage setting. For example: V_R = 1.8V, 2.7V, 2.8V, 3.0V.

3:

$$TCV_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$$

4: Regulation is measured at a constant junction temperature using low duty-cycle pulse testing. Load regulation is tested over a load range from 0.1 mA to the maximum specified output current. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

5: Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value at a 1V differential.

6: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a current pulse equal to I_{LMAX} at V_{IN} = 6V for t = 10 msec.

7: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction-to-air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown. Please see **Section 5.1 "Thermal Shutdown"**, for more details.

8: Output current is limited to 120 mA (typ) when V_{OUT} is less than 0.5V due to a load fault or short-circuit condition.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise noted, $V_{IN} = V_R + 1V$, $I_L = 100\ \mu A$, $C_L = 1.0\ \mu F$, $\overline{SHDN} > V_{IH}$, $T_A = +25°C$
Boldface type specifications apply for junction temperatures of –40°C to +125°C.

Parameter	Sym	Min	Typ	Max	Units	Test Conditions
Settling Time (from Shutdown mode)	t_S	—	32	—	µs	V_{IN} = 5V, I_L = 60 mA, C_{IN} = 1 µF, C_{OUT} = 1 µF, f = 100 Hz
Output Short-Circuit Current	I_{OUTSC}	—	120	—	mA	V_{OUT} = 0V, Average Current **(Note 8)**
Thermal Regulation	V_{OUT}/P_D	—	0.04	—	V/W	**Notes 6, 7**
Thermal Shutdown Die Temperature	T_{SD}	—	160	—	°C	
Thermal Shutdown Hysteresis	ΔT_{SD}	—	10	—	°C	
Output Noise	eN	—	800	—	nV/√Hz	f = 10 kHz
$\overline{SHDN}$ Input High Threshold	V_{IH}	**45**	—	—	%V_{IN}	V_{IN} = 2.7V to 6.0V
$\overline{SHDN}$ Input Low Threshold	V_{IL}	—	—	**15**	%V_{IN}	V_{IN} = 2.7V to 6.0V

Note 1: The minimum V_{IN} has to meet two conditions: $V_{IN} \geq 2.7V$ and $V_{IN} \geq (V_R + 2.5\%) + V_{DROPOUT}$.

2: V_R is the regulator voltage setting. For example: V_R = 1.8V, 2.7V, 2.8V, 3.0V.

3:

$$TCV_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$$

4: Regulation is measured at a constant junction temperature using low duty-cycle pulse testing. Load regulation is tested over a load range from 0.1 mA to the maximum specified output current. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

5: Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value at a 1V differential.

6: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a current pulse equal to I_{LMAX} at V_{IN} = 6V for t = 10 msec.

7: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction-to-air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown. Please see **Section 5.1 "Thermal Shutdown"**, for more details.

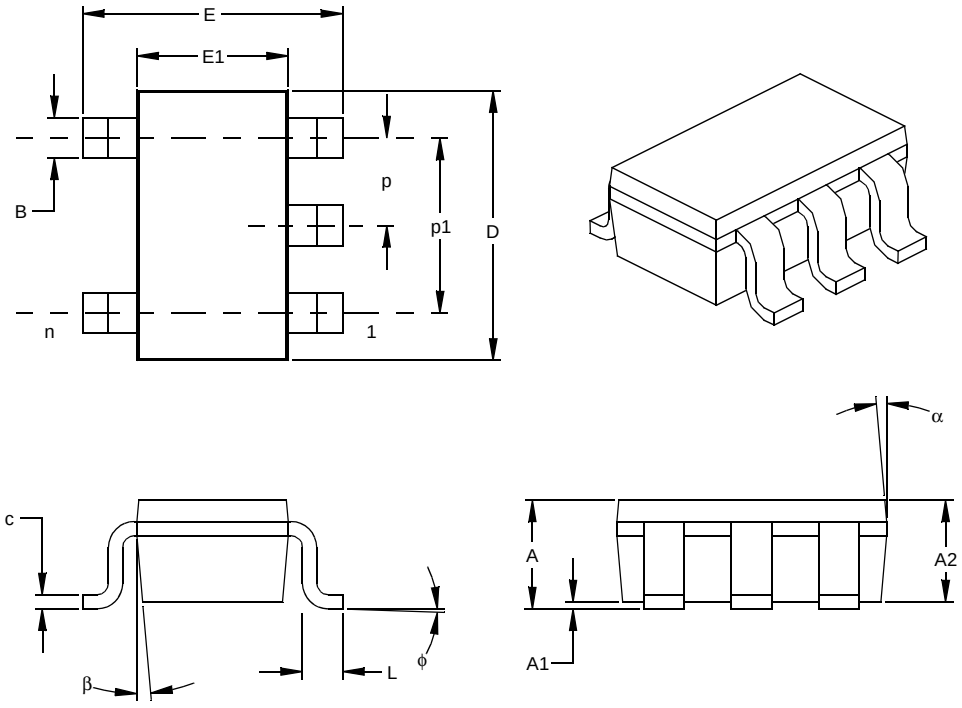
8: Output current is limited to 120 mA (typ) when V_{OUT} is less than 0.5V due to a load fault or short-circuit condition.

TEMPERATURE CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, V_{DD} = +2.7V to +6.0V and V_{SS} = GND.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Temperature Ranges						
Specified Temperature Range	T_A	-40	—	+125	°C	Extended Temperature parts
Operating Temperature Range	T_A	-40	—	+125	°C	
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances3						
Thermal Resistance, 5L-SOT23	θ_{JA}	—	255	—	°C/W	
Thermal Resistance, 5L-SC-70	θ_{JA}	—	450	—	°C/W	

5-Lead Plastic Small Outline Transistor (OT) (SOT-23)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		5			5	
Pitch	p		.038			0.95	
Outside lead pitch (basic)	p1		.075			1.90	
Overall Height	A	.035	.046	.057	0.90	1.18	1.45
Molded Package Thickness	A2	.035	.043	.051	0.90	1.10	1.30
Standoff §	A1	.000	.003	.006	0.00	0.08	0.15
Overall Width	E	.102	.110	.118	2.60	2.80	3.00
Molded Package Width	E1	.059	.064	.069	1.50	1.63	1.75
Overall Length	D	.110	.116	.122	2.80	2.95	3.10
Foot Length	L	.014	.018	.022	0.35	0.45	0.55
Foot Angle	ϕ	0	5	10	0	5	10
Lead Thickness	c	.004	.006	.008	0.09	0.15	0.20
Lead Width	B	.014	.017	.020	0.35	0.43	0.50
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.
JEDEC Equivalent: MO-178
Drawing No. C04-091

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X.XX	X	XXXX
Device	Voltage Options	Temperature Range	Package

Device:	TC1017: 150 mA Tiny CMOS LDO with Shutdown TC1017R:150 mA Tiny CMOS LDO with Shutdown (SC-70 only)	
Voltage Options:* (Standard)	1.8V 1.85V 2.5V 2.6V 2.7V 2.8V 2.85V 2.9V 3.0V 3.2V 3.3V 4.0V	 SC-70 only SC-70 only
	* Other voltage options available. Please contact your local Microchip sales office for details.	
Temperature Range:	V = -40°C to +125°C	
Package:	LTTR = 5-pin SC-70 (Tape and Reel) CTTR = 5-pin SOT-23 (Tape and Reel)	

Examples:

a) TC1017-1.8VLTTR: 150 mA, Tiny CMOS LDO with Shutdown, SC-70 package.

b) TC1017R-1.8VLTTR:150mA, Tiny CMOS LDO with Shutdown, SC-70R package.

c) TC1017-2.6VCTTR: 150 mA, Tiny CMOS LDO with Shutdown, SOT-23 package.

d) TC1017-2.7VLTTR: 150 mA, Tiny CMOS LDO with Shutdown, SC-70 package.

e) TC1017-2.8VCTTR: 150 mA, Tiny CMOS LDO with Shutdown, SOT-23 package.

f) TC1017-2.85VLTTR:150 mA, Tiny CMOS LDO with Shutdown, SC-70 package.

g) TC1017-2.9VCTTR: 150 mA, Tiny CMOS LDO with Shutdown, SOT-23 package.

h) TC1017-3.0VLTTR: 150 mA, Tiny CMOS LDO with Shutdown, SC-70 package.

i) TC1017-3.3VCTTR: 150 mA, Tiny CMOS LDO with Shutdown, SOT-23 package.

j) TC1017-4.0VLTTR: 150 mA, Tiny CMOS LDO with Shutdown, SC-70 package.