TC2117

800mA Fixed Low Dropout Positive Regulator

Features

- Fixed Output Voltages: 1.8V, 2.5V, 3.0V, 3.3V
- Very Low Dropout Voltage
- Rated 800mA Output Current
- High Output Voltage Accuracy
- Standard or Custom Output Voltages
- Over-Current and Over-Temperature Protection
- Space Saving SOT-223 Package

Applications

- 5V to 3.3V Linear Regulator
- Portable Computers
- Instrumentation
- Battery Operated Systems
- Linear Post-Regulator for SMPS
- Core Voltage Supply for FPGAs, PLDs, CPUs, DSPs

Device Selection Table

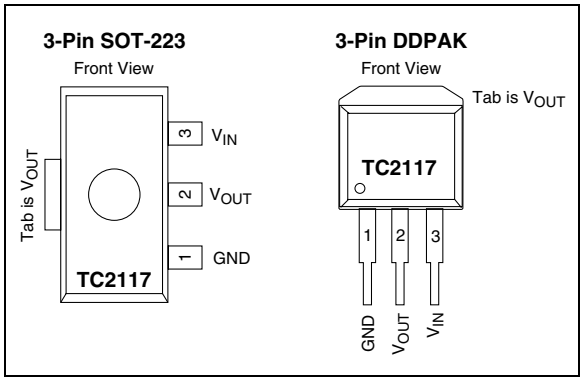
Part Number	Package	Junction Temperature Range
TC2117-xxVDB	3-Pin SOT-223	-40°C to +125°C
TC2117-xxVEB	3-Pin DDPAK	-40°C to +125°C

Note: xx indicates output voltages.

Available Output Voltages: 1.8, 2.5, 3.0, 3.3.

Other output voltages are available. Please contact Microchip Technology Inc. for details.

Package Type

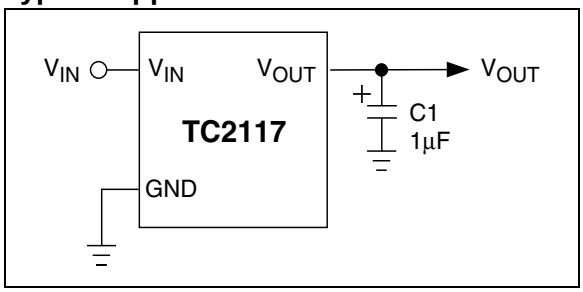


General Description

The TC2117 is a fixed, high accuracy (typically ±0.5%) CMOS low dropout regulator. Designed specifically for battery operated systems, the TC2117's CMOS construction eliminates wasted ground current, significantly extending battery life. Total supply current is typically 80µA at full load (20 to 60 times lower than in bipolar regulators).

TC2117 key features include ultra low noise, very low dropout voltage (typically 450mV at full load), and fast response to step changes in load. The TC2117 incorporates both over-temperature and over-current protection. The TC2117 is stable with an output capacitor of only 1µF and has a maximum output current of 800mA. This device is available in 3-Pin SOT-223, and 3-Pin DDPAK packages.

Typical Application



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1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Input Voltage 6.5V
Output Voltage..... (V_{SS} – 0.3) to (V_{IN} + 0.3V)
Power Dissipation.....Internally Limited **(Note 7)**
Maximum Voltage on Any Pin .....V_{IN} +0.3V to -0.3V
Operating Temperature .....-40°C < T_J < +125°C
Storage temperature .....-65°C to +150°C

*Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

TC2117 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: $V_{IN} = V_R + 1.5V$ **(Note 1)**, I_L = 100µA, C_L = 3.3µF, T_A = 25°C, unless otherwise specified. **Boldface** type specifications apply for junction temperatures of -40°C to +125°C.

Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V_{IN}	Input Operating Voltage	**2.7**	—	**6.0**	V	**(Note 2)**
I_{OUTMAX}	Maximum Output Current	**800**	—	—	mA	
V_{OUT}	Output Voltage	**V_R – 2.5%** **V_R – 2%**	V_R – 0.5% V_R – 0.5%	**V_R + 2.5%** **V_R + 3%**	V	$V_R \geq 2.5V$ V_R = 1.8V
$\Delta V_{OUT}/\Delta T$	V_{OUT} Temperature Coefficient	—	40	—	ppm/°C	**(Note 3)**
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	—	0.007	**0.35**	%	(V_R + 1V) V_{IN} 6V
$\Delta V_{OUT}/V_{OUT}$	Load Regulation	**-0.01**	0.002	0	%/mA	I_L = 0.1mA to I_{OUTMAX} **(Note 4)**
V_{IN} - V_{OUT}	Dropout Voltage	— — — — — — —	20 60 190 340 600 700 890	**30** **160** **480** **800** **1300** **1000** **1400**	mV	$V_R \geq 2.5V$, I_L = 100 µA I_L = 100 µA I_L = 300 µA I_L = 500 µA I_L = 800 µA V_R = 1.8V, I_L = 500 µA I_L = 800 µA **(Note 5)**
I_{DD}	Supply Current	—	80	**130**	µA	I_L = 0
PSRR	Power Supply Rejection Ratio	—	55	—	dB	F ≤ 120Hz
I_{OUTSC}	Output Short Circuit Current	—	1200	—	mA	V_{OUT} = 0V
$\Delta V_{OUT}/\Delta P_D$	Thermal Regulation	—	0.04	—	V/W	**(Note 6)**
eN	Output Noise	—	300	—	nV/√Hz	I_L = 100mA, F = 10kHz

Note 1: V_R is the regulator output voltage setting.

2: The minimum V_{IN} has to justify the conditions: $V_{IN} \geq V_R + V_{DROPOUT}$ and $V_{IN} \geq 2.7V$ for I_L = 0.1mA to I_{OUTMAX}.

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

4: Regulation is measured at a constant junction temperature using low duty cycle pulse testing. Load regulation is tested over a load range from 0.1mA 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, measured at a 1.5V 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 = 10msec.

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 **Thermal Considerations** section of this data sheet for more details.

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2.0 PIN DESCRIPTIONS

The descriptions for the pins are listed in Table 2-1.

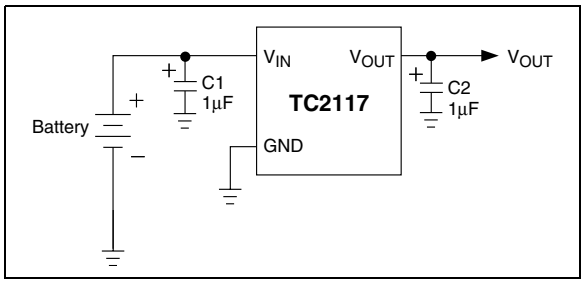
TABLE 2-1: PIN FUNCTION TABLE

Pin No. (3-Pin SOT-223) (3-Pin DDPAK)	Symbol	Description
1	GND	Connect this pin to the circuit ground.
2	V_{OUT}	Regulated output voltage.
3	V_{IN}	Unregulated Input voltage.

3.0 DETAILED DESCRIPTION

The TC2117 is a precision, positive output LDO. Unlike bipolar regulators, the TC2117 supply current does not increase proportionally with load current. In addition, V_{OUT} remains stable and within regulation over the entire 0mA to 800mA operating load range.

FIGURE 3-1: TYPICAL APPLICATION CIRCUIT



3.1 Output Capacitor

A 1µF (min) capacitor from V_{OUT} to ground is required. The output capacitor should have an effective series resistance of 0.2Ω to 10Ω. A 1µF capacitor should be connected from V_{IN} to GND if there is more than 10 inches of wire between the regulator and the AC filter capacitor, or if a battery is used as the power source. Aluminum electrolytic or tantalum capacitor types can be used. (Since many aluminum electrolytic capacitors freeze at approximately -30°C, solid tantalums are recommended for applications operating below -25°C.) When operating from sources other than batteries, supply noise rejection and transient response can be improved by increasing the value of the input and output capacitors and employing passive filtering techniques.

3.2 Thermal Considerations

3.2.1 THERMAL SHUTDOWN

Integrated thermal protection circuitry shuts the regulator off when die temperature exceeds 160°C. The regulator remains off until the die temperature drops to approximately 150°C.

3.2.2 POWER DISSIPATION

The amount of power the regulator dissipates is primarily a function of input and output voltage, and output current. The following equation is used to calculate worst case actual power dissipation:

EQUATION 3-1:

$$P_D \approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX}$$

Where:

P_D = Worst case actual power dissipation

V_{INMAX} = Maximum voltage on V_{IN}

V_{OUTMIN} = Maximum regulator output voltage

$I_{LOADMAX}$ = Maximum output (load) current

The maximum *allowable* power dissipation (Equation 3-2) is a function of the maximum ambient temperature (T_{AMAX}), the maximum allowable die temperature (125°C) and the thermal resistance from junction-to-air (θ_{JA}).

EQUATION 3-2:

$$P_{DMAX} = \frac{T_{JMAX} - T_{AMAX}}{\theta_{JA}}$$

Where all terms are previously defined.

Table 3-1 shows various values of θ_{JA} for the TC2117 mounted on a 1/16 inch, 2-layer PCB with 1 oz. copper foil.

TABLE 3-1: THERMAL RESISTANCE GUIDELINES FOR TC2117 IN 3-PIN SOT-223 PACKAGE

Copper Area (Topside)*	Copper Area (Backside)	Board Area	Thermal Resistance
2500 sq mm	2500 sq mm	2500 sq mm	45°C/W
1000 sq mm	2500 sq mm	2500 sq mm	45°C/W
225 sq mm	2500 sq mm	2500 sq mm	53°C/W
100 sq mm	2500 sq mm	2500 sq mm	59°C/W
1000 sq mm	1000 sq mm	1000 sq mm	52°C/W
1000 sq mm	0 sq mm	1000 sq mm	55°C/W

*Tab of device attached to topside copper.

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TABLE 3-2: THERMAL RESISTANCE GUIDELINES FOR TC2117 IN 3-PIN DDPAK PACKAGE

Copper Area (Topside)*	Copper Area (Backside)	Board Area	Thermal Resistance (θ_{JA})
2500 sq mm	2500 sq mm	2500 sq mm	25°C/W
1000 sq mm	2500 sq mm	2500 sq mm	27°C/W
125 sq mm	2500 sq mm	2500 sq mm	35°C/W

*Tab of device attached to topside copper.

Equation 3-1 can be used in conjunction with Equation 3-2 to ensure regulator thermal operation is within limits. For example:

Given:
$V_{INMAX} = 5.0V \pm 5\%$
$V_{OUTMIN} = 3.3V \pm 0.5\%$
$I_{LOADMAX} = 400mA$
$T_{JMAX} = 125°C$
$T_{AMAX} = 55°C$
$\theta_{JA} = 59°C/W$ (SOT-223)

Find:
1. Actual power dissipation
2. Maximum allowable dissipation

Actual power dissipation:

$$P_D \approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX}$$
$$= [(5.0 \times 1.05) - (3.3 \times .995)]\ 400 \times 10^{-3}$$
$$= 786mW$$

Maximum allowable power dissipation:

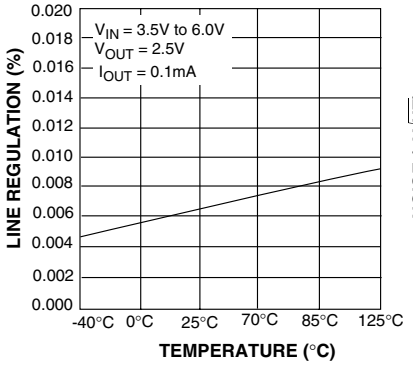
$$P_{DMAX} = \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}}$$
$$= \frac{(125 - 55)}{59}$$
$$= 1.186mW$$

In this example, the TC2117 dissipates a maximum of only 786mW; below the allowable limit of 1.186mW. In a similar manner, Equation 3-1 and Equation 3-2 can be used to calculate maximum current and/or input voltage limits.

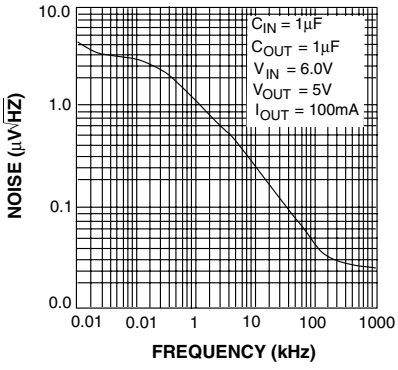
4.0 TYPICAL CHARACTERISTICS

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

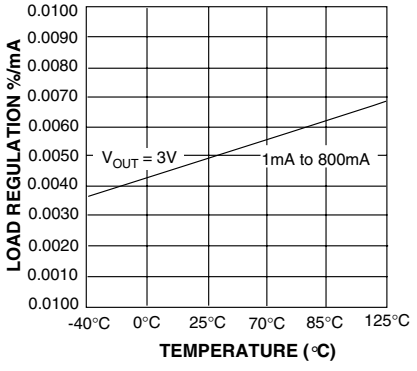
Line Regulation vs. Temperature



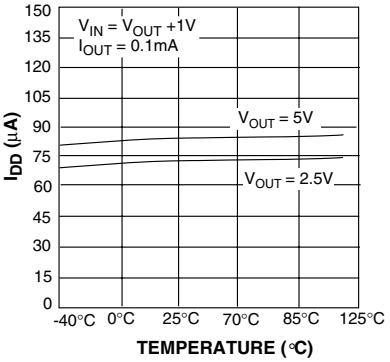
Output Noise vs. Frequency



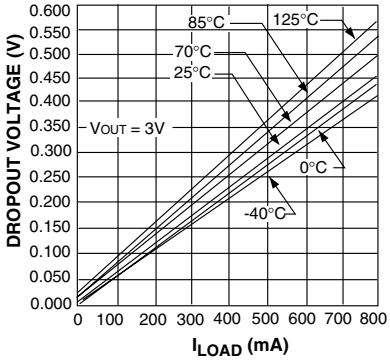
Load Regulation vs. Temperature



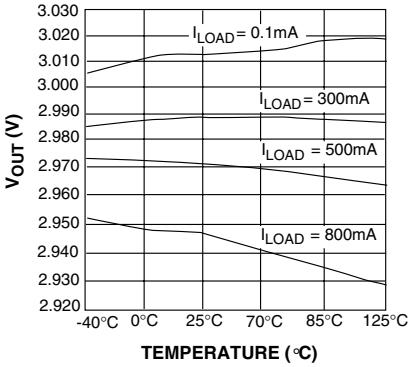
I_{DD} vs. Temperature



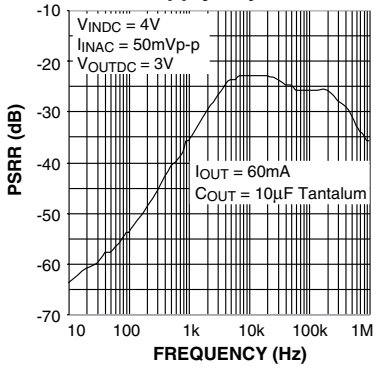
Dropout Voltage vs. I_{LOAD}



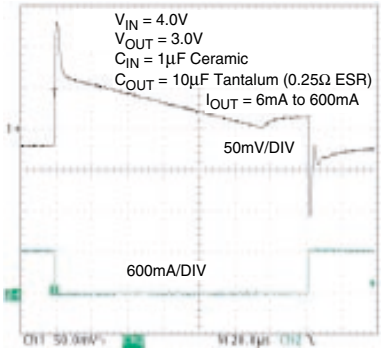
3.0V V_{OUT} vs. Temperature



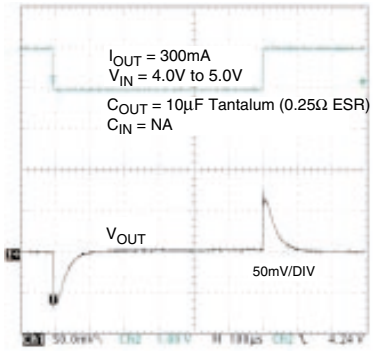
Power Supply Rejection Ratio



Load Step Response



Line Step Response



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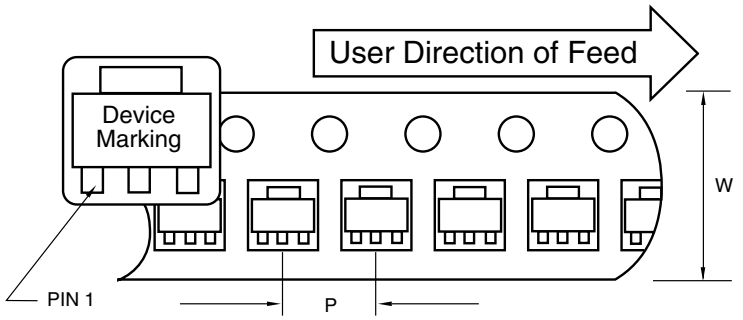
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

Package marking information not available at this time.

5.2 Taping Information

Component Taping Orientation for 3-Pin SOT-223 Devices

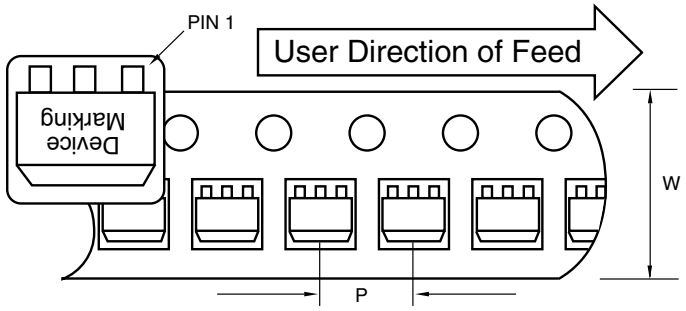


Standard Reel Component Orientation
for TR Suffix Device
(Mark Right Side Up)

Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
3-Pin SOT-223	12 mm	8 mm	4000	13 in

Component Taping Orientation for 3-Pin DDPAK Devices



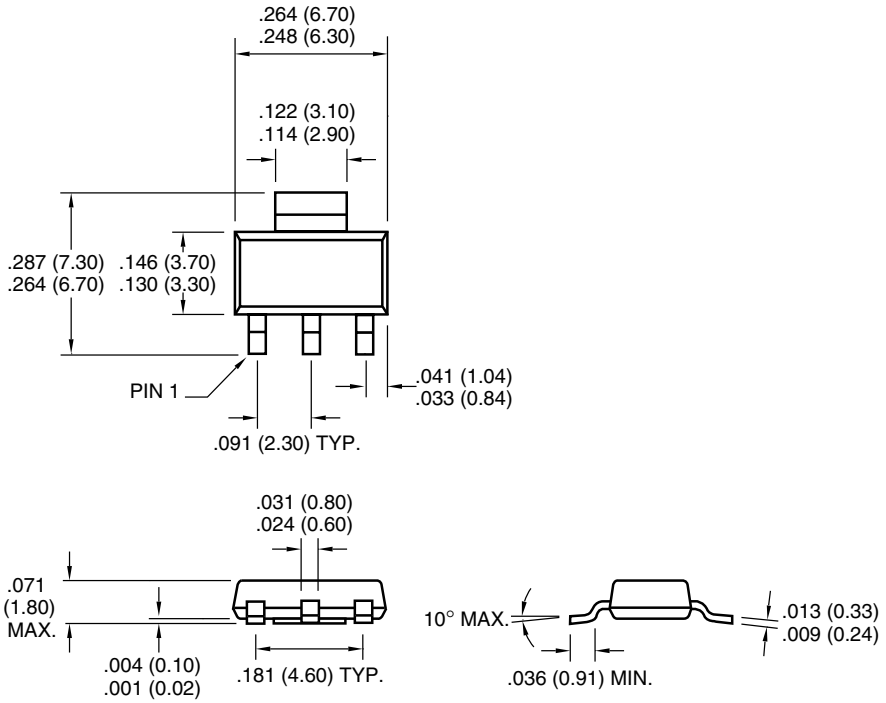
Standard Reel Component Orientation
for TR Suffix Device
(Mark Right Side Up)

Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
3-Pin DDPAK	24 mm	16 mm	750	13 in

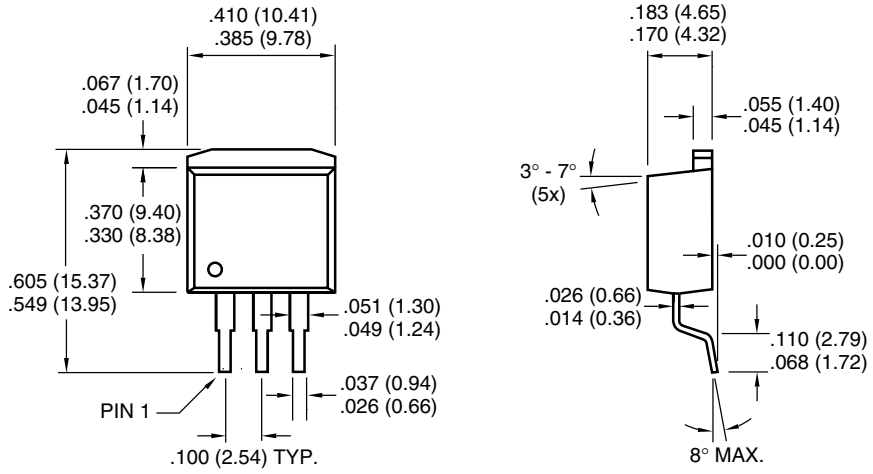
5.3 Packaging Dimensions

3-Pin SOT-223



Dimensions: inches (mm)

3-Pin DDPAK



Dimensions: inches (mm)

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NOTES:

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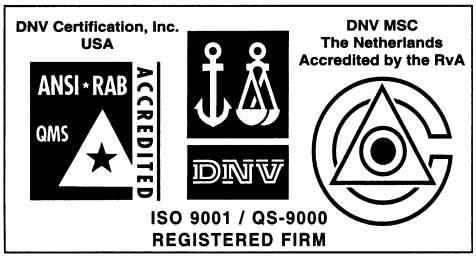
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