

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.

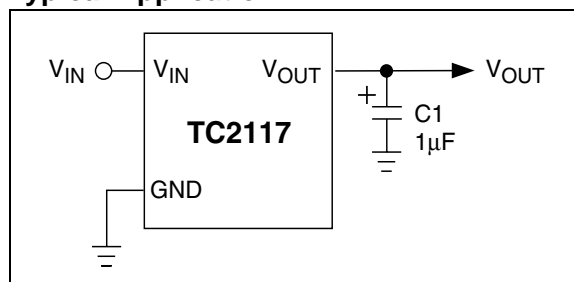
Other output voltages are available. Please contact Microchip Technology Inc. for details.

General Description

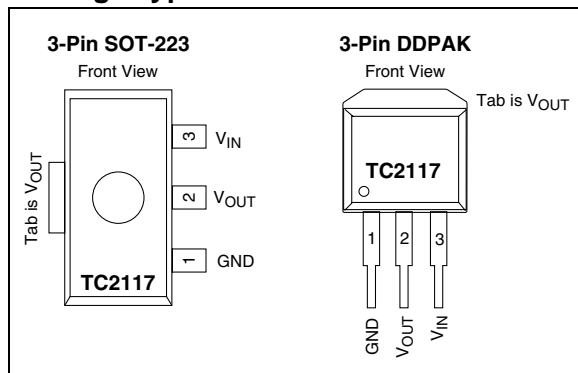
The TC2117 is a fixed, high accuracy (typically $\pm 0.5\%$) CMOS low dropout regulator. Designed specifically for battery operated systems, the TC2117's CMOS construction eliminates wasted ground current, significantly extending battery life. Total supply current is typically 80 μ A at full load (20 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 1 μ F and has a maximum output current of 800mA. This device is available in 3-Pin SOT-223, and 3-Pin DDPAK packages.

Typical Application



Package Type



TC2117

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 ≥ 2.5V V _R = 1.8V
ΔV _{OUT} /ΔT	V _{OUT} Temperature Coefficient	—	40	—	ppm/°C	(Note 3)
ΔV _{OUT} /ΔV _{IN}	Line Regulation	—	0.007	0.35	%	(V _R + 1V) V _{IN} 6V
ΔV _{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 ≥ 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
ΔV _{OUT} /ΔP _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.
- Note 2:** The minimum V_{IN} has to justify the conditions: V_{IN} ≥ V_R + V_{DROPOUT} and V_{IN} ≥ 2.7V for I_L = 0.1mA to I_{OUTMAX}.
- Note 3:** $T_C V_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$
- Note 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.
- Note 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.
- Note 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.
- Note 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.

2.0 PIN DESCRIPTIONS

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

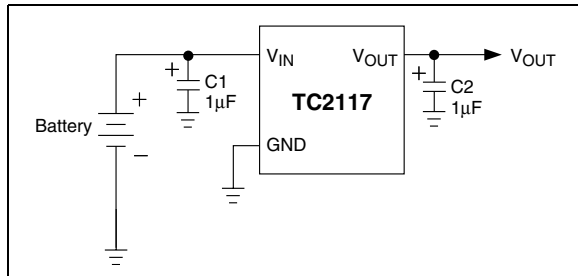
TABLE 2-1: PIN FUNCTION TABLE

Pin No. (3-Pin SOT-223) (3-Pin DPAK)	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.

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

$$V_{INMAX} = 5.0V \pm 5\%$$

$$V_{OUTMIN} = 3.3V \pm 0.5\%$$

$$I_{LOADMAX} = 400mA$$

$$T_{JMAX} = 125^{\circ}C$$

$$T_{AMAX} = 55^{\circ}C$$

$$\theta_{JA} = 59^{\circ}C/W \text{ (SOT-223)}$$

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:

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

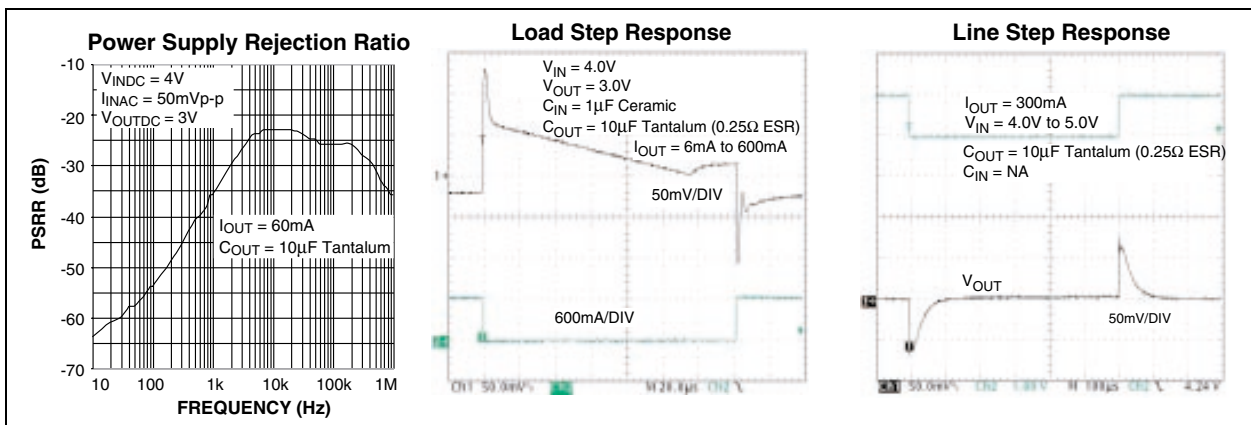
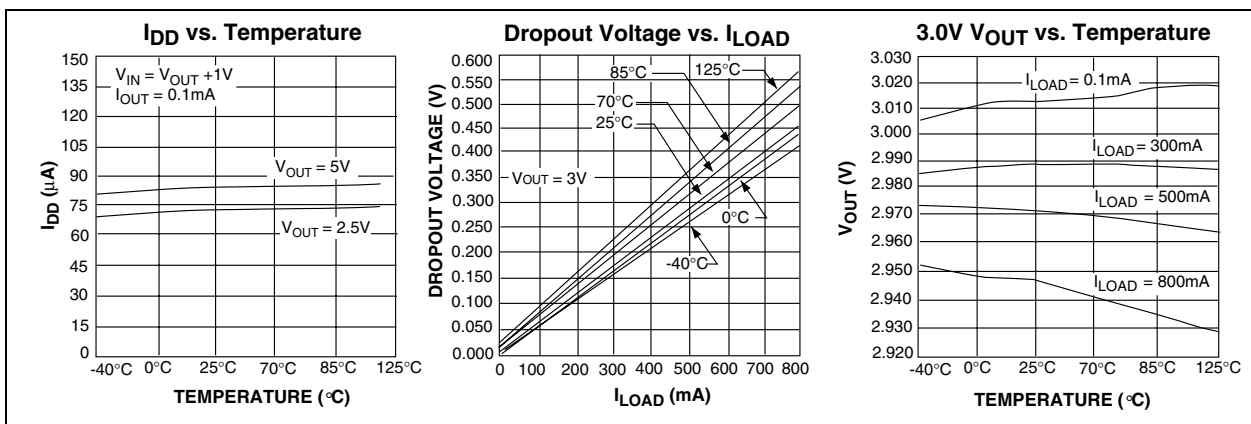
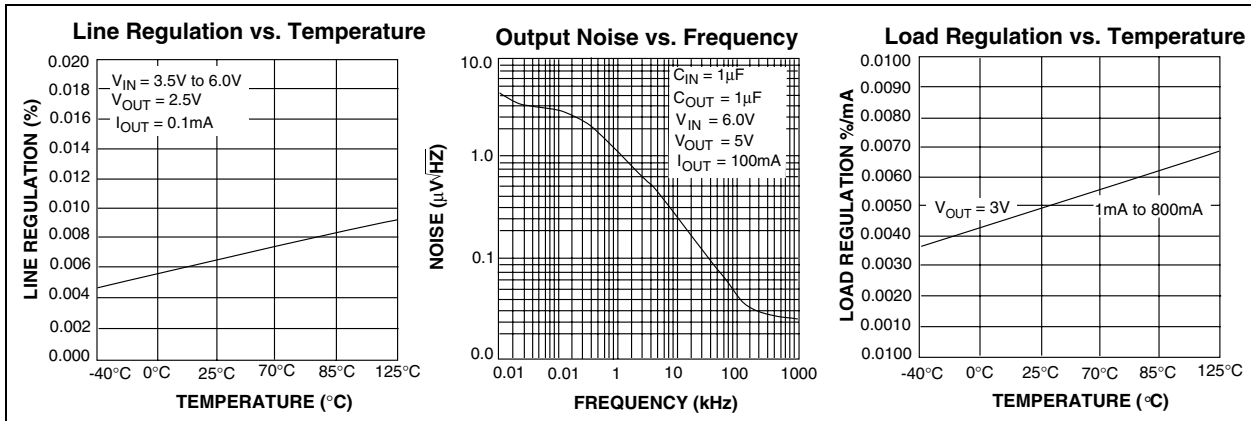
$$= \frac{(125 - 55)}{59}$$

$$= 1.186mW$$

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.



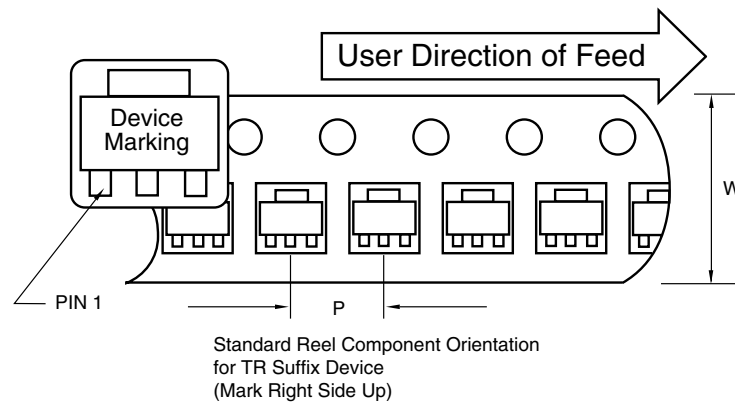
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

Package marking information not available at this time.

5.2 Taping Information

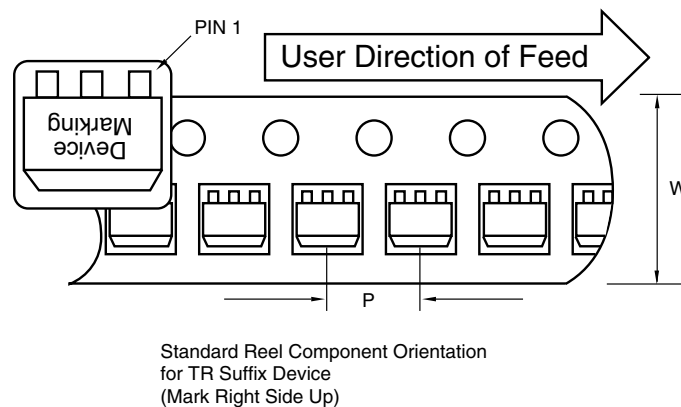
Component Taping Orientation for 3-Pin SOT-223 Devices



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

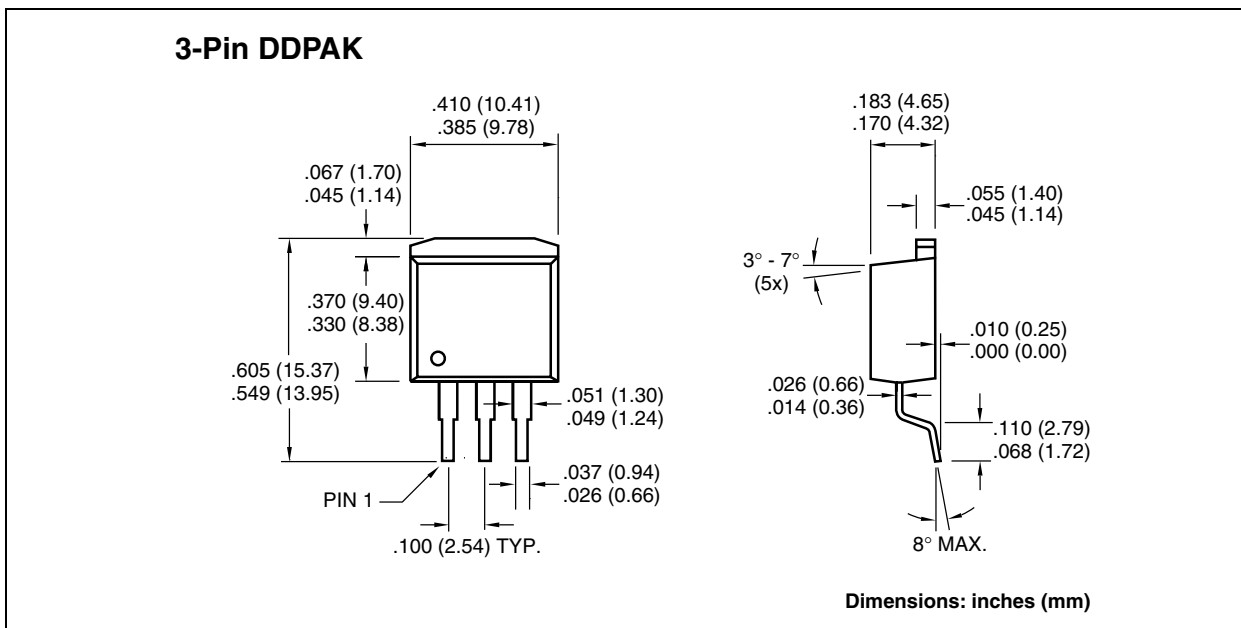
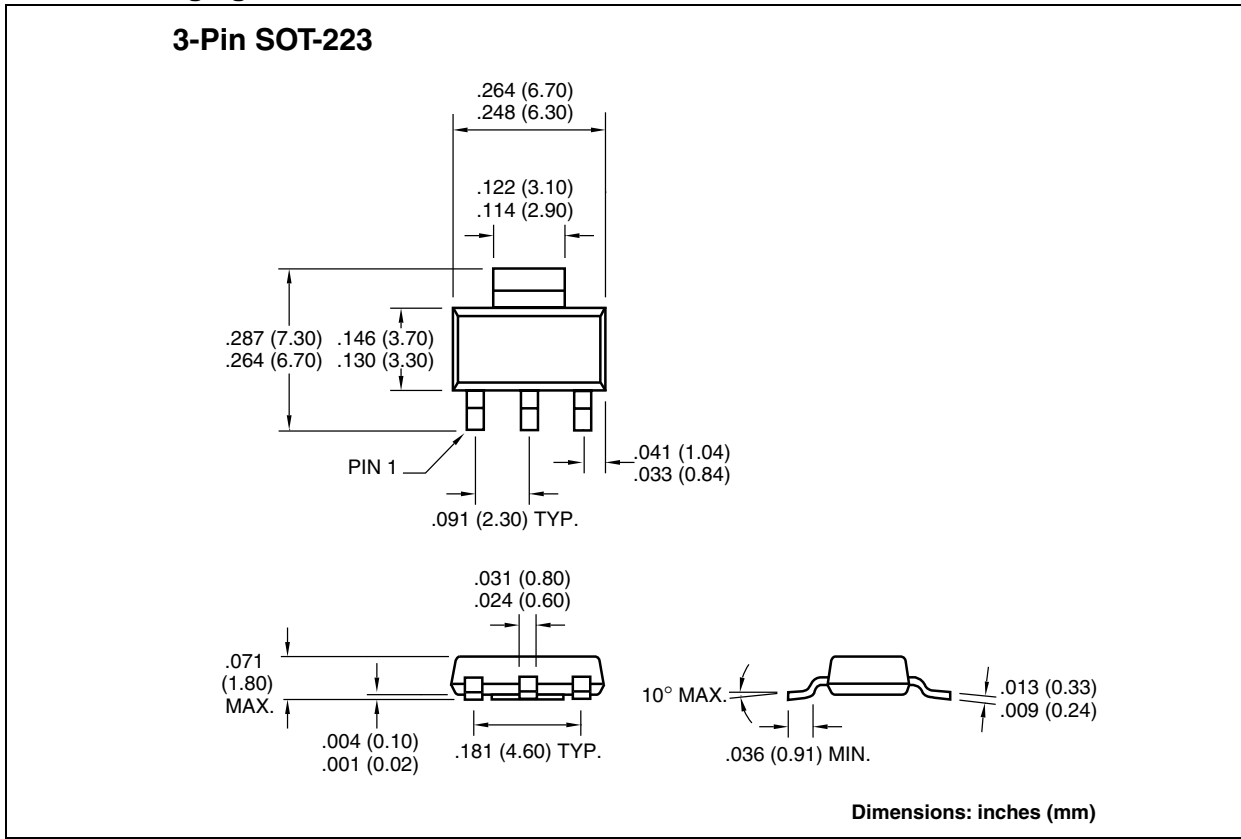


Carrier Tape, Number of Components Per Reel and Reel Size

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

TC2117

5.3 Packaging Dimensions



NOTES:

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Data Sheets

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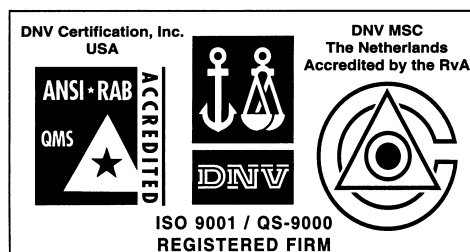
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Corporate Office

2355 West Chandler Blvd.
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Technical Support: 480-792-7627
Web Address: <http://www.microchip.com>

Rocky Mountain

2355 West Chandler Blvd.
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Los Angeles

18201 Von Karman, Suite 1090
Irvine, CA 92612
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New York

150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

San Jose

Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto

6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC

Australia

Microchip Technology Australia Pty Ltd
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing

Microchip Technology Consulting (Shanghai)
Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu

Microchip Technology Consulting (Shanghai)
Co., Ltd., Chengdu Liaison Office
Rm. 2401, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-6766200 Fax: 86-28-6766599

China - Fuzhou

Microchip Technology Consulting (Shanghai)
Co., Ltd., Fuzhou Liaison Office
Unit 28F, World Trade Plaza
No. 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Shanghai

Microchip Technology Consulting (Shanghai)
Co., Ltd.
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

China - Shenzhen

Microchip Technology Consulting (Shanghai)
Co., Ltd., Shenzhen Liaison Office
Rm. 1315, 13/F, Shenzhen Kerry Centre,
Renminnan Lu
Shenzhen 518001, China
Tel: 86-755-2350361 Fax: 86-755-2366086

Hong Kong

Microchip Technology Hongkong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

India

Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan

Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471-6166 Fax: 81-45-471-6122

Korea

Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore

Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-6334-8870 Fax: 65-6334-8850

Taiwan

Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Denmark

Microchip Technology Nordic ApS
Regus Business Centre
Lautrup høj 1-3
Ballerup DK-2750 Denmark
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France

Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
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Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany

Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Italy

Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom

Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
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