

## 500mA Fixed Output CMOS LDO with Shutdown

### Features

- Very Low Dropout Voltage
- 500mA Output Current
- High Output Voltage Accuracy
- Standard or Custom Output Voltages
- Over Current and Over Temperature Protection
- SHDN Input for Active Power Management
- ERROR Output Can Be Used as a Low Battery Detector (SOIC only)

### Applications

- Battery Operated Systems
- Portable Computers
- Medical Instruments
- Instrumentation
- Cellular/GSM/PHS Phones
- Linear Post-Regulators for SMPS
- Pagers

### Device Selection Table

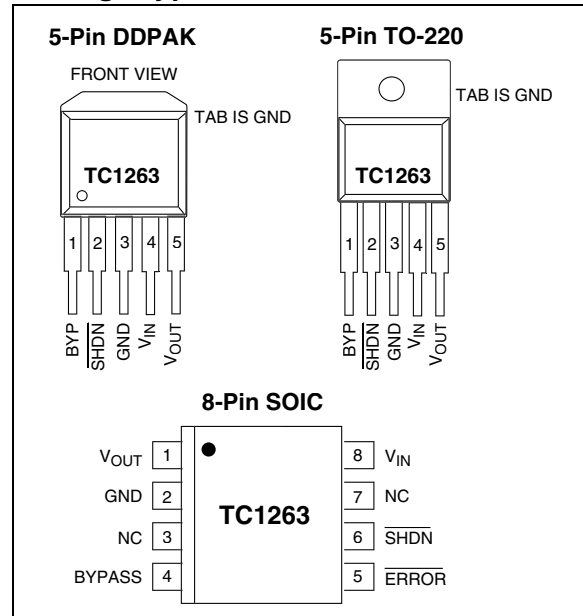
Part Number	Package	Junction Temp. Range
TC1263-xxVOA	8-Pin SOIC	-40°C to +125°C
TC1263-xxVAT	5-Pin TO-220	-40°C to +125°C
TC1263-xxVET	5-Pin DDPAK	-40°C to +125°C

**NOTE:** xx indicates output voltages.

Available Output Voltages: 2.5, 2.8, 3.0, 3.3, 5.0.

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

### Package Type



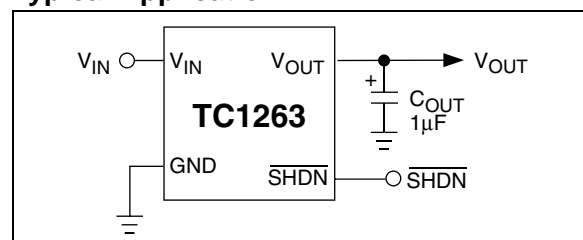
### General Description

The TC1263 is a fixed output, high accuracy (typically  $\pm 0.5\%$ ) CMOS low dropout regulator. Designed specifically for battery-operated systems, the TC1263's CMOS construction eliminates wasted ground current, significantly extending battery life. Total supply current is typically 80 $\mu$ A at full load (20 to 60 times lower than in bipolar regulators).

TC1263 key features include ultra low noise operation, very low dropout voltage (typically 350mV at full load), and fast response to step changes in load.

The TC1263 incorporates both over temperature and over current protection. The TC1263 is stable with an output capacitor of only 1 $\mu$ F and has a maximum output current of 500mA. It is available in 8-Pin SOIC, 5-Pin TO-220 and 5-Pin DDPAK packages.

### Typical Application



# TC1263

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings\*

Input Voltage .....	6.5V
Output Voltage.....	(V <sub>SS</sub> – 0.3V) to (V <sub>IN</sub> + 0.3V)
Power Dissipation.....	Internally Limited ( <b>Note 6</b> )
Maximum Voltage on Any Pin .....	V <sub>IN</sub> +0.3V to -0.3V
Operating Temperature Range.....	-40°C < T <sub>J</sub> < 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.

### TC1263 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: V <sub>IN</sub> = V <sub>OUT</sub> + 1V, I <sub>L</sub> = 100μA, C <sub>L</sub> = 3.3μF, $\overline{\text{SHDN}} > V_{IH}$ , T <sub>A</sub> = 25°C, unless otherwise noted. <b>Boldface</b> type specifications apply for junction temperatures of -40°C to +125°C.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V <sub>IN</sub>	Input Operating Voltage	<b>2.7</b>	—	<b>6.0</b>	V	<b>Note 8</b>
I <sub>OUTMAX</sub>	Maximum Output Current	<b>500</b>	—	—	mA	
V <sub>OUT</sub>	Output Voltage	— <b>V<sub>R</sub> – 2.5%</b>	V <sub>R</sub> ±0.5% —	— <b>V<sub>R</sub> + 2.5%</b>	V	<b>Note 1</b>
ΔV <sub>OUT</sub> /ΔT	V <sub>OUT</sub> Temperature Coefficient	—	40	—	ppm/°C	<b>Note 2</b>
ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>	Line Regulation	—	0.05	<b>0.35</b>	%	(V <sub>R</sub> + 1V) ≤ V <sub>IN</sub> ≤ 6V
ΔV <sub>OUT</sub> /V <sub>OUT</sub>	Load Regulation	—	0.002	<b>0.01</b>	%/mA	I <sub>L</sub> = 0.1mA to I <sub>OUTMAX</sub> ( <b>Note 3</b> )
V <sub>IN</sub> -V <sub>OUT</sub>	Dropout Voltage	— — —	20 60 200 350	<b>30</b> <b>130</b> <b>390</b> <b>650</b>	mV	I <sub>L</sub> = 100μA I <sub>L</sub> = 100mA I <sub>L</sub> = 300mA I <sub>L</sub> = 500mA ( <b>Note 4</b> )
I <sub>DD</sub>	Supply Current	—	80	<b>130</b>	μA	$\overline{\text{SHDN}} = V_{IH}$ , I <sub>L</sub> = 0
I <sub>SHDN</sub>	Shutdown Supply Current	—	0.05	<b>1</b>	μA	$\overline{\text{SHDN}} = 0V$
PSRR	Power Supply Rejection Ratio	—	64	—	dB	F <sub>RE</sub> ≤ 1kHz
I <sub>OUTsc</sub>	Output Short Circuit Current	—	1200	1400	mA	V <sub>OUT</sub> = 0V
ΔV <sub>OUT</sub> /ΔP <sub>D</sub>	Thermal Regulation	—	0.04	—	V/W	<b>Note 5</b>
eN	Output Noise	—	260	—	nV/√Hz	I <sub>L</sub> = I <sub>OUTMAX</sub>
<b>SHDN Input</b>						
V <sub>IH</sub>	$\overline{\text{SHDN}}$ Input High Threshold	<b>60</b>	—	—	%V <sub>IN</sub>	
V <sub>IL</sub>	$\overline{\text{SHDN}}$ Input Low Threshold	—	—	<b>15</b>	%V <sub>IN</sub>	
<b>ERROR Output (SOIC Only)</b>						
V <sub>MIN</sub>	Minimum Operating Voltage	1.0	—	—	V	
V <sub>OL</sub>	Output Logic Low Voltage	—	—	<b>400</b>	mV	1 mA Flows to $\overline{\text{ERROR}}$
V <sub>TH</sub>	$\overline{\text{ERROR}}$ Threshold Voltage	—	0.95 x V <sub>R</sub>	—	V	
V <sub>HYS</sub>	$\overline{\text{ERROR}}$ Positive Hysteresis	—	50	—	mV	<b>Note 7</b>

**Note 1:** V<sub>R</sub> is the regulator output voltage setting.

**Note 2:** TC V<sub>OUT</sub> =  $\frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$

- Note 3:** 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 4:** Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at a 1V differential.
- Note 5:** 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<sub>LMAX</sub> at V<sub>IN</sub> = 6V for T = 10 msec.
- Note 6:** 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<sub>A</sub>, T<sub>J</sub>, θ<sub>JA</sub>). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown. Please see Section 4.0 Thermal Considerations for more details.
- Note 7:** Hysteresis voltage is referenced to V<sub>R</sub>.
- Note 8:** The minimum V<sub>IN</sub> has to justify the conditions: V<sub>IN</sub> ≥ V<sub>R</sub> + V<sub>DROPOUT</sub> and V<sub>IN</sub> ≥ 2.7V for I<sub>L</sub> = 0.1mA to I<sub>OUTMAX</sub>.

## 2.0 PIN DESCRIPTIONS

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

**TABLE 2-1: PIN FUNCTION TABLE**

Pin No. (8-Pin SOIC)	Symbol	Description
1	$V_{OUT}$	Regulated voltage output.
2	GND	Ground terminal.
3	NC	No connect.
4	BYPASS	Reference bypass input. Connecting a 470pF to this input further reduces output noise.
5	$\overline{ERROR}$	Out-of-Regulation Flag (open drain output). This output goes low when $V_{OUT}$ is out-of-tolerance by approximately – 5%.
6	NC	No connect.
7	$\overline{SHDN}$	Shutdown control input. The regulator is fully enabled when a logic high is applied to this input. The regulator enters shutdown when a logic low is applied to this input. During shutdown, output voltage falls to zero and supply current is reduced to 0.05 $\mu$ A (typical).
8	$V_{IN}$	Unregulated supply input.

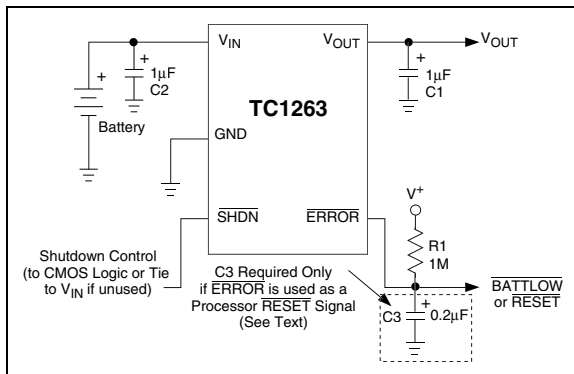
Pin No. (5-Pin DDPACK) (5-Pin TO-220)	Symbol	Description
1	BYP	Reference bypass input. Connecting a 470pF to this input further reduces output noise.
2	$\overline{SHDN}$	Shutdown control input. The regulator is fully enabled when a logic high is applied to this input. The regulator enters shutdown when a logic low is applied to this input. During shutdown, output voltage falls to zero and supply current is reduced to 0.05 $\mu$ A (typical).
3	GND	Ground terminal.
4	$V_{IN}$	Unregulated supply input.
5	$V_{OUT}$	Regulated voltage output.

## 3.0 DETAILED DESCRIPTION

The TC1263 is a precision, fixed output LDO. Unlike bipolar regulators, the TC1263's supply current does not increase with load current. In addition,  $V_{OUT}$  remains stable and within regulation over the entire 0mA to  $I_{LOADMAX}$  load current range (an important consideration in RTC and CMOS RAM battery back-up applications).

Figure 3-1 shows a typical application circuit.

**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 greater than 0.1Ω and less than 5Ω, and a resonant frequency above 1MHz. 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.

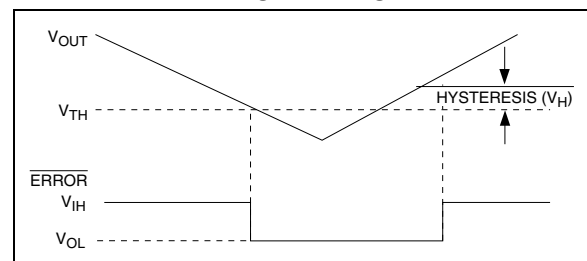
### 3.2 ERROR Output

$\overline{ERROR}$  is driven low whenever  $V_{OUT}$  falls out of regulation by more than -5% (typical). This condition may be caused by low input voltage, output current limiting, or thermal limiting. The  $\overline{ERROR}$  threshold is 5% below rated  $V_{OUT}$  regardless of the programmed output voltage value (e.g.,  $ERROR = V_{OL}$  at 4.75V (typ.) for a 5.0V regulator and 2.85V (typ.) for a 3.0V regulator).  $\overline{ERROR}$  output operation is shown in Figure 3-2.

Note that  $\overline{ERROR}$  is active when  $V_{OUT}$  is at or below  $V_{TH}$ , and inactive when  $V_{OUT}$  is above  $V_{TH} + V_H$ .

As shown in Figure 3-1,  $\overline{ERROR}$  can be used as a battery low flag, or as a processor  $\overline{RESET}$  signal (with the addition of timing capacitor C3).  $R1 \times C3$  should be chosen to maintain  $\overline{ERROR}$  below  $V_{IH}$  of the processor  $\overline{RESET}$  input for at least 200 msec to allow time for the system to stabilize. Pull-up resistor R1 can be tied to  $V_{OUT}$ ,  $V_{IN}$  or any other voltage less than  $(V_{IN} + 0.3V)$ .

**FIGURE 3-2: ERROR OUTPUT OPERATION**



## 4.0 THERMAL CONSIDERATIONS

### 4.1 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.

### 4.2 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 4-1:

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

Where:

- $P_D$  = Worst case actual power dissipation
- $V_{INMAX}$  = Maximum voltage on  $V_{IN}$
- $V_{OUTMIN}$  = Minimum regulator output voltage
- $I_{LOADMAX}$  = Maximum output (load) current

The maximum allowable power dissipation (Equation 4-2) is a function of the maximum ambient temperature ( $T_{AMAX}$ ), the maximum allowable die temperature ( $T_{JMAX}$ ) and the thermal resistance from junction-to-air ( $\theta_{JA}$ ).

#### EQUATION 4-2:

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

Where all terms are previously defined.

Table 4-1 and Table 4-2 show various values of  $\theta_{JA}$  for the TC1263 packages.

**TABLE 4-1: THERMAL RESISTANCE GUIDELINES FOR TC1263 IN 8-PIN SOIC PACKAGE**

Copper Area (Topside)*	Copper Area (Backside)	Board Area	Thermal Resistance ( $\theta_{JA}$ )
2500 sq mm	2500 sq mm	2500 sq mm	60°C/W
1000 sq mm	2500 sq mm	2500 sq mm	60°C/W
225 sq mm	2500 sq mm	2500 sq mm	68°C/W
100 sq mm	2500 sq mm	2500 sq mm	74°C/W

\*Pin 2 is ground. Device is mounted on topside.

**TABLE 4-2: THERMAL RESISTANCE GUIDELINES FOR TC1263 IN 3-PIN TO-220/DDPAK PACKAGE**

Copper Area (Topside)*	Copper Area (Backside)	Board Area	Thermal Resistance ( $\theta_{JA}$ )
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 4-1 can be used in conjunction with Equation 4-2 to ensure regulator thermal operation is within limits. For example:

Given:

$$\begin{aligned} V_{INMAX} &= 3.3V \pm 10\% \\ V_{OUTMIN} &= 2.7V \pm 0.5\% \\ I_{LOADMAX} &= 275mA \\ T_{JMAX} &= 125^\circ C \\ T_{AMAX} &= 95^\circ C \\ \theta_{JA} &= 60^\circ C/W \end{aligned}$$

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

Actual power dissipation:

$$\begin{aligned} P_D &\approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX} \\ &= [(3.3 \times 1.1) - (2.7 \times .995)]275 \times 10^{-3} \\ &= 260mW \end{aligned}$$

Maximum allowable power dissipation:

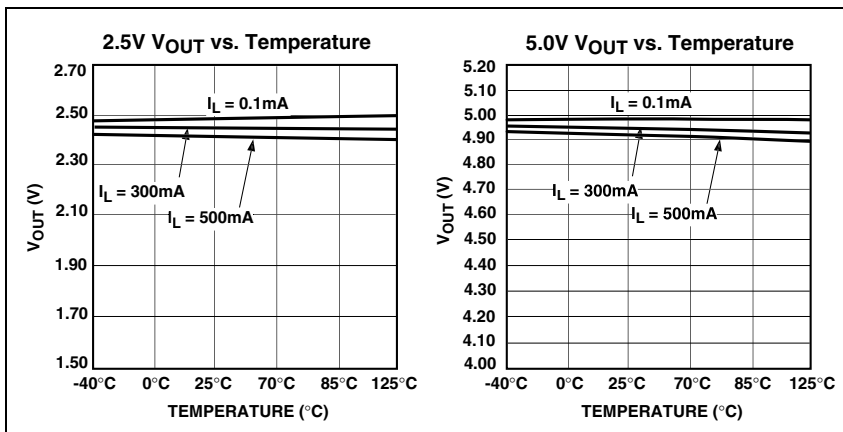
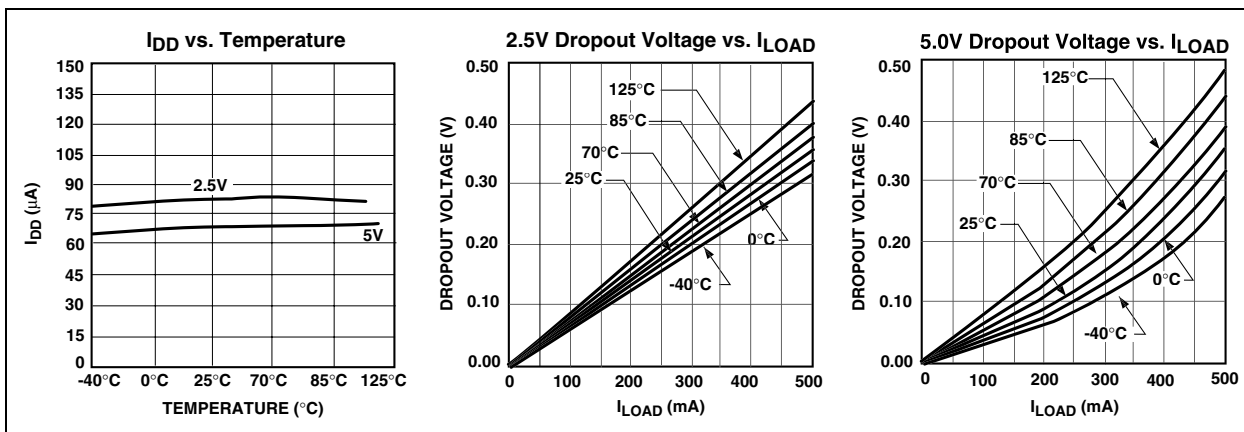
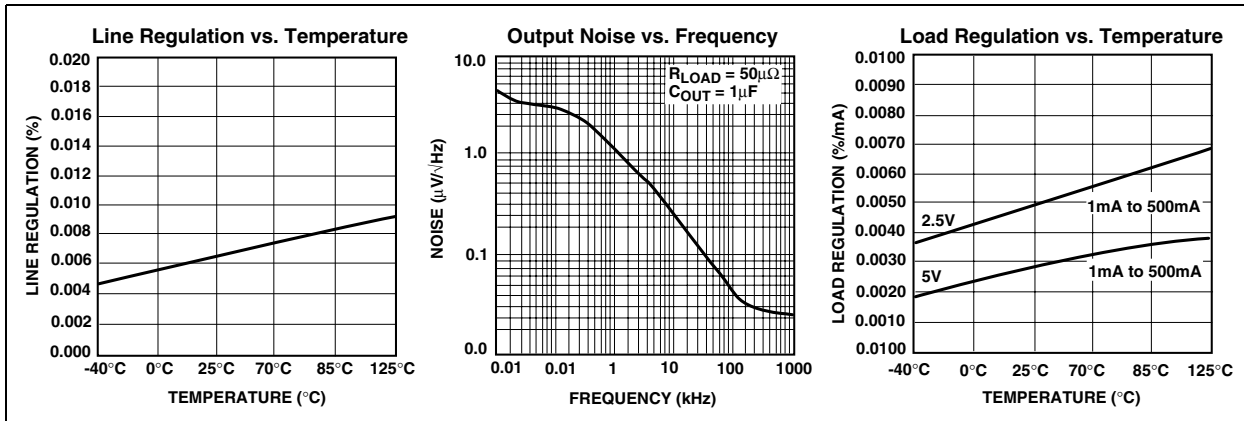
$$\begin{aligned} P_{DMAX} &= \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}} \\ &= \frac{(125 - 95)}{60} \\ &= 500mW \end{aligned}$$

In this example, the TC1263 dissipates a maximum of 260mW; below the allowable limit of 500mW. In a similar manner, Equation 4-1 and Equation 4-2 can be used to calculate maximum current and/or input voltage limits. For example, the maximum allowable  $V_{IN}$  is found by substituting the maximum allowable power dissipation of 500mW into Equation 4-1, from which  $V_{INMAX} = 4.6V$ .

# TC1263

## 5.0 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.



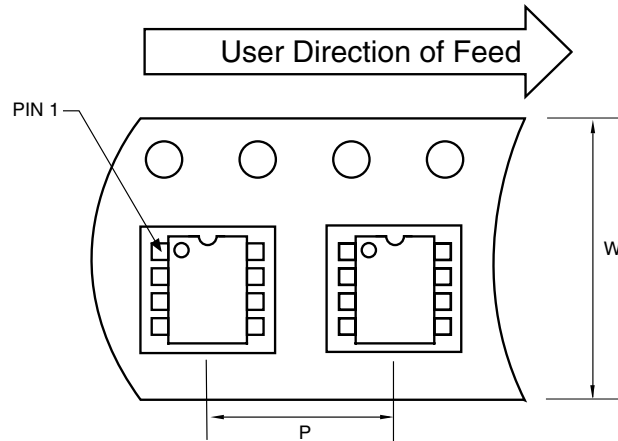
## 6.0 PACKAGING INFORMATION

### 6.1 Package Marking Information

Package marking data not available at this time.

### 6.2 Taping Form

#### Component Taping Orientation for 8-Pin SOIC (Narrow) Devices

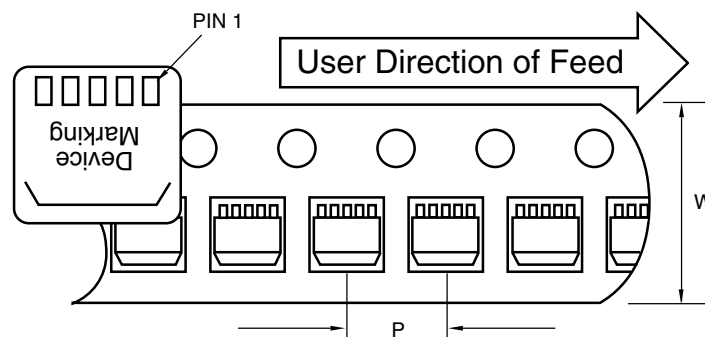


Standard Reel Component Orientation  
for TR Suffix Device

#### Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
8-Pin SOIC (N)	12 mm	8 mm	2500	13 in

#### Component Taping Orientation for 5-Pin DDPAK Devices



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

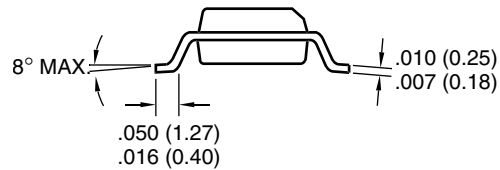
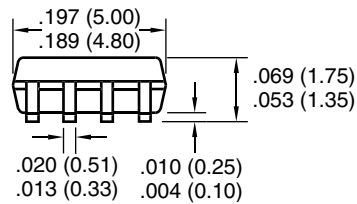
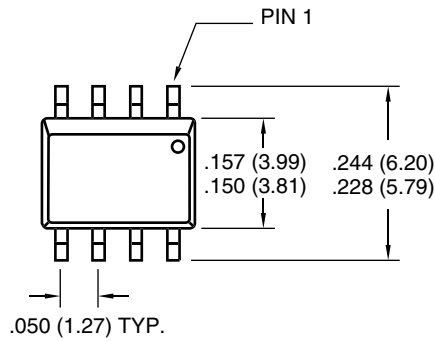
#### Carrier Tape, Number of Components Per Reel and Reel Size

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

# TC1263

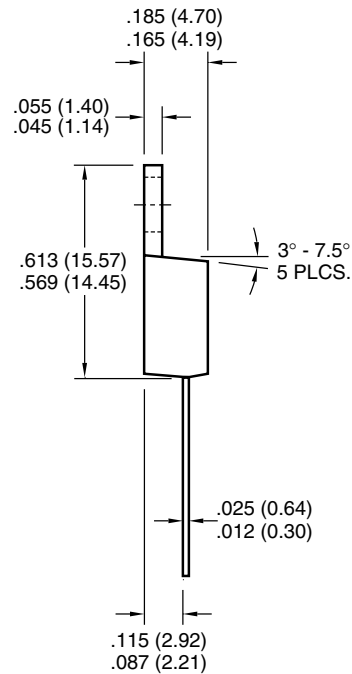
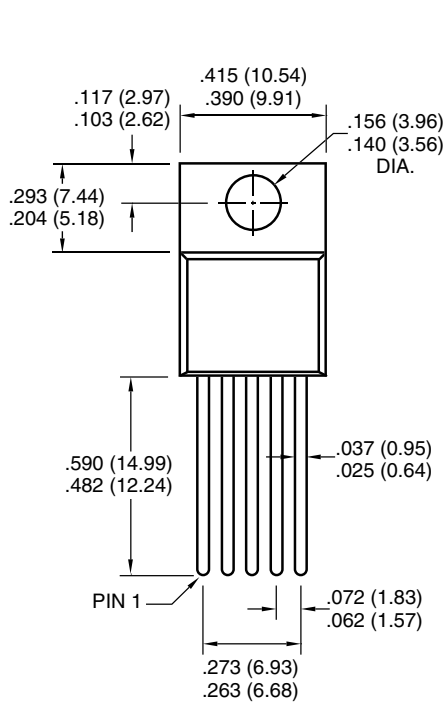
## 6.3 Package Dimensions

### 8-Pin SOIC



Dimensions: inches (mm)

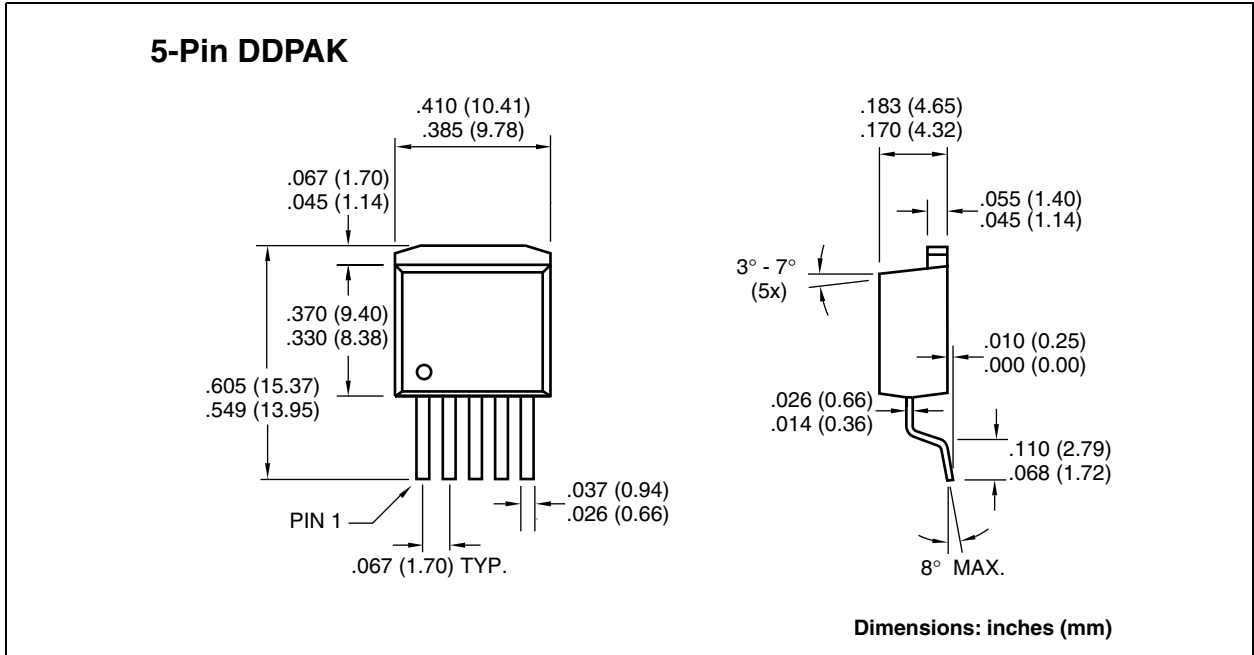
### 5-Pin TO-220



Dimensions: inches (mm)



## 6.3 Package Dimensions (Continued)



# TC1263

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NOTES:

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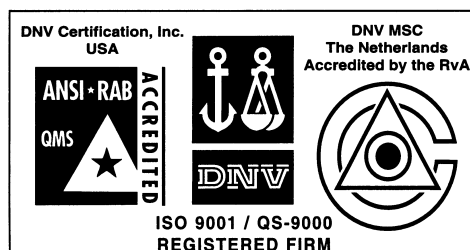
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Tel: 631-273-5305 Fax: 631-273-5335

#### 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: 86-28-86766200 Fax: 86-28-86766599

#### China - Fuzhou

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Co., Ltd., Fuzhou Liaison Office  
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No. 71 Wusi Road  
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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

#### China - Hong Kong SAR

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  
Tel: 45 4420 9895 Fax: 45 4420 9910

#### France

Microchip Technology SARL  
Parc d'Activite du Moulin de Massy  
43 Rue du Saule Trapu  
Batiment A - 1er Etage  
91300 Massy, France  
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

Microchip Ltd.  
505 Eskdale Road  
Winnersh Triangle  
Wokingham  
Berkshire, England RG41 5TU  
Tel: 44 118 921 5869 Fax: 44-118 921-5820

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