

800mA Fixed Output CMOS LDO with Shutdown

Features

- Very Low Dropout Voltage
- 800mA 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

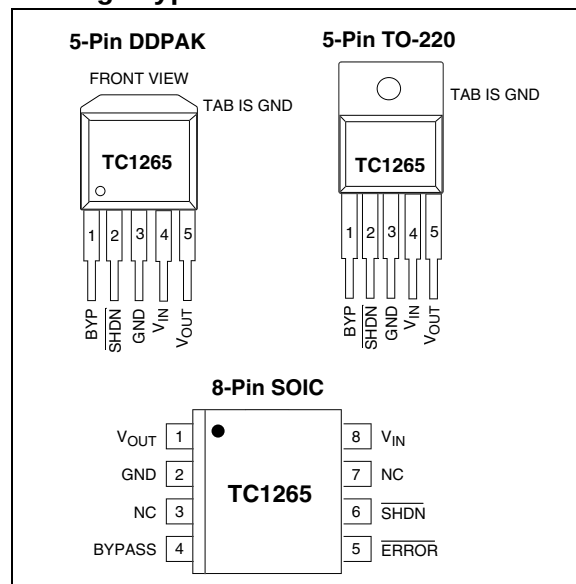
Part Number	Package	Junction Temp. Range
TC1265-xxVOA	8-Pin SOIC (Narrow)	-40°C to +125°C
TC1265-xxVAT	5-Pin TO-220	-40°C to +125°C
TC1265-xxVET	5-Pin DDPAK	-40°C to +125°C

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



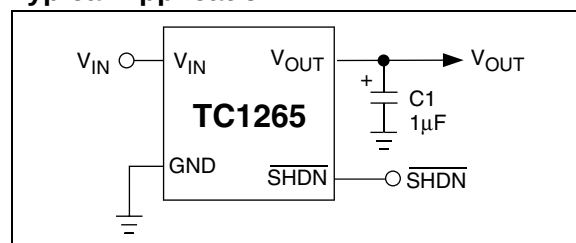
General Description

The TC1265 is a fixed output, high accuracy (typically $\pm 0.5\%$) CMOS low dropout regulator. Designed specifically for battery-operated systems, the TC1265'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).

TC1265 key features include ultra low noise operation, very low dropout voltage (typically 450mV at full load), and fast response to step changes in load.

The TC1265 incorporates both over temperature and over current protection. The TC1265 is stable with an output capacitor of only 1 μ F and has a maximum output current of 800mA. It is available in 8-Pin SOIC, 5-Pin TO-220 and 5-Pin DDPAK packages.

Typical Application



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Input Voltage	6.5V
Output Voltage.....	(V _{SS} – 0.3V) 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 Range.....	-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.

TC1265 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: V _{IN} = V _R + 1.5V, (Note 1), I _L = 100μA, C _L = 3.3μF, $\overline{\text{SHDN}} > V_{IH}$, T _A = 25°C, unless otherwise noted. 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} /I _{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 50 150 260 450 700 890	30 160 480 800 1300 1000 1400	mV	V _R ≥ 2.5V, I _L = 100μA I _L = 100mA I _L = 300mA I _L = 500mA I _L = 800mA V _R = 1.8V, I _L = 500mA I _L = 800mA (Note 5)
I _{DD}	Supply Current	—	80	130	μA	$\overline{\text{SHDN}} = V_{IH}$, I _L = 0
I _{SHDN}	Shutdown Supply Current	—	0.05	1	μA	$\overline{\text{SHDN}} = 0V$
PSRR	Power Supply Rejection Ratio	—	64	—	dB	F ≤ 1kHz
I _{OUTSC}	Output Short Circuit Current	—	1200	1400	mA	V _{OUT} = 0V
ΔV _{OUT} /ΔP _D	Thermal Regulation	—	0.04	—	V/W	Note 6
eN	Output Noise	—	260	—	nV/√Hz	I _L = I _{OUTMAX} , F = 10kHz
SHDN Input						
V _{IH}	SHDN Input High Threshold	45	—	—	%V _{IN}	
V _{IL}	SHDN Input Low Threshold	—	—	15	%V _{IN}	

- Note**
- 1: V_R is the regulator output voltage setting.
 - 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}.
 - 3: $TC\ V_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$
 - 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 = 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 4.0 Thermal Considerations for more details.
 - 8: Hysteresis voltage is referenced to V_R.

TC1265 ELECTRICAL SPECIFICATIONS (CONTINUED)

Electrical Characteristics: $V_{IN} = V_R + 1.5V$, (**Note 1**), $I_L = 100\mu A$, $C_L = 3.3\mu F$, $\overline{SHDN} > V_{IH}$, $T_A = 25^\circ C$, unless otherwise noted. **Boldface** type specifications apply for junction temperatures of $-40^\circ C$ to $+125^\circ C$.

ERROR Output (SOIC Only)

V_{MIN}	Minimum Operating Voltage	1.0	—	—	V	
V_{OL}	Output Logic Low Voltage	—	—	400	mV	1 mA Flows to ERROR
V_{TH}	ERROR Threshold Voltage	—	$0.95 \times V_R$	—	V	
V_{HYS}	ERROR Positive Hysteresis	—	50	—	mV	Note 8

- 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: $TC V_{OUT} = \frac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$
 - 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.
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 - 8: Hysteresis voltage is referenced to V_R .

2.0 PIN DESCRIPTIONS

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

TABLE 2-1: PIN FUNCTION TABLE

Pin No. (5-Pin DDPAK) (5-Pin TO-220)	Symbol	Description
1	BYPASS	Reference bypass input. Connecting a 470pF to this input further reduces output noise.
2	$\overline{\text{SHDN}}$	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 μ A (typical).
3	GND	Ground terminal.
4	V_{IN}	Unregulated supply input.
5	V_{OUT}	Regulated voltage output.

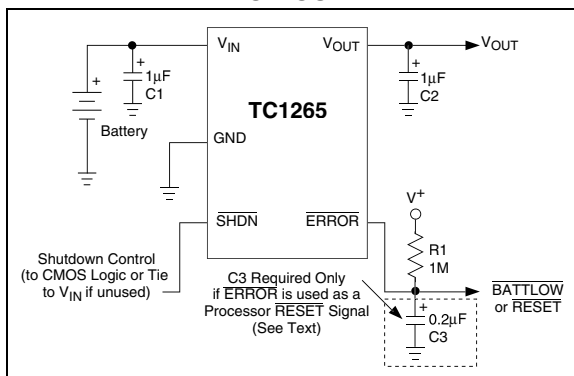
Pin No. (8-Pin SOIC)	Symbol	Description
1	V_{OUT}	Regulated voltage output.
2	GND	Ground terminal.
3	NC	No connect.
4	BYPASS	Reference bypass input. Connecting a 470pF to this input further reduces output noise.
5	$\overline{\text{ERROR}}$	Out-of-Regulation Flag (open drain output). This output goes low when V_{OUT} is out-of-tolerance by approximately – 5%.
6	NC	No connect.
7	$\overline{\text{SHDN}}$	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 μ A (typical).
8	V_{IN}	Unregulated supply input.

3.0 DETAILED DESCRIPTION

The TC1265 is a precision, fixed output LDO. Unlike bipolar regulators, the TC1265'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. 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.

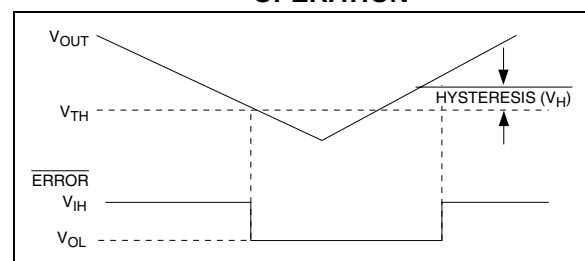
3.2 ERROR Output

$\overline{ERROR}$ 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 (θ_{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 θ_{JA} for the TC1265 package types.

TABLE 4-1: THERMAL RESISTANCE GUIDELINES FOR TC1265 IN 8-PIN SOIC PACKAGE

Copper Area (Topside)*	Copper Area (Backside)	Board Area	Thermal Resistance (θ_{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

*Tab of device attached to topside copper

TABLE 4-2: THERMAL RESISTANCE GUIDELINES FOR TC1265 IN 5-PIN DDPAK/TO-220 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 4-1 can be used in conjunction with Equation 4-2 to ensure regulator thermal operation is within limits. For example:

Given:

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

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

Actual power dissipation:

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

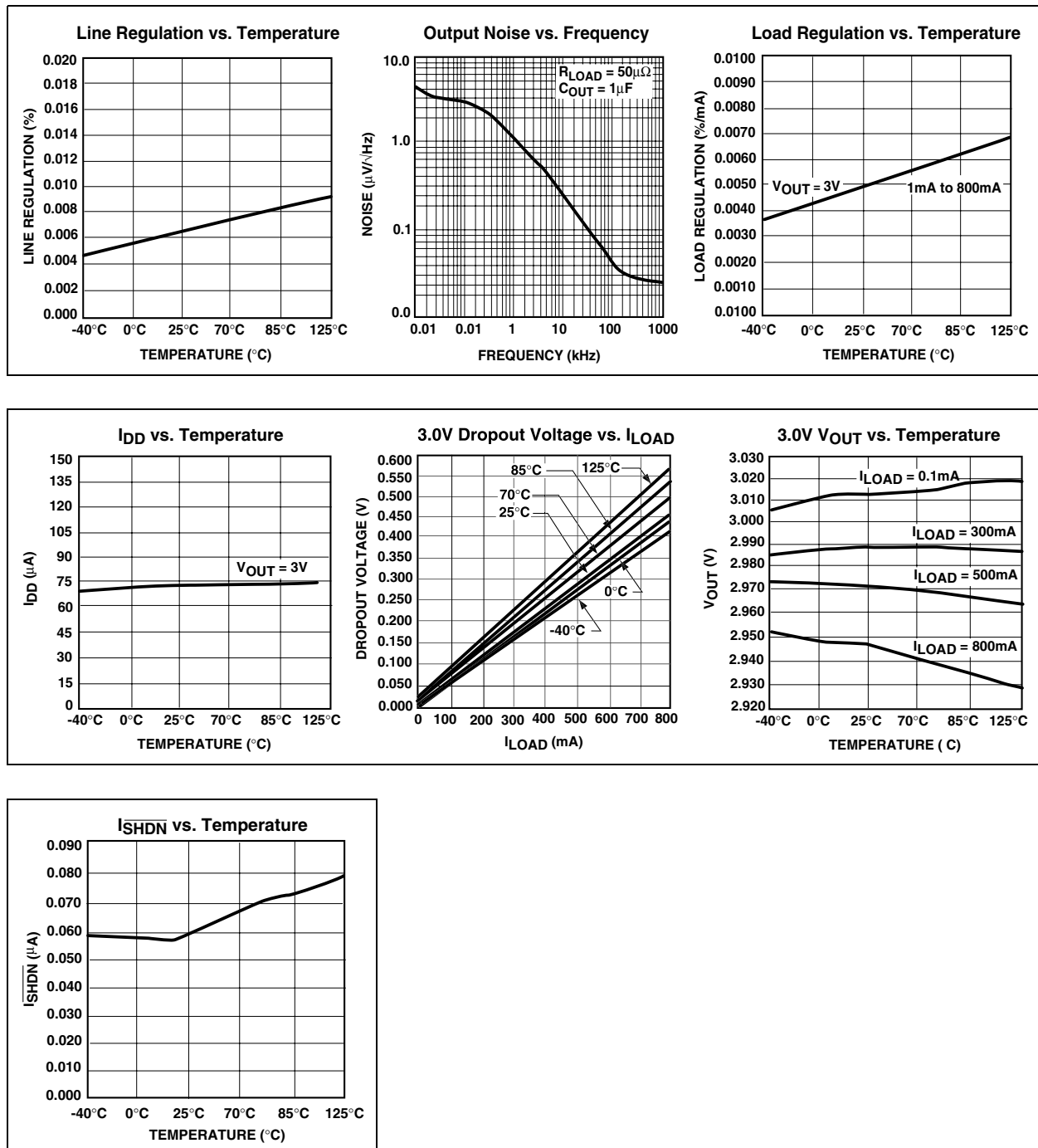
Maximum allowable power dissipation:

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

In this example, the TC1265 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 $V_{INMAX} = 4.6V$.

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.



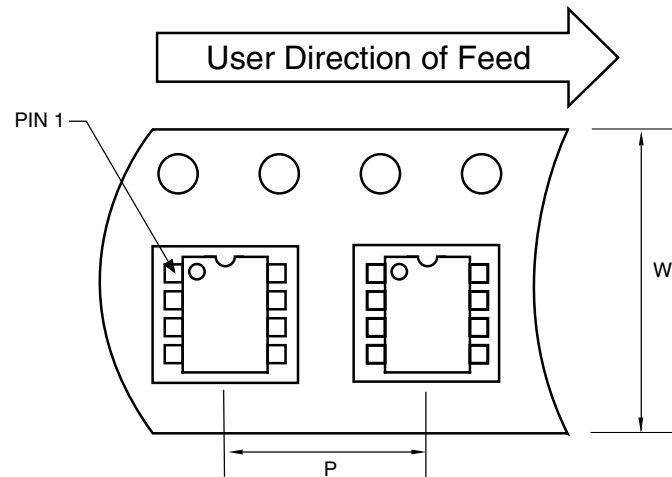
6.0 PACKAGING INFORMATION

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

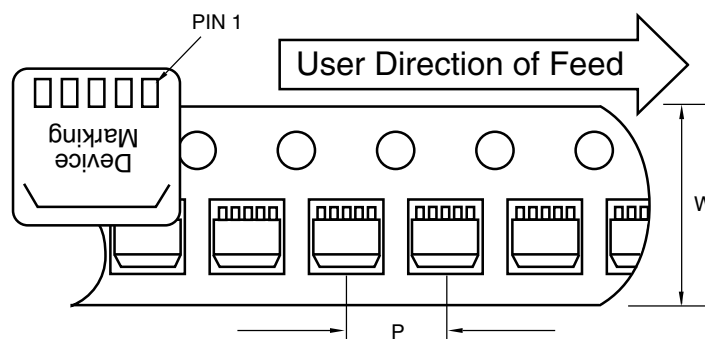


Standard Reel Component Orientation
for TR Suffix Device

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



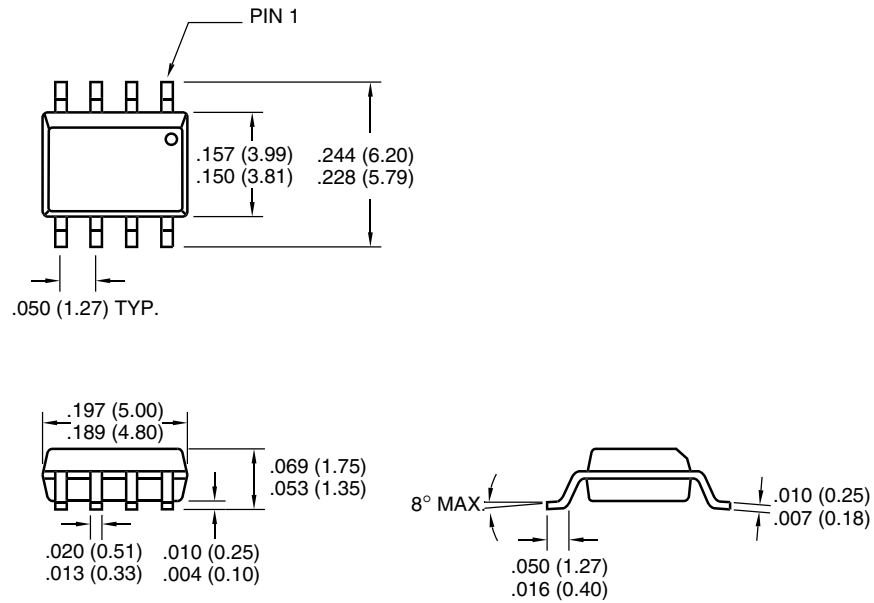
Standard Reel Component Orientation
for TR Suffix Device
(Mark Right Side Up)

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

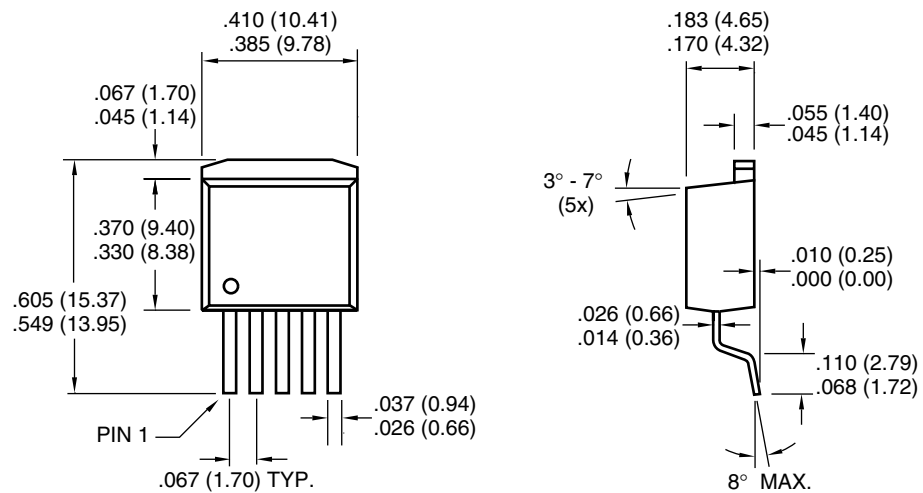
6.3 Package Dimensions

8-Pin SOIC



Dimensions: inches (mm)

5-Pin DDPAK



Dimensions: inches (mm)

SALES AND SUPPORT

Data Sheets

Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
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TC1265

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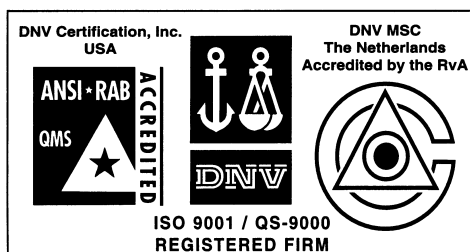
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