TC1265

800mA Fixed Output CMOS LDO with Shutdown

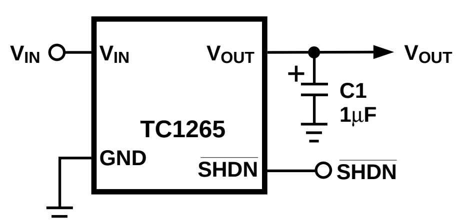
FEATURES

- **Very Low Dropout Voltage**
- **Guaranteed 800mA Output**
- **High Output Voltage Accuracy**
- **Standard or Custom Output Voltages**
- **Over-Current and Over-Temperature Protection**
- **$\overline{\text{SHDN}}$ Input for Active Power Management**
- **$\overline{\text{ERROR}}$ Output to Detect Low Battery (SOIC Only)**

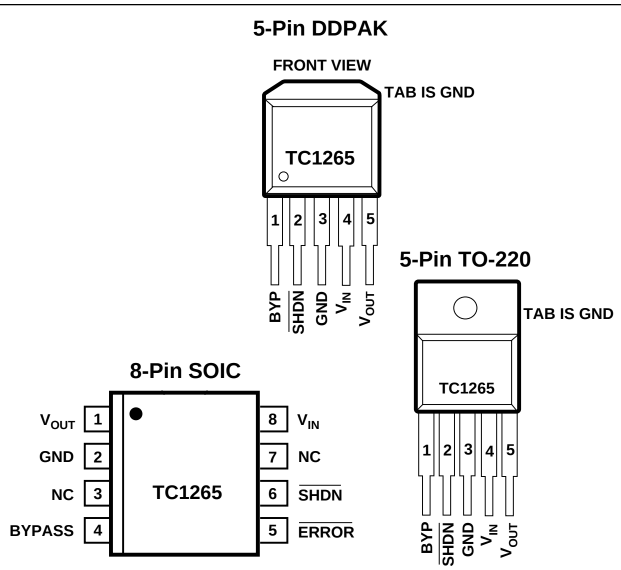
APPLICATIONS

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

TYPICAL APPLICATION



PIN CONFIGURATION



GENERAL DESCRIPTION

The TC1265 is a fixed output, high accuracy (typically ±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 80µA at full load *(20 to 60 times lower than in bipolar regulators*!).

TC1265 key features include ultra low noise, 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 1µF and has a maximum output current of 800mA. It is available in 8-Pin SOIC, 5-Pin TO-220, and 5-Pin DDPAK packages.

ORDERING INFORMATION

Part Number	Package	Junction Temperature 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

Available Output Voltages:
1.8, 2.5, 3.0, 3.3
xx indicates ouput voltages

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

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ABSOLUTE MAXIMUM RATINGS*

Input Voltage 6.5V
Output Voltage .... (V_{SS} – 0.3) to (V_{IN} + 0.3)
Power Dissipation .... Internally Limited (Note 7)
Operating Temperature .... – 40°C < T_J < 125°C
Storage Temperature .... – 65°C to +150°C
Maximum Voltage on Any Pin .... V_{IN} + 0.3V to – 0.3V
Lead Temperature (Soldering, 10 Sec.) .... +260°C

*Absolute Maximum Ratings indicate device operation limits beyond damage may occur. Device operation beyond the limits listed in Electrical Characteristics is not recommended.

ELECTRICAL CHARACTERISTICS: $V_{IN} = V_R$ + 1.5V (Note 1), I_L = 100µA, C_L = 3.3µF, $\overline{SHDN} > V_{IH}$, T_A = 25°C, unless otherwise specified. **BOLDFACE** type specifications apply for junction temperatures of – 40°C to +125°C.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
V_{IN}	Input Operating Voltage	(Note 2)	**2.7**	—	**6.0**	V
I_{OUTMAX}	Maximum Output Current	(SOIC-8 TBD)	**800**	—	—	mA
V_{OUT}	Output Voltage	$V_R \geq 2.5V$ $V_R = 1.8V$	**V_R – 2.5%** **V_R – 2%**	$V_R \pm 0.5\%$ $V_R \pm 0.5\%$	**V_R + 2.5%** **V_R + 3%**	V
$\Delta V_{OUT}/\Delta T$	V_{OUT} Temperature Coefficient	(Note 3)	—	40	—	ppm/°C
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$(V_R + 1V) \leq V_{IN} \leq 6V$	—	0.007	**0.35**	%
$\Delta V_{OUT}/V_{OUT}$	Load Regulation	I_L = 0.1mA to I_{OUTMAX} (Note 4)	**-0.01**	0.002	0	%/mA
$V_{IN} - V_{OUT}$	Dropout Voltage (Note 5)	$V_R \geq 2.5V$, I_L= 100µA I_L= 100mA I_L= 300mA I_L= 500mA I_L= 800mA (SOIC TBD) V_R = 1.8V, I_L = 500mA I_L = 800mA (SOIC TBD)	— — — — — — —	20 50 150 260 450 700 890	**30** **160** **480** **800** **1300** **1000** **1400**	mV
I_{DD}	Supply Current	$\overline{SHDN} = V_{IH}$, I_L = 0	—	80	**130**	µA
I_{SHDN}	Shutdown Supply Current	$\overline{SHDN}$ = 0V	—	0.05	**1**	µA
PSRR	Power Supply Rejection Ratio	F ≤ 1KHz	—	64	—	dB
I_{OUTSC}	Output Short Circuit Current	V_{OUT} = 0V	—	1200	1400	mA
$\Delta V_{OUT}/\Delta P_D$	Thermal Regulation	(Note 6)	—	0.04	—	V/W
eN	Output Noise	$I_L = I_{OUTMAX}$, F = 10kHz	—	260	—	$nV/\sqrt{Hz}$
$\overline{SHDN}$ Input						
V_{IH}	$\overline{SHDN}$ Input High Threshold		**45**	—	—	$\%V_{IN}$
V_{IL}	$\overline{SHDN}$ Input Low Threshold		—	—	**15**	$\%V_{IN}$
$\overline{ERROR}$ Output (SOIC Only)						
V_{MIN}	Minimum Operating Voltage		1.0	—	—	V
V_{OL}	Output Logic Low Voltage	1mA Flows to $\overline{ERROR}$	—	—	**400**	mV
V_{TH}	$\overline{ERROR}$ Threshold Voltage		—	0.95 x V_R	—	V
V_{HYS}	$\overline{ERROR}$ Positive Hysteresis	(Note 8)	—	50	—	mV

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

DETAILED DESCRIPTION

The TC1265 is a precision, fixed output LDO. Unlike bipolar regulators, the TC1265 supply current does not increase with load current. In addition, V_{OUT} remains stable and within regulation at very low load currents (an important consideration in RTC and CMOS RAM battery backup applications). Figure 1 shows a typical application circuit.

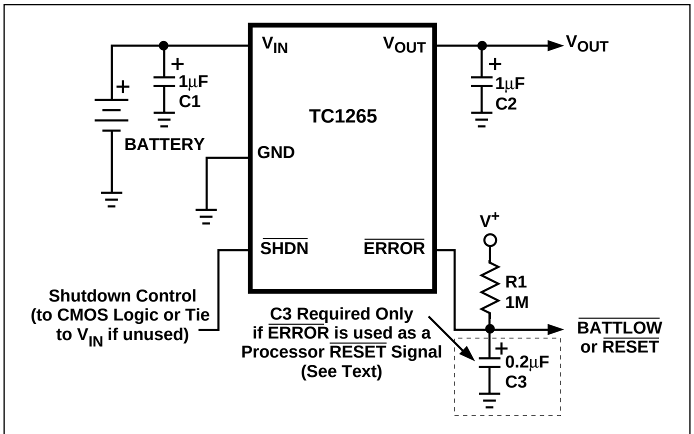


Figure 1: Typical Application Circuit

Output Capacitor

A 1µF (min) capacitor from V_{OUT} to ground is required. The output capacitor should have an effective series resistance of 5Ω or less. 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.

$\overline{\text{ERROR}}$ Output

$\overline{\text{ERROR}}$ 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 $\overline{\text{ERROR}}$ threshold is 5% below rated V_{OUT} regardless of the programmed output voltage value (e.g., $\overline{\text{ERROR}}$ = V_{OL} at 4.75V (typ) for a 5.0V regulator and 2.85V (typ) for a 3.0V regulator). $\overline{\text{ERROR}}$ output operation is shown in Figure 2. Note that $\overline{\text{ERROR}}$ 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 1, $\overline{\text{ERROR}}$ can be used as a battery low flag, or as a processor $\overline{\text{RESET}}$ signal (with the addition of timing capacitor C3). R1 x C3 should be chosen to maintain $\overline{\text{ERROR}}$ below V_{IH} of the processor $\overline{\text{RESET}}$ 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.)

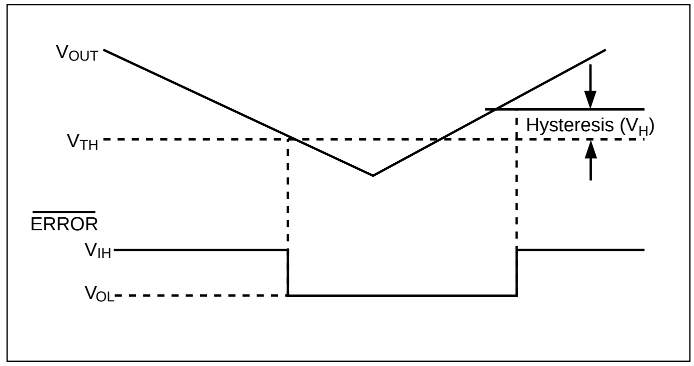


Figure 2: $\overline{\text{ERROR}}$ Output Operation

Thermal Considerations

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.

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:

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

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

Equation 1.

The maximum *allowable* power dissipation (Equation 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}).

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

Where all terms are previously defined.

Equation 2.

TC1265

Table 1 shows various values of θ_{JA} for the TC1265 mounted on a 1/16 inch, 2-layer PCB with 1 oz. copper foil.

Table 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

NOTES: *Pin 2 is ground. Device is mounted on topside.

Table 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

NOTES: *Tab of device attached to topside copper

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

GIVEN:
$V_{INMAX} = 3.3V \pm 10\%$
$V_{OUTMIN} = 2.7V \pm 0.5\%$
$I_{LOADMAX} = 275mA$
$T_{JMAX} = 125°C$
$T_{AMAX} = 95°C$
$\theta_{JA} = 60°C/W(SOIC)$

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

Actual power dissipation:

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

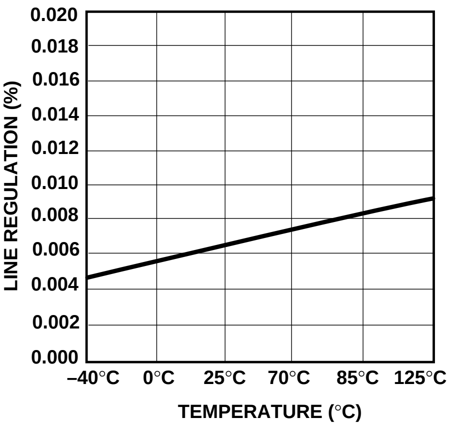
Maximum allowable power dissipation:

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

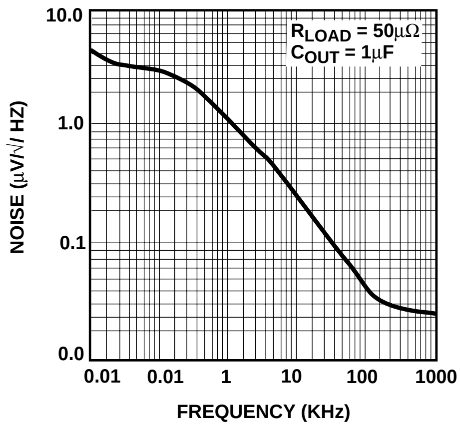
In this example, the TC1265 dissipates a maximum of only 260mW; far below the allowable limit of 500 mW. In a similar manner, Equation 1 and Equation 2 can be used to calculate maximum current and/or input voltage limits. For example, the maximum allowable V_{IN} is found by substituting the maximum allowable power dissipation of 500 mW into Equation 1, from which V_{INMAX} = 4.6V.

TYPICAL CHARACTERISTICS

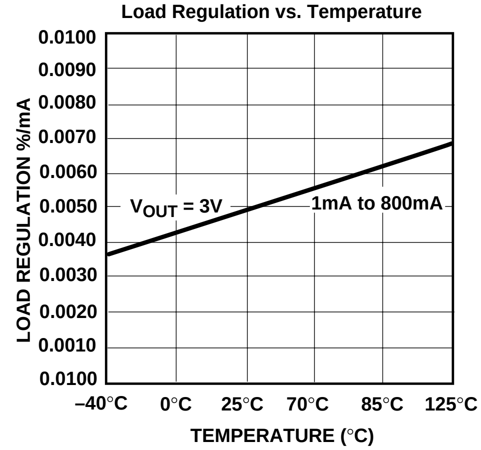
Line Regulation vs. Temperature



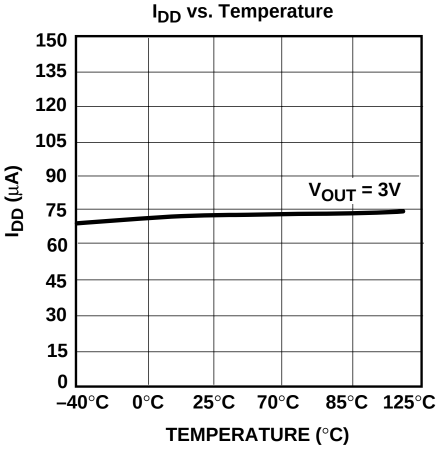
Output Noise vs. Frequency



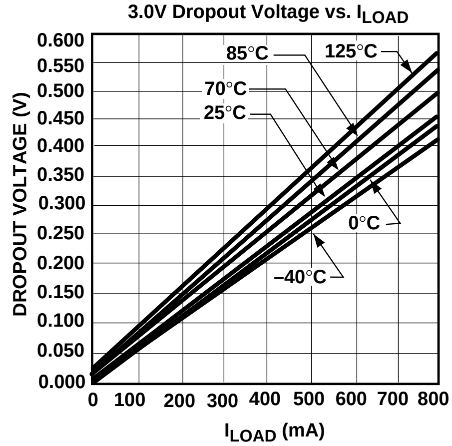
Load Regulation vs. Temperature



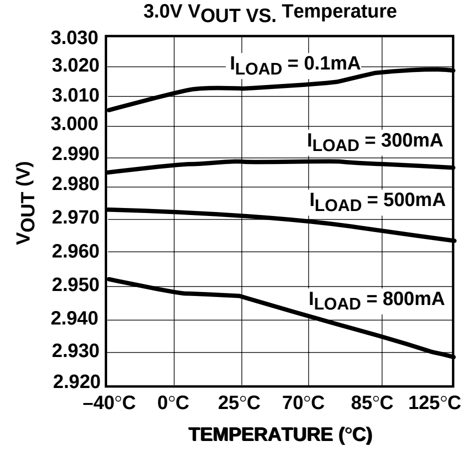
I_{DD} vs. Temperature



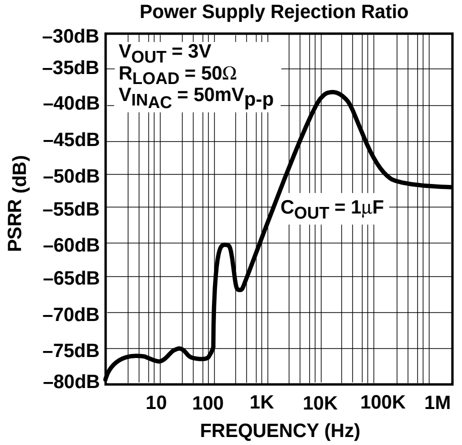
3.0V Dropout Voltage vs. I_{LOAD}



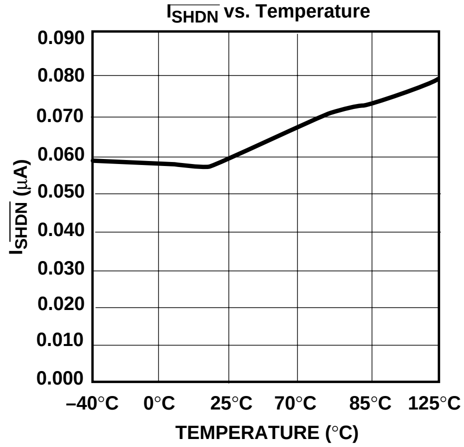
3.0V V_{OUT} VS. Temperature



Power Supply Rejection Ratio



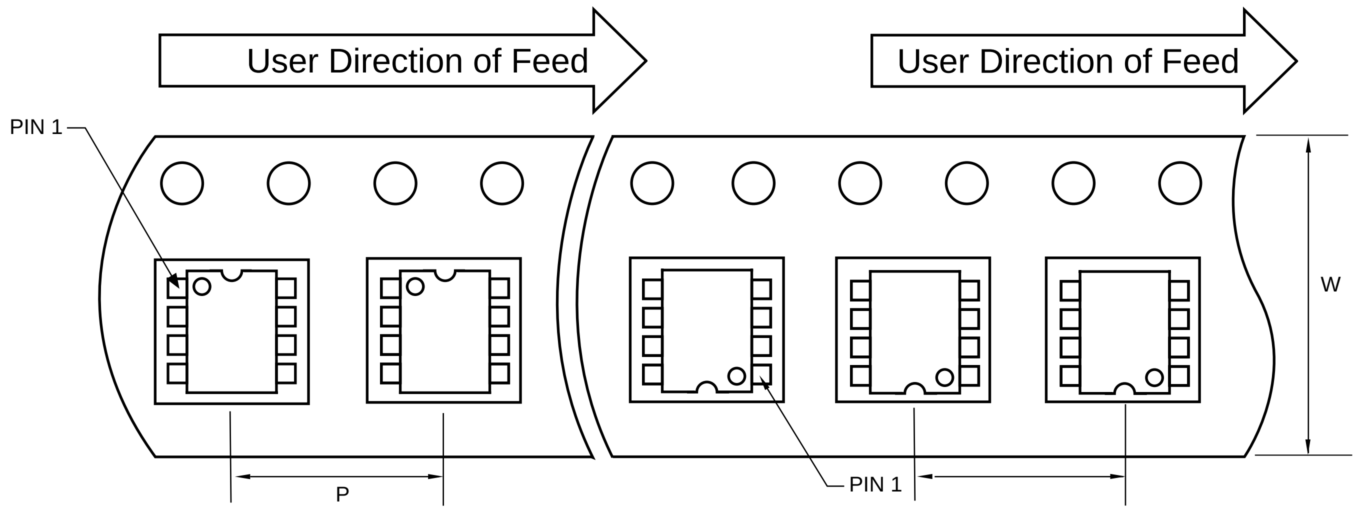
$I_{\overline{SHDN}}$ vs. Temperature



TC1265

TAPING FORM

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



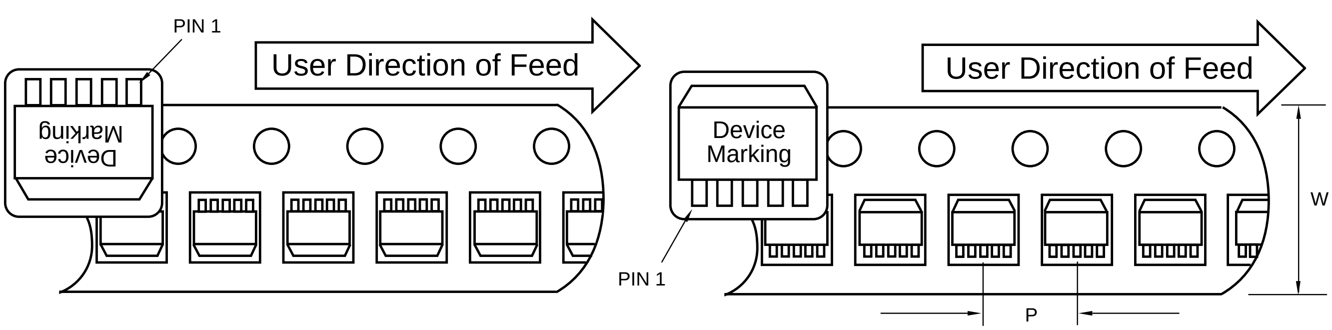
Standard Reel Component Orientation
for TR Suffix Device

Standard Reel Component Orientation
for RT 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)

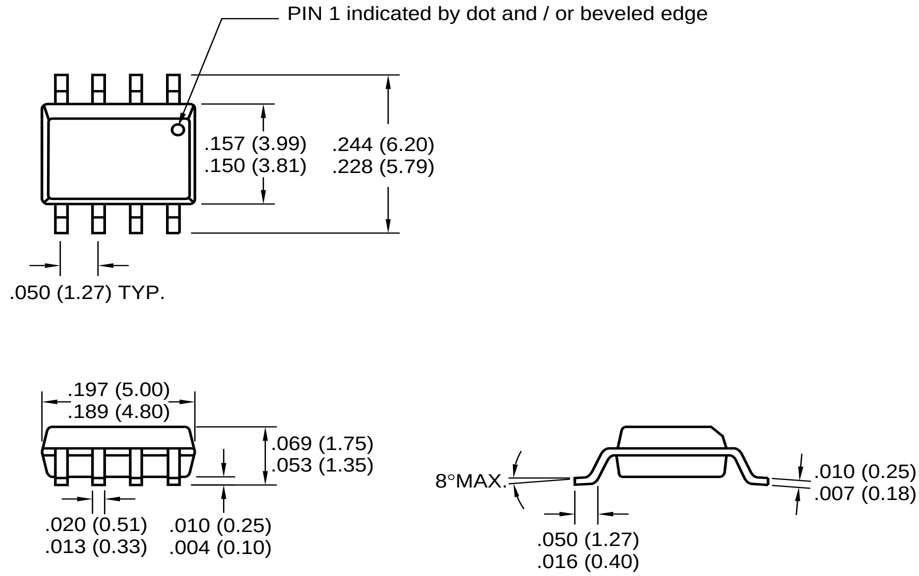
Reverse Reel Component Orientation
for RT Suffix Device
(Mark Upside Down)

Carrier Tape, Number of Components Per Reel and Reel Size

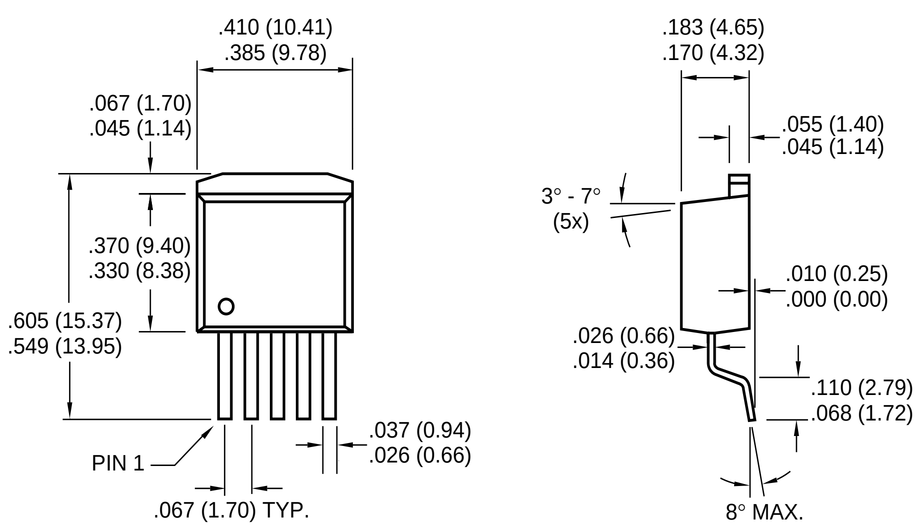
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
5-Pin DDPAK	24 mm	16 mm	750	13 in

PACKAGE DIMENSIONS

8-Pin SOIC



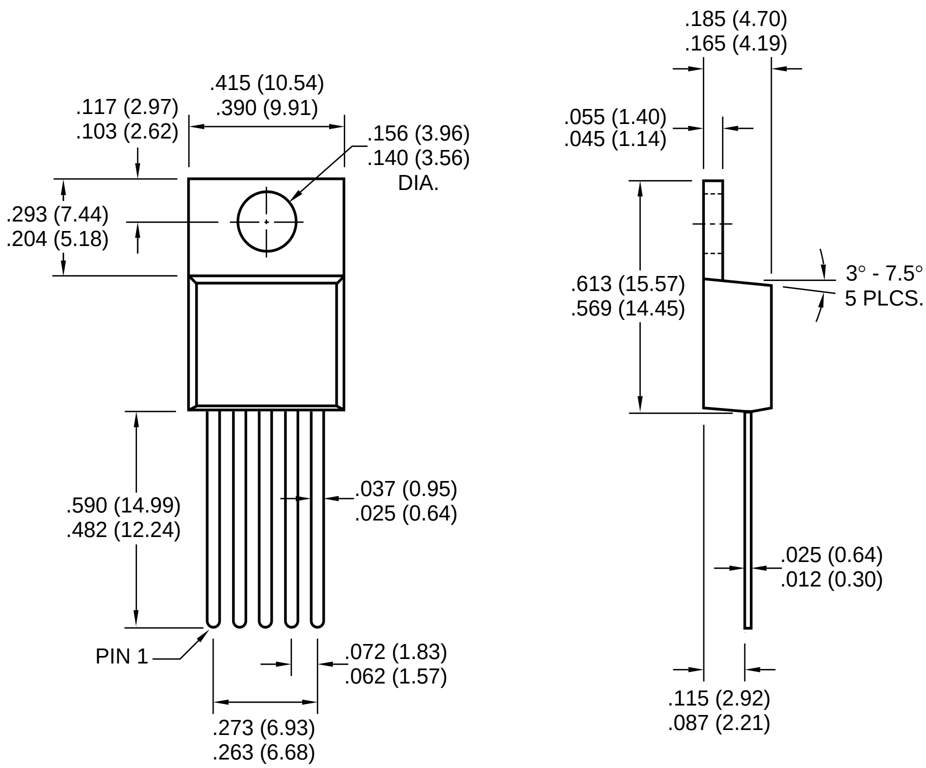
5-Pin DDPAK



Dimensions: inches (mm)

PACKAGE DIMENSIONS (CONT.)

5-Pin TO-220



Dimensions: inches (mm)

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