# TC1266

## 200mA PCI LDO

### Features

- Glitch Free Transition Between Input Sources
- Automatic Input Source Selection
- External PMOS Bypass Switch Control
- Built-in 5V Detector
- 1% Regulated Output Voltage Accuracy
- 200mA Load Current Capability
- Kelvin Sense Input
- Low Dropout Voltage (240mV @ Full Load)
- Low Ground Current, Independent of Load

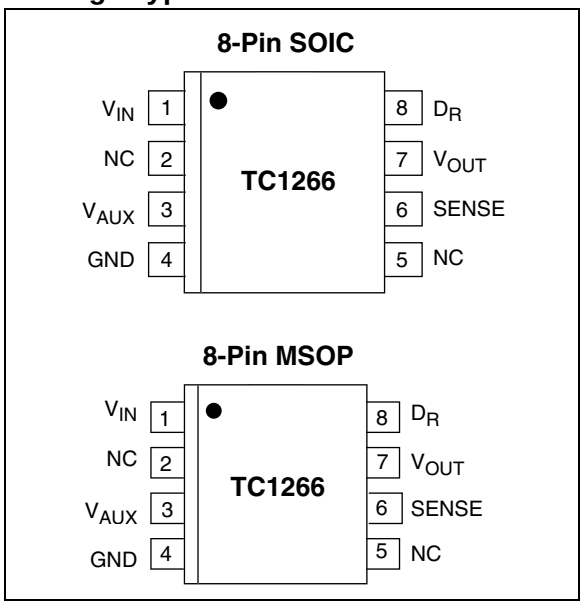
### Applications

- PCMCIA
- PCI
- Network Interface Cards (NICs)
- Cardbus™ Technology

### Device Selection Table

| Part Number | Package | Junction Temp. Range |
|---|---|---|
| TC1266VOA | 8-Pin SOIC (Narrow) | -5°C to +125°C |
| TC1266VUA | 8-Pin MSOP | -5°C to +125°C |

### Package Type

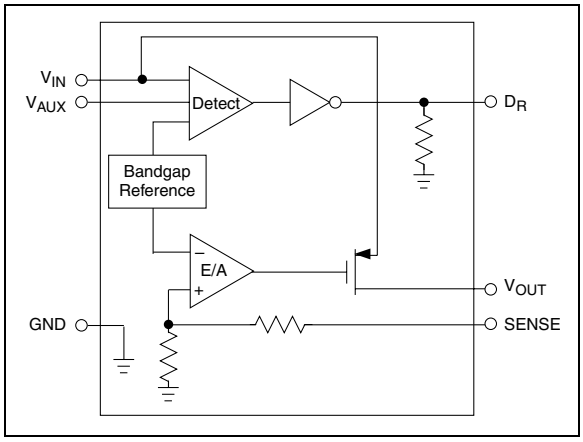



### General Description

The TC1266 is an application-specific, low dropout regulator (LDO), specifically intended for use in PCI peripheral card applications complying with PCI Power Management (PCI 2.0). It provides an uninterrupted, 3.3V, 200mA (max) output voltage when the main (5V) or auxiliary (3.3V) input voltage supplies are present.

The TC1266 consists of an LDO, a voltage threshold detector, external switchover logic and gate drive circuitry. It functions as a conventional LDO as long as the voltage on the main supply input ($V_{IN}$) is above the lower threshold (3.90V typical). Should the voltage on $V_{IN}$ fall below the lower threshold, the LDO is disabled and an external P-channel MOSFET is automatically turned on, connecting the auxiliary supply input to $V_{OUT}$, and ensuring an uninterrupted 3.3V output. The main supply is automatically selected, if both the main and auxiliary input supplies are present, and transition from one input supply to the other is ensured glitch-free. High integration, automatic secondary supply switchover, Kelvin sensing, and small size make the TC1266 the optimum LDO for PCI 2.0 applications.

### Functional Block Diagram



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings*

Input Supply Voltage ($V_{IN}$).....-0.5V to +7V (Max)
Auxiliary Supply Voltage ($V_{AUX}$) .....-0.5V to +7V (Max)
LDO Output Current ($I_{OUT}$).....200mA
Thermal Impedance,
Junction-to-Ambient ($\theta_{JA}$).....130°C/W for SOIC
ESD Rating ..... 2 KV
Operating Temperature Range ($T_A$).....-5°C to +70°C
Storage Temperature Range ($T_{STG}$)...-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.

### TC1266 ELECTRICAL SPECIFICATIONS

**Electrical Characteristics:** $T_A$ = +25°C, $V_{IN}$ = 5V, $V_{AUX}$ = 3.3V, $I_{OUT}$ = 0.1mA, $C_{OUT}$ = 4.7µF, unless otherwise noted. **Boldface** type specifications apply over full operating temperature range.

| Symbol | Parameter | Min | Typ | Max | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $V_{IN}$ | Supply Voltage | **4.3** | **5.0** | **5.5** | V | $V_{AUX}$ = 0V |
| $I_{GND}$ | Ground Current | —<br>— | 230<br>260 | **450**<br>**500** | µA | $V_{AUX}$ = 0V **(Note 6)**<br>$V_{AUX}$ = 3.3V **(Note 6)** |
| $I_{VIN}$ | Reverse Leakage from $V_{AUX}$ | — | -0.1 | **-1.0** | µA | $V_{AUX}$ = 3.6V, $V_{IN}$ = 0V, $I_{OUT}$ = 0mA |
| $V_{AUX}$ | Supply Voltage | **3.0** | **3.3** | **3.6** | V | |
| $I_{Q(AUX)}$ | Quiescent Current | —<br>— | 50<br>— | 70<br>**100** | µA | $V_{IN}$ = 0V, $I_{OUT}$ = 0mA |
| | | —<br>— | 60<br>— | 80<br>**120** | µA | $V_{IN}$ = 5V, $I_{OUT}$= 0mA |
| $I_{VAUX}$ | Reverse Leakage from $V_{IN}$ | — | -0.1 | **-1.0** | µA | $V_{IN}$ = 5,5V, $V_{AUX}$ = 0V, $I_{OUT}$ = 0mA |
| $V_{TH(LO)}$ | 5V Detector<br>Low Threshold Voltage | —<br>**3.75** | 3.90<br>— | —<br>**4.05** | V | $V_{IN}$ Falling **(Notes 2, 3)** |
| $V_{HYST}$ | 5V Detector<br>Hysteresis Voltage | —<br>**200** | 260<br>— | —<br>**300** | mV | **(Notes 2, 3)** |
| $V_{TH(HI)}$ | 5V Detector<br>High Threshold Voltage | —<br>**4.0** | 4.15<br>— | —<br>**4.30** | V | $V_{IN}$ Rising **(Notes 2, 3)** |
| $V_{OUT}$ | LDO Output Voltage | — | 3.300 | — | V | $I_{OUT}$ = 20mA |
| | | **3.234** | — | **3.366** | | 4.3V ≤ $V_{IN}$ ≤ 5.5V, 0mA ≤ $I_{OUT}$ ≤ 200mA |
| | | **3.000** | — | — | | 3.75V ≤ $V_{IN}$ ≤ 4.3V,<br>0mA ≤ $I_{OUT}$ ≤ 200mA **(Note 4)** |
| $I_{OUT}$ | Output Current | 200 | — | — | mA | |
| $REG_{(LINE)}$ | Line Regulation | —<br>**-0.5** | 0.05<br>— | —<br>**0.5** | % | $V_{IN}$ = 4.3V to 5.5V |
| $REG_{(LOAD)}$ | Load Regulation | —<br>**-0.5** | 0.05<br>— | —<br>**0.5** | % | $I_{OUT}$= 0.1mA to 200mA |

**Note 1:** Ensured by design.
**2:** See 5V Detect Thresholds, Figure 4-1.
**3:** Recommended source impedance for 5V supply: ≤ 0.25Ω. This will ensure that $I_{OUT}$ x $R_{SOURCE}$ < $V_{HYST}$, thus avoiding $D_R$ toggling during 5V detect threshold transitions.
**4:** In Application Circuit, Figure 3-1.
**5:** See Timing Diagram, Figure 4-2.
**6:** Ground Current is independent of $I_{LOAD}$.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## TC1266 ELECTRICAL SPECIFICATIONS (CONTINUED)

**Electrical Characteristics:** $T_A$ = +25°C, $V_{IN}$ = 5V, $V_{AUX}$ = 3.3V, $I_{OUT}$ = 0.1mA, $C_{OUT}$ = 4.7µF, unless otherwise noted. **Boldface** type specifications apply over full operating temperature range.

| Symbol | Parameter | Min | Typ | Max | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $V_{DR}$ | Drive Voltage | $V_{IN}$ - 0.2<br>**$V_{IN}$ - 0.3** | $V_{IN}$ - 0.1<br>— | —<br>— | V | 4.3V ≤ $V_{IN}$ ≤ 5.5V, $I_{DR}$ = 200µA |
| | | —<br>— | 35<br>— | 150<br>**200** | mV | $V_{IN}$ < $V_{TH(LO)}$, $I_{DR}$ = 200µA |
| $I_{DR(PK)}$ | Peak Drive Current | 7<br>**6** | —<br>— | —<br>— | mA | Sinking: $V_{IN}$ = 3.75V, $V_{DR}$ = 1V;<br>Sourcing: $V_{IN}$ = 4.3V, $V_{IN}$ – $V_{DR}$ = 2V |
| $t_{DH}$ | Drive High Delay<br>**(Notes 1, 5)** | —<br>— | 4<br>— | —<br>**8** | µsec | $C_{DR}$ = 1.2nF, $V_{IN}$ ramping up,<br>measured from $V_{IN}$ = $V_{TH(HI)}$ to $V_{DR}$ = 2V |
| $t_{DL}$ | Drive Low Delay<br>**(Notes 1, 5)** | —<br>— | 0.6<br>— | 1.5<br>**3.0** | µsec | $C_{DR}$ = 1.2nF, $V_{IN}$ ramping down,<br>measured from $V_{IN}$ = $V_{TH(LO)}$ to $V_{DR}$ = 2V |

**Note 1:** Ensured by design.
**2:** See 5V Detect Thresholds, Figure 4-1.
**3:** Recommended source impedance for 5V supply: ≤ 0.25Ω. This will ensure that $I_{OUT}$ x $R_{SOURCE}$ < $V_{HYST}$, thus avoiding $D_R$ toggling during 5V detect threshold transitions.
**4:** In Application Circuit, Figure 3-1.
**5:** See Timing Diagram, Figure 4-2.
**6:** Ground Current is independent of $I_{LOAD}$.

## 2.0 PIN DESCRIPTIONS

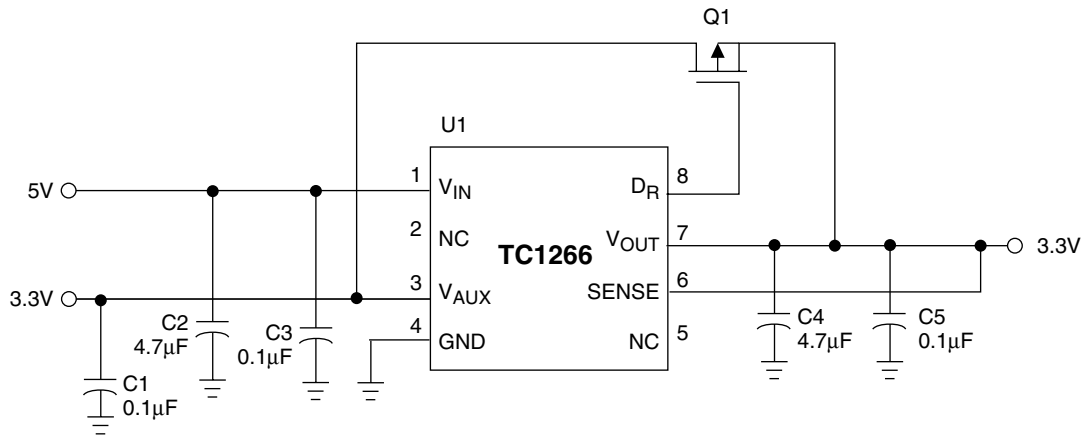
The descriptions of the pins are listed in Table 2-1.

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

| Pin No. (8-Pin SOIC) (8-Pin MSOP) | Symbol | Description |
|---|---|---|
| 1 | $V_{IN}$ | Main input supply for the TC1266, nominally 5V. |
| 2 | NC | Not connected. |
| 3 | $V_{AUX}$ | Auxiliary input supply, nominally 3.3V. |
| 4 | GND | Logic and power ground. |
| 5 | NC | Not connected. |
| 6 | SENSE | Sense pin for $V_{OUT}$. Connect to $V_{OUT}$ at the load to minimize voltage drop across PCB traces. |
| 7 | $V_{OUT}$ | LDO 3.3V output. |
| 8 | $D_R$ | Driver output for external P-channel MOSFET pass element. |

## 3.0 DETAILED DESCRIPTION

**FIGURE 3-1: APPLICATION CIRCUIT**




**NOTE:** External switch (Q1): use Motorola MGSF1P02ELT1 or equivalent
(PMOS, typical Gate Threshold Voltage = 1V, typical $R_{DS(ON)}$ = 0.4Ω at VGS = 2.5V)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# 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.

Equation 4-1 can be used in conjunction with Equation 4-2 to ensure regulator thermal operation is within limits. For example:

Given:

$V_{INMAX}$ = 5V ± 5%
$V_{OUTMIN}$ = 3.217V
$I_{LOADMAX}$ = 200mA
$T_{JMAX}$ = 125°C
$T_{AMAX}$ = 70°C
$\theta_{JA}$ = 130°C/W (SOIC)

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

Actual power dissipation:

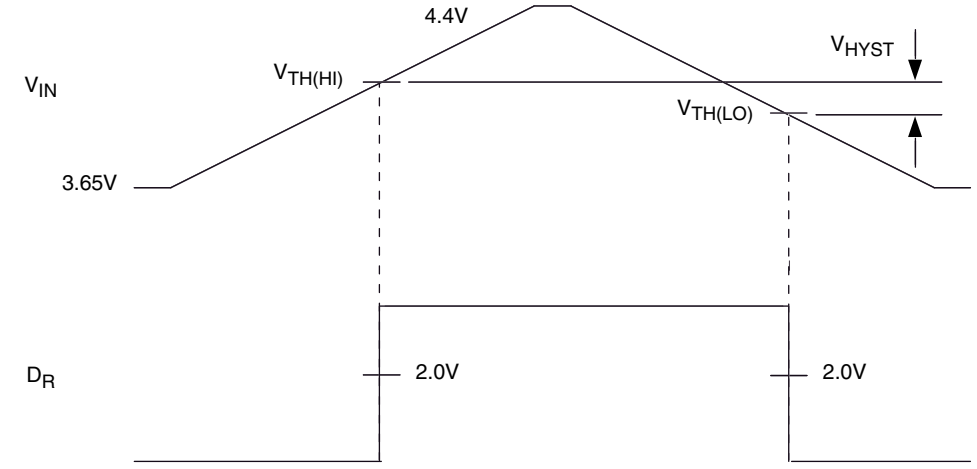
$$P_D \approx (V_{INMAX} - V_{OUTMIN})I_{LOADMAX}$$
$$= (5.25V - 3.217V)\ 200mA$$
$$= 407mW$$

Maximum allowable power dissipation:

$$P_{DMAX} = \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}}$$
$$= \frac{(125 - 70)}{130}$$
$$= 423mW$$

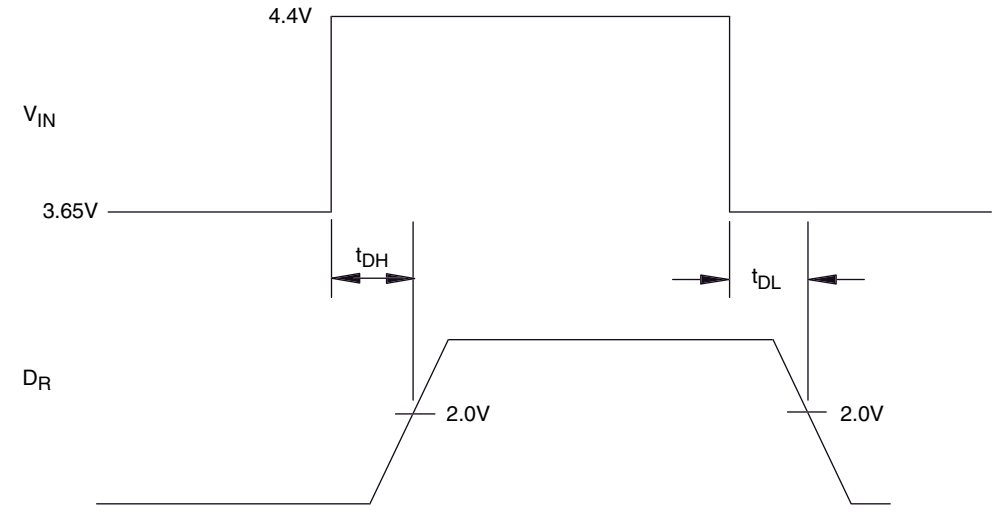
In this example, the TC1266 dissipates a maximum of 407mW; below the allowable limit of 423mW.

**FIGURE 4-1: 5V DETECT THRESHOLD**




**NOTE:** $V_{IN}$ rise and fall times (10% to 90%) to be ≥ 100µsec.

**FIGURE 4-2: TIMING DIAGRAM**




**NOTE:** $V_{IN}$ rise and fall times (10% to 90%) to be ≤ 0.1µsec.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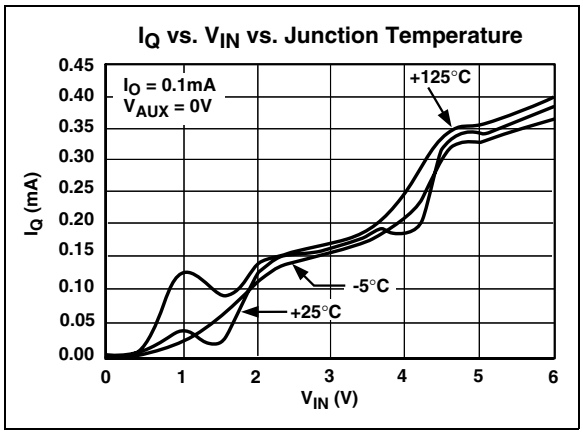
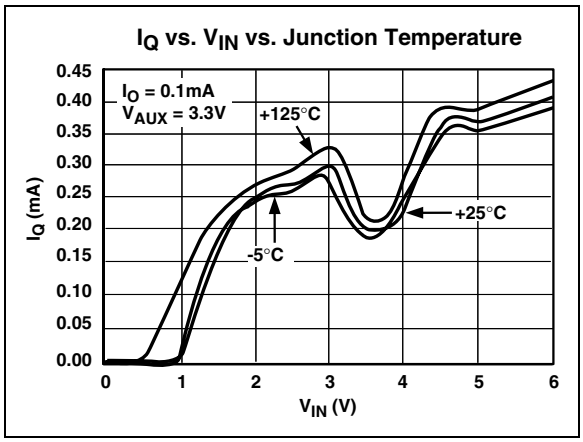
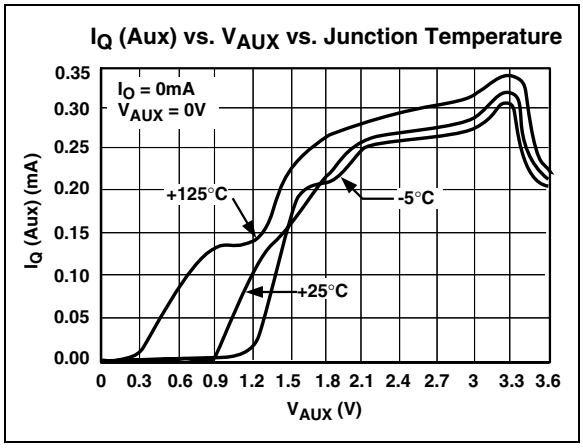
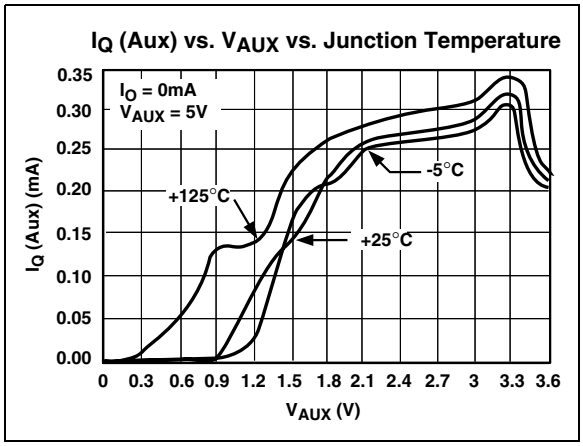
## 5.0 TYPICAL CHARACTERISTICS

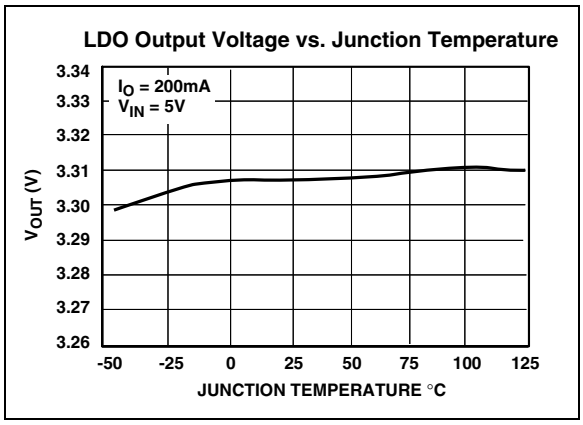
**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be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



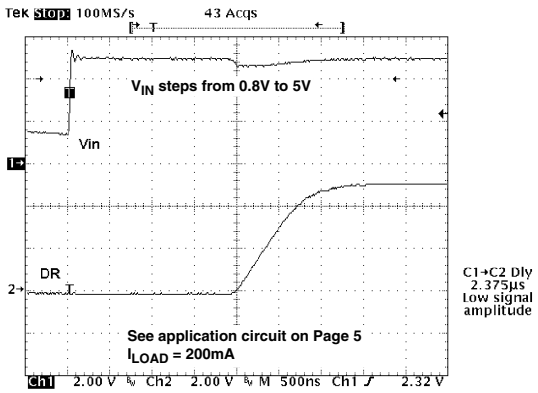



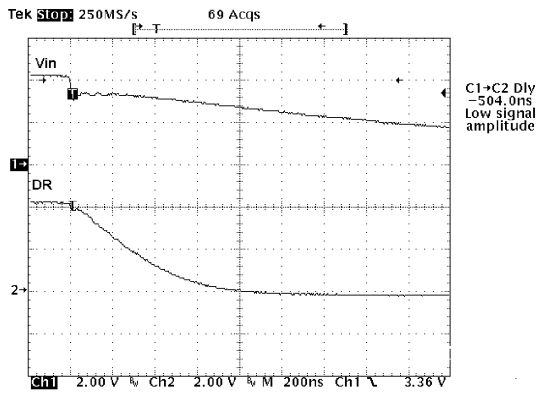
## 5.0 TYPICAL CHARACTERISTICS (CONTINUED)

**Drive High Delay**



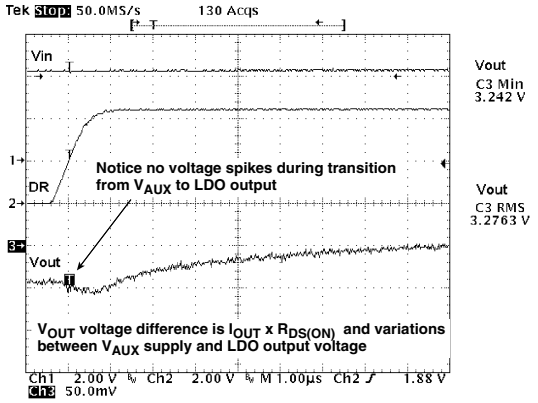

Trace 1: $V_{IN}$ stepping for 0.8V to 5V
Trace 2: $D_R$ going high at $V_{TH(HI)}$
TDH = < 4µS

**Drive Low Delay**



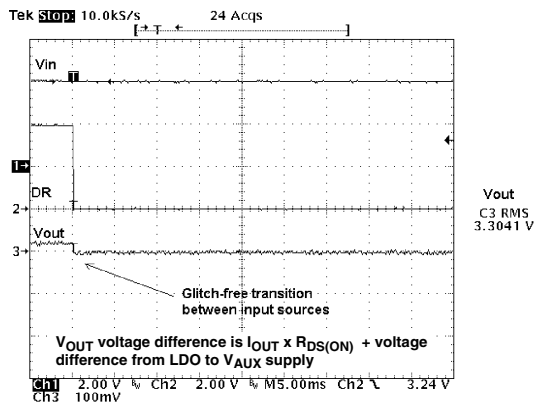

Trace 1: $V_{IN}$ stepping for 5.5V to 0V
Trace 2: $D_R$ going low
TDL = < 600nS

**$V_O$ (min) with $V_{IN}$ Rising**




Trace 1: $V_{IN}$ – 3A charging a 1500µF capacitor
Trace 2: $D_R$ going high at $V_{TH(HI)}$
Trace 3: $V_{OUT}$, offset 3.3V. $V_{OUT(min)}$ = 3.24V
$I_{LOAD}$ = 200µA

**$V_O$ (min) with $V_{IN}$ Falling**




Trace 1: $V_{IN}$ – discharging a 1500µF capacitor
Trace 2: $D_R$ going low at $V_{TH(LO)}$
Trace 3: $V_{OUT}$, offset 3.3V. $V_{OUT(min)}$ = 3.14V
$I_{LOAD}$ = 200µA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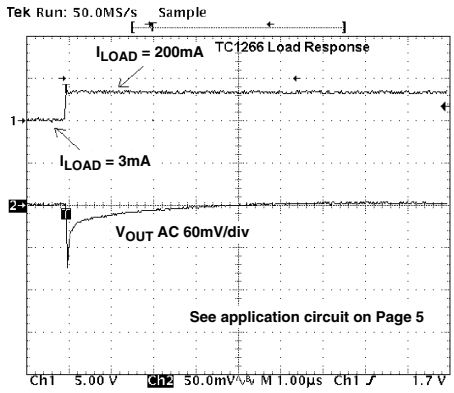
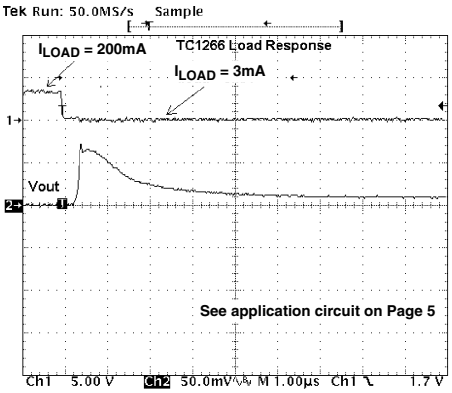
## 5.0 TYPICAL CHARACTERISTICS (CONTINUED)

**Load Response Rising Edge**




**Load Response Falling Edge**



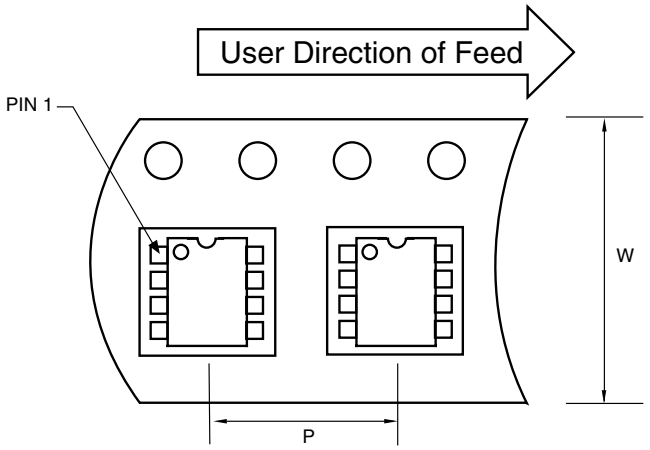
## 6.0 PACKAGING INFORMATION

### 6.1 Package Marking Information

Package marking data not available at this time.

### 6.2 Taping Form

**Component Taping Orientation for 8-Pin MSOP Devices**

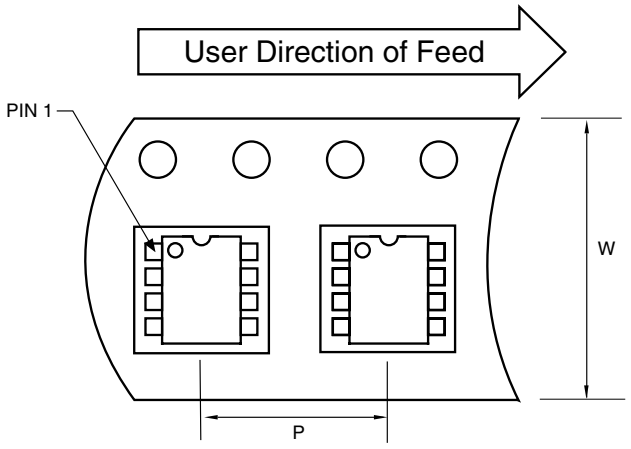



Standard Reel Component Orientation
for TR Suffix Device

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

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

**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 |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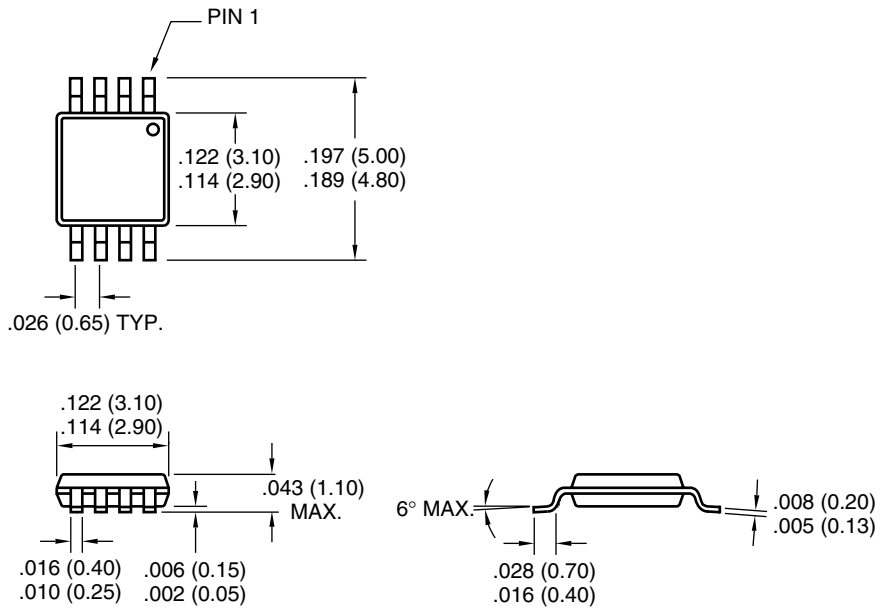
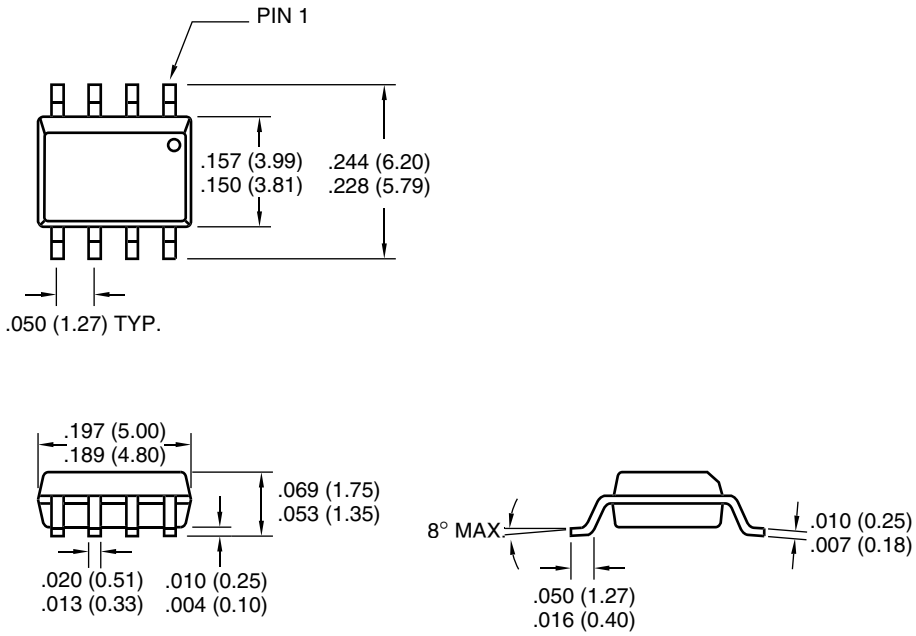
## 6.3 Package Dimensions

### 8-Pin MSOP




**Dimensions: inches (mm)**

### 8-Pin SOIC




**Dimensions: inches (mm)**

**NOTES:**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**Data Sheets**
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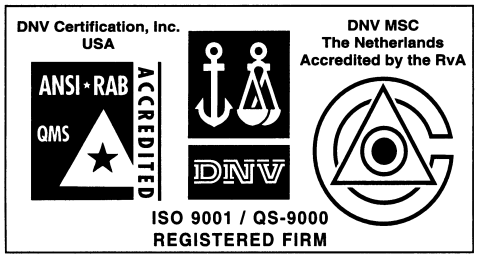


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05/01/02


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