

## TL499A Wide-Range Power-Supply Controllers

## 1 Features

- Internal Series-Pass and Step-Up Switching Regulator
- Output Adjustable From 2.9 V to 30 V
- 1-V to 10-V Input for Switching Regulator
- 4.5-V to 32-V Input for Series Regulator
- Externally Controlled Switching Current
- No External Rectifier Required

## 2 Applications

- Voltage Boosting
- Dual-Supply Voltage Regulation
- Battery Back-Ups
- Microprocessor Memory Power

### 3 Description

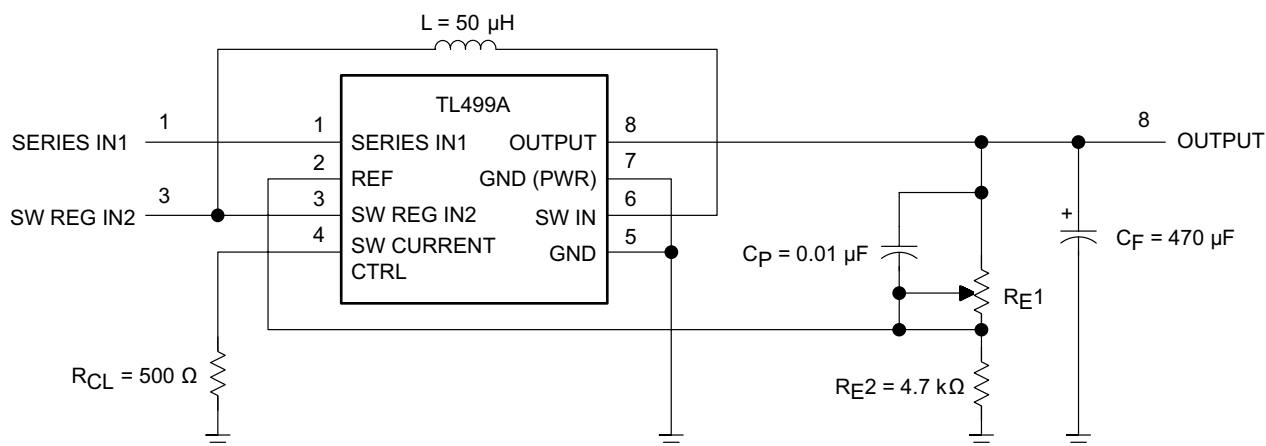
The TL499A device is an integrated circuit designed to provide a wide range of adjustable regulated supply voltages. The regulated output voltage can be varied from 2.9 V to 30 V by adjusting two external resistors. When the TL499A is ac-coupled to line power through a step-down transformer, it operates as a series DC voltage regulator to maintain the regulated output voltage. With the addition of a battery from 1.1 V to 10 V, an inductor, a filter capacitor, and two resistors, the TL499A operates as a step-up switching regulator during an AC-line failure. The adjustable regulated output voltage makes the TL499A useful for a wide range of applications. Providing backup power during an AC-line failure makes the TL499A extremely useful in microprocessor memory applications. The TL499AC is characterized for operation from  $-20^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

### Device Information<sup>(1)</sup>

| PART NUMBER | PACKAGE (PIN) | BODY SIZE (NOM)   |
|-------------|---------------|-------------------|
| TL499A      | SO (8)        | 6.20 mm × 5.30 mm |
|             | PDIP (8)      | 9.81 mm × 6.35 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

## Typical Application



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

## Table of Contents

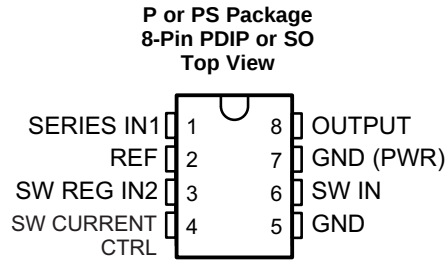
|                                                |          |                                                                  |           |
|------------------------------------------------|----------|------------------------------------------------------------------|-----------|
| <b>1 Features</b> .....                        | <b>1</b> | 7.3 Feature Description .....                                    | <b>6</b>  |
| <b>2 Applications</b> .....                    | <b>1</b> | 7.4 Device Functional Modes .....                                | <b>6</b>  |
| <b>3 Description</b> .....                     | <b>1</b> | <b>8 Application and Implementation</b> .....                    | <b>7</b>  |
| <b>4 Revision History</b> .....                | <b>2</b> | 8.1 Application Information .....                                | <b>7</b>  |
| <b>5 Pin Configuration and Functions</b> ..... | <b>3</b> | 8.2 Typical Application .....                                    | <b>7</b>  |
| <b>6 Specifications</b> .....                  | <b>3</b> | <b>9 Power Supply Recommendations</b> .....                      | <b>10</b> |
| 6.1 Absolute Maximum Ratings .....             | <b>3</b> | <b>10 Layout</b> .....                                           | <b>11</b> |
| 6.2 ESD Ratings .....                          | <b>3</b> | 10.1 Layout Guidelines .....                                     | <b>11</b> |
| 6.3 Recommended Operating Conditions .....     | <b>4</b> | 10.2 Layout Example .....                                        | <b>11</b> |
| 6.4 Thermal Information .....                  | <b>4</b> | <b>11 Device and Documentation Support</b> .....                 | <b>12</b> |
| 6.5 Electrical Characteristics .....           | <b>4</b> | 11.1 Community Resources .....                                   | <b>12</b> |
| 6.6 Typical Characteristics .....              | <b>5</b> | 11.2 Trademarks .....                                            | <b>12</b> |
| <b>7 Detailed Description</b> .....            | <b>6</b> | 11.3 Electrostatic Discharge Caution .....                       | <b>12</b> |
| 7.1 Overview .....                             | <b>6</b> | 11.4 Glossary .....                                              | <b>12</b> |
| 7.2 Functional Block Diagram .....             | <b>6</b> | <b>12 Mechanical, Packaging, and Orderable Information</b> ..... | <b>12</b> |

## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision G (September 2001) to Revision H                                                                                                                                                                                                                                                                                                                                                                                              | Page     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <ul style="list-style-type: none"> <li>Added <i>Pin Configuration and Functions</i> section, <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i>, <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section .....</li> </ul> | <b>1</b> |

## 5 Pin Configuration and Functions



### Pin Functions

| PIN             |     | I/O | DESCRIPTION                                   |
|-----------------|-----|-----|-----------------------------------------------|
| NAME            | NO. |     |                                               |
| GND             | 5   | —   | Signal ground.                                |
| GND (PWR)       | 7   | —   | Power ground.                                 |
| OUTPUT          | 8   | O   | Regulated output                              |
| REF             | 2   | I   | Feedback tap for output voltage               |
| SERIES IN1      | 1   | —   | Power source for series voltage regulator.    |
| SW CURRENT CTRL | 4   | I/O | Resistor to ground controls switching current |
| SW IN           | 6   | I/O | Step up switching inductor node               |
| SW REG IN2      | 3   | —   | Power source for step-up switching regulator. |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                  |                                                              | MIN  | MAX | UNIT |
|------------------|--------------------------------------------------------------|------|-----|------|
| V <sub>O</sub>   | Output voltage <sup>(2)</sup>                                | −0.3 | 35  | V    |
| V <sub>I1</sub>  | Input voltage, series regulator                              | −0.3 | 35  | V    |
| V <sub>I2</sub>  | Input voltage, switching regulator                           | −0.3 | 10  | V    |
|                  | Blocking-diode reverse voltage                               |      | 35  | V    |
|                  | Blocking-diode forward current                               |      | 1   | A    |
| SW IN            | Power switch current                                         |      | 1   | A    |
|                  | Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds |      | 260 | °C   |
| T <sub>J</sub>   | Junction temperature                                         |      | 150 | °C   |
| T <sub>stg</sub> | Storage temperature                                          | −65  | 150 | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to network ground terminal.

### 6.2 ESD Ratings

|                    |                         | VALUE                                                                          | UNIT  |
|--------------------|-------------------------|--------------------------------------------------------------------------------|-------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | ±200  |
|                    |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | ±2000 |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions. Pins listed as ±200-V may actually have higher performance.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                                                                                                 | MIN | NOM | MAX  | UNIT         |
|-------------------------------------------------------------------------------------------------|-----|-----|------|--------------|
| Output voltage, $V_O$                                                                           | 2.9 |     | 30   | V            |
| Input voltage, $V_{I1}$ (SERIES IN1)                                                            | 4.5 |     | 32   | V            |
| Input voltage, $V_{I2}$ (SW REG IN2)                                                            | 1.1 |     | 10   | V            |
| Output-to-input differential voltage, switching regulator, $V_O - V_{I2}$ (see <sup>(1)</sup> ) | 1.2 |     | 28.9 | V            |
| Continuous output current, $I_O$                                                                |     |     | 100  | mA           |
| Power switch current (at SW IN)                                                                 |     |     | 500  | mA           |
| Current-limiting resistor, $R_{CL}$                                                             | 150 |     | 1000 | $\Omega$     |
| Filter capacitor                                                                                | 100 |     | 470  | $\mu$ F      |
| Pass capacitor                                                                                  |     | 0.1 |      | $\mu$ F      |
| Inductor, L (dcr $\leq 0.1 \Omega$ )                                                            | 50  |     | 150  | $\mu$ H      |
| Operating free-air temperature, $T_A$                                                           | -20 |     | 85   | $^{\circ}$ C |

- (1) When operating temperature range is  $T_A \leq 70^{\circ}\text{C}$ , minimum  $V_O - V_{I2}$  is  $\geq 1.2$  V. When operating temperature range is  $T_A \leq 85^{\circ}\text{C}$ , minimum  $V_O - V_{I2}$  is  $\geq 1.9$  V.

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                                          | TL499A   |         | UNIT                 |
|-------------------------------|----------------------------------------------------------|----------|---------|----------------------|
|                               |                                                          | P (PDIP) | PS (SO) |                      |
|                               |                                                          | 8 PINS   | 8 PINS  |                      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance <sup>(2)(3)</sup> | 49.7     | 110.7   | $^{\circ}\text{C/W}$ |
| $R_{\theta JC(\text{top})}$   | Junction-to-case (top) thermal resistance                | 38.8     | 69.0    | $^{\circ}\text{C/W}$ |
| $R_{\theta JB}$               | Junction-to-board thermal resistance                     | 26.9     | 55.7    | $^{\circ}\text{C/W}$ |
| $\psi_{JT}$                   | Junction-to-top characterization parameter               | 16.1     | 20.1    | $^{\circ}\text{C/W}$ |
| $\psi_{JB}$                   | Junction-to-board characterization parameter             | 26.7     | 54.9    | $^{\circ}\text{C/W}$ |

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).  
(2) Maximum power dissipation is a function of  $T_{J(\text{max})}$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_{J(\text{max})} - T_A) / \theta_{JA}$ . Operating at the absolute maximum  $T_J$  of  $150^{\circ}\text{C}$  can affect reliability.  
(3) The package thermal impedance is calculated in accordance with JESD 51-7.

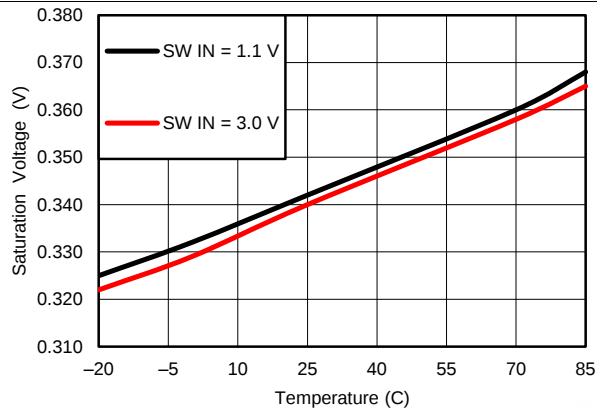
### 6.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

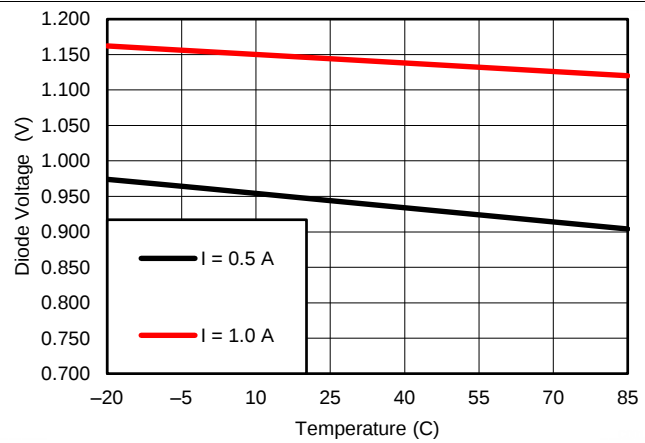
| PARAMETER                                         |                                   | TEST CONDITIONS                                                                       | MIN | TYP  | MAX  | UNIT    |
|---------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------|-----|------|------|---------|
| Voltage deviation (see <sup>(1)</sup> )           |                                   |                                                                                       |     | 20   | 30   | mV/V    |
| $V_O - V_{I2}$                                    | Switching regulator minimum boost | $T_A = -20^{\circ}\text{C}$ to $70^{\circ}\text{C}$                                   | 1.2 |      |      | V       |
|                                                   |                                   | $T_A = -20^{\circ}\text{C}$ to $85^{\circ}\text{C}$                                   | 1.9 |      |      |         |
| Dropout voltage                                   | Series regulator                  | $V_{I1} = 15$ V, $I_O = 50$ mA                                                        |     |      | 1.8  | V       |
| Reference voltage (internal)                      |                                   | $V_{I1} = 5$ V, $V_O = 3$ V, $I_O = 1$ mA                                             | 1.2 | 1.26 | 1.32 | V       |
| Reference-voltage change with temperature         |                                   |                                                                                       |     | 5    | 10   | mV/V    |
| Output regulation (of reference voltage)          |                                   | $I_O = 1$ mA to 50 mA                                                                 |     | 10   | 30   | mV/V    |
| Output current<br>(see <a href="#">Figure 3</a> ) | Switching regulator               | $V_{I2} = 1.1$ V, $V_O = 12$ V,<br>$R_{CL} = 150 \Omega$ , $T_A = 25^{\circ}\text{C}$ |     |      | 10   | mA      |
|                                                   |                                   | $V_{I2} = 1.5$ V, $V_O = 15$ V,<br>$R_{CL} = 150 \Omega$ , $T_A = 25^{\circ}\text{C}$ |     |      | 15   |         |
|                                                   |                                   | $V_{I2} = 6$ V, $V_O = 30$ V,<br>$R_{CL} = 150 \Omega$ , $T_A = 25^{\circ}\text{C}$   |     |      | 65   |         |
|                                                   | Series regulator                  |                                                                                       |     |      | 100  |         |
| Standby current                                   | Switching regulator               | $V_{I2} = 3$ V, $V_O = 9$ V, $T_A = 25^{\circ}\text{C}$                               |     | 15   | 80   | $\mu$ A |
|                                                   | Series regulator                  | $V_{I1} = 15$ V, $V_O = 9$ V, $R_{E2} = 4.7$ k $\Omega$                               |     | 0.8  | 1.2  | mA      |

- (1) Voltage deviation is the output voltage difference that occurs in a change from series regulation to switching regulation: Voltage deviation =  $V_O$  (series regulation) –  $V_O$  (switching regulation)

## 6.6 Typical Characteristics



**Figure 1. Switch Saturation Voltage vs Temperature**



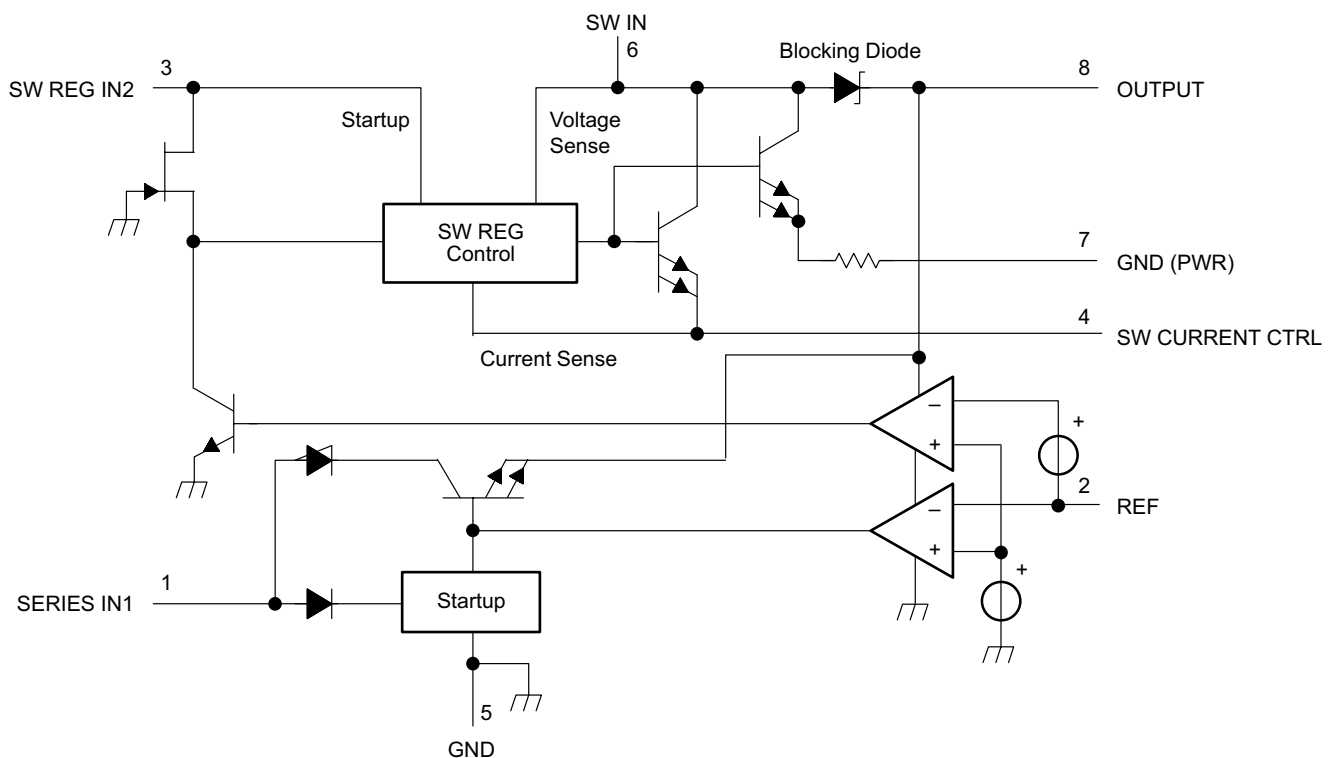
**Figure 2. Diode Forward Voltage vs Temperature**

## 7 Detailed Description

### 7.1 Overview

The TL499A provides an adjustable output voltage between 2.9 V and 30 V. The primary power source uses the internal linear regulator to provide the output voltage. When the primary power source is removed, the secondary power source is stepped up using the internal switching regulator to provide the output voltage.

### 7.2 Functional Block Diagram



### 7.3 Feature Description

The TL499A has an adjustable output voltage set by feedback provided to REF pin. An adjustable switching current is set by the value of the resistor on the SW CURRENT CONTROL pin. The lower resistance provides increased switching current.

Dual power supply inputs also provide protection against power faults on the main supply of the TL499A.

### 7.4 Device Functional Modes

The TL499A has two functional modes:

- Linear voltage regulation when SERIES IN1 supply is present.
- Step-up voltage regulation when SERIES IN1 supply is absent.

## 8 Application and Implementation

### NOTE

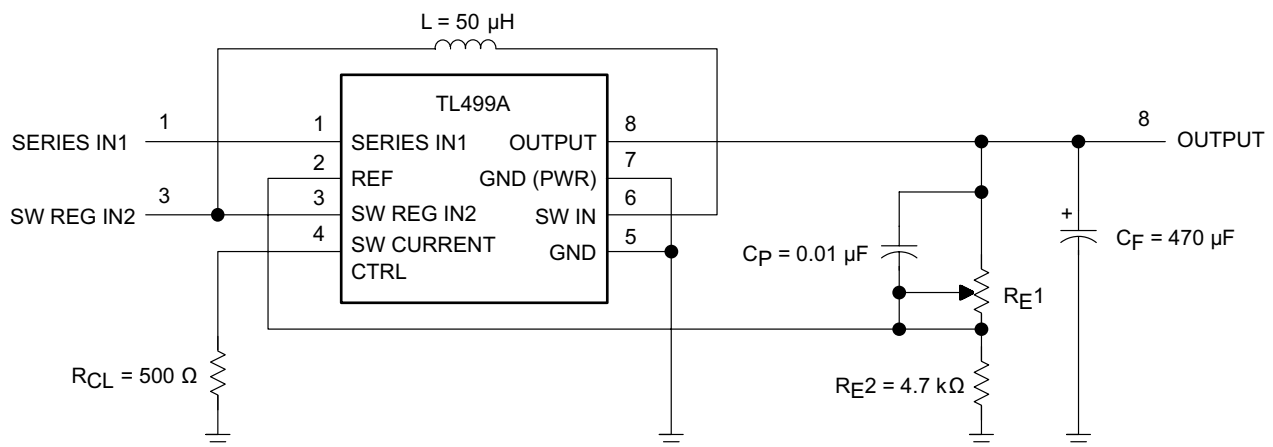
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 8.1 Application Information

One or two power sources will be regulated to an output voltage set by two feedback resistors.

### 8.2 Typical Application

Figure 3 shows the basic configuration of the two power source voltage regulator



**Figure 3. TL499A Basic Configuration**

#### 8.2.1 Design Requirements

Provide one or more of the following power sources:

- SERIES IN1 voltage greater than OUTPUT voltage by more than dropout voltage
- SW REG IN2 voltage less than OUTPUT voltage

Select  $R_{CL}$  value based on Table 1 through Table 5.

**Table 1. Maximum Output Current vs Input and Output Voltages for Step-Up Switching Regulator With  $R_{CL} = 150 \Omega$**

| OUTPUT<br>VOLTAGE (V) | SWITCHING REGULATOR INPUT VOLTAGE (SW REG IN2) (V) |     |     |     |     |    |     |     |     |     |     |
|-----------------------|----------------------------------------------------|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|
|                       | 1.1                                                | 1.2 | 1.3 | 1.5 | 1.7 | 2  | 2.5 | 3   | 5   | 6   | 9   |
|                       | OUTPUT CURRENT (mA)                                |     |     |     |     |    |     |     |     |     |     |
| 30                    |                                                    |     |     |     |     |    |     |     |     | 65  | 90  |
| 25                    |                                                    |     |     |     |     |    |     |     | 50  | 80  | 100 |
| 20                    |                                                    |     |     |     |     | 20 | 25  | 30  | 85  | 100 | 100 |
| 15                    |                                                    |     |     | 15  | 20  | 30 | 45  | 55  | 100 | 100 | 100 |
| 12                    | 10                                                 | 15  | 20  | 25  | 30  | 40 | 55  | 70  | 100 | 100 | 100 |
| 10                    | 15                                                 | 20  | 25  | 30  | 35  | 45 | 65  | 80  | 100 | 100 |     |
| 9                     | 20                                                 | 25  | 25  | 35  | 40  | 50 | 70  | 90  | 100 | 100 |     |
| 6                     | 30                                                 | 35  | 40  | 45  | 55  | 75 | 95  | 100 |     |     |     |

## Typical Application (continued)

**Table 1. Maximum Output Current vs Input and Output Voltages for Step-Up Switching Regulator With  $R_{CL} = 150\ \Omega$  (continued)**

| OUTPUT<br>VOLTAGE (V) | SWITCHING REGULATOR INPUT VOLTAGE (SW REG IN2) (V) |                   |                   |                    |                    |    |     |                    |                                                                                                                                |   |   |
|-----------------------|----------------------------------------------------|-------------------|-------------------|--------------------|--------------------|----|-----|--------------------|--------------------------------------------------------------------------------------------------------------------------------|---|---|
|                       | 1.1                                                | 1.2               | 1.3               | 1.5                | 1.7                | 2  | 2.5 | 3                  | 5                                                                                                                              | 6 | 9 |
|                       | OUTPUT CURRENT (mA)                                |                   |                   |                    |                    |    |     |                    |                                                                                                                                |   |   |
| 5                     | 35                                                 | 40                | 45                | 55                 | 70                 | 85 | 100 | 100                | Circuit of <a href="#">Figure 1</a> , except:<br>R <sub>CL</sub> = 150 Ω<br>C <sub>F</sub> = 330 μF<br>C <sub>P</sub> = 0.1 μF |   |   |
| 4.5                   | 35                                                 | 45                | 50                | 60                 | 75                 | 95 | 100 | 100 <sup>(1)</sup> |                                                                                                                                |   |   |
| 3                     | 55                                                 | 65 <sup>(1)</sup> | 75 <sup>(1)</sup> | 95 <sup>(1)</sup>  | 100 <sup>(1)</sup> |    |     |                    |                                                                                                                                |   |   |
| 2.9                   | 60 <sup>(1)</sup>                                  | 70 <sup>(1)</sup> | 75 <sup>(1)</sup> | 100 <sup>(1)</sup> | 100 <sup>(1)</sup> |    |     |                    |                                                                                                                                |   |   |

(1) The difference between the output and input voltage for these combinations is greater than the minimum output-to-input differential-voltage specification at 70°C (1.2 V), but less than the minimum at 85°C (1.9 V).

**Table 2. Maximum Output Current vs Input and Output Voltages for Step-Up Switching Regulator With  $R_{CL} = 200\ \Omega$**

| OUTPUT<br>VOLTAGE (V) | SWITCHING REGULATOR INPUT VOLTAGE (SW REG IN2) (V) |                   |                   |                   |                    |    |     |                    |                                                                                                                                |     |     |
|-----------------------|----------------------------------------------------|-------------------|-------------------|-------------------|--------------------|----|-----|--------------------|--------------------------------------------------------------------------------------------------------------------------------|-----|-----|
|                       | 1.1                                                | 1.2               | 1.3               | 1.5               | 1.7                | 2  | 2.5 | 3                  | 5                                                                                                                              | 6   | 9   |
|                       | OUTPUT CURRENT (mA)                                |                   |                   |                   |                    |    |     |                    |                                                                                                                                |     |     |
| 30                    |                                                    |                   |                   |                   |                    |    |     |                    |                                                                                                                                | 50  | 100 |
| 25                    |                                                    |                   |                   |                   |                    |    |     |                    | 50                                                                                                                             | 70  | 100 |
| 20                    |                                                    |                   |                   |                   |                    | 15 | 25  | 30                 | 70                                                                                                                             | 90  | 100 |
| 15                    |                                                    |                   |                   | 10                | 15                 | 25 | 35  | 45                 | 90                                                                                                                             | 100 | 100 |
| 12                    | 10                                                 | 10                | 15                | 20                | 25                 | 35 | 45  | 60                 | 100                                                                                                                            | 100 | 100 |
| 10                    | 15                                                 | 20                | 20                | 25                | 30                 | 40 | 55  | 70                 | 100                                                                                                                            | 100 |     |
| 9                     | 20                                                 | 20                | 25                | 30                | 35                 | 45 | 60  | 80                 | 100                                                                                                                            |     |     |
| 6                     | 25                                                 | 30                | 35                | 45                | 50                 | 65 | 90  | 100                |                                                                                                                                |     |     |
| 5                     | 30                                                 | 35                | 40                | 55                | 60                 | 75 | 100 | 100                | Circuit of <a href="#">Figure 1</a> , except:<br>R <sub>CL</sub> = 200 Ω<br>C <sub>F</sub> = 330 μF<br>C <sub>P</sub> = 0.1 μF |     |     |
| 4.5                   | 35                                                 | 40                | 45                | 55                | 65                 | 85 | 100 | 100 <sup>(1)</sup> |                                                                                                                                |     |     |
| 3                     | 50                                                 | 55 <sup>(1)</sup> | 65 <sup>(1)</sup> | 80 <sup>(1)</sup> | 90 <sup>(1)</sup>  |    |     |                    |                                                                                                                                |     |     |
| 2.9                   | 50 <sup>(1)</sup>                                  | 60 <sup>(1)</sup> | 65 <sup>(1)</sup> | 85 <sup>(1)</sup> | 100 <sup>(1)</sup> |    |     |                    |                                                                                                                                |     |     |

(1) The difference between the output and input voltage for these combinations is greater than the minimum output-to-input differential-voltage specification at 70°C (1.2 V), but less than the minimum at 85°C (1.9 V).

**Table 3. Maximum Output Current vs Input and Output Voltages for Step-Up Switching Regulator With  $R_{CL} = 300\ \Omega$**

| OUTPUT<br>VOLTAGE (V) | SWITCHING REGULATOR INPUT VOLTAGE (SW REG IN2) (V) |     |     |     |     |    |     |    |     |     |     |
|-----------------------|----------------------------------------------------|-----|-----|-----|-----|----|-----|----|-----|-----|-----|
|                       | 1.1                                                | 1.2 | 1.3 | 1.5 | 1.7 | 2  | 2.5 | 3  | 5   | 6   | 9   |
|                       | OUTPUT CURRENT (mA)                                |     |     |     |     |    |     |    |     |     |     |
| 30                    |                                                    |     |     |     |     |    |     |    |     | 40  | 70  |
| 25                    |                                                    |     |     |     |     |    |     |    | 40  | 55  | 100 |
| 20                    |                                                    |     |     |     |     | 10 | 15  | 20 | 55  | 70  | 100 |
| 15                    |                                                    |     |     | 10  | 10  | 20 | 30  | 35 | 75  | 95  | 100 |
| 12                    | 10                                                 | 10  | 10  | 15  | 20  | 25 | 35  | 45 | 95  | 100 | 100 |
| 10                    | 15                                                 | 15  | 15  | 20  | 25  | 30 | 45  | 55 | 100 | 100 |     |
| 9                     | 15                                                 | 15  | 20  | 25  | 30  | 35 | 50  | 60 | 100 | 100 |     |
| 6                     | 25                                                 | 25  | 30  | 35  | 45  | 55 | 70  | 90 |     |     |     |

**Table 3. Maximum Output Current vs Input and Output Voltages for Step-Up Switching Regulator With  $R_{CL} = 300\ \Omega$  (continued)**

| OUTPUT<br>VOLTAGE (V) | SWITCHING REGULATOR INPUT VOLTAGE (SW REG IN2) (V) |                   |                   |                   |                   |    |     |                    |                                                                                                                                |   |   |
|-----------------------|----------------------------------------------------|-------------------|-------------------|-------------------|-------------------|----|-----|--------------------|--------------------------------------------------------------------------------------------------------------------------------|---|---|
|                       | 1.1                                                | 1.2               | 1.3               | 1.5               | 1.7               | 2  | 2.5 | 3                  | 5                                                                                                                              | 6 | 9 |
|                       | OUTPUT CURRENT (mA)                                |                   |                   |                   |                   |    |     |                    |                                                                                                                                |   |   |
| 5                     | 30                                                 | 30                | 35                | 45                | 50                | 65 | 85  | 100                | Circuit of <a href="#">Figure 1</a> , except:<br>R <sub>CL</sub> = 300 Ω<br>C <sub>F</sub> = 330 μF<br>C <sub>P</sub> = 0.1 μF |   |   |
| 4.5                   | 30                                                 | 35                | 40                | 45                | 55                | 70 | 95  | 100 <sup>(1)</sup> |                                                                                                                                |   |   |
| 3                     | 45                                                 | 50 <sup>(1)</sup> | 55 <sup>(1)</sup> | 70 <sup>(1)</sup> | 90 <sup>(1)</sup> |    |     |                    |                                                                                                                                |   |   |
| 2.9                   | 45 <sup>(1)</sup>                                  | 50 <sup>(1)</sup> | 60 <sup>(1)</sup> | 75 <sup>(1)</sup> | 95 <sup>(1)</sup> |    |     |                    |                                                                                                                                |   |   |

(1) The difference between the output and input voltage for these combinations is greater than the minimum output-to-input differential-voltage specification at 70°C (1.2 V), but less than the minimum at 85°C (1.9 V).

**Table 4. Maximum Output Current vs Input and Output Voltages for Step-Up Switching Regulator With  $R_{CL} = 510\ \Omega$** 

| OUTPUT<br>VOLTAGE (V) | SWITCHING REGULATOR INPUT VOLTAGE (SW REG IN2) (V) |                   |                   |                   |                   |    |     |                   |                                                                                                                                |     |     |
|-----------------------|----------------------------------------------------|-------------------|-------------------|-------------------|-------------------|----|-----|-------------------|--------------------------------------------------------------------------------------------------------------------------------|-----|-----|
|                       | 1.1                                                | 1.2               | 1.3               | 1.5               | 1.7               | 2  | 2.5 | 3                 | 5                                                                                                                              | 6   | 9   |
|                       | OUTPUT CURRENT (mA)                                |                   |                   |                   |                   |    |     |                   |                                                                                                                                |     |     |
| 30                    |                                                    |                   |                   |                   |                   |    |     |                   |                                                                                                                                | 30  | 50  |
| 25                    |                                                    |                   |                   |                   |                   |    |     |                   | 25                                                                                                                             | 40  | 75  |
| 20                    |                                                    |                   |                   |                   |                   |    |     |                   | 40                                                                                                                             | 55  | 90  |
| 15                    |                                                    |                   |                   |                   |                   |    | 15  | 20                | 55                                                                                                                             | 70  | 100 |
| 12                    |                                                    |                   |                   |                   | 10                | 15 | 25  | 35                | 65                                                                                                                             | 80  | 100 |
| 10                    |                                                    |                   |                   | 10                | 20                | 25 | 30  | 40                | 70                                                                                                                             | 85  |     |
| 9                     | 10                                                 | 10                | 10                | 15                | 20                | 25 | 35  | 45                | 75                                                                                                                             | 100 |     |
| 6                     | 15                                                 | 20                | 20                | 25                | 30                | 35 | 50  | 60                |                                                                                                                                |     |     |
| 5                     | 20                                                 | 20                | 35                | 30                | 35                | 45 | 55  | 70                | Circuit of <a href="#">Figure 1</a> , except:<br>R <sub>CL</sub> = 510 Ω<br>C <sub>F</sub> = 330 μF<br>C <sub>P</sub> = 0.1 μF |     |     |
| 4.5                   | 25                                                 | 25                | 30                | 35                | 40                | 50 | 65  | 90 <sup>(1)</sup> |                                                                                                                                |     |     |
| 3                     | 35                                                 | 35 <sup>(1)</sup> | 40 <sup>(1)</sup> | 50 <sup>(1)</sup> | 75 <sup>(1)</sup> |    |     |                   |                                                                                                                                |     |     |
| 2.9                   | 35 <sup>(1)</sup>                                  | 35 <sup>(1)</sup> | 40 <sup>(1)</sup> | 55 <sup>(1)</sup> | 80 <sup>(1)</sup> |    |     |                   |                                                                                                                                |     |     |

(1) The difference between the output and input voltage for these combinations is greater than the minimum output-to-input differential-voltage specification at 70°C (1.2 V), but less than the minimum at 85°C (1.9 V).

**Table 5. Maximum Output Current vs Input and Output Voltages for Step-Up Switching Regulator With  $R_{CL} = 1\ k\Omega$** 

| OUTPUT<br>VOLTAGE (V) | SWITCHING REGULATOR INPUT VOLTAGE (SW REG IN2) (V) |                   |                   |                   |                   |    |     |                   |                                                                                                                               |    |    |
|-----------------------|----------------------------------------------------|-------------------|-------------------|-------------------|-------------------|----|-----|-------------------|-------------------------------------------------------------------------------------------------------------------------------|----|----|
|                       | 1.1                                                | 1.2               | 1.3               | 1.5               | 1.7               | 2  | 2.5 | 3                 | 5                                                                                                                             | 6  | 9  |
|                       | OUTPUT CURRENT (mA)                                |                   |                   |                   |                   |    |     |                   |                                                                                                                               |    |    |
| 30                    |                                                    |                   |                   |                   |                   |    |     |                   |                                                                                                                               |    | 35 |
| 25                    |                                                    |                   |                   |                   |                   |    |     |                   |                                                                                                                               | 35 | 50 |
| 20                    |                                                    |                   |                   |                   |                   |    |     |                   |                                                                                                                               | 35 | 60 |
| 15                    |                                                    |                   |                   |                   |                   |    |     | 10                | 30                                                                                                                            | 45 | 65 |
| 12                    |                                                    |                   |                   |                   |                   |    |     | 20                | 40                                                                                                                            | 45 | 85 |
| 10                    |                                                    |                   |                   |                   |                   |    | 15  | 25                | 40                                                                                                                            | 55 |    |
| 9                     |                                                    |                   |                   | 10                | 10                | 15 | 25  | 30                | 45                                                                                                                            | 60 |    |
| 6                     | 10                                                 | 10                | 10                | 15                | 20                | 20 | 30  | 35                |                                                                                                                               |    |    |
| 5                     | 10                                                 | 10                | 15                | 20                | 20                | 25 | 35  | 40                | Circuit of <a href="#">Figure 1</a> , except:<br>R <sub>CL</sub> = 1 kΩ<br>C <sub>F</sub> = 330 μF<br>C <sub>P</sub> = 0.1 μF |    |    |
| 4.5                   | 15                                                 | 15                | 15                | 20                | 25                | 30 | 40  | 45 <sup>(1)</sup> |                                                                                                                               |    |    |
| 3                     | 20                                                 | 25 <sup>(1)</sup> | 25 <sup>(1)</sup> | 30 <sup>(1)</sup> | 35 <sup>(1)</sup> |    |     |                   |                                                                                                                               |    |    |
| 2.9                   | 20 <sup>(1)</sup>                                  | 25 <sup>(1)</sup> | 25 <sup>(1)</sup> | 30 <sup>(1)</sup> | 45 <sup>(1)</sup> |    |     |                   |                                                                                                                               |    |    |

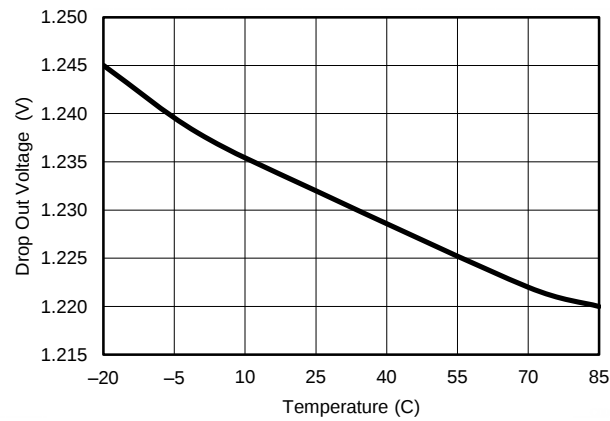
(1) The difference between the output and input voltage for these combinations is greater than the minimum output-to-input differential-voltage specification at 70°C (1.2 V), but less than the minimum at 85°C (1.9 V).

### 8.2.2 Detailed Design Procedure

Select the values for  $R_{E1}$  and  $R_{E2}$  using [Equation 1](#):

$$V_{OUT} = V_{REF} \times (1 + R_{E1}/R_{E2}) \quad (1)$$

### 8.2.3 Application Curve



$I_{OUT} = 50 \text{ mA}$

**Figure 4. Dropout Voltage vs Temperature**

## 9 Power Supply Recommendations

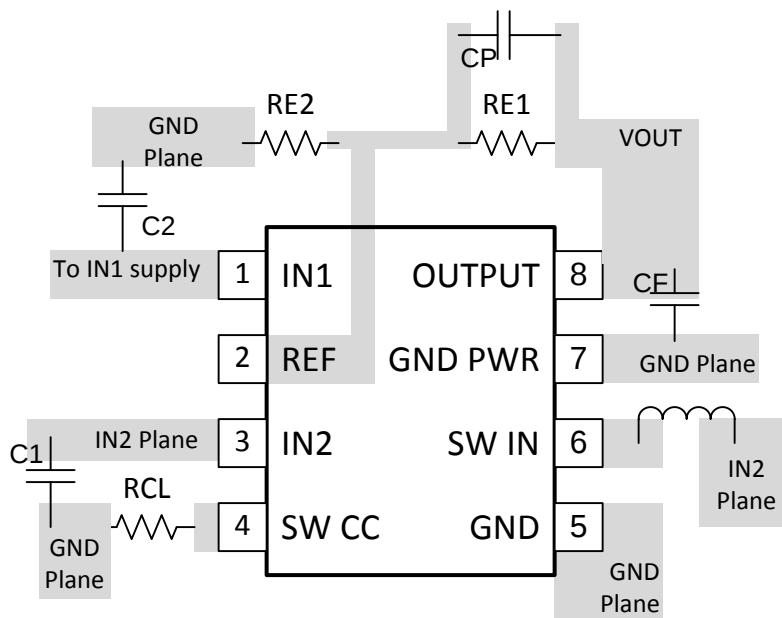
See [Recommended Operating Conditions](#) for allowable range for the power supply. Bypass capacitors must be placed near device supply pins.

## 10 Layout

### 10.1 Layout Guidelines

The switching nodes at pins 3, 6, 7, and 8 must use short traces with ground and power planes for reduced noise and improved performance.

### 10.2 Layout Example



**Figure 5. Typical Layout**

## 11 Device and Documentation Support

### 11.1 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At [e2e.ti.com](http://e2e.ti.com), you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 11.2 Trademarks

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 11.3 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 11.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## PACKAGING INFORMATION

| Orderable part number      | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|----------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">TL499ACP</a>   | Active        | Production           | PDIP (P)   8   | 50   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -20 to 85    | TL499ACP            |
| <a href="#">TL499ACPSR</a> | Active        | Production           | SO (PS)   8    | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | T499A               |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

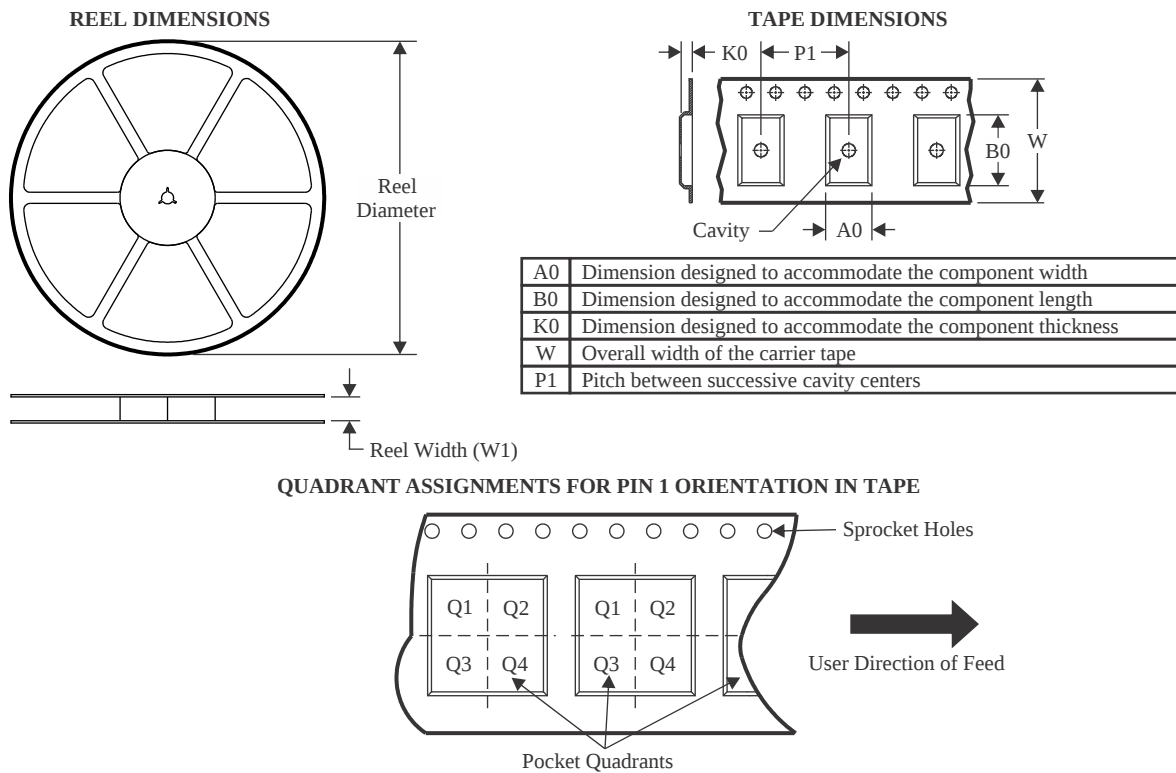
<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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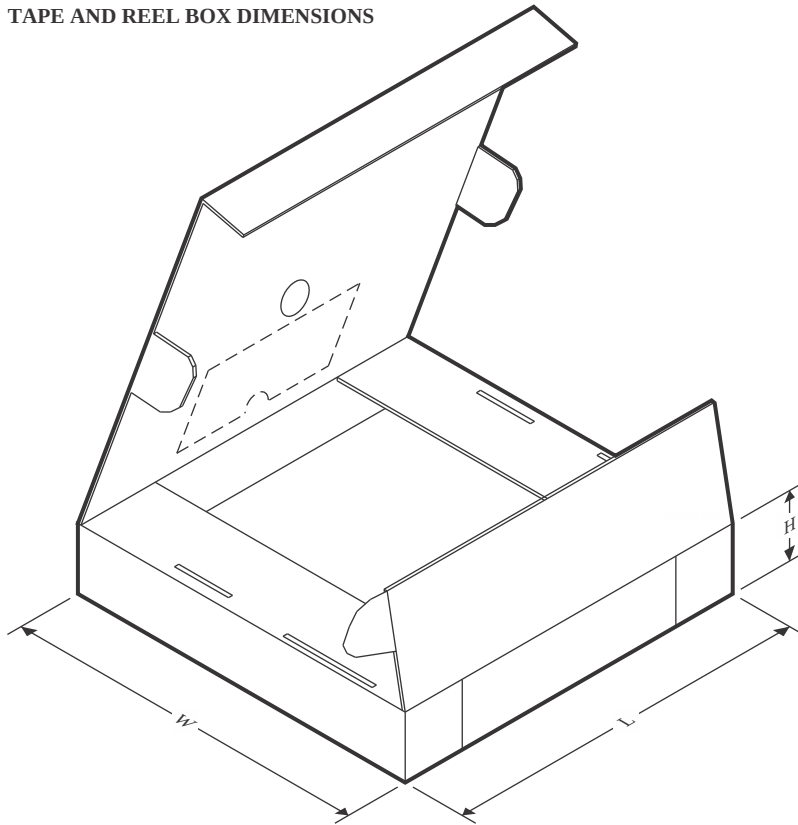
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device     | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TL499ACPSR | SO           | PS              | 8    | 2000 | 330.0              | 16.4               | 8.35    | 6.6     | 2.4     | 12.0    | 16.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device     | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TL499ACPSR | SO           | PS              | 8    | 2000 | 356.0       | 356.0      | 35.0        |

## TUBE



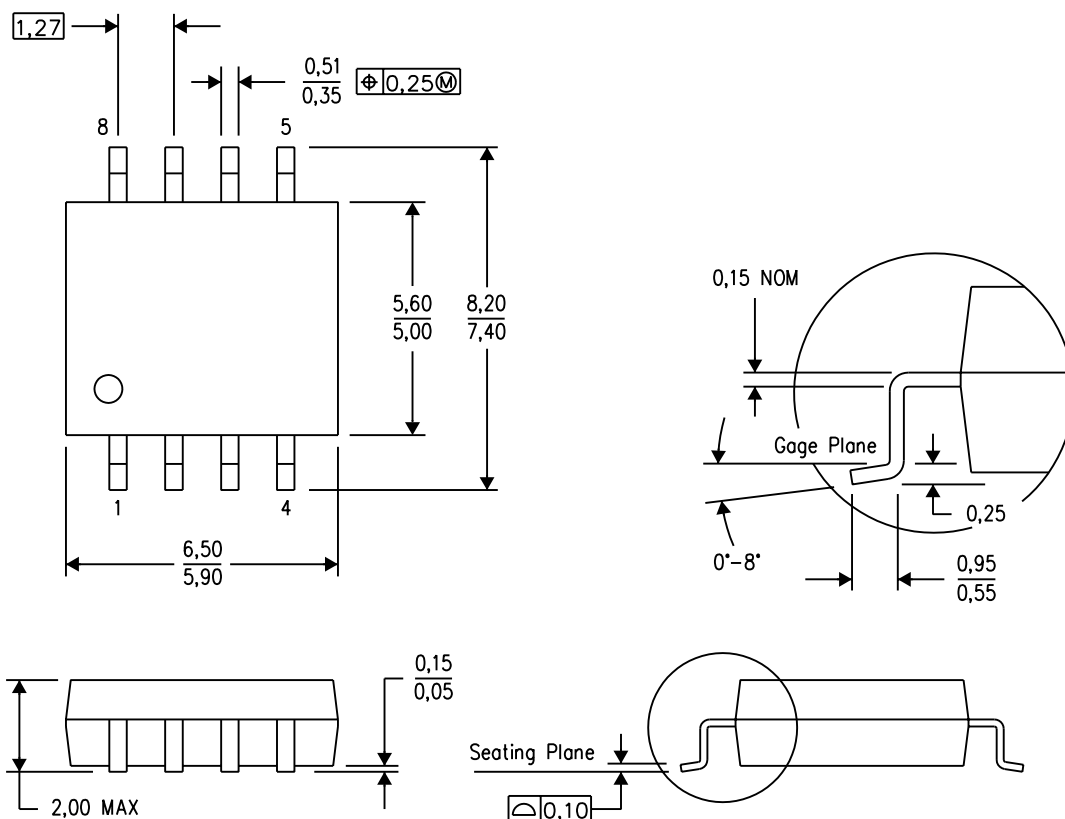
\*All dimensions are nominal

| Device   | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|----------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TL499ACP | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |

## MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

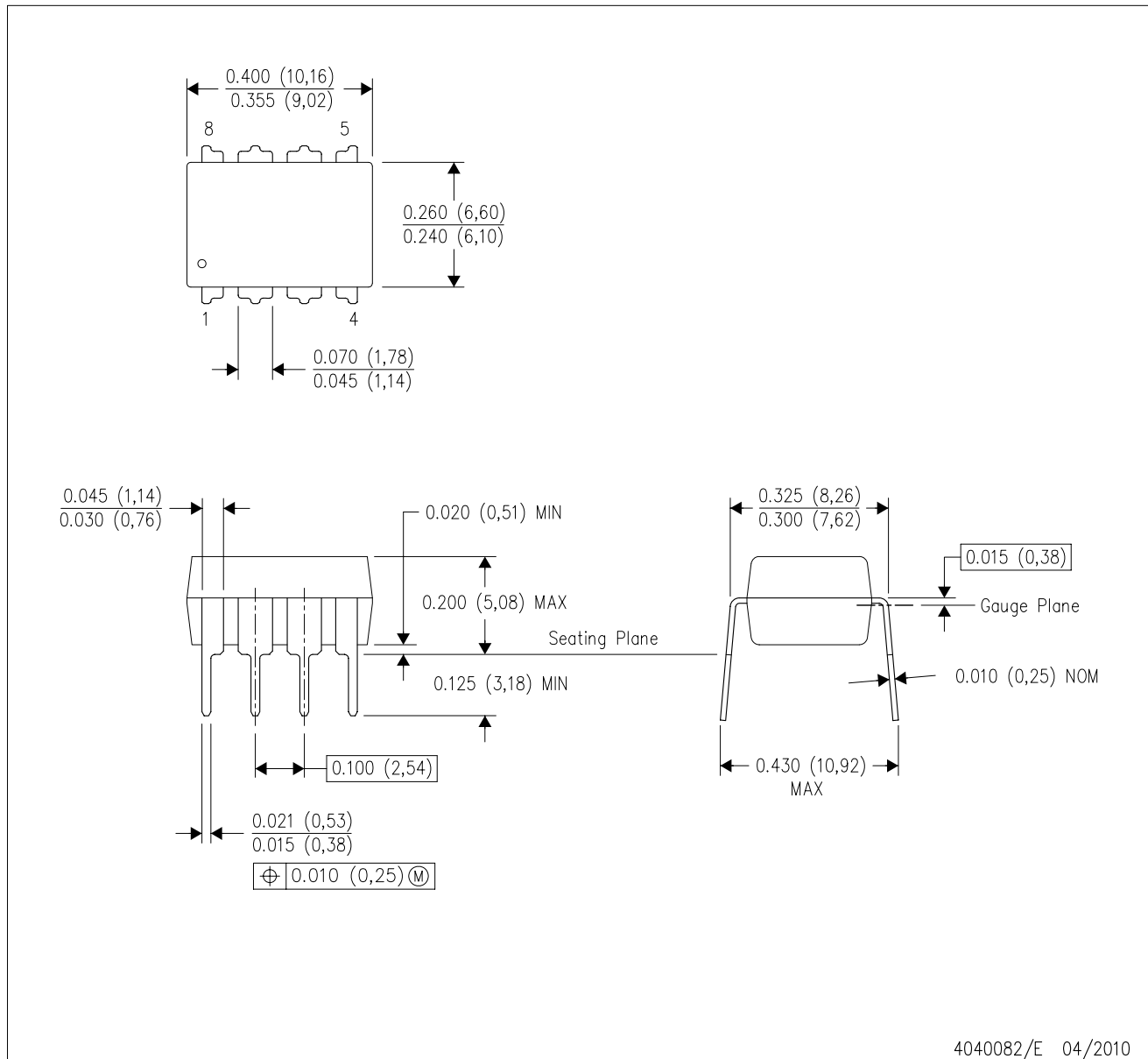


4040063/C 03/03

- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

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