

# TPPM0304 250-mA LOW-DROPOUT REGULATOR WITH AUXILIARY POWER MANAGEMENT

SLVS320 – OCTOBER 2000

- Automatic Input Voltage Source Selection
- Glitch-Free Regulated Output
- 5-V Input Voltage Source Detector With Hysteresis
- 250-mA Load Current Capability With 5-V or 3.3-V Input Source
- Low  $r_{DS(on)}$  Auxiliary Switch

## description

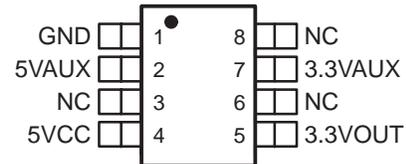
The TPPM0304 is a low-dropout regulator with auxiliary power management that provides a constant 3.3-V supply at the output capable of driving a 250-mA load.

The TPPM0304 provides a regulated power output for systems that have multiple input sources and require a constant voltage source with a low-dropout voltage. This is a single output, multiple input, intelligent power source selection device with a low-dropout regulator for either 5VCC or 5VAUX inputs, and a low-resistance bypass switch for the 3.3VAUX input.

Transitions may occur from one input supply to another without generating a glitch, outside of the specification range, on the 3.3-V output. The device has an incorporated reverse blocking scheme to prevent excess leakage from the input terminals in the event that the output voltage is greater than the input voltage.

The input voltage is prioritized in the following order: 5VCC, 5VAUX, and 3.3VAUX.

D PACKAGE†  
(TOP VIEW)



NC – No internal connection

† This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TPPM0304DR).



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

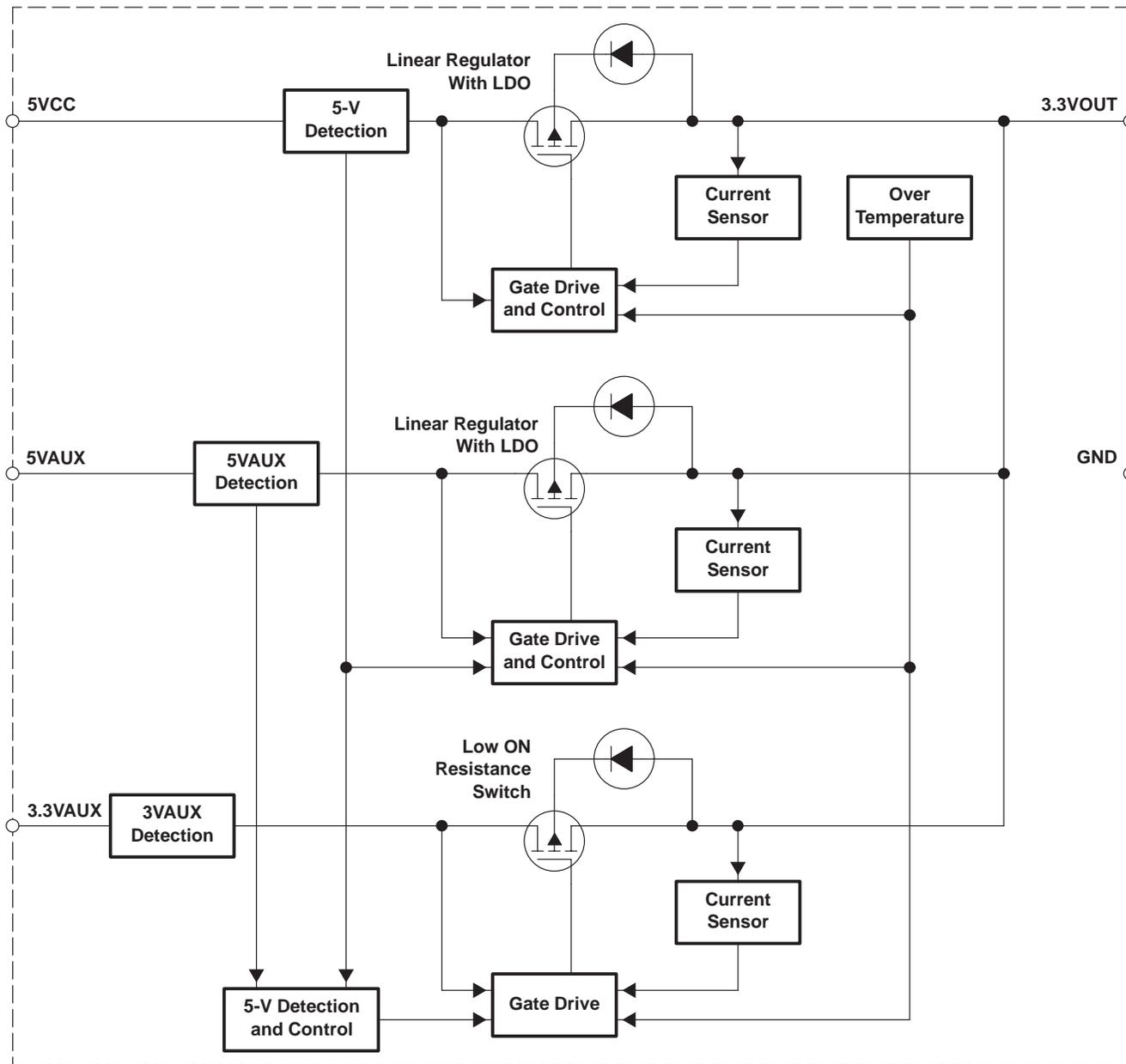
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**functional block diagram**



**Terminal Functions**

| TERMINAL NAME | NO.     | I/O | DESCRIPTION   |
|---------------|---------|-----|---|
| 3.3VAUX       | 7       | I   | 3.3-V auxiliary input                                       |
| 3.3VOUT       | 5       | O   | 3.3-V output with a typical capacitance load of 4.7 $\mu$ F |
| 5VAUX         | 2       | I   | 5-V auxiliary input   |
| 5VCC          | 4       | I   | 5-V main input  |
| GND           | 1       | I   | Ground  |
| NC            | 3, 6, 8 | I/O | No internal connection                                      |



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**Table 1. Input Selection**

| INPUT VOLTAGE STATUS (V) |       |         | INPUT SELECTED     | OUTPUT (V) | OUTPUT (I)          |
|--------------------------|-------|---------|--------------------|------------|---------------------|
| 5VCC                     | 5VAUX | 3.3VAUX | 5VCC/5VAUX/3.3VAUX | 3.3VOUT    | I <sub>L</sub> (mA) |
| 0                        | 0     | 0       | None               | 0          | 0                   |
| 0                        | 0     | 3.3     | 3.3VAUX            | 3.3        | 250                 |
| 0                        | 5     | 0       | 5VAUX              | 3.3        | 250                 |
| 0                        | 5     | 3.3     | 5VAUX              | 3.3        | 250                 |
| 5                        | 0     | 0       | 5VCC               | 3.3        | 250                 |
| 5                        | 0     | 3.3     | 5VCC               | 3.3        | 250                 |
| 5                        | 5     | 0       | 5VCC               | 3.3        | 250                 |
| 5                        | 5     | 3.3     | 5VCC               | 3.3        | 250                 |

**absolute maximum ratings over operating free-air temperature (unless otherwise noted)†**

|   |                |
|---|----------------|
| Supply voltage, 5-V main input, V <sub>(5VCC)</sub> (see Notes 1 and 2)         | 7 V            |
| Auxiliary voltage, 5-V input, V <sub>(5VAUX)</sub> (see Notes 1 and 2)          | 7 V            |
| Auxiliary voltage, 3.3-V input, V <sub>(3.3VAUX)</sub> (see Notes 1 and 2)      | 5 V            |
| 3.3-V output current limit, I <sub>(LIMIT)</sub>                                | 1.5 A          |
| Continuous power dissipation (low-K), P <sub>D</sub> (see Note 3)               | 0.625 W        |
| Electrostatic discharge susceptibility, human body model, V <sub>(HBMESD)</sub> | 2 kV           |
| Operating ambient temperature range, T <sub>A</sub>                             | 0°C to 70°C    |
| Storage temperature range, T <sub>stg</sub>                                     | –55°C to 150°C |
| Operating junction temperature range, T <sub>J</sub>                            | –5°C to 120°C  |
| Lead temperature (soldering, 10 second), T <sub>(LEAD)</sub>                    | 260°C          |

† Stresses beyond 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 beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values are with respect to GND.  
 2. Absolute negative voltage on these terminal should not be below –0.5 V.  
 3. The device derates with increase in ambient temperature, T<sub>A</sub>. See Thermal Information section.

**recommended operating conditions**

|   | MIN  | TYP | MAX  | UNIT |
|---|------|-----|------|------|
| 5-V main input, V <sub>(5VCC)</sub>           | 4.5  |     | 5.5  | V    |
| 5-V auxiliary input, V <sub>(5VAUX)</sub>     | 4.5  |     | 5.5  | V    |
| 3.3-V auxiliary input, V <sub>(3.3VAUX)</sub> | 3    |     | 3.6  | V    |
| Load capacitance, C <sub>L</sub>              | 4.23 | 4.7 | 5.17 | μF   |
| Load current, I <sub>L</sub>                  | 0    |     | 250  | mA   |
| Ambient temperature, T <sub>A</sub>           | 0    |     | 70   | °C   |

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**electrical characteristics over recommended operating free-air temperature range,  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ,  $C_L = 4.7 \mu\text{F}$  (unless otherwise noted)**

| PARAMETER  | TEST CONDITIONS  | MIN   | TYP | MAX   | UNIT             |
|--|--|-------|-----|-------|------------------|
| $V_{(5VCC)}/V_{(5VAUX)}$<br>5-V inputs           |  | 4.5   | 5   | 5.5   | V                |
| $I_{(Q)}$<br>Quiescent supply current            | From 5VCC or 5VAUX terminals, $I_L = 0$ to 250 mA                                |       | 2.5 | 5     | mA               |
|  | From 3.3VAUX terminal, $I_L = 0$ A   |       | 250 | 500   | $\mu\text{A}$    |
| $I_L$<br>Output load current                     |  | 0.25  |     |       | A                |
| $I_{(LIMIT)}$<br>Output current limit            | 3.3VOUT = 0 V  |       |     | 2     |                  |
| $T_{(TSD)}^\dagger$<br>Thermal shutdown          | 3.3VOUT output shorted to 0 V  |       |     | 150   | $^\circ\text{C}$ |
| $T_{hys}^\dagger$<br>Thermal hysteresis          |  |       |     | 15    |                  |
| $V_{(3.3VOUT)}$<br>3.3-V output                  | $I_L = 250$ mA   | 3.135 | 3.3 | 3.465 | V                |
| $C_L$<br>Load capacitance                        | Minimal ESR to insure stability of regulated output                              |       | 4.7 |       | $\mu\text{F}$    |
| $I_{lkg(REV)}$<br>Reverse leakage output current | Tested for input that is grounded. 3.3VAUX, 5VAUX or 5VCC = GND, 3.3VOUT = 3.3 V |       |     | 50    | $\mu\text{A}$    |

$^\dagger$  Design targets only. Not tested in production.

**5-V detect**

| PARAMETER                                 | TEST CONDITIONS            | MIN  | TYP  | MAX  | UNIT |
|---|----------------------------|------|------|------|------|
| $V_{(TO\_LO)}$<br>Threshold voltage, low  | 5VAUX or 5VCC $\downarrow$ | 3.85 | 4.05 | 4.25 | V    |
| $V_{(TO\_HI)}$<br>Threshold voltage, high | 5VAUX or 5VCC $\uparrow$   | 4.1  | 4.3  | 4.5  | V    |

**auxiliary switch**

| PARAMETER  | TEST CONDITIONS                                     | MIN | TYP | MAX | UNIT     |
|--|---|-----|-----|-----|----------|
| $R_{(SWITCH)}$<br>Auxiliary switch resistance        | 5VAUX = 5VCC = 0 V, 3.3VAUX = 3.3 V, $I_L = 150$ mA |     |     | 0.4 | $\Omega$ |
| $\Delta V_{O(\Delta VI)}$<br>Line regulation voltage | 5VAUX or 5VCC = 4.5 V to 5.5 V                      |     | 2   |     | mV       |
| $\Delta V_{O(\Delta IO)}$<br>Load regulation voltage | 20 mA < $I_L$ < 250 mA                              |     | 40  |     | mV       |
| $V_I - V_O$<br>Dropout voltage                       | $I_L < 250$ mA                                      |     |     | 1   | V        |

**thermal characteristics**

| PARAMETER  | MIN                 | TYP | MAX | UNIT                      |
|--|---------------------|-----|-----|---------------------------|
| $R_{\theta JC}$ Thermal impedance, junction-to-case    |                     |     | 39  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ Thermal impedance, junction-to-ambient | Low-K (see Note 4)  |     | 176 | $^\circ\text{C}/\text{W}$ |
|  | High-K (see Note 4) |     | 98  |                           |

NOTE 4: See JEDEC PCB specifications for low-K and high-K.



### TYPICAL CHARACTERISTICS

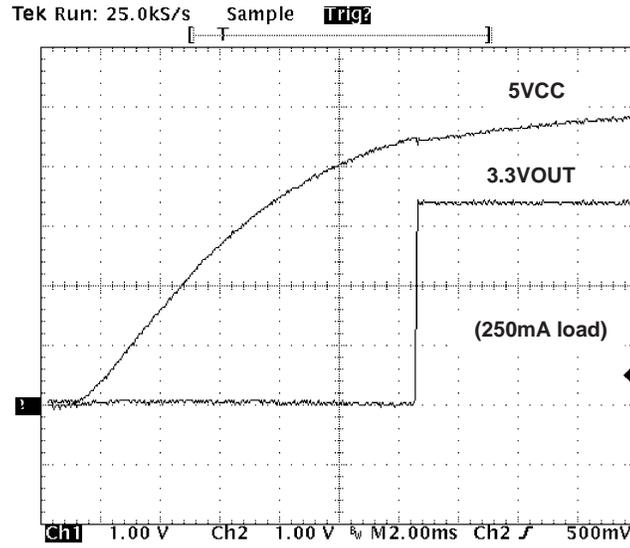


Figure 1. 5VCC Cold Start

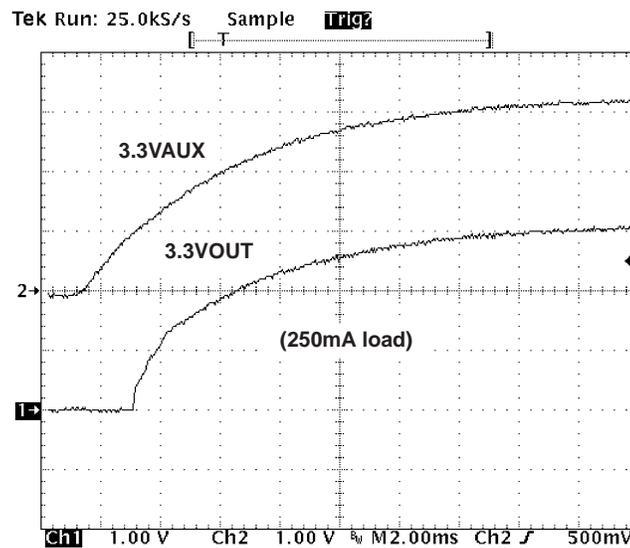


Figure 2. 3.3VAUX Cold Start

TYPICAL CHARACTERISTICS

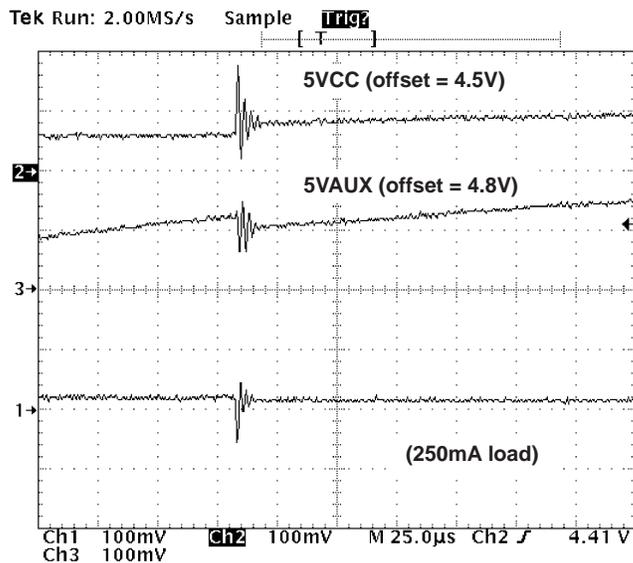


Figure 3. 5VCC Power Up (5VAUX = 5 V)

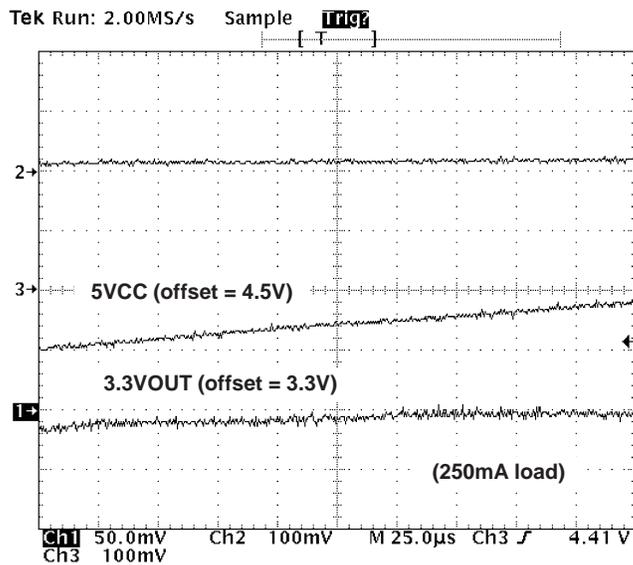


Figure 4. 5VCC Power Up (3.3VAUX = 3.3 V)

TYPICAL CHARACTERISTICS

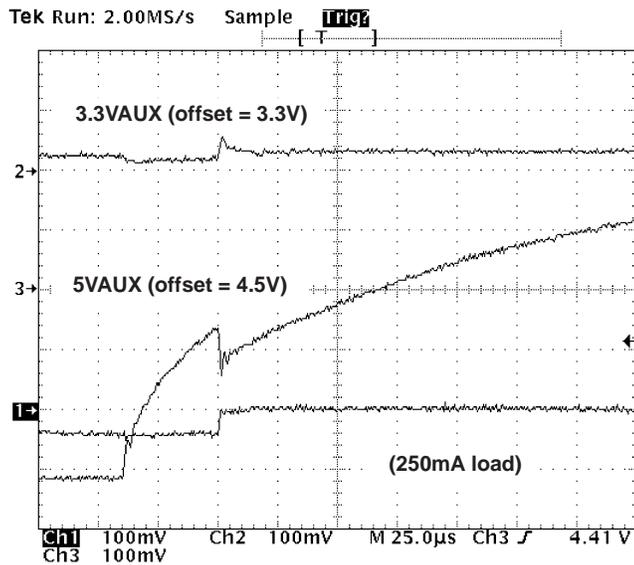


Figure 5. 5VAUX Power Up (3.3VAUX = 3.3 V)

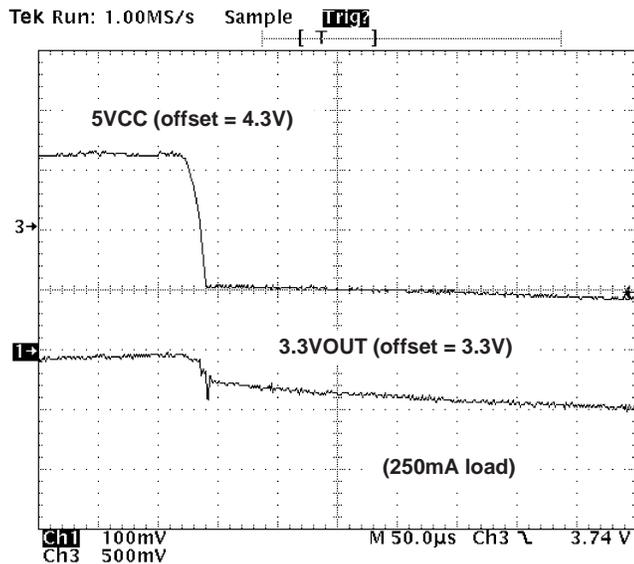


Figure 6. 5VCC Power Down (3.3VAUX = 3.3 V)

TYPICAL CHARACTERISTICS

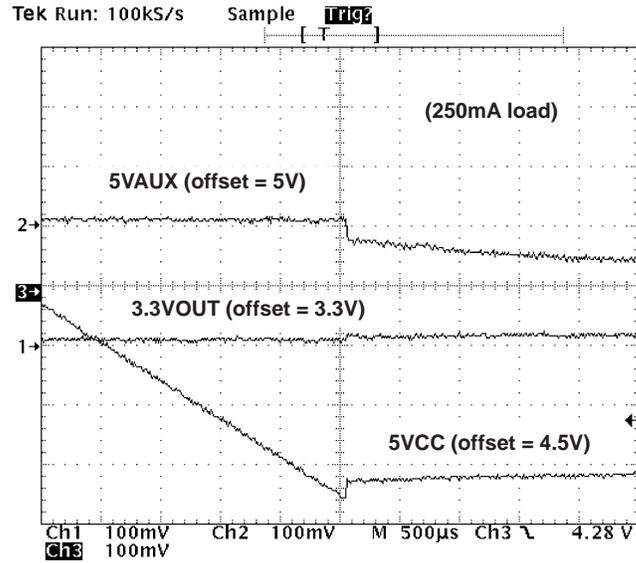


Figure 7. 5VCC Power Down (5VAUX = 5 V)

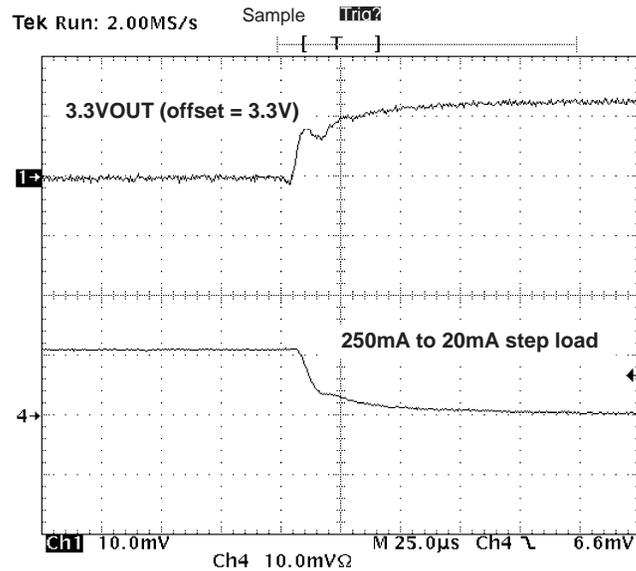


Figure 8. 5VCC Load Transient Response Falling

TYPICAL CHARACTERISTICS

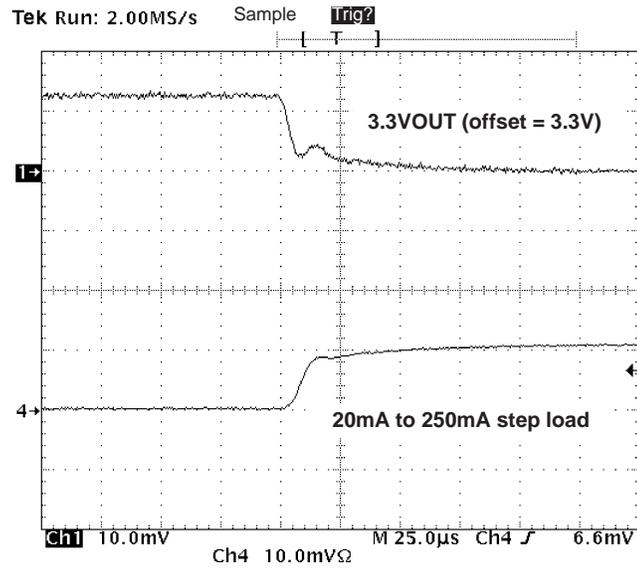


Figure 9. 5VCC Load Transient Response Rising

# TPPM0304

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### THERMAL INFORMATION

To ensure reliable operation of the device, the junction temperature of the output device must be within the safe operating area (SOA). This is achieved by having a means to dissipate the heat generated from the junction of the output structure. There are two components that contribute to thermal resistance. They consist of two paths in series. The first is the junction to case thermal resistance,  $R_{\theta JC}$ ; the second is the case to ambient thermal resistance,  $R_{\theta CA}$ . The overall junction to ambient thermal resistance,  $R_{\theta JA}$ , is determined by:

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$$

The ability to efficiently dissipate the heat from the junction is a function of the package style and board layout incorporated in the application. The operating junction temperature is determined by the operating ambient temperature,  $T_A$ , and the junction power dissipation,  $P_J$ .

The junction temperature,  $T_J$ , is equal to the following thermal equation:

$$T_J = T_A + P_J (R_{\theta JC}) + P_J (R_{\theta CA})$$

$$T_J = T_A + P_J (R_{\theta JA})$$

This particular application uses the 8-pin SO package with standard lead frame with a dedicated ground terminal. Hence, the maximum power dissipation allowable for an operating ambient temperature of 70°C, and a maximum junction temperature of 150°C is determined as:

$$P_J = (T_J - T_A) / R_{\theta JA}$$

$$P_J = (150 - 70) / 176 = 0.45 \text{ W when using a low-K PCB.}$$

$$P_J = (150 - 70) / 98 = 0.81 \text{ W when using a high-K PCB.}$$

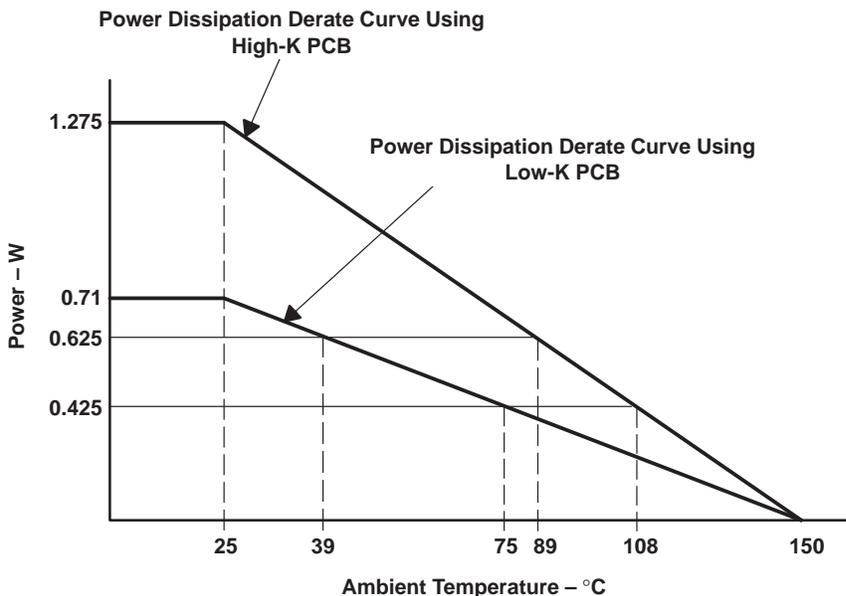
Worst case maximum power dissipation is determined by:

$$P_D = (5.5 - 3) \times 0.25 = 0.625 \text{ W}$$

Normal operating maximum power dissipation is (see Figure 1):

$$P_D = (5 - 3.3) \times 0.25 = 0.425 \text{ W}$$

THERMAL INFORMATION



NOTE: These curves are to be used for guideline purposes only. For a particular application, a more specific thermal characterization is required.

Figure 10. Power Dissipation Derating Curves

APPLICATION INFORMATION

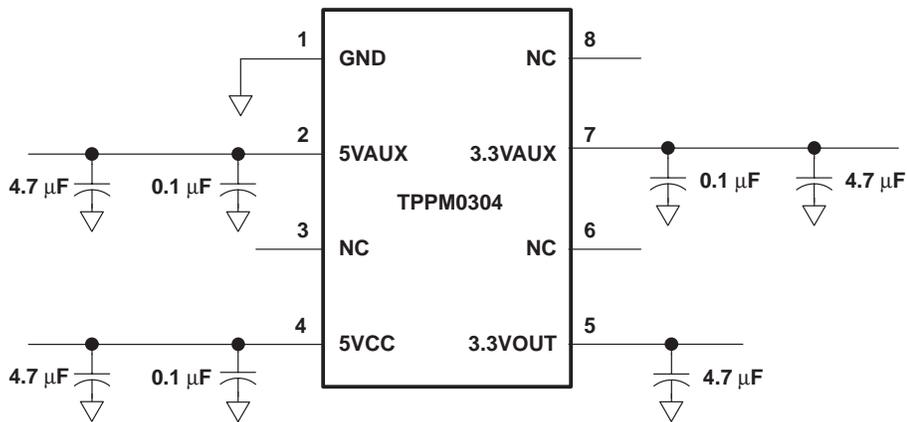


Figure 11. Typical Application Schematic

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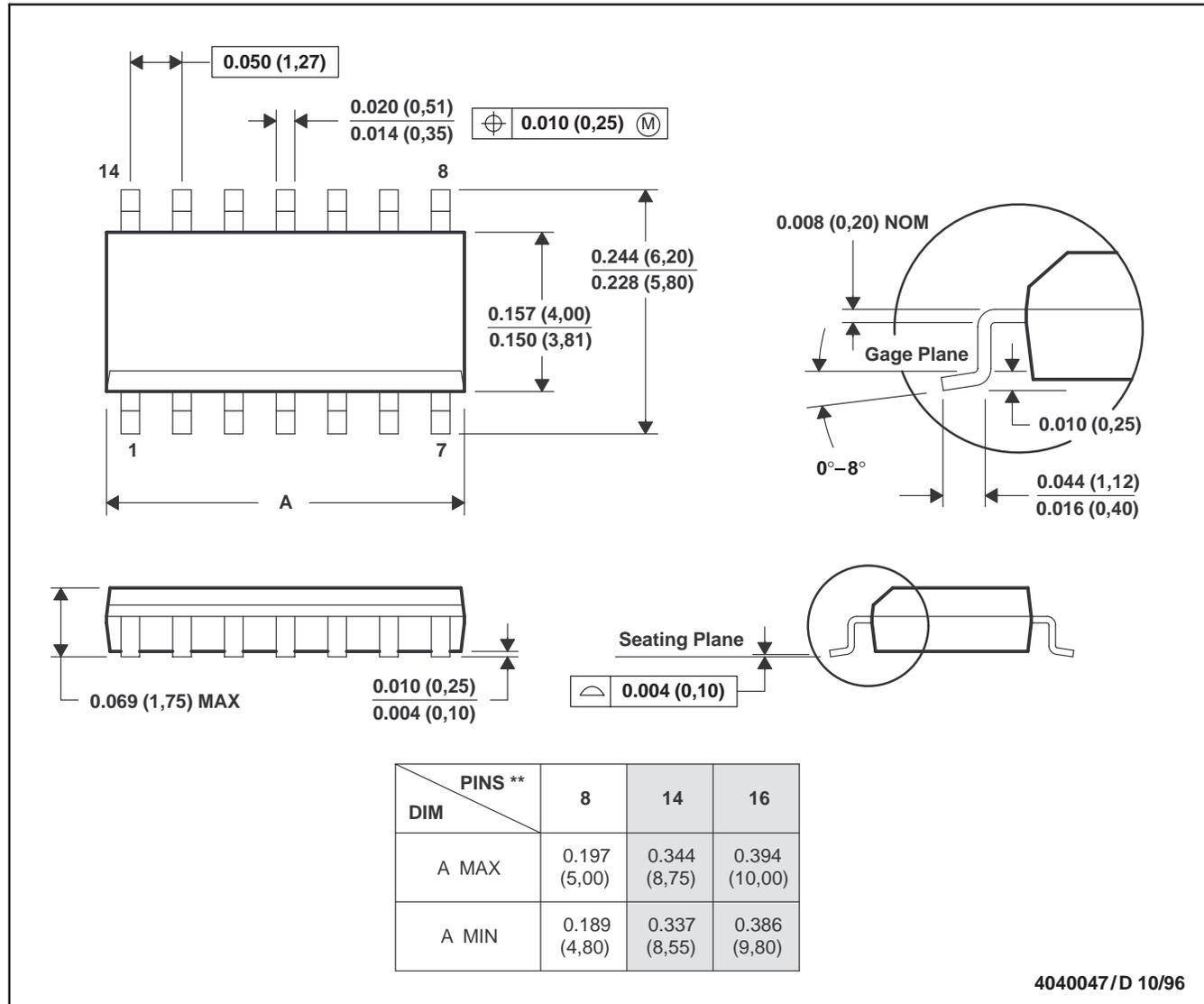
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**MECHANICAL DATA**

**D (R-PDSO-G\*\*)**

**PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TPPM0304DR       | OBSOLETE              | SOIC         | D               | 8    |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

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<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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| Power Mgmt       | <a href="http://power.ti.com">power.ti.com</a>                     | Optical Networking  | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Microcontrollers | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> | Security            | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
|                  |  | Telephony           | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
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