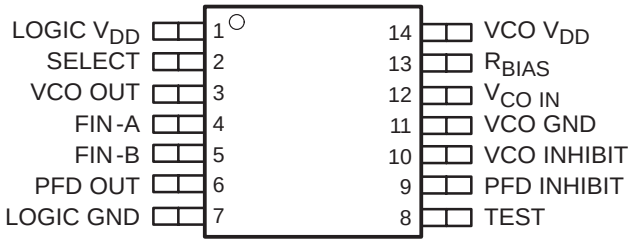
- **Voltage-Controlled Oscillator (VCO)**
  - **Ring Oscillator Using Only One External Biasing Resistor ($R_{BIAS}$)**
- **Recommended Lock Frequency**
  - **100 MHz to 130 MHz**
  - **($V_{DD}$ = 3.3 V + 5%, $T_A$ = –20°C to 75°C)**
- **Phase-Frequency Detector (PFD) Includes a High-Speed Edge-Triggered Detector With Internal Charge Pump**
- **Independent VCO, PFD Power-Down Mode**
- **Thin Small-Outline Package (14 Terminal)**
- **Compatible Pin Assignment to TLC2932, TLC2933**

**PW PACKAGE**
**(TOP VIEW)**



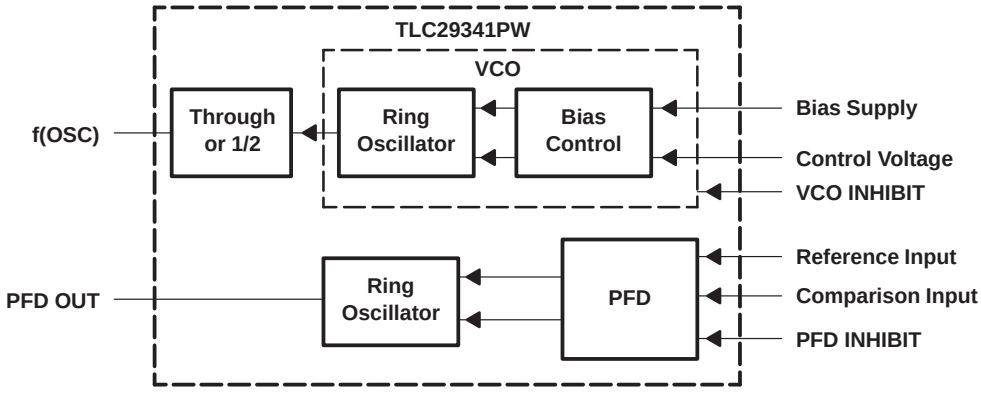

## description

The TLC2934, a mixed signal IC designed for phase-locked-loop (PLL) systems, is composed of a voltage-controlled oscillator (VCO) and an edge-triggered-type phase frequency detector (PFD).

The internal VCO is based on the TLC2932 and TLC2933s ring oscillator. It oscillates in wider frequency with lower supply voltage, and it has stable oscillating performance. The oscillation function, provided by only one external resistor connection, supplies bias to the VCI internal circuit. Oscillator range is covered from 10 MHz to 130 MHz with a 3.3-V supply voltage. The VCO has an inhibit function to stop oscillation and for the power-down mode.

The internal PFD, a high-speed rising edge triggered type, has an internal charge pump with a high-impedance output buffer. The PFD detects phase difference between the reference frequency input and the signal frequency input from the VCO output through an external counter device. This functions the same as TLC2932 and TLC2933. The PFD also has the inhibit function for stop phase comparison and for power-down mode.

## block diagram

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## Terminal Functions

| TERMINAL NAME | TERMINAL NO. | I/O | DESCRIPTION |
|---|---|---|---|
| FIN-A, FIN-B | 4 5 | I | Frequency signal inputs for PFD. The reference frequency signal ($f_{REF-IN}$) and the VCO output signal through the external counter device are applied to these terminals. When the LPF design is the lag-lead filter (passive filter and noninverting), $f_{(REF-IN)}$ is input to FIN-A, and the VCO output signal is to FIN-B. |
| LOGIC GND | 7 | | GND terminal for the internal logic circuit |
| LOGIC $V_{DD}$ | 1 | | Power supply terminal for the internal logic circuit. This power supply terminal separates from VCO $V_{DD}$ to reduce cross-coupling between supplies. |
| PFD INHIBIT | 9 | I | PFD INHIBIT (power-down) control signal input terminal |
| PFD OUT | 6 | O | PFD output terminal. When PFD INHIBIT is high, PFD OUT is in the high-impedance state. |
| $R_{BIAS}$ | 13 | I | Bias resistor ($R_{BIAS}$) terminal. Connect a resistor between VCO GND and this terminal to supply bias to internal VCO circuit. TLC2934 bias resistor connection is different from TLC2932 and TLC2933, where bias resistor $R_{BIAS}$ is connected to VCO $V_{DD}$. |
| SELECT | 2 | I | 1/2 divider select terminal. L=through output, H=1/2 output. |
| TEST | 8 | | Test terminal. Use for production test. Tie to GND when in normal use. |
| VCO GND | 11 | | GND terminal for internal VCO |
| VCO OUT | 3 | O | VCO output terminal. When VCO INHIBIT = high, VCO OUT is low. |
| VCO INHIBIT | 10 | I | VCO INHIBIT (power-down) control signal input terminal |
| $V_{CO\ IN}$ | 12 | I | VCO control voltage input terminal. Normally, The external LPF is connected to this terminal. |
| VCO $V_{DD}$ | 14 | | Power supply terminal for the internal VCO circuit. This power supply terminal should be separate from LOGIC $V_{DD}$ to reduce cross-coupling between supplies. |

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

Supply voltage (each supply), $V_{DD}$ (see Note 1) . . . . . –0.5 V to 4 V
Input voltage range (each input), $V_I$ (see Note 1) . . . . . –0.5 V to $V_{DD}$ + 0.5 V
Input current (each input), $I_I$ . . . . . ±20 mA
Output current (each output), $I_O$ . . . . . ±20 mA
Continuous total power dissipation at (or below) $T_A$ = 25°C (see Note 2), $P_D$ . . . . . 700 mW
Operating free-air temperature range. $T_A$ . . . . . –20°C to 75°C
Storage temperature range, $T_{stg}$ . . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 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 network ground terminal.
2. For operation above 25°C free–air temperature, derate linearly at the rate of 5.6 mW/°C

## recommended operating conditions

| | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Supply voltage (each supply, $V_{DD}$ (see Notes 3 and 4) | | 3.15 | 3.3 | 3.45 | V |
| Input voltage (each input except for $V_{CO\ IN}$, $V_I$ | | 0 | | $V_{DD}$ | V |
| Output current (each output), $I_O$ | | 0 | | ±2 | mA |
| VCO control voltage, $V_{CO\ IN}$ | | 0.5 | | $V_{DD}$ | V |
| Lock frequency (through output) | $R_{BIAS}$ = 1 kΩ | 36 | | 130 | MHz |
| | $R_{BIAS}$ = 1.8 kΩ | 28 | | 90 | |
| | $R_{BIAS}$ = 2.4 kΩ | 26 | | 80 | |
| | $R_{BIAS}$ = 3.3 kΩ | 20 | | 60 | |
| Lock frequency (1/2 output) | $R_{BIAS}$ = 1 kΩ | 18 | | 65 | MHz |
| | $R_{BIAS}$ = 1.8 kΩ | 14 | | 45 | |
| | $R_{BIAS}$ = 2.4 kΩ | 13 | | 40 | |
| | $R_{BIAS}$ = 3.3 kΩ | 10 | | 30 | |
| Bias resistor, $R_{BIAS}$ | | 1.0 | | 3.3 | KΩ |
| Operating temperature range, $T_A$ | | –20 | | 75 | °C |
| $V_{CO\ IN}$ voltage at VCO INHIBIT↓, $V_{(CINH)}$ (see Note 5) | | | 0 | 0.5 | V |

NOTES: 3. It is recommended that the logic supply terminal (LOGIC $V_{DD}$) and the VCO supply terminal (VCO $V_{DD}$) be at the same voltage and separated from each other.
4. A bypass capacitor is placed as close as possible to each supply terminal.
5. For stable restart of VCO, $V_{COIN}$ is 0 V when VCO INHIBIT is pulled down to GND level to disable the VCO INHIBIT function. And also, $V_{CO\ IN}$ should be 0 V when the operation will be started by supplying the power.

## electrical characteristics over recommended operating free-air temperature range, $V_{DD}$=3.3 V (unless otherwise noted)

### VCO

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = –2 mA | 3.1 | | | V |
| $V_{OL}$ | Low-level output voltage | $I_{OL}$= 2 mA | | | 0.2 | V |
| $V_{IH}$ | High-level input voltage | Logic signal input | 2.3 | | | V |
| $V_{IL}$ | Low-level input voltage | Logic signal input | | | 1.0 | V |
| $I_I$ | Input current at TEST, VCO INHIBIT | $V_I$ = $V_{DD}$ or GND | | | ±1 | µA |
| $Z_{V(CO\ IN)}$ | Input impedance at $V_{COIN}$ | $V_{COIN}$ = 1/2 $V_{DD}$ | | 10 | | MΩ |
| $I_{DD(INH)}$ | VCO supply current (inhibit) | See Note 6 | | 0.01 | 1 | µA |
| $I_{DD(VCO)}$ | VCO supply current | See Note 7 | | 10 | 15 | mA |

NOTES: 6. Current into VCO $V_{DD}$, when VCO INHIBIT = $V_{DD}$, PFD is inhibited.
7. Current into VCO $V_{DD}$, when $V_{COIN}$ = 1/2 $V_{DD}$, $R_{BIAS}$ = 1 kΩ, VCO INHIBIT = GND, PFD is inhibited.

## electrical characteristics over recommended operating free-air temperature range, $V_{DD}$=3.3 V (unless otherwise noted) (continued)

### VCO

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = –2 mA | 3.1 | | | V |
| $V_{OL}$ | Low-level output voltage | $I_{OL}$ = 2 mA | | | 0.2 | V |
| $I_{OZ}$ | High-impedance state output current | PFD INHIBIT = high, $V_O = V_{DD}$ or GND | | | ±1 | µA |
| $V_{IH}$ | High-level input voltage at FIN–A,B | | 2.3 | | | V |
| $V_{IL}$ | Low-level input voltage at FIN–A,B | | | | 1.0 | V |
| $V_{(TO)}$ | Positive input threshold voltage at PFD INHIBIT | | 1.0 | 1.65 | 2.3 | V |
| $C_I$ | Input capacitance at FIN-A,B | | | 5 | | pF |
| $Z_{(IN)}$ | Input impedance at FIN-A,B | | | 10 | | MΩ |
| $I_{DD(PFD)}$ | PFD supply current | See Note 8 | | 1.5 | 6.0 | mA |

NOTE 8: Current into LOGIC $V_{DD}$, when FIN-A, FIN-B=50 MHz ($V_{I(pp)}$ = 3.3V, rectangular wave), Test=GND, no load, and VCO OUT is inhibited.

### VCO

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $f_{(OSC)}$ | Operating oscillation frequency | $R_{BIAS}$ = 1 kΩ | 67 | 90 | 113 | MHz |
| $t_{(STB)}$ | Time to stable oscillation | See Note 9 | | 0.7 | 10 | µs |
| $t_r$ | Rise time | $C_L$ = 15 pF, See Figure 3 | | 1.7 | 5 | ns |
| $t_f$ | Fall time | $C_L$ = 15 pF, See Figure 3 | | 1.1 | 4 | ns |
| $f_{(duty)}$ | Duty cycle at VCO OUT | $R_{BIAS}$ = 1.0 kΩ, $V_{CO\ IN}$ = 1/2 $V_{DD}$ | 45% | 50% | 55% | |
| | Temperature coefficient of oscillation frequency | $R_{BIAS}$=1.0kΩ, $V_{CO\ IN}$ = 1/2 $V_{DD}$, $T_A$ = –20°C to 75°C | | 0.03 | | %/°C |
| | Supply voltage coefficient of oscillation frequency | $R_{BIAS}$ = 1 kΩ, $V_{CO\ IN}$ = 1.65 V, $V_{DD}$ = 3.15 V to 3.45 V | | 0.02 | | %/mV |
| | Jitter absolute | $R_{BIAS}$ = 1 kΩ, $V_{CO\ IN}$ = 1/2 $V_{DD}$ | | 50 | | ps |

NOTE 9: Current into VCO $V_{DD}$, when VCO INHIBIT = $V_{DD}$, PFD is inhibited.

### PFD AC

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $f_{MAX}$ | Maximum operating frequency | | 50 | | | MHz |
| $t_{PLZ}$ | PFD output disable time from low level | See Figures 4 and 5 and Table 6 | | 15.3 | 40 | ns |
| $t_{PHZ}$ | PFD output disable time from high level | | | 15.5 | 40 | ns |
| $t_{PZL}$ | PFD output enable time from low level | | | 2.4 | 10 | ns |
| $t_{PZH}$ | PFD output enable time from high level | | | 2.5 | 10 | ns |
| $t_r$ | Rise time | $C_L$=15 pF (see Figure 3) | | 1.2 | 5 | ns |
| $t_f$ | Fall time | $C_L$=15 pF (see Figure 3) | | 0.7 | 5 | ns |

## PARAMETER MEASUREMENT INFORMATION

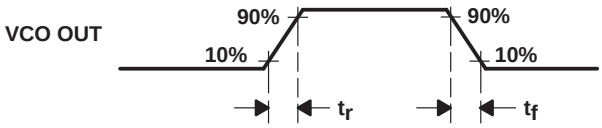
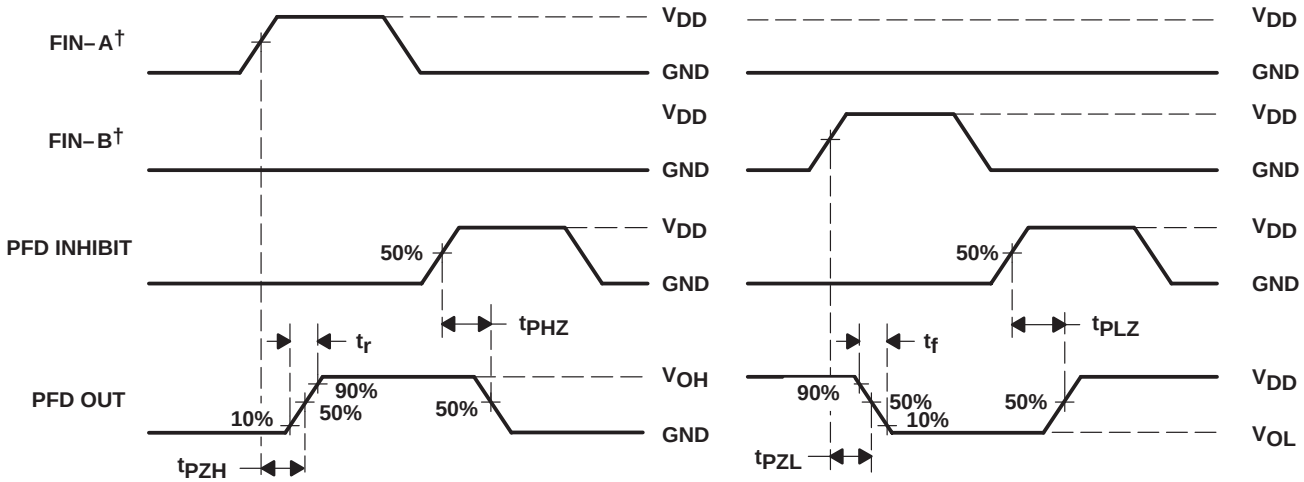



**Figure 1. VCO Output Voltage Waveform**




**(see Figure 3 and PFD Output Test Conditions Table)**

† FIN-A and FIN-B are for reference phase only, not for timing.

**Figure 2. PFD Output Voltage Waveform**

**PFD Output Test Conditions**

| PARAMETER | $R_L$ | $C_L$ | $S_L$ | $S_2$ |
|---|---|---|---|---|
| $t_{PZH}$ | 1 kΩ | 15 pF | Open | Close |
| $t_{PHZ}$ | | | | |
| $t_r$ | | | | |
| $t_{PZL}$ | | | Close | Open |
| $t_{PLZ}$ | | | | |
| $t_f$ | | | | |

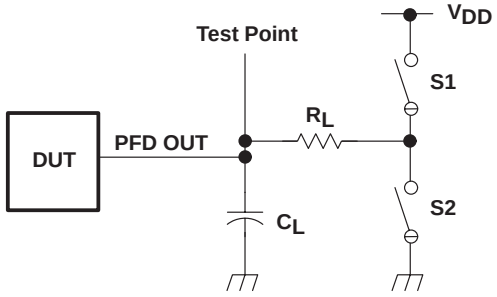



**Figure 3. PFD Output Test Condition**

## TYPICAL CHARACTERISTICS

VCO OSCILLATION FREQUENCY
vs
VCO CONTROL VOLTAGE

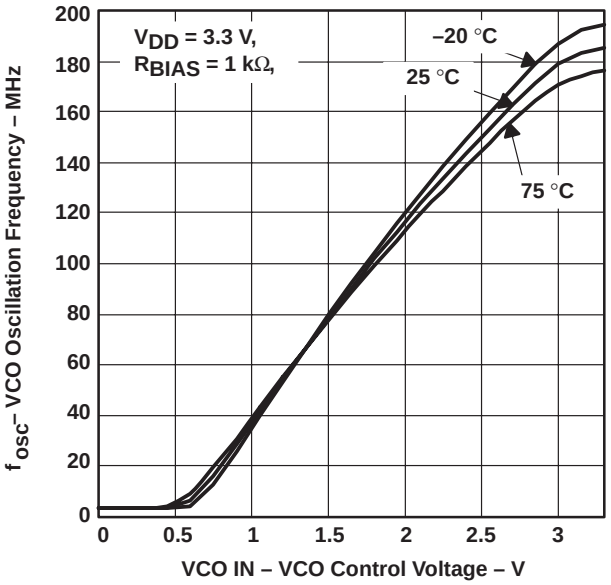



Figure 4

VCO OSCILLATION FREQUENCY
vs
VCO CONTROL VOLTAGE

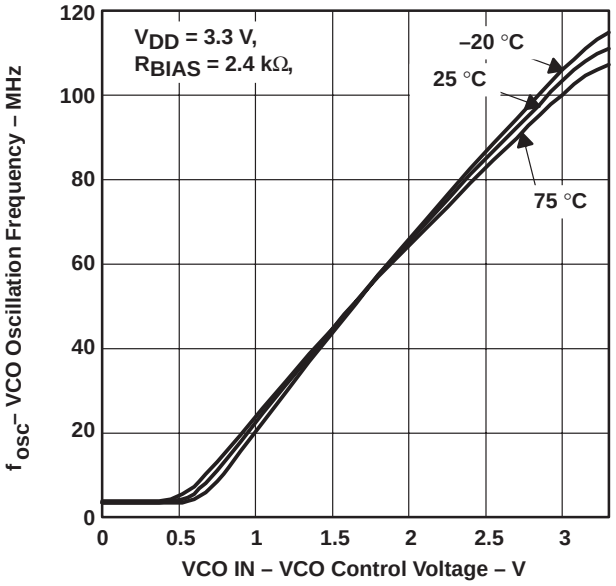



Figure 5

VCO OSCILLATION FREQUENCY
vs
VCO CONTROL VOLTAGE

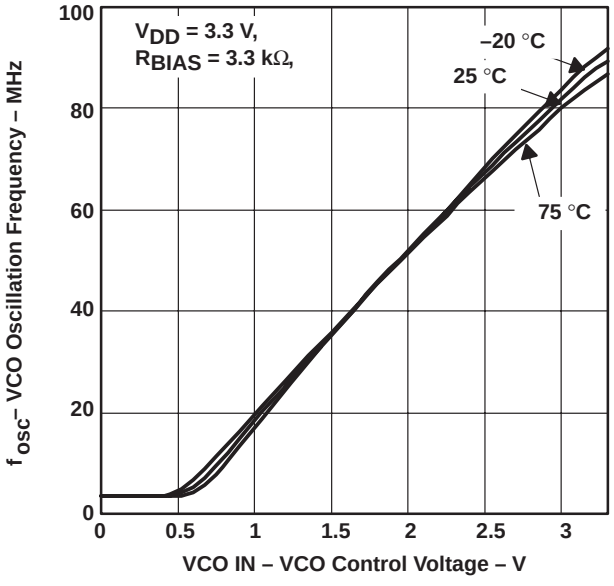



Figure 6

VCO OSCILLATION FREQUENCY
vs
VCO SUPPLY VOLTAGE

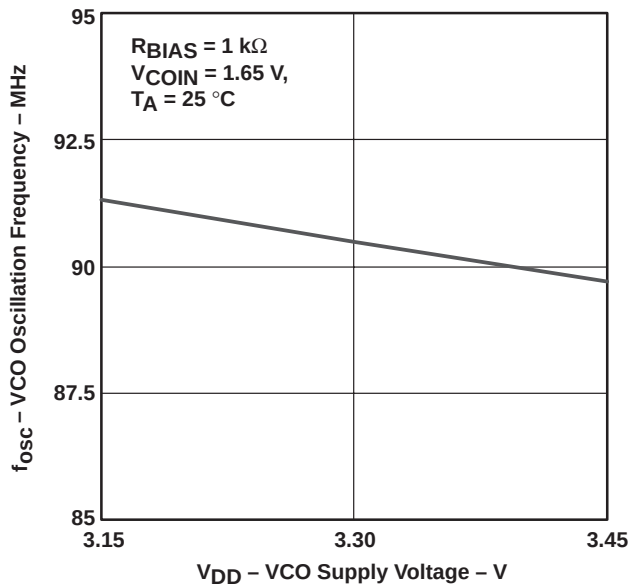



Figure 7

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/ Ball Finish | MSL Peak Temp (3) | Samples (Requires Login) |
|---|---|---|---|---|---|---|---|---|---|
| TLC2934IPW | NRND | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| TLC2934IPWG4 | NRND | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| TLC2934IPWR | NRND | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

(1) 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.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), 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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**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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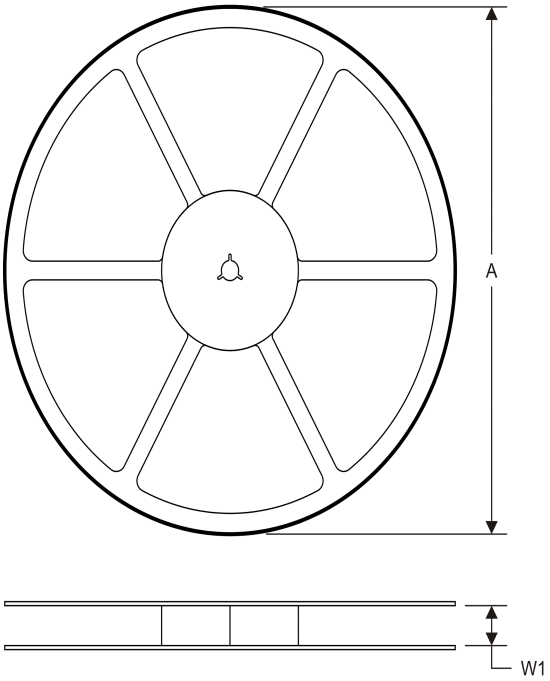
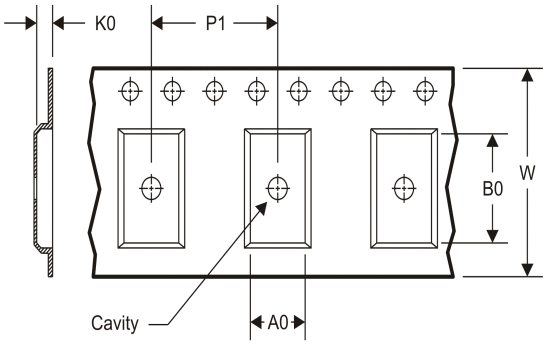
**REEL DIMENSIONS**




**TAPE DIMENSIONS**



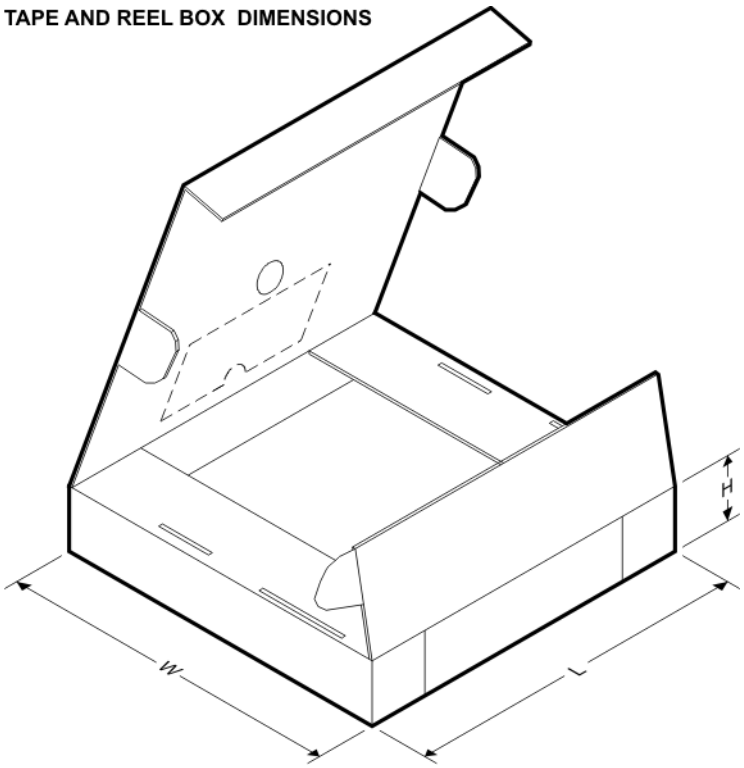

| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TLC2934IPWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TLC2934IPWR | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |

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