

# TL331, TL331V

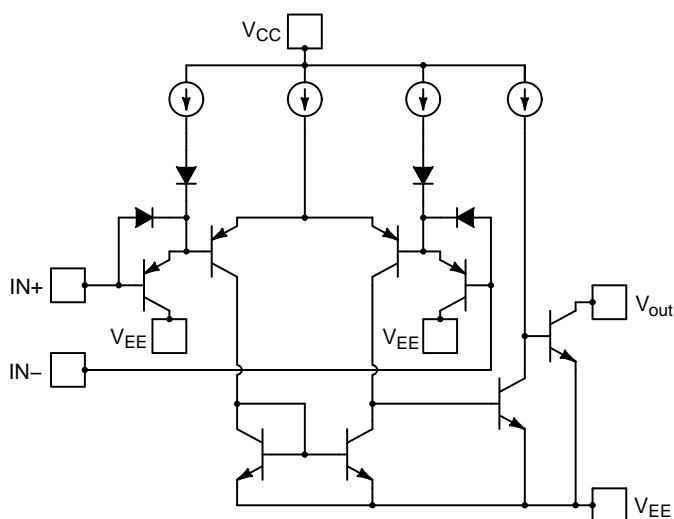
## Comparator, Single Channel, Open Collector, Low Power, Wide Supply Range

### Description

The TL331 is an open collector, low-power comparator designed specifically to operate over a wide supply range from 2 V to 36 V single supply and  $\pm 1$  V to  $\pm 18$  V for split supplies. The input common-mode voltage range includes ground, even when operated from a single power supply voltage. TL331 comes in a space saving TSOP-5 package and is also available in an automotive qualified version.

### Features

- Wide Single Supply Voltage Range or Dual Supplies
- Low Supply Current: 0.5 mA Typical
- Low Input Bias Current: 25 nA Typical
- Low Input Offset Current:  $\pm 5$  nA Typical
- Low Input Offset Voltage:  $\pm 2$  mV Typical
- Input Common Mode Voltage Range includes Ground
- Low Output Saturation Voltage: 150 mV Typ at  $I_O = 4$  mA
- Differential Input Voltage Range Equal to the Supply Voltage
- TTL, DTL, ECL, CMOS Compatible Devices
- TL331V for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable\*
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



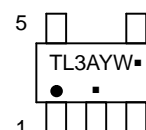
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TSOP-5  
SN SUFFIX  
CASE 483

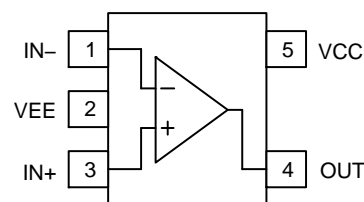
### MARKING DIAGRAM



TL3 = Specific Device Code  
A = Assembly Location  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

### PIN CONNECTIONS



### ORDERING INFORMATION

| Device        | Package          | Shipping†          |
|---------------|------------------|--------------------|
| TL331SN4T3G   | TSOP-5 (Pb-Free) | 3000 / Tape & Reel |
| TL331VSN4T3G* | TSOP-5 (Pb-Free) | 3000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# TL331, TL331V

**Table 1. MAXIMUM RATINGS** (Over operating free-air temperature, unless otherwise stated)

| Parameter                            | Symbol | Limit | Unit |
|--------------------------------------|--------|-------|------|
| Supply Voltage ( $V_{CC} - V_{EE}$ ) | $V_S$  | 36    | V    |

## INPUT AND OUTPUT PINS

|                                       |          |            |    |
|---------------------------------------|----------|------------|----|
| Input Voltage (Note 1)                | $V_{IN}$ | $\pm 36$   | V  |
| Differential Input Voltage (Note 1)   | $V_{ID}$ | -0.3 to 36 | V  |
| Output Short Circuit Current (Note 2) | $I_{SC}$ | 20         | mA |

## TEMPERATURE

|                      |           |             |    |
|----------------------|-----------|-------------|----|
| Storage Temperature  | $T_{STG}$ | -65 to +150 | °C |
| Junction Temperature | $T_J$     | +150        | °C |

## ESD RATINGS

|                      |     |      |   |
|----------------------|-----|------|---|
| Human Body Model     | HBM | 2000 | V |
| Charged Device Model | CDM | 2500 | V |
| Machine Model        | MM  | 150  | V |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Positive excursions of the input voltage may exceed the power supply level. The low input voltage state must not be less than 0.3 V below the negative supply rail.
2. Short circuits from the output to  $V_{CC}$  can cause excessive heating and potential destruction. The maximum short circuit current is independent of the magnitude of  $V_{CC}$ .

**Table 2. THERMAL INFORMATION** (Note 3)

| Parameter                              | Symbol        | Single Layer Board<br>(Note 4) | Multi-Layer Board<br>(Note 5) | Unit |
|--|---------------|--------------------------------|-------------------------------|------|
| Junction to Ambient Thermal Resistance | $\theta_{JA}$ | 274                            | 209                           | °C/W |

3. Short-circuits can cause excessive heating and destructive dissipation. These values are typical.
4. Values based on a 1S standard PCB according to JEDEC 51-3 with 1.0 oz copper and a 400 mm<sup>2</sup> copper area
5. Values based on a 1S2P standard PCB according to JEDEC 51-7 with 1.0 oz copper and a 25 mm<sup>2</sup> copper area

**Table 3. OPERATING CONDITIONS**

| Parameter                 | Symbol | Limit       | Unit |
|---------------------------|--------|-------------|------|
| Operating Supply Voltage  | $V_S$  | 2 to 36     | V    |
| Specified Operating Range | $T_A$  | -40 to +125 | °C   |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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**Table 4. ELECTRICAL CHARACTERISTICS (Vs=+5.0 V, At TA = +25°C, VCM = mid-supply, unless otherwise noted)**

**Boldface** limits apply over the specified temperature range, TA = -40°C to +125°C.

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

## INPUT CHARACTERISTICS

|  |                   |  |  |  |     |                       |           |
|--|-------------------|--|--|--|-----|-----------------------|-----------|
| Input Offset Voltage                   | V <sub>OS</sub>   | V <sub>O</sub> = 1.4 V,<br>R <sub>S</sub> = 0 Ω,<br>V <sub>S</sub> = 5 V to 30 V | V <sub>CM</sub> = 0 to<br>V <sub>CC</sub> -1.5 V |  | 1   | 5                     | mV        |
|  |                   |  | V <sub>CM</sub> = 0 to<br>V <sub>CC</sub> -2 V   |  |     | <b>9</b>              | <b>mV</b> |
| Input Bias Current                     | I <sub>IB</sub>   |  |  |  | -25 | -250                  | nA        |
|  |                   |  |  |  |     | <b>-400</b>           | <b>nA</b> |
| Input Offset Current                   | I <sub>OS</sub>   |  |  |  | 5   | 50                    | nA        |
|  |                   |  |  |  |     | <b>150</b>            | <b>nA</b> |
| Input Common Mode Range<br>(Note 6)    | V <sub>ICMR</sub> |  | 0  |  |     | V <sub>CC</sub> - 1.5 | V         |
| Differential Input Voltage<br>(Note 7) | V <sub>ID</sub>   |  |  |  |     | V <sub>CC</sub>       | V         |

## OUTPUT CHARACTERISTICS

|                        |                 |  |   |     |            |           |
|------------------------|-----------------|--|---|-----|------------|-----------|
| Output Voltage Low     | V <sub>OL</sub> | V <sub>ID</sub> = -1 V, I <sub>O</sub> = 4 mA                  |   | 150 | 400        | mV        |
|                        |                 |  |   |     | <b>700</b> | <b>mV</b> |
| Output Sink Current    | I <sub>O</sub>  | V <sub>ID</sub> = -1 V, V <sub>O</sub> = 1.5 V                 | 6 | 16  |            | mA        |
| Output Leakage Current | I <sub>OH</sub> | V <sub>ID</sub> = 1 V, V <sub>CC</sub> = V <sub>O</sub> = 5 V  |   | 0.1 | 50         | nA        |
|                        |                 | V <sub>ID</sub> = 1 V, V <sub>CC</sub> = V <sub>O</sub> = 30 V |   |     | <b>1</b>   | <b>μA</b> |

## DYNAMIC PERFORMANCE

|   |                  |  |    |     |  |      |
|---|------------------|--|----|-----|--|------|
| Large Signal Differential<br>Voltage Gain | A <sub>VD</sub>  | V <sub>CC</sub> = 15 V, R <sub>PU</sub> = 15 kΩ,<br>V <sub>O</sub> = 1.4 V to 11.4 V | 50 | 200 |  | V/mV |
| Propagation Delay L-H<br>(Note 8)         | t <sub>PLH</sub> | 5 mV overdrive, R <sub>PU</sub> = 5.1 kΩ   |    | 850 |  | ns   |
|   |                  | 20 mV overdrive, R <sub>PU</sub> = 5.1 kΩ  |    | 600 |  | ns   |
|   |                  | 100 mV overdrive, R <sub>PU</sub> = 5.1 kΩ   |    | 400 |  | ns   |
|   |                  | TTL Input, V <sub>ref</sub> = +1.4 V,<br>R <sub>PU</sub> = 5.1 kΩ                    |    | 300 |  | ns   |
| Propagation Delay H-L                     | t <sub>PHL</sub> | 5 mV overdrive, R <sub>PU</sub> = 5.1 kΩ   |    | 700 |  | ns   |
|   |                  | 20 mV overdrive, R <sub>PU</sub> = 5.1 kΩ  |    | 400 |  | ns   |
|   |                  | 100 mV overdrive, R <sub>PU</sub> = 5.1 kΩ   |    | 250 |  | ns   |
|   |                  | TTL Input, V <sub>ref</sub> = +1.4 V,<br>R <sub>PU</sub> = 5.1 kΩ                    |    | 300 |  | ns   |

## POWER SUPPLY

|                   |                 |                                 |  |     |      |    |
|-------------------|-----------------|---------------------------------|--|-----|------|----|
| Quiescent Current | I <sub>CC</sub> | No load, V <sub>CC</sub> = 5 V  |  | 0.5 | 0.7  | mA |
|                   |                 | No load, V <sub>CC</sub> = 30 V |  | 0.6 | 1.25 | mA |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

- The input common mode voltage of either input signal should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is V<sub>CC</sub> - 1.5 V, but either or both inputs can go to +36 V without damage.
- Positive excursions of the input voltage may exceed the power supply level. As long as the other voltage remains within the common mode range, the comparator will provide a proper output stage. The low input voltage state must not be less than 0.3 V below the negative supply rail.
- TL331 is an open collector comparator. Rise time is a function of the RC time constant. A 5.1 kΩ pull-up resistor was used for these measurements.

TYPICAL CHARACTERISTICS

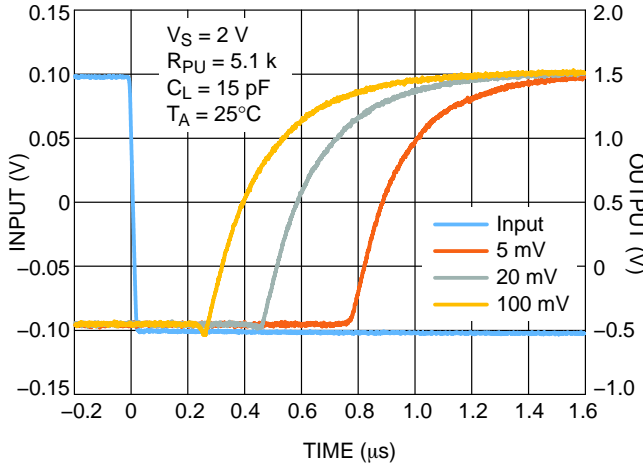


Figure 1. Low-to-High Propagation Delay vs. Overdrive at 2 V Supply

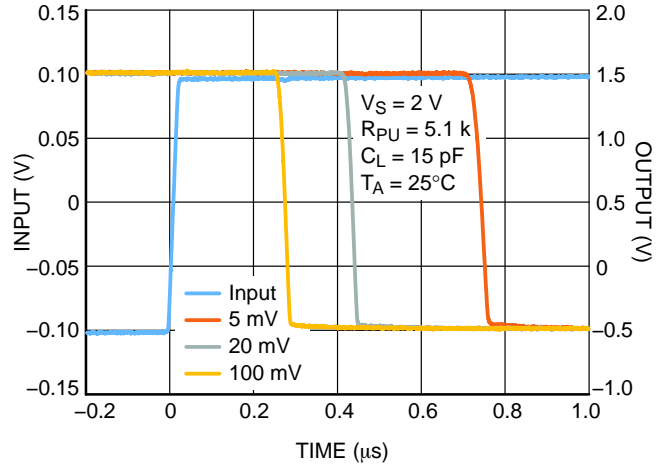


Figure 2. High-to-Low Propagation Delay vs. Overdrive at 2 V Supply

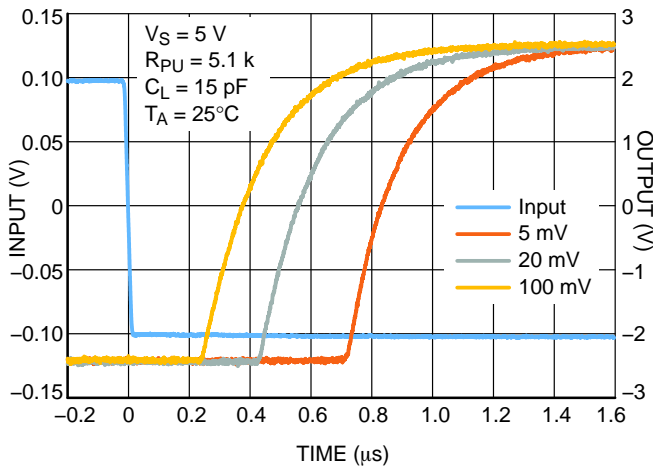


Figure 3. Low-to-High Propagation Delay vs. Overdrive at 5 V Supply

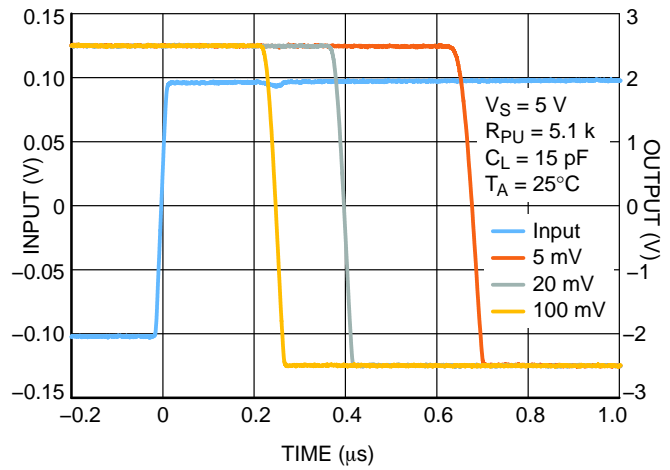


Figure 4. High-to-Low Propagation Delay vs. Overdrive at 5 V Supply

TYPICAL CHARACTERISTICS

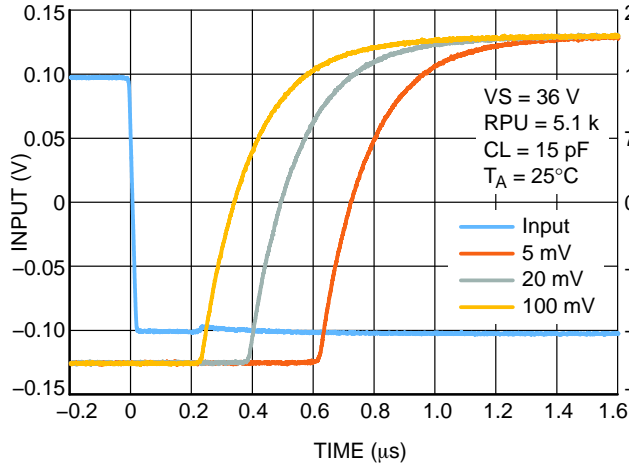


Figure 5. Low-to-High Propagation Delay vs. Overdrive at 36 V Supply

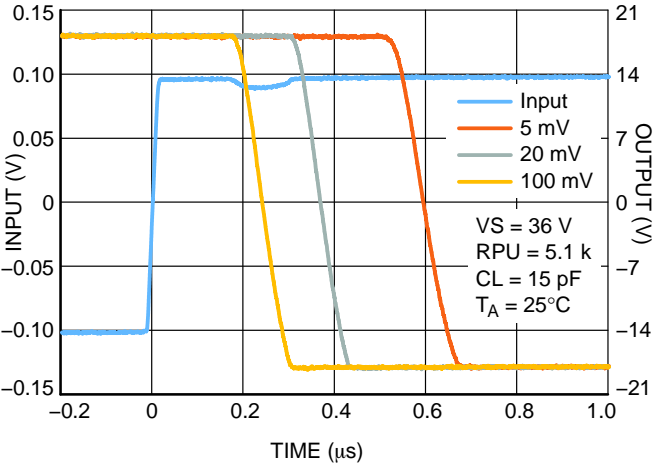


Figure 6. High-to-Low Propagation Delay vs. Overdrive at 36 V Supply

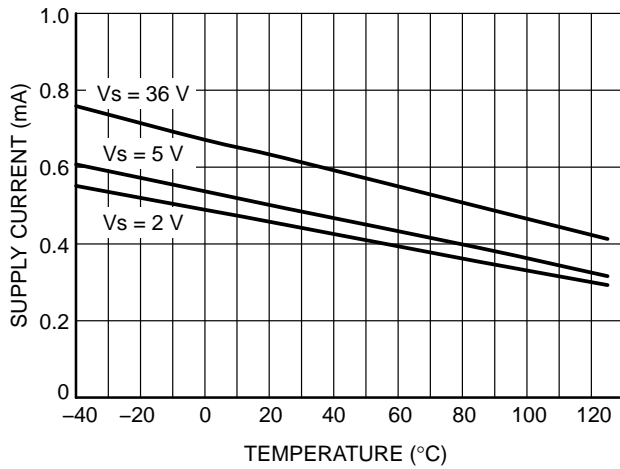


Figure 7. Quiescent Current vs. Temperature

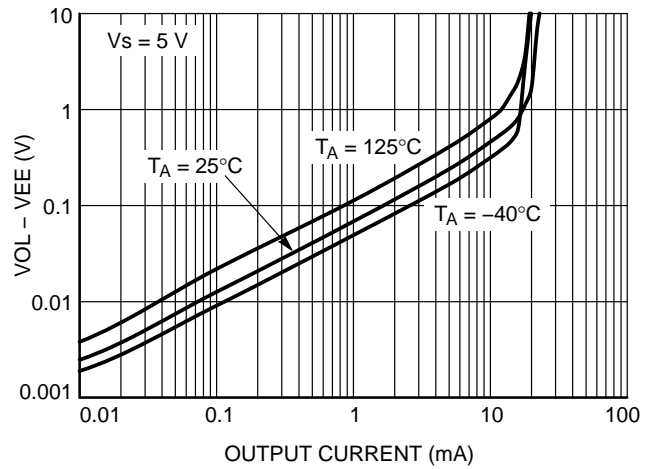
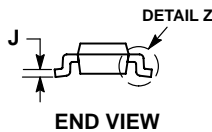
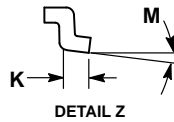
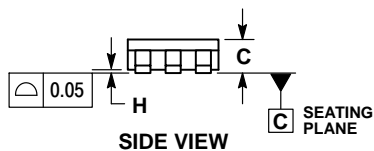
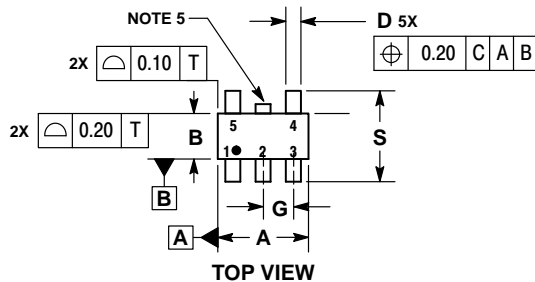


Figure 8. Low Level Output Voltage vs. Output Current at 5 V Supply

# TL331, TL331V

## PACKAGE DIMENSIONS

### TSOP-5 CASE 483 ISSUE M

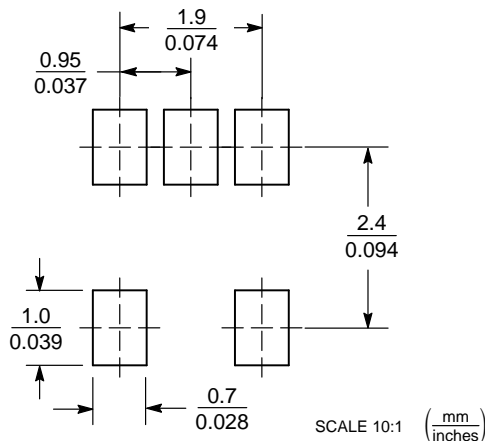


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE. DIMENSION A.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 2.85        | 3.15 |
| B   | 1.35        | 1.65 |
| C   | 0.90        | 1.10 |
| D   | 0.25        | 0.50 |
| G   | 0.95 BSC    |      |
| H   | 0.01        | 0.10 |
| J   | 0.10        | 0.26 |
| K   | 0.20        | 0.60 |
| M   | 0°          | 10°  |
| S   | 2.50        | 3.00 |

### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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