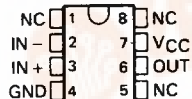


# TL331 TL331C DIFFERENTIAL COMPARATORS

D2344, APRIL 1977—REVISED OCTOBER 1988

- Single Supply or Dual Supplies
- Wide Range of Supply Voltage  
2 to 36 V
- Low Supply Current Drain Independent of  
Supply Voltage . . . 0.8 mA Typ
- Low Input Bias Current . . . 25 nA Typ
- Low Input Offset Current  
3 to 5 nA Typ
- Low Input Offset Voltage . . . 2 mV Typ
- Common-Mode Input Voltage Range  
Includes Ground
- Differential Input Voltage Range Equal to  
Maximum-Rated Supply Voltage . . .  $\pm 36$  V
- Low Output Saturation Voltage
- Output Compatible with TTL, MOS, and  
CMOS

D, JG, OR P PACKAGE  
(TOP VIEW)



NC—No internal connection

## AVAILABLE OPTIONS

| T <sub>A</sub>      | V <sub>IO</sub> MAX<br>at 25°C | PACKAGE                 |                        |                       |
|---------------------|--------------------------------|-------------------------|------------------------|-----------------------|
|                     |                                | SMALL<br>OUTLINE<br>(D) | CERAMIC<br>DIP<br>(JG) | PLASTIC<br>DIP<br>(P) |
| 0°C<br>to<br>70°C   | 5 mV                           | TL331CD                 | TL331CJG               | TL331CP               |
| -25°C<br>to<br>85°C | 5 mV                           | TL331ID                 | TL331IJG               | TL331IP               |

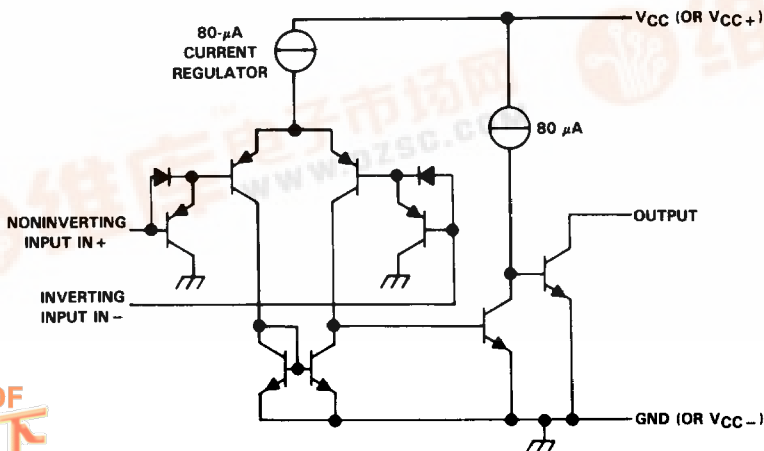
## description

The TL331 is a voltage comparator that is designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies is also possible so long as the difference between the two supplies is 2 V to 36 V and pin 7 is at least 1.5 V more positive than the input common-mode voltage. Current drain is independent of the supply voltage.

The TL331I is characterized for operation from -25°C to 85°C. The TL331C is characterized for operation from 0°C to 70°C.

The D package is available taped and reeled. Add the suffix R to the device type (e.g., TL331CDR)

## schematic



Current values shown are nominal.



# **TL331I, TL331C** **DIFFERENTIAL COMPARATORS**

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

|                                                                              |                              |
|------------------------------------------------------------------------------|------------------------------|
| Supply voltage, $V_{CC}$ (see Note 1)                                        | 36 V                         |
| Differential input voltage (see Note 2)                                      | $\pm 36$ V                   |
| Input voltage range (either input)                                           | -0.3 V to 36 V               |
| Output voltage                                                               | 36 V                         |
| Output current                                                               | 20 mA                        |
| Duration of output short-circuit to ground (see Note 3)                      | unlimited                    |
| Continuous total dissipation                                                 | See Dissipation Rating Table |
| Operating free-air temperature range: TL331I                                 | -25°C to 85°C                |
| TL331C                                                                       | 0°C to 70°C                  |
| Storage temperature range                                                    | -65°C to 150°C               |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package     | 300°C                        |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P package | 260°C                        |

- NOTES: 1. All voltage values, except differential voltages, are with respect to the network ground terminal.  
2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.  
3. Short circuits from the output to  $V_{CC}$  can cause excessive heating and eventual destruction.

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING FACTOR<br>ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 85^\circ\text{C}$<br>POWER RATING |
|---------|---------------------------------------------|---------------------------------------------------|------------------------------------------|------------------------------------------|
| D       | 680 mW                                      | 5.8 mW/°C                                         | 464 mW                                   | 377 mW                                   |
| JG      | 680 mW                                      | 6.6 mW/°C                                         | 528 mW                                   | 429 mW                                   |
| P       | 680 mW                                      | 8.0 mW/°C                                         | 640 mW                                   | 520 mW                                   |

**recommended operating conditions**

|                                       |                 | TL331I |     | TL331C |     | UNIT |
|---------------------------------------|-----------------|--------|-----|--------|-----|------|
|                                       |                 | MIN    | MAX | MIN    | MAX |      |
| Supply voltage, $V_{CC}$              |                 | 5      | 30  | 5      | 30  | V    |
| Common-mode input voltage, $V_{IC}$   | $V_{CC} = 5$ V  | 0      | 3   | 0      | 3   | V    |
|                                       | $V_{CC} = 30$ V | 0      | 28  | 0      | 28  |      |
| Operating free-air temperature, $T_A$ |                 | -25    | 85  | 0      | 70  | °C   |

# TL331I, TL331C DIFFERENTIAL COMPARATORS

electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER        |                                                 | TEST CONDITIONS†                                                                                          |                        | TL331I                        |     |       | TL331C                        |     |       | UNIT |
|------------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------|------------------------|-------------------------------|-----|-------|-------------------------------|-----|-------|------|
|                  |                                                 |                                                                                                           |                        | MIN                           | TYP | MAX   | MIN                           | TYP | MAX   |      |
| V <sub>IO</sub>  | Input offset voltage                            | V <sub>CC</sub> = 5 V to 30 V,<br>V <sub>IC</sub> = V <sub>ICR</sub> min, V <sub>O</sub> = 1.4 V          | 25 °C                  | 2                             |     | 5     | 2                             |     | 5     | mV   |
|                  |                                                 |                                                                                                           | Full range             |                               |     | 9     |                               |     | 9     |      |
| I <sub>IO</sub>  | Input offset current                            | V <sub>O</sub> = 1.4 V                                                                                    | 25 °C                  | 3                             |     | 25    | 5                             |     | 50    | nA   |
|                  |                                                 |                                                                                                           | Full range             |                               |     | 100   |                               |     | 150   |      |
| I <sub>IB</sub>  | Input bias current                              |                                                                                                           | 25 °C                  | – 25                          |     | – 100 | – 25                          |     | – 250 | nA   |
|                  |                                                 |                                                                                                           | Full range             |                               |     | – 300 |                               |     | – 400 |      |
| V <sub>ICR</sub> | Common-mode input voltage range                 | V <sub>CC</sub> = 5 V to 30 V                                                                             | 25 °C                  | 0 to<br>V <sub>CC</sub> – 1.5 |     |       | 0 to<br>V <sub>CC</sub> – 1.5 |     |       | V    |
|                  |                                                 |                                                                                                           | Full range             | 0 to<br>V <sub>CC</sub> – 2   |     |       | 0 to<br>V <sub>CC</sub> – 2   |     |       |      |
| A <sub>VD</sub>  | Large-signal differential voltage amplification | V <sub>CC</sub> = 15 V,<br>V <sub>O</sub> = 1.4 V to 11.4 V,<br>R <sub>L</sub> = 15 kΩ to V <sub>CC</sub> | 25 °C                  | 200                           |     |       | 200                           |     |       | V/mV |
| I <sub>OH</sub>  | High-level output current                       | V <sub>ID</sub> = 1 V                                                                                     | V <sub>OH</sub> = 5 V  | 25 °C                         | 0.1 |       | 0.1                           |     |       | nA   |
|                  |                                                 |                                                                                                           | V <sub>OH</sub> = 30 V | Full range                    | 1   |       | 1                             |     |       | μA   |
| V <sub>OL</sub>  | Low-level output voltage                        | V <sub>ID</sub> = – 1 V, I <sub>OL</sub> = 4 mA                                                           | 25 °C                  | 150                           |     | 400   | 150                           |     | 400   | mV   |
|                  |                                                 |                                                                                                           | Full range             |                               |     | 700   |                               |     | 700   |      |
| I <sub>OL</sub>  | Low-level output current                        | V <sub>ID</sub> = – 1 V, V <sub>OL</sub> = 1.5 V                                                          | 25 °C                  | 6                             |     |       | 6                             |     |       | mA   |
| I <sub>CC</sub>  | Supply current                                  | V <sub>O</sub> = 2.5 V, No load                                                                           | 25 °C                  | 0.5                           |     | 0.8   | 0.5                           |     | 0.8   | mA   |

† Full range (MIN to MAX) for the TL331I is -25°C to 85°C and for the TL331C is 0°C to 70°C. All characteristics are measured with zero common-mode input voltage unless otherwise specified.

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER     | TEST CONDITIONS                                                                                   |                                       | MIN | TYP | MAX | UNIT          |
|---------------|---------------------------------------------------------------------------------------------------|---------------------------------------|-----|-----|-----|---------------|
| Response time | $R_L$ connected to 5 V through 5.1 k $\Omega$ ,<br>$C_L = 15\text{ pF}$ , <sup>‡</sup> See Note 4 | 100-mV input step with 5-mV overdrive |     | 1.3 |     | $\mu\text{s}$ |
|               |                                                                                                   | TTL-level input step                  |     | 0.3 |     |               |

<sup>‡</sup> $C_L$  includes probe and jig capacitance.

NOTE 4: The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.