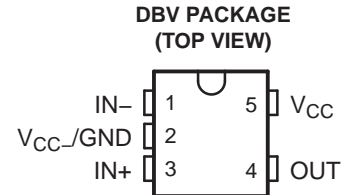


## SINGLE DIFFERENTIAL COMPARATOR

### FEATURES

- **Single Supply or Dual Supplies**
- **Wide Range of Supply Voltage . . . 2 V to 36 V**
- **Low Supply-Current Drain Independent of Supply Voltage . . . 0.4 mA Typ**
- **Low Input Bias Current . . . 25 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**



### DESCRIPTION/ORDERING INFORMATION

This device consists of a single voltage comparator that is designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible if the difference between the two supplies is 2 V to 36 V and  $V_{CC}$  is at least 1.5 V more positive than the input common-mode voltage. Current drain is independent of the supply voltage. The output can be connected to other open-collector outputs to achieve wired-AND relationships.

#### ORDERING INFORMATION<sup>(1)</sup>

$T_A$	$V_{IO(max)}$ AT 25°C	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>
–40°C to 85°C	5 mV	SOT-23 – DBV	Reel of 3000	TL331IDBVR	T1L_
			Reel of 250	TL331IDBVT	
–40°C to 105°C	5 mV	SOT-23 – DBV	Reel of 3000	TL331KDBVR	T1K_
			Reel of 250	TL331KDBVT	

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(3) The actual top-side marking has one additional character that designates the wafer fab/assembly site.

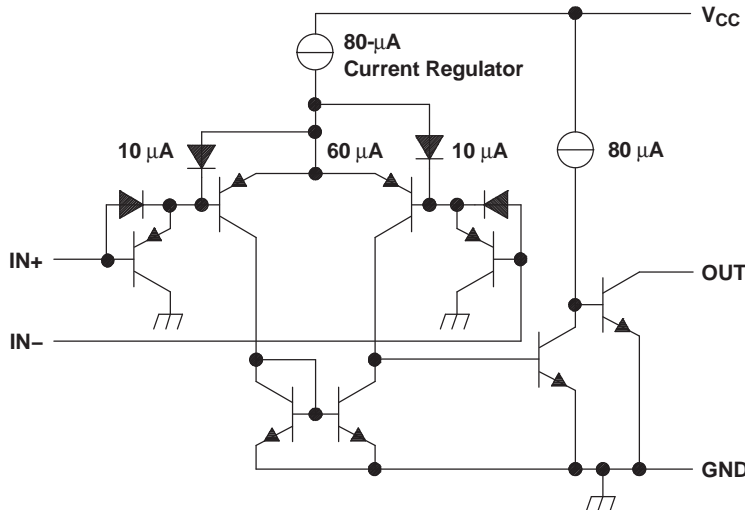


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**LOGIC DIAGRAM**



**SCHEMATIC**



COMPONENT COUNT	
Epi-FET	1
Diodes	2
Resistors	1
Transistors	20

Note: Current values shown are nominal.

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

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

$V_{CC}$	Supply voltage <sup>(2)</sup>	36 V
$V_{ID}$	Differential input voltage <sup>(3)</sup>	$\pm 36$ V
$V_I$	Input voltage range (either input)	-0.3 V to 36 V
$V_O$	Output voltage	36 V
$I_O$	Output current	20 mA
	Duration of output short-circuit to ground <sup>(4)</sup>	Unlimited
$\theta_{JA}$	Package thermal impedance <sup>(5)(6)</sup>	206°C/W
$T_J$	Operating virtual junction temperature	150°C
$T_{stg}$	Storage temperature range	-65°C to 150°C

- (1) 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.
- (2) All voltage values, except differential voltages, are with respect to the network ground.
- (3) Differential voltages are at IN+ with respect to IN-.
- (4) Short circuits from outputs to  $V_{CC}$  can cause excessive heating and eventual destruction.
- (5) Maximum power dissipation is a function of  $T_J(max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(max) - T_A) / \theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can impact reliability.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

## ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS <sup>(1)</sup>	$T_A$ <sup>(2)</sup>	MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage	$V_{CC} = 5\text{ V to } 30\text{ V}$ , $V_O = 1.4\text{ V}$ , $V_{IC} = V_{IC(min)}$	25°C	2	5		mV
			Full range			9	
$I_{IO}$	Input offset current	$V_O = 1.4\text{ V}$	25°C	5	50		nA
			Full range			250	
$I_{IB}$	Input bias current	$V_O = 1.4\text{ V}$	25°C	-25	-250		nA
			Full range			-400	
$V_{ICR}$	Common-mode input voltage range <sup>(3)</sup>		25°C	0 to $V_{CC} - 1.5$			V
			Full range	0 to $V_{CC} - 1.5$			
$A_{VD}$	Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$ , $V_O = 1.4\text{ V to } 11.4\text{ V}$ , $R_L \geq 15\text{ k}\Omega$ to $V_{CC}$	25°C	50	200		V/mV
$I_{OH}$	High-level output current	$V_{OH} = 5\text{ V}$ , $V_{ID} = 1\text{ V}$	25°C	0.1	50		nA
		$V_{OH} = 30\text{ V}$ , $V_{ID} = 1\text{ V}$	Full range			1	$\mu\text{A}$
$V_{OL}$	Low-level output voltage	$I_{OL} = 4\text{ mA}$ , $V_{ID} = -1\text{ V}$	25°C	150	400		mV
			Full range			700	
$I_{OL}$	Low-level output current	$V_{OL} = 1.5\text{ V}$ , $V_{ID} = 1\text{ V}$	25°C	6			mA
$I_{CC}$	Supply current	$R_L = \infty$ , $V_{CC} = 5\text{ V}$	25°C	0.4	0.7		mA

(1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

(2) Full range  $T_A$  is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for I-suffix devices and  $-40^\circ\text{C}$  to  $105^\circ\text{C}$  for K-suffix devices.

(3) The voltage at either input or common-mode should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is  $V_{CC+} - 1.5\text{ V}$ , but either or both inputs can go to 30 V without damage.

## SWITCHING CHARACTERISTICS

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

PARAMETER	TEST CONDITIONS	TYP	UNIT
Response time	$R_L$ connected to 5 V through 5.1 k $\Omega$ , $C_L = 15\text{ pF}$ <sup>(1)(2)</sup>	100-mV input step with 5-mV overdrive	1.3
		TTL-level input step	0.3

(1)  $C_L$  includes probe and jig capacitance.

(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL331IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(T1I3 ~ T1IG ~ T1IL ~ T1IS)	<a href="#">Samples</a>
TL331IDBVE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(T1I3 ~ T1IG ~ T1IL ~ T1IS)	<a href="#">Samples</a>
TL331IDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(T1I3 ~ T1IG ~ T1IL ~ T1IS)	<a href="#">Samples</a>
TL331IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(T1I3 ~ T1IG ~ T1IL ~ T1IU)	<a href="#">Samples</a>
TL331IDBVTE4	ACTIVE	SOT-23	DBV	5		TBD	Call TI	Call TI	-40 to 85	(T1I3 ~ T1IG ~ T1IL ~ T1IU)	<a href="#">Samples</a>
TL331IDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(T1I3 ~ T1IG ~ T1IL ~ T1IU)	<a href="#">Samples</a>
TL331KDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	(T1KG ~ T1KL)	<a href="#">Samples</a>
TL331KDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	(T1KG ~ T1KL)	<a href="#">Samples</a>
TL331KDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	(T1KG ~ T1KL)	<a href="#">Samples</a>
TL331KDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	(T1KG ~ T1KL)	<a href="#">Samples</a>

(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.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**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.
- (4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.
- (5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.
- (6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**OTHER QUALIFIED VERSIONS OF TL331 :**

- Automotive: [TL331-Q1](#)
- Enhanced Product: [TL331-EP](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*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
TL331IDBVR	SOT-23	DBV	5	3000	180.0	9.2	3.17	3.23	1.37	4.0	8.0	Q3
TL331IDBVR	SOT-23	DBV	5	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TL331IDBVT	SOT-23	DBV	5	250	180.0	9.2	3.17	3.23	1.37	4.0	8.0	Q3
TL331KDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TL331KDBVR	SOT-23	DBV	5	3000	180.0	9.2	3.17	3.23	1.37	4.0	8.0	Q3

## TAPE AND REEL BOX DIMENSIONS



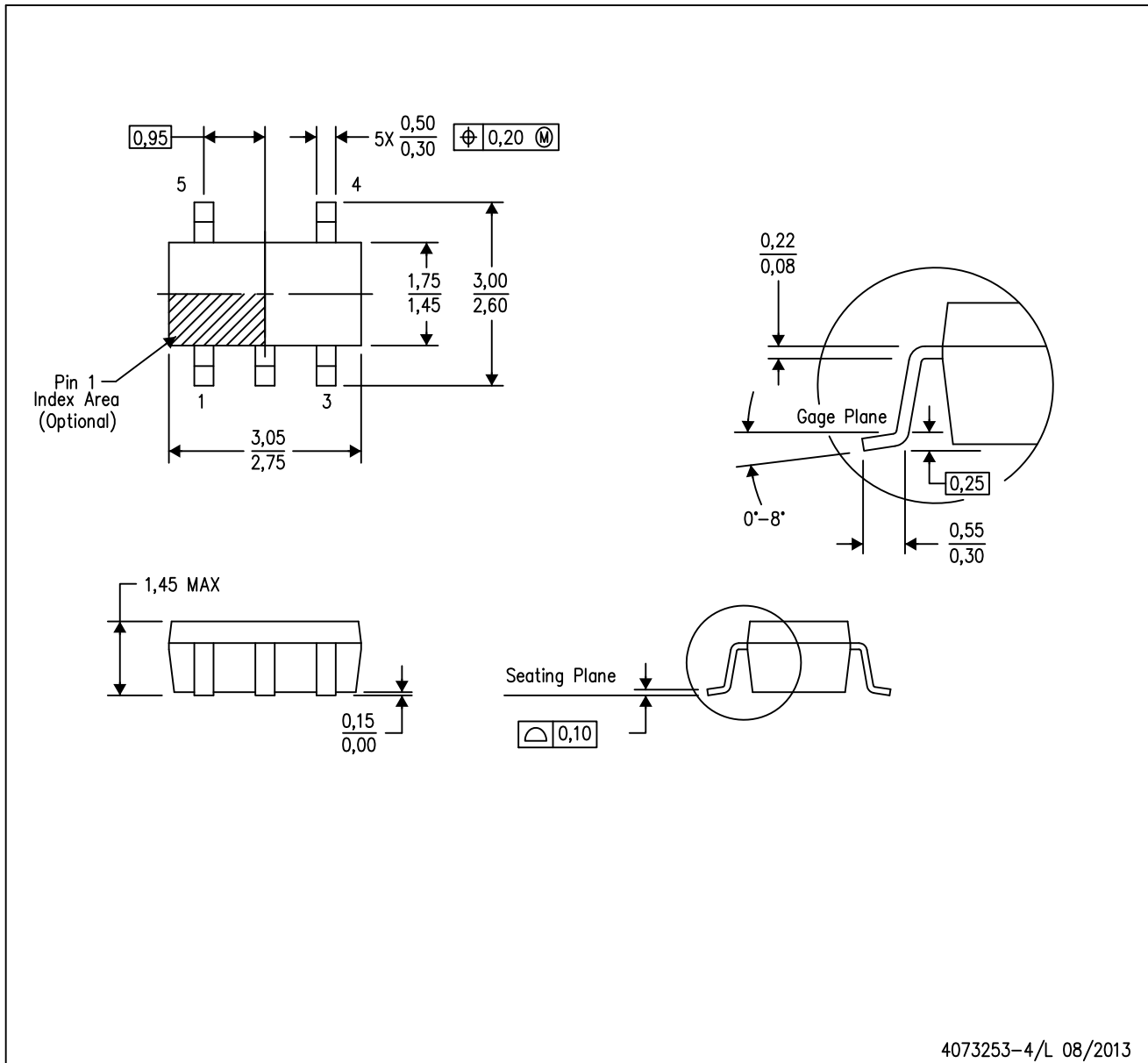
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL331IDBVR	SOT-23	DBV	5	3000	205.0	200.0	33.0
TL331IDBVR	SOT-23	DBV	5	3000	202.0	201.0	28.0
TL331IDBVT	SOT-23	DBV	5	250	205.0	200.0	33.0
TL331KDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TL331KDBVR	SOT-23	DBV	5	3000	205.0	200.0	33.0

# MECHANICAL DATA

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-178 Variation AA.



DBV (R-PDSO-G5)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

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