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

TL331, TL331V

TSOP−5
SN SUFFIX
CASE 483

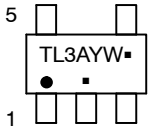
Description

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 ±1 V to ±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: ±5 nA Typical
- Low Input Offset Voltage: ±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

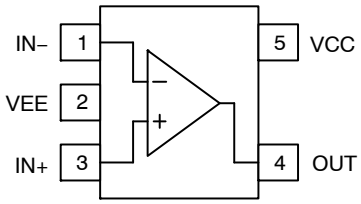
MARKING DIAGRAM



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

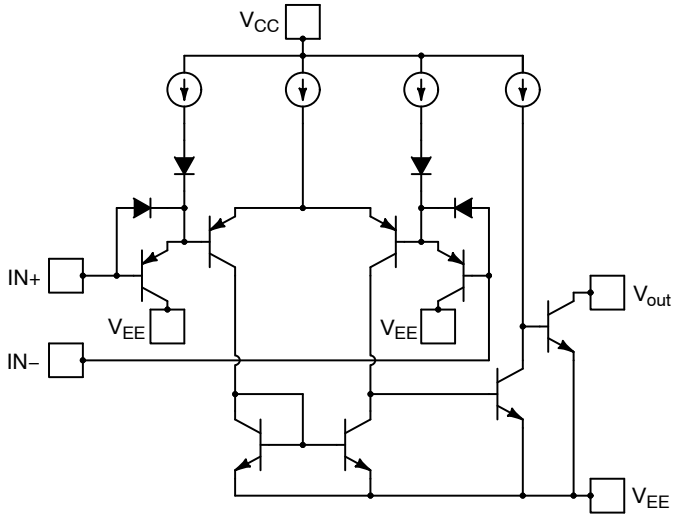
(Note: Microdot may be in either location)

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.



DEVICE ORDERING INFORMATION

Device	Automotive	Package	Shipping†
TL331SN4T1G	No	TSOP−5 (Pb−Free)	3000 / Tape & Reel
TL331SN4T3G*	No		
TL331VSN4T1G	Yes		
TL331VSN4T3G*	Yes		

*Discontinued part number. Not recommended for new designs.
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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}	±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 (Note 4)	Multi−Layer Board (Note 5)	Unit
Junction to Ambient Thermal Resistance	θ_{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^2 copper area
5. Values based on a 1S2P standard PCB according to JEDEC 51−7 with 1.0 oz copper and a 25 mm^2 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.

Table 4. ELECTRICAL CHARACTERISTICS (Vs=+5.0 V, At T_A = +25°C, V_{CM} = mid−supply, unless otherwise noted**)**
Boldface limits apply over the specified temperature range, T_A = −40°C to +125°C.

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	Vo = 1.4 V, R_S = 0 Ω, V_S = 5 V to 30 V	V_{CM} = 0 to V_{CC} −1.5 V		1	5	mV
			V_{CM} = 0 to V_{CC} −2 V			**9**	**mV**
Input Bias Current	I_{IB}				−25	−250	nA
						−400	**nA**
Input Offset Current	I_{OS}				5	50	nA
						150	**nA**
Input Common Mode Range (Note 6)	V_{ICMR}			0		V_{CC} − 1.5	V
Differential Input Voltage (Note 7)	V_{ID}					V_{CC}	V
OUTPUT CHARACTERISTICS							
Output Voltage Low	V_{OL}	V_{ID} = −1 V, I_O = 4 mA			150	400	mV
						700	**mV**
Output Sink Current	I_O	V_{ID} = −1 V, V_O = 1.5 V		6	16		mA
Output Leakage Current	I_{OH}	V_{ID} = 1 V, V_{CC} = V_O = 5 V			0.1	50	nA
		V_{ID} = 1 V, V_{CC} = V_O = 30 V				**1**	**μA**
DYNAMIC PERFORMANCE							
Large Signal Differential Voltage Gain	A_{VD}	V_{CC} = 15 V, R_{PU} = 15 kΩ, V_O = 1.4 V to 11.4 V		50	200		V/mV
Propagation Delay L−H (Note 8)	t_{PLH}	5 mV overdrive, R_{PU} = 5.1 kΩ			850		ns
		20 mV overdrive, R_{PU} = 5.1 kΩ			600		ns
		100 mV overdrive, R_{PU} = 5.1 kΩ			400		ns
		TTL Input, Vref = +1.4 V, R_{PU} = 5.1 kΩ			300		ns
Propagation Delay H−L	t_{PHL}	5 mV overdrive, R_{PU} = 5.1 kΩ			700		ns
		20 mV overdrive, R_{PU} = 5.1 kΩ			400		ns
		100 mV overdrive, R_{PU} = 5.1 kΩ			250		ns
		TTL Input, Vref = +1.4 V, R_{PU} = 5.1 kΩ			300		ns
POWER SUPPLY							
Quiescent Current	I_{CC}	No load, V_{CC} = 5 V			0.5	0.7	mA
		No load, V_{CC} = 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.

6. 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 VCC − 1.5 V, but either or both inputs can go to +36 V without damage.
7. 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.
8. 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

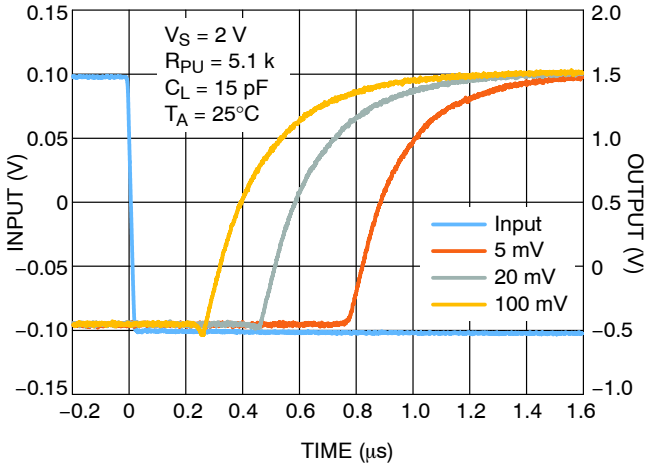


Figure 1. Low−to−High Propagation Delay vs. Overdrive at 2 V Supply

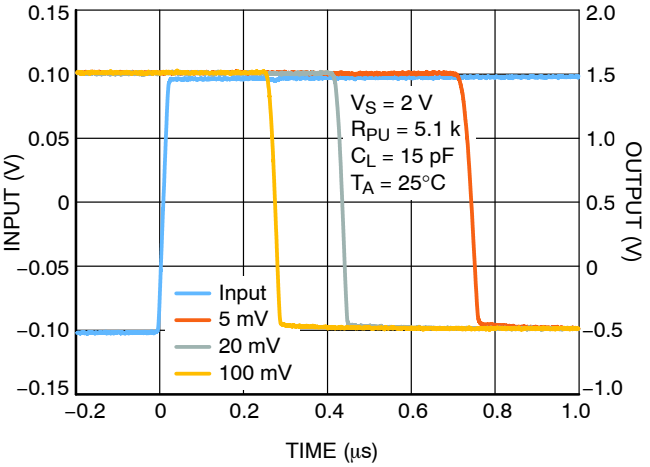


Figure 2. High−to−Low Propagation Delay vs. Overdrive at 2 V Supply

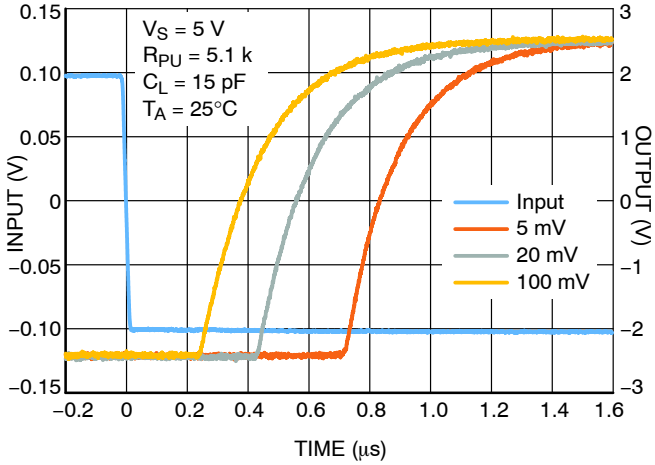


Figure 3. Low−to−High Propagation Delay vs. Overdrive at 5 V Supply

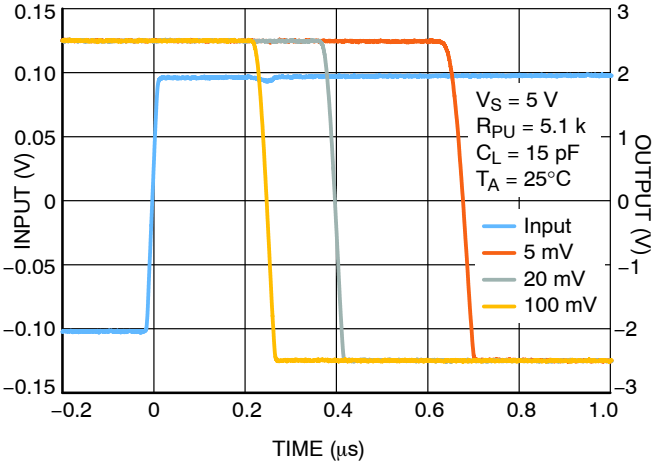


Figure 4. High−to−Low Propagation Delay vs. Overdrive at 5 V Supply

TYPICAL CHARACTERISTICS

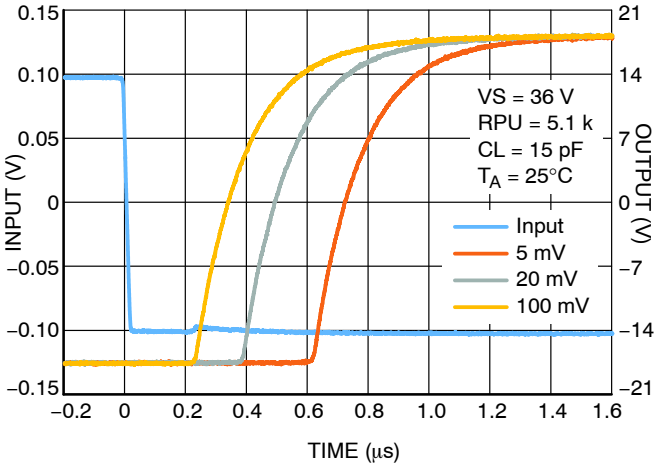


Figure 5. Low−to−High Propagation Delay vs. Overdrive at 36 V Supply

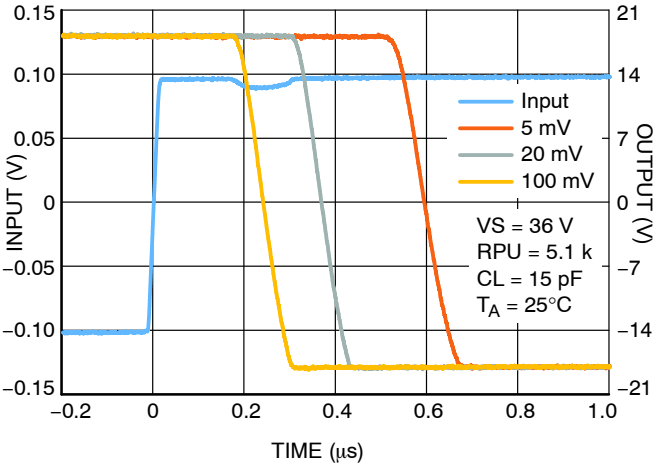


Figure 6. High−to−Low Propagation Delay vs. Overdrive at 36 V Supply

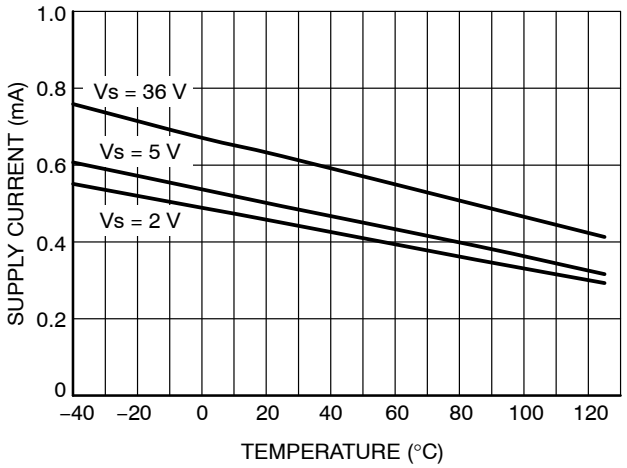


Figure 7. Quiescent Current vs. Temperature

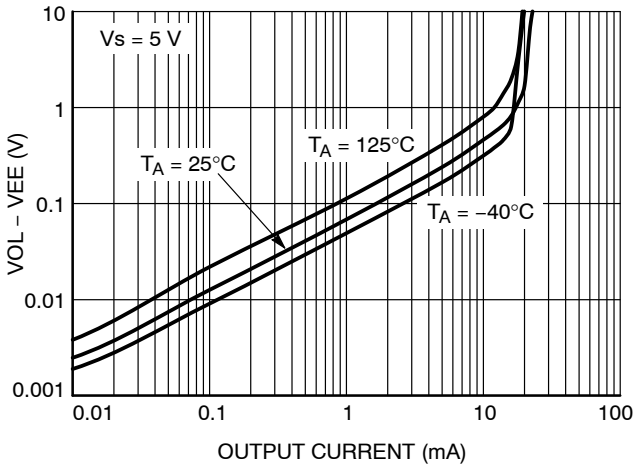
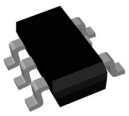


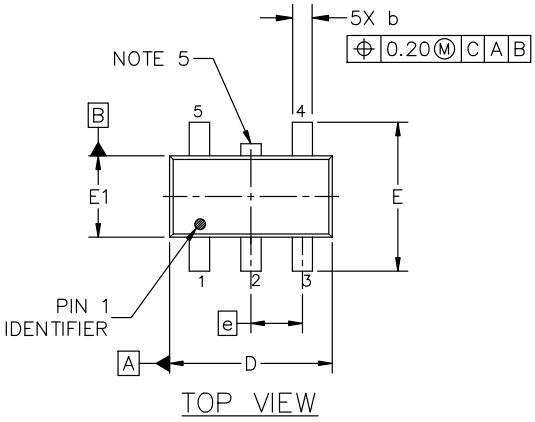
Figure 8. Low Level Output Voltage vs. Output Current at 5 V Supply

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

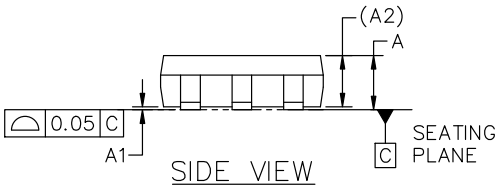


TSOP−5 3.00x1.50x0.95, 0.95P
CASE 483
ISSUE P

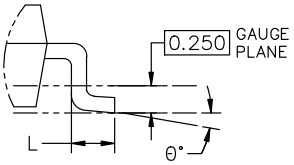
DATE 01 APR 2024



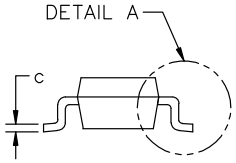
TOP VIEW



SIDE VIEW



DETAIL "A"
SCALE 2:1

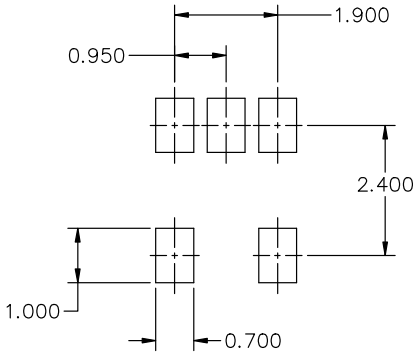


END VIEW

NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5−2018.
2. ALL DIMENSION ARE IN MILLIMETERS (ANGLES IN DEGREES).
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OF GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE. DIMENSION D.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

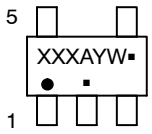
DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.900	1.000	1.100
A1	0.010	0.055	0.100
A2		0.950 REF.	
b	0.250	0.375	0.500
c	0.100	0.180	0.260
D	2.850	3.000	3.150
E	2.500	2.750	3.000
E1	1.350	1.500	1.650
e		0.950 BSC	
L	0.200	0.400	0.600
θ	0°	5°	10°



RECOMMENDED MOUNTING 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.

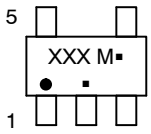
GENERIC
MARKING DIAGRAM*



Analog

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

(Note: Microdot may be in either location)



Discrete/Logic

XXX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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DESCRIPTION:	**TSOP−5 3.00x1.50x0.95, 0.95P**	**PAGE 1 OF 1**

ADDITIONAL INFORMATION

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