



### SOT-25



#### Pin Definition:

1. Input +
2. Ground
3. Input -
4. Output
5. Vcc

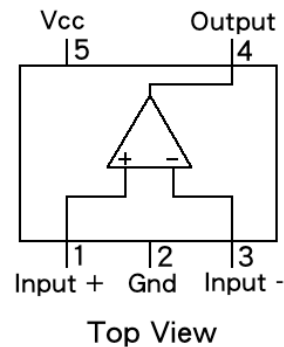
### General Description

The TS331 is single precision voltage comparators capable of single-supply or split-supply operation. The specifications as low as 2.0 mV make this device an excellent ground level with single-supply operation. Input offset-voltage selection for many applications in consumer automotive, and It is designed to permit a common mode range-to- industrial electronics.

### Features

- Output voltage compatible with DTL, ECL, TTL, MOS and CMOS Logic levels
- Low input bias current 25nA
- Low input offset current  $\pm 0.5\text{nA}$
- Low input offset voltage  $\pm 2\text{mV}(\text{typ})$
- Input common mode range to ground level
- Differential input voltage range equal to power supply voltage
- Very low supply current drain (0.4mA) - independent of supply voltage
- Wide single-supply range 2V~36V
- Split-supply range  $\pm 1\text{V}$  to  $\pm 18\text{V}$

### Block Diagram



### Ordering Information

Part No.	Package	Packing
TS331CX5 RF	SOT-25	3Kpcs / 7" Reel

### Absolute Maximum Rating

Parameter	Symbol	Limit	Unit
Supply Voltage	$V_{CC}$	+36 or $\pm 18$	V
Differential Input Voltage	$V_{IDR}$	36	V
Input Common Mode Voltage Range	$V_{ICR}$	-0.3 to 36	V
Input Current	$I_{IN}$	50	mA
Output Short Circuit to Ground	$I_{SC}$	Continuous	
Output Sink Current	$I_{SINK}$	20	mA
Operating Temperature Range	$T_{OPR}$	-40 ~ +85	$^{\circ}\text{C}$
Junction Temperature	$T_J$	150	$^{\circ}\text{C}$
Storage Temperature Range	$T_{STG}$	-65 ~ +150	$^{\circ}\text{C}$
Lead Temperature 1.6mm(1/16") from case for 10Sec.	$T_{LEAD}$	260	$^{\circ}\text{C}$

### Electrical Characteristics ( $V_{CC} = 5V$ , $T_a=25^{\circ}C$ ; unless otherwise specified.)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (note 3)	$V_{io}$	--	2	5	mV
Input Offset Current, $I_{IN(+)} - I_{IN(-)}$ , $V_{CM}=0V$	$I_{io}$	--	--	50	nA
Input Offset Current (note 4), $I_{IN(+)} - I_{IN(-)}$ , $V_{CM}=0V$	$I_{IB}$	--	--	250	nA
Input Common Mode Voltage Range, $V_{CC}=30V$	$V_{ICR}$	-0	--	$V_{CC}-1.5$	V
Voltage Gain, $R_L \geq 15K$ , $V_{CC}=15V$ , $V_o=1V \sim 11V$	$A_{VOL}$	50	200	--	V/mV
Large Signal Response Time $V_{in}=TTL$ Logic Swing. $V_{ref} = 1.4V$ , $V_{RL}=5V$ . $R_L=5.1K\Omega$	--	--	300	--	nS
Response Time (note 6), $V_{RL}=5V$ . $R_L=5.1K\Omega$	$t_{TLH}$	--	1.3	--	$\mu S$
Output Sink Current, $V_{IN(-)}=1V$ , $V_{IN(+)}=0V$ , $V_o \leq 1.5V$	$I_{SINK}$	6.0	16	--	mA
Output Saturation Voltage, $V_{IN(-)}=1V$ , $V_{IN(+)}=0V$ , $I_{SINK} \leq 4mA$	$V_{OL}$	--	250	400	mV
Output Leakage Current, $V_{IN(-)}=0V$ , $V_{IN(+)}=1V$ , $V_o=5V$	$I_{OL}$	--	0.1	--	nA
Supply Current $R_L = \infty$ , $V_{CC} = 5V$ $R_L = \infty$ , $V_{CC} = 36V$	$I_{CC}$	--	0.4 1.0	1.0 2.5	mA

Note 1. The max. Output current may be as high as 20mA, independent of the magnitude of  $V_{CC}$ , output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.

Note 2. This magnitude of input current will only occur if the input leads are driven more negative than ground or the negative supply voltage. This is due to the input PNP collector base junction becoming forward biased acting as an input clamp diode. There is also a lateral PNP parasitic transistor action on the IC chip. This phenomena can cause the output voltage of the comparators to go to the  $V_{CC}$  voltage level (or ground if overdrive is large) during the time the input is driven negative. This will not destroy the device and normal output states will recover when the inputs become  $-0.3V$  of ground or negative supply.

Note 3. At output switch point,  $V_o=1.4V_{dc}$ ,  $R_S=0\Omega$  with  $V_{CC}$  from 5Vdc to 30Vdc, and over the full input common-mode

Note 4. Due to the PNP transistor inputs, bias current will flow out of the inputs, this current is essentially constant independent of the output state, therefore, no loading changes will exist on the input lines.

Note 5. Input common mode of either input should not be permitted to go more than 0.3V negative of ground or minus supply. The upper limit of common mode range is  $V_{CC} - 1.5V$  but either or both inputs can betaken to as high as 30volts without damage.

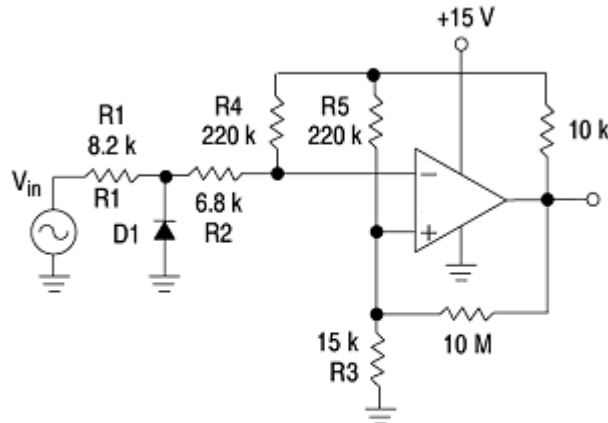
Note 6. Response time is specified with a 100mV step and 5.0mV of overdrive. With larger magnitudes of overdrive faster response times are obtainable.

### Application information

This comparator feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitive coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions ( $V_{OL}$  to  $V_{OH}$ ). To alleviate this situation input resistors  $< 10K\Omega$  should be used. The addition of positive feedback ( $< 10$  mV) is also recommended.

It is good design practice to ground all unused pins. Differential input voltages may be larger than supply voltage without damaging the comparator's inputs. Voltages more negative than  $-0.3V$  should not be used.

Application information (continues)

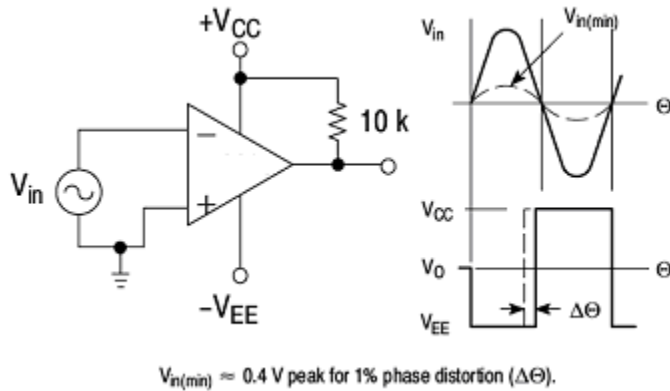


D1 prevents input from going negative by more than 0.6 V.

$$R1 + R2 = R3$$

$$R3 \leq \frac{R5}{10} \text{ for small error in zero crossing.}$$

Figure 4. Zero Crossing Detector (Single Supply)



$V_{in(min)} \approx 0.4 \text{ V peak for } 1\% \text{ phase distortion } (\Delta\Theta).$

Figure 6. Time Delay Generator

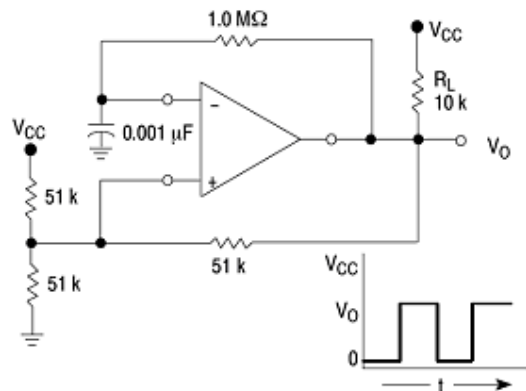
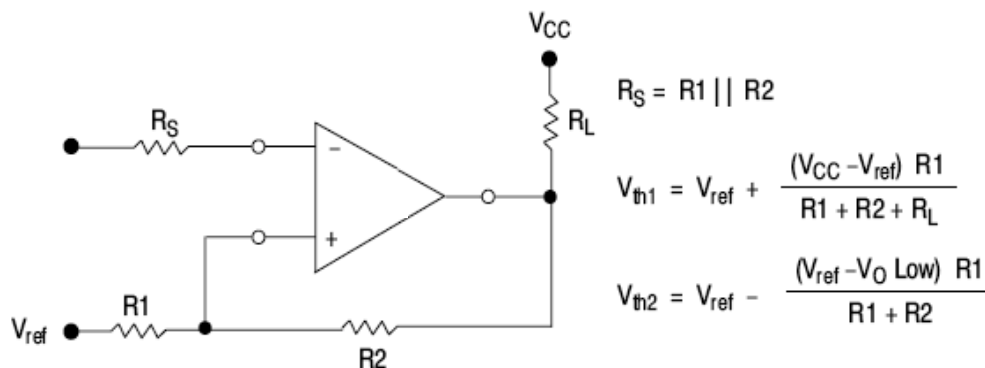


Figure 7. Free-Running Square-Wave Oscillator



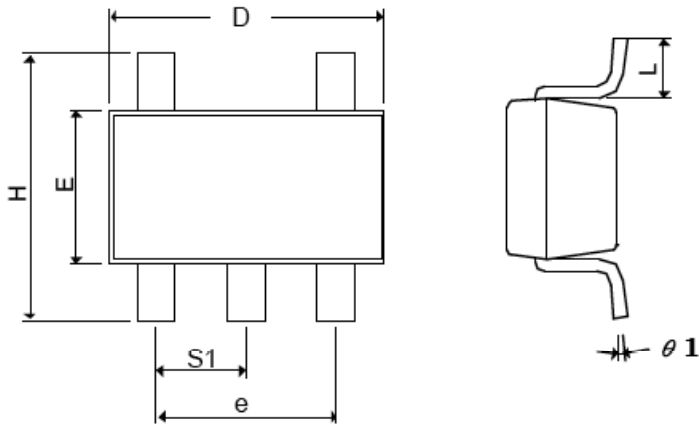
$$R_S = R1 \parallel R2$$

$$V_{th1} = V_{ref} + \frac{(V_{CC} - V_{ref}) R1}{R1 + R2 + R_L}$$

$$V_{th2} = V_{ref} - \frac{(V_{ref} - V_{O \text{ Low}}) R1}{R1 + R2}$$

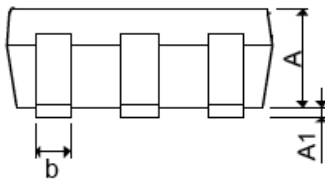
Figure 8. Comparator with Hysteresis

**SOT-25 Mechanical Drawing**

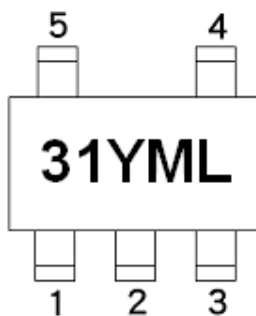


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A+A1	0.09	1.25	0.0354	0.0492
B	0.30	0.50	0.0118	0.0197
C	0.09	0.25	0.0035	0.0098
D	2.70	3.10	0.1063	0.1220
E	1.40	1.80	0.0551	0.0709
E	1.90 BSC		0.0748 BSC	
H	2.40	3.00	0.09449	0.1181
L	0.35 BSC		0.0138 BSC	
$\theta 1$	0°	10°	0°	10°
S1	0.95 BSC		0.0374 BSC	

Front View



**Marking Diagram**



- 31** = Product Code for TS331CX5
- Y** = Year Code
- M** = Month Code  
(A=Jan, B=Feb, C=Mar, D=Apl, E=May, F=Jun, G=Jul, H=Aug, I=Sep, J=Oct, K=Nov, L=Dec)
- L** = Lot Code

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