TS331

Micropower low-voltage rail-to-rail comparator

Features

- Supply operation from 1.6 to 5 V
- Low current consumption: 20 µA
- Rail-to-rail inputs
- Wide temperature range: -40°C to +125°C
- Low output saturation voltage
- Low propagation delay: 210 ns
- Open-drain output
- ESD tolerance: 2 kV HBM/200 V MM
- SMD packages: SC70-5 and SOT23-5

Applications

- Mobile phones
- Notebooks and PDAs
- Battery supplied electronics
- General-purpose portable devices
- General-purpose low voltage applications

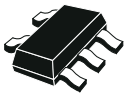
Description

The TS331 is a single micropower and low-voltage comparator. It can operate with a supply voltage ranging from 1.6 to 5 V with only 20 µA current consumption. In addition, rail-to-rail inputs make it a perfect choice for low-voltage applications.

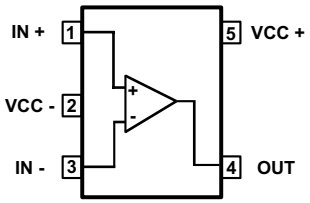
SOT23-5 and SC70-5 package availability is a real advantage for space saving constraints. The SC70-5 is approximately half the size of the SOT23-5.

The TS331 is specified for a wide temperature range of -40°C to +125°C, making it ideal for a wide range of applications.

TS331
SOT23-5/SC70-5



Pin connections (top view)



1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage(1)	5.5	V
V_{ID}	Differential input voltage(2)	± 5.5	V
V_{IN}	Input voltage range	(V_{CC}-) -0.3 to (V_{CC}+) + 0.3	V
R_{thja}	Thermal resistance junction to ambient(3) SC70-5 SOT23-5	 205 250	°C/W
R_{thjc}	Thermal resistance junction to case (3) SC70-5 SOT23-5	 172 81	°C/W
T_{stg}	Storage temperature	-65 to +150	°C
T_j	Junction temperature	150	°C
T_{LEAD}	Lead temperature (soldering 10 seconds)	260	°C
ESD	Human body model (HBM)(4)	2000	V
	Machine model (MM)(5)	200	
	Charged device model (CDM)(6)	1500	
	Latch-up immunity	200	mA

1. All voltage values, except differential voltage, are referenced to V_{cc}-.
2. The magnitude of input and output voltages must never exceed the supply rail ±0.3 V.
3. Short-circuits can cause excessive heating. These values are typical.
4. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
5. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
6. Charged device model: all pins and package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
T_{oper}	Operating temperature range	-40 to +125	°C
V_{CC}	Supply voltage (V_{CC}+) - (V_{CC}-) -40°C < T_{amb} < +125°C	1.6 to 5.0	V
V_{ICM}	Common mode input voltage range T_{amb} = +25°C -40°C < T_{amb} < +125°C	(V_{CC}-) -0.2 to (V_{CC}+)+0.2 (V_{CC}-) to (V_{CC}+)	V

2 Electrical characteristics

Table 3. V_{CC}+ = +1.8 V, V_{CC}- = 0 V, T_{amb} = +25°C (unless otherwise specified)(1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	V_{ICM} = 0 V -40°C < T_{amb} < +125°C		0.5	5 6	mV
ΔV_{IO}	Input offset voltage drift	-40°C < T_{amb} < +125°C		4.5		µV/°C
I_{IB}	Input bias current(2)	-40°C < T_{amb} < +125°C		25	40 100	nA
I_{IO}	Input offset current(2)	-40°C < T_{amb} < +125°C		1	10 100	nA
I_{CC}	Supply current	No load, output low, V_{ICM} = 0 V -40°C < T_{amb} < +125°C No load, output high, V_{ICM} = 0 V -40°C < T_{amb} < +125°C		20 22	26 30 29 33	µA
I_{OH}	Output current leakage	V_{OUT} = V_{CC}+ -40°C < T_{amb} < +125°C		1	10 500	nA
V_{OL}	Output voltage low	I_{SINK} = 1 mA -40°C < T_{amb} < +125°C		24	30 50	mV
I_{SINK}	Output sink current	V_{OUT} = 1.5 V -40°C < T_{amb} < +125°C	20 15	22		mA
CMRR	Common mode rejection ratio	0 < V_{ICM} < 1.8 V	50	68		dB
TP_{HL}	Propagation delay(3) High to low output level	V_{ICM} = 0 V, R_L = 5.1 kΩ, C_L = 50 pF Overdrive = 10 mV Overdrive = 100 mV		 300 210	 310	ns
TP_{LH}	Propagation delay(4) Low to high output level	V_{ICM} = 0 V, R_L = 5.1 kΩ, C_L = 50 pF Overdrive = 10 mV Overdrive = 100 mV		 540 420	 620	ns

1. All values over the temperature range are guaranteed through correlation and simulation. No production tests have been performed at the temperature range limits.
2. Maximum values include unavoidable inaccuracies of the industrial tests.
3. TP_{HL} is measured when the output signal crosses a voltage level at 50% of Vcc with the following conditions: inverting input voltage (IN-) = VICM and non-inverting input voltage (IN+) moving from VICM + 100 mV to VICM - overdrive.
4. TP_{LH} is measured when the output signal crosses a voltage level at 50% of Vcc with the following conditions: inverting input voltage (IN-) = VICM and non-inverting input voltage (IN+) moving from VICM - 100 mV to VICM + overdrive.

Table 4. V_{CC}+ = +2.7 V, V_{CC}- = 0 V, T_{amb} = +25°C (unless otherwise specified)(1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	V_{ICM} = 0 V -40°C < T_{amb} < +125°C		0.5	5 6	mV
ΔV_{IO}	Input offset voltage drift	-40°C < T_{amb} < +125°C		3.3		µV/°C
I_{IB}	Input bias current(2)	-40°C < T_{amb} < +125°C		25	40 100	nA
I_{IO}	Input offset current(2)	-40°C < T_{amb} < +125°C		1	10 100	nA
I_{CC}	Supply current	No load, output low, V_{ICM} = 0 V -40°C < T_{amb} < +125°C No load, output high, V_{ICM} = 0 V -40°C < T_{amb} < +125°C		21 23	27 31 30 34	µA
I_{OH}	Output current leakage	V_{OUT} = V_{CC}+ -40°C < T_{amb} < +125°C		1	10 500	nA
V_{OL}	Output voltage low	I_{SINK} = 1 mA -40°C < T_{amb} < +125°C		17	30 50	mV
I_{SINK}	Output sink current	V_{OUT} = 1.5 V -40°C < T_{amb} < +125°C	40 30	47		mA
CMRR	Common mode rejection ratio	0 < V_{ICM} < 2.7 V -40°C < T_{amb} < +125°C	54 53	74		dB
TP_{HL}	Propagation delay(3) High to low output level	V_{ICM} = 0 V, R_L = 5.1 kΩ, C_L = 50 pF Overdrive = 10 mV Overdrive = 100 mV		 320 220	 320	ns
TP_{LH}	Propagation delay(4) Low to high output level	V_{ICM} = 0 V, R_L = 5.1 kΩ, C_L = 50 pF Overdrive = 10 mV Overdrive = 100 mV		 550 420	 640	ns

1. All values over the temperature range are guaranteed through correlation and simulation. No production tests have been performed at the temperature range limits.
2. Maximum values include unavoidable inaccuracies of the industrial tests.
3. TP_{HL} is measured when the output signal crosses a voltage level at 50% of Vcc with the following conditions: Inverting input voltage (IN-) = VICM and Non-inverting input voltage (IN+) moving from VICM + 100 mV to VICM - overdrive.
4. TP_{LH} is measured when the output signal crosses a voltage level at 50% of Vcc with the following conditions: Inverting input voltage (IN-) = VICM and Non-inverting input voltage (IN+) moving from VICM - 100 mV to VICM + overdrive.

Table 5. V_{CC}+ = +5 V, V_{CC}- = 0 V, T_{amb} = +25°C (unless otherwise specified)(1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	V_{ICM} = 0 V -40°C < T_{amb} < +125°C		0.5	5 6	mV
ΔV_{IO}	Input offset voltage drift	-40°C < T_{amb} < +125°C		1.3		µV/°C
I_{IB}	Input bias current(2)	-40°C < T_{amb} < +125°C		30	40 100	nA
I_{IO}	Input offset current(2)	-40°C < T_{amb} < +125°C		1	10 100	nA
I_{CC}	Supply current	No load, output low, V_{ICM} = 0 V -40°C < T_{amb} < +125°C No load, output high, V_{ICM} = 0 V -40°C < T_{amb} < +125°C		23 26	30 34 34 38	µA
I_{OH}	Output current leakage	V_{OUT} = V_{CC}+ -40°C < T_{amb} < +125°C		1	10 600	nA
V_{OL}	Output voltage low	I_{SINK} = 4 mA -40°C < T_{amb} < +125°C		48	60 80	mV
I_{SINK}	Output sink current	V_{OUT} = 1.5 V -40°C < T_{amb} < +125°C	82 68	93		mA
A_V	Voltage gain		40	100		V/mV
CMRR	Common mode rejection ratio	0 < V_{ICM} < 5 V -40°C < T_{amb} < +125°C	60 58	79		dB
SVR	Supply voltage rejection	ΔV_{CC} = 1.8 to 5 V -40°C < T_{amb} < +125°C	56 56	75		dB
TP_{HL}	Propagation delay(3) High to low output level	V_{ICM} = 0 V, R_L = 5.1 kΩ, C_L = 50 pF Overdrive = 10 mV Overdrive = 100 mV		 380 270	 430	ns
TP_{LH}	Propagation delay(4) Low to high output level	V_{ICM} = 0 V, R_L = 5.1 kΩ, C_L = 50 pF Overdrive = 10 mV Overdrive = 100 mV		 570 450	 720	ns

1. All values over the temperature range are guaranteed through correlation and simulation. No production tests have been performed at the temperature range limits.
2. Maximum values include unavoidable inaccuracies of the industrial tests.
3. TP_{HL} is measured when the output signal crosses a voltage level at 50% of Vcc with the following conditions: Inverting input voltage (IN-) = VICM and Non-inverting input voltage (IN+) moving from VICM + 100 mV to VICM - overdrive.
4. TP_{LH} is measured when the output signal crosses a voltage level at 50% of Vcc with the following conditions: Inverting input voltage (IN-) = VICM and Non-inverting input voltage (IN+) moving from VICM - 100 mV to VICM + overdrive.

Figure 1. Supply current versus supply voltage with output high, V_{ICM} = 0 V

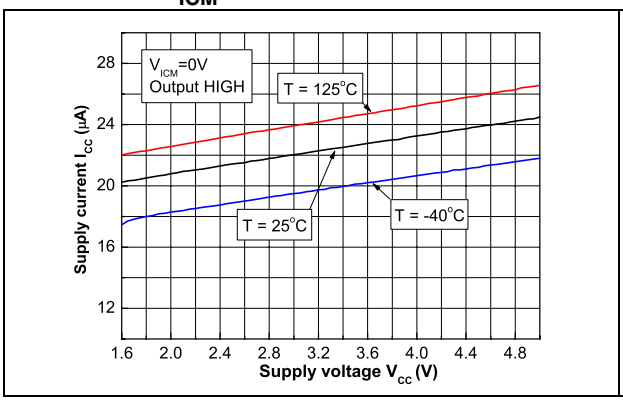


Figure 2. Supply current versus supply voltage with output high, V_{ICM} = V_{CC}

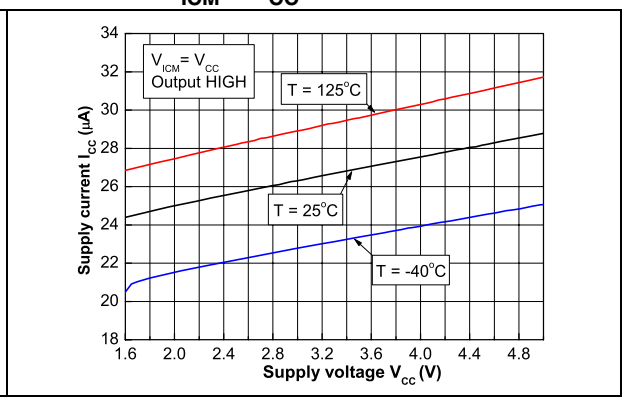


Figure 3. Supply current versus supply voltage with output low, V_{ICM} = 0 V

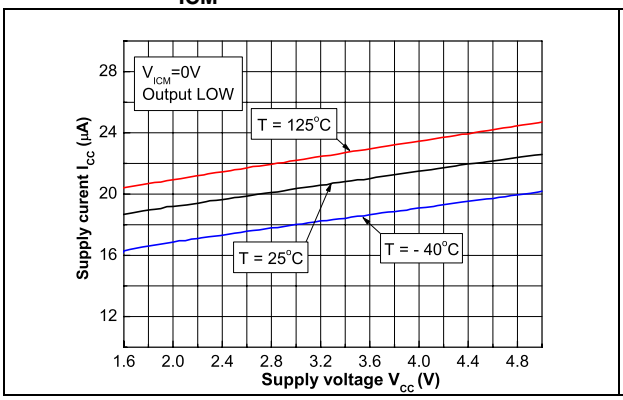


Figure 4. Supply current versus supply voltage with output low, V_{ICM} = V_{CC}

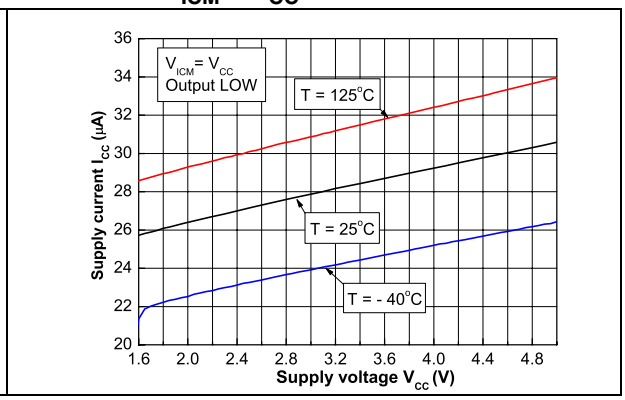


Figure 5. Supply current versus temperature

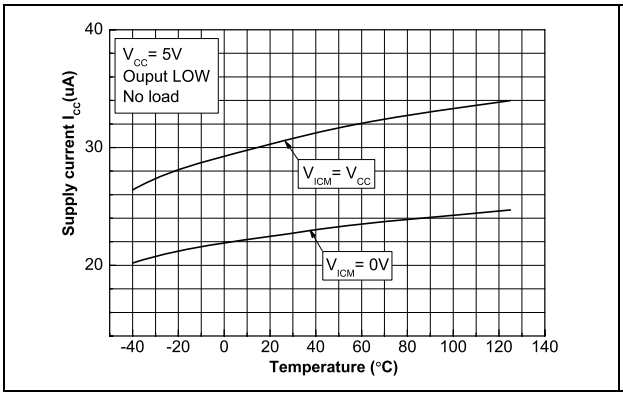


Figure 6. Input bias current versus input common-mode voltage

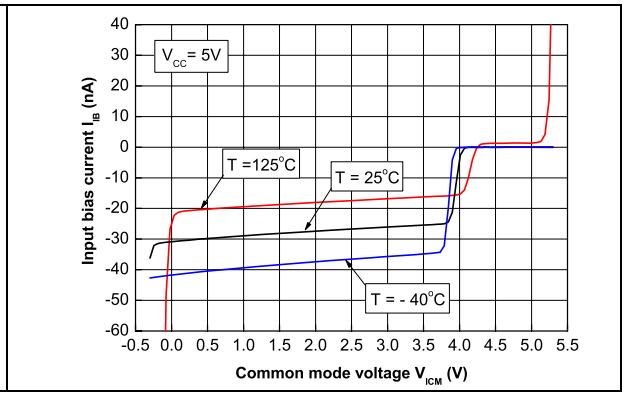


Figure 7. Input current versus differential input voltage

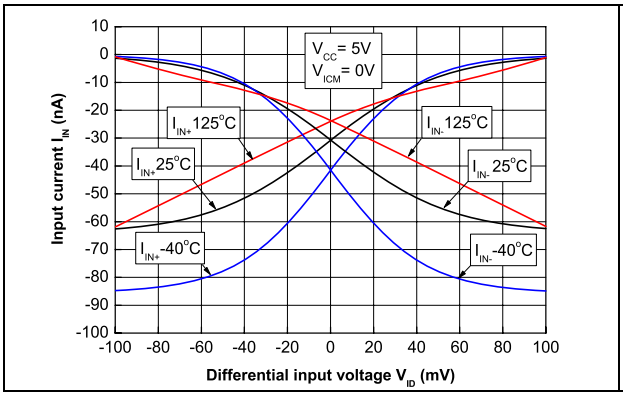


Figure 8. Input offset voltage versus temperature

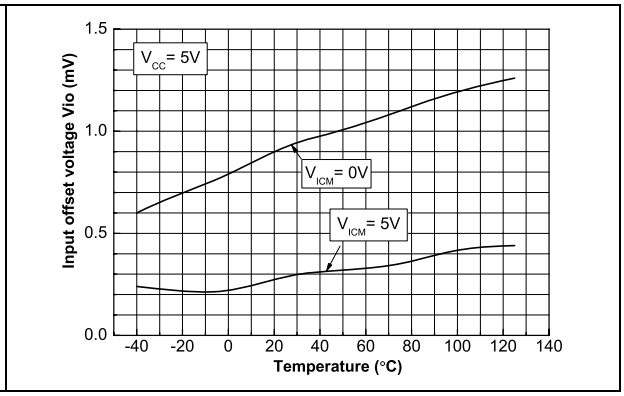


Figure 9. Output voltage versus output sink current, V_{CC} = 1.8 V

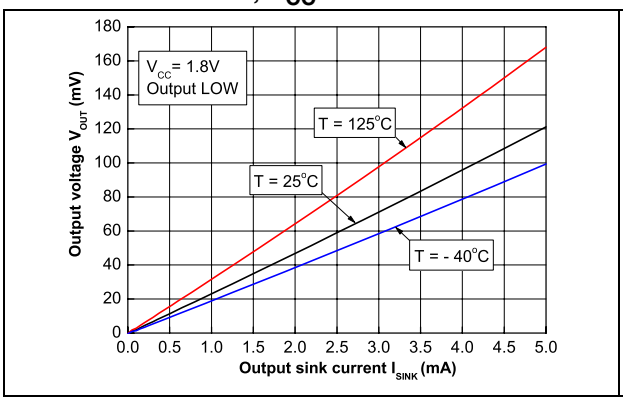


Figure 10. Output voltage versus output sink current, V_{CC} = 2.7 V

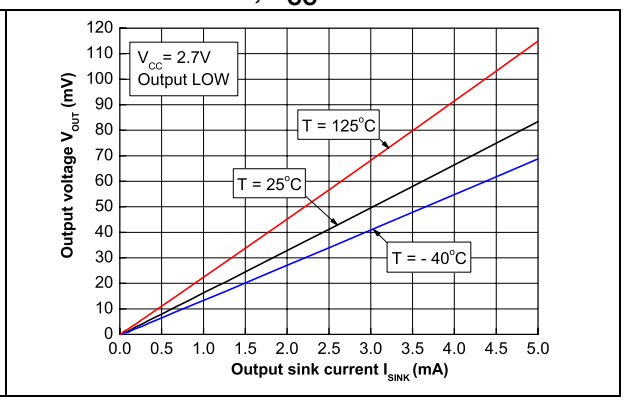


Figure 11. Output voltage versus output sink current, V_{CC} = 5 V

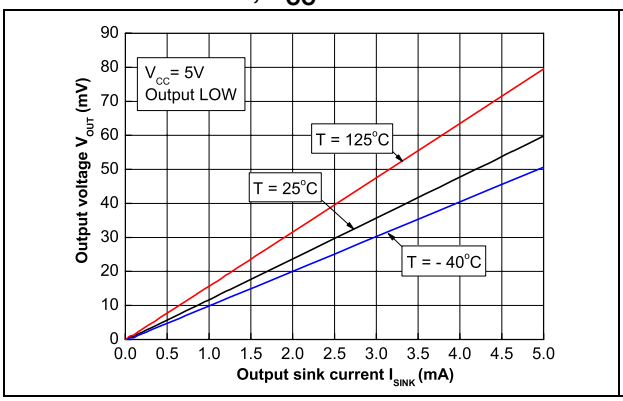


Figure 12. Output sink current versus output voltage

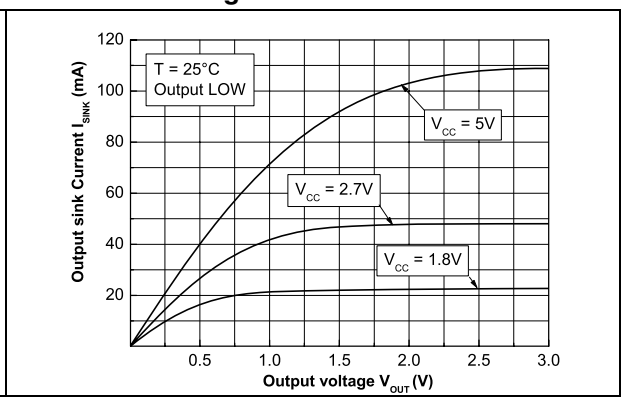


Figure 13. Output voltage versus temperature

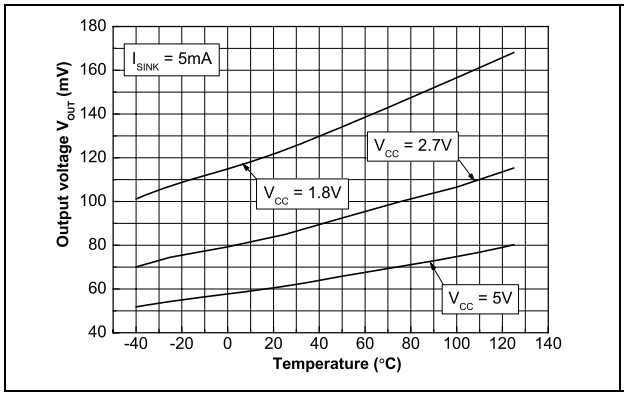


Figure 14. Propagation delay versus overdrive with negative transition, V_{CC} = 1.8 V

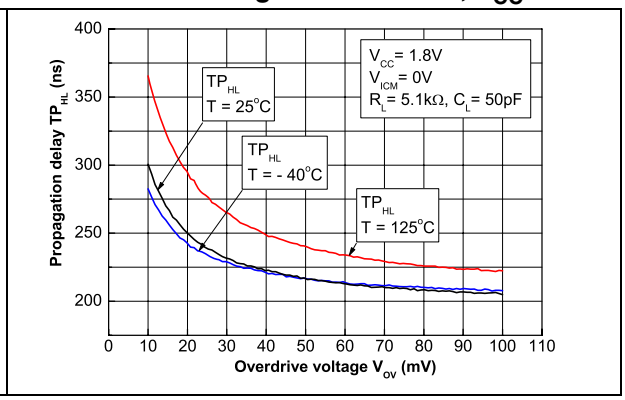


Figure 15. Propagation delay versus overdrive with positive transition, V_{CC} = 1.8 V

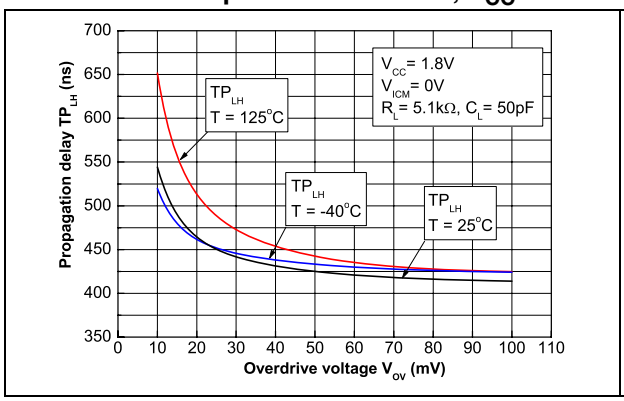


Figure 16. Propagation delay versus common mode voltage, V_{CC} = 1.8 V

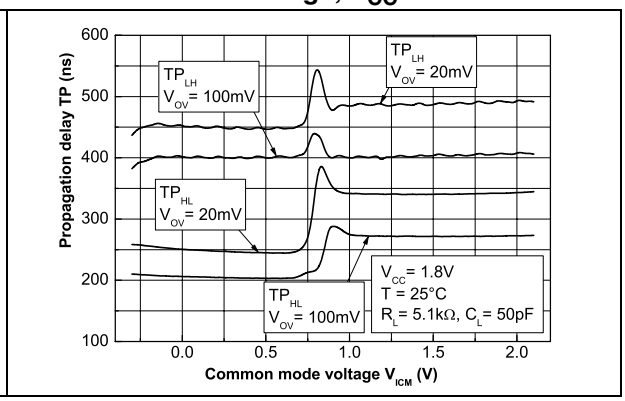


Figure 17. Propagation delay versus overdrive with negative transition, V_{CC} = 2.7 V

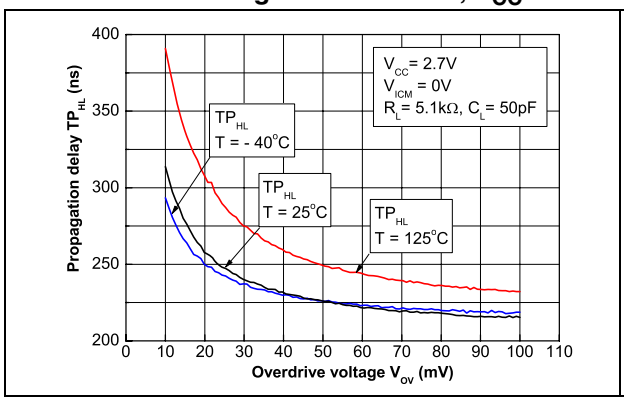


Figure 18. Propagation delay versus overdrive with positive transition, V_{CC} = 2.7 V

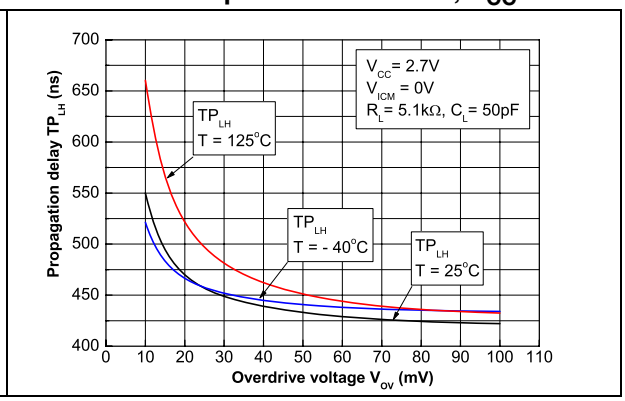


Figure 19. Propagation delay versus common mode voltage, V_{CC} = 2.7 V

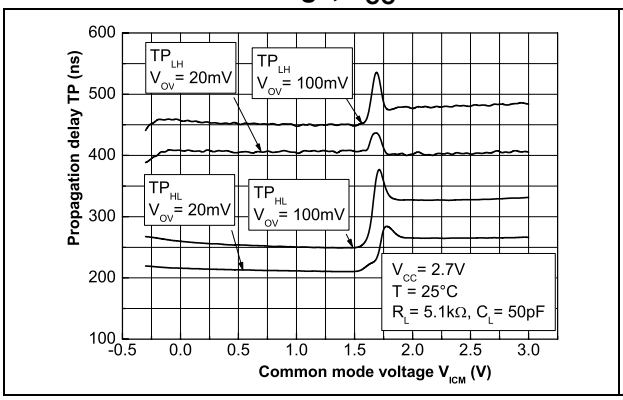


Figure 20. Propagation delay versus overdrive with negative transition, V_{CC} = 5 V

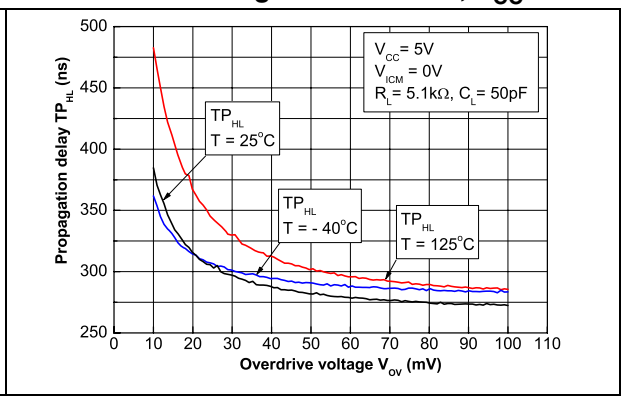


Figure 21. Propagation delay versus overdrive with positive transition, V_{CC} = 5 V

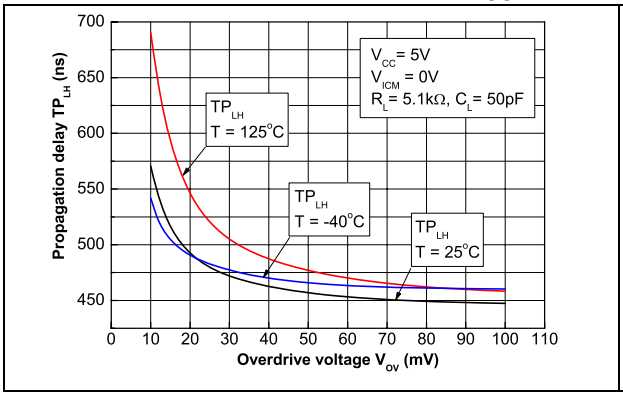


Figure 22. Propagation delay versus common mode voltage, V_{CC} = 5 V

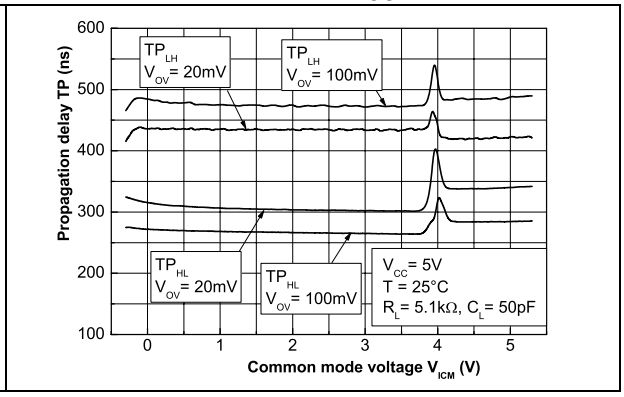


Figure 23. Propagation delay versus time with negative transition

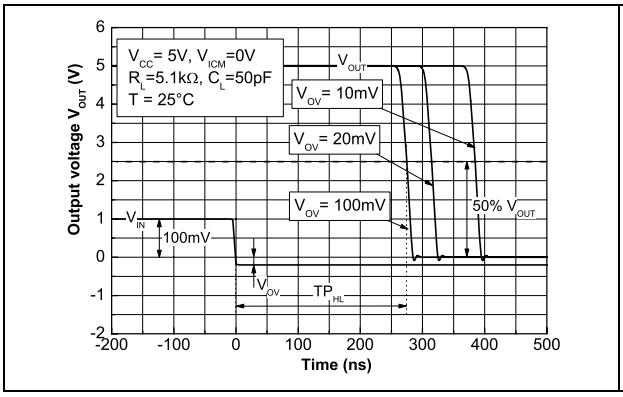
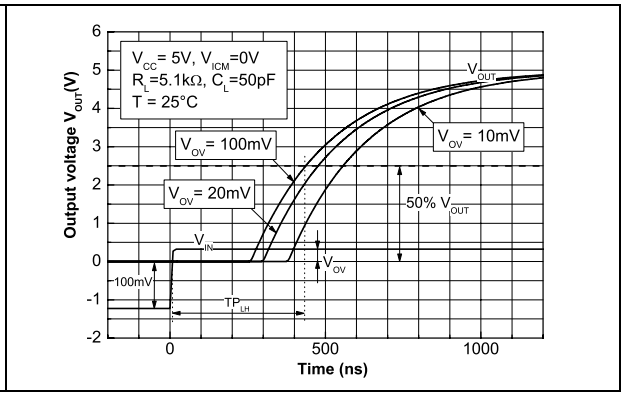


Figure 24. Propagation delay versus time with positive transition



3 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

3.1 SOT23-5 package

Figure 25. SOT23-5 package mechanical drawing

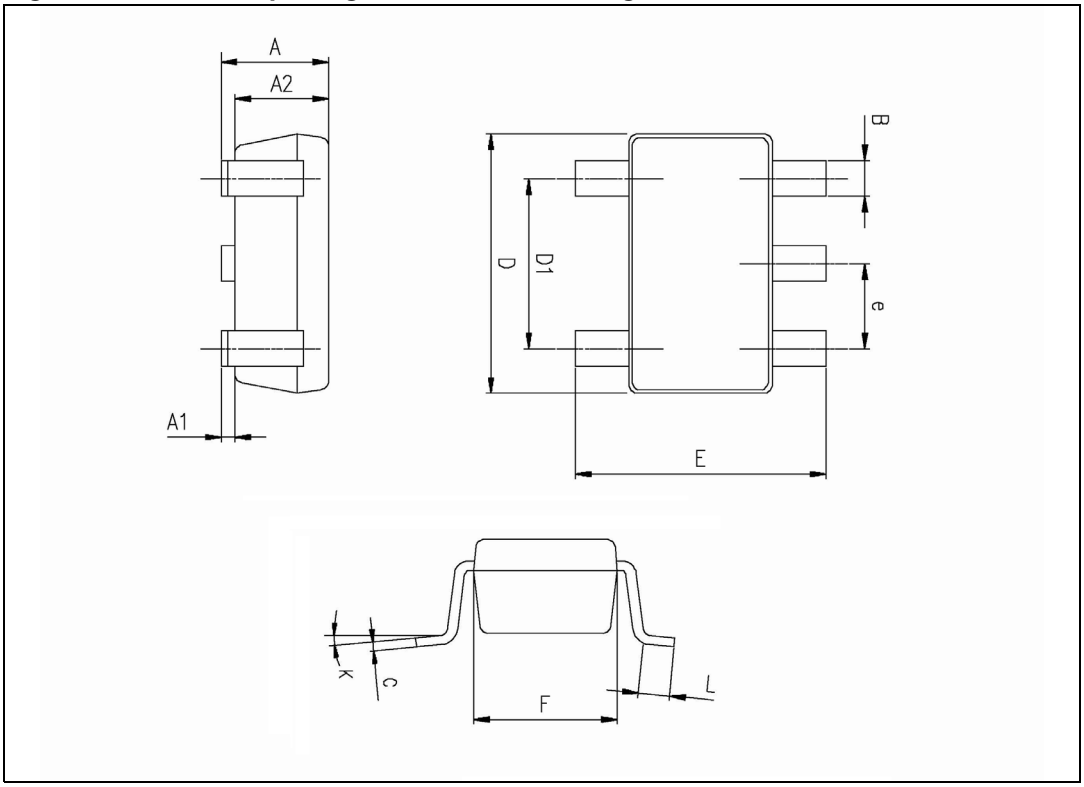


Table 6. SOT23-5 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1			0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.013	0.015	0.019
C	0.09	0.15	0.20	0.003	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.35	0.60	0.004	0.013	0.023
K	0 degrees		10 degrees			

3.2 SC70-5 (SOT323-5) package

Figure 26. SC70-5 (SOT323-5) package mechanical drawing

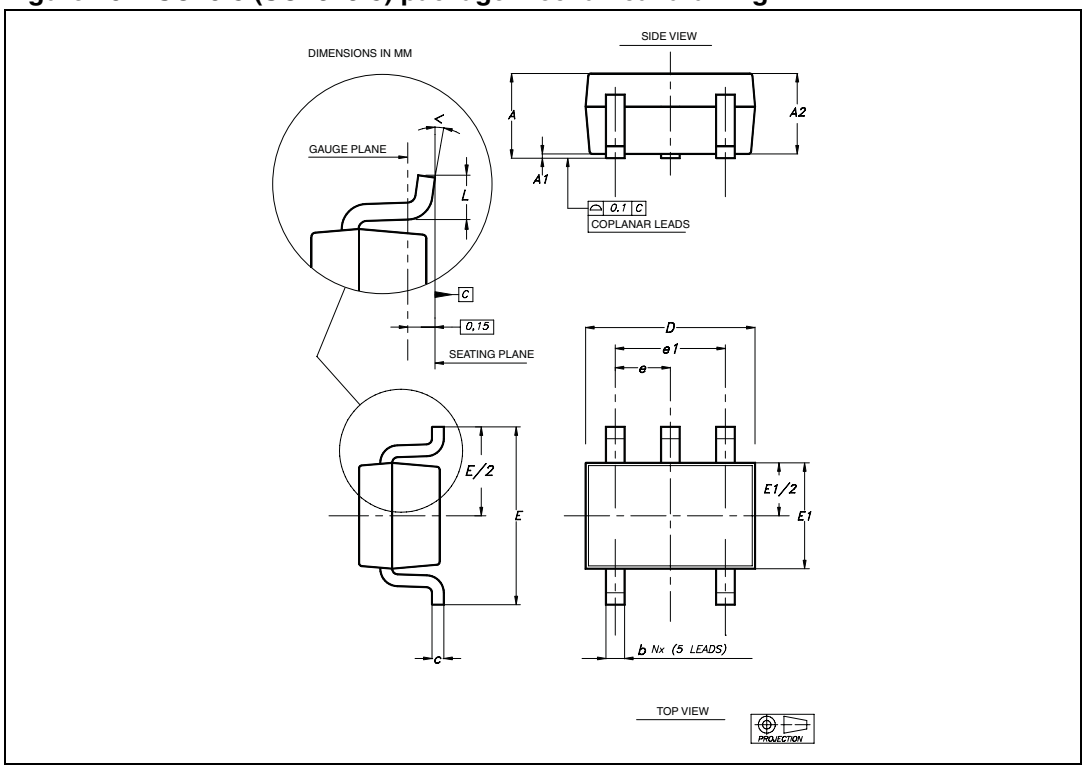


Table 7. SC70-5 (or SOT323-5) package mechanical data

Ref	Dimensions					
	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	0.80		1.10	0.315		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.315	0.035	0.039
b	0.15		0.30	0.006		0.012
c	0.10		0.22	0.004		0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e		0.65			0.025	
e1		1.30			0.051	
L	0.26	0.36	0.46	0.010	0.014	0.018
<	0°		8°			

4 Ordering information

Table 8. Order codes

Part number	Temperature range	Package	Packaging	Marking
TS331ILT	-40°C, +125°C	SOT23-5	Tape & reel	K506
TS331ICT		SC70-5	Tape & reel	K55

5 Revision history

Table 9. Document revision history

Date	Revision	Changes
29-Mar-2010	1	Initial release.

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