TS331, TS332, TS334

Micropower low-voltage rail-to-rail comparators

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

Applications

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

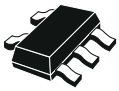
Description

The TS331, TS332 and TS334 are single, dual and quad micropower and low-voltage comparators. They can operate with a supply voltage ranging from 1.6 to 5 V with a typical current consumption as low as 20 µA. In addition, rail-to-rail inputs make them a perfect choice for low-voltage applications.

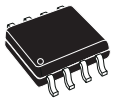
Their availability in tiny packages is a real advantage for space saving constraints.

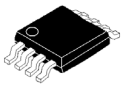
The TS33x are specified for a wide temperature range of -40°C to +125°C, making them ideal for a wide range of applications.

TS331
SOT23-5 / SC70-5

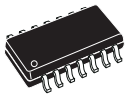


TS332
SO8 / MiniSO8



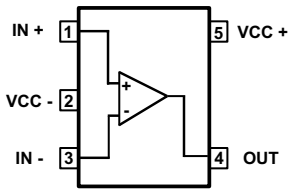


TS334
SO14 / TSSOP14

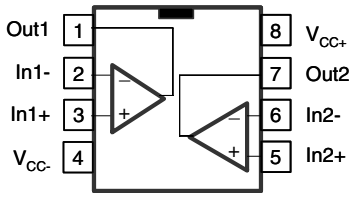


1 Package pin connections

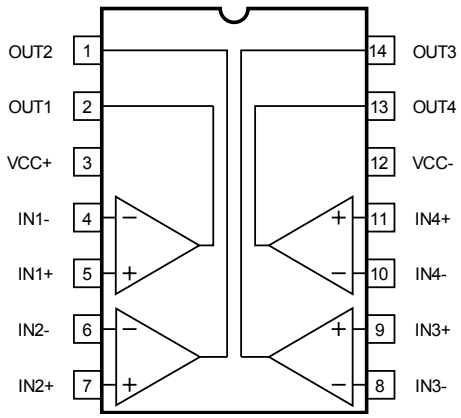
Figure 1. Pin connections for each package (top view)



TS331
SOT23-5 / SC70-5



TS332
SO-8 / MiniSO-8



TS334
SO-14 / TSSOP14

2 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	± 5.5	V
V_{IN}	Input voltage range	(V_{CC}-) -0.3 to (V_{CC}+) + 0.3	V
V_{out}	Output voltage(1)	5.5	V
R_{thja}	Thermal resistance junction to ambient(2) SC70-5 SOT23-5 SO8 MiniSO8 SO14 TSSOP14	 205 250 125 190 105 100	°C/W
R_{thjc}	Thermal resistance junction to case (2) SC70-5 SOT23-5 SO8 MiniSO8 SO14 TSSOP14	 172 81 40 39 31 32	°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)(3)	2000	V
	Machine model (MM)(4)	200	
	Charged device model (CDM)(5)	1500	
	Latch-up immunity	200	mA

1. All voltage values, except differential voltage, are referenced to V_{cc}-.
2. Short-circuits can cause excessive heating. These values are typical.
3. 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.
4. 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.
5. 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

3 Electrical characteristics

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	-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(1)	-40°C < T_{amb} < +125°C		25	40 100	nA
I_{IO}	Input offset current(1)	-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(2) 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(3) 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. Maximum values include unavoidable inaccuracies of the industrial tests.
2. 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.
3. 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)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	-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(1)	-40°C < T_{amb} < +125°C		25	40 100	nA
I_{IO}	Input offset current(1)	-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(2) 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(3) 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. Maximum values include unavoidable inaccuracies of the industrial tests.
2. 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.
3. 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)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	-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(1)	-40°C < T_{amb} < +125°C		30	40 100	nA
I_{IO}	Input offset current(1)	-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 60	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(2) 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(3) 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. Maximum values include unavoidable inaccuracies of the industrial tests.
2. 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.
3. 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 2. Supply current versus supply voltage with output high, V_{ICM} = 0 V

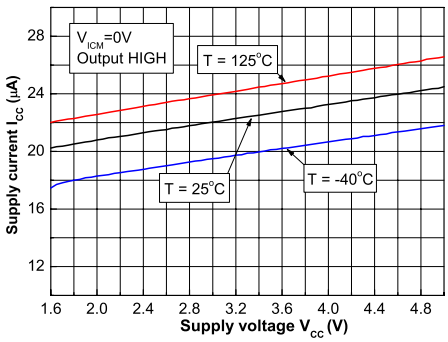


Figure 3. Supply current versus supply voltage with output high, V_{ICM} = V_{CC}

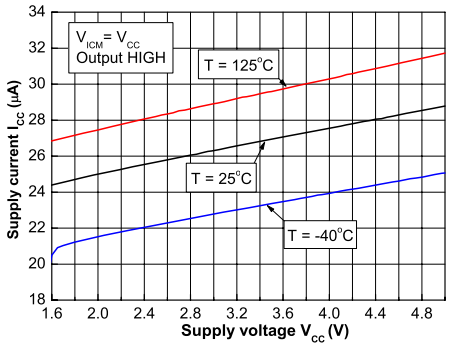


Figure 4. Supply current versus supply voltage with output low, V_{ICM} = 0 V

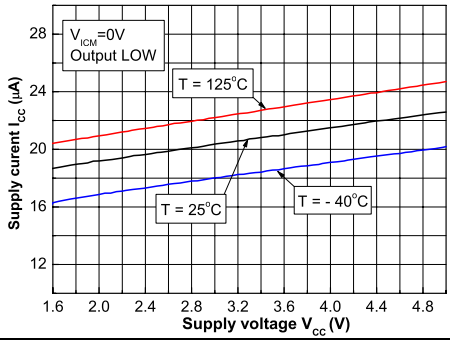


Figure 5. Supply current versus supply voltage with output low, V_{ICM} = V_{CC}

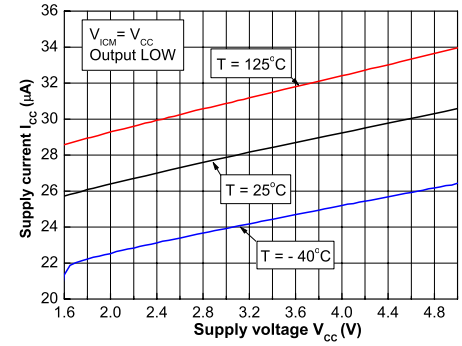


Figure 6. Supply current versus temperature

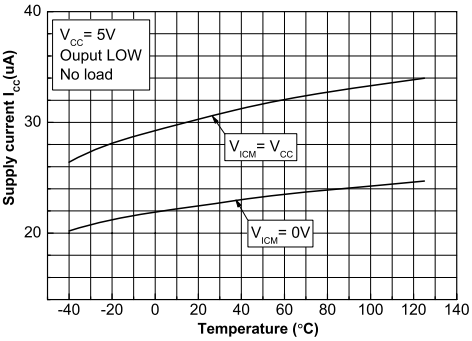


Figure 7. Input bias current versus input common-mode voltage

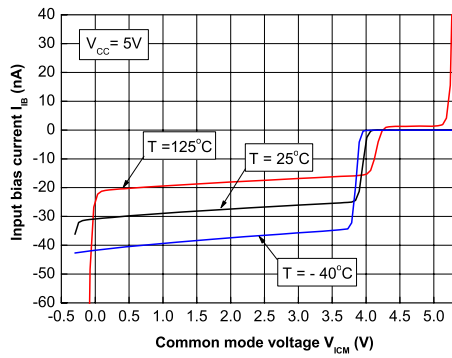


Figure 8. Input current versus differential input voltage

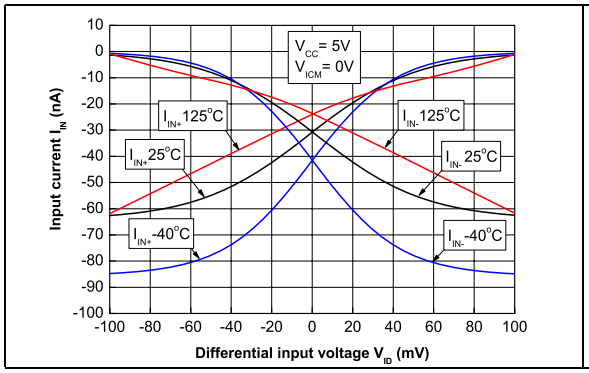


Figure 9. Input offset voltage versus temperature

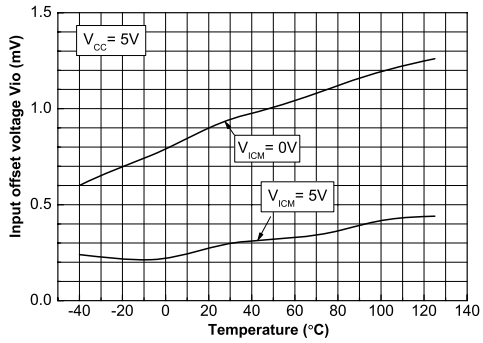


Figure 10. Output voltage versus output sink current, V_{CC} = 1.8 V

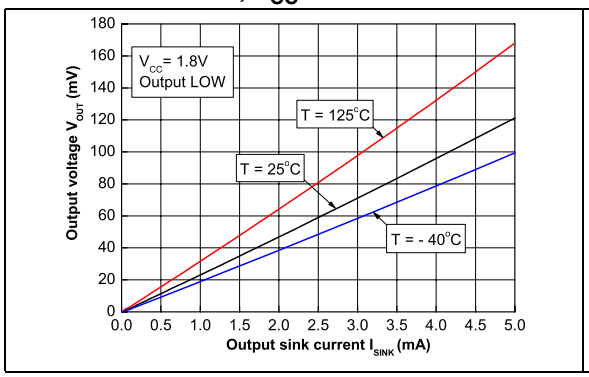


Figure 11. Output voltage versus output sink current, V_{CC} = 2.7 V

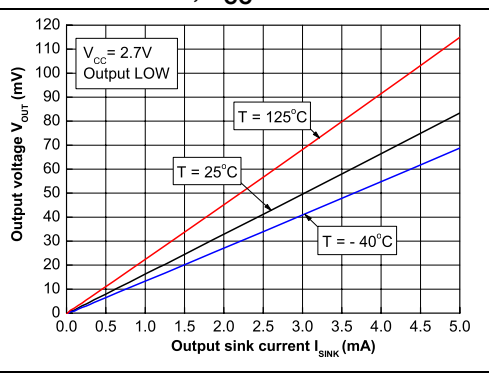


Figure 12. Output voltage versus output sink current, V_{CC} = 5 V

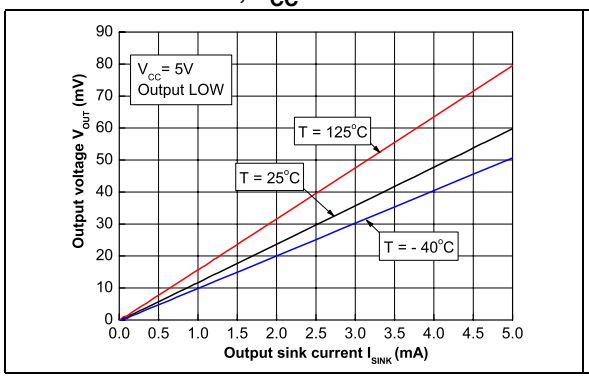


Figure 13. Output sink current versus output voltage

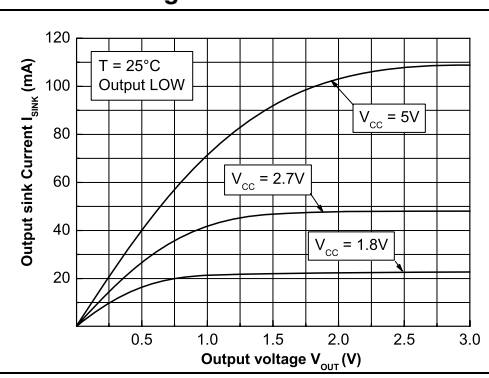


Figure 14. Output voltage versus temperature

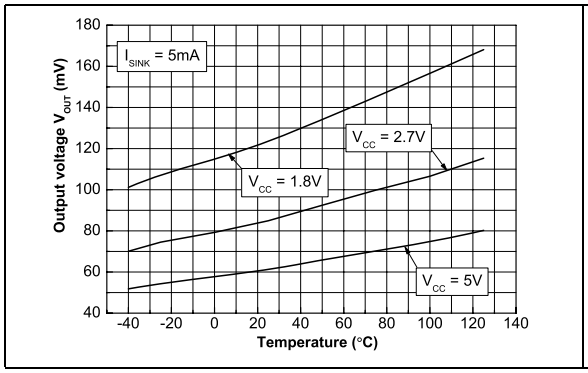


Figure 15. Propagation delay versus overdrive with negative transition, V_{CC} = 1.8 V

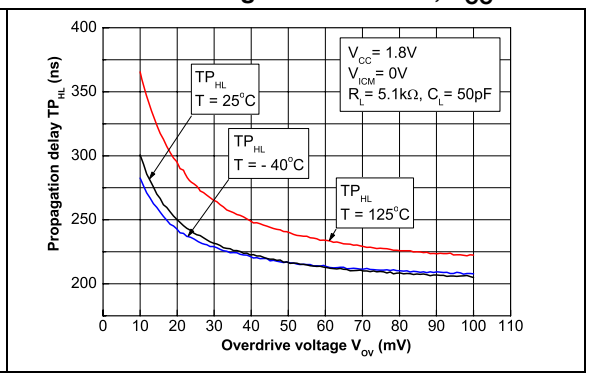


Figure 16. Propagation delay versus overdrive with positive transition, V_{CC} = 1.8 V

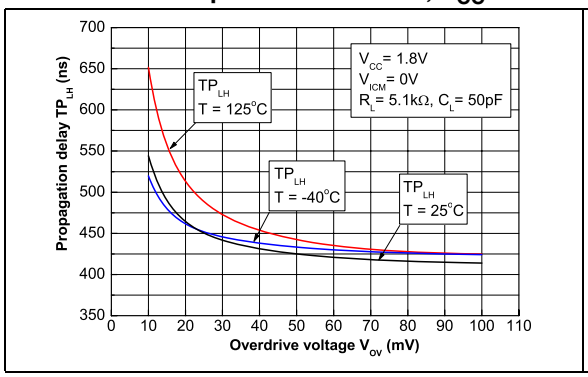


Figure 17. Propagation delay versus common mode voltage, V_{CC} = 1.8 V

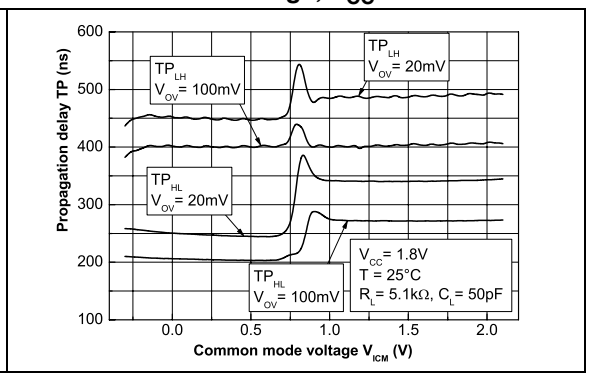


Figure 18. Propagation delay versus overdrive with negative transition, V_{CC} = 2.7 V

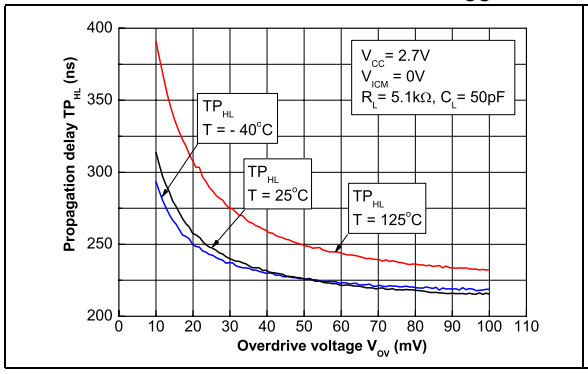


Figure 19. Propagation delay versus overdrive with positive transition, V_{CC} = 2.7 V

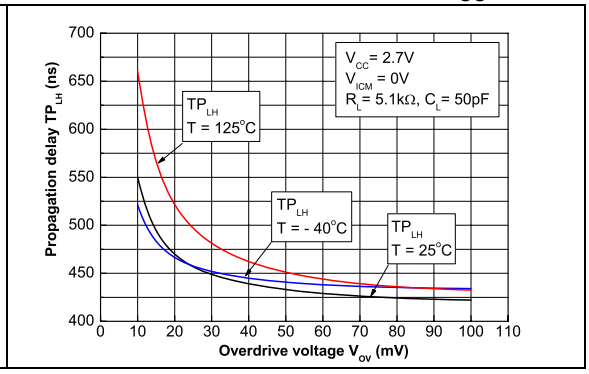


Figure 20. Propagation delay versus common mode voltage, V_{CC} = 2.7 V

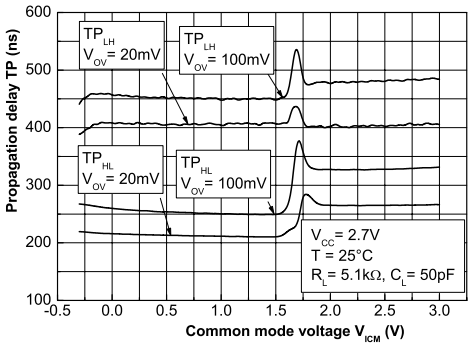


Figure 21. Propagation delay versus overdrive with negative transition, V_{CC} = 5 V

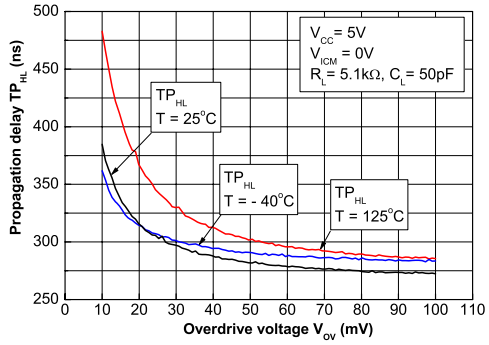


Figure 22. Propagation delay versus overdrive with positive transition, V_{CC} = 5 V

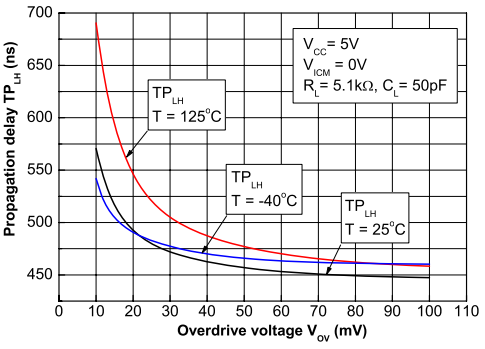


Figure 23. Propagation delay versus common mode voltage, V_{CC} = 5 V

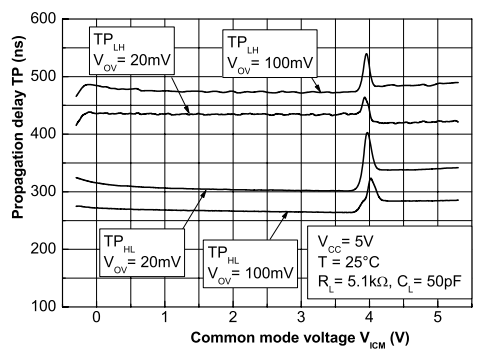


Figure 24. Propagation delay versus time with negative transition

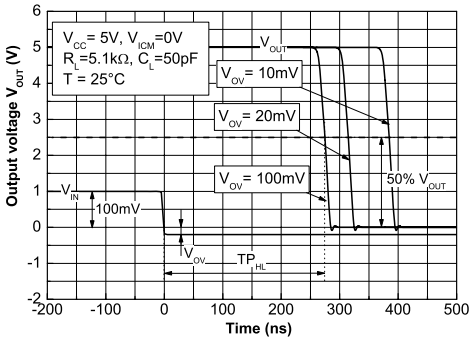
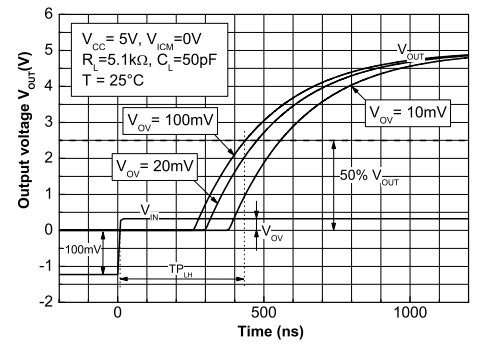


Figure 25. Propagation delay versus time with positive transition



4 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.

4.1 SOT23-5 package

Figure 26. SOT23-5 package mechanical drawing

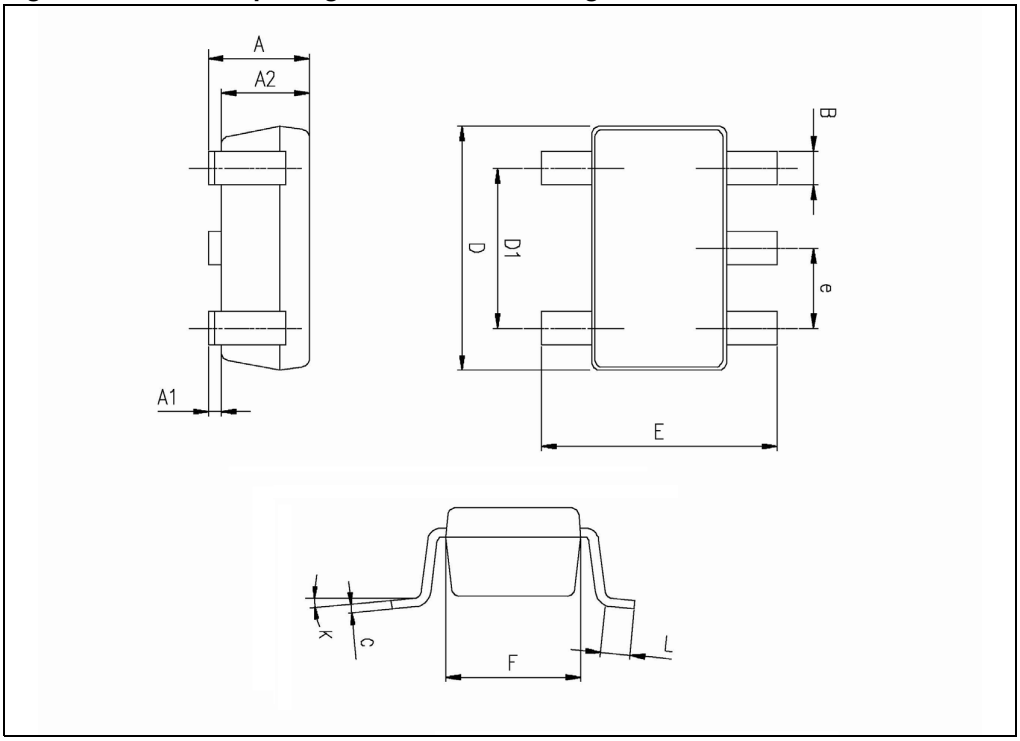


Table 6. SOT23-5 package mechanical data

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			

4.2 SC70-5 (SOT323-5) package

Figure 27. SC70-5 (SOT323-5) package mechanical drawing

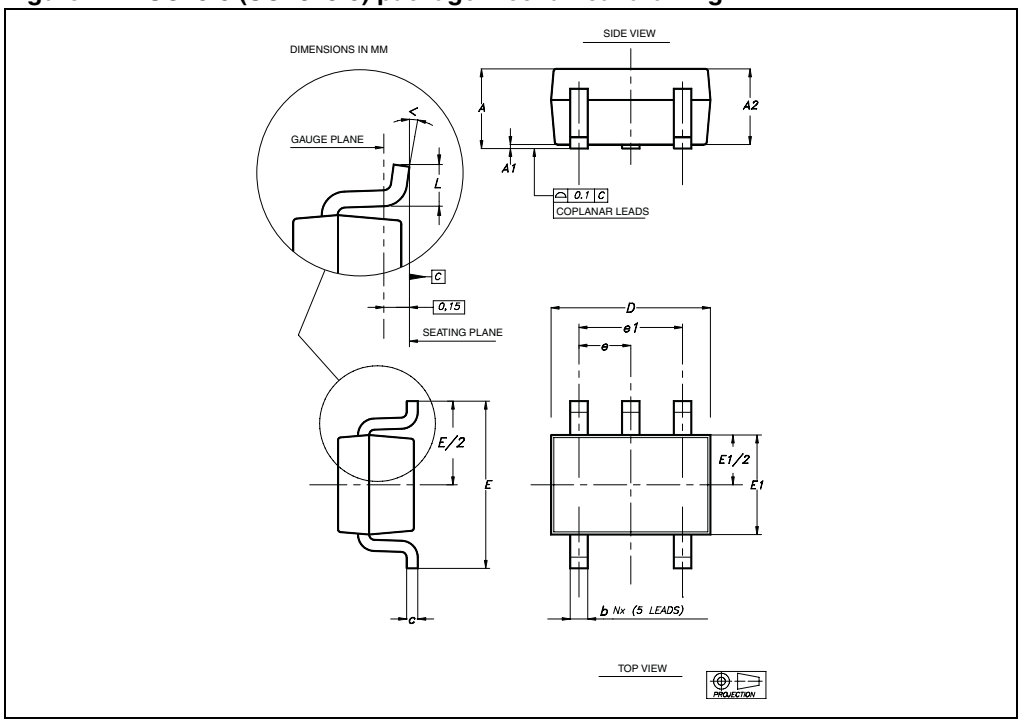


Table 7. SC70-5 (or SOT323-5) package mechanical data

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°			

4.3 SO-8 package information

Figure 28. SO-8 package mechanical drawing

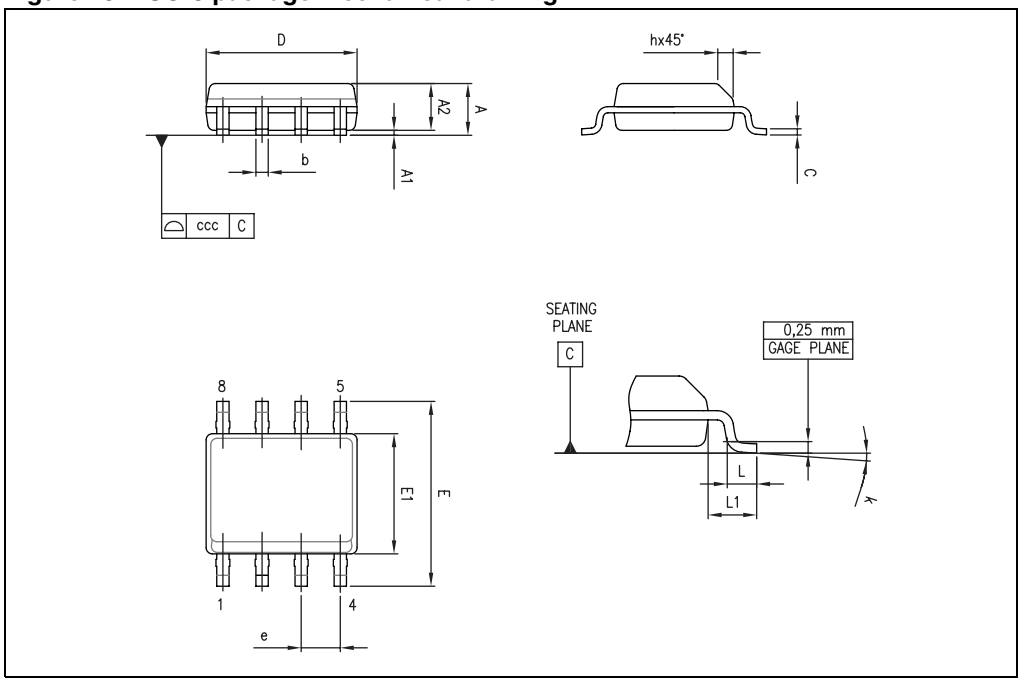


Table 8. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	0		8°	1°		8°
ccc			0.10			0.004

4.4 MiniSO-8 package information

Figure 29. MiniSO-8 package mechanical drawing

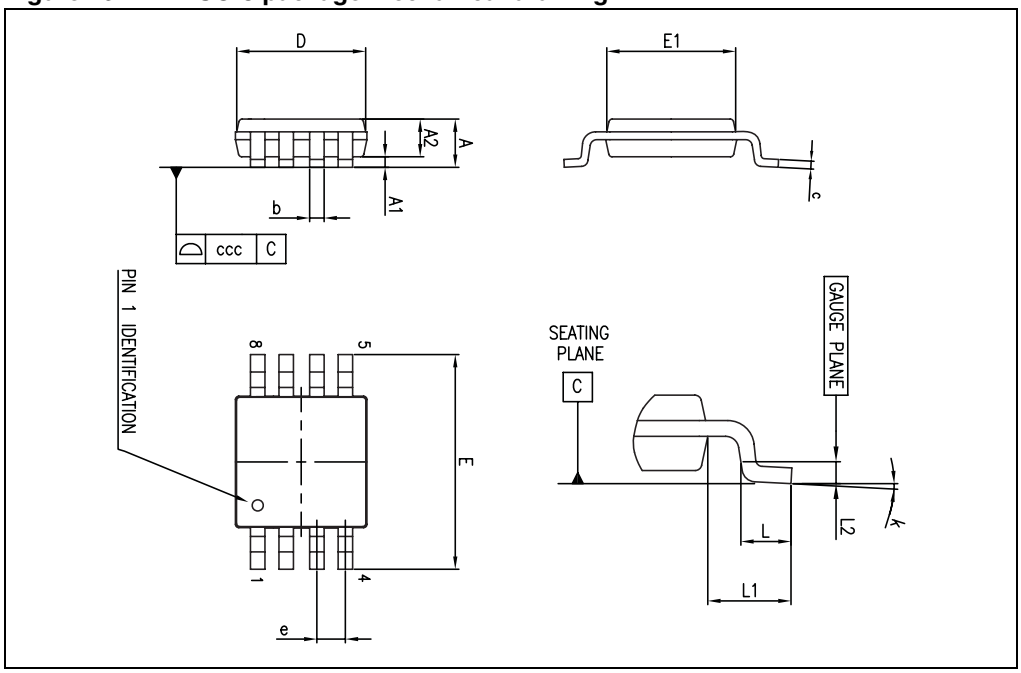


Table 9. MiniSO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

4.5 SO-14 package information

Figure 30. SO-14 package mechanical drawing

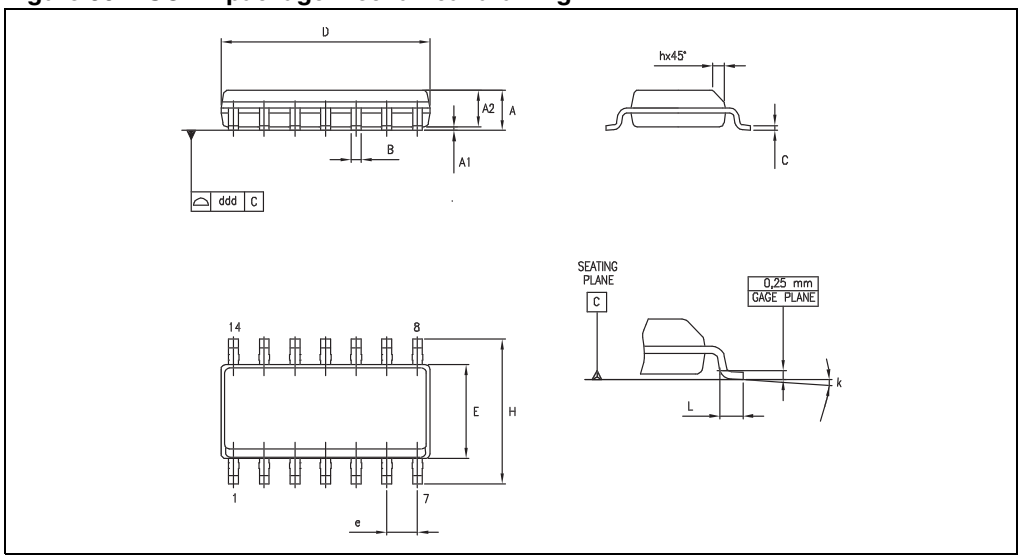


Table 10. SO-14 package mechanical data

Dimensions						
Ref.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.05		0.068
A1	0.10		0.25	0.004		0.009
A2	1.10		1.65	0.04		0.06
B	0.33		0.51	0.01		0.02
C	0.19		0.25	0.007		0.009
D	8.55		8.75	0.33		0.34
E	3.80		4.0	0.15		0.15
e		1.27			0.05	
H	5.80		6.20	0.22		0.24
h	0.25		0.50	0.009		0.02
L	0.40		1.27	0.015		0.05
k	8° (max.)					
ddd			0.10			0.004

4.6 TSSOP14 package information

Figure 31. TSSOP14 package mechanical drawing

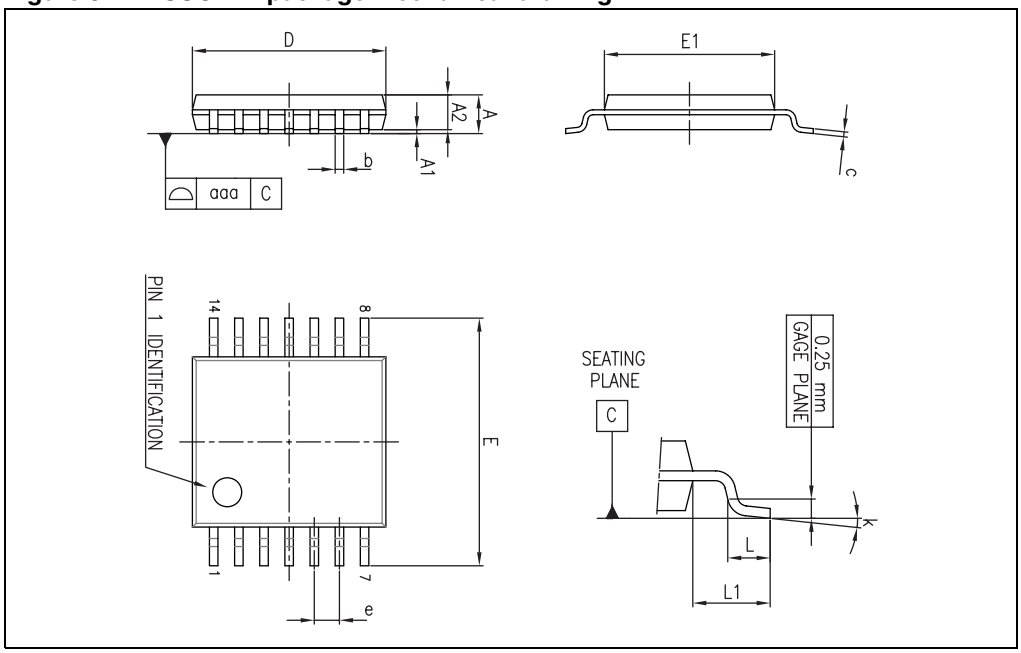


Table 11. TSSOP14 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.176
e		0.65			0.0256	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
k	0°		8°	0°		8°
aaa			0.10			0.004

5 Ordering information

Table 12. Order codes

Part number	Temperature range	Package	Packaging	Marking
TS331ILT	-40°C, +125°C	SOT23-5	Tape & reel	K506
TS331ICT		SC70-5		K55
TS332IDT		SO8		332I
TS332IST		MiniSO8		K507
TS334IDT		SO14		334I
TS334IPT		TSSOP14		334I

6 Revision history

Table 13. Document revision history

Date	Revision	Changes
29-Mar-2010	1	Initial release.
01-Dec-2011	2	– Added TS332 and TS334 devices. – Added V_{out} parameter in *Table 1: Absolute maximum ratings*. – Removed note "*The magnitude of input and output voltages must never exceed the supply rail ±0.3 V.*" from *Table 1*. – Removed note "*All values over the temperature range are guaranteed through correlation and simulation. No production tests have been performed at the temperature range limits.*" from *Table 3*, *Table 4* and *Table 5*. – Removed "*Vicm = 0 V*" from *Test conditions* column in *Table 3*, *Table 4* and *Table 5*. – Modified minimal Isink value in *Table 5*.

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