TS3021

Rail-to-rail 1.8 V high-speed comparator

Datasheet — production data

Features

- Propagation delay: 38 ns
- Low current consumption: 73 µA
- Rail-to-rail inputs
- Push-pull outputs
- Supply operation from 1.8 to 5 V
- Wide temperature range: -40° C to +125° C
- High ESD tolerance: 5 kV HBM / 300 V MM
- Latch-up immunity: 200 mA
- SMD packages
- Automotive qualification

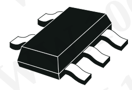
Related products

- TS3022 for a dual comparator with similar performances
- TS3011 for a high-speed comparator

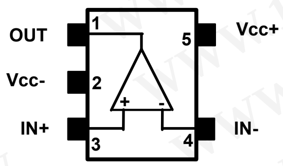
Applications

- Telecom
- Instrumentation
- Signal conditioning
- High-speed sampling systems
- Portable communication systems

TS3021
SOT23-5/SC70-5



Pin connections (top view)



Description

The TS3021 single comparator features high-speed response time with rail-to-rail inputs. With a supply voltage specified from 2 to 5 V, this comparator can operate over a wide temperature range: -40° C to +125° C.

The TS3021 comparator offers micropower consumption as low as a few tens of microamperes thus providing an excellent ratio of power consumption current versus response time.

The TS3021 includes push-pull outputs and is available in small packages (SOT23-5 and SC70-5).

This is information on a product in full production. www.st.com

Contents

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage(1) $V_{CC} = (V_{CC+}) - (V_{CC-})$	5.5	V
V_{ID}	Differential input voltage(2)	±5	
V_{IN}	Input voltage range	(V_{CC-}) - 0.3 to (V_{CC+}) + 0.3	
R_{thja}	Thermal resistance junction to ambient(3) SOT23-5 SC70-5	 250 205	°C/W
R_{thjc}	Thermal resistance junction to case (3) SOT23-5 SC70-5	 81 172	
T_{stg}	Storage temperature	-65 to +150	°C
T_j	Junction temperature	150	
T_{LEAD}	Lead temperature (soldering 10 seconds)	260	
ESD	Human body model (HBM)(4)	5000	V
	Machine model (MM)(5)	300	
	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 the package are charged together to the specified voltage and then discharged directly to the 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 $0°C < T_{amb} < +125°C$ $-40°C < T_{amb} < +125°C$	 1.8 to 5 2 to 5	V
V_{icm}	Common mode input voltage range $-40°C < T_{amb} < +85°C$ $+85°C < T_{amb} < +125°C$	 V_{CC-} - 0.2 to V_{CC+} + 0.2 V_{CC-} to V_{CC+}	

2 Electrical characteristics

Table 3. V_{CC} = +2 V, T_{amb} = +25° C, full V_{icm} range (unless otherwise specified)(1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	 -40° C < T_{amb} < +125° C	-	0.5	6 7	mV
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40° C < T_{amb} < +125° C	-	3	20	µV/°C
I_{IO}	Input offset current(2)	 -40° C < T_{amb} < +125° C	-	1	20 100	nA
I_{IB}	Input bias current(2)	 -40° C < T_{amb} < +125° C	-	86	160 300	
I_{CC}	Supply current	No load, output high, V_{icm} = 0 V -40° C < T_{amb} < +125° C No load, output low, V_{icm} = 0 V -40° C < T_{amb} < +125° C	-	73 84	90 115 105 125	µA
I_{SC}	Short-circuit current	Source Sink	-	9 10	-	mA
V_{OH}	Output voltage high	I_{source} = 1 mA -40° C < T_{amb} < +125° C	1.88 1.80	1.92	-	V
V_{OL}	Output voltage low	I_{sink} = 1 mA -40° C < T_{amb} < +125° C	-	60	100 150	mV
CMRR	Common mode rejection ratio	0 < V_{icm} < 2 V	-	67	-	dB
SVR	Supply voltage rejection	ΔV_{CC} = 2 to 5 V	58	73	-	
TP_{LH}	Propagation delay(3) Low to High output level	V_{icm}= 0 V, f = 10 kHz, C_L = 50 pF, Overdrive = 100 mV Overdrive = 20 mV	-	38 48	60 75	ns
TP_{HL}	Propagation delay(4) High to Low output level	V_{icm}= 0 V, f = 10 kHz, C_L = 50 pF, Overdrive = 100 mV Overdrive = 20 mV	-	40 49	60 75	
T_F	Fall time	f = 10 kHz, C_L = 50 pF, R_L = 10 kΩ Overdrive = 100 mV	-	8	-	
T_R	Rise time	f = 10 kHz, C_L = 50 pF, R_L = 10 kΩ Overdrive = 100 mV	-	9	-	

1. All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits.
2. Maximum values include unavoidable inaccuracies of the industrial tests.
3. Response time is measured 10%/90% of final output value with following conditions: Inverting input voltage (IN-) = V_{ICM} and Non-inverting input voltage (IN+) moving from V_{ICM} - 100 mV to V_{ICM} + overdrive.
4. Response time is measured 10%/90% of final output value with following conditions: Inverting input voltage (IN-) = V_{ICM} and Non-inverting input voltage (IN+) moving from V_{ICM} + 100 mV to V_{ICM} - overdrive.

Table 4. V_{CC} = +3.3 V, T_{amb} = +25° C, full V_{icm} range (unless otherwise specified)[1]

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	 -40° C < T_{amb} < +125° C	-	0.2	6 7	mV
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40° C < T_{amb} < +125° C	-	3	20	µV/°C
I_{IO}	Input offset current[2]	 -40° C < T_{amb} < +125° C	-	1	20 100	nA
I_{IB}	Input bias current[2]	 -40° C < T_{amb} < +125° C	-	86	160 300	nA
I_{CC}	Supply current	No load, output high, V_{icm} = 0 V -40° C < T_{amb} < +125° C No load, output low, V_{icm} = 0 V -40° C < T_{amb} < +125° C	-	75 86	90 120 110 125	µA
I_{SC}	Short circuit current	Source Sink	-	26 24	-	mA
V_{OH}	Output voltage high	I_{source} = 1 mA -40° C < T_{amb} < +125° C	3.20 3.10	3.25	-	V
V_{OL}	Output voltage low	I_{sink} = 1 mA -40° C < T_{amb} < +125° C	-	40	80 150	mV
CMRR	Common mode rejection ratio	0 < V_{icm} < 3.3 V	-	75	-	dB
SVR	Supply voltage rejection	ΔV_{CC} = 2 to 5 V	58	73	-	dB
TP_{LH}	Propagation delay[3] Low to High output level	V_{icm} = 0 V, f = 10 kHz, C_L = 50 pF, Overdrive = 100 mV Overdrive = 20 mV	-	39 50	65 85	ns
TP_{HL}	Propagation delay[4] High to Low output level	V_{icm} = 0 V, f = 10 kHz, C_L = 50 pF, Overdrive = 100 mV Overdrive = 20 mV	-	41 51	65 80	ns
T_F	Fall time	f = 10 kHz, C_L = 50 pF, R_L = 10 kΩ Overdrive = 100 mV	-	5	-	ns
T_R	Rise time	f = 10 kHz, C_L = 50 pF, R_L = 10 kΩ Overdrive = 100 mV	-	7	-	ns

1. All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits.
2. Maximum values include unavoidable inaccuracies of the industrial tests.
3. Response time is measured 10%/90% of final output value with following conditions: Inverting input voltage (IN-) = V_{ICM} and Non-inverting input voltage (IN+) moving from V_{ICM} - 100 mV to V_{ICM} + overdrive.
4. Response time is measured 10%/90% of final output value with following conditions: Inverting input voltage (IN-) = V_{ICM} and Non-inverting input voltage (IN+) moving from V_{ICM} + 100 mV to V_{ICM} - overdrive.

Table 5. V_{CC} = +5 V, T_{amb} = +25° C, full V_{icm} range (unless otherwise specified)[1]

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	 -40° C < T_{amb} < +125° C	-	0.2	6 7	mV
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40° C < T_{amb} < +125° C	-	3	20	µV/°C
I_{IO}	Input offset current[2]	 -40° C < T_{amb} < +125° C	-	1	20 100	nA
I_{IB}	Input bias current[2]	 -40° C < T_{amb} < +125° C	-	86	160 300	nA
I_{CC}	Supply current	No load, output high, V_{icm} = 0 V -40° C < T_{amb} < +125° C No load, output low, V_{icm} = 0 V -40° C < T_{amb} < +125° C	-	77 89	95 125 115 135	µA
I_{SC}	Short circuit current	Source Sink	-	51 40	-	mA
V_{OH}	Output voltage high	I_{source} = 4 mA -40° C < T_{amb} < +125° C	4.80 4.70	4.84	-	V
V_{OL}	Output voltage low	I_{sink} = 4 mA -40° C < T_{amb} < +125° C	-	130	180 250	mV
CMRR	Common mode rejection ratio	0 < V_{icm} < 5 V	-	79	-	dB
SVR	Supply voltage rejection	ΔV_{CC} = 2 to 5 V	58	73	-	dB
TP_{LH}	Propagation delay[3] Low to High output level	V_{icm}= 0 V, f = 10 kHz, C_L = 50 pF, Overdrive = 100 mV Overdrive = 20 mV	-	42 54	75 105	ns
TP_{HL}	Propagation delay[4] High to Low output level	V_{icm}= 0 V, f = 10 kHz, C_L = 50 pF, Overdrive = 100 mV Overdrive = 20 mV	-	45 55	75 95	ns
T_F	Fall time	f = 10 kHz, C_L = 50 pF, R_L = 10 kΩ, Overdrive = 100 mV	-	4	-	ns
T_R	Rise time	f = 10 kHz, C_L = 50 pF, R_L = 10 kΩ, Overdrive = 100 mV	-	4	-	ns

1. All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits.
2. Maximum values include unavoidable inaccuracies of the industrial tests.
3. Response time is measured 10%/90% of final output value with following conditions: Inverting input voltage (IN-) = V_{ICM} and Non-inverting input voltage (IN+) moving from V_{ICM} - 100 mV to V_{ICM} + overdrive.
4. Response time is measured 10%/90% of final output value with following conditions: Inverting input voltage (IN-) = V_{ICM} and Non-inverting input voltage (IN+) moving from V_{ICM} + 100 mV to V_{ICM} - overdrive.

Figure 1. Current consumption vs. supply voltage (V_{icm} = 0 V, output high)

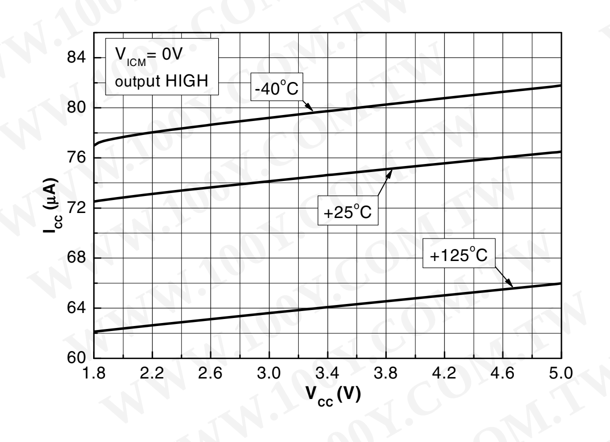


Figure 2. Current consumption vs. supply voltage (V_{icm} = V_{cc} output high)

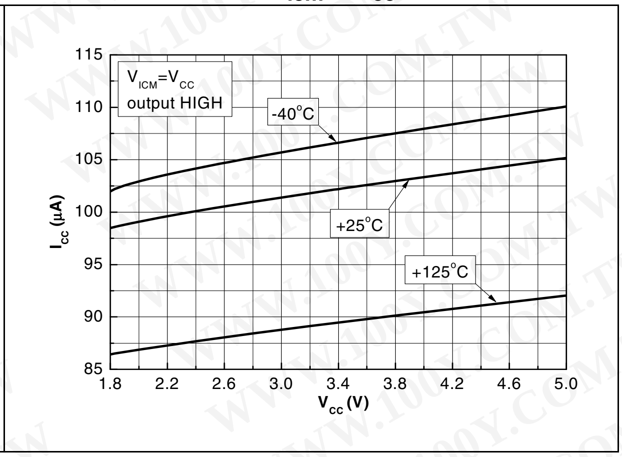


Figure 3. Current consumption vs. supply voltage (V_{icm} = 0 V, output low)

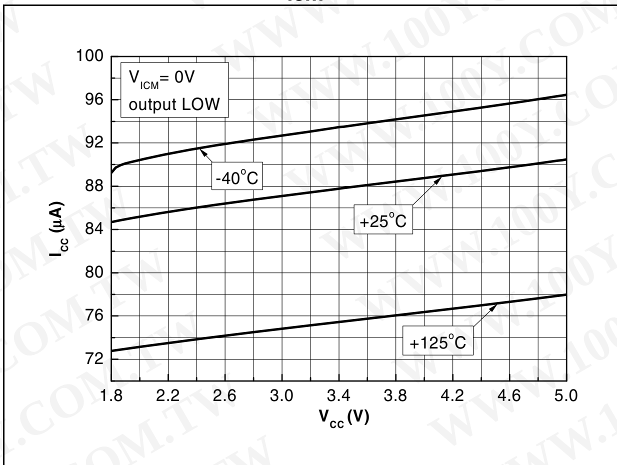


Figure 4. Current consumption vs. supply voltage (V_{icm} = V_{cc} output low)

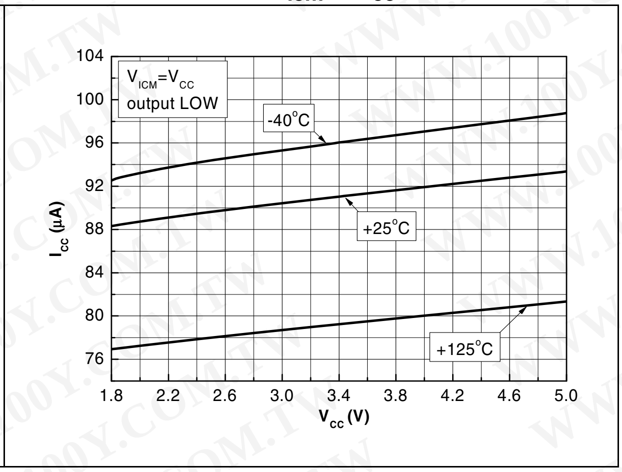


Figure 5. Output voltage vs. source current V_{CC} = 2 V

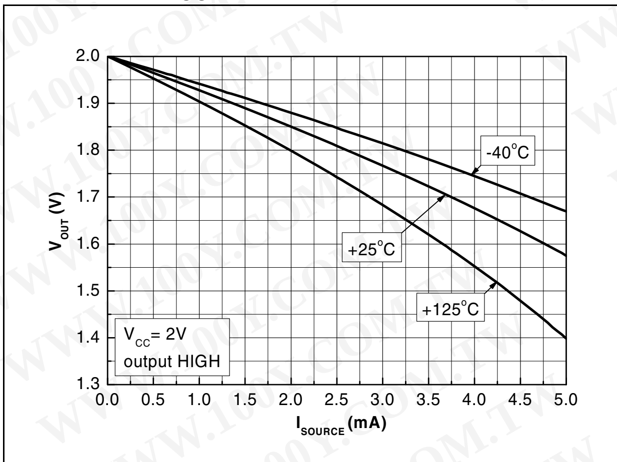


Figure 6. Output voltage vs. sink current V_{CC} = 2 V

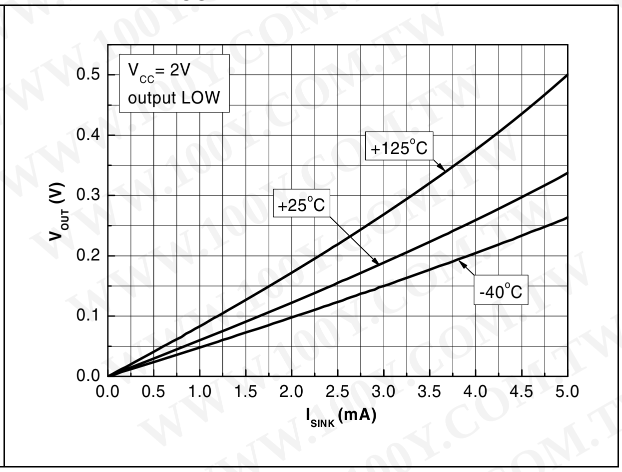


Figure 7. Output voltage vs. source current V_{CC} = 3.3 V

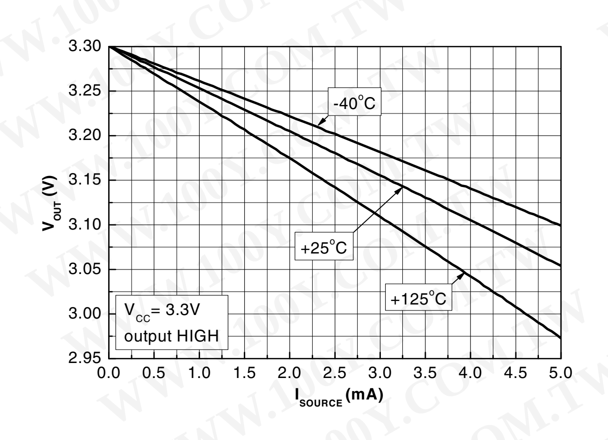


Figure 8. Output voltage vs. sink current V_{CC} = 3.3 V

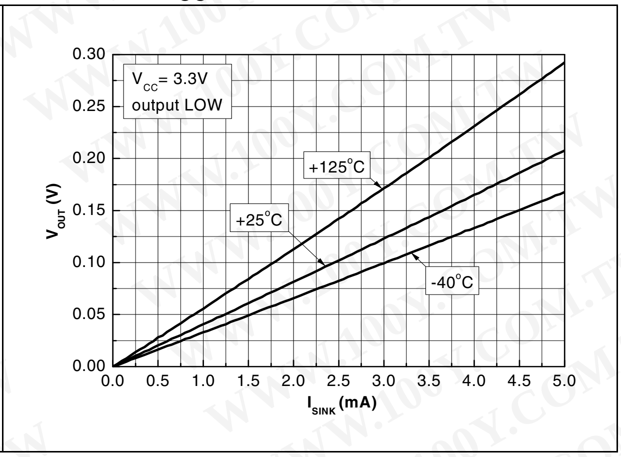


Figure 9. Output voltage vs. source current V_{CC} = 5 V

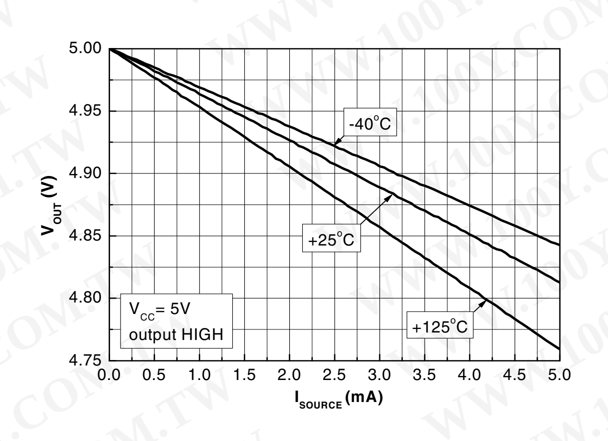


Figure 10. Output voltage vs. sink current V_{CC} = 5 V

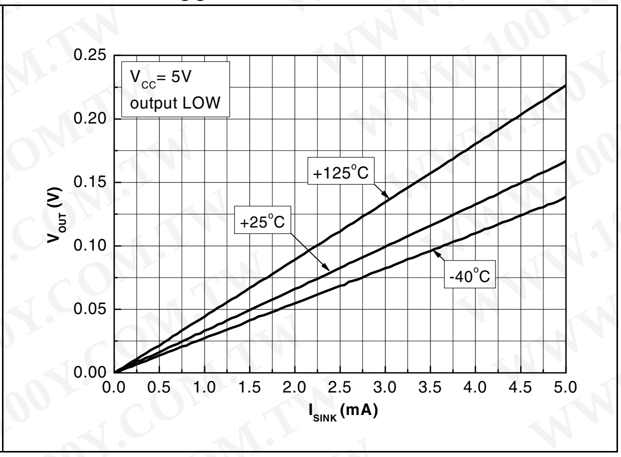


Figure 11. Input offset voltage vs. temperature and common mode voltage

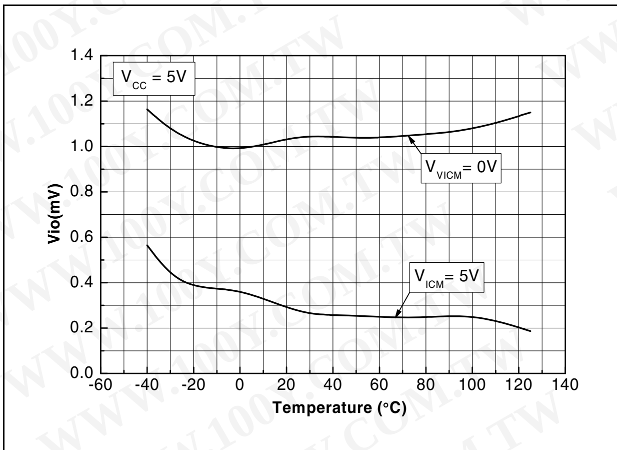


Figure 12. Input bias current vs. temperature and input voltage

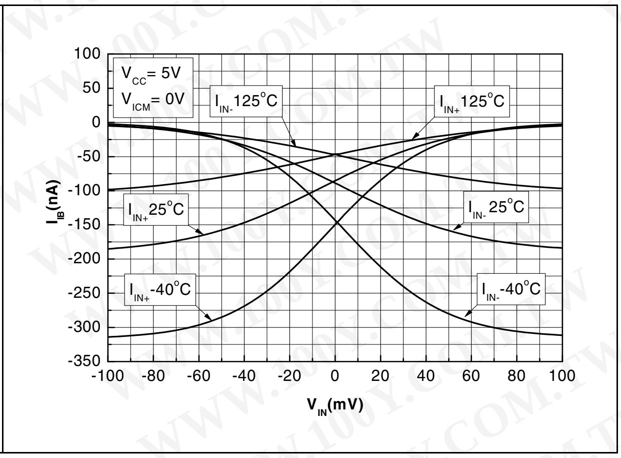


Figure 13. Current consumption vs. commutation frequency

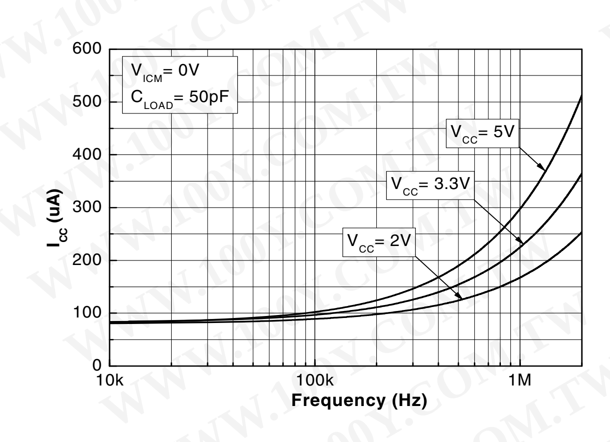


Figure 14. Propagation delay (HL) vs. overdrive at V_{CC} = 2 V, V_{icm} = 0 V

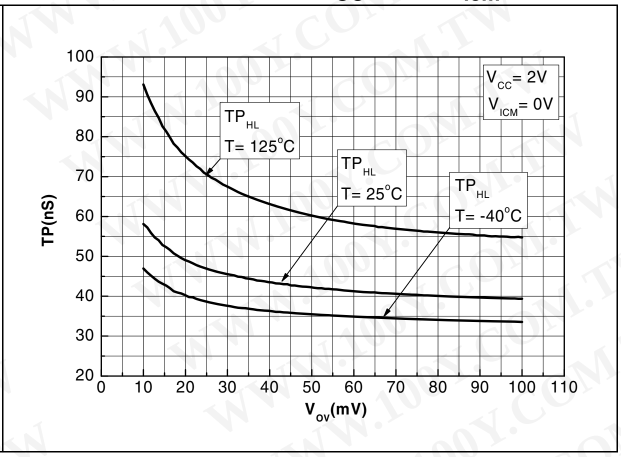


Figure 15. Propagation delay (HL) vs. overdrive at V_{CC} = 2 V, V_{icm} = V_{cc}

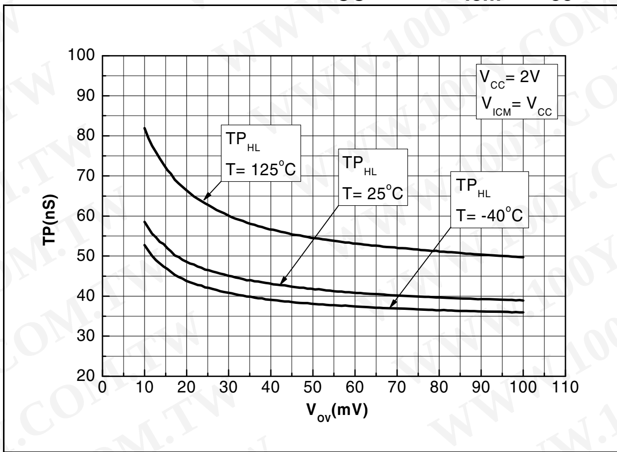


Figure 16. Propagation delay (LH) vs. overdrive at V_{CC} = 2 V, V_{icm} = 0 V

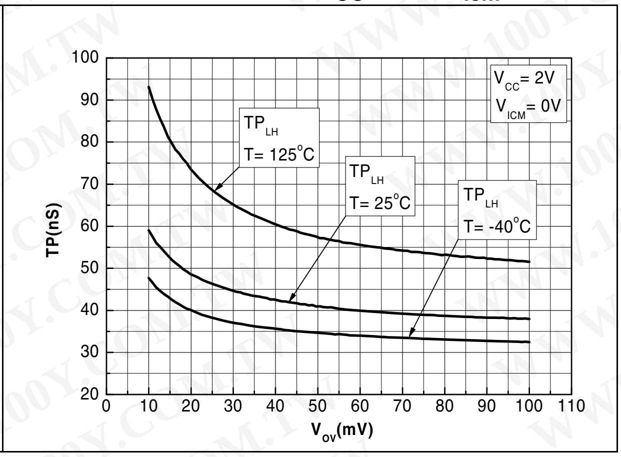


Figure 17. Propagation delay (LH) vs. overdrive at V_{CC} = 2 V, V_{icm} = V_{cc}

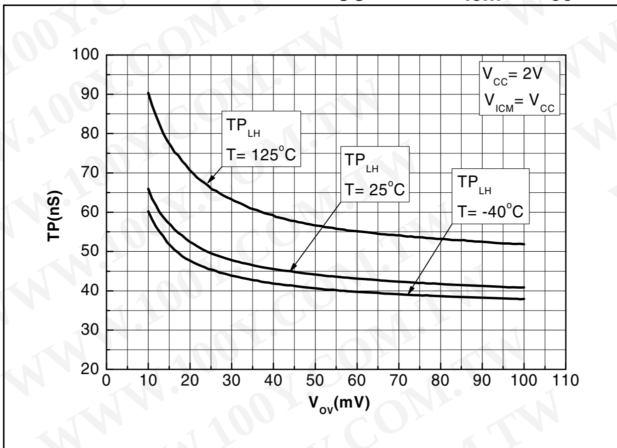


Figure 18. Propagation delay (HL) vs. overdrive at V_{CC} = 3.3 V, V_{icm} = 0 V

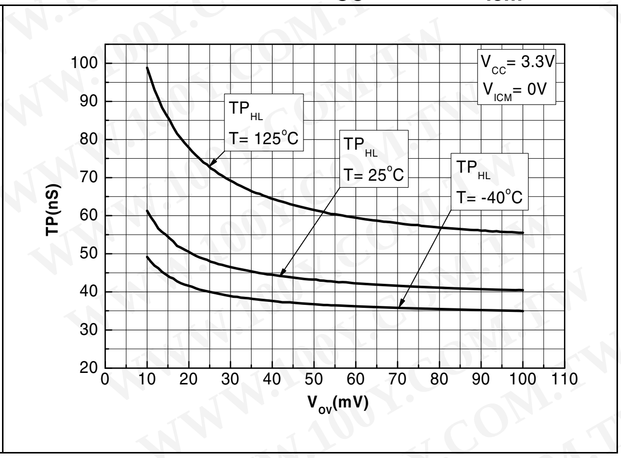


Figure 19. Propagation delay (HL) vs. overdrive at V_{CC} = 3.3 V, V_{icm} = V_{cc}

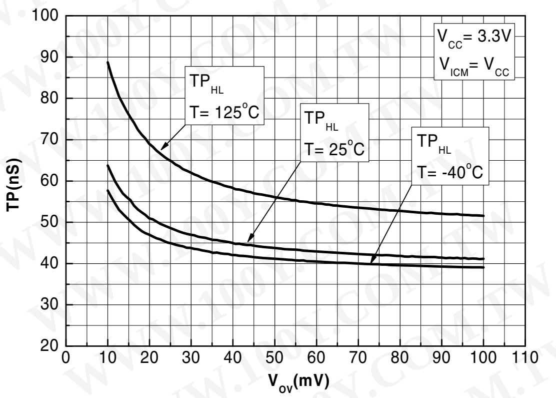


Figure 20. Propagation delay (LH) vs. overdrive at V_{CC} = 3.3 V, V_{icm} = 0 V

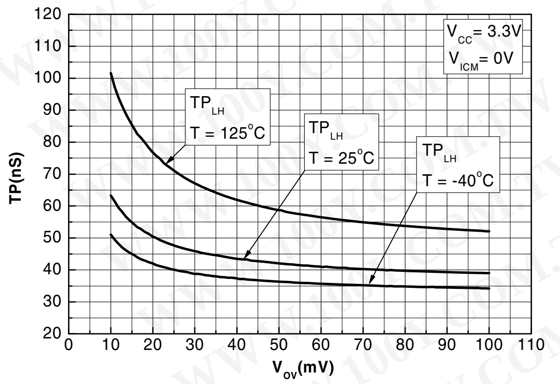


Figure 21. Propagation delay (LH) vs. overdrive at V_{CC} = 3.3 V, V_{icm} = V_{cc}

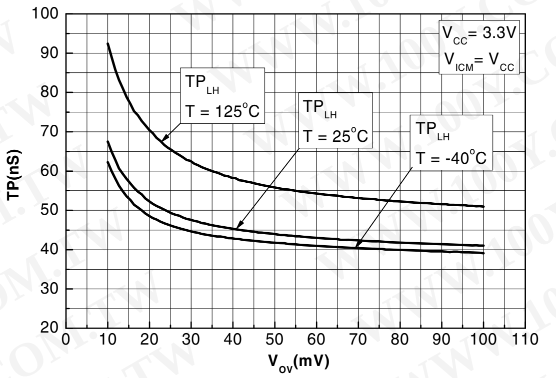


Figure 22. Propagation delay (HL) vs. overdrive at V_{CC} = 5 V, V_{icm} = 0 V

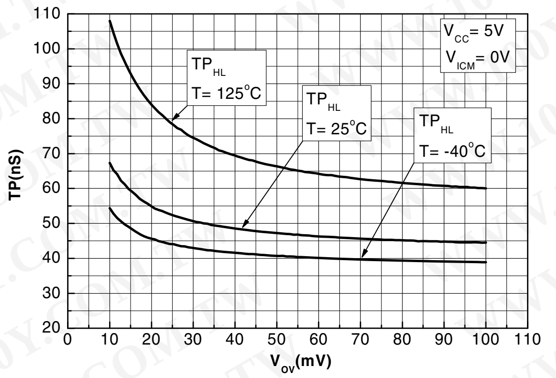


Figure 23. Propagation delay (HL) vs. overdrive at V_{CC} = 5 V, V_{icm} = V_{cc}

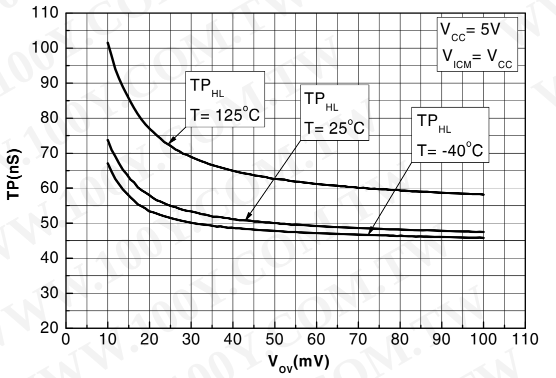


Figure 24. Propagation delay (LH) vs. overdrive at V_{CC} = 5 V, V_{icm} = 0 V

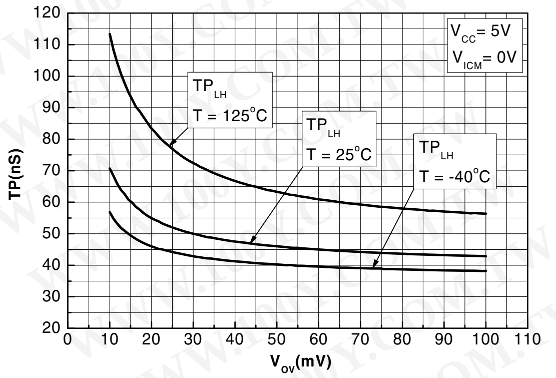


Figure 25. Propagation delay (LH) vs. overdrive at V_{CC} = 5 V, V_{icm} = V_{cc}

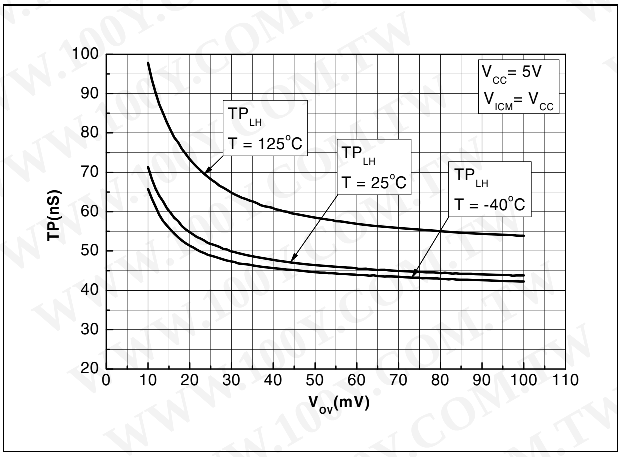


Figure 26. Propagation delay vs. temperature V_{CC} = 5 V, overdrive = 100 mV

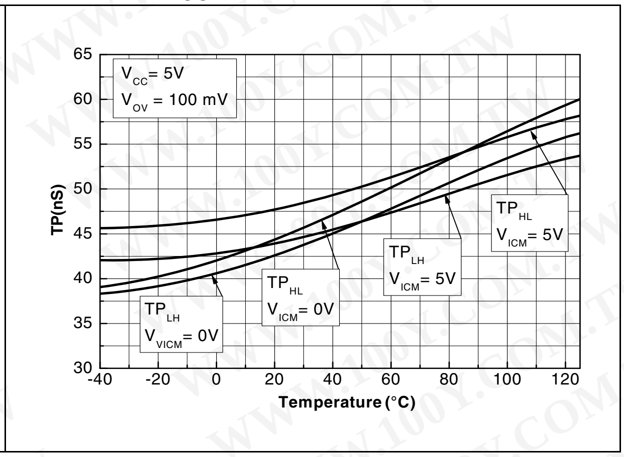
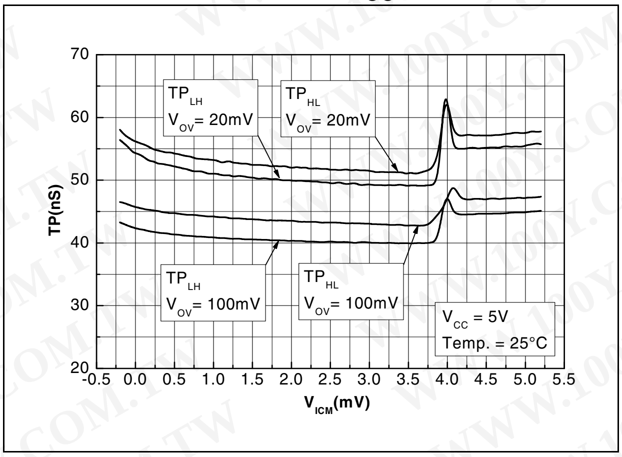


Figure 27. Propagation delay vs. common mode voltage, V_{CC} = 5 V



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 mechanical data

Figure 28. SOT23-5 package mechanical drawing

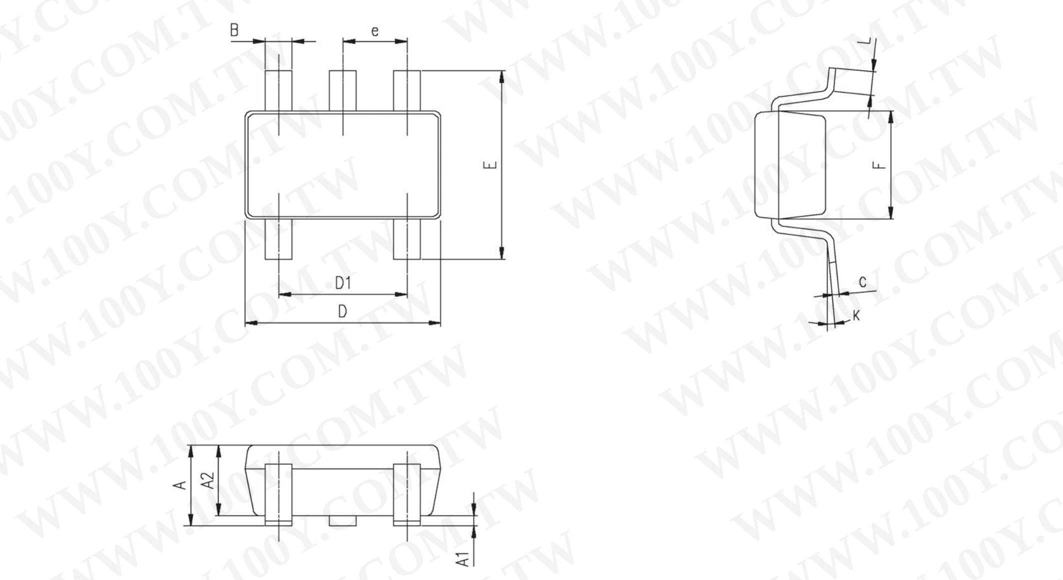


Table 6. SOT23-5 package mechanical data

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 °		10 °	0 °		10 °

3.2 SC70-5 (or SOT323-5) package mechanical data

Figure 29. SC70-5 (or SOT323-5) package mechanical drawing

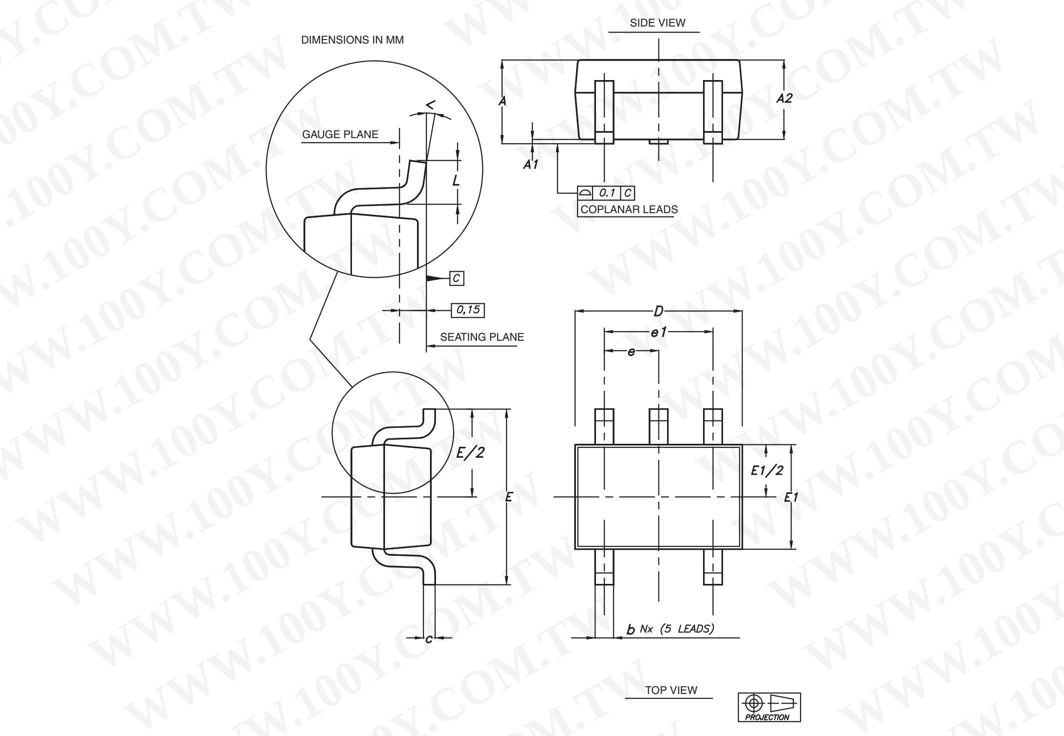


Table 7. SC70-5 (or SOT323-5) package mechanical data

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 °	0 °		8 °

4 Ordering information

Table 8. Order codes

Order code	Temperature range	Package	Packing	Marking
TS3021ILT	-40°C, +125°C	SOT23-5	Tape & reel	K520
TS3021IYLT[(1)]		SOT23-5	Tape & reel	K529
TS3021ICT		SC70-5	Tape & reel	K52

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q 002 or equivalent.

5 Revision history

Table 9. Document revision history

Date	Revision	Changes
01-Jun-2006	1	Initial release.
01-Sep-2006	2	Dual version added. Pinout of single TS3021 corrected. Modified temperature range for input common mode voltage.
22-Feb-2007	3	Addition of MiniSO-8 package for dual version.
17-Oct-2007	4	Marking corrected for SO-8 package. Thermal resistance values corrected in AMR table. Notes on ESD added in AMR table.
04-Dec-2008	5	Dual version (TS3022) removed. ESD tolerance modified in *Table 1: Absolute maximum ratings*. Made the following changes in *Table 3*: – modified V_{IO} typical value and maximum limits. – modified I_{IB} typical value. – modified I_{CC} typical values and corrected maximum limits. – modified I_{SC} typical values. – modified V_{OH} and V_{OL} typical values. – modified CMRR and SVR typical values. – modified TP_{HL} and TP_{LH} typical values. All curves modified.
03-Jan-2013	6	*Features*: added “automotive qualification”; added *Related products*. *Table 1*, and *Table 2*: V_{DD} and V_{CC} replaced by (V_{CC-}) and (V_{CC+}) respectively. *Table 3*, *Table 4*, and *Table 5*: replaced ΔV_{io} symbol with $\Delta V_{io}/\Delta T$. *Table 6* and *Table 7*: minor update (added angle dimensions to “inches” columns). *Table 8*: added automotive order code.

Please Read Carefully: