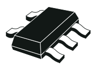
TS3021, TS3021A

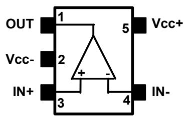
Datasheet

Rail-to-rail 1.8 V high-speed comparator

SOT23-5/SC70-5



Pin connections (top view)



Maturity status link
TS3021, TS3021A

Related products	
TS3022	For a dual comparator with similar performances
TS3011	For a high-speed comparator

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
- SMD packages
- Automotive qualification

Applications

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

Description

The TS3021, TS3021A 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, TS3021A 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, TS3021A includes push-pull outputs and is available in small packages (SOT23-5 and SC70-5).

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings (AMR)

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage, $V_{CC} = (V_{CC+}) - (V_{CC-})$ (1)		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	250	°C/W
		SC70-5	205	
R_{thjc}	Thermal resistance junction-to-case (3)	SOT23-5	81	
		SC70-5	172	
T_{stg}	Storage temperature		-65 to 150	°C
T_j	Junction temperature		150	
T_{LEAD}	Lead temperature (soldering 10 s)		260	
ESD	HBM: human body model (4)		5000	V
	MM: machine model (5)		300	
	CDM: charged device model (6)		1500	

1. *All voltage values, except the differential voltage are referenced to (V_{CC-})*
2. *The magnitude of the 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
V_{CC}	Supply voltage	0 °C < Tamb < 125 °C	1.8 to 5	V
		-40 °C < Tamb < 125°C	2 to 5	
V_{icm}	Common mode input voltage range	-40 °C < Tamb < 85 °C	(V_{CC-}) - 0.2 to (V_{CC+}) + 0.2	
		85 °C < Tamb < 125 °C	(V_{CC-}) to (V_{CC+})	
T_{oper}	Operating temperature range		-40 to 125	°C

2 Electrical characteristics

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

Symbol	Parameter	Test conditions [1]	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	TS3021A		0.5	2	mV
		TS3021		0.5	6	
		-40 °C < Tamb < 125 °C, TS3021A			4	
		-40 °C < Tamb < 125 °C, TS3021			7	
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40 °C < Tamb < 125 °C		3	20	µV/°C
I_{IO}	Input offset current [2]	Tamb		1	20	nA
		-40 °C < Tamb < 125 °C			100	
I_{IB}	Input bias current [2]	Tamb		86	160	
		-40 °C < Tamb < 125 °C			300	
I_{CC}	Supply current	No load, output high, Vicm = 0 V		73	90	µA
		No load, output high, Vicm = 0 V, -40 °C < Tamb < 125 °C			115	
		No load, output low, Vicm = 0 V		84	105	
		No load, output low, Vicm = 0 V, -40 °C < Tamb < 125 °C			125	
I_{SC}	Short-circuit current	Source		9		mA
		Sink		10		
V_{OH}	Output voltage high	Isource = 1 mA	1.88	1.92		V
		-40 °C < Tamb < 125 °C	1.80			
V_{OL}	Output voltage low	Isink = 1 mA		60	100	mV
		-40 °C < Tamb < 125 °C			150	
CMRR	Common mode rejection ratio	0 < Vicm < 2 V		67		dB
SVR	Supply voltage rejection	ΔVcc = 2 to 5 V	58	73		
TP_{LH}	Propagation delay, low to high output level [3]	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		38	60	ns
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		48	75	
TP_{HL}	Propagation delay, high to low output level [4]	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		40	60	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		49	75	
T_F	Fall time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		8		
T_R	Rise time	f = 10 kHz, CL = 50 pF, RL = 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 the final output value with the following conditions: inverting input voltage (IN-) = Vicm and non-inverting input voltage (IN+) moving from Vicm - 100 mV to Vicm + overdrive.*
4. *Response time is measured 10%/90% of the final output value 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. Electrical characteristics at V_{CC} = 3.3 V, T_{amb} = 25 ° C, and full V_{icm} range (unless otherwise specified)

Symbol	Parameter	Test conditions (1)	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	TS3021A		0.5	2	mV
		TS3021		0.5	6	
		-40 °C < Tamb < 125 °C, TS3021A			4	
		-40 °C < Tamb < 125 °C, TS3021			7	
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40 °C < Tamb < 125 °C		3	20	μV/°C
I_{IO}	Input offset current (2)	Tamb		1	20	nA
		-40 °C < Tamb < 125 °C			100	
I_{IB}	Input bias current (2)	Tamb		86	160	
		-40 °C < Tamb < 125 °C			300	
I_{CC}	Supply current	No load, output high, Vicm = 0 V		75	90	μA
		No load, output high, Vicm = 0 V, -40 °C < Tamb < 125 °C			120	
		No load, output low, Vicm = 0 V		86	110	
		No load, output low, Vicm = 0 V, -40 °C < Tamb < 125 °C			125	
I_{SC}	Short-circuit current	Source		26		mA
		Sink		24		
V_{OH}	Output voltage high	Isource = 1 mA	3.20	3.25		V
		-40 °C < Tamb < 125 °C	3.10			
V_{OL}	Output voltage low	Isink = 1 mA		40	80	mV
		-40 °C < Tamb < 125 °C			150	
CMRR	Common mode rejection ratio	0 < Vicm < 3.3 V		75		dB
SVR	Supply voltage rejection	ΔVcc = 2 to 5 V	58	73		
TP_{LH}	Propagation delay, low to high output level (3)	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		39	65	ns
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		50	85	
TP_{HL}	Propagation delay, high to low output level (4)	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		41	65	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		51	80	
T_F	Fall time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		5		
T_R	Rise time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		7		

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 the final output value with the following conditions: inverting input voltage (IN-) = Vicm and non-inverting input voltage (IN+) moving from Vicm - 100 mV to Vicm + overdrive.*
4. *Response time is measured 10%/90% of the final output value 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. Electrical characteristics at V_{CC} = 5 V, T_{amb} = 25 ° C, and full V_{icm} range (unless otherwise specified)

Symbol	Parameter	Test conditions [1]	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage	TS3021A		0.5	2	mV
		TS3021		0.5	6	
		-40 °C < Tamb < 125 °C, TS3021A			4	
		-40 °C < Tamb < 125 °C, TS3021			7	
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40 °C < Tamb < 125 °C		3	20	µV/°C
I_{IO}	Input offset current [2]	Tamb		1	20	nA
		-40 °C < Tamb < 125 °C			100	
I_{IB}	Input bias current [2]	Tamb		86	160	
		-40 °C < Tamb < 125 °C			300	
I_{CC}	Supply current	No load, output high, Vicm = 0 V		77	95	µA
		No load, output high, Vicm = 0 V, -40 °C < Tamb < 125 °C			125	
		No load, output low, Vicm = 0 V		89	115	
		No load, output low, Vicm = 0 V, -40 °C < Tamb < 125 °C			135	
I_{SC}	Short-circuit current	Source		51		mA
		Sink		40		
V_{OH}	Output voltage high	Isource = 4 mA	4.80	4.84		V
		-40 °C < Tamb < 125 °C	4.70			
V_{OL}	Output voltage low	Isink = 4 mA		130	180	mV
		-40 °C < Tamb < 125 °C			250	
CMRR	Common mode rejection ratio	0 < Vicm < 5 V		79		dB
SVR	Supply voltage rejection	∆Vcc = 2 to 5 V	58	73		
TP_{LH}	Propagation delay, low to high output level [3]	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		42	75	ns
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		54	105	
TP_{HL}	Propagation delay, high to low output level [4]	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		45	75	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		55	95	
T_F	Fall time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		4		
T_R	Rise time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		4		

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 the final output value with the following conditions: inverting input voltage (IN-) = Vicm and non-inverting input voltage (IN+) moving from Vicm - 100 mV to Vicm + overdrive.*
4. *Response time is measured 10%/90% of the final output value with the following conditions: Inverting input voltage (IN-) = Vicm and non-inverting input voltage (IN+) moving from Vicm + 100 mV to Vicm - overdrive.*

3 Electrical characteristic curves

Figure 1. Current consumption vs. supply voltage (Vicm = 0 V, output high)

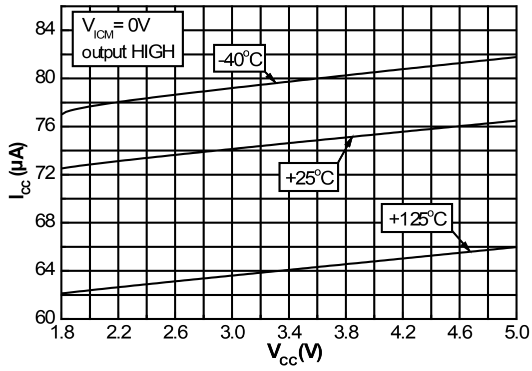


Figure 2. Current consumption vs. supply voltage (Vicm = Vcc output high)

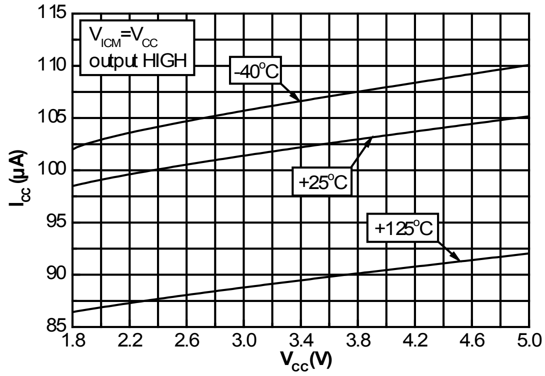


Figure 3. Current consumption vs. supply voltage (Vicm = 0 V, output low)

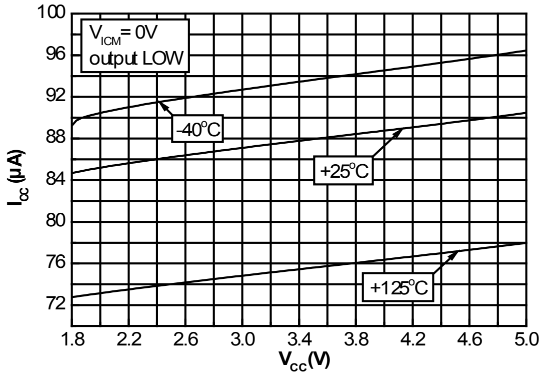


Figure 4. Current consumption vs. supply voltage (Vicm = Vcc output low)

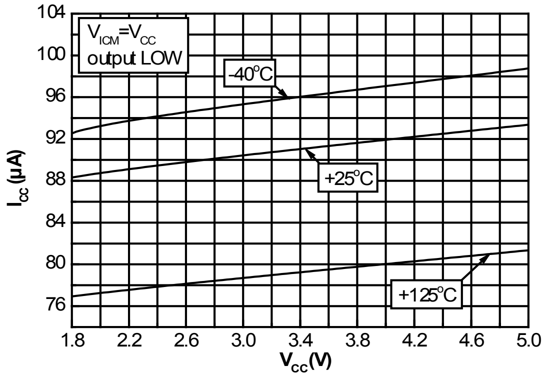


Figure 5. Output voltage vs. source current, Vcc = 2 V

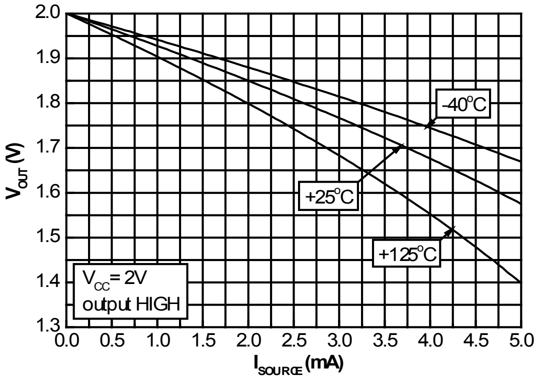


Figure 6. Output voltage vs. sink current, Vcc = 2 V

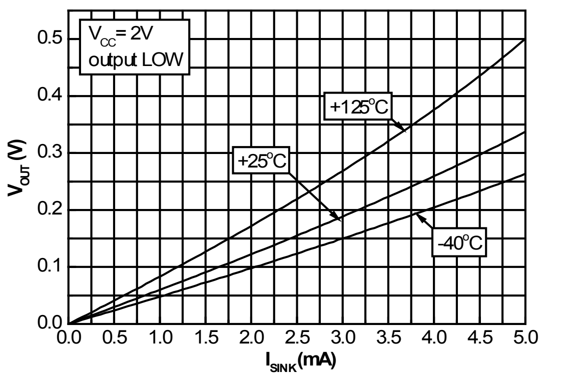


Figure 7. **Output voltage vs. source current, Vcc = 3.3 V**

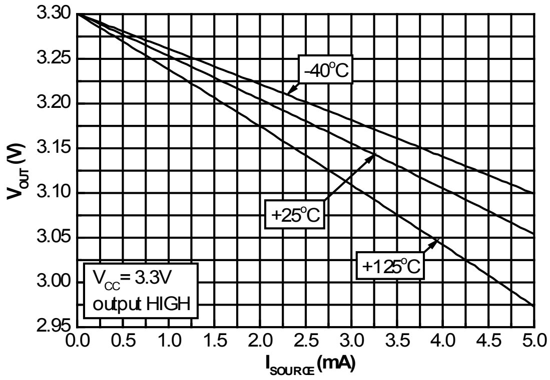


Figure 8. **Output voltage vs. sink current, Vcc = 3.3 V**

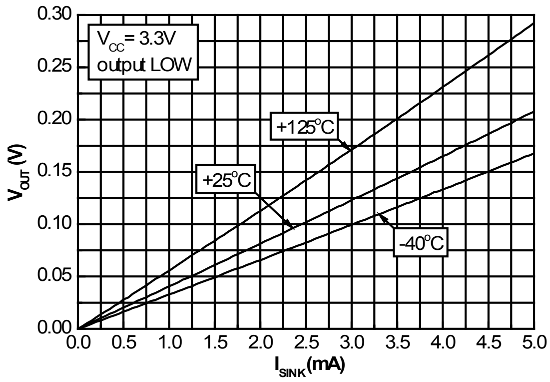


Figure 9. **Output voltage vs. source current, Vcc = 5 V**

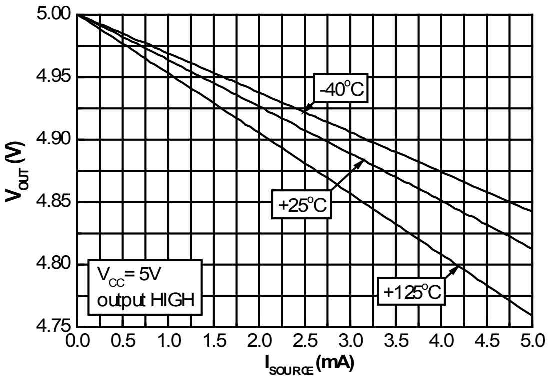


Figure 10. **Output voltage vs. sink current, Vcc = 5 V**

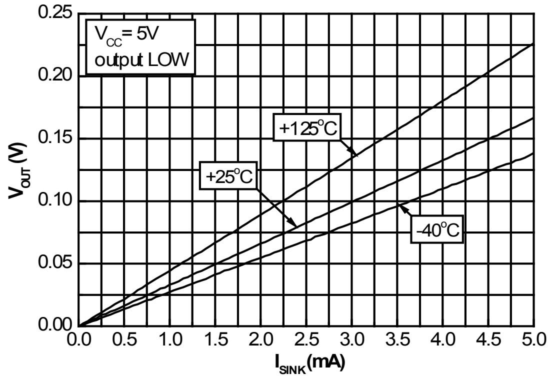


Figure 11. **Input offset voltage vs. temperature and common mode voltage**

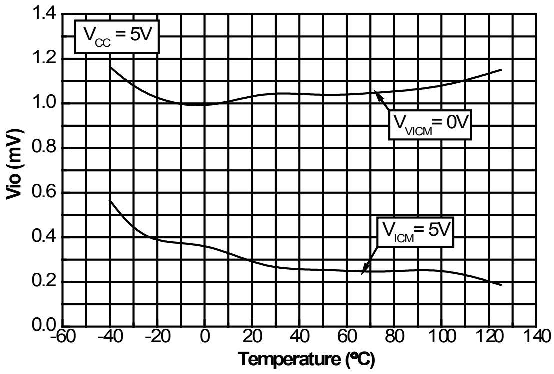


Figure 12. **Input bias current vs. temperature and input voltage**

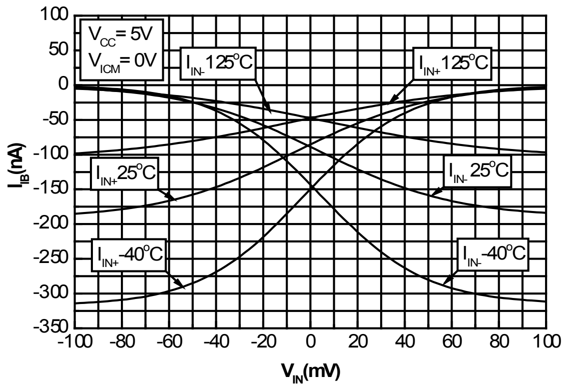


Figure 13. Current consumption vs. commutation frequency

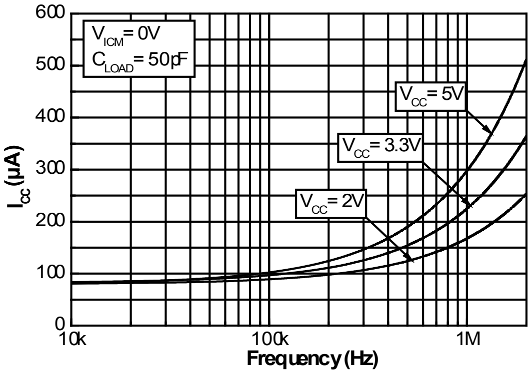


Figure 14. Propagation delay (HL) vs. overdrive at Vcc = 2 V, Vicm = 0 V

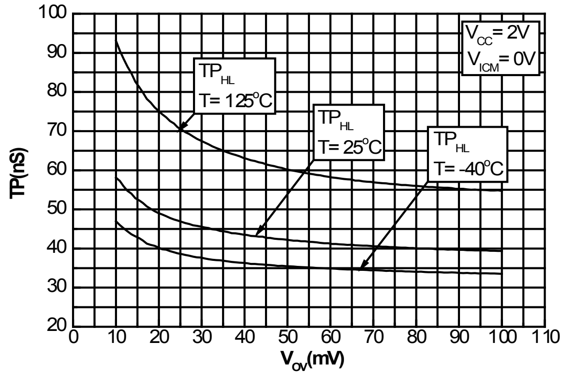


Figure 15. Propagation delay (HL) vs. overdrive at Vcc = 2 V, Vicm = Vcc

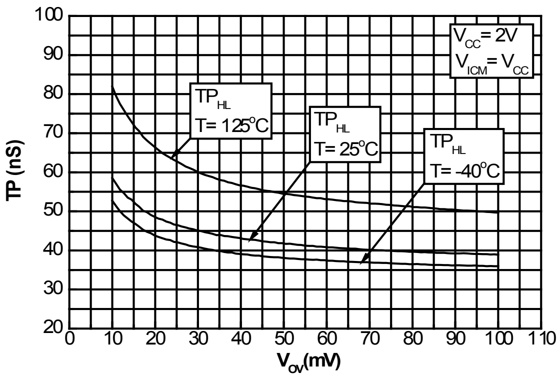


Figure 16. Propagation delay (LH) vs. overdrive at Vcc = 2 V, Vicm = 0 V

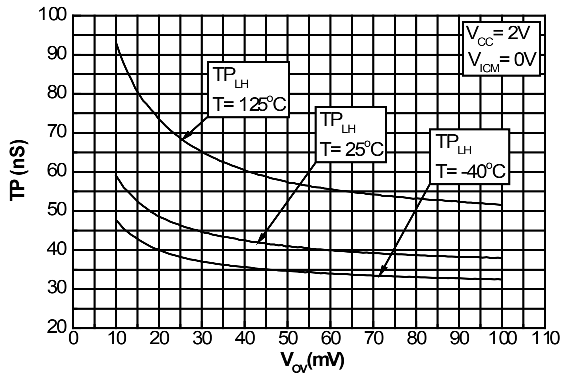


Figure 17. Propagation delay (LH) vs. overdrive at Vcc = 2 V, Vicm = Vcc

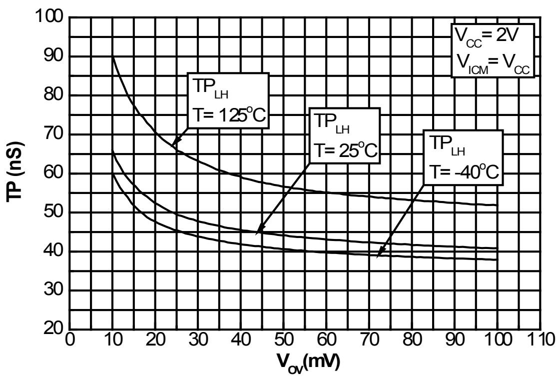


Figure 18. Propagation delay (HL) vs. overdrive at Vcc = 3.3 V, Vicm = 0 V

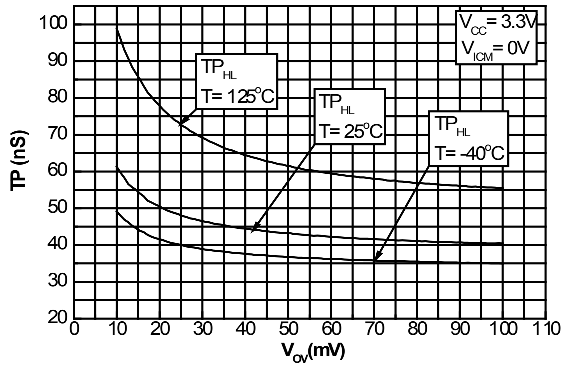


Figure 19. Propagation delay (HL) vs. overdrive at Vcc = 3.3 V, Vicm = Vcc

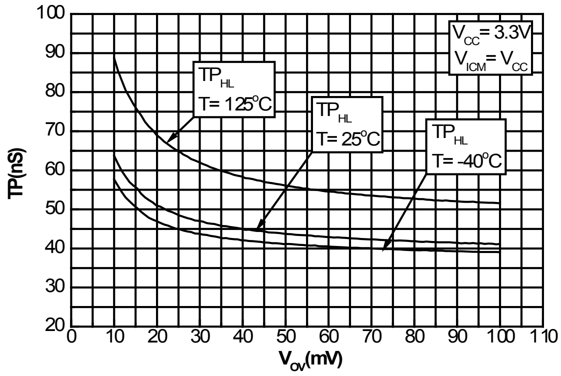


Figure 20. Propagation delay (LH) vs. overdrive at Vcc = 3.3 V, Vicm = 0 V

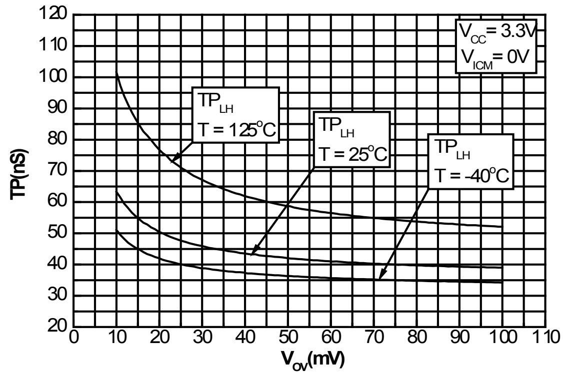


Figure 21. Propagation delay (LH) vs. overdrive at Vcc = 3.3 V, Vicm = Vcc

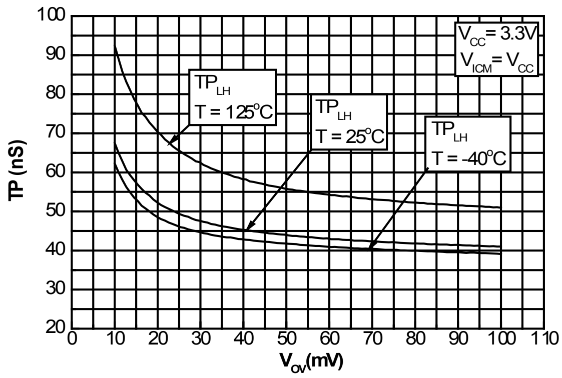


Figure 22. Propagation delay (HL) vs. overdrive at Vcc = 5 V, Vicm = 0 V

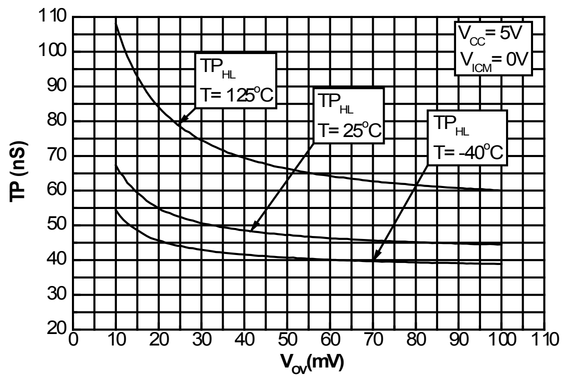


Figure 23. Propagation delay (HL) vs. overdrive at Vcc = 5 V, Vicm = Vcc

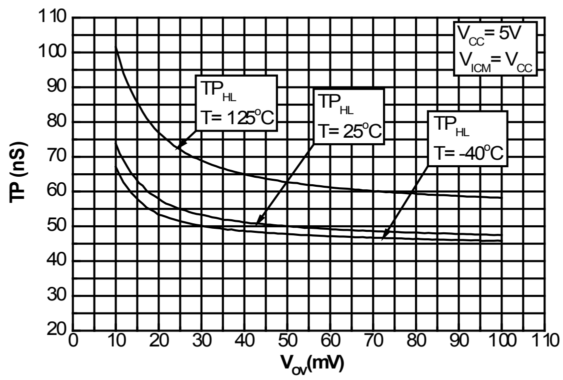


Figure 24. Propagation delay (LH) vs. overdrive at Vcc = 5 V, Vicm = 0 V

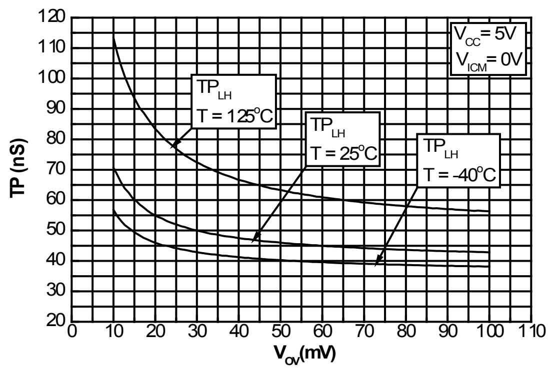


Figure 25. Propagation delay (LH) vs. overdrive at Vcc = 5 V, Vicm = Vcc

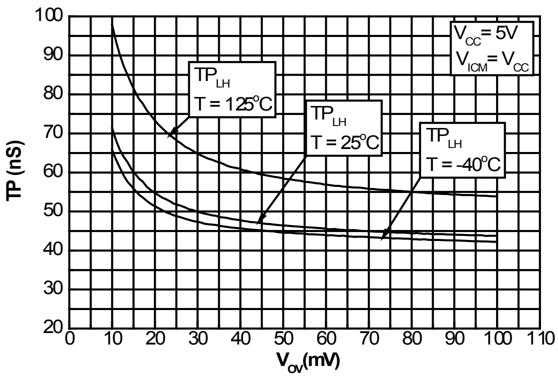


Figure 26. Propagation delay vs. temperature, Vcc = 5 V, overdrive = 100 mV

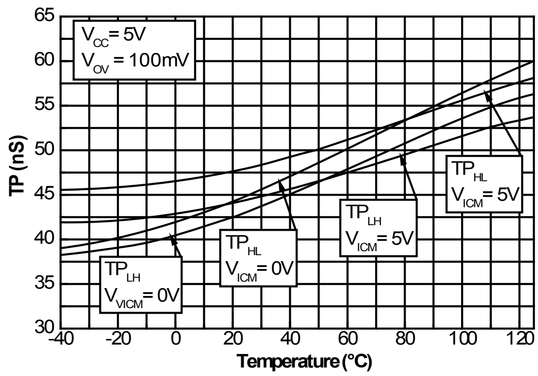
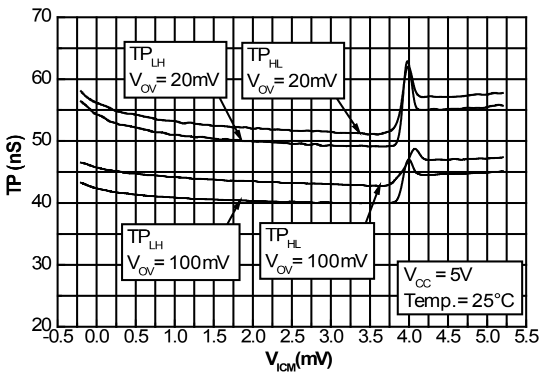


Figure 27. Propagation delay vs. common mode voltage, Vcc = 5 V



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 information

Figure 28. **SOT23-5 package outline**

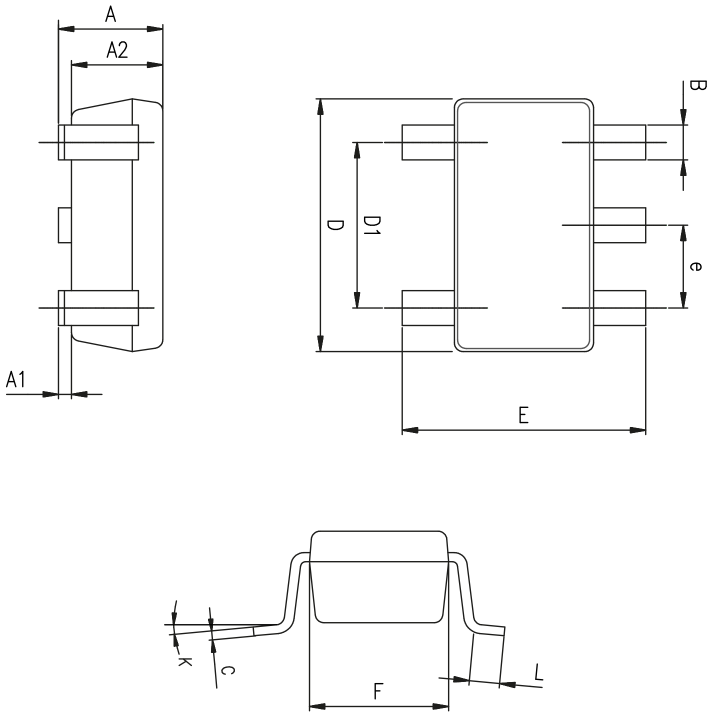


Table 6. **SOT23-5 mechanical data**

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	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	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	0.014	0.024
K	0 degrees		10 degrees	0 degrees		10 degrees

4.2 SC70-5 (or SOT323-5) package information

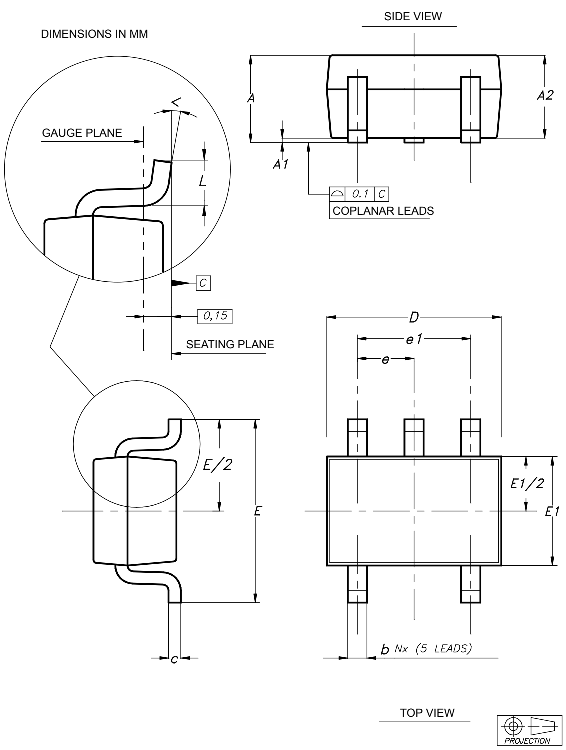


Figure 29. SC70-5 (or SOT323-5) package outline

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

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80		1.10	0.032		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.032	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°

5 Ordering information

Table 8. Order codes

Order code	Temperature range	Package	Packaging	Marking
TS3021ILT	-40 to 125 °C	SOT23-5	Tape and reel	K520
TS3021IYLT [(1)]				K529
TS3021ICT		SC70-5		K52
TS3021IYCT [(1)]				K5S
TS3021AILT		SOT23-5		K522

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

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 Vio typical value and maximum limits – modified Iib typical value – modified Icc typical values and corrected maximum limits – modified Isc typical values – modified Voh and Vol typical values – modified CMRR and SVR typical values – modified TPhl and TPlh typical values All curves modified
03-Jan-2013	6	Features: added “automotive qualification”; added Related products. Table 1 and Table 2: Vdd and Vcc replaced by (Vcc-) and (Vcc+) respectively. Table 3, Table 4, and Table 5: replaced ΔVio symbol with ΔVio/ΔT. Table 6 and Table 7: minor update (added angle dimensions to “inches” columns). Table 8: added automotive order code
02-Jun-2015	7	Table 3, Table 4, and Table 5: updated Vio parameter Table 6: small "rounding-off modifications to inches parameter Table 8: added order code TS3021AILT
07-Jul-2016	8	Added new part number TS3021A Updated document layout Table 3, Table 4, and Table 5: updated VIO test conditions and values.
17-Oct-2022	9	Added new TS3021IYCT order code in Table 8. Order codes