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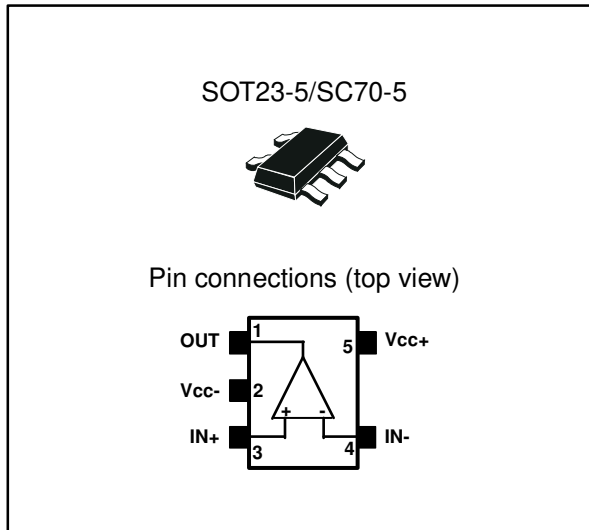
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Rail-to-rail 1.8 V high-speed comparator

Datasheet - production data

**Features**

- Propagation delay: 38 ns
- Low current consumption: 73 μ A
- 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

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).

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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		
	Latch-up immunity	200	mA	

Notes:

⁽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 < T_{amb} < 125 °C	1.8 to 5	V
		-40 °C < T_{amb} < 125 °C	2 to 5	
V_{icm}	Common mode input voltage range	-40 °C < T_{amb} < 85 °C	$(V_{CC-}) - 0.2$ to $(V_{CC+}) + 0.2$	
		85 °C < T_{amb} < 125 °C	(V_{CC-}) to (V_{CC+})	
T_{oper}	Operating temperature range	-40 to 125	°C	

2 Electrical characteristics

Table 3: Electrical characteristics at $V_{CC} = 2\text{ V}$, $T_{amb} = 25\text{ °C}$, and full Vicm 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	
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$, TS3021A			4	
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$, TS3021			7	
$\Delta V_{IO}/\Delta T$	Input offset voltage drift	$-40\text{ °C} < T_{amb} < 125\text{ °C}$		3	20	$\mu\text{V}/\text{°C}$
I_{IO}	Input offset current ⁽²⁾	T_{amb}		1	20	nA
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$			100	
I_{IB}	Input bias current ⁽²⁾	T_{amb}		86	160	nA
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$			300	
I_{CC}	Supply current	No load, output high, Vicm = 0 V		73	90	μA
		No load, output high, Vicm = 0 V, $-40\text{ °C} < T_{amb} < 125\text{ °C}$			115	
		No load, output low, Vicm = 0 V		84	105	
		No load, output low, Vicm = 0 V, $-40\text{ °C} < T_{amb} < 125\text{ °C}$			125	
I_{SC}	Short-circuit current	Source		9		mA
		Sink		10		
V_{OH}	Output voltage high	$I_{source} = 1\text{ mA}$	1.88	1.92		V
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$	1.80			
V_{OL}	Output voltage low	$I_{sink} = 1\text{ mA}$		60	100	mV
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$			150	
CMRR	Common mode rejection ratio	$0 < Vicm < 2\text{ V}$		67		dB
SVR	Supply voltage rejection	$\Delta V_{CC} = 2\text{ to }5\text{ V}$	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	ns
		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 k Ω , overdrive = 100 mV		8		
T_R	Rise time	f = 10 kHz, CL = 50 pF, RL = 10 k Ω , overdrive = 100 mV		9		

Notes:

⁽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-) = V_{icm} and non-inverting input voltage (IN+) moving from $V_{icm} - 100\text{ mV}$ to $V_{icm} + \text{overdrive}$.

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

Table 4: Electrical characteristics at VCC = 3.3 V, Tamb = 25 ° C, and full Vicm 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	
ΔV _{IO} /ΔT	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	nA
		-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	I _{source} = 1 mA	3.20	3.25		V
		-40 °C < Tamb < 125 °C	3.10			
V _{OL}	Output voltage low	I _{sink} = 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	ΔV _{CC} = 2 to 5 V	58	73		
T _{PLH}	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	
T _{PHL}	Propagation delay, high to low output level ⁽⁴⁾	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		41	65	ns
		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		

Notes:

⁽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-) = V_{icm} and non-inverting input voltage (IN+) moving from $V_{icm} - 100\text{ mV}$ to $V_{icm} + \text{overdrive}$.

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

Table 5: Electrical characteristics at VCC = 5 V, Tamb = 25 °C, and full Vicm 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	
ΔV _{IO} /ΔT	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	nA
		-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	I _{source} = 4 mA	4.80	4.84		V
		-40 °C < Tamb < 125 °C	4.70			
V _{OL}	Output voltage low	I _{sink} = 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	ΔV _{CC} = 2 to 5 V	58	73		
T _{PLH}	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	
T _{PHL}	Propagation delay, high to low output level ⁽⁴⁾	Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 100 mV		45	75	ns
		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		

Notes:

⁽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
($V_{icm} = 0\text{ V}$, output high)

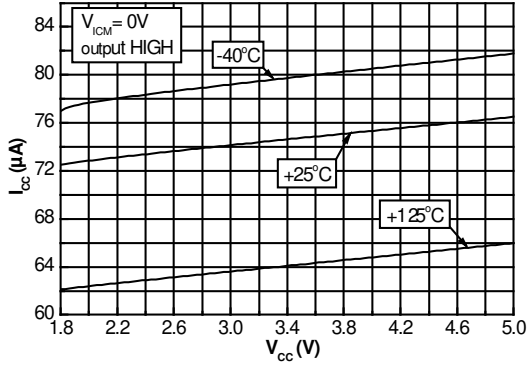


Figure 2: Current consumption vs. supply voltage
($V_{icm} = V_{cc}$ output high)

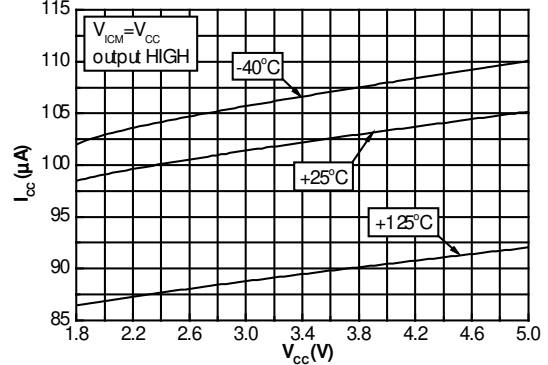


Figure 3: Current consumption vs. supply voltage
($V_{icm} = 0\text{ V}$, output low)

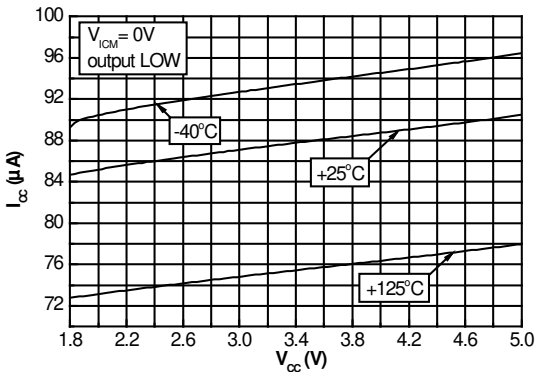


Figure 4: Current consumption vs. supply voltage
($V_{icm} = V_{cc}$ output low)

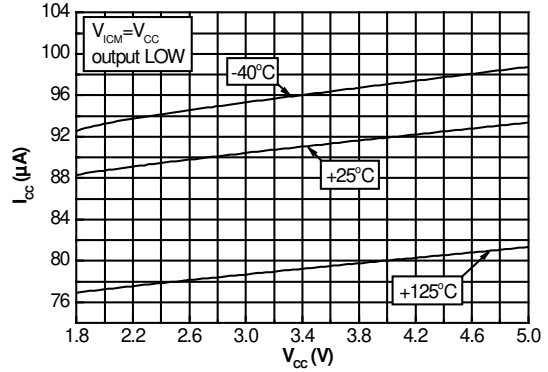


Figure 5: Output voltage vs. source current, $V_{cc} = 2\text{ V}$

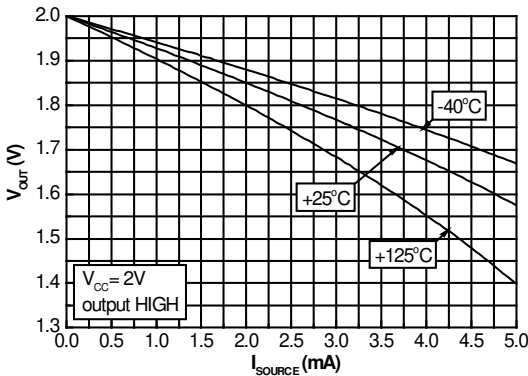


Figure 6: Output voltage vs. sink current, $V_{cc} = 2\text{ V}$

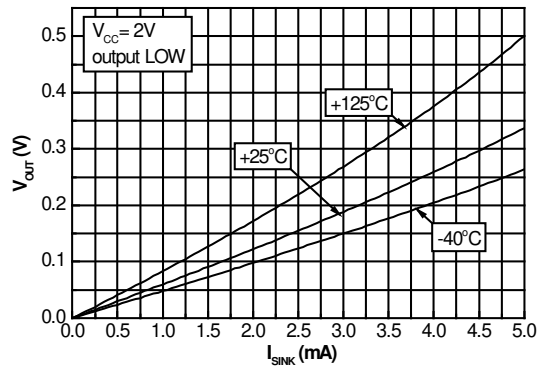


Figure 7: Output voltage vs. source current, $V_{CC} = 3.3\text{ V}$

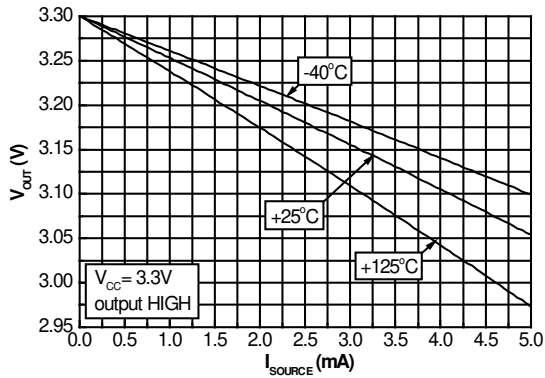


Figure 8: Output voltage vs. sink current, $V_{CC} = 3.3\text{ V}$

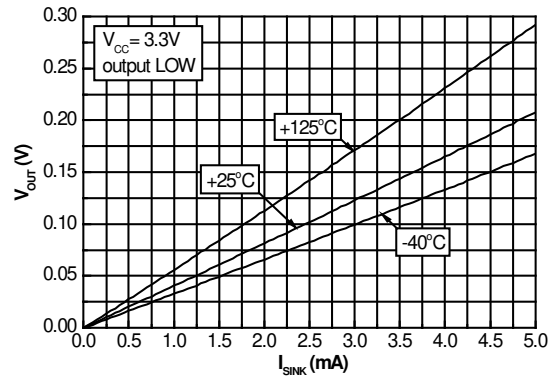


Figure 9: Output voltage vs. source current, $V_{CC} = 5\text{ V}$

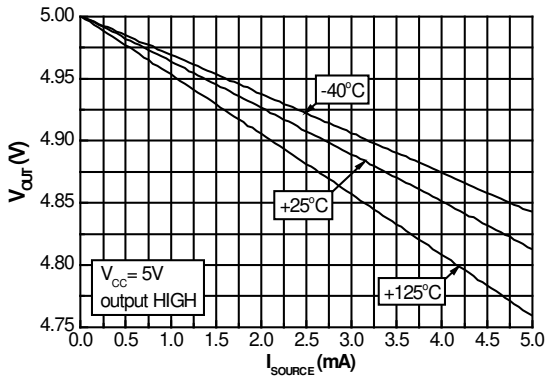


Figure 10: Output voltage vs. sink current, $V_{CC} = 5\text{ V}$

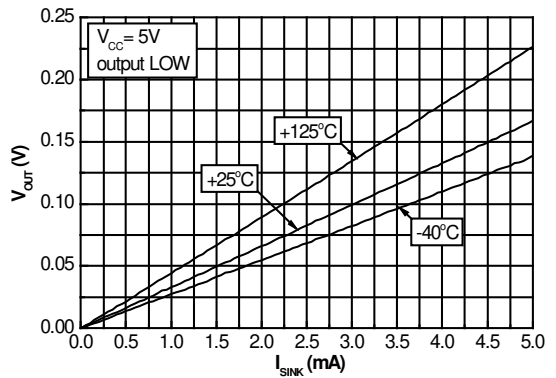


Figure 11: Input offset voltage vs. temperature and common mode voltage

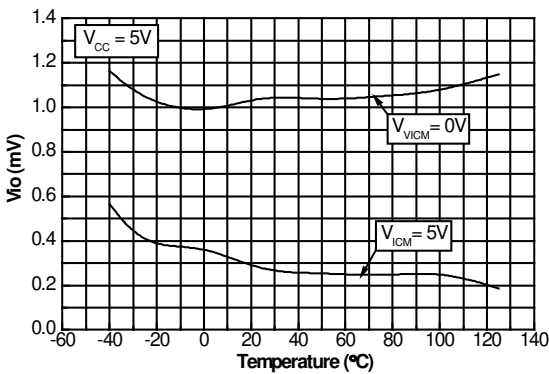


Figure 12: Input bias current vs. temperature and input voltage

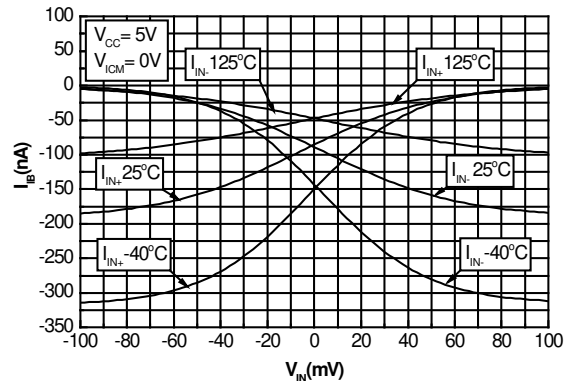


Figure 13: Current consumption vs. commutation frequency

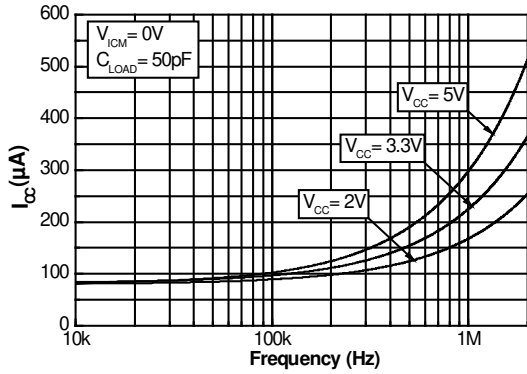


Figure 14: Propagation delay (HL) vs. overdrive at $V_{CC} = 2V$, $V_{ICM} = 0V$

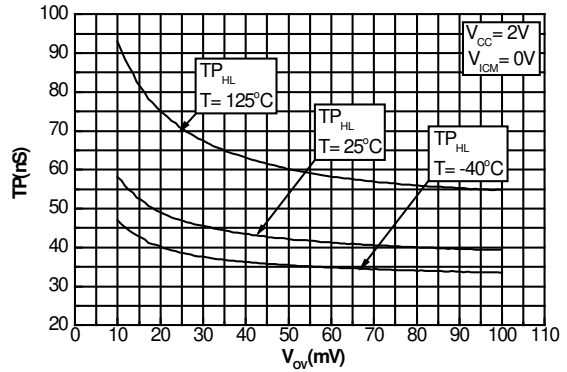


Figure 15: Propagation delay (HL) vs. overdrive at $V_{CC} = 2V$, $V_{ICM} = V_{CC}$

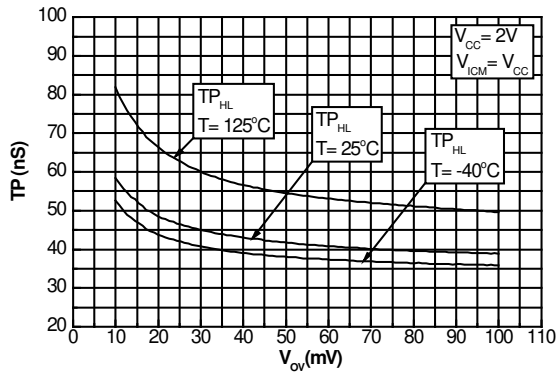


Figure 16: Propagation delay (LH) vs. overdrive at $V_{CC} = 2V$, $V_{ICM} = 0V$

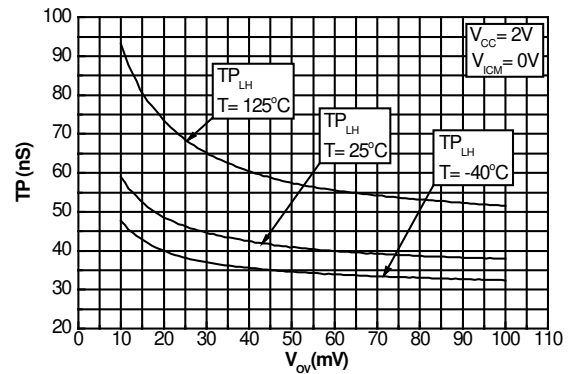


Figure 17: Propagation delay (LH) vs. overdrive at $V_{CC} = 2V$, $V_{ICM} = V_{CC}$

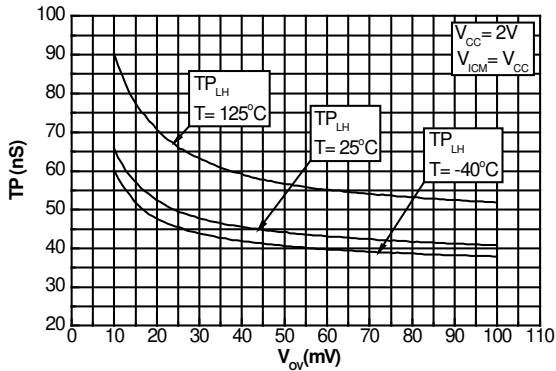


Figure 18: Propagation delay (HL) vs. overdrive at $V_{CC} = 3.3V$, $V_{ICM} = 0V$

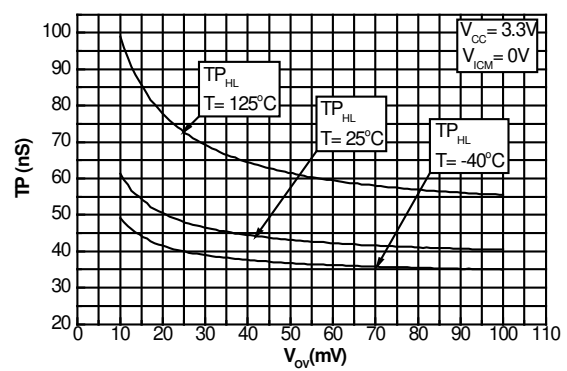


Figure 19: Propagation delay (HL) vs. overdrive at $V_{CC} = 3.3\text{ V}$, $V_{ICM} = V_{CC}$

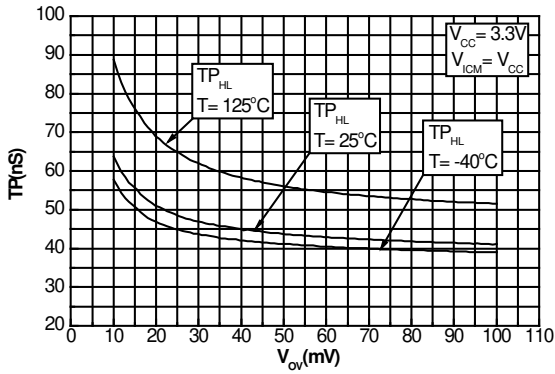


Figure 20: Propagation delay (LH) vs. overdrive at $V_{CC} = 3.3\text{ V}$, $V_{ICM} = 0\text{ V}$

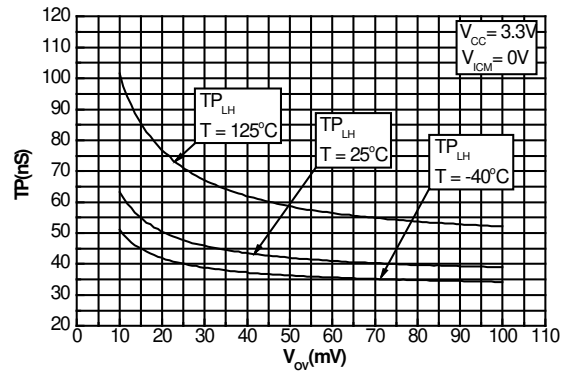


Figure 21: Propagation delay (LH) vs. overdrive at $V_{CC} = 3.3\text{ V}$, $V_{ICM} = V_{CC}$

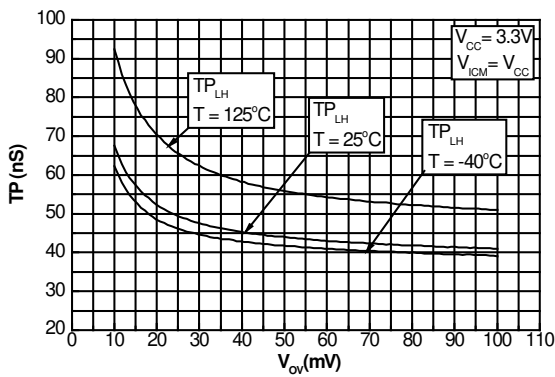


Figure 22: Propagation delay (HL) vs. overdrive at $V_{CC} = 5\text{ V}$, $V_{ICM} = 0\text{ V}$

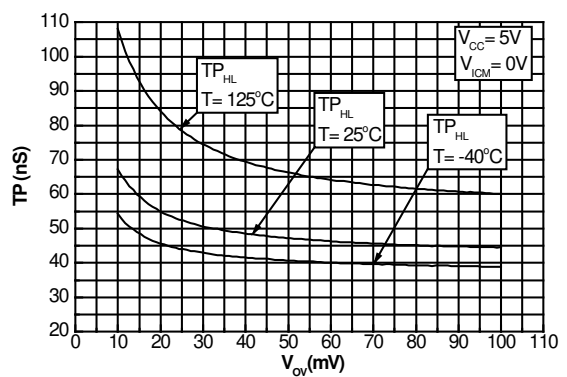


Figure 23: Propagation delay (HL) vs. overdrive at $V_{CC} = 5\text{ V}$, $V_{ICM} = V_{CC}$

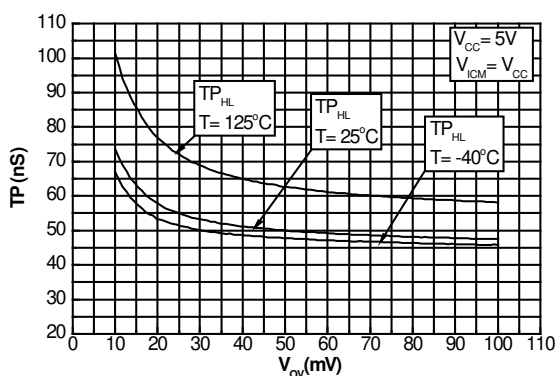
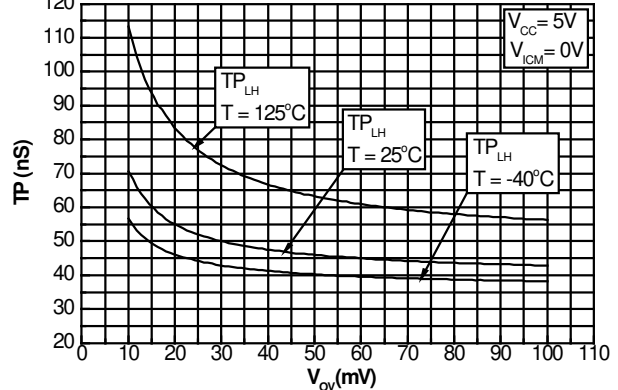
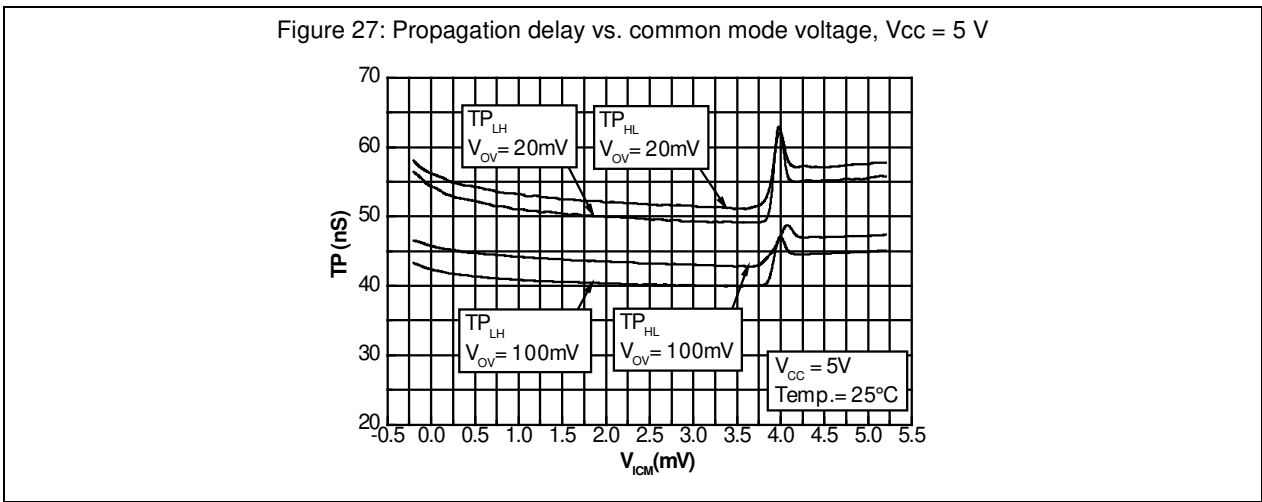
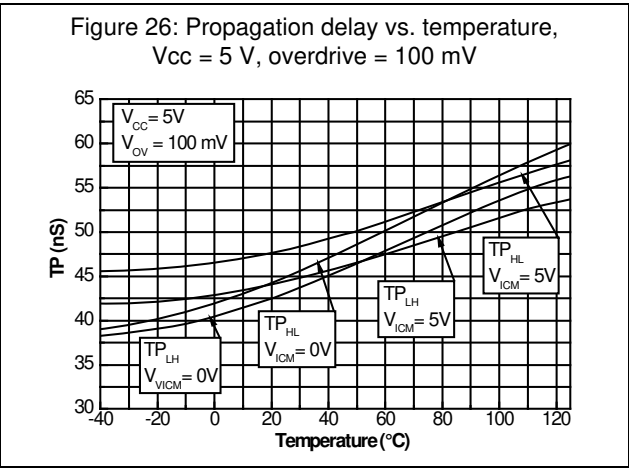
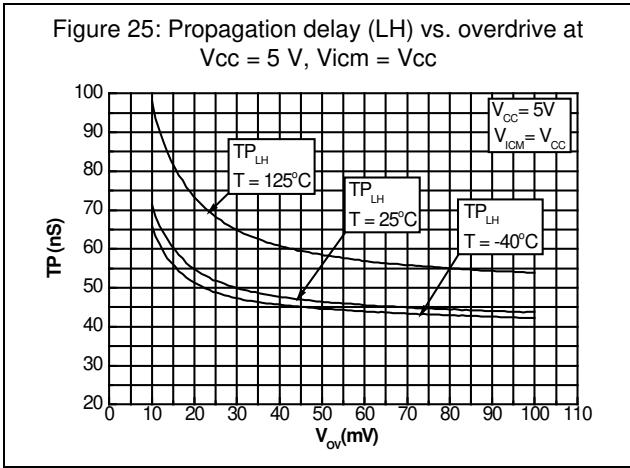


Figure 24: Propagation delay (LH) vs. overdrive at $V_{CC} = 5\text{ V}$, $V_{ICM} = 0\text{ V}$





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

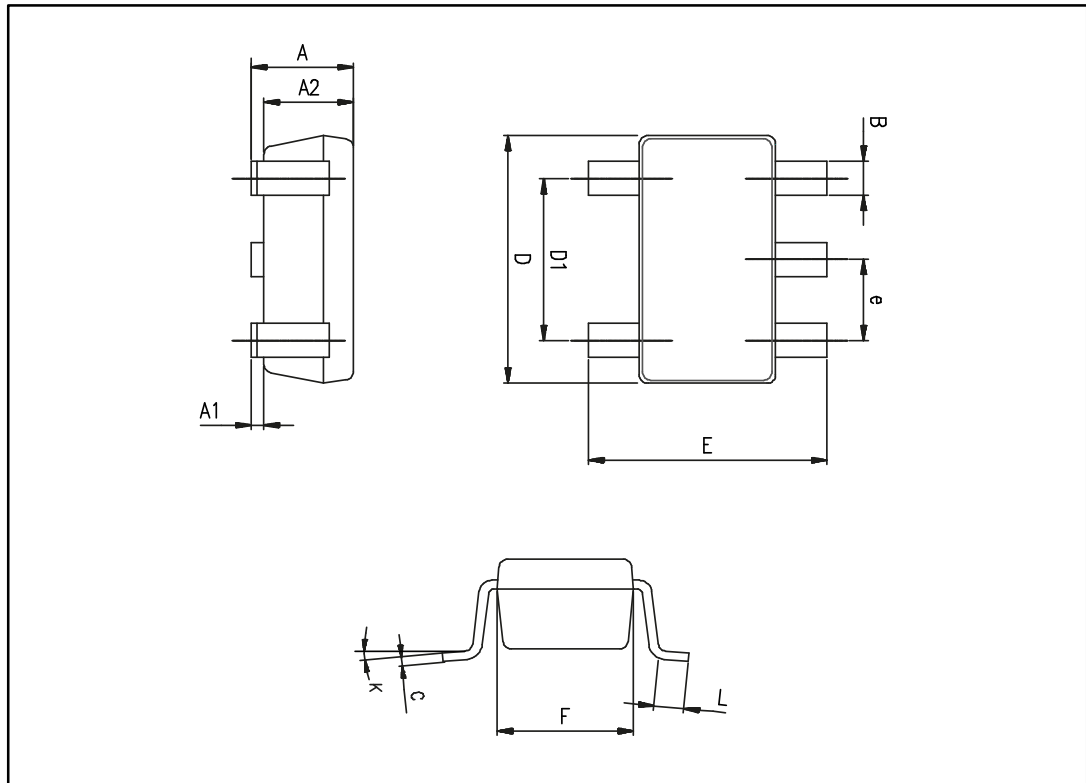


Table 6: SOT23-5 mechanical data

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

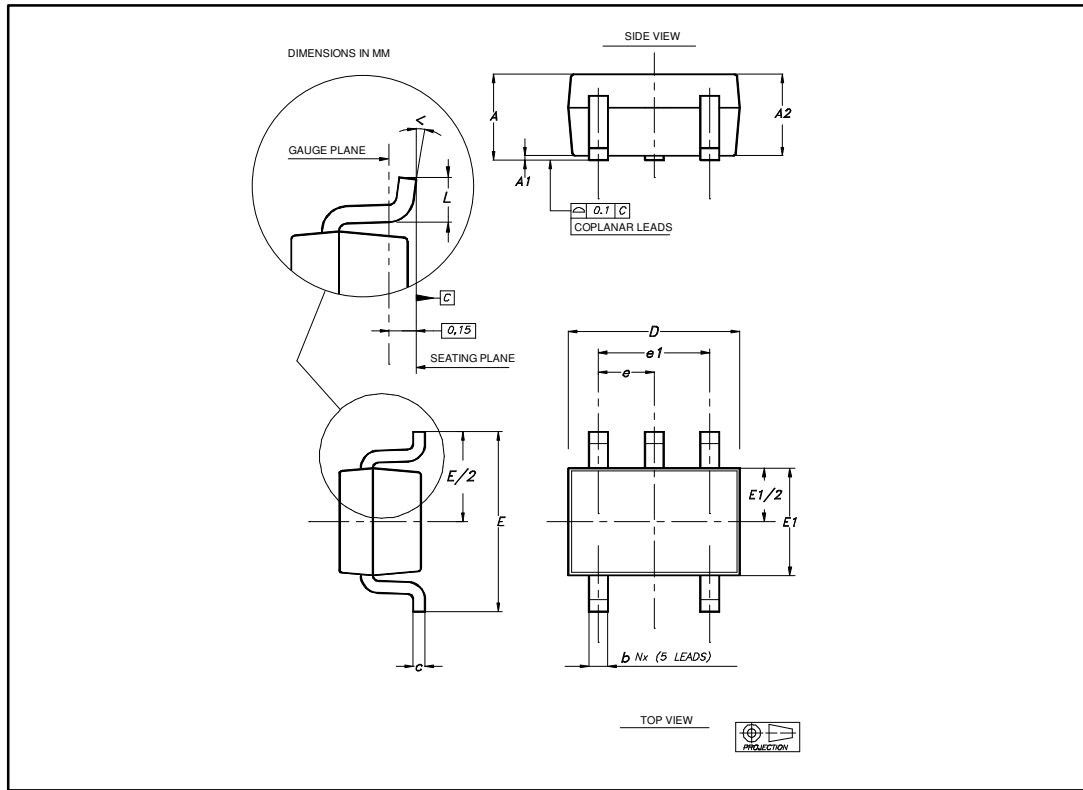


Table 7: SC70-5 (or SOT323-5) mechanical data

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
TS3021AILT		SOT23-5		K522

Notes:

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

6 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 T_{PHl} and T_{PLh} 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
02-Jun-2015	7	Table 3, Table 4, and Table 5: updated V_{io} 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 V_{io} test conditions and values.

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