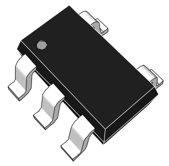
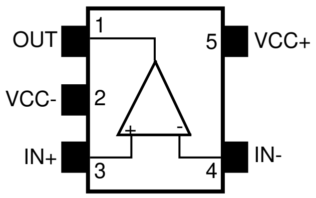
TS3021H

Automotive rail-to-rail 1.8 V high-speed comparator

Datasheet - production data



SOT23-5



Features

- AEC-Q100 and Q003 qualified
- Extended temperature range: -40 °C to 150 °C
- Propagation delay: 38 ns
- Low current consumption: 73 µA
- Rail-to-rail inputs
- Push-pull outputs
- Supply operation from 1.8 to 5 V
- High ESD tolerance: 5 kV HBM, 300 V MM
- Latch-up immunity: 200 mA
- SMD package

Related products

- TS3021 for standard temperature range (-40 °C to 125 °C)

Applications

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

Description

The TS3021H 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 150 °C.

The TS3021H 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 TS3021H includes push-pull outputs and is available in the small SOT23-5 package.

Contents

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 $(V_{CC+}) + 0.3$	
I_{IN}	Input current (3)	10	mA
R_{thja}	Thermal resistance junction-to-ambient (4)	250	°C/W
R_{thjc}	Thermal resistance junction-to-case (4)	81	
T_{stg}	Storage temperature	-65 to 160	°C
T_j	Junction temperature	160	
T_{LEAD}	Lead temperature (soldering 10 s)	260	
ESD	HBM: human body model (5)	5000	V
	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)The input current must be limited by a resistor in series with the inputs.

(4)Short circuits can cause excessive heating. These values are typical

(5)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.

(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 < 150 °C	1.8 to 5	V
		-40 °C < Tamb < 150 °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 < 150 °C	(V_{CC-}) to (V_{CC+})	
T_{oper}	Operating temperature range		-40 to 150	°C

2 Electrical characteristics

Table 3: Electrical characteristics at VCC = 2 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	Tamb		0.5	6	mV
		-40 °C < Tamb < 150 °C		0.5	7	
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40 °C < Tamb < 150 °C		3	20	µV/°C
I_{IO}	Input offset current [2]	Tamb		1	20	nA
		-40 °C < Tamb < 150 °C			100	
I_{IB}	Input bias current [2]	Tamb		86	160	
		-40 °C < Tamb < 150 °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 < 150 °C			115	
		No load, output low, Vicm = 0 V		84	105	
		No load, output low, Vicm = 0 V, -40 °C < Tamb < 150 °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 < 150 °C	1.79			
V_{OL}	Output voltage low	Isink = 1 mA		60	100	mV
		-40 °C < Tamb < 150 °C			170	
CMRR	Common-mode rejection ratio	0 < Vicm < 2 V		67		dB
SVR	Supply voltage rejection	ΔVcc = 2 to 5 V, Vicm = 0 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 = 100 mV, -40 °C < Tamb < 150 °C			120	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		48	75	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV, -40 °C < Tamb < 150 °C			140	

Symbol	Parameter	Test conditions [1]	Min.	Typ.	Max.	Unit
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 = 100 mV, -40 °C < Tamb < 150 °C			120	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		49	75	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV, -40 °C < Tamb < 150 °C			140	
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		

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.

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	Tamb		0.2	6	mV
		-40 °C < Tamb < 150 °C		0.2	7	
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40 °C < Tamb < 150 °C		3	20	µV/°C
I_{IO}	Input offset current [2]	Tamb		1	20	nA
		-40 °C < Tamb < 150 °C			100	
I_{IB}	Input bias current [2]	Tamb		86	160	
		-40 °C < Tamb < 150 °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 < 150 °C			120	
		No load, output low, Vicm = 0 V		86	110	
		No load, output low, Vicm = 0 V, -40 °C < Tamb < 150 °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 < 150 °C	3.16			
V_{OL}	Output voltage low	Isink = 1 mA		40	80	mV
		-40 °C < Tamb < 150 °C			120	
CMRR	Common-mode rejection ratio	0 < Vicm < 3.3 V		75		dB
SVR	Supply voltage rejection	ΔVcc = 2 to 5 V, Vicm = 0 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 = 100 mV, -40 °C < Tamb < 150 °C			115	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		50	85	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV, -40 °C < Tamb < 150 °C			145	

Symbol	Parameter	Test conditions [(1)]	Min.	Typ.	Max.	Unit
TP_{HL}	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 = 100 mV, -40 °C < Tamb < 150 °C			115	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		51	80	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV, -40 °C < Tamb < 150 °C			145	
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-) = 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 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	Tamb		0.2	6	mV
		-40 °C < Tamb < 150 °C		0.2	7	
$\Delta V_{io}/\Delta T$	Input offset voltage drift	-40 °C < Tamb < 150 °C		3	20	µV/°C
I_{IO}	Input offset current (2)	Tamb		1	20	nA
		-40 °C < Tamb < 150 °C			100	
I_{IB}	Input bias current (2)	Tamb		86	160	
		-40 °C < Tamb < 150 °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 < 150 °C			125	
		No load, output low, Vicm = 0 V		89	115	
		No load, output low, Vicm = 0 V, -40 °C < Tamb < 150 °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 < 150 °C	4.68			
V_{OL}	Output voltage low	Isink = 4 mA		130	180	mV
		-40 °C < Tamb < 150 °C			270	
CMRR	Common-mode rejection ratio	0 < Vicm < 5 V		79		dB
SVR	Supply voltage rejection	∆Vcc = 2 to 5 V, Vicm = 0 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 = 100 mV, -40 °C < Tamb < 150 °C			120	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		54	105	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV, -40 °C < Tamb < 150 °C			150	

Symbol	Parameter	Test conditions (1)	Min.	Typ.	Max.	Unit
TP_{HL}	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 = 100 mV, -40 °C < Tamb < 150 °C			120	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV		55	95	
		Vicm = 0 V, f = 10 kHz, CL = 50 pF, overdrive = 20 mV, -40 °C < Tamb < 150 °C			150	
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.

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

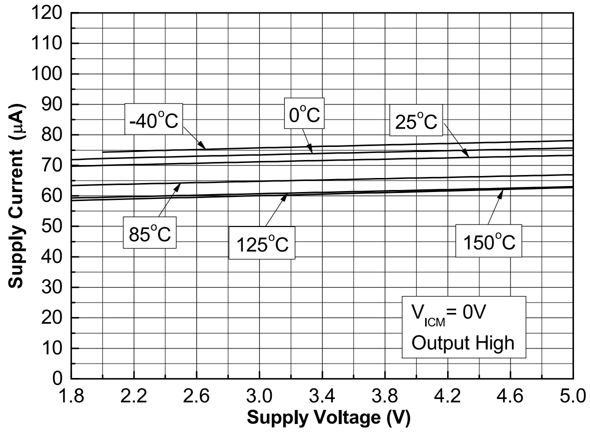


Figure 2: Current consumption vs. supply voltage (Vicm = Vcc output high)

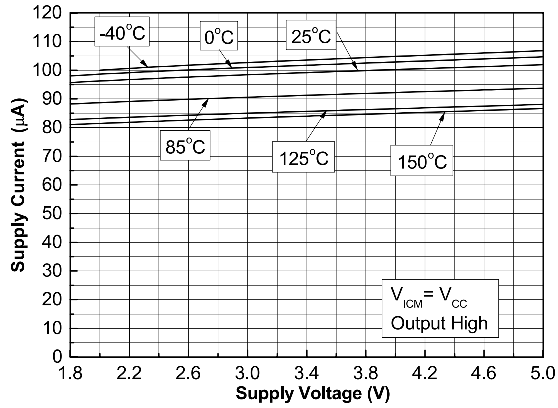


Figure 3: Current consumption vs. supply voltage (Vicm = 0 V, output low)

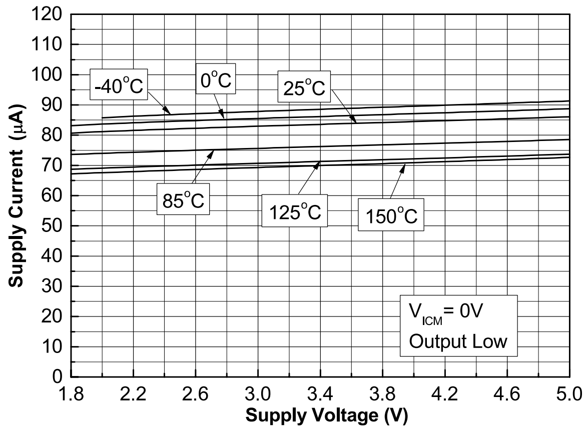


Figure 4: Current consumption vs. supply voltage (Vicm = Vcc output low)

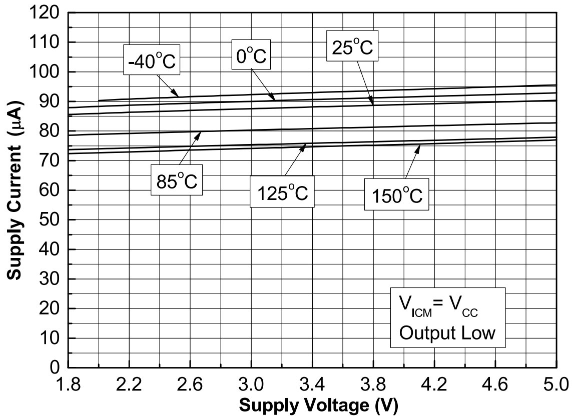


Figure 5: Output voltage vs. source current, Vcc = 2 V

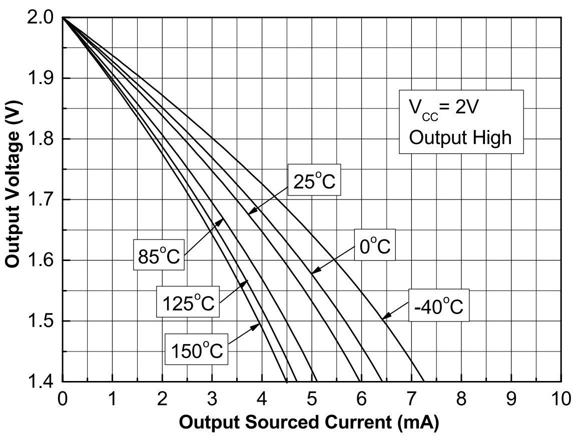


Figure 6: Output voltage vs. sink current, Vcc = 2 V

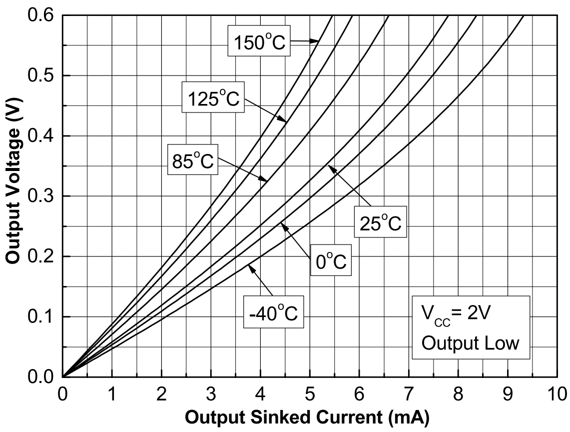


Figure 7: Output voltage vs. source current, Vcc = 3.3 V

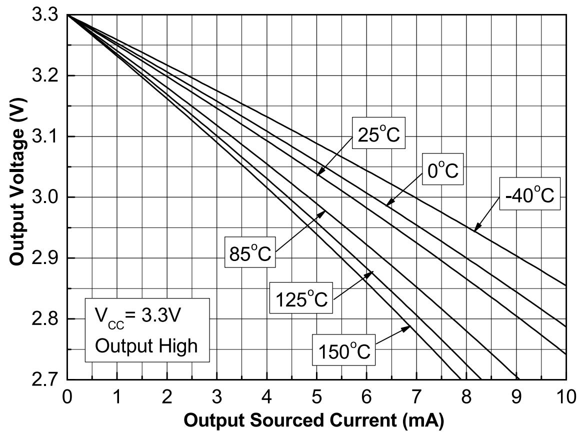


Figure 8: Output voltage vs. sink current, Vcc = 3.3 V

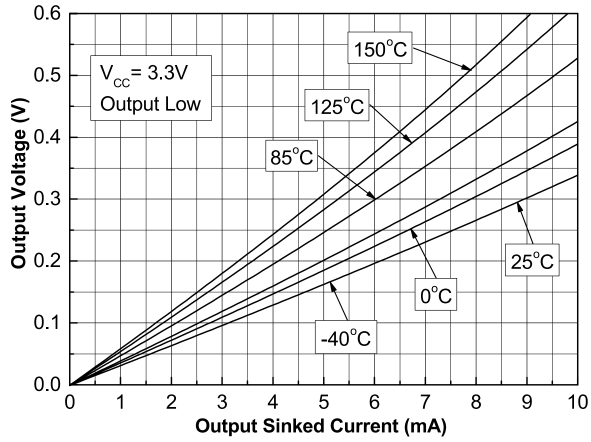


Figure 9: Output voltage vs. source current, Vcc = 5 V

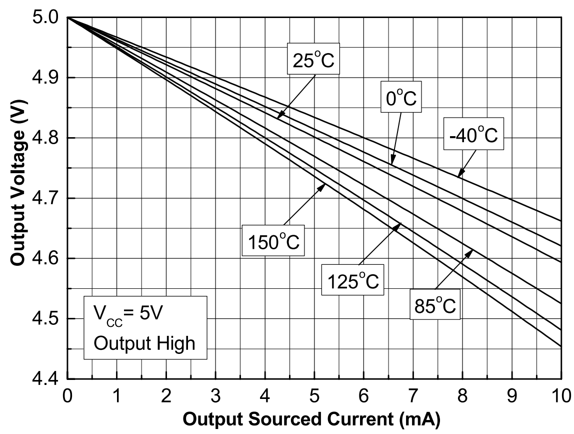


Figure 10: Output voltage vs. sink current, Vcc = 5 V

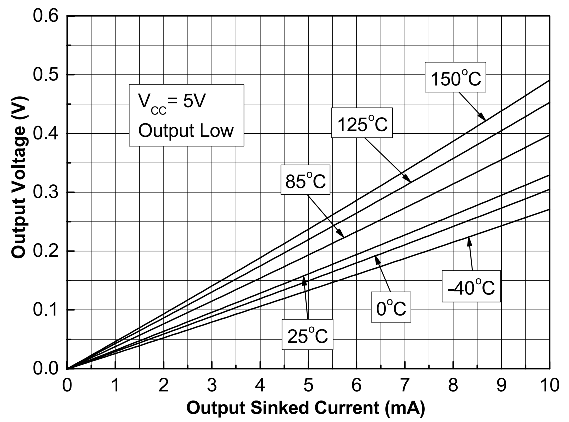


Figure 11: Input offset voltage vs. input common-mode voltage and temperature

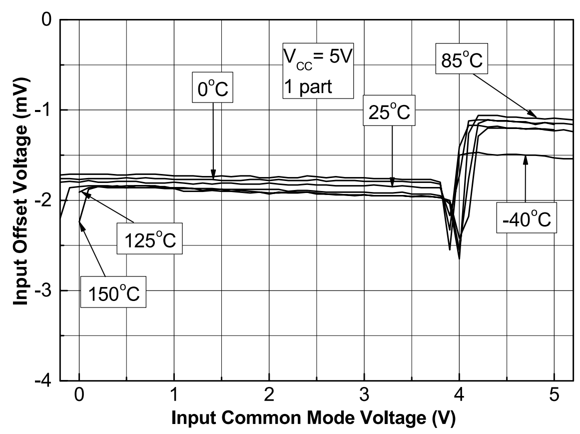


Figure 12: Input bias current vs. input differential voltage and temperature

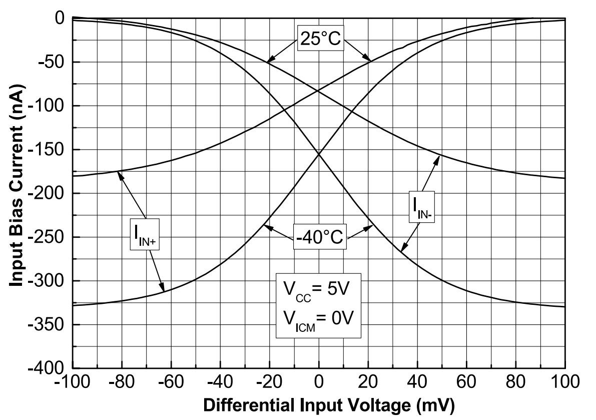


Figure 13: Input bias current vs. input common-mode voltage

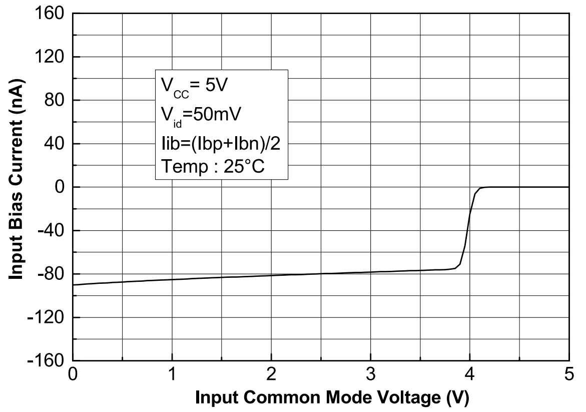


Figure 14: Input bias current vs. temperature

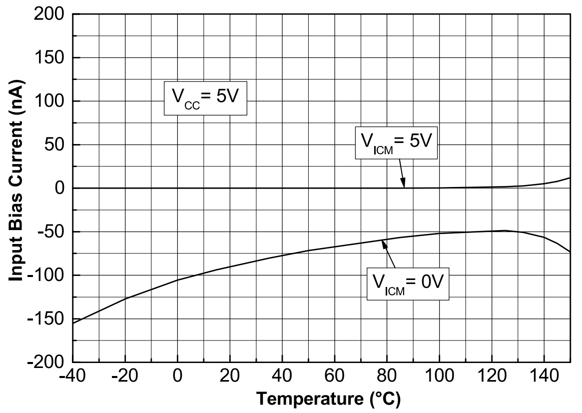


Figure 15: Current consumption vs. commutation frequency

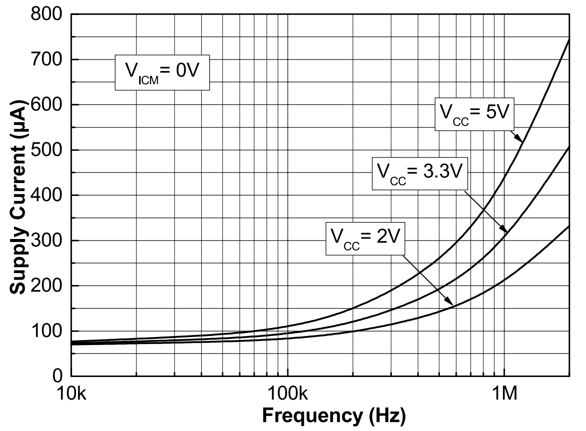


Figure 16: Propagation delay (HL) vs. overdrive at Vcc = 2 V, Vicm = 0 V

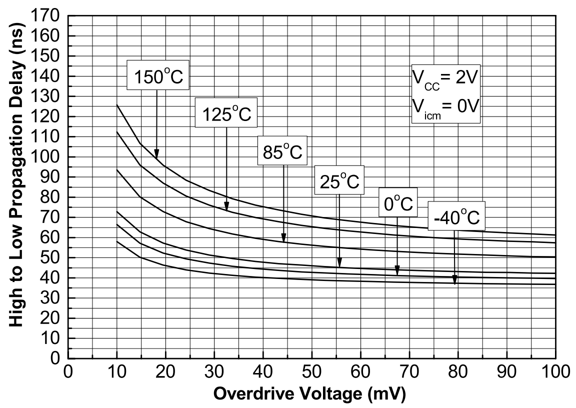


Figure 17: Propagation delay (HL) vs. overdrive at Vcc = 2 V, Vicm = Vcc

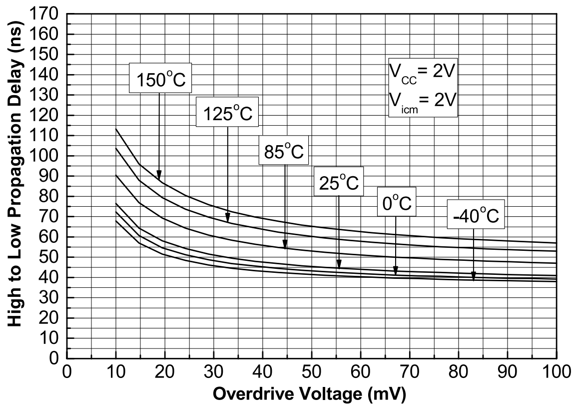


Figure 18: Propagation delay (LH) vs. overdrive at Vcc = 2 V, Vicm = 0 V

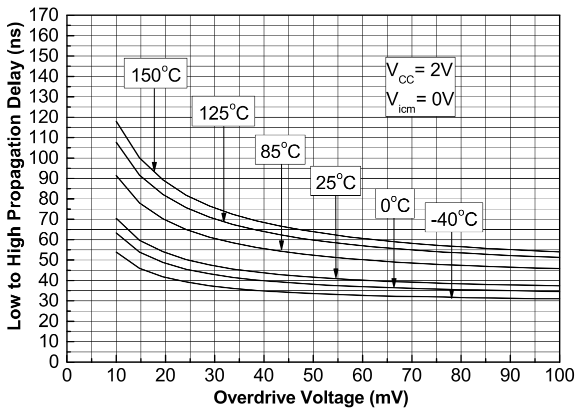


Figure 19: Propagation delay (LH) vs. overdrive at Vcc = 2 V, Vicm = Vcc

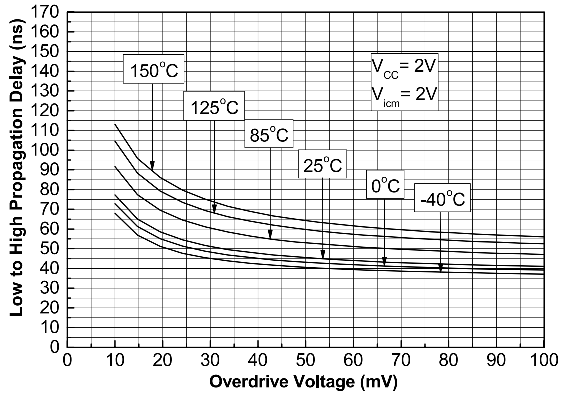


Figure 20: Propagation delay (HL) vs. overdrive at Vcc = 3.3 V, Vicm = 0 V

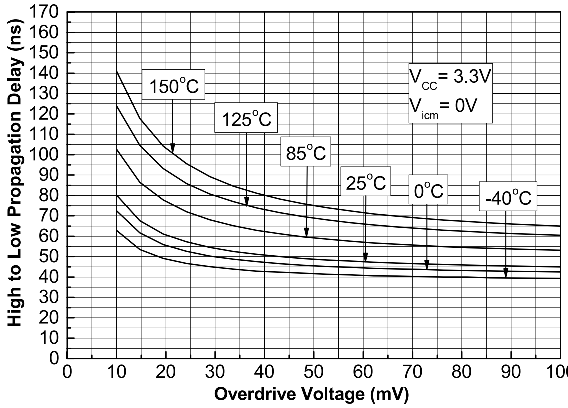


Figure 21: Propagation delay (HL) vs. overdrive at Vcc = 3.3 V, Vicm = Vcc

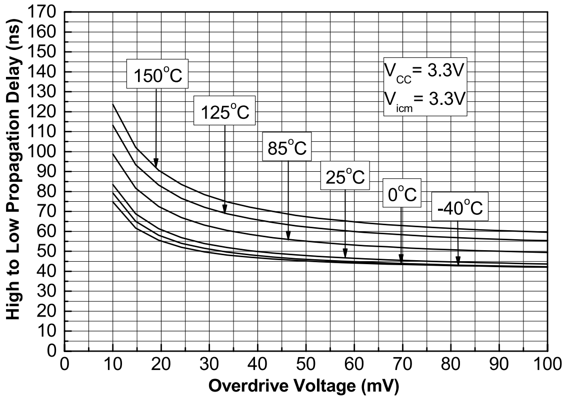


Figure 22: Propagation delay (LH) vs. overdrive at Vcc = 3.3 V, Vicm = 0 V

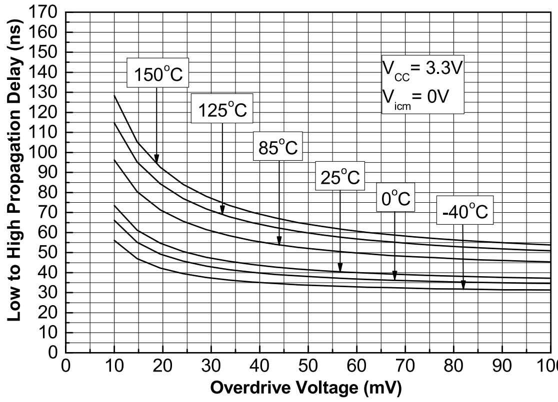


Figure 23: Propagation delay (LH) vs. overdrive at Vcc = 3.3 V, Vicm = Vcc

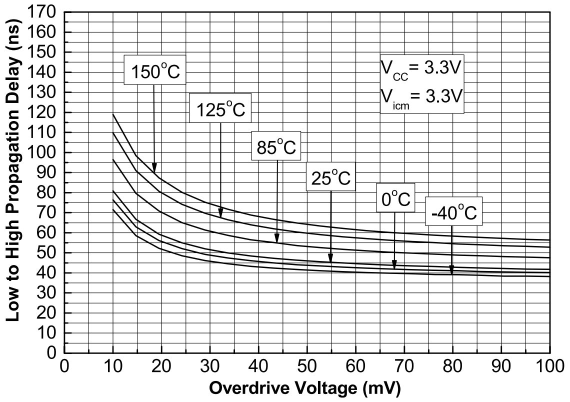


Figure 24: Propagation delay (HL) vs. overdrive at Vcc = 5 V, Vicm = 0 V

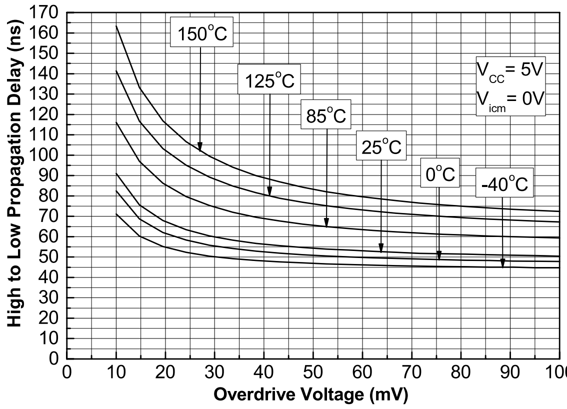


Figure 25: Propagation delay (HL) vs. overdrive at Vcc = 5 V, Vicm = Vcc

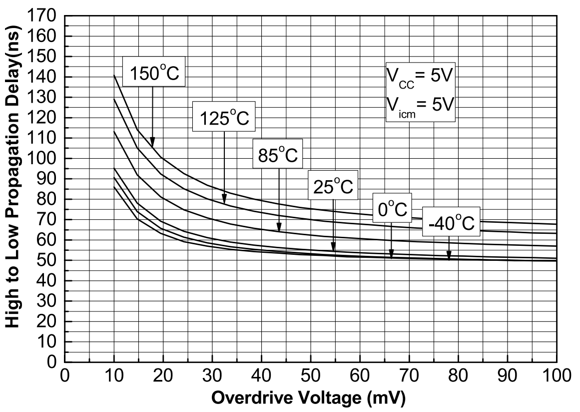


Figure 26: Propagation delay (LH) vs. overdrive at Vcc = 5 V, Vicm = 0 V

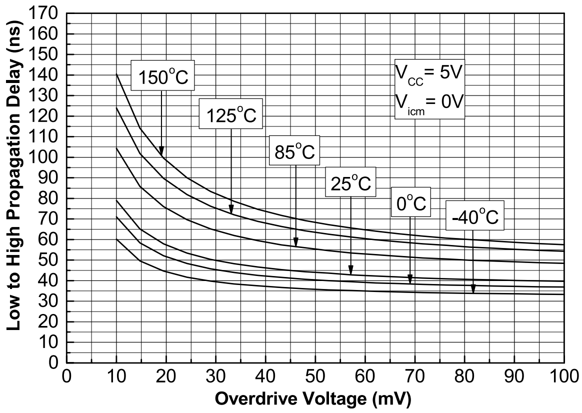


Figure 27: Propagation delay (LH) vs. overdrive at Vcc = 5 V, Vicm = Vcc

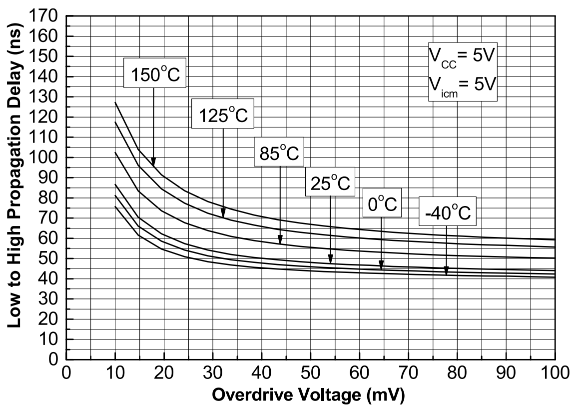


Figure 28: Propagation delay vs. temperature, Vcc = 5 V, overdrive = 100 mV

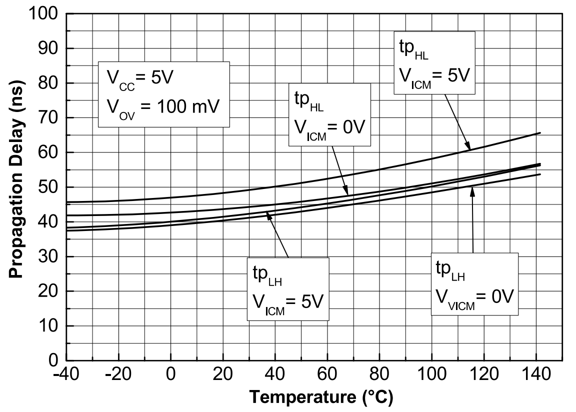
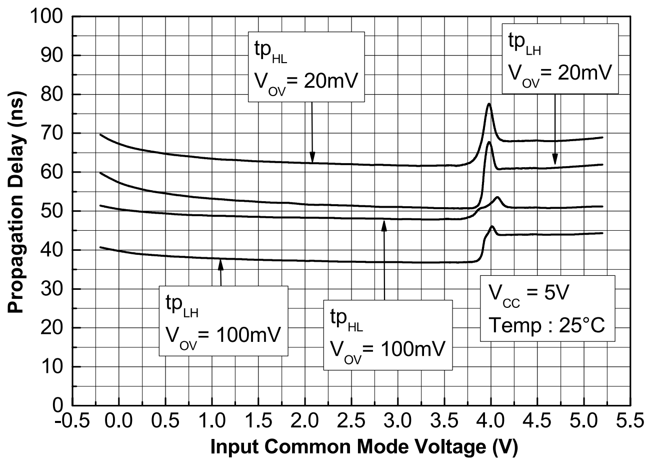


Figure 29: Propagation delay vs. common-mode voltage, Vcc = 5 V



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 information

Figure 30: SOT23-5 package outline

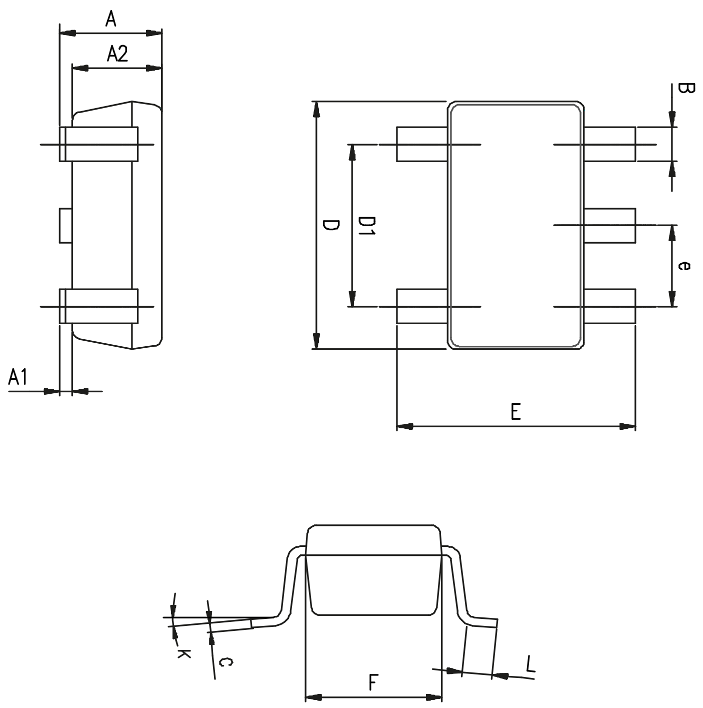


Table 6: SOT23-5 mechanical data

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 Ordering information

Table 7: Order codes

Order code	Temperature range	Package	Packaging	Marking
TS3021HIYLT [(1)]	-40 to 150 °C	SOT23-5	Tape and reel	K528

Notes:

[(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 8: Document revision history

Date	Version	Changes
13-Oct-2015	1	Initial release
24-Aug-2016	2	Updated document title (automotive qualified) Added AEC-Q100 and Q003 qualified in Features section *Table 1: "Absolute maximum ratings (AMR)"*: removed ESD MM value. *Table 7: "Order codes"*: updated footnote, product is now automotive qualified.