

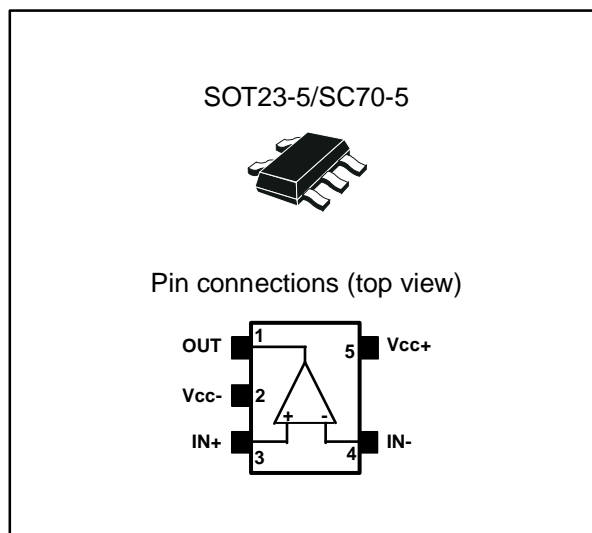


# THE DATASHEET OF TS3021AILT



**Rail-to-rail 1.8 V high-speed comparator**

Datasheet - production data

**Features**

- Propagation delay: 38 ns
- Low current consumption: 73  $\mu$ 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 <sub>CC</sub>	Supply voltage, V <sub>CC</sub> = (V <sub>CC+</sub> ) - (V <sub>CC-</sub> ) <sup>(1)</sup>	5.5	V	
V <sub>ID</sub>	Differential input voltage <sup>(2)</sup>	±5		
V <sub>IN</sub>	Input voltage range	(V <sub>CC-</sub> ) - 0.3 to (V <sub>CC+</sub> ) + 0.3		
R <sub>thja</sub>	Thermal resistance junction-to-ambient <sup>(3)</sup>	SOT23-5	250	°C/W
		SC70-5	205	
R <sub>thjc</sub>	Thermal resistance junction-to-case <sup>(3)</sup>	SOT23-5	81	
		SC70-5	172	
T <sub>stg</sub>	Storage temperature	-65 to 150	°C	
T <sub>j</sub>	Junction temperature	150		
T <sub>LEAD</sub>	Lead temperature (soldering 10 s)	260		
ESD	HBM: human body model <sup>(4)</sup>	5000	V	
	MM: machine model <sup>(5)</sup>	300		
	CDM: charged device model <sup>(6)</sup>	1500		
	Latch-up immunity	200	mA	

**Notes:**

<sup>(1)</sup>All voltage values, except the differential voltage are referenced to (V<sub>CC-</sub>)

<sup>(2)</sup>The magnitude of the input and output voltages must never exceed the supply rail ±0.3 V

<sup>(3)</sup>Short circuits can cause excessive heating. These values are typical

<sup>(4)</sup>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.

<sup>(5)</sup>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.

<sup>(6)</sup>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 <sub>CC</sub>	Supply voltage	0 °C < Tamb < 125 °C	1.8 to 5	V
		-40 °C < Tamb < 125 °C	2 to 5	
V <sub>icm</sub>	Common mode input voltage range	-40 °C < Tamb < 85 °C	(V <sub>CC-</sub> ) - 0.2 to (V <sub>CC+</sub> ) + 0.2	
		85 °C < Tamb < 125 °C	(V <sub>CC-</sub> ) to (V <sub>CC+</sub> )	
T <sub>oper</sub>	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  $V_{icm}$  range (unless otherwise specified)

Symbol	Parameter	Test conditions <sup>(1)</sup>	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 <sup>(2)</sup>	$T_{amb}$		1	20	nA
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$			100	
$I_{IB}$	Input bias current <sup>(2)</sup>	$T_{amb}$		86	160	nA
		$-40\text{ °C} < T_{amb} < 125\text{ °C}$			300	
$I_{CC}$	Supply current	No load, output high, $V_{icm} = 0\text{ V}$		73	90	$\mu\text{A}$
		No load, output high, $V_{icm} = 0\text{ V}$ , $-40\text{ °C} < T_{amb} < 125\text{ °C}$			115	
		No load, output low, $V_{icm} = 0\text{ V}$		84	105	
		No load, output low, $V_{icm} = 0\text{ V}$ , $-40\text{ °C} < T_{amb} < 125\text{ °C}$			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	$0 < V_{icm} < 2\text{ V}$		67		dB
SVR	Supply voltage rejection	$\Delta V_{CC} = 2\text{ to }5\text{ V}$	58	73		
$T_{PLH}$	Propagation delay, low to high output level <sup>(3)</sup>	$V_{icm} = 0\text{ V}$ , $f = 10\text{ kHz}$ , $CL = 50\text{ pF}$ , overdrive = 100 mV		38	60	ns
		$V_{icm} = 0\text{ V}$ , $f = 10\text{ kHz}$ , $CL = 50\text{ pF}$ , overdrive = 20 mV		48	75	
$T_{PHL}$	Propagation delay, high to low output level <sup>(4)</sup>	$V_{icm} = 0\text{ V}$ , $f = 10\text{ kHz}$ , $CL = 50\text{ pF}$ , overdrive = 100 mV		40	60	ns
		$V_{icm} = 0\text{ V}$ , $f = 10\text{ kHz}$ , $CL = 50\text{ pF}$ , overdrive = 20 mV		49	75	
$T_F$	Fall time	$f = 10\text{ kHz}$ , $CL = 50\text{ pF}$ , $RL = 10\text{ k}\Omega$ , overdrive = 100 mV		8		
$T_R$	Rise time	$f = 10\text{ kHz}$ , $CL = 50\text{ pF}$ , $RL = 10\text{ k}\Omega$ , overdrive = 100 mV		9		

**Notes:**

<sup>(1)</sup>All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits

<sup>(2)</sup>Maximum values include unavoidable inaccuracies of the industrial tests

<sup>(3)</sup>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  $V_{icm} + \text{overdrive}$ .

<sup>(4)</sup>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 <sup>(1)</sup>	Min.	Typ.	Max.	Unit
V <sub>IO</sub>	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 <sub>IO</sub> /ΔT	Input offset voltage drift	-40 °C < Tamb < 125 °C		3	20	μV/°C
I <sub>IO</sub>	Input offset current <sup>(2)</sup>	Tamb		1	20	nA
		-40 °C < Tamb < 125 °C			100	
I <sub>IB</sub>	Input bias current <sup>(2)</sup>	Tamb		86	160	nA
		-40 °C < Tamb < 125 °C			300	
I <sub>CC</sub>	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 <sub>SC</sub>	Short-circuit current	Source		26		mA
		Sink		24		
V <sub>OH</sub>	Output voltage high	I <sub>source</sub> = 1 mA	3.20	3.25		V
		-40 °C < Tamb < 125 °C	3.10			
V <sub>OL</sub>	Output voltage low	I <sub>sink</sub> = 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 <sub>CC</sub> = 2 to 5 V	58	73		
T <sub>PLH</sub>	Propagation delay, low to high output level <sup>(3)</sup>	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 <sub>PHL</sub>	Propagation delay, high to low output level <sup>(4)</sup>	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 <sub>F</sub>	Fall time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		5		
T <sub>R</sub>	Rise time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		7		

**Notes:**

<sup>(1)</sup>All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits

<sup>(2)</sup>Maximum values include unavoidable inaccuracies of the industrial tests

<sup>(3)</sup>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.

<sup>(4)</sup>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 <sup>(1)</sup>	Min.	Typ.	Max.	Unit
V <sub>IO</sub>	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 <sub>IO</sub> /ΔT	Input offset voltage drift	-40 °C < Tamb < 125 °C		3	20	μV/°C
I <sub>IO</sub>	Input offset current <sup>(2)</sup>	Tamb		1	20	nA
		-40 °C < Tamb < 125 °C			100	
I <sub>IB</sub>	Input bias current <sup>(2)</sup>	Tamb		86	160	nA
		-40 °C < Tamb < 125 °C			300	
I <sub>CC</sub>	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 <sub>SC</sub>	Short-circuit current	Source		51		mA
		Sink		40		
V <sub>OH</sub>	Output voltage high	I <sub>source</sub> = 4 mA	4.80	4.84		V
		-40 °C < Tamb < 125 °C	4.70			
V <sub>OL</sub>	Output voltage low	I <sub>sink</sub> = 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 <sub>CC</sub> = 2 to 5 V	58	73		
T <sub>PLH</sub>	Propagation delay, low to high output level <sup>(3)</sup>	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 <sub>PHL</sub>	Propagation delay, high to low output level <sup>(4)</sup>	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 <sub>F</sub>	Fall time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		4		
T <sub>R</sub>	Rise time	f = 10 kHz, CL = 50 pF, RL = 10 kΩ, overdrive = 100 mV		4		

**Notes:**

<sup>(1)</sup>All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits

<sup>(2)</sup>Maximum values include unavoidable inaccuracies of the industrial tests

<sup>(3)</sup>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  $V_{icm} + \text{overdrive}$ .

<sup>(4)</sup>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  $V_{icm} - \text{overdrive}$ .

### 3 Electrical characteristic curves

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

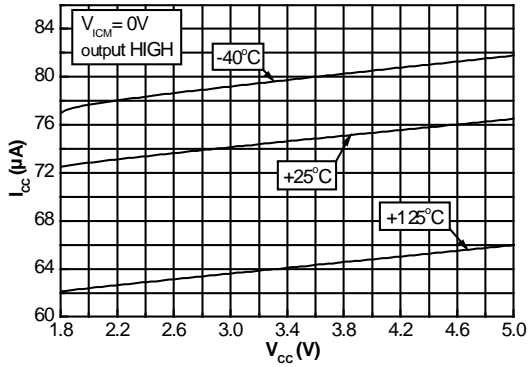


Figure 2: Current consumption vs. supply voltage  
( $V_{icm} = V_{cc}$  output high)

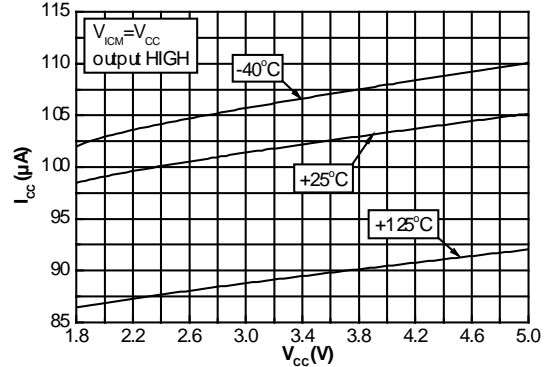


Figure 3: Current consumption vs. supply voltage  
( $V_{icm} = 0\text{ V}$ , output low)

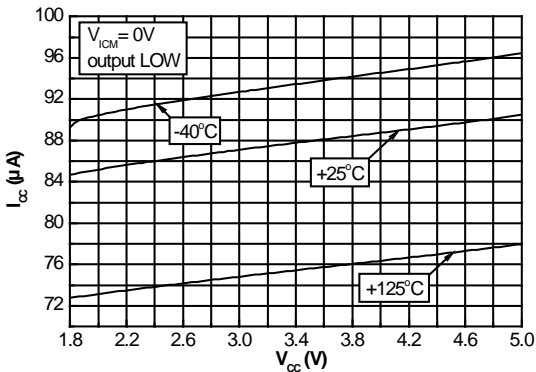


Figure 4: Current consumption vs. supply voltage  
( $V_{icm} = V_{cc}$  output low)

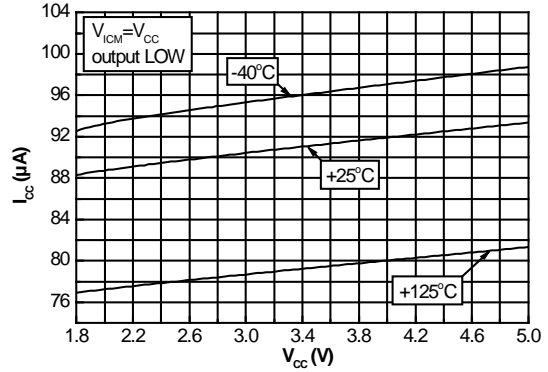


Figure 5: Output voltage vs. source current,  $V_{cc} = 2\text{ V}$

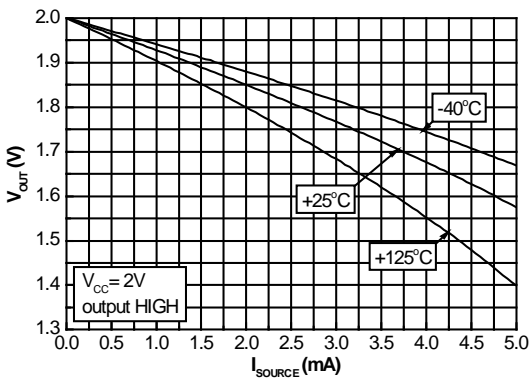


Figure 6: Output voltage vs. sink current,  $V_{cc} = 2\text{ V}$

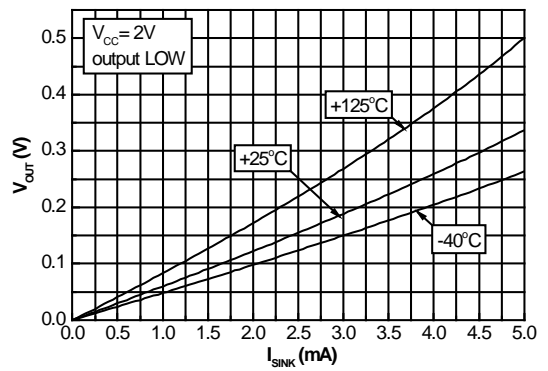


Figure 7: Output voltage vs. source current,  $V_{CC} = 3.3\text{ V}$

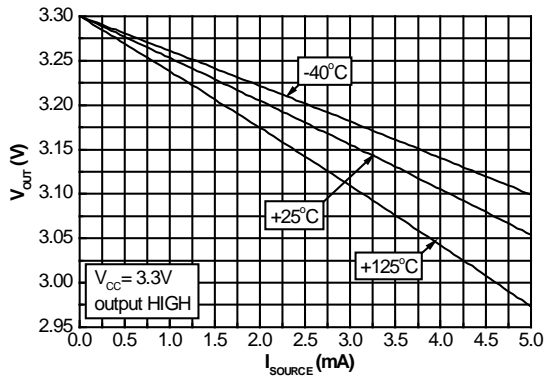


Figure 8: Output voltage vs. sink current,  $V_{CC} = 3.3\text{ V}$

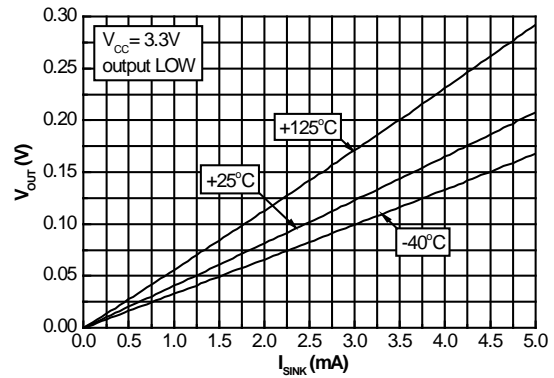


Figure 9: Output voltage vs. source current,  $V_{CC} = 5\text{ V}$

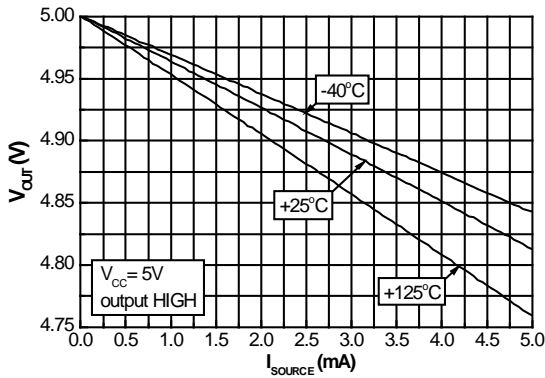


Figure 10: Output voltage vs. sink current,  $V_{CC} = 5\text{ V}$

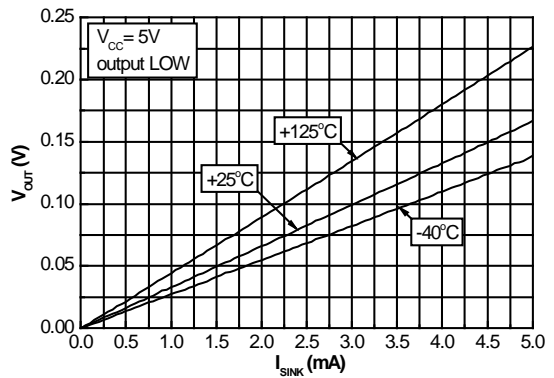


Figure 11: Input offset voltage vs. temperature and common mode voltage

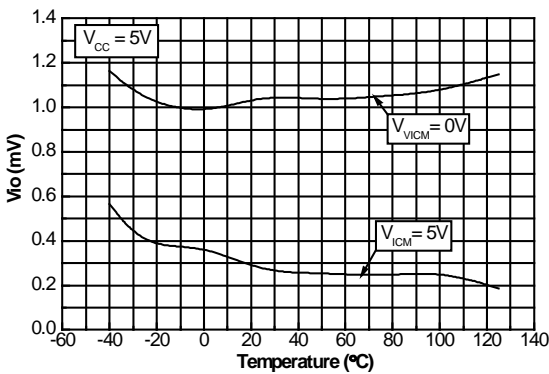


Figure 12: Input bias current vs. temperature and input voltage

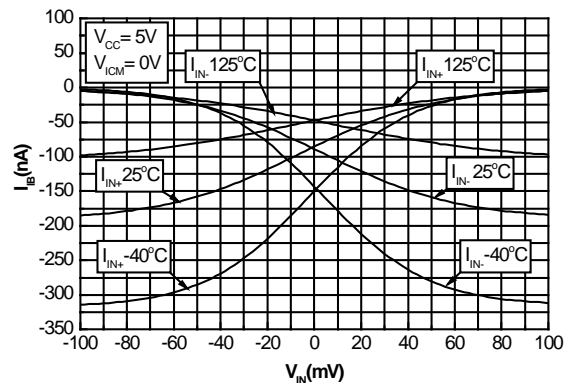


Figure 13: Current consumption vs. commutation frequency

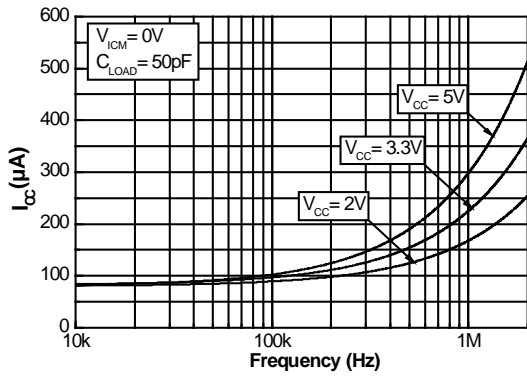


Figure 14: Propagation delay (HL) vs. overdrive at  $V_{CC} = 2V$ ,  $V_{ICM} = 0V$

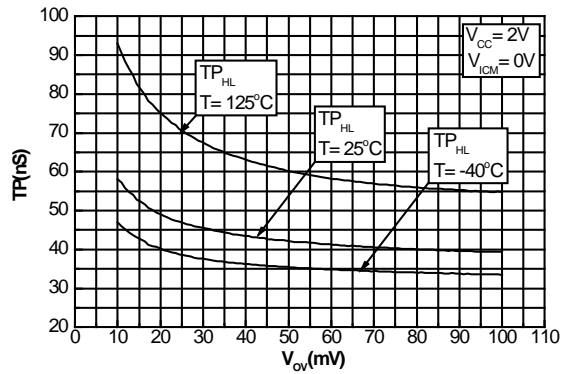


Figure 15: Propagation delay (HL) vs. overdrive at  $V_{CC} = 2V$ ,  $V_{ICM} = V_{CC}$

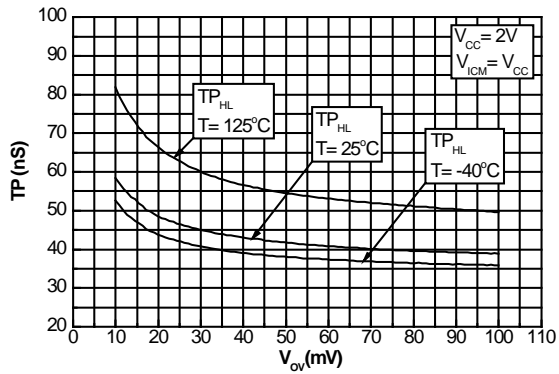


Figure 16: Propagation delay (LH) vs. overdrive at  $V_{CC} = 2V$ ,  $V_{ICM} = 0V$

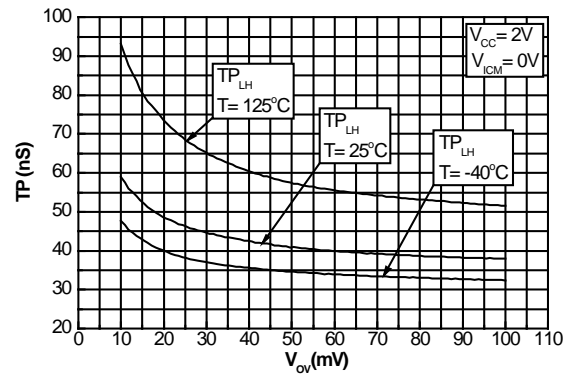


Figure 17: Propagation delay (LH) vs. overdrive at  $V_{CC} = 2V$ ,  $V_{ICM} = V_{CC}$

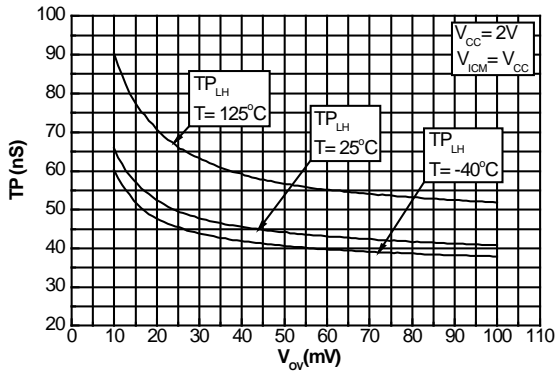
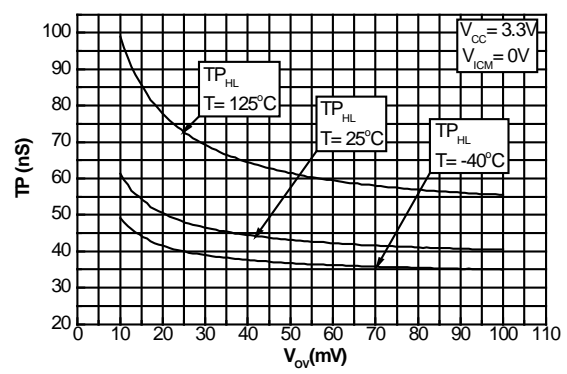
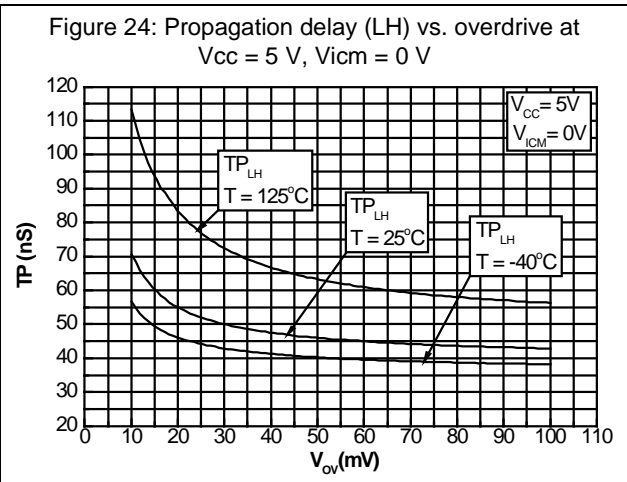
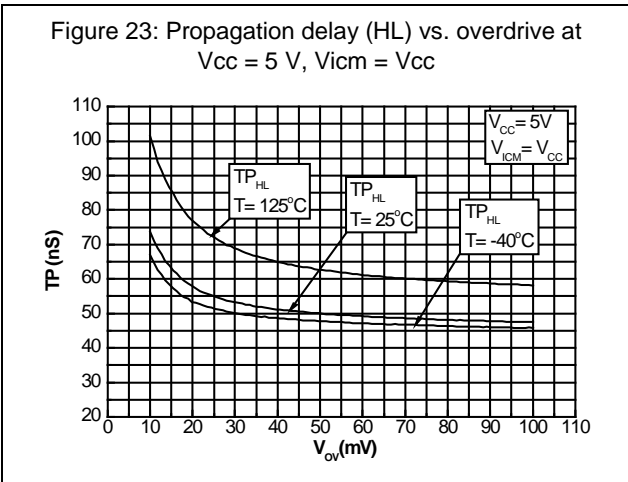
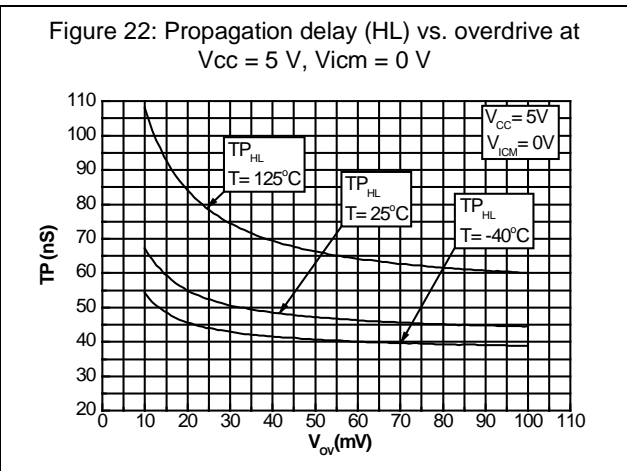
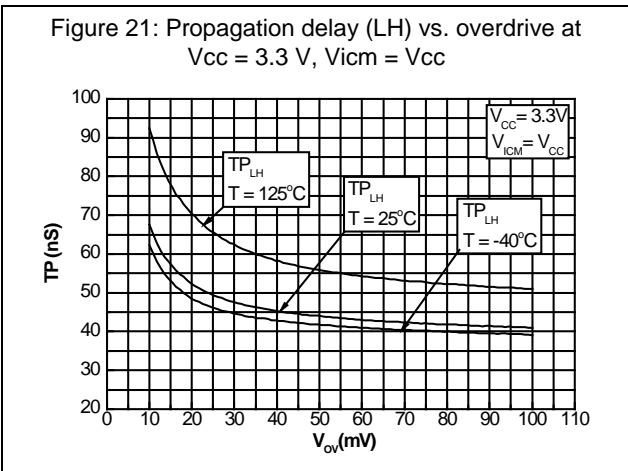
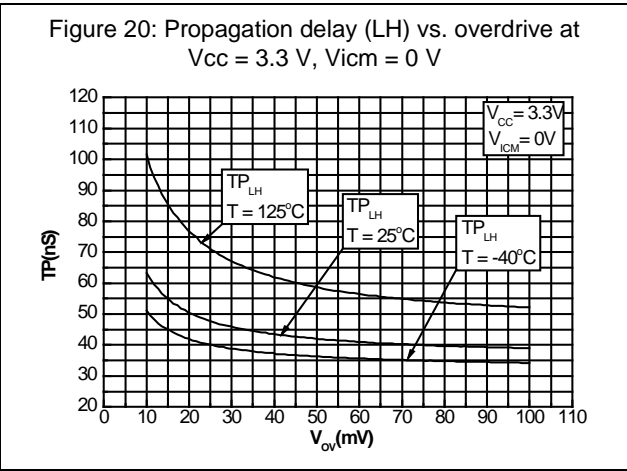
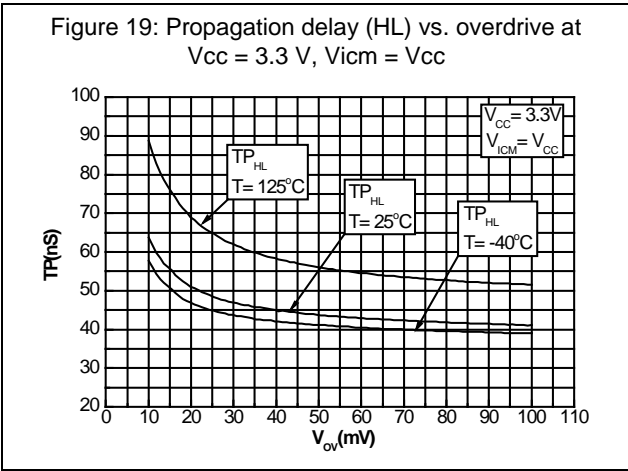
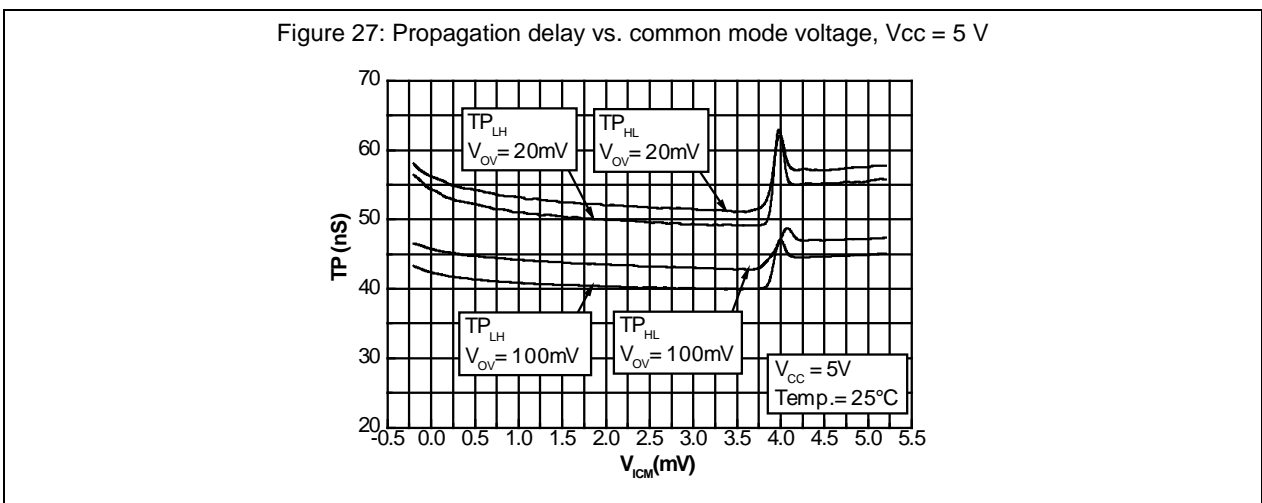
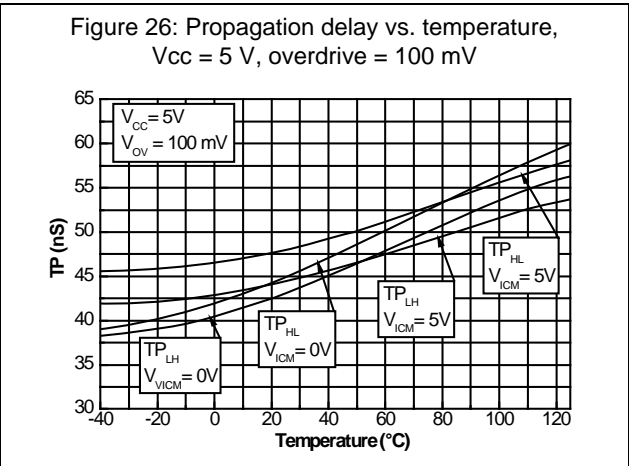
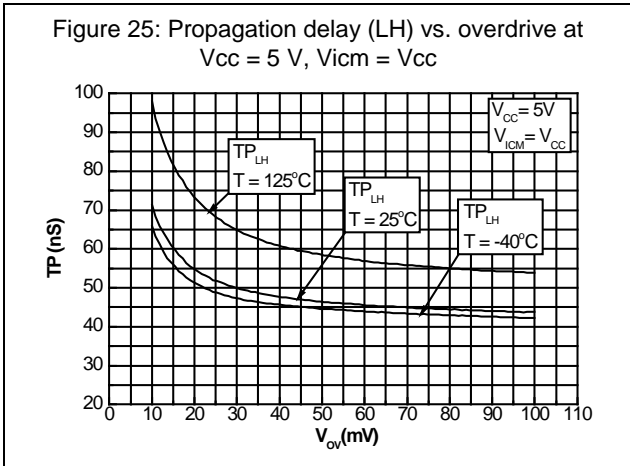


Figure 18: Propagation delay (HL) vs. overdrive at  $V_{CC} = 3.3V$ ,  $V_{ICM} = 0V$







## 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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 SOT23-5 package information

Figure 28: SOT23-5 package outline

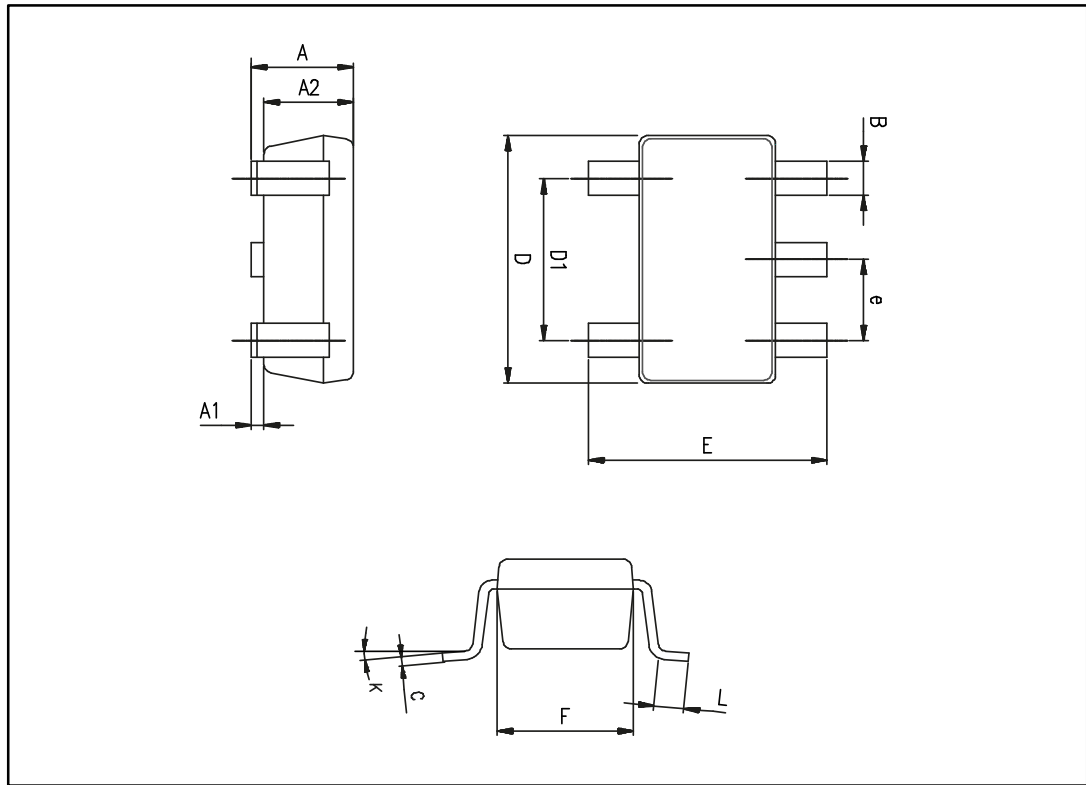


Table 6: SOT23-5 mechanical data

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

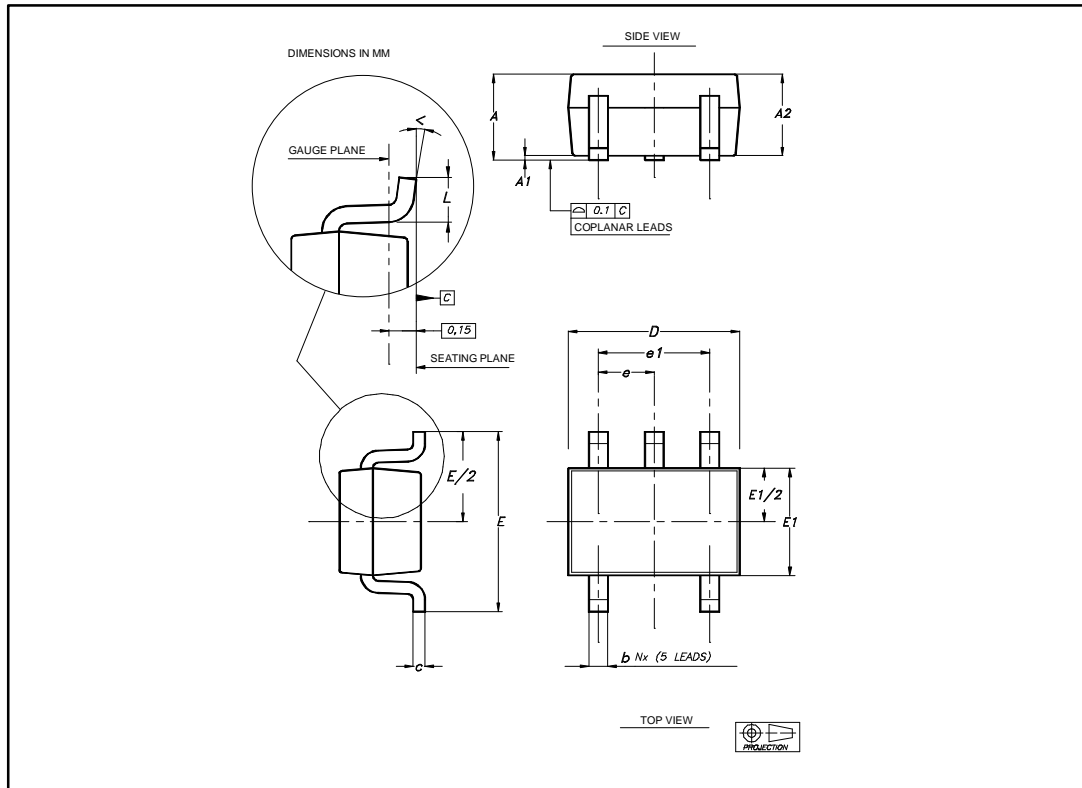


Table 7: SC70-5 (or SOT323-5) mechanical data

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 <sup>(1)</sup>				K529
TS3021ICT		SC70-5		K52
TS3021AILT		SOT23-5		K522

**Notes:**

<sup>(1)</sup>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 $\Delta V_{io}$ 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 <a href="#">Table 3</a> , <a href="#">Table 4</a> , and <a href="#">Table 5</a> : updated $V_{io}$ test conditions and values.

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