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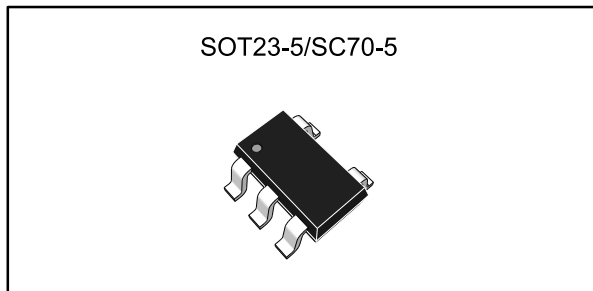
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# TS3011

## Rail-to-rail high-speed comparator

Datasheet - production data



### Description

The TS3011 single comparator features a high-speed response time with rail-to-rail inputs. Specified for a supply voltage of 2.2 to 5 V, this comparator can operate over a wide temperature range from -40 °C to 125 °C.

The TS3011 offers micropower consumption as low as a few hundred microamperes, thus providing an excellent ratio of power consumption current versus response time.

The TS3011 includes push-pull outputs and is available in small packages (SMD): SOT23-5 and SC70-5.

### Features

- Propagation delay: 8 ns
- Low current consumption: 470 µA typ at 5 V
- Rail-to-rail inputs
- Push-pull outputs
- Supply operation from 2.2 to 5 V
- Wide temperature range: -40 °C to 125 °C
- ESD tolerance: 2 kV HBM/200 V MM
- Latch-up immunity: 200 mA
- SMD packages
- Automotive qualification

### Applications

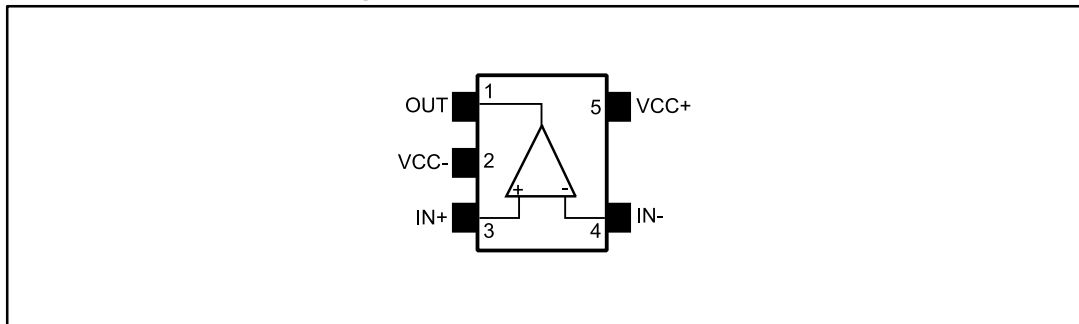
- Telecoms
- Instrumentation
- Signal conditioning
- High-speed sampling systems
- Portable communication systems

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## 1 Package pin connections

Figure 1: Pin connections (top view)



Absolute maximum ratings and operating conditions

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## 2 Absolute maximum ratings and operating conditions

Table 1: Absolute maximum ratings

Symbol	Parameter	Value	Unit	
V <sub>CC</sub>	Supply voltage <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> <sup>+</sup> ) + 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 seconds)	260		
ESD	Human body model (HBM) <sup>(4)</sup>	2000	V	
	Machine model (MM) <sup>(5)</sup>	200		
	Charged device model (CDM) <sup>(6)</sup>	SOT23-5		1500
		SC70-5		1300
	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 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 package are charged together to the specified voltage and then discharged directly to ground.

Table 2: Operating conditions

Symbol	Parameter	Value	Unit
T <sub>Oper</sub>	Operating temperature range	-40 to 125	°C
V <sub>CC</sub>	Supply voltage (V <sub>CC</sub> <sup>+</sup> - V <sub>CC</sub> <sup>-</sup> ), -40 °C < T <sub>amb</sub> < 125 °C	2.2 to 5	V
V <sub>ICM</sub>	Common mode input voltage range, -40 °C < T <sub>amb</sub> < 125 °C	(V <sub>CC</sub> ) - 0.2 to (V <sub>CC</sub> <sup>+</sup> ) + 0.2	

### 3 Electrical characteristics

In the electrical characteristic tables below, all values over the temperature range are guaranteed through correlation and simulation. No production tests are performed at the temperature range limits.

Table 3: VCC = 2.2 V, VICM = VCC/2, Tamb = 25 °C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>IO</sub>	Input offset voltage <sup>(1)</sup>		-7	-0.2	7	mV
		-40 °C < T <sub>amb</sub> < 125 °C	-8		8	
ΔV <sub>IO</sub>	Input offset voltage drift	-40 °C < T <sub>amb</sub> < 125 °C		5	20	μV/°C
V <sub>HYST</sub>	Input hysteresis voltage <sup>(2)</sup>			2		mV
I <sub>IO</sub>	Input offset current <sup>(3)</sup>			1	20	pA
		-40 °C < T <sub>amb</sub> < 125 °C			100	
I <sub>IB</sub>	Input bias current			1	20	pA
		-40 °C < T <sub>amb</sub> < 125 °C			100	
I <sub>CC</sub>	Supply current	No load, output high		0.52	0.64	mA
		No load, output high, -40 °C < T <sub>amb</sub> < 125 °C			0.9	
		No load, output low		0.65	0.88	
		No load, output low, -40 °C < T <sub>amb</sub> < 125 °C			1.1	
I <sub>SC</sub>	Short circuit current	Source	14	18		mA
		Sink	11	14		
V <sub>OH</sub>	Output voltage high	I <sub>source</sub> = 4 mA	1.94	1.97		V
		-40 °C < T <sub>amb</sub> < 125 °C	1.85			
V <sub>OL</sub>	Output voltage low	I <sub>sink</sub> = 4 mA		150	190	mV
		-40 °C < T <sub>amb</sub> < 125 °C			250	
CMRR	Common-mode rejection ratio	0 < V <sub>ICM</sub> < 2.7 V	50	68		dB
T <sub>PLH</sub>	Propagation delay, low to high output level <sup>(4)</sup>	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 5 mV		16		ns
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 15 mV		12		
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 50 mV		10	15	
T <sub>PHL</sub>	Propagation delay, high to low output level <sup>(5)</sup>	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 5 mV		16		ns
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 15 mV		12		
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 50 mV		10	15	
T <sub>R</sub>	Rise time (10 % to 90 %)	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 100 mV		3.0		ns
T <sub>F</sub>	Fall time (90 % to 10 %)	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 100 mV		2.5		ns

## Electrical characteristics

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### Notes:

- (1)The offset is defined as the average value of positive ( $V_{TRIP+}$ ) and negative ( $V_{TRIP-}$ ) trip points (input voltage differences) requested to change the output state in each direction.
- (2)Hysteresis is a built-in feature of the TS3011. It is defined as the voltage difference between the trip points.
- (3)Maximum values include unavoidable inaccuracies of the industrial tests.
- (4)Overdrive is measured with reference to the  $V_{TRIP+}$  point.
- (5)Overdrive is measured with reference to the  $V_{TRIP-}$  point.

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Electrical characteristics

Table 4: VCC = 2.7 V, VICM = VCC/2, Tamb = 25 °C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>IO</sub>	Input offset voltage <sup>(1)</sup>		-7	-0.1	7	mV
		-40 °C < T <sub>amb</sub> < 125 °C	-9		9	
ΔV <sub>IO</sub>	Input offset voltage drift	-40 °C < T <sub>amb</sub> < 125 °C		5	20	μV/°C
V <sub>HYST</sub>	Input hysteresis voltage <sup>(2)</sup>			2		mV
I <sub>IO</sub>	Input offset current <sup>(3)</sup>			1	20	pA
		-40 °C < T <sub>amb</sub> < 125 °C			100	
I <sub>IB</sub>	Input bias current			1	20	pA
		-40 °C < T <sub>amb</sub> < 125 °C			100	
I <sub>CC</sub>	Supply current	No load, output high		0.52	0.65	mA
		No load, output high, -40 °C < T <sub>amb</sub> < 125 °C			0.9	
		No load, output low		0.66	0.89	
		No load, output low, -40 °C < T <sub>amb</sub> < 125 °C			1.1	
I <sub>SC</sub>	Short circuit current	Source	24	27		mA
		Sink	19	22		
V <sub>OH</sub>	Output voltage high	I <sub>source</sub> = 4 mA	2.48	2.52		V
		-40 °C < T <sub>amb</sub> < 125 °C	2.40			
V <sub>OL</sub>	Output voltage low	I <sub>sink</sub> = 4 mA		130	170	mV
		-40 °C < T <sub>amb</sub> < 125 °C			220	
CMRR	Common-mode rejection ratio	0 < V <sub>ICM</sub> < 2.7 V	52	70		dB
T <sub>PLH</sub>	Propagation delay, low to high output level <sup>(4)</sup>	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 5 mV		16		ns
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 15 mV		11		
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 50 mV		9	13	
T <sub>PHL</sub>	Propagation delay, high to low output level <sup>(5)</sup>	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 5 mV		16		ns
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 15 mV		11		
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 50 mV		9	13	
T <sub>R</sub>	Rise time (10 % to 90 %)	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 100 mV		2.3		ns
T <sub>F</sub>	Fall time (90 % to 10 %)	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 100 mV		1.8		ns



## Electrical characteristics

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### Notes:

- <sup>(1)</sup>The offset is defined as the average value of positive ( $V_{TRIP+}$ ) and negative ( $V_{TRIP-}$ ) trip points (input voltage differences) requested to change the output state in each direction.
- <sup>(2)</sup>Hysteresis is a built-in feature of the TS3011. It is defined as the voltage difference between the trip points.
- <sup>(3)</sup>Maximum values include unavoidable inaccuracies of the industrial tests.
- <sup>(4)</sup>Overdrive is measured with reference to the  $V_{TRIP+}$  point.
- <sup>(5)</sup>Overdrive is measured with reference to the  $V_{TRIP-}$  point.

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Electrical characteristics

Table 5: VCC = 5 V, VICM = VCC/2, Tamb = 25 °C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>IO</sub>	Input offset voltage <sup>(1)</sup>		-7	-0.4	7	mV
		-40 °C < T <sub>amb</sub> < 125 °C	-9		9	
ΔV <sub>IO</sub>	Input offset voltage drift	-40 °C < T <sub>amb</sub> < 125 °C		10	30	μV/°C
V <sub>HYST</sub>	Input hysteresis voltage <sup>(2)</sup>			2		mV
I <sub>IO</sub>	Input offset current <sup>(3)</sup>			1	20	pA
		-40 °C < T <sub>amb</sub> < 125 °C			100	
I <sub>IB</sub>	Input bias current			1	20	pA
		-40 °C < T <sub>amb</sub> < 125 °C			100	
I <sub>CC</sub>	Supply current	No load, output high		0.47	0.69	mA
		No load, output high, -40 °C < T <sub>amb</sub> < 125 °C			0.9	
		No load, output low		0.60	0.91	
		No load, output low, -40 °C < T <sub>amb</sub> < 125 °C			1.1	
I <sub>SC</sub>	Short circuit current	Source	58	62		mA
		Sink	58	64		
V <sub>OH</sub>	Output voltage high	I <sub>source</sub> = 4 mA	4.84	4.89		V
		-40 °C < T <sub>amb</sub> < 125 °C	4.80			
V <sub>OL</sub>	Output voltage low	I <sub>sink</sub> = 4 mA		90	120	mV
		-40 °C < T <sub>amb</sub> < 125 °C			180	
CMRR	Common-mode rejection ratio	0 < V <sub>ICM</sub> < 2.7 V	57	74		dB
SVR	Supply voltage rejection	ΔV <sub>CC</sub> = 2.2 V to 5 V		79		
T <sub>PLH</sub>	Propagation delay, low to high output level <sup>(4)</sup>	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 5 mV		14		ns
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 15 mV		10		
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 50 mV		8	11	
T <sub>PHL</sub>	Propagation delay, high to low output level <sup>(5)</sup>	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 5 mV		16		ns
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 15 mV		11		
		C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 50 mV		9	12	
T <sub>R</sub>	Rise time (10 % to 90 %)	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 100 mV		1.1		ns
T <sub>F</sub>	Fall time (90 % to 10 %)	C <sub>L</sub> = 12 pF, R <sub>L</sub> = 1 MΩ, overdrive = 100 mV		1.0		ns

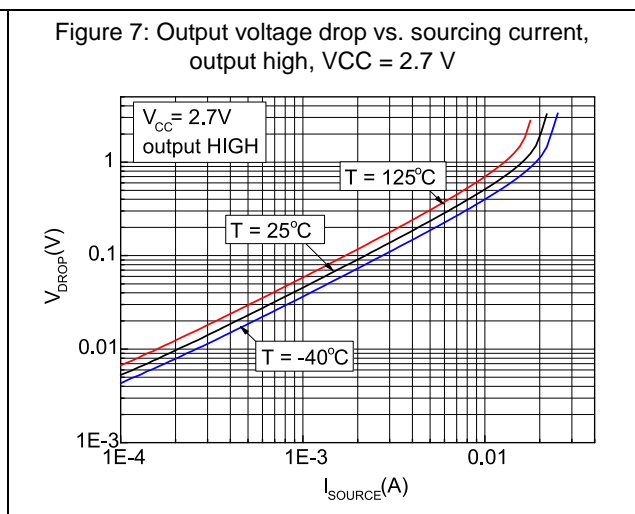
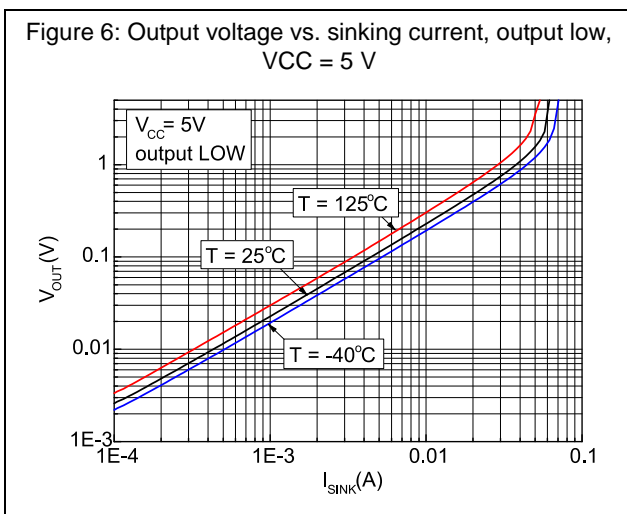
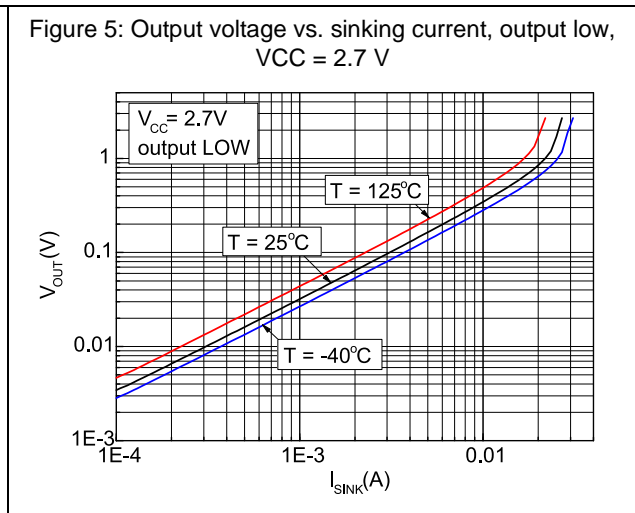
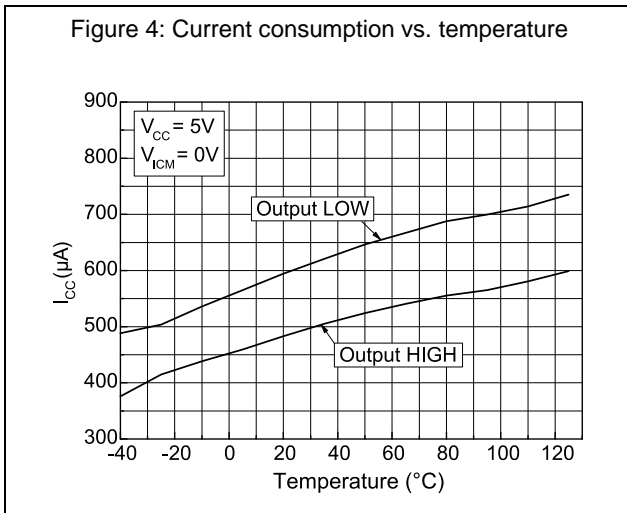
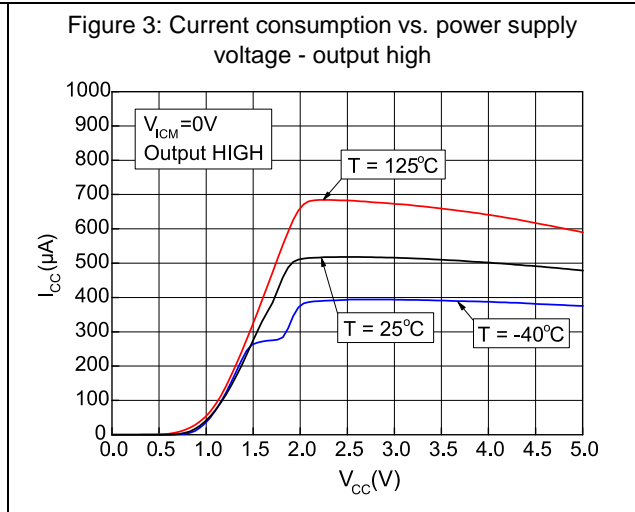
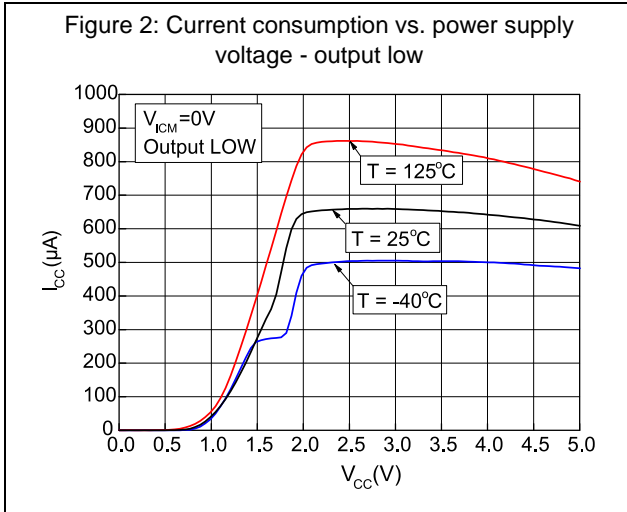
## Electrical characteristics

TS3011

### Notes:

- <sup>(1)</sup>The offset is defined as the average value of positive ( $V_{TRIP+}$ ) and negative ( $V_{TRIP-}$ ) trip points (input voltage differences) requested to change the output state in each direction.
- <sup>(2)</sup>Hysteresis is a built-in feature of the TS3011. It is defined as the voltage difference between the trip points.
- <sup>(3)</sup>Maximum values include unavoidable inaccuracies of the industrial tests.
- <sup>(4)</sup>Overdrive is measured with reference to the  $V_{TRIP+}$  point.
- <sup>(5)</sup>Overdrive is measured with reference to the  $V_{TRIP-}$  point.

## 4 Electrical characteristic curves



**Electrical characteristic curves**

**TS3011**

Figure 8: Output voltage drop vs. sourcing current, output high, VCC = 5 V

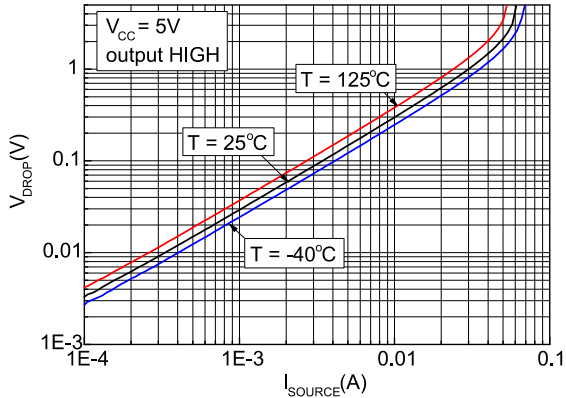


Figure 9: Input offset voltage vs. common mode voltage

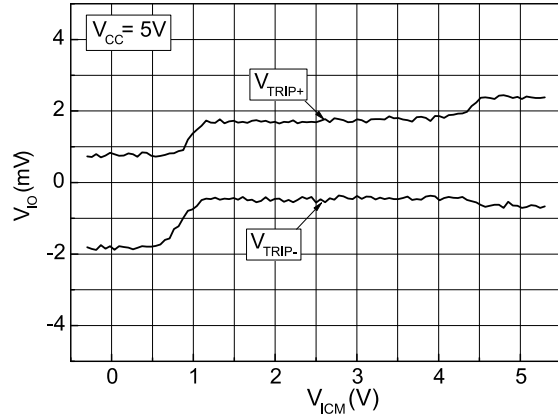


Figure 10: Input offset voltage vs. temperature

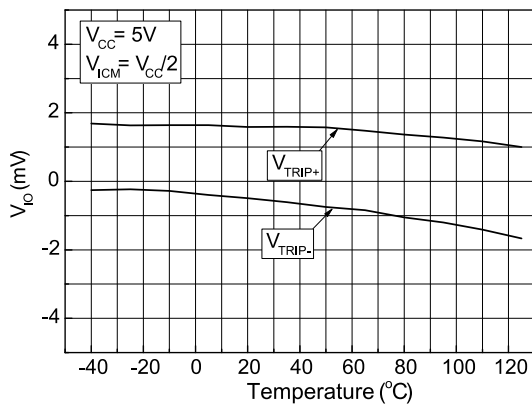


Figure 11: Propagation delay vs. common mode voltage with negative transition

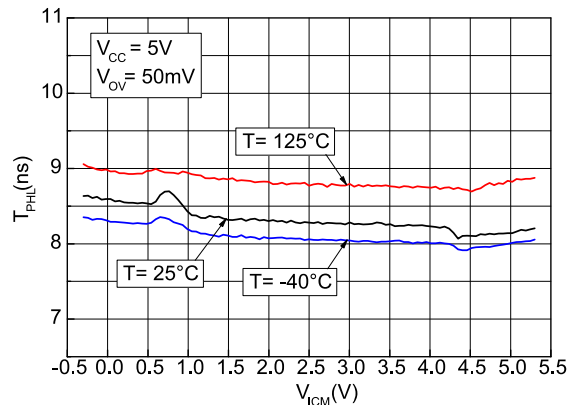


Figure 12: Propagation delay vs. common mode voltage with positive transition

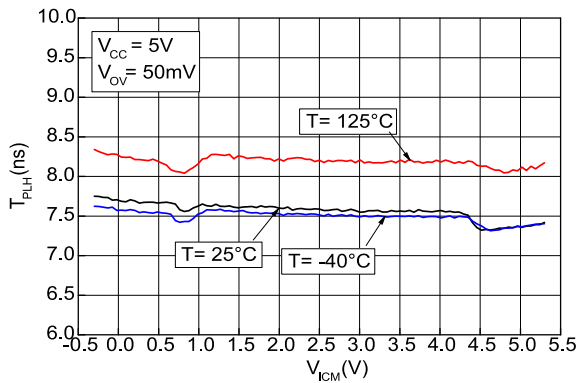
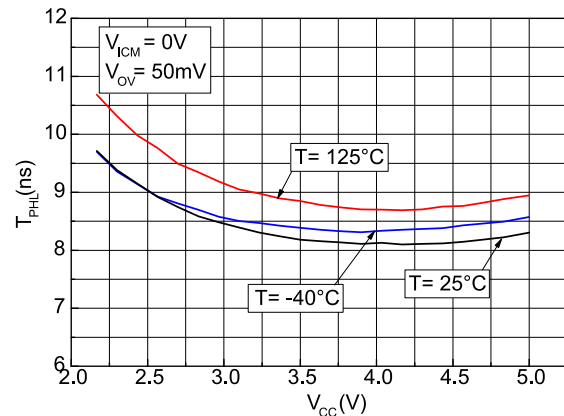


Figure 13: Propagation delay vs. power supply voltage with negative transition



**TS3011**

**Electrical characteristic curves**

Figure 14: Propagation delay vs. power supply voltage with positive transition

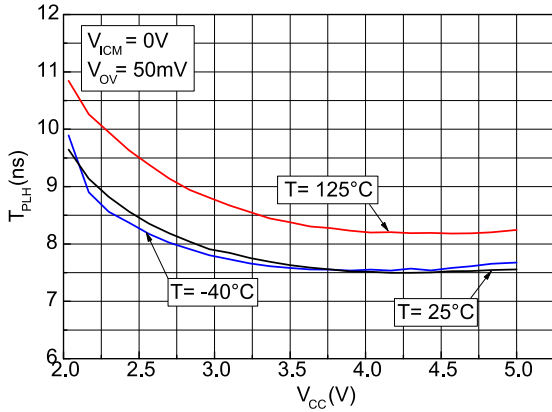


Figure 15: Propagation delay vs. overdrive with negative transition,  $V_{CC} = 2.7\text{V}$

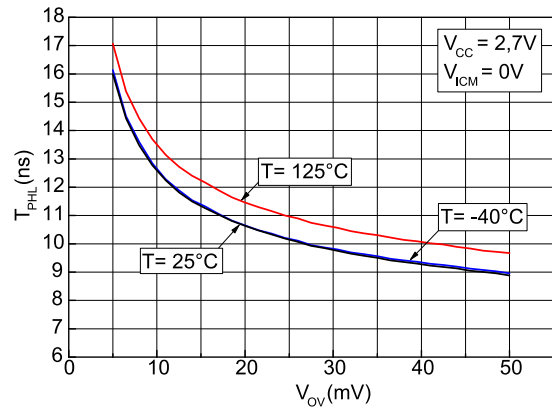


Figure 16: Propagation delay vs. overdrive with positive transition,  $V_{CC} = 2.7\text{V}$

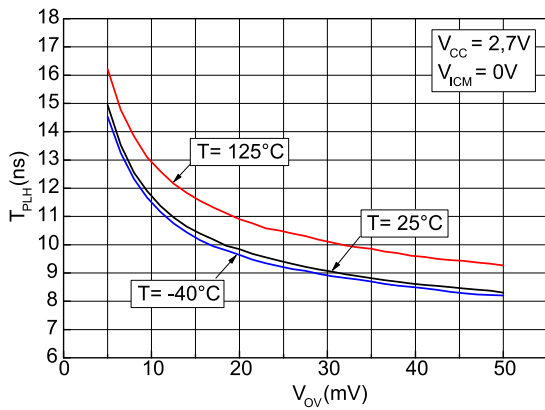


Figure 17: Propagation delay vs. overdrive with negative transition,  $V_{CC} = 5\text{V}$

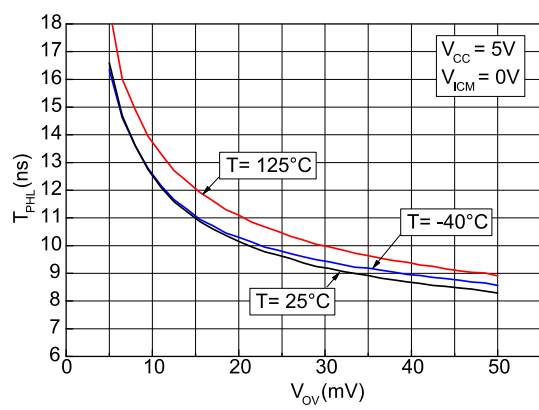


Figure 18: Propagation delay vs. overdrive with positive transition,  $V_{CC} = 5\text{V}$

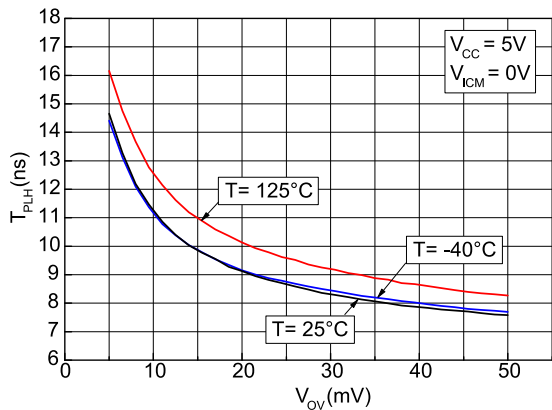
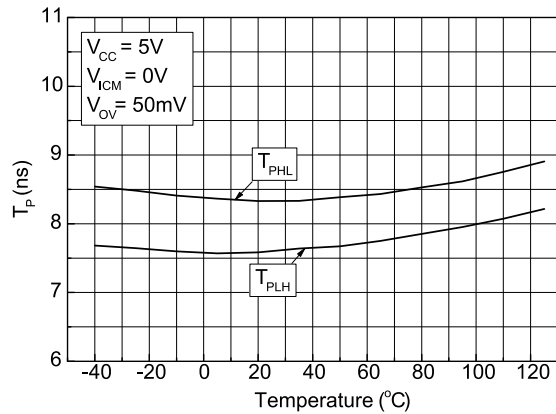


Figure 19: Propagation delay vs. temperature



## 5 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.

### 5.1 SOT23-5 package information

Figure 20: SOT23-5 package outline

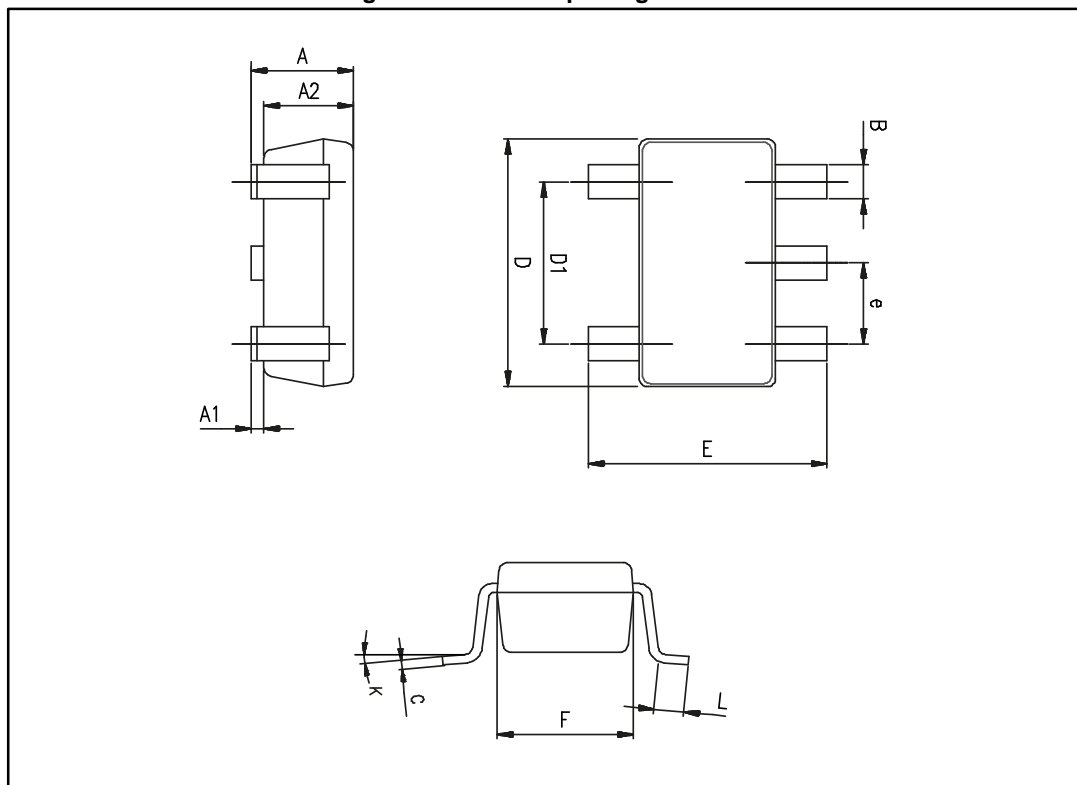


Table 6: SOT23-5 mechanical data

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



## 5.2 SC70-5 (or SOT323-5) package information

Figure 21: SC70-5 (or SOT323-5) package outline

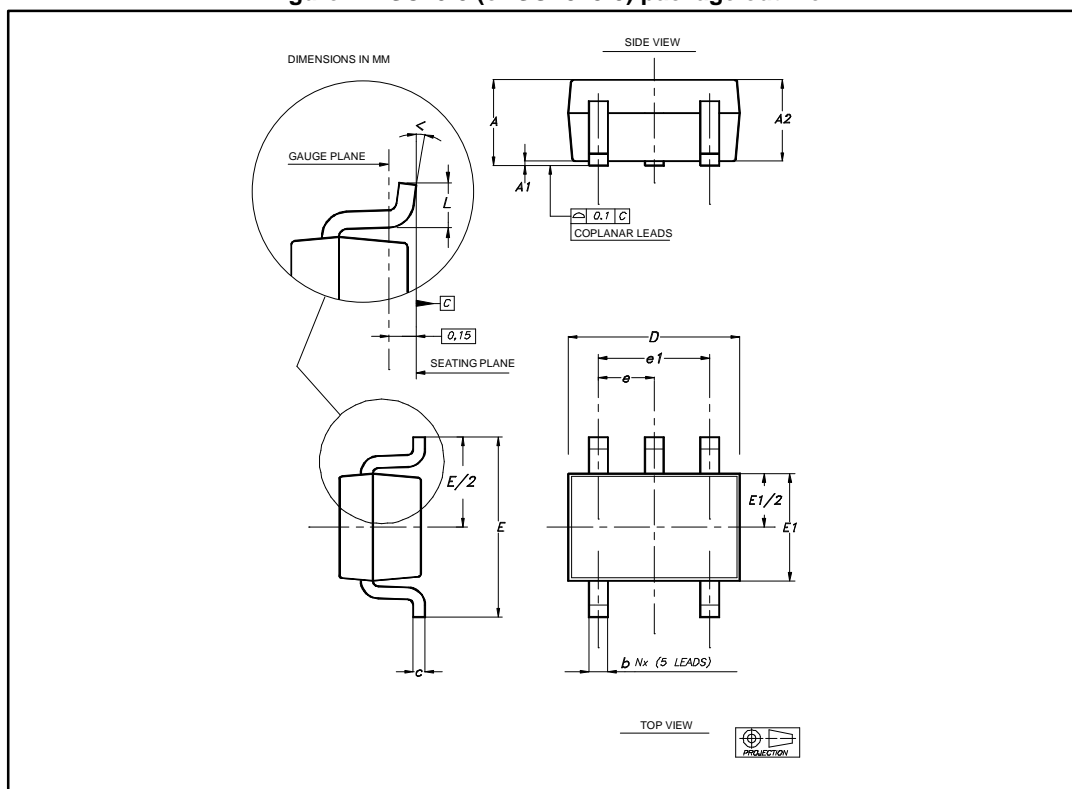


Table 7: SC70-5 (or SOT323-5) mechanical data

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°

## 6 Ordering information

Table 8: Order codes

Part number	Temperature range	Package	Packaging	Marking
TS3011ILT	-40 °C to 125 °C	SOT23-5	Tape and reel	K540
TS3011IYLT <sup>(1)</sup>				K541
TS3011ICT		SC70-5		K54

**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.

## 7 Revision history

Table 9: Document revision history

Date	Revision	Changes
03-Oct-2011	1	Initial release.
18-Feb-2014	2	Updated Table 8: Order codes to add the order code TS3011IYLT. Added: Automotive qualification among the Features in the cover page.
27-May-2016	3	Updated document layout <i>Section 3: "Electrical characteristics"</i> : updated unit of "Input offset voltage drift" parameter to $\mu\text{V}/^\circ\text{C}$ (not $\text{mV}/^\circ\text{C}$ ). <i>Section 4: "Electrical characteristic curves"</i> : X-axes changed to $\text{mV}$ (not $\text{V}$ ) in figures 15, 16, 17, and 18. <i>Table 6</i> : added "K" values for inches <i>Table 7</i> : updated A and A2 min values for inches and added "<" values for inches.

## TS3011

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