

## Single BiCMOS rail-to-rail micropower comparator

### Features

- Rail-to-rail inputs
- Open drain output
- Supply operation from 2.7V to 10V
- Typical supply current: 6µA @ 5V
- Response time of 0.5µs at 5V
- Low input current
- ESD protection: 2kV (HBM), 200V (MM)
- Available in tiny SOT23-5 package

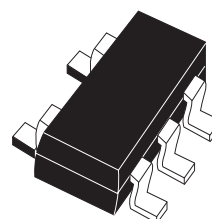
### Applications

- Battery-powered systems
- Notebooks and PDAs
- PCMCIA cards
- Cellulare and mobile communication
- Alarm and security systems
- Replacement of amplifiers used in comparator configuration for better performance

### Description

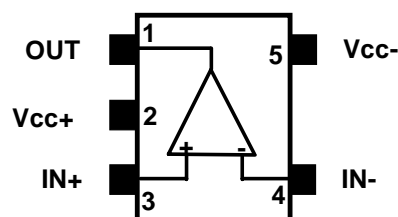
The TS7221 is a micropower comparator featuring rail-to-rail input performance in a tiny SOT23-5 package. This comparator is ideally suited to space and weight-critical applications. It is fully specified at 2.7V, 5V and 10V operation over the industrial temperature range (-40°C to +85°C).

The TS7221 features an open drain output stage. The speed-to-power ratio makes this device ultra-versatile for a wide range of applications.



L  
SOT23-5L

#### TS7221 Open drain output



# 1 Absolute maximum ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
ESD	Human body model (HBM)	2000	V
	Machine model (MM)	200	
$V_{ID}$	Differential input voltage	$(V_{CC}^-) - 0.3$ to $(V_{CC}^+) + 0.3$	V
$V_{IN}$	Input voltage <sup>(1)</sup>	$(V_{CC}^-) - 0.3$ to $(V_{CC}^+) + 0.3$	V
$V_{OUT}$	Output voltage	12	V
$V_{CC}$	Supply voltage	12	V
$I_{IN}$	Current at input pins <sup>(1)</sup>	$\pm 5$	mA
$I_{OUT}$	Current at output pin	$\pm 30$	mA
$T_{Lead}$	Lead temperature (soldering 10 seconds, Pb-free package)	260	°C
$T_{stg}$	Storage temperature	-65 to +150	°C
$T_J$	Junction temperature	150	°C
$P_D$	Power dissipation <sup>(2)</sup> SOT23-5	500	mW

1. The magnitude of input voltages must never exceed 0.3V beyond the supply voltage.

2.  $T_J = 150^\circ\text{C}$ ,  $T_{AMB} = 25^\circ\text{C}$  with  $R_{TH-JA} = 250^\circ\text{C/W}$  for SOT23-5 package.

**Table 2. Operating conditions**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage	2.7 to 10	V
$T_{amb}$	Ambient temperature	-40 to +85	°C
$V_{icm}$	Common mode input voltage range	$(V_{CC}^-) - 0.3$ to $(V_{CC}^+) + 0.3$	V

## 2 Electrical characteristics

**Table 3. Electrical characteristics at  $V_{CC}^+ = 2.7V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)<sup>(1)</sup>**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{IO}$	Input offset voltage (full common mode range) – TS7221A at $T_{min} \leq T_{amb} \leq T_{max}$ – TS7221B at $T_{min} \leq T_{amb} \leq T_{max}$			7 10 15 18	mV
$\Delta V_{IO}$	Input offset voltage drift with temperature		6		$\mu V/^\circ C$
$I_{IB}$	Input bias current <sup>(2)</sup> at $T_{min} \leq T_{amb} \leq T_{max}$		1	300 600	pA
$I_{IO}$	Input offset current <sup>(2)</sup> at $T_{min} \leq T_{amb} \leq T_{max}$		1	150 300	pA
CMRR	Common-mode rejection ratio ( $0 < V_{icm} < 2.7V$ )		65		dB
PSRR	Power supply rejection ratio ( $2.7 < V_{CC} < 10V$ )		80		dB
$A_{VD}$	Voltage gain <sup>(3)</sup>		240		dB
$V_{icm}$	Input common mode voltage range at $T_{min} \leq T_{amb} \leq T_{max}$	-0.3 0.0		3 2.7	V
$I_{OH}$	High level output voltage ( $I_N^+ = 0.5V$ , $I_N^- = 0V$ & $OUT = 10V$ )		0.1	500	nA
$V_{OL}$	Low level output voltage, $I_{sink} = 5mA$ at $T_{min} \leq T_{amb} \leq T_{max}$		0.2	0.35 0.45	V
$I_{CC}$	Supply current Output low Output high		6 8	12 14	$\mu A$
$T_{PLH}$	Response time low to high ( $V_{ic} = 1.35V$ , $C_L = 50pF$ , $R_L = 10k\Omega$ ) Overdrive = 10mV Overdrive = 100mV		1.5 0.6		$\mu s$
$T_{PHL}$	Response time high to low ( $V_{ic} = 1.35V$ , $C_L = 50pF$ , $R_L = 10k\Omega$ ) Overdrive = 10mV Overdrive = 100mV		1.5 0.5		$\mu s$
$T_F$	Fall time $C_L = 50pF$ , $R_L = 5k\Omega$ , Overdrive = 10mV		0.3		$\mu s$
$T_R$	Rise time $C_L = 50pF$ , $R_L = 5k\Omega$ , Overdrive = 10mV		0.3		$\mu s$

1. Limits are 100% production tested at  $+25^\circ C$ . Behavior at the temperature range limits is guaranteed through correlation and by design.
2. Maximum values include unavoidable inaccuracies of industrial testing.
3. Design evaluation.

**Table 4. Electrical characteristics for  $V_{CC}^+ = 5V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)<sup>(1)</sup>**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{IO}$	Input offset voltage (full common mode range) – TS7221A at $T_{min} \leq T_{amb} \leq T_{max}$ – TS7221B $T_{min} \leq T_{amb} \leq T_{max}$			7 10 15 18	mV
$\Delta V_{IO}$	Input offset voltage drift with temperature		6		$\mu V/^\circ C$
$I_{IB}$	Input bias current <sup>(2)</sup> at $T_{min} \leq T_{amb} \leq T_{max}$		1	300 600	pA
$I_{IO}$	Input offset current <sup>(2)</sup> at $T_{min} \leq T_{amb} \leq T_{max}$		1	150 300	pA
CMRR	Common-mode rejection ratio ( $0 < V_{icm} < 5V$ )		70		dB
PSRR	Power supply rejection ratio ( $2.7 < V_{CC} < 10V$ )		80		dB
$A_{VD}$	Voltage gain <sup>(3)</sup>		240		dB
$V_{icm}$	Input common mode voltage range at $T_{min} \leq T_{amb} \leq T_{max}$	-0.3 0.0		5.3 5.0	V
$I_{OH}$	High level output voltage ( $I_N^+ = 0.5V$ , $I_N^- = 0V$ & $OUT = 10V$ )		0.1	500	nA
$V_{OL}$	Low level output voltage, $I_{sink} = 5mA$ at $25^\circ C$ at $T_{min} \leq T_{amb} \leq T_{max}$		0.2	0.40 0.55	V
$I_{CC}$	Supply current Output low Output high		6 8	12 14	$\mu A$
$T_{PLH}$	Response time low to high ( $V_{ic} = 2.5V$ , $C_L = 50pF$ , $R_L = 10k\Omega$ ) Overdrive = 10mV Overdrive = 100mV		2 0.5		$\mu s$
$T_{PHL}$	Response time high to low ( $V_{ic} = 2.5V$ , $C_L = 50pF$ , $R_L = 10k\Omega$ ) Overdrive = 10mV Overdrive = 100mV		2 0.4		$\mu s$
$T_F$	Fall time $C_L = 50pF$ , $R_L = 5k\Omega$ , Overdrive = 10mV		0.3		$\mu s$
$T_R$	Rise time $C_L = 50pF$ , $R_L = 5k\Omega$ , Overdrive = 10mV		0.3		$\mu s$

1. Limits are 100% production tested at  $+25^\circ C$ . Behavior at the temperature range limits is guaranteed through correlation and by design.
2. Maximum values include unavoidable inaccuracies of industrial testing.
3. Design evaluation.

**Table 5. Electrical characteristics for  $V_{CC}^+ = 10V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)<sup>(1)</sup>**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{IO}$	Input offset voltage (full common mode range) – TS7221A at $T_{min} \leq T_{amb} \leq T_{max}$ – TS7221B $T_{min} \leq T_{amb} \leq T_{max}$			7 10 15 18	mV
$\Delta V_{IO}$	Input offset voltage drift with temperature		6		$\mu V/^\circ C$
$I_{IB}$	Input bias current <sup>(2)</sup> at $T_{min} \leq T_{amb} \leq T_{max}$		1	300 600	pA
$I_{IO}$	Input offset current <sup>(2)</sup> at $T_{min} \leq T_{amb} \leq T_{max}$		1	150 300	pA
CMRR	Common-mode rejection ratio ( $0 < V_{icm} < 10V$ )		75		dB
PSRR	Power supply rejection ratio ( $2.7 < V_{CC} < 10V$ )		80		dB
$A_{VD}$	Voltage gain <sup>(3)</sup>		240		dB
$V_{ICM}$	Input common mode voltage range at $T_{min} \leq T_{amb} \leq T_{max}$	-0.3 0.0		10.3 10.0	V
$I_{OH}$	High level output voltage ( $I_{N^+}=0.5V$ , $I_{N^-}=0V$ & $OUT=10V$ )		0.1	500	nA
$V_{OL}$	Low level output voltage, $I_{sink} = 5mA$ at $T_{min} \leq T_{amb} \leq T_{max}$		0.2	0.40 0.55	V
$I_{CC}$	Supply current Output low Output high		7 10	14 16	$\mu A$
$T_{PLH}$	Response time low to high ( $V_{ic} = 5V$ , $C_L = 50pF$ , $R_L=10k\Omega$ ) Overdrive = 10mV Overdrive = 100mV		3 0.5		$\mu s$
$T_{PHL}$	Response time high to low ( $V_{ic} = 5V$ , $C_L = 50pF$ , $R_L=10k\Omega$ ) Overdrive = 10mV Overdrive = 100mV		4 0.4		$\mu s$
$T_F$	Fall time $C_L = 50pF$ , $R_L=5k\Omega$ , Overdrive = 10mV		0.3		$\mu s$
$T_R$	Rise time $C_L = 50pF$ , $R_L=5k\Omega$ , Overdrive = 10mV		0.3		$\mu s$

1. Limits are 100% production tested at  $+25^\circ C$ . Behavior at the temperature range limits is guaranteed through correlation and by design.
2. Maximum values include unavoidable inaccuracies of industrial testing.
3. Design evaluation.

Figure 1. Supply current vs. supply voltage (output low)

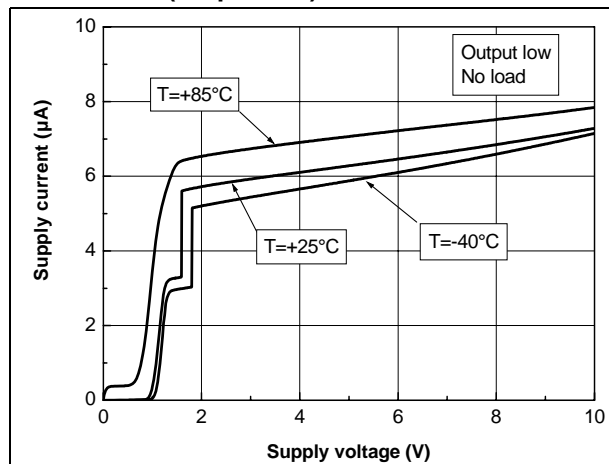


Figure 2. Supply current vs. supply voltage (output high)

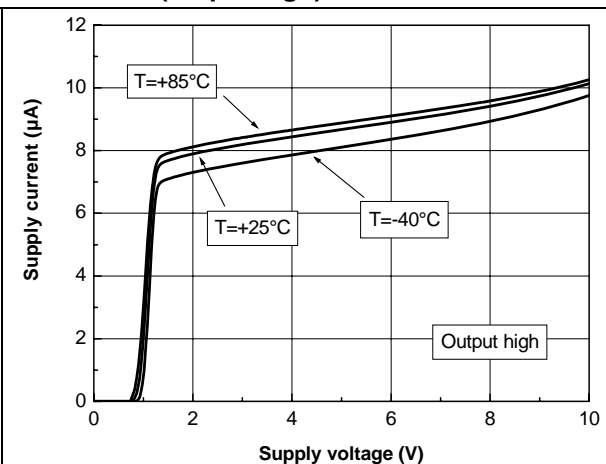
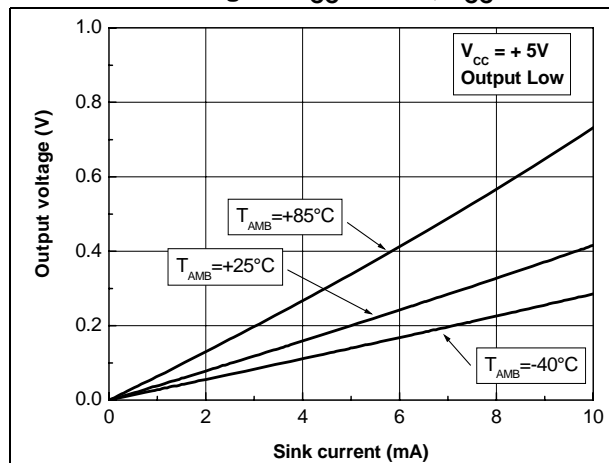
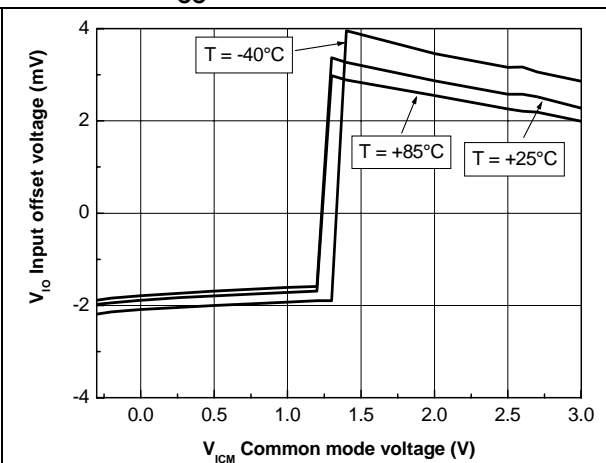
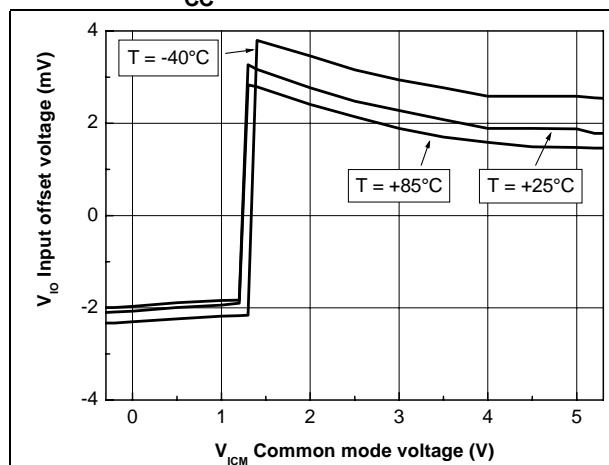
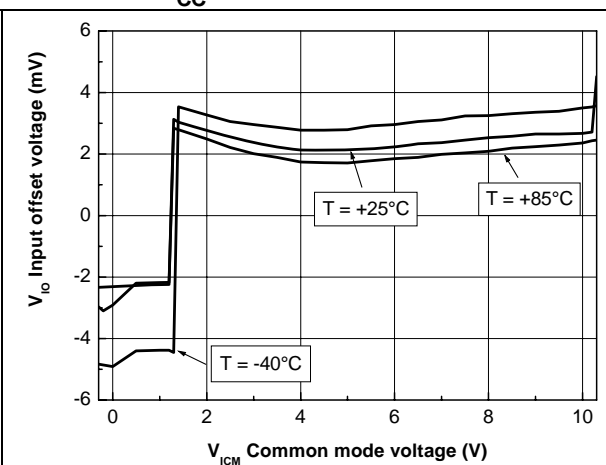
Figure 3. Output sinking current vs. output voltage at  $V_{CC} = +2.7V$ ,  $V_{CC} = +5V$ Figure 4.  $V_{IO}$  vs.  $V_{ICM}$  and temperature at  $V_{CC} = 2.7V$ Figure 5.  $V_{IO}$  vs.  $V_{ICM}$  and temperature at  $V_{CC} = 5V$ Figure 6.  $V_{IO}$  vs.  $V_{ICM}$  and temperature at  $V_{CC} = 10V$ 

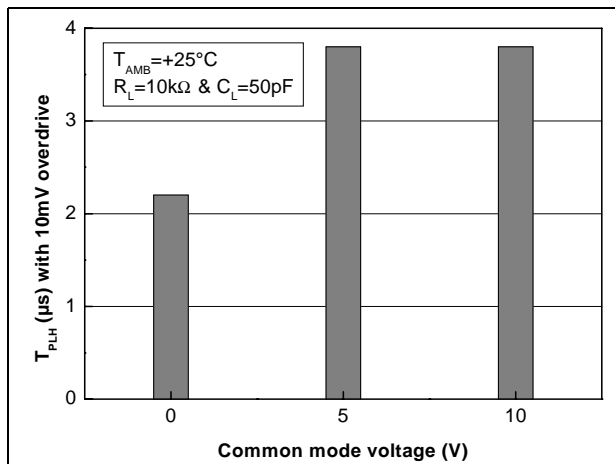
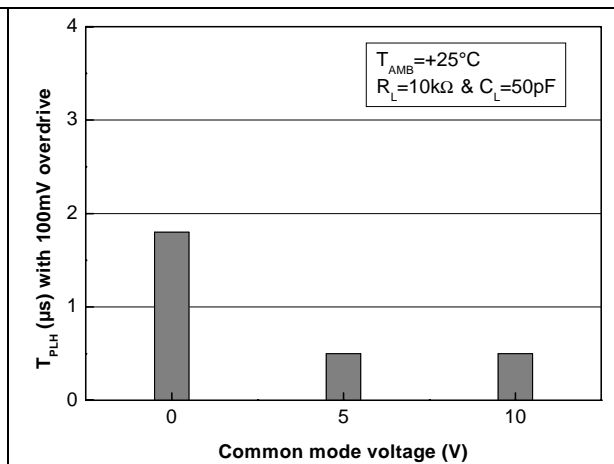
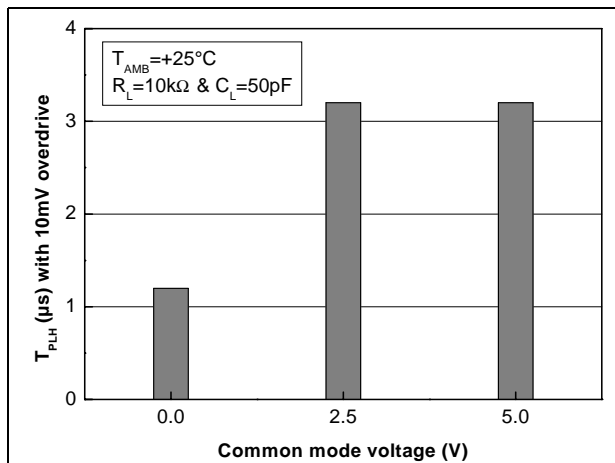
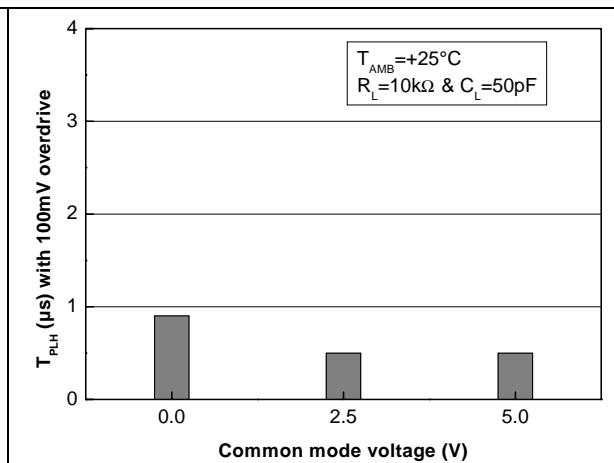
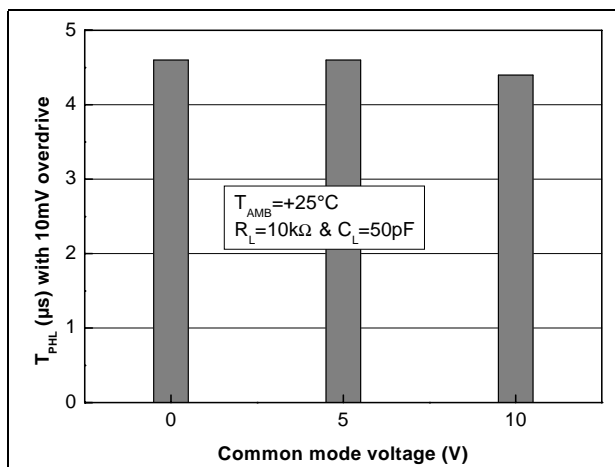
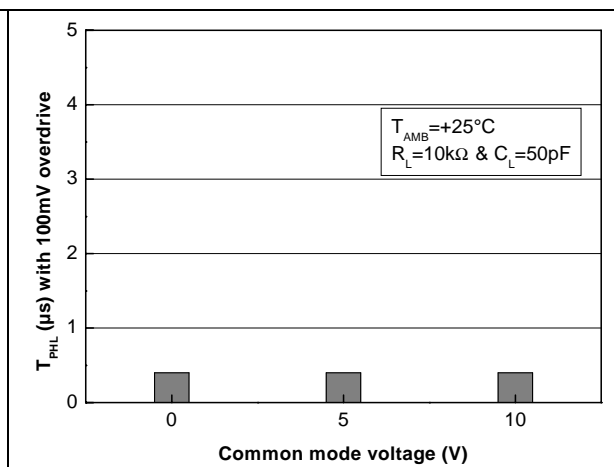
Figure 7.  $T_{PLH}$  vs  $V_{icm}$  at  $V_{CC} = 10V$  and 10mV overdriveFigure 8.  $T_{PLH}$  vs  $V_{icm}$  at  $V_{CC} = 10V$  and 100mV overdriveFigure 9.  $T_{PLH}$  vs  $V_{icm}$  at  $V_{CC} = 5V$  and 10mV overdriveFigure 10.  $T_{PLH}$  vs  $V_{icm}$  at  $V_{CC} = 5V$  and 100mV overdriveFigure 11.  $T_{PHL}$  vs  $V_{icm}$  at  $V_{CC} = 10V$  and 10mV overdriveFigure 12.  $T_{PHL}$  vs  $V_{icm}$  at  $V_{CC} = 10V$  and 100mV overdrive

Figure 13.  $T_{PHL}$  vs  $V_{icm}$  at  $V_{CC}=5V$  and 10mV overdrive

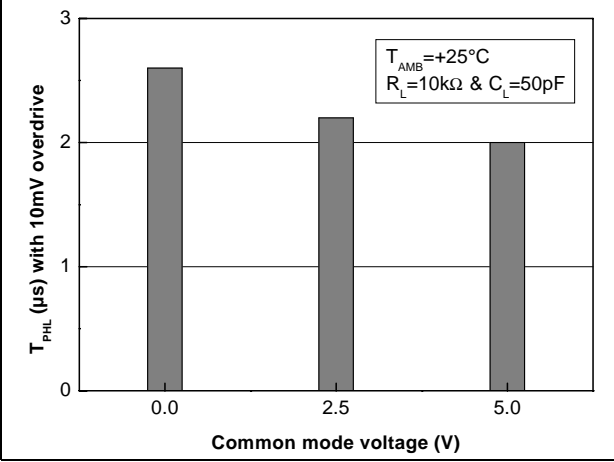
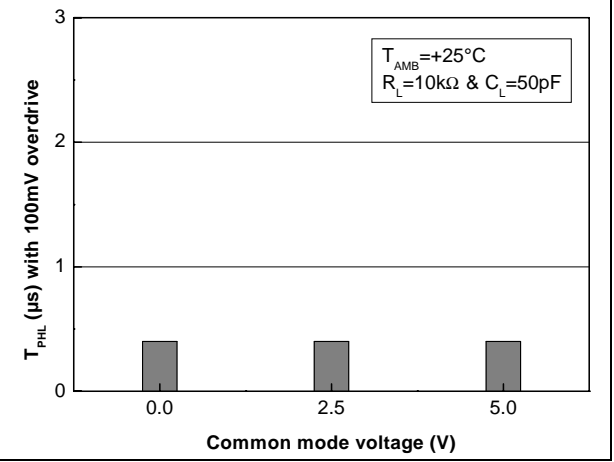


Figure 14.  $T_{PHL}$  vs  $V_{icm}$  at  $V_{CC}=5V$  and 100mV overdrive





### 3 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

**Figure 15. SOT23-5L package mechanical data**

Ref.	Dimensions					
	Millimeters			Mils		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.45	35.4		57.1
A1	0.00		0.15	0.00		5.9
A2	0.90		1.30	35.4		51.2
b	0.35		0.50	13.7		19.7
C	0.09		0.20	3.5		7.8
D	2.80		3.00	110.2		118.1
E	2.60		3.00	102.3		118.1
E1	1.50		1.75	59.0		68.8
e		0.95			37.4	
e1		1.9			74.8	
L	0.35		0.55	13.7		21.6

The figure includes two mechanical drawings of the SOT23-5L package. The left drawing is a side view showing dimensions A (total width), A1 (lead width), A2 (body width), b (lead thickness), C (lead height), and L (lead length). The right drawing is a top view showing dimensions D (body length), E (body width), E1 (lead width), e (pitch), and e1 (total pitch).

## 4 Ordering information

Table 6. Order codes

Part number	Temperature range	Package	Packing	Marking
TS7221AILT	-40°C, +85°C	SOT23-5L	Tape & reel	K518
TS7221BILT				K519
TS7221AIYLT <sup>(1)</sup>		SOT23-5L (automotive grade)		K522
TS7221BIYLT <sup>(1)</sup>				K523

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

## 5 Revision history

Table 7. Document revision history

Date	Revision	Changes
1-Dec-2002	1	Initial release
1-Sep-2005	2	Update of datasheet presentation and format. Change of $T_{lead}$ temperature in <a href="#">Table 1 on page 2</a> , to reflect change to Pb-free package. Corrections to $V_{icm}$ upper rail parameters in <a href="#">Electrical characteristics</a> tables. Addition of Pb-free information in <a href="#">Section 3: Package information on page 9</a> . Correction to package mechanical data given in <a href="#">Figure 15 on page 9</a> .
26-Mar-2007	3	Added automotive grade part numbers in <a href="#">Section 4: Ordering information on page 10</a> .
5-Jul-2007	4	Corrected automotive grade part numbers in <a href="#">Table 6: Order codes</a> .

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