
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: 6 μ A @ 5V
- Response time of 0.5 μ s at 5V
- Low input current
- ESD protection: 2kV (HBM), 200V (MM)
- Available in tiny SOT23-5 package

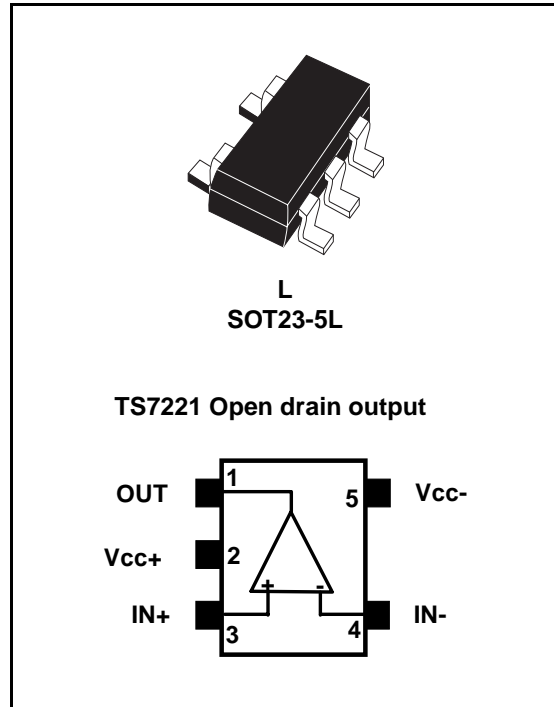
Applications

- 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.



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 ⁽¹⁾ | $(V_{CC}^-) - 0.3$ to $(V_{CC}^+) + 0.3$ | V |
| V_{OUT} | Output voltage | 12 | V |
| V_{CC} | Supply voltage | 12 | V |
| I_{IN} | Current at input pins ⁽¹⁾ | ± 5 | mA |
| I_{OUT} | Current at output pin | ± 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 ⁽²⁾ 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)⁽¹⁾

| 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 |
| ΔV_{IO} | Input offset voltage drift with temperature | | 6 | | $\mu V/^\circ C$ |
| I_{IB} | Input bias current ⁽²⁾ at $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 300 600 | pA |
| I_{IO} | Input offset current ⁽²⁾ 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 ⁽³⁾ | | 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 ($IN^+ = 0.5V$, $IN^- = 0V$ & $OUT = 10V$) | | 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 | μA |
| 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 | | μs |
| 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 | | μs |
| T_F | Fall time $C_L = 50pF$, $R_L = 5k\Omega$, Overdrive = 10mV | | 0.3 | | μs |
| T_R | Rise time $C_L = 50pF$, $R_L = 5k\Omega$, Overdrive = 10mV | | 0.3 | | μs |

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)⁽¹⁾

| 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 |
| ΔV_{IO} | Input offset voltage drift with temperature | | 6 | | $\mu V/^\circ C$ |
| I_{IB} | Input bias current ⁽²⁾ at $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 300 600 | pA |
| I_{IO} | Input offset current ⁽²⁾ 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 ⁽³⁾ | | 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 | μA |
| 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 | | μs |
| 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 | | μs |
| T_F | Fall time $C_L = 50pF$, $R_L = 5k\Omega$, Overdrive = 10mV | | 0.3 | | μs |
| T_R | Rise time $C_L = 50pF$, $R_L = 5k\Omega$, Overdrive = 10mV | | 0.3 | | μs |

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)⁽¹⁾

| 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 |
| ΔV_{IO} | Input offset voltage drift with temperature | | 6 | | $\mu V/^{\circ}C$ |
| I_{IB} | Input bias current ⁽²⁾ at $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 300 600 | pA |
| I_{IO} | Input offset current ⁽²⁾ 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 ⁽³⁾ | | 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 ($I_N^+ = 0.5V$, $I_N^- = 0V$ & $O_U = 10V$) | | 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 | μA |
| T_{PLH} | Response time low to high ($V_{ic} = 5V$, $C_L = 50pF$, $R_L = 10k\Omega$) Overdrive = 10mV Overdrive = 100mV | | 3 0.5 | | μs |
| T_{PHL} | Response time high to low ($V_{ic} = 5V$, $C_L = 50pF$, $R_L = 10k\Omega$) Overdrive = 10mV Overdrive = 100mV | | 4 0.4 | | μs |
| T_F | Fall time $C_L = 50pF$, $R_L = 5k\Omega$ Overdrive = 10mV | | 0.3 | | μs |
| T_R | Rise time $C_L = 50pF$, $R_L = 5k\Omega$ Overdrive = 10mV | | 0.3 | | μs |

1. Limits are 100% production tested at +25°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)

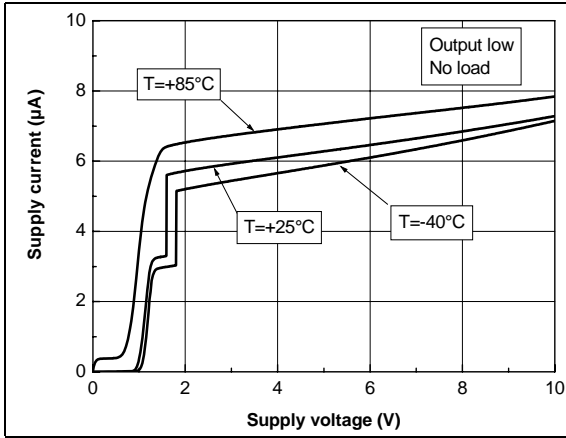


Figure 2. Supply current vs. supply voltage (output high)

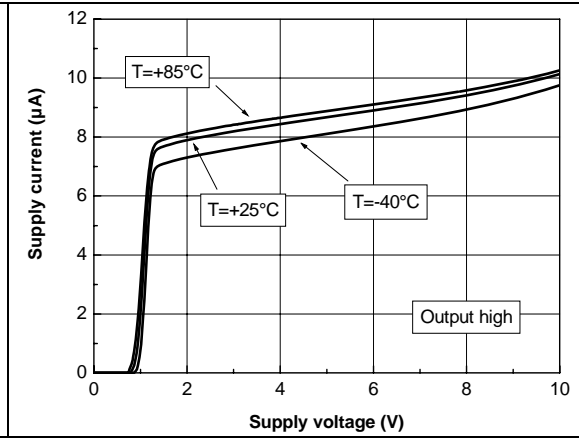


Figure 3. Output sinking current vs. output voltage at $V_{CC} = +2.7V, V_{CC} = +5V$

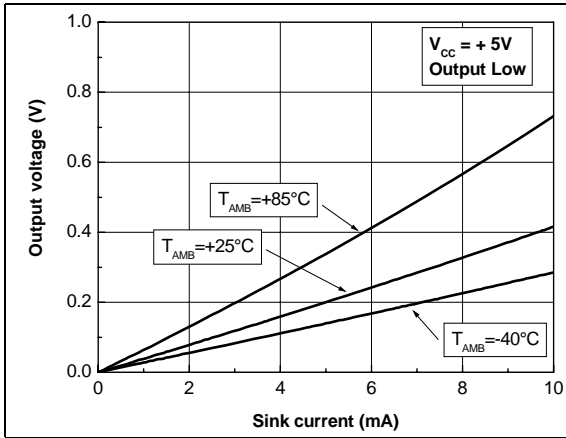


Figure 4. V_{IO} vs. V_{ICM} and temperature at $V_{CC} = 2.7V$

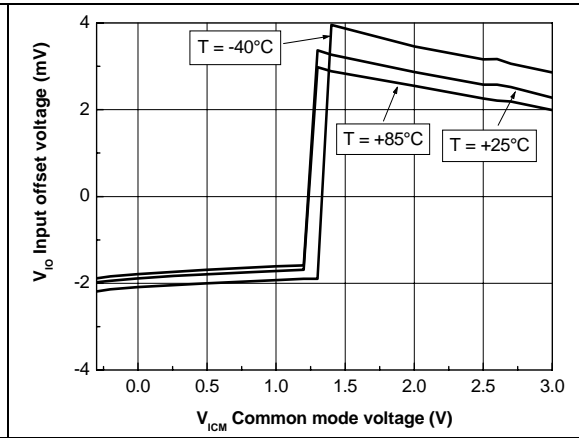


Figure 5. V_{IO} vs. V_{ICM} and temperature at $V_{CC} = 5V$

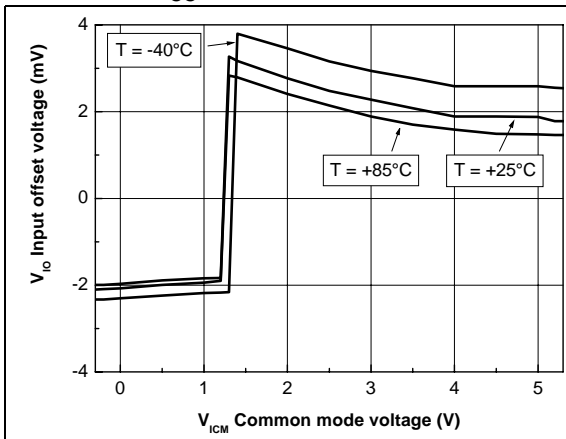


Figure 6. V_{IO} vs. V_{ICM} and temperature at $V_{CC} = 10V$

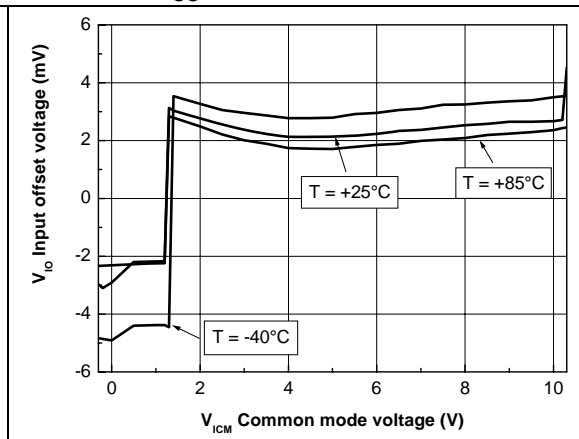


Figure 7. T_{PLH} vs V_{icm} at $V_{CC} = 10V$ and 10mV overdrive Figure 8. T_{PLH} vs V_{icm} at $V_{CC} = 10V$ and 100mV overdrive

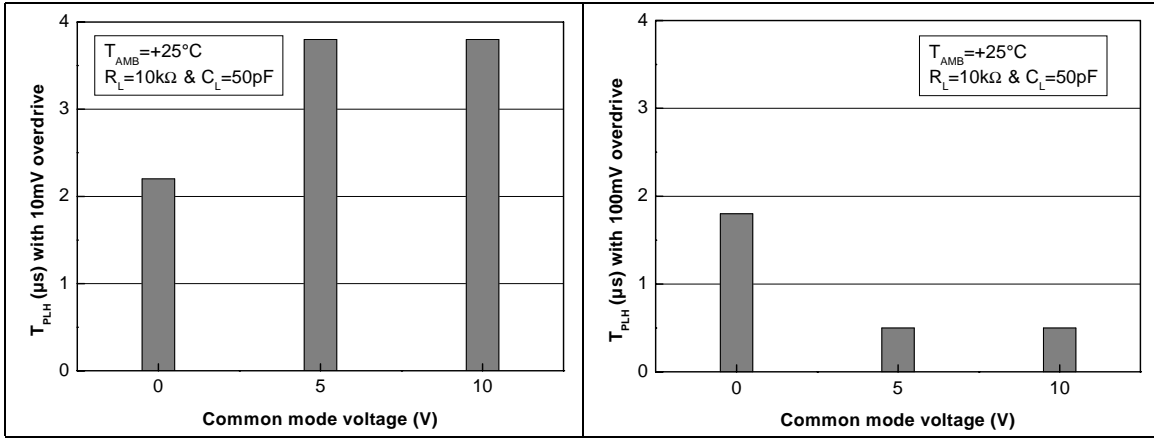


Figure 9. T_{PLH} vs V_{icm} at $V_{CC} = 5V$ and 10mV overdrive Figure 10. T_{PLH} vs V_{icm} at $V_{CC} = 5V$ and 100mV overdrive

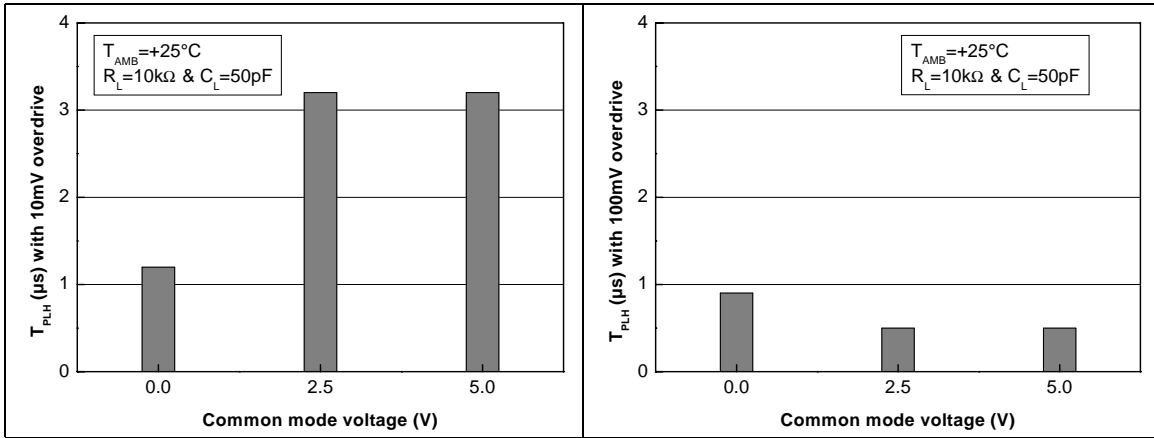


Figure 11. T_{PHL} vs V_{icm} at $V_{CC} = 10V$ and 10mV overdrive Figure 12. T_{PHL} vs V_{icm} at $V_{CC} = 10V$ and 100mV overdrive

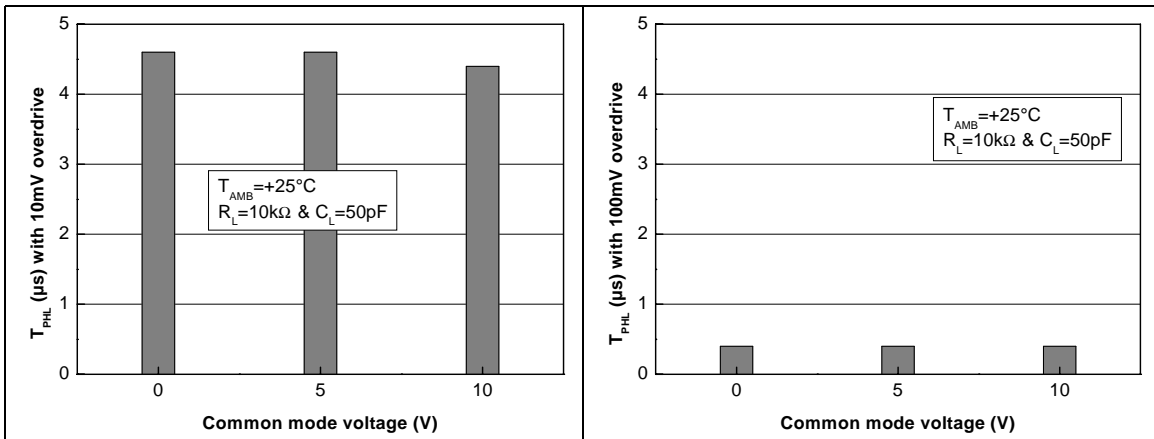


Figure 13. T_{PHL} vs V_{icm} at $V_{CC}=5V$ and 10mV overdrive

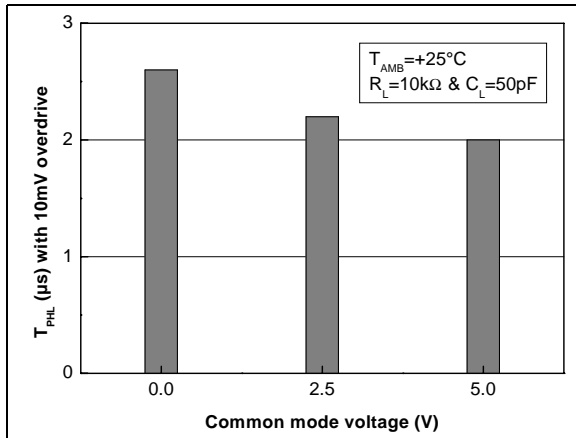
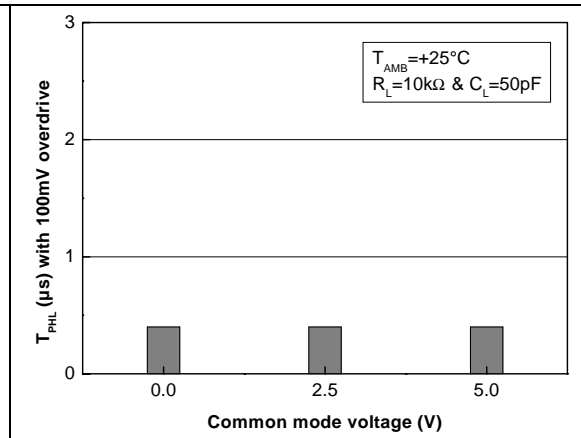


Figure 14. T_{PHL} vs V_{icm} at $V_{CC}=5V$ and 100mV overdrive



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.

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

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 ⁽¹⁾ | | SOT23-5L (automotive grade) | | K522 |
| TS7221BIYLT ⁽¹⁾ | | | | 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 Table 1 on page 2 , to reflect change to Pb-free package. Corrections to V_{icm} upper rail parameters in Electrical characteristics tables. Addition of Pb-free information in Section 3: Package information on page 9 . Correction to package mechanical data given in Figure 15 on page 9 . |
| 26-Mar-2007 | 3 | Added automotive grade part numbers in Section 4: Ordering information on page 10 . |
| 5-Jul-2007 | 4 | Corrected automotive grade part numbers in Table 6: Order codes . |

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