

### Low-power single voltage comparator

Datasheet - production data

#### **Features**

- Wide single supply voltage range or dual supplies +2 V to +36 V or ±1 V to ±18 V
- Very low supply current (0.2 mA) independent of supply voltage (1 mW/comparator at +5 V)
- Low input bias current: 25 nA typ.
- Low input offset current: ±5 nA typ.
- Low input offset voltage: ±1 mV typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage: 250 mV typ. (I<sub>o</sub> = 4 mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, CMOS compatible outputs

#### **Description**

This device consists of a low-power voltage comparator designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

This comparator also has a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.



L SOT23-5 (Plastic package)



Q2 DFN8 2x2 mm (Plastic micropackage) Schematic diagram TS391

## 1 Schematic diagram

Figure 1. Schematic diagram

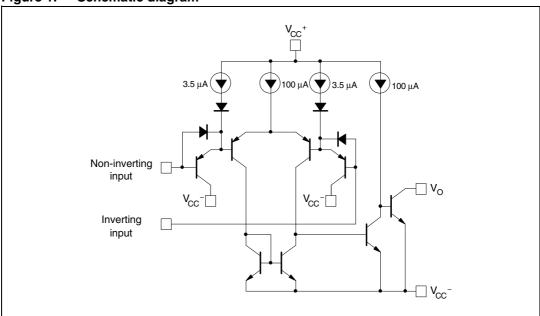
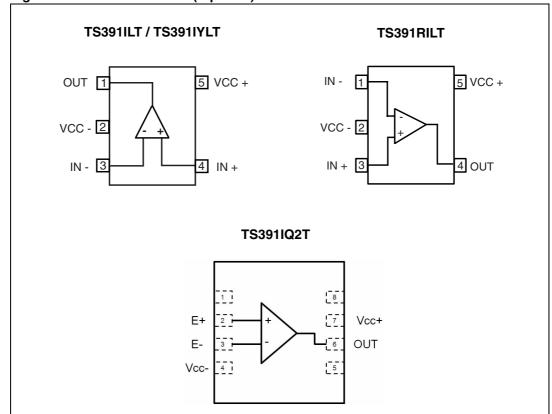


Figure 2. Pin connections (top view)



### 2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	±18 or 36	V
V <sub>id</sub>	Differential input voltage	±36	V
V <sub>i</sub>	Input voltage	-0.3 to +36	V
	Output short-circuit to ground <sup>(1)</sup>	Infinite	
Tj	Maximum junction temperature	150	°C
R <sub>thja</sub>	Thermal resistance junction to ambient <sup>(2)</sup> SOT23-5 DFN8 2x2	250 57	°C/W
T <sub>stg</sub>	Storage temperature range	-65 to +150	°C
	Human body model (HBM) <sup>(3)</sup>	1500	
ESD	Machine model (MM) <sup>(4)</sup>	100	V
	Charged device model (CDM) <sup>(5)</sup>	1000	

<sup>1.</sup> Short-circuits from the output to  $V_{CC}^+$  can cause excessive heating and potential destruction. The maximum output current is approximately 20 mA independent of the magnitude of  $V_{CC}^+$ .

- 2. Short-circuits can cause excessive heating. These values are typical.
- 3. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k $\Omega$  resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- 4. 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  $\Omega$ ). This is done for all couples of connected pin combinations while the other pins are floating.
- Charged device model: all pins and package are charged together to the specified voltage and then discharged directly to 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	2 to 36 or ±1 to ±18	V
V <sub>icm</sub>	Input common mode voltage range <sup>(1)</sup> $T_{amb} = 25^{\circ}C$ $T_{min} \le T_{amb} \le T_{max}$	0 to V <sub>CC</sub> <sup>+</sup> -1.5 0 to V <sub>CC</sub> <sup>+</sup> -2	V
T <sub>oper</sub>	Operating free-air temperature range	-40 to +125	°C

The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V<sub>CC</sub><sup>+</sup> -1.5 V, but either or both inputs can go to +30 V without damage.

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Electrical characteristics TS391

### 3 Electrical characteristics

Table 3.  $V_{CC}^+ = +5 \text{ V}, V_{CC}^- = 0 \text{ V}, T_{amb} = 25^{\circ}\text{C}$  (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V <sub>io</sub>	Input offset voltage (1)	$T_{min} \le T_{amb} \le T_{max}$		1	5 9	mV
I <sub>io</sub>	Input offset current	$T_{min} \le T_{amb} \le T_{max}$		5	50 150	nA
I <sub>ib</sub>	Input bias current (2)	$T_{min} \le T_{amb} \le T_{max}$		25	250 400	nA
A <sub>vd</sub>	Large signal voltage gain	$V_{CC}^{+} = 15V, R_{L} = 15k\Omega$ $V_{o} = 1 \text{ to } 11V$	50	200		V/mV
I <sub>CC</sub>	Supply current	$V_{CC}^+$ = 5V, no load $V_{CC}^+$ = 30V, no load		0.2 0.5	0.5 1.25	mA
V <sub>id</sub>	Differential input voltage (3)				V <sub>CC</sub> <sup>+</sup>	V
I <sub>sink</sub>	Output sink current	$V_{id} = -1V, V_O = 1.5V$	6	16		mA
V <sub>OL</sub>	Low level output voltage	$V_{id} = 1V, V_{CC}^+ = V_O = 30V$		250	400 700	mV
I <sub>OH</sub>	High level output current	$V_{id} = 1V, V_{CC}^{+} = V_{O} = 30V$		0.1	1	nΑ μΑ
tre	Small signal response time	$R_L = 5.1 k\Omega \text{ to } V_{CC}^{+ (4)}$		1.3		μs
t <sub>rel</sub>	Large signal response time	$V_i$ = TTL, $V_{ref}$ = +1.4V, $R_L$ = 5.1k $\Omega$ to $V_{CC}^+$		300		ns

<sup>1.</sup> At output switch point,  $V_O \approx 1.4 \text{V}$ ,  $R_S = 0 \Omega$  with  $V_{CC}^+$  from 5V to 30V and over the full input common-mode range (0 V to  $V_{CC}^+$  -1.5 V).

The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so there is no loading charge on the reference or input lines.

<sup>3.</sup> Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than -0.3 V (or 0.3 V below the negative power supply, if used).

<sup>4.</sup> The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals, 300 ns can be obtained.

TS391 Electrical characteristics

Figure 3. Supply current vs. supply voltage Figure 4. Response time for various input overdrives - negative transition

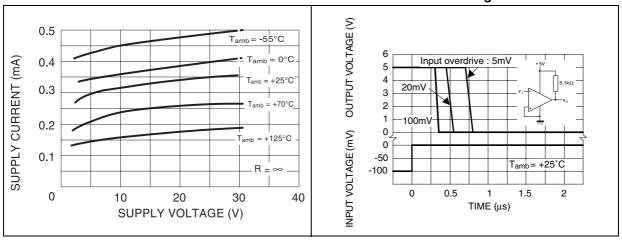


Figure 5. Input current vs. supply voltage

Figure 6. Response time for various input overdrives - positive transition

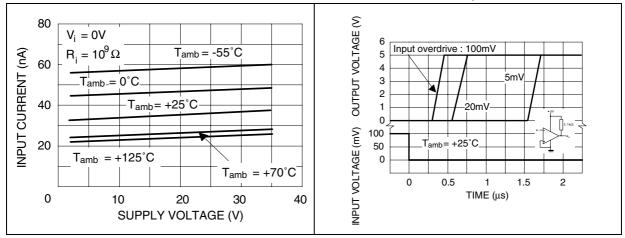
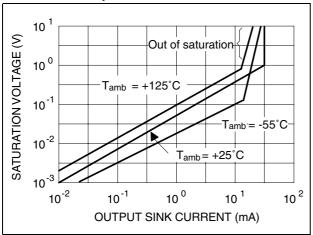


Figure 7. Output saturation voltage vs. output current



Package information TS391

## 4 Package information

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In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: <a href="https://www.st.com">www.st.com</a>. ECOPACK<sup>®</sup> is an ST trademark.

TS391 Package information

## 4.1 DFN8 2x2 mm package mechanical data

SEATING PLANE

C

PIN#1 ID

PIN#1 ID

PIN#1 ID

D2

BOTTOM VIEW

Figure 8. DFN8 2x2 mm package mechanical drawing

Table 4. DFN8 2x2x0.6 mm package mechanical data (pitch 0.5 mm)

	Dimensions					
Ref.	Millimeters			Inches		
	Min.	Тур.	Max.	Min.	Тур.	Max.
Α	0.51	0.55	0.60	0.020	0.022	0.024
A1			0.05			0.002
A3		0.15			0.006	
b	0.18	0.25	0.30	0.007	0.010	0.012
D	1.85	2.00	2.15	0.073	0.079	0.085
D2	1.45	1.60	1.70	0.057	0.063	0.067
Е	1.85	2.00	2.15	0.073	0.079	0.085
E2	0.75	0.90	1.00	0.030	0.035	0.039
е		0.50			0.020	
L			0.50			0.020
ddd			0.08			0.003

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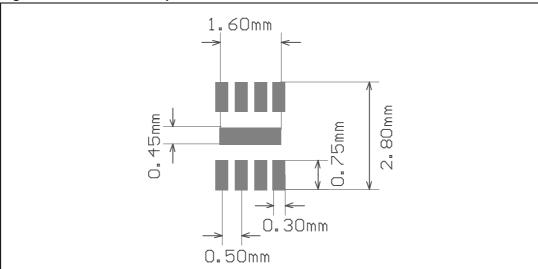


Figure 9. DFN8 2x2 footprint recommendation

TS391 **Package information** 

#### 4.2 SOT23-5L package mechanical data

Figure 10. SOT23-5L package mechanical drawing

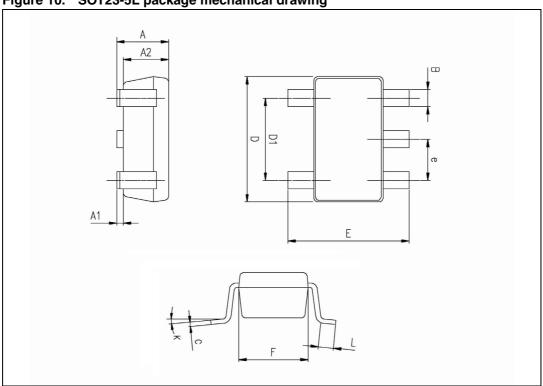


Table 5. SOT23-5L package mechanical data

	Dimensions					
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
А	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
В	0.35	0.40	0.50	0.013	0.015	0.019
С	0.09	0.15	0.20	0.003	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
е		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	0.013	0.023
K	0 degrees		10 degrees			

Ordering information TS391

## 5 Ordering information

Table 6. Order codes

Part number	Temperature range	Package	Packaging	Marking
TS391ILT		SOT23-5L		K511
TS391IYLT <sup>(1)</sup>	-40°C, +125°C	SOT23-5L (Automotive grade)	Tape & reel	K510
TS391RILT		SOT23-5L		K509
TS391IQ2T		DFN8 2x2		K5D

<sup>1.</sup> Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q002 or equivalent.

TS391 Revision history

# 6 Revision history

Table 7. Document revision history

Date	Revision	Changes
22-Sep-2004	1	Initial release.
06-Jan-2006	2	PPAP reference inserted in the document.
21-Nov-2007	3	Added values for R <sub>thja</sub> , R <sub>thjc</sub> and ESD in <i>Table 1: Absolute maximum ratings (AMR)</i> .  Added footnote for automotive grade order code in order codes table.  Updated format.
21-Jan-2010	4	Corrected ESD tolerance values for human body model and machine model in <i>Table 1: Absolute maximum ratings (AMR)</i> and added ESD tolerance value for charged device model.  Updated note 1 in <i>Table 6: Order codes</i> .
23-May-2011	5	Added TS391R pinout on page 1.  Modified V <sub>CC</sub> range in <i>Table 2: Operating conditions</i> .  Added TS391RILT order code in <i>Table 6: Order codes</i> .
02-Mar-2012	6	Added DFN8 package information and changed SOT23-5L package drawing in <i>Chapter 4</i> .

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