

## Low-power single voltage comparator

Datasheet – production data

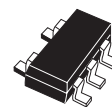
### Features

- Wide single supply voltage range or dual supplies +2 V to +36 V or  $\pm 1$  V to  $\pm 18$  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:  $\pm 5$  nA typ.
- Low input offset voltage:  $\pm 1$  mV typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage: 250 mV typ. ( $I_o = 4$  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)

# 1 Schematic diagram

Figure 1. Schematic diagram

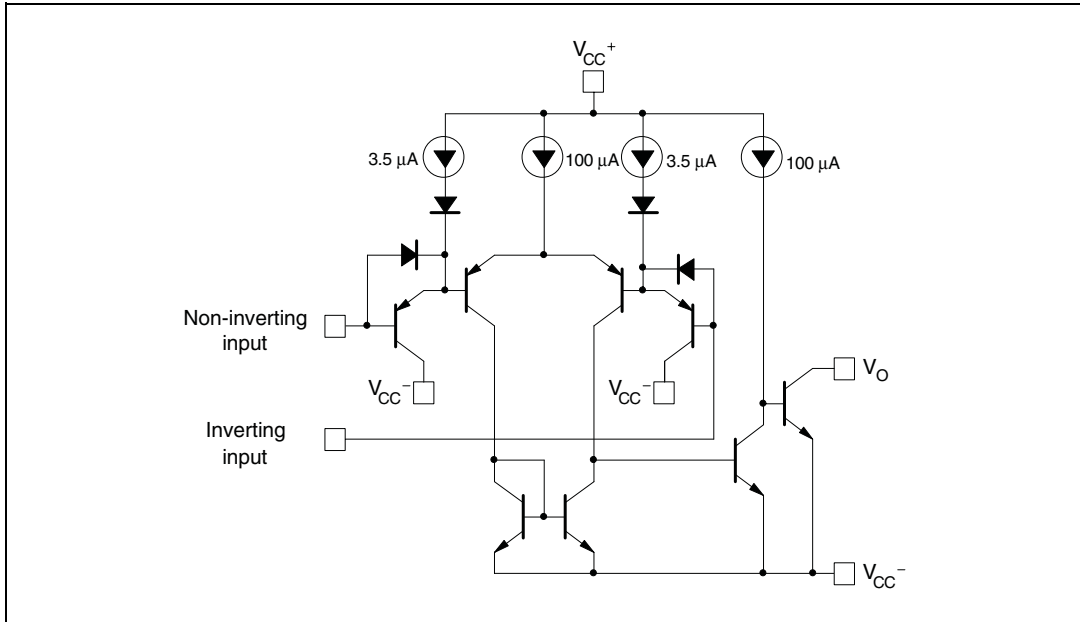
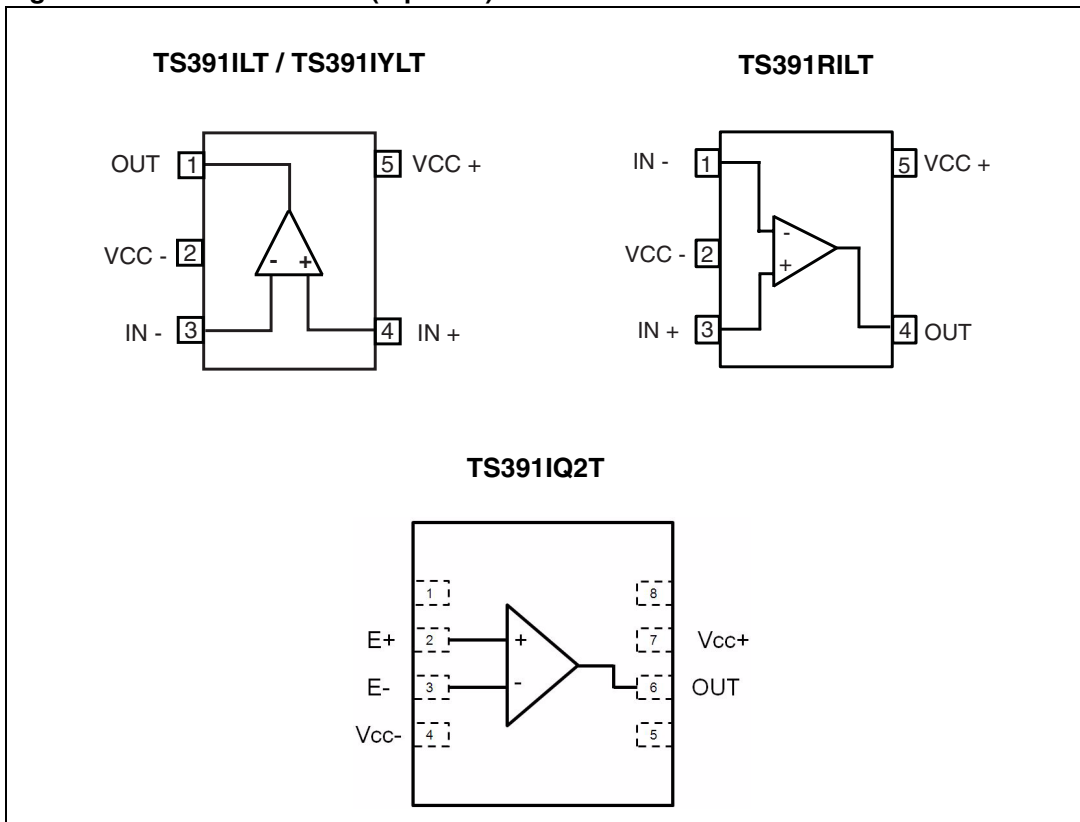


Figure 2. Pin connections (top view)



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings (AMR)**

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

- 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  $V_{CC}^+$ .
- Short-circuits can cause excessive heating. These values are typical.
- 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.
- 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
$V_{CC}$	Supply voltage	2 to 36 or $\pm 1$ to $\pm 18$	V
$V_{icm}$	Input common mode voltage range <sup>(1)</sup>		V
	$T_{amb} = 25^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	0 to $V_{CC}^+ - 1.5$ 0 to $V_{CC}^+ - 2$	
$T_{oper}$	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  $V_{CC}^+ - 1.5$  V, but either or both inputs can go to +30 V without damage.

### 3 Electrical characteristics

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

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

1. At output switch point,  $V_o \approx 1.4\text{V}$ ,  $R_S = 0\Omega$  with  $V_{CC}^+$  from  $5\text{V}$  to  $30\text{V}$  and over the full input common-mode range ( $0\text{ V}$  to  $V_{CC}^+ - 1.5\text{ V}$ ).
2. 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.
3. 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  $-0.3\text{ V}$  (or  $0.3\text{ V}$  below the negative power supply, if used).
4. The response time specified is for a  $100\text{ mV}$  input step with  $5\text{ mV}$  overdrive. For larger overdrive signals,  $300\text{ ns}$  can be obtained.

Figure 3. Supply current vs. supply voltage

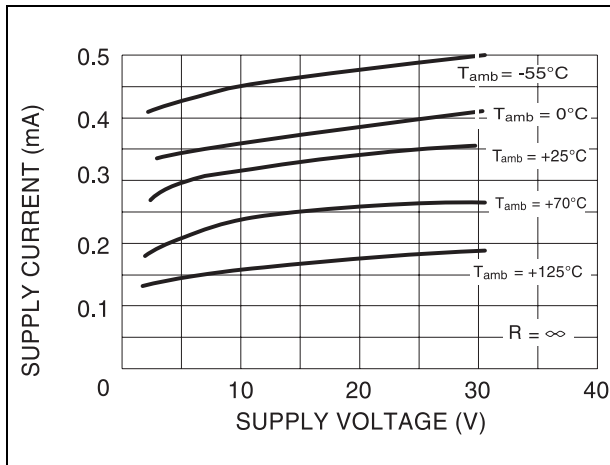


Figure 4. Response time for various input overdrives - negative transition

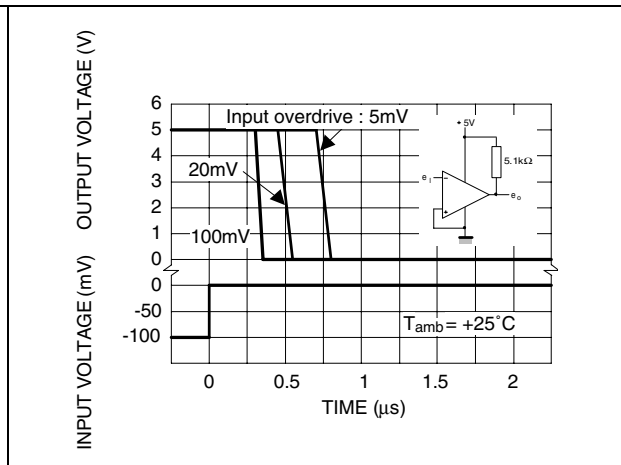


Figure 5. Input current vs. supply voltage

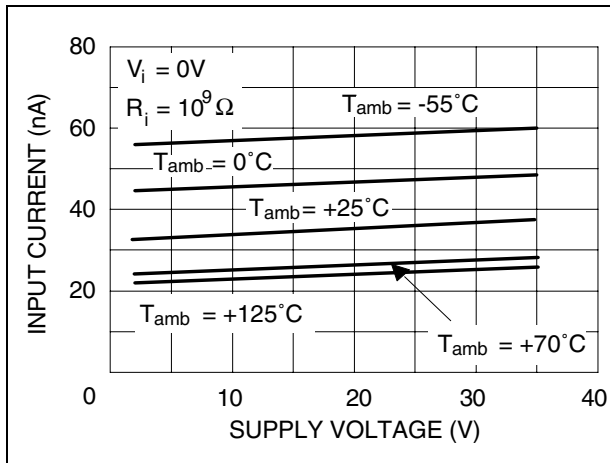


Figure 6. Response time for various input overdrives - positive transition

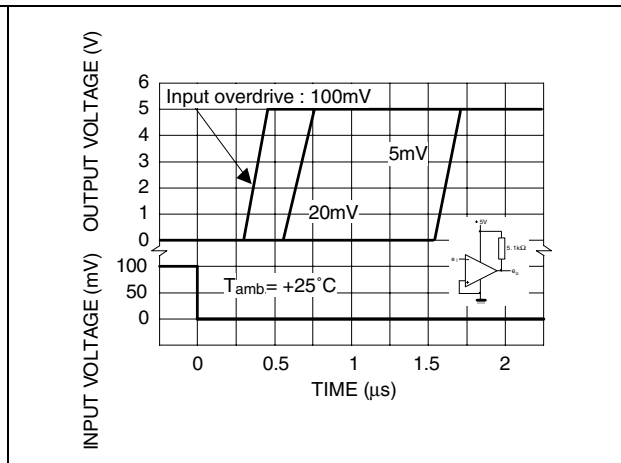
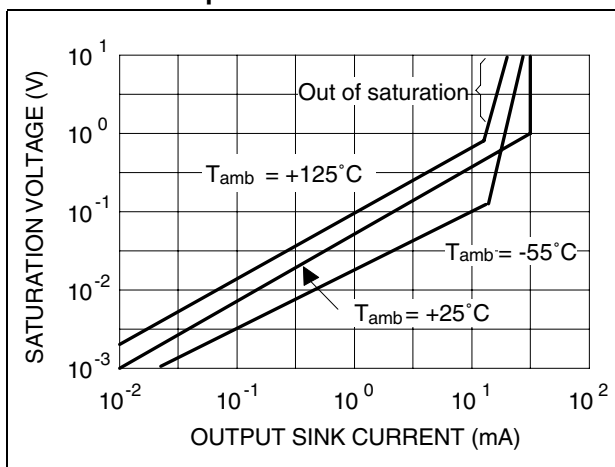


Figure 7. Output saturation voltage vs. output current



## 4 Package information

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: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 4.1 DFN8 2x2 mm package mechanical data

Figure 8. DFN8 2x2 mm package mechanical drawing

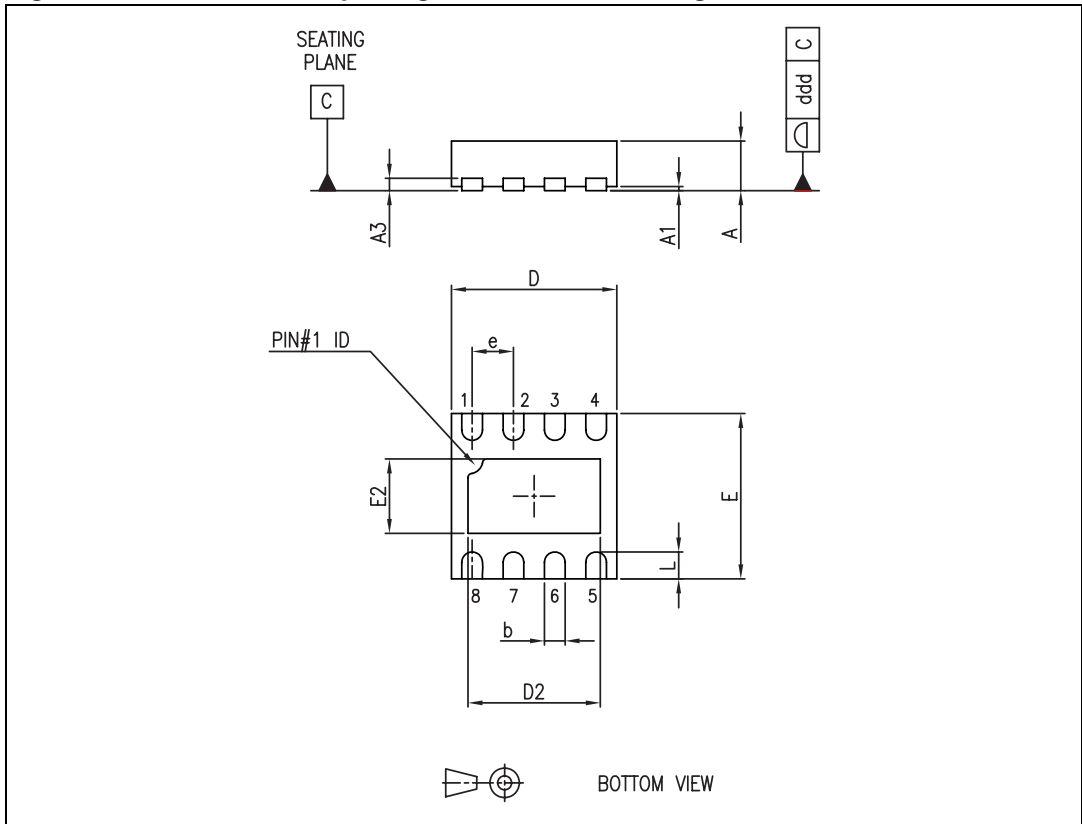
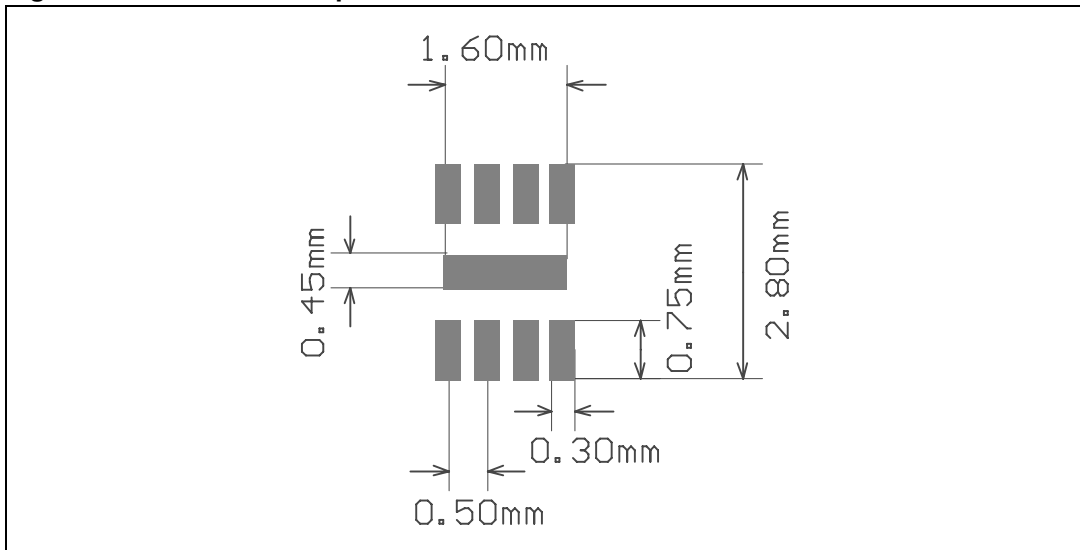


Table 4. DFN8 2x2x0.6 mm package mechanical data (pitch 0.5 mm)

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	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
E	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
e		0.50			0.020	
L			0.50			0.020
ddd			0.08			0.003

Figure 9. DFN8 2x2 footprint recommendation



## 4.2 SOT23-5L package mechanical data

Figure 10. SOT23-5L package mechanical drawing

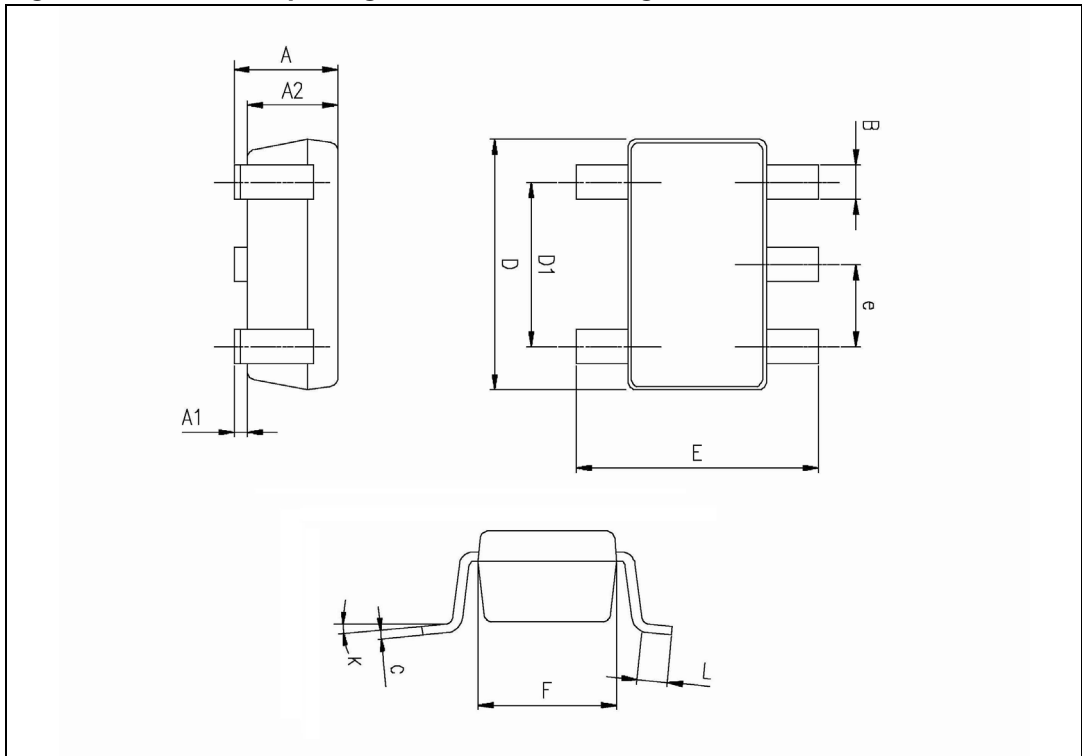


Table 5. SOT23-5L package mechanical data

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	0.013	0.015	0.019
C	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	
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	0.013	0.023
K	0 degrees		10 degrees			

## 5 Ordering information

**Table 6. Order codes**

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

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

## 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 $R_{thja}$ , $R_{thjc}$ and ESD in <a href="#">Table 1: Absolute maximum ratings (AMR)</a> . 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 <a href="#">Table 1: Absolute maximum ratings (AMR)</a> and added ESD tolerance value for charged device model. Updated note 1 in <a href="#">Table 6: Order codes</a> .
23-May-2011	5	Added TS391R pinout on page 1. Modified $V_{CC}$ range in <a href="#">Table 2: Operating conditions</a> . Added TS391RILT order code in <a href="#">Table 6: Order codes</a> .
02-Mar-2012	6	Added DFN8 package information and changed SOT23-5L package drawing in <a href="#">Chapter 4</a> .

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