

## Micropower dual CMOS voltage comparators

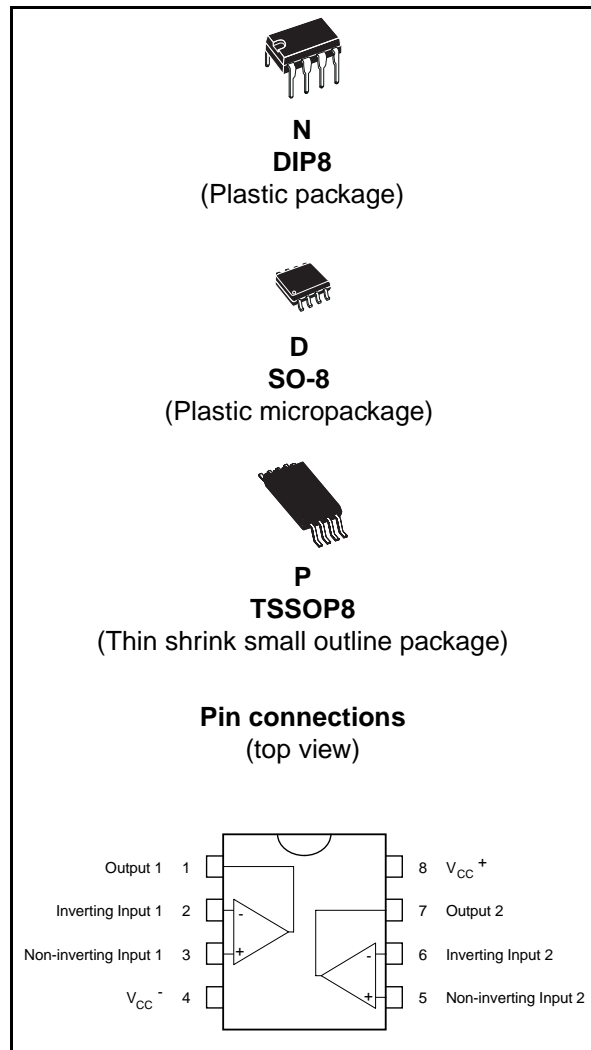
### Features

- Extremely low supply current: typically 9  $\mu\text{A}$  per comparator
- Wide single supply range 2.7 V to 16 V or dual supplies ( $\pm 1.35$  V to  $\pm 8$  V)
- Extremely low input bias current: 1 pA typical
- Extremely low input offset current: 1 pA typical
- Input common-mode voltage range includes ground
- High input impedance:  $10^{12} \Omega$  typ
- Fast response time: 2.5  $\mu\text{s}$  typ. for 5 mV overdrive
- Pin-to-pin and functionally compatible with dual bipolar LM393

### Description

The TS393 is a micropower CMOS dual voltage comparator with extremely low consumption of 9  $\mu\text{A}$  typically per comparator (20 times less than the dual bipolar LM393). Similar performance is offered by the dual micropower comparator TS3702 with a push-pull CMOS output.

Thus response times remain similar to the LM393.



# 1 Absolute maximum ratings

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

Symbol	Parameter	Value	Unit
$V_{CC}^+$	Supply voltage <sup>(1)</sup>	18	V
$V_{id}$	Differential input voltage <sup>(2)</sup>	±18	V
$V_{in}$	Input voltage <sup>(3)</sup>	18	V
$V_o$	Output voltage	18	V
$I_o$	Output current	20	mA
$I_F$	Forward current in ESD protection diodes on inputs <sup>(4)</sup>	50	mA
$T_j$	Maximum junction temperature	150	°C
$R_{thja}$	Thermal resistance junction to ambient <sup>(5)</sup>		°C/W
	DIP8	85	
	SO-8 TSSOP8	125 120	
$R_{thjc}$	Thermal resistance junction to case <sup>(5)</sup>		°C/W
	DIP8	41	
	SO-8 TSSOP8	40 37	
$T_{stg}$	Storage temperature range	-65 to +150	°C
ESD	HBM: human body model <sup>(6)</sup>	500	V
	MM: machine model <sup>(7)</sup>	200	V
	CDM: charged device model <sup>(8)</sup>	1	kV

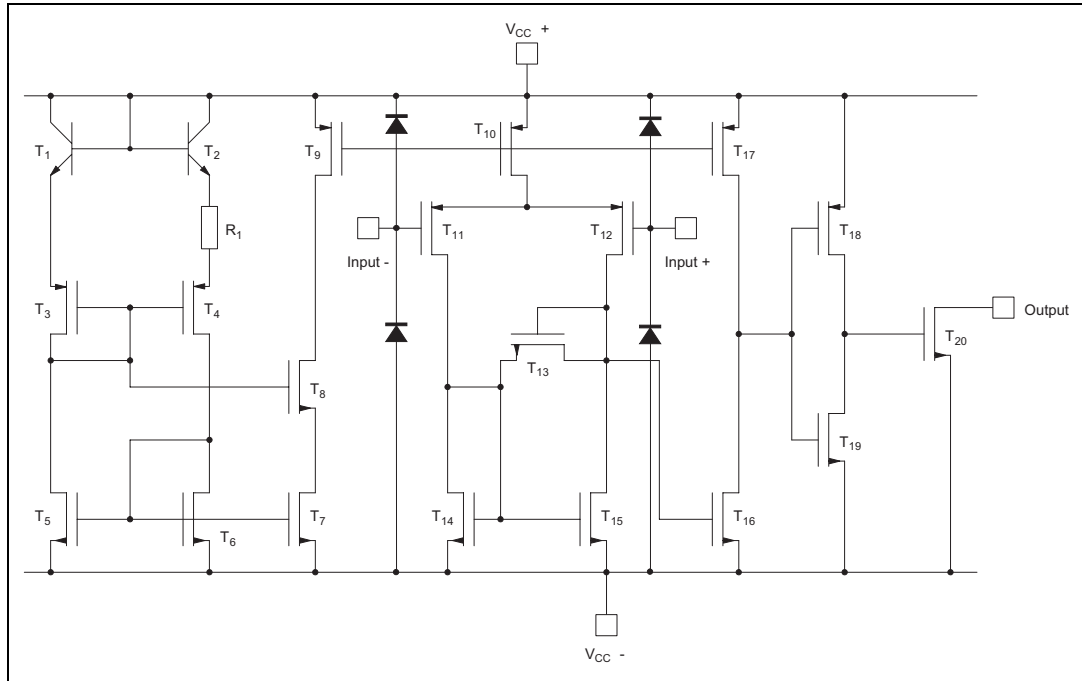
1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. Excursions of input voltages may exceed the power supply level. As long as the common mode voltage  $[V_{icm}=(V_{in}^+ + V_{in}^-)/2]$  remains within the specified range, the comparator will provide a stable output state. However, the maximum current through the ESD diodes ( $I_F$ ) of the input stage must strictly be observed.
4. Guaranteed by design.
5. Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
6. 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.
7. 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.
8. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

**Table 2. Operating conditions**

Symbol	Parameter	Value	Unit
$V_{CC}^+$	Supply voltage TS393C, TS393I	2.7 to 16	V
$V_{icm}$	Common mode input voltage range $T_{min} \leq T_{amb} \leq T_{max}$	0 to $V_{CC}^+ - 1.5$ 0 to $V_{CC}^+ - 2$	V
$T_{oper}$	Operating free-air temperature range TS393C TS393I	0 to +70 -40 to +125	°C

## 2 Schematic diagram

Figure 1. Schematic diagram (for 1/2 TS393)



### 3 Electrical characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage <sup>(1)</sup> $V_{ic} = 1.5V$ $T_{min} \leq T_{amb} \leq T_{max}$			5 6.5	mV
$I_{io}$	Input offset current <sup>(2)</sup> $V_{ic} = 1.5V$ $T_{min} \leq T_{amb} \leq T_{max}$		1	300	pA
$I_{ib}$	Input bias current <sup>(2)</sup> $V_{ic} = 1.5V$ $T_{min} \leq T_{amb} \leq T_{max}$		1	600	pA
CMR	Common-mode rejection ratio $V_{ic} = V_{icm-min}$		70		dB
SVR	Supply voltage rejection ratio $V_{CC}^+ = 3V$ to $5V$		70		dB
$I_{OH}$	High level output current $V_{id} = +1V$ , $V_{OH} = 3V$ $T_{min} \leq T_{amb} \leq T_{max}$		2	40 1000	nA
$V_{OL}$	Low level output voltage $V_{id} = -1V$ , $I_{OL} = +6mA$ $T_{min} \leq T_{amb} \leq T_{max}$		400	550 800	mV
$I_{CC}$	Supply current (each comparator) No load - outputs low $T_{min} \leq T_{amb} \leq T_{max}$		9	20 25	$\mu A$
$t_{PLH}$	Response time low to high $V_{ic} = 0V$ , $f = 10kHz$ , $R_L = 5.1k\Omega$ , $C_L = 50pF$ Overdrive = 5mV TTL input		1.5 0.7		$\mu s$
$t_{PHL}$	Response time high to low $V_{ic} = 0V$ , $f = 10kHz$ , $R_L = 5.1k\Omega$ , $C_L = 50pF$ Overdrive = 5mV TTL input		2.5 0.08		$\mu s$

1. The specified offset voltage is the maximum value required to drive the output up to 2.5 V or down to 0.3 V.

2. Maximum values include unavoidable inaccuracies of the industrial tests.

**Table 4.**  $V_{CC}^+ = 5V, V_{CC}^- = 0V, T_{amb} = 25^{\circ}C$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage <sup>(1)</sup> $V_{ic} = 2.5V, V_{CC}^+ = 5V \text{ to } 10V$ $T_{min} \leq T_{amb} \leq T_{max}$		1.4	5 6.5	mV
$I_{io}$	Input offset current <sup>(2)</sup> $V_{ic} = 2.5V$ $T_{min} \leq T_{amb} \leq T_{max}$		1	300	pA
$I_{ib}$	Input bias current <sup>(2)</sup> $V_{ic} = 2.5V$ $T_{min} \leq T_{amb} \leq T_{max}$		1	600	pA
CMR	Common-mode rejection ratio $V_{ic} = 0V$		71		dB
SVR	Supply voltage rejection ratio $V_{CC}^+ = +5V \text{ to } +10V$		80		dB
$I_{OH}$	High level output voltage $V_{id} = 1V, V_{OH} = +5V$ $T_{min} \leq T_{amb} \leq T_{max}$		2	40 1000	nA
$V_{OL}$	Low level output voltage $V_{id} = -1V, I_{OL} = 6mA$ $T_{min} \leq T_{amb} \leq T_{max}$		260	400 650	mV
$I_{CC}$	Supply current (each comparator) No load - outputs low $T_{min} \leq T_{amb} \leq T_{max}$		10	20 25	$\mu A$
$t_{PLH}$	Response time low to high $V_{ic} = 0V, f = 10kHz, R_L = 5.1k\Omega, C_L = 50pF,$ Overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL input		1.5 1.2 1.0 0.8 0.7		$\mu s$
$t_{PHL}$	Response time high to low $V_{ic} = 0V, f = 10kHz, R_L = 5.1k\Omega, C_L = 50pF,$ Overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL input		2.5 1.9 1.2 0.8 0.08		$\mu s$
$t_f$	Fall time $f = 10kHz, C_L = 50pF, R_L = 5.1k\Omega, \text{overdrive } 50mV$		25		ns

1. The specified offset voltage is the maximum value required to drive the output up to 4.5V or down to 0.3V.
2. Maximum values including unavoidable inaccuracies of the industrial tests.

## 4 Package information

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> 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 ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

### 4.1 DIP8 package information

Figure 2. DIP8 package mechanical drawing

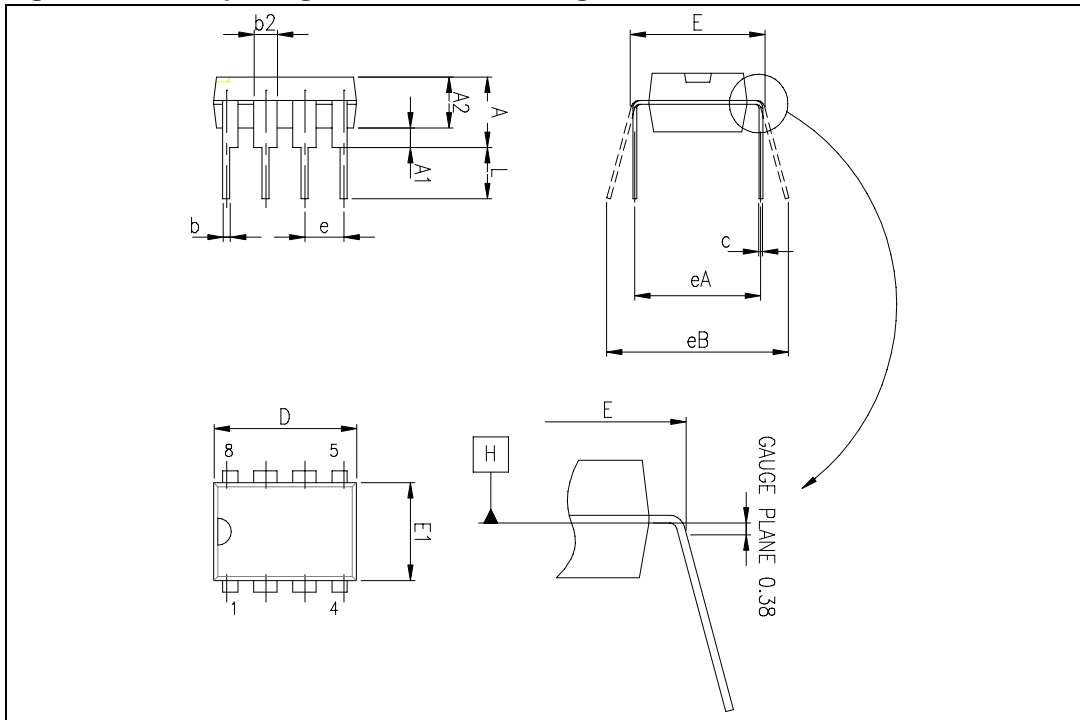


Table 5. DIP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150



## 4.2 SO-8 package information

Figure 3. SO-8 package mechanical drawing

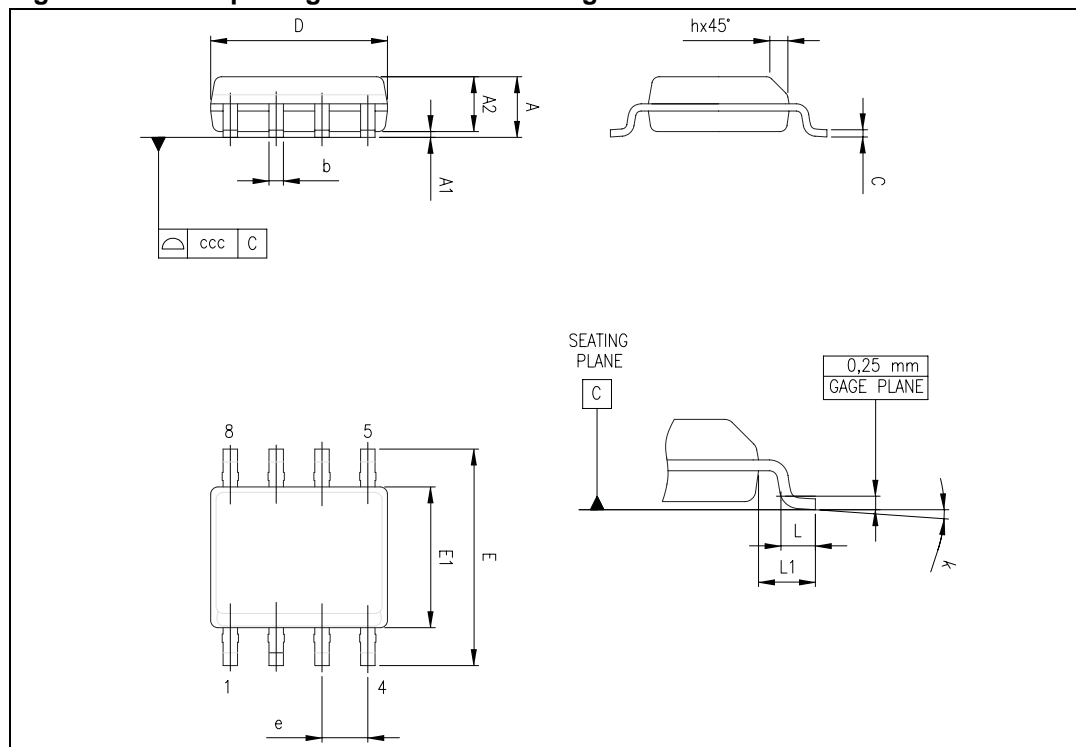


Table 6. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	1°		8°	1°		8°
ccc			0.10			0.004

### 4.3 TSSOP8 package information

Figure 4. TSSOP8 package mechanical drawing

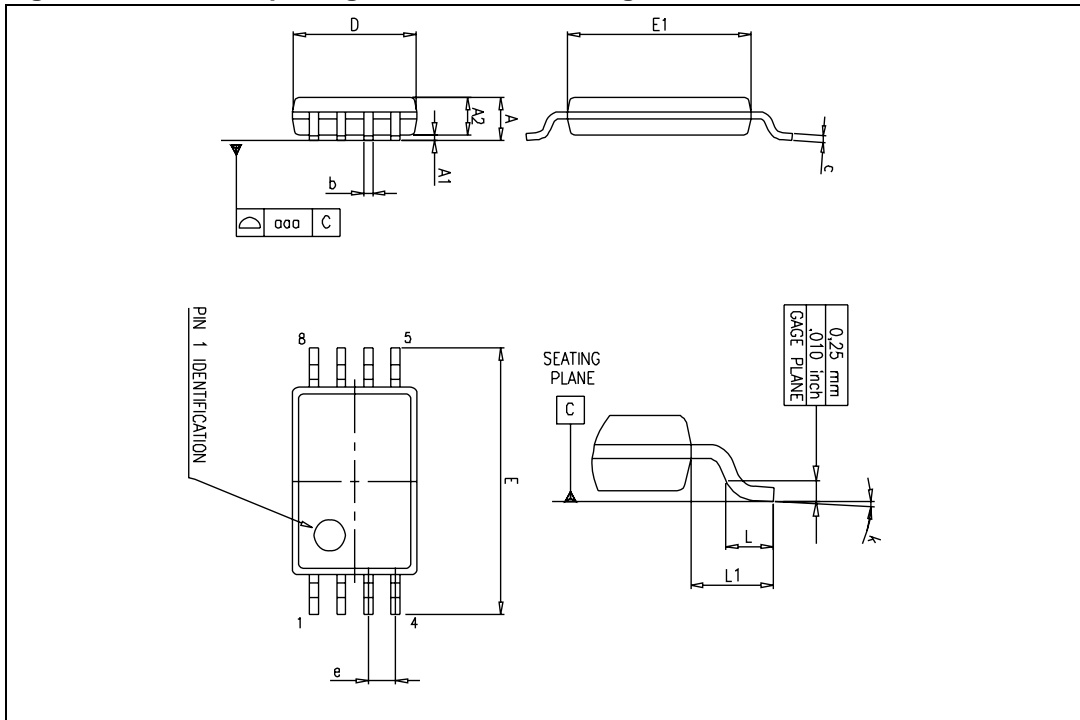


Table 7. TSSOP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa		0.1			0.004	

## 5 Ordering information

**Table 8. Order codes**

Order code	Temperature range	Package	Packing	Marking
TS393CN	0°C, +70°C	DIP8	Tube	TS393CN
TS393CD TS393CDT		SO-8	Tube or Tape & reel	S393C
TS393IN	-40°C, +125°C	DIP8	Tube	TS393IN
TS393ID TS393IDT		SO-8	Tube or Tape & reel	S393I
TS393IPT		TSSOP8	Tape & reel	S393I
TS393IYD <sup>(1)</sup> TS393IYDT <sup>(1)</sup>	-40°C, +125°C	SO-8 (Automotive grade)	Tube or Tape & reel	S393IY

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

## 6 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
31-Jan-2003	1	Initial release.
31-Jul-2005	2	PPAP references inserted in the datasheet, see order codes table. ESD protection inserted in AMR table.
28-Apr-2008	3	Added footnotes for automotive grade order codes in order codes table. Updated ESD values for HBM and MM. Updated document format.

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