TS393

Micropower dual CMOS voltage comparators

Datasheet – production data

Features

- Extremely low supply current: typically 9 µA per comparator
- Wide single supply range 2.7 V to 16 V or dual supplies (±1.35 V to ±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} Ω typ.
- Fast response time: 2.5 µs typ. for 5 mV overdrive
- Pin-to-pin and functionally compatible with dual bipolar LM393

Description

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

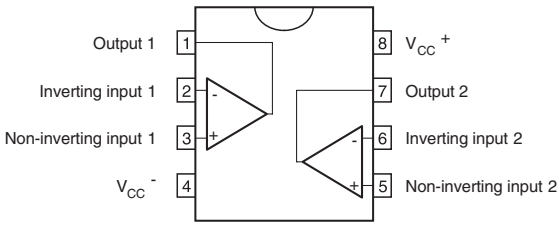
Thus response times remain similar to the LM393 device.

N
DIP8
(plastic package)

D
SO-8
(plastic micropackage)

P
TSSOP8
(thin shrink small outline package)

Pin connections
(top view)



1 Absolute maximum ratings

Table 1. Absolute maximum ratings (AMR)

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

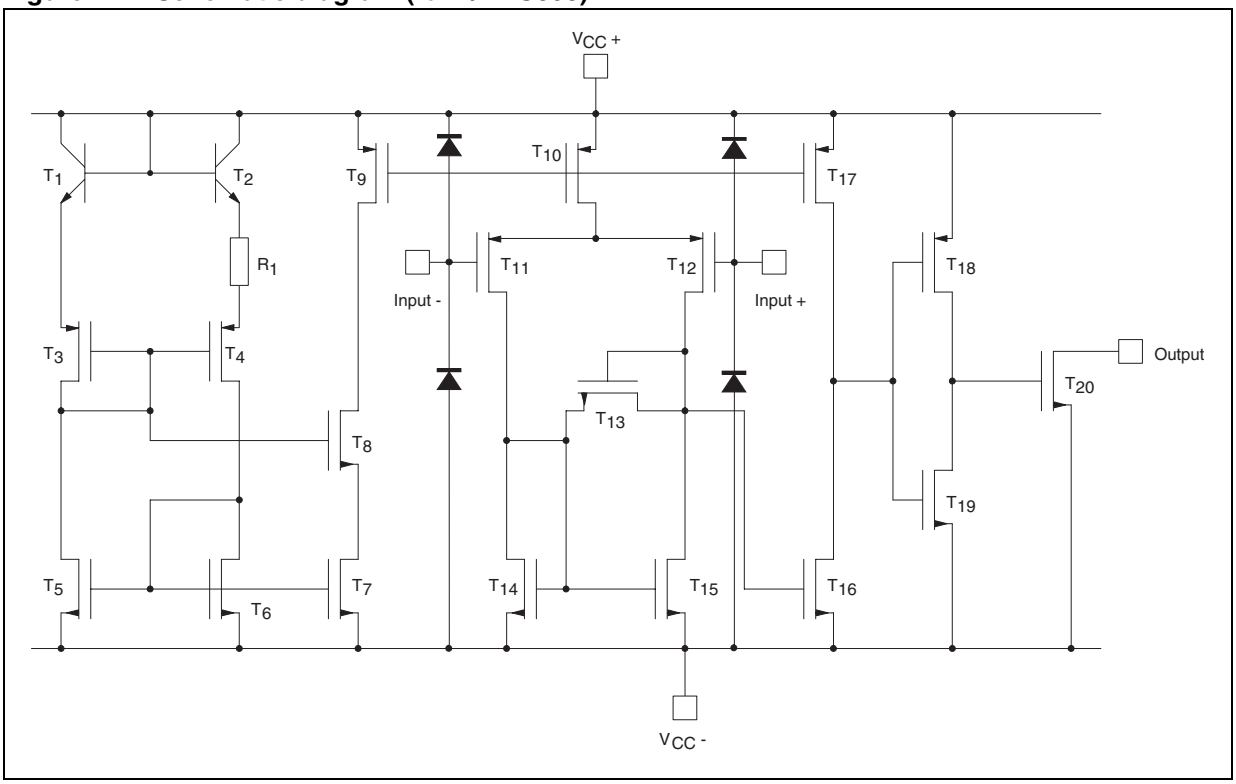
1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. Excursions of input voltages may exceed the power supply level. As long as the common mode voltage $[V_{icm} = (V_{in}^+ + V_{in}^-)/2]$ remains within the specified range, the comparator will provide a stable output state. However, the maximum current through the ESD diodes (IF) 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 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}^+ = 3 V, V_{CC}^- = 0 V, T_{amb} = 25 °C (unless otherwise specified)

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

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}^+ = 5 V, V_{CC}^- = 0 V, T_{amb} = 25 °C (unless otherwise specified)

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

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

4 Package information

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

4.1 DIP8 package

Figure 2. DIP8 package outline

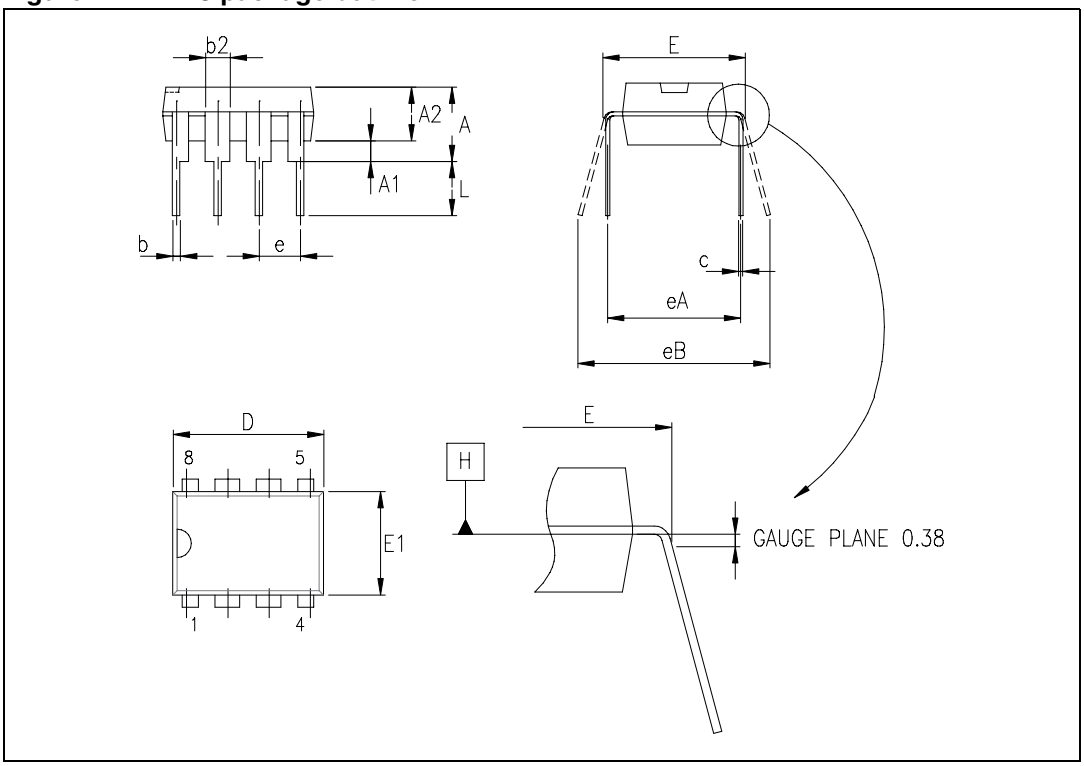


Table 5. DIP8 package mechanical data

Symbol	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

Figure 3. SO-8 package outline

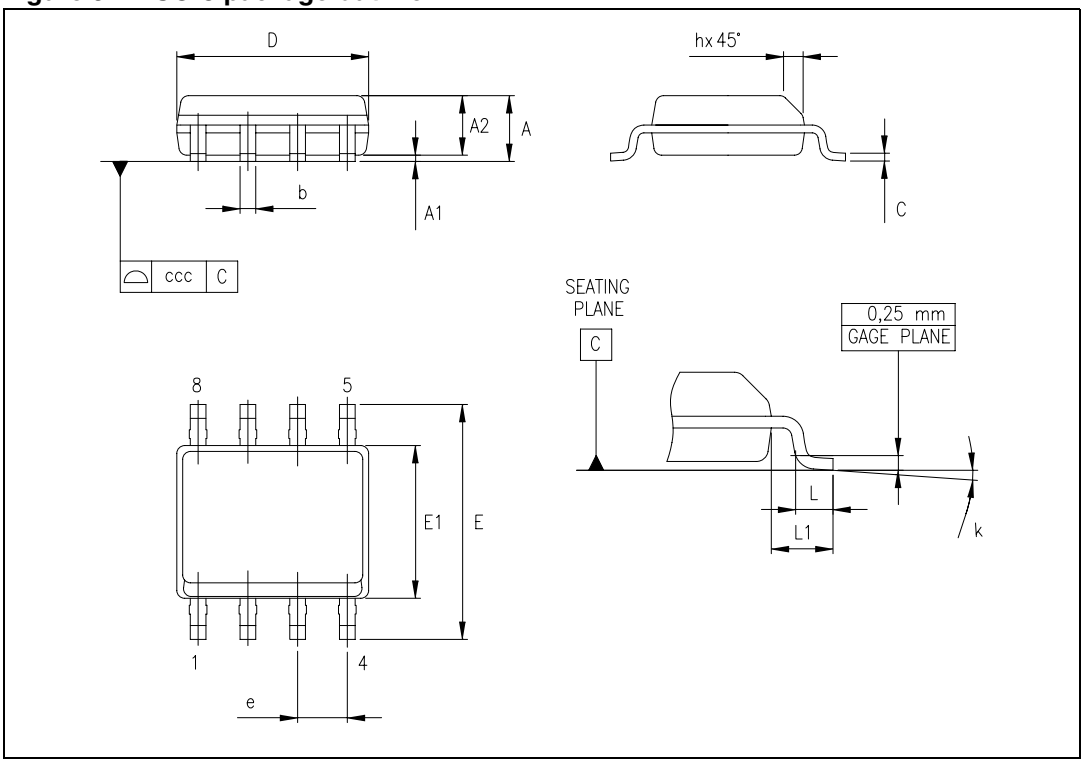


Table 6. SO-8 package mechanical data

Symbol	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

Figure 4. TSSOP8 package outline

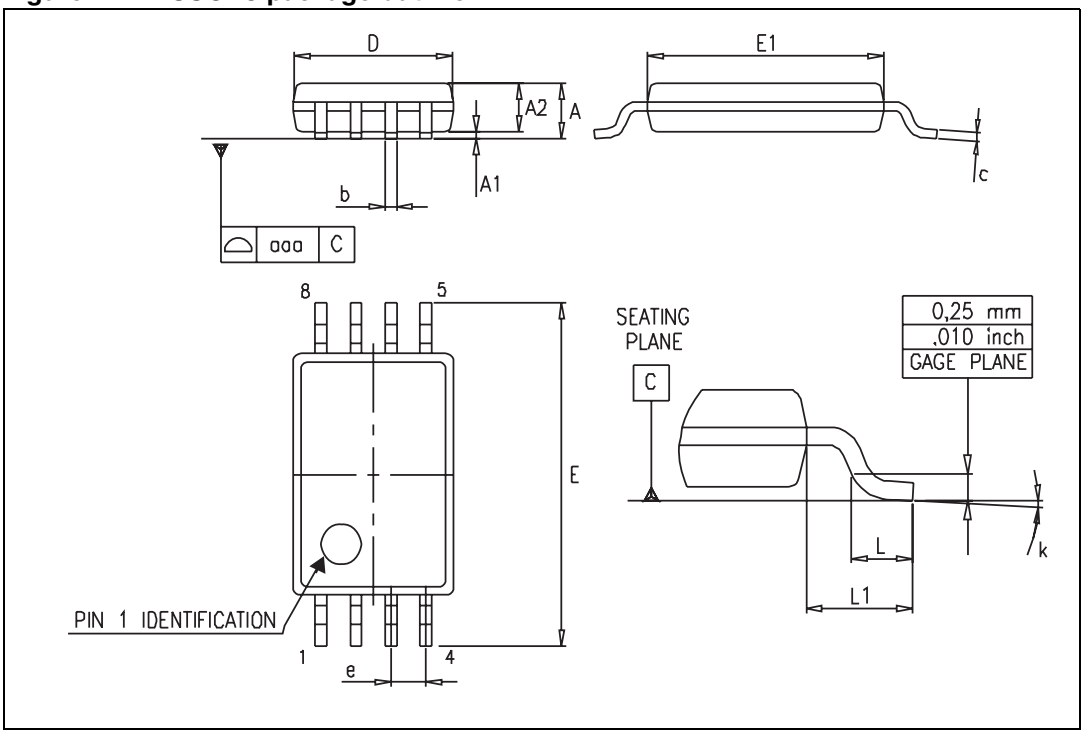


Table 7. TSSOP8 package mechanical data

Symbol	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 and reel	S393C
TS393IN	-40 °C, +125 °C	DIP8	Tube	TS393IN
TS393ID TS393IDT		SO-8	Tube or tape and reel	S393I
TS393IPT		TSSOP8	Tape and reel	S393I
TS393IYDT(1)		SO-8 (automotive grade)	Tube or tape and reel	S393IY

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

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.
21-Nov-2012	4	Updated ECOPACK text in *Section 4: Package information*. Updated *Table 8* (qualified TS393IYDT and removed TS393IYD order code). Minor corrections throughout document.

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