

## Micropower dual CMOS voltage comparators

Datasheet – production data

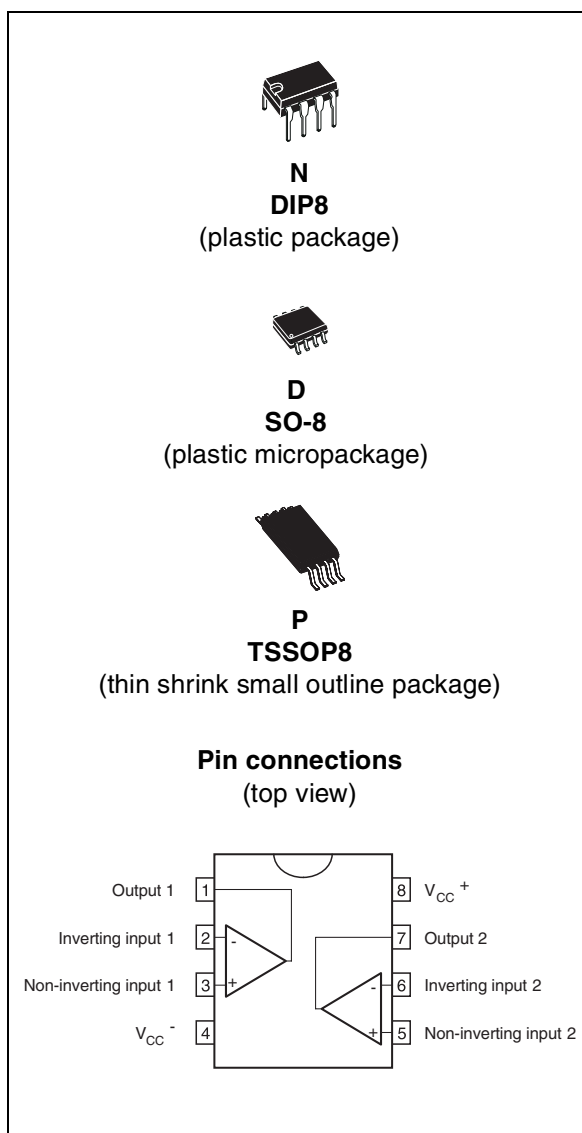
### Features

- 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 device 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 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.



# 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>		
	DIP8	85	°C/W
	SO-8	125	
TSSOP8	120		
$R_{thjc}$	Thermal resistance junction-to-case <sup>(5)</sup>		
	DIP8	41	°C/W
	SO-8	40	
TSSOP8	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

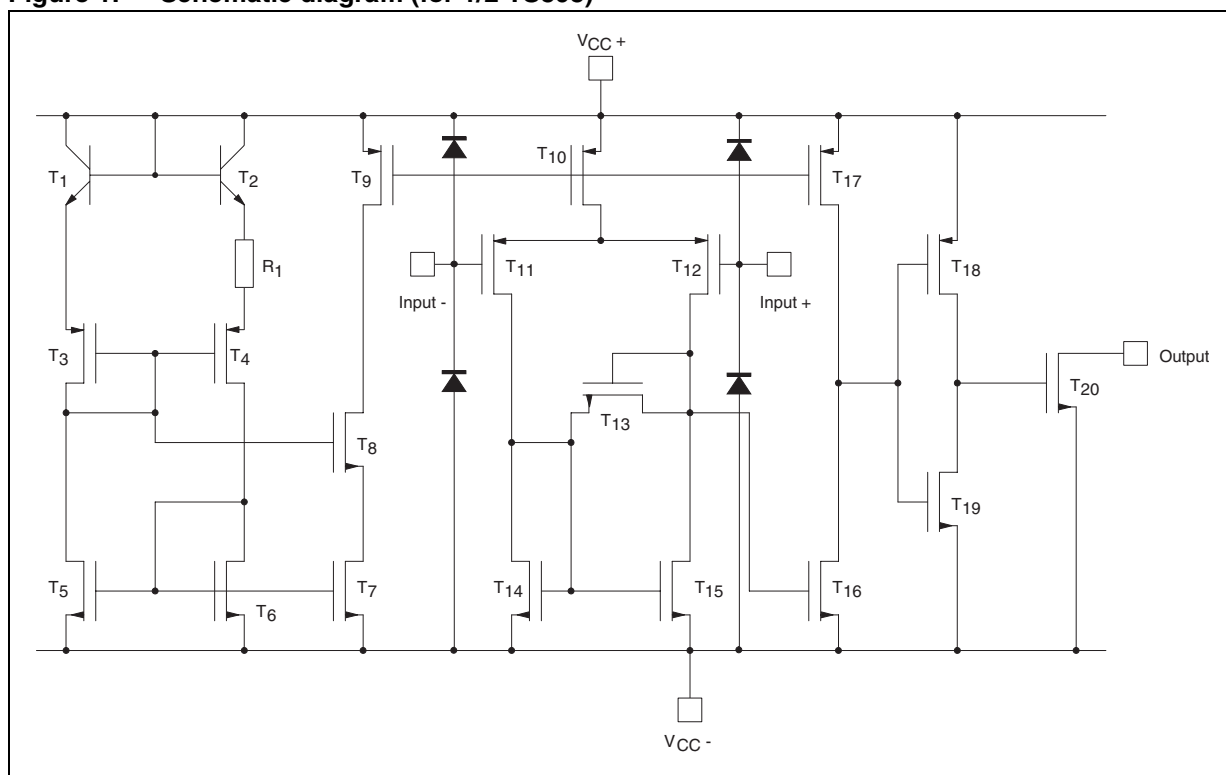
1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. Excursions of input voltages may exceed the power supply level. As long as the common mode voltage  $[V_{icm} = (V_{in}^+ + V_{in}^-)/2]$  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 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.**  $V_{CC}^+ = 3\text{ V}$ ,  $V_{CC}^- = 0\text{ V}$ ,  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$  (unless otherwise specified)

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

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage <sup>(1)</sup> $V_{ic} = 2.5\text{ V}$ , $V_{CC}^+ = 5\text{ V to } 10\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$		1.4	5 6.5	mV
$I_{io}$	Input offset current <sup>(2)</sup> $V_{ic} = 2.5\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$		1	300	pA
$I_{ib}$	Input bias current <sup>(2)</sup> $V_{ic} = 2.5\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$		1	600	pA
CMR	Common-mode rejection ratio $V_{ic} = 0\text{ V}$		71		dB
SVR	Supply voltage rejection ratio $V_{CC}^+ = +5\text{ V to } +10\text{ V}$		80		dB
$I_{OH}$	High level output voltage $V_{id} = 1\text{ V}$ , $V_{OH} = +5\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$		2	40 1000	nA
$V_{OL}$	Low level output voltage $V_{id} = -1\text{ V}$ , $I_{OL} = 6\text{ mA}$ $T_{min} \leq T_{amb} \leq T_{max}$		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	$\mu\text{A}$
$t_{PLH}$	Response time low to high $V_{ic} = 0\text{ V}$ , $f = 10\text{ kHz}$ , $R_L = 5.1\text{ k}\Omega$ , $C_L = 50\text{ pF}$ , Overdrive = 5 mV Overdrive = 10 mV Overdrive = 20 mV Overdrive = 40 mV TTL input		1.5 1.2 1.0 0.8 0.7		$\mu\text{s}$
$t_{PHL}$	Response time high to low $V_{ic} = 0\text{ V}$ , $f = 10\text{ kHz}$ , $R_L = 5.1\text{ k}\Omega$ , $C_L = 50\text{ pF}$ , Overdrive = 5 mV Overdrive = 10 mV Overdrive = 20 mV Overdrive = 40 mV TTL input		2.5 1.9 1.2 0.8 0.08		$\mu\text{s}$
$t_f$	Fall time $f = 10\text{ kHz}$ , $C_L = 50\text{ pF}$ , $R_L = 5.1\text{ k}\Omega$ 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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 DIP8 package

Figure 2. DIP8 package outline

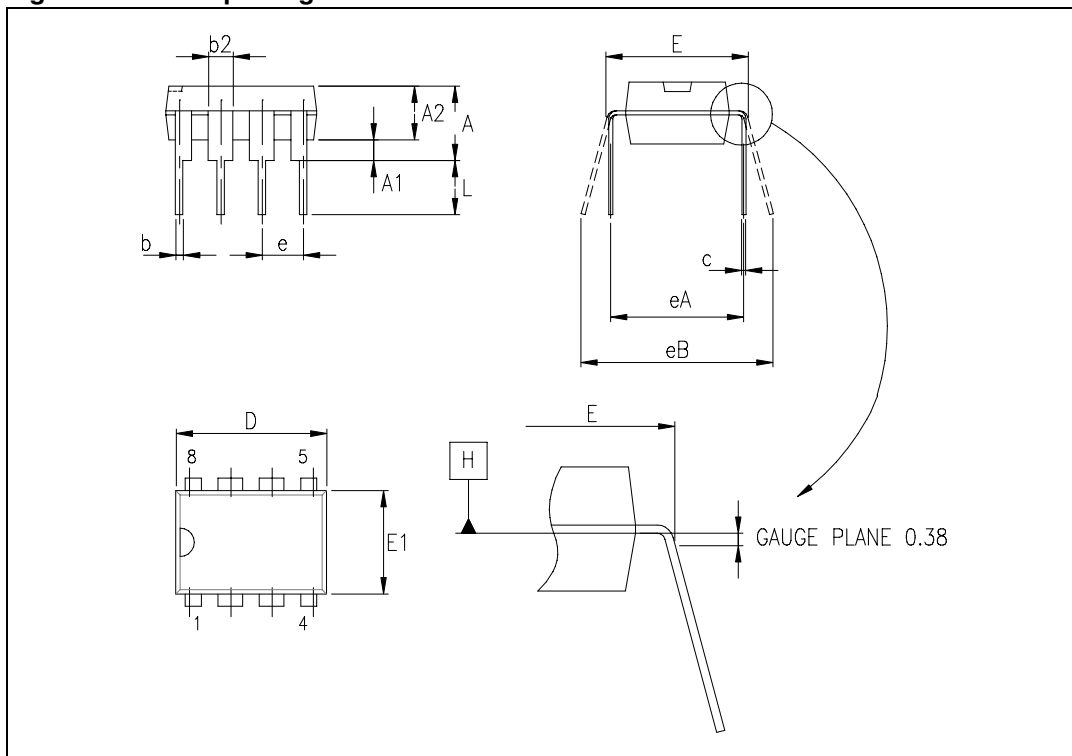


Table 5. DIP8 package mechanical data

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

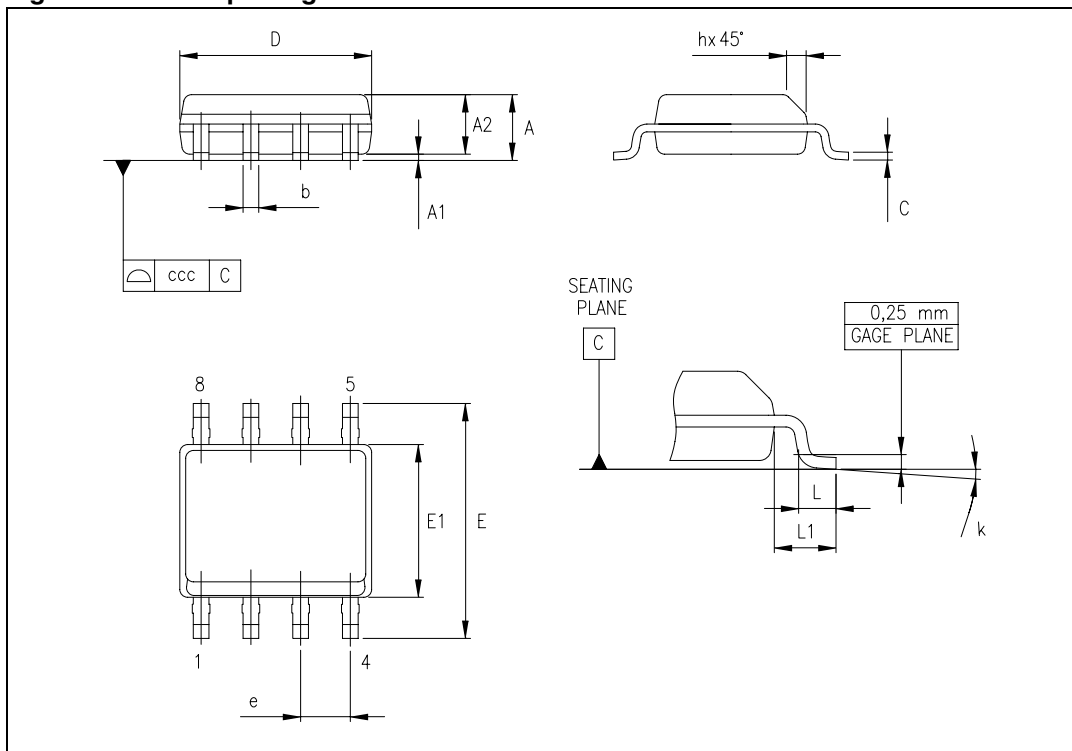


Table 6. SO-8 package mechanical data

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

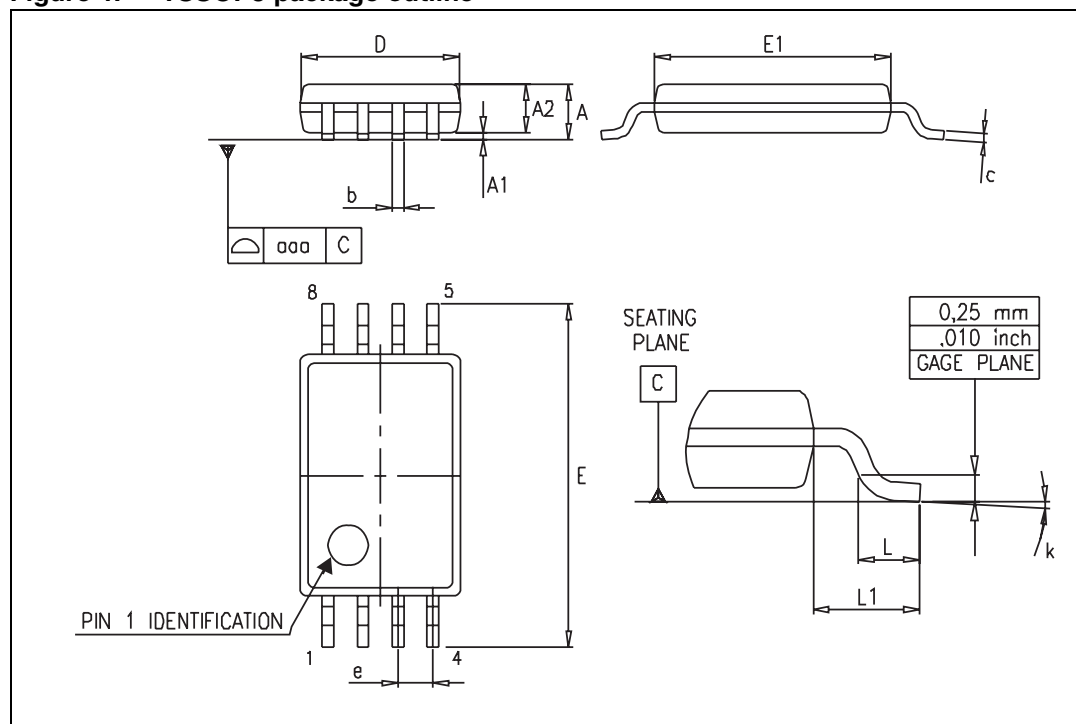


Table 7. TSSOP8 package mechanical data

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 <sup>(1)</sup>		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 <a href="#">Section 4: Package information</a> . Updated <a href="#">Table 8</a> (qualified TS393IYDT and removed TS393IYD order code). Minor corrections throughout document.

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