LM193, LM193A, LM293, LM293A, LM393, LM393A

Low Power Dual Voltage Comparators

- Wide single-supply voltage range or dual supplies: +2V to +36V or ±1V to ±18V
- Very low supply current (0.4mA) independent of supply voltage (1mW/comparator at +5V)
- Low input bias current: 25nA typ.
- Low input offset current: ±5nA typ.
- Low input offset voltage: ±1mV typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage: 250mV typ. (Io = 4mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs

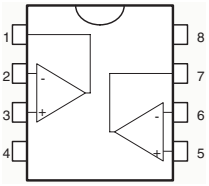
N
DIP8
(Plastic Package)

D
SO-8
(Plastic Micropackage)

P
TSSOP8
(Thin Shrink Small Outline Package)

S
Mini SO-8
(Plastic Micropackage)

Pin connections (top view)



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^-
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^+

Description

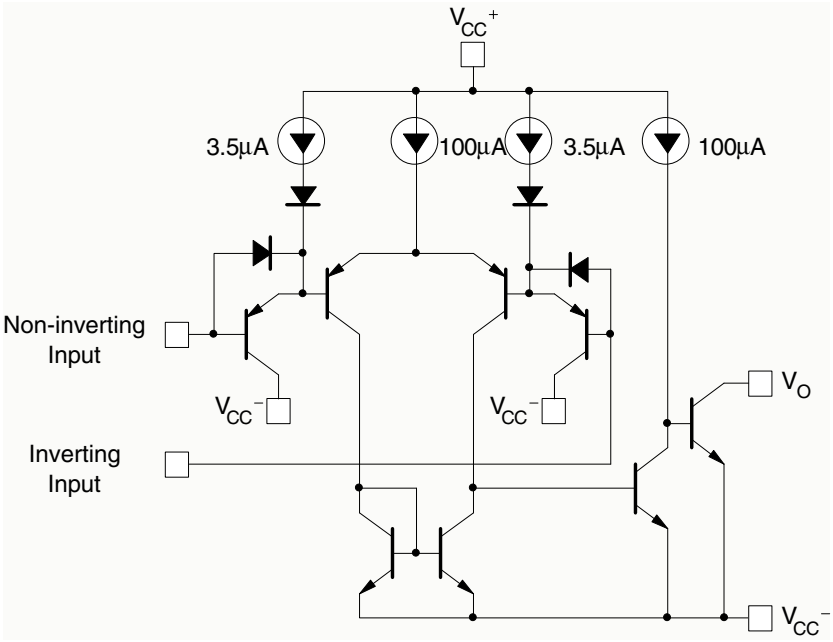
These devices consist of two independent low voltage comparators designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

1 Order Codes

Part Number	Temperature Range	Package	Packing	Marking
LM193AD/LM193ADT	-55°C, +125°C	SO-8	Tube or Tape & Reel	
LM193AN		DIP8	Tube	
LM193D/LM193DT		SO-8	Tube or Tape & Reel	
LM193N		DIP8	Tube	
LM293AD/LM293ADT	-40°C, +105°C	SO-8	Tube or Tape & Reel	
LM293AN		DIP8	Tube	
LM293D/LM293DT		SO-8	Tube or Tape & Reel	
LM293N		DIP8	Tube	
LM293PT		TSSOP8 (Thin Shrink Outline Package)	Tape & Reel	
LM293ST		Mini SO-8	Tape & Reel	
LM393AD/LM393ADT	0°C, +70°C	SO-8	Tube or Tape & Reel	
LM393D/LM393DT		SO-8	Tube or Tape & Reel	
LM393N		DIP8	Tube	
LM393PT		TSSOP8 (Thin Shrink Outline Package)	Tape & Reel	
LM393ST		Mini SO-8	Tape & Reel	
LM393YDT/YD	-40°C, +125°C	SO-8 (automotive grade level)	Tube or Tape & Reel	

2 Schematic Diagram (1/2 LM193)



3 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±18 or 36	V
V_{id}	Differential Input Voltage	±36	V
Vi	Input Voltage	-0.3 to +36	V
	Output Short-circuit to Ground - note (1)	Infinite	
P_d	Power Dissipation (2) DIP-8 SO-8 TSSOP8 Mini SO-8	 1250 710 625 580	mW
T_{stg}	Storage Temperature Range	-65 to +150	°C

1. Short-circuits from the output to V_{CC}^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA independent of the magnitude of V_{CC}^+.
2. Pd is calculated with T_{amb} = +25°C, T_j = +150°C and
   R_{thja} = 100°C/W for DIP8 package
   R_{thja} = 175°C/W for SO-8 package
   R_{thja} = 200°C/W for TSSOP8 package
   R_{thja} = 215°C/W for Mini SO-8 package

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{icm}	Common Mode Input Voltage Range	0 to V_{CC}^+ -1.5	V
T_{oper}	Operating Free-Air Temperature range LM193, A LM293, A LM393, A	 -55 to +125 -40 to +105 0 to +70	°C

4 Electrical Characteristics

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

Symbol	Parameter	LM193A - LM293A LM393A			LM193- LM293 LM393			Unit
		Min.	Typ.	Max.	Min	Typ.	Max.	
V_{io}	Input Offset Voltage - note (1) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		1	2 4		1	5 9	mV
I_{io}	Input Offset Current T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		3	25 100		5	50 150	nA
I_{ib}	Input Bias Current (I^+ or I^-) - note (2) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		25	100 300		25	250 400	nA
A_{vd}	Large Signal Voltage Gain V_{CC} = 15V, R_L = 15kΩ, V_o = 1V to 11V	50	200		50	200		V/mV
I_{CC}	Supply Current (all comparators) V_{CC} = +5V, no load V_{CC} = +30V, no load		0.4 1	1 2.5		0.4 1	1 2.5	mA
V_{icm}	Input Common Mode Voltage Range - note (3) V_{CC} = 30V T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	0 0		V_{CC}^+ -1.5 V_{CC}^+ -2	0 0		V_{CC}^+ -1.5 V_{CC}^+ -2	V
V_{id}	Differential Input Voltage -note (4)			V_{CC}^+			V_{CC}^+	
V_{OL}	Low Level Output Voltage V_{id} = -1V, I_{sink} = 4mA T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		250	400 700		250	400 700	mV
I_{OH}	High Level Output Current (V_{id} = 1V) V_{CC} = V_o = 30V T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		0.1	 1		0.1	 1	nA µA
I_{SINK}	Output Sink Current V_{id}= 1V, V_o = 1.5V	6	16		6	16		mA
tre	Response Time - note (5) R_L= 5.1kΩ connected to V_{CC}^+		1.3			1.3		µs
trel	Large Signal Response Time R_L= 5.1kΩ connected to V_{CC}^+, e_I = TTL, $V_{(ref)}$ = +1.4v		300			300		ns

1. At output switch point, $V_o \approx$ 1.4V, R_s = 0 with V_{CC}^+ from 5V to 30V, and over the full common-mode range (0V to V_{CC}^+ - 1.5V).
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 no loading charge exists on the reference of input lines.
3. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V_{CC}^+ -1.5V, but either or both inputs can go to +30V without damage.
4. The response time specified is for a 100mV input step with 5mV overdrive. For larger overdrive signals 300ns can be obtained.
5. 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 -0.3V (or 0.3V bellow the negative power supply, if used).

Figure 1. Supply current vs. supply voltage

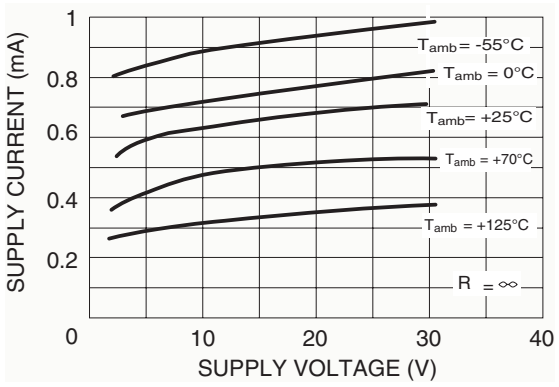


Figure 2. Input current vs. supply voltage

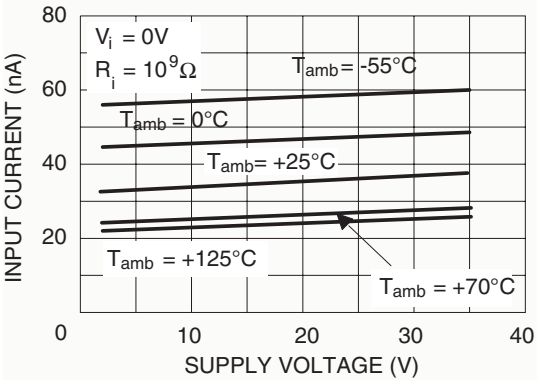


Figure 3. Output saturation voltage vs. frequency

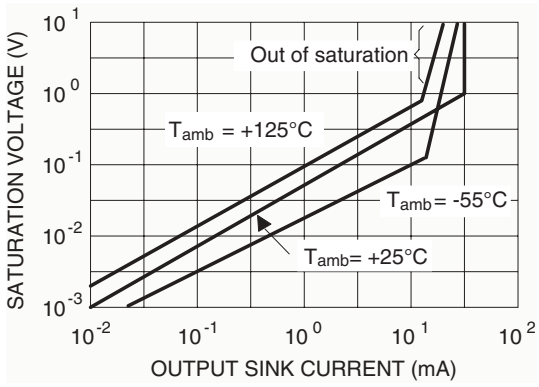


Figure 4. Response time for various input overdrives - negative transition

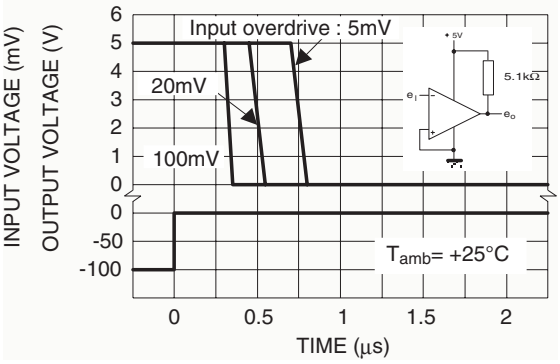
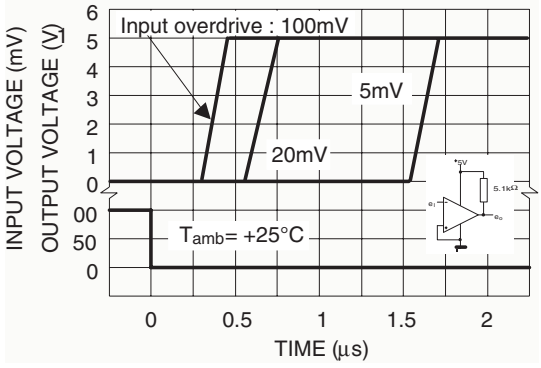


Figure 5. Response time for various input overdrives - positive transition



4.1 Typical applications

Figure 6. Basic comparator

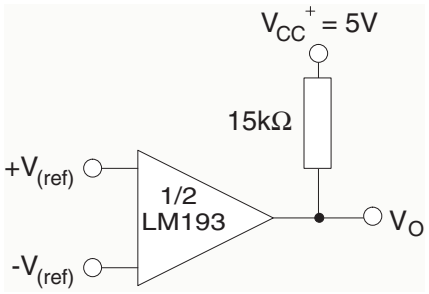


Figure 7. Driving TTL

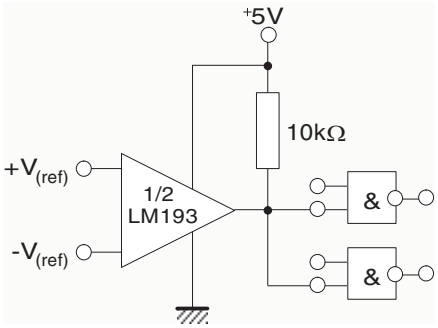


Figure 8. Low frequency op-amp

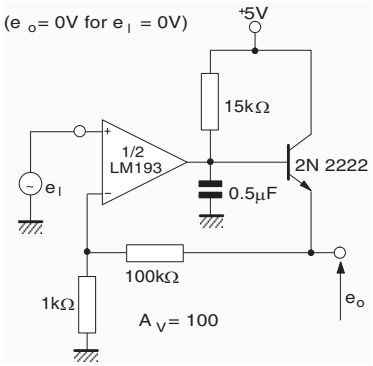


Figure 9. Driving CMOS

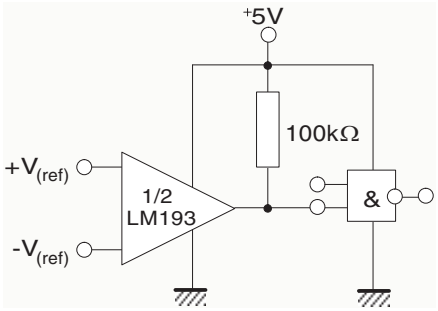


Figure 10. Low frequency op-amp

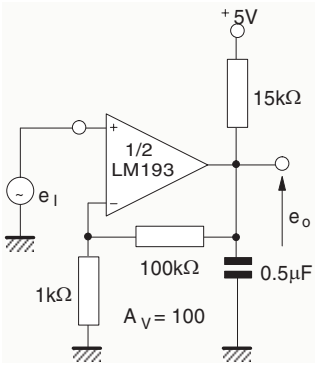


Figure 11. Transducer amplifier

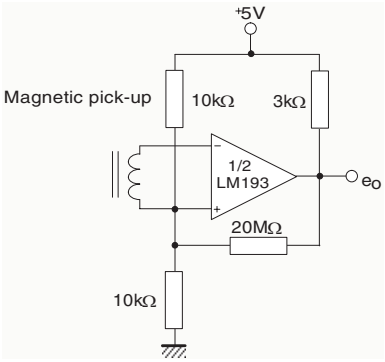


Figure 12. Low frequency op-amp with offset adjust

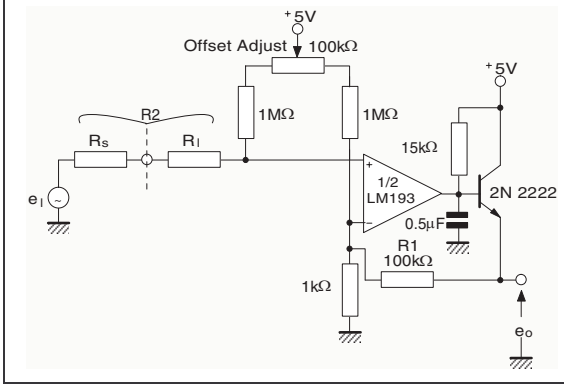


Figure 13. Zero crossing detector (single power supply)

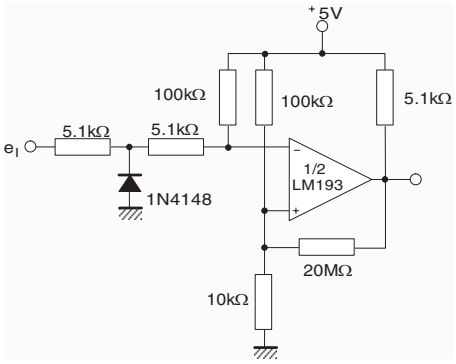


Figure 14. Limit comparator

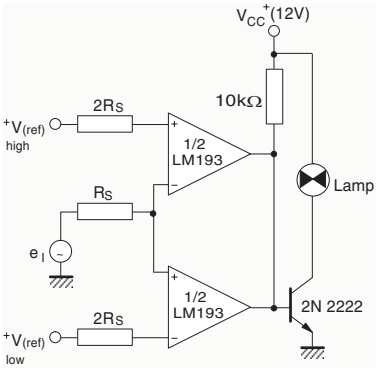


Figure 15. Crystal controlled oscillator

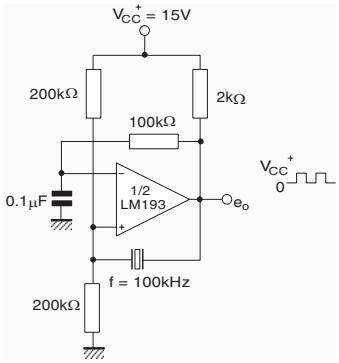


Figure 16. Split-supply applications - zero crossing detector

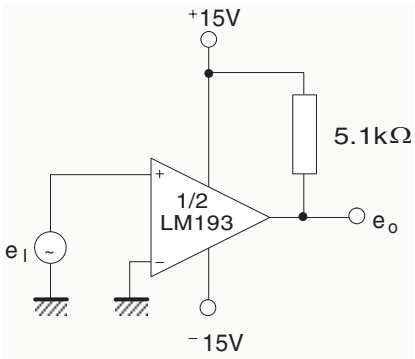


Figure 17. Comparator with a negative reference

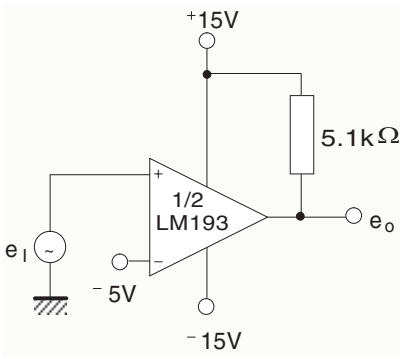
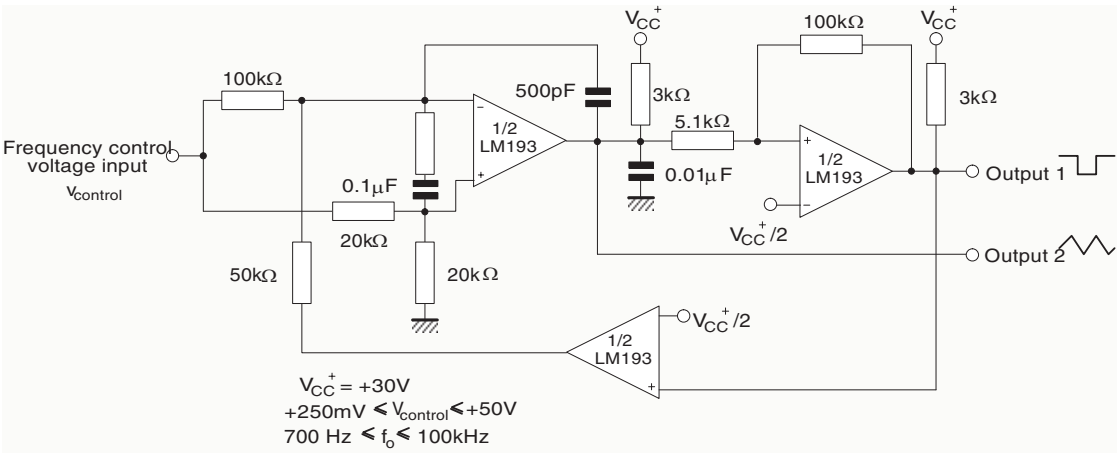


Figure 18. Two-decade high-frequency VCO



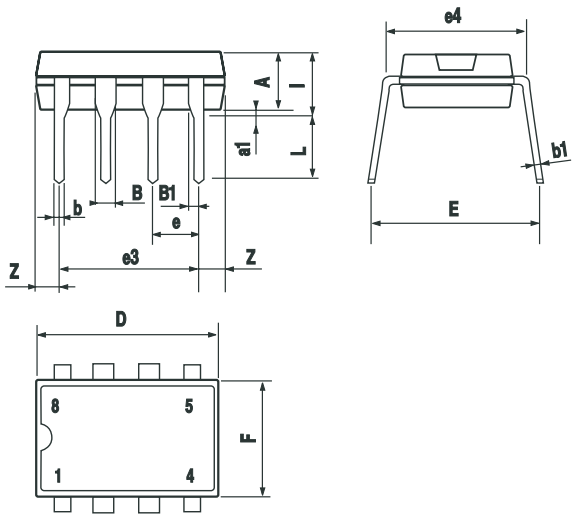
5 Package Mechanical Data

In order to meet environmental requirements, ST offers these devices in ECOPACK® 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.

5.1 DIP8 package

Plastic DIP-8 MECHANICAL DATA

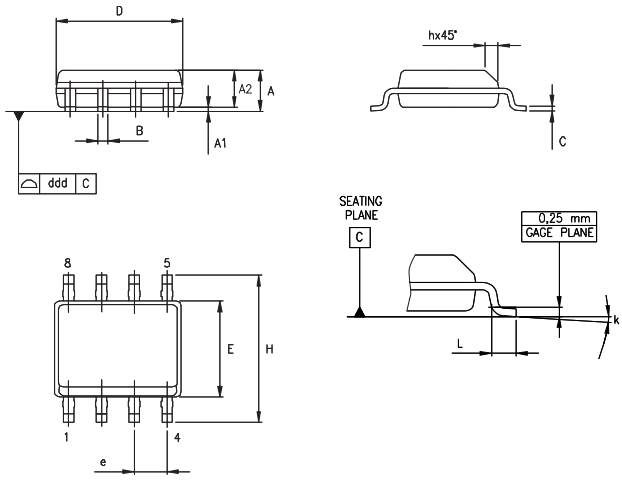
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
I			4.8			0.189
L		3.3			0.130	
Z	0.44		1.6	0.017		0.063



5.2 SO8 package

SO-8 MECHANICAL DATA

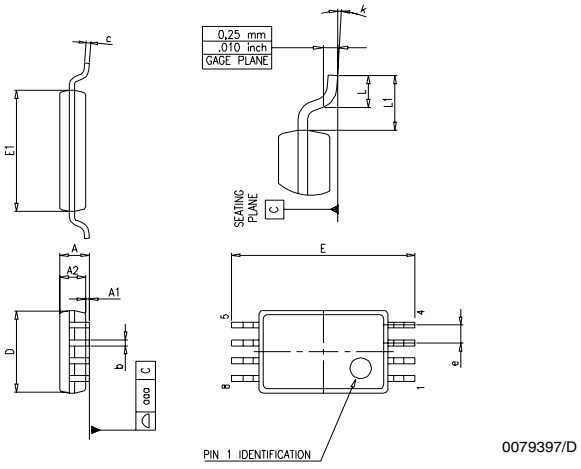
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



5.3 TSSOP8 package

TSSOP8 MECHANICAL DATA

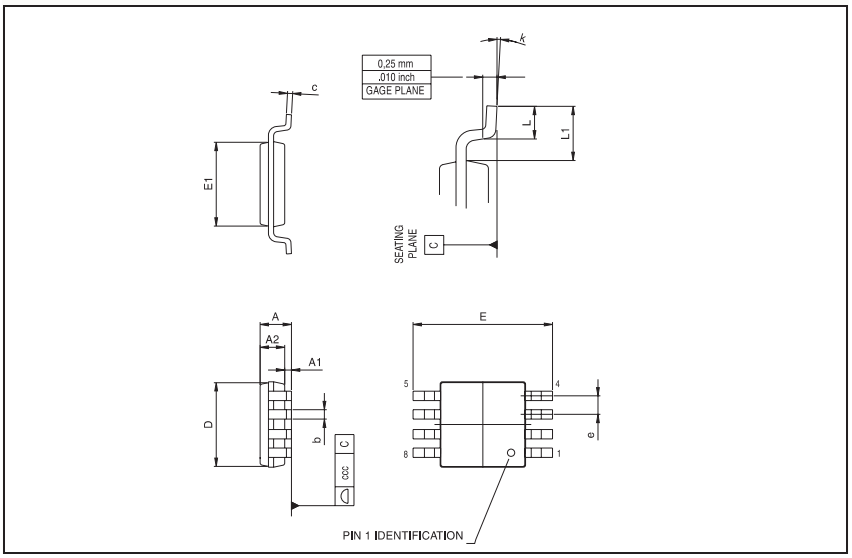
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	



5.4 MiniSO8 package

miniSO-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.1			0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.78	0.86	0.94	0.031	0.031	0.037
b	0.25	0.33	0.40	0.010	0.13	0.013
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	.0114	0.118	0.122
e		0.65			0.026	
K	0°		6°	0°		6°
L	0.40	0.55	0.70	0.016	0.022	0.028
L1			0.10			0.004



6 Revision History

Table 4. Document revision history

Date	Revision	Changes
July 2002	1	First Release
Jan. 2005	2	Class A of the product included in the datasheet.
May 2005	3	PPAP references inserted in the datasheet see *Table 1 on page 2*.
July 2005	4	Modification on PPAP references - Errors on part numbers see *Table 1 on page 2*.
Nov. 2005	5	Modification on *Table 3 on page 5*. LM293,A must be -40/+105°C instead of -40/+125°C.
Feb. 2006	6	Unit error for Vol parameter see *Table 3 on page 5*.