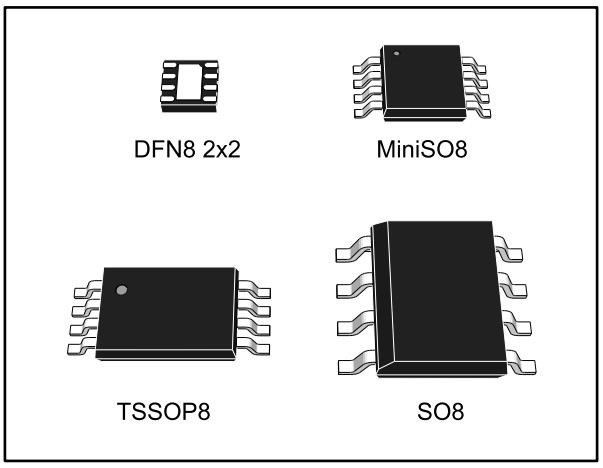
LM193, LM293, LM393

Low-power, dual-voltage comparators

Datasheet - production data



Features

- Wide single-supply voltage range or dual supplies: 2 V to 36 V or ±1 V to ±18 V
- Very low supply current (0.45 mA) independent of supply voltage (1 mW/comparator at 5 V)
- Low input bias current: 20 nA typ.
- Low input offset current: ±3 nA typ.
- Low input offset voltage: ±1 mV typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage: 80 mV typ. (I_{sink} = 4 mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs
- Available in DFN8 2x2, MiniSO8, TSSOP8, and SO8 packages

Description

The LM193, LM293, and LM393 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.

This is information on a product in full production.

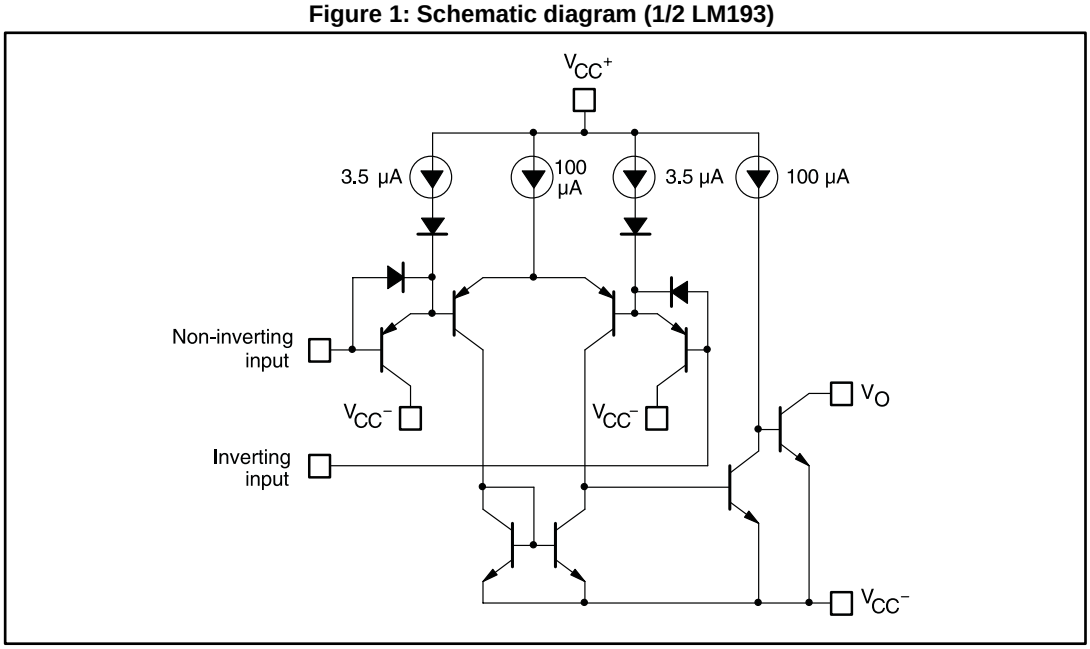
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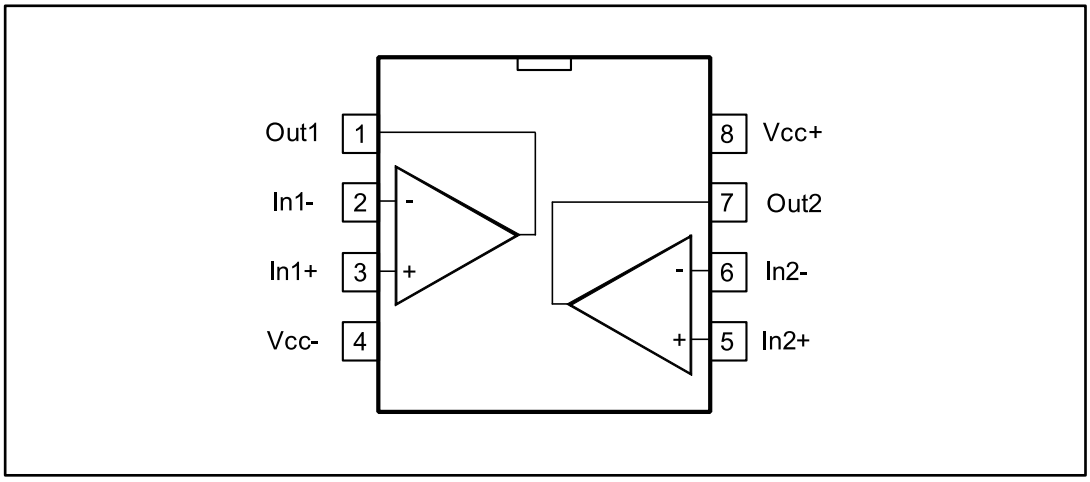
1 Schematic diagram

Figure 1: Schematic diagram (1/2 LM193)



2 Package pin connections

Figure 2: Pin connections (top view)



1. The exposed pad of the DFN8 2x2 can be left floating or connected to ground

3 Absolute maximum ratings and operating conditions

Table 1: Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage		±18 or 36	V
V_{id}	Differential input voltage		±36	
V_{in}	Input voltage		-0.3 to 36	
	Output short-circuit to ground (1)		Infinite	
R_{thja}	Thermal resistance junction to ambient (2)	DFN8 2x2	57	°C/W
		MiniSO8	190	
		TSSOP8	120	
		SO8	125	
R_{thjc}	Thermal resistance junction to case (2)	DFN8 2x2	—	
		MiniSO8	39	
		TSSOP8	37	
		SO8	40	
T_j	Maximum junction temperature		150	°C
T_{stg}	Storage temperature range		-65 to 150	
ESD class (3)	HBM: human body model (4)		H1B	
	MM: machine model (5)		M2	
	CDM: charged device model (6)		C5	

Notes:

(1)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}+.

(2)Short-circuits can cause excessive heating and destructive dissipation. Values are typical.

(3)ESD class definition from AEC-Q100:

(4)HBM class H1B: ESD voltage level from 500 V to 1000 V

(5)MM class M2: ESD voltage level from 100 V to 200 V

(6)CDM class C5: ESD voltage level greater than 1500 V.

Table 2: Operating conditions

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage (V_{CC}^+) - (V_{CC}^-)		2 to 36	V
V_{icm}	Common mode input voltage range (V_{CC}^+ = 30 V) (1)	T_{amb} = 25 °C	0 to (V_{CC}^+) - 1.5	
		$T_{min} \leq T_{amb} \leq T_{max}$	0 to (V_{CC}^+) - 2	
T_{oper}	Operating free-air temperature range	LM193, LM193A	-55 to 125	°C
		LM293, LM293A	-40 to 105	
		LM393, LM393A	0 to 70	

Notes:

(1)The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The high 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.

4 Electrical characteristics

Table 3: VCC+ = 5 V, VCC- = 0 V, Tamb = 25 °C (unless otherwise specified)

Symbol	Parameter	Condition	LM193A, LM293A, LM393A			LM193, LM293, LM393			Unit
			Min.	Typ.	Max.	Min	Typ.	Max.	
V_{io}	Input offset voltage (1)			1	2		1	5	mV
		$T_{min} \le T_{amb} \le T_{max}$			4			9	
I_{io}	Input offset current			3	25		3	50	nA
		$T_{min} \le T_{amb} \le T_{max}$			100			150	
I_{ib}	Input bias current (I^+ or I^-) (2)			20	100		20	250	
		$T_{min} \le T_{amb} \le T_{max}$			300			400	
A_{vd}	Large signal voltage gain	V_{CC} = 15 V, R_L = 15 kΩ, V_o = 1 V to 11 V	50	200		50	200		V/mV
I_{CC}	Supply current (all comparators)	V_{CC} = 5 V, no load		0.45	1		0.45	1	mA
		V_{CC} = 30 V, no load		0.6	2.5		0.6	2.5	
V_{id}	Differential input voltage (3)				V_{CC}^+			V_{CC}^+	
V_{OL}	Low-level output voltage	V_{id} = -1 V, I_{sink} = 4 mA		80	400		80	400	mV
		$T_{min} \le T_{amb} \le T_{max}$			700			700	
I_{OH}	High-level output current	V_{CC} = V_o = 30 V, V_{id} = 1 V		0.1			0.1		nA
		$T_{min} \le T_{amb} \le T_{max}$			1			1	µA
I_{sink}	Output sink current	V_{id} = 1 V, V_o = 1.5 V	6	18		6	18		mA
t_{re}	Response time (4)	R_L = 5.1 kΩ connected to V_{CC}^+		1.3			1.3		µs
t_{rel}	Large signal response time	R_L = 5.1 kΩ connected to V_{CC}^+, e_I = TTL, $V_{(ref)}$ = 1.4 V		300			300		ns

Notes:

(1)At output switch point, V_o = 1.4 V, R_s = 0 with V_{CC}^+ from 5 V to 30 V, and over the full common-mode range (0 V to (V_{CC}^+) - 1.5 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 no loading charge exists on the reference of 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 V (or 0.3 V below the negative power supply, if used).

(4)The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals, 300 ns can be obtained.

5 Electrical characteristic curves

Figure 3: Supply current vs. supply voltage

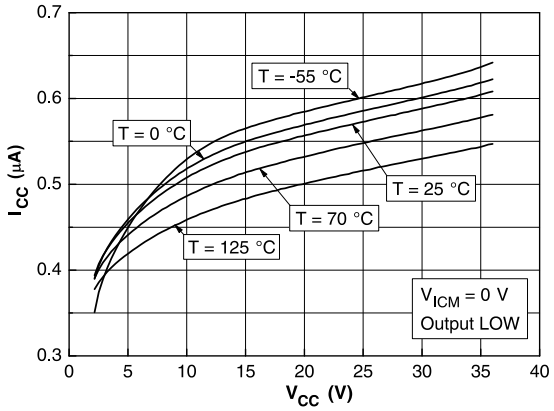


Figure 4: Input current vs. supply voltage

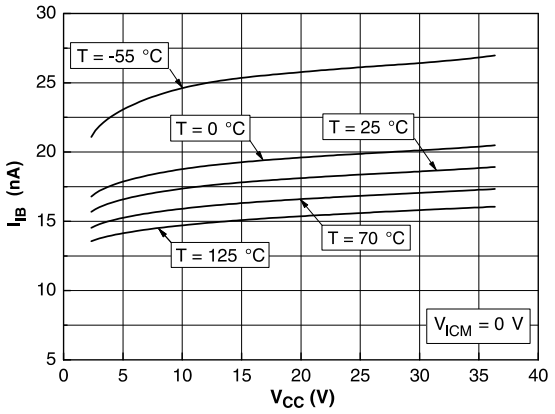


Figure 5: Output saturation voltage vs. output current

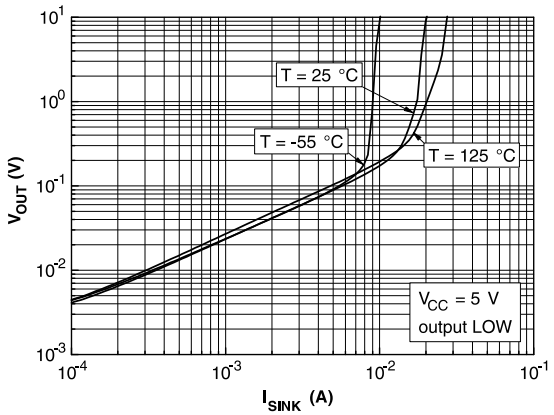


Figure 6: Response time for various input overdrives - negative transition

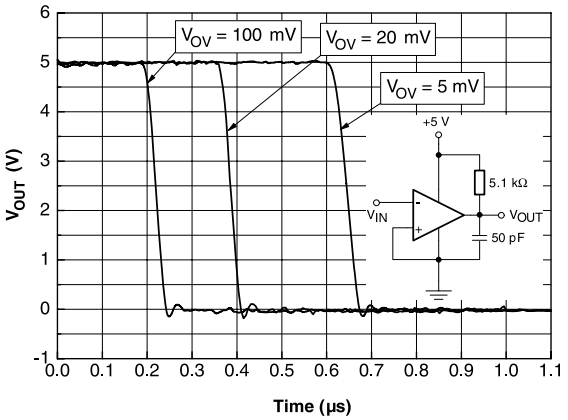
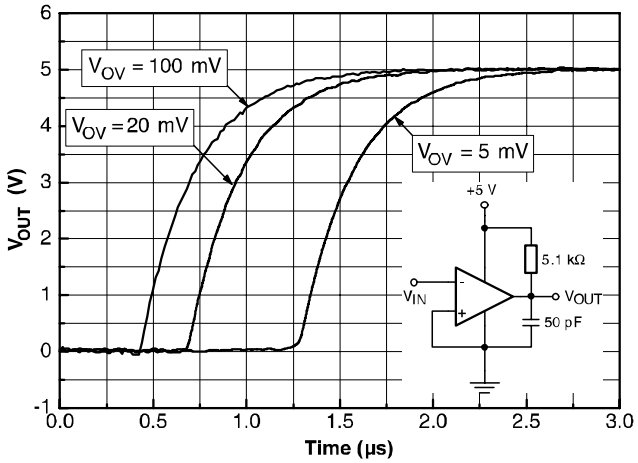


Figure 7: Response time for various input overdrives - positive transition



6 Typical applications

Figure 8: Basic comparator

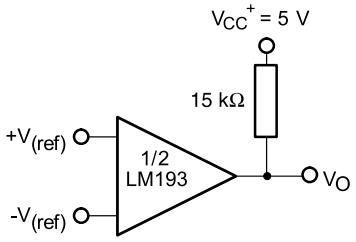


Figure 9: Driving TTL

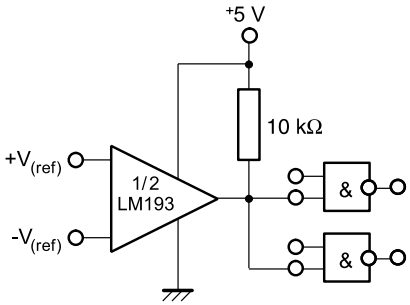


Figure 10: Low-frequency op amp (1)

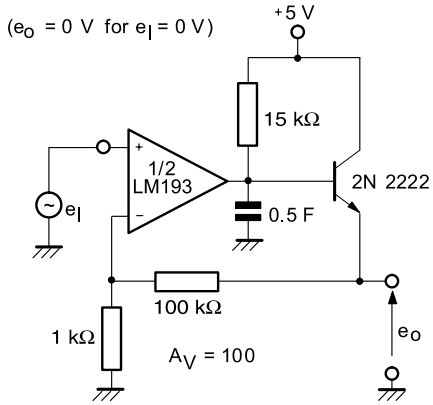


Figure 11: Driving CMOS

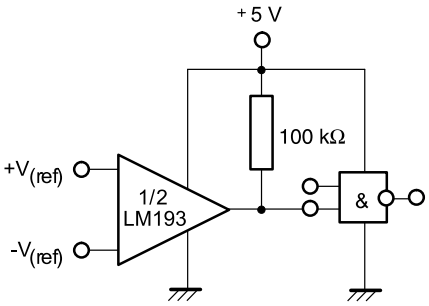


Figure 12: Low-frequency op amp (2)

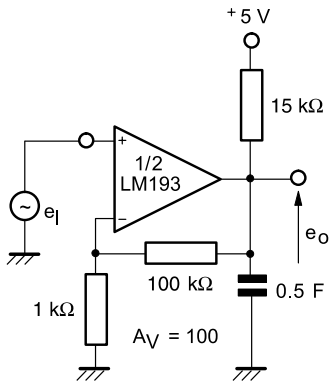


Figure 13: Transducer amplifier

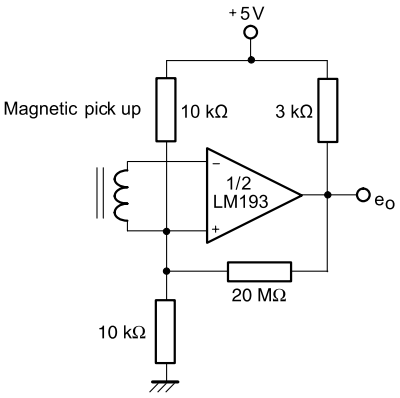


Figure 14: Low-frequency op amp with offset adjust

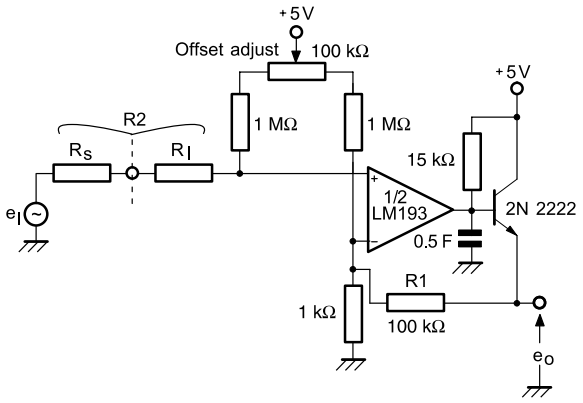


Figure 15: Zero crossing detector (single power supply)

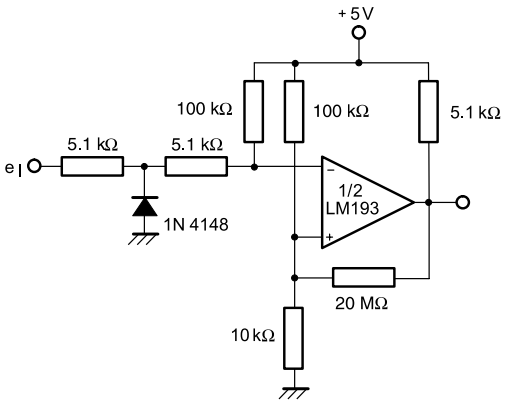


Figure 16: Limit comparator

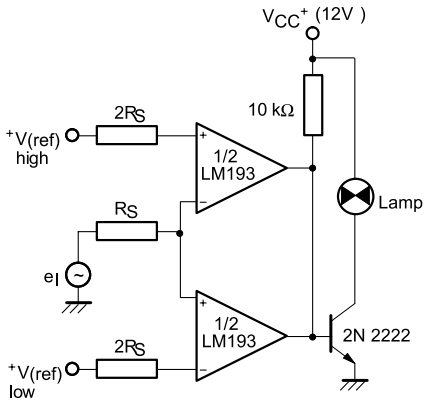


Figure 17: Crystal controlled comparator

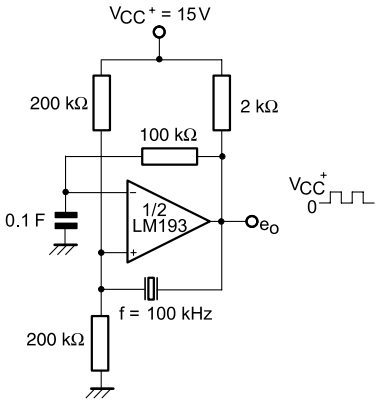


Figure 18: Split supply applications (zero crossing detector)

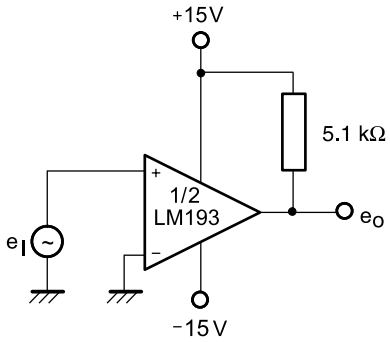


Figure 19: Comparator with a negative reference

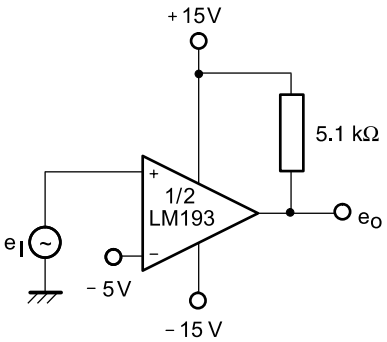
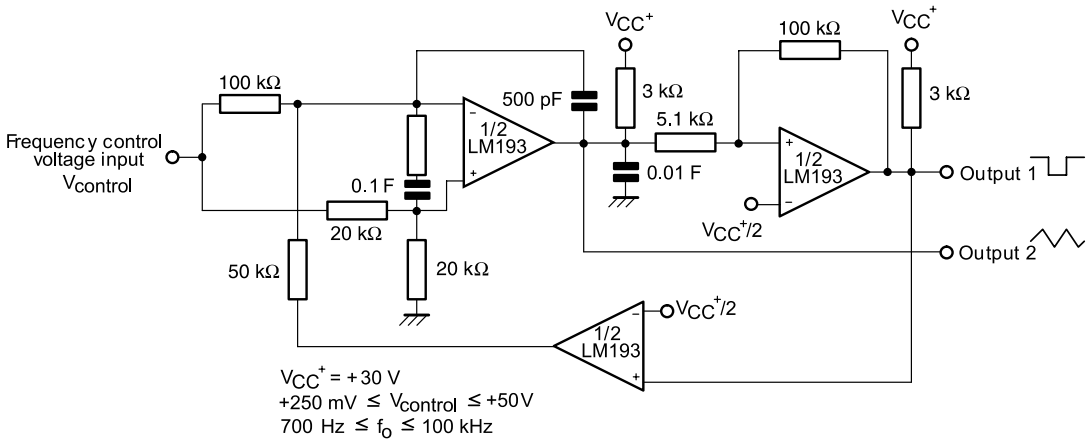


Figure 20: Two-decade, high-frequency VCO



7 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.

7.1 DFN8 2x2 package information

Figure 21: DFN8 2x2 package outline

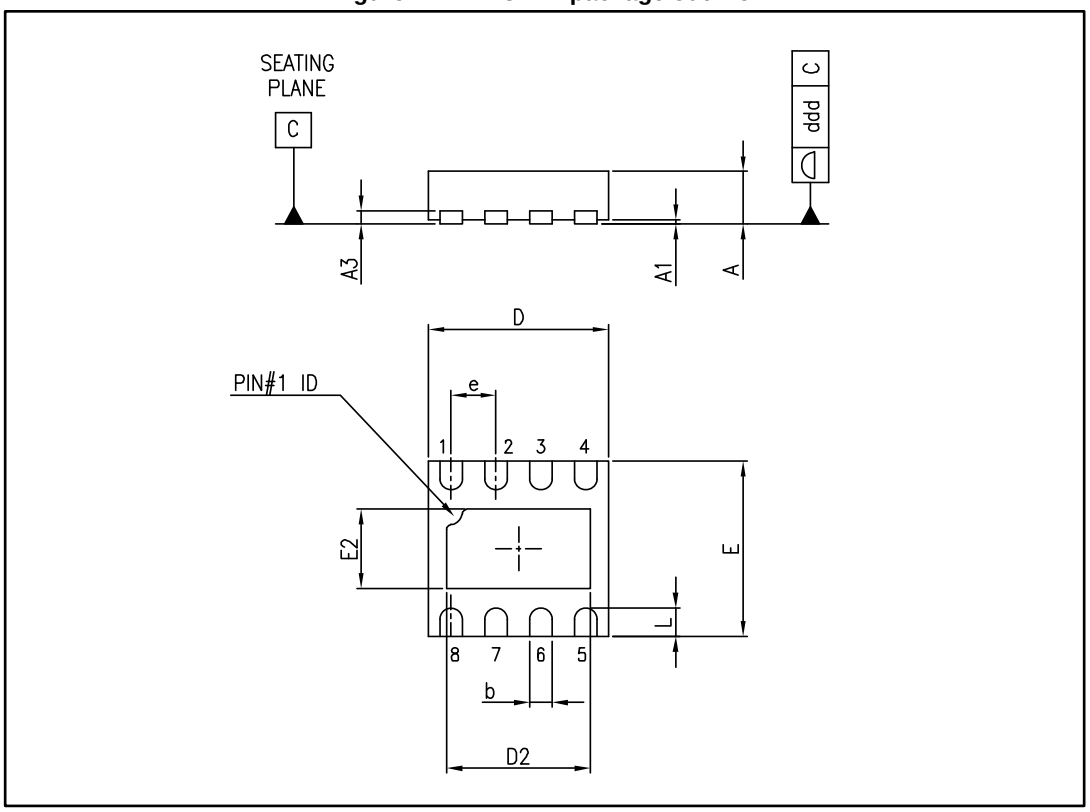
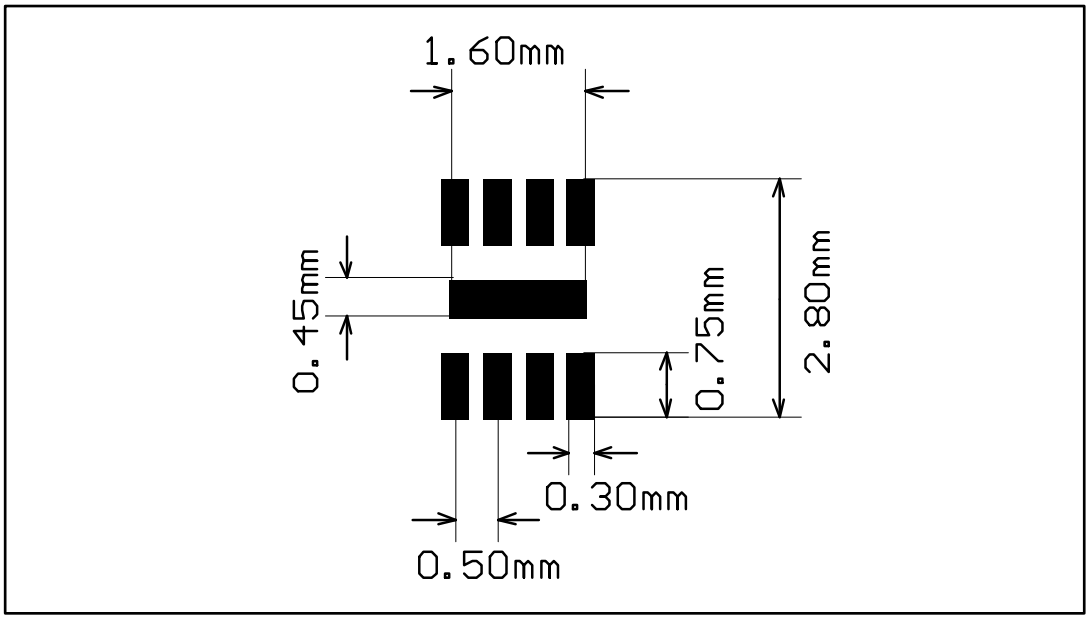


Table 4: DFN8 2x2 mechanical data

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			0.425			0.017
ddd			0.08			0.003

Figure 22: DFN8 2x2 recommended footprint



7.2 MiniSO8 package information

Figure 23: MiniSO8 package outline

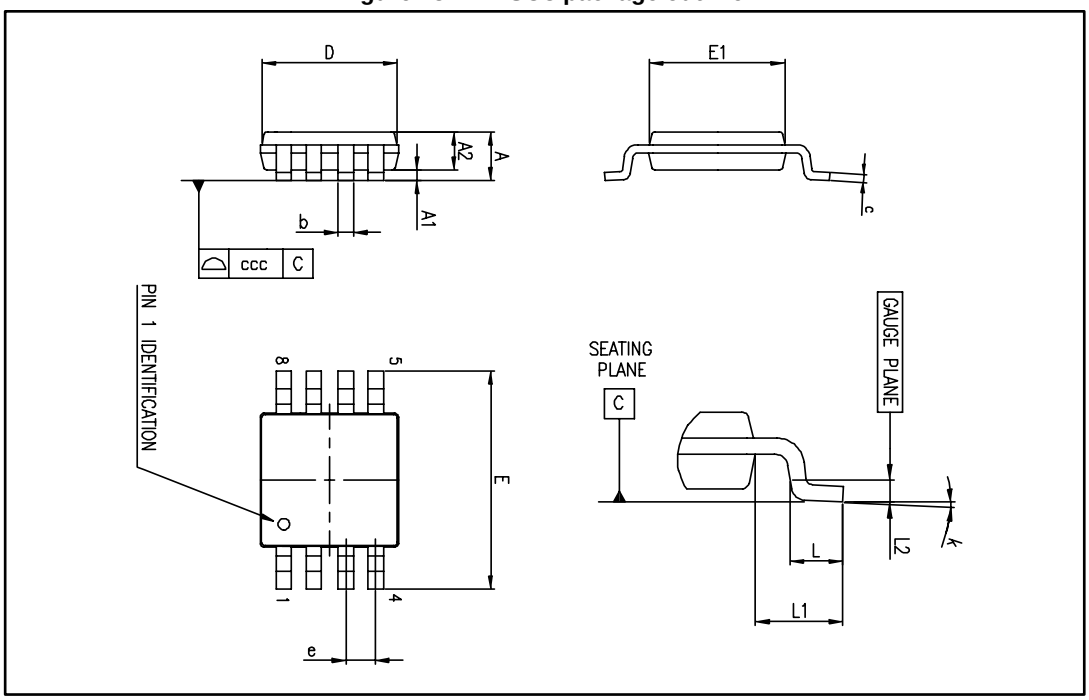


Table 5: MiniSO8 mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

7.3 TSSOP8 package information

Figure 24: TSSOP8 package outline

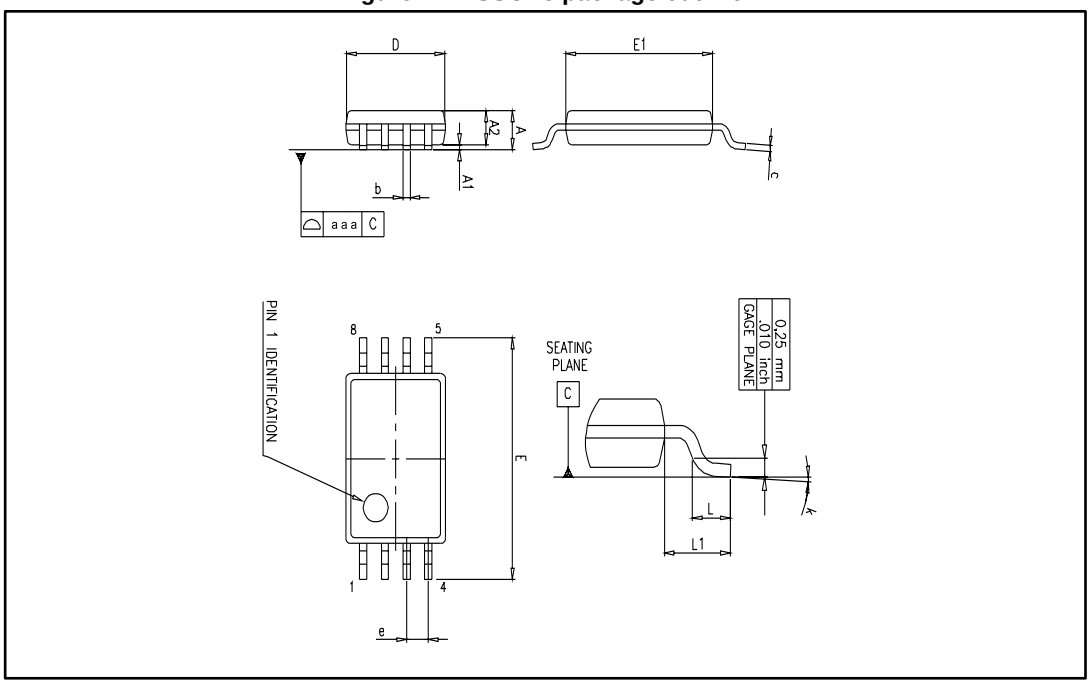


Table 6: TSSOP8 mechanical data

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	

7.4 SO8 package information

Figure 25: SO8 package outline

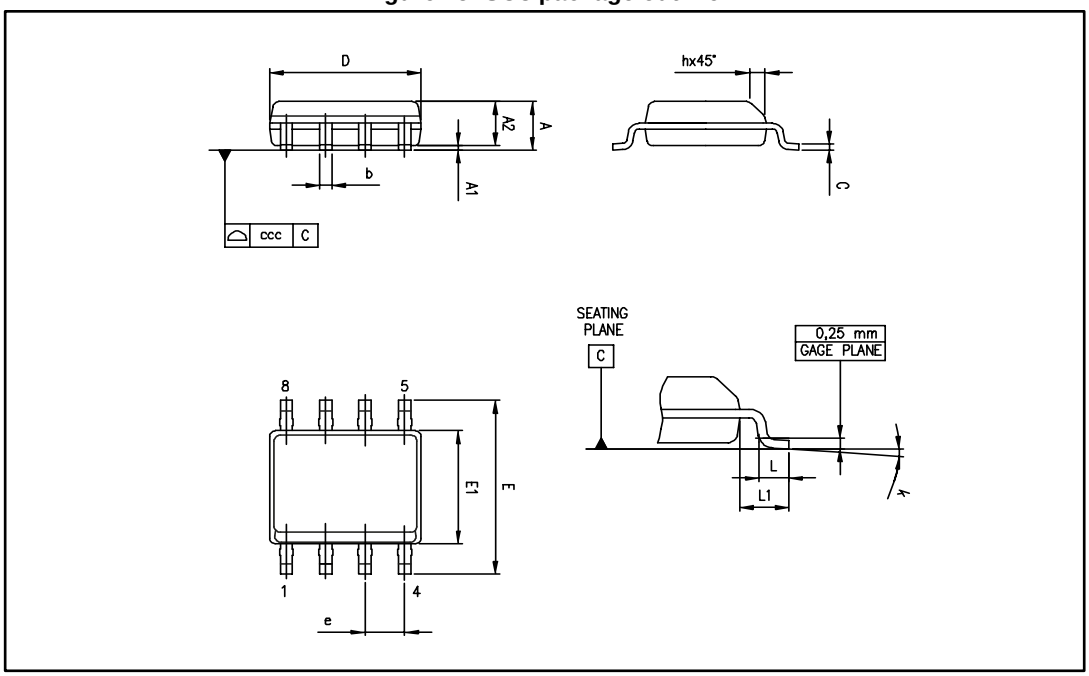


Table 7: SO8 mechanical data

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
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

8 Ordering information

Table 8: Order codes

Order code	Temperature range	Package	Packing	Marking
LM193ADT (1)	-55 °C to 125 °C	SO8	Tube or tape and reel	193A
LM193DT				193
LM293ADT	-40 °C to 105 °C			293A
LM293D				293
LM293DT				
LM293PT		TSSOP8	Tape and reel	
LM293ST		MiniSO8		K512
LM293QT		DFN8 2x2		K59
LM393ADT	0 °C to 70 °C	SO8	Tube or tape and reel	393A
LM393D				393
LM393DT				
LM393PT		TSSOP8	Tape and reel	
LM393ST		MiniSO8		M393
LM393QT		DFN8 2x2		K5B

Notes:

(1)Not recommended for new design (NRND)

9 Revision history

Table 9: Document revision history

Date	Revision	Changes
02-Jul-2002	1	First release.
02-Jan-2005	2	Class A of the product included in the datasheet.
02-May-2005	3	PPAP references inserted in the datasheet, see Table 7: Ordering information on page 18.
02-Jul-2005	4	Modification on PPAP references - Errors on part numbers, see Table 7: Ordering information on page 18.
22-Nov-2005	5	Modification on Table 3 on page 6. LM293,A must be -40/+105°C instead of -40/+125°C.
16-Feb-2006	6	Unit error for V_{ol} parameter see Table 3 on page 6.
23-Aug-2007	7	Corrected error in DIP8 package information related to lead thickness, see Figure 21 on page 12. Added values for R_{thja} and R_{thjc}, and ESD parameters in Table 1: Absolute maximum ratings.
08-Nov-2007	8	Updated MiniSO-8 package information. Reformatted package information. Added automotive grade order codes.
19-Feb-2008	9	Corrected error in SO-8 package mechanical data: E dimension in drawing was marked with an F in table.
15-Dec-2008	10	Corrected heading in Figure 5.
22-Feb-2010	11	Deleted automotive grade order codes for LM293 and LM393.
22-Jun-2011	12	Updated typical performance curves. Updated typical values on Table 3 on page 6. Updated ESD parameters with ESD classes in Table 1: Absolute maximum ratings. Added DFN8 2x2mm package mechanical drawing. Added DFN8 2x2mm recommended footprint. Added DFN8 2x2mm order codes in Table 9.
27-Jun-2012	13	Updated Features (added package information), Description (added RPNs), Figure 1: Pin connections (top view) moved to page 3, added Contents, updated marking of the LM293QT device in Table 9, minor text corrections throughout document.
18-Jan-2013	14	Updated Table 8 (added dimensions in inches).

Date	Revision	Changes
09-Feb-2016	15	Updated document layout Removed DIP8 package *Features*: removed “plastic micropackage” from the DFN8 2x2, MiniSO8, and SO8 silhouettes; removed “thin shrink small outline package” from the TSSOP8 silhouette. *Figure 2*: added footnote about the exposed pad of the DFN8 2x2 *Table 4*: updated “L” value *Table 6*: “aaa” value is a typ. value not a max. value *Table 7*: updated min. “k” millimeters value *Table 8*: removed following obsolete order codes: LM193AD, LM193D, LM193AN, LM193N, LM293AD, LM293AN, LM293N, LM393AD, LM393AN, LM393N; added footnote (not recommended for new design) to order code LM193ADT; replaced marking of LM393QT with “K5B” instead of “K5C”.

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