

LM393 Dual Differential Comparators

1. General Description

1.1 Description

The LM393 consists of two independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible. Current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships. The LM393 can use the standard 5V power supply in the digital system without the need for additional power supply.

1.2 Features

- Wide range of single supply voltage 2V to 32V

- Low output saturation voltage
0.1V@ $I_{OL}=4mA(Typ)$
- Low power dissipation 0.9mA@ $V_{CC}=5V(Typ)$
- Low input offset voltage $\pm 1mV(Typ)$
- Range of dual supply voltage $\pm 16V$
- Range of differential input voltage $\pm V_{CC}$
- Open drain output
- DIP8/SOP8 package

1.3 Device Information

PART NUMBER	PACKAGE
LM393	DIP
	SOP
	MSOP

2. Connection Diagrams and Pin Description

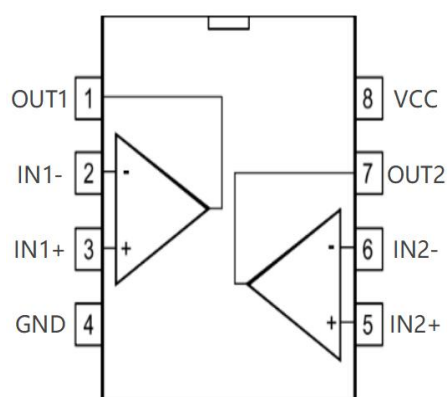


Figure 2.1 Top View

PIN No.	NAME	I/O	FUNCTION
1	OUT1	O	Output pin of comparator 1
2	IN1-	I	Negative input pin of comparator 1
3	IN1+	I	Positive input pin of comparator 1
4	GND		Ground
5	IN2+	I	Positive input pin of comparator 2
6	IN2-	I	Negative input pin of comparator 2
7	OUT2	O	Output pin of comparator 2
8	VCC		Power supply

3. Schematic Diagram

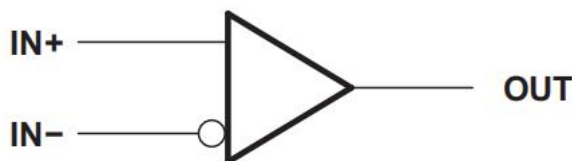


Figure 3.1: 1/2 LM393 simplified schematic

4. Specifications

4.1 Absolute Maximum Ratings

(Ta=25°C, unless otherwise specified)

Symbol	Parameter	MIN	MAX	Unit
V _{CC}	Single Supply Voltage ⁽¹⁾		36	V
V _S	Dual Supply Voltage	-18	18	
V _{IDR}	Differential Input Voltage ⁽²⁾	-18	18	V
V _{ICR}	Common-Mode Input Voltage	-0.3	V _{CC}	V
T _{SC}	Output Short-Circuit Time	Continue		
V _O	Output Voltage		36	V
I _O	Output Current		30	mA
	Duration of Output Short Circuit to Ground	Unlimited		
T _J	Junction Temperature		125	°C
T _{OP}	Operating Temperature	-40	85	°C

Absolute maximum ratings are those values beyond which the device could be permanently damaged. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions.

(1) All voltage values, except differential voltages, are with respect to network ground.

(2) Differential voltages are at IN+ with respect to IN-.

4.2 Electrical Characteristics

(Ta=25°C, V_{CC}=5V, unless otherwise specified)

Symbol	Parameter	Test Condition	MIN	TYP	MAX	Unit
I _{CC}	Supply Current	V _{CC} =5V, no load	--	0.9	2	mA
		V _{CC} =30V, no load	--	1.25	3	mA
I _B	Input Bias Current	V _O =1.4V	--	100	500	nA
V _{OS}	Input Offset Voltage	V _{CC} =5-30V V _O =1.4V, V _{CM} =V _{CMR} (min)	--	1	5	mV
I _{OS}	Input Offset Current	V _O =1.4V	--	5	50	nA
V _{CMR}	Common-Mode Voltage Range ⁽¹⁾	T _a =25°C	0	-	V _{CC} -0.5	V
A _{VD}	Large Signal Differential Voltage	V _{CC} =15V, V _O =1.4V to 11.4V, R _L ≥15kΩ to V _{CC}	--	200	--	V/mV

	Amplification					
V_{OL}	Low-Level Output Voltage	$I_{OL}=4mA, V_{DM}=-1V$	--	100	400	mV
I_{OL}	Output Current(sinking)	$V_{OL}=1.5V, V_{DM}=-1V$	--	20	--	mA
I_{OH}	High-level Output Current	$V_{OH}=5V, V_{DM}=1V$	--		1	uA
		$V_{OH}=30V, V_{DM}=1V$	--		1	uA
V_{CC}	Single Supply Voltage		2	--	32	V
V_S	Dual Supply Voltage		-16	--	16	V

- (1) The voltage at either input should not be allowed to go negative by more than 0.3V otherwise output may be incorrect and excessive input current can flow. The upper end of the common-mode voltage range is limited by $V_{CC}-2V$. However only one input needs to be in the valid common mode range, the other input can go up the maximum V_{CC} level and the comparator provides a proper output state. Either or both inputs can go to maximum V_{CC} level without damage.

5. Detailed Description

5.1 Overview

The LM393 has proven ubiquity and versatility across a wide range of applications. This is due to its low power, wide range of supply voltage and high speed. The open-drain output allows the user to configure the output's logic high voltage (V_{OH}) and can be used to enable the comparator to be used in AND functionality.

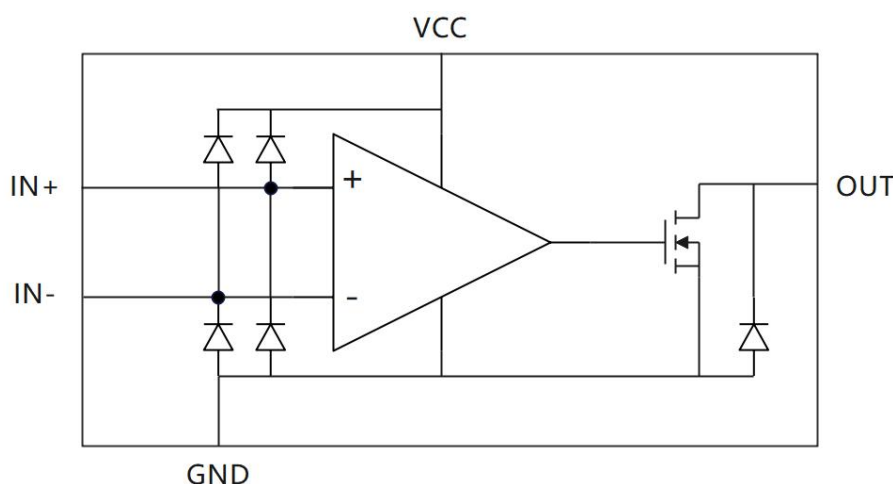


Figure 5.1 Functional Block Diagram(Each Comparator)

6. Applications information

6.1 Application Information

LM393 is typically used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes this comparator optimal for level shifting to a higher or lower voltage.

6.2 Typical Application

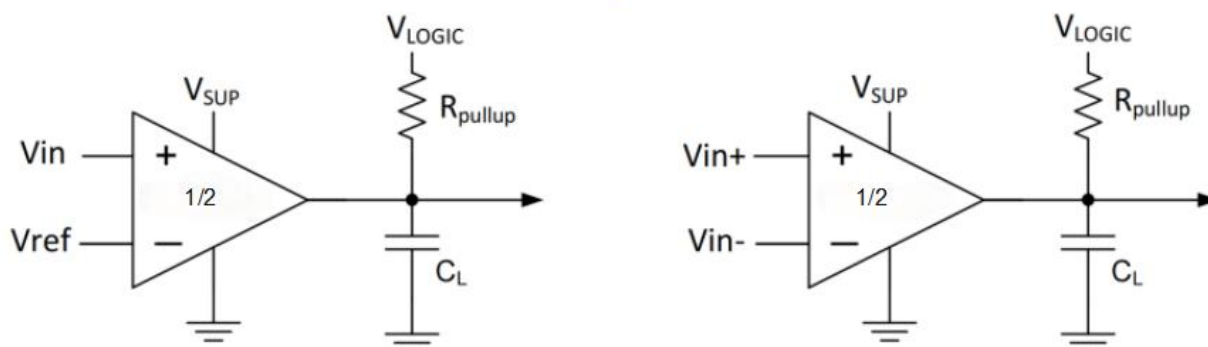


Figure 6.1 Single-Ended and Differential Comparator Configurations

6.3 Detailed Design Procedure

When using the device in a general comparator application, determine the following:

- Input Voltage Range
- Minimum Overdrive Voltage
- Output and Drive Current
- Response Time

6.4 Input Voltage Range

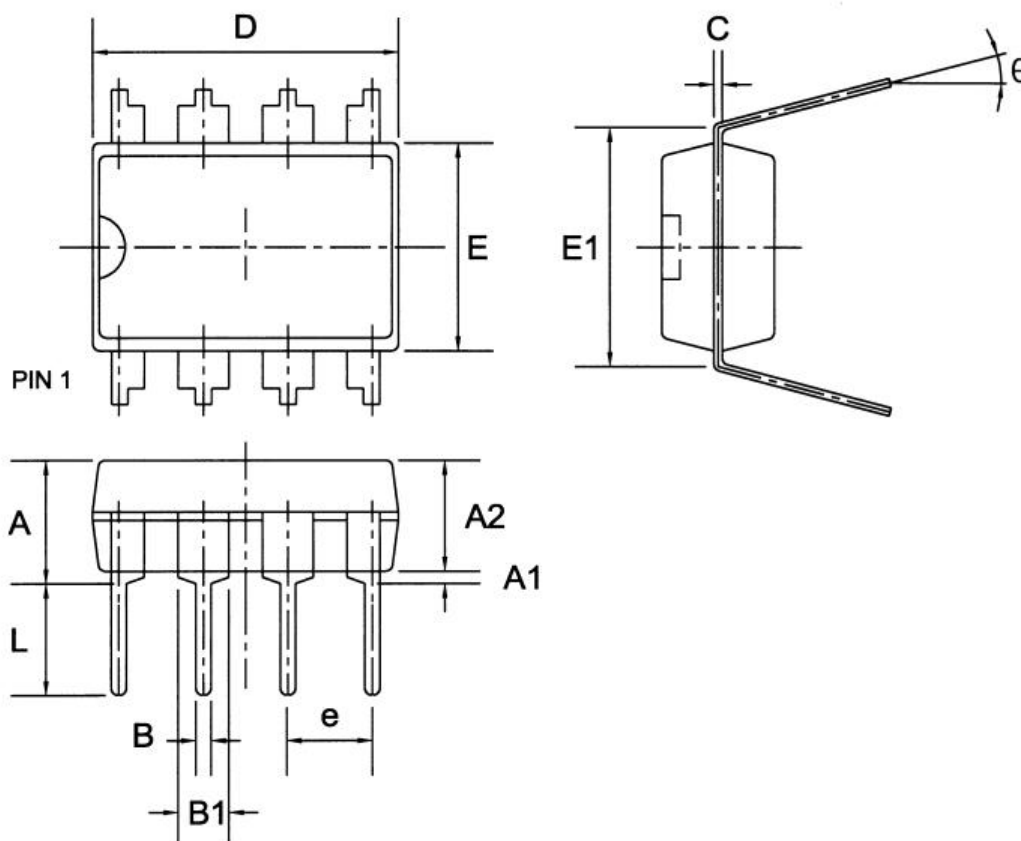
When choosing the input voltage range, the input common mode voltage range (V_{CMR}) must be taken in to account. If temperature operation is below 25°C the V_{CMR} can range from 0V to $V_{CC} - 2.0V$. This limits the input voltage range to as high as $V_{CC} - 2.0V$ and as low as 0V. Operation outside of this range can yield incorrect comparisons.

7. Ordering Information

Orderable Device	Package Type	Pins	Packing	Package Qty
LM393ND08ATEQ	DIP	8	Tube	50
LM393NS08ARBE	SOP	8	Tape & Reel	2500
LM393MS08ARDQ	MSOP8	8	Tape & Reel	4000

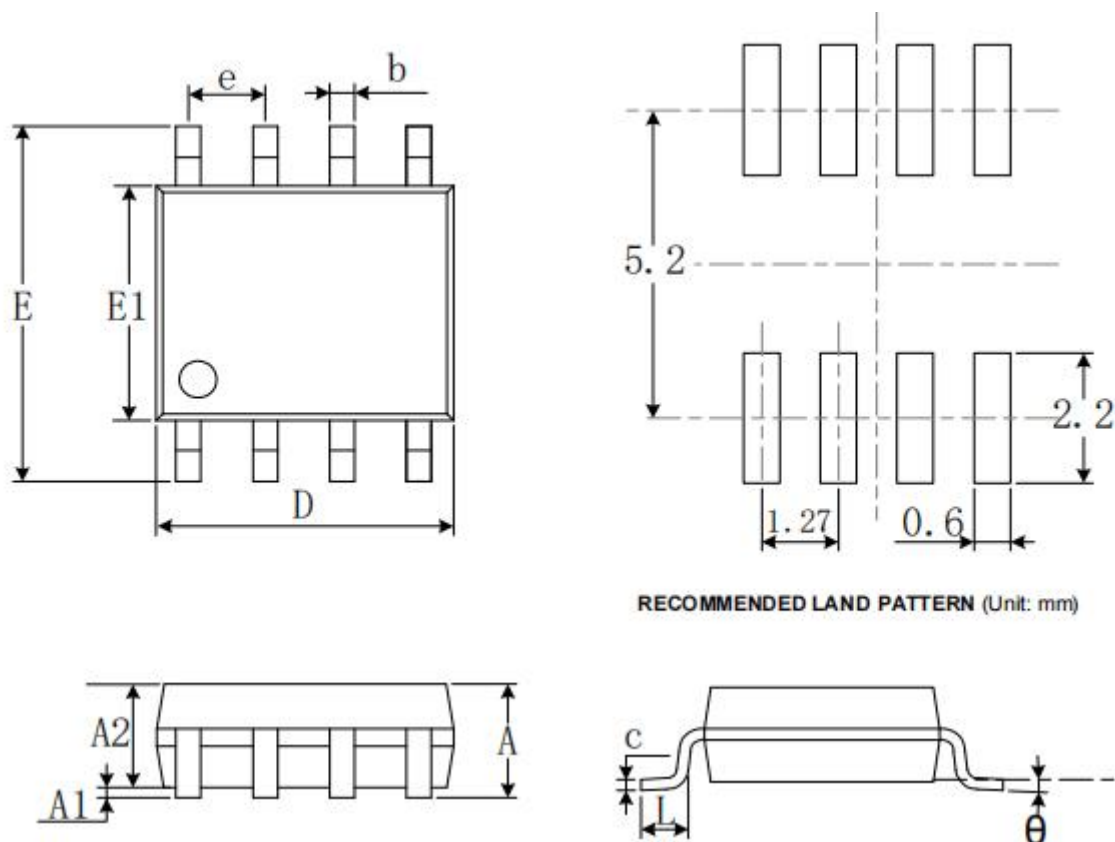
8. Package Information

8.1 DIP8



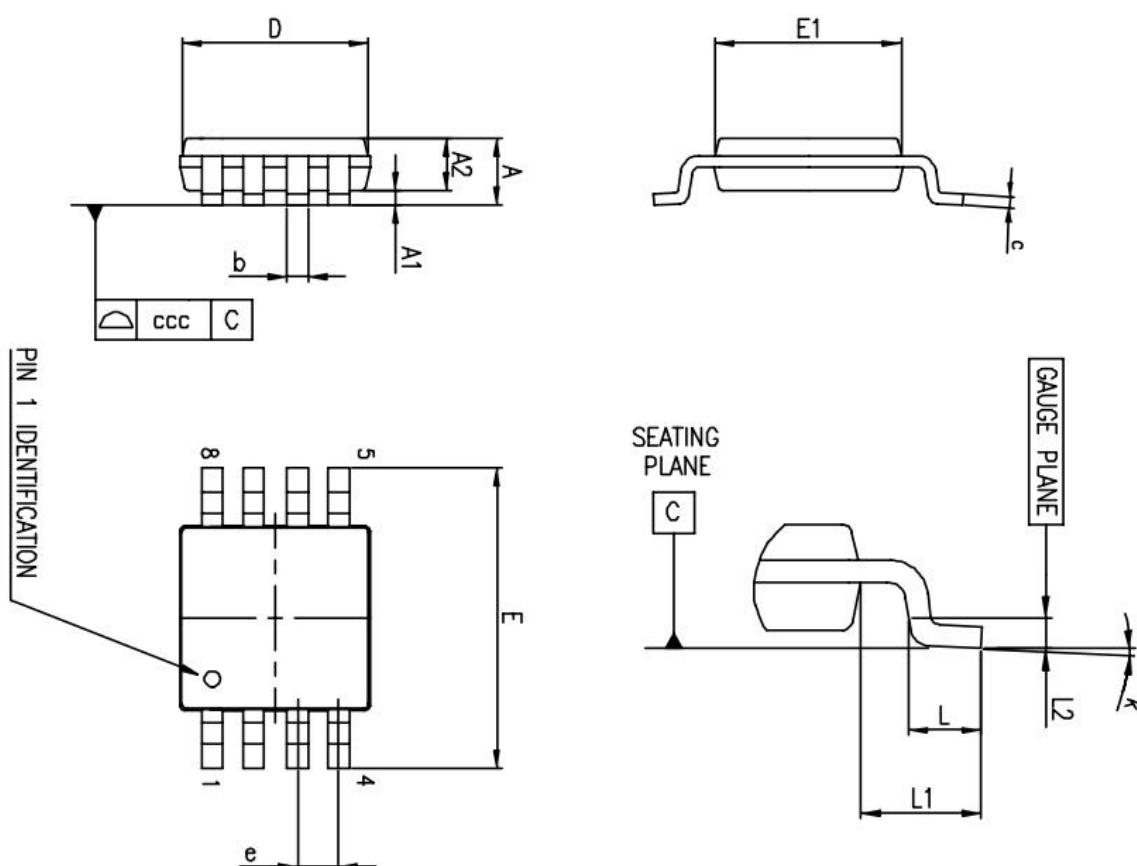
Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min	Nom	Max	Min	Nom	Max
A	—	—	4.31	—	—	0.170
A1	0.38	—	—	0.015	—	—
A2	3.15	3.40	3.65	0.124	0.134	0.144
B	0.38	0.46	0.51	0.015	0.018	0.020
B1	1.27	1.52	1.77	0.050	0.060	0.070
C	0.20	0.25	0.30	0.008	0.010	0.012
D	8.95	9.20	9.45	0.352	0.362	0.372
E	6.15	6.40	6.65	0.242	0.252	0.262
E1	—	7.62	—	—	0.300	—
e	—	2.54	—	—	0.100	—
L	3.00	3.30	3.65	0.118	0.130	0.142
θ	0°	—	15°	0°	—	15°

8.2 SOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

8.3 MSOP8



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