

General-Purpose Open-Drain Output High-Voltage Comparator

FEATURES

- Wide Supply Range: 3V to 32V
- Low Input Offset: 2mV (Typ)
- Low Quiescent Current:
75 μ A at $V_s=5V$
- Low Input Bias Current: 1nA
- Input Common-Mode Voltage Range
Includes Ground
- Open-Drain Output
- Short Response Time
- SIZE PACKAGES: LM331 SOT23-5
LM393 SOP8 VSOP8
LM339 SOP14 TSSOP14

APPLICATIONS

- Hysteresis Comparators
- Floor mopping robot
- One-way UPS
- Server PSU
- Cordless power tool
- Industrial Automation and Control
- Motor driver
- Instruments and apparatus

GENERAL DESCRIPTION

The LM331/LM393/LM339 series is a voltage comparator used in integrated circuit. It provides lower offset voltage, higher power supply voltage capability, lower power supply current, lower propagation delay, wider temperature range and higher ESD performance.

The chip supports single power and dual power supply. For dual power supply, the supply voltage ranges from $\pm 1.5V$ to $\pm 16V$, and the V_s is at least 1.5V higher than the input common-mode voltage. The output is compatible with TTL and CMOS, and the drain current is not affected by the power supply voltage. The output can be connected to other drain open circuit output to achieve the wired-and" relationship.

SIMPLIFIED SCHEMATIC

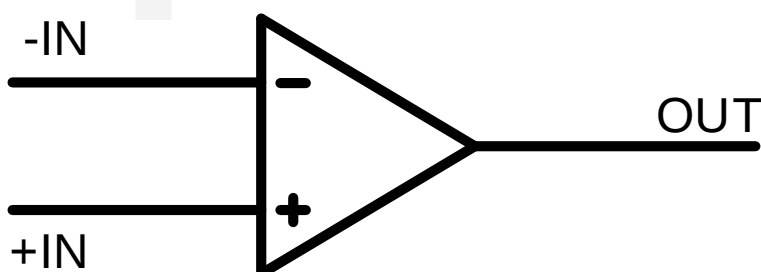


Figure 1. Simplified Schematic



SPECIFICATIONS

Absolute Maximum Ratings⁽¹⁾

		MIN	MAX	UNIT
Voltage	Supply, $V_s = (V+) - (V-)$		36	V
	Input pin (IN+, IN-) ⁽²⁾	(V-) - 0.3	(V+) + 0.3	V
	Signal output pin ⁽³⁾	(V-) - 0.3	(V+) + 0.3	V
Current	Signal Input pin (IN+, IN-) ⁽²⁾	-10	10	mA
	Signal output pin ⁽³⁾	-55	55	mA
Temperature	Operating Range	-40	85	°C
	Storage	-65	150	°C
	Junction		150	°C

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(2) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ± 55 mA or less.

(3) Short-circuit from output to V_{CC} can cause excessive heating and eventual destruction.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	± 2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	± 1000	V

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.

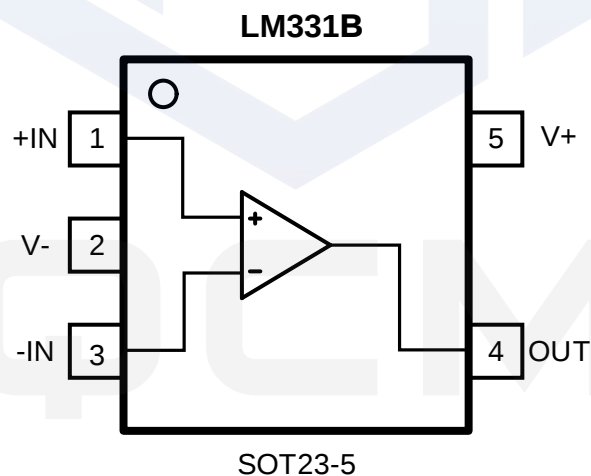
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

		MIN	MAX	UNIT
Supply voltage, $V_s = (V+) - (V-)$	Single-supply	3	32	V
	Dual-supply	± 1.5	± 16	V

**PACKAGE/ORDER INFORMATION**

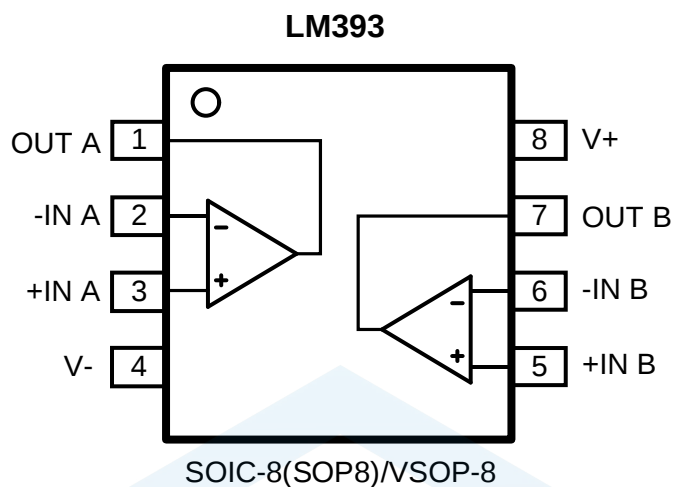
MODEL	OPERATING TEMPERATURE RANGE	ORDERING NUMBER	PACKAE DESCRIPTION
LM331	-40°C~85°C	LM331BXF	SOT23-5
LM393	-40°C~85°C	LM393DR	SOIC-8(SOP8)
		LM393DGKR	VSOP-8
LM339	-40°C~85°C	LM339DR	SOIC-14(SOP14)
		LM339PWR	TSSOP-14

Pin Configuration and Functions (Top View)**Pin Description**

Pin Name	Pin Number	I/O	Description
	SOT23-5		
+IN	1	I	Noninverting input
V-	2	-	Negative(lowest) power supply
-IN	3	I	Inverting input
OUT	4	O	Output
V+	5	-	Positive (highest) power supply



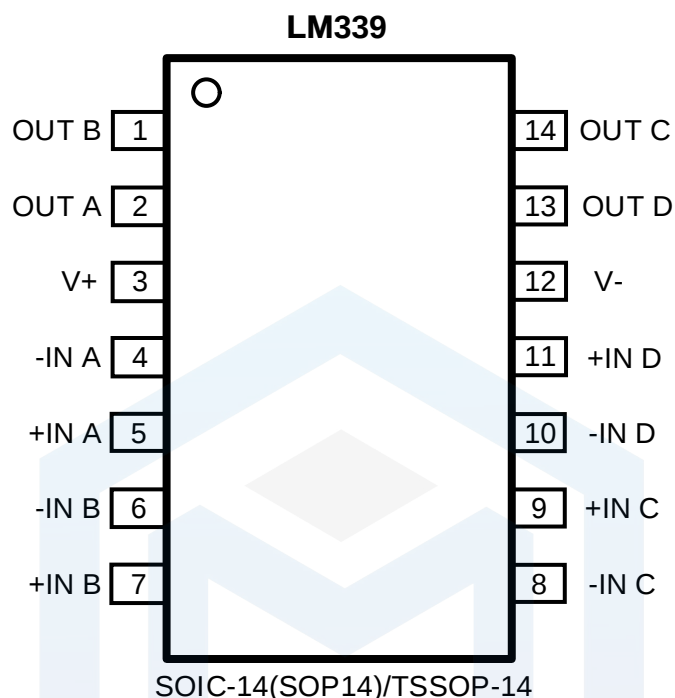
Pin Configuration and Functions (Top View)



Pin Description

Pin Name	Pin Number	I/O	Description
	SOIC-8(SOP8)/MSOP-8		
OUTA	1	O	Output, channel A
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
V-	4	-	Negative(lowest) power supply
+INB	5	I	Noninverting input, channel B
-INB	6	I	Inverting input, channel B
OUTB	7	O	Output, channel B
V+	8	-	Positive (highest) power supply

Pin Configuration and Functions (Top View)



Pin Description

Pin Name	Pin Number	I/O	Description
	SOP-14/TSSOP-14		
OUTB	1	O	Output, channel B
OUTA	2	O	Output, channel A
V+	3	-	Positive (highest) power supply
-INA	4	I	Inverting input, channel A
+INA	5	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	7	I	Noninverting input, channel B
-INC	8	I	Inverting input, channel C
+INC	9	I	Noninverting input, channel C
-IND	10	I	Inverting input, channel D
+IND	11	I	Noninverting input, channel D
V-	12	-	Negative(lowest) power supply
OUTD	13	O	Output, channel D
OUTC	14	O	Output, channel C

**ELECTRICAL CHARACTERISTICS**

At $T_A = 25^\circ\text{C}$, $V_S = +5\text{V}$, $V_{IN+} = V_S$, $V_{IN-} = 1.4\text{V}$, $R_{PU} = 10\text{k}\Omega$, unless otherwise noted.

Symbol	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
Vs	Operating Voltage Range		3		32	V
Iq	Quiescent Current /per channel	Vs=5V		75		μA
		Vs=36V		110		μA
INPUT CHARACTERISTICS						
Vos	Input offset voltage		-5	2	5	mV
IB	Input Bias Current	VCM=Vs/2		1		nA
Ios	Input Offset Current			1		nA
VCM	Common-Mode Voltage Range		Vs-		Vs+-1.5	V
AVD	Large-signal Differential- voltage Amplification	Vs = 15 V, Vo = 1.4 V to 11.4 V, RL ≥ 15 kΩ to Vs	50	200		V/mV
OUTPUT CHARACTERISTICS						
IOH	High-level Output Current	VOH=36V, VID=1V		2	30	nA
IOL	Low-level Output Current	VOL=1.5V, VID=-1V		30		mA
VOL	Low-level Output Voltage	IOL=4mA, VID=-1V		270		mV
DYNAMIC CHARACTERISTICS						
tRT	Propagation Delay H To L	Vs=5V, RPU=5.1kΩ, Overdrive =10mV		485		ns
		Vs=5V, RPU=5.1kΩ, Overdrive =100mV		400		
	Propagation Delay L To H	Vs=5V, RPU=5.1kΩ, Overdrive =10mV		360		
		Vs=5V, RPU=5.1kΩ, Overdrive =100mV		90		



DETAILED DESCRIPTION

Overview

The LM331 family of comparators can operate up to 32V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to its low power and high speed. The open-drain output allows the user to configure the output's logic low voltage (V_{OL}) and can be utilized to enable the comparator to be used in AND functionality.

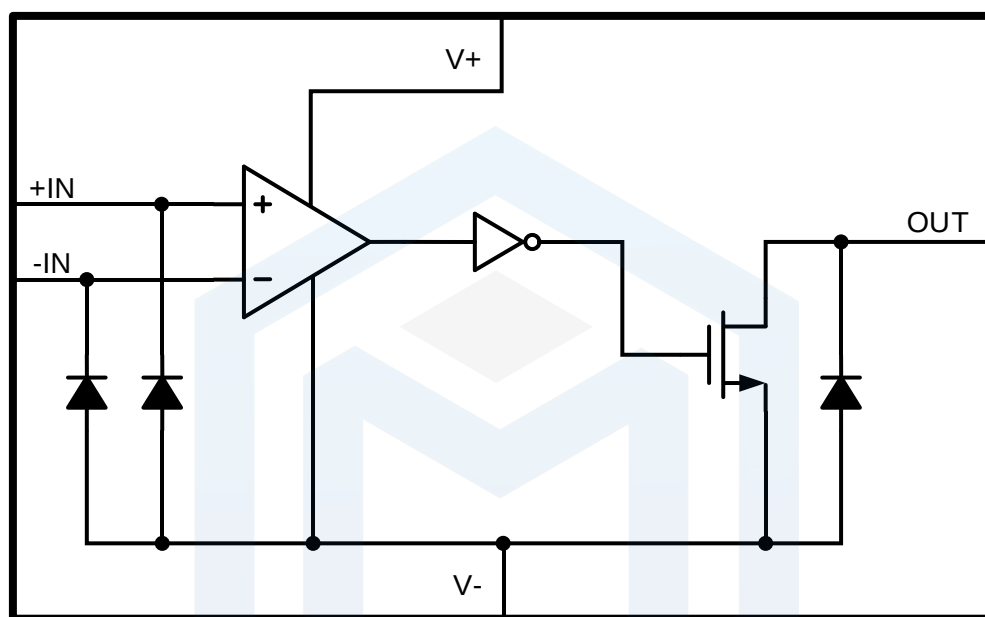


Figure 2. Functional Block Diagram

APPLICATION and IMPLEMENTATION

Application Information

The LM331 will typically be used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output (logic high with pull-up) to drive the comparison logic output to a logic voltage level to an MCU or logic device.

Typical Application

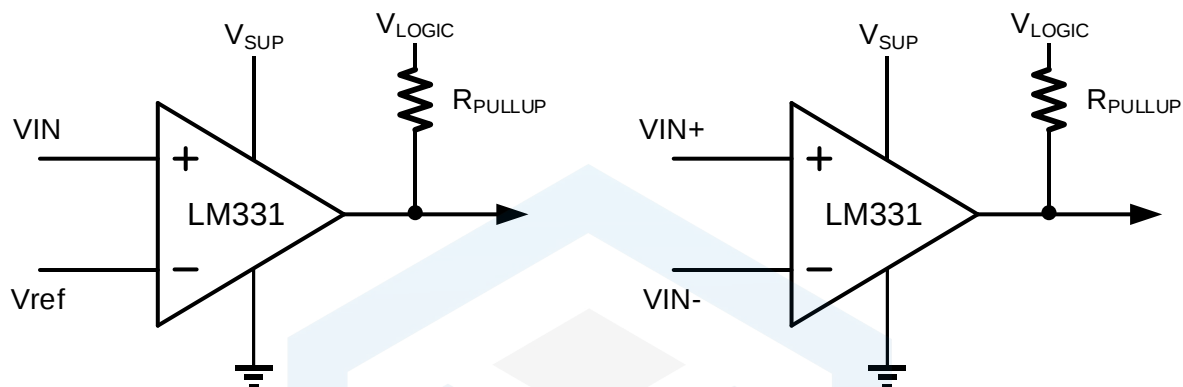


Figure 3. Typical Application Schematic

Power Supply Recommendations

For fast response and comparison applications with noisy or AC inputs, it is recommended to use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation causes temporary fluctuations in the comparator's input common mode range and create an inaccurate comparison.

Layout

Layout Guidelines

For accurate comparator applications without hysteresis it is important maintain a stable power supply with minimized noise and glitches, which can affect the high-level input common mode voltage range. In order to achieve this, it is best to add a bypass capacitor between the supply voltage and ground. This should be implemented on the positive power supply and negative supply (if available). If a negative supply is not being used, do not put a capacitor between the IC's GND pin and system ground.

Layout Example

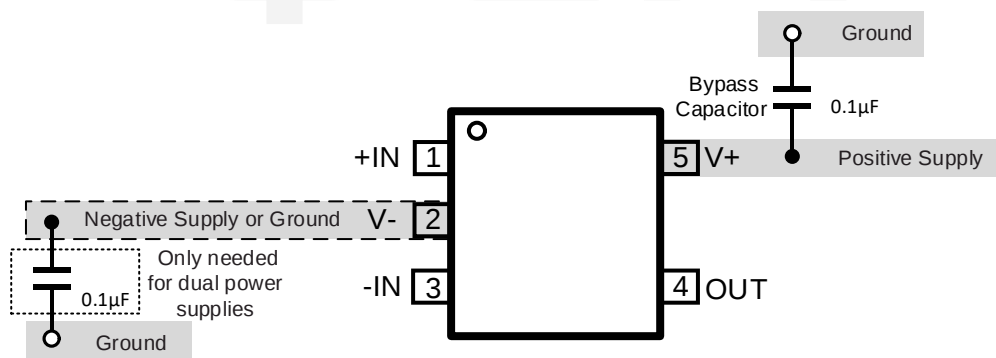


Figure 4. LM331 Layout Example

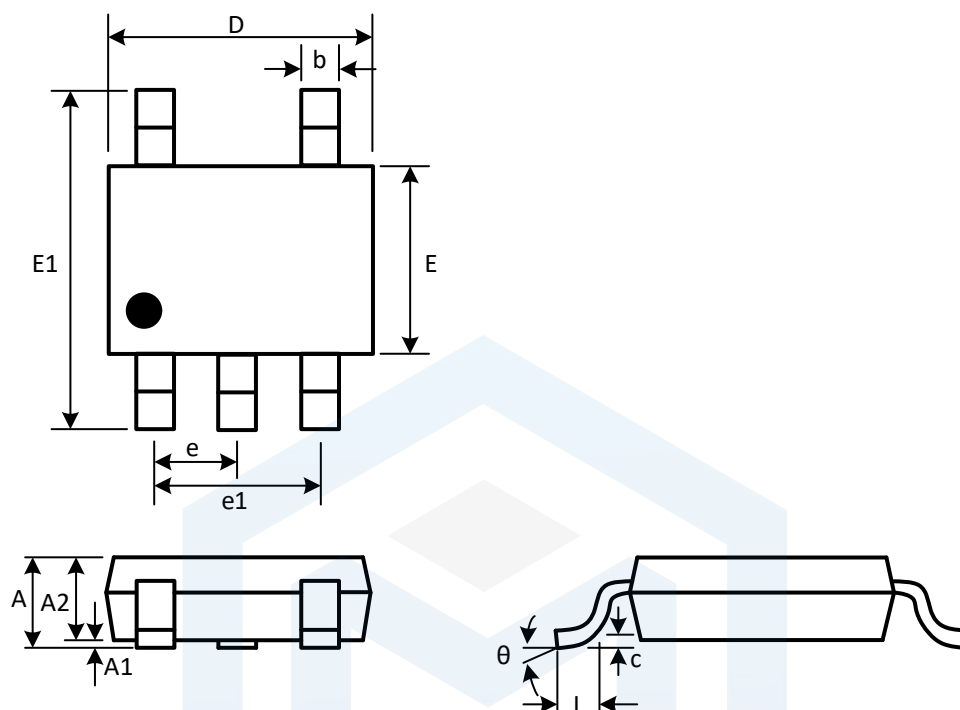


QCM

LM331/LM393/LM339

PACKAGE DESCRIPTION

SOT23-5



(Unit: mm)

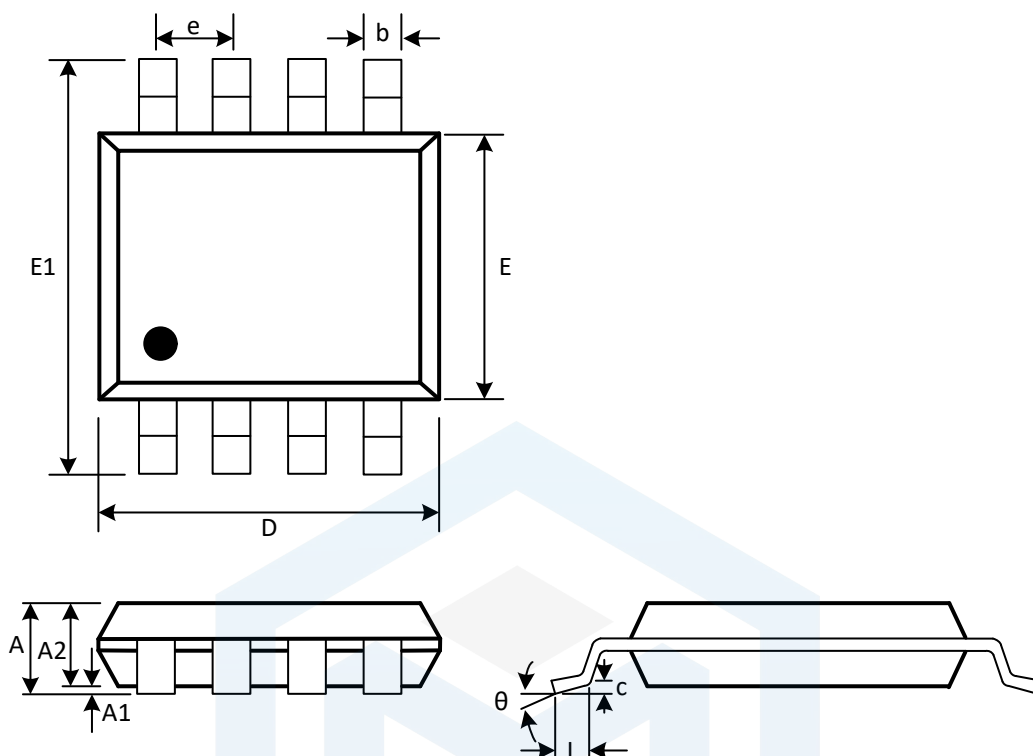
Symbol	Min	Max
A	1.050	1.250
A1	0.000	0.100
A2	1.050	1.150
b	0.300	0.500
c	0.100	0.200
D	2.820	3.020
e	0.950(BSC)	
e1	1.800	2.000
E	1.500	1.700
E1	2.650	2.950
L	0.300	0.600
θ	0°	8°



QCM

LM331/LM393/LM339

SOIC-8(SOP8)



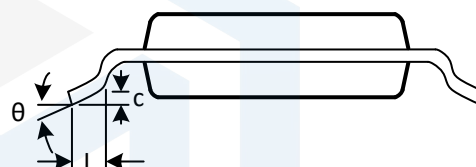
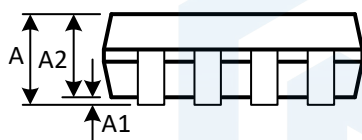
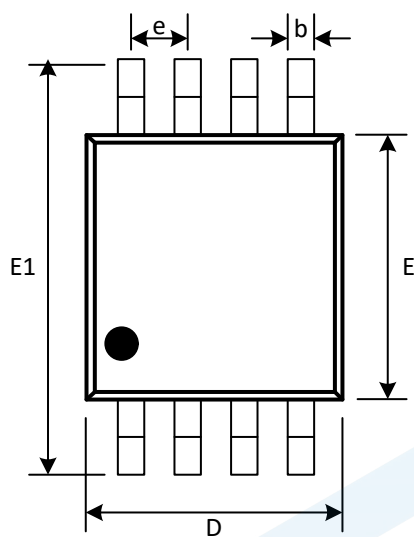
(Unit: mm)

Symbol	Min	Max
A	1.350	1.750
A1	0.100	0.250
A2	1.350	1.550
b	0.330	0.510
c	0.170	0.250
D	4.800	5.000
e	1.270(BSC)	
E	3.800	4.000
E1	5.800	6.200
L	0.400	1.270
θ	0°	8°



QCM
VSOP-8

LM331/LM393/LM339

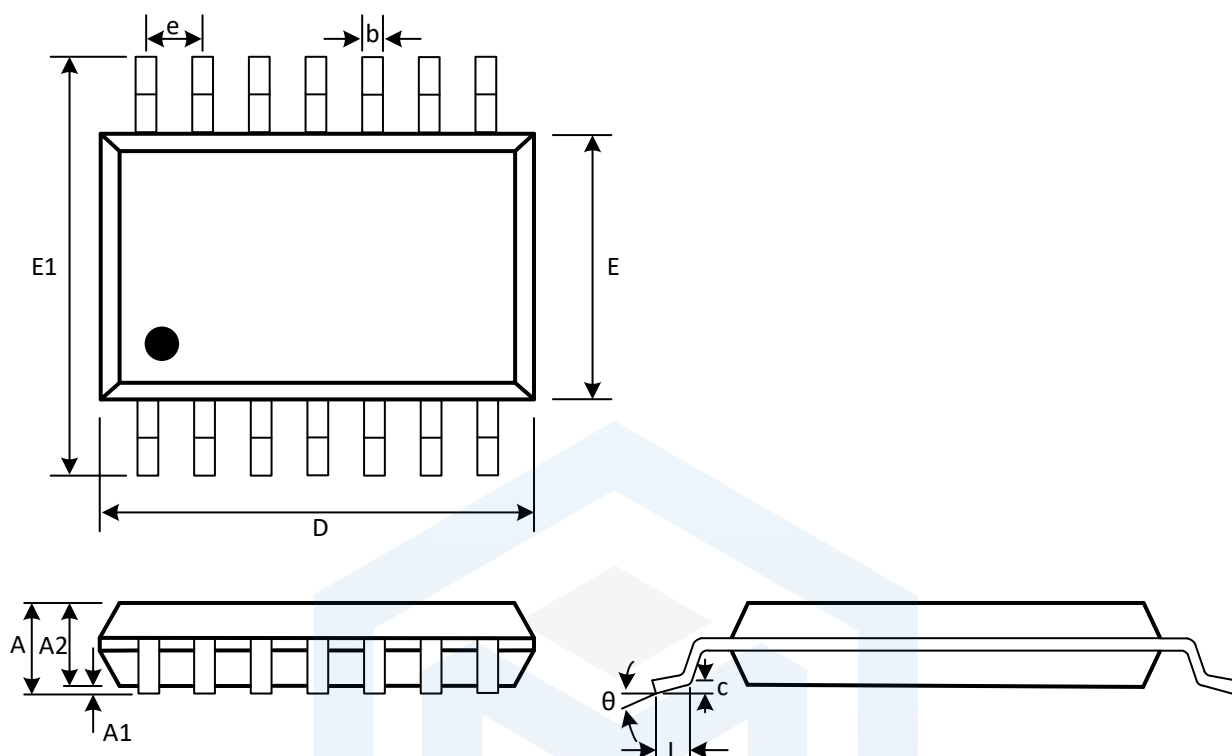


(Unit: mm)

Symbol	Min	Max
A	0.820	1.100
A1	0.020	0.150
A2	0.750	0.950
b	0.250	0.380
c	0.090	0.230
D	2.900	3.100
e	0.650(BSC)	
E	2.900	3.100
E1	4.750	5.050
L	0.400	0.800
θ	0°	6°

**QCM**

LM331/LM393/LM339

SOIC-14(SOP14)

(Unit: mm)

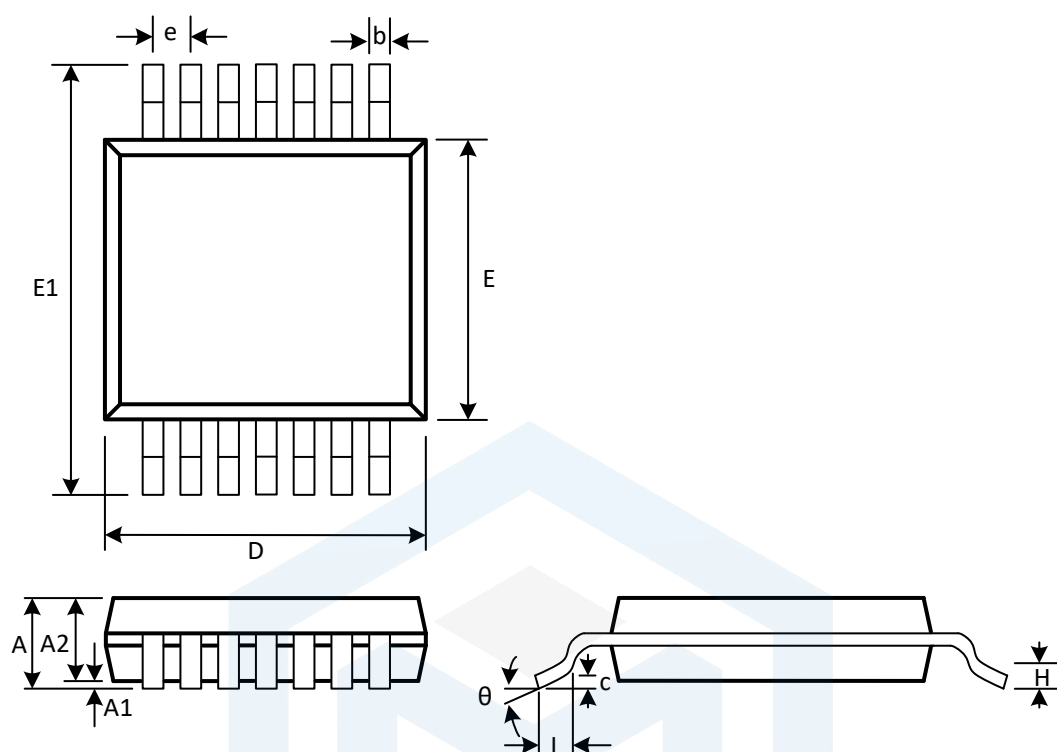
Symbol	Min	Max
A	1.350	1.750
A1	0.100	0.250
A2	1.350	1.550
b	0.310	0.510
c	0.100	0.250
D	8.450	8.850
e	1.270(BSC)	
E1	5.800	6.200
E	3.800	4.000
L	0.400	1.270
θ	0°	8°



QCM

TSSOP-14

LM331/LM393/LM339



(Unit: mm)

Symbol	Min	Max
A		1.200
A1	0.050	0.150
A2	0.800	1.050
b	0.190	0.300
c	0.090	0.200
D	4.860	5.100
e	0.650(BSC)	
E	4.300	4.500
E1	6.250	6.550
L	0.500	0.700
	0.250(TYP)	
θ	1°	7°