Low Offset Voltage Dual Comparators

The 393 series are dual independent precision voltage comparators capable of single or split supply operation. These devices are designed to permit a common mode range−to−ground level with single supply operation. Input offset voltage specifications as low as 2.0 mV make this device an excellent selection for many applications.

Features

- Wide Single−Supply Range: 2.0 Vdc to 36 Vdc
- Split−Supply Range: ±1.0 Vdc to ±18 Vdc
- Very Low Current Drain Independent of Supply Voltage: 0.4 mA
- Low Input Bias Current: 25 nA
- Low Input Offset Current: 5.0 nA
- Low Input Offset Voltage: 5.0 mV (max) 293/393/2903
- Input Common Mode Range to Ground Level
- Differential Input Voltage Range Equal to Power Supply Voltage
- Output Voltage Compatible with DTL, ECL, TTL, MOS, and CMOS Logic Levels
- ESD Clamps on the Inputs Increase the Ruggedness of the Device without Affecting Performance

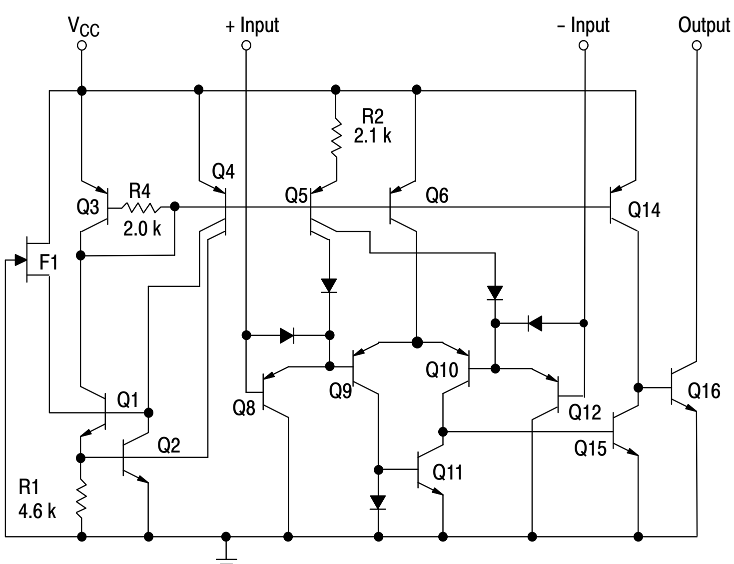
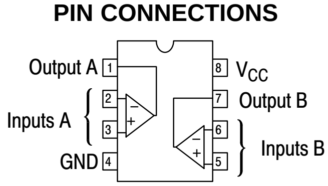


Figure 1. Representative Schematic Diagram
(Diagram shown is for 1 comparator)

PIN CONNECTIONS



293 393 2903

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	+36 or ±18	V
Input Differential Voltage	V_{IDR}	36	V
Input Common Mode Voltage Range (Note 1)	V_{ICR}	−0.3 to +36	V
Output Voltage	V_O	36	V
Output Short Circuit−to−Ground Output Sink Current (Note 2)	I_{SC} I_{Sink}	Continuous 20	mA
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D $1/R_{\theta JA}$	570 5.7	mW mW/°C
Operating Ambient Temperature Range 293 393 2903	T_A	-40 85°	°C
Maximum Operating Junction Temperature 293 393 2903	$T_{J(max)}$	150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
ESD Protection at any Pin (Note 4) − Human Body Model − Machine Model	V_{ESD}	1500 150	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. For supply voltages less than 36 V, the absolute maximum input voltage is equal to the supply voltage.
2. The maximum output current may be as high as 20 mA, independent of the magnitude of V_{CC}, output short circuits to V_{CC} can cause excessive heating and eventual destruction.
3. V_{ESD} rating for NCV/SC devices is: Human Body Model − 2000 V; Machine Model − 200 V.

Ordering Information

part Number	Device Marking	Package type	Body size (mm)	Temperature(℃)	MSL	Transport Media	Package Quantity
XL293-KR	XL293-KR	VSSOP8	3.0*3.0	-40 to +85	MSL3	T&R	2500
XL293D-8	XL293D-8	SOP8	4.9*3.9	-40 to +85	MSL3	T&R	2500
XL293-TS	XL293-TS	TSSOP8	3.0*4.4	-40 to +85	MSL3	T&R	2500
XD293-8	XD293-8	DIP8	9.25*6.38	-40 to +85	MSL3	Tube 50	2000
XL393-KR	XL393-KR	VSSOP8	3.0*3.0	-40 to +85	MSL3	T&R	2500
XL393	XL393	SOP8	4.9*3.9	-40 to +85	MSL3	T&R	2500
XL393-TS	XL393-TS	TSSOP8	3.0*4.4	-40 to +85	MSL3	T&R	2500
XD393	XD393	DIP8	9.25*6.38	-40 to +85	MSL3	Tube 50	2000
XL2903-KR	XL2903-KR	VSSOP8	3.0*3.0	-40 to +85	MSL3	T&R	2500
XL2903	XL2903	SOP8	4.9*3.9	-40 to +85	MSL3	T&R	2500
XL2903-TS	XL2903-TS	TSSOP8	3.0*4.4	-40 to +85	MSL3	T&R	2500
XD2903	XD2903	DIP8	9.25*6.38	-40 to +85	MSL3	Tube 50	2000

293 393 2903

ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0 Vdc, $T_{low} \le T_A \le T_{high}$, unless otherwise noted.)

Characteristic	Symbol	293，393			2903			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 6) T_A = 25°C $T_{low} \le T_A \le T_{high}$	V_{IO}	 – –	 ±1.0 –	 ±5.0 ±9.0	 – –	 ±2.0 ±9.0	 ±7.0 ±15	mV
Input Offset Current T_A = 25°C $T_{low} \le T_A \le T_{high}$	I_{IO}	 – –	 ±5.0 –	 ±50 ±150	 – –	 ±5.0 ±50	 ±50 ±200	nA
Input Bias Current (Note 7) T_A = 25°C $T_{low} \le T_A \le T_{high}$	I_{IB}	 – –	 20 –	 250 400	 – –	 20 20	 250 500	nA
Input Common Mode Voltage Range (Note 7) T_A = 25°C $T_{low} \le T_A \le T_{high}$	V_{ICR}	 0 0	 – –	 V_{CC} −1.5 V_{CC} −2.0	 0 0	 – –	 V_{CC} −1.5 V_{CC} −2.0	V
Voltage Gain $R_L \ge 15$ kΩ, V_{CC} = 15 Vdc, T_A = 25°C	A_{VOL}	50	200	–	25	200	–	V/mV
Large Signal Response Time V_{in} = TTL Logic Swing, V_{ref} = 1.4 Vdc V_{RL} = 5.0 Vdc, R_L = 5.1 kΩ, T_A = 25°C	–	–	300	–	–	300	–	ns
Response Time (Note 9) V_{RL} = 5.0 Vdc, R_L = 5.1 kΩ, T_A = 25°C	t_{TLH}	–	1.3	–	–	1.5	–	μs
Input Differential Voltage (Note 10) All $V_{in} \ge$ GND or V− Supply (if used)	V_{ID}	–	–	V_{CC}	–	–	V_{CC}	V
Output Sink Current $V_{in} \ge 1.0$ Vdc, V_{in+} = 0 Vdc, $V_O \le 1.5$ Vdc T_A = 25°C	I_{Sink}	6.0	16	–	6.0	16	–	mA
Output Saturation Voltage $V_{in} \ge 1.0$ Vdc, V_{in+} = 0, $I_{Sink} \le 4.0$ mA, T_A = 25°C $T_{low} \le T_A \le T_{high}$	V_{OL}	 – –	 150 –	 400 700	 – –	 – 200	 400 700	mV
Output Leakage Current V_{in-} = 0 V, $V_{in+} \ge 1.0$ Vdc, V_O = 5.0 Vdc, T_A = 25°C V_{in-} = 0 V, $V_{in+} \ge 1.0$ Vdc, V_O = 30 Vdc, $T_{low} \le T_A \le T_{high}$	I_{OL}	 – –	 0.1 –	 – 1000	 – –	 0.1 –	 – 1000	nA
Supply Current $R_L = \infty$ Both Comparators, T_A = 25°C $R_L = \infty$ Both Comparators, V_{CC} = 30 V	I_{CC}	 – –	 0.4 –	 1.0 2.5	 – –	 0.4 –	 1.0 2.5	mA

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. The maximum output current may be as high as 20 mA, independent of the magnitude of V_{CC}, output short circuits to V_{CC} can cause excessive heating and eventual destruction.
5. At output switch point, $V_O \simeq 1.4$ Vdc, R_S = 0 Ω with V_{CC} from 5.0 Vdc to 30 Vdc, and over the full input common mode range (0 V to V_{CC} = −1.5 V).
6. Due to the PNP transistor inputs, bias current will flow out of the inputs. This current is essentially constant, independent of the output state, therefore, no loading changes will exist on the input lines.
7. Input common mode of either input should not be permitted to go more than 0.3 V negative of ground or minus supply. The upper limit of common mode range is V_{CC} −1.5 V.
8. Response time is specified with a 100 mV step and 5.0 mV of overdrive. With larger magnitudes of overdrive faster response times are obtainable.
9. The comparator will exhibit proper output state if one of the inputs becomes greater than V_{CC}, the other input must remain within the common mode range. The low input state must not be less than −0.3 V of ground or minus supply.

293 393 2903

293/393

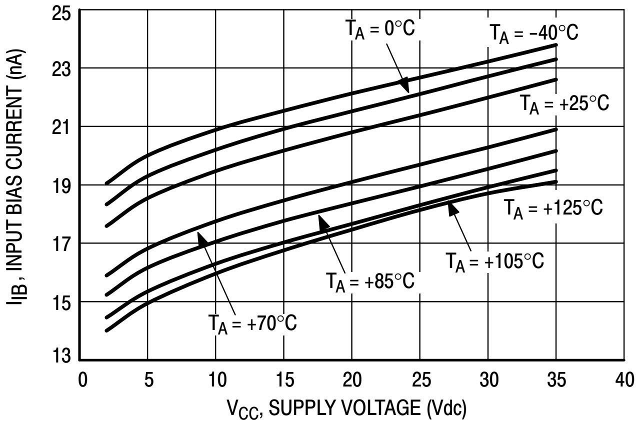


Figure 2. Input Bias Current versus Power Supply Voltage

2903

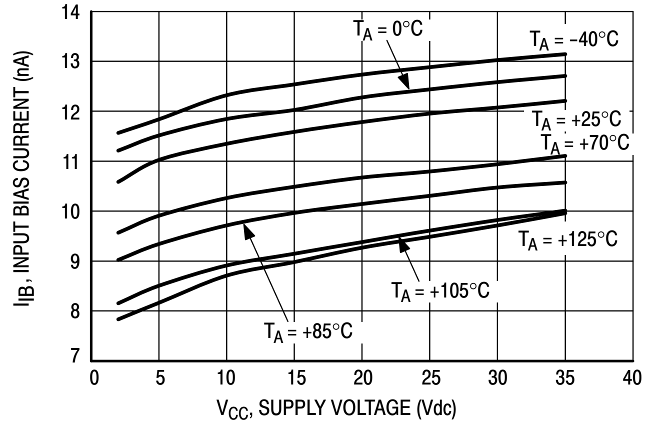


Figure 3. Input Bias Current versus Power Supply Voltage

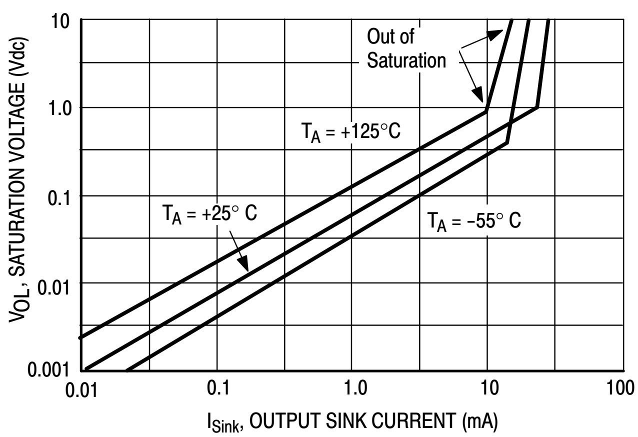


Figure 4. Output Saturation Voltage versus Output Sink Current

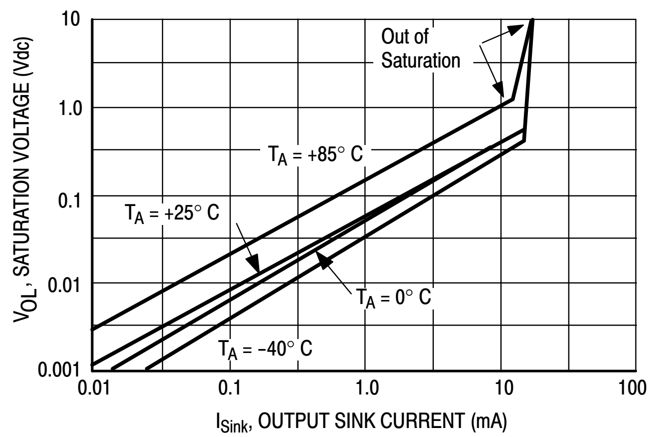


Figure 5. Output Saturation Voltage versus Output Sink Current

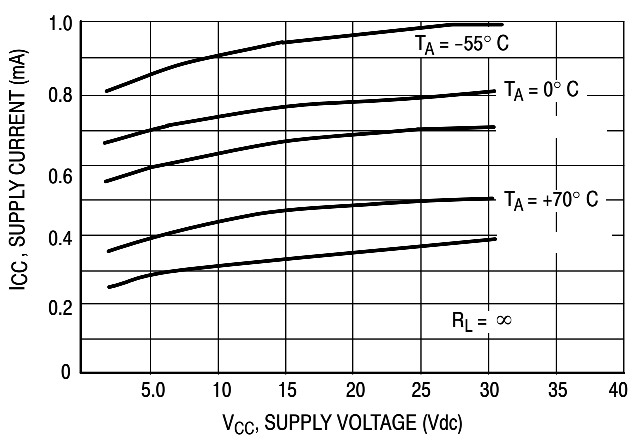


Figure 6. Power Supply Current versus Power Supply Voltage

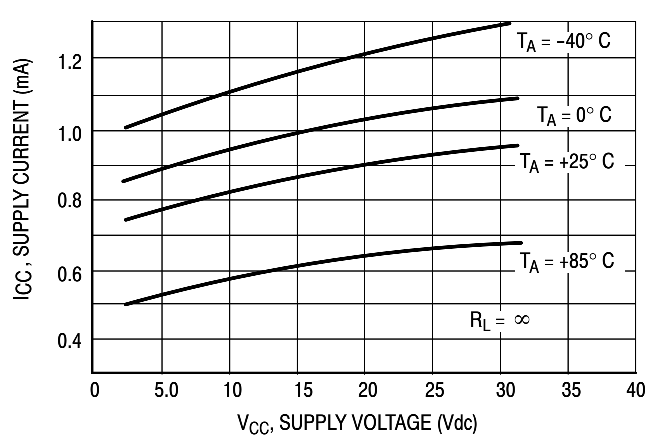


Figure 7. Power Supply Current versus Power Supply Voltage

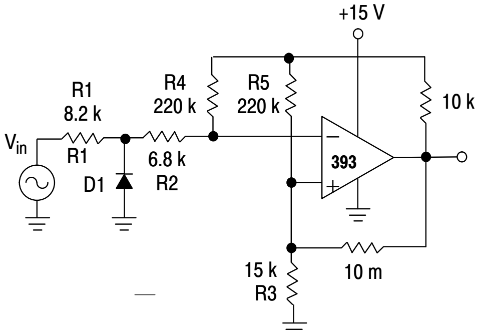
293 393 2903

APPLICATIONS INFORMATION

These dual comparators feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitively coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions (V_{OL} to V_{OH}). To alleviate this situation, input resistors < 10 kΩ should be used.

The addition of positive feedback (< 10 mV) is also recommended. It is good design practice to ground all unused pins.

Differential input voltages may be larger than supply voltage without damaging the comparator's inputs. Voltages more negative than −0.3 V should not be used.

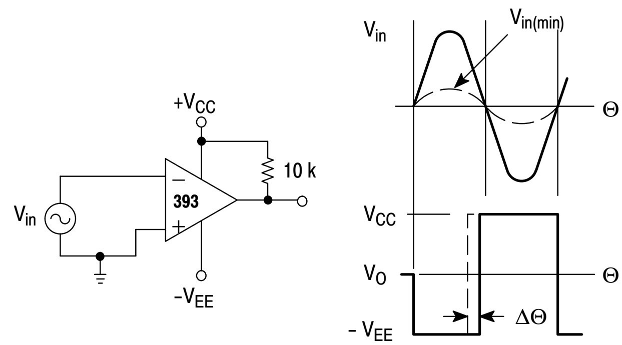


D1 prevents input from going negative by more than 0.6 V.

$R1 + R2 = R3$

$R3 \leq \frac{R5}{10}$ for small error in zero crossing.

Figure 8. Zero Crossing Detector (Single Supply)



$V_{in(min)} \approx 0.4$ V peak for 1% phase distortion (ΔΘ).

Figure 9. Zero Crossing Detector (Split Supply)

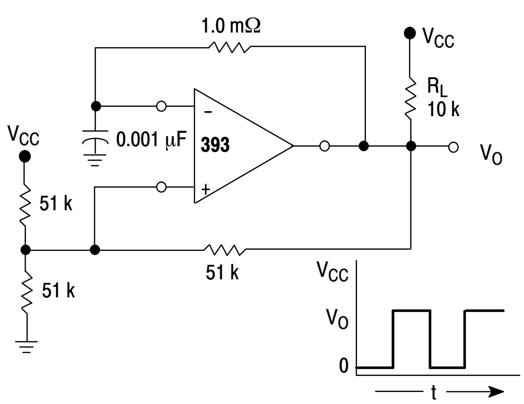


Figure 10. Free−Running Square−Wave Oscillator

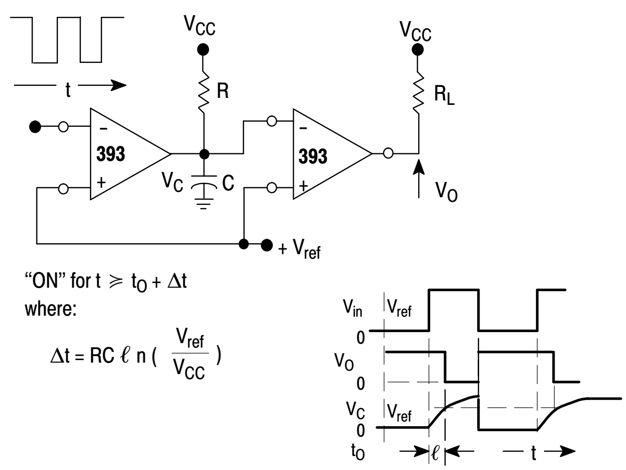
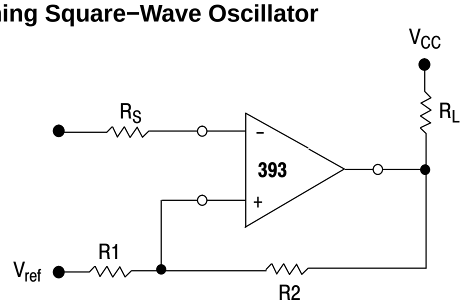


Figure 11. Time Delay Generator



$R_S = R1 \,||\, R2$

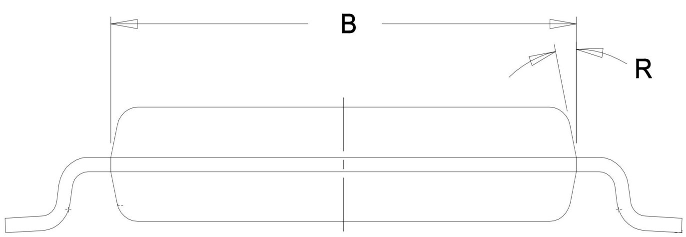
$V_{th1} = V_{ref} + \frac{(V_{CC} - V_{ref})\,R1}{R1 + R2 + R_L}$

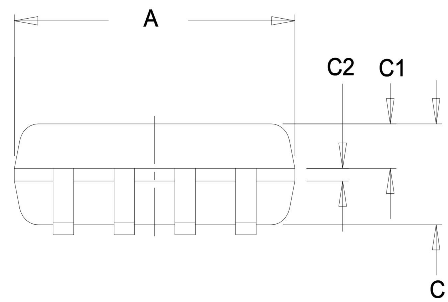
$V_{th2} = V_{ref} - \frac{(V_{ref} - V_O\ \text{Low})\,R1}{R1 + R2}$

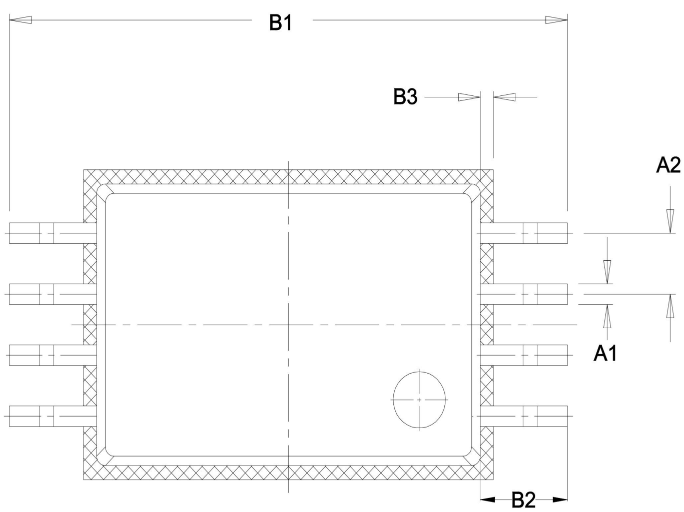
Figure 12. Comparator with Hysteresis

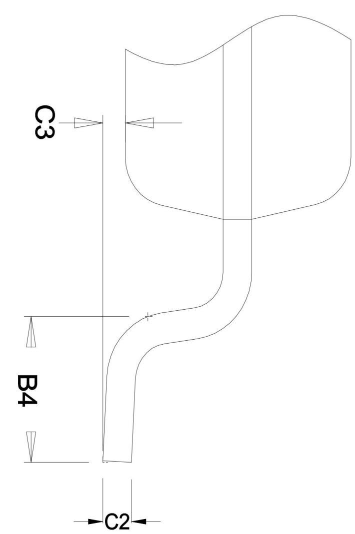
TSSOP8封装尺寸图

尺寸 标注	最小值（mm)	平均值（mm)	最大值（mm)	尺寸 标注	最小值（mm)	平均值（mm)	最大值（mm)
A	2.95	3.00	3.05	B4	0.50	0.60	0.70
A1		0.22		C	0.95	1.00	1.05
A2	0.63	0.65	0.68	C1	0.39	0.44	0.49
B	4.35	4.40	4.45	C2		0.127	
B1	6.30	6.40	6.50	C3	0.05	0.10	0.15
B2	0.90	1.00	1.10	R		12°	
B3			0.12				

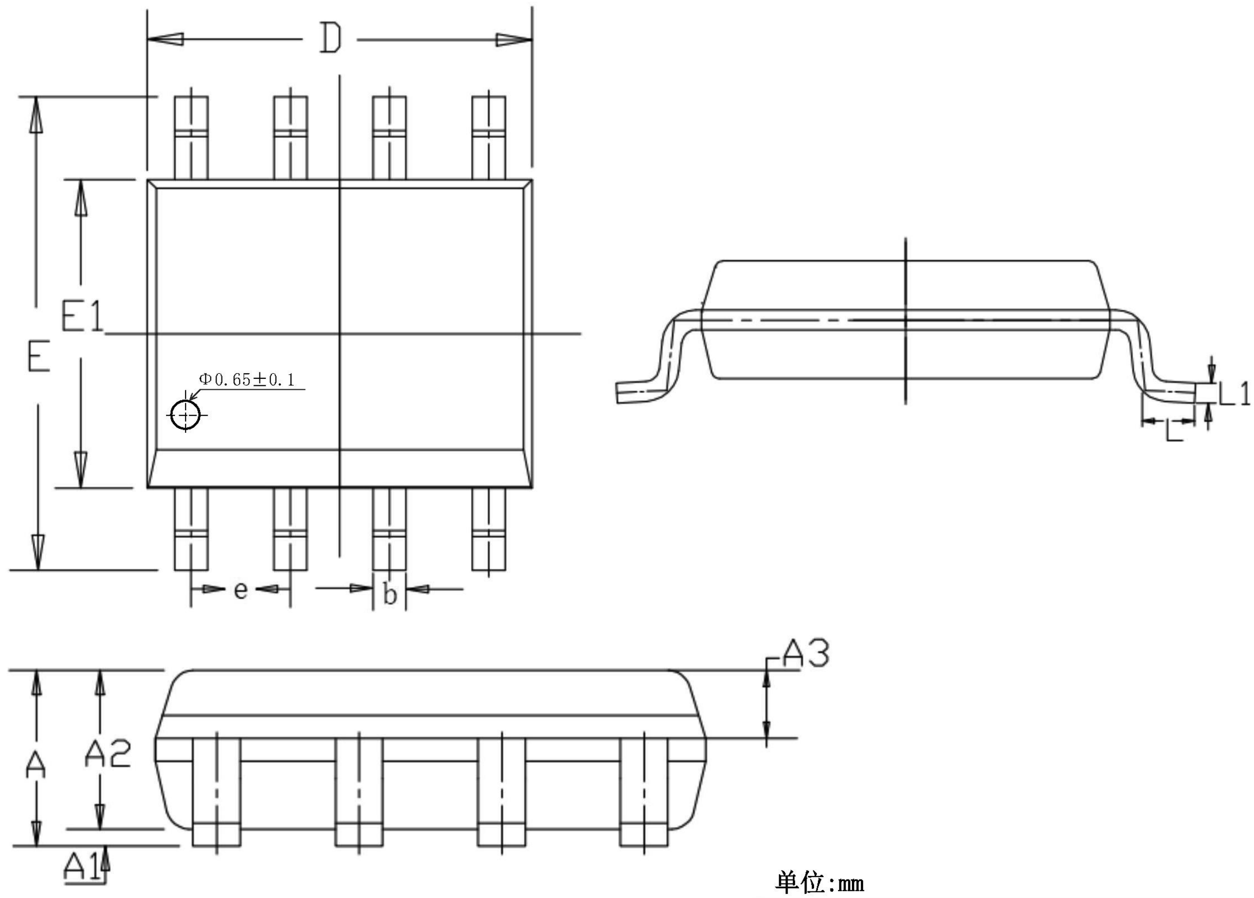








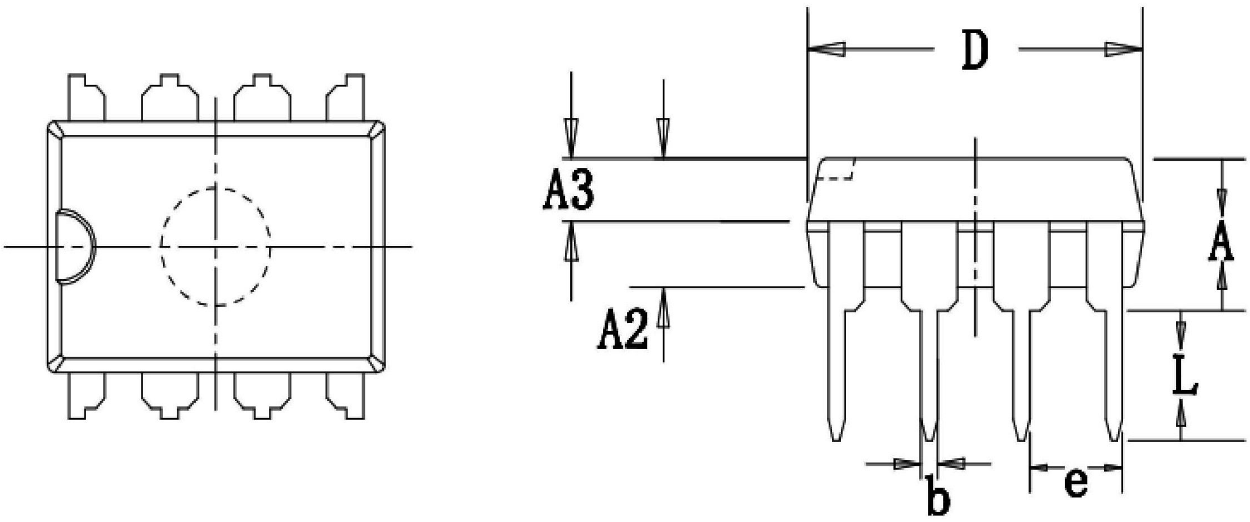
SOP8封装尺寸图

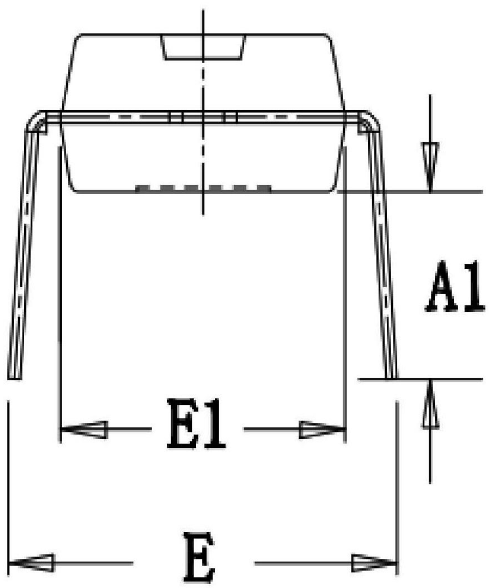


单位:mm

	MIN	NOM	MAX
A	1.450	1.550	1.650
A1(站高)	0.100	0.150	0.200
A2(厚度)	1.300	1.400	1.500
A3	0.600	0.650	0.700
b	0.380	–	0.510
e(脚间距)	1.240	1.270	1.300
D(长度)	4.800	4.900	5.000
E(跨度)	5.800	6.000	6.200
E1(宽度)	3.800	3.900	4.000
L(脚长)	0.450	0.600	0.750
L1	—	0.25BSC	—

DIP8封装尺寸图

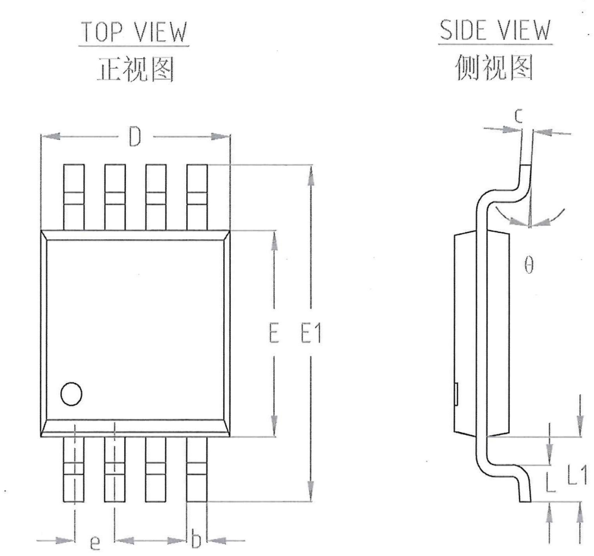


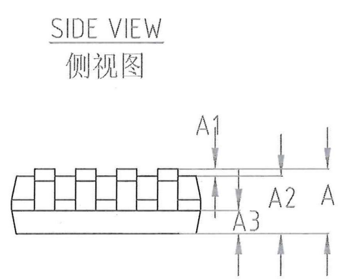


单位:mm

	MIN	NOM	MAX
A	3.600	3.800	4.000
A1(站高)	3.786	3.886	3.986
A2(厚度)	3.200	3.300	3.400
A3	1.550	1.600	1.650
b	0.440	—	0.490
e(脚间距)	2.510	2.540	2.570
D(长度)	9.150	9.250	9.350
E(跨度)	7.800	8.500	9.200
E1(宽度)	6.280	6.380	6.480
L(脚长)	3.000	—	—

VSSOP8封装尺寸图





机械尺寸/mm Dimensions			
字符 SYMBOL	最小值 MIN	典型值 NOMINAL	最大值 MAX
A	-	-	1.10
A1	0.05	-	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.28	-	0.36
c	0.15	-	0.19
D	2.90	3.00	3.10
E	2.90	3.00	3.10
E1	4.70	4.90	5.10
e	0.65 BSC		
L1	0.95 REF		
L	0.40	-	0.70
θ	0°	-	8°