

Overview:

The LM393 includes two independent and precision voltage comparators with input offset voltage lower than 2.0mV. It can work with single power supply or dual power supplies, and its operating current is not affected by the power supply voltage. A unique characteristic is that its input common-mode voltage range can reach zero level even under single power supply operation. It is mainly applied in consumer and industrial electronic products, and adopts SOP8 package.

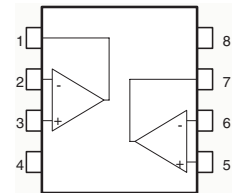
Package Outline Drawing



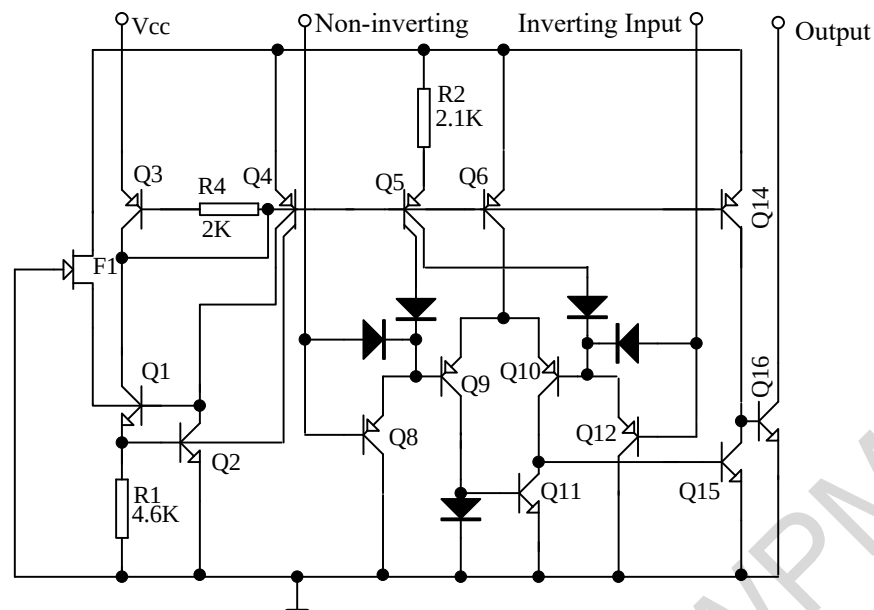
SOP-8

Main Features:

- Wide operating supply voltage range: Single supply: 2.0V~36V
Dual supply: $\pm 1.0\text{V} \sim \pm 18\text{V}$
- Low supply current: 0.8mA, independent of supply voltage
- Low input bias current: 25nA
- Low input offset current: 5.0nA
- Low input offset voltage: 5.0mV
- Input common-mode voltage range down to zero level
- Input differential voltage range is consistent with supply voltage range
- Compatible with TTL, DTL, ECL, MOS and CMOS circuits



Internal Circuit Diagram



Pin Definition

Pin No.	Function	Symbol	Pin No.	Function	Symbol
1	Comparator 1 Output	OUT1	5	Comparator 2 Non-inverting Input	IN2+
2	Comparator 1 Inverting Input	IN1-	6	Comparator 2 Inverting Input	IN2-
3	Comparator 1 Non-inverting Input	IN1+	7	Comparator 2 Output	OUT2
4	Ground	GND	8	Power Supply	Vcc

Absolute Maximum Ratings (Unless otherwise specified, Tamb=25°C)

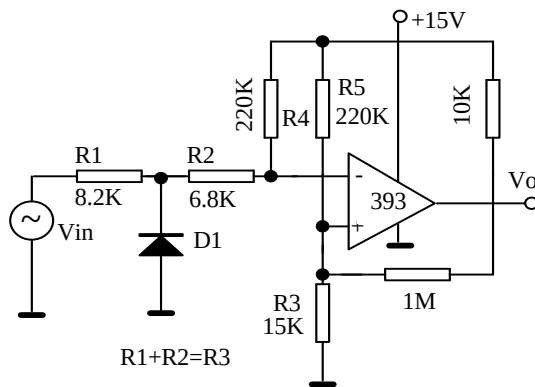
Parameter Name		Symbol	Pin No.		Unit
			Min	Max	
Power voltage	Dual Power Supply Voltage	Vcc	-	±18	V
	Single Power Supply Voltage			36	
Input Differential Voltage		V _{IDR}		36	V
Input Common-Mode Voltage		V _{ICR}	-0.3	36	V
Output Short-circuit Current to Ground		I _{OG}		20	mA
Maximum Junction Temperature		T _J (MAX)		125	°C
Power Dissipation (*)		P _D		570	mW
Operating Ambient Temperature		T _{amb}	0	70	°C
Storage Temperature		T _{stg}	-65	150	°C

Electrical Characteristics (Unless otherwise specified, Vcc=5V, Tamb=25°C)

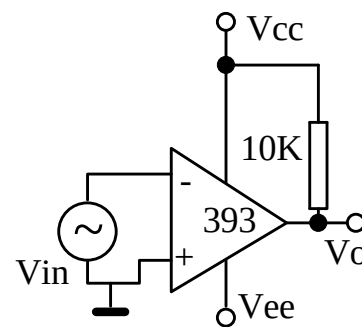
Characteristics	Test Conditions	Symbol	Range value			Unit
			Min	Typ	Max	
Input Offset Voltage	Ta=25°C	V _{IO}		±1.0	±5.0	mV
	0°C ≤ Ta ≤ 70°C				±9.0	
Input Offset Current	Ta=25°C	I _{IO}		±5.0	±50	nA
	0°C ≤ Ta ≤ 70°C				±150	
Input Bias Current	Ta=25°C	I _{IB}		25	250	nA
	0°C ≤ Ta ≤ 70°C				400	
Input Common-Mode Voltage Rang	Ta=25°C	V _{ICR}	0		Vcc-1.5	V
	0°C ≤ Ta ≤ 70°C		0		Vcc-2.0	
Supply Current	R _L =∞ Dual Comparators	I _{CC}		0.4	1.0	mA
	R _L =∞ Dual Comparators, Vcc=30V				2.5	
Voltage Gain	R _L ≥ 15KΩ, Vcc=15V	G _v	50	200		V/mV

Large Signal Response Time	$V_{IN}=TTL$ logic swing, $V_{REF}=1.4V$, $V_{RL}=5.0V$, $R_L=5.1K\Omega$	t_{RES}		300		ns
Response Time	$V_{RL}=5.0V$, $R_L=5.1K\Omega$	t_{RES}		1.3		ns
Input Differential Voltage		V_{ID}			V_{CC}	V
Output Sink Current	$V_{IN}(-) \geq 1.0V$, $V_{IN}(+) = 0V$, $V_O \leq 1.5V$	I_{SINK}	6.0	16		mA
Output Saturation Voltage	$V_{IN}(-) \geq 1.0V$, $V_{IN}(+) = 0V$, $I_{SINK} \leq 4.0mA$	V_{SAT}		150	400	mV
	$V_{IN}(-) \geq 1.0V$, $V_{IN}(+) = 0V$, $I_{SINK} \leq 4.0mA$ $0^\circ C \leq T_a \leq 70^\circ C$				700	
Output Leakage Current	$V_{IN}(+) \geq 1.0V$, $V_{IN}(-) = 0V$, $V_O = 5.0V$	I_{OL}		0.1		nA
	$V_{IN}(+) \geq 1.0V$, $V_{IN}(-) = 0V$, $V_O = 30V$ $0^\circ C \leq T_a \leq 70^\circ C$				1000	

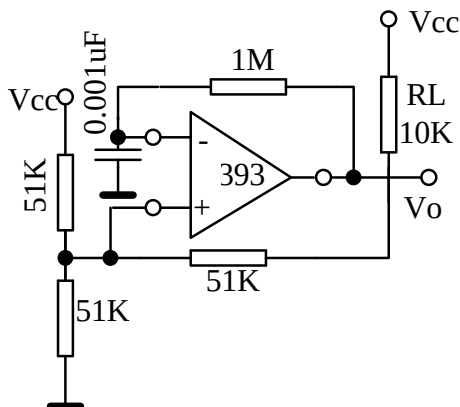
Application Circuits



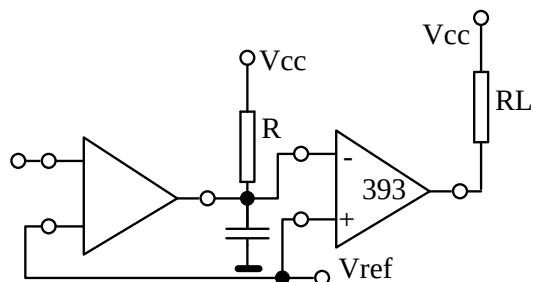
Zero Crossing Detector (Single Power Supply)



Zero Crossing Detector (Dual Power Supply)



Square Wave Oscillator



Delay Generator

Instructions for Use:

The LM393 is a high-gain and wide-bandwidth device. Like most comparators, it is prone to oscillation caused by parasitic capacitive coupling between output and input pins, which only occurs during the output voltage transition when the comparator state changes. Power supply bypass filter cannot solve this problem. Optimized PCB design helps reduce parasitic capacitive coupling between input and output.

Reducing input resistance below 10K Ω can weaken feedback signals. Adding a small amount of positive feedback (hysteresis 1.0~10mV) enables fast switching and eliminates oscillation caused by parasitic capacitance. Without hysteresis, simply adding resistors to pins will lead to oscillation during short transition periods. Hysteresis is not required if the input signal is a fast rising/falling pulse.

All unused pins of the comparator must be grounded.

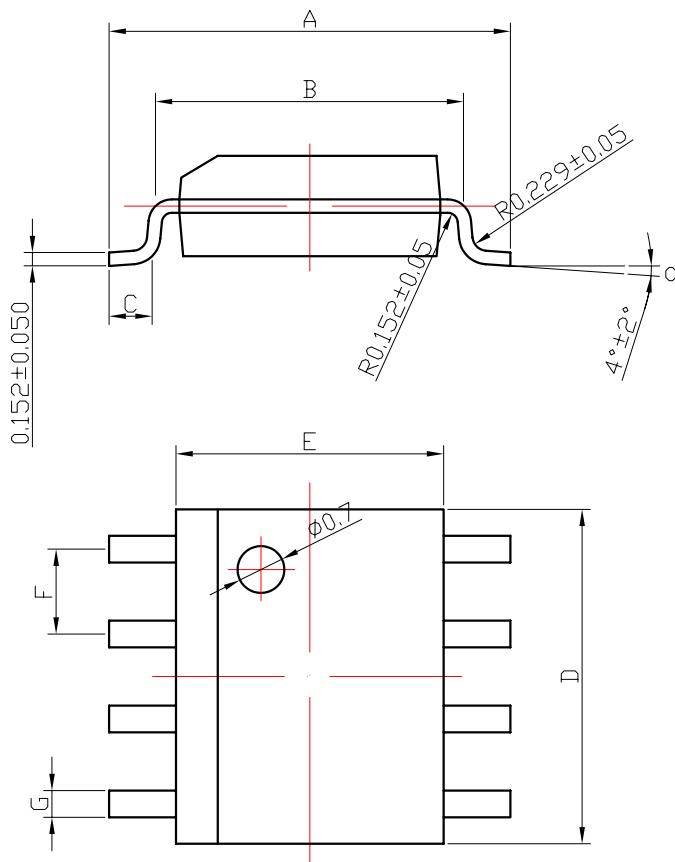
The bias network of LM393 ensures its static current is independent of supply voltage within 2.0V~30V.

Generally, no bypass capacitor is required for power supply.

The input differential voltage can exceed V_{cc} without damaging the device. Protection circuits shall prevent input voltage from going below -0.3V.

The output stage is an open-collector NPN transistor with emitter grounded, which supports wired-OR function with multiple outputs. The output load resistor can be connected to any power supply within the allowable voltage range, independent of V_{cc}. When no load resistor is used, the output acts as an open circuit to ground. The output sink current is limited by driving capability and transistor gain. When reaching the limit current of 16mA, the output transistor will cut off and output voltage rises rapidly. The output saturation voltage is limited by the on-resistance (about 60 Ω) of the output transistor. Thanks to the low offset voltage (approx. 1.0mV), the output can be clamped to zero level under small load current.

Package:SOP8



DIM	MILLIMETERS
A	5.80~6.20
B	4.45~4.67
C	0.584~0.83
D	5.00~5.20
E	3.81~4.00
F	1.27(TYP)
G	0.35~0.51
α	2°~6°

Sample Measured Values

Items No.	A	B	C	D	E	F	G	α
1	6.183	4.565	0.779	5.081	3.925	1.271	0.423	4°16'
2	6.182	4.546	0.778	5.083	3.930	1.277	0.422	4°12'
3	6.174	4.552	0.776	5.079	3.926	1.270	0.425	4°18'
4	6.178	4.557	0.774	5.086	3.926	1.281	0.421	4°06'
5	6.164	4.552	0.775	5.082	3.923	1.276	0.418	4°15'
6	6.174	4.559	0.780	5.079	3.921	1.272	0.419	4°14'
7	6.028	4.501	0.769	5.080	3.919	1.274	0.417	4°19'
8	6.090	4.599	0.768	5.078	3.920	1.269	0.420	4°20'
9	6.050	4.556	0.769	5.079	3.921	1.268	0.419	4°13'
10	6.078	4.563	0.780	5.076	3.905	1.270	0.417	4°17'
Average	6.1301	4.5420	0.7736	5.0801	3.9216	1.2728	0.4201	4°15'

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