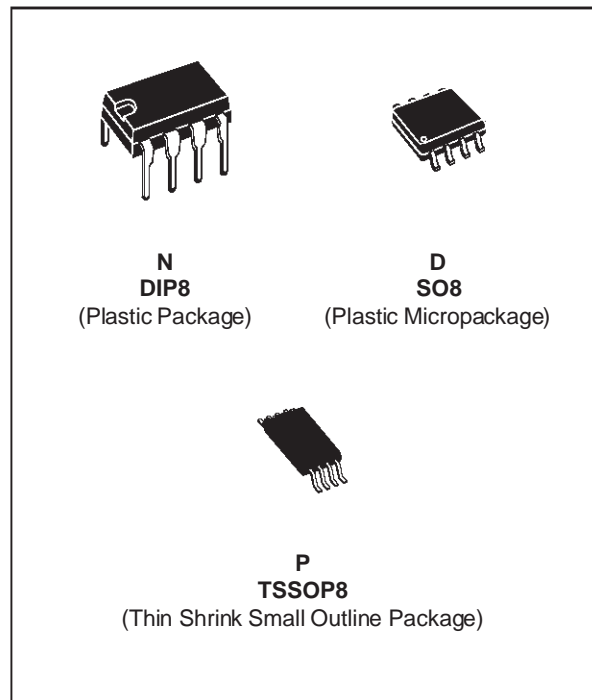




# LM193 - LM293 LM393

## LOW POWER DUAL VOLTAGE COMPARATORS

- WIDE SINGLE SUPPLY VOLTAGE RANGE OR DUAL SUPPLIES +2V TO +36V OR  $\pm 1V$  TO  $\pm 18V$
- VERY LOW SUPPLY CURRENT (0.4mA) INDEPENDENT OF SUPPLY VOLTAGE (1 mW/comparator at +5V)
- LOW INPUT BIAS CURRENT : 25nA TYP
- LOW INPUT OFFSET CURRENT :  $\pm 5nA$  TYP
- LOW INPUT OFFSET VOLTAGE :  $\pm 1mV$  TYP
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- LOW OUTPUT SATURATION VOLTAGE : 250mV TYP. ( $I_o = 4mA$ )
- DIFFERENTIAL INPUT VOLTAGE RANGE EQUAL TO THE SUPPLY VOLTAGE
- TTL, DTL, ECL, MOS, CMOS COMPATIBLE OUTPUTS



### DESCRIPTION

These devices consist of two independent low power voltage comparators designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

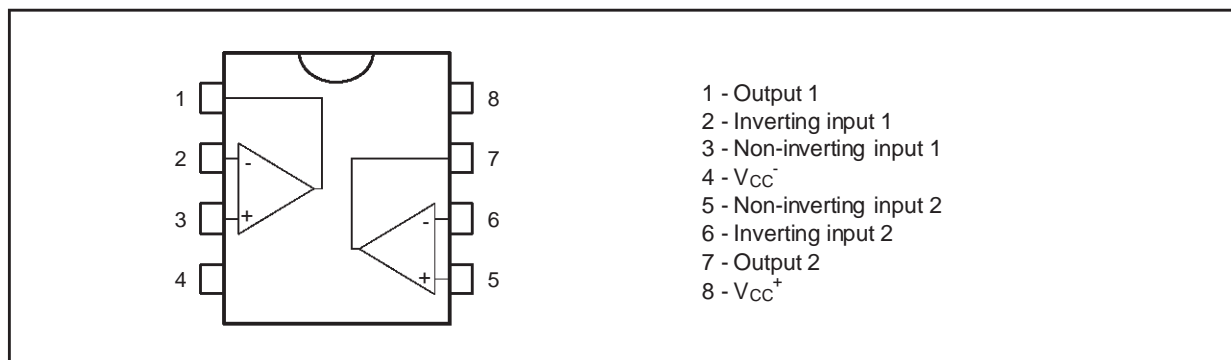
These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

### ORDER CODES

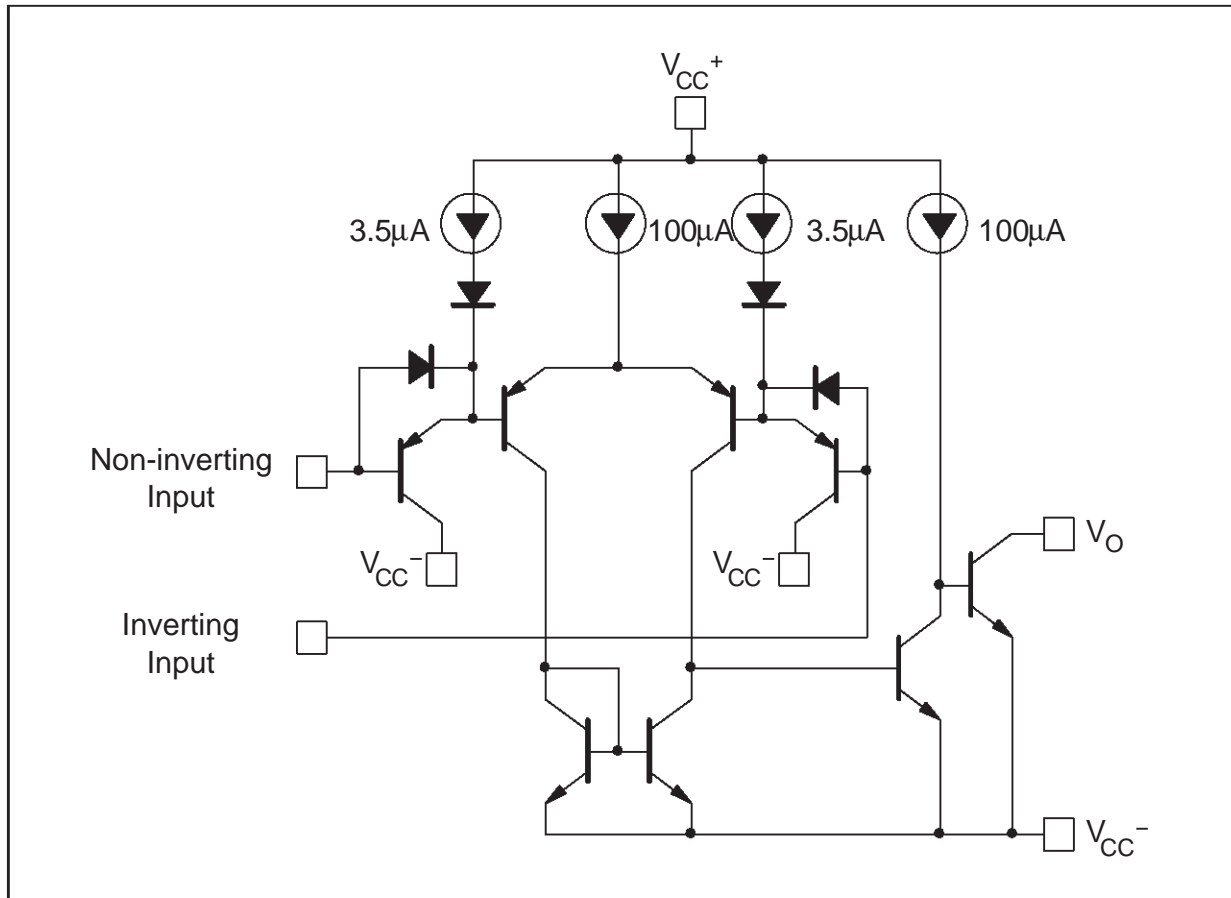
Part Number	Temperature Range	Package		
		N	D	P
LM193	-55, +125°C	•	•	•
LM293	-40, +105°C	•	•	•
LM393	0, +70°C	•	•	•

**Example : LM393D**

### PIN CONNECTIONS (top view)



**SCHEMATIC DIAGRAM (1/2 LM193)**



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	LM193	LM293	LM393	Unit
$V_{CC}$	Supply Voltage	$\pm 18$ or 36	$\pm 18$ or 36	$\pm 18$ or 36	V
$V_{id}$	Differential Input Voltage	$\pm 36$	$\pm 36$	$\pm 36$	V
$V_i$	Input Voltage	-0.3 to +36	-0.3 to +36	-0.3 to +36	V
	Output Short-circuit to Ground – (note 1)	Infinite			
$P_{tot}$	Power Dissipation	830			mW
$T_{oper}$	Operating Free-air Temperature Range	-55 to +125	-40 to +105	0 to +70	$^{\circ}C$
$T_{stg}$	Storage Temperature Range	-65 to +150	-65 to +150	-65 to +150	$^{\circ}C$

**Notes :** 1. Short-circuit from the output to  $V_{CC}^+$  can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA, independent of the magnitude of  $V_{CC}^+$ .

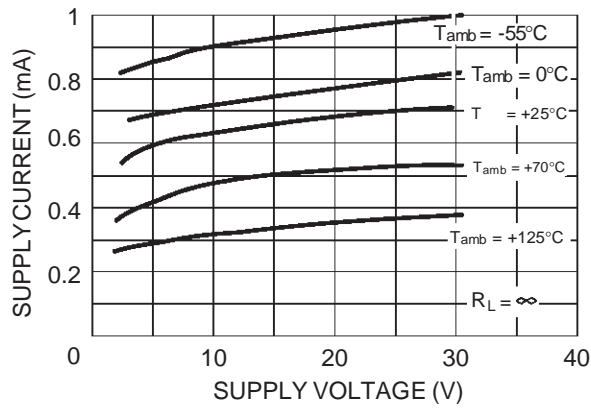
**ELECTRICAL CHARACTERISTICS**

$V_{CC}^+ = +5V$ ,  $V_{CC}^- = 0V$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

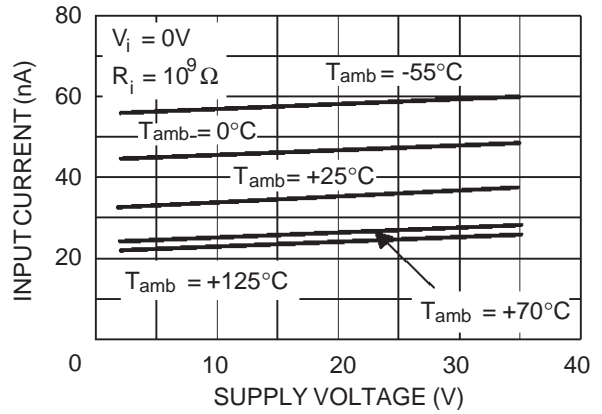
Symbol	Parameter	LM193 - LM293 - LM393			Unit
		Min.	Typ.	Max.	
$V_{io}$	Input Offset Voltage – (note 2) $T_{amb} = +25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1	5 9	mV
$I_{ib}$	Input Bias Current – (note 3) $T_{amb} = +25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		25	250 400	nA
$I_{io}$	Input Offset Current $T_{amb} = +25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		5	50 150	nA
$A_{vd}$	Large Signal Voltage Gain $V_{CC} = 15V$ , $R_L = 15k\Omega$ , $V_o = 1$ to $11V$	50	200		V/mV
$I_{CC}$	Supply Current (all comparators) $V_{CC} = 5V$ , no load $V_{CC} = 30V$ , no load		0.4 1	1 2.5	mA
$V_{icm}$	Input Common Mode Voltage Range - (note 4) $T_{amb} = +25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	0 0		$V_{CC}^+ - 1.5$ $V_{CC}^+ - 2$	V
$V_{id}$	Differential Input Voltage - (note 6)			$V_{CC}^+$	V
$I_{sink}$	Output Sink Current ( $V_{id} = -1V$ , $V_o = 1.5V$ )	6	16		mA
$V_{OL}$	Low Level Output Voltage ( $V_{id} = -1V$ , $I_{sink} = 4mA$ ) $T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		250	400 700	mV
$I_{OH}$	High Level Output Current ( $V_{id} = 1V$ , $V_{CC} = V_o = 30V$ ) $T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		0.1	1	nA $\mu A$
$t_{re}$	Response Time ( $R_L = 5.1k\Omega$ to $V_{CC}^+$ ) – (note 5)		1.3		$\mu s$
$t_{rel}$	Large Signal Response Time ( $V_i = TTL$ , $V_{ref} = +1.4V$ , $R_L = 5.1k\Omega$ to $V_{CC}^+$ )		300		ns

- Notes :**
- At output switch point,  $V_o \approx 1.4V$ ,  $R_s = 0\Omega$  with  $V_{CC}^+$  from 5V to 30V and over the full input common-mode range (0V to  $V_{CC}^+ - 1.5V$ ).
  - 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 or input lines.
  - The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V.  
The upper end of the common-mode voltage range is  $V_{CC}^+ - 1.5V$ , but either or both inputs can go to +30V without damage.
  - The response time specified is for a 100mV input step with 5mV overdrive. For larger overdrive signals 300ns can be obtained.
  - 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 -0.3V (or 0.3V below the negative power supply, if used).

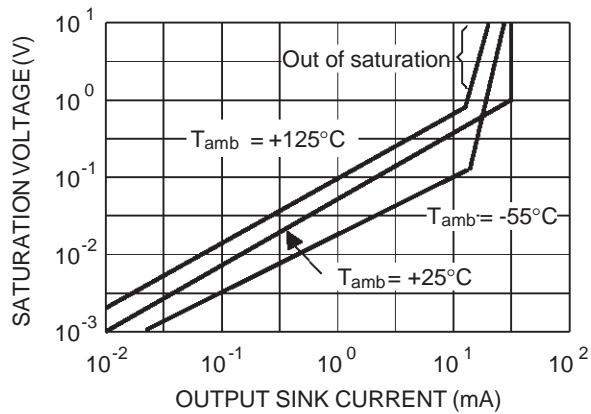
**SUPPLY CURRENT versus SUPPLY VOLTAGE**



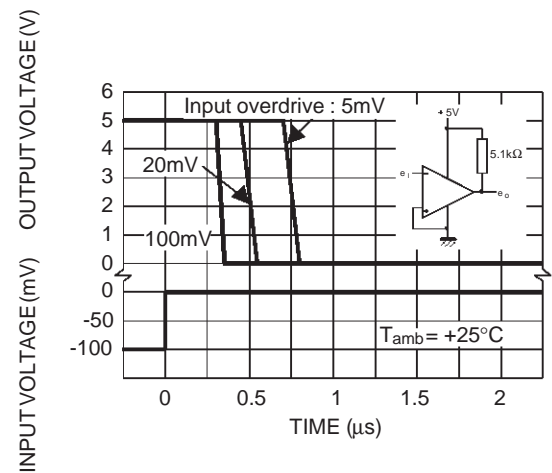
**INPUT CURRENT versus SUPPLY VOLTAGE**



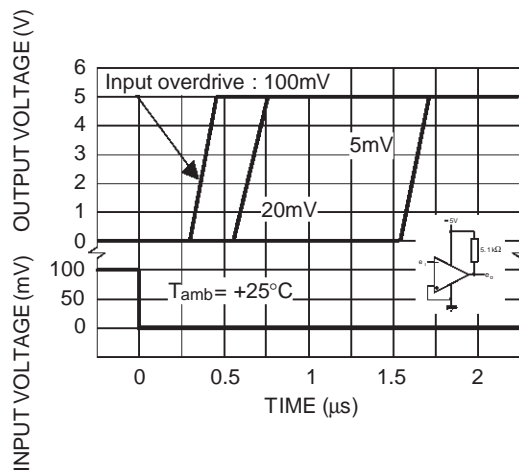
**OUTPUT SATURATION VOLTAGE versus OUTPUT CURRENT**



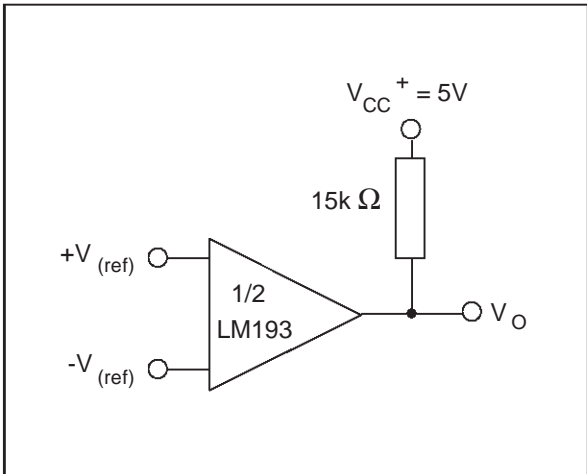
**RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - NEGATIVE TRANSITION**



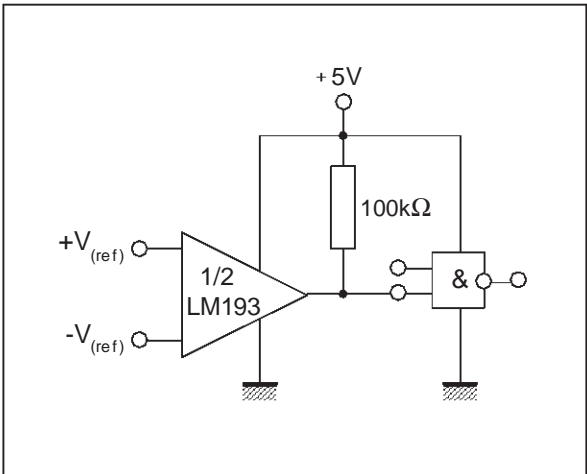
**RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION**



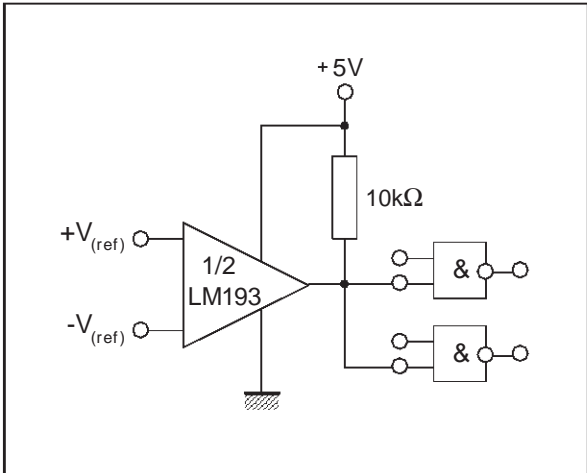
**TYPICAL APPLICATIONS**  
**BASIC COMPARATOR**



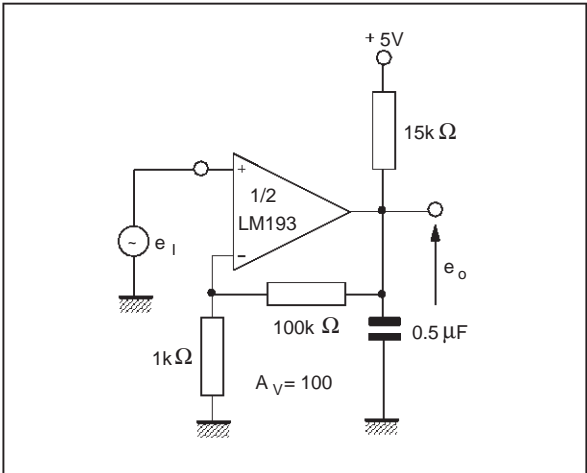
**DRIVING CMOS**



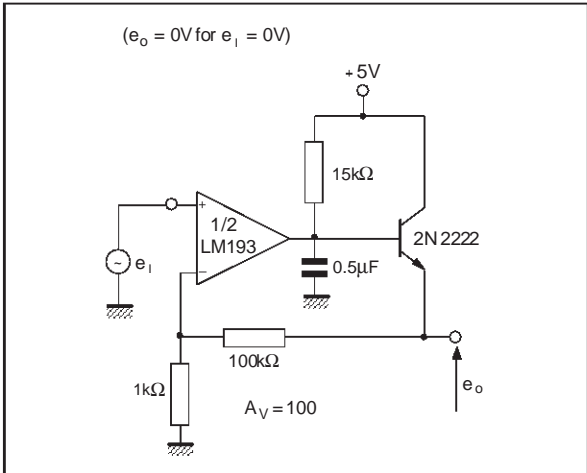
**DRIVING TTL**



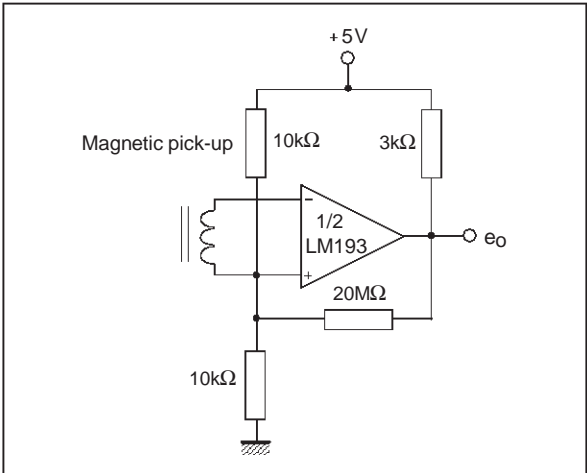
**LOW FREQUENCY OP AMP**



**LOW FREQUENCY OP AMP**

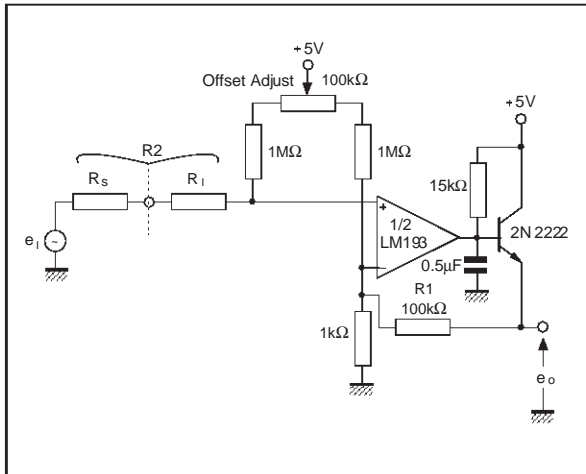


**TRANSDUCER AMPLIFIER**

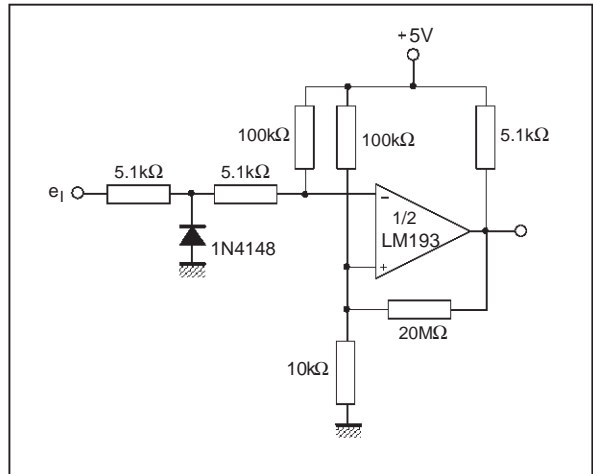


# LM193 - LM293 - LM393

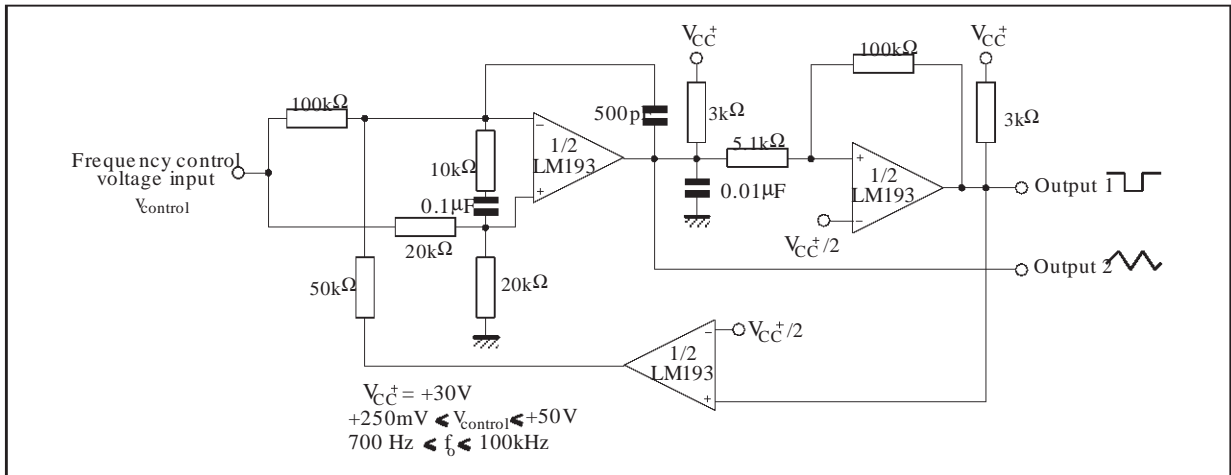
## LOW FREQUENCY OP AMP WITH OFFSET ADJUST



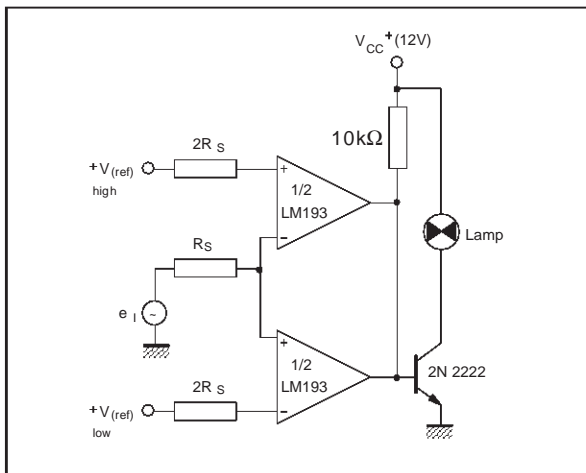
## ZERO CROSSING DETECTOR (SINGLE POWER SUPPLY)



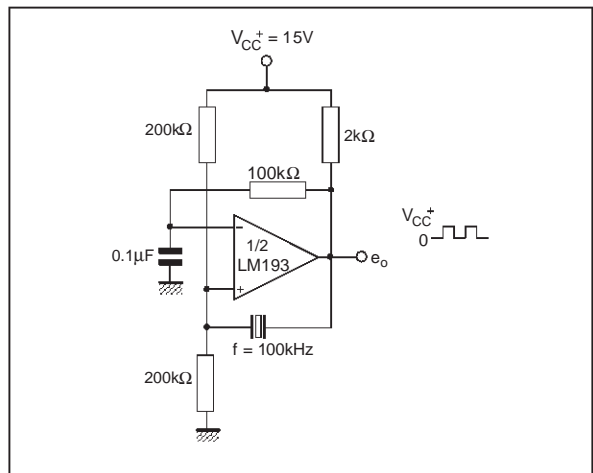
## TWO DECADES HIGH FREQUENCY VCO



## LIMIT COMPARATOR

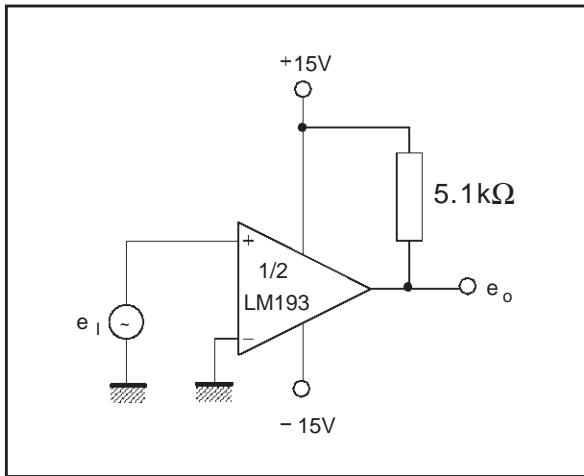


## CRYSTAL CONTROLLED OSCILLATOR

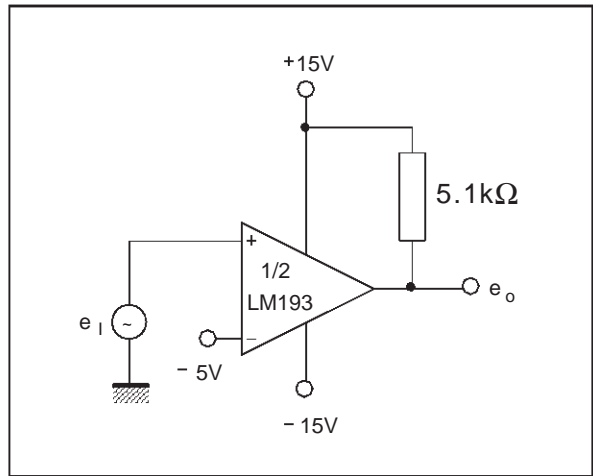


193-17/EPS

**SPLIT-SUPPLY APPLICATIONS**  
**ZERO CROSSING DETECTOR**



**COMPARATOR WITH A NEGATIVE REFERENCE**



LM193 - LM293 - LM393

PACKAGE MECHANICAL DATA  
8 PINS -PLASTIC DIP



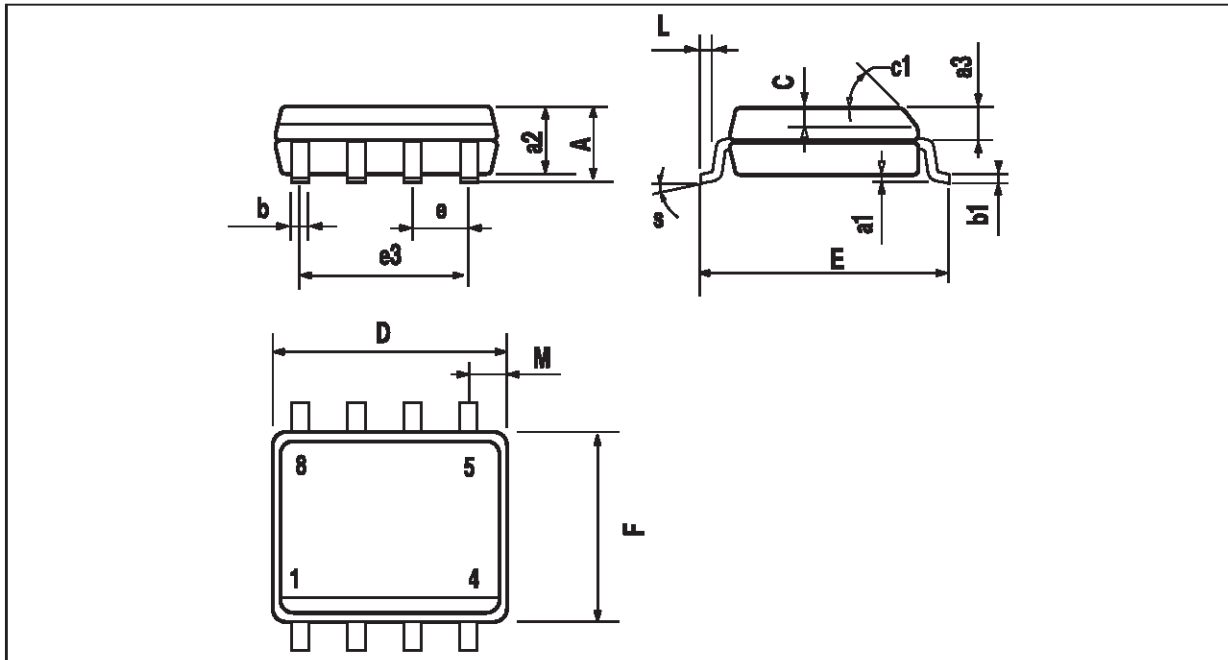
PM-DIP8.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

DIP8.TBL



**PACKAGE MECHANICAL DATA**  
8 PINS -PLASTIC MICROPACKAGE (SO)



PM-SOB:EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

SO8:TBL

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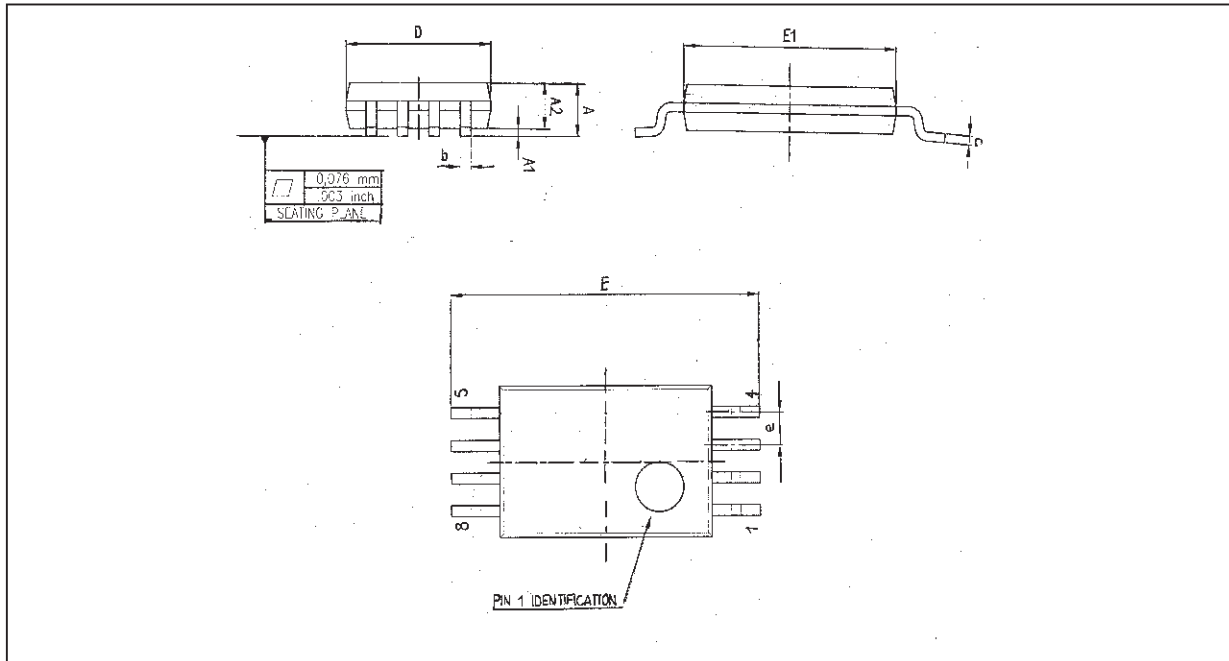
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ORDER CODE



**PACKAGE MECHANICAL DATA**  
**8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE**



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0°		8°	0°		8°
l	0.50	0.60	0.75	0.09	0.0236	0.030