

**LOW POWER DUAL VOLTAGE COMPARATORS**

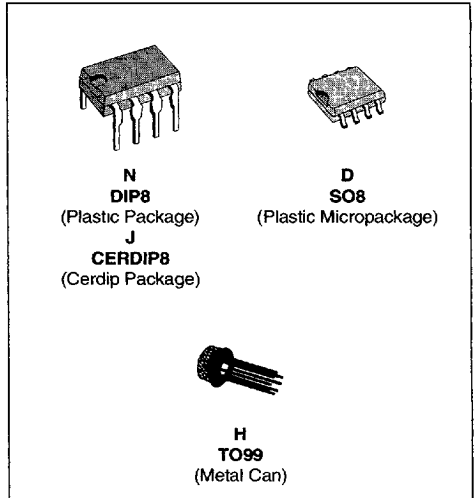
- WIDE SINGLE SUPPLY VOLTAGE RANGE OR DUAL SUPPLIES +2V TO +36V OR  $\pm 1V$  TO  $\pm 18V$
- VERY LOW SUPPLY CURRENT (0.4mA) INDEPENDENT OF SUPPLY VOLTAGE (1 mW/comparator at +5V)
- LOW INPUT BIAS CURRENT : 25nA TYP
- LOW INPUT OFFSET CURRENT :  $\pm 5nA$  TYP
- LOW INPUT OFFSET VOLTAGE :  $\pm 1mV$  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 precision voltage comparators with an offset voltage specifications as low as 2mV max for LM393A, LM293A and LM193A.

All these comparators were designed specifically to operate from a single power 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.

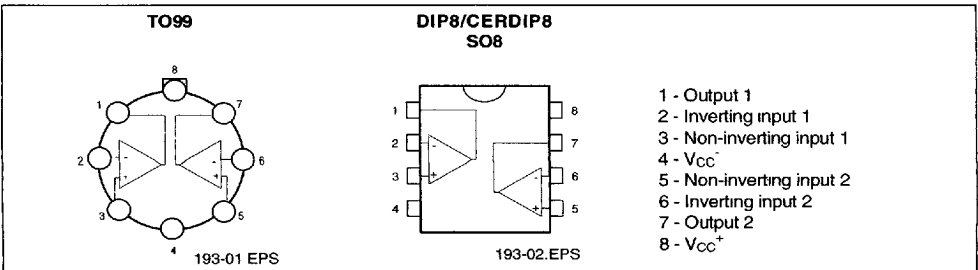


**ORDER CODES**

Part Number	Temperature Range	Package			
		H	N	J	D
LM193/A	-55, +125°C	•	•	•	•
LM293/A	-40, +105°C	•	•	•	•
LM393/A	0, +70°C	•	•	•	•
LM2903	-40, +105°C	•	•	•	•

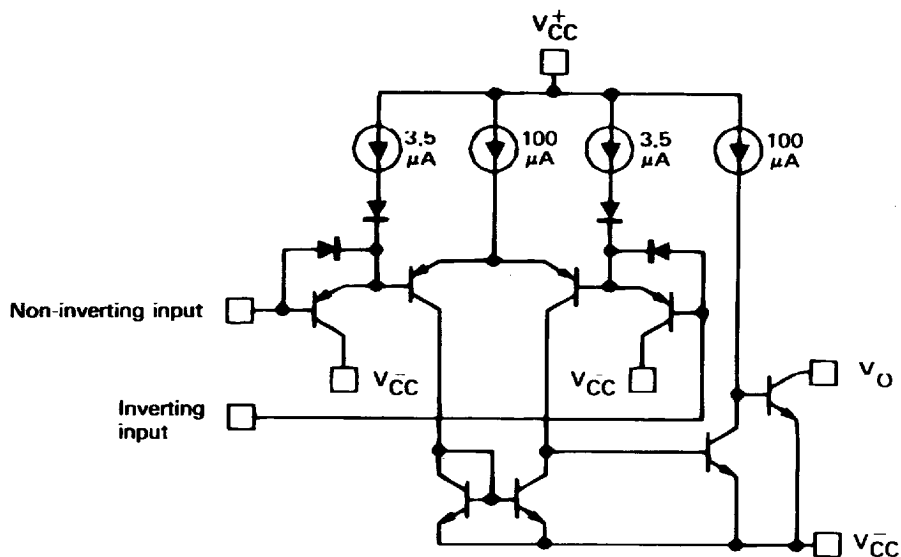
**Examples :** LM193H, LM393D

**PIN CONNECTIONS (top views)**



193-01.TBL

SCHEMATIC DIAGRAM (1/2 LM193)



193-03.EPS

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM193,A	LM293,A	LM393,A LM2903	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	830	570 830	mW
$T_{oper}$	Operating Free-air Temperature Range	-55 to +125	-40 to +105	0 to +70 -40 to +105	$^{\circ}C$
$T_{stg}$	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  $V_{CC}^+$ .

193-02.TBL

## ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	LM193A - LM293A LM393A			LM193 - LM293 LM393 - LM2903			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{io}$	Input Offset Voltage - (note 2) $T_{amb} = +25^\circ C$ LM2903 $T_{min.} \leq T_{amb} \leq T_{max}$ LM2903		1	2 4		1	5 7 9 15	mV
$I_{ib}$	Input Bias Current - (note 3) $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max}$		25	100 300		25	250 400	nA
$I_{io}$	Input Offset Current $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max}$		3	25 100		5	50 150	nA
$A_{vd}$	Large Signal Voltage Gain $V_{CC} = 15V$ , $R_L = 15k\Omega$ , $V_O = 1$ to $11V$ LM2903	50	200		50 25	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		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		$V_{CC}^+ - 1.5$ $V_{CC}^+ - 2$	0 0		$V_{CC}^+ - 1.5$ $V_{CC}^+ - 2$	V
$V_{id}$	Differential Input Voltage - (note 6)			$V_{CC}^+$			$V_{CC}^+$	V
$I_{sink}$	Output Sink Current ( $V_{id} = -1V$ , $V_O = 1.5V$ )	6	16		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		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		0.1	1	nA $\mu A$
$t_{re}$	Response Time ( $R_L = 5.1k\Omega$ to $V_{CC}^+$ , $V_{ref} = +1.4V$ ) - (note 5)		1.3			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			300		ns

- Notes :
- At output switch point,  $V_O = 1.4V$ ,  $R_S = 0\Omega$  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).

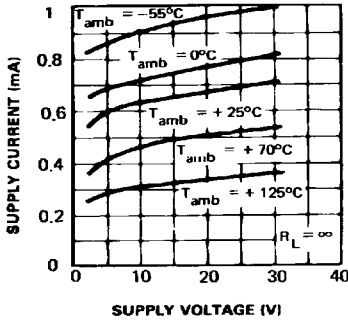
193-03.TBL

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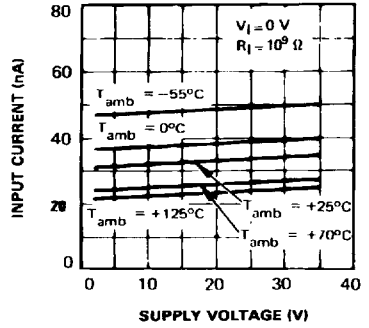
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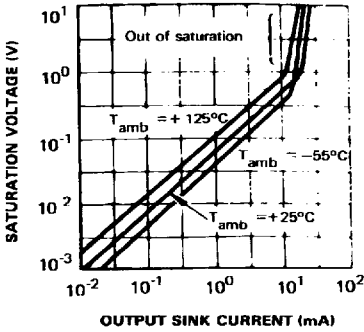
SUPPLY CURRENT



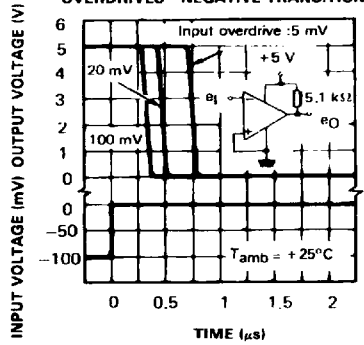
INPUT CURRENT



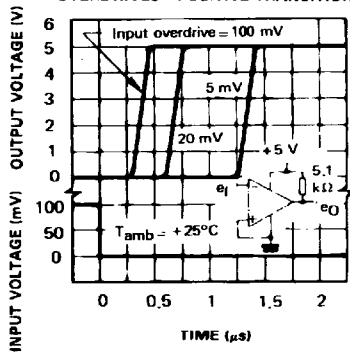
OUTPUT SATURATION VOLTAGE



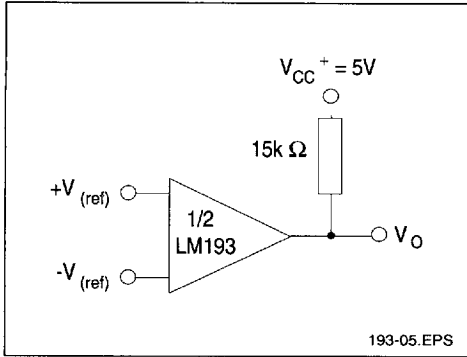
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - NEGATIVE TRANSITION



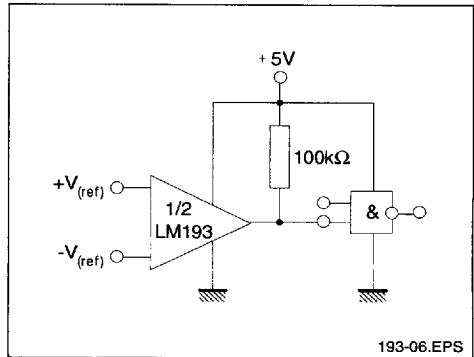
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION



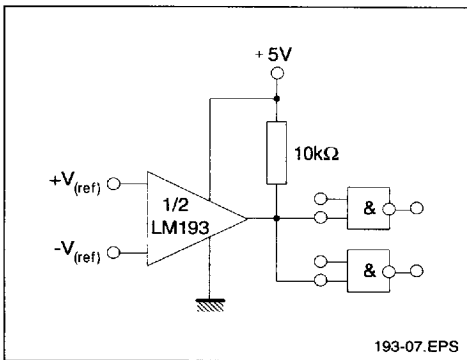
**TYPICAL APPLICATIONS**  
**BASIC COMPARATOR**



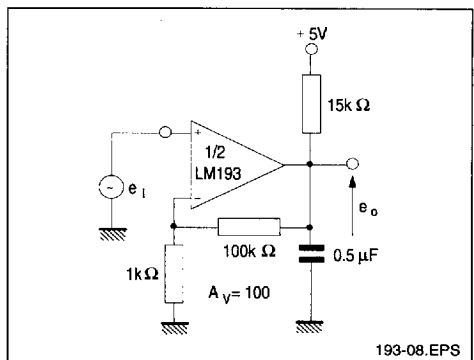
**DRIVING CMOS**



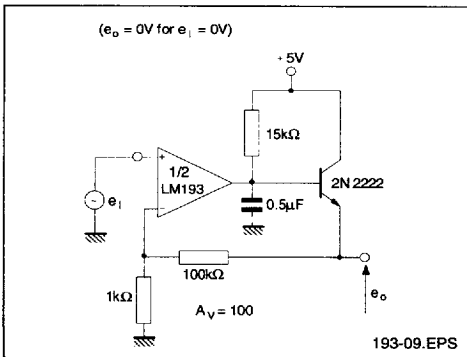
**DRIVING TTL**



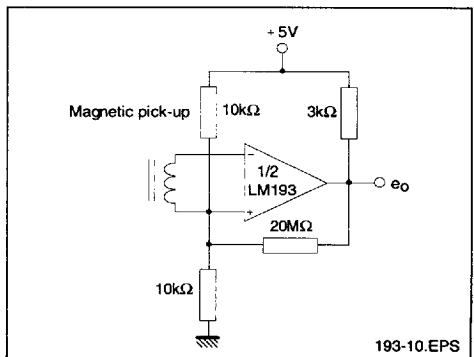
**LOW FREQUENCY OP AMP**



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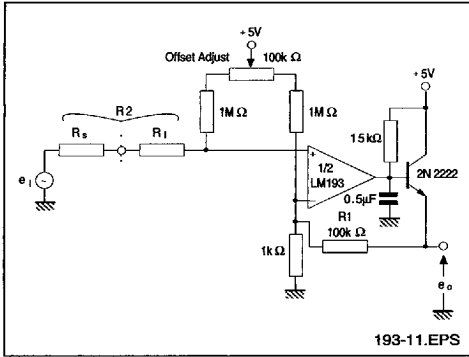


**TRANSDUCER AMPLIFIER**

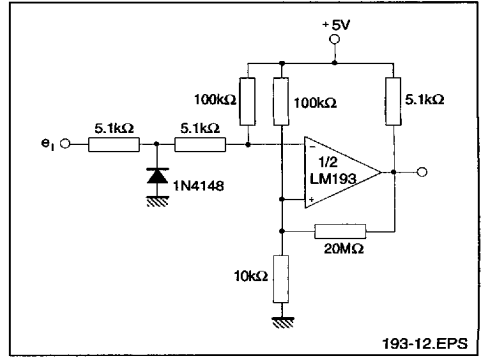


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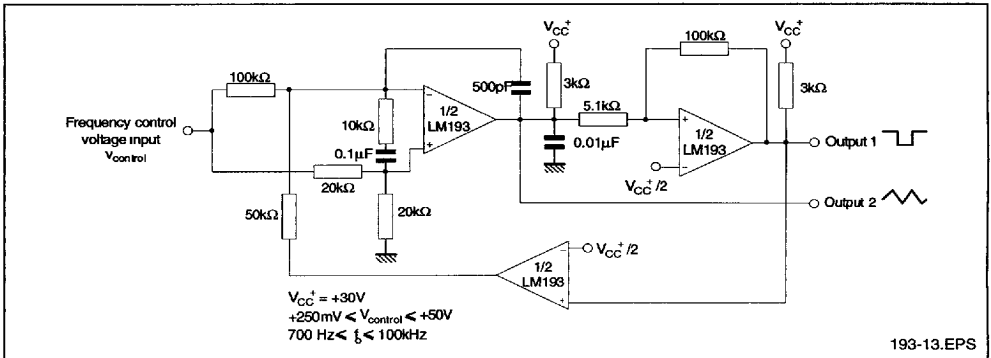
LOW FREQUENCY OP AMP WITH OFFSET ADJUST



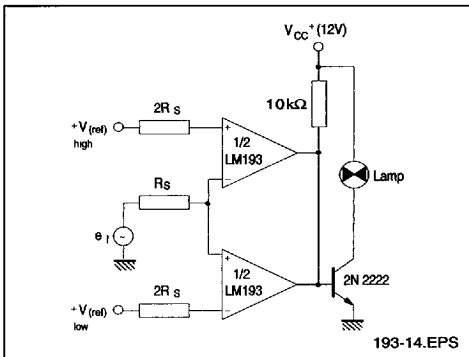
ZERO CROSSING DETECTOR (SINGLE POWER SUPPLY)



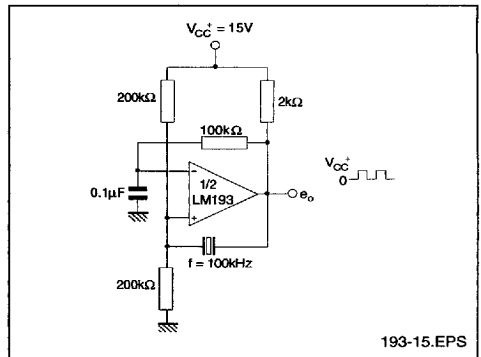
TWO DECADES HIGH FREQUENCY VCO



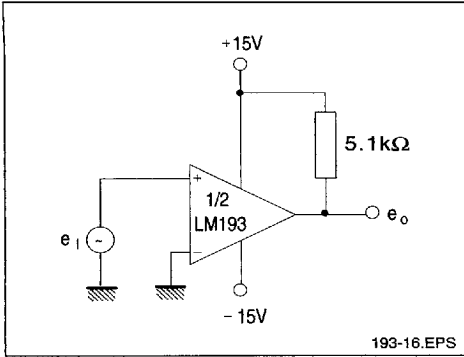
LIMIT COMPARATOR



CRYSTAL CONTROLLED OSCILLATOR



### SPLIT-SUPPLY APPLICATIONS ZERO CROSSING DETECTOR



### COMPARATOR WITH A NEGATIVE REFERENCE

