

4 Electrical characteristics

Table 3. $V_{CC}^+ = +5V$, $V_{CC}^- = 0V$, $T_{amb} = +25\text{ }^\circ\text{C}$ (unless otherwise specified)

Symbol	Parameter	LM193A - LM293A LM393A			LM193 - LM293 LM393			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input offset voltage ⁽¹⁾ $T_{min} \leq T_{amb} \leq T_{max}$		1	2		1	5	mV
I_{io}	Input offset current $T_{min} \leq T_{amb} \leq T_{max}$		3	25		3	50	nA
I_{ib}	Input bias current (I^+ or I^-) ⁽²⁾ $T_{min} \leq T_{amb} \leq T_{max}$		20	100		20	250	nA
A_{vd}	Large signal voltage gain $V_{CC} = 15\text{ V}$, $R_L = 15\text{ k}\Omega$, $V_O = 1\text{ V to }11\text{ V}$	50	200		50	200		V/mV
I_{CC}	Supply current (all comparators) $V_{CC} = +5\text{ V}$, no load $V_{CC} = +30\text{ V}$, no load		0.45 0.6	1 2.5		0.45 0.6	1 2.5	mA
V_{id}	Differential input voltage ⁽³⁾			V_{CC}^+			V_{CC}^+	
V_{OL}	Low level output voltage $V_{id} = -1\text{ V}$, $I_{sink} = 4\text{ mA}$ $T_{min} \leq T_{amb} \leq T_{max}$		80	400		80	400	mV
I_{OH}	High level output current $V_{CC} = V_O = 30\text{ V}$, $V_{id} = 1\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$		0.1	1		0.1	1	nA μA
I_{sink}	Output sink current $V_{id} = 1\text{ V}$, $V_O = 1.5\text{ V}$	6	18		6	18		mA
t_{re}	Response time ⁽⁴⁾ $R_L = 5.1\text{ k}\Omega$ connected to V_{CC}^+		1.3			1.3		μs
t_{rel}	Large signal response time $R_L = 5.1\text{ k}\Omega$ connected to V_{CC}^+ $e_1 = \text{TTL}$, $V_{(ref)} = +1.4\text{ V}$		300			300		ns

- At output switch point, $V_O = 1.4\text{ V}$, $R_L = 0$ with V_{CC}^+ from $5\text{ V to }30\text{ V}$, and over the full common-mode range ($0\text{ V to }V_{CC}^+ - 1.5\text{ V}$).
- 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 of input lines.
- 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 -0.3 V (or 0.3 V below the negative power supply, if used).
- The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained.



LM193, LM293, LM393

Low power dual voltage comparators

Datasheet –production data

Features

- Wide single-supply voltage range or dual supplies: $+2\text{ V to }+36\text{ V}$ or $\pm 1\text{ V to } \pm 18\text{ V}$
- Very low supply current (0.45 mA) independent of supply voltage (1 mW/comparator at $+5\text{ V}$)
- Low input bias current: 20 nA typ.
- Low input offset current: $\pm 3\text{ nA}$ typ.
- Low input offset voltage: $\pm 1\text{ mV}$ typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage: 80 mV typ. ($I_{sink} = 4\text{ mA}$)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs
- Available in DIP8, SO-8, TSSOP8, MiniSO-8, and DFN8 $2 \times 2\text{ mm}$ packages

Description

The LM193, LM293, and LM393 devices consist of two independent low 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.



DIP8
(plastic package)



SO-8
(plastic micropackage)



TSSOP8
(thin shrink small outline package)



MiniSO-8
(plastic micropackage)



DFN8 $2 \times 2\text{ mm}$
(plastic micropackage)

3 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	± 18 or 36	V
V_{id}	Differential input voltage	± 36	V
V_{in}	Input voltage	-0.3 to +36	V
	Output short-circuit to ground ⁽¹⁾	Infinite	
R_{thja}	Thermal resistance junction to ambient ⁽²⁾		°C/W
	SO-8	125	
	TSSOP8	120	
	DIP8	85	
	MiniSO-8	190	
	DFN8 2 x 2 mm	57	
R_{thjc}	Thermal resistance junction to case ⁽²⁾		°C/W
	SO-8	40	
	TSSOP8	37	
	DIP8	41	
	MiniSO-8	39	
	DFN8 2 x 2 mm		
T_j	Maximum junction temperature	150	°C
T_{stg}	Storage temperature range	-65 to +150	°C
ESD Class ⁽³⁾	HBM: human body model	H1B	
	MM: machine model	M2	
	CDM: charged device model	C5	

1. Short-circuits from the output to V_{CC+} can cause excessive heating and potential destruction. The maximum output current is approximately 20 mA independent of the magnitude of V_{CC+} .

2. Short-circuits can cause excessive heating and destructive dissipation. Values are typical.

3. ESD class definition from AEC-Q100:
 HBM class H1B: ESD voltage level from 500 V to 1000 V
 MM class M2: ESD voltage level from 100 V to 200 V
 CDM class C5: ESD voltage level greater than 1500 V.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage ($V_{CC+} - V_{CC-}$)	2 to 36	V
V_{icm}	Common mode input voltage range ($V_{CC+} = 30$ V) ⁽¹⁾		V
	$T_{amb} = +25$ °C	0 to $V_{CC+} - 1.5$	
	$T_{min} \leq T_{amb} \leq T_{max}$	0 to $V_{CC+} - 2$	
T_{oper}	Operating free-air temperature range		°C
	LM193, LM193A	-55 to +125	
	LM293, LM293A	-40 to +105	
	LM393, LM393A	0 to +70	

1. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The high end of the common-mode voltage range is $V_{CC+} - 1.5$ V, but either or both inputs can go to +30 V without damage.

Figure 3. Supply current vs. supply voltage

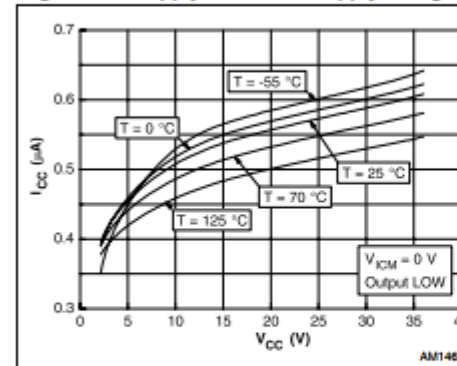


Figure 4. Input current vs. supply voltage

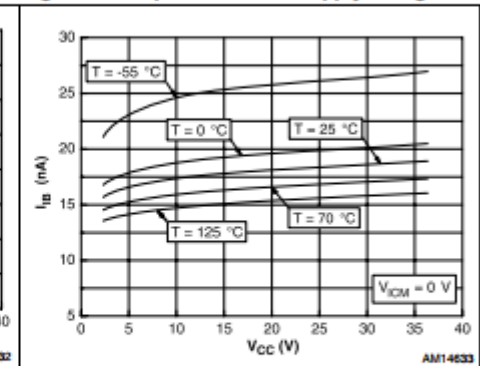


Figure 5. Output saturation voltage vs. output current

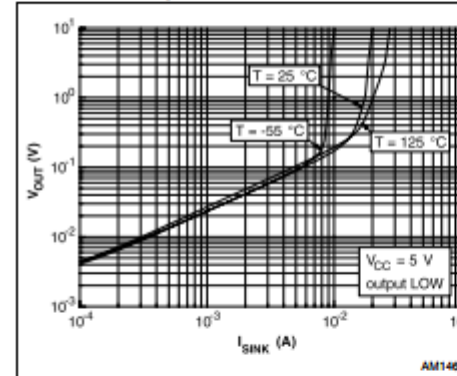


Figure 6. Response time for various input overdrives - negative transition

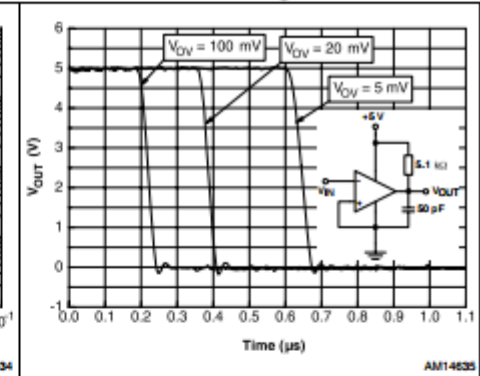
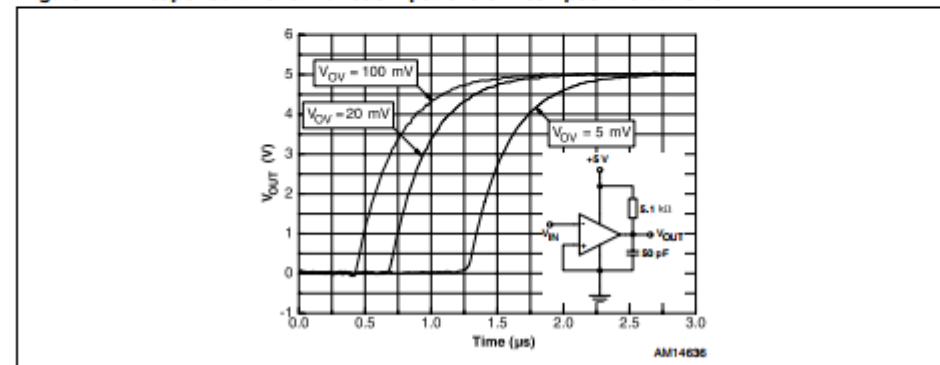


Figure 7. Response time for various input overdrives - positive transition



5 Typical applications

Figure 8. Basic comparator

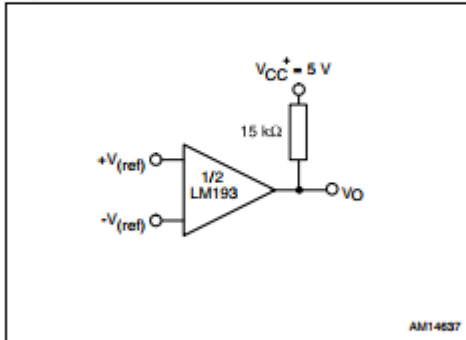


Figure 9. Driving TTL

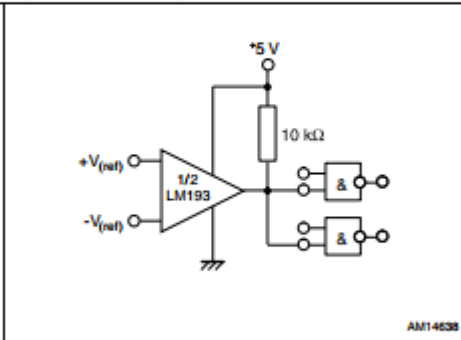


Figure 10. Low frequency op amp

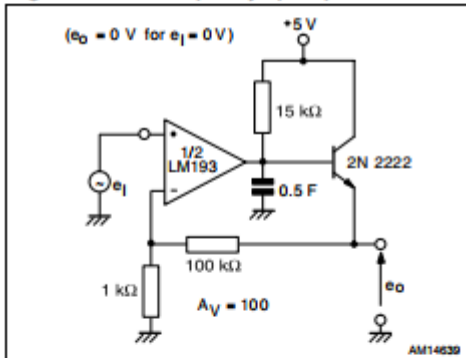


Figure 11. Driving CMOS

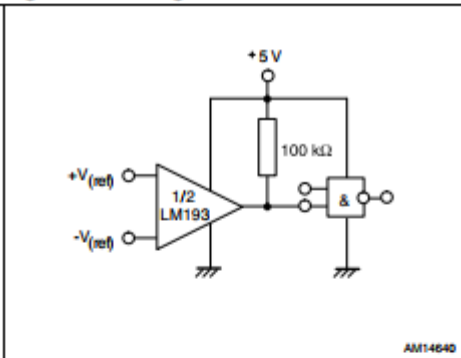


Figure 12. Low frequency op amp

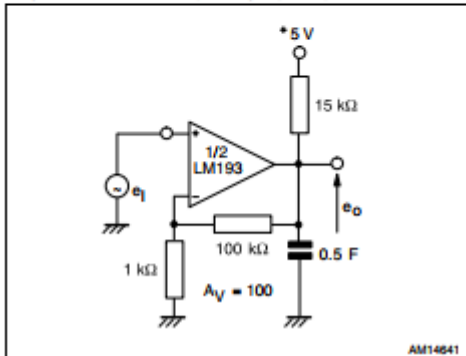


Figure 13. Transducer amplifier

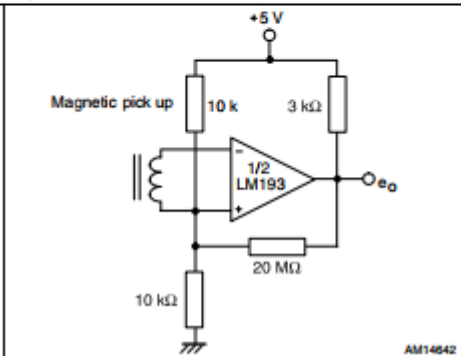


Figure 14. Low frequency op amp with offset adjust

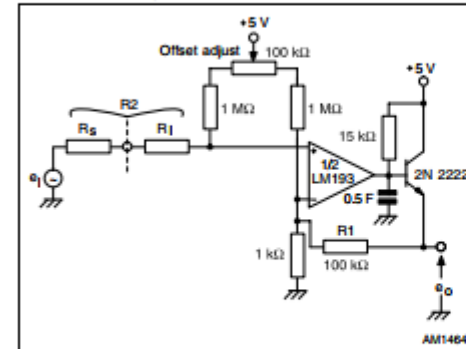


Figure 15. Zero crossing detector (single power supply)

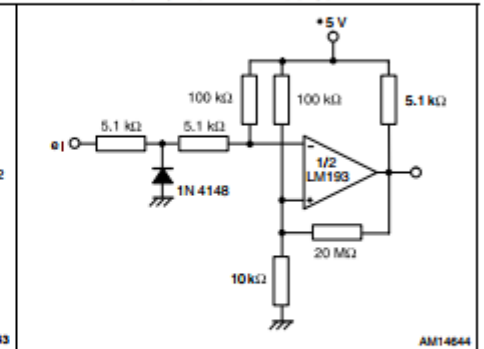


Figure 16. Limit comparator

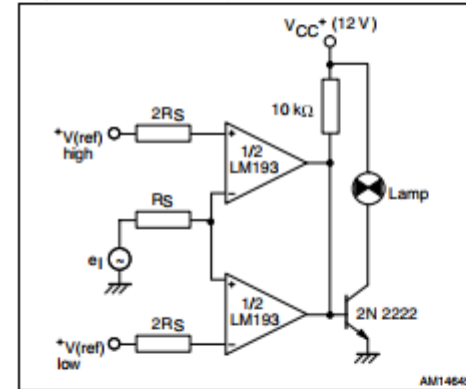


Figure 17. Crystal controlled oscillator

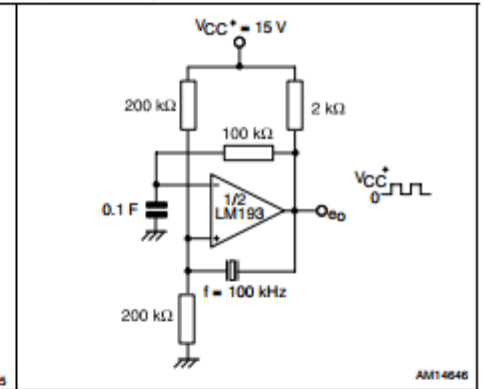


Figure 18. Split-supply applications - zero crossing detector

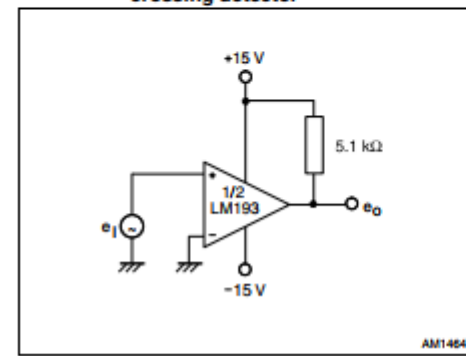


Figure 19. Comparator with a negative reference

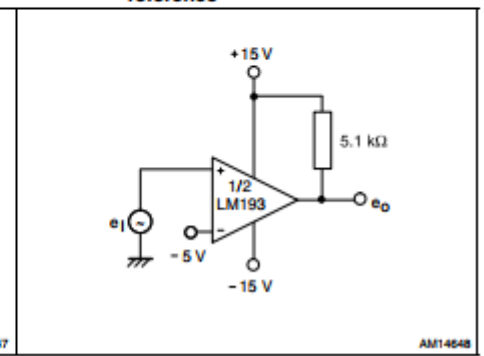
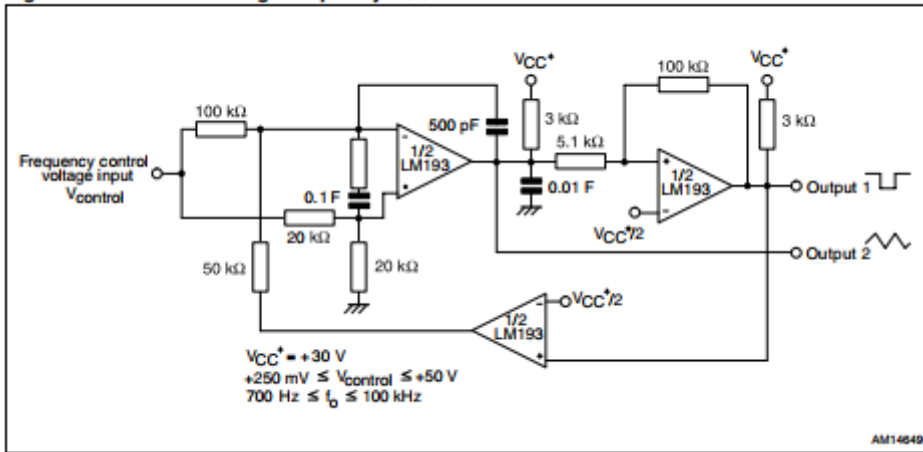
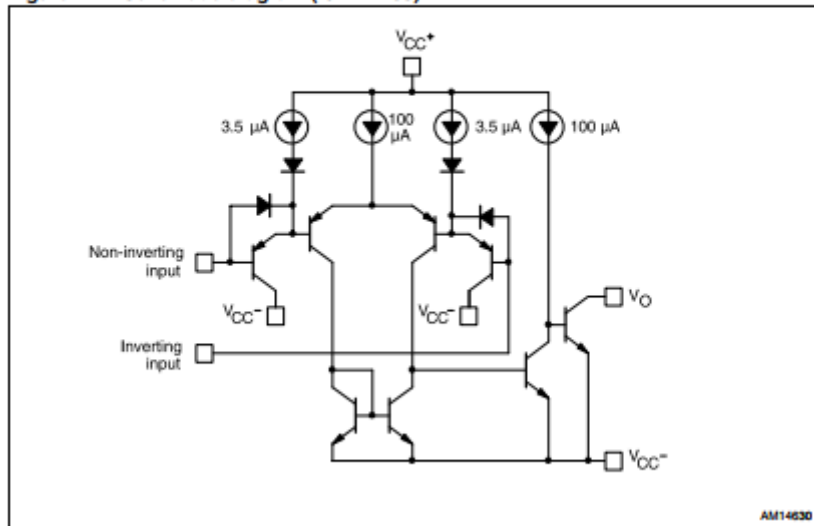


Figure 20. Two-decade high frequency VCO



Schematic diagram

Figure 2. Schematic diagram (1/2 LM193)



Pin connections

Figure 1. Pin connections (top view)

