

**MNLM193A-X REV 1B3**

Original Creation Date: 05/18/95

Last Update Date: 06/14/04

Last Major Revision Date: 09/02/97

## LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS

### General Description

The LM193A consists of two independent precision voltage comparators with an offset voltage specification as low as 2.0mV max for two comparators which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. 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.

Application areas include limit comparators, simple analog to digital converters; pulse, squarewave and time delay generators; wide range VCO; MOS clock timers; multivibrators and high voltage digital logic gates. The LM193A was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM193A will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

### Industry Part Number

LM193A

### Prime Die

LM193A

### NS Part Numbers

LM193AH-QMLV

LM193AH/883

LM193AJ-QMLV

LM193AJ/883

### Controlling Document

See Features Page

### Processing

MIL-STD-883, Method 5004

### Quality Conformance Inspection

MIL-STD-883, Method 5005

### Subgrp Description

### Temp ( °C)

1	Static tests at	+25
2	Static tests at	+125
3	Static tests at	-55
4	Dynamic tests at	+25
5	Dynamic tests at	+125
6	Dynamic tests at	-55
7	Functional tests at	+25
8A	Functional tests at	+125
8B	Functional tests at	-55
9	Switching tests at	+25
10	Switching tests at	+125
11	Switching tests at	-55

**Features**

- Wide supply
  - Voltage range 2.0Vdc to 36Vdc
  - Single or dual supplies  $\pm 1.0\text{Vdc}$  to  $\pm 18\text{Vdc}$
- Very low supply current drain (0.4mA)  
independent of supply voltage
- Low input biasing current 25nA Typ
- Low input offset current  $\pm 3\text{nA}$  Typ
- Input common-mode voltage range  
includes ground
- Differential input voltage range  
equal to the power supply voltage
- Low output saturation voltage 250mV at 4mA Typ
- Output voltage compatible with TTL,  
DTL, ECL, MOS and CMOS logic systems

CONTROLLING DOCUMENTS:

LM193AH/883	5962-9452602MGA
LM193AH-QMLV	5962-9452602VGA
LM193AJ-QMLV	5962-9452602VPA
LM193AJ/883	5962-9452602MPA

**(Absolute Maximum Ratings)**

(Note 1)

Supply Voltage, V+	36Vdc or ±18Vdc
Differential Input Voltage (Note 6)	36Vdc
Input Voltage	-0.3Vdc to +36Vdc
Input Current (Vin < -0.3 Vdc) (Note 5)	50mA
Maximum Junction Temperature	150 C
Power Dissipation (Note 2, 3)	
METAL CAN	660mW
CERDIP	780mW
Output Short-Circuit to Gnd (Note 4)	Continuous
Operating Temperature Range	-55 C to +125 C
Thermal Resistance	
ThetaJA	
METAL CAN (Still Air)	174 C/W
(500LF/Min Air flow)	99 C/W
CERDIP (Still Air)	146 C/W
(500LF/Min Air flow)	85 C/W
ThetaJC	
METAL CAN	44 C/W
CERDIP	33 C/W
Lead Temperature (Soldering, 10 seconds)	+260 C
ESD Tolerance (Note 7)	500V

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 2: The maximum power dissipation must be derated at elevated temperatures and is dictated by Tjmax (maximum junction temperature), ThetaJA (package junction to ambient thermal resistance), and TA (ambient temperature). The maximum allowable power dissipation at any temperature is  $P_{dmax} = (T_{jmax} - T_A) / \Theta_{JA}$  or the number given in the Absolute Maximum Ratings, whichever is lower.

Note 3: The LM193A must be derated based on a 150 C maximum junction temperature. The low bias dissipation and the ON-OFF characteristic of the outputs keeps the chip dissipation very small ( $P_D \leq 100mW$ ), provided the output transistors are allowed to saturate.

Note 4: Short circuits from the output to V+ can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 20mA independent of the magnitude of V+.

**(Continued)**

- Note 5: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the comparators to go to the V+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than -0.3Vdc.
- Note 6: 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 -0.3Vdc (or 0.3Vdc below the magnitude of the negative power supply, if used).
- Note 7: Human body model, 1.5K Ohms in series with 100pF.

## Electrical Characteristics

### DC PARAMETERS

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC:  $V_+ = 5V$ ,  $V_{cm} = 0$

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS
I <sub>cc</sub>	Supply Current	R <sub>L</sub> = Infinity				1.0	mA	1, 2, 3
		V <sub>+</sub> = 36V, R <sub>L</sub> = Infinity				2.5	mA	1, 2, 3
I <sub>ce</sub>	Output Leakage Current	V <sub>+</sub> = 30V, V <sub>in+</sub> = 1V, V <sub>o</sub> = 30, V <sub>in-</sub> = 0			-0.65	0.65	uA	1
					-1.0	1.0	uA	2, 3
I <sub>sink</sub>	Output Sink Current	V <sub>o</sub> = 1.5V, V <sub>in-</sub> = 1V, V <sub>in+</sub> = 0			6.0		mA	1
					4.0		mA	2, 3
V <sub>sat</sub>	Output Saturation Voltage	I <sub>sink</sub> = 4mA, V <sub>in-</sub> = 1V, V <sub>in+</sub> = 0				0.4	V	1
						0.7	V	2, 3
V <sub>io</sub>	Input Offset Voltage				-2.0	2.0	mV	1
					-4.0	4.0	mV	2, 3
		V <sub>+</sub> = 30V, V <sub>cm</sub> = 0			-2.0	2.0	mV	1
					-4.0	4.0	mV	2, 3
		V <sub>+</sub> = 30V, V <sub>cm</sub> = 28.5V			-2.0	2.0	mV	1
I <sub>ib+</sub>	Input Bias Current	V <sub>out</sub> = 1.5V			-100	-1	nA	1
					-300	-1	nA	2, 3
I <sub>ib-</sub>	Input Bias Current	V <sub>out</sub> = 1.5V			-100	-1	nA	1
					-300	-1	nA	2, 3
I <sub>io</sub>	Input offset Current	R <sub>s</sub> = 50 Ohms, V <sub>out</sub> = 1.5V			-25	25	nA	1
					-100	100	nA	2, 3
V <sub>cm</sub>	Common Mode Voltage	V <sub>+</sub> = 30V	1			28.5	V	1
			1			28	V	2, 3
PSRR	Power Supply Rejection Ratio	V <sub>+</sub> = 5V to 30V, R <sub>s</sub> = 50 Ohms			60		dB	1
CMRR	Common Mode Rejection Ratio	V <sub>+</sub> = 30V, V <sub>cm</sub> = 0V to 28.5V, R <sub>s</sub> = 50 Ohms			60		dB	1
V <sub>diff</sub>	Differential Input Voltage	V <sub>+</sub> = 30V, +V <sub>in</sub> = 36V, -V <sub>in</sub> = 0V	4			500	nA	1, 2, 3
		V <sub>+</sub> = 30V, +V <sub>in</sub> = 0V, -V <sub>in</sub> = +36V	4			500	nA	1, 2, 3
A <sub>vs</sub>	Voltage Gain	V <sub>+</sub> = 15V, 1V ≤ V <sub>out</sub> ≤ 11V, R <sub>PULLUP</sub> = 15K	2		50		V/mV	4
			2		25		V/mV	5, 6

## Electrical Characteristics

### AC PARAMETERS

(The following conditions apply to all the following parameters, unless otherwise specified.)

AC:  $V_{cc} = 5V$ ,  $V_{cm} = 0$

SYMBOL	PARAMETER	CONDITIONS	NOTES	PIN-NAME	MIN	MAX	UNIT	SUB-GROUPS
tRLH	Response Time	$V_+ = 5V$ , $V_{od} = 5mV$	3			5.0	$\mu S$	9
		$V_+ = 5V$ , $V_{od} = 50mV$	3			0.8	$\mu S$	9
tRHL	Response Time	$V_+ = 5V$ , $V_{od} = 5mV$	3			2.5	$\mu S$	9
		$V_+ = 5V$ , $V_{od} = 50mV$	3			0.8	$\mu S$	9

### DC PARAMETERS: DRIFT VALUES

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC:  $V_+ = 5V$ ,  $V_{cm} = 0$ . "Delta calculations performed on Jan S and QMLV devices at Group B, Subgroup 5 ONLY."

Vio	Input Offset Voltage	$V_+ = 30V$ , $V_{cm} = 0$			-1	1	mV	1
Iib+	Input Bias Current				-15	15	nA	1
Iib-	Input Bias Current				-15	15	nA	1

Note 1: Parameter guaranteed by the Vio tests

Note 2: Datalog reading in  $K = V/mV$ .

Note 3: Bench Tested

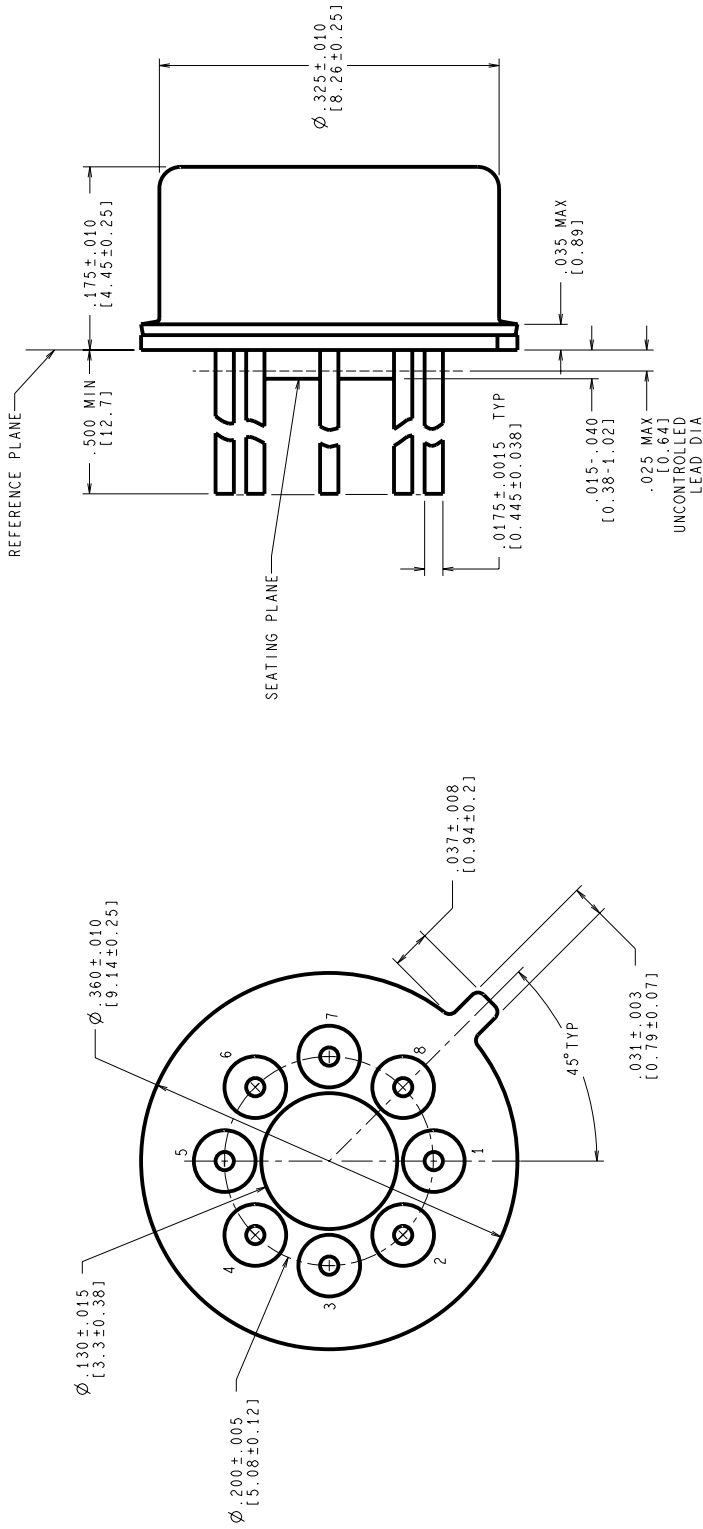
Note 4: The value for Vdiff is not data logged during Read and Record.

## Graphics and Diagrams

GRAPHICS#	DESCRIPTION
06048HRA2	CERDIP (J), 8 LEAD (B/I CKT)
09319HRA2	METAL CAN (H), TO-99, 8 LD, .200 DIA P.C. (B/I CKT)
H08CRF	METAL CAN (H), TO-99, 8LD .200 DIA P.C. (P/P DWG)
J08ARL	CERDIP (J), 8 LEAD (P/P DWG)
P000171A	METAL CAN (H), TO-99, 8LD, .200 DIA P.C. (PINOUT)
P000172B	CERDIP (J), 8 LEAD (PINOUT)

See attached graphics following this page.

REVISIONS			
LTR	DESCRIPTION	E.C.N.	DATE
F	REVISE & REDRAW PER CURRENT STANDARD; UPDATE MIL/AERO STAMP & TITLE.	11002	06/22/95
			MS/



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

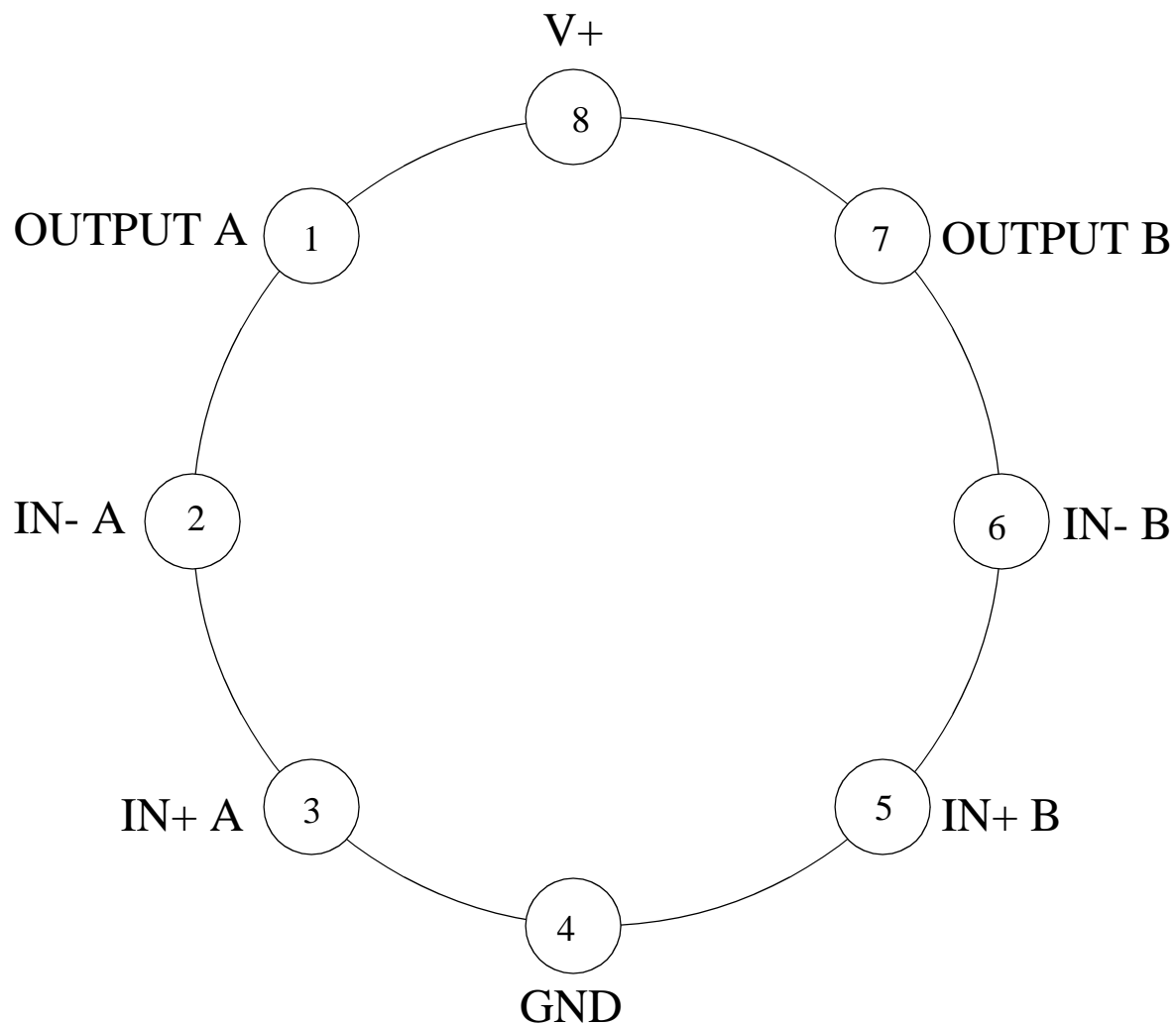
MIL-I-38535  
CONFIGURATION CONTROL

NOTES: UNLESS OTHERWISE SPECIFIED

- LEADS TO BE LOCATED WITHIN .007 IN/ 0.18 mm OF THEIR TRUE POSITIONS RELATIVE TO A MAXIMUM WIDTH TAB.
- STANDARD METAL CAN TYPE: SOLID BASE WITH CERAMIC STANDOFF.
- APPLIES TO MIL-AERO AND LINEAR PRODUCTS.
- REFERENCE JEDEC REGISTRATION TO-99, JEDEC PUBLICATION No.95.

APPROVALS		DATE	National Semiconductor	
DESIGN	MARIA SUCHY	06/22/95	2000 Semiconductor dr., Santa Clara, CA 95052-8000	
DFTG	CHK		METAL CAN, TO-99, 8 LEAD, .200 DIA P.C.	
ENGR	CHK			
PROJECTION			SCALE	SIZE
			N/A	C
			DRAWING NUMBER	REV
			MKT-H08C	F
			DO NOT SCALE DRAWING	SHEET 1 of 1

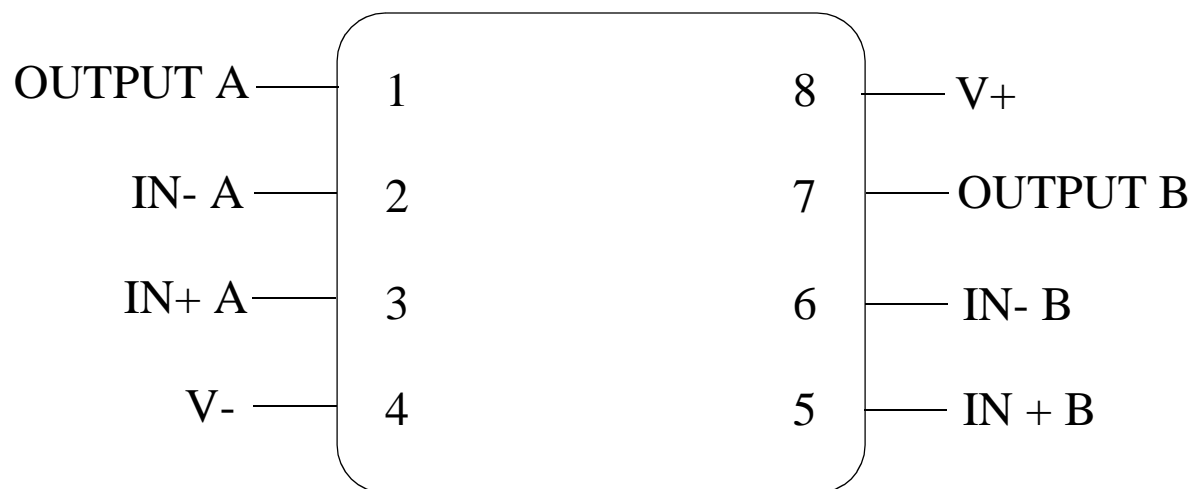




LM193AH, LM193H  
8 - PIN METAL CAN  
CONNECTION DIAGRAM  
TOP VIEW  
P000171A



National Semiconductor™  
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2900 SEMICONDUCTOR DRIVE  
SANTA CLARA, CA 95050



LM193J, LM193AJ  
8 - LEAD DIP  
CONNECTION DIAGRAM  
TOP VIEW  
P000172B



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SANTA CLARA, CA 95050

**Revision History**

Rev	ECN #	Rel Date	Originator	Changes
1A2	M0002817	01/16/03	Rose Malone	Update MDS: MNLM193A-X, Rev. 1A1 to MNLM193A-X, Rev. 1A2. Main Table Adding reference to LM193AJ/883 and SMD number, B/I CKTS and Pin Out for J pkg.
1A3	M0004087	06/14/04	Rose Malone	Updated MDS: MNLM193A-X, Rev. 1A2 to MNLM193A-X, Rev. 1A3. Updated Burn-In Ckt from 05363HRA2 to 09319HRA2 in Graphics Section.
1B3	M0004391	06/14/04	Rose Malone	Update MDS: MNLM193A-X, Rev. 1A3 to 1B3. Added Note 4 to Vdiff parameter and to note section.