General-Purpose High-Voltage Open-Drain Output Dual Comparator

FEATURES

- **Supply Range: +3V to +36V**
- **Low Supply Current**
  20μA (TYP) per channel at Vs = 5V
- **Common-Mode Input Voltage Range Includes Ground**
- **Low Output Saturation Voltage**
- **Open-Drain Output for Maximum Flexibility**
- **SPECIFIED UP TO +125°C**
- ***Micro* SIZE PACKAGES: SOIC-8(SOP8)**

APPLICATIONS

- **Hysteresis Comparators**
- **Factory automation & control**
- **Industrial Equipment**
- **Test and Measurement**
- **Cordless power tool**
- **Vacuum robot**
- **Wireless Infrastructure**

DESCRIPTION

The LM393 is the dual comparator version, and the outputs can be connected to other open-collector outputs to achieve wired-AND relationships. It can operate from 3V to 36V, and have low power consuming 20uA (TYP) per channel.

The LM393 consist of two independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Quiescent current is independent of the supply voltage. The device is the most cost-effective solutions for applications where low offset voltage, high supply voltage capability, low supply current, and space saving are the primary specifications in circuit design for portable consumer products.

The LM393 is available in Green SOIC-8 packages. It operates over an ambient temperature range of -40°C to +125°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM393	SOIC-8(SOP8)	4.90mm×3.90mm

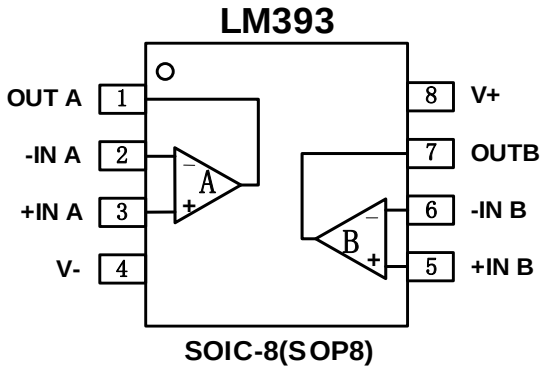
(1) For all available packages, see the orderable addendum at the end of the data sheet.

Revision History

Note: Page numbers for previous revisions may different from page numbers in the current version.

VERSION	Change Date	Change Item
A.0	2020.10	Preview version completed
A.1	2021.2	Initial version completed

Pin Configuration and Functions (Top View)



Pin Description

NAME	PIN	I/O(1)	DESCRIPTION
	SOIC-8(SOP8)		
OUTA	1	O	Output, channel A
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
V-	4	P	Negative (lowest) power supply
+INB	5	I	Noninverting input, channel B
-INB	6	I	Inverting input, channel B
OUTB	7	O	Output, channel B
V+	8	P	Positive (highest) power supply

(1)I=Input, O=Output, P=Power

SPECIFICATIONS

Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

		MIN	MAX	UNIT
Voltage	Supply, Vs=(V+) - (V-)		36	V
	Input pin (IN+, IN-) (2)	(V-)-0.3	(V+) +0.3	
	Signal output pin (3)	(V-)-0.3	(V+) +0.3	
Current	Signal input pin (IN+, IN-) (2)	-10	10	mA
	Signal output pin (3)	-55	55	mA
	Output short-circuit (4)	Continuous		
Temperature	Operating range, T_A	-40	125	°C
	Junction, T_J		150	
	Storage, T_{stg}	-65	150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.
(3) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ±55mA or less.
(4) Short-circuit from output to V_{CC} can cause excessive heating and eventual destruction.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins (1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins (2)	±1000	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage，Vs= (V+) - (V-)	Single-supply	3		36	V
	Dual-supply	±1.5		±18	

Thermal Information: LM393

THERMAL METRIC (1)		LM393 8PINS SOIC-8(SOP-8)	UNIT
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	116	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	60	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	56	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	12.8	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	98.3	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	°C/W

PACKAGE/ORDERING INFORMATION

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking(1)	Package Qty
LM393XK	SOIC-8(SOP8)	8	2	-40°C ~+125°C	LM393	Tape and Reel,4000

NOTE:

(1) There may be additional marking, which relates to the lot trace code information(data code and vendor code)，the logo or the environmental category on the device.

ELECTRICAL CHARACTERISTICS

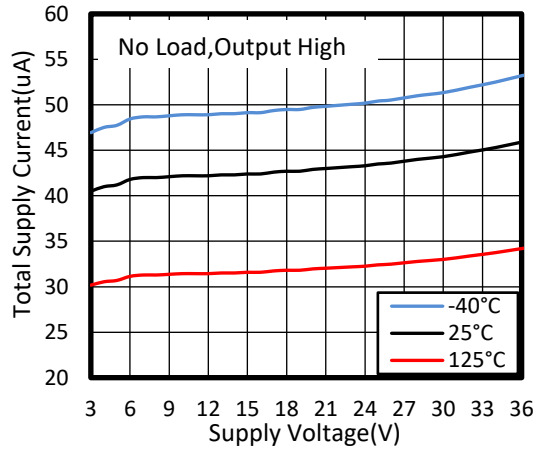
(At T_A = +25°C, V_{CM}=(Vs/2), Vs=5V, unless otherwise noted.)

PARAMETER			CONDITIONS	LM393			UINTS
				MIN	TYP	MAX	
Vs	Operating Voltage Range			3		36	V
I_Q	Quiescent Current		V_S=5V, no load		40	80	uA
			V_S=36V, no load, T_A=-40°C to +125°C		42	85	
V_{OS}	Input offset voltage		V_S=5V to 36V	-4.5	±1	4.5	mV
			V_S=5V to 36V T_A=-40°C to +125°C	-5		5	
IB	Input Bias Current		T_A=25°C		10	50	pA
			T_A=-40°C to +125°C			100	nA
I_{OS}	Input Offset Current		T_A=25°C		10	50	pA
			T_A=-40°C to +125°C			100	nA
V_{CM}	Common-Mode Voltage Range		V_S=3V to 36V	(V-)		(V+)-1.5	V
			V_S=3V to 36V T_A=-40°C to +125°C	(V-)		(V+)-2.0	
A_{VD}	Large signal differential voltage amplification		V_S=15V, Vo=1.4V to 11.4V $R_L \geqslant$15k to (V+)	50	200		V/mV
V_{OL}	Low-Level output voltage		$I_{sink} \leqslant$4mA, V_{ID}=-1V		210	300	mV
I_{OL}	Output Current(sinking)		V_O=1.5V; V_{ID}=-1V; Vs=5V		27		mA
I_{LEAK}	High-Level Output Leakage Current		(V+) =Vo=5V; V_{ID}=1V		2	20	nA
			(V+) =Vo=36V; V_{ID}=1V		4	50	nA
Switching Characteristics							
T_{PHL}	Propagation Delay H To L	Vs=5V	RPU=5.1KΩ, Overdrive =10mV		7.8		us
			RPU=5.1KΩ, Overdrive =100mV		2.0		
		Vs=36V	RPU=5.1KΩ, Overdrive =10mV		11.5		
			RPU=5.1KΩ, Overdrive =100mV		3.0		
T_{PLH}	Propagation Delay L To H	Vs=5V	RPU=5.1KΩ, Overdrive =10mV		28		
			RPU=5.1KΩ, Overdrive =100mV		6.1		
		Vs=36V	RPU=5.1KΩ, Overdrive =10mV		29		
			RPU=5.1KΩ, Overdrive =100mV		7.1		

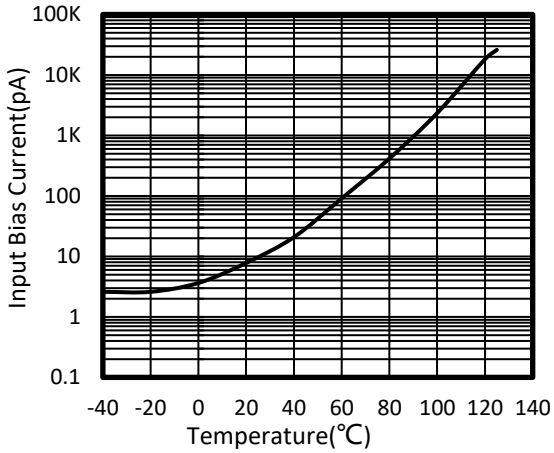
TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_{PULLUP}=5.1K V_{CM} = Vs/2, C_L=15pF, $V_{OVERDRIVE}$=100mV, unless otherwise noted.

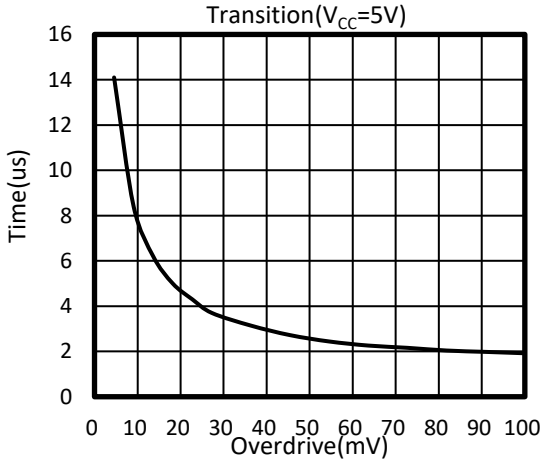
Total Supply Current vs Supply Voltage



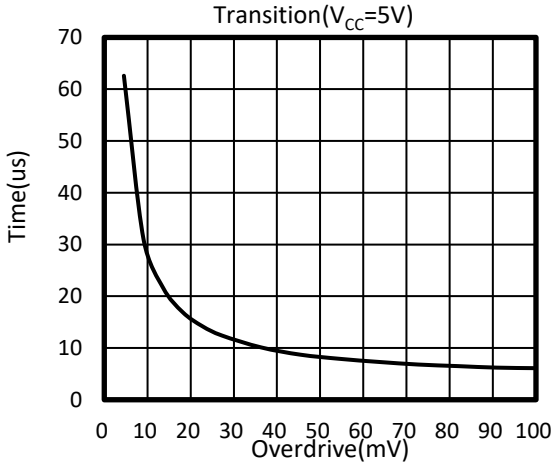
INPUT BIAS CURRENT vs TEMPERATURE



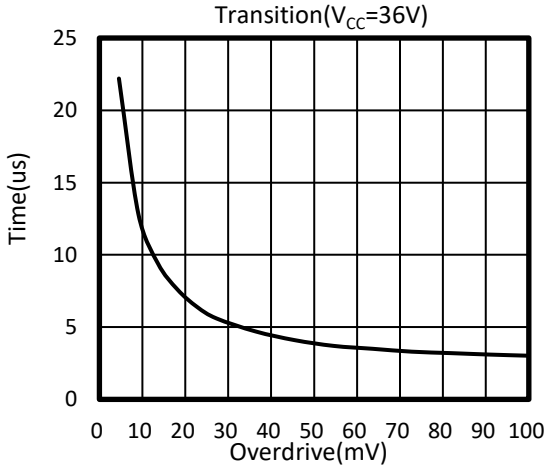
Response Time vs Input Overdrives Negative Transition(V_{CC}=5V)



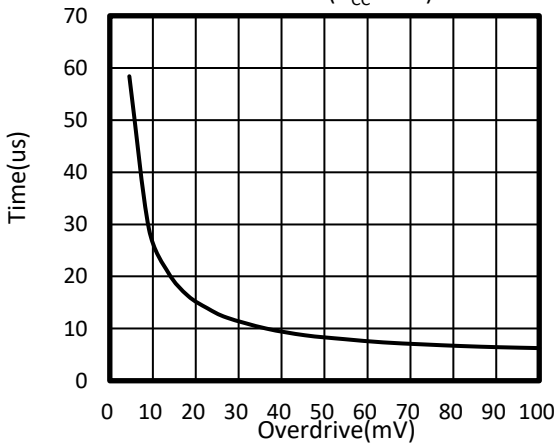
Response Time vs Input Overdrives Positive Transition(V_{CC}=5V)



Response Time vs Input Overdrives Negative Transition(V_{CC}=36V)



Response Time vs Input Overdrives Positive Transition(V_{CC}=36V)



Detailed Description

Overview

The LM393 family of comparators can operate up to 36V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to its low power and high speed. The open-drain output allows the user to configure the output's logic low voltage (V_{OL}) and can be utilized to enable the comparator to be used in AND functionality.

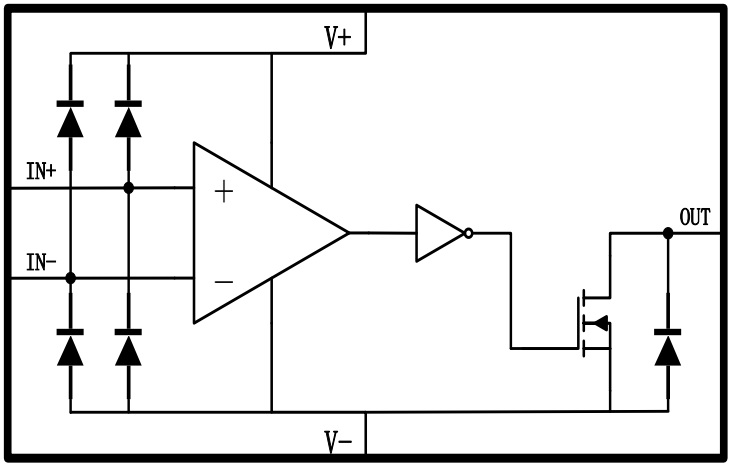


Figure 1. Functional Block Diagram

Application and Implementation

Application Information

LM393 is typically used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output (logic high with pull-up) to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes this comparator optimal for level shifting to a higher or lower voltage.

Typical Application

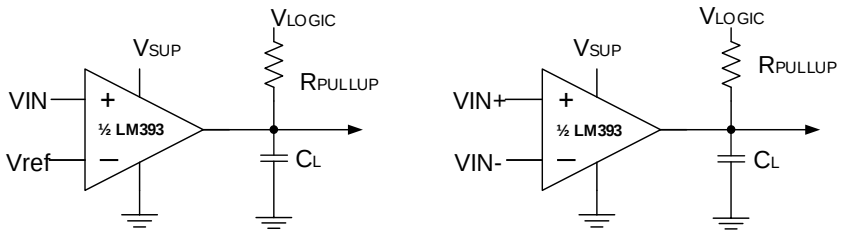


Figure 2. Single-Ended and Differential Comparator Configurations

Detailed Design Procedure

When using the device in a general comparator application, determine the following:

- Input Voltage Range
- Minimum Overdrive Voltage
- Output and Drive Current
- Response Time

Input Voltage Range

When choosing the input voltage range, the input common mode voltage range (V_{ICR}) must be taken in to account. If temperature operation is below 25°C the V_{ICR} can range from 0 V to V_{CC}– 2.0 V. This limits the input voltage range to as high as V_{CC}– 2.0 V and as low as 0 V. Operation outside of this range can yield incorrect comparisons.

Layout

Layout Guidelines

For accurate comparator applications without hysteresis it is important maintain a stable power supply with minimized noise and glitches. To achieve this, it is best to add a bypass capacitor between the supply voltage and ground. This should be implemented on the positive power supply and negative supply (if available). If a negative supply is not being used, do not put a capacitor between the IC's GND pin and system ground. Minimize coupling between outputs and inverting inputs to prevent output oscillations. Do not run output and inverting input traces in parallel unless there is a VCC or GND trace between output and inverting input traces to reduce coupling. When series resistance is added to inputs, place resistor close to the device.

Layout Example

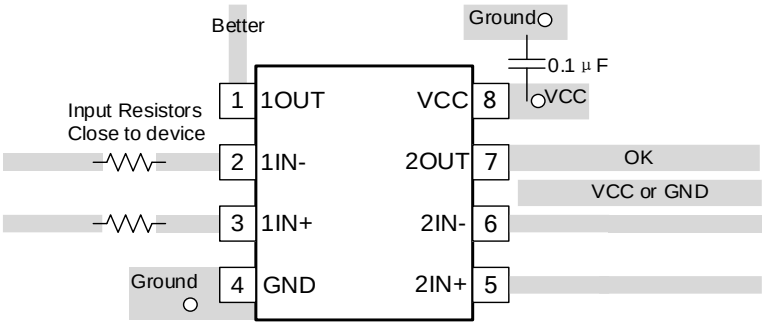
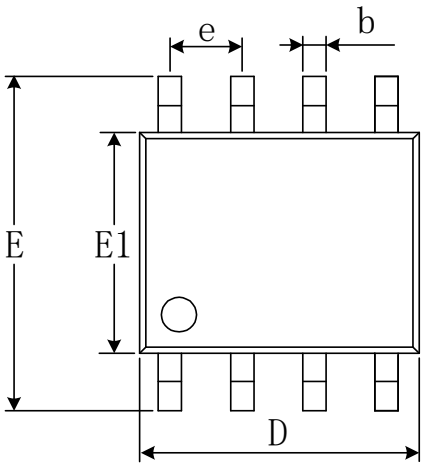
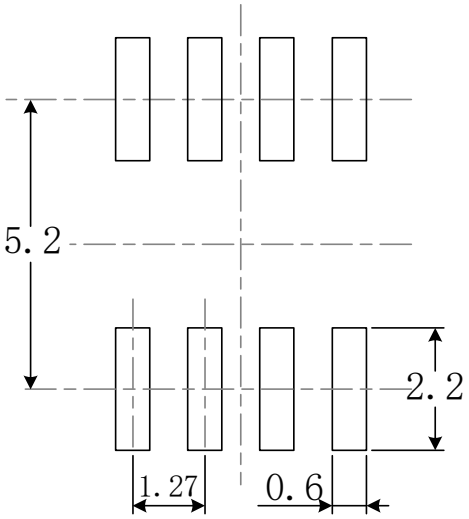


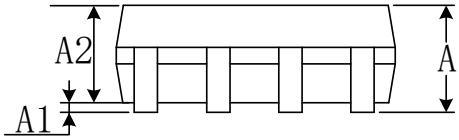
Figure 3. LM393 Layout Example

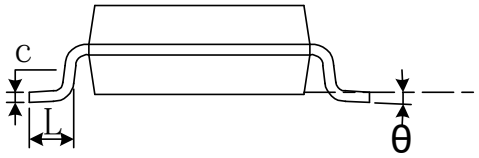
PACKAGE OUTLINE DIMENSIONS
SOIC-8(SOP8)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°