Raytheon

Low Power, Low Offset Voltage Dual Comparator

LM393/ RC2403

Features

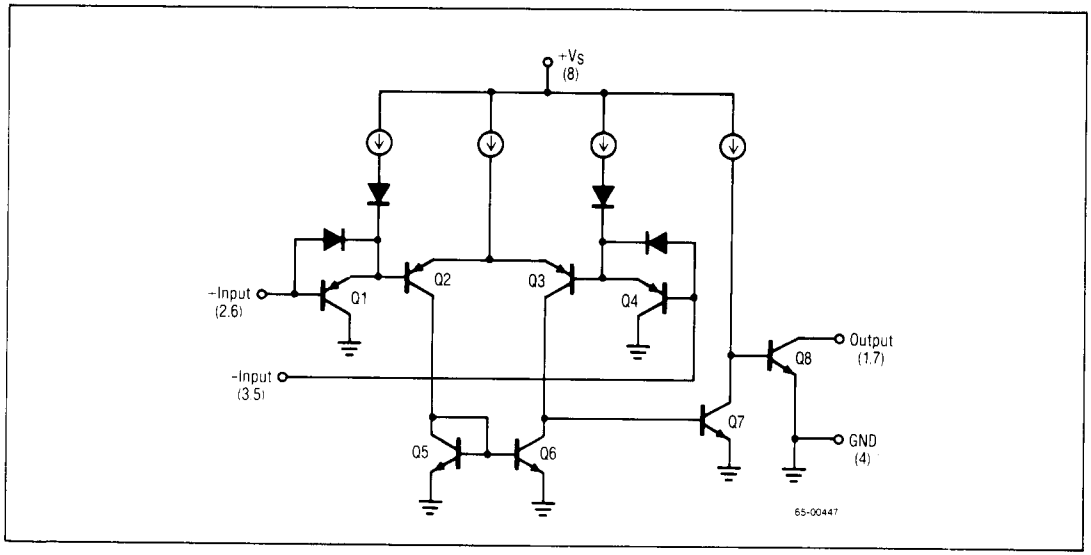
- Wide single supply voltage range — 2.0V to 36V or dual supplies — ±1.0V to ±18V
- Very low supply current drain (0.8mA) independent of supply voltage (1.0mW/comparator at 5.0V)
- Low input bias current — 25nA
- Low input offset current — ±5.0nA and maximum offset voltage — ±3.0mV
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Low output saturation voltage LM393 — 250mV at 3mA RC2403 — 400mV at 15mA
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems
- Reduced V_{OS} drift over temperature
- Eliminates need for dual supplies
- Allows sensing near ground
- Compatible with all forms of logic
- Power drain suitable for battery operation

Description

The LM393 consists of two independent precision voltage comparators with an offset voltage specification as low as 5.0mV 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. The LM393 has a unique characteristic: 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, square-wave and time delay generators; wide range V_{CO}; MOS clock timers; multivibrators and high voltage digital logic gates. The LM393 was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM393 will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

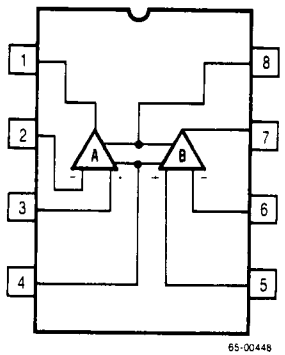
Schematic Diagram (1/2 Shown)



Low Power, Low Offset Voltage Dual Comparator

Connection Diagram

Dual In-Line Package
(Top View)

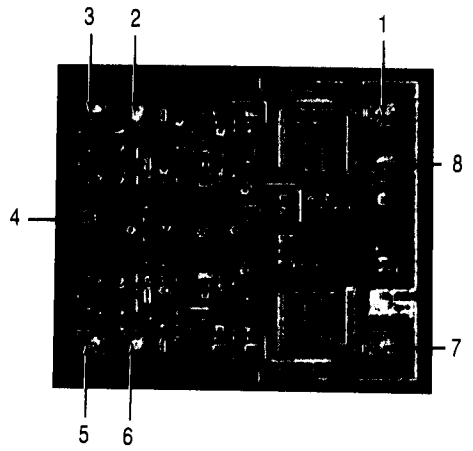


Pin	Function
1	Output A
2	Inverting Input A
3	Non-Inverting Input A
4	GND
5	Non-Inverting Input B
6	Inverting Input B
7	Output B
8	$+V_S$

Absolute Maximum Ratings

Supply Voltage, $+V_S$ ..... +36V or ±18V
Differential Input Voltage 36V
Input Voltage ..... -0.3V to +36V
Output Short Circuit to Ground[2] .. Continuous
Input Current 50mA
Operating Temperature
Range ..... 0°C to +70°C
Lead Soldering Temperature (10 Sec)
LM393NB ..... +300°C
LM393M ..... +260°C

Mask Pattern



Die Size: 52 x 61 mils
Min. Pad Dimensions: 4 x 4 mils

Thermal Characteristics

	8-Lead Micro-Pak Plastic DIP	8-Lead Plastic DIP
Max. Junction Temp.	125°C	125°C
Max. P_D $T_A < 50°C$	300mW	468mW
Therm. Res. θ_{JC}	—	—
Therm. Res. θ_{JA}	240°C/W	160°C/W
For $T_A > 50°C$ Derate at	4.17mW per °C	6.25mW per °C

Ordering Information

Part Number	Package	Operating Temperature Range
LM393NB	Plastic	0°C to +70°C
LM393M	Micro-Plastic	0°C to +70°C
RC2403NB	Plastic	0°C to +70°C
RC2403M	Micro-Plastic	0°C to +70°C

Electrical Characteristics ($+V_S = +5V$; $T_A = +25°C$)

Parameters	Test Conditions	LM393			RC2403			Units
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage[7]			2.0	5.0		2.0	10	mV
Input Bias Current[3]	Output in Linear Range		25	250		50	500	nA
Input Offset Current			5.0	50		10	100	nA
Input Voltage Range[4]		0		$+V_S$ -1.5	0	$+V_S$	-1.5	V
Supply Current	$R_L = \infty$ on all Comparators		0.8	10		0.8	1.5	mA
Large Signal Voltage Gain	$R_L \geq 15k\Omega$, $V_S = +15V$ (To Support Large V_O Swing)	50	200		50	200		V/mV
Large Signal Response Time	V_{IN} = TTL Logic Swing, $V_{REF} = +1.4V$ $V_{RL} = +5.0V$, $R_L = 5.1k\Omega$		300			300		nS
Response Time[5]	$V_{RL} = +5.0V$, $R_L = 5.1k\Omega$		1.3			1.5		μS
Output Sink Current	$V_{IN-} \geq +1.0V$, $V_{IN+} = 0$, $V_O \leq +1.5V$	6.0	16		20	40		mA
Output Saturation Voltage	$V_{IN-} \geq +1.0V$, $V_{IN+} = 0$, $I_{SINK} \leq 3.0mA$		250	400				mV
	$I_{SINK} \leq 15mA$					250	400	mV
Output Leakage Current	$V_{IN} = 0$, $V_{IN-} \geq +1.0V$, $V_O = +5.0V$		0.1			0.1		μA
The following specifications apply for $V_S = +5V$, $0°C \leq T_A \leq +70°C$								
Input Offset Voltage[7]			3.0	9.0		3.0	12	mV
Input Offset Current			50	150		50	150	nA
Input Bias Current	Output in Linear Range		200	400		200	650	nA
Input Voltage Range		0		$+V_S$ -2.0	0		$+V_S$ -2.0	V
Output Saturation Voltage	$V_{IN-} \geq +1.0V$, $V_{IN+} = 0$, $I_{SINK} \leq 3.0mA$		400	700				mV
	$I_{SINK} \leq 15mA$					400	700	mV
Output Leakage Current	$V_{IN-} = 0$, $V_{IN+} \geq +1.0V$, $V_O = +30V$			1.0			1.0	μA
Supply Current	$R_L = \infty$ on all Amps, $V_S = +30V$		1.0	2.5		1.0	3.0	mA

Notes: 1. Short circuits from the output to $+V_S$ can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA independent of the magnitude of $+V_S$.
2. 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

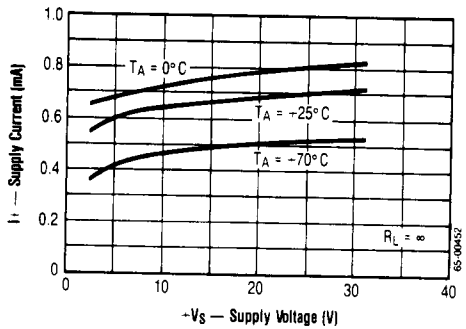
Electrical Characteristics (Continued)

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 $+V_S$ 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 -0.3V.

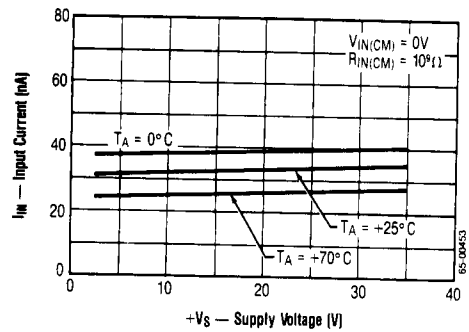
3. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
4. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common mode voltage range is $+V_S$ -1.5V, but either or both inputs can go to 30V without damage.
5. The response time specified is for a 100mV input step with 5.0mV overdrive. For larger overdrive signals 300nS can be obtained, see Typical Performance Characteristics section.
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 -0.3V (or 0.3V below the magnitude of the negative power supply, if used).
7. At output switch point, $V_O \cong 1.4V$, $R_S = 0\Omega$ with $+V_S$ from +5.0V to +30V; and over the full input common mode range (0V to $+V_S$ -1.5V).
8. For input signals that exceed $+V_S$, only the overdriven comparator is affected. With a +5.0V supply, V_{IN} should be limited to 25V max, and a limiting resistor should be used on all inputs that might exceed the positive supply.

Typical Performance Characteristics

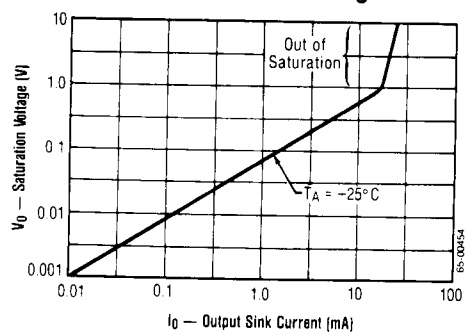
Supply Current



Input Current

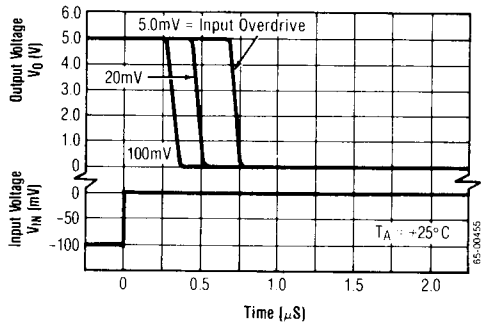


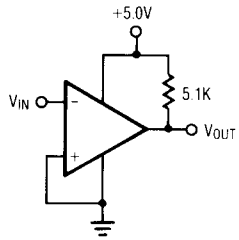
Output Saturation Voltage



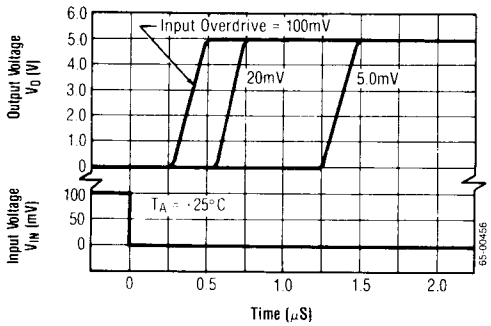
Typical Performance Characteristics (Continued)

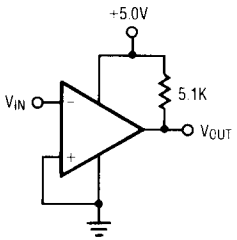
Response Time for Various Input Overdrives — Negative Transition





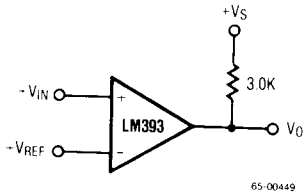
Response Time for Various Input Overdrives — Positive Transition



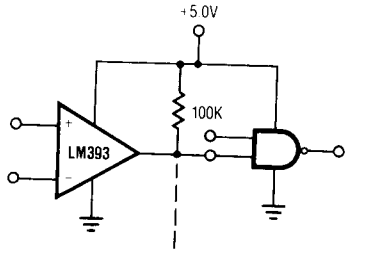


Typical Applications (V_S = +5.0V)

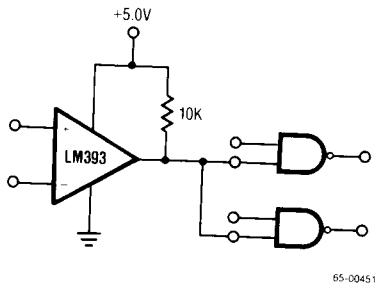
Basic Comparator



Driving CMOS



Driving TTL



Comparison of Standard vs Micro-Package