National Semiconductor

MM54C909/MM74C909 Quad Comparator

General Description

The MM54C909/MM74C909 contains four independent bipolar voltage comparators designed to operate from standard 54C/74C power supplies. The output allows current sinking only, thus the wire OR function is possible using a common resistor pull-up.

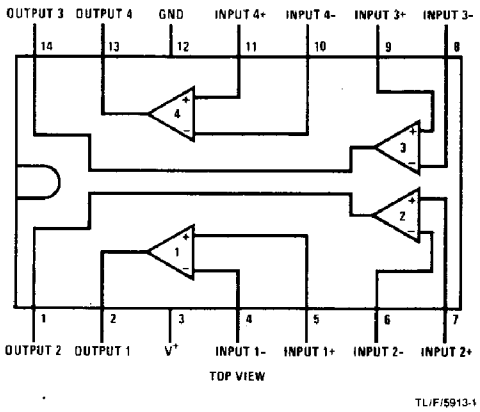
Not only does the MM54C909/MM74C909 function as a comparator for analog inputs, but also has many applications as a voltage translator and buffer when interfacing the 54C/74C family to other logic systems.

Features

■ Wide supply voltage range	3.0 V to 15 V
■ TTL compatibility	fan out of 1 driving 74
■ Low power consumption	I_{CC} = 800 μA (typ.) at V_{CC} = 5.0 V_{DC}
■ Low input bias current	250 nA max.
■ Low input offset current	±50 nA max.
■ Low input offset voltage	±5.0 mV max.
■ Large common mode input voltage range	0 V to V_{CC} − 1.5 V
■ Large differential input voltage range	V_{CC}

Connection Diagram

Dual-In-Line Package



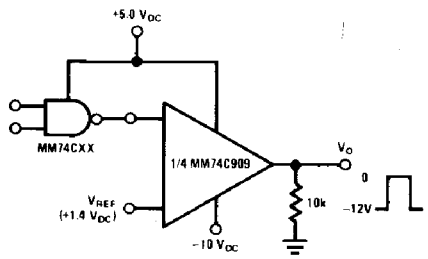
TL/F/5913-1

Order Number MM54C909J or MM74C909J
See NS Package J14A

Order Number MM54C909N or MM74C909N
See NS Package N14A

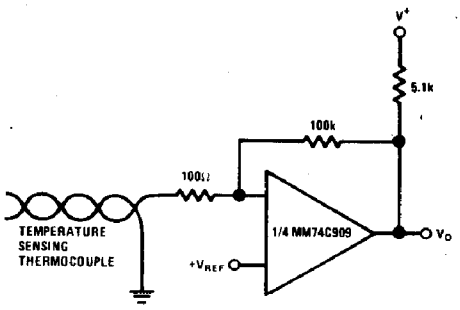
Typical Applications (V^+ = 5.0 V_{DC})

CMOS/TTL to MOS Logic Converter



TL/F/5913-2

Ground Referenced Thermocouple in Single Supply System



TL/F/5913-3

Absolute Maximum Ratings (Note 1)

Voltage at Any Pin	−0.3V to V_{CC} + 0.3V	Package Dissipation (Notes 2 and 3)	500 mW
Operating Temperature Range		Operating V_{CC} Range	3.0V to 15V
MM54C909	−55°C to +125°C	Absolute Maximum V_{CC}	18V
MM74C909	−40°C to +85°C	Input Current (V_{IN} < −0.3V) (Note 4)	50 mA
Storage Temperature Range	−65°C to +150°C	Lead Temperature (Soldering, 10 seconds)	300°C

DC Electrical Characteristics

Min/max limits apply across temperature range, unless otherwise noted. (V_{CC} = +5.0 V_{DC})

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage (Note 9)				±9	mV
	T_A = 25°C		±2	±5	mV
Input Bias Current ($I_{IN(+)}$ or $I_{IN(-)}$) (Note 5)	T_A = 25°C, With Output in Linear Range		25	250	nA
				400	nA
Input Offset Current ($I_{IN(+)} - I_{IN(-)}$)	T_A = 25°C		±5	±150	nA
				±50	nA
Input Common Mode Voltage (Note 6)	T_A = 25°C	0		V_{CC}−2	V
		0		V_{CC}−1.5	V
Supply Current (I_{CC})	T_A = 25°C, R_L = ∞ On All Outputs		800	2000	μA
Voltage Gain	T_A = 25°C, $R_L \geq$ 15 kΩ		200		V/mV
OUTPUT DRIVE (See 54C/74C Family Characteristics Data Sheet)					
Output Sink Current (I_{SINK}) MM54C909	V_{CC} = 4.50V	1.6	3.2		mA
MM74C909	V_{CC} = 4.75V, V_{OUT} = 0.4V				
	$V_{IN(-)} \geq$ 1.0 V_{DC}				
	$V_{IN(+)}$ = 0 V_{DC}				
Output Leakage Current	$V_{IN(+)} \geq$ 1.0 V_{DC}, $V_{IN(-)}$ = 0 V_{DC}, V_{OUT} = 15 V_{DC}			1	μA
	$V_{IN(+)} \geq$ 1.0 V_{DC}, $V_{IN(-)}$ = 0 V_{DC}, V_{OUT} = 5 V_{DC}, T_A = 25°C		0.1		nA
Differential Input Voltage (Note 8)	All V_{IN}'s ≥ 0 V_{DC}			15	V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: For operating at high temperatures, the MM74C909 must be derated based on +125°C maximum junction temperature and a thermal resistance of +175°C/W which applies to the device soldered in a printed circuit board, operating in a still air ambient. The MM54C909 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 (Pd ≤ 100 mW), provided the output sink current is within specified limits.

Note 3: Short circuits from the output to V^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20 mA independent of the magnitude of V^+.

Note 4: This input current will only exist when the voltage at any of the input leads is driven negative. There is a lateral NPN parasitic transistor action on the IC chip. The 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 reestablish when the input voltage, which was negative, again returns to a value greater than −0.3V.

Note 5: The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.

Note 6: 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^+ − 1.5V, but either or both inputs can go to +15V without damage.

Note 7: The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger overdrive signals 300 ns can be obtained, see typical performance characteristics section.

Note 8: The positive excursions of the input can equal V_{CC} supply voltage level, and if the other input voltage remains within the common-mode voltage range, the comparator will provide a proper output state. The low input voltage state must not be less than −0.3V.

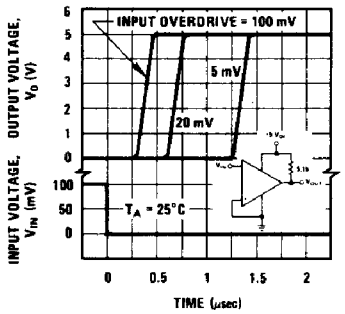
Note 9: At output switch point, V_O = 1.4 V_{DC}, R_S = 0Ω with V^+ from 5 V_{DC} to 30 V_{DC} and over the full input common mode range (0V_{DC}) to V^+ ±1.5 V_{DC}).

AC Electrical Characteristics R_L = 5.1 kΩ, V_{RL} = 5.0 V_{DC}, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Large Signal Response Time	V_{IN} = TTL Swing V_{REF} = 1.4 V_{DC}		300		ns
Response Time	T_A = 25°C (Note 7)		1.3		μs

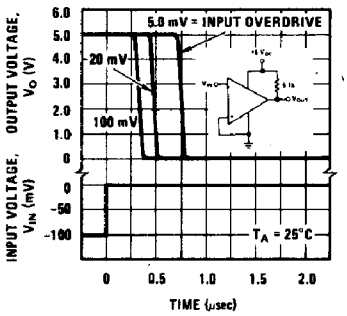
Typical Performance Characteristics

Response Time for Various Input Overdrives — Positive Transition



TL/F/5913-4

Response Time for Various Input Overdrives — Negative Transition



TL/F/5913-5

Application Hints

The MM54C909/MM74C909 is a high gain, wide bandwidth device; which, like most comparators, can easily oscillate if the output lead is inadvertently allowed to capacitively couple to the inputs via stray capacitance. This shows up only during the output voltage transition intervals as the comparator changes states. Power supply bypassing is not required to solve this problem. Standard PC board layout is helpful as it reduces stray input-output coupling. Reducing the input resistors to <10 kΩ reduces the feedback signal levels and finally, adding even a small amount (1 to 10 mV) of positive feedback (hysteresis) causes such a rapid transition that oscillations due to stray feedback are not possible. Simply socketing the I/C and attaching resistors to the pins will cause input-output oscillations during the small transition intervals unless hysteresis is used. If the input signal is a pulse waveform, with relatively fast rise and fall times, hysteresis is not required.

All pins of any unused comparators should be grounded.

The bias network of the MM54C909/MM74C909 establishes an I_{CC} current which is independent of the magnitude of the power supply voltage over the range of from 3.0V to 15V.

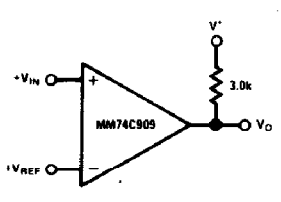
It is usually unnecessary to use a bypass capacitor across the power supply line.

The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than −0.3 V_{DC} (at 25°C). An input clamp diode and input resistor can be used as shown in the applications section.

Many outputs can be tied together to provide an output OR'ing function. An output "pull-up" resistor can be connected to any available power supply voltage within the permitted supply voltage range and there is no restriction on this voltage due to the magnitude of the voltage which is applied to the V^+ terminal of the MM54C909/MM74C909 package. The output can also be used as a simple SPST switch to ground (when a "pull-up" resistor is not used). The amount of current which the output device can sink is limited by the drive available (which is independent of V^+) and the gain of the output device. When the maximum current limit is reached (approximately 16 mA), the output transistor will come out of saturation and the output voltage will rise very rapidly.

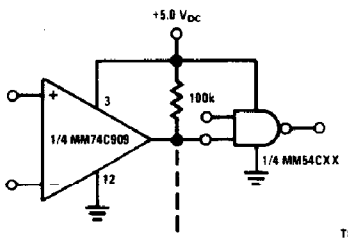
Typical Applications (Continued) (V^+ = 5.0 V_{DC})

Basic Comparator



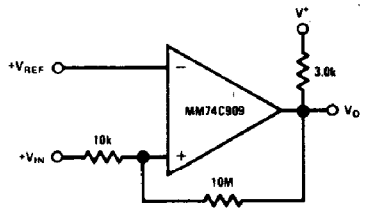
TL/F/5913-6

Driving CMOS



TL/F/5913-7

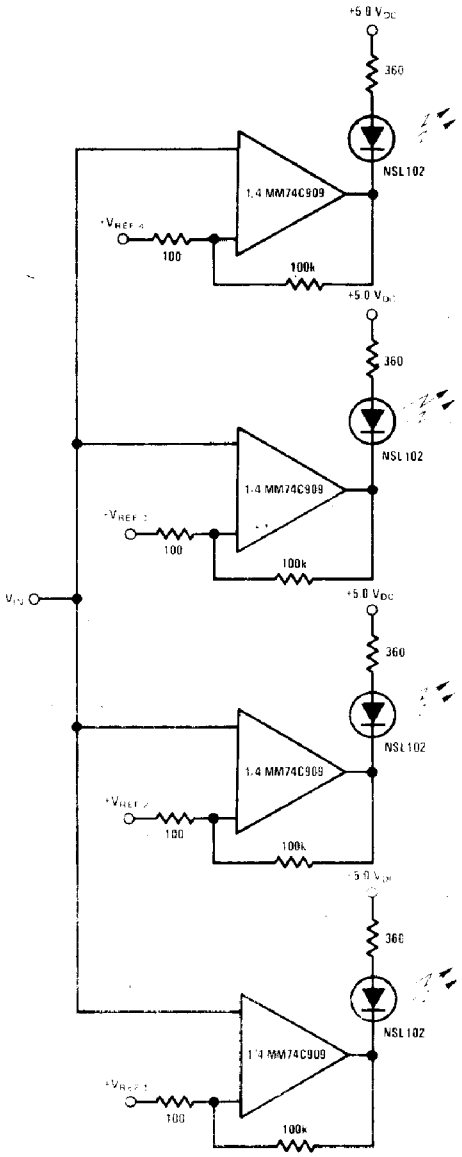
Non-Inverting Comparator with Hysteresis



TL/F/5913-8

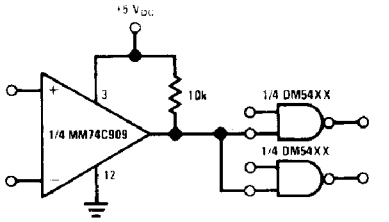
Typical Applications (Continued) ($V^+ = 5.0\ V_{DC}$)

Visible Voltage Indicator



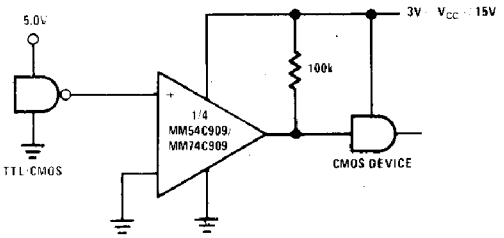
TL/F/5913-9

Driving TTL



TL/F/5913-10

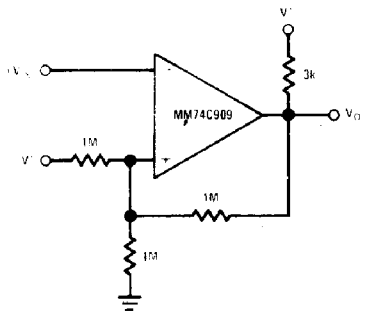
5V Logic to CMOS Operating at $V_{CC} \neq 5V$



Note: For inverting buffer reverse input connection.

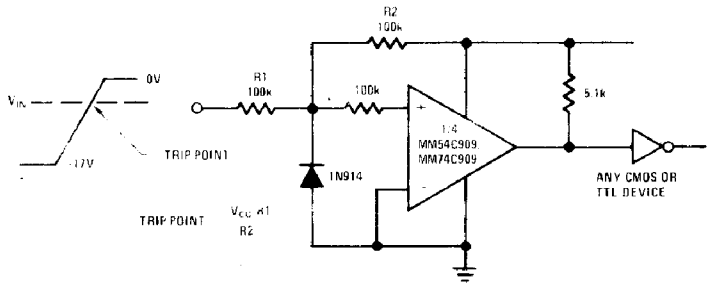
TL/F/5913-11

Inverting Comparator with Hysteresis



TL/F/5913-12

Hi Voltage Inverting PMOS to CMOS or TTL

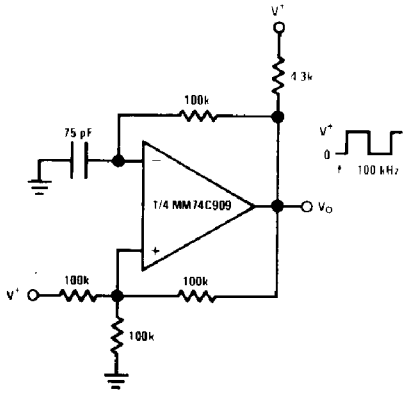


Note: For non-inverting buffer reverse input connection.

TL/F/5913-13

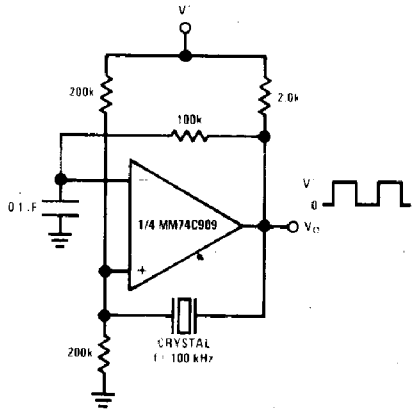
Typical Applications (Continued) ($V^+ = 5.0\ V_{DC}$)

Squarewave Oscillator



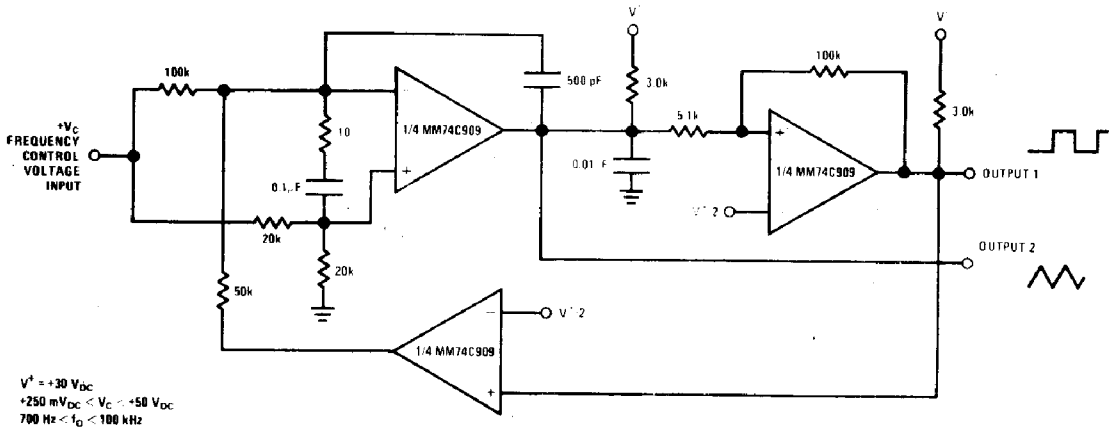
TL/F/5913-14

Crystal Controlled Oscillator



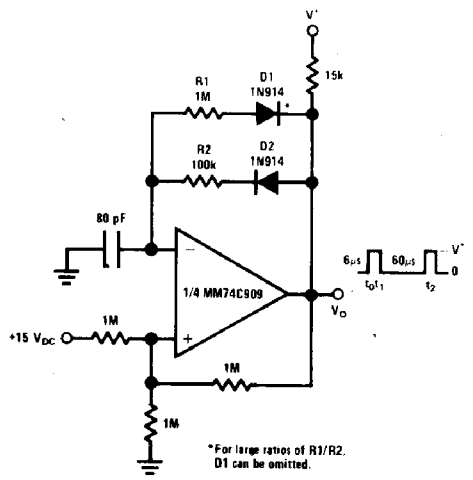
TL/F/5913-15

Two-Decade High-Frequency VCO



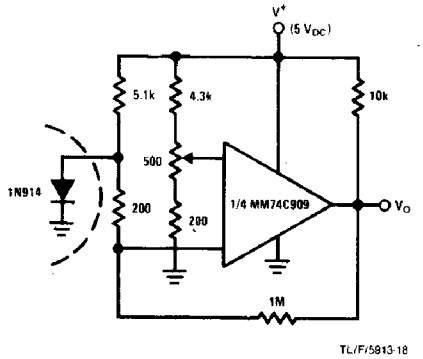
TL/F/5913-16

Pulse Generator



TL/F/5913-17

Remote Temperature Sensing



TL/F/5913-18