

# Hex Unbuffered Inverter

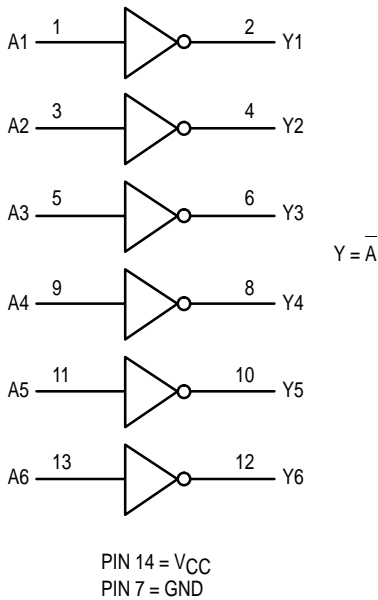
## High-Performance Silicon-Gate CMOS

The MC74HCU04A is identical in pinout to the LS04 and the MC14069UB. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

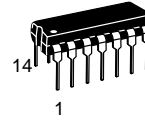
This device consists of six single-stage inverters. These inverters are well suited for use as oscillators, pulse shapers, and in many other applications requiring a high-input impedance amplifier. For digital applications, the HC04A is recommended.

- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2 to 6 V; 2.5 to 6 V in Oscillator Configurations
- Low Input Current: 1  $\mu$ A
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No. 7A
- Chip Complexity: 12 FETs or 3 Equivalent Gates

### LOGIC DIAGRAM



# MC74HCU04A



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646-06



**D SUFFIX**  
SOIC PACKAGE  
CASE 751A-03



**DT SUFFIX**  
TSSOP PACKAGE  
CASE 948G-01

### ORDERING INFORMATION

MC74HCUXAN	Plastic
MC74HCUXAD	SOIC
MC74HCUXADT	TSSOP

### PIN ASSIGNMENT

A1	1	14	$V_{CC}$
Y1	2	13	A6
A2	3	12	Y6
Y2	4	11	A5
A3	5	10	Y5
Y3	6	9	A4
GND	7	8	Y4

### FUNCTION TABLE

Inputs A	Outputs Y
L	H
H	L



**MAXIMUM RATINGS\***

Symbol	Parameter	Value	Unit	
V <sub>CC</sub>	DC Supply Voltage (Referenced to GND)	- 0.5 to + 7.0	V	
V <sub>in</sub>	DC Input Voltage (Referenced to GND)	- 0.5 to V <sub>CC</sub> + 0.5	V	
V <sub>out</sub>	DC Output Voltage (Referenced to GND)	- 0.5 to V <sub>CC</sub> + 0.5	V	
I <sub>in</sub>	DC Input Current, per Pin	± 20	mA	
I <sub>out</sub>	DC Output Current, per Pin	± 25	mA	
I <sub>CC</sub>	DC Supply Current, V <sub>CC</sub> and GND Pins	± 50	mA	
P <sub>D</sub>	Power Dissipation in Still Air	Plastic DIP†	750	mW
		SOIC Package†	500	
		TSSOP Package†	450	
T <sub>stg</sub>	Storage Temperature	- 65 to + 150	°C	
T <sub>L</sub>	Lead Temperature, 1 mm from case for 10 Seconds Plastic DIP, SOIC or TSSOP Package	260	°C	

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V<sub>in</sub> and V<sub>out</sub> should be constrained to the range GND ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>CC</sub>. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V<sub>CC</sub>). Unused outputs must be left open.

\* Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.

† Derating — Plastic DIP: -10mW/°C from 65° to 125°C  
SOIC Package: -7mW/°C from 65° to 125°C  
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

For high frequency or heavy load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	DC Supply Voltage (Referenced to GND)	2.0	6.0	V
V <sub>in</sub> , V <sub>out</sub>	DC Input Voltage, Output Voltage (Referenced to GND)	0	V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature, All Package Types	- 55	+ 125	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise and Fall Time (Figure 1)	—	No Limit	ns

**DC ELECTRICAL CHARACTERISTICS** (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	Guaranteed Limit			Unit
				- 55 to 25°C	≤ 85°C	≤ 125°C	
V <sub>IH</sub>	Minimum High-Level Input Voltage	V <sub>out</sub> = 0.5 V*  I <sub>out</sub>   ≤ 20 μA	2.0	1.7	1.7	1.7	V
			3.0	2.5	2.5	2.5	
			4.5	3.6	3.6	3.6	
			6.0	4.8	4.8	4.8	
V <sub>IL</sub>	Maximum Low-Level Input Voltage	V <sub>out</sub> = V <sub>CC</sub> - 0.5 V*  I <sub>out</sub>   ≤ 20 μA	2.0	0.3	0.3	0.3	V
			3.0	0.5	0.5	0.5	
			4.5	0.8	0.8	0.8	
			6.0	1.1	1.1	1.1	
V <sub>OH</sub>	Minimum High-Level Output Voltage	V <sub>in</sub> = GND  I <sub>out</sub>   ≤ 20 μA	2.0	1.8	1.8	1.8	V
			4.5	4.0	4.0	4.0	
			6.0	5.5	5.5	5.5	
		V <sub>in</sub> = GND  I <sub>out</sub>   ≤ 2.4 mA  I <sub>out</sub>   ≤ 4.0 mA  I <sub>out</sub>   ≤ 5.2 mA	3.0	2.36	2.26	2.20	
			4.5	3.86	3.76	3.70	
			6.0	5.36	5.26	5.20	
V <sub>OL</sub>	Maximum Low-Level Output Voltage	V <sub>in</sub> = V <sub>CC</sub>  I <sub>out</sub>   ≤ 20 μA	2.0	0.2	0.2	0.2	V
			4.5	0.5	0.5	0.5	
			6.0	0.5	0.5	0.5	
		V <sub>in</sub> = V <sub>CC</sub>  I <sub>out</sub>   ≤ 2.4 mA  I <sub>out</sub>   ≤ 4.0 mA  I <sub>out</sub>   ≤ 5.2 mA	3.0	0.32	0.32	0.32	
			4.5	0.32	0.37	0.40	
			6.0	0.32	0.37	0.40	

**DC ELECTRICAL CHARACTERISTICS** (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	Guaranteed Limit			Unit
				- 55 to 25°C	≤ 85°C	≤ 125°C	
I <sub>in</sub>	Maximum Input Leakage Current	V <sub>in</sub> = V <sub>CC</sub> or GND	6.0	± 0.1	± 1.0	± 1.0	μA
I <sub>CC</sub>	Maximum Quiescent Supply Current (per Package)	V <sub>in</sub> = V <sub>CC</sub> or GND I <sub>out</sub> = 0 μA	6.0	1	10	40	μA

NOTE: Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

\* For V<sub>CC</sub> = 2.0 V, V<sub>out</sub> = 0.2 V or V<sub>CC</sub> - 0.2 V.

**AC ELECTRICAL CHARACTERISTICS** (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6 ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			- 55 to 25°C	≤ 85°C	≤ 125°C	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Input A to Output Y (Figures 1 and 2)	2.0	70	90	105	ns
		3.0	40	45	50	
		4.5	14	18	21	
		6.0	12	15	18	
t <sub>TLH</sub> , t <sub>THL</sub>	Maximum Output Transition Time, Any Output (Figures 1 and 2)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	22	
		6.0	13	16	19	
C <sub>in</sub>	Maximum Input Capacitance	—	10	10	10	pF

## NOTES:

1. For propagation delays with loads other than 50 pF, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).
2. Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

C <sub>PD</sub>	Power Dissipation Capacitance (Per Inverter)*	Typical @ 25°C, V <sub>CC</sub> = 5.0 V	pF
		15	

\* Used to determine the no-load dynamic power consumption: P<sub>D</sub> = C<sub>PD</sub> V<sub>CC</sub><sup>2</sup>f + I<sub>CC</sub> V<sub>CC</sub>. For load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

# MC74HCU04A

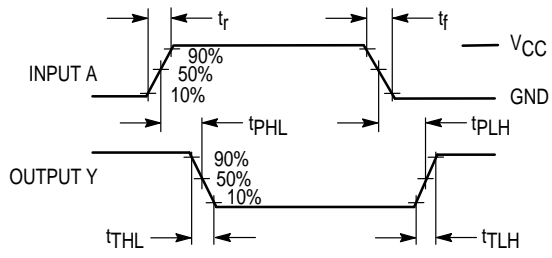
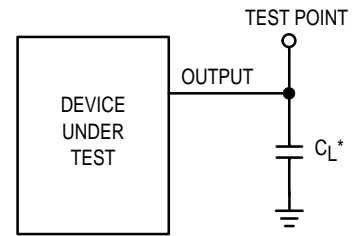


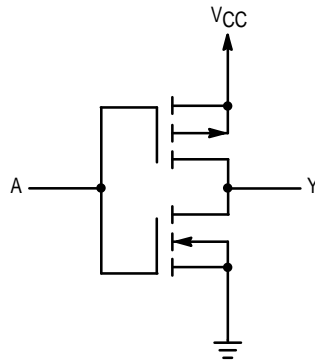
Figure 1. Switching Waveforms



\* Includes all probe and jig capacitance

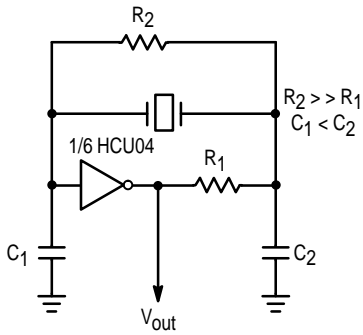
Figure 2. Test Circuit

## LOGIC DETAIL (1/6 of Device Shown)

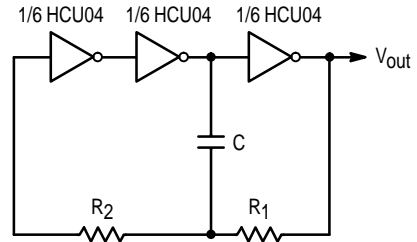


TYPICAL APPLICATIONS

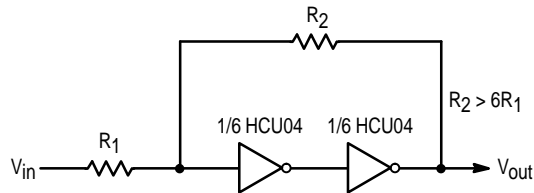
Crystal Oscillator



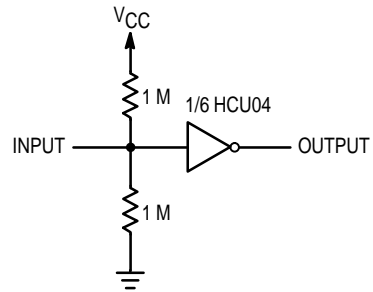
Stable RC Oscillator



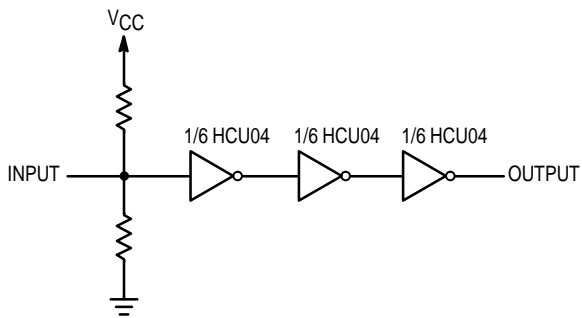
Schmitt Trigger



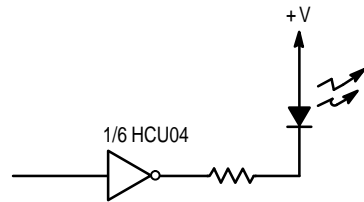
High Input Impedance Single-Stage Amplifier with a 2 to 6 V Supply Range



Multi-Stage Amplifier



LED Driver

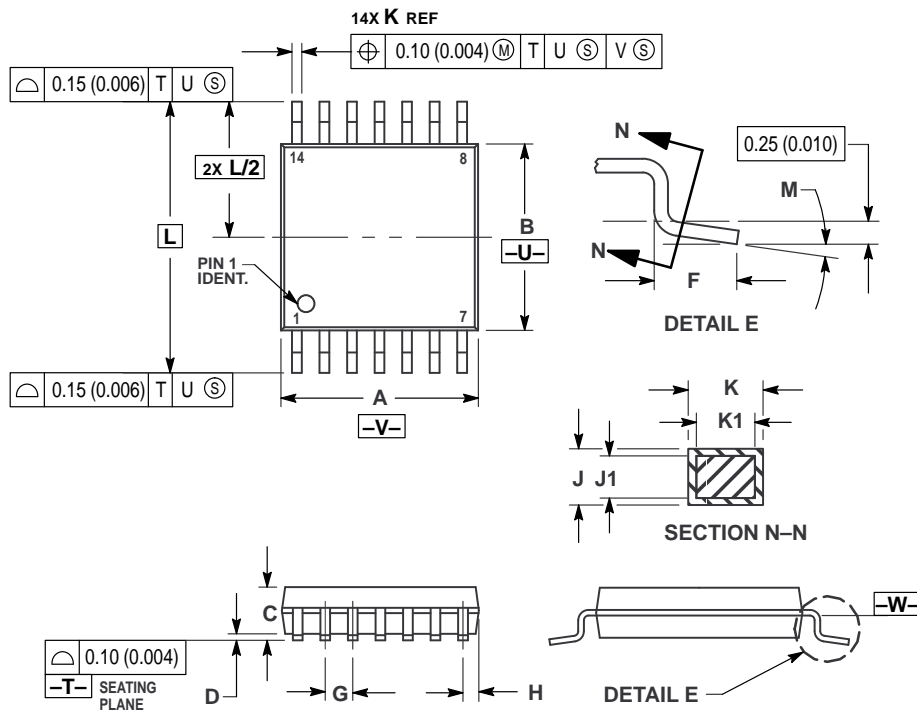


For reduced power supply current, use high-efficiency LEDs such as the Hewlett-Packard HLMP series or equivalent.



OUTLINE DIMENSIONS

DT SUFFIX  
 PLASTIC TSSOP PACKAGE  
 CASE 948G-01  
 ISSUE O



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
  4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
  5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
  7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	—	1.20	—	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.50	0.60	0.020	0.024
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

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