# Hex Unbuffered Inverter
## High–Performance Silicon–Gate CMOS

MC74HCU04

The MC74HCU04 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 HC04 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 μA
- 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
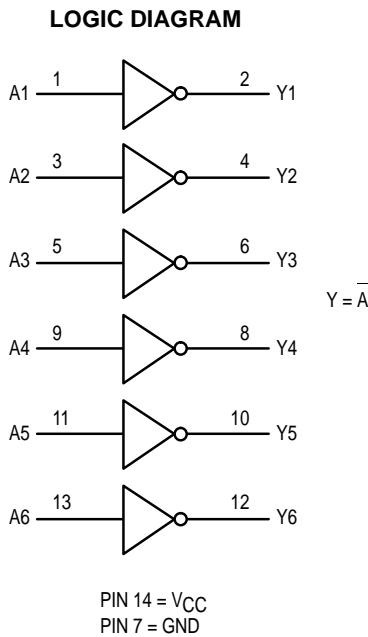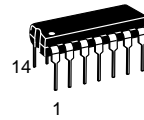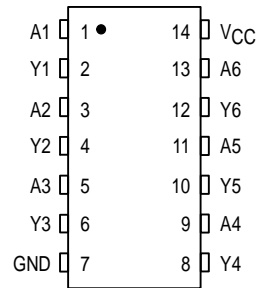
N SUFFIX
PLASTIC PACKAGE
CASE 646–06

D SUFFIX
SOIC PACKAGE
CASE 751A–03

ORDERING INFORMATION

MC74HCUXXN   Plastic
MC74HCUXXD   SOIC

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

LOGIC DIAGRAM

A1	1	2	Y1
A2	3	4	Y2
A3	5	6	Y3
A4	9	8	Y4
A5	11	10	Y5
A6	13	12	Y6

$Y = \overline{A}$

PIN 14 = V_{CC}
PIN 7 = GND

FUNCTION TABLE

Inputs A	Outputs Y
L	H
H	L

REV 6

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MC74HCU04

MAXIMUM RATINGS*

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage (Referenced to GND)	– 0.5 to + 7.0	V
V_{in}	DC Input Voltage (Referenced to GND)	– 1.5 to V_{CC} + 1.5	V
V_{out}	DC Output Voltage (Referenced to GND)	– 0.5 to V_{CC} + 0.5	V
I_{in}	DC Input Current, per Pin	± 20	mA
I_{out}	DC Output Current, per Pin	± 25	mA
I_{CC}	DC Supply Current, V_{CC} and GND Pins	± 50	mA
P_D	Power Dissipation in Still Air Plastic DIP† SOIC Package†	750 500	mW
T_{stg}	Storage Temperature	– 65 to + 150	°C
T_L	Lead Temperature, 1 mm from case for 10 Seconds (Plastic DIP or SOIC 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_{in} and V_{out} should be constrained to the range GND ≤ (V_{in} or V_{out}) ≤ V_{CC}.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}). 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
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_{CC}	DC Supply Voltage (Referenced to GND)	2.0	6.0	V
V_{in}, V_{out}	DC Input Voltage, Output Voltage (Referenced to GND)	0	V_{CC}	V
T_A	Operating Temperature, All Package Types	– 55	+ 125	°C
t_r, t_f	Input Rise and Fall Time (Figure 1)	—	No Limit	ns

DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V_{CC} V	Guaranteed Limit – 55 to 25°C	≤ 85°C	≤ 125°C	Unit
V_{IH}	Minimum High–Level Input Voltage	V_{out} = 0.5 V* $|I_{out}|$ ≤ 20 µA	2.0 4.5 6.0	1.7 3.6 4.8	1.7 3.6 4.8	I.7 3.6 4.8	V
V_{IL}	Maximum Low–Level Input Voltage	V_{out} = V_{CC} – 0.5 V* $|I_{out}|$ ≤ 20 µA	2.0 4.5 6.0	0.3 0.8 1.1	0.3 0.8 1.1	0.3 0.8 1.1	V
V_{OH}	Minimum High–Level Output Voltage	V_{in} = GND $|I_{out}|$ ≤ 20 µA	2.0 4.5 6.0	1.8 4.0 5.5	1.8 4.0 5.5	1.8 4.0 5.5	V
		V_{in} = GND $|I_{out}|$ ≤ 4.0 mA $|I_{out}|$ ≤ 5.2 mA	4.5 6.0	3.86 5.36	3.76 5.26	3.70 5.20	
V_{OL}	Maximum Low–Level Output Voltage	V_{in} = V_{CC} $|I_{out}|$ ≤ 20 µA	2.0 4.5 6.0	0.2 0.5 0.5	0.2 0.5 0.5	0.2 0.5 0.5	V
		V_{in} = V_{CC} $|I_{out}|$ ≤ 4.0 mA $|I_{out}|$ ≤ 5.2 mA	4.5 6.0	0.32 0.32	0.37 0.37	0.40 0.40	
I_{in}	Maximum Input Leakage Current	V_{in} = V_{CC} or GND	6.0	± 0.1	± 1.0	± 1.0	µA
I_{CC}	Maximum Quiescent Supply Current (per Package)	V_{in} = V_{CC} or GND I_{out} = 0 µA	6.0	2	20	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_{CC} = 2.0 V, V_{out} = 0.2 V or V_{CC} – 0.2 V.

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input $t_r = t_f$ = 6 ns)

Symbol	Parameter	V_{CC} V	Guaranteed Limit			Unit
			− 55 to 25°C	≤ 85°C	≤ 125°C	
t_{PLH}, t_{PHL}	Maximum Propagation Delay, Input A to Output Y (Figures 1 and 2)	2.0	80	100	120	ns
		4.5	16	20	24	
		6.0	14	17	20	
t_{TLH}, t_{THL}	Maximum Output Transition Time, Any Output (Figures 1 and 2)	2.0	75	95	110	ns
		4.5	15	19	22	
		6.0	13	16	19	
C_{in}	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).

		Typical @ 25°C, V_{CC} = 5.0 V	
C_{PD}	Power Dissipation Capacitance (Per Inverter)*	15	pF

* Used to determine the no–load dynamic power consumption: $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$. For load considerations, see Chapter 2 of the Motorola High–Speed CMOS Data Book (DL129/D).
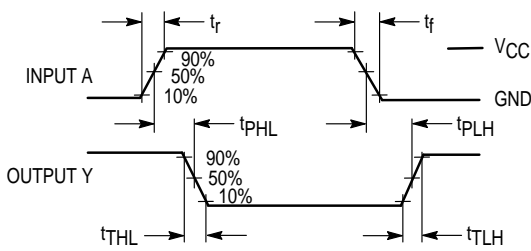
Figure 1. Switching Waveforms
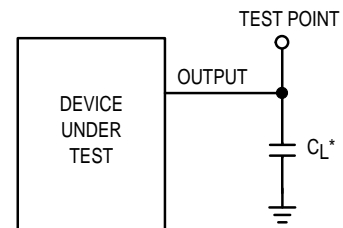
* Includes all probe and jig capacitance

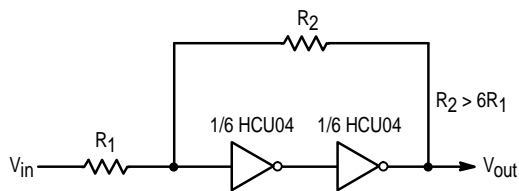**Figure 2. Test Circuit**

LOGIC DETAIL
(1/6 of Device Shown)

MC74HCU04
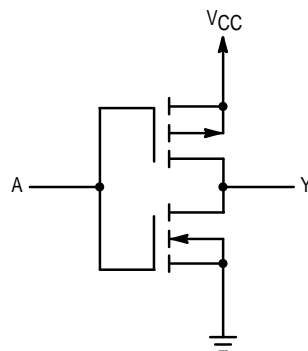
TYPICAL APPLICATIONS

Crystal Oscillator

$$R_2 >> R_1$$
$$C_1 < C_2$$

R$_2$

1/6 HCU04

R$_1$

C$_1$

C$_2$

V$_{out}$

Stable RC Oscillator

1/6 HCU04   1/6 HCU04   1/6 HCU04

V$_{out}$

C

R$_2$

R$_1$

Schmitt Trigger

R$_2$

$$R_2 > 6R_1$$

V$_{in}$

R$_1$

1/6 HCU04   1/6 HCU04

V$_{out}$
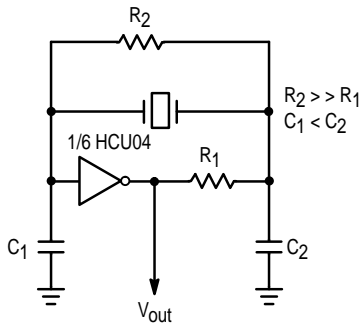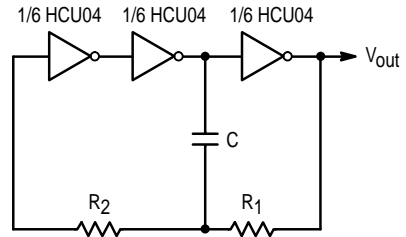
High Input Impedance Single–Stage Amplifier with a 2 to 6 V Supply Range

V$_{CC}$

1 M

1/6 HCU04

INPUT

OUTPUT

1 M

Multi–Stage Amplifier

V$_{CC}$

INPUT

1/6 HCU04   1/6 HCU04   1/6 HCU04

OUTPUT

LED Driver

+V

1/6 HCU04
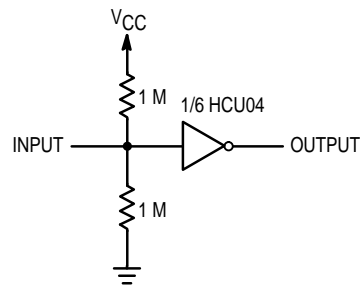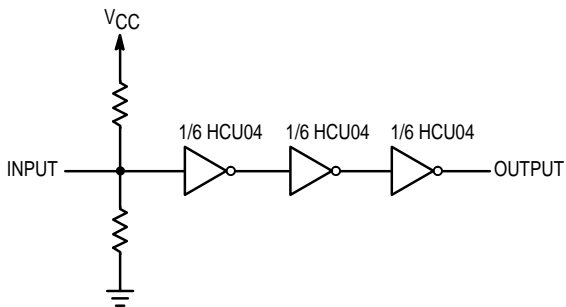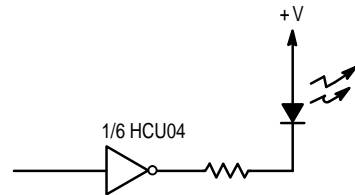
For reduced power supply current, use high–efficiency LEDs
such as the Hewlett–Packard HLMP series or equivalent.

OUTLINE DIMENSIONS

N SUFFIX
PLASTIC DIP PACKAGE
CASE 646–06
ISSUE L
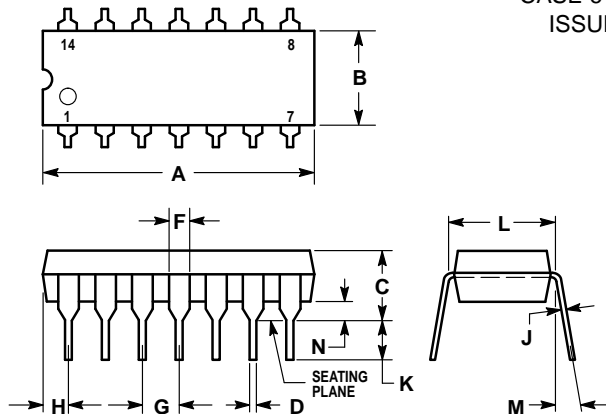
NOTES:
1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	19.56
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.039	0.39	1.01

D SUFFIX
PLASTIC SOIC PACKAGE
CASE 751A–03
ISSUE F

$\oplus$ | 0.25 (0.010) $\circledM$ | B $\circledM$

$\oplus$ | 0.25 (0.010) $\circledM$ | T | B $\circledS$ | A $\circledS$
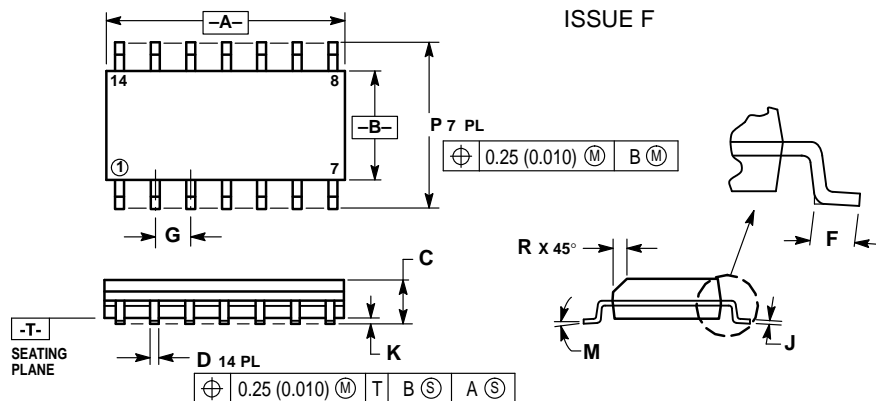
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

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◇ CODELINE