Hex Buffers/Logic-Level Down Converters

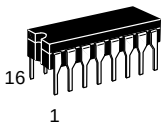
High–Performance Silicon–Gate CMOS

MC54/74HC4049
MC54/74HC4050

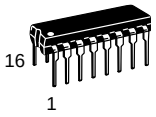
The MC54/74HC4049 consists of six inverting buffers, and the MC54/74HC4050 consists of six noninverting buffers. They are identical in pinout to the MC14049UB and MC14050B metal–gate CMOS buffers. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

The input protection circuitry on these devices has been modified by eliminating the V_{CC} diodes to allow the use of input voltages up to 15 volts. Thus, the devices may be used as logic–level translators that convert from a high voltage to a low voltage while operating at the low–voltage power supply. They allow MC14000–series CMOS operating up to 15 volts to be interfaced with High–Speed CMOS at 2 to 6 volts. The protection diodes to GND are Zener diodes, which protect the inputs from both positive and negative voltage transients.

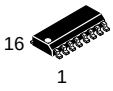
- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2 to 6 V
- Low Input Current: 5 μA
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No. 7A
- Chip Complexity: 36 FETs or 9 Equivalent Gates (4049)
  24 FETs or 6 Equivalent Gates (4050)



J SUFFIX
CERAMIC PACKAGE
CASE 620–10



N SUFFIX
PLASTIC PACKAGE
CASE 648–08



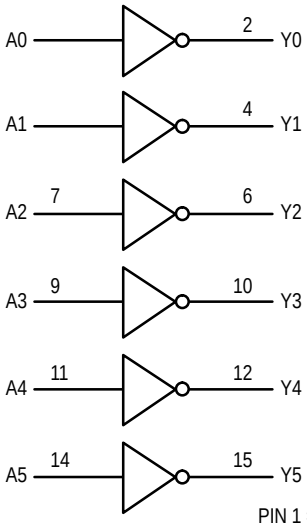
D SUFFIX
SOIC PACKAGE
CASE 751B–05

ORDERING INFORMATION

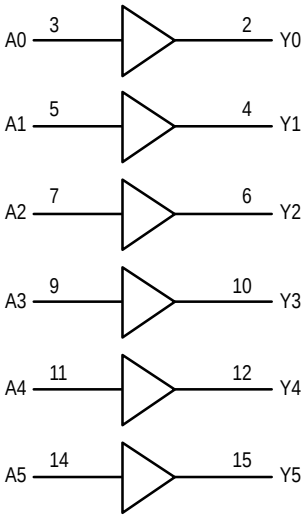
MC54HCXXXXJ	Ceramic
MC74HCXXXXN	Plastic
MC74HCXXXXD	SOIC

LOGIC DIAGRAMS

HC4049
(INVERTING BUFFER)

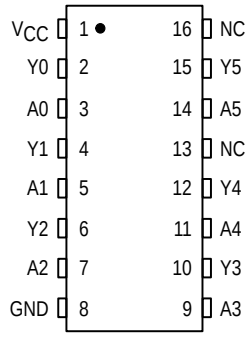


HC4050
(NONINVERTING BUFFER)



PIN 1 = V_{CC}
PIN 8 = GND
PINS 13, 16 = NO CONNECTION

PIN ASSIGNMENT



NC = NO CONNECTION

FUNCTION TABLE

A Input	Y Outputs HC4049	Y Outputs HC4060
L	H	L
H	L	H

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 + 18	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 or Ceramic 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) (Ceramic DIP)	 260 300	°C

* 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: – 10 mW/°C from 65° to 125°C
Ceramic DIP: – 10 mW/°C from 100° to 125°C
SOIC Package: – 7 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).

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields referenced to the GND pin, only. Extra precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high–impedance circuit. For proper operation, the ranges GND ≤ V_{in} ≤ 15 V and GND ≤ V_{out} ≤ V_{CC} are recommended.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}).

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter		Min	Max	Unit
V_{CC}	DC Supply Voltage (Referenced to GND)		2.0	6.0	V
V_{in}	DC Input Voltage (Referenced to GND)		0	V_{CC} to 15	V
V_{out}	DC 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)	V_{CC} = 2.0 V V_{CC} = 4.5 V V_{CC} = 6.0 V	0 0 0	1000 500 400	ns

DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V_{CC} V	Guaranteed Limit			Unit
				– 55 to 25°C	≤ 85°C	≤ 125°C	
V_{IH}	Minimum High–Level Input Voltage	V_{out} = V_{CC} – 0.1 V $\|I_{out}\|$ ≤ 20 μA	2.0 4.5 6.0	1.5 3.15 4.2	1.5 3.15 4.2	1.5 3.15 4.2	V
V_{IL}	Maximum Low–Level Input Voltage	V_{out} = 0.1 V or V_{CC} – 0.1 V $\|I_{out}\|$ ≤ 20 μA	2.0 4.5 6.0	0.3 0.9 1.2	0.3 0.9 1.2	0.3 0.9 1.2	V
V_{OH}	Minimum High–Level Output Voltage	V_{in} = V_{IH} $\|I_{out}\|$ ≤ 20 μA	2.0 4.5 6.0	1.9 4.4 5.9	1.9 4.4 5.9	1.9 4.4 5.9	V
		V_{in} = V_{IH} or V_{IL} $\|I_{out}\|$ ≤ 4.0 mA $\|I_{out}\|$ ≤ 5.2 mA	4.5 6.0	3.98 5.48	3.84 5.34	3.70 5.20	
V_{OL}	Maximum Low–Level Output Voltage	V_{in} = V_{IH} or V_{IL} $\|I_{out}\|$ ≤ 20 μA	2.0 4.5 6.0	0.1 0.1 0.1	0.1 0.1 0.1	0.1 0.1 0.1	V
		V_{in} = V_{IH} or V_{IL} $\|I_{out}\|$ ≤ 4.0 mA $\|I_{out}\|$ ≤ 5.2 mA	4.5 6.0	0.26 0.26	0.33 0.33	0.40 0.40	
I_{in}	Maximum Input Leakage Current	V_{in} = V_{CC} or GND V_{in} = 15 V	6.0 6.0	± 0.1 0.5	± 1.0 5.0	± 1.0 5.0	μA
I_{CC}	Maximum Quiescent Supply Current (per Package)	V_{in} = 15 V 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).

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 4.5 6.0	85 17 14	105 21 18	130 26 22	ns
t_{TLH}, t_{THL}	Maximum Output Transition Time, Any Output (Figures 1 and 2)	2.0 4.5 6.0	75 15 13	95 19 16	110 22 19	ns
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 Buffer)*	27	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).

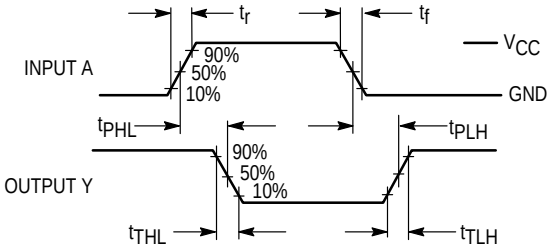


Figure 1a. Switching Waveforms (HC4049)

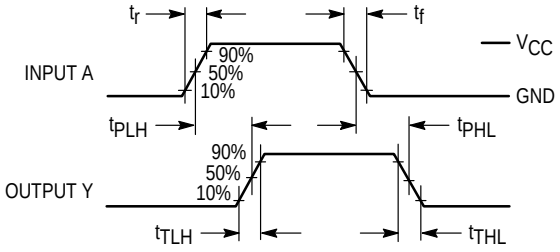
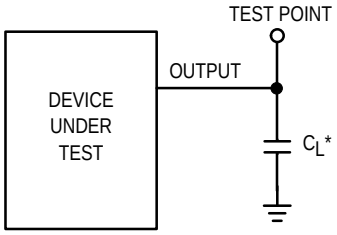


Figure 1b. Switching Waveforms (HC4050)

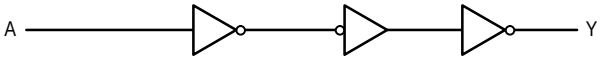


* Includes all probe and jig capacitance

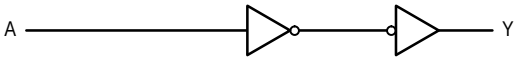
Figure 2. Test Circuit

LOGIC DETAIL

HC4049
(1/6 of the Device)

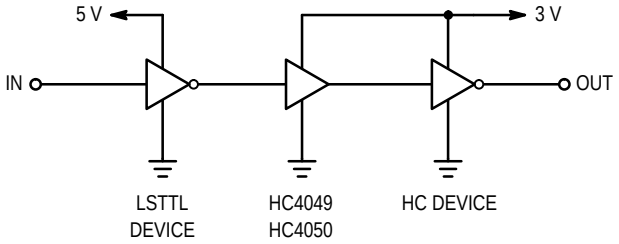


HC4050
(1/6 of the Device)

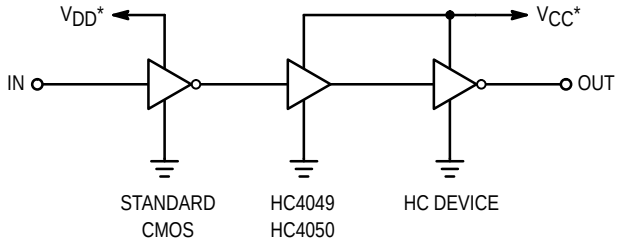


TYPICAL APPLICATIONS

LSTTL to Low–Voltalge HSCMOS



High–Voltage CMOS to HSCMOS



NOTE: To determine the noise immunity for the LSTTL to low–voltage configuration, use Eq. 1 and Eq. 2:
(TTL) V_{OH} – (CMOS) V_{IH} Eq. 1
(TTL) V_{OL} – (CMOS) V_{IL} Eq. 2

For the supply levels shown:
2.4 – 3 (75%) = 2.4 – 2.25 = 0.15 V
0.4 – 3 (15%) = 0.4 – 0.45 = 0.05 V

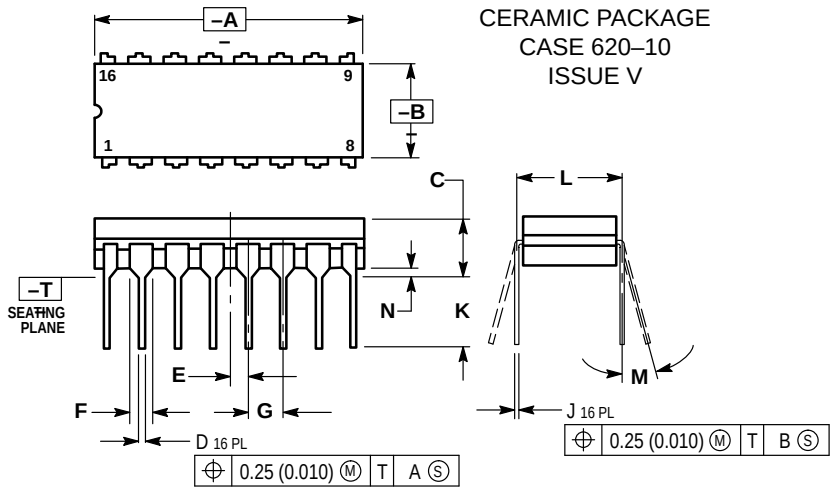
Therefore, worst case noise immunity is 50 mV.
For supply levels greater than 4.5 volts use the 74HCT04A for direct interface to TTL outputs.

***Table 1. Supply Examples**

V_{DD}	V_{CC}
15 V	2 V
12 V	5 V
12 V	3 V

OUTLINE DIMENSIONS

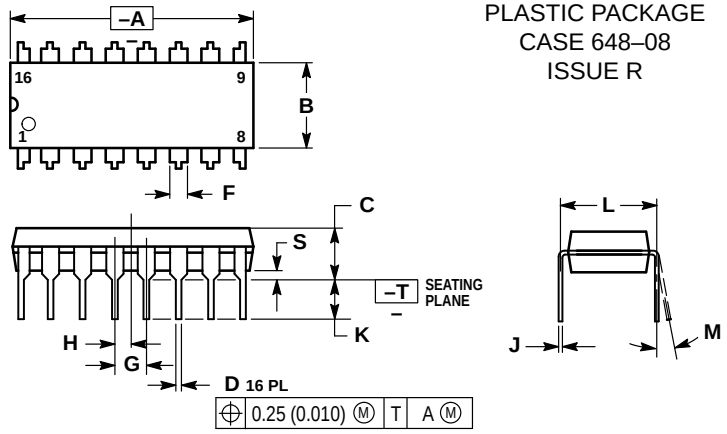
J SUFFIX
CERAMIC PACKAGE
CASE 620–10
ISSUE V



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIM F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.750	0.785	19.05	19.93
B	0.240	0.295	6.10	7.49
C	—	0.200	—	5.08
D	0.015	0.020	0.39	0.50
E	0.050 BSC		1.27 BSC	
F	0.055	0.065	1.40	1.65
G	0.100 BSC		2.54 BSC	
J	0.008	0.015	0.21	0.38
K	0.125	0.170	3.18	4.31
L	0.300 BSC		7.62 BSC	
M	0°	15°	0°	15°
N	0.020	0.040	0.51	1.01

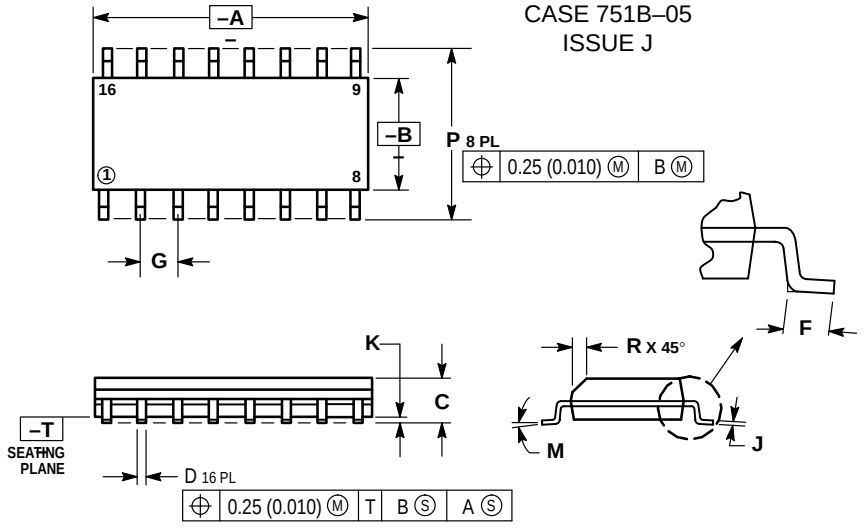
N SUFFIX
PLASTIC PACKAGE
CASE 648–08
ISSUE R



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.740	0.770	18.80	19.55
B	0.250	0.270	6.35	6.85
C	0.145	0.175	3.69	4.44
D	0.015	0.021	0.39	0.53
F	0.040	0.070	1.02	1.77
G	0.100 BSC		2.54 BSC	
H	0.050 BSC		1.27 BSC	
J	0.008	0.015	0.21	0.38
K	0.110	0.130	2.80	3.30
L	0.295	0.305	7.50	7.74
M	0°	10°	0°	10°
S	0.020	0.040	0.51	1.01

D SUFFIX
PLASTIC SOIC PACKAGE
CASE 751B–05
ISSUE J



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.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
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	0.229	0.244
R	0.25	0.50	0.010	0.019

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