

## CD4049UBM/CD4049UBC Hex Inverting Buffer CD4050BM/CD4050BC Hex Non-Inverting Buffer

### General Description

These hex buffers are monolithic complementary MOS (CMOS) integrated circuits constructed with N- and P-channel enhancement mode transistors. These devices feature logic level conversion using only one supply voltage ( $V_{DD}$ ). The input signal high level ( $V_{IH}$ ) can exceed the  $V_{DD}$  supply voltage when these devices are used for logic level conversions. These devices are intended for use as hex buffers, CMOS to DTL/TTL converters, or as CMOS current drivers, and at  $V_{DD} = 5.0V$ , they can drive directly two DTL/TTL loads over the full operating temperature range.

### Features

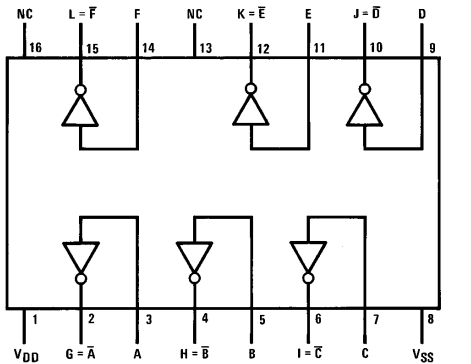
- Wide supply voltage range 3.0V to 15V
- Direct drive to 2 TTL loads at 5.0V over full temperature range
- High source and sink current capability
- Special input protection permits input voltages greater than  $V_{DD}$

### Applications

- CMOS hex inverter/buffer
- CMOS to DTL/TTL hex converter
- CMOS current "sink" or "source" driver
- CMOS high-to-low logic level converter

### Connection Diagrams

CD4049UBM/CD4049UBC  
Dual-In-Line Package

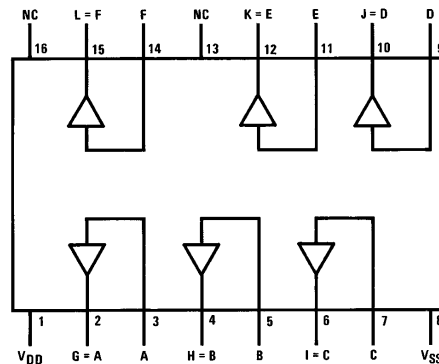


TL/F/5971-1

Top View

Order Number CD4049UB or CD4049B

CD4050BM/CD4050BC  
Dual-In-Line Package



TL/F/5971-2

Top View

Order Number CD4050UB or CD4050B

**CD4049UBM/CD4049UBC Hex Inverting Buffer  
CD4050BM/CD4050BC Hex Non-Inverting Buffer**

## Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage ( $V_{DD}$ )	-0.5V to +18V
Input Voltage ( $V_{IN}$ )	-0.5V to +18V
Voltage at Any Output Pin ( $V_{OUT}$ )	-0.5V to $V_{DD}$ + 0.5V
Storage Temperature Range ( $T_S$ )	-65°C to +150°C
Power Dissipation ( $P_D$ )	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature ( $T_L$ )	
(Soldering, 10 seconds)	260°C

## Recommended Operating Conditions (Note 2)

Supply Voltage ( $V_{DD}$ )	3V to 15V
Input Voltage ( $V_{IN}$ )	0V to 15V
Voltage at Any Output Pin ( $V_{OUT}$ )	0 to $V_{DD}$
Operating Temperature Range ( $T_A$ )	
CD4049UBM, CD4050BM	-55°C to +125°C
CD4049UBC, CD4050BC	-40°C to +85°C

## DC Electrical Characteristics CD4049M/CD4050BM (Note 2)

Symbol	Parameter	Conditions	-55°C		+25°C			+125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
$I_{DD}$	Quiescent Device Current	$V_{DD} = 5V$		1.0		0.01	1.0		30	$\mu A$
		$V_{DD} = 10V$		2.0		0.01	2.0		60	$\mu A$
		$V_{DD} = 15V$		4.0		0.03	4.0		120	$\mu A$
$V_{OL}$	Low Level Output Voltage	$V_{IH} = V_{DD}, V_{IL} = 0V,$ $ I_O  < 1 \mu A$								
		$V_{DD} = 5V$		0.05		0	0.05		0.05	V
		$V_{DD} = 10V$		0.05		0	0.05		0.05	V
		$V_{DD} = 15V$		0.05		0	0.05		0.05	V
$V_{OH}$	High Level Output Voltage	$V_{IH} = V_{DD}, V_{IL} = 0V,$ $ I_O  < 1 \mu A$								
		$V_{DD} = 5V$	4.95		4.95	5		4.95		V
		$V_{DD} = 10V$	9.95		9.95	10		9.95		V
		$V_{DD} = 15V$	14.95		14.95	15		14.95		V
$V_{IL}$	Low Level Input Voltage (CD4050BM Only)	$ I_O  < 1 \mu A$								
		$V_{DD} = 5V, V_O = 0.5V$		1.5		2.25	1.5		1.5	V
		$V_{DD} = 10V, V_O = 1V$		3.0		4.5	3.0		3.0	V
		$V_{DD} = 15V, V_O = 1.5V$		4.0		6.75	4.0		4.0	V
$V_{IL}$	Low Level Input Voltage (CD4049UBM Only)	$ I_O  < 1 \mu A$								
		$V_{DD} = 5V, V_O = 4.5V$		1.0		1.5	1.0		1.0	V
		$V_{DD} = 10V, V_O = 9V$		2.0		2.5	2.0		2.0	V
		$V_{DD} = 15V, V_O = 13.5V$		3.0		3.5	3.0		3.0	V
$V_{IH}$	High Level Input Voltage (CD4050BM Only)	$ I_O  < 1 \mu A$								
		$V_{DD} = 5V, V_O = 4.5V$	3.5		3.5	2.75		3.5		V
		$V_{DD} = 10V, V_O = 9V$	7.0		7.0	5.5		7.0		V
		$V_{DD} = 15V, V_O = 13.5V$	11.0		11.0	8.25		11.0		V
$V_{IH}$	High Level Input Voltage (CD4049UBM Only)	$ I_O  < 1 \mu A$								
		$V_{DD} = 5V, V_O = 0.5V$	4.0		4.0	3.5		4.0		V
		$V_{DD} = 10V, V_O = 1V$	8.0		8.0	7.5		8.0		V
		$V_{DD} = 15V, V_O = 1.5V$	12.0		12.0	11.5		12.0		V
$I_{OL}$	Low Level Output Current (Note 3)	$V_{IH} = V_{DD}, V_{IL} = 0V$								
		$V_{DD} = 5V, V_O = 0.4V$	5.6		4.6	5		3.2		mA
		$V_{DD} = 10V, V_O = 0.5V$	12		9.8	12		6.8		mA
		$V_{DD} = 15V, V_O = 1.5V$	35		29	40		20		mA

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

**Note 2:**  $V_{SS} = 0V$  unless otherwise specified.

**Note 3:** These are *peak* output current capabilities. Continuous output current is rated at 12 mA maximum. The output current should not be allowed to exceed this value for extended periods of time.  $I_{OL}$  and  $I_{OH}$  are tested one output at a time.

## DC Electrical Characteristics CD4049M/CD4050BM (Note 2) (Continued)

Symbol	Parameter	Conditions	-55°C		+25°C			+125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I <sub>OH</sub>	High Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V			-1.1	-1.6		-0.72		mA
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V	-1.3		-2.2	-3.6		-1.5		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V	-2.6		-7.2	-12		-5.0		mA
I <sub>IN</sub>	Input Current	V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V		-0.1		-10 <sup>-5</sup>	-0.1		-1.0	μA
		V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V		0.1		10 <sup>-5</sup>	0.1		1.0	μA

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

**Note 2:** V<sub>SS</sub> = 0V unless otherwise specified.

**Note 3:** These are *peak* output current capabilities. Continuous output current is rated at 12 mA maximum. The output current should not be allowed to exceed this value for extended periods of time. I<sub>OL</sub> and I<sub>OH</sub> are tested one output at a time.

## DC Electrical Characteristics CD4049UBC/CD4050BC (Note 2)

Symbol	Parameter	Conditions	-40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I <sub>DD</sub>	Quiescent Device Current	V <sub>DD</sub> = 5V		4	0.03	4.0		30	μA	
		V <sub>DD</sub> = 10V		8	0.05	8.0		60	μA	
		V <sub>DD</sub> = 15V		16	0.07	16.0		120	μA	
V <sub>OL</sub>	Low Level Output Voltage	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V,  I <sub>O</sub>   < 1 μA								
		V <sub>DD</sub> = 5V		0.05	0	0.05		0.05	V	
		V <sub>DD</sub> = 10V		0.05	0	0.05		0.05	V	
V <sub>OH</sub>	High Level Output Voltage	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V,  I <sub>O</sub>   < 1 μA								
		V <sub>DD</sub> = 5V	4.95		4.95	5		4.95	V	
		V <sub>DD</sub> = 10V	9.95		9.95	10		9.95	V	
V <sub>IL</sub>	Low Level Input Voltage (CD4050BC Only)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V		1.5	2.25	1.5		1.5	V	
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V		3.0	4.5	3.0		3.0	V	
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V		4.0	6.75	4.0		4.0	V	
V <sub>IL</sub>	Low Level Input Voltage (CD4049UBC Only)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.5V		1.0	1.5	1.0		1.0	V	
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 9V		2.0	2.5	2.0		2.0	V	
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V		3.0	3.5	3.0		3.0	V	
V <sub>IH</sub>	High Level Input Voltage (CD4050BC Only)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.5V	3.5		3.5	2.75		3.5	V	
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 9V	7.0		7.0	5.5		7.0	V	
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V	11.0		11.0	8.25		11.0	V	
V <sub>IH</sub>	High Level Input Voltage (CD4049UBC Only)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V	4.0		4.0	3.5		4.0	V	
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V	8.0		8.0	7.5		8.0	V	
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V	12.0		12.0	11.5		12.0	V	

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

**Note 2:** V<sub>SS</sub> = 0V unless otherwise specified.

**Note 3:** These are *peak* output current capabilities. Continuous output current is rated at 12 mA maximum. The output current should not be allowed to exceed this value for extended periods of time. I<sub>OL</sub> and I<sub>OH</sub> are tested one output at a time.

## DC Electrical Characteristics CD4049UBC/CD4050BC (Note 2) (Continued)

Symbol	Parameter	Conditions	-40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I <sub>OL</sub>	Low Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V			4.0	5		3.2		mA
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V	4.6		8.5	12		6.8		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V	9.8		25	40		20		mA
I <sub>OH</sub>	High Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V			-0.9	-1.6		-0.72		mA
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V	-1.0		-1.9	-3.6		-1.5		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V	-2.1		-6.2	-12		-5		mA
I <sub>IN</sub>	Input Current	V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V	-0.3		-0.3	-10 <sup>-5</sup>			-1.0	μA
		V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V	0.3		0.3	10 <sup>-5</sup>			1.0	μA

## AC Electrical Characteristics\* CD4049UBM/CD4049UBC

T<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200k, t<sub>r</sub> = t<sub>f</sub> = 20 ns, unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t <sub>PHL</sub>	Propagation Delay Time High-to-Low Level	V <sub>DD</sub> = 5V		30	65	ns
		V <sub>DD</sub> = 10V		20	40	ns
		V <sub>DD</sub> = 15V		15	30	ns
t <sub>PLH</sub>	Propagation Delay Time Low-to-High Level	V <sub>DD</sub> = 5V		45	85	ns
		V <sub>DD</sub> = 10V		25	45	ns
		V <sub>DD</sub> = 15V		20	35	ns
t <sub>THL</sub>	Transition Time High-to-Low Level	V <sub>DD</sub> = 5V		30	60	ns
		V <sub>DD</sub> = 10V		20	40	ns
		V <sub>DD</sub> = 15V		15	30	ns
t <sub>TLH</sub>	Transition Time Low-to-High Level	V <sub>DD</sub> = 5V		60	120	ns
		V <sub>DD</sub> = 10V		30	55	ns
		V <sub>DD</sub> = 15V		25	45	ns
C <sub>IN</sub>	Input Capacitance	Any Input		15	22.5	pF

\*AC Parameters are guaranteed by DC correlated testing.

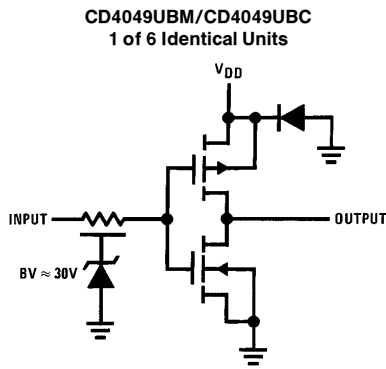
## AC Electrical Characteristics\* CD4050BM/CD4050BC

T<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200k, t<sub>r</sub> = t<sub>f</sub> = 20 ns, unless otherwise specified

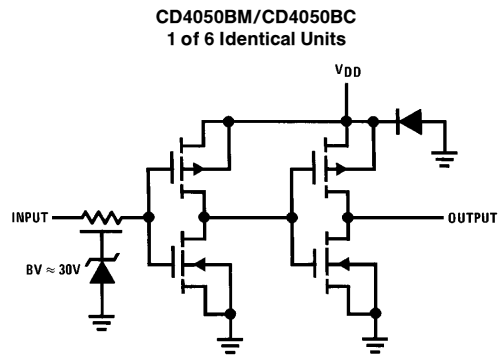
Symbol	Parameter	Conditions	Min	Typ	Max	Units
t <sub>PHL</sub>	Propagation Delay Time High-to-Low Level	V <sub>DD</sub> = 5V		60	110	ns
		V <sub>DD</sub> = 10V		25	55	ns
		V <sub>DD</sub> = 15V		20	30	ns
t <sub>PLH</sub>	Propagation Delay Time Low-to-High Level	V <sub>DD</sub> = 5V		60	120	ns
		V <sub>DD</sub> = 10V		30	55	ns
		V <sub>DD</sub> = 15V		25	45	ns
t <sub>THL</sub>	Transition Time High-to-Low Level	V <sub>DD</sub> = 5V		30	60	ns
		V <sub>DD</sub> = 10V		20	40	ns
		V <sub>DD</sub> = 15V		15	30	ns
t <sub>TLH</sub>	Transition Time Low-to-High Level	V <sub>DD</sub> = 5V		60	120	ns
		V <sub>DD</sub> = 10V		30	55	ns
		V <sub>DD</sub> = 15V		25	45	ns
C <sub>IN</sub>	Input Capacitance	Any Input		5	7.5	pF

\*AC Parameters are guaranteed by DC correlated testing.

## Schematic Diagrams

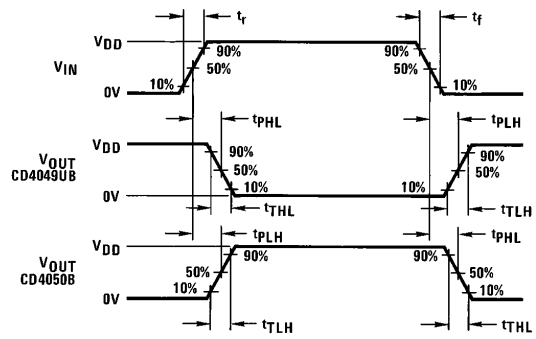


TL/F/5971-3



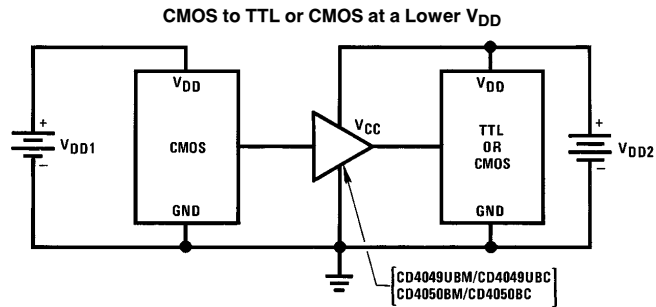
TL/F/5971-4

## Switching Time Waveforms



TL/F/5971-5

## Typical Applications

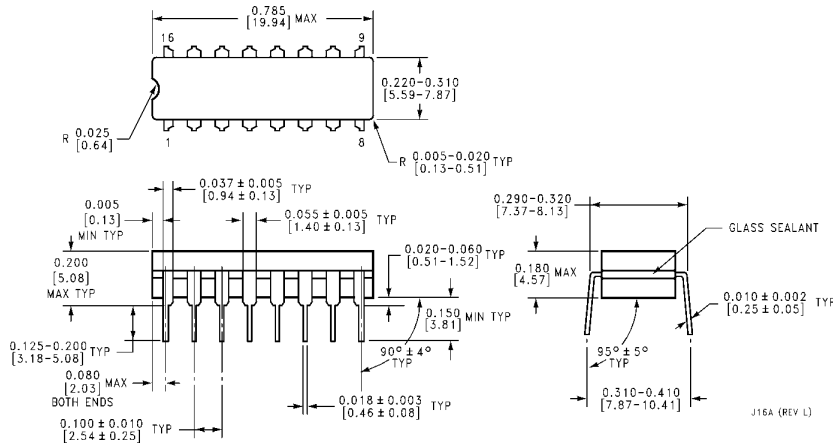


Note:  $V_{DD1} \geq V_{DD2}$

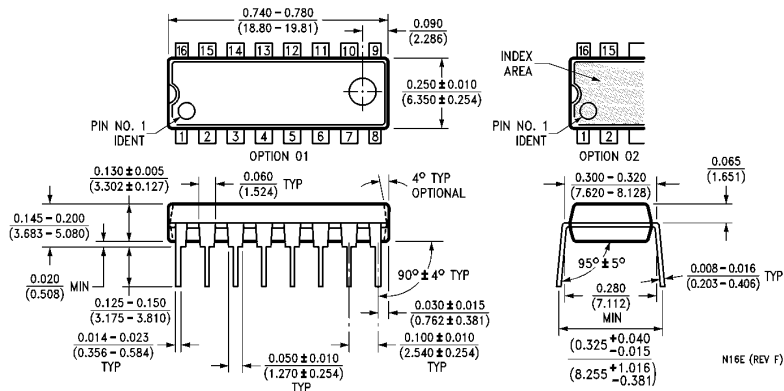
Note: In the case of the CD4049UBM/CD4049UBC the output drive capability increases with increasing input voltage. E.g., if  $V_{DD1} = 10V$  the CD4049UBM/CD4049UBC could drive 4 TTL loads.

TL/F/5971-6

**Physical Dimensions** inches (millimeters)



**Ceramic Dual-In-Line Package (J)**  
**Order Number CD4049UBMJ, CD4049UBCJ, CD4049BMJ or CD4049BCJ**  
**NS Package Number J16A**



**Molded Dual-In-Line Package (N)**  
**Order Number CD4050BMN, CD4050BCN, CD4050BMN or CD4050BCN**  
**NS Package Number N16E**

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**National Semiconductor Corporation**  
 1111 West Bardin Road  
 Arlington, TX 76017  
 Tel: 1(800) 272-9959  
 Fax: 1(800) 737-7018

**National Semiconductor Europe**  
 Fax: (+49) 0-180-530 85 86  
 Email: cnjwge@tevm2.nsc.com  
 Deutsch Tel: (+49) 0-180-530 85 85  
 English Tel: (+49) 0-180-532 78 32  
 Français Tel: (+49) 0-180-532 93 58  
 Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
 19th Floor, Straight Block,  
 Ocean Centre, 5 Canton Rd.  
 Tsimshatsui, Kowloon  
 Hong Kong  
 Tel: (852) 2737-1600  
 Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
 Tel: 81-043-299-2309  
 Fax: 81-043-299-2408

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