



# 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

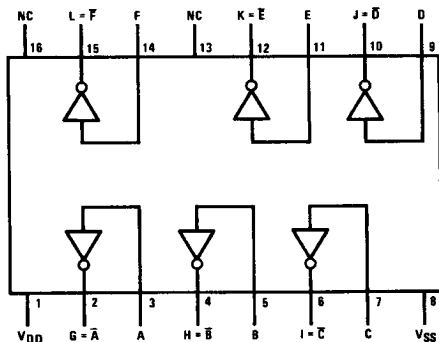
- Wide supply voltage range 3.0V to 15V
- Direct drive to 2 TTL loads at 5.0V over full temperature range
- High source and sink current capability
- Special input protection permits input voltages greater than  $V_{DD}$

## 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

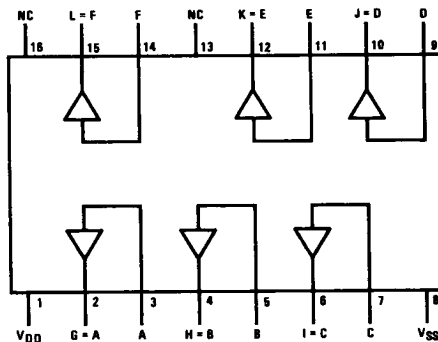


TL/F/5971-1

Top View

Order Number CD4049UB\* or CD4049B\*

CD4050BM/CD4050BC  
Dual-In-Line Package



TL/F/5971-2

Top View

Order Number CD4050UB\* or CD4050B\*

\*Please look into Section 8, Appendix D for availability of various package types.

### Absolute Maximum Ratings (Notes 1 & 2)

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

Supply Voltage (V <sub>DD</sub> )	-0.5V to +18V
Input Voltage (V <sub>IN</sub> )	-0.5V to +18V
Voltage at Any Output Pin (V <sub>OUT</sub> )	-0.5V to V <sub>DD</sub> + 0.5V
Storage Temperature Range (T <sub>S</sub> )	-65°C to +150°C
Power Dissipation (P <sub>D</sub> )	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T <sub>L</sub> )	
(Soldering, 10 seconds)	260°C

### Recommended Operating Conditions (Note 2)

Supply Voltage (V <sub>DD</sub> )	3V to 15V
Input Voltage (V <sub>IN</sub> )	0V to 15V
Voltage at Any Output Pin (V <sub>OUT</sub> )	0 to V <sub>DD</sub>
Operating Temperature Range (T <sub>A</sub> )	
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 <sub>DD</sub>	Quiescent Device Current	V <sub>DD</sub> = 5V		1.0		0.01	1.0		30	μA
		V <sub>DD</sub> = 10V		2.0		0.01	2.0		60	μA
		V <sub>DD</sub> = 15V		4.0		0.03	4.0		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>DD</sub> = 15V		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>DD</sub> = 15V	14.95		14.95	15		14.95		V
V <sub>IL</sub>	Low Level Input Voltage (CD4050BM Only)	I <sub>O</sub>   < 1 μA								
		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 (CD4049UBM Only)	I <sub>O</sub>   < 1 μA								
		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 (CD4050BM Only)	I <sub>O</sub>   < 1 μA								
		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 (CD4049UBM Only)	I <sub>O</sub>   < 1 μA								
		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
I <sub>OL</sub>	Low Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V								
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V	5.6		4.6	5		3.2		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V	12		9.8	12		6.8		mA
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 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<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 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	-1.3		-1.1	-1.6		-0.72		mA
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V	-2.6		-2.2	-3.6		-1.5		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V	-8.0		-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								
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V	4.6		4.0	5		3.2		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V	9.8		8.5	12		6.8		mA
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V	29		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								
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V	-1.0		-0.9	-1.6		-0.72		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V	-2.1		-1.9	-3.6		-1.5		mA
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V	-7.1		-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.

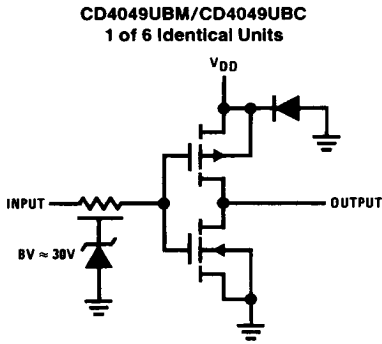
**AC Electrical Characteristics\*** CD4050BM/CD4050BC

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

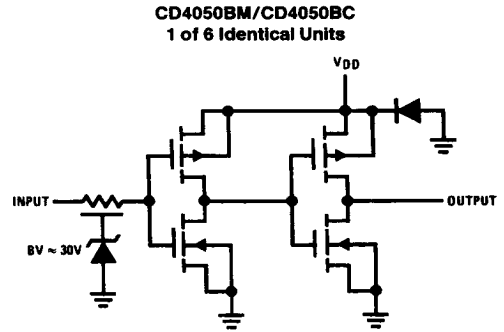
Symbol	Parameter	Conditions	Min	Typ	Max	Units
t <sub>PHL</sub>	Propagation Delay Time High-to-Low Level	V <sub>DD</sub> = 5V		60	110	ns
		V <sub>DD</sub> = 10V		25	55	ns
		V <sub>DD</sub> = 15V		20	30	ns
t <sub>PLH</sub>	Propagation Delay Time Low-to-High Level	V <sub>DD</sub> = 5V		60	120	ns
		V <sub>DD</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**

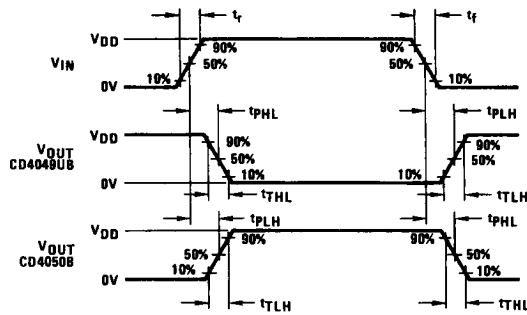


TL/F/5971-3



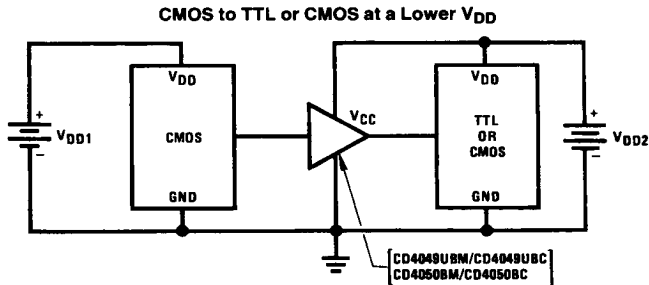
TL/F/5971-4

**Switching Time Waveforms**



TL/F/5971-5

**Typical Applications**



TL/F/5971-6

**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.