

## CMOS HEX VOLTAGE-LEVEL SHIFTER FOR TTL-TO-CMOS or CMOS-TO-CMOS OPERATION

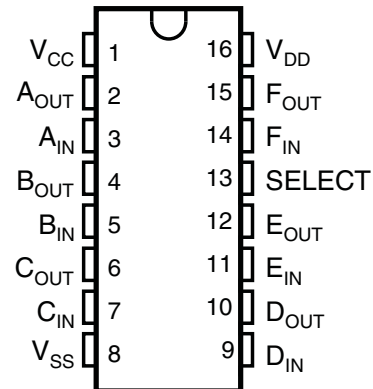
### FEATURES

- Independence of Power-Supply Sequence Considerations –  $V_{CC}$  Can Exceed  $V_{DD}$ ; Input Signals Can Exceed Both  $V_{CC}$  and  $V_{DD}$
- Up and Down Level-Shifting Capability
- Shiftable Input Threshold for Either CMOS or TTL Compatibility
- Standardized Symmetrical Output Characteristics
- 100% Tested for Quiescent Current at 20 V
- Maximum Input Current of 1  $\mu$ A at 18 V Over Full Package-Temperature Range: 100 nA at 18 V and 25°C
- 5 V, 10 V, and 15 V Parametric Ratings
- Meets All Requirements of JEDEC Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

### SUPPORTS DEFENSE, AEROSPACE, AND MEDICAL APPLICATIONS

- Controlled Baseline
- One Assembly/Test Site
- One Fabrication Site
- Available in Military (–55°C/125°C) Temperature Range<sup>(1)</sup>
- Extended Product Life Cycle
- Extended Product-Change Notification
- Product Traceability

(TOP VIEW)



(1) Additional temperature ranges are available – contact factory

### DESCRIPTION

CD4504B hex voltage level-shifter consists of six circuits which shift input signals from the  $V_{CC}$  logic level to the  $V_{DD}$  logic level. To shift TTL signals to CMOS logic levels, the SELECT input is at the  $V_{CC}$  HIGH logic state. When the SELECT input is at a LOW logic state, each circuit translates signals from one CMOS level to another.

### ORDERING INFORMATION<sup>(1)</sup>

$T_A$	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–55°C to 125°C	TSSOP – PW	Reel of 2000	CD4504BMPWREP	4504BEP

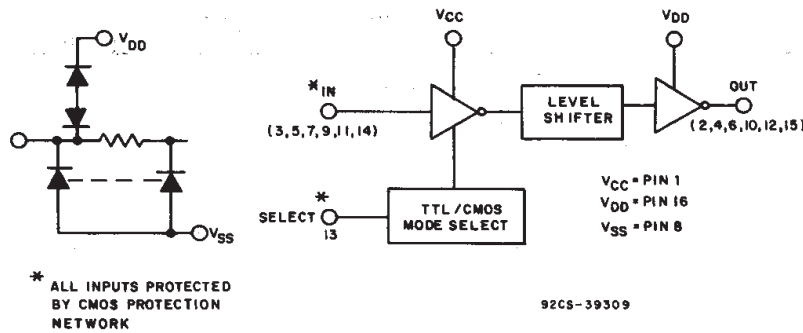
(1) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).



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**FUNCTIONAL BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS**

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT	
$V_{DD}$	DC supply-voltage range, voltages referenced to $V_{SS}$ terminal	-0.5	+20	V	
	Input voltage range, all inputs	-0.5	$V_{CC} + 0.5$	V	
	DC input current, any one input		$\pm 10$	mA	
$P_D$	Power dissipation per package	$T_A = -55^\circ\text{C to } +100^\circ\text{C}$		500	mW
		$T_A = +100^\circ\text{C to } +125^\circ\text{C}$		Derate Linearly at 12 mW/°C to 200 nW	
	Device dissipation per output transistor, for $T_A =$ full package-temperature range (all package types)		100	mW	
$T_A$	Operating temperature range	-55	+125	°C	
$\theta_{JA}$	Package thermal impedance <sup>(1)</sup>		91.1	°C/W	
$T_{stg}$	Storage temperature range	-85	+150	°C	
	Lead temperature (during soldering), at distance $1/16 \pm 1/32$ inch ( $1.59 \pm 0.79$ mm) from case for 10 s max		+265	°C	

(1) The package thermal impedance is calculated in accordance with JESD 51-7.

**STATIC ELECTRICAL CHARACTERISTICS**

over operating free-air temperature range (unless otherwise noted)

CHARACTERISTIC	CONDITIONS				LIMITS AT INDICATED TEMPERATURES (°C)							UNIT	
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>CC</sub> (V)	V <sub>CC</sub> (V)	-55	-40	+85	+125	+25				
									MIN	TYP	MAX		
Quiescent device current, I <sub>DD</sub> max and I <sub>CC</sub> in CMOS-CMOS mode		0, 5	5	5	1.5	1.5	1.5	1.5		0.02	1.5	mA	
		0, 10	5	10	2	2	2	2		0.02	2		
		0, 15	5	15	4	4	120	120		0.02	4	μA	
		0, 20	5	20	20	20	600	600		0.04	20		
Quiescent device current, I <sub>CC</sub> max TTL-CMOS mode		0, 5	5	5	5	5	6	6		2.5	5	mA	
		0, 10	5	10	5	5	6	6		2.5	5		
		0, 15	5	15	5	5	6	6		2.5	5		
Output low (sink) current, I <sub>OL</sub> min	0.4	0, 5		5	0.64	0.61	0.42	0.36	0.51	1		mA	
	0.5	0, 10		10	1.6	1.5	1.1	0.9	1.3	2.6			
	1.5	0, 15		15	4.2	4	2.8	2.4	3.4	6.8			
Output high (source) current, I <sub>OH</sub> min	4.6	0, 5		5	-0.64	-0.61	-0.42	-0.36	-0.51	-1		mA	
	2.5	0, 5		5	-2	-1.8	-1.3	-1.15	-1.6	-3.2			
	9.5	0, 10		10	-1.6	-1.5	-1.1	-0.9	-1.3	-2.6			
	13.5	0, 15		15	-4.2	-4	-2.8	-2.4	-3.4	-6.8			
Output voltage: low-level, V <sub>OL</sub> max		0, 5		5	0.05					0	0.05	V	
		0, 10		10	0.05					0	0.05		
		0, 15		15	0.05					0	0.05		
Output voltage: high-level, V <sub>OH</sub> min		0, 5		5	4.95				4.95	5		V	
		0, 10		10	9.95				9.95	10			
		0, 15		15	14.95				14.95	15			
Input low voltage, V <sub>IL</sub> max <sup>(1)</sup>	TTL-CMOS	1		5	10	0.8						0.8	V
	TTL-CMOS	1		5	15	0.8						0.8	
	CMOS-CMOS	1		5	10	1.5						1.5	
	CMOS-CMOS	1.5		5	15	1.5						1.5	
	CMOS-CMOS	1.5		10	15	3						3	
Input high voltage, V <sub>IH</sub> min <sup>(1)</sup>	TTL-CMOS	9		5	10	2				2			V
	TTL-CMOS	13.5		5	15	2				2			
	CMOS-CMOS	9		5	10	3.5				3.5			
	CMOS-CMOS	13.5		5	15	3.5				3.5			
	CMOS-CMOS	13.5		10	15	7				7			
Input current, I <sub>IN</sub> max		0, 18		18	±0.1	±0.1	±1	±1		±10 <sup>-5</sup>	±0.1	μA	

(1) Applies to the six input signals. For mode control (P13), only the CMOS-CMOS ratings apply.

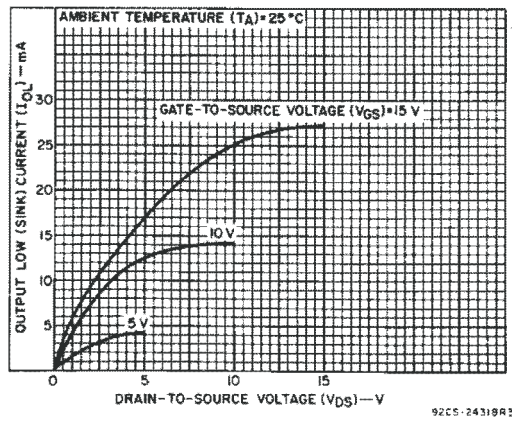


Figure 1. Typical Output Low (sink) Current Characteristics

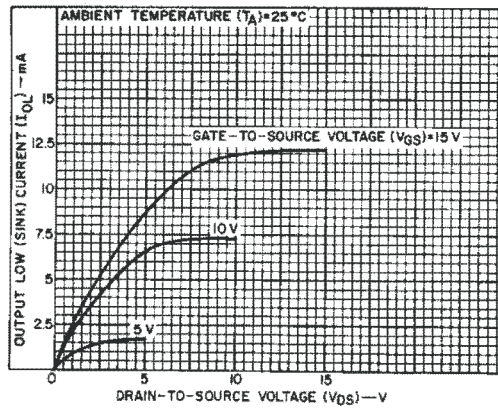


Figure 2. Minimum Output Low (sink) Current Characteristics

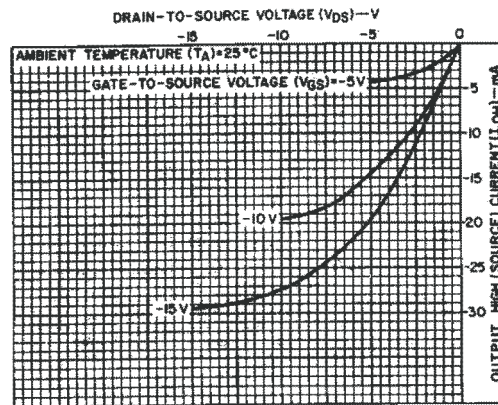


Figure 3. Typical Output High (source) Current Characteristics

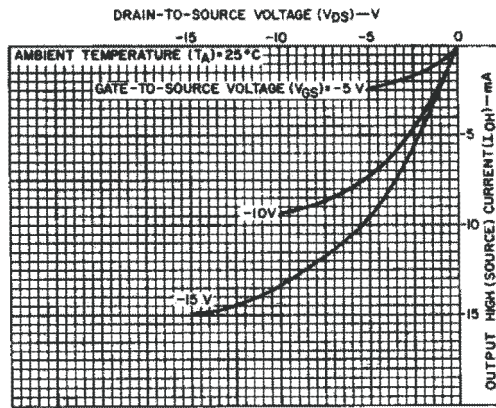


Figure 4. Minimum Output High (source) Current Characteristics

**RECOMMENDED OPERATING CONDITIONS**

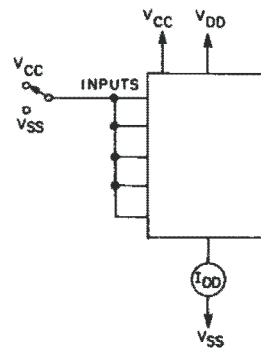
For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC		MIN	MAX	UNIT
V <sub>DD</sub>	Supply-voltage range (for T <sub>A</sub> = full package temperature range)	5	18	V

**DYNAMIC ELECTRICAL CHARACTERISTICS**

T<sub>A</sub> = 25°C, Input t<sub>r</sub>, t<sub>f</sub> = 20 ns, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200 Ω

CHARACTERISTIC	SHIFTING MODE	V <sub>CC</sub> (V)	V <sub>DD</sub> (V)	LIMITS		UNIT		
				TYP	MAX			
t <sub>PHL</sub> Propagation delay: high-to-low,	TTL to CMOS V <sub>DD</sub> > V <sub>CC</sub>	5	10	140	280	ns		
		5	15	140	280			
	CMOS to CMOS V <sub>DD</sub> > V <sub>CC</sub>	5	10	120	240			
		5	15	120	240			
	CMOS to CMOS V <sub>CC</sub> > V <sub>DD</sub>	10	15	70	140			
		10	5	275	550			
		15	5	275	550			
	t <sub>PLH</sub> Propagation delay: low-to-high	TTL to CMOS V <sub>DD</sub> > V <sub>CC</sub>	5	10	140		280	ns
			5	15	140		280	
CMOS to CMOS V <sub>DD</sub> > V <sub>CC</sub>		5	10	120	240			
		5	15	120	240			
CMOS to CMOS V <sub>CC</sub> > V <sub>DD</sub>		10	15	70	140			
		10	5	200	400			
		15	5	200	400			
t <sub>THL</sub> , t <sub>TLH</sub> Transition time		All modes		5	100	200	ns	
				10	50	100		
	15			40	80			
C <sub>IN</sub> Input capacitance	Any input			5	7.5	pF		



**Figure 5. Quiescent Device Current**

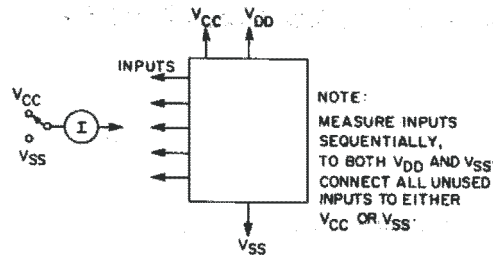


Figure 6. Input Current

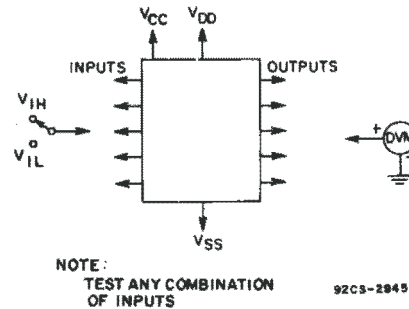


Figure 7. Input Voltage

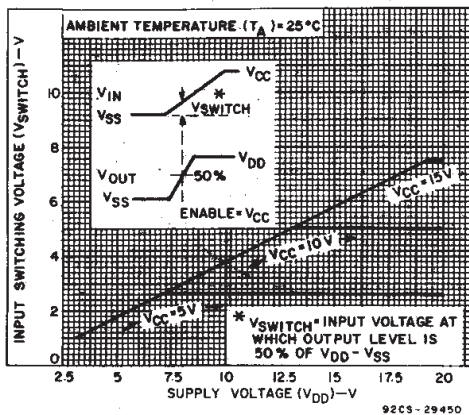


Figure 8. Typical Input Switching as a Function of High-Level Supply Voltage (SELECT at  $V_{CC}$  – CMOS Mode)

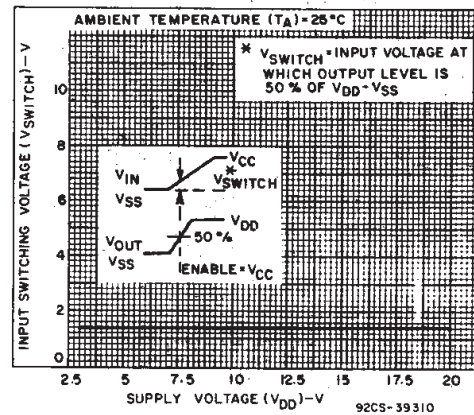


Figure 9. Typical Input Switching as a Function of High-Level Supply Voltage (SELECT at  $V_{SS}$  – TTL Mode)

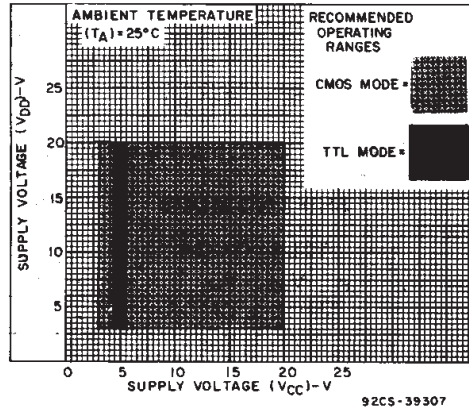
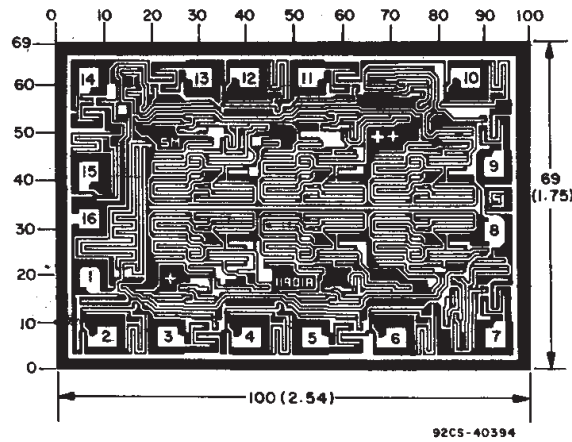


Figure 10. High-Level Supply Voltage vs. Low-Level Supply Voltage



- A. Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

Figure 11. Dimensions and Pad Layout



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
CD4504BMPWREP	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
V62/09606-01XE	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**OTHER QUALIFIED VERSIONS OF CD4504B-EP :**

- Catalog: [CD4504B](#)
- Military: [CD4504B-MIL](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CD4504BMPWREP	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD4504BMPWREP	TSSOP	PW	16	2000	346.0	346.0	29.0

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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