

CMOS Hex Buffers/Converters

High-Voltage Types (20-Volt Rating)

Inverting Type: CD4009UB

Non-Inverting Type: CD4010B

■ CD4009UB and CD4010B Hex Buffer/Converters may be used as CMOS to TTL or DTL logic-level converters or CMOS high-sink-current drivers.

The CD4049UB and CD4050B are preferred hex buffer replacements for the CD4009UB and CD4010B, respectively, in all applications except multiplexers. For applications not requiring high sink current or voltage conversion, the CD4069UB Hex Inverter is recommended.

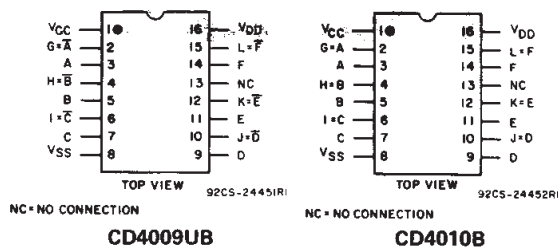
The CD4009UB and CD4010B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (M, M96, MT, and NSR suffixes), and 16-lead thin shink small-outline packages (PW and PWR suffixes).

Features:

- 100% tested for quiescent current at 20 V
- Maximum input current of 1 μ 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

Applications:

- CMOS to DTL/TTL hex converter
- CMOS current “sink” or “source” driver
- CMOS high-to-low logic-level converter
- Multiplexer — 1 to 6 or 6 to 1



TERMINAL ASSIGNMENTS

MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V_{DD})

Voltages referenced to V_{SS} Terminal) -0.5V to +20V

INPUT VOLTAGE RANGE, ALL INPUTS -0.5V to V_{DD} +0.5V

DC INPUT CURRENT, ANY ONE INPUT ± 10 mA

POWER DISSIPATION PER PACKAGE (P_D):

For $T_A = -55^\circ\text{C}$ to $+100^\circ\text{C}$ 500mW

For $T_A = +100^\circ\text{C}$ to $+125^\circ\text{C}$ Derate Linearly at 12mW/ $^\circ\text{C}$ to 200mW

DEVICE DISSIPATION PER OUTPUT TRANSISTOR

FOR $T_A = \text{FULL PACKAGE-TEMPERATURE RANGE (All Package Types)}$ 100mW

OPERATING-TEMPERATURE RANGE (T_A) -55°C to $+125^\circ\text{C}$

STORAGE TEMPERATURE RANGE (T_{stg}) -65°C to $+150^\circ\text{C}$

LEAD TEMPERATURE (DURING SOLDERING):

At distance 1/16 \pm 1/32 inch (1.59 \pm 0.79mm) from case for 10s max $+265^\circ\text{C}$

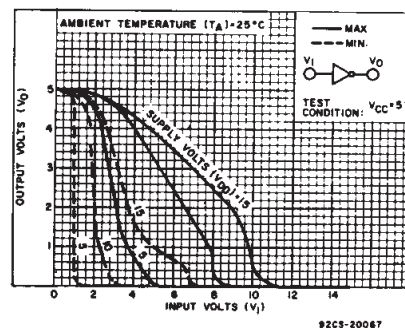
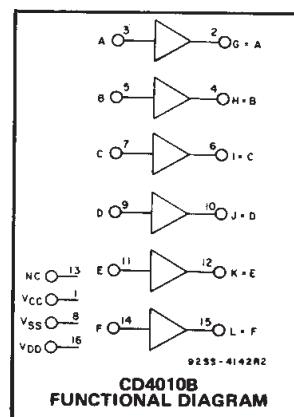
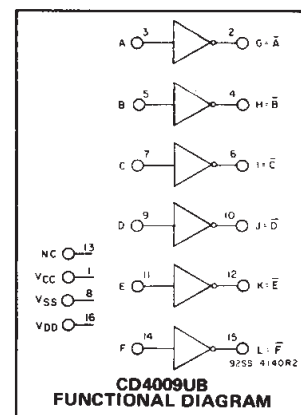


Fig. 3 – Minimum and maximum voltage transfer characteristics—CD4009UB.

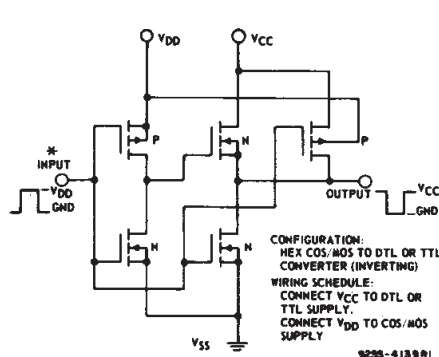


Fig. 1 – Schematic diagram of CD4009UB—1 of 6 identical stages.

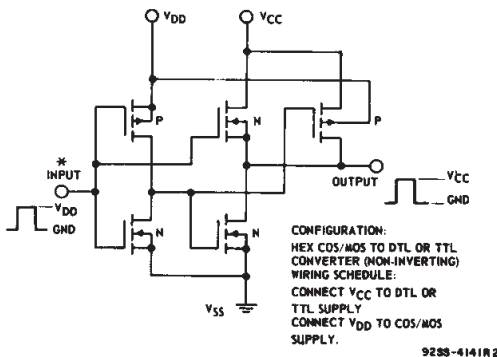
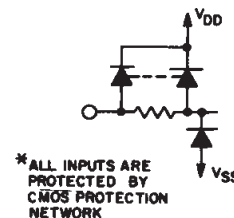


Fig. 2 – Schematic diagram of CD4010B—1 of 6 identical stages.



CD4009UB, CD4010B Types

RECOMMENDED OPERATING CONDITIONS

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

CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range (For T_A = Full Package Temperature Range), V_{DD}	3	18	V
V_{CC}^*	3	V_{DD}	
Input Voltage Range (V_I)	V_{CC}^*	V_{DD}	V

*The CD4009UB and CD4010B have high-to-low level voltage conversion capability but not low-to-high level, therefore it is recommended that $V_{DD} > V_I > V_{CC}$.

STATIC ELECTRICAL CHARACTERISTICS

CHARAC- TERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)								UNITS
	V _O (V)	V _{IN} (V)	V _{DD} (V)	-55	-40	+85	+125	+25				
								Min.	Typ.	Max.		
Quiescent Device Current, I _{DD} Max.	—	0,5	5	1	1	30	30	—	0.02	1	μA	
	—	0,10	10	2	2	60	60	—	0.02	2		
	—	0,15	15	4	4	120	120	—	0.02	4		
	—	0,20	20	20	20	600	600	—	0.04	20		
Output Low (Sink) Current I _{OL} Min.	0.4	0,5	4.5	3.2	3.1	2.1	1.8	2.6	3.4	—	mA	
	0.4	0,5	5	3.75	3.6	2.4	2.1	3	4	—		
	0.5	0,10	10	10	9.6	6.4	5.6	8	10	—		
	1.5	0,15	15	30	40	19	16	24	36	—		
Output High (Source) Current I _{OH} Min.	4.6	0,5	5	-0.25	-0.23	-0.18	-0.15	-0.2	-0.4	—	mA	
	2.5	0,5	5	-1	-0.9	-0.65	-0.58	-0.8	-1.6	—		
	9.5	0,10	10	-0.55	-0.5	-0.38	-0.33	-0.45	-0.9	—		
	13.5	0,15	15	-1.65	-1.6	-1.25	-1.1	-1.5	-3	—		
Output Voltage: Low-Level, V _{OL} 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 _{OH} 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 _{IL} Max. CD4009UB	4.5	—	5	1				—	—	1	V	
	9	—	10	2				—	—	2		
	13.5	—	15	2.5				—	—	2.5		
Input Low Voltage: V _{IL} Max. CD4010B	0.5	—	5	1.5				—	—	1.5	V	
	1	—	10	3				—	—	3		
	1.5	—	15	4				—	—	4		
Input High Voltage: V _{IH} Min. CD4009UB	0.5	—	5	4				4	—	—	V	
	1	—	10	8				8	—	—		
	1.5	—	15	12.5				12.5	—	—		
Input High Voltage: V _{IH} Min. CD4010B	4.5	—	5	3.5				3.5	—	—	V	
	9	—	10	7				7	—	—		
	13.5	—	15	11				11	—	—		
Input Current, I _{IN} Max.	—	0,18	18	±0.1	±0.1	±1	±1	—	±10 ⁻⁵	±0.1	μA	

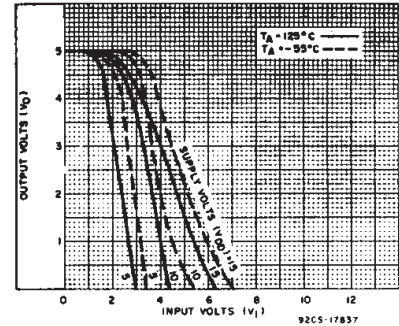


Fig. 4 — Typical voltage transfer characteristics as function of temp.—CD4009UB.

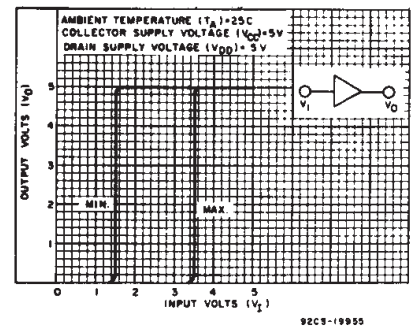


Fig. 5 — Minimum and maximum voltage transfer characteristics ($V_{DD}=5$)—CD4010B.

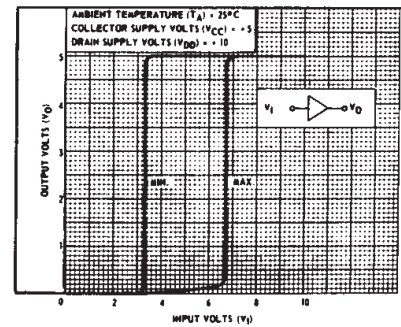


Fig. 6 — Minimum and maximum voltage transfer characteristics ($V_{DD}=10$)—CD4010B.

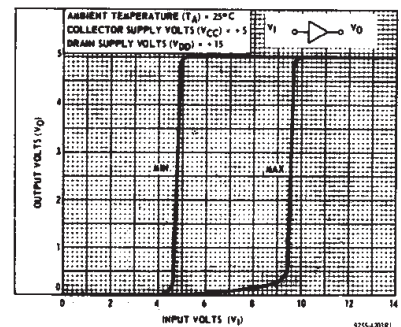


Fig. 7 — Minimum and maximum voltage transfer characteristics ($V_{DD}=15$)—CD4010B.

CD4009UB, CD4010B Types

DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A=25^\circ\text{C}$; Input $t_r, t_f=20\text{ ns}$,
 $C_L=50\text{ pF}$, $R_L=200\text{ K}\Omega$

CHARACTERISTIC	CONDITIONS			LIMITS ALL PKGS		UNIT
	V_{DD} (V)	V_I (V)	V_{CC} (V)	TYP.	MAX.	
Propagation Delay Time: Low-to-High, t_{PLH}	5	5	5	70	140	ns
	10	10	10	40	80	
	10	10	5	35	70	
	15	15	15	30	60	
	15	15	5	30	60	
CD4010B	5	5	5	100	200	ns
	10	10	10	50	100	
	10	10	5	50	100	
	15	15	15	35	70	
	15	15	5	35	70	
High-to-Low, t_{PHL}	5	5	5	30	60	ns
	10	10	10	20	40	
	10	10	5	15	30	
	15	15	15	15	30	
	15	15	5	10	20	
CD4010B	5	5	5	65	130	ns
	10	10	10	35	70	
	10	10	5	30	70	
	15	15	15	25	50	
	15	15	5	20	40	
Transition Time: Low-to-High, t_{TLH}	5	5	5	150	350	ns
	10	10	10	75	150	
	15	15	15	55	110	
High-to-Low, t_{THL}	5	5	5	35	70	ns
	10	10	10	20	40	
	15	15	15	15	30	
Input Capacitance, C_{IN}						pF
CD4009UB	—	—	—	15	22.5	
CD4010B	—	—	—	5	7.5	

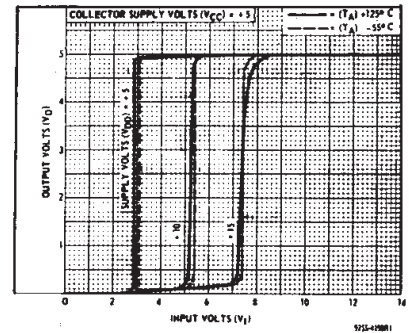


Fig. 8 — Typical voltage transfer characteristics as a function of temperature—CD4010B.

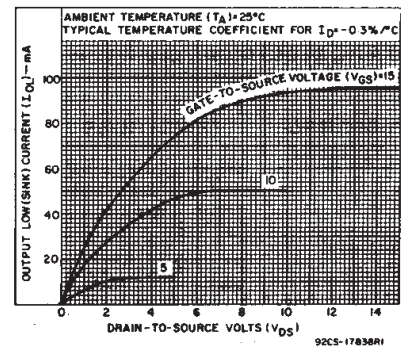


Fig. 9 — Typical output low (sink) current characteristics.

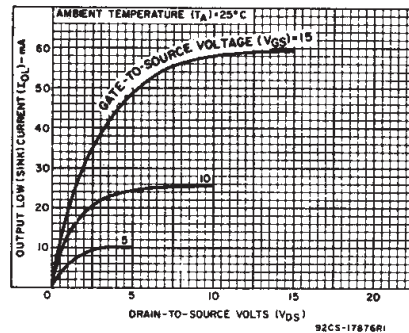


Fig. 10 — Minimum output low (sink) current characteristics.

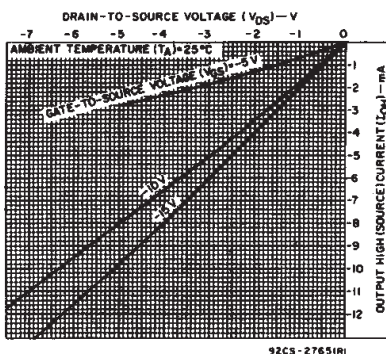


Fig. 11 — Typical output high (source) current characteristics.

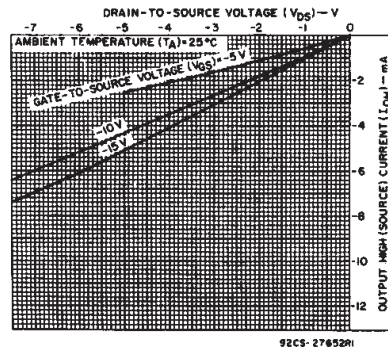


Fig. 12 — Minimum output high (source) current characteristics.

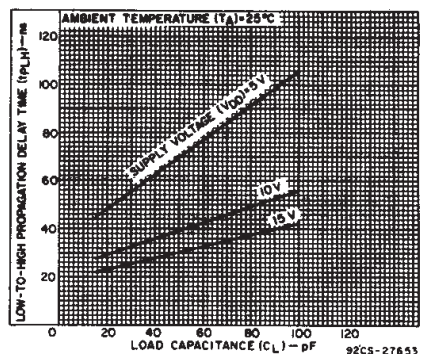


Fig. 13 — Typical low-to-high propagation time vs. load capacitance (CD4009UB).

CD4009UB, CD4010B Types

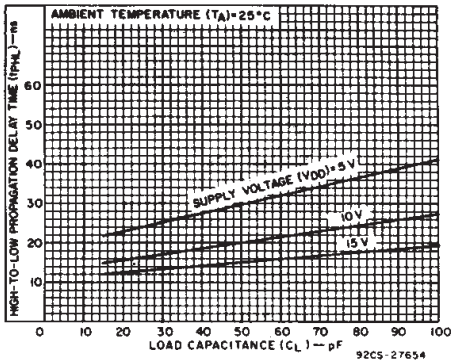


Fig. 14 - Typical high-to-low propagation delay time vs. load capacitance (CD4009UB).

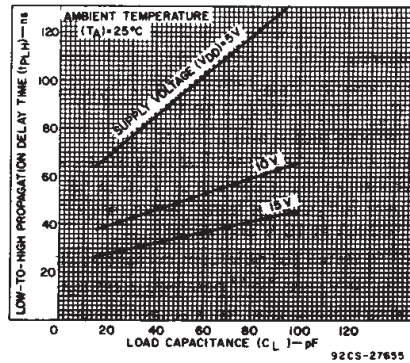


Fig. 15 - Typical low-to-high propagation delay time vs. load capacitance (CD4010B).

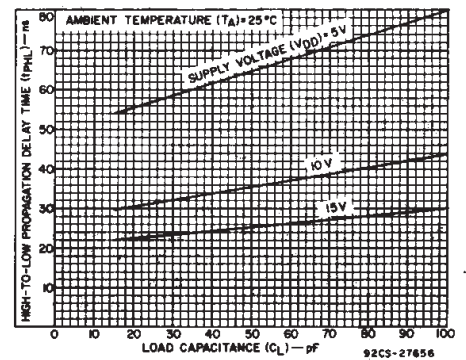


Fig. 16 - Typical high-to-low propagation delay time vs. load capacitance (CD4010B).

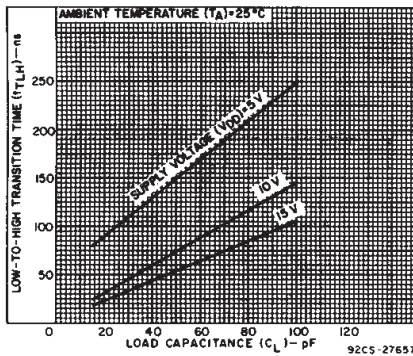


Fig. 17 - Typical low-to-high transition time vs. load capacitance.

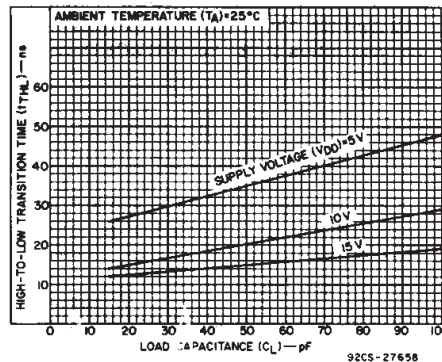


Fig. 18 - Typical high-to-low transition time vs. load capacitance.

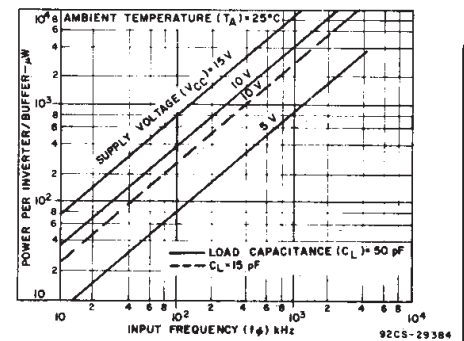


Fig. 19 - Typical dissipation characteristics.

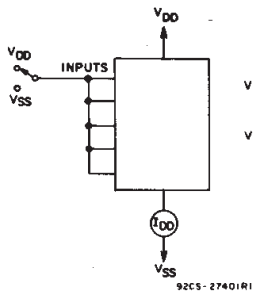


Fig. 20 - Quiescent device current test circuit.

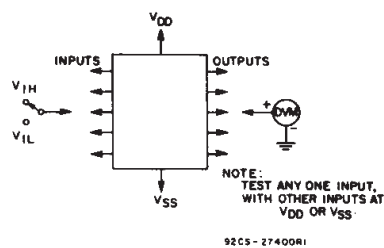


Fig. 21 - Noise immunity test circuit.

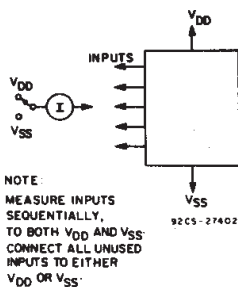
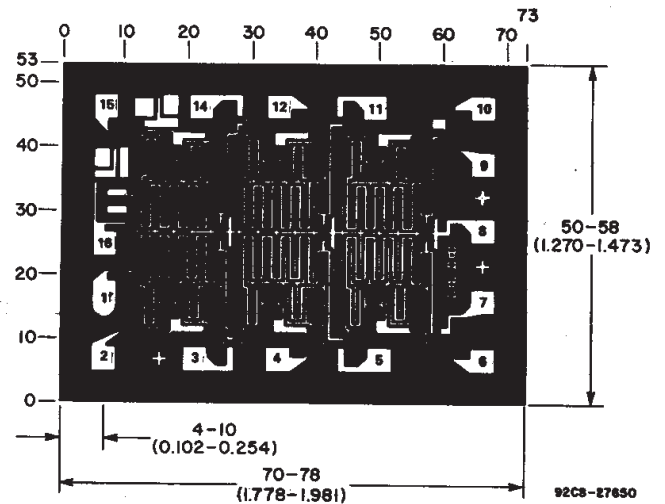


Fig. 22 - Input current test circuit.



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid Graduations Are In Mils (10⁻³ Inch)

Photograph of chip for CD4009UB. Dimensions and pad layout for CD4010B are identical.

3
COMMERCIAL CMOS
HIGH VOLTAGE ICs

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
89264UKB3T	OBSOLETE	CFP	WR	16		None	Call TI	Call TI
CD4009UBE	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD4009UBF	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD4009UBF3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD4009UBM	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4009UBM96	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4009UBMT	ACTIVE	SOIC	D	16	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4009UBNSR	ACTIVE	SO	NS	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4009UBPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD4009UBPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD4010BE	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD4010BF	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD4010BF3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD4010BM	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4010BM96	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4010BMT	ACTIVE	SOIC	D	16	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4010BNSR	ACTIVE	SO	NS	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4010BPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD4010BPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM

⁽¹⁾ 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.

⁽²⁾ Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

None: Not yet available Lead (Pb-Free).

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.

Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

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

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J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



PINS ** DIM	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package is hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

N (R-PDIP-T**)

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



PINS ** DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-001 VARIATION	AA	BB	AC	AD



4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 -  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 -  The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-4/F 07/2004

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

- 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.

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- 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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