

# CD40109B Types

## CMOS Quad Low-to-High Voltage Level Shifter

### High-Voltage Types (20-Volt Rating)

■ CD40109B contains four low-to-high-voltage level-shifting circuits. Each circuit will shift a low-voltage digital-logic input signal (A, B, C, D) with logical 1 =  $V_{CC}$  and logical 0 =  $V_{SS}$  to a higher-voltage output signal (E, F, G, H) with logical 1 =  $V_{DD}$  and logical 0 =  $V_{SS}$ .

The CD40109, unlike other low-to-high level-shifting circuits, does not require the presence of the high-voltage supply ( $V_{DD}$ ) before the application of either the low-voltage supply ( $V_{CC}$ ) or the input signals. There are no restrictions on the sequence of application of  $V_{DD}$ ,  $V_{CC}$ , or the input signals. In addition, with one exception there are no restrictions on the relative magnitudes of the supply voltages or input signals within the device maximum ratings, provided that the input signal swings between  $V_{SS}$  and at least 0.7  $V_{CC}$ ;  $V_{CC}$  may exceed  $V_{DD}$ , and input signals may exceed  $V_{CC}$  and  $V_{DD}$ . When operated in the mode  $V_{CC} > V_{DD}$ , the CD40109 will operate as a high-to-low level-shifter.

The CD40109 also features individual three-state output capability. A low level on any of the separately enabled three-state output controls produces a high-impedance-state in the corresponding output.

The CD40109B-Series types are supplied in 16-lead ceramic dual-in-line packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

### Applications:

- High-or-low level-shifting with three-state outputs for unidirectional or bidirectional bussing
- Isolation of logic subsystems using separate power supplies from supply sequencing, supply loss and supply regulation considerations

### 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
- Three-state outputs with separate enable controls
- 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
- Noise margin (full package-temperature range)
  - = 1 V at  $V_{CC} = 5 V$ ,  $V_{DD} = 10 V$
  - = 2 V at  $V_{CC} = 10 V$ ,  $V_{DD} = 15 V$
- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

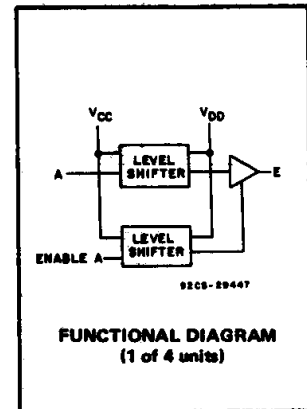
### RECOMMENDED OPERATING CONDITIONS

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)	3	18	V

### MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, ( $V_{DD}$ )	..... -0.5V to +20V
Voltages referenced to $V_{SS}$ Terminal)	..... -0.5V to $V_{DD} + 0.5 V$
OUTPUT VOLTAGE RANGE, ALL OUTPUTS	..... -0.5 V to $V_{DD} + 0.5 V$
DC INPUT CURRENT, ANY ONE INPUT	..... $\pm 10mA$
POWER DISSIPATION PER PACKAGE ( $P_D$ ):	
For $T_A = -55^\circ C$ to $+100^\circ C$	..... 500mW
For $T_A = +100^\circ C$ to $+125^\circ C$	..... Derate Linearly at 12mW/ $^\circ C$ to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR $T_A =$ FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	..... 100mW
OPERATING-TEMPERATURE RANGE ( $T_A$ )	..... $-55^\circ C$ to $+125^\circ C$
STORAGE TEMPERATURE RANGE ( $T_{stg}$ )	..... $-65^\circ C$ to $+150^\circ C$
LEAD TEMPERATURE (DURING SOLDERING):	
At distance $1/16 \pm 1/32$ inch ( $1.59 \pm 0.79mm$ ) from case for 10s max	..... $+265^\circ C$



INPUTS		OUTPUTS
A, B, C, D	ENABLE A, B, C, D	E, F, G, H
0	1	0
1	1	1
X	0	Z

LOGIC 0 = LOW ( $V_{SS}$ )    X = DON'T CARE    Z = HIGH IMPEDANCE  
LOGIC 1 =  $V_{CC}$  at INPUTS and  $V_{DD}$  at OUTPUTS

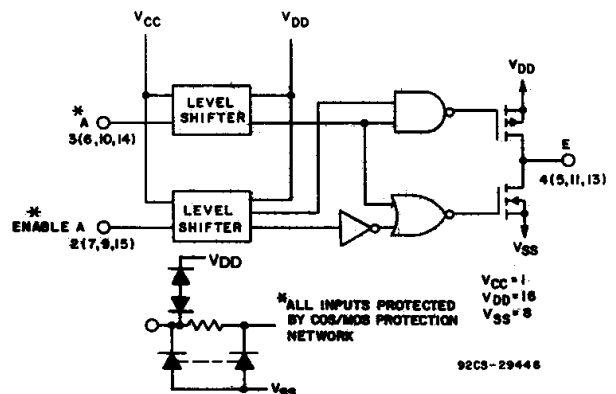


Fig. 1 – CD40109B logic diagram (1 of 4 units).

# CD40109B Types

## STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)	-55	-40	+85	+125	+25			
								Min.	Typ.	Max.	
Quiescent Device Current, I <sub>DD</sub> 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 <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 Current I <sub>IN</sub> Max.		0,18	18	±0.1	±0.1	±1	±1	-	±10 <sup>-5</sup>	±0.1	μA
3-State Output Leakage Current I <sub>OUT</sub> Max.		0,18	18	±0.4	±0.4	±12	±12	-	±10 <sup>-4</sup>	±0.4	μA
	V <sub>O</sub> (V)	V <sub>CC</sub> (V)	V <sub>DD</sub> (V)								
Input Low Voltage, V <sub>IL</sub> Max.	1,9	5	10	1.5				-	-	1.5	V
	1.5, 13.5	10	15	3				-	-	3	
Input High Voltage, V <sub>IH</sub> Min.	1,9	5	10	3.5				3.5	-	-	V
	1.5, 13.5	10	15	7				7	-	-	

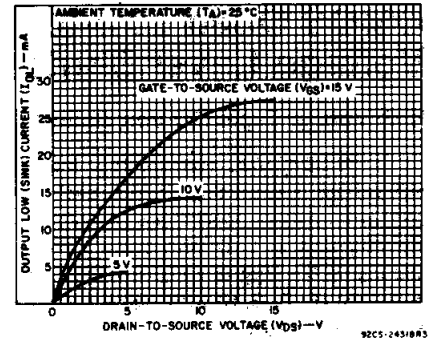


Fig.2 - Typical output low (sink) current characteristics.

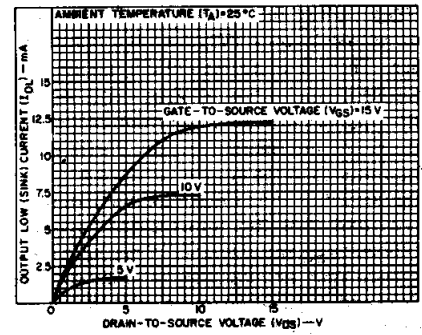


Fig.3 - Minimum output low (sink) current characteristics.

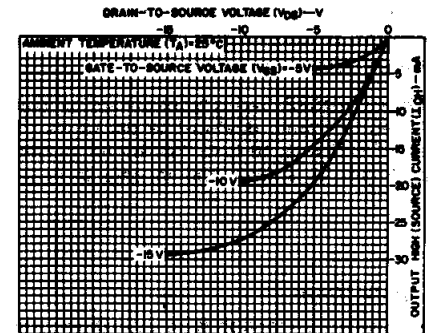


Fig.4 - Typical output high (source) current characteristics.

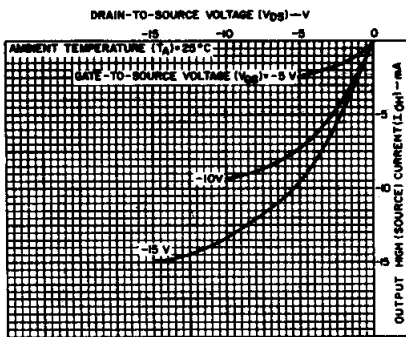


Fig.5 - Minimum output high (source) current characteristics.

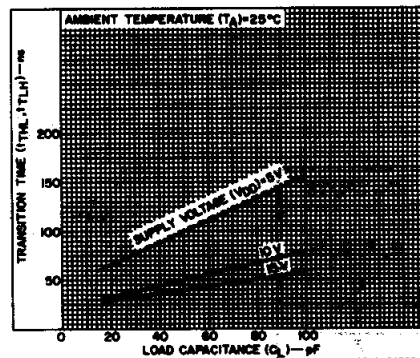


Fig.6 - Typical transition time as a function of load capacitance.

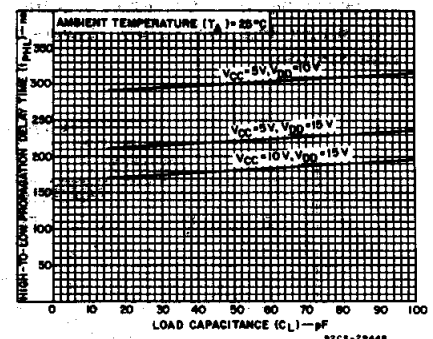


Fig.7 - Typical high-to-low propagation delay time as a function of load capacitance.

# CD40109B Types

**DYNAMIC ELECTRICAL CHARACTERISTICS** at  $T_A = 25^\circ\text{C}$ , Input  $t_r, t_f = 20 \text{ ns}$ ,  $C_L = 50 \text{ pF}$ ,  $R_L = 200 \text{ k}\Omega$  unless otherwise specified

CHARACTERISTIC	SHIFTING MODE	VCC (V)	VDD (V)	LIMITS		UNITS
				Typ.	Max.	
Propagation Delay – Data Input to Output: High-to-Low Level, $t_{pHL}$	L–H	5	10	300	600	ns
		5	15	220	440	
		10	15	180	360	
	H–L	10	5	250	500	
		15	5	250	500	
		15	10	120	240	
Low-to-High Level, $t_{pLH}$	L–H	5	10	130	260	ns
		5	15	120	240	
		10	15	70	140	
	H–L	10	5	230	460	
		15	5	230	460	
		15	10	80	160	
3-State Disable Delay: $R_L = 1 \text{ k}\Omega$ Output High to High Impedance, $t_{pHZ}$	L–H	5	10	60	120	ns
		5	15	75	150	
		10	15	35	70	
	H–L	10	5	200	400	
		15	5	200	400	
		15	10	40	80	
Output Low to High Impedance, $t_{pLZ}$	L–H	5	10	370	740	ns
		5	15	300	600	
		10	15	250	500	
	H–L	10	5	250	500	
		15	5	250	500	
		15	10	130	260	
High Impedance to Output High, $t_{pZH}$	L–H	5	10	320	640	ns
		5	15	230	460	
		10	15	180	360	
	H–L	10	5	300	600	
		15	5	300	600	
		15	10	130	260	
High Impedance to Output Low, $t_{pZL}$	L–H	5	10	100	200	ns
		5	15	80	160	
		10	15	40	80	
	H–L	10	5	200	400	
		15	5	200	400	
		15	10	40	80	
Transition Time, $t_{THL}, t_{TLH}$	L–H	5	10	50	100	ns
		5	15	40	80	
		10	15	40	80	
	H–L	10	5	100	200	
		15	5	100	200	
		15	10	50	100	
Input Capacitance, $C_i$		Any Input		5	7.5	pF

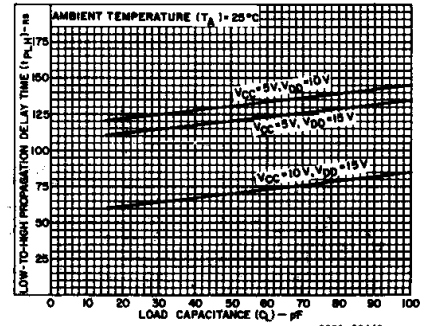


Fig. 8 – Typical low-to-high propagation delay time as a function of load capacitance.

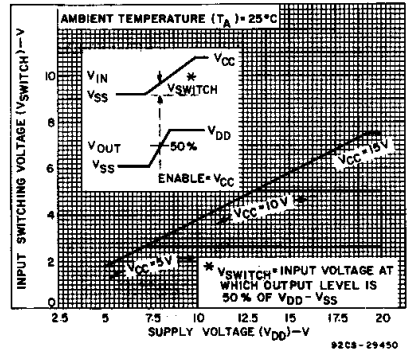


Fig. 9 – Typical input switching as a function of high-level supply voltage.

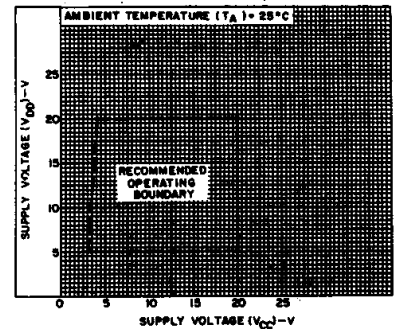


Fig. 10 – High-level supply voltage vs. low-level supply voltage.

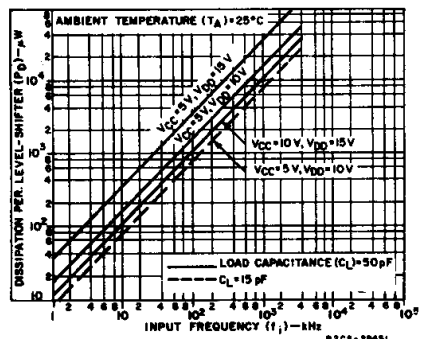


Fig. 11 – Typical dynamic power dissipation as a function of input frequency.

3  
COMMERCIAL CMOS  
HIGH VOLTAGE ICs

# CD40109B Types

## TEST CIRCUITS

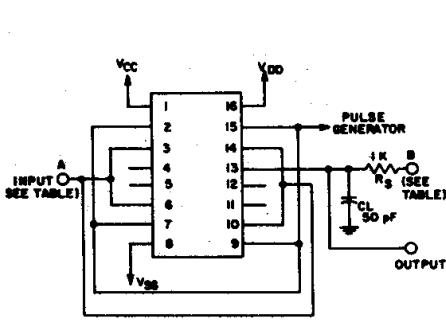
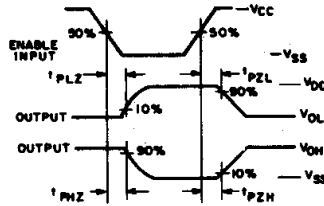


Fig. 12 - Output enable delay times test circuit and waveforms.

CHAR.	TEST VOLTAGE	
	AT A	AT B
1PHZ	V <sub>CC</sub>	V <sub>SS</sub>
1PLZ	V <sub>SS</sub>	V <sub>DD</sub>
1PZH	V <sub>SS</sub>	V <sub>SS</sub>
1PZH	V <sub>CC</sub>	V <sub>SS</sub>



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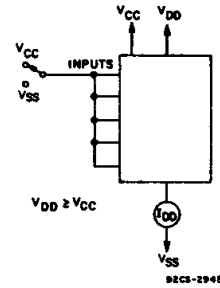


Fig. 13 - Quiescent device current.

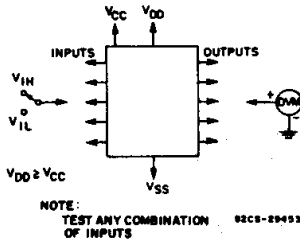


Fig. 14 - Input voltage.

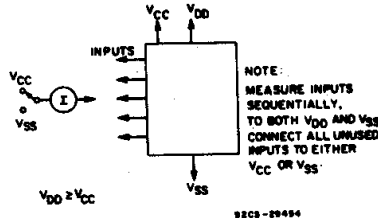


Fig. 15 - Input current.

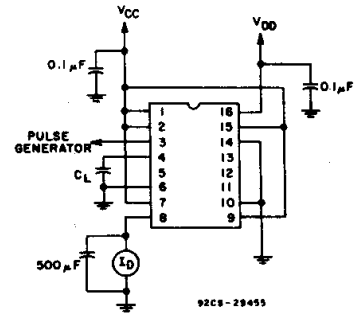
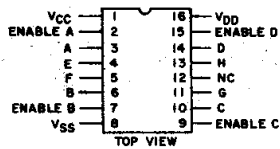
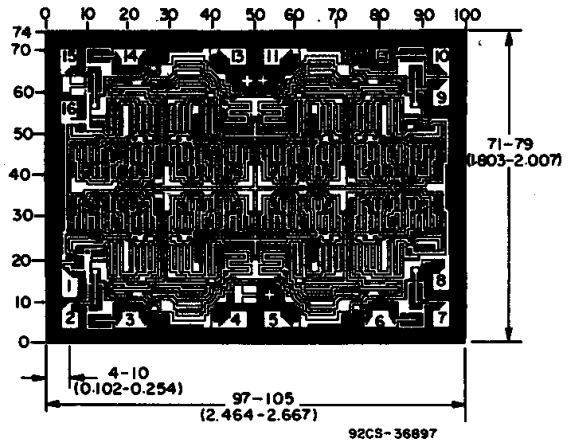


Fig. 16 - Dynamic power dissipation test circuit.



### CD40109B TERMINAL ASSIGNMENT

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



Dimensions and pad layout for CD40109BH.

**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>
CD40109BE	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD40109BF	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD40109BF3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD40109BNSR	ACTIVE	SO	NS	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD40109BPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD40109BPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-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.

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

<sup>(2)</sup> 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.

<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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J (R-GDIP-T\*\*)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



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

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- 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.

# MECHANICAL DATA

NS (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.



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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