

# 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, ( $V_{DD}$ )	Voltages referenced to $V_{SS}$ Terminal)	–0.5V to +20V
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/°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°C to $+125^\circ C$
STORAGE TEMPERATURE RANGE ( $T_{stg}$ )		–65°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		$+265^\circ C$

TRUTH TABLE		
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

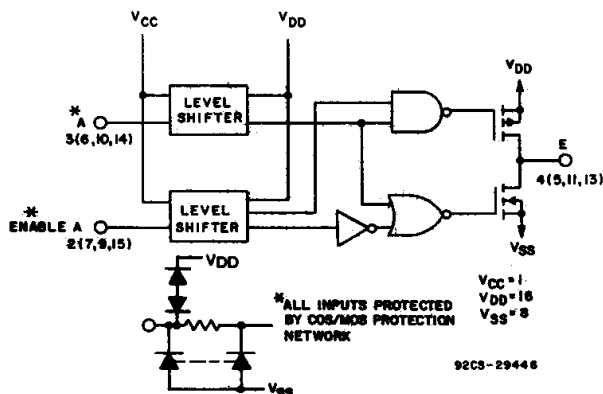
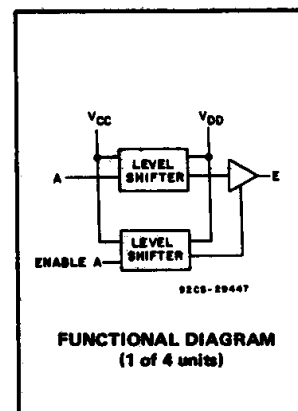


Fig. 1 – CD40109B logic diagram (1 of 4 units).

# CD40109B Types

## STATIC ELECTRICAL CHARACTERISTICS

CHARACTER- ISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)					+25			
				-55	-40	+85	+125	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	—	—	

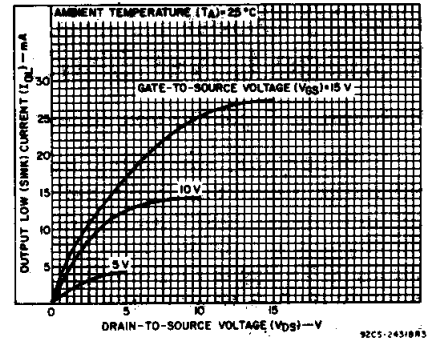


Fig. 2 - Typical output low (sink) current characteristics.

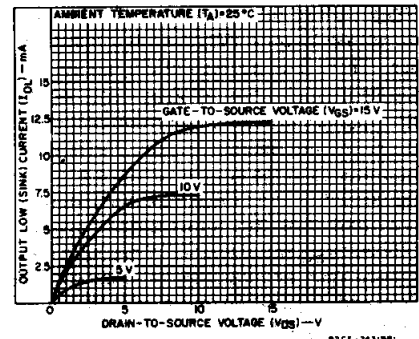


Fig. 3 - Minimum output low (sink) current characteristics.

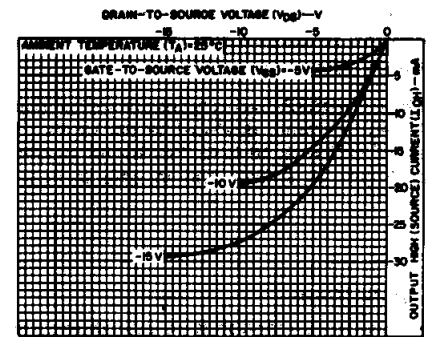


Fig. 4 - Typical output high (source) current characteristics.

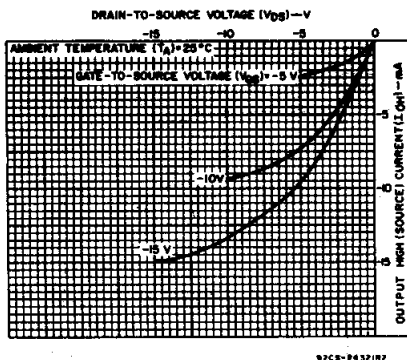


Fig. 5 - Minimum output high (source) current characteristics.

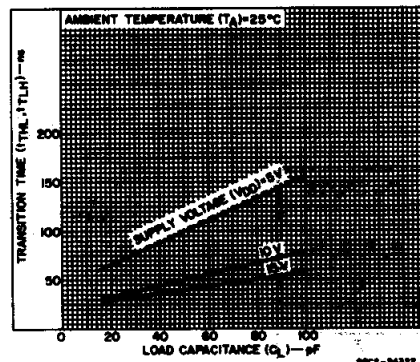


Fig. 6 - Typical transition time as a function of load capacitance.

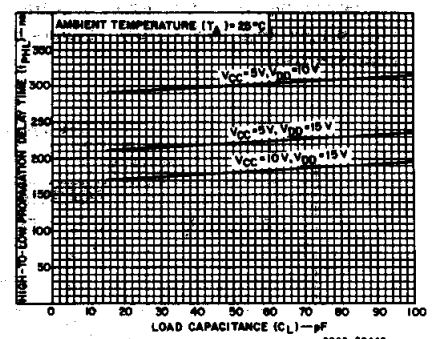


Fig. 7 - Typical high-to-low propagation delay time as a function of load capacitance.

## 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	ns
		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	ns
		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	ns
		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	ns
		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	ns
		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	ns
		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	ns
		15	5	100	200	
		15	10	50	100	
Input Capacitance, $C_i$			Any Input	5	7.5	pF

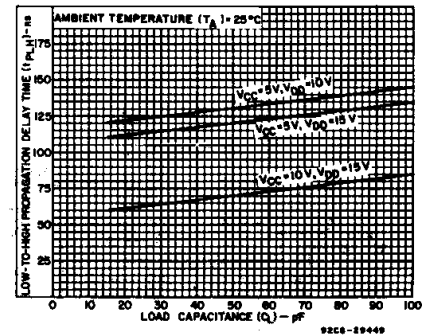


Fig. 8 — Typical low-to-high propagation delay time as a function of load capacitance.

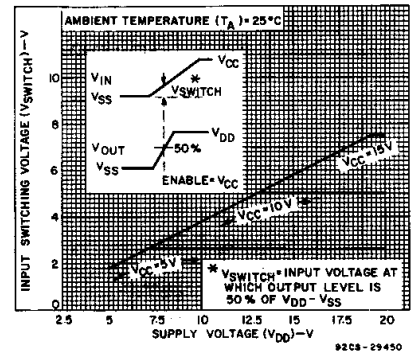


Fig. 9 — Typical input switching as a function of high-level supply voltage.

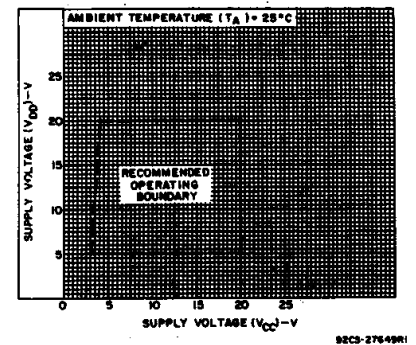


Fig. 10 — High-level supply voltage vs. low-level supply voltage.

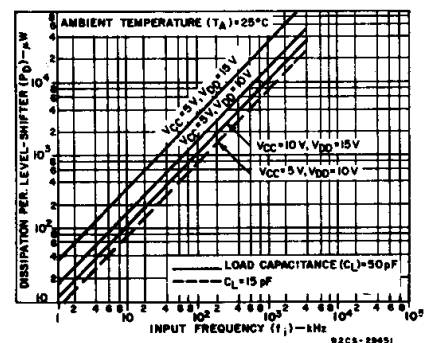


Fig. 11 — Typical dynamic power dissipation as a function of input frequency.

# CD40109B Types

## TEST CIRCUITS

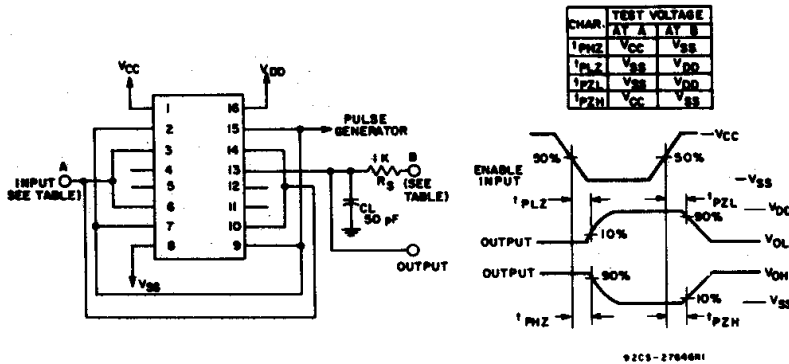


Fig. 12 - Output enable delay times test circuit and waveforms.

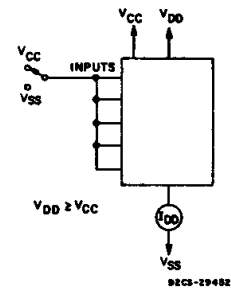


Fig. 13 - Quiescent device current.

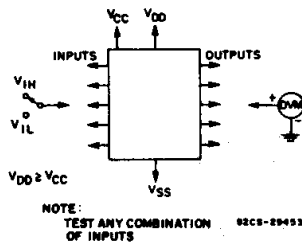


Fig. 14 - Input voltage.

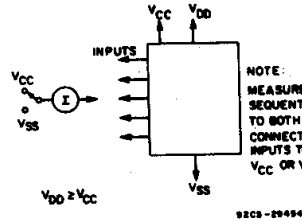


Fig. 15 - Input current.

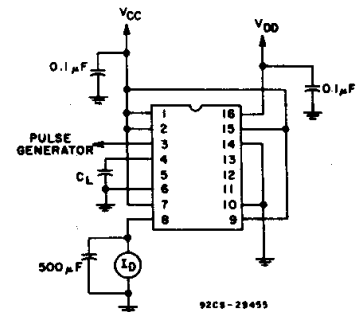
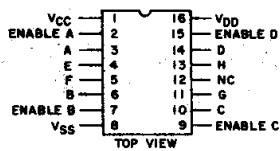
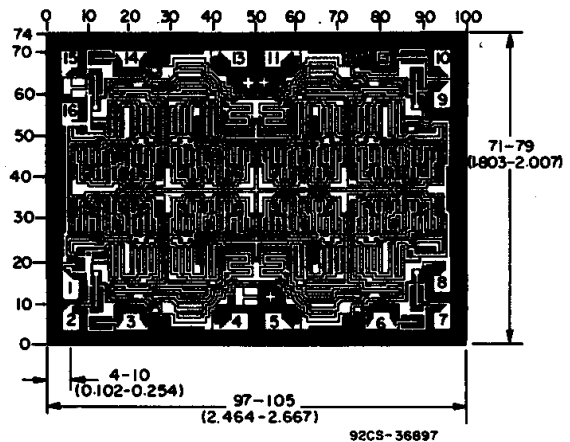


Fig. 16 - Dynamic power dissipation test circuit.



## 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 part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">CD40109BE</a>	Active	Production	PDIP (N)   16	25   TUBE	Yes	NIPDAU	N/A for Pkg Type	-55 to 125	CD40109BE
CD40109BE.A	Active	Production	PDIP (N)   16	25   TUBE	Yes	NIPDAU	N/A for Pkg Type	-55 to 125	CD40109BE
<a href="#">CD40109BF</a>	Active	Production	CDIP (J)   16	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	CD40109BF
CD40109BF.A	Active	Production	CDIP (J)   16	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	CD40109BF
<a href="#">CD40109BF3A</a>	Active	Production	CDIP (J)   16	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	CD40109BF3A
CD40109BF3A.A	Active	Production	CDIP (J)   16	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	CD40109BF3A
<a href="#">CD40109BNSR</a>	Active	Production	SOP (NS)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CD40109B
CD40109BNSR.A	Active	Production	SOP (NS)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CD40109B
CD40109BNSRE4	Active	Production	SOP (NS)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CD40109B
<a href="#">CD40109BPW</a>	Active	Production	TSSOP (PW)   16	90   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM0109B
CD40109BPW.A	Active	Production	TSSOP (PW)   16	90   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM0109B
CD40109BPWE4	Active	Production	TSSOP (PW)   16	90   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM0109B
<a href="#">CD40109BPWR</a>	Active	Production	TSSOP (PW)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM0109B
CD40109BPWR.A	Active	Production	TSSOP (PW)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM0109B
CD40109BPWRE4	Active	Production	TSSOP (PW)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM0109B
CD40109BPWRG4	Active	Production	TSSOP (PW)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM0109B

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

**(6) Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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**OTHER QUALIFIED VERSIONS OF CD40109B, CD40109B-MIL :**

- Catalog : [CD40109B](#)
- Automotive : [CD40109B-Q1](#), [CD40109B-Q1](#)
- Military : [CD40109B-MIL](#)

**NOTE: Qualified Version Definitions:**

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Military - QML certified for Military and Defense Applications

## TAPE AND REEL INFORMATION



\*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
CD40109BNSR	SOP	NS	16	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1
CD40109BPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	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)
CD40109BNSR	SOP	NS	16	2000	353.0	353.0	32.0
CD40109BPWR	TSSOP	PW	16	2000	353.0	353.0	32.0



## TUBE



\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
CD40109BE	N	PDIP	16	25	506	13.97	11230	4.32
CD40109BE	N	PDIP	16	25	506	13.97	11230	4.32
CD40109BE.A	N	PDIP	16	25	506	13.97	11230	4.32
CD40109BE.A	N	PDIP	16	25	506	13.97	11230	4.32
CD40109BPW	PW	TSSOP	16	90	530	10.2	3600	3.5
CD40109BPW.A	PW	TSSOP	16	90	530	10.2	3600	3.5
CD40109BPWE4	PW	TSSOP	16	90	530	10.2	3600	3.5

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.



4220204/B 12/2023

## NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

4220204/B 12/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4220204/B 12/2023

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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.



# PACKAGE OUTLINE

NS0016A

SOP - 2.00 mm max height

SOP



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## NOTES:

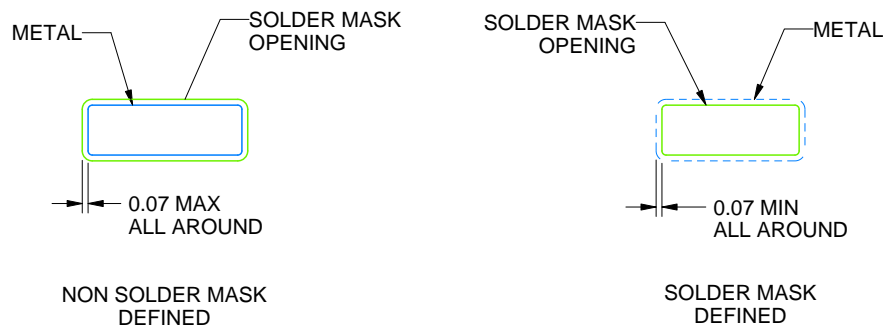
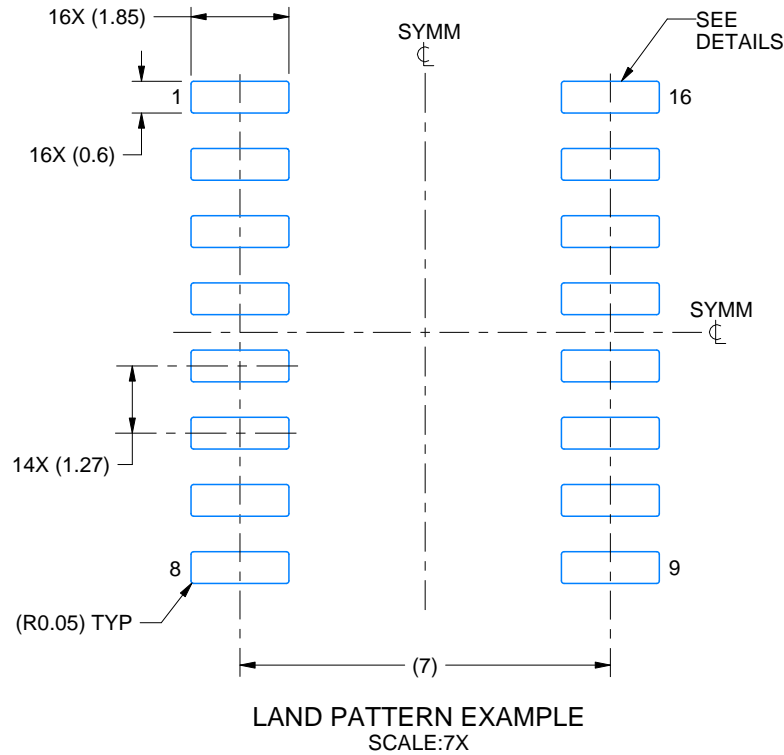
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.

# EXAMPLE BOARD LAYOUT

NS0016A

SOP - 2.00 mm max height

SOP



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NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



# EXAMPLE STENCIL DESIGN

NS0016A

SOP - 2.00 mm max height

SOP



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:7X

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NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

# MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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