

CMOS QUAD LOW-TO-HIGH VOLTAGE SHIFTER

Check for Samples: [CD40109B-Q1](#)

FEATURES

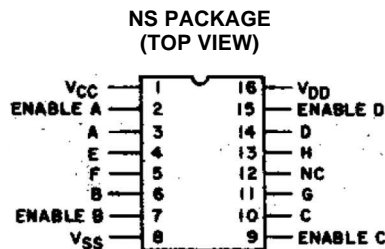
- Qualified for Automotive Applications
- Independent of Power Supply Sequence Considerations
 - V_{CC} Can Exceed V_{DD}
 - Input Signals can Exceed Both V_{CC} and V_{DD}
- Up and Down Level-Shifting Capability
- Three-State Outputs With Separate Enable Controls
- Standardized Symmetrical Output Characteristics
- 100% Tested for Quiescent Current at 20 V
- Maximum Input Current:
 - 1 μ 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"

- Latch-Up Performance Meets 50 mA per JESD 78, Class I

APPLICATIONS

- High-or-Low Level-Shifting With Three-State Outputs for Unidirectional or Bidirectional Bussing
- Isolation of Logic Subsystem Using Separate Power Supplies from Supply Sequencing, Supply Loss, and Supply Regulation Considerations



DESCRIPTION

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 high-voltage output signal (E, F, G, H) with logical 1 = V_{DD} and logical 0 = V_{SS} .

The RCA-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.

ORDERING INFORMATION⁽¹⁾

T_A	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOIC – NS	Reel of 2000	CD40109BQNSRQ1	CD40109BQ

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



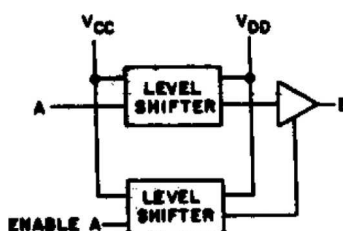
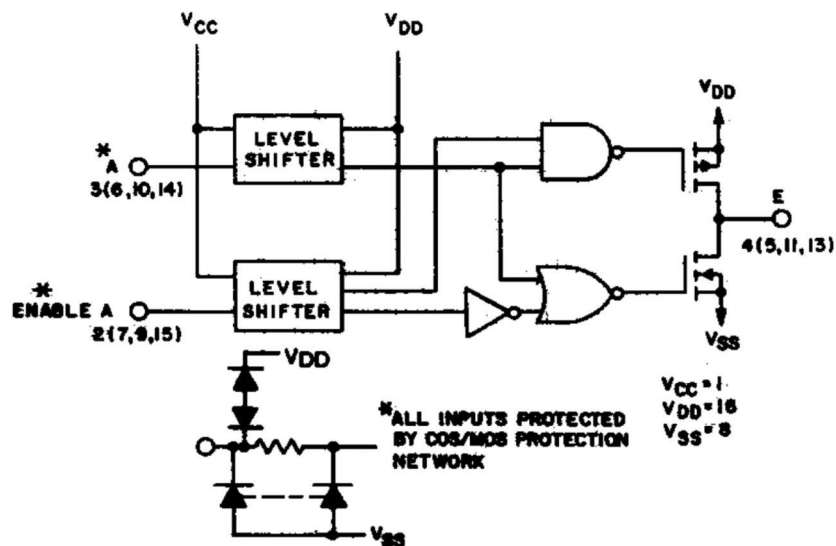
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

TRUTH TABLE⁽¹⁾

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

(1) 0 = V_{SS} , 1 = V_{CC} at inputs and V_{DD} at outputs, X = Don't care, Z = High impedance

Functional Diagram (1 of 4 Units)**Logic Diagram (1 of 4 Units)**

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

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

			VALUE	UNIT
V _{DD}	DC supply voltage range	Voltages referenced to V _{SS} terminal	–0.5 to +20	V
	Output voltage range	All outputs	–0.5 to V _{DD} + 0.5	V
	DC input current	Any one input	±10	mA
P _D	Power dissipation per package	T _A = –40°C to + 100°C	500	mW
		T _A = 100°C to + 125°C	Derate linearly at 12 mW/°C to 200 mW	
	Device dissipation per output transistor (for T _A = full package-temperature range, all package types)		100	mW
T _A	Operating-temperature range		–40 to +125	°C
T _{stg}	Storage temperature range		–65 to +150	°C
	Latch-Up Performance per JESD 78, Class I		50	mA

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V _{DD}	Supply-voltage range (for T _A = full package-temperature range)	3	18	V

STATIC ELECTRICAL CHARACTERISTICS

PARAMETER		CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)						UNIT
		V _O (V)	V _{IN} (V)	V _{DD} (V)	−40	+85	+125	+25			
								MIN	TYP	MAX	
I _{DD} Max	Quiescent device current		0, 5	5	1	30	30	0.02	1	μA	
			0, 10	10	2	60	60	0.02	2		
			0, 15	15	4	120	120	0.02	4		
			0, 20	20	20	600	600	0.04	20		
I _{OL} Min	Output low (sink) current	0.4	0, 5	5	0.61	0.42	0.36	0.51	1	mA	
		0.5	0, 10	10	1.5	1.1	0.9	1.3	2.6		
		1.5	0, 15	15	4	2.8	2.4	3.4	6.8		
I _{OH} Min	Output high (source) current	4.6	0, 5	5	−0.61	−0.42	−0.36	−0.51	−1		
		2.5	0, 5	5	−1.8	−1.3	−1.15	−1.6	−3.2		
		9.5	0, 10	10	−1.5	−1.1	−0.9	−1.3	−2.6		
		13.5	0, 15	15	−4	−2.8	−2.4	−3.4	−6.8		
V _{OL} Max	Output voltage: low-level		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		
V _{OH} Min	Output voltage: high-level		0, 5	5	4.95			4.95	5		
			0, 10	10	9.95			9.95	10		
			0, 15	15	14.95			14.95	15		
I _{IN} Max	Input current		0, 18	18	±0.1	±1	±1	±10 ^{−5}	±0.1	μA	
I _{OUT} Max			0, 18	18	±0.4	±12	±12	±10 ^{−4}	±0.4	μA	
V _{IL} Max	Input low voltage	1, 9	5	10	1.5			1.5		V	
		1.5, 13.5	10	15	3			3			
V _{IH} Min	Input high voltage	1, 9	5	10	3.5			3.5			
		1.5, 13.5	10	15	7			7			

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

PARAMETER	TEST CONDITIONS	SHIFTING MODE	V_{CC} (V)	V_{DD} (V)	MIN	MAX	UNIT
t_{PHL} Propagation delay time, high-to-low level, data input to output		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	
t_{PLH} Propagation delay time, low-to-high level, data input to output		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	
t_{PHZ} Propagation delay time, 3-state disable, delay, output high to high impedance	$R_L = 1\text{ k}\Omega$	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	
t_{PLZ} Propagation delay time, 3-state disable, delay, output low to high impedance	$R_L = 1\text{ k}\Omega$	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	
t_{PZH} Propagation delay time, 3-state disable, delay, output high impedance to high	$R_L = 1\text{ k}\Omega$	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	
t_{PZL} Propagation delay time, 3-state disable, delay, output high impedance to low	$R_L = 1\text{ k}\Omega$	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	
t_{THL}, t_{TLH} Transition time		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	
C_i Input capacitance			Any input		5	7.5	pF

TYPICAL CHARACTERISTICS

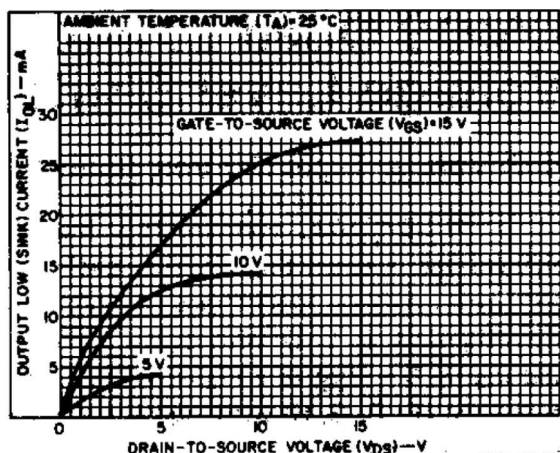


Figure 1. Typical Output Low (Sink) Current Characteristics

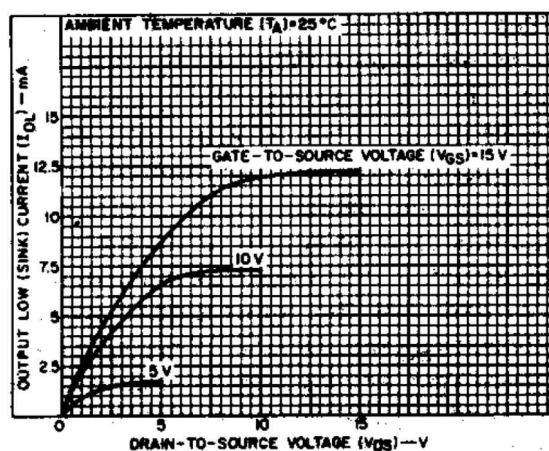


Figure 2. Minimum Output Low (Sink) Current Characteristics

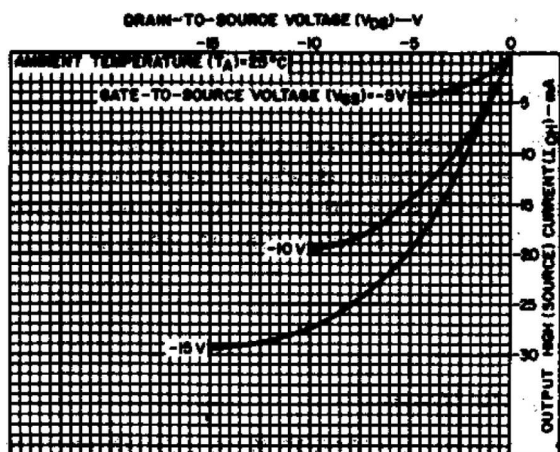


Figure 3. Typical Output High (Source) Current Characteristics

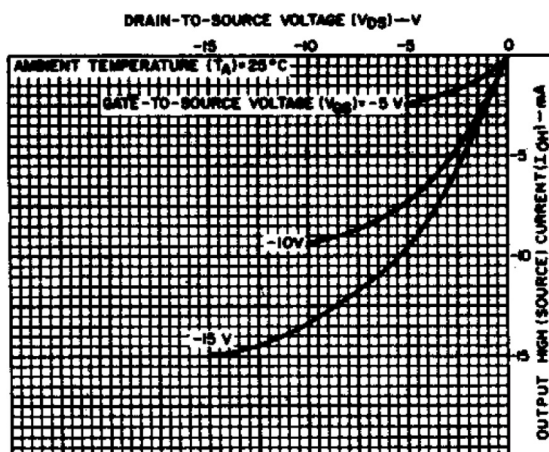


Figure 4. Minimum Output High (Source) Current Characteristics

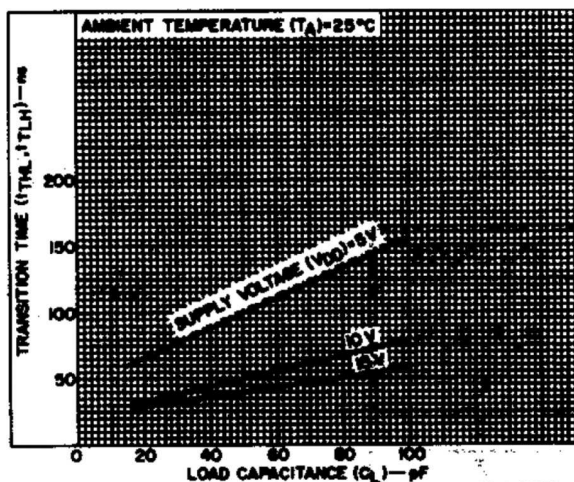


Figure 5. Typical Transition Time as a Function of Load Capacitance

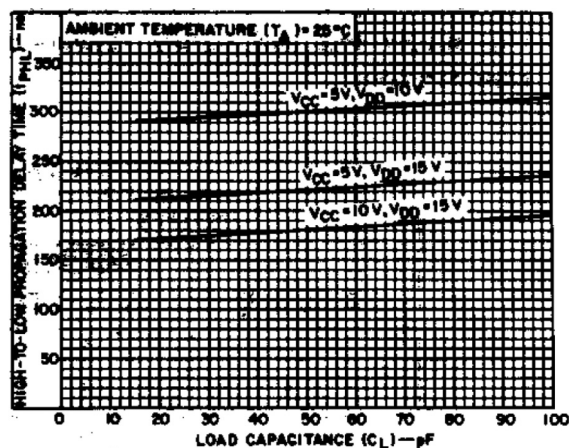


Figure 6. Typical High-to-Low Propagation Delay Time as a Function of Load Capacitance

TYPICAL CHARACTERISTICS (continued)

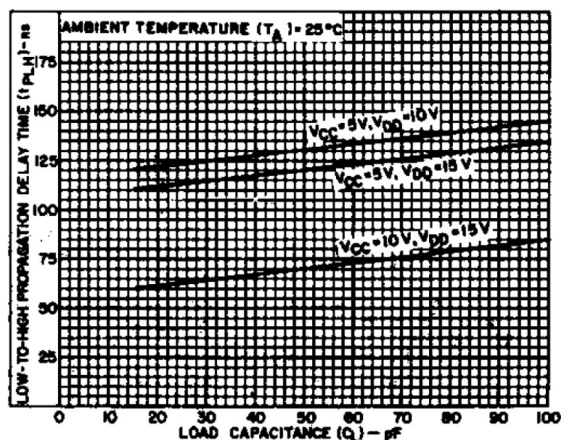


Figure 7. Typical Low-to-High Propagation Delay Time as a Function of Load Capacitance

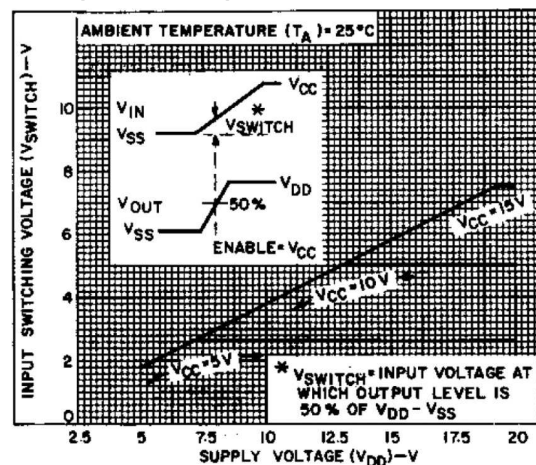


Figure 8. Typical Input Switching as a Function of High-Level Supply Voltage

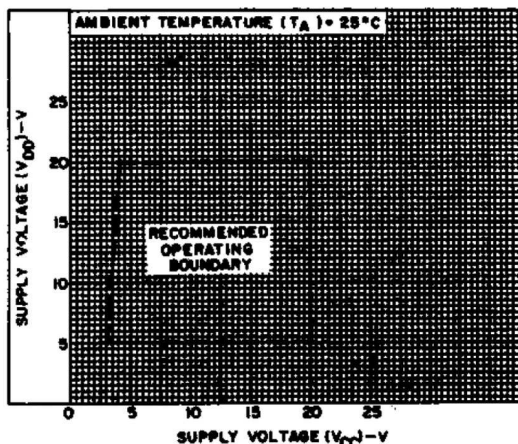


Figure 9. High-Level Supply Voltage vs Low-Level Supply Voltage

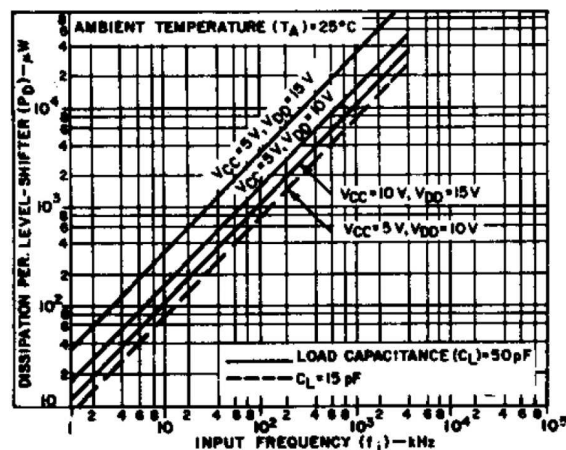


Figure 10. Typical Dynamic Power Dissipation as a Function of Input Frequency

PARAMETER MEASUREMENT INFORMATION

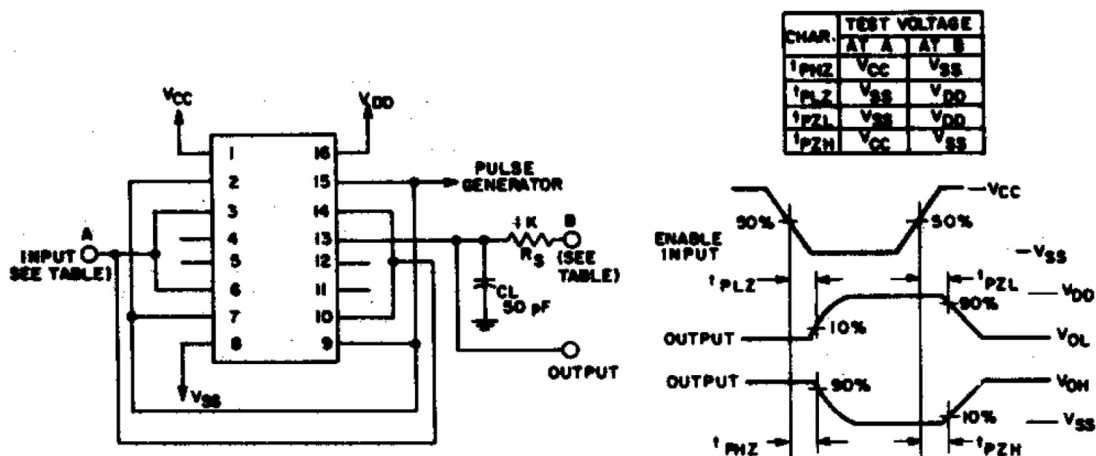


Figure 11. Output Enable Delay Times Test Circuit and Waveforms

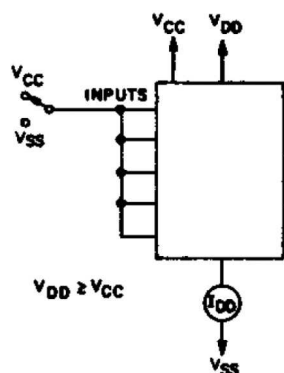


Figure 12. Quiescent Device Current Test Circuit

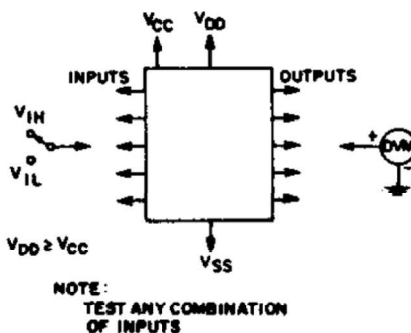


Figure 13. Input Voltage Test Circuit

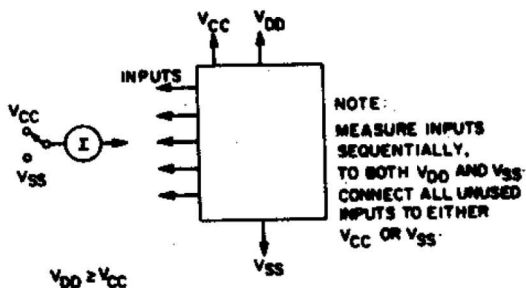


Figure 14. Input Current Test Circuit

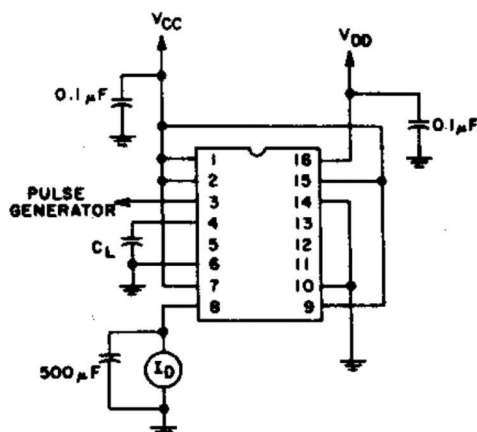
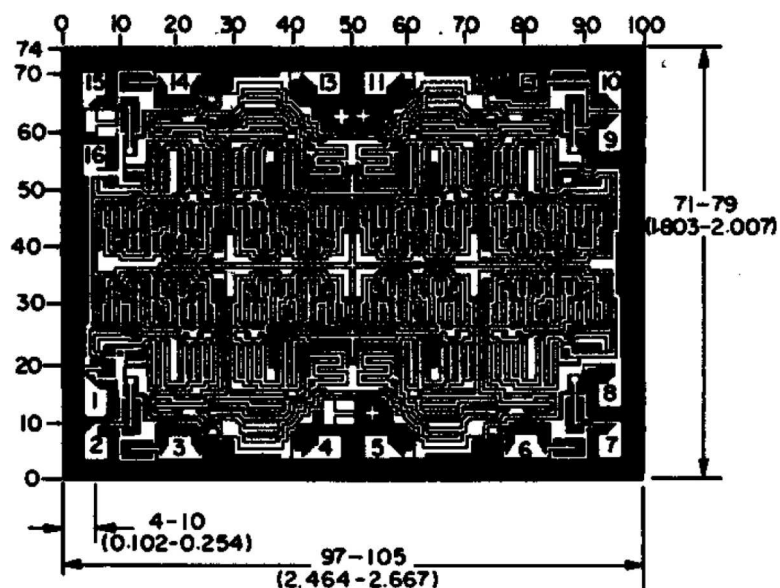


Figure 15. Dynamic Power Dissipation Test Circuit



Note: 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 16. Dimensions and Pad Layout

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CD40109BQNSRQ1	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 125	CD40109BQ	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF CD40109B-Q1 :

- Catalog: [CD40109B](#)
- Military: [CD40109B-MIL](#)

NOTE: Qualified Version Definitions:

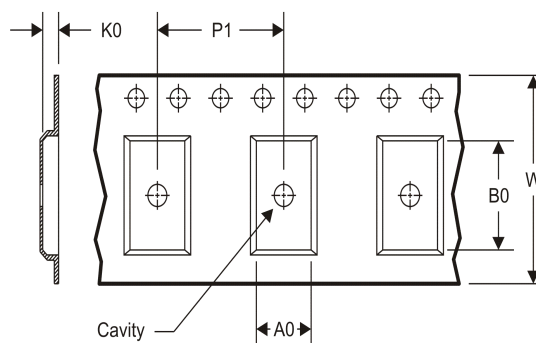
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
CD40109BQNSRQ1	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD40109BQNSRQ1	SO	NS	16	2000	367.0	367.0	38.0

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.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated