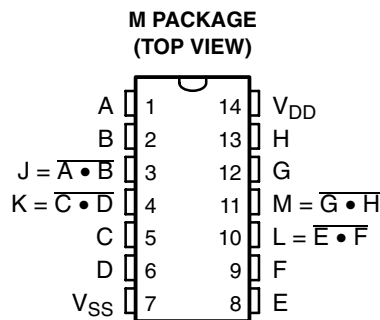


CD4093B-Q1 CMOS QUAD 2-INPUT NAND SCHMITT TRIGGER

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- Qualified for Automotive Applications
- Schmitt-Trigger Action on Each Input With No External Components
- Hysteresis Voltage Typically 0.9 V at $V_{DD} = 5\text{ V}$ and 2.3 V at $V_{DD} = 10\text{ V}$
- Noise Immunity Greater Than 50%
- No Limit on Input Rise and Fall Times
- Standardized, Symmetrical Output Characteristics
- 100% Tested for Quiescent Current at 20 V
- Maximum Input Current of $1\mu\text{A}$ 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
- ESD Protection Level Per AEC-Q100 Classification
 - 2000-V (H2) Human-Body Model
 - 200-V (M3) Machine-Model
 - 1000-V (C5) Charge-Device Model
- Applications
 - Wave and Pulse Shapers
 - High-Noise-Environment Systems
 - Monostable Multivibrators
 - Astable Multivibrators
 - NAND Logic



description/ordering information

The CD4093B consists of four Schmitt-trigger circuits. Each circuit functions as a two-input NAND gate, with Schmitt-trigger action on both inputs. The gate switches at different points for positive- and negative-going signals. The difference between the positive voltage (V_P) and the negative voltage (V_N) is defined as hysteresis voltage (V_H) (see Figure 2).

The CD4093B is available in 14-lead small-outline plastic package (M96) and 14-lead thin shrink small-outline packages (PWR suffixes).

ORDERING INFORMATION[†]

| T_A | PACKAGE [‡] | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|--|----------------------|--------------|-----------------------|------------------|
| -40°C to 125°C | SOIC (M) | Reel of 2000 | CD4093BQM96Q1 | CD4093BQ |

[†] 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 <http://www.ti.com>.

[‡] Package drawings, thermal data, and symbolization are available at <http://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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

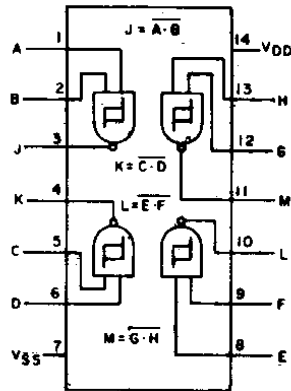
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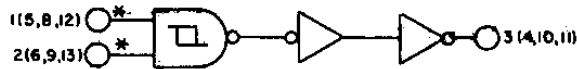
CD4093B-Q1 CMOS QUAD 2-INPUT NAND SCHMITT TRIGGER

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functional block diagram



logic diagram



* ALL INPUTS PROTECTED BY CMOS PROTECTION NETWORK

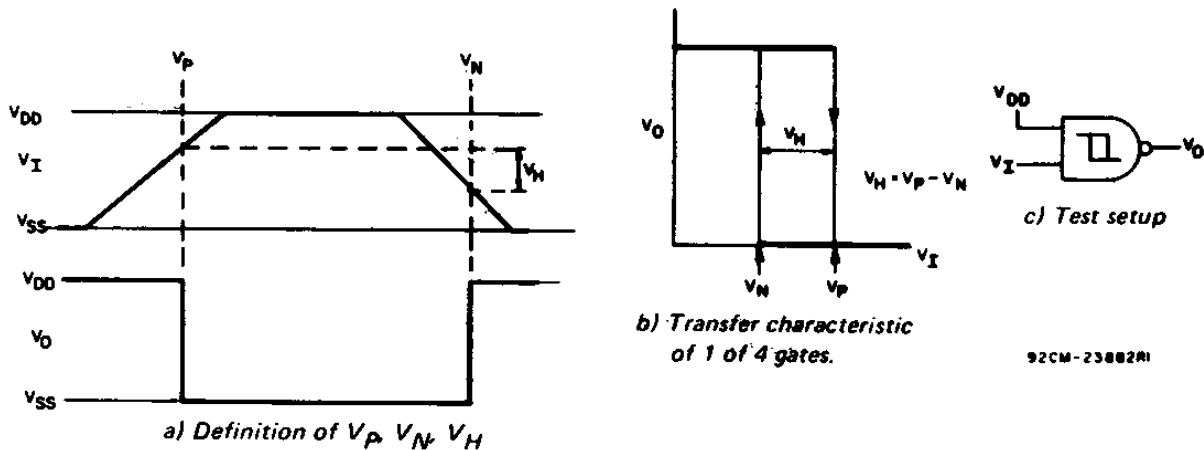
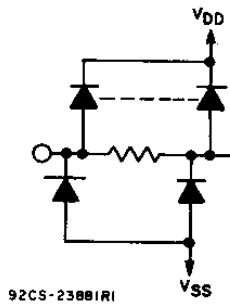


Figure 1. Hysteresis Definition, Characteristic, and Test Setup

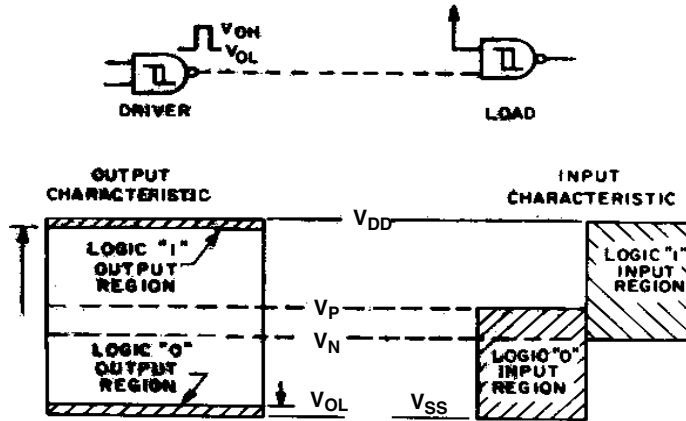


Figure 2. Input and Output Characteristics

TYPICAL CHARACTERISTICS

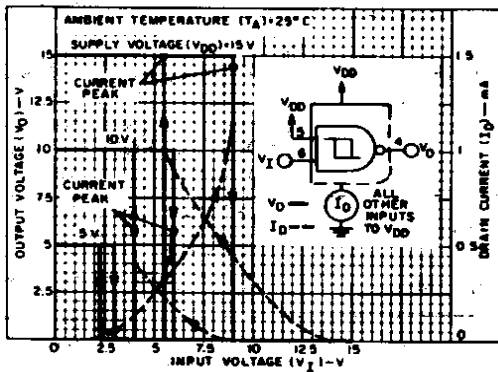


Figure 3. Typical Current and Voltage Transfer Characteristics

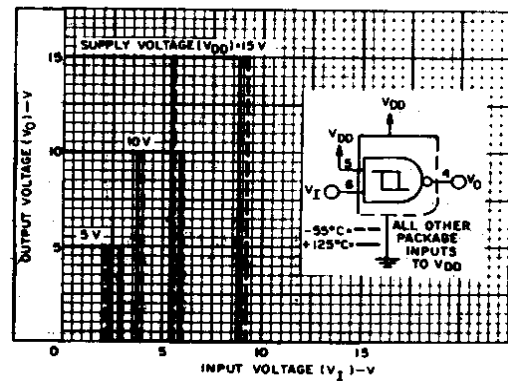


Figure 4. Typical Voltage Transfer Characteristics as a Function of Temperature

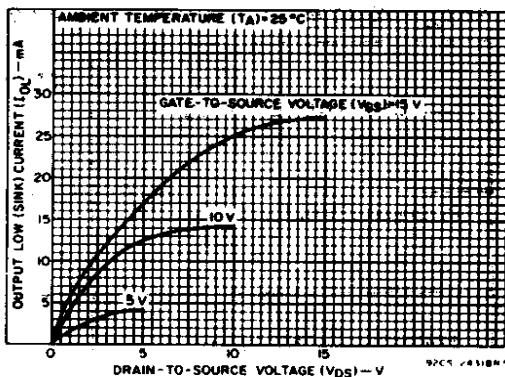


Figure 5. Typical Output Low (Sink) Current Characteristics

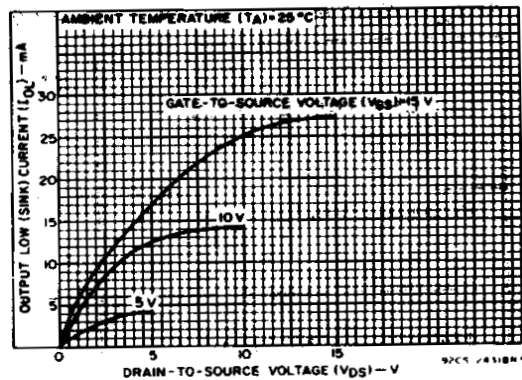


Figure 6. Minimum Output Low (Sink) Current Characteristics

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TYPICAL CHARACTERISTICS

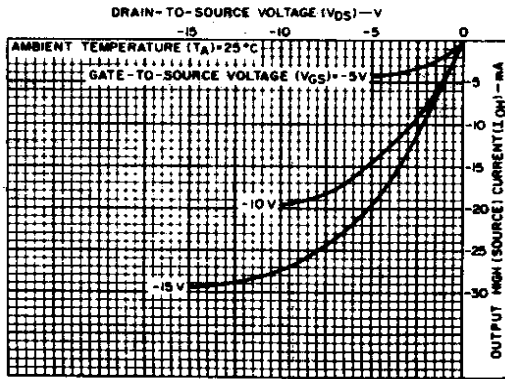


Figure 7. Typical Output High (Source) Current Characteristics

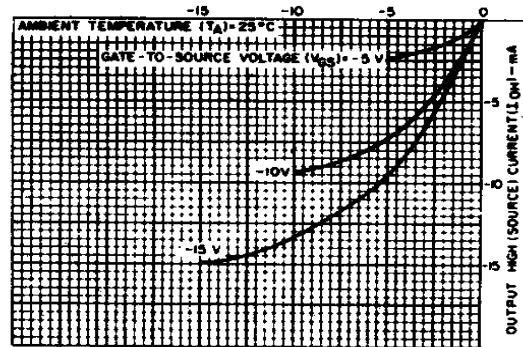


Figure 8. Minimum Output High (Source) Current Characteristics

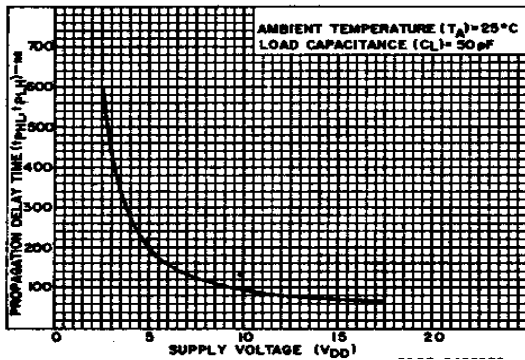


Figure 9. Typical Propagation Delay Time vs Supply Voltage

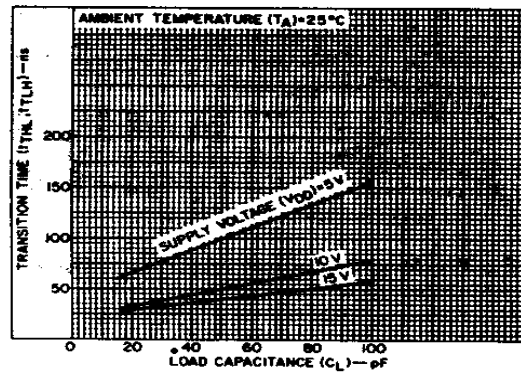


Figure 10. Typical Transition Time vs Load Capacitance

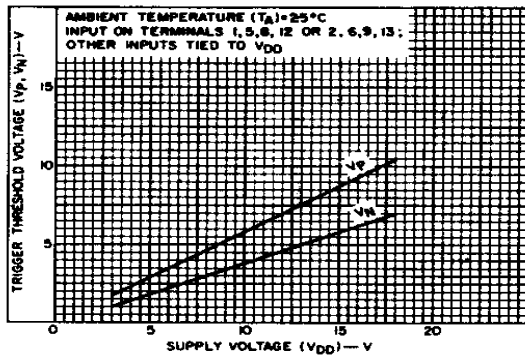


Figure 11. Typical Trigger Threshold Voltage vs V_{DD}

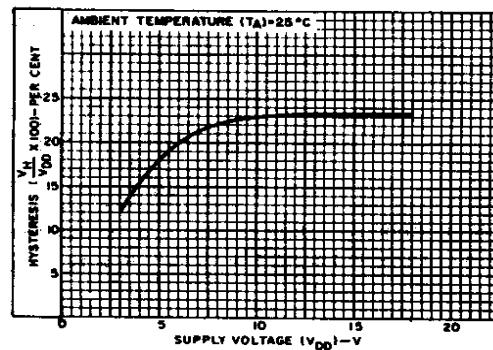


Figure 12. Typical Percent Hysteresis vs Supply Voltage

TYPICAL CHARACTERISTICS

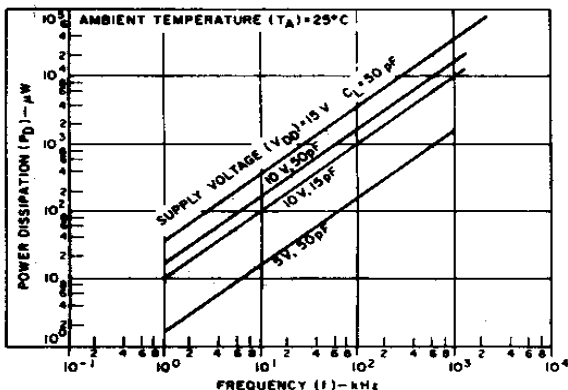


Figure 13. Typical Power Dissipation vs Frequency Characteristics

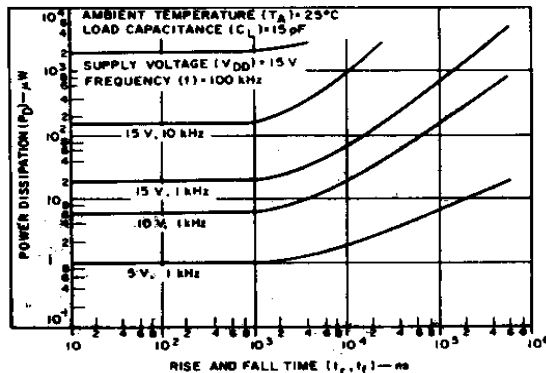
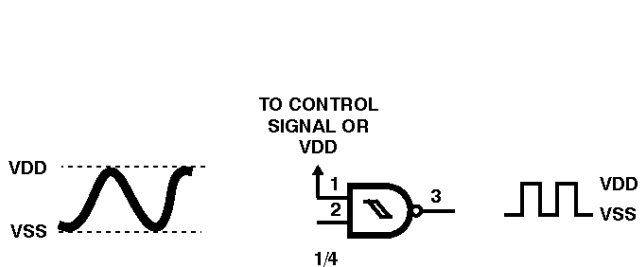


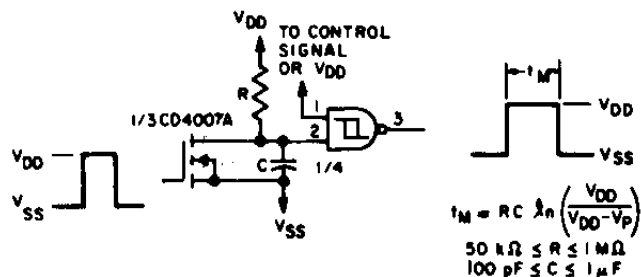
Figure 14. Typical Power Dissipation vs Rise and Fall Times

APPLICATION INFORMATION



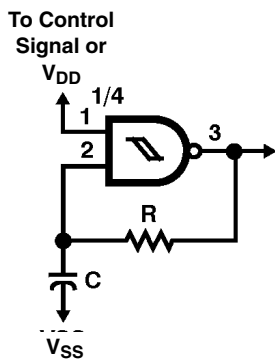
FREQUENCY RANGE OF WAVE SHAPE IS FROM DC TO 1MHz

Figure 15. Wave Shaper



FOR THE RANGE OF R AND C GIVEN $5\mu s < t_M < 1s$

Figure 16. Monostable Multivibrator



$$t_A = RC \ln \left[\left(\frac{V_P}{V_N} \right) \left(\frac{V_{DD} - V_N}{V_{DD} - V_P} \right) \right]$$

50 kΩ ≤ R ≤ 1 MΩ
100 pF ≤ C ≤ 1 μF
For the Range of R and C
Given 2 ms < t_A < 0.4 s

Figure 17. Astable Multivibrator

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

| | |
|--|----------------------------|
| DC supply voltage range, V_{DD} | -0.5 V to 20 V |
| Input voltage range, V_I , all inputs | -0.5 V to $V_{DD} + 0.5$ V |
| DC input current, any one input | ± 10 mA |
| Package thermal impedance, θ_{JA} (see Note 1) | 86°C/W |
| Device dissipation per output transistor for T_A , all package types | 100 mW |
| Operating temperature range, T_A | -40°C to 125°C |
| Storage temperature range, T_{stg} | -65°C to 150°C |

[†] 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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions[‡]

| | MIN | MAX | UNIT |
|---|-----|-----|------|
| V_{CC} Supply voltage range (T_A = full package temperature range) | 3 | 18 | V |

[‡] For maximum reliability, nominal operating conditions should be selected so that operation is always within the given range.



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CMOS QUAD 2-INPUT NAND SCHMITT TRIGGER

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static electrical characteristics

| CHARACTERISTIC | CONDITIONS | | | LIMITS AT INDICATED TEMPERATURES (°C) | | | | | UNIT |
|--|-----------------------|-----------------------|------------------------|---------------------------------------|------|------|------|------|------|
| | V _O (V) | V _I (V) | V _{DD} (V) | -40 | 85 | 125 | 25 | | |
| | | | | | | | MIN | TYP† | |
| Quiescent device current, I _{DD} max | | 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 | |
| Positive trigger threshold voltage, V _P min | | A | 5 | 2.2 | 2.2 | 2.2 | 2.2 | 2.9 | V |
| | | A | 10 | 4.6 | 4.6 | 4.6 | 4.6 | 5.9 | |
| | | A | 15 | 6.8 | 6.8 | 6.8 | 6.8 | 8.8 | |
| | | B | 5 | 2.6 | 2.6 | 2.6 | 2.6 | 3.3 | |
| | | B | 10 | 5.6 | 5.6 | 5.6 | 5.6 | 7 | |
| | | B | 15 | 6.3 | 6.3 | 6.3 | 6.3 | 9.4 | |
| V _P max | | A | 5 | 3.6 | 3.6 | 3.6 | 2.9 | 3.6 | V |
| | | A | 10 | 7.1 | 7.1 | 7.1 | 5.9 | 7.1 | |
| | | A | 15 | 10.8 | 10.8 | 10.8 | 8.8 | 10.8 | |
| | | B | 5 | 4 | 4 | 4 | 3.3 | 4 | |
| | | B | 10 | 8.2 | 8.2 | 8.2 | 7 | 8.2 | |
| | | B | 15 | 12.7 | 12.7 | 12.7 | 9.4 | 12.7 | |
| Negative trigger threshold voltage, V _N min | | A | 5 | 0.9 | 0.9 | 0.9 | 0.9 | 1.9 | V |
| | | A | 10 | 2.5 | 2.5 | 2.5 | 2.5 | 3.9 | |
| | | A | 15 | 4 | 4 | 4 | 4 | 5.8 | |
| | | B | 5 | 1.4 | 1.4 | 1.4 | 1.4 | 2.3 | |
| | | B | 10 | 3.4 | 3.4 | 3.4 | 3.4 | 5.1 | |
| | | B | 15 | 4.8 | 4.8 | 4.8 | 4.8 | 7.3 | |
| V _N max | | A | 5 | 2.8 | 2.8 | 2.8 | 1.9 | 2.8 | V |
| | | A | 10 | 5.2 | 5.2 | 5.2 | 3.9 | 5.2 | |
| | | A | 15 | 7.4 | 7.4 | 7.4 | 5.8 | 7.4 | |
| | | B | 5 | 3.2 | 3.2 | 3.2 | 2.3 | 3.2 | |
| | | B | 10 | 6.6 | 6.6 | 6.6 | 5.1 | 6.6 | |
| | | B | 15 | 9.6 | 9.6 | 9.6 | 7.3 | 9.6 | |
| Hysteresis voltage, V _H min | | A | 5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.9 | V |
| | | A | 10 | 1.2 | 1.2 | 1.2 | 1.2 | 2.3 | |
| | | A | 15 | 1.6 | 1.6 | 1.6 | 1.6 | 3.5 | |
| | | B | 5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.9 | |
| | | B | 10 | 1.2 | 1.2 | 1.2 | 1.2 | 2.3 | |
| | | B | 15 | 1.6 | 1.6 | 1.6 | 1.6 | 3.5 | |
| V _H max | | A | 5 | 1.6 | 1.6 | 1.6 | 0.9 | 1.6 | V |
| | | A | 10 | 3.4 | 3.4 | 3.4 | 2.3 | 3.4 | |
| | | A | 15 | 5 | 5 | 5 | 3.5 | 5 | |
| | | B | 5 | 1.6 | 1.6 | 1.6 | 0.9 | 1.6 | |
| | | B | 10 | 3.4 | 3.4 | 3.4 | 2.3 | 3.4 | |
| | | B | 15 | 5 | 5 | 5 | 3.5 | 5 | |

NOTES: A. Inputs on terminals 1, 5, 8, 12 or 2, 6, 9, 13; other inputs to V_{DD}.
 B. Inputs on terminals 1 and 2, 5 and 6, 8 and 9, or 12 and 13; other inputs to V_{DD}.



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static electrical characteristics (continued)

| CHARACTERISTIC | CONDITIONS | | | LIMITS AT INDICATED TEMPERATURES (°C) | | | | | UNIT | |
|---|-----------------------|-----------------------|------------------------|---------------------------------------|-------|-------|-------------------|------|------|-----|
| | V _O (V) | V _I (V) | V _{DD} (V) | -40 | 85 | 125 | 25 | | | |
| | | | | | | | MIN | TYP† | | MAX |
| Output low (sink) current, I _{OL} min | 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 | | |
| Output high (source) current, I _{OH} min | 4.6 | 0,5 | 5 | -0.61 | -0.42 | -0.36 | -0.51 | -1 | mA | |
| | 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 | | |
| Output voltage low level, V _{OL} max | | 0,5 | 5 | 0.05 | 0.05 | 0.05 | 0 | 0.05 | V | |
| | | 0,10 | 10 | 0.05 | 0.05 | 0.05 | 0 | 0.05 | | |
| | | 0,15 | 15 | 0.05 | 0.05 | 0.05 | 0 | 0.05 | | |
| Output voltage high level, V _{OH} min | | 0,5 | 5 | 4.95 | 4.95 | 4.95 | 4.95 | 5 | V | |
| | | 0,10 | 10 | 9.95 | 9.95 | 9.95 | 9.95 | 10 | | |
| | | 0,15 | 15 | 14.95 | 14.95 | 14.95 | 14.95 | | | |
| Input current, I _{IN} max | | 0,18 | 18 | ±0.1 | ±1 | ±1 | ±10 ⁻⁵ | ±0.1 | µA | |

dynamic electrical characteristics

T_A = 25°C, input t_r, t_f = 20 ns, C_L = 50 pF, R_L = 200 kΩ

| CHARACTERISTIC | TEST CONDITIONS | V _{DD} (V) | LIMITS | | | UNIT |
|---|-----------------|---------------------|--------|-----|-----|------|
| | | | MIN | TYP | MAX | |
| Propagation delay time, t _{PHL} , t _{PLH} | | 5 | | 190 | 380 | ns |
| | | 10 | | 90 | 180 | |
| | | 15 | | 65 | 130 | |
| Transition time, t _{THL} , t _{TLH} | | 5 | | 100 | 200 | ns |
| | | 10 | | 50 | 100 | |
| | | 15 | | 40 | 80 | |
| Input capacitance, C _{IN} | Any Input | | | 5 | 7.5 | pF |



PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| CD4093BQM96G4Q1 | ACTIVE | SOIC | D | 14 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | CD4093BQ | Samples |
| CD4093BQM96Q1 | ACTIVE | SOIC | D | 14 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | CD4093BQ | 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 finish/Ball material - Orderable Devices 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.

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OTHER QUALIFIED VERSIONS OF CD4093B-Q1 :

- Catalog: [CD4093B](#)
- Military: [CD4093B-MIL](#)

NOTE: Qualified Version Definitions:

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

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AB.

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