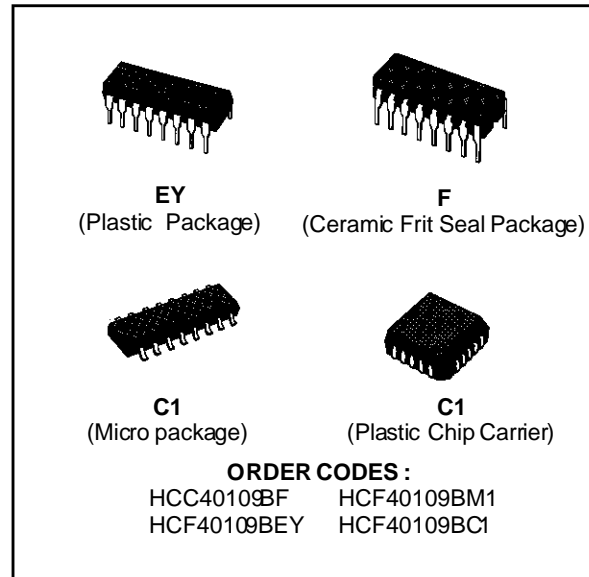


QUAD LOW-TO-HIGH VOLTAGE LEVEL SHIFTER

- 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
- QUIESCENT CURRENT SPECIFIED AT 20V FOR HCC DEVICE
- 5V, 10V, AND 15V PARAMETRIC RATINGS
- INPUT CURRENT OF 100nA AT 18V AND 25°C FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD N° 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

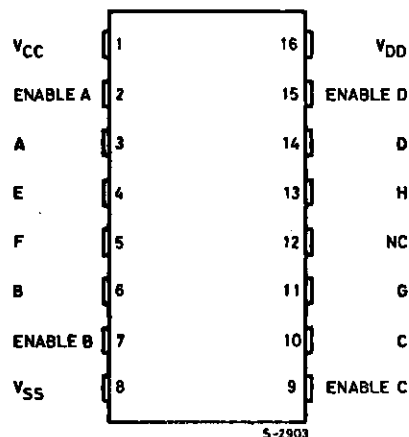
controls produces a high-impedance state in the corresponding output.



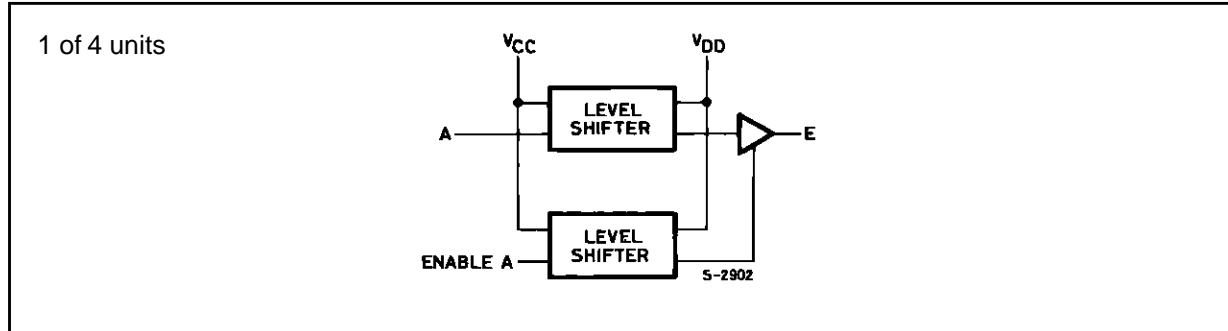
DESCRIPTION

The **HCC40109B** (extended temperature range) and **HCF40109B** (intermediate temperature range) are monolithic integrated circuits, available in 16-lead dual in-line plastic or ceramic package and plastic micropackage. The **HCC/HCF40109B** 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 **HCC/HCF40109B**, 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, there are no restrictions on the relative magnitudes of the supply voltages or input signals within the device maximum ratings; 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 **HCC/HCF40109B**, will operate as a high-to-low level-shifter. The **HCC/HCF 40109B** also features individual three-state output capability. A low level on any of the separately enabled three-state output

PIN CONNECTIONS



FUNCTIONAL DIAGRAM



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------|---|--------------------------------|-------------|
| V_{DD}^* | Supply Voltage : HCC Types HCF Types | - 0.5 to + 20 - 0.5 to + 18 | V |
| V_i | Input Voltage | - 0.5 to $V_{DD} + 0.5$ | V |
| I_I | DC Input Current (any one input) | ± 10 | mA |
| P_{tot} | Total Power Dissipation (per package) Dissipation per Output Transistor for $T_{op} =$ Full Package-temperature Range | 200 100 | mW |
| T_{op} | Operating Temperature : HCC Types HCF Types | - 55 to + 125 - 40 to + 85 | $^{\circ}C$ |
| T_{stg} | Storage Temperature | - 65 to + 150 | $^{\circ}C$ |

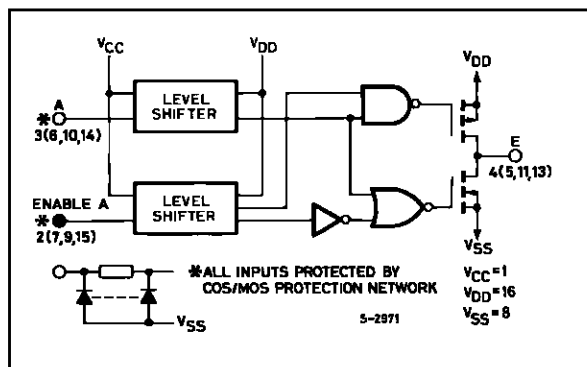
Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for external periods may affect device reliability.

* All voltage are with respect to V_{SS} (GND).

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|----------|--|-------------------------------|-------------|
| V_{DD} | Supply Voltage : HCC Types HCF Types | 3 to 18 3 to 15 | V |
| V_I | Input Voltage | 0 to V_{DD} | V |
| T_{op} | Operating Temperature : HCC Types HCF Types | - 55 to + 125 - 40 to + 85 | $^{\circ}C$ |

LOGIC DIAGRAM



TRUTH TABLE

| Mode | Inputs | | Outputs |
|----------------------------|------------|----------------------|------------|
| | A, B, C, D | Enable A, B, C, D | E, F, G, H |
| Low to High Level Shift | 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.

STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

| Symbol | Parameter | | Test Conditions | | | | | Value | | | | | | Unit | |
|-----------------------------------|-----------------------|-----------|-----------------------|-----------------------|--------------------------------|------------------------|------------------------|--------------------|-----------|--------|------------------------|-----------|---------------------|---------|---------|
| | | | V _I (V) | V _O (V) | I _O (μ A) | V _{CC} (V) | V _{DD} (V) | T _{Low} * | | 25°C | | | T _{High} * | | |
| | | | | | | | | Min. | Max. | Min. | Typ. | Max. | Min. | | Max. |
| I _L | Quiescent Current | HCC Types | 0/ 5 | | | | 5 | | 1 | 0.02 | 1 | | 30 | μ A | |
| | | | 0/10 | | | | 10 | | 2 | 0.02 | 2 | | 60 | | |
| | | | 0/15 | | | | 15 | | 4 | 0.02 | 4 | | 120 | | |
| | | | 0/20 | | | | 20 | | 20 | 0.04 | 20 | | 600 | | |
| | | HCF Types | 0/ 5 | | | | 5 | | 4 | 0.02 | 4 | | 30 | | |
| | | | 0/10 | | | | 10 | | 8 | 0.02 | 8 | | 60 | | |
| | | | 0/15 | | | | 15 | | 16 | 0.02 | 16 | | 120 | | |
| V _{OH} | Output High Voltage | 0/ 5 | | < 1 | | 5 | 4.95 | | 4.95 | | | 4.95 | V | | |
| | | 0/10 | | < 1 | | 10 | 9.95 | | 9.95 | | | 9.95 | | | |
| | | 0/15 | | < 1 | | 15 | 14.95 | | 14.95 | | | 14.95 | | | |
| V _{OL} | Output Low Voltage | 5/0 | | < 1 | | 5 | | 0.05 | | | 0.05 | 0.05 | V | | |
| | | 10/0 | | < 1 | | 10 | | 0.05 | | | 0.05 | 0.05 | | | |
| | | 15/0 | | < 1 | | 15 | | 0.05 | | | 0.05 | 0.05 | | | |
| V _{IH} | Input High Voltage | | 1/9 | < 1 | 5 | 10 | 3.5 | | 3.5 | | | 3.5 | V | | |
| | | | 1.5/13.5 | < 1 | 10 | 15 | 7 | | 7 | | | 7 | | | |
| V _{IL} | Input Low Voltage | | 1/9 | < 1 | 5 | 10 | | 1.5 | | | 1.5 | 1.5 | V | | |
| | | | 1.5/13.5 | < 1 | 10 | 15 | | 3 | | | 3 | 3 | | | |
| I _{OH} | Output Drive Current | HCC Types | 0/ 5 | 2.5 | | | 5 | - 2 | | - 1.6 | - 3.2 | | - 1.15 | mA | |
| | | | 0/ 5 | 4.6 | | | 5 | - 0.64 | | - 0.51 | - 1 | | - 0.36 | | |
| | | | 0/10 | 9.5 | | | 10 | - 1.6 | | - 1.3 | - 2.6 | | - 0.9 | | |
| | | | 0/15 | 13.5 | | | 15 | - 4.2 | | - 3.4 | - 6.8 | | - 2.4 | | |
| | | HCF Types | 0/ 5 | 2.5 | | | 5 | - 1.53 | | - 1.36 | - 3.2 | | - 1.1 | | |
| | | | 0/ 5 | 4.6 | | | 5 | - 0.52 | | - 0.44 | - 1 | | - 0.36 | | |
| | | | 0/10 | 9.5 | | | 10 | - 1.3 | | - 1.1 | - 2.6 | | - 0.9 | | |
| 0/15 | 13.5 | | | 15 | - 3.6 | | - 3.0 | - 6.8 | | - 2.4 | | | | | |
| I _{OL} | Output Sink Current | HCC Types | 0/ 5 | 0.4 | | | 5 | 0.64 | | 0.51 | 1 | | 0.36 | mA | |
| | | | 0/10 | 0.5 | | | 10 | 1.6 | | 1.3 | 2.6 | | 0.9 | | |
| | | | 0/15 | 1.5 | | | 15 | 4.2 | | 3.4 | 6.8 | | 2.4 | | |
| | | HCF Types | 0/ 5 | 0.4 | | | 5 | 0.52 | | 0.44 | 1 | | 0.36 | | |
| | | | 0/10 | 0.5 | | | 10 | 1.3 | | 1.1 | 2.6 | | 0.9 | | |
| | | | 0/15 | 1.5 | | | 15 | 3.6 | | 3.0 | 6.8 | | 2.4 | | |
| | | | | | | | | | | | | | | | |
| I _{IH} , I _{IL} | Input Leakage Current | HCC Types | 0/18 | Any Input | | | 18 | | \pm 0.1 | | \pm 10 ⁻⁵ | \pm 0.1 | | \pm 1 | μ A |
| | | HCF Types | 0/15 | Any Input | | | 15 | | \pm 0.3 | | \pm 10 ⁻⁵ | \pm 0.3 | | \pm 1 | |

* T_{Low} = - 55°C for HCC device : - 40°C for HCF device.* T_{High} = + 125°C for HCC device : + 85°C for HCF device.The Noise Margin for both "1" and "0" level is : 1V min. with V_{DD} = 5V, 2V min. with V_{DD} = 10V, 2.5V min. with V_{DD} = 15V.

** Forced output disabled

STATIC ELECTRICAL CHARACTERISTICS (continued)

| Symbol | Parameter | | Test Conditions | | | | | Value | | | | | | Unit | |
|---|---|--------------|-----------------------|-----------------------|-------------------------|------------------------|------------------------|--------------------|-------|-------|-------------------|-------|---------------------|-------|------|
| | | | V _I (V) | V _O (V) | I _O (V) | V _{CC} (V) | V _{DD} (V) | T _{Low} * | | 25 °C | | | T _{High} * | | |
| | | | | | | | | Min. | Max. | Min. | Typ. | Max. | Min. | | Max. |
| I _{OH} , I _{OL} ** | 3-State Output Leakage Current | HCC Types | 0/18 | 0/18 | | | 18 | | ± 0.4 | | ±10 ⁻⁴ | ± 0.4 | | ± 12 | µA |
| | | HCF Types | 0/15 | 0/15 | | | 15 | | ± 1.0 | | ±10 ⁻⁴ | ± 1.0 | | ± 7.5 | |
| C _I | Input Capacitance | | | Any Input | | | | | | | 5 | 7.5 | | | pF |

* T_{Low} = - 55°C for HCC device : - 40°C for HCF device.

* T_{High} = + 125°C for HCC device : + 85°C for HCF device.

The Noise Margin for both "1" and "0" levels is : 1V min. with V_{DD} = 5V, 2V min. with V_{DD} = 10V, 2.5V min. with V_{DD} = 15V.

** Forced output disabled

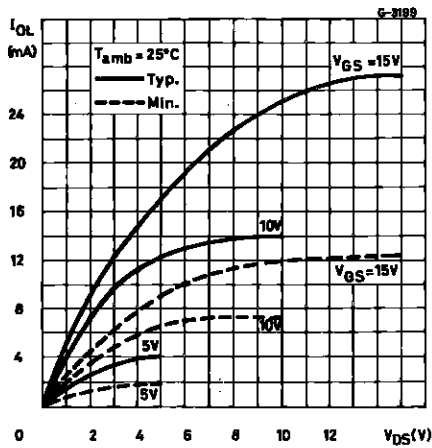
DYNAMIC ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C, C_L = 50pF, R_L = 200kΩ, typical temperature coefficient for all V_{DD} values is 0.3%/°C, all input rise and fall time = 20ns)

| Symbol | Parameter | Shifting Mode | Test Conditions | | Value | | | Unit |
|--|---|---------------|---------------------|---------------------|-------|------|------|------|
| | | | V _{CC} (V) | V _{DD} (V) | Min. | Typ. | Max. | |
| t _{PHL} , t _{PLH} | Propagation Delay Time (data input to output) High to Low Level | L - H | 5 | 10 | | 300 | 600 | ns |
| | | | 5 | 15 | | 220 | 440 | |
| | | | 10 | 15 | | 180 | 360 | |
| | | H - L | 10 | 5 | | 850 | 1600 | |
| | | | 15 | 5 | | 850 | 1600 | |
| | | | 15 | 10 | | 290 | 580 | |
| | Low to High Level | 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} | 3-State Disable Delay Time Output High to High Impedance | L - H | 5 | 10 | | 60 | 120 | ns |
| | | | 5 | 15 | | 50 | 100 | |
| | | | 10 | 15 | | 35 | 70 | |
| | | H - L | 10 | 5 | | 120 | 240 | |
| | | | 15 | 5 | | 120 | 240 | |
| | | | 15 | 10 | | 40 | 80 | |
| t _{PZH} | High Impedance to Output High | L - H | 5 | 10 | | 320 | 640 | ns |
| | | | 5 | 15 | | 230 | 460 | |
| | | | 10 | 15 | | 180 | 360 | |
| | | H - L | 10 | 5 | | 800 | 1500 | |
| | | | 15 | 5 | | 800 | 1500 | |
| | | | 15 | 10 | | 280 | 560 | |
| t _{PLZ} | Output Low to High Impedance | L - H | 5 | 10 | | 370 | 740 | ns |
| | | | 5 | 15 | | 300 | 600 | |
| | | | 10 | 15 | | 250 | 500 | |
| | | H - L | 10 | 5 | | 850 | 1600 | |
| | | | 15 | 5 | | 850 | 1600 | |
| | | | 15 | 10 | | 350 | 700 | |

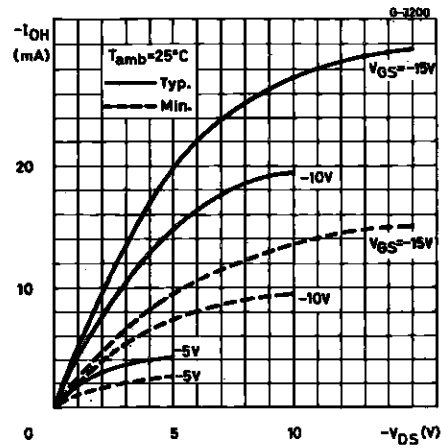
DYNAMIC ELECTRICAL CHARACTERISTICS (continued)

| Symbol | Parameter | Shifting Mode | Test Conditions | | Value | | | Unit |
|--|------------------------------|---------------|---------------------|---------------------|-------|------|------|------|
| | | | V _{CC} (V) | V _{DD} (V) | Min. | Typ. | Max. | |
| t _{PZL} | High Impedance to Output Low | L - H | 5 | 10 | | 100 | 200 | ns |
| | | | 5 | 15 | | 80 | 160 | |
| | | | 10 | 15 | | 40 | 80 | |
| | | H - L | 10 | 5 | | 120 | 240 | |
| | | | 15 | 5 | | 120 | 240 | |
| | | | 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 | |

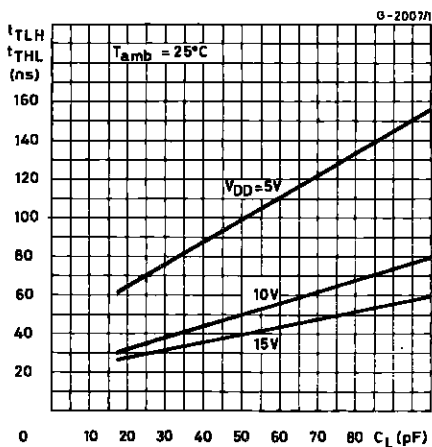
Output Low (sink) Current Characteristics.



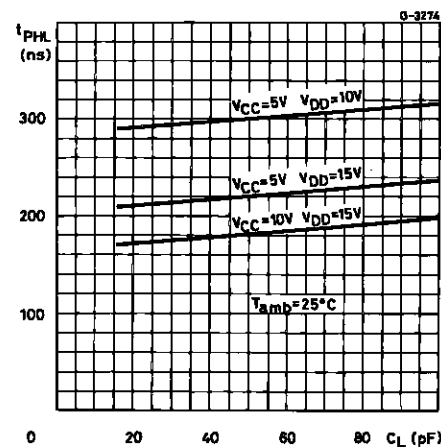
Output High (source) Current Characteristics.



Typical Transition Times. Load Capacitance.

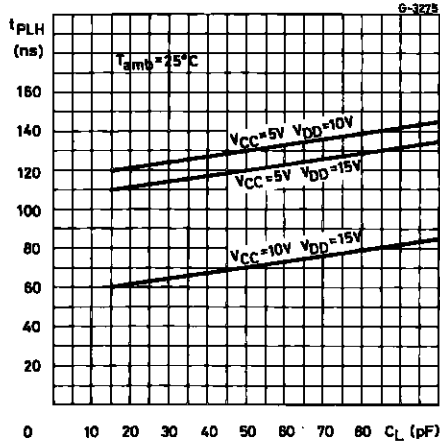


Typical High-to-low Propagation Delay Time vs. Load Capacitance.

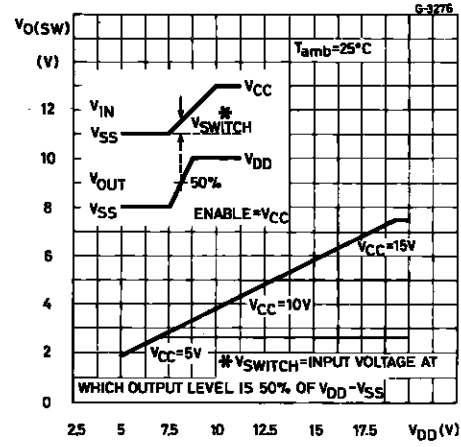


HCC/HCF40109B

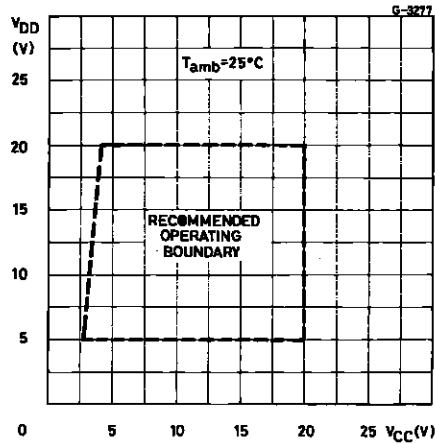
Typical Low-to-high Propagation Delay Time vs. Load Capacitance.



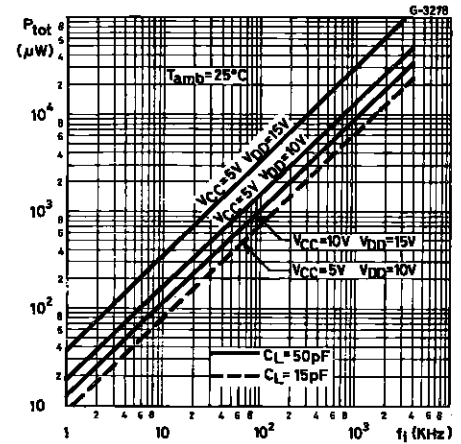
Typical Input Switching vs. High-level Supply Voltage.



High-level Supply Voltage vs. Low-level Supply Voltage.



Typical Dynamic Power Dissipation vs. Input Frequency.



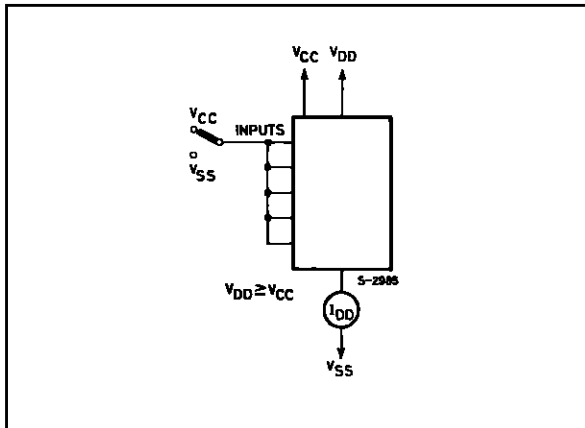
TEST CIRCUITS

Output Enable Delay Times Test Circuit and Waveforms.

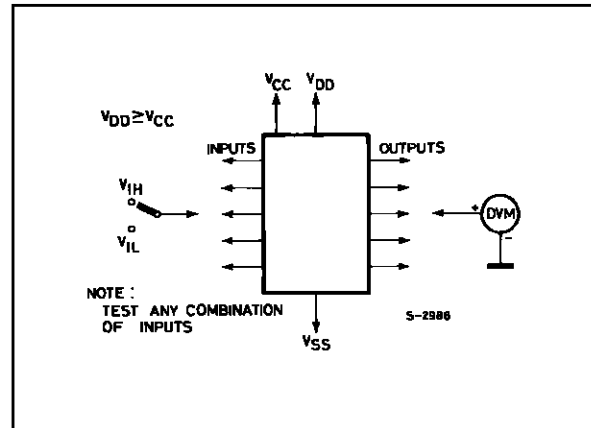
| CHAR. | TEST VOLTAGE | |
|-------|--------------|------|
| | AT A | AT B |
| tPHZ | VCC | VSS |
| tPLZ | VSS | VDD |
| tPZL | VSS | VDD |
| tPZH | VCC | VSS |

TEST CIRCUITS (continued)

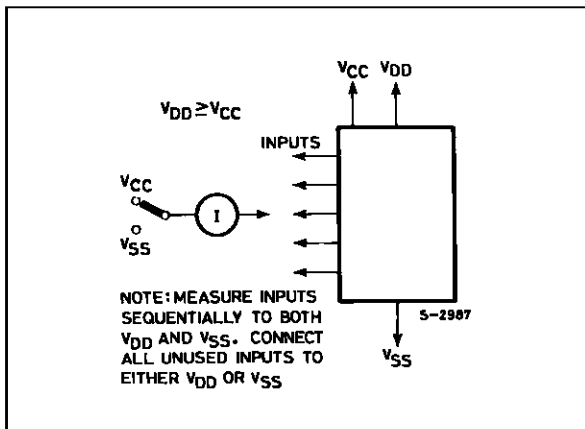
Quiescent Device Current.



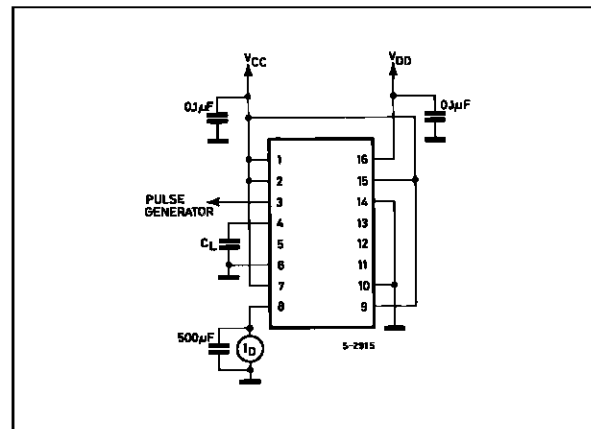
Input Voltage.



Input Leakage Current.



Dynamic Power Dissipation.



Plastic DIP16 (0.25) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 17.78 | | | 0.700 | |
| F | | | 7.1 | | | 0.280 |
| l | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.27 | | | 0.050 |



P001C

Ceramic DIP16/1 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 20 | | | 0.787 |
| B | | | 7 | | | 0.276 |
| D | | 3.3 | | | 0.130 | |
| E | 0.38 | | | 0.015 | | |
| e3 | | 17.78 | | | 0.700 | |
| F | 2.29 | | 2.79 | 0.090 | | 0.110 |
| G | 0.4 | | 0.55 | 0.016 | | 0.022 |
| H | 1.17 | | 1.52 | 0.046 | | 0.060 |
| L | 0.22 | | 0.31 | 0.009 | | 0.012 |
| M | 0.51 | | 1.27 | 0.020 | | 0.050 |
| N | | | 10.3 | | | 0.406 |
| P | 7.8 | | 8.05 | 0.307 | | 0.317 |
| Q | | | 5.08 | | | 0.200 |



SO16 (Narrow) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.007 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.62 | | | 0.024 |
| S | 8° (max.) | | | | | |



P013H

PLCC20 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 9.78 | | 10.03 | 0.385 | | 0.395 |
| B | 8.89 | | 9.04 | 0.350 | | 0.356 |
| D | 4.2 | | 4.57 | 0.165 | | 0.180 |
| d1 | | 2.54 | | | 0.100 | |
| d2 | | 0.56 | | | 0.022 | |
| E | 7.37 | | 8.38 | 0.290 | | 0.330 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 5.08 | | | 0.200 | |
| F | | 0.38 | | | 0.015 | |
| G | | | 0.101 | | | 0.004 |
| M | | 1.27 | | | 0.050 | |
| M1 | | 1.14 | | | 0.045 | |



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