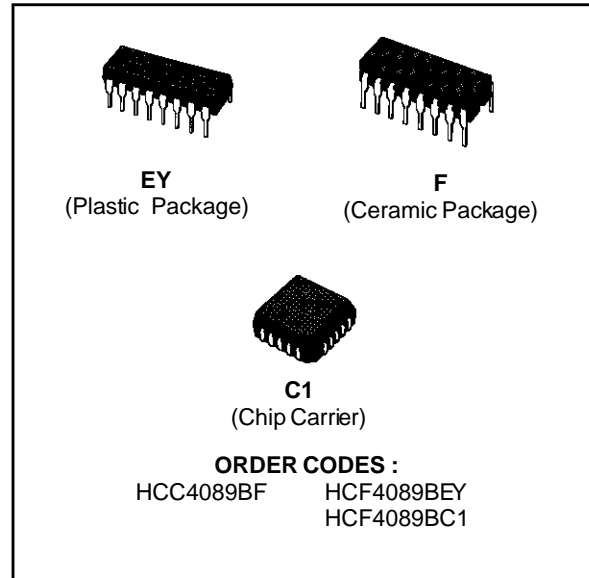


BINARY RATE MULTIPLIER

- CASCADABLE IN MULTIPLES OF 4-BITS
- SET TO "15" INPUT AND "15" DETECT OUTPUT
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- STANDARDIZED SYMMETRICAL OUTPUT CHARACTERISTICS
- 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"



DESCRIPTION

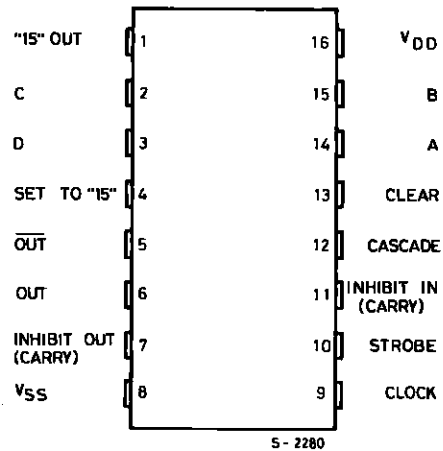
The **HCC4089B** (extended temperature range) and **HCF4089B** (intermediate temperature range) are monolithic integrated circuit available in 16-lead dual in-line plastic or ceramic package.

The **HCC/HCF4089B** is a low-power 4-bit digital rate multiplier that provides an output pulse rate that is the clock-input-pulse rate multiplied by 1/16 times the binary input. For example, when the binary input number is 13, there will be 13 output pulses for every 16 input pulses.

The **HCC/HCF4089B** has an internal synchronous 4-bit counter which, together with one of the four binary input bits, produces pulse trains as shown in timing diagram.

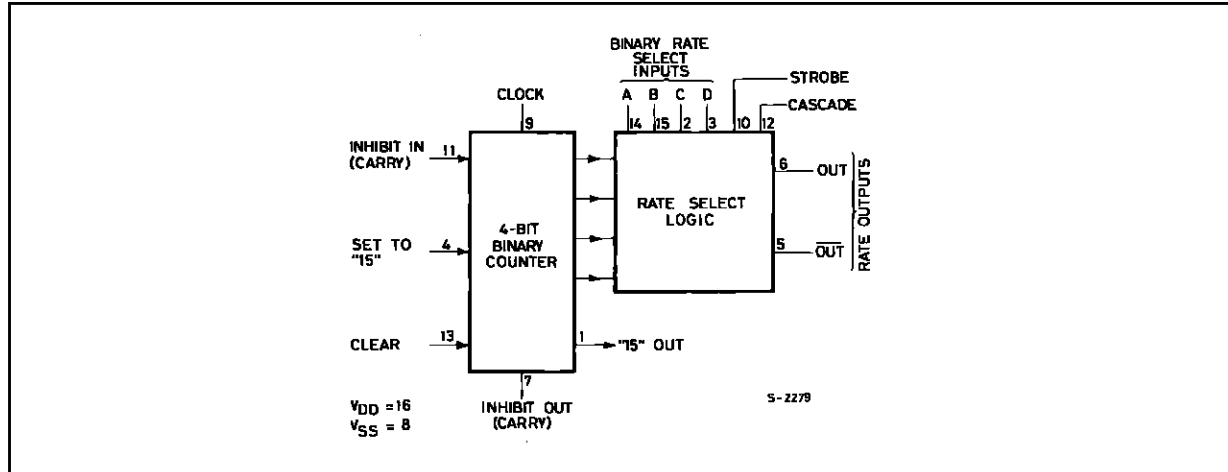
If more than one binary input bit is high, the resulting pulse train is a combination of the above separate pulse trains. This device may be used to perform arithmetic operations (add, subtract, divide, raise to a power), solve algebraic and differential equations, generate natural logarithms and trigonometric functions, A/D and D/A conversions, and frequency division.

PIN CONNECTIONS



HCC/HCF4089B

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 | °C |
| T _{stg} | Storage Temperature | - 65 to + 150 | °C |

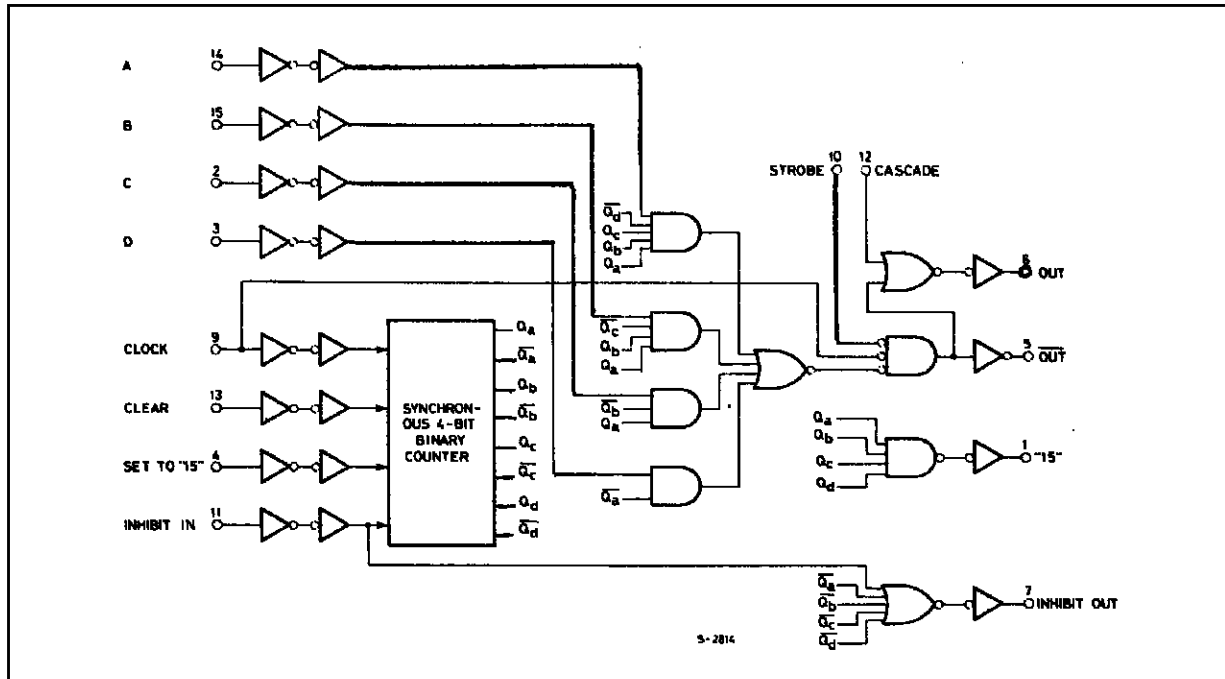
Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure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

* All voltage values are referred to V_{SS} pin voltage.

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 | °C |

LOGIC DIAGRAM



TRUTH TABLE

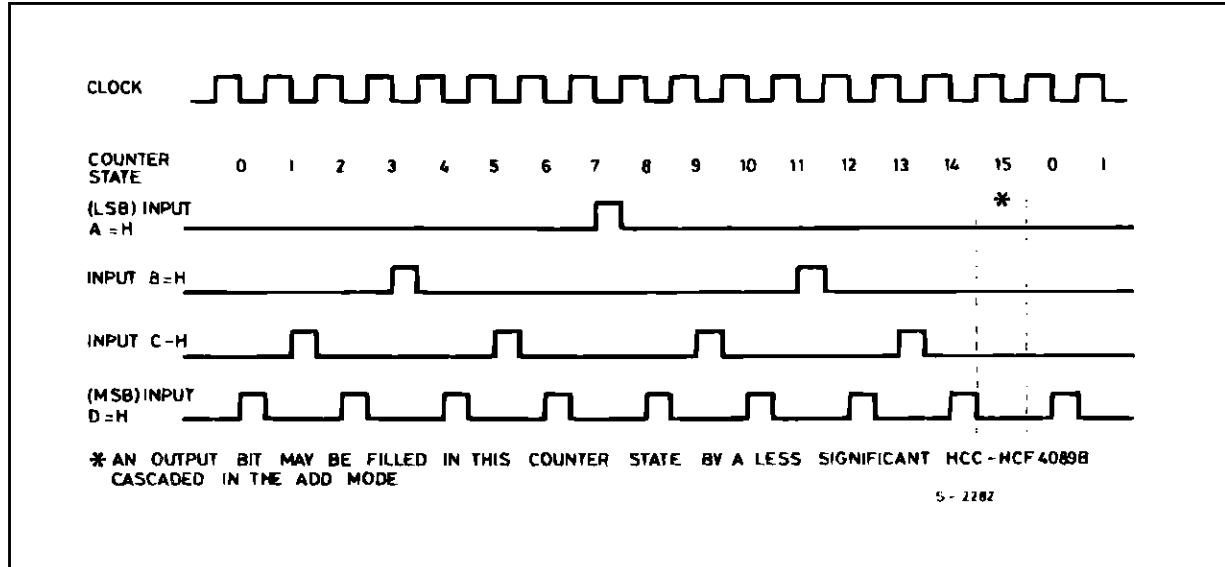
| Inputs | | | | | | | | | | Outputs | | | |
|--|---|---|---|-----|--------|-----|-----|-----|-----|--|-------------------------|---------|----------|
| Number of Pulses or Input Logic Level (0 = low ; 1 = high ; X = don't care) | | | | | | | | | | Number of Pulses or Output Logic Level (L = low ; H = high) | | | |
| D | C | B | A | CLK | INH IN | STR | CAS | CLR | SET | OUT | $\overline{\text{OUT}}$ | INH OUT | "15" OUT |
| 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | L | H | 1 | 1 |
| 0 | 0 | 0 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 1 |
| 0 | 0 | 1 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 1 |
| 0 | 1 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 1 |
| 0 | 1 | 0 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 1 | 1 |
| 0 | 1 | 1 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 6 | 6 | 1 | 1 |
| 0 | 1 | 1 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 1 | 1 |
| 1 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 1 | 1 |
| 1 | 0 | 0 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 1 | 1 |
| 1 | 0 | 1 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 1 | 1 |
| 1 | 0 | 1 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 11 | 11 | 1 | 1 |
| 1 | 1 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 12 | 12 | 1 | 1 |
| 1 | 1 | 0 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 13 | 13 | 1 | 1 |
| 1 | 1 | 1 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 14 | 14 | 1 | 1 |
| 1 | 1 | 1 | 1 | 16 | 0 | 0 | 0 | 0 | 0 | 15 | 15 | 1 | 1 |
| X | X | X | X | 16 | 1 | 0 | 0 | 0 | 0 | • | • | H | • |
| X | X | X | X | 16 | 0 | 1 | 0 | 0 | 0 | L | H | 1 | 1 |
| X | X | X | X | 16 | 0 | 0 | 1 | 0 | 0 | H | * | 1 | 1 |
| 1 | X | X | X | 16 | 0 | 0 | 0 | 1 | 0 | 16 | 16 | H | L |
| 0 | X | X | X | 16 | 0 | 0 | 0 | 1 | 0 | L | H | H | L |
| X | X | X | X | 16 | 0 | 0 | 0 | 0 | 1 | L | H | L | H |

* Output same as the first 16 lines of this truth table (depending on values of A, B, C, D).

• Depends on internal state of counter.

HCC/HCF4089B

TIMING DIAGRAM



STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

| Symbol | Parameter | Test Conditions | | | | Value | | | | | | Unit | | |
|-----------------|---------------------|-----------------------|-----------------------|--------------------------------|------------------------|--------------------|------|-------|------|------|---------------------|------|------|---------|
| | | V _I (V) | V _O (V) | I _O (μ A) | 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 | | 5 | | 0.04 | 5 | | 150 | μ A |
| | | | 0/10 | | | 10 | | 10 | | 0.04 | 10 | | 300 | |
| | | | 0/15 | | | 15 | | 20 | | 0.04 | 20 | | 600 | |
| | | HCF Types | 0/20 | | | 20 | | 100 | | 0.08 | 100 | | 3000 | |
| | | | 0/ 5 | | | 5 | | 20 | | 0.04 | 20 | | 150 | |
| | | | 0/10 | | | 10 | | 40 | | 0.04 | 40 | | 300 | |
| 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 | | | 0.5/4.5 | < 1 | 5 | 3.5 | | 3.5 | | | 3.5 | V | |
| | | | | 1/9 | < 1 | 10 | 7 | | 7 | | | 7 | | |
| | | | | 1.5/13.5 | < 1 | 15 | 11 | | 11 | | | 11 | | |
| V _{IL} | Input Low Voltage | | | 4.5/0.5 | < 1 | 5 | | 1.5 | | | 1.5 | | 1.5 | V |
| | | | | 9/1 | < 1 | 10 | | 3 | | | 3 | | 3 | |
| | | | | 13.5/1.5 | < 1 | 15 | | 4 | | | 4 | | | |

* 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.

STATIC ELECTRICAL CHARACTERISTICS (continued)

| Symbol | Parameter | | Test Conditions | | | | Value | | | | | | Unit | |
|-----------------------------------|-----------------------|-----------|-----------------------|-----------------------|--------------------------------|------------------------|--------------------|-----------|--------|---------------|-----------|---------------------|---------|---------|
| | | | V _I (V) | V _O (V) | I _O (μ A) | V _{DD} (V) | T _{Low} * | | 25°C | | | T _{High} * | | |
| | | | | | | | Min. | Max. | Min. | Typ. | Max. | Min. | | Max. |
| 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 | | ± 0.1 | | $\pm 10^{-5}$ | ± 0.1 | | ± 1 | μ A |
| | | HCF Types | 0/15 | | | 15 | | ± 0.3 | | $\pm 10^{-5}$ | ± 0.3 | | ± 1 | |
| 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.

HCC/HCF4089B

DYNAMIC ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$, $C_L = 50\text{pF}$, $R_L = 200\text{k}\Omega$, typical temperature coefficient for all V_{DD} values is $0.3\%/^{\circ}\text{C}$, all input rise and fall times = 20ns)

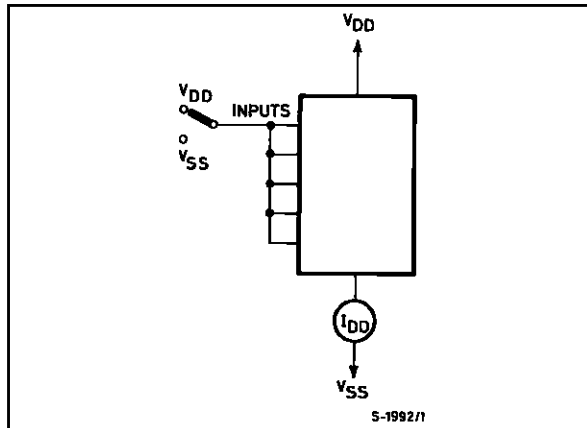
| Symbol | Parameter | | Test Conditions | | Value | | | Unit |
|-----------------------|------------------------|--|-----------------|--------------|-------|------|------|------|
| | | | | V_{DD} (V) | Min. | Typ. | Max. | |
| t_{PHL} , t_{PLH} | Propagation Delay Time | Clock to $\overline{\text{out}}$ | | 5 | | 110 | 220 | ns |
| | | | | 10 | | 55 | 110 | |
| | | | | 15 | | 45 | 90 | |
| | | Clock or Strobe to out | | 5 | | 150 | 300 | ns |
| | | | | 10 | | 75 | 150 | |
| | | | | 15 | | 60 | 120 | |
| | | Clock to Inhibit High Level to Low Level | | 5 | | 360 | 720 | ns |
| | | | | 10 | | 160 | 320 | |
| | | | | 15 | | 110 | 220 | |
| | | Low Level to High Level | | 5 | | 250 | 500 | ns |
| | | | | 10 | | 100 | 200 | |
| | | | | 15 | | 75 | 150 | |
| | | Clear to out | | 5 | | 380 | 760 | ns |
| | | | | 10 | | 175 | 350 | |
| | | | | 15 | | 130 | 260 | |
| | | Clock to "9" or "15" out | | 5 | | 300 | 600 | ns |
| | | | | 10 | | 125 | 250 | |
| | | | | 15 | | 90 | 180 | |
| | | Cascade to out | | 5 | | 90 | 180 | ns |
| | | | | 10 | | 45 | 90 | |
| | | | | 15 | | 35 | 70 | |
| | | Inhibit in to Inhibit out | | 5 | | 160 | 320 | ns |
| | | | | 10 | | 75 | 150 | |
| | | | | 15 | | 55 | 110 | |
| Set to out | | 5 | | 330 | 660 | ns | | |
| | | 10 | | 150 | 300 | | | |
| | | 15 | | 110 | 220 | | | |

DYNAMIC ELECTRICAL CHARACTERISTICS (continued)

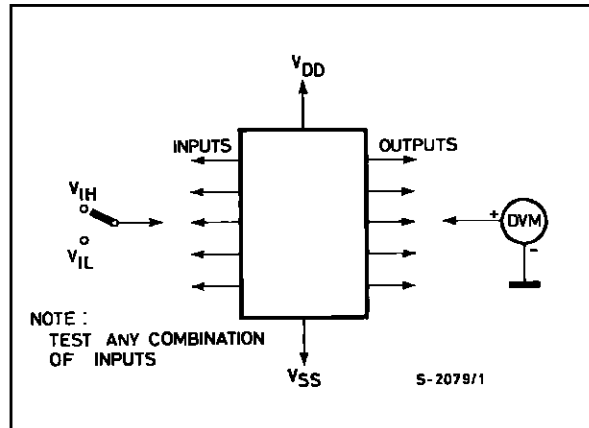
| Symbol | Parameter | Test Conditions | | Value | | | Unit |
|-------------------------------------|---|-----------------|---------------------|-------|------|------|------|
| | | | V _{DD} (V) | Min. | Typ. | Max. | |
| t _{THL} , t _{TLH} | Transition Time | | 5 | | 100 | 200 | ns |
| | | | 10 | | 50 | 100 | |
| | | | 15 | | 40 | 80 | |
| f _{CL} | Maximum Clock Frequency | | 5 | 1.2 | 2.4 | | MHz |
| | | | 10 | 2.5 | 5 | | |
| | | | 15 | 3.5 | 7 | | |
| t _w | Clock Pulse Width | | 5 | 330 | 165 | | ns |
| | | | 10 | 170 | 85 | | |
| | | | 15 | 100 | 50 | | |
| t _r , t _f | Clock Rise or Fall Time | | 5 | | | 15 | μs |
| | | | 10 | | | 15 | |
| | | | 15 | | | 15 | |
| t _w | Set or Clear Pulse Width | | 5 | 160 | 80 | | ns |
| | | | 10 | 90 | 45 | | |
| | | | 15 | 60 | 30 | | |
| t _{setup} | Inhibit Input Setup Time, High Level to Low Level | | 5 | 100 | 50 | | ns |
| | | | 10 | 40 | 20 | | |
| | | | 15 | 20 | 10 | | |
| t _R | Inhibit, Input Removal Time | | 5 | 240 | 120 | | ns |
| | | | 10 | 130 | 65 | | |
| | | | 15 | 110 | 55 | | |
| t _R | Minimum Set Removal Time | | 5 | 150 | 75 | | ns |
| | | | 10 | 80 | 40 | | |
| | | | 15 | 50 | 25 | | |
| t _R | Clear Removal Time | | 5 | 60 | 30 | | ns |
| | | | 10 | 40 | 20 | | |
| | | | 15 | 30 | 15 | | |

TEST CIRCUITS

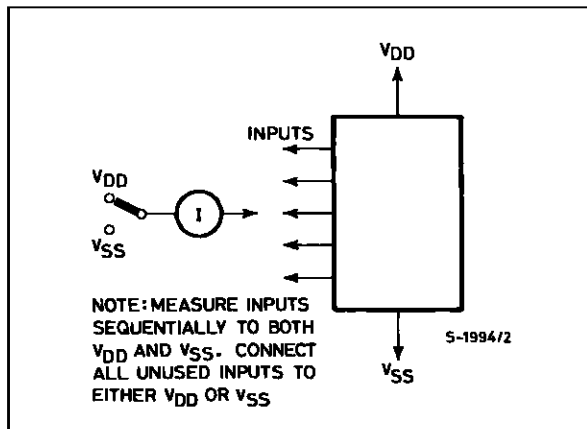
Quiescent Device Current



Noise Immunity

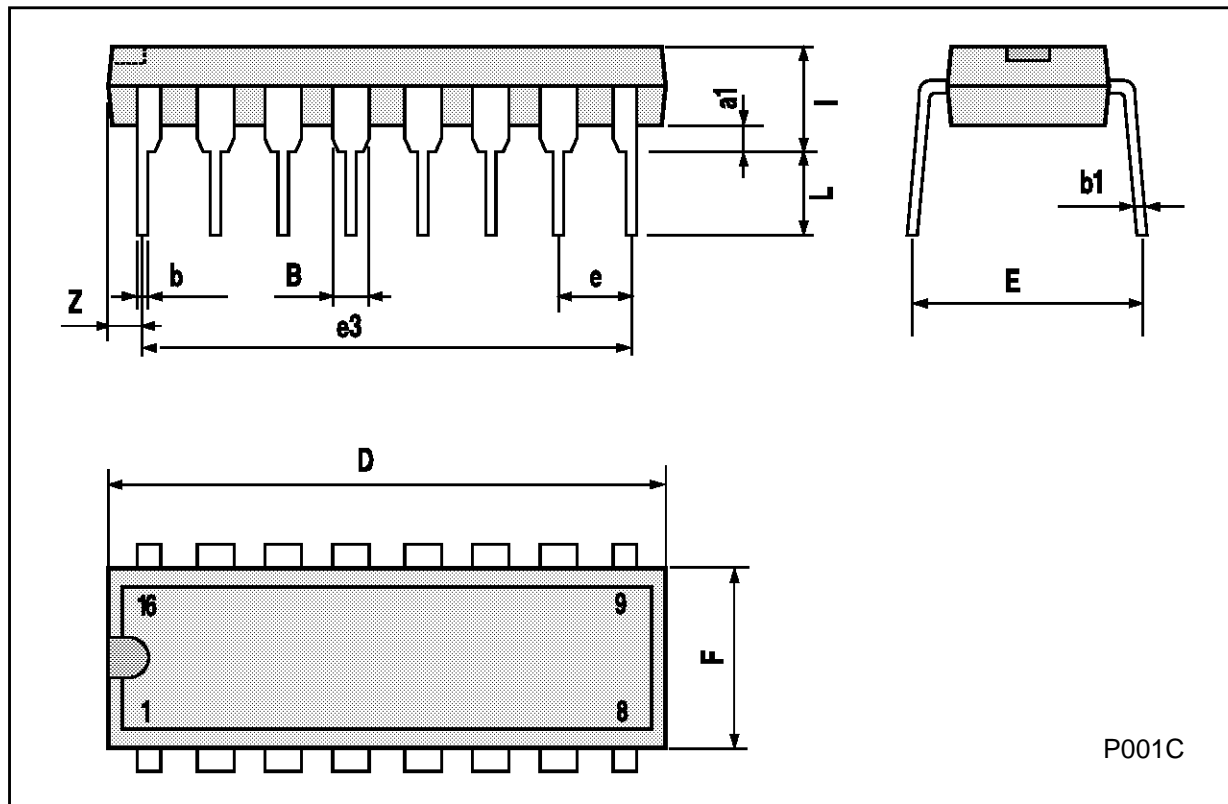


Input Leakage Current



Plastic DIP16 (0.25) MECHANICAL DATA

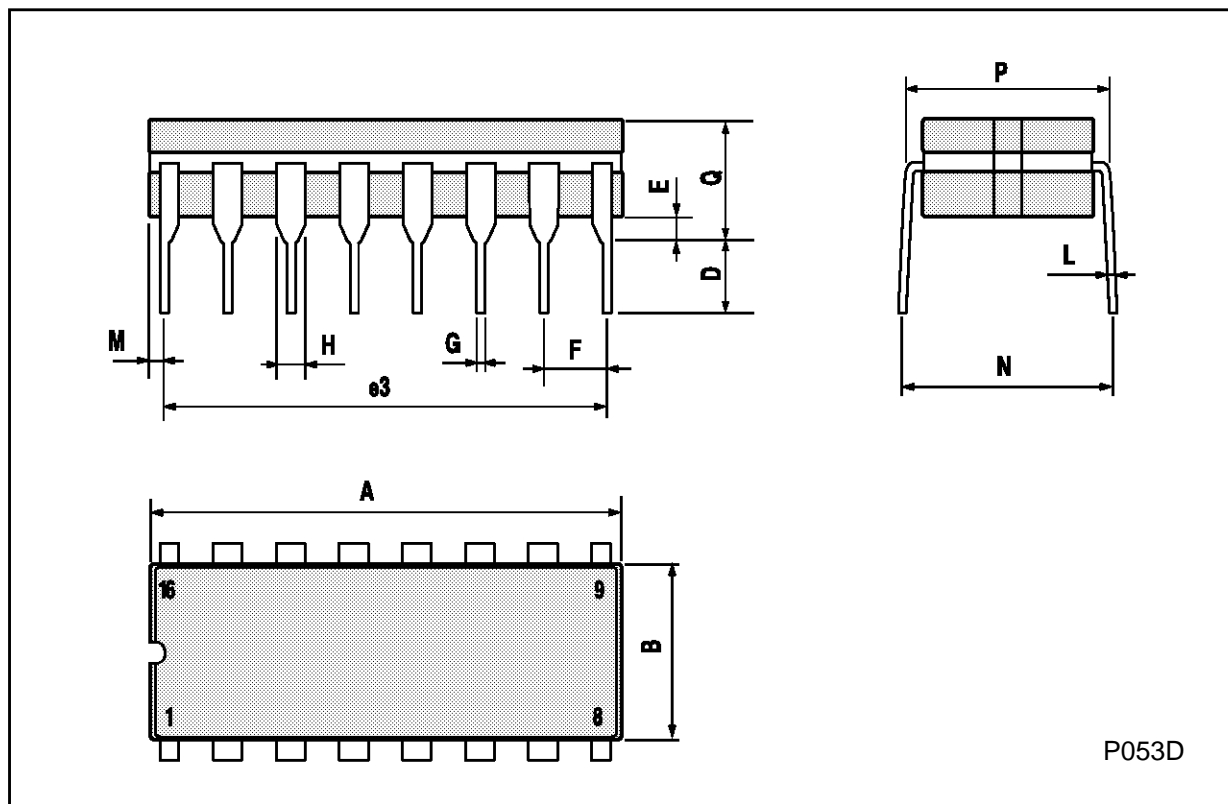
| DIM. | mm | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | |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



P001C

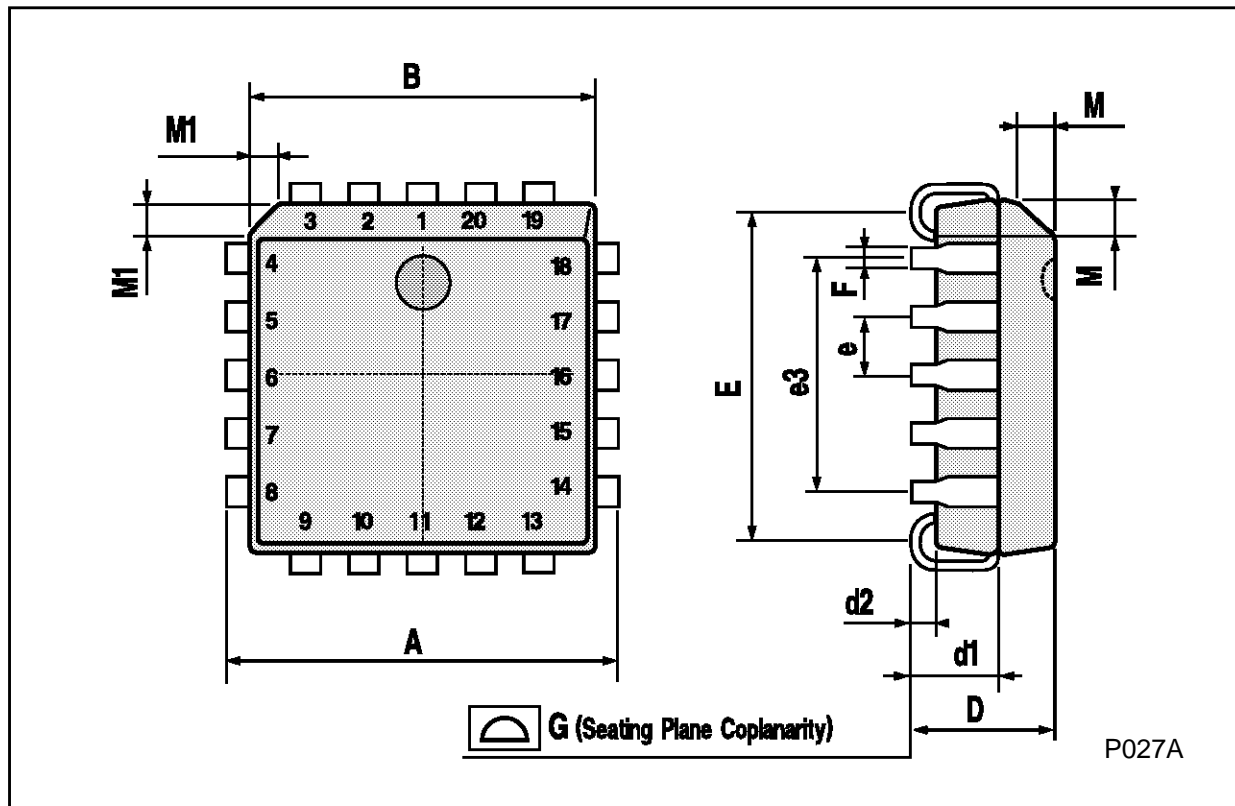
Ceramic DIP16/1 MECHANICAL DATA

| 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 |



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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