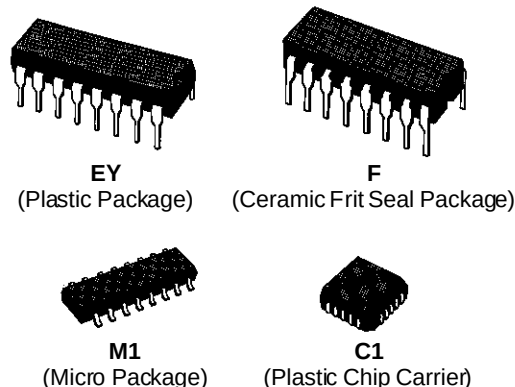


## DUAL UP-COUNTERS

### HCC/HCF4518B DUAL BCD UP-COUNTER

### HCC/HCF4520B DUAL BINARY UP-COUNTER

- MEDIUM-SPEED OPERATION – 6MHz TYP. CLOCK FREQUENCY AT 10V
- POSITIVE - OR NEGATIVE - EDGE TRIGGERING
- SYNCHRONOUS INTERNAL CARRY PROPAGATION
- QUIESCENT CURRENT SPECIFIED TO 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"



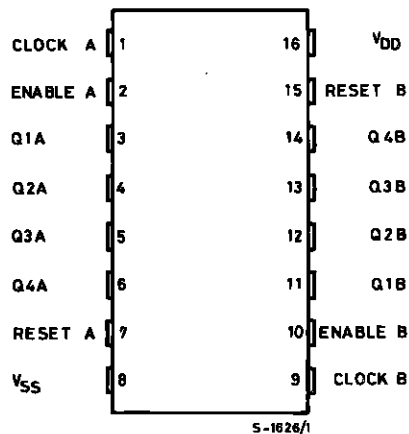
#### ORDER CODES :

|            |            |
|------------|------------|
| HCC45XXBF  | HCF45XXBM1 |
| HCF45XXBEY | HCF45XXBC1 |

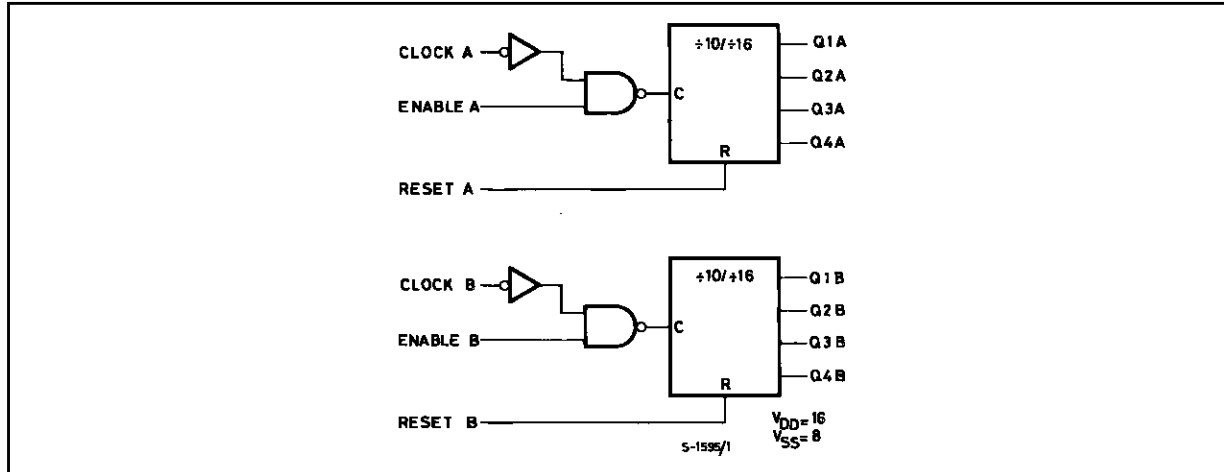
### DESCRIPTION

The **HCC4518B/4520B** (extended temperature range) and **HCF4518B/4520B** (intermediate temperature range) are monolithic integrated circuits, available in 16-lead dual in-line plastic or ceramic package and plastic micro package. The **HCC/HCF4518B** Dual BCD Up Counter and **HCC/HCF4520B** Dual Binary Up Counter each consist of two identical, internally synchronous 4-stage counters. The counter stages are D-type flip-flops having interchangeable Clock and Enable lines for incrementing on either the positive-going or negative-going transition. For single-unit operation the Enable input is maintained "high" and the counter advances on each positive-going transition of the Clock. The counters are cleared by high levels on their Reset lines. The counter can be cascaded in the ripple mode by connecting Q4 to the enable input of the subsequent counter while the clock input of the latter is held low.

### PIN CONNECTIONS



## FUNCTIONAL DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

| Symbol     | Parameter                                                                                 | Value                          | Unit     |
|------------|-------------------------------------------------------------------------------------------|--------------------------------|----------|
| $V_{DD}^*$ | Supply Voltage : <b>HCC</b> Types<br><b>HCF</b> Types                                     | – 0.5 to + 20<br>– 0.5 to + 18 | V<br>V   |
| $V_i$      | Input Voltage                                                                             | – 0.5 to $V_{DD} + 0.5$        | V        |
| $I_i$      | DC Input Current (any one input)                                                          | $\pm 10$                       | mA       |
| $P_{tot}$  | Total Power Dissipation (per package)                                                     | 200                            | mW       |
|            | Dissipation per Output Transistor<br>for $T_{op} = \text{Full Package-temperature Range}$ | 100                            | mW       |
| $T_{op}$   | Operating Temperature : <b>HCC</b> Types<br><b>HCF</b> Types                              | – 55 to + 125<br>– 40 to + 85  | °C<br>°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 : <b>HCC</b> Types<br><b>HCF</b> Types        | 3 to 18<br>3 to 15            | V<br>V   |
| $V_i$    | Input Voltage                                                | 0 to $V_{DD}$                 | V        |
| $T_{op}$ | Operating Temperature : <b>HCC</b> Types<br><b>HCF</b> Types | – 55 to + 125<br>– 40 to + 85 | °C<br>°C |

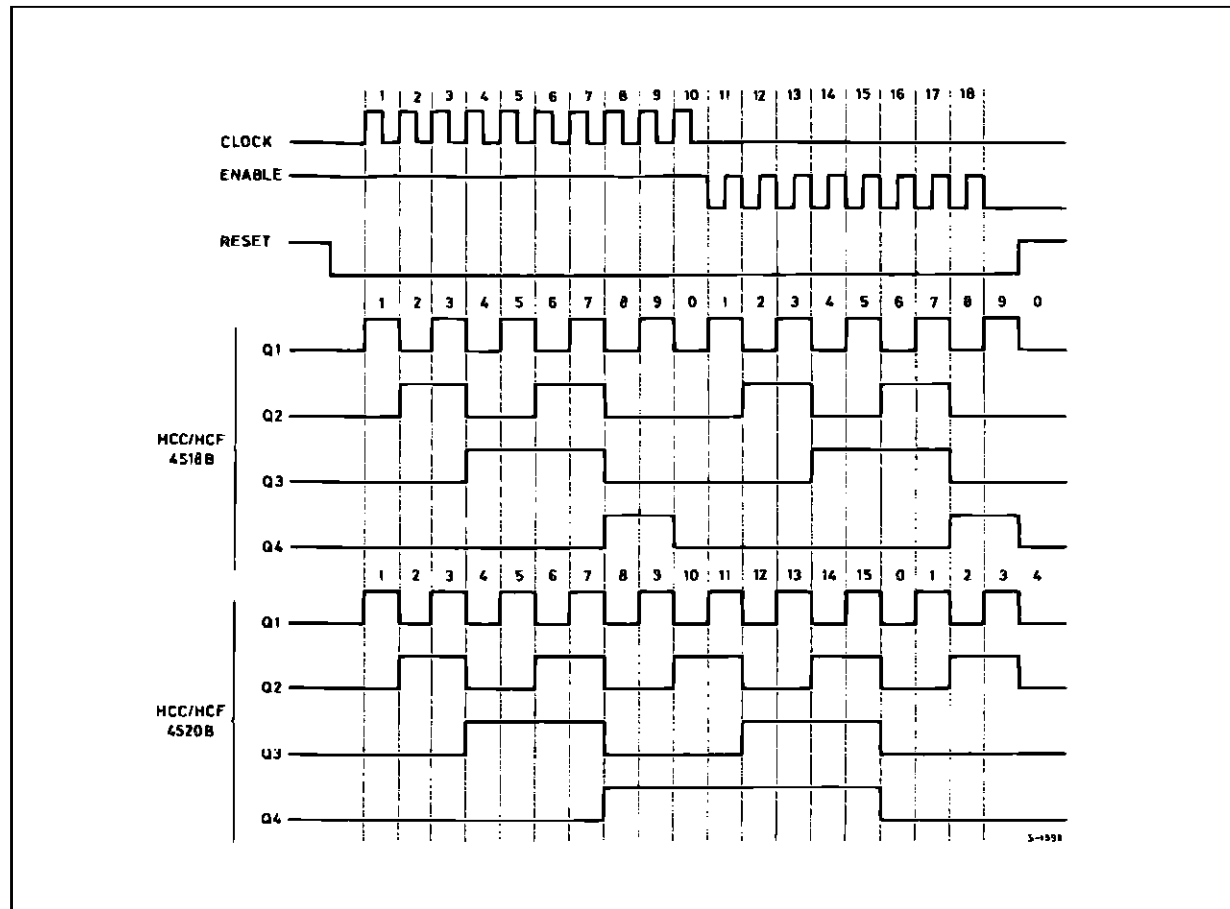


## TRUTH TABLE

| Clock | Enable | Reset | Action            |
|-------|--------|-------|-------------------|
|       | 1      | 0     | Increment Counter |
| 0     |        | 0     | Increment Counter |
|       | X      | 0     | No Change         |
| X     |        | 0     | No Change         |
|       | 0      | 0     | No Change         |
| 1     |        | 0     | No Change         |
| X     | X      | 1     | Q1 Thru Q4 = 0    |

X = Don't Care    Logic 1 = High State    Logic 0 = Low

## TIMING DIAGRAM



## STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

| Symbol                            | Parameter             |           | Test Conditions       |                       |                          |                        | Value              |       |                   |       |       |                     |      | Unit |
|-----------------------------------|-----------------------|-----------|-----------------------|-----------------------|--------------------------|------------------------|--------------------|-------|-------------------|-------|-------|---------------------|------|------|
|                                   |                       |           | V <sub>I</sub><br>(V) | V <sub>O</sub><br>(V) | I <sub>O</sub>  <br>(μA) | V <sub>DD</sub><br>(V) | T <sub>Low</sub> * |       | 25°C              |       |       | T <sub>High</sub> * |      |      |
|                                   |                       |           |                       |                       |                          |                        | Min.               | Max.  | Min.              | Typ.  | Max.  | Min.                | Max. |      |
| I <sub>L</sub>                    | Quiescent Current     | HCC Types | 0/ 5                  |                       |                          | 5                      |                    | 5     |                   | 0.04  | 5     |                     | 150  | μA   |
|                                   |                       |           | 0/10                  |                       |                          | 10                     |                    | 10    |                   | 0.04  | 10    |                     | 300  |      |
|                                   |                       |           | 0/15                  |                       |                          | 15                     |                    | 20    |                   | 0.04  | 20    |                     | 600  |      |
|                                   |                       |           | 0/20                  |                       |                          | 20                     |                    | 100   |                   | 0.08  | 100   |                     | 3000 |      |
|                                   |                       | HCF Types | 0/ 5                  |                       |                          | 5                      |                    | 20    |                   | 0.04  | 20    |                     | 150  |      |
|                                   |                       |           | 0/10                  |                       |                          | 10                     |                    | 40    |                   | 0.04  | 40    |                     | 300  |      |
|                                   |                       |           | 0/15                  |                       |                          | 15                     |                    | 80    |                   | 0.04  | 80    |                     | 600  |      |
| V <sub>OH</sub>                   | 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 <sub>OL</sub>                   | 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 <sub>IH</sub>                   | 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 <sub>IL</sub>                   | 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     |       | 4                   |      |      |
| I <sub>OH</sub>                   | 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 <sub>OL</sub>                   | 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 <sub>IH</sub> , I <sub>IL</sub> | Input Leakage Current | HCC Types | 0/18                  | Any Input             | 18                       |                        | ± 0.1              |       | ±10 <sup>−5</sup> | ± 0.1 |       | ± 1                 | μA   |      |
|                                   |                       | HCF Types | 0/15                  |                       | 15                       |                        | ± 0.3              |       | ±10 <sup>−5</sup> | ± 0.3 |       | ± 1                 |      |      |
| C <sub>I</sub>                    | Input Capacitance     |           |                       | Any Input             |                          |                        |                    |       | 5                 | 7.5   |       |                     | pF   |      |

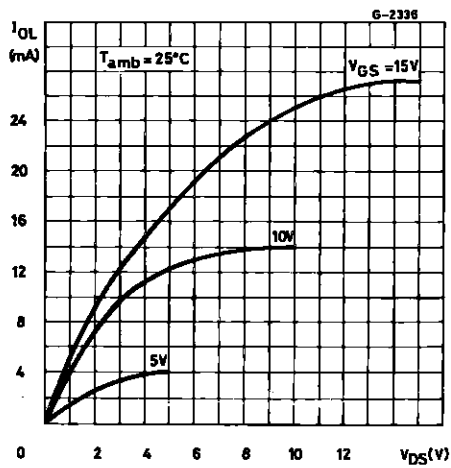
\* T<sub>Low</sub> = - 55°C for HCC device : - 40°C for HCF device.\* T<sub>High</sub> = + 125°C for HCC device : + 85°C for HCF device.The Noise Margin for both "1" and "0" level is : 1V min. with V<sub>DD</sub> = 5V, 2V min. with V<sub>DD</sub> = 10V, 2.5V min. with V<sub>DD</sub> = 15V.

**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  $V_{DD} = 0.3\%/^{\circ}\text{C}$  values, all input rise and fall time = 20ns)

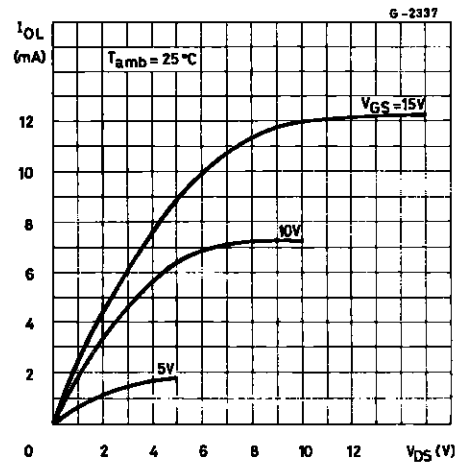
| Symbol                   | Parameter                                             | Test Conditions |              | Value |      |      | Unit          |
|--------------------------|-------------------------------------------------------|-----------------|--------------|-------|------|------|---------------|
|                          |                                                       |                 | $V_{DD}$ (V) | Min.  | Typ. | Max. |               |
| $t_{PLH}$ ,<br>$t_{PHL}$ | Propagation Delay Time<br>(clock or enable to output) |                 | 5            |       | 280  | 560  | ns            |
|                          |                                                       |                 | 10           |       | 115  | 230  |               |
|                          |                                                       |                 | 15           |       | 80   | 160  |               |
| $t_{PLH}$ ,<br>$t_{PHL}$ | Propagation Delay Time<br>(reset to output)           |                 | 5            |       | 330  | 650  | ns            |
|                          |                                                       |                 | 10           |       | 130  | 225  |               |
|                          |                                                       |                 | 15           |       | 90   | 170  |               |
| $t_{TLH}$ , $t_{THL}$    | Transition Time                                       |                 | 5            |       | 100  | 200  | ns            |
|                          |                                                       |                 | 10           |       | 50   | 100  |               |
|                          |                                                       |                 | 15           |       | 40   | 80   |               |
| $t_W$                    | Clock Pulse Width                                     |                 | 5            | 200   | 100  |      | ns            |
|                          |                                                       |                 | 10           | 100   | 50   |      |               |
|                          |                                                       |                 | 15           | 70    | 35   |      |               |
| $t_W$                    | Reset Pulse Width                                     |                 | 5            | 250   | 125  |      | ns            |
|                          |                                                       |                 | 10           | 110   | 55   |      |               |
|                          |                                                       |                 | 15           | 80    | 40   |      |               |
| $t_W$                    | Enable Pulse Width                                    |                 | 5            | 400   | 200  |      | ns            |
|                          |                                                       |                 | 10           | 200   | 100  |      |               |
|                          |                                                       |                 | 15           | 140   | 70   |      |               |
| $t_r$ ,<br>$t_f$         | Clock or Enable Rise and Fall Time                    |                 | 5            |       |      | 15   | $\mu\text{s}$ |
|                          |                                                       |                 | 10           |       |      | 15   |               |
|                          |                                                       |                 | 15           |       |      | 5    |               |
| $f_{max}$                | Maximum Clock Frequency                               |                 | 5            | 1.5   | 3    |      | MHz           |
|                          |                                                       |                 | 10           | 3     | 6    |      |               |
|                          |                                                       |                 | 15           | 4     | 8    |      |               |
| $t_r$ ,<br>$t_f$         | Clock Input Rise or Fall Time                         |                 | 5            |       |      | 15   | $\mu\text{s}$ |
|                          |                                                       |                 | 10           |       |      | 5    |               |
|                          |                                                       |                 | 15           |       |      | 5    |               |

Typical Output Low (sink) Current Characteristics.

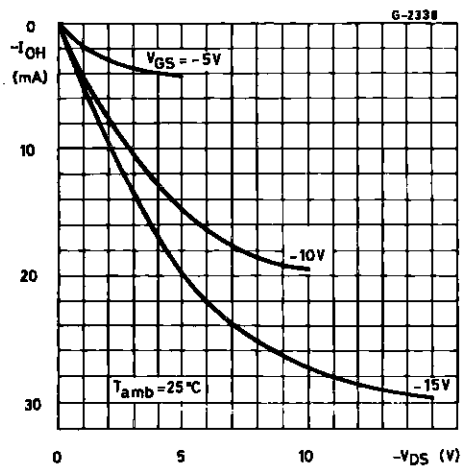
Mini-



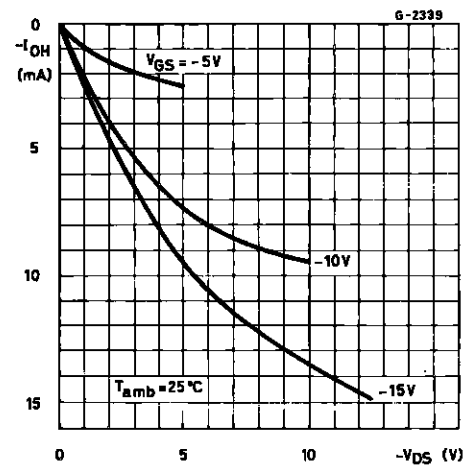
Minimum Output Low (sink) Current Characteristics.



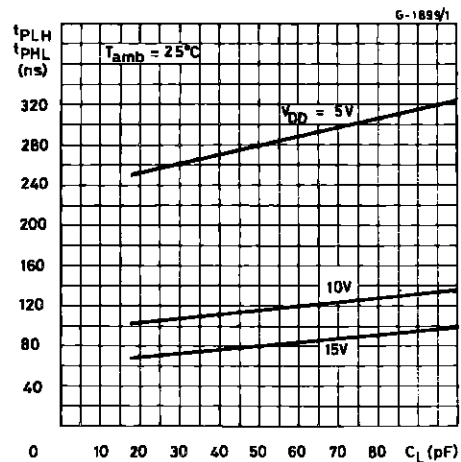
Typical Output High (source) Current Characteristics.



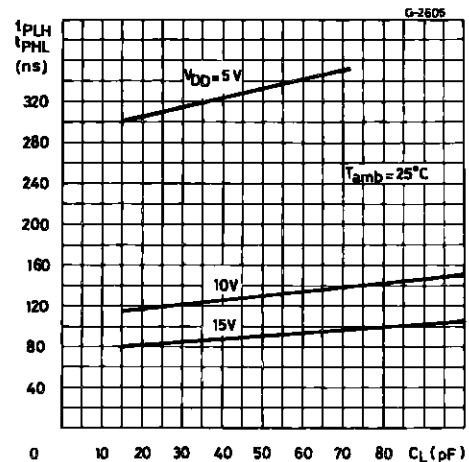
Minimum output High (source) Current Characteristics.



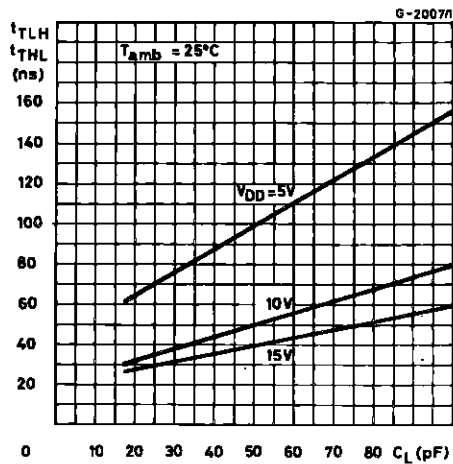
Typical Propagation Delay vs. Load Capacitance, Reset to output.



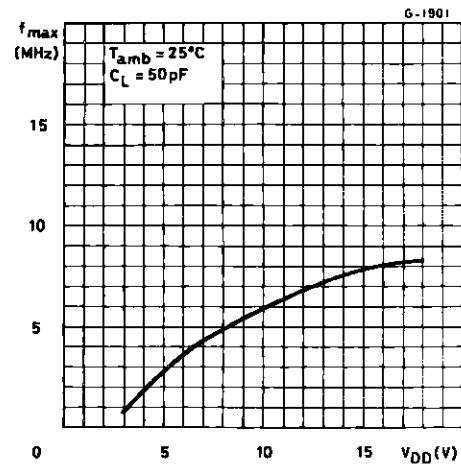
Typical Propagation Delay Time vs. Load Capacitance, Clock or Enable to Output.



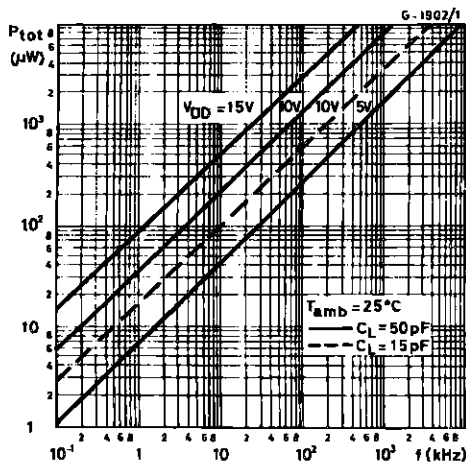
Typical Transition Time vs. load Capacitance.



Typical Maximum-clock Frequency vs. Supply Voltage.

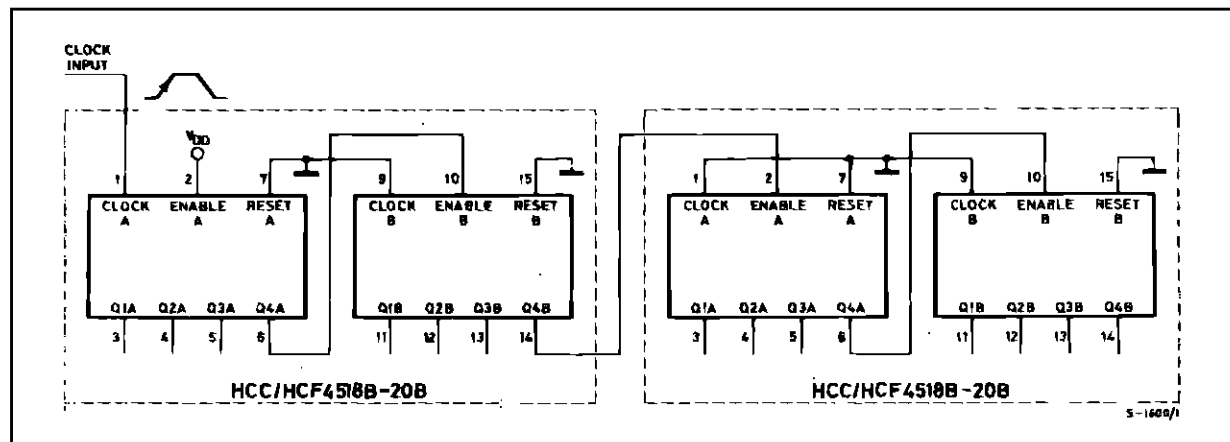


Typical Power Dissipation/Counter vs. Frequency.



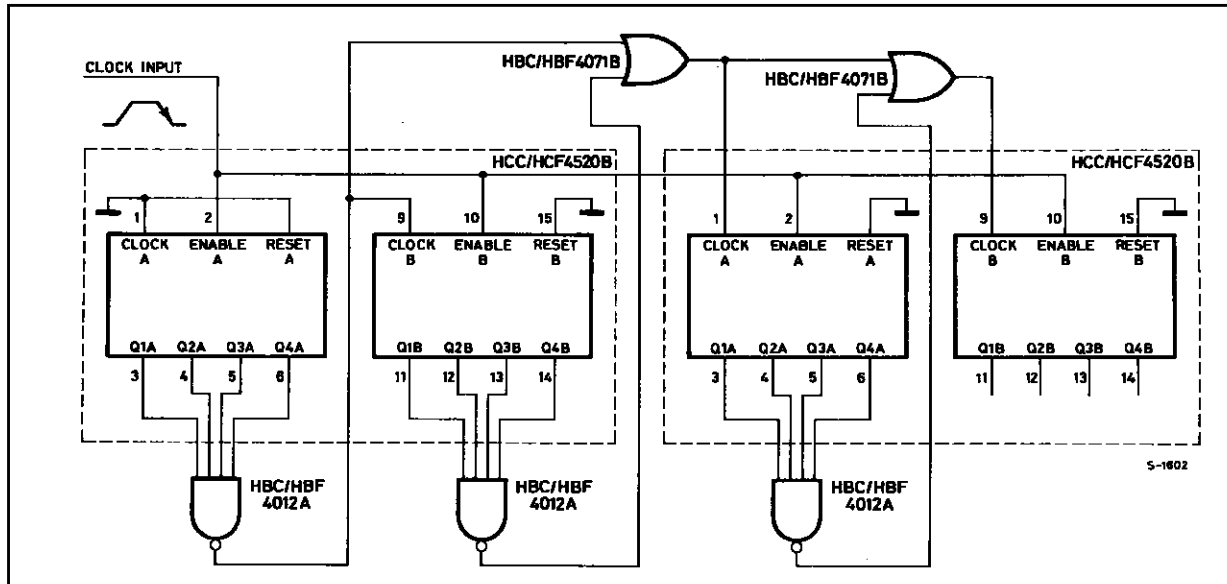
## TYPICAL APPLICATIONS

RIPPLE CASCADING OF FOUR COUNTERS WITH POSITIVE-EDGE TRIGGERING.



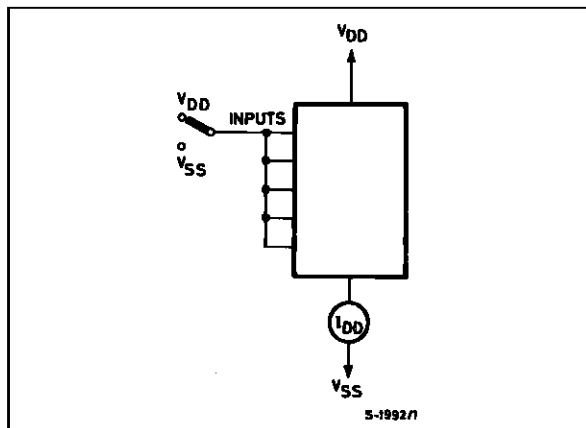


SYNCHRONOUS CASCADING OF FOUR BINARY COUNTERS WITH NEGATIVE-EDGE TRIGGERING.

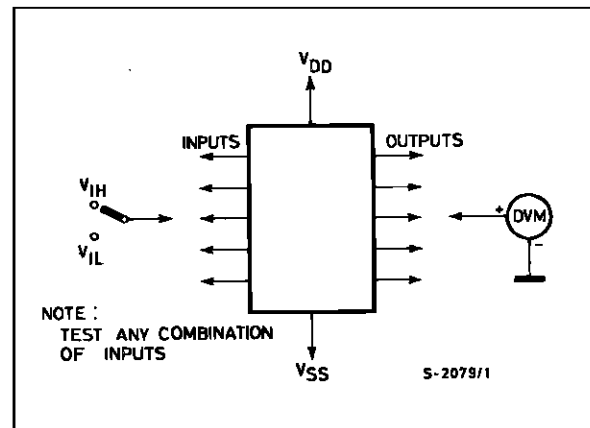


## TEST CIRCUITS

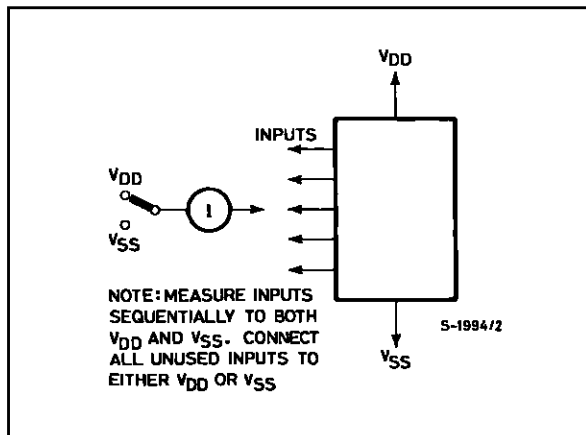
### Quiescent Device Current



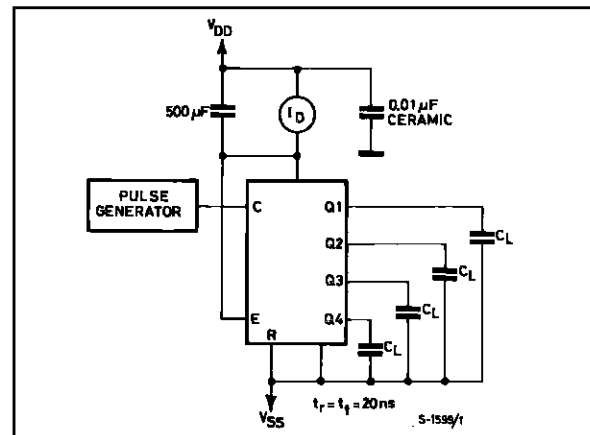
### Noise Immunity.



Input Leakage Current.

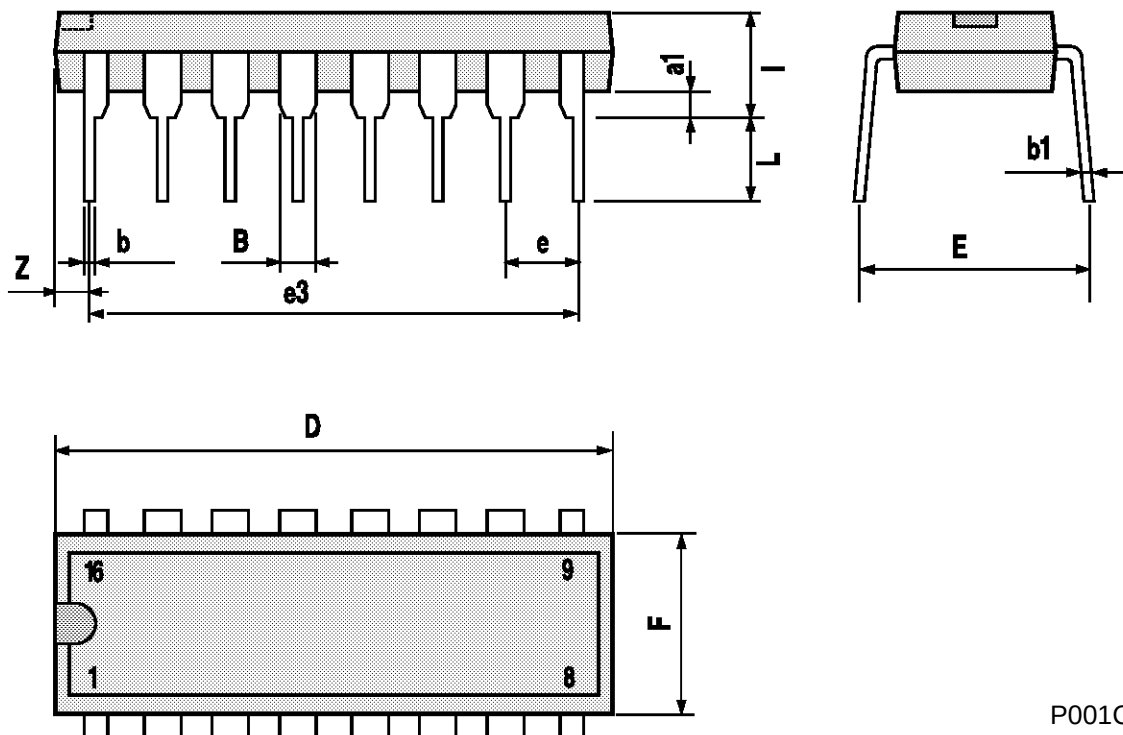


### Dynamic Power Dissipation.



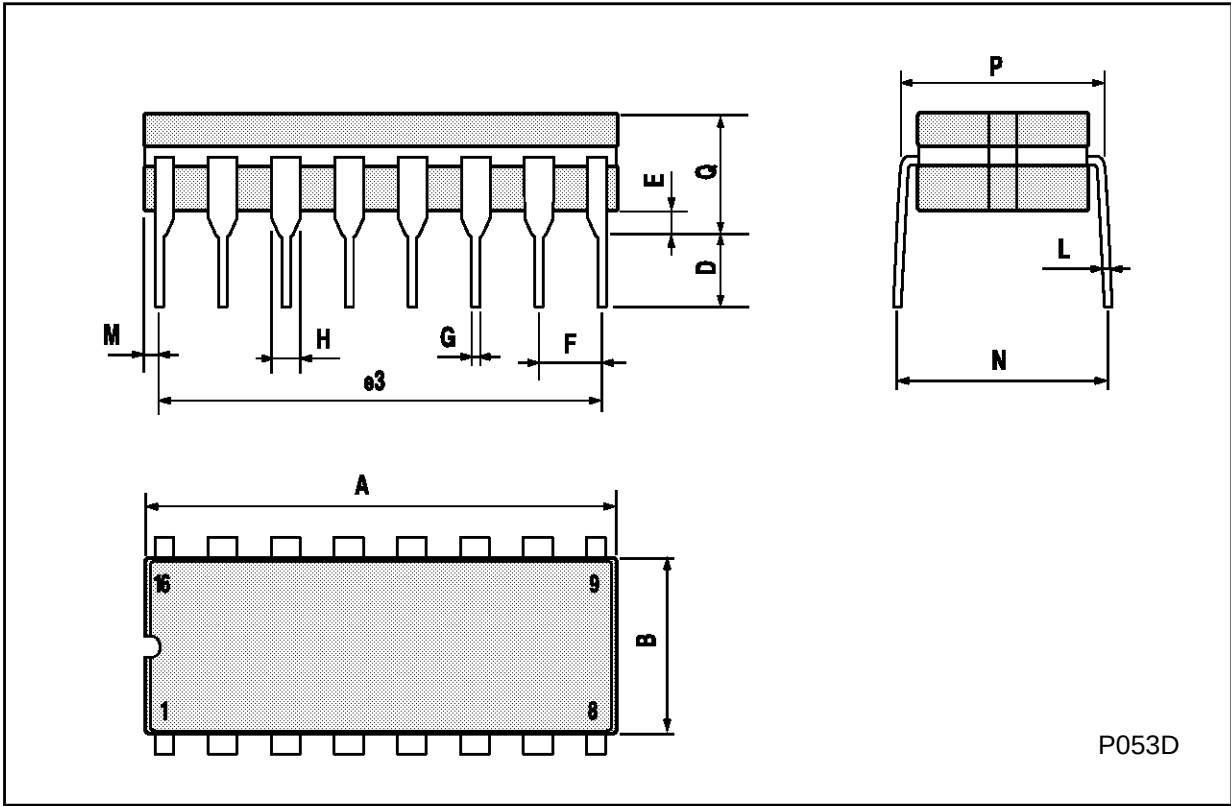
## Plastic DIP16 (0.25) MECHANICAL DATA

| 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 |
| I    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    |      |       | 1.27 |       |       | 0.050 |



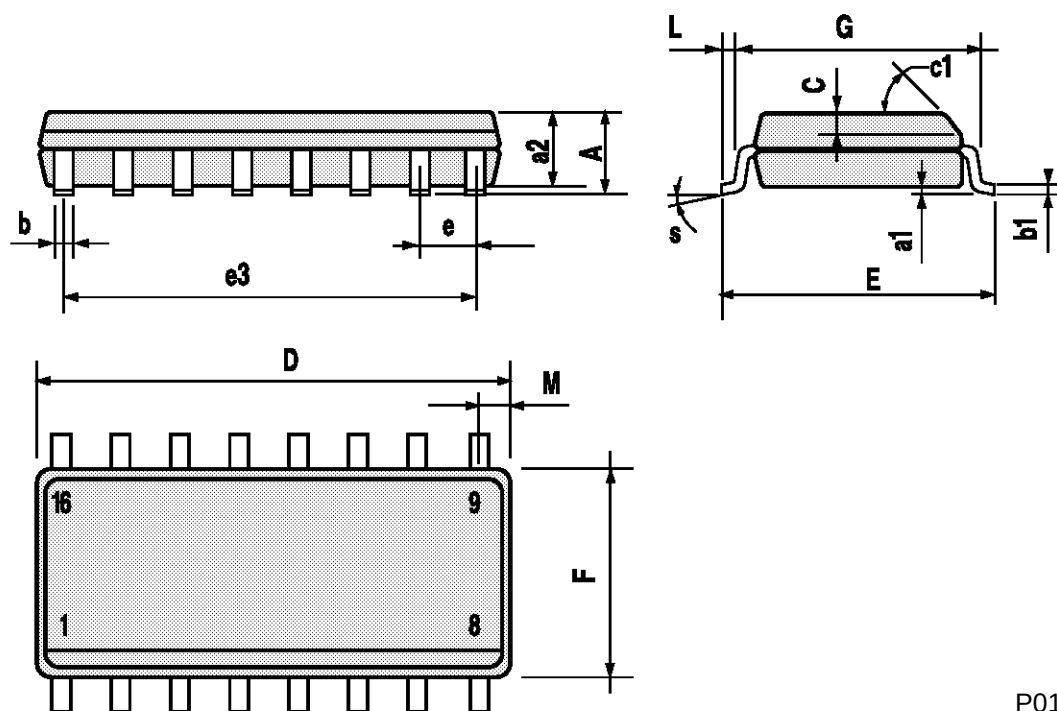
Ceramic DIP16/1 MECHANICAL DATA

| 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

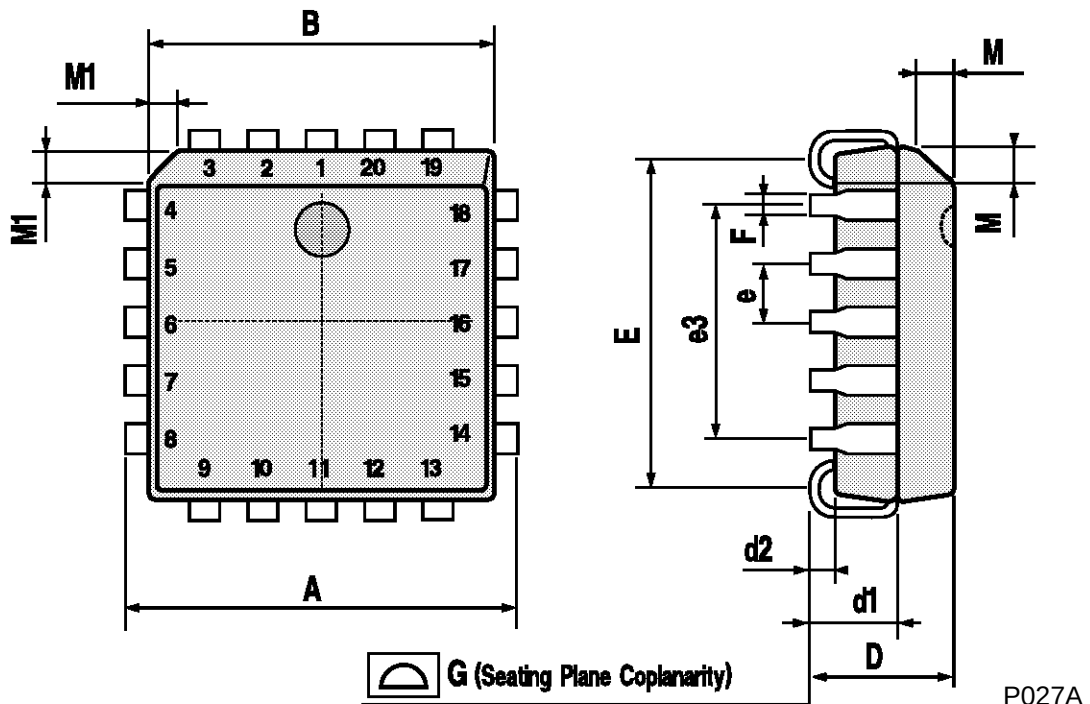
| DIM. | mm         |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.004 |       | 0.007 |
| 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 |       |



P027A

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