



## HCC/HCF40160B-40161B-40162-40163

cascading counter for n-bit synchronous application without additional gating. Instrumental in accomplishing this function are two count-enable input and a carry output (COUT). Counting is enable when both PE and TE inputs are high. The TE input is fed forward to enable COUT. This enable output

produces a positive output pulse with a duration approximately equal to the positive portion of the Q1 output. This positive overflow carry pulse can be used to enable successive cascaded stages. Logic transitions at the PE or TE inputs may occur when the clock is either high or low.

### ABSOLUTE MAXIMUM RATING

| Symbol     | Parameter   | Value                  | Unit               |
|------------|---|------------------------|--------------------|
| $V_{DD}^*$ | Supply Voltage: <b>HCC Types</b><br><b>HCF Types</b>                          | -0.5 to +20            | V                  |
|            |   | -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)  | $\pm 10$               | mA                 |
| $P_{tot}$  | Total Power Dissipation (per package)   | 200                    | mW                 |
|            | Dissipation per Output Transistor<br>for Top = Full Package Temperature Range | 100                    | mW                 |
| $T_{op}$   | Operating Temperature: <b>HCC Types</b><br><b>HCF Types</b>                   | -55 to +125            | $^{\circ}\text{C}$ |
|            |   | -40 to +85             | $^{\circ}\text{C}$ |
| $T_{stg}$  | Storage Temperature   | -65 to +150            | $^{\circ}\text{C}$ |







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

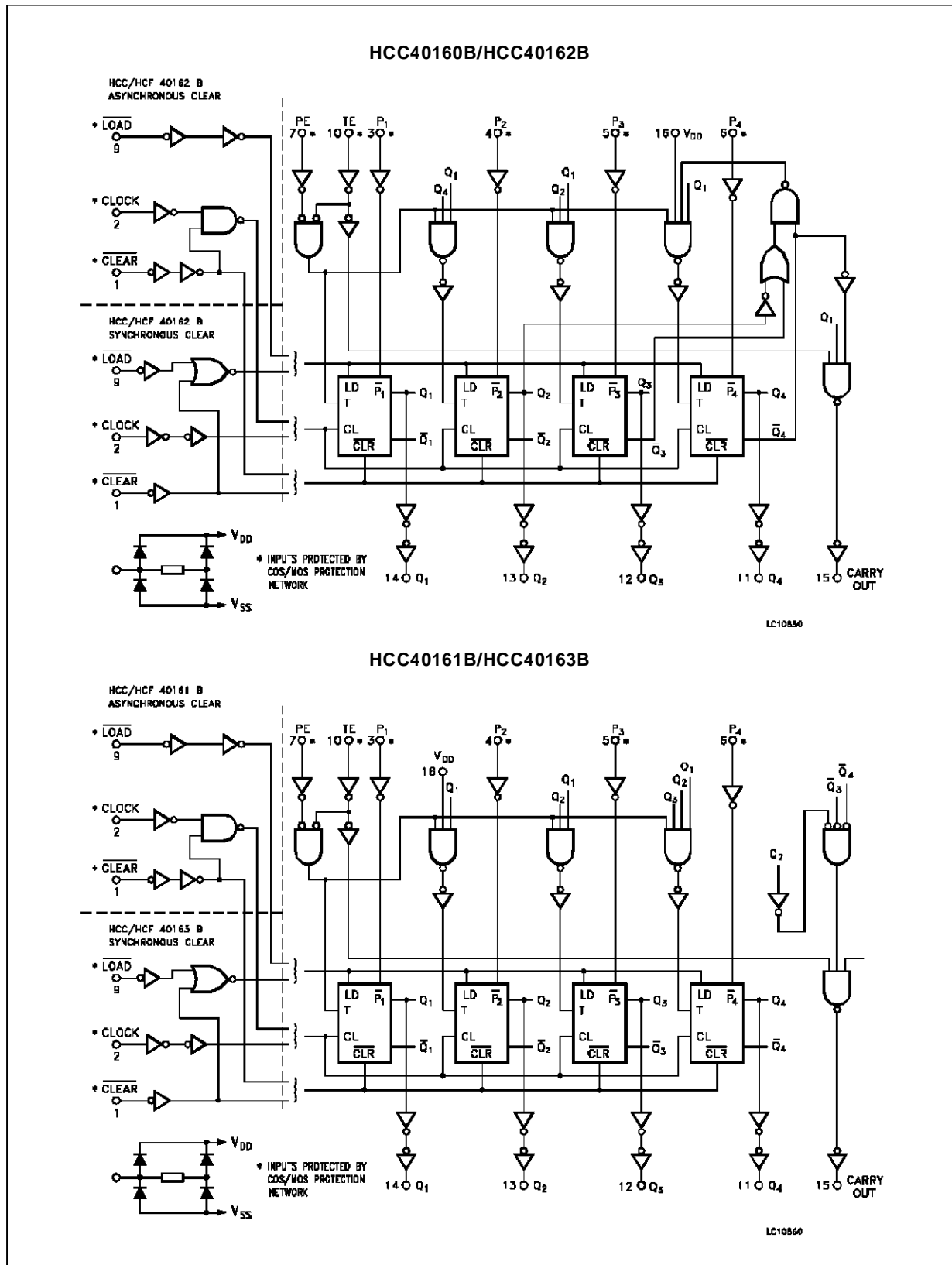
| Symbol   | Parameter   | Value         | Unit               |
|----------|---|---------------|--------------------|
| $V_{DD}$ | Supply Voltage: <b>HCC Types</b><br><b>HCF Types</b>        | 3 to 18       | V                  |
|          |   | 3 to 15       | V                  |
| $V_i$    | Input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

### TRUTH TABLE

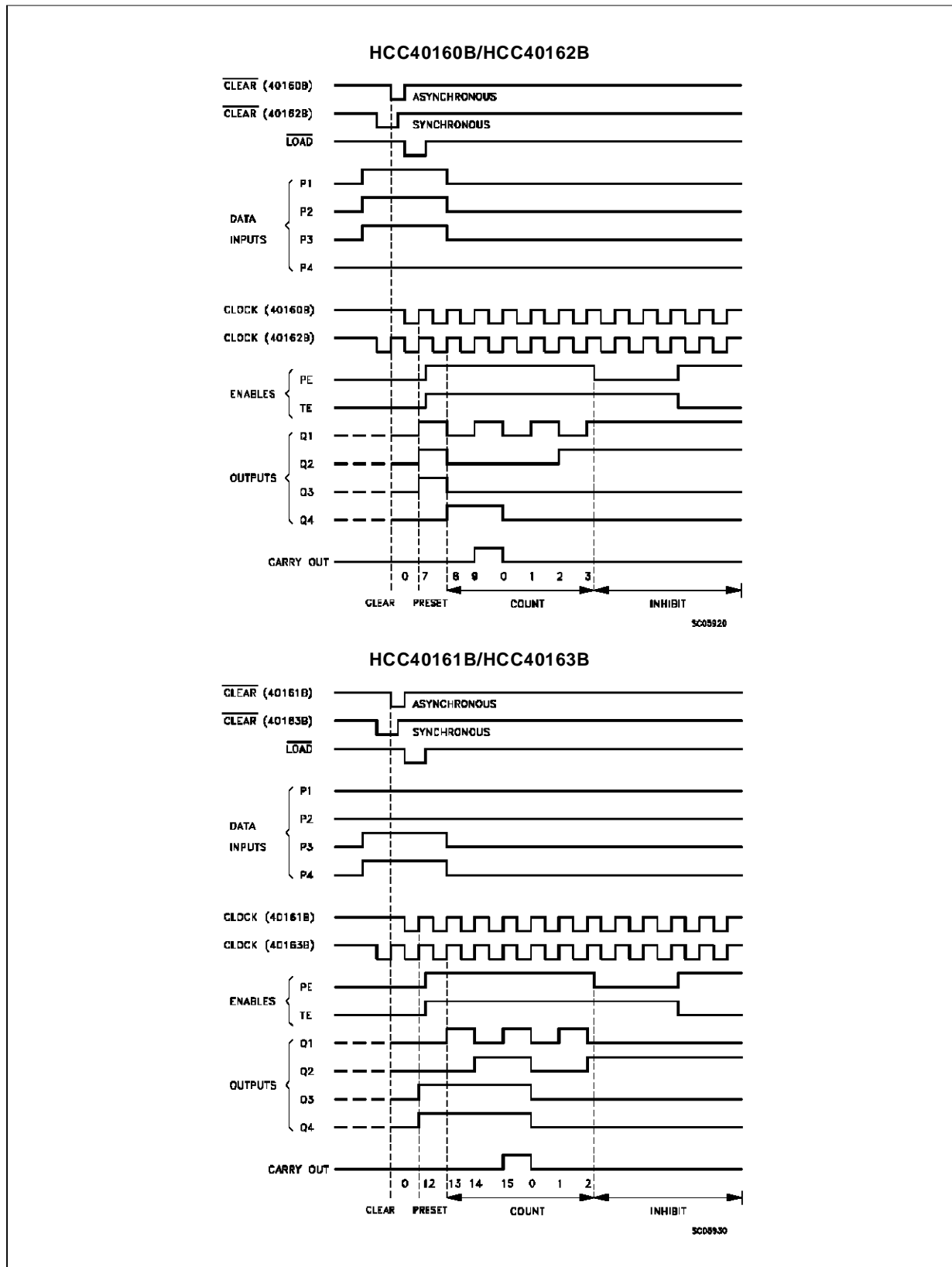
| Clock   | CLR | LOAD | PE | TE | Operation                            |
|---|-----|------|----|----|--------------------------------------|
|  | 1   | 0    | X  | X  | Preset                               |
|  | 1   | 1    | 0  | X  | NC                                   |
|  | 1   | 1    | X  | 0  | NC                                   |
|  | 1   | 1    | 1  | 1  | Count                                |
| X   | 0   | X    | X  | X  | Reset (HCC/HCF40160B, HCC/HCF40161B) |
|  | 0   | X    | X  | X  | Reset (HCC/HCF40162B, HCC/HCF40163B) |
|  | 1   | X    | X  | X  | NC (HCC/HCF40162B, HCC/HCF40163B)    |

1 = HIGH LEVEL, 0 = LOW LEVEL, X = DON'T CARE, NC = NO CHANGE

LOGIC DIAGRAMS



TIMING DIAGRAMS



**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>( $\mu$ A) | 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     | $\mu$ A |
|                                   |                       |           | 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     |         |
| 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                      | 0.53               |           | 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                     |                    | $\pm 0.1$ |       | $\pm 10^{-5}$ | $\pm 0.1$ |                     | $\pm 1$ | $\mu$ A |
|                                   |                       | HCC Types | 0/15                  |                       |                                |                        |                    |           |       |               |           |                     |         |         |
| 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

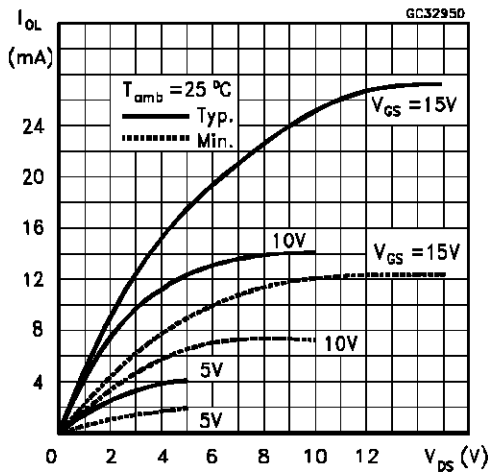
## HCC/HCF40160B-40161B-40162-40163

**DYNAMIC ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ K}\Omega$ , typical temperature coefficient for all  $V_{DD}$  values is  $03\text{ } \%/^{\circ}\text{C}$ , all input rise and fall times =  $20\text{ ns}$ )

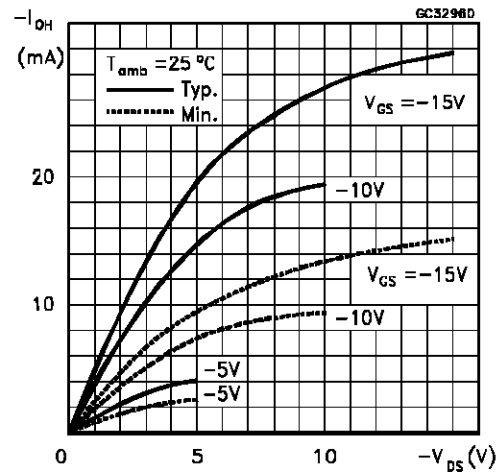
| Symbol                 | Parameter   | Test Conditions |              | Value |      |      | Unit |
|------------------------|---|-----------------|--------------|-------|------|------|------|
|                        |   |                 | $V_{DD}$ (V) | Min.  | Typ. | Max. |      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay Time<br>Clock to Q                  |                 | 5            |       | 200  | 400  | ns   |
|                        |   |                 | 10           |       | 80   | 160  |      |
|                        |   |                 | 15           |       | 60   | 120  |      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay Time<br>Clock to $C_{OUT}$          |                 | 5            |       | 225  | 450  | ns   |
|                        |   |                 | 10           |       | 95   | 190  |      |
|                        |   |                 | 15           |       | 70   | 140  |      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay Time<br>TE to $C_{OUT}$             |                 | 5            |       | 125  | 250  | ns   |
|                        |   |                 | 10           |       | 55   | 110  |      |
|                        |   |                 | 15           |       | 40   | 80   |      |
| $t_{setup}$            | Setup Time<br>Data to Clock                           |                 | 5            | 240   | 120  |      | ns   |
|                        |   |                 | 10           | 90    | 45   |      |      |
|                        |   |                 | 15           | 60    | 30   |      |      |
| $t_{setup}$            | Setup Time<br>Load to Clock                           |                 | 5            | 240   | 120  |      | ns   |
|                        |   |                 | 10           | 90    | 45   |      |      |
|                        |   |                 | 15           | 60    | 30   |      |      |
| $t_{setup}$            | Setup Time<br>PE or TE to Clock                       |                 | 5            | 340   | 170  |      | ns   |
|                        |   |                 | 10           | 140   | 70   |      |      |
|                        |   |                 | 15           | 100   | 50   |      |      |
| $t_{hold}$             | Hold Time   |                 | 5            | 0     |      |      | ns   |
|                        |   |                 | 10           | 0     |      |      |      |
|                        |   |                 | 15           | 0     |      |      |      |
| $t_{THL}$<br>$t_{TLH}$ | Transition Time                                       |                 | 5            |       | 100  | 200  | ns   |
|                        |   |                 | 10           |       | 50   | 100  |      |
|                        |   |                 | 15           |       | 40   | 80   |      |
| $t_w$                  | Clock Input Pulse Width                               |                 | 5            | 170   | 85   |      | ns   |
|                        |   |                 | 10           | 70    | 35   |      |      |
|                        |   |                 | 15           | 50    | 25   |      |      |
| $f_{CL}$               | Maximum Clock Input Frequency                         |                 | 5            | 2     | 3    |      | MHz  |
|                        |   |                 | 10           | 5.5   | 8.5  |      |      |
|                        |   |                 | 15           | 8     | 12   |      |      |
| $t_r$ $t_f$            | Clock Input Rise or Fall Time *                       |                 |              |       |      | 200  | ns   |
|                        |   |                 |              |       |      | 70   |      |
|                        |   |                 |              |       |      | 15   |      |
| $t_{PHL}$              | Propagation Delay Time (40160B, 40161B)<br>Clear to Q |                 | 5            |       | 250  | 500  | ns   |
|                        |   |                 | 10           |       | 110  | 220  |      |
|                        |   |                 | 15           |       | 80   | 160  |      |
| $t_{setup}$            | Setup Time (40162B, 40163B)<br>Clear to Clock         |                 | 5            | 340   | 170  |      | ns   |
|                        |   |                 | 10           | 140   | 70   |      |      |
|                        |   |                 | 15           | 100   | 50   |      |      |
| $t_{hold}$             | Hold Time (40162B, 40163B)<br>Clear to Clock          |                 | 5            | 0     |      |      | ns   |
|                        |   |                 | 10           | 0     |      |      |      |
|                        |   |                 | 15           | 0     |      |      |      |
| $t_{rem}$              | Clear Removal Time (40162B, 40163B)                   |                 | 5            | 200   | 100  |      | ns   |
|                        |   |                 | 10           | 100   | 50   |      |      |
|                        |   |                 | 15           | 70    | 35   |      |      |
| $t_w$                  | Clear Input Pulse Width Low Level (40160B, 40161B)    |                 | 5            | 170   | 85   |      | ns   |
|                        |   |                 | 10           | 70    | 35   |      |      |
|                        |   |                 | 15           | 50    | 25   |      |      |

\* If more than one unit is cascaded in the parallel clocked application,  $t_r$  should be made less than or equal to the sum of the fixed propagation delay at  $50\text{ pF}$  and the transition time of the carry output driving stage for the estimated capacitance

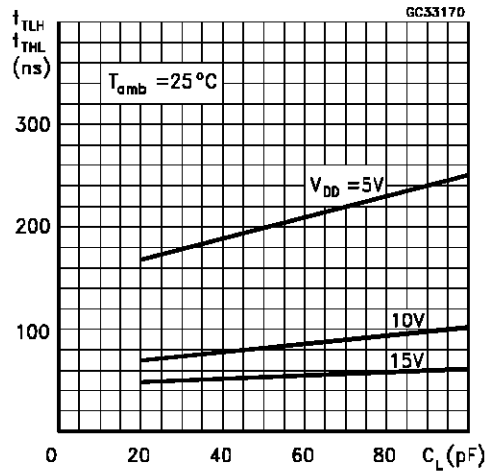
Output Low (sink) Current Characteristics



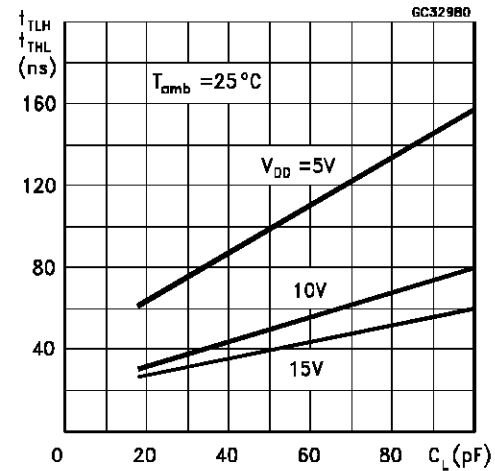
Output High (source) Current Characteristics



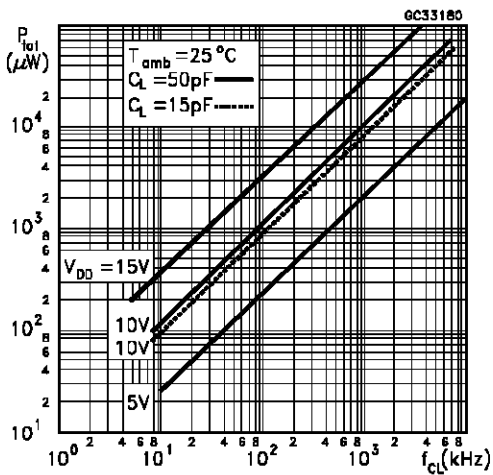
Typical Propagation Delay Time vs Load Capacitance



Typical Transition Time vs Load Capacitance

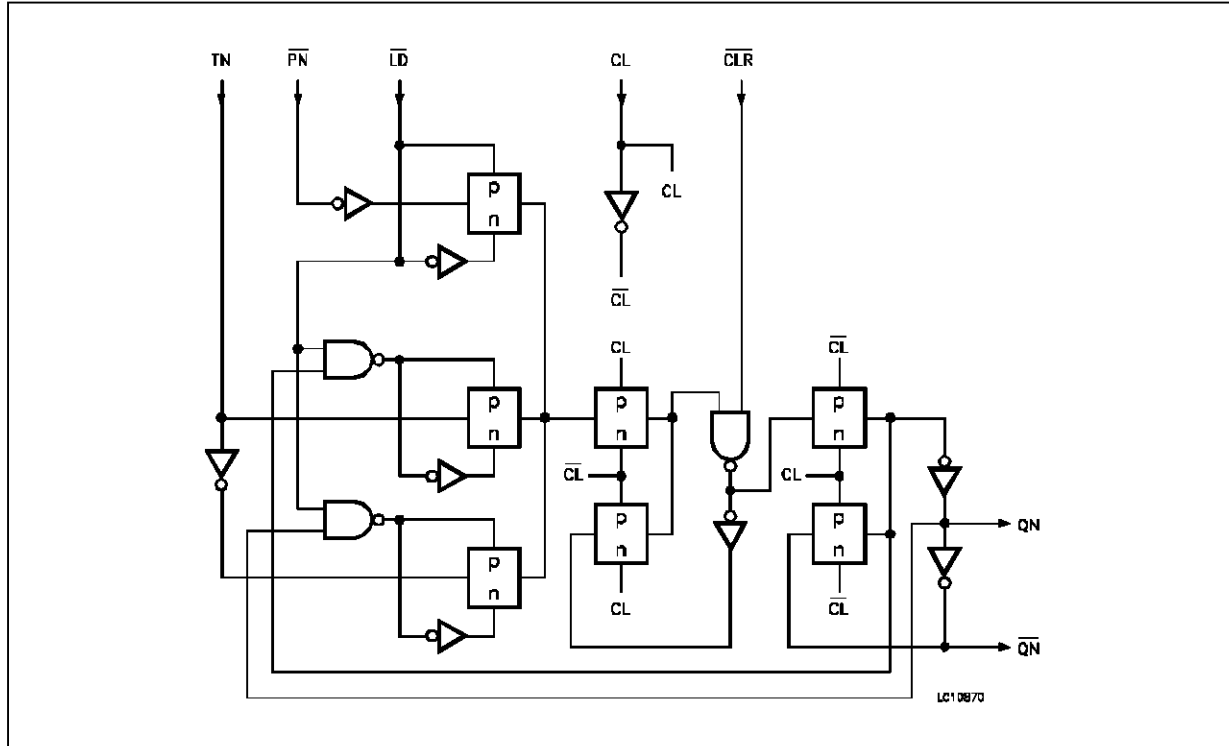


Typical Dynamic Power Dissipation vs Input Frequency

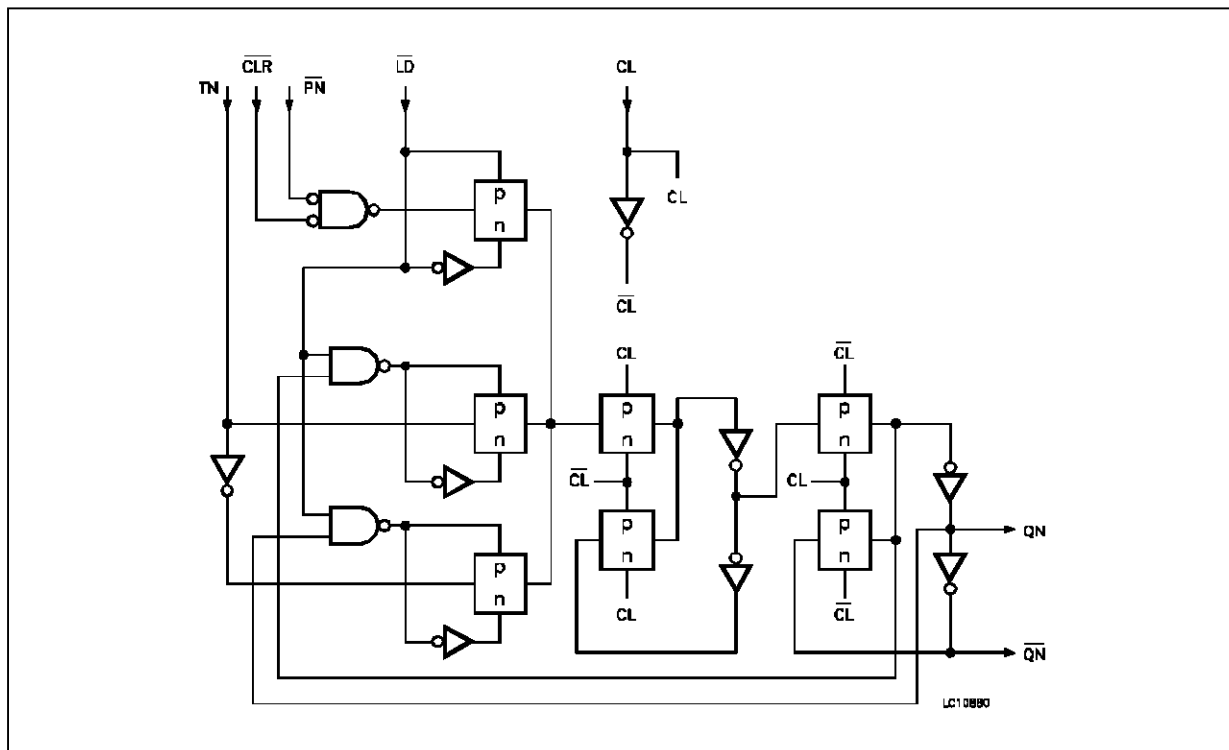


TYPICAL APPLICATIONS

Detail of Flip-flops For 40160B And 40161B (Asynchronous Clear)

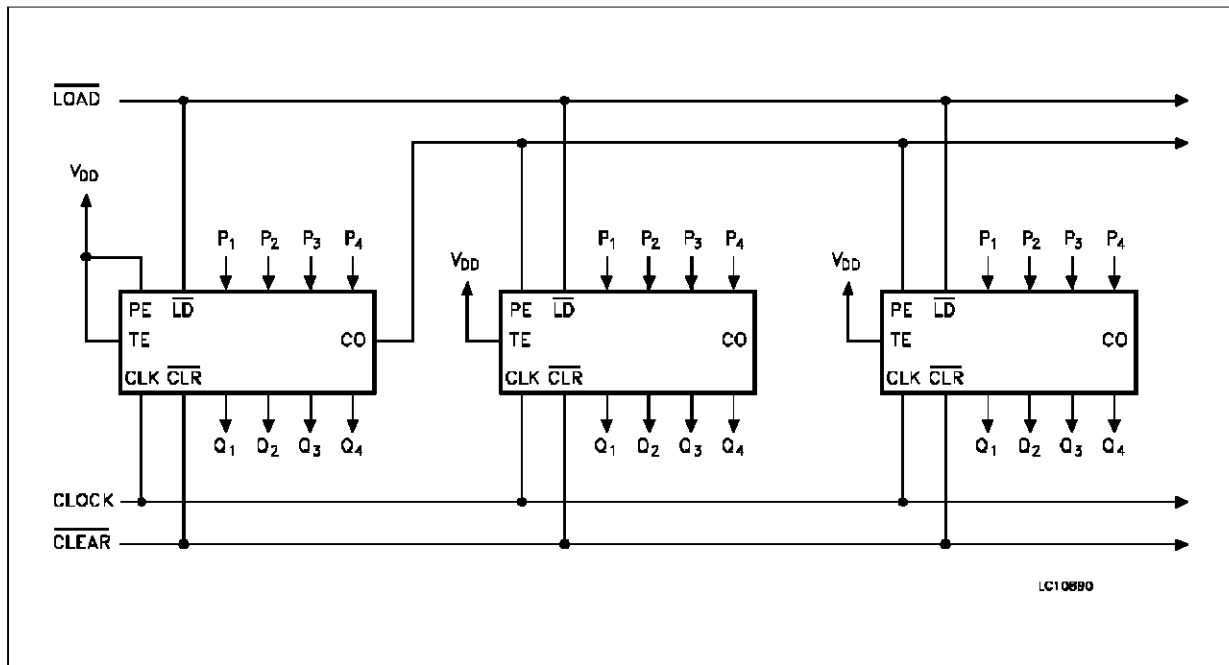


Detail of Flip-flops For 40162B And 40163B (Synchronous Clear)

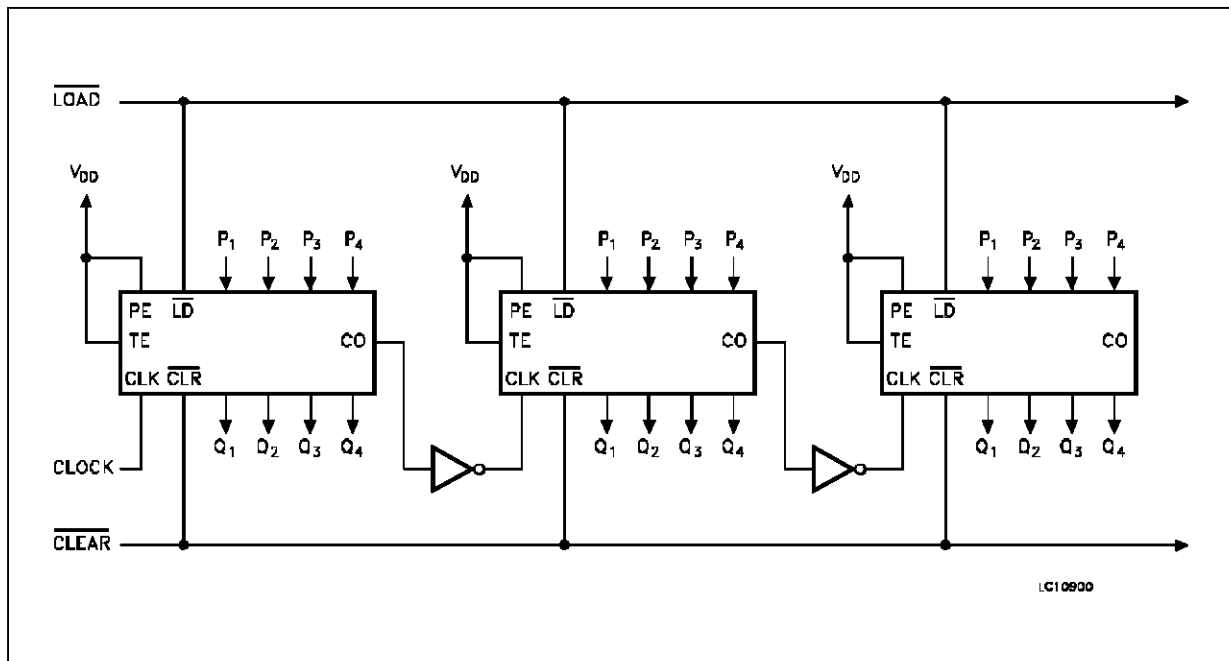




Cascading Counter Packages In The Parallel-Clocked Mode

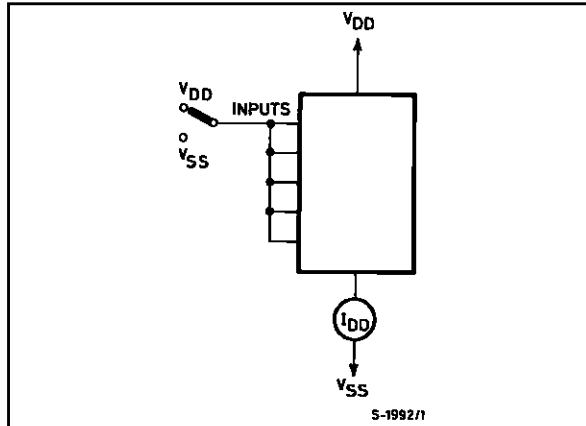


Cascading Counter Packages In The Ripple-Clocked Mode

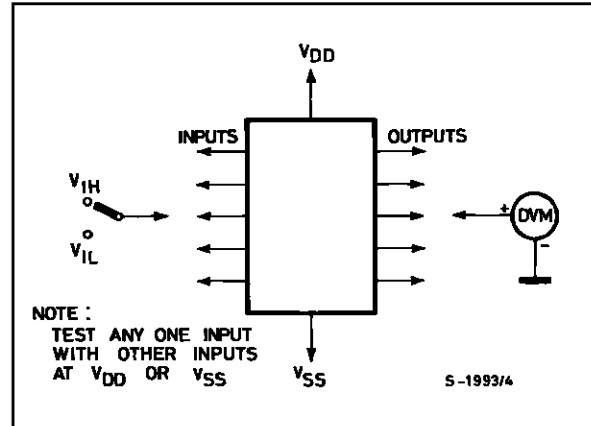


**TEST CIRCUIT**

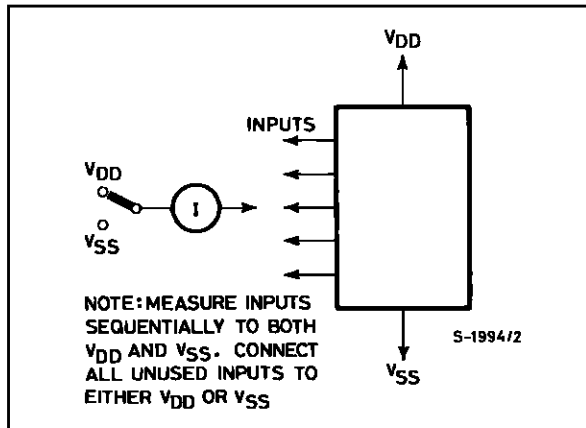
Quiescent Device Current



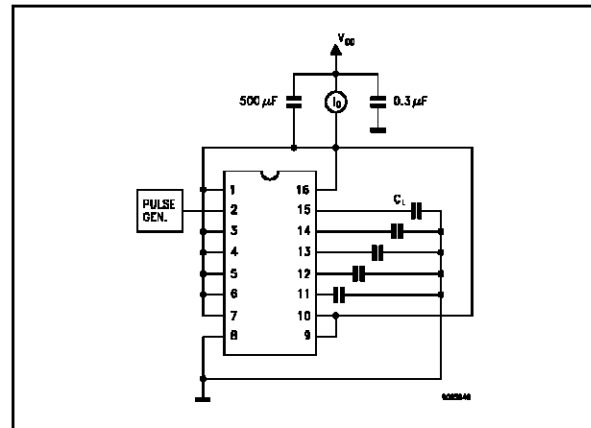
Input Voltage.



Input Leakage Current.

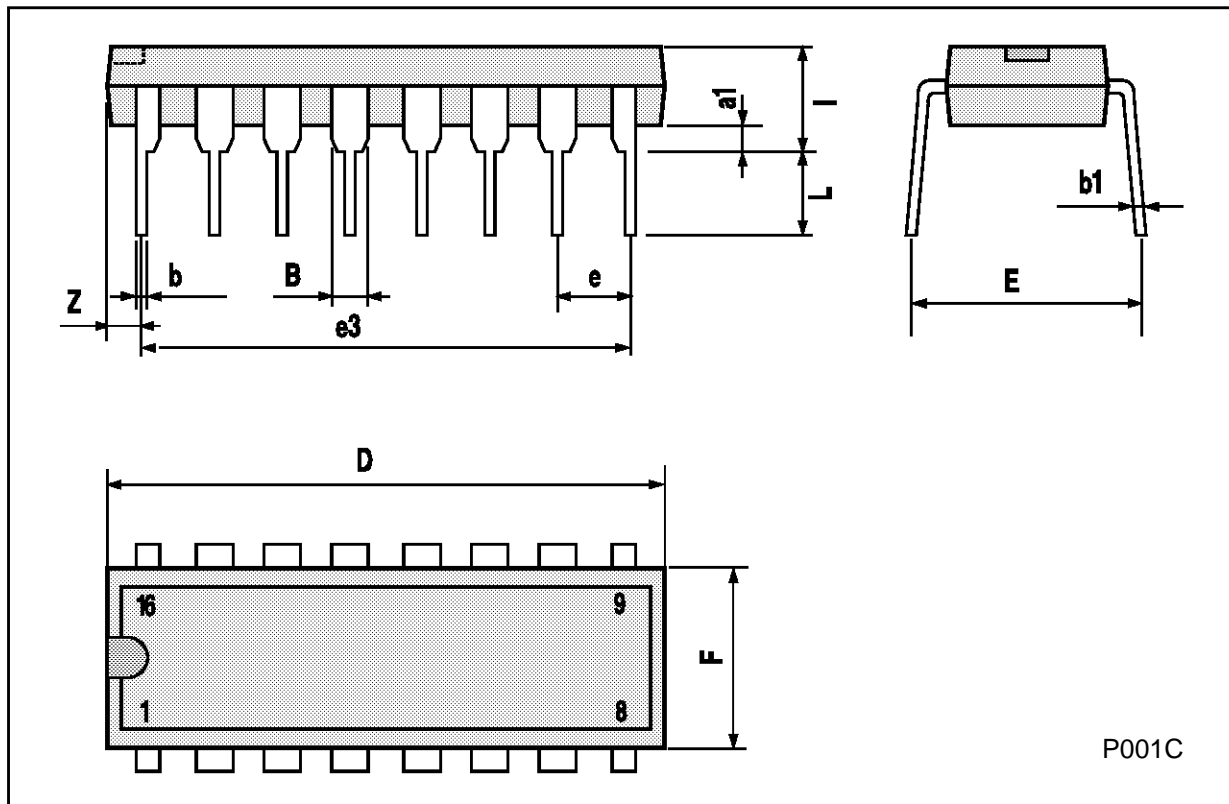


Dynamic Power Dissipation



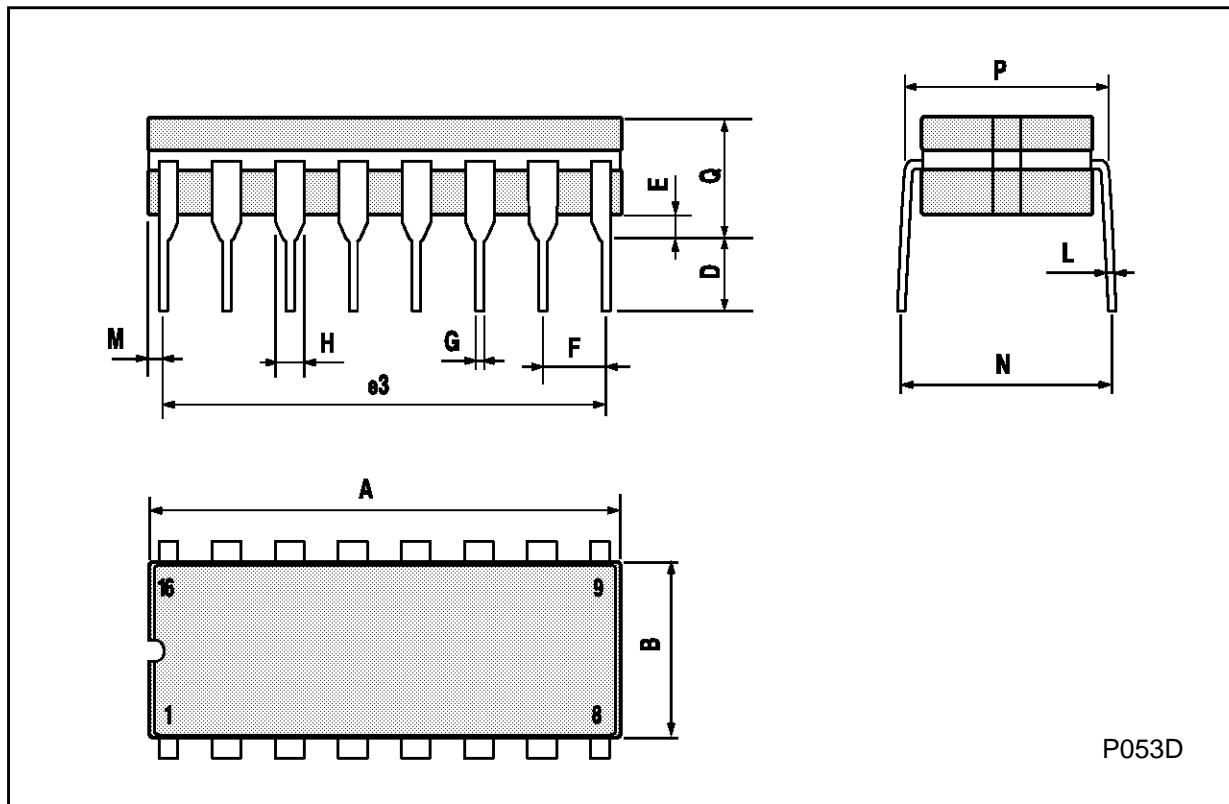
**Plastic DIP16 (0.25) MECHANICAL DATA**

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



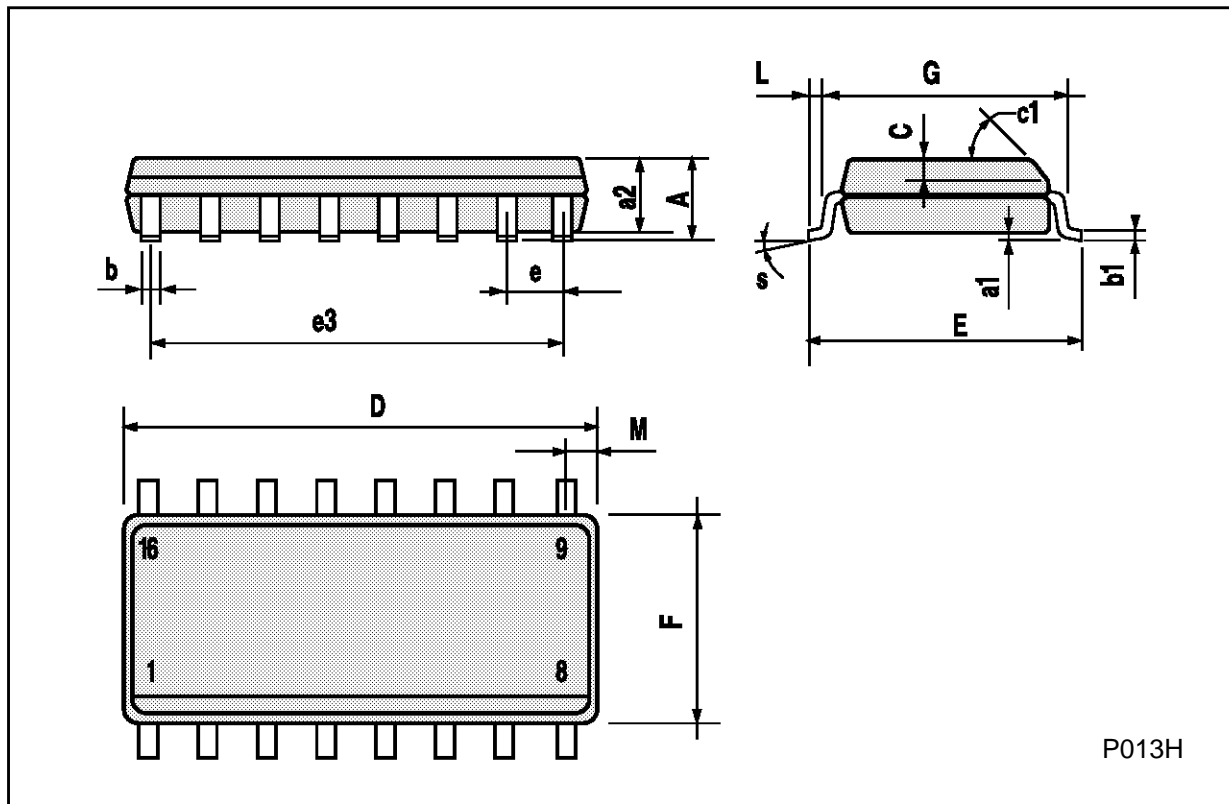
**Ceramic DIP16/1 MECHANICAL DATA**

| 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**

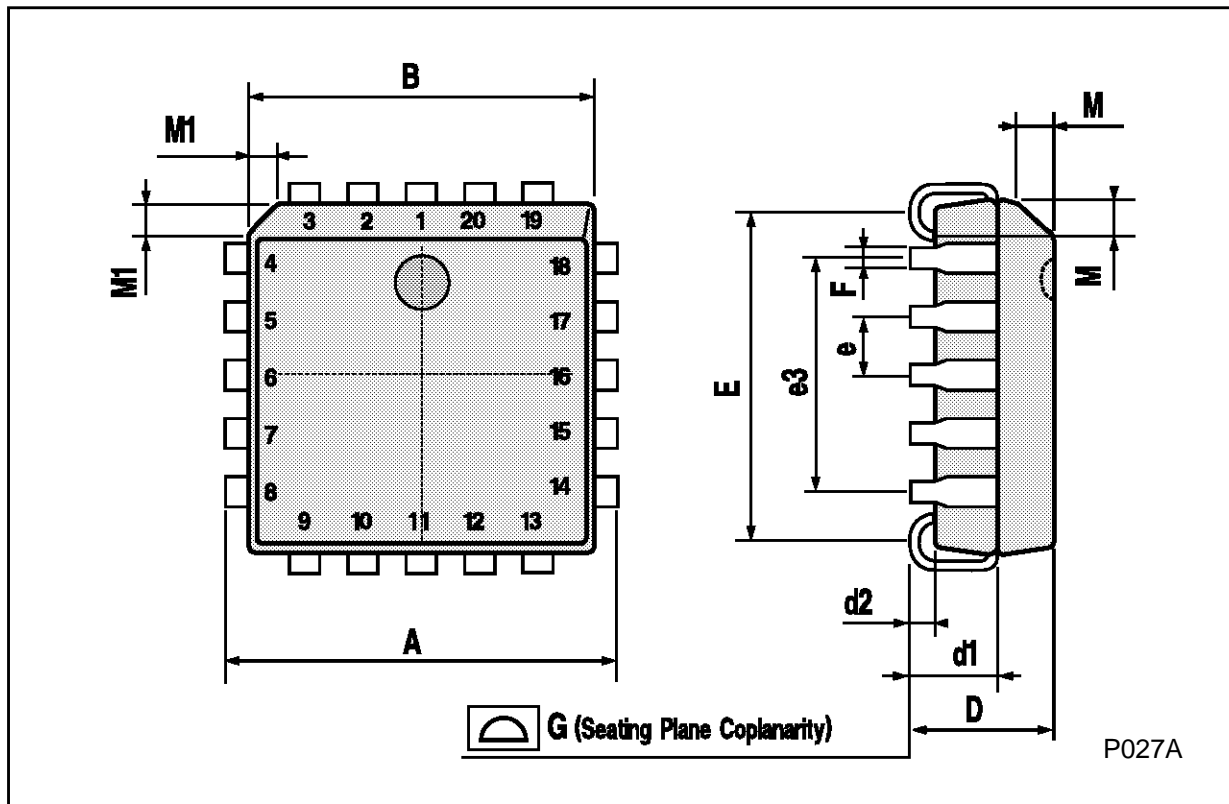
| DIM. | mm         |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.004 |       | 0.007 |
|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



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