

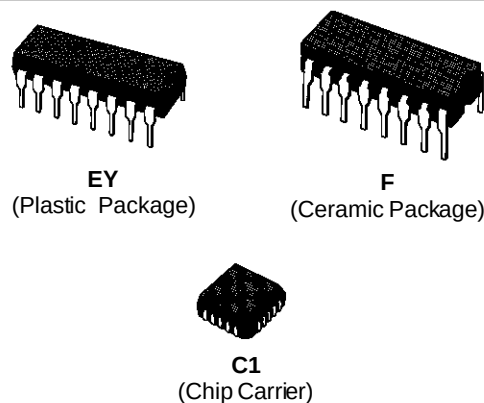
## 64-STAGE STATIC SHIFT REGISTER

- FULLY STATIC OPERATION : DC to 16MHz (TYP.) @  $V_{DD} - V_{SS} = 15V$
- STANDARD TTL DRIVE CAPABILITY ON Q OUTPUT
- RECIRCULATION CAPABILITY
- THREE CASCADING MODES :  
DIRECT CLOCKING FOR HIGH-SPEED OPERATION  
DELAYED CLOCKING FOR REDUCED CLOCK DRIVE REQUIREMENTS  
ADDITIONAL 1/2 STAGE FOR SLOW CLOCKS
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- STANDARDIZED, SYMMETRICAL OUTPUT CHARACTERISTICS
- 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<sup>o</sup>. 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

### DESCRIPTION

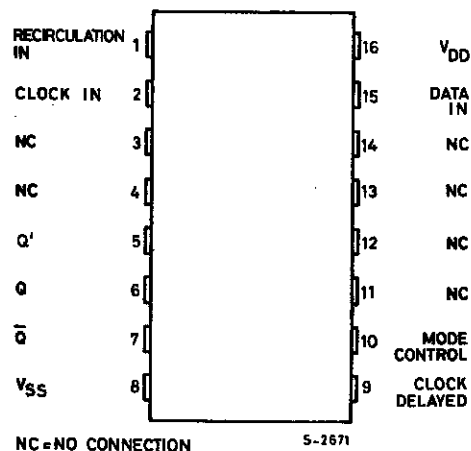
The **HCC4031B** (extended temperature range) and **HCF4031B** (intermediate temperature range) are monolithic integrated circuits, available in 16-lead dual in-line plastic or ceramic package.

The **HCC/HCF4031B** is a static shift register that contains 64 D-type, master-slave flip-flop stages and one stage which is a D-type master flip-flop only (referred to as a 1/2 stage). The logic level present at the DATA input is transferred into the first stage and shifted one stage at each positive-going clock transition. Maximum clock frequencies up to 16 Megahertz (typical) can be obtained. Because fully static operation is allowed, information can be permanently stored with the clock line in either the low or high state. The **HCC/HCF4031B** has a MODE CONTROL input that, when in the high state, allows operation in the recirculating mode. The MODE CONTROL input can also be used to select between two separate data sources. Register packages can be cascaded and the clock lines driven directly for high-speed operation. Alternatively, a delayed clock output (CL<sub>D</sub>) is provided that enables cascading reg-



**ORDER CODES :**  
HCC4031BF      HCF4031BEY  
HCF4031BC1

### PIN CONNECTIONS

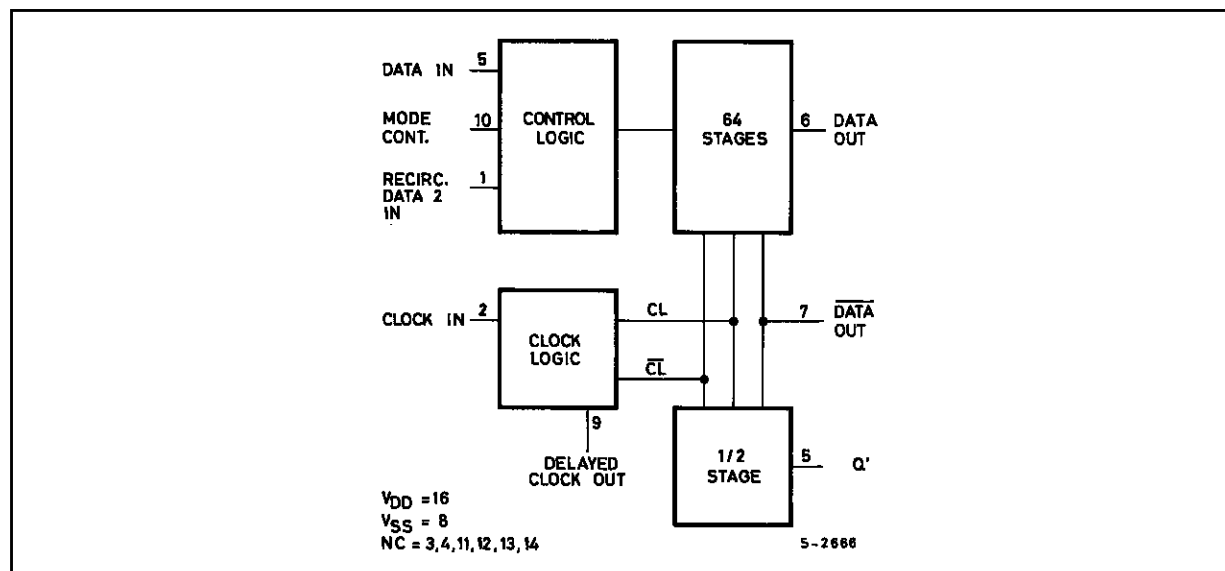


## HCC/HCF4031B

ister packages while allowing reduced clock drive fan-out and transition-time requirements. A third cascading option makes use of the Q' output from the 1/2 stage, which is available on the next nega-

tive-going transition of the clock after the Q output occurs. This delayed output, like the delayed clock CL<sub>D</sub>, is used with clocks having slow rise and fall times.

### FUNCTIONAL DIAGRAM



### ABSOLUTE MAXIMUM RATINGS

| Symbol            | Parameter                                                                                                                          | Value                          | Unit     |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------|
| V <sub>DD</sub> * | Supply Voltage : HCC Types<br>HCF Types                                                                                            | - 0.5 to + 20<br>- 0.5 to + 18 | V<br>V   |
| V <sub>I</sub>    | Input Voltage                                                                                                                      | - 0.5 to V <sub>DD</sub> + 0.5 | V        |
| I <sub>I</sub>    | DC Input Current (any one input)                                                                                                   | ± 10                           | mA       |
| P <sub>tot</sub>  | Total Power Dissipation (per package)<br>Dissipation per Output Transistor<br>for T <sub>op</sub> = Full Package-temperature Range | 200<br>100                     | mW<br>mW |
| T <sub>op</sub>   | Operating Temperature : HCC Types<br>HCF Types                                                                                     | - 55 to + 125<br>- 40 to + 85  | °C<br>°C |
| T <sub>stg</sub>  | Storage Temperature                                                                                                                | - 65 to + 150                  | °C       |

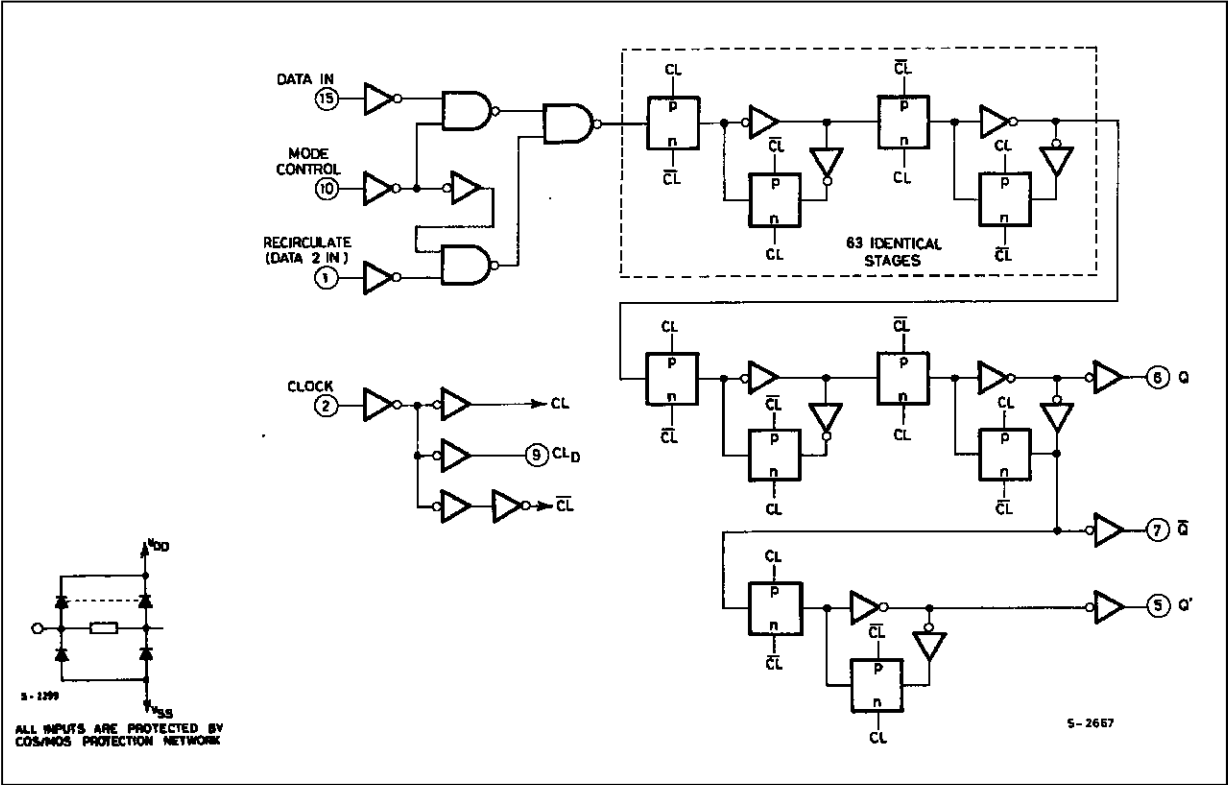
Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure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

\* All voltage values are referred to V<sub>SS</sub> pin voltage.

### RECOMMENDED OPERATING CONDITIONS

| Symbol          | Parameter                                      | Value                         | Unit     |
|-----------------|------------------------------------------------|-------------------------------|----------|
| V <sub>DD</sub> | Supply Voltage : HCC Types<br>HCF Types        | 3 to + 18<br>3 to + 15        | V<br>V   |
| V <sub>I</sub>  | Input Voltage                                  | 0 to V <sub>DD</sub>          | V        |
| T <sub>op</sub> | Operating Temperature : HCC Types<br>HCF Types | - 55 to + 125<br>- 40 to + 85 | °C<br>°C |

LOGIC DIAGRAM AND TRUTH TABLES



INPUT CONTROL CIRCUIT

| Data | Recirc. | Mode | Bit Into Stage 1 |
|------|---------|------|------------------|
| 1    | X       | 0    | 1                |
| 0    | X       | 0    | 0                |
| X    | 1       | 1    | 1                |
| X    | 0       | 1    | 0                |

TYPICAL STAGE

| Data | CL | Data + 1 |
|------|----|----------|
| 0    |    | 0        |
| 1    |    | 1        |
| X    |    | NC       |

1 = HIGH LEVEL  
0 = LOW LEVEL  
X = DON'T CARE

OUTPUT FROM Q' (pin 5)

| Data + 64 | CL | Data + 64.5 |
|-----------|----|-------------|
| 0         |    | 0           |
| 1         |    | 1           |
| X         |    | NC          |

NC = NO CHANGE

## 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<br>0/10<br>0/15 |                            | < 1<br>< 1<br>< 1     | 5<br>10<br>15            | 4.95<br>9.95<br>14.95  |                      | 4.95<br>9.95<br>14.95 |                   |                      | 4.95<br>9.95<br>14.95 |                      | V    |      |
| V <sub>OL</sub>                   | Output Low Voltage                                     | 5/0<br>10/0<br>15/0  |                            | < 1<br>< 1<br>< 1     | 5<br>10<br>15            |                        | 0.05<br>0.05<br>0.05 |                       |                   | 0.05<br>0.05<br>0.05 |                       | 0.05<br>0.05<br>0.05 | V    |      |
| V <sub>IH</sub>                   | Input High Voltage                                     |                      | 0.5/4.5<br>1/9<br>1.5/13.5 | < 1<br>< 1<br>< 1     | 5<br>10<br>15            | 3.5<br>7<br>11         |                      | 3.5<br>7<br>11        |                   |                      | 3.5<br>7<br>11        |                      | V    |      |
| V <sub>IL</sub>                   | Input Low Voltage                                      |                      | 4.5/0.5<br>9/1<br>13.5/1.5 | < 1<br>< 1<br>< 1     | 5<br>10<br>15            |                        | 1.5<br>3<br>4        |                       |                   | 1.5<br>3<br>4        |                       | 1.5<br>3<br>4        | V    |      |
| I <sub>OH</sub>                   | Output Source Current (Source) Q, Q̄, Q <sub>CLD</sub> | 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 Q                                  | HCC Types            | 0/ 5                       | 0.4                   |                          | 5                      | 2.56                 |                       | 2.04              | 4                    |                       | 1.44                 |      | mA   |
|                                   |                                                        |                      | 0/10                       | 0.5                   |                          | 10                     | 6.4                  |                       | 5.2               | 10.4                 |                       | 3.6                  |      |      |
|                                   |                                                        |                      | 0/15                       | 1.5                   |                          | 15                     | 16.8                 |                       | 13.6              | 27.2                 |                       | 9.6                  |      |      |
|                                   |                                                        | HCF Types            | 0/ 5                       | 0.4                   |                          | 5                      | 2.08                 |                       | 1.74              | 4                    |                       | 1.43                 |      |      |
|                                   |                                                        |                      | 0/10                       | 0.5                   |                          | 10                     | 5.01                 |                       | 4.42              | 10.4                 |                       | 3.74                 |      |      |
|                                   |                                                        |                      | 0/15                       | 1.5                   |                          | 15                     | 13.6                 |                       | 11.56             | 27.2                 |                       | 9.52                 |      |      |
| I <sub>OL</sub>                   | Output Sink Current Q, Q' CL <sub>D</sub>              | 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, 2.5 V 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  $V_{DD}$  values is  $0.3\%/^{\circ}\text{C}$ , all input rise and fall times =  $20\text{ns}$ )

| Symbol                                 | Parameter                                                | Test Conditions |              | Value |      |      | Unit          |
|----------------------------------------|----------------------------------------------------------|-----------------|--------------|-------|------|------|---------------|
|                                        |                                                          |                 | $V_{DD}$ (V) | Min.  | Typ. | Max. |               |
| $t_{PHL}$ ,<br>$t_{PLH}$ , $t_{PLH}$   | Propagation Delay Time :<br>Clock to Q,<br>Clock to Q    |                 | 5            |       | 250  | 500  | ns            |
|                                        |                                                          |                 | 10           |       | 110  | 220  |               |
|                                        |                                                          |                 | 15           |       | 90   | 180  |               |
| $t_{PHL}$ ,<br>$t_{PLH}$ , $t_{PHL}$   | Propagation Delay Time :<br>Clock to Q',<br>Clock to Q   |                 | 5            |       | 190  | 380  | ns            |
|                                        |                                                          |                 | 10           |       | 80   | 160  |               |
|                                        |                                                          |                 | 15           |       | 65   | 130  |               |
|                                        | Clock to $CL_D$                                          |                 | 5            |       | 100  | 200  | ns            |
|                                        |                                                          |                 | 10           |       | 50   | 100  |               |
|                                        |                                                          |                 | 15           |       | 40   | 80   |               |
| $t_{THL}$ , $t_{TLH}$<br><br>$t_{THL}$ | Transition Time :<br>(any output, except $Q_{t_{THL}}$ ) |                 | 5            |       | 100  | 200  | ns            |
|                                        |                                                          |                 | 10           |       | 50   | 100  |               |
|                                        |                                                          |                 | 15           |       | 40   | 80   |               |
|                                        | Q,                                                       |                 | 5            |       | 50   | 100  | ns            |
|                                        |                                                          |                 | 10           |       | 25   | 50   |               |
|                                        |                                                          |                 | 15           |       | 20   | 40   |               |
| $t_{setup}$                            | Data Setup Time                                          |                 | 5            |       | 30   | 60   | ns            |
|                                        |                                                          |                 | 10           |       | 15   | 30   |               |
|                                        |                                                          |                 | 15           |       | 10   | 20   |               |
| $t_{hold}$                             | Data Hold Time                                           |                 | 5            |       | 30   | 60   | ns            |
|                                        |                                                          |                 | 10           |       | 15   | 30   |               |
|                                        |                                                          |                 | 15           |       | 10   | 20   |               |
| $t_w$                                  | Clock Pulse Width                                        |                 | 5            |       | 120  | 240  | ns            |
|                                        |                                                          |                 | 10           |       | 50   | 100  |               |
|                                        |                                                          |                 | 15           |       | 40   | 80   |               |
| $f_{max}$                              | Maximum Clock Input Frequency**                          |                 | 5            | 2     | 4    |      | MHz           |
|                                        |                                                          |                 | 10           | 5     | 10   |      |               |
|                                        |                                                          |                 | 15           | 6     | 12   |      |               |
| $t_r$ , $t_f$                          | Clock Input Rise or Fall Time*                           |                 | 5            |       |      | 1000 | $\mu\text{s}$ |
|                                        |                                                          |                 | 10           |       |      | 1000 |               |
|                                        |                                                          |                 | 15           |       |      | 200  |               |

\* If more than one unit is cascaded in the parallel clocked application,  $t_{rCL}$  should be made less than or equal to the sum of the propagation delay at  $50\text{pF}$  and the transmission time of the output driving stage.

\* \* Maximum Clock Frequency for Cascaded Units;

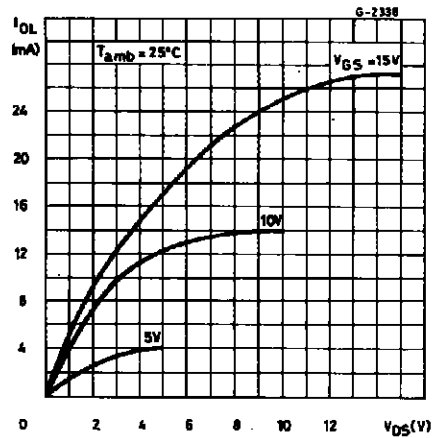
a) Using Delayed Clock Feature in Recirculation Mode :

$$f_{max} = \frac{1}{(n-1) \text{ CLD prop. delay} + Q \text{ prop. delay} + \text{set-up time}} \text{ where } n = \text{number of packages}$$

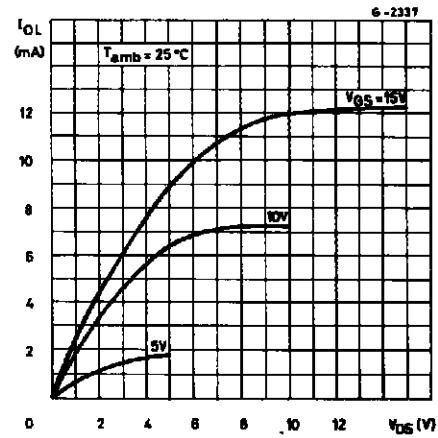
b) Not Using Delayed Clock :

$$f_{max} = \frac{1}{\text{propagation delay} + \text{set-up time}}$$

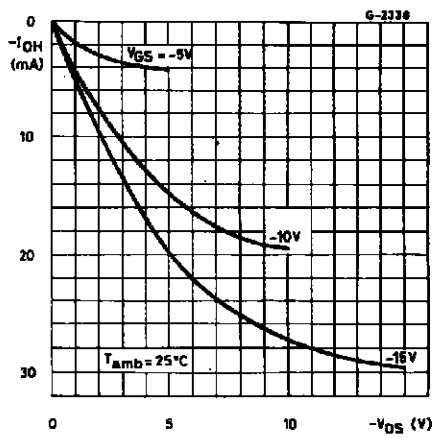
Typical Output Low (sink) Current Characteristics.



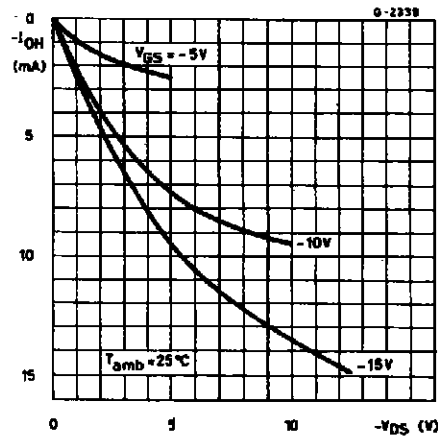
Minimum Output Low (sink) Current Characteristics.



Typical Output High (source) Current Characteristics.

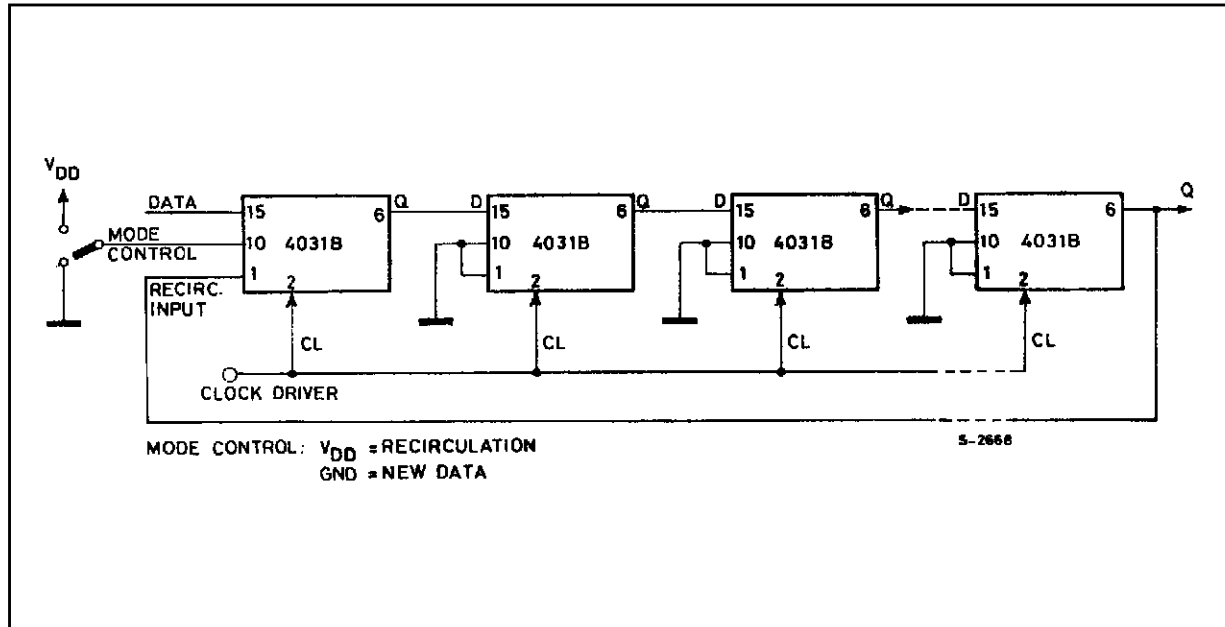


Minimum Output High (source) Current Characteristics.

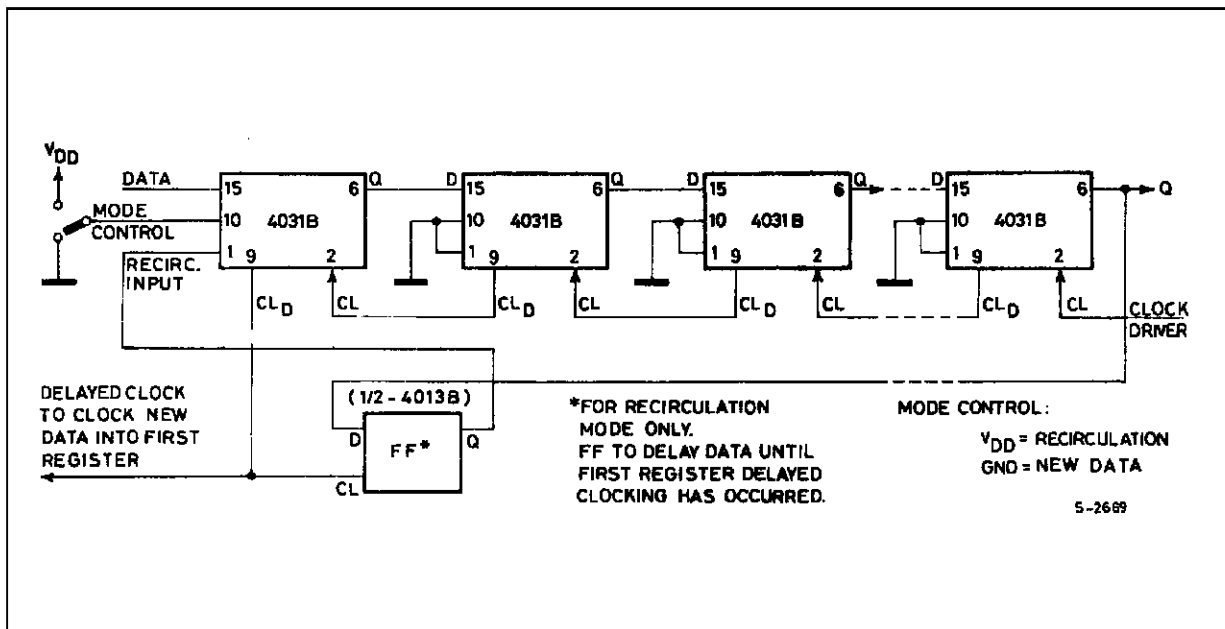


## TYPICAL APPLICATIONS

CASCADING USING DIRECT CLOCKING FOR HIGH SPEED OPERATION (SEE CLOCK RISE AND FALL TIME REQUIREMENT).

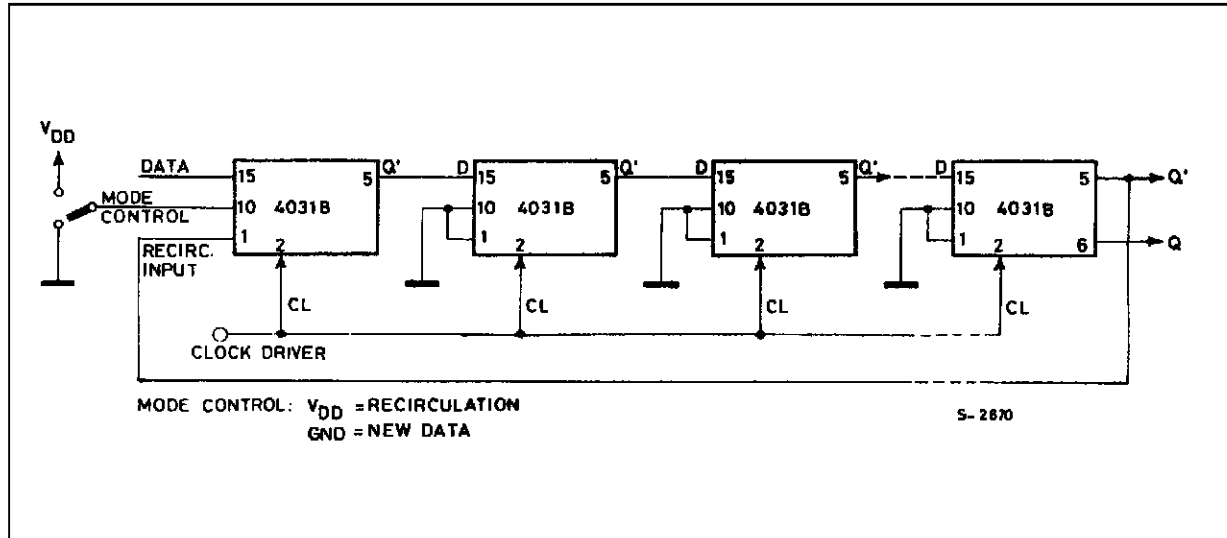


CASCADING USING DELAYED CLOCKING FOR REDUCED CLOCK DRIVE REQUIREMENTS.



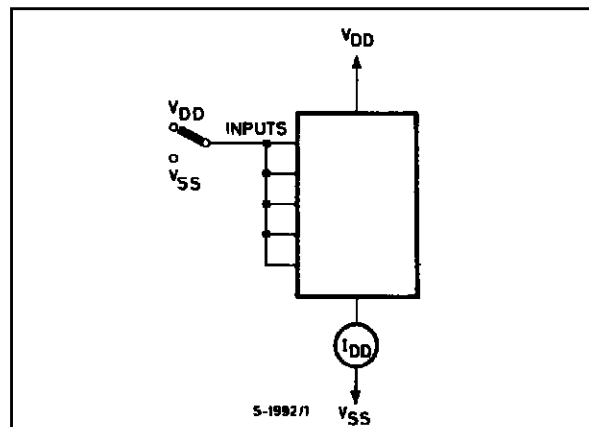
## TYPICAL APPLICATIONS (continued)

CASCADING USING HALF- CLOCK-PULSE DELAYED DATA OUTPUT (Q') TO PERMIT USE OF SLOW RISE AND FALL TIME CLOCK INPUTS.

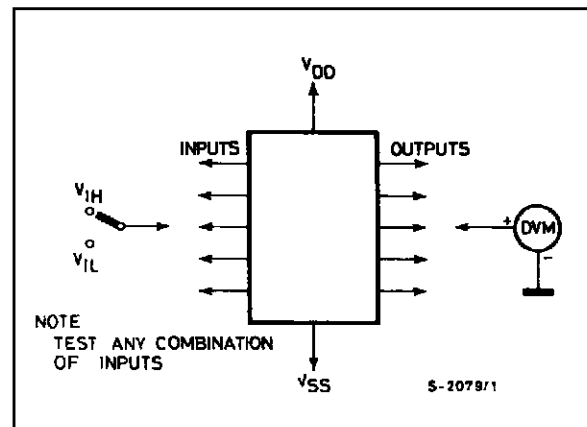


## TEST CIRCUITS

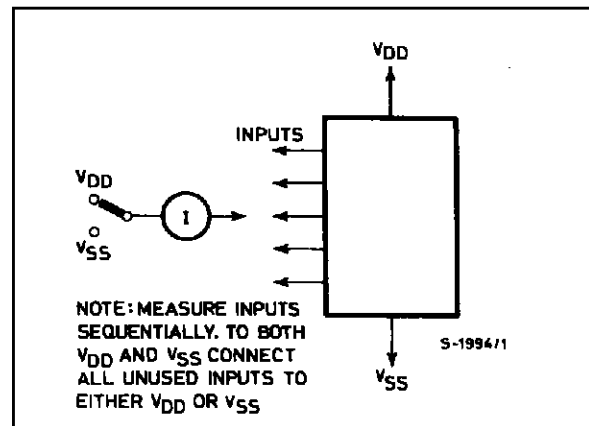
Quiescent Device Current.



Noise Immunity.



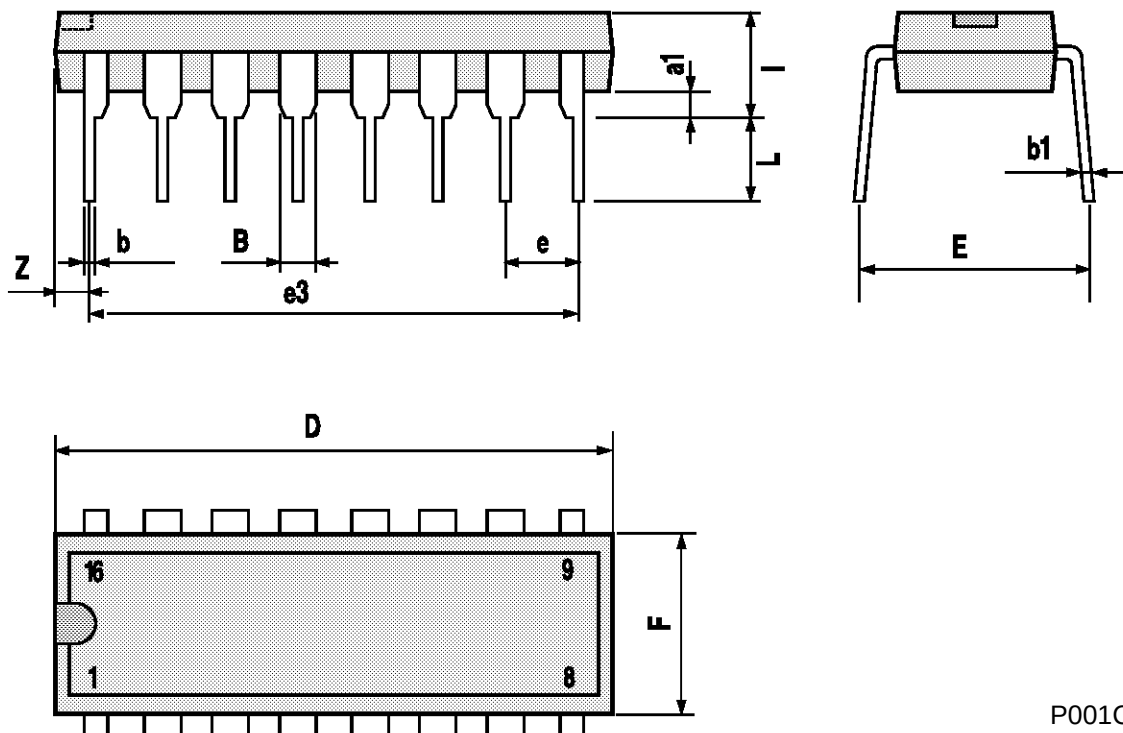
Input Leakage Current.





# Plastic DIP16 (0.25) MECHANICAL DATA

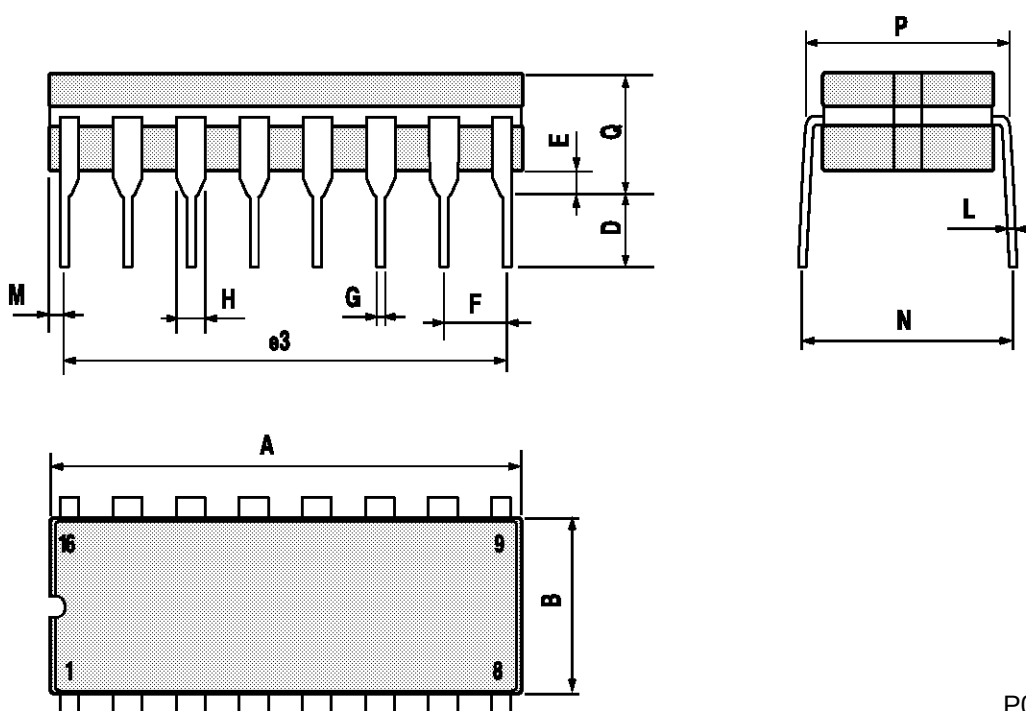
| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 0.77 |       | 1.65 | 0.030 |       | 0.065 |
| b    |      | 0.5   |      |       | 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

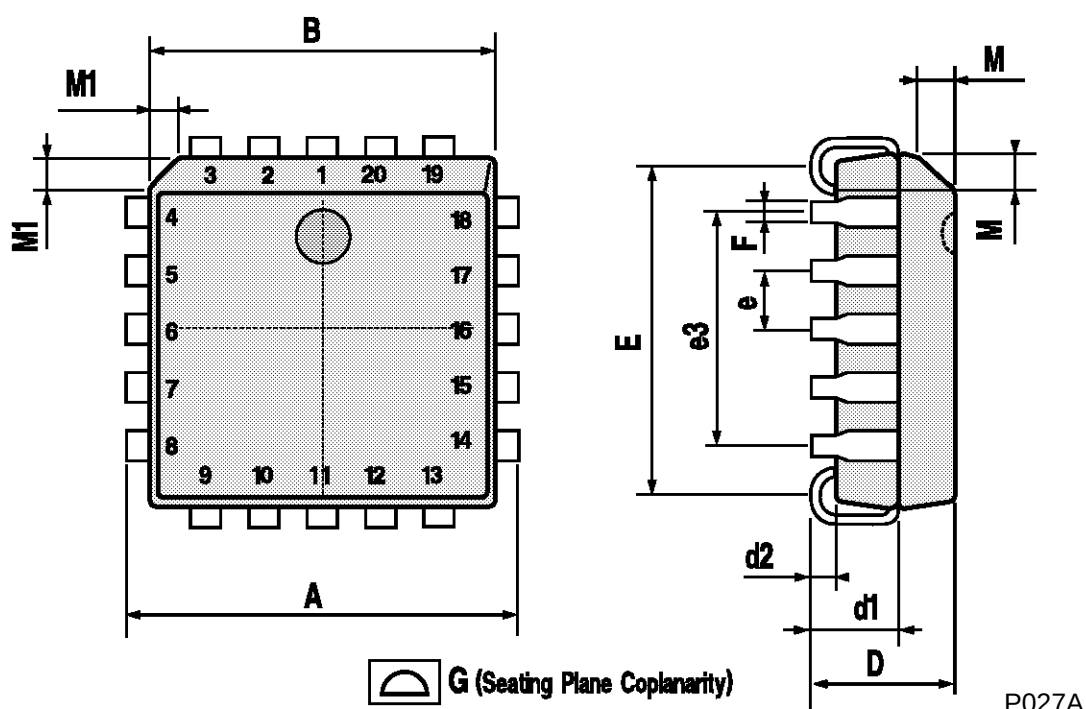
| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |      |       | 20   |       |       | 0.787 |
| B    |      |       | 7    |       |       | 0.276 |
| D    |      | 3.3   |      |       | 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 |



P053D

## 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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