

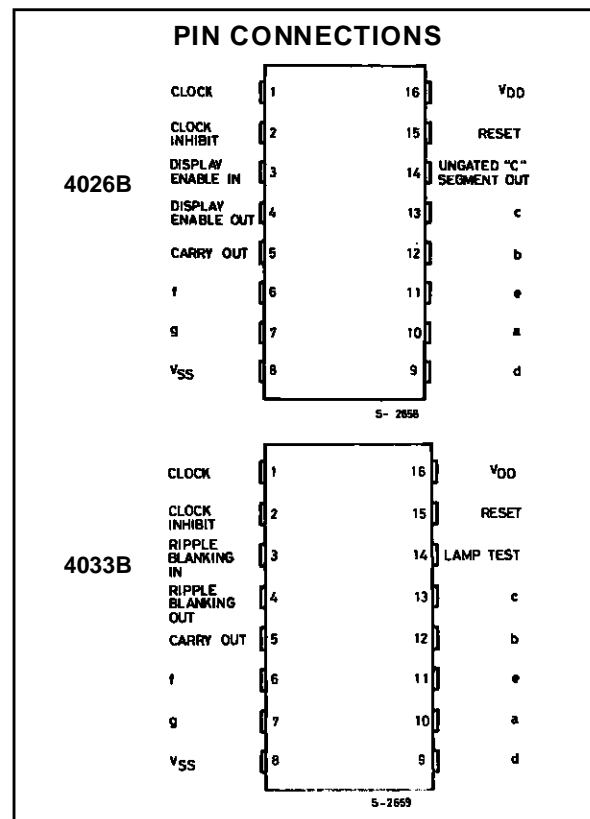
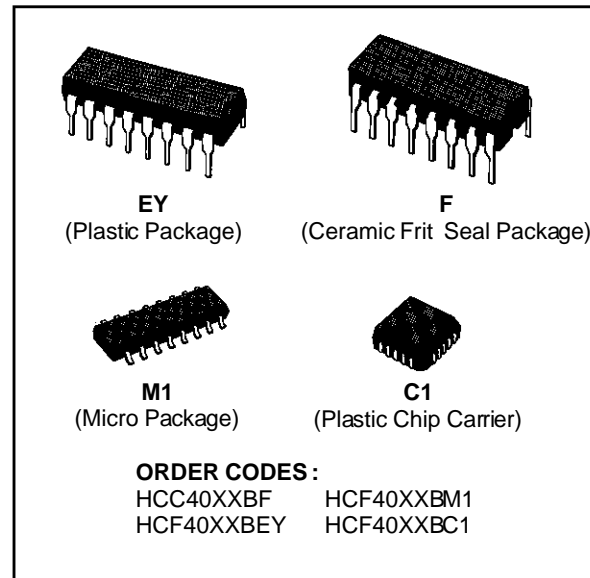
## DECADE COUNTERS/DIVIDERS WITH DECODED 7-SEGMENT DISPLAY OUTPUTS

### WITH; DISPLAY ENABLE 4026B RIPPLE BLANKING 4033B

- COUNTER AND 7-SEGMENT DECODING IN ONE PACKAGE
- EASILY INTERFACED WITH 7-SEGMENT DISPLAY TYPES
- FULLY STATIC COUNTER OPERATION : DC TO 6MHz (typ.) AT  $V_{DD} = 10V$
- IDEAL FOR LOW-POWER DISPLAYS
- DISPLAY ENABLE OUTPUT - 4026B
- "RIPPLE BLANKING" AND LAMP TEST - 4033B
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- STANDARDIZED SYMMETRICAL OUTPUT CHARACTERISTICS
- 5V, 10V, AND 15V PARAMETRIC RATING
- INPUT CURRENT OF 100nA AT 18V AND 25°C FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD N° 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

### DESCRIPTION

The **HCC4026B/4033B** (extended temperature range) and **HCF4026B/4033B** (intermediate temperature range) are monolithic integrated circuits, available in 16-lead dual in-line plastic or ceramic package and plastic micro package. The **HCC/HCF4026B** and **HCC/HCF4033B** each consist of a 5-stage Johnson decade counter and an output decoder which converts the Johnson code to a 7-segment decoded output for driving one stage in a numerical display. These devices are particularly advantageous in display applications where low power dissipation and/or low package count are important. Inputs common to both types are CLOCK, RESET, & CLOCK INHIBIT ; common outputs are CARRY OUT and the seven decoded outputs (a, b, c, d, e, f, g). Additional inputs and outputs for the **HCC/HCF4026B** include DISPLAY ENABLE input and DISPLAY ENABLE and UNGATED "C-SEGMENT" outputs. Signals peculiar to the **HCC/HCF4033B** are RIPPLE-BLANKING INPUT AND LAMP TEST INPUT and a RIPPLE-BLANKING OUTPUT. A high RESET signal clears the de-



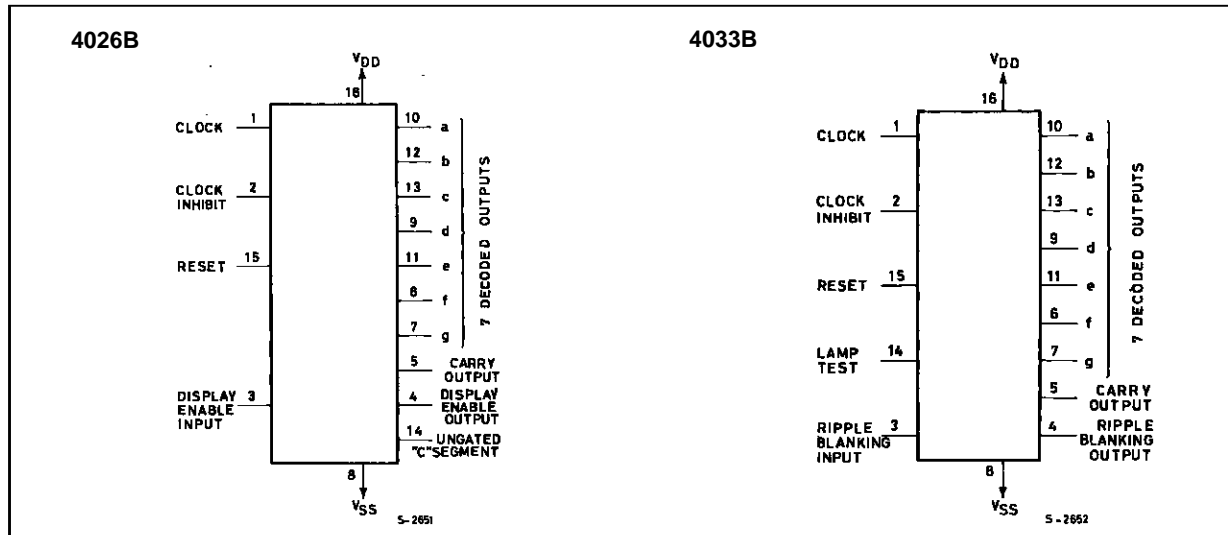
cade counter to its zero count. The counter is advanced one count at the positive clock signal transition if the CLOCK INHIBIT signal is low. Counter advancement via the clock line is inhibited when the CLOCK INHIBIT signal is high. Antilock gating is provided on the JOHNSON counter, thus assuring proper counting sequence. The CARRY-OUT ( $C_{out}$ ) signal completes one cycle every ten CLOCK INPUT cycles and is used to clock the succeeding decade directly in a multi-decade counting chain. The seven decoded outputs (a, b, c, d, e, f, g) illuminate the proper segments in a seven segment display device used for representing the decimal numbers 0 to 9. The 7-segment outputs go high on selection in the **HCC/HCF4033B** ; in the **HCC/HCF4026B** these outputs go high only when the DISPLAY ENABLE IN is high.

**HCC/HCF4026B** - When the DISPLAY ENABLE IN is low the seven decoded outputs are forced low regardless of the state of the counter. Activation of the display only when required results in significant power savings. This system also facilitates implementation of display-character multiplexing. The CARRY OUT and UNGATED "C-SEGMENT" signals are not gated by the DISPLAY ENABLE and therefore are available continuously. This feature is a requirement in implementation of certain divider functions such as divide-by-60 and divide-by-12.

**HCC/HCF4033B** - The **HCC/HCF4033B** has provisions for automatic blanking of the non-significant zeros in a multi-digit decimal number which results in an easily readable display consistent with

normal writing practice. For example, the number 0050.07000 in an eight digit display would be displayed as 50.07. Zero suppression on the integer side is obtained by connecting the RBI terminal of the **HCC/HCF4033B** associated with the most significant digit in the display to a low-level voltage and connecting the RBO terminal of that stage to the RBI terminal of the **HCC/HCF4033B** in the next-lower significant position in the display. This procedure is continued for each succeeding **HCC/HCF4033B** on the integer side of the display. On the fraction side of the display the RBI of the **HCC/HCF4033B** associated with the least significant bit is connected to a low-level voltage and the RBO of that **HCC/HCF4033B** is connected to the RBI terminal of the **HCC/HCF4033B** in the next more-significant-bit position. Again, this procedure is continued for all **HCC/HCF4033B**'s on the fraction side of the display. In a purely fractional number the zero immediately preceding the decimal point can be displayed by connecting the RBI of that stage to a high level voltage (instead of to the RBO of the next more-significant-stage). For example : optional zero → 0.7346. Likewise, the zero in a number such as 763.0 can be displayed by connecting the RBI of the **HCC/HCF4033B** associated with it to a high-level voltage. Ripple blanking of non-significant zeros provides an appreciable savings in display power. The **HCC/HCF4033B** has a LAMP TEST input which, when connected to a high-level voltage, overrides normal decoder operation and enables a check to be made on possible display malfunctions by putting the seven outputs in the high state.

FUNCTIONAL DIAGRAMS



ABSOLUTE MAXIMUM RATINGS

| Symbol     | Parameter   | Value                          | Unit                       |
|------------|---|--------------------------------|----------------------------|
| $V_{DD}^*$ | Supply Voltage : HCC Types<br>HCF 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)<br>Dissipation per Output Transistor<br>for $T_{op} =$ Full Package-temperature Range | 200<br>100                     | mW<br>mW                   |
| $T_{op}$   | Operating Temperature : HCC Types<br>HCF Types  | - 55 to + 125<br>- 40 to + 85  | $^{\circ}C$<br>$^{\circ}C$ |
| $T_{stg}$  | Storage Temperature   | - 65 to + 150                  | $^{\circ}C$                |

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

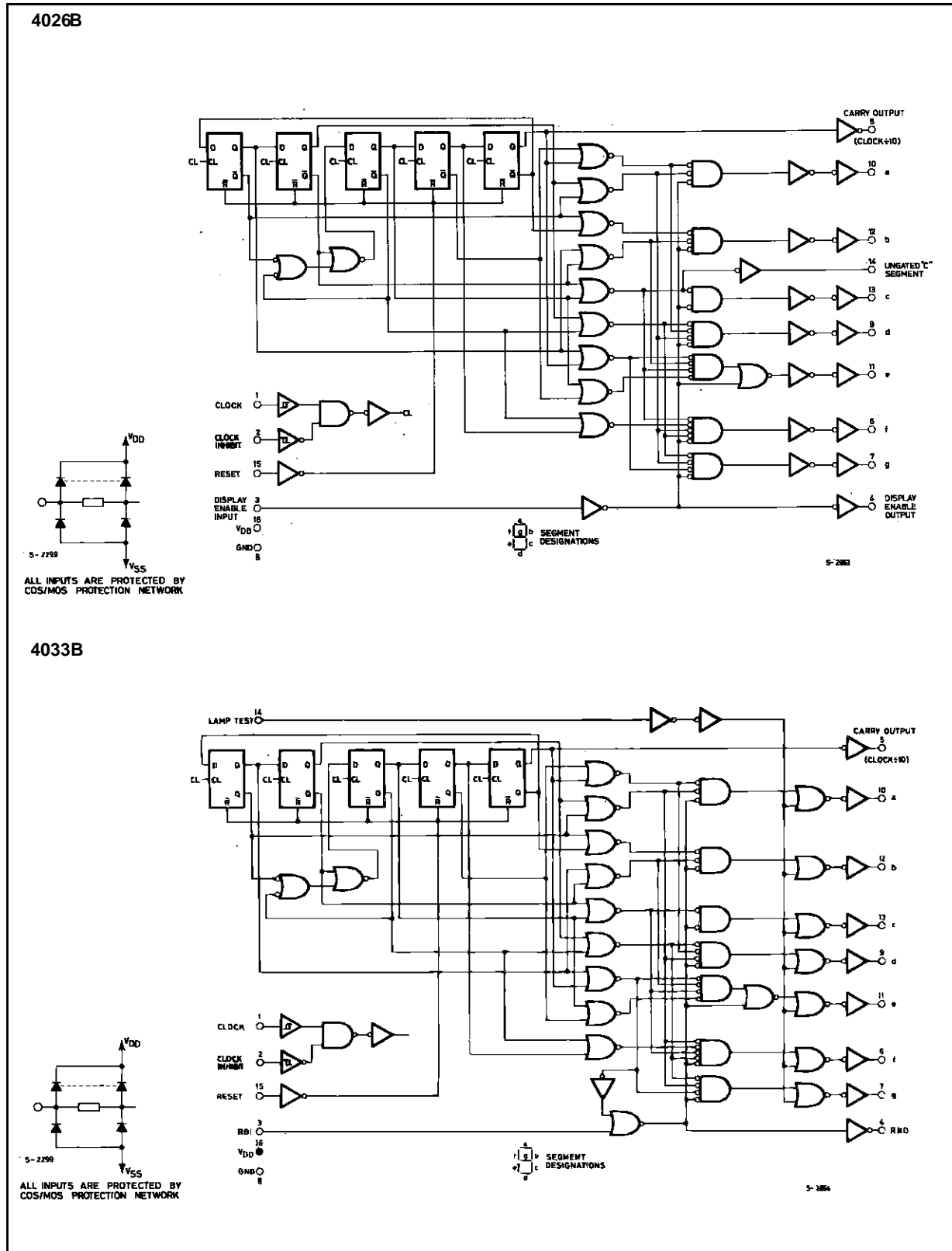
\* All voltages values are referred to  $V_{SS}$  pin voltage.

RECOMMENDED OPERATING CONDITIONS

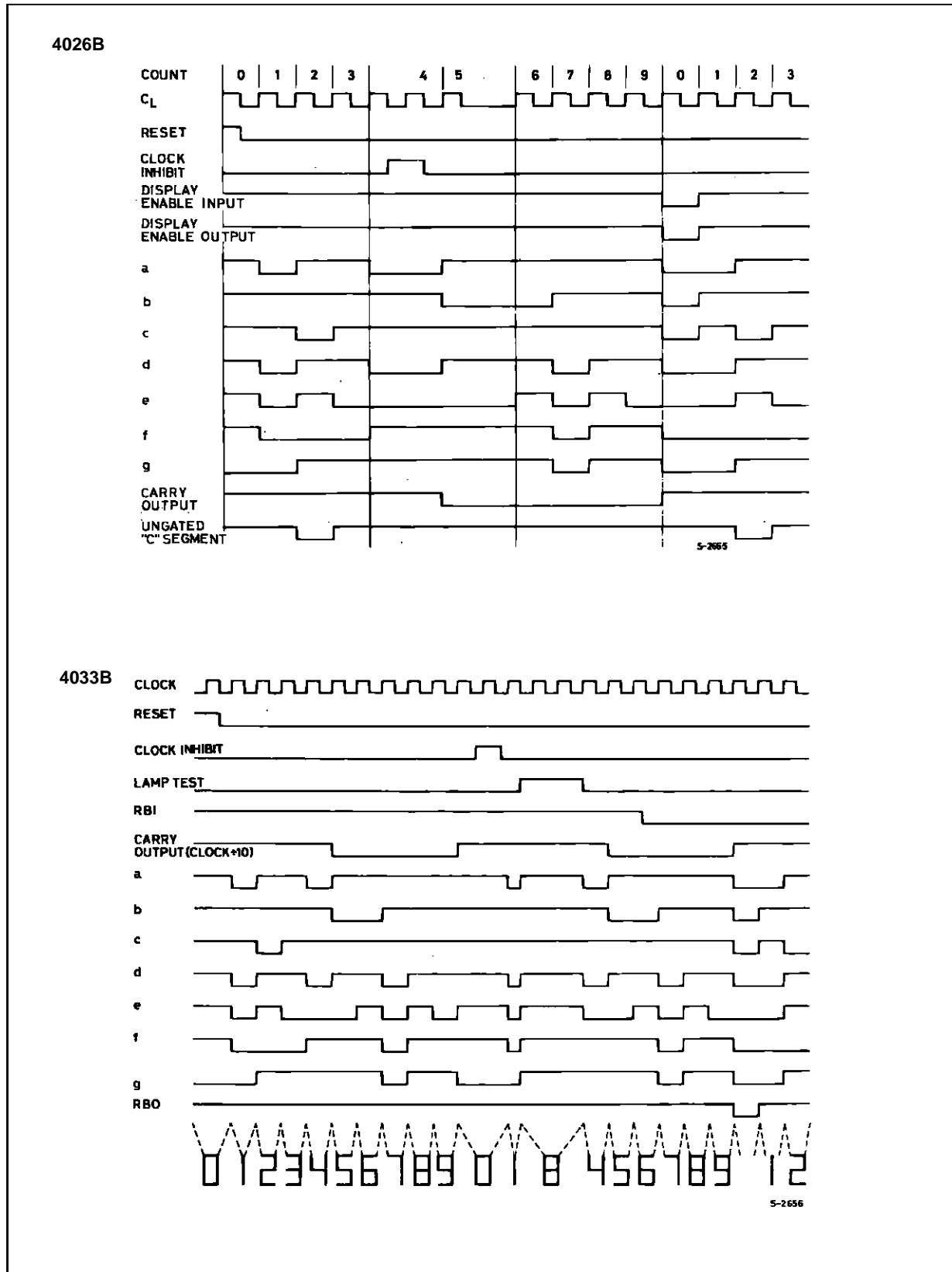
| Symbol   | Parameter                                      | Value                         | Unit                       |
|----------|--|-------------------------------|----------------------------|
| $V_{DD}$ | Supply Voltage : HCC Types<br>HCF Types        | 3 to 18<br>3 to 15            | V<br>V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

# HCC/HCF4026B/4033B

## LOGIC DIAGRAMS



TIMING DIAGRAMS



# HCC/HCF4026B/4033B

## 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      |                     | V       |         |
|                                   |                       |           | 10/0                  |                       | < 1                            | 10                     |                    | 0.05      |        |                        | 0.05      |                     |         |         |
|                                   |                       |           | 15/0                  |                       | < 1                            | 15                     |                    | 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       |                     | V       |         |
|                                   |                       |           |                       | 9/1                   | < 1                            | 10                     |                    | 3         |        |                        | 3         |                     |         |         |
|                                   |                       |           |                       | 13.5/1.5              | < 1                            | 15                     |                    | 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                     |                    | $\pm$ 0.1 |        | $\pm$ 10 <sup>-5</sup> | $\pm$ 0.1 |                     | $\pm$ 1 | $\mu$ A |
|                                   |                       | HCF Types | 0/15                  | Any Input             |                                | 15                     |                    | $\pm$ 0.3 |        | $\pm$ 10 <sup>-5</sup> | $\pm$ 0.3 |                     | $\pm$ 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.

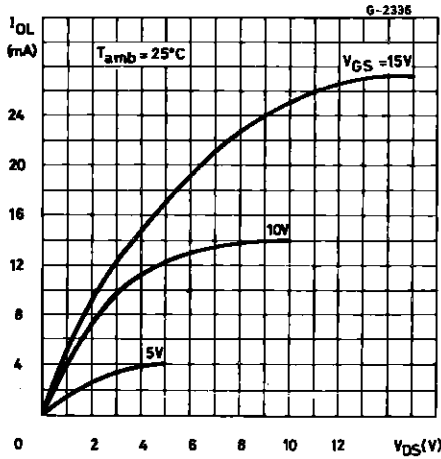
The Noise Margin for both "1" and "0" level is : 1V min. with V<sub>DD</sub> = 5V, 2V min. with V<sub>DD</sub> = 10V, 2.5V min. with V<sub>DD</sub> = 15V.

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

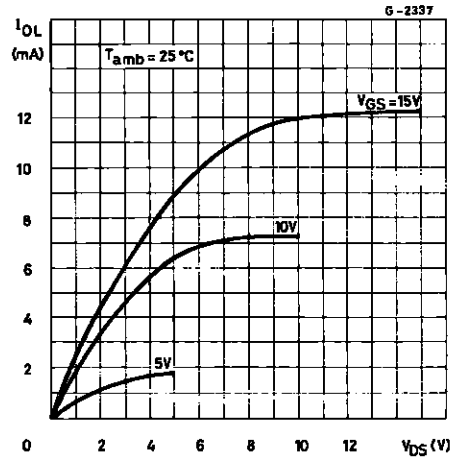
| Symbol                   | Parameter                                  | Test Conditions |              | Value     |      |      | Unit          |
|--------------------------|--|-----------------|--------------|-----------|------|------|---------------|
|                          |  |                 | $V_{DD}$ (V) | Min.      | Typ. | Max. |               |
| <b>CLOCKED OPERATION</b> |  |                 |              |           |      |      |               |
| $t_{PLH}, t_{PHL}$       | Propagation Delay Time<br>Carry Out Line   |                 | 5            |           | 250  | 500  | ns            |
|                          |  |                 | 10           |           | 100  | 200  |               |
|                          |  |                 | 15           |           | 75   | 150  |               |
| $t_{PLH}, t_{PHL}$       | Propagation Delay Time<br>Decode Out Lines |                 | 5            |           | 350  | 700  | ns            |
|                          |  |                 | 10           |           | 125  | 250  |               |
|                          |  |                 | 15           |           | 90   | 180  |               |
| $t_{THL}, t_{TLH}$       | Transition Time<br>Carry Out Line          |                 | 5            |           | 100  | 200  | ns            |
|                          |  |                 | 10           |           | 50   | 100  |               |
|                          |  |                 | 15           |           | 25   | 50   |               |
| $f_{CL}^*$               | Maximum Clock Input Frequency              |                 | 5            | 2.5       | 5    |      | MHz           |
|                          |  |                 | 10           | 5.5       | 11   |      |               |
|                          |  |                 | 15           | 8         | 16   |      |               |
| $t_{WC}$                 | Clock Pulse Width                          |                 | 5            |           | 110  | 270  | ns            |
|                          |  |                 | 10           |           | 50   | 100  |               |
|                          |  |                 | 15           |           | 40   | 80   |               |
| $t_r, t_f$               | Clock Input Rise or Fall Time              |                 | 5            | Unlimited |      |      | $\mu\text{s}$ |
|                          |  |                 | 10           |           |      |      |               |
|                          |  |                 | 15           |           |      |      |               |
| <b>RESET OPERATION</b>   |  |                 |              |           |      |      |               |
| $t_{PLH}, t_{PHL}$       | Propagation Delay Time<br>Carry Out Line   |                 | 5            |           | 275  | 550  | ns            |
|                          |  |                 | 10           |           | 120  | 240  |               |
|                          |  |                 | 15           |           | 80   | 160  |               |
| $t_{PLH}, t_{PHL}$       | Propagation Delay Time<br>Decode Out Lines |                 | 5            |           | 300  | 600  | ns            |
|                          |  |                 | 10           |           | 125  | 250  |               |
|                          |  |                 | 15           |           | 90   | 180  |               |
| $t_{WR}$                 | Reset Pulse Width                          |                 | 5            |           | 100  | 120  | ns            |
|                          |  |                 | 10           |           | 50   | 100  |               |
|                          |  |                 | 15           |           | 25   | 50   |               |
| $t_{rem}$                | Reset Removal Time                         |                 | 5            |           | 0    | 30   | ns            |
|                          |  |                 | 10           |           | 0    | 15   |               |
|                          |  |                 | 15           |           | 0    | 10   |               |

\* Measured with respect to carry output line.

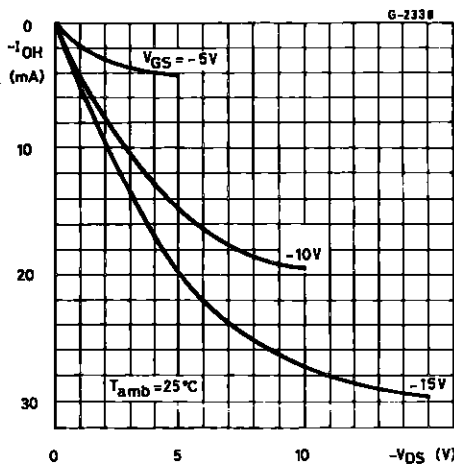
Typical Output Low (sink) Current



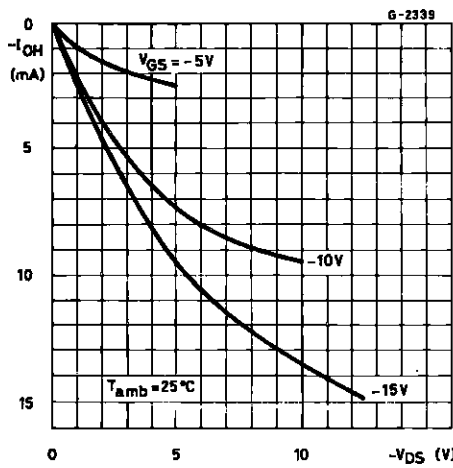
Minimum Output Low (sink) Current Characteristics.



Typical Output High (source) Current Characteristics.

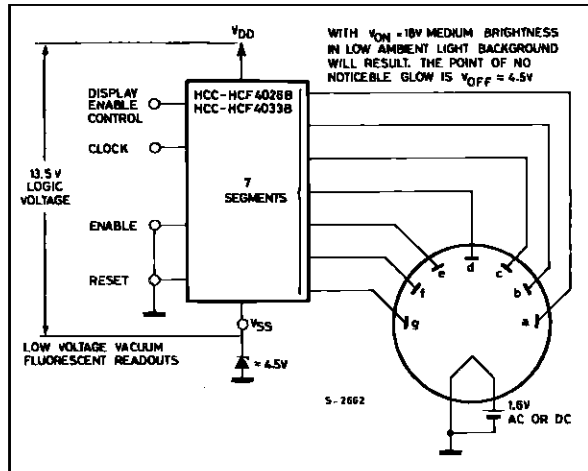


Minimum Output High (source) Current Characteristics.

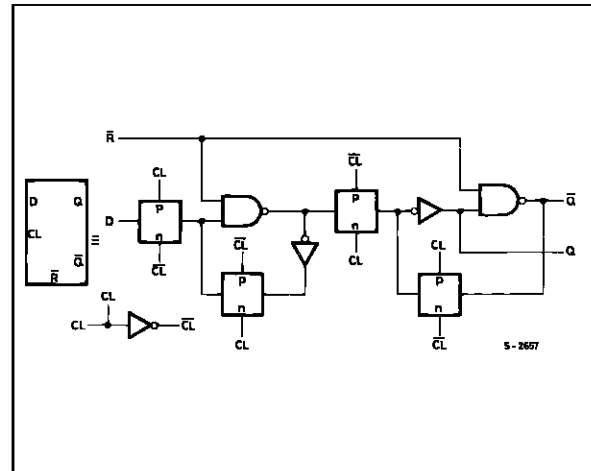


TYPICAL APPLICATIONS

Interfacing with Filament Fluorescent Display.



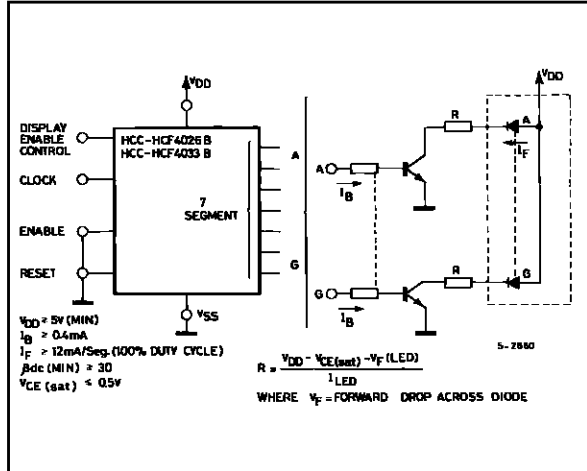
Detail of Typical Flip-flop Stage for Both Types.



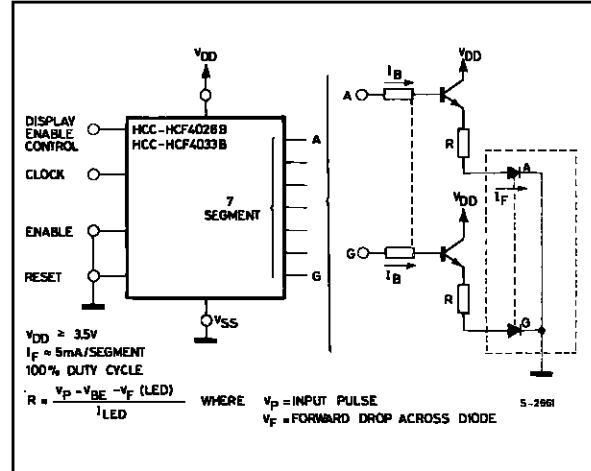


TYPICAL APPLICATIONS (continued)

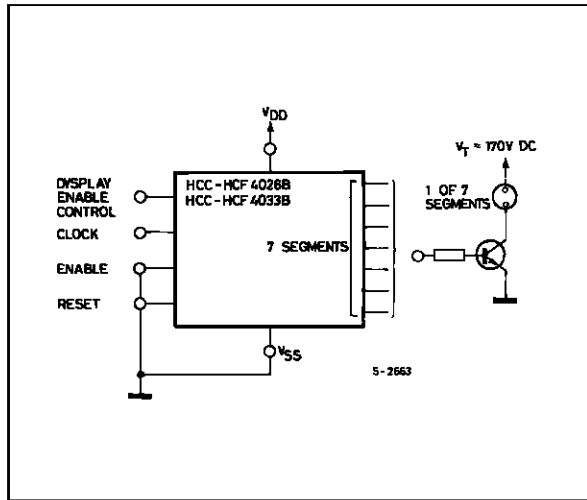
Interfacing with LED Displays (display common anode).



(Display Common Cathode).

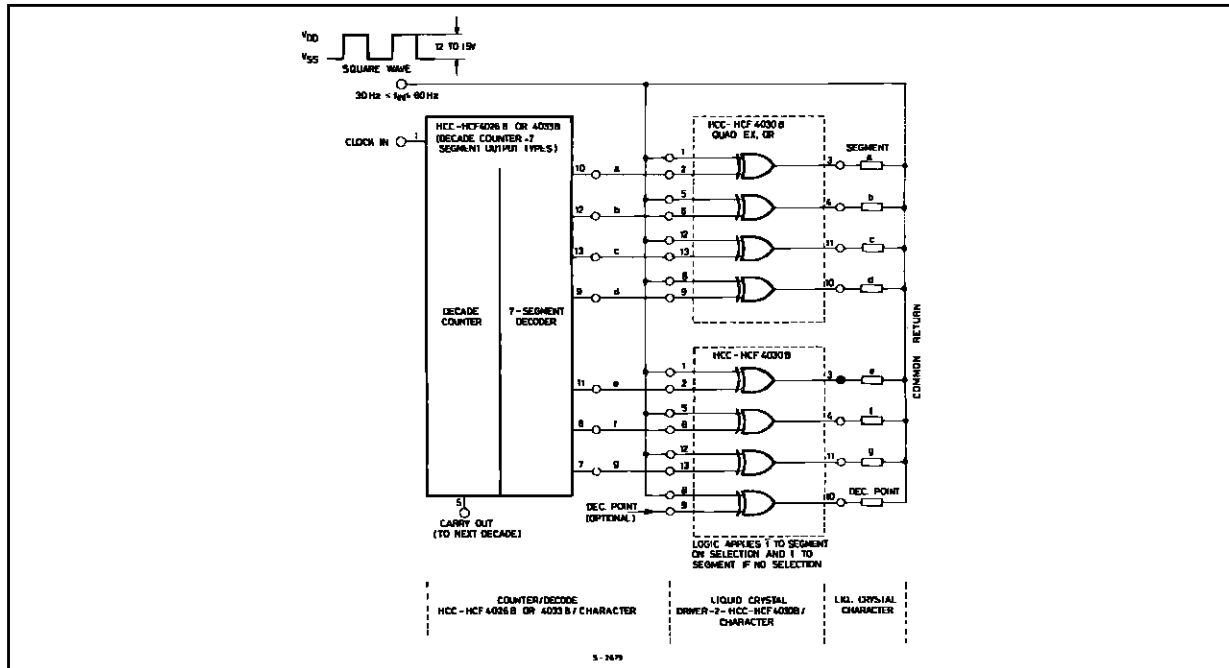


Interfacing with NIXIE Tube.



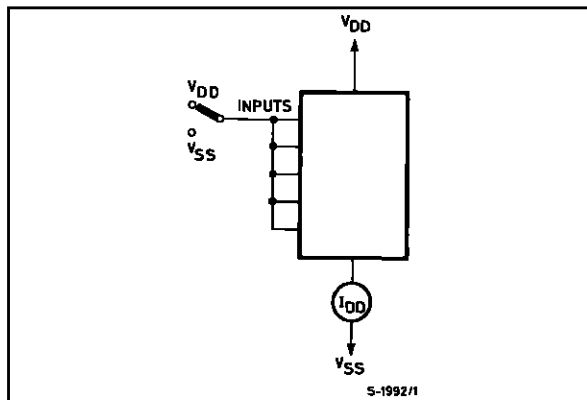
# HCC/HCF4026B/4033B

Interfacing with Liquid Cristal Displays.

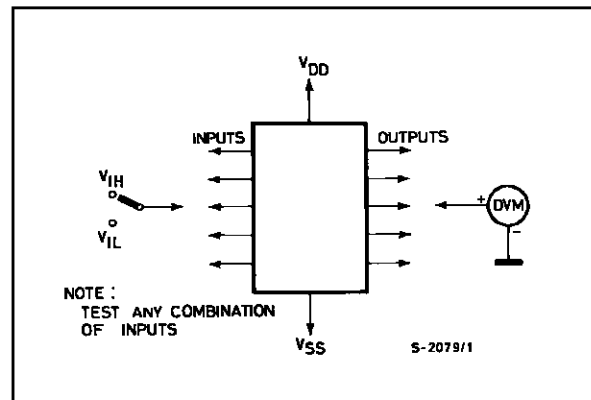


## TEST CIRCUITS

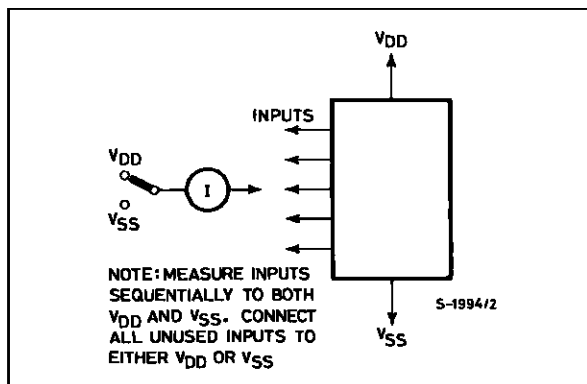
Quiescent Device Current



Input Voltage

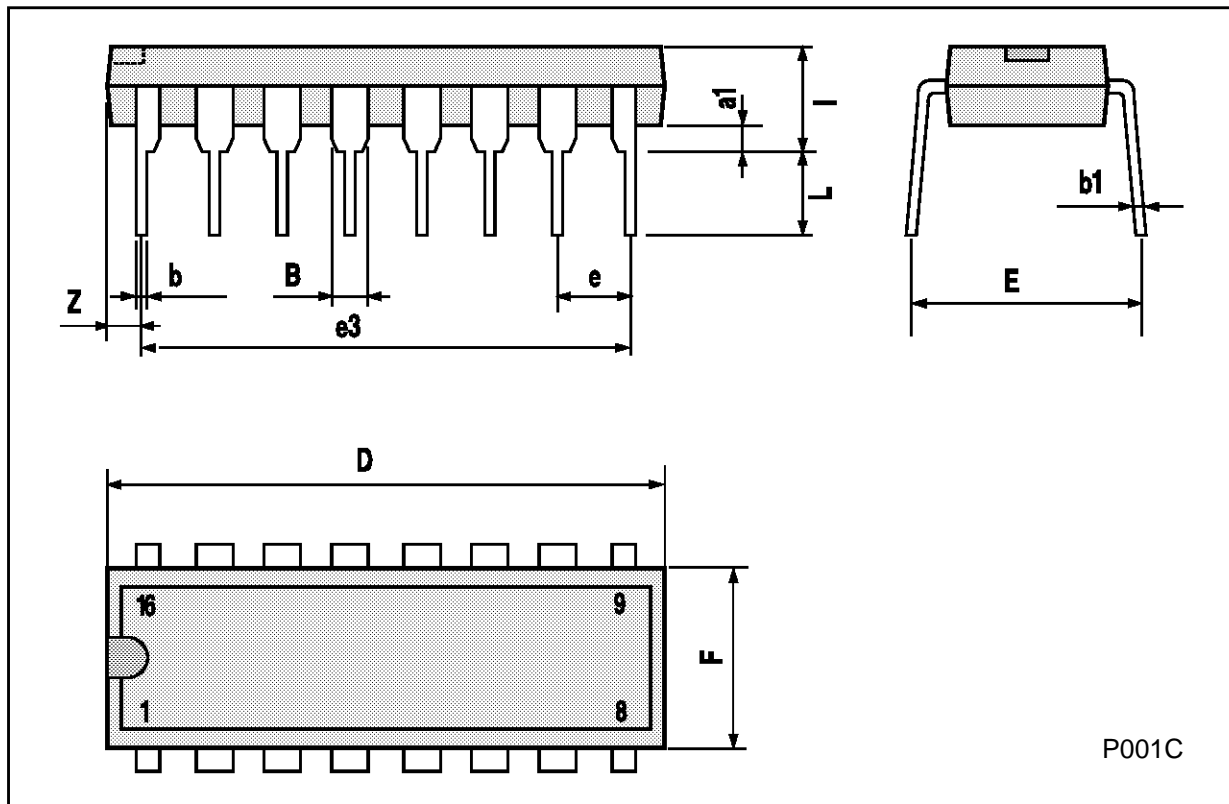


Input Current



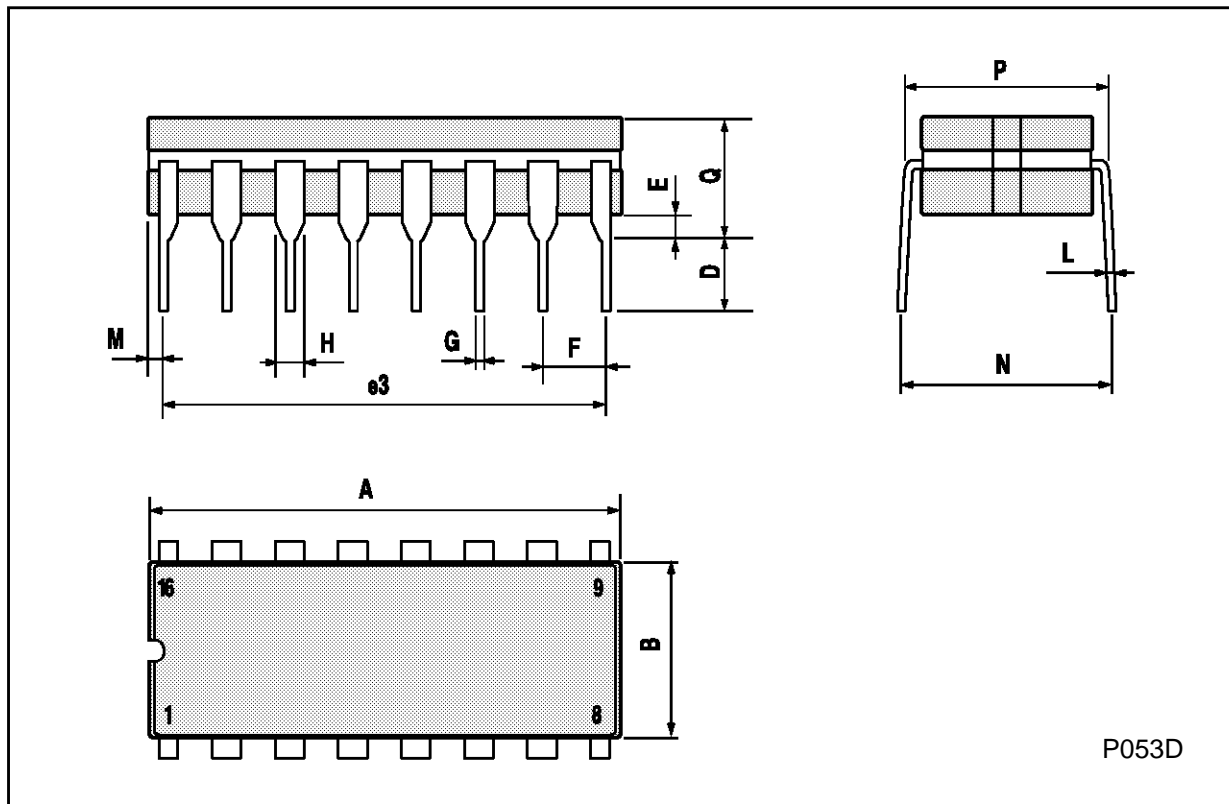
**Plastic DIP16 (0.25) MECHANICAL DATA**

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



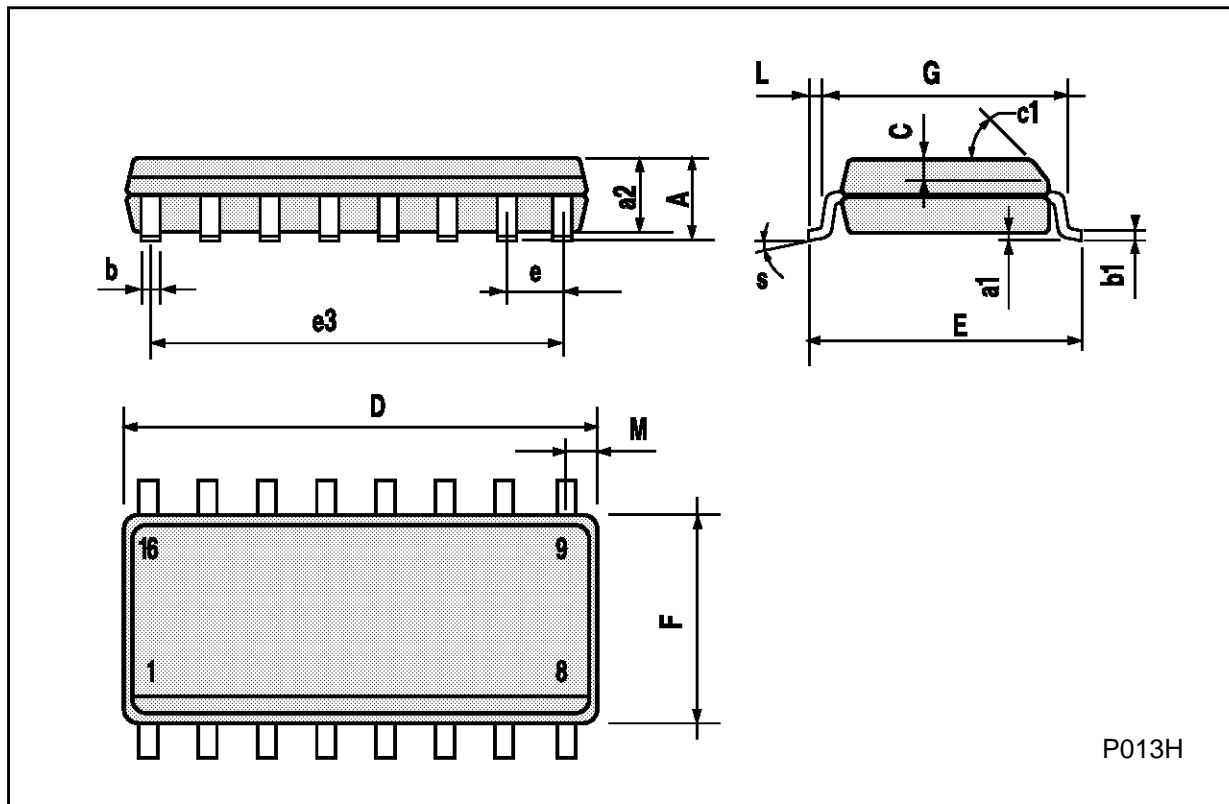
**Ceramic DIP16/1 MECHANICAL DATA**

| 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**

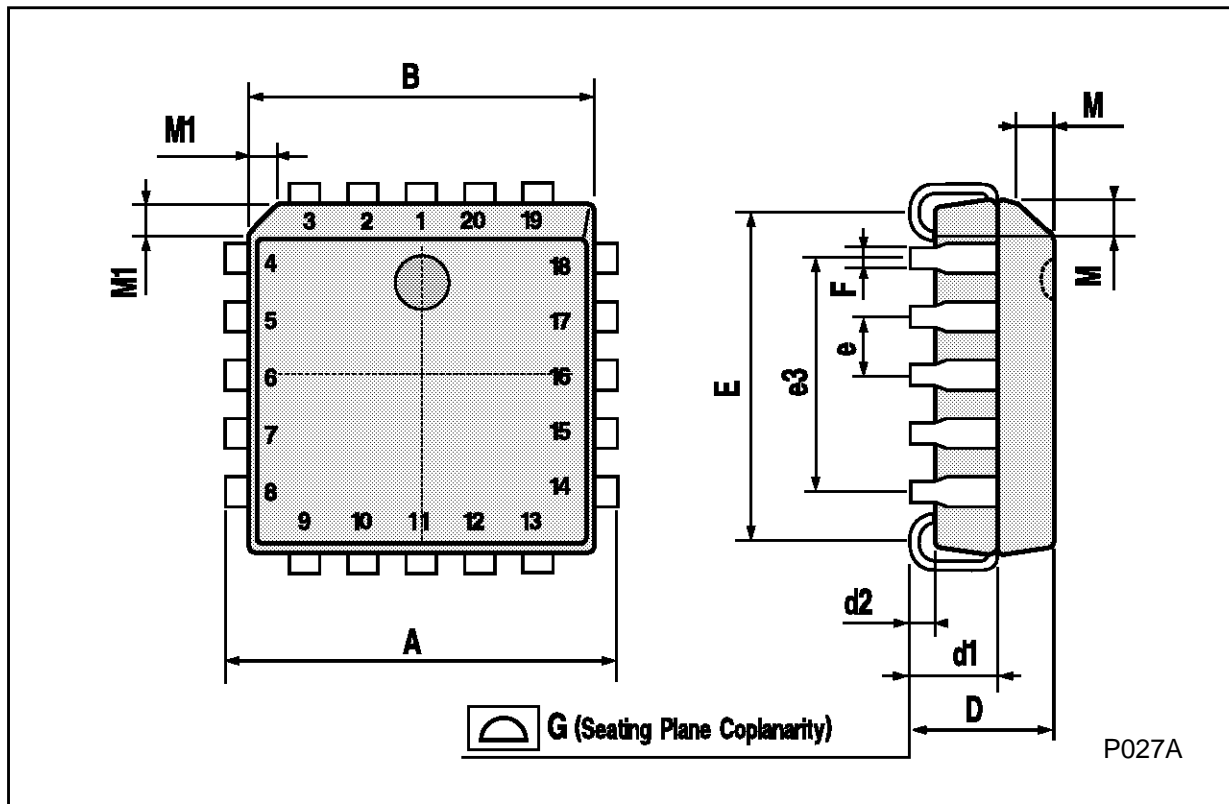
| DIM. | mm         |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.004 |       | 0.007 |
|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