



# HCF4056B

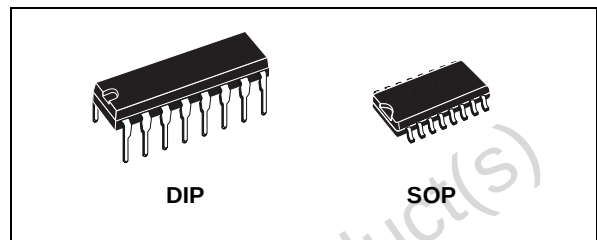
## BCD TO 7 SEGMENT DECODER /DRIVER WITH STROBED LATCH FUNCTION

- QUIESCENT CURRENT SPECIF. UP TO 20V
- OPERATION OF LIQUID CRYSTALS WITH CMOS CIRCUITS PROVIDES ULTRA LOW POWER DISPLAY.
- EQUIVALENT AC OUTPUT DRIVE FOR LIQUID CRYSTAL DISPLAYS - NO EXTERNAL CAPACITOR REQUIRED
- VOLTAGE DOUBLING ACROSS DISPLAY [( $V_{DD} - V_{EE}$ ) = 18V] RESULTS IN EFFECTIVE 36V (p-p) DRIVE ACROSS SELECTED DISPLAY SEGMENTS
- LOW OR HIGH OUTPUT LEVEL DC DRIVE FOR OTHER TYPES OF DISPLAYS
- ONE CHIP LOGIC LEVEL CONVERSION FOR DIFFERENT INPUT AND OUTPUT LEVEL SWINGS
- FULL DECODING OF ALL INPUT COMBINATIONS : "0 - 9, L, H, P, A" AND BLANK POSITIONS
- INPUT LEAKAGE CURRENT  
 $I_l = 100\text{nA (MAX) AT } V_{DD} = 18\text{V } T_A = 25^\circ\text{C}$
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC JESD13B "STANDARD SPECIFICATIONS FOR DESCRIPTION OF B SERIES CMOS DEVICES"

### DESCRIPTION

HCF4056B is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor technology available in DIP and SOP packages.

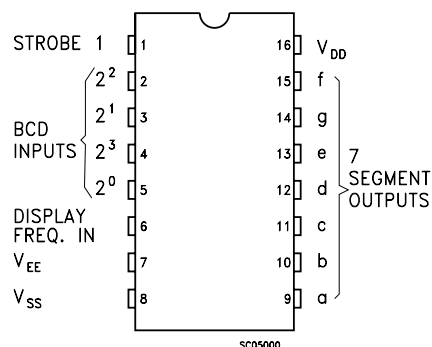
### PIN CONNECTION



### ORDER CODES

| PACKAGE | TUBE       | T & R         |
|---------|------------|---------------|
| DIP     | HCF4056BEY |               |
| SOP     | HCF4056BM1 | HCF4056M013TR |

HCF4056B is a single digit BCD to 7 segment decoder driver circuit that provides a level shifting function on the chip. This feature permits the BCD input-signal swings ( $V_{DD}$  to  $V_{SS}$ ) to be the same as or different from the 7-segment output signal swings ( $V_{DD}$  to  $V_{EE}$ ). For example, the BCD input-signal swings ( $V_{DD}$  to  $V_{SS}$ ) may be as low as 0 to -3V, whereas the output-display drive signal swing ( $V_{DD}$  to  $V_{EE}$ ) may be from 0 to -5V. If  $V_{DD}$  to  $V_{EE}$  exceeds 15V,  $V_{DD}$  to  $V_{SS}$  should be at least 4V. The 7-segment outputs are controlled by the DISPLAY-FREQUENCY (DF) input, which causes the selected segment outputs to be low, high, or a square wave output (for liquid crystal displays).

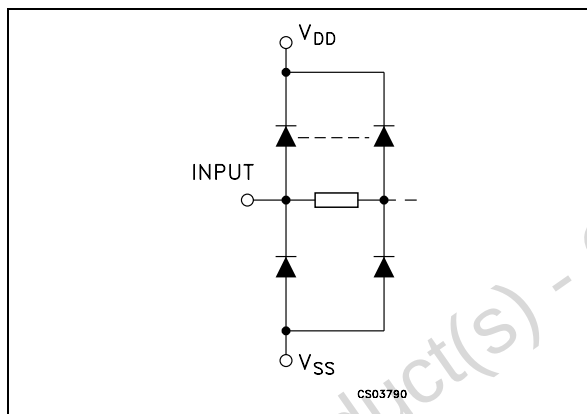


## HCF4056B

When the DF input is low, the output segments will be high when selected by the BCD inputs. When the DF input is high, the output segments will be low when selected by the BCD inputs. When a square wave is present at the DF input, the selected segments will have a square wave output that is 180° out of phase with the DF input. Those segments which are not selected will have a square wave output that is in phase with the input. DF square wave repetition rates for liquid crystal displays usually range from 30Hz (well above flicker rate) to 200Hz (well below the upper limit of the liquid crystal frequency response). HCF4056B provides a strobed-latch function at the BCD inputs. The decoding of all input combinations in

this device provides displays of 0 to 9 as well as L, P, H, A, -, and a blank position. The level shifted function permits the use of different input and output signal swings. The input swings from a low level of  $V_{SS}$  to a high level of  $V_{DD}$ , while the outputs swing from a low level of  $V_{EE}$  to the same high level of  $V_{DD}$ . Thus, the input and output swings can be selected independently of each other over a 3 to 18V range.  $V_{SS}$  may be connected to  $V_{EE}$  when no level-shift function is required. The HCF4056B, however must be used together with HCF4054B to provide the common DF output.

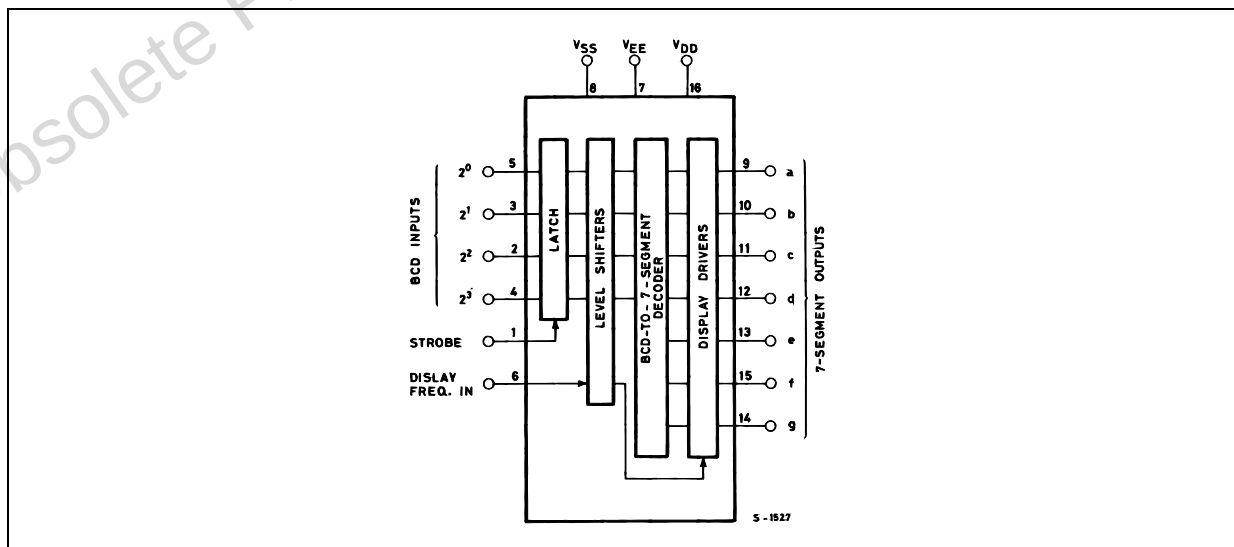
### INPUT EQUIVALENT CIRCUIT



### PIN DESCRIPTION

| PIN No                    | SYMBOL               | NAME AND FUNCTION       |
|---------------------------|----------------------|-------------------------|
| 5, 3, 2, 4                | $2^0, 2^1, 2^2, 2^3$ | BCD Inputs              |
| 9, 10, 11, 12, 13, 15, 14 | a to g               | 7 - Segments Outputs    |
| 6                         | DISPLAY FREQ. IN     | Display Frequency Input |
| 1                         | STROBE               | Strobe Input            |
| 7                         | $V_{EE}$             | Negative Supply Voltage |
| 8                         | $V_{SS}$             | Negative Supply Voltage |
| 16                        | $V_{DD}$             | Positive Supply Voltage |

### FUNCTIONAL DIAGRAM



## TRUTH TABLE

| INPUT CODE |       |       |       | OUTPUT STATE |   |   |   |   |   |   | DISPLAY CHARACTER |
|------------|-------|-------|-------|--------------|---|---|---|---|---|---|-------------------|
| $2^3$      | $2^2$ | $2^1$ | $2^0$ | a            | b | c | d | e | f | g |                   |
| L          | L     | L     | L     | H            | H | H | H | H | H | L | 0                 |
| L          | L     | L     | H     | L            | H | H | L | L | L | L | 1                 |
| L          | L     | H     | L     | H            | H | L | H | H | L | H | 2                 |
| L          | L     | H     | H     | H            | H | H | H | L | L | H | 3                 |
| L          | H     | L     | L     | L            | H | H | L | L | H | H | 4                 |
| L          | H     | L     | H     | H            | L | H | H | L | H | H | 5                 |
| L          | H     | H     | L     | H            | L | H | H | H | H | H | 6                 |
| L          | H     | H     | H     | H            | H | H | L | L | L | L | 7                 |
| H          | L     | L     | L     | H            | H | H | H | H | H | H | 8                 |
| H          | L     | L     | H     | H            | H | H | H | L | H | H | 9                 |
| H          | L     | H     | L     | L            | L | L | H | H | H | L | L                 |
| H          | L     | H     | H     | L            | H | H | L | H | H | H | H                 |
| H          | H     | L     | L     | H            | H | L | L | H | H | H | P                 |
| H          | H     | L     | H     | H            | H | H | L | H | H | H | A                 |
| H          | H     | H     | L     | L            | L | L | L | L | L | H | -                 |
| H          | H     | H     | H     | L            | L | L | L | L | L | L | BLANK             |

## ABSOLUTE MAXIMUM RATINGS

| Symbol    | Parameter                               | Value                  | Unit |
|-----------|-----------------------------------------|------------------------|------|
| $V_{DD}$  | Supply Voltage                          | -0.5 to +22            | V    |
| $V_I$     | DC Input Voltage                        | -0.5 to $V_{DD} + 0.5$ | V    |
| $I_I$     | DC Input Current                        | $\pm 10$               | mA   |
| $P_D$     | Power Dissipation per Package           | 200                    | mW   |
|           | Power Dissipation per Output Transistor | 100                    | mW   |
| $T_{op}$  | Operating Temperature                   | -55 to +125            | °C   |
| $T_{stg}$ | Storage Temperature                     | -65 to +150            | °C   |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

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

## RECOMMENDED OPERATING CONDITIONS

| Symbol   | Parameter             | Value         | Unit |
|----------|-----------------------|---------------|------|
| $V_{DD}$ | Supply Voltage        | 3 to 20       | V    |
| $V_I$    | Input Voltage         | 0 to $V_{DD}$ | V    |
| $T_{op}$ | Operating Temperature | -55 to 125    | °C   |

## DC SPECIFICATIONS

| Symbol          | Parameter                         | Test Condition         |                       |                       |                        |                        | Value                 |                   |      |             |      |              |      | Unit |
|-----------------|-----------------------------------|------------------------|-----------------------|-----------------------|------------------------|------------------------|-----------------------|-------------------|------|-------------|------|--------------|------|------|
|                 |                                   | V <sub>EE</sub><br>(V) | V <sub>I</sub><br>(V) | V <sub>O</sub><br>(V) | V <sub>SS</sub><br>(V) | V <sub>DD</sub><br>(V) | T <sub>A</sub> = 25°C |                   |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |                                   |                        |                       |                       |                        |                        | Min.                  | Typ.              | Max. | Min.        | Max. | Min.         | Max. |      |
| I <sub>L</sub>  | Quiescent Current                 | -5                     | 0/5                   |                       | 0                      | 5                      |                       | 0.04              | 5    |             | 150  |              | 150  | μA   |
|                 |                                   | 0                      | 0/10                  |                       | 0                      | 10                     |                       | 0.04              | 10   |             | 300  |              | 300  |      |
|                 |                                   | 0                      | 0/15                  |                       | 0                      | 15                     |                       | 0.04              | 20   |             | 600  |              | 600  |      |
|                 |                                   | 0                      | 0/20                  |                       | 0                      | 20                     |                       | 0.08              | 100  |             | 3000 |              | 3000 |      |
| V <sub>OH</sub> | High Level Output Voltage         | 0                      | 0/5                   |                       | 0                      | 5                      | 4.95                  |                   |      | 4.95        |      | 4.95         |      | V    |
|                 |                                   | 0                      | 0/10                  |                       | 0                      | 10                     | 9.95                  |                   |      | 9.95        |      | 9.95         |      |      |
|                 |                                   | 0                      | 0/15                  |                       | 0                      | 15                     | 14.95                 |                   |      | 14.95       |      | 14.95        |      |      |
| V <sub>OL</sub> | Low Level Output Voltage          | 0                      | 5/0                   |                       | 0                      | 5                      |                       | 0.05              |      |             | 0.05 |              | 0.05 | V    |
|                 |                                   | 0                      | 10/0                  |                       | 0                      | 10                     |                       | 0.05              |      |             | 0.05 |              | 0.05 |      |
|                 |                                   | 0                      | 15/0                  |                       | 0                      | 15                     |                       | 0.05              |      |             | 0.05 |              | 0.05 |      |
| V <sub>IH</sub> | High Level Input Voltage          | -5                     |                       | 0.5/4.5               | 0                      | 5                      | 3.5                   |                   |      | 3.5         |      | 3.5          |      | V    |
|                 |                                   | 0                      |                       | 1/9                   | 0                      | 10                     | 7                     |                   |      | 7           |      | 7            |      |      |
|                 |                                   | 0                      |                       | 1.5/18.5              | 0                      | 15                     | 11                    |                   |      | 11          |      | 11           |      |      |
| V <sub>IL</sub> | Low Level Input Voltage           | 5                      |                       | 0.5/4.5               | 0                      | 5                      |                       |                   | 1.5  |             | 1.5  |              | 1.5  | V    |
|                 |                                   | 0                      |                       | 9/1                   | 0                      | 10                     |                       |                   | 3    |             | 3    |              | 3    |      |
|                 |                                   | 0                      |                       | 1.5/18.5              | 0                      | 15                     |                       |                   | 4    |             | 4    |              | 4    |      |
| I <sub>OH</sub> | Output Drive Current              | -5                     | 0/5                   | 4.5                   | 0                      | 5                      | -0.38                 | -0.9              |      | -0.28       |      | -0.28        |      | mA   |
|                 |                                   | 0                      | 0/10                  | 9.5                   | 0                      | 10                     | -0.38                 | -0.9              |      | -0.28       |      | -0.28        |      |      |
|                 |                                   | 0                      | 0/15                  | 13.5                  | 0                      | 15                     | -1.27                 | -3                |      | -0.95       |      | -0.95        |      |      |
| I <sub>OL</sub> | Output Sink Current               | -5                     | 0/5                   | 0.4                   | 0                      | 5                      | 1.1                   | 2.6               |      | 0.82        |      | 0.82         |      | mA   |
|                 |                                   | 0                      | 0/10                  | 0.5                   | 0                      | 10                     | 1.1                   | 2.6               |      | 0.82        |      | 0.82         |      |      |
|                 |                                   | 0                      | 0/15                  | 1.5                   | 0                      | 15                     | 2.9                   | 6.8               |      | 2.17        |      | 2.17         |      |      |
| I <sub>I</sub>  | Input Leakage Current (any input) | 0                      | 0/18                  |                       | 0                      | 18                     |                       | ±10 <sup>-5</sup> | ±0.1 |             | ±1   |              | ±1   | μA   |
| C <sub>I</sub>  | Input Capacitance (any input)     |                        |                       |                       |                        |                        |                       | 5                 | 7.5  |             |      |              |      | pF   |

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<sub>amb</sub> = 25°C, C<sub>L</sub> = 50pF, R<sub>L</sub> = 200KΩ, t<sub>r</sub> = t<sub>f</sub> = 20 ns)

| Symbol                            | Parameter                                        | Test Condition         |                        |                        |  | Value (*) |      |      | Unit |
|-----------------------------------|--------------------------------------------------|------------------------|------------------------|------------------------|--|-----------|------|------|------|
|                                   |                                                  | V <sub>EE</sub><br>(V) | V <sub>SS</sub><br>(V) | V <sub>DD</sub><br>(V) |  | Min.      | Typ. | Max. |      |
| t <sub>PHL</sub> t <sub>PLH</sub> | Propagation Delay Time (any Input to any Output) | -5                     | 0                      | 5                      |  |           | 650  | 1300 | ns   |
|                                   |                                                  | 0                      | 0                      | 10                     |  |           | 575  | 1150 |      |
|                                   |                                                  | 0                      | 0                      | 15                     |  |           | 375  | 750  |      |
| t <sub>THL</sub> t <sub>TLH</sub> | Transition Time (any Output)                     | -5                     | 0                      | 5                      |  |           | 100  | 200  | ns   |
|                                   |                                                  | 0                      | 0                      | 10                     |  |           | 100  | 200  |      |
|                                   |                                                  | 0                      | 0                      | 15                     |  |           | 75   | 150  |      |

(\*) Typical temperature coefficient for all V<sub>DD</sub> value is 0.3 %/°C.

## TYPICAL APPLICATIONS

FIGURE 1 : Display Driver Circuit

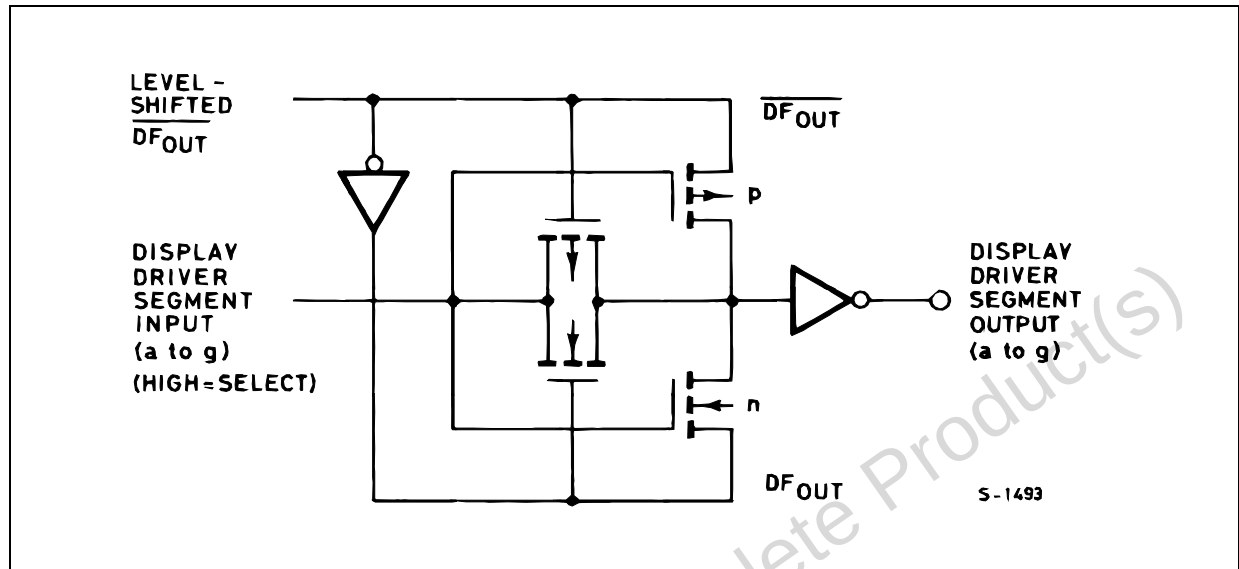
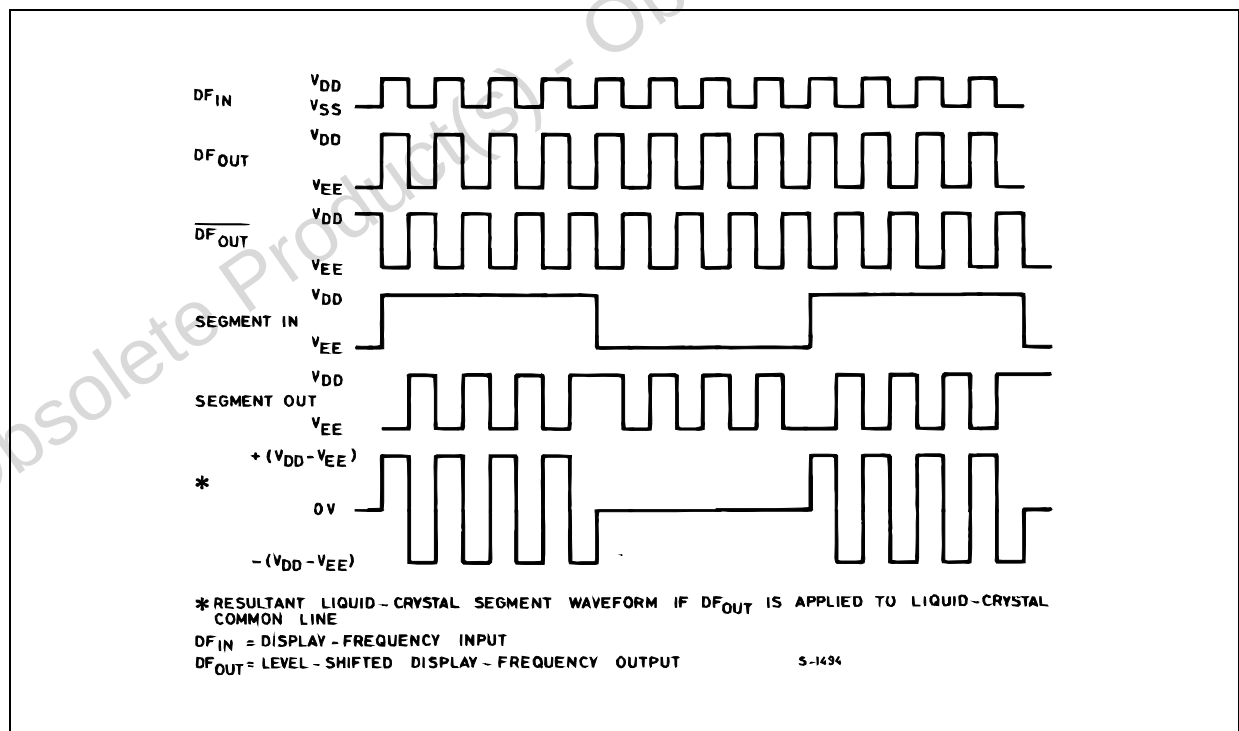
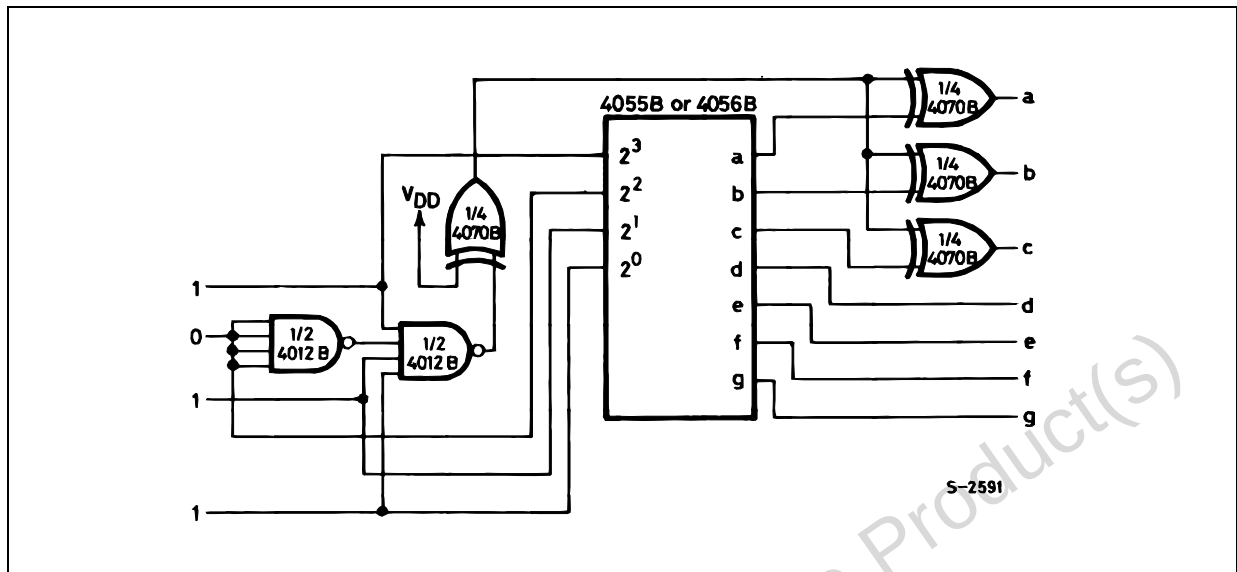
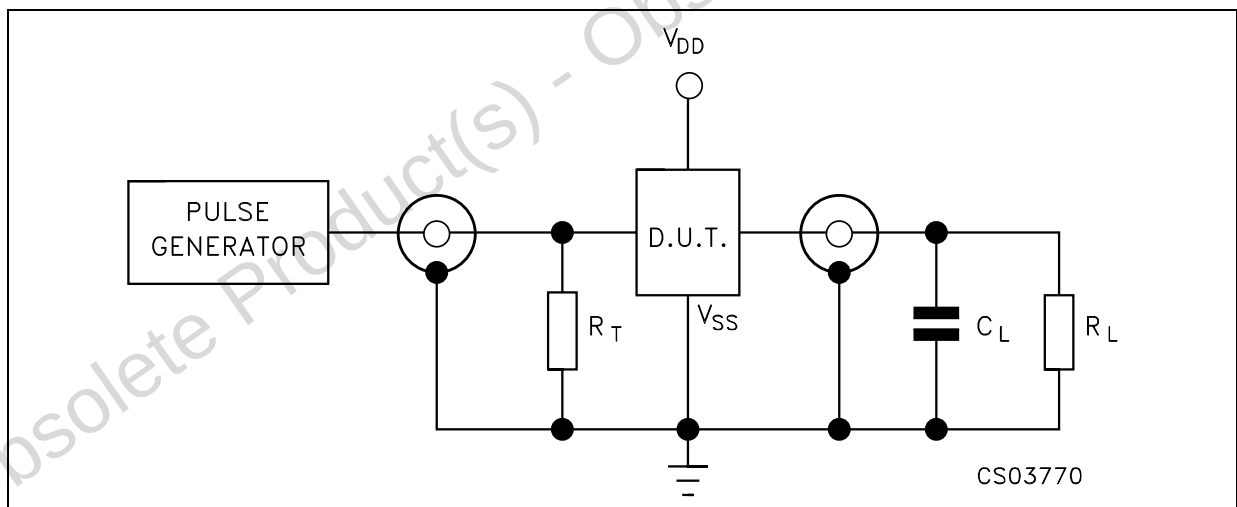


FIGURE 2 : Display Driver Waveforms.



**FIGURE 3** : Conversion Of "H" Display To "F" Display

Example of a circuit that converts an "H" display (code 1011) to an "F" display.

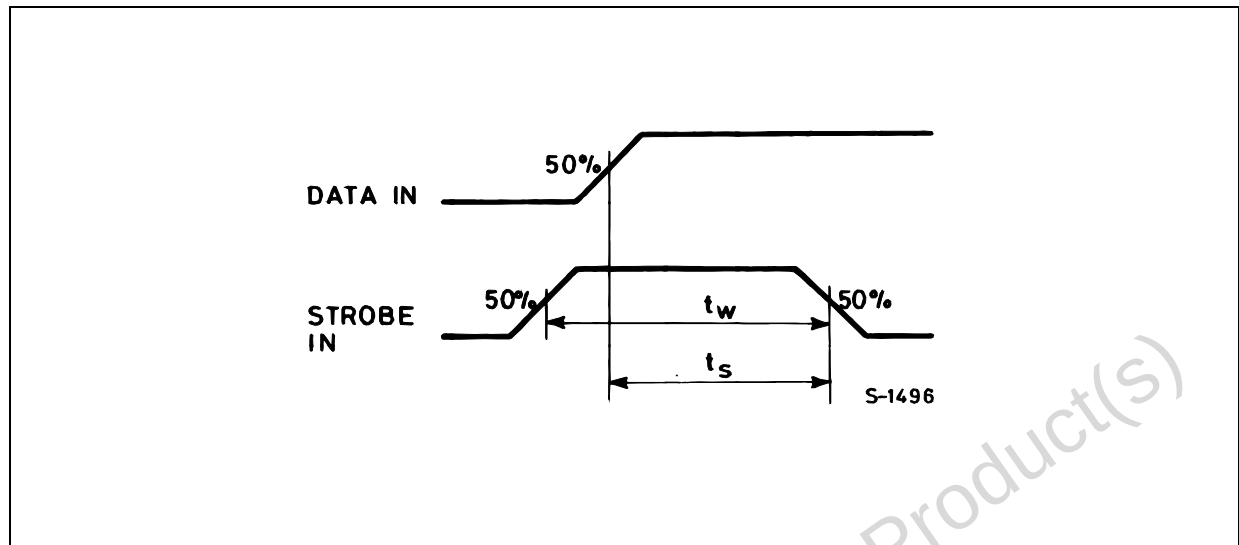
**TEST CIRCUIT**

$C_L = 50\text{pF}$  or equivalent (includes jig and probe capacitance)

$R_L = 200\text{K}\Omega$

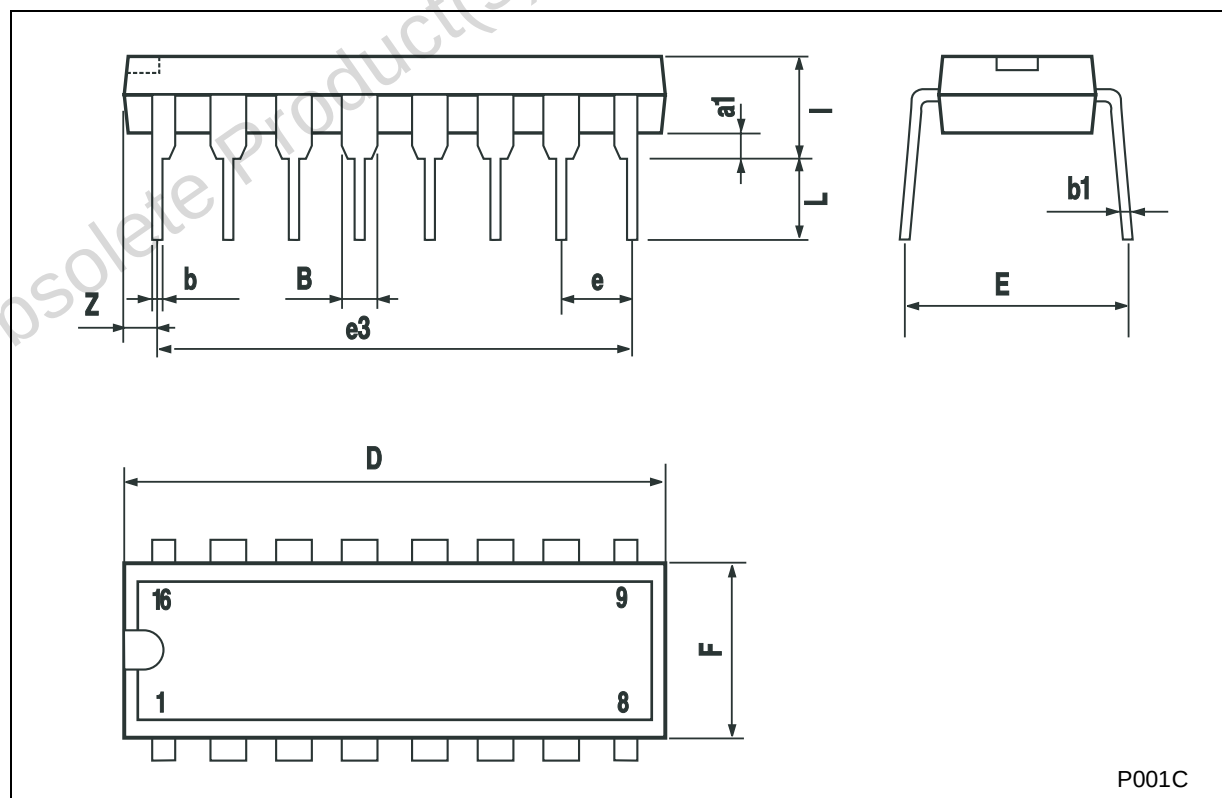
$R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

WAVEFORM : DATA SETUP TIME AND STROBE PULSE DURATION (f=1MHz; 50% duty cycle )



## Plastic DIP-16 (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 |

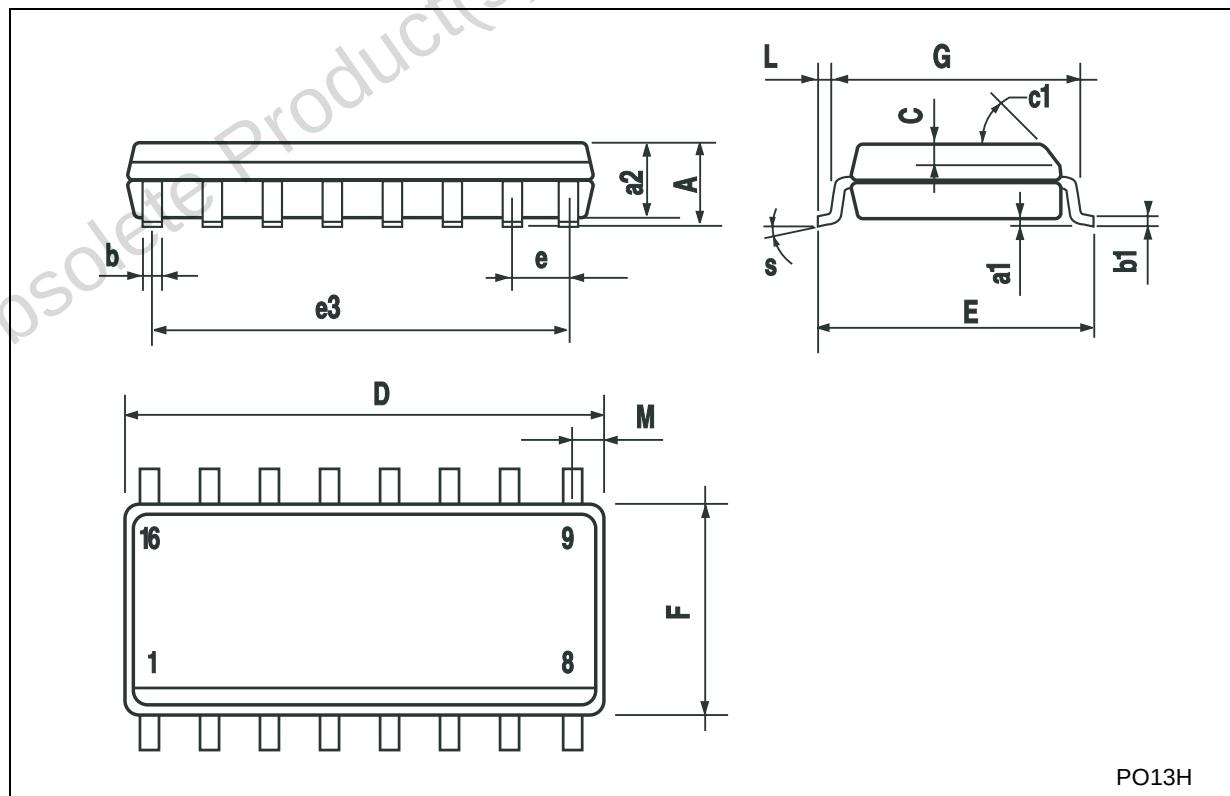


P001C



## SO-16 MECHANICAL DATA

| DIM. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 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.)  |      |      |       |       |       |



PO13H

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