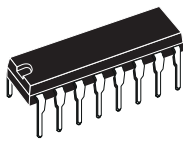
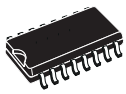
# HCF4055B

## BCD TO 7 SEGMENT LIQUID CRYSTAL DISPLAY DECODER/DRIVER WITH DISPLAY FREQUENCY OUTPUT

- QUIESCENT CURRENT SPECIF. UP TO 20V
- OPERATION OF LIQUID CRYSTALS WITH CMOS CIRCUITS PROVIDES ULTRA LOW POWER DISPLAYS
- 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 $I_I$ = 100nA (MAX) AT $V_{DD}$ = 18V $T_A$ = 25°C
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC JESD13B "STANDARD SPECIFICATIONS FOR DESCRIPTION OF B SERIES CMOS DEVICES"



**DIP**



**SOP**

**ORDER CODES**

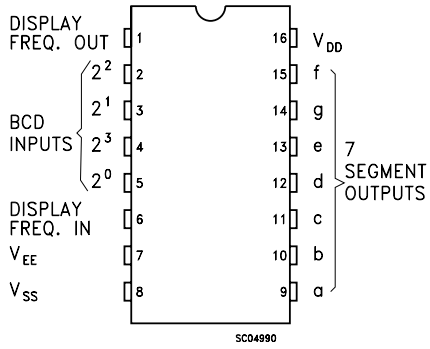
| PACKAGE | TUBE | T & R |
|---|---|---|
| DIP | HCF4055BEY | |
| SOP | HCF4055BM1 | HCF4055M013TR |

### DESCRIPTION

HCF4055B is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor technology available in DIP and SOP packages.

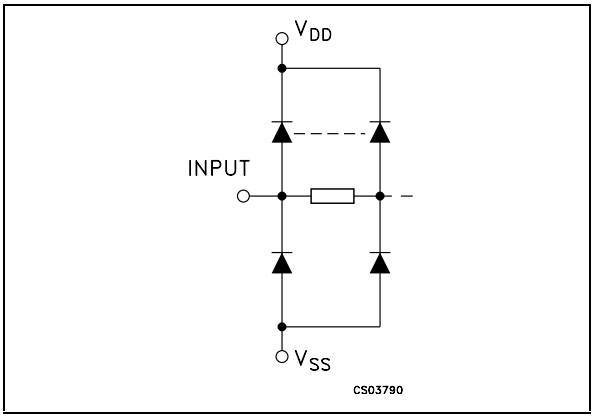
HCF4055B is a single digit BCD to 7 segment decoder driver circuit that provides a level shifting function on the chip. This feature permits the BCD input-signals swings ($V_{DD}$ to $V_{SS}$) to be the same as or different from the 7-segment output signal swings ($V_{DD}$ to $V_{EE}$). For example, 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).

### PIN CONNECTION



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). HCF4055B provides a level-shifted high amplitude DF output, which is required for driving the common electrode in liquid crystal displays. 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. Whenever the level-shifting function is required HCF4055B can be used by itself to drive a liquid crystal display (see Figure 3 and 4).

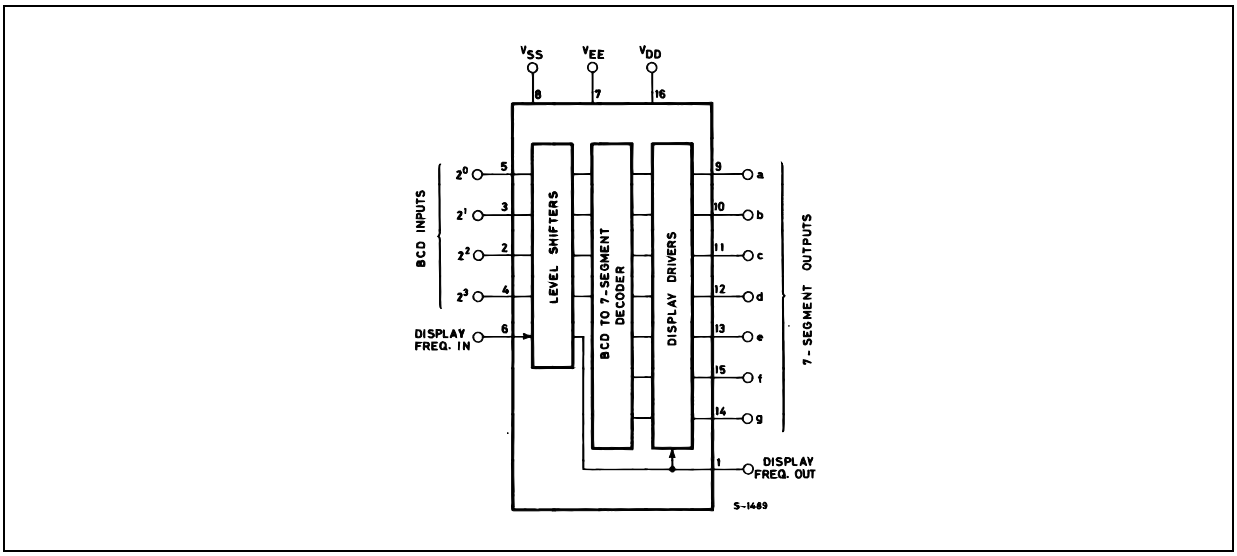
## INPUT EQUIVALENT CIRCUIT




## 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 | DISPLAY FREQ. OUT | Display Frequency Output |
| 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 | ± 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{EE}$ (V) | $V_I$ (V) | $V_O$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $I_L$ | 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 | |
| $V_{OH}$ | 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 | | |
| $V_{OL}$ | 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 | |
| $V_{IH}$ | 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 | | |
| $V_{IL}$ | 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 | |
| $I_{OH}$ | 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 | | |
| $I_{OL}$ | 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 | | |
| $I_I$ | Input Leakage Current (any input) | 0 | 0/18 | | 0 | 18 | | $\pm 10^{-5}$ | ±0.1 | | ±1 | | ±1 | µA |
| $C_I$ | Input Capacitance (any input) | | | | | | | 5 | 7.5 | | | | | pF |

The Noise Margin for both "1" and "0" level is: 1V min. with $V_{DD}$=5V, 2V min. with $V_{DD}$=10V, 2.5V min. with $V_{DD}$=15V

## DYNAMIC ELECTRICAL CHARACTERISTICS ($T_{amb}$ = 25°C, $C_L$ = 50pF, $R_L$ = 200KΩ, $t_r = t_f$ = 20 ns)

| Symbol | Parameter | Test Condition | | | | Value (*) | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | $V_{EE}$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | | Min. | Typ. | Max. | |
| $t_{PHL}$ $t_{PLH}$ | Propagation Delay Time (any Input to any Output) | -5 | 0 | 5 | | | 650 | 1300 | ns |
| | | 0 | 0 | 10 | | | 575 | 1150 | |
| | | 0 | 0 | 15 | | | 375 | 750 | |
| $t_{THL}$ $t_{TLH}$ | 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 $V_{DD}$ value is 0.3 %/°C.

## TYPICAL APPLICATIONS

**FIGURE 1** : Display Driver Circuits.

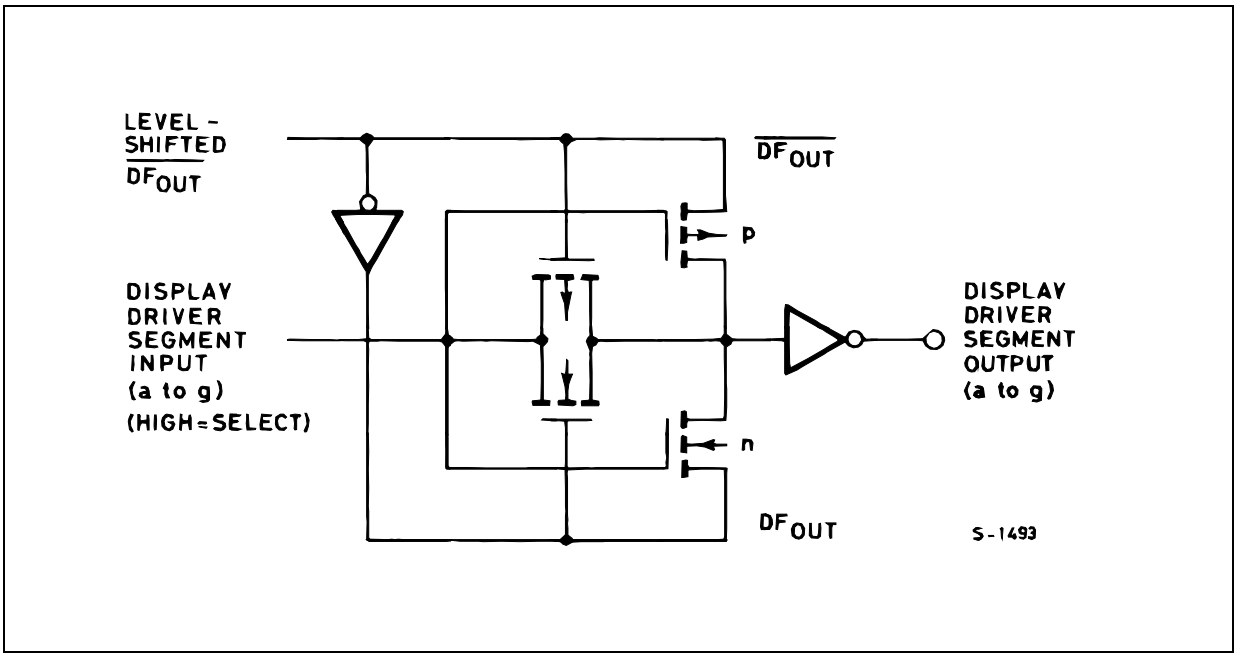



**FIGURE 2** : Display Driver Waveforms.

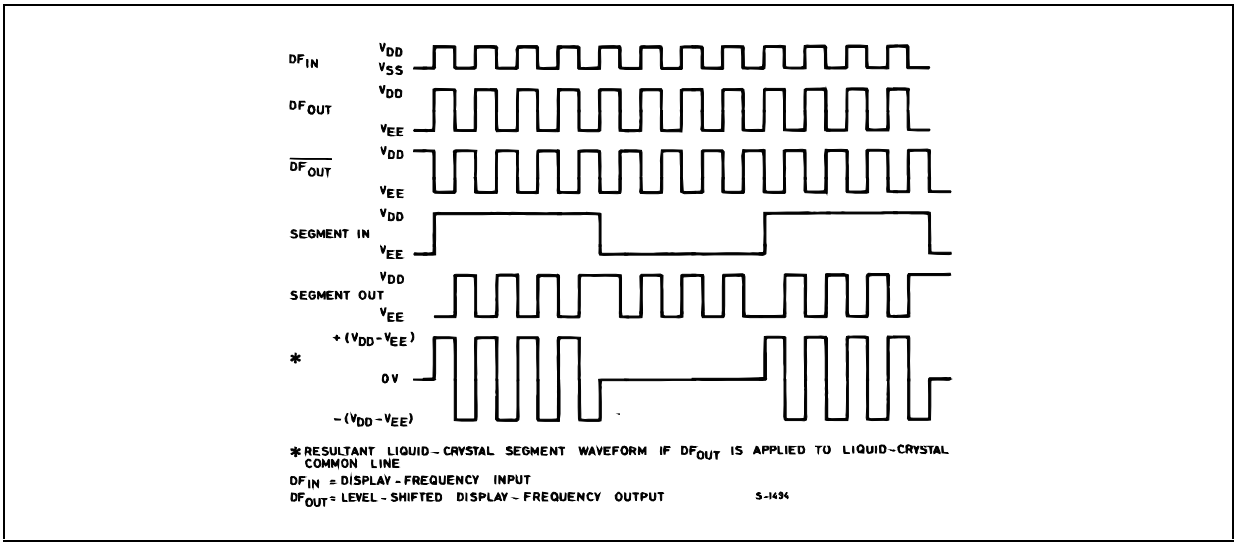


**FIGURE 3** : Clock Display.

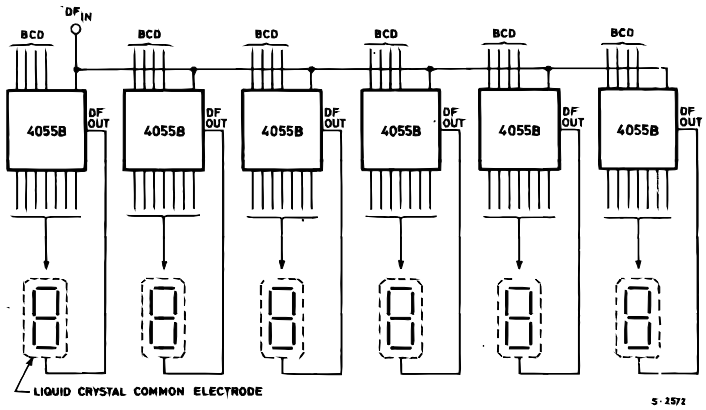



**FIGURE 4** : Single-digit Liquid Crystal Display

**BCD IN FROM DTL, TTL, OR CMOS LOGIC**

| OPTION 1 | OPTION 2 |
|---|---|
| $V_{DD}$ 0V | $V_{DD}$ +5V |
| $V_{SS}$ -5V | $V_{SS}$ 0V |
| $V_{EE}$ -15V | $V_{EE}$ -10V |

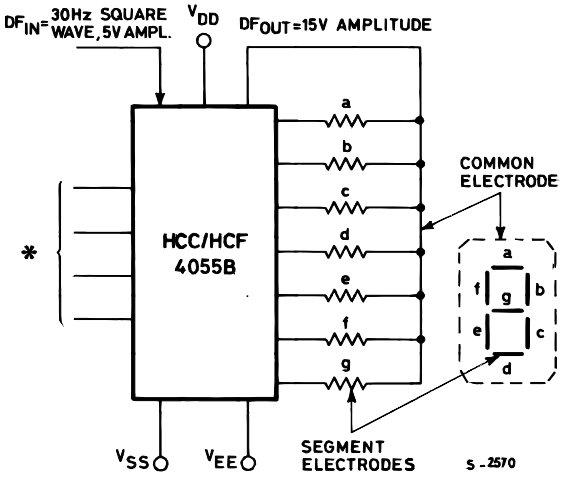
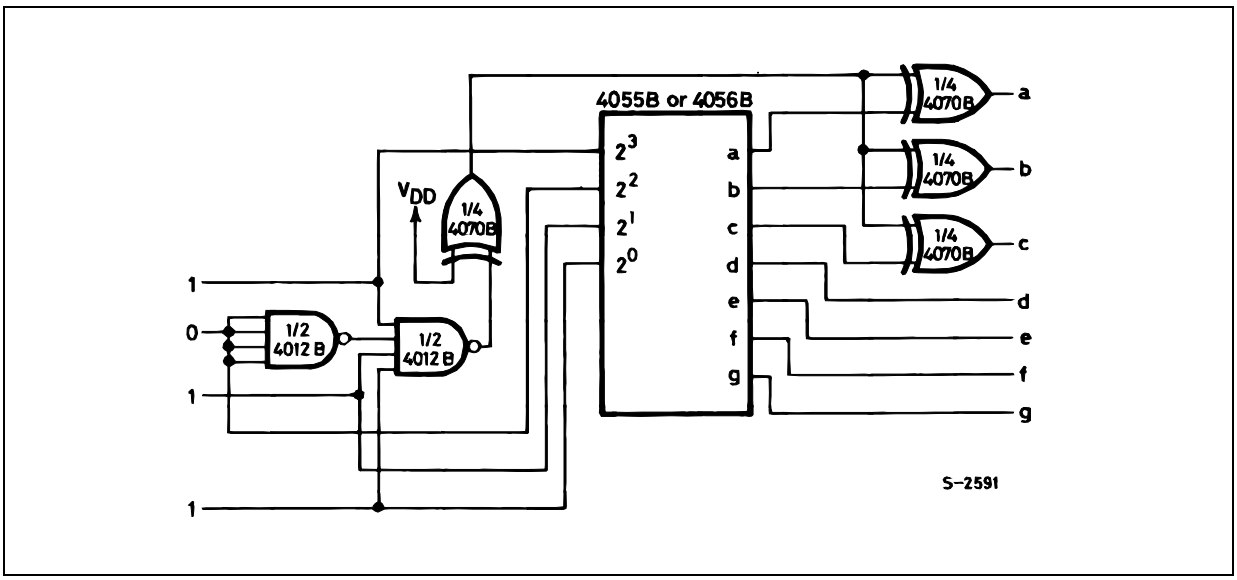
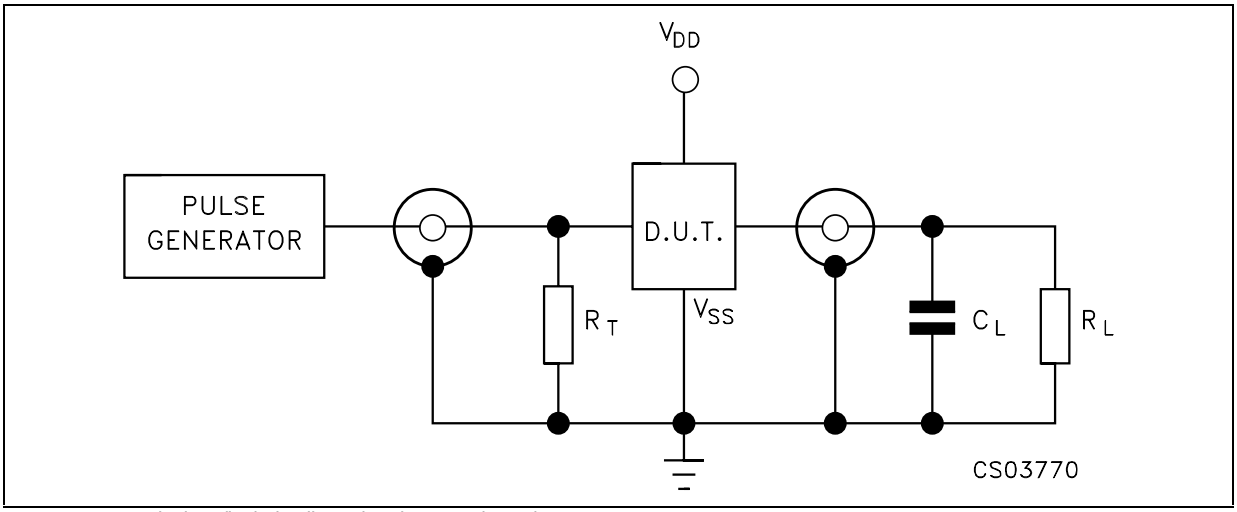


**FIGURE 5** : Conversion Of "H" Display To "F" Display



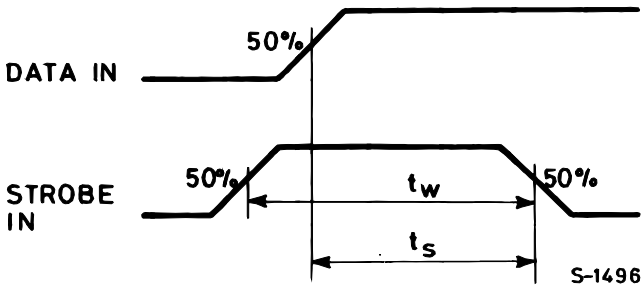

Example of a circuit that converts an "H" display (code 1011) to an "F" display.

## TEST CIRCUIT



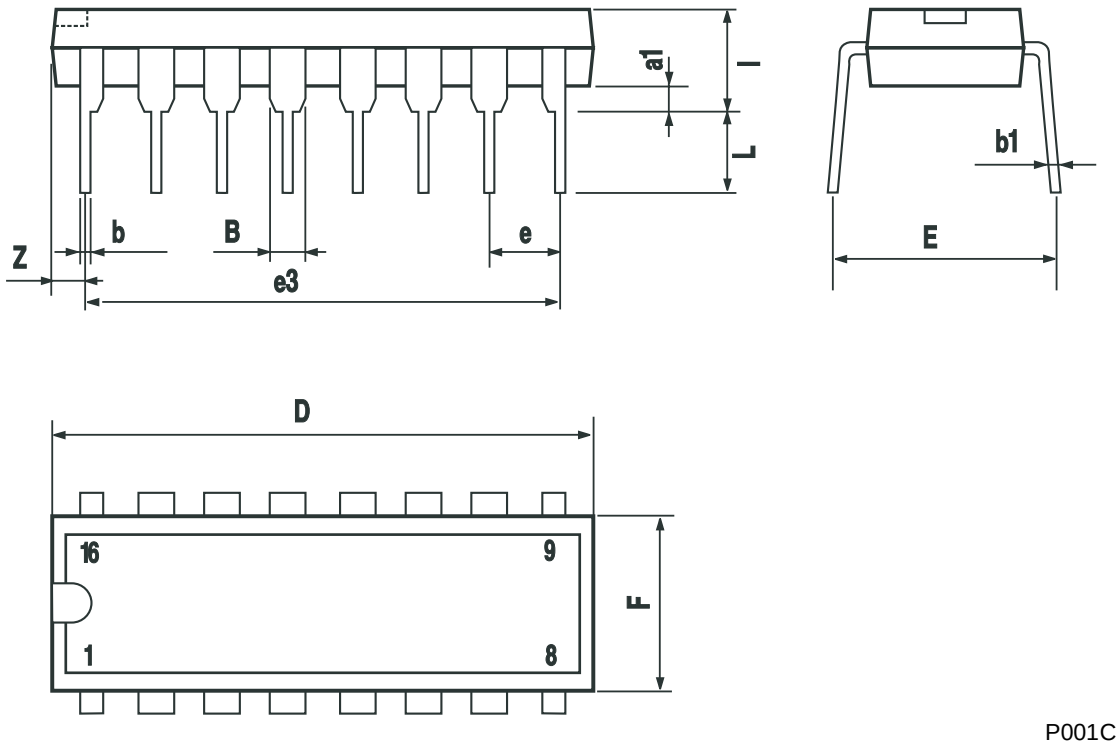

$C_L$ = 50pF or equivalent (includes jig and probe capacitance)
$R_L$ = 200KΩ
$R_T$ = $Z_{OUT}$ of pulse generator (typically 50Ω)

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



## Plastic DIP-16 (0.25) MECHANICAL DATA

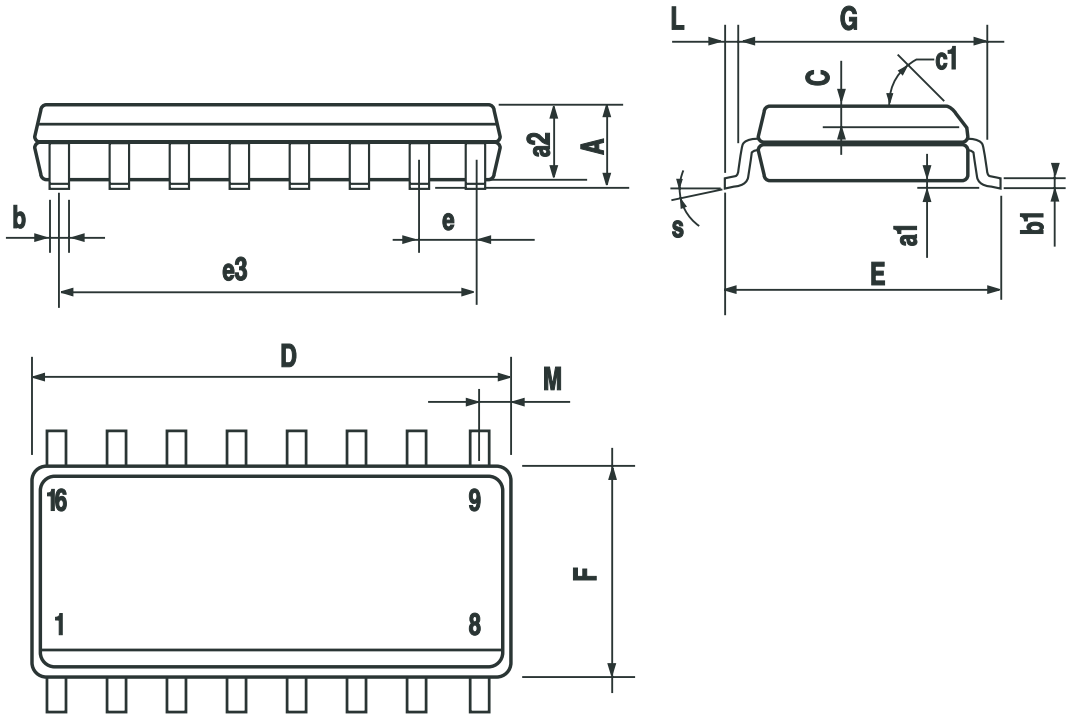
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 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