

DATA SHEET

For a complete data sheet, please also download:

- The IC04 LOCMOS HE4000B Logic Family Specifications HEF, HEC
- The IC04 LOCMOS HE4000B Logic Package Outlines/Information HEF, HEC

HEF40193B

MSI

4-bit up/down binary counter

Product specification
File under Integrated Circuits, IC04

January 1995

4-bit up/down binary counter

HEF40193B MSI

DESCRIPTION

The HEF40193B is a 4-bit synchronous up/down binary counter. The counter has a count-up clock input (CP_U), a count-down clock input (CP_D), an asynchronous parallel load input (\overline{PL}), four parallel data inputs (P_0 to P_3), an asynchronous master reset input (MR), four counter outputs (O_0 to O_3), an active LOW terminal count-up (carry) output (\overline{TC}_U) and an active LOW terminal count-down (borrow) output (\overline{TC}_D).

The counter outputs change state on the LOW to HIGH transition of either clock input. However, for correct counting, both clock inputs cannot be LOW simultaneously. The outputs \overline{TC}_U and \overline{TC}_D are normally HIGH. When the circuit has reached the maximum count state of '15', the next HIGH to LOW transition of CP_U will cause \overline{TC}_U to go LOW. \overline{TC}_U will stay LOW until CP_U goes HIGH again. Likewise, output \overline{TC}_D will go LOW when the circuit is in the zero state and CP_D goes LOW. When \overline{PL} is LOW, the information on P_0 to P_3 is asynchronously loaded into the counter. A HIGH on MR resets the counter independent of all other input conditions. The counter stages are of a static toggle type flip-flop.

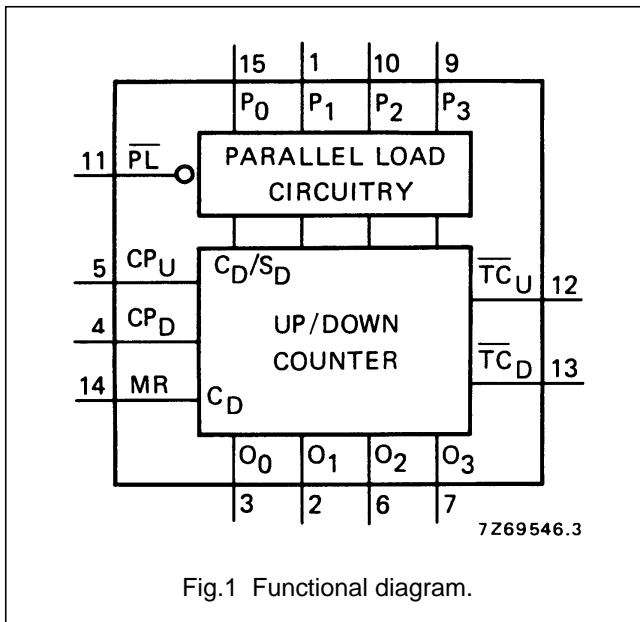


Fig.1 Functional diagram.

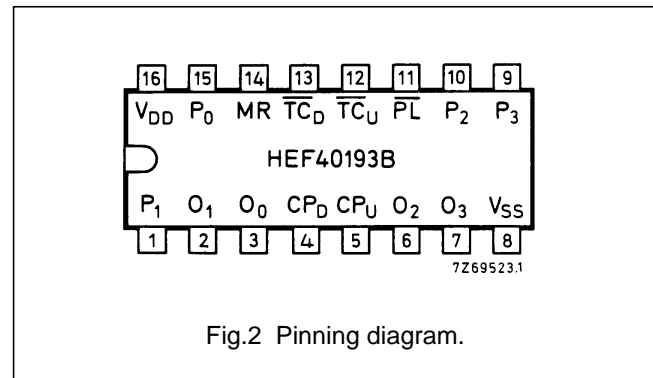


Fig.2 Pinning diagram.

PINNING

- \overline{PL} parallel load input (active LOW)
- P_0 to P_3 parallel data inputs
- CP_U count-up clock pulse input (LOW to HIGH, edge-triggered)
- CP_D count-down clock pulse input (LOW to HIGH, edge-triggered)
- MR master reset input (asynchronous)
- \overline{TC}_U buffered terminal count-up (carry) output (active LOW)
- \overline{TC}_D buffered terminal count-down (borrow) output (active LOW)
- O_0 to O_3 buffered counter outputs

- HEF40193BP(N): 16-lead DIL; plastic (SOT38-1)
- HEF40193BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)
- HEF40193BT(D): 16-lead SO; plastic (SOT109-1)
- (): Package Designator North America

FAMILY DATA, I_{DD} LIMITS category MSI

See Family Specification

4-bit up/down binary counter

HEF40193B
MSI

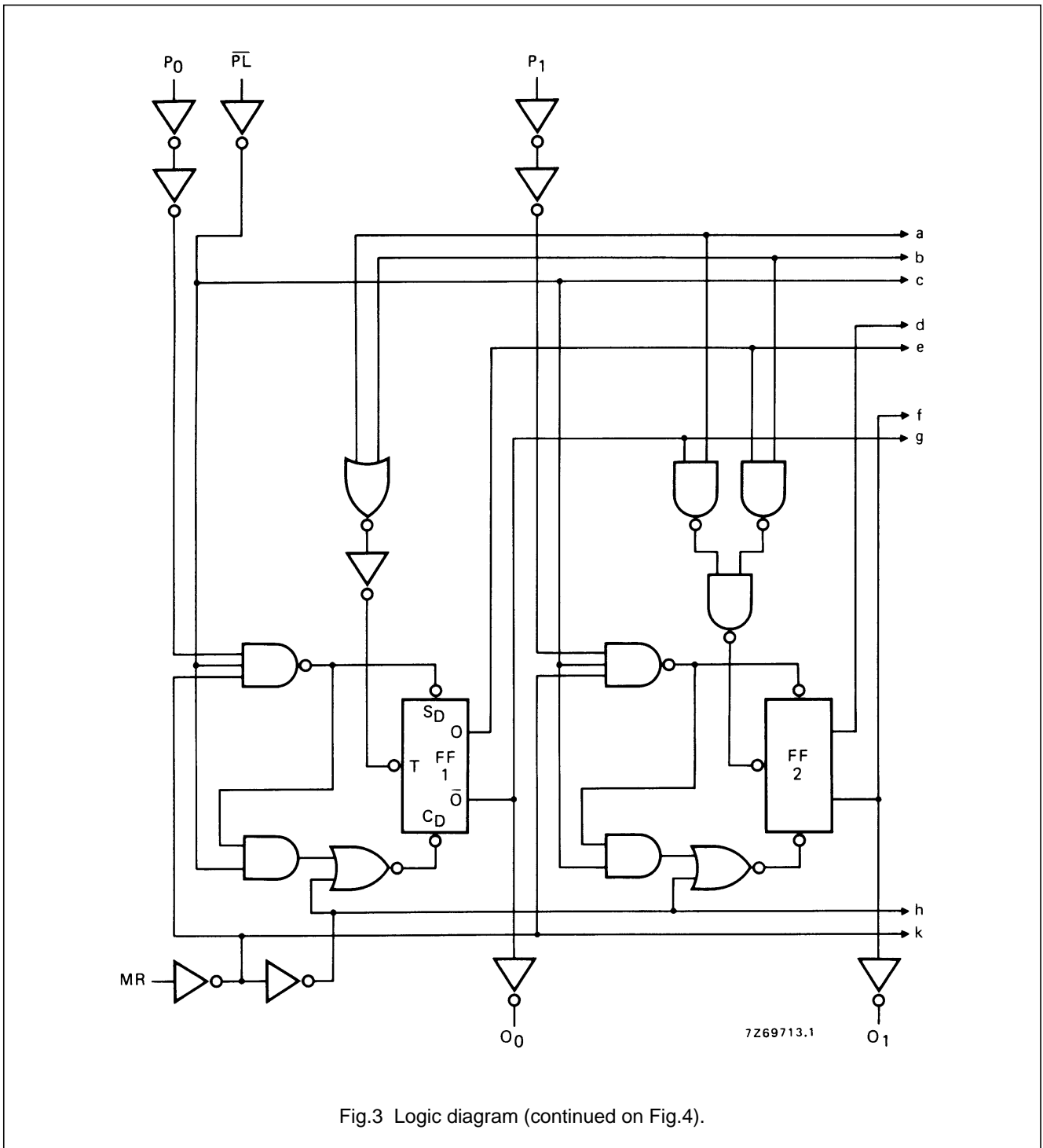


Fig.3 Logic diagram (continued on Fig.4).

4-bit up/down binary counter

HEF40193B
MSI

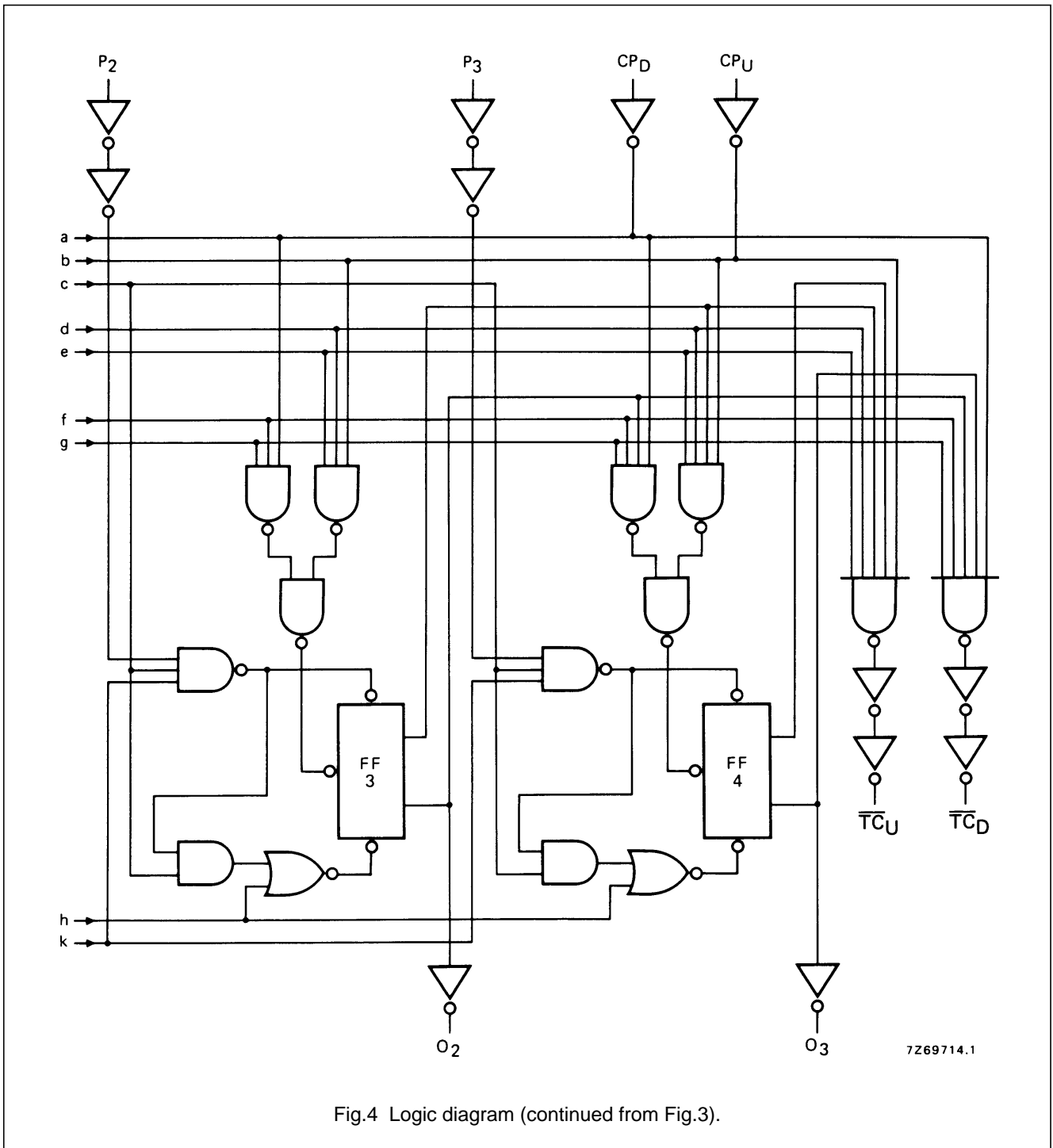




Fig.4 Logic diagram (continued from Fig.3).

4-bit up/down binary counter


HEF40193B
MSI

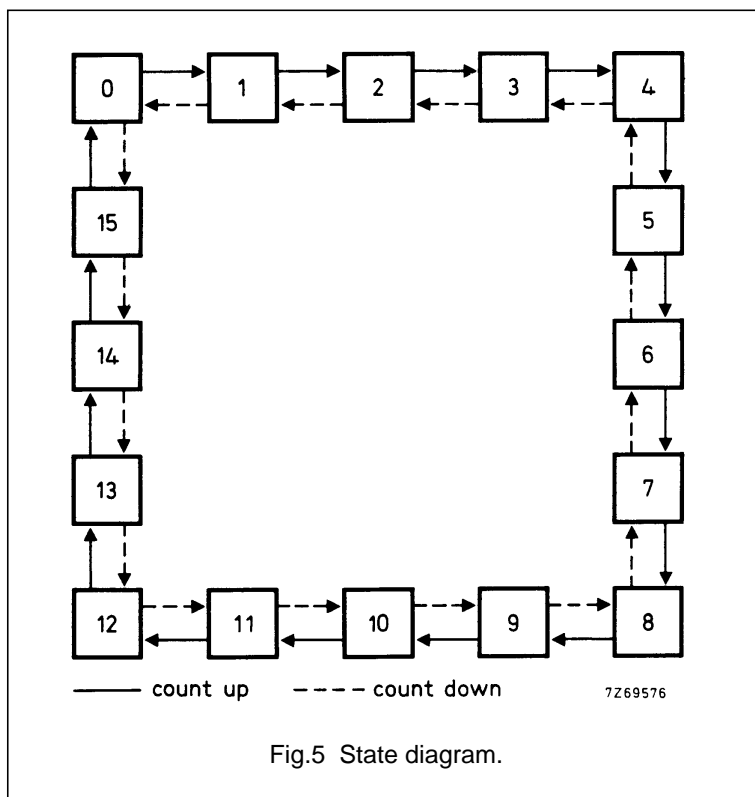
FUNCTION TABLE

| MR | \overline{PL} | CP_U | CP_D | MODE |
|----|-----------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------|
| H | X | X | X | reset (asyn.) |
| L | L | X | X | parallel load |
| L | H |  | H | count-up |
| L | H | H |  | count-down |

Notes

- H = HIGH state (the more positive voltage)
L = LOW state (the less positive voltage)
X = state is immaterial

 = positive-going transition



Logic equations for terminal count:

$$\overline{TC}_U = \overline{O_0 \cdot O_1 \cdot O_2 \cdot O_3 \cdot CP_U}$$

$$\overline{TC}_D = \overline{\overline{O_0} \cdot \overline{O_1} \cdot \overline{O_2} \cdot \overline{O_3} \cdot CP_D}$$

AC CHARACTERISTICS

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$; input transition times $\leq 20\text{ ns}$

| | V_{DD} V | TYPICAL FORMULA FOR P (μW) | |
|-------------------------------------------|---------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dynamic power dissipation per package (P) | 5 | $600 f_i + \sum(f_o C_L) \times V_{DD}^2$ | where f_i = input freq. (MHz) f_o = output freq. (MHz) C_L = load capacitance (pF) $\sum(f_o C_L)$ = sum of outputs V_{DD} = supply voltage (V) |
| | 10 | $2700 f_i + \sum(f_o C_L) \times V_{DD}^2$ | |
| | 15 | $7500 f_i + \sum(f_o C_L) \times V_{DD}^2$ | |

4-bit up/down binary counter

HEF40193B
MSI

AC CHARACTERISTICS

 $V_{SS} = 0$ V; $T_{amb} = 25$ °C; $C_L = 50$ pF; input transition times ≤ 20 ns

| | V_{DD} V | SYMBOL | MIN. | TYP. | MAX. | TYPICAL EXTRAPOLATION FORMULA | |
|-------------------------------------------------------------|---------------|-----------|-----------|------|------|---------------------------------------------|---------------------------------------------|
| Propagation delays $CP_U \rightarrow O_n$ HIGH to LOW | 5 | t_{PHL} | 210 | 415 | ns | $183 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 85 | 165 | ns | $74 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 60 | 120 | ns | $52 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |
| | LOW to HIGH | 5 | t_{PLH} | 170 | 340 | ns | $143 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ |
| | | 10 | | 70 | 140 | ns | $59 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ |
| | | 15 | | 50 | 100 | ns | $42 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ |
| $CP_D \rightarrow O_n$ HIGH to LOW | 5 | t_{PHL} | 210 | 425 | ns | $183 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 85 | 170 | ns | $74 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 60 | 125 | ns | $57 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |
| | LOW to HIGH | 5 | t_{PLH} | 170 | 340 | ns | $143 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ |
| | | 10 | | 70 | 140 | ns | $59 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ |
| | | 15 | | 50 | 100 | ns | $42 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ |
| $CP_U \rightarrow \overline{TC_U}$ HIGH to LOW | 5 | t_{PHL} | 125 | 250 | ns | $98 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 50 | 100 | ns | $39 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 35 | 70 | ns | $27 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |
| | LOW to HIGH | 5 | t_{PLH} | 95 | 185 | ns | $68 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ |
| | | 10 | | 40 | 80 | ns | $29 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ |
| | | 15 | | 30 | 60 | ns | $22 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ |
| $CP_D \rightarrow \overline{TC_D}$ HIGH to LOW | 5 | t_{PHL} | 140 | 280 | ns | $113 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 55 | 110 | ns | $44 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 40 | 80 | ns | $32 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |
| | LOW to HIGH | 5 | t_{PLH} | 100 | 195 | ns | $73 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ |
| | | 10 | | 40 | 85 | ns | $29 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ |
| | | 15 | | 30 | 65 | ns | $22 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ |
| $MR \rightarrow O_n$ HIGH to LOW | 5 | t_{PHL} | 195 | 390 | ns | $168 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 80 | 160 | ns | $69 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 60 | 120 | ns | $52 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |
| $MR \rightarrow \overline{TC_U}$ LOW to HIGH | 5 | t_{PLH} | 145 | 285 | ns | $118 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 60 | 115 | ns | $49 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 45 | 90 | ns | $37 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |
| $MR \rightarrow \overline{TC_D}$ HIGH to LOW | 5 | t_{PHL} | 365 | 730 | ns | $338 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 130 | 265 | ns | $119 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 100 | 205 | ns | $92 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |
| $\overline{PL} \rightarrow O_n$ HIGH to LOW | 5 | t_{PHL} | 185 | 360 | ns | $158 \text{ ns} + (0,55 \text{ ns/pF}) C_L$ | |
| | 10 | | 75 | 150 | ns | $64 \text{ ns} + (0,23 \text{ ns/pF}) C_L$ | |
| | 15 | | 55 | 110 | ns | $47 \text{ ns} + (0,16 \text{ ns/pF}) C_L$ | |

4-bit up/down binary counter

HEF40193B
MSI

| | V _{DD} V | SYMBOL | MIN. | TYP. | MAX. | TYPICAL EXTRAPOLATION FORMULA |
|-------------|----------------------|------------------|------|------|------|--------------------------------------|
| LOW to HIGH | 5 | t _{PLH} | 145 | 290 | ns | 118 ns + (0,55 ns/pF) C _L |
| | 10 | | 60 | 120 | ns | 49 ns + (0,23 ns/pF) C _L |
| | 15 | | 45 | 90 | ns | 37 ns + (0,16 ns/pF) C _L |

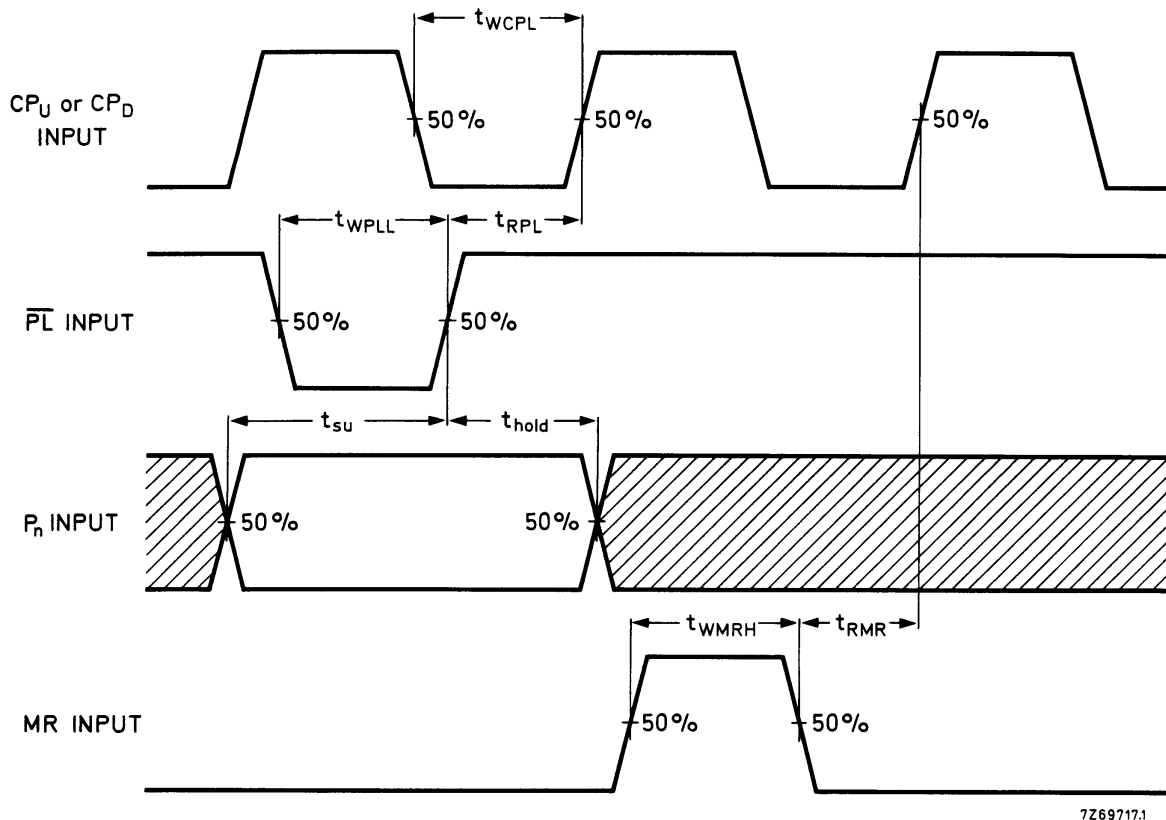
AC CHARACTERISTICS

V_{SS} = 0 V; T_{amb} = 25 °C; C_L = 50 pF; input transition times ≤ 20 ns

| | V _{DD} V | SYMBOL | MIN. | TYP. | MAX. | TYPICAL EXTRAPOLATION FORMULA | |
|----------------------------------------------------------------|----------------------|-------------------|------------------|------|------|------------------------------------|------------------------------------|
| Output transition times HIGH to LOW | 5 | t _{THL} | 60 | 120 | ns | 10 ns + (1,0 ns/pF) C _L | |
| | 10 | | 30 | 60 | ns | 9 ns + (0,42 ns/pF) C _L | |
| | 15 | | 20 | 40 | ns | 6 ns + (0,28 ns/pF) C _L | |
| | LOW to HIGH | 5 | t _{TLH} | 60 | 120 | ns | 10 ns + (1,0 ns/pF) C _L |
| | | 10 | | 30 | 60 | ns | 9 ns + (0,42 ns/pF) C _L |
| | | 15 | | 20 | 40 | ns | 6 ns + (0,28 ns/pF) C _L |
| Set-up time P _n → \overline{PL} | 5 | t _{su} | 160 | 80 | ns | see also waveforms Fig.6 | |
| | 10 | | 60 | 30 | ns | | |
| | 15 | | 50 | 25 | ns | | |
| Hold time P _n → \overline{PL} | 5 | t _{hold} | 10 | -70 | ns | | |
| | 10 | | 5 | -25 | ns | | |
| | 15 | | 5 | -20 | ns | | |
| Minimum CP _U or CP _D pulse width; LOW | 5 | t _{WCPL} | 150 | 75 | ns | | |
| | 10 | | 50 | 25 | ns | | |
| | 15 | | 35 | 20 | ns | | |
| Minimum MR pulse width; HIGH | 5 | t _{WMRH} | 180 | 90 | ns | | |
| | 10 | | 70 | 35 | ns | | |
| | 15 | | 60 | 30 | ns | | |
| Minimum \overline{PL} pulse width; LOW | 5 | t _{WPLL} | 120 | 60 | ns | | |
| | 10 | | 45 | 20 | ns | | |
| | 15 | | 30 | 15 | ns | | |
| Recovery time for MR | 5 | t _{RMR} | 125 | 65 | ns | | |
| | 10 | | 70 | 35 | ns | | |
| | 15 | | 50 | 25 | ns | | |
| Recovery time for \overline{PL} | 5 | t _{RPL} | 90 | 45 | ns | | |
| | 10 | | 35 | 15 | ns | | |
| | 15 | | 25 | 10 | ns | | |
| Maximum clock pulse frequency | 5 | f _{max} | 2,5 | 5 | MHz | | |
| | 10 | | 7 | 14 | MHz | | |
| | 15 | | 9 | 18 | MHz | | |

4-bit up/down binary counter

HEF40193B
MSI

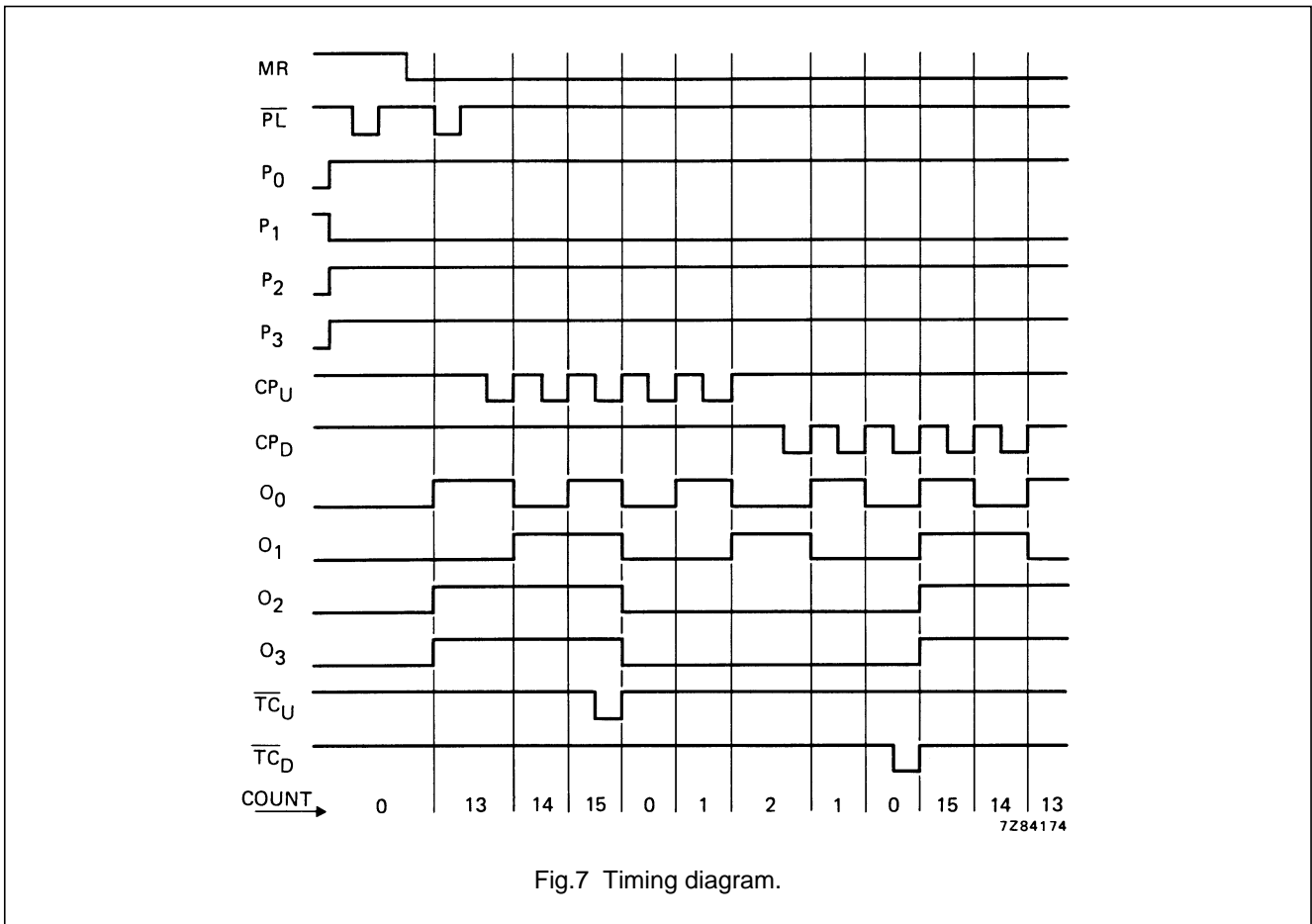


7Z69717.1

Fig.6 Waveforms showing recovery times for $\overline{P_L}$ and MR, minimum pulse widths for CP_U, CP_D, $\overline{P_L}$ and MR, and set-up and hold times for P to $\overline{P_L}$. Set-up times and hold times are shown as positive values but may be specified as negative values.

4-bit up/down binary counter

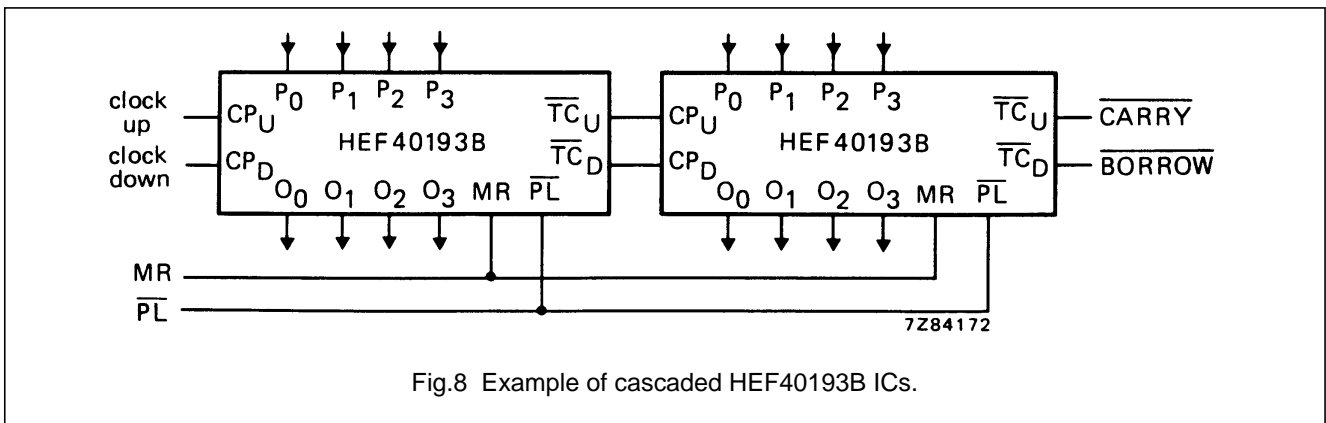
HEF40193B
MSI



APPLICATION INFORMATION

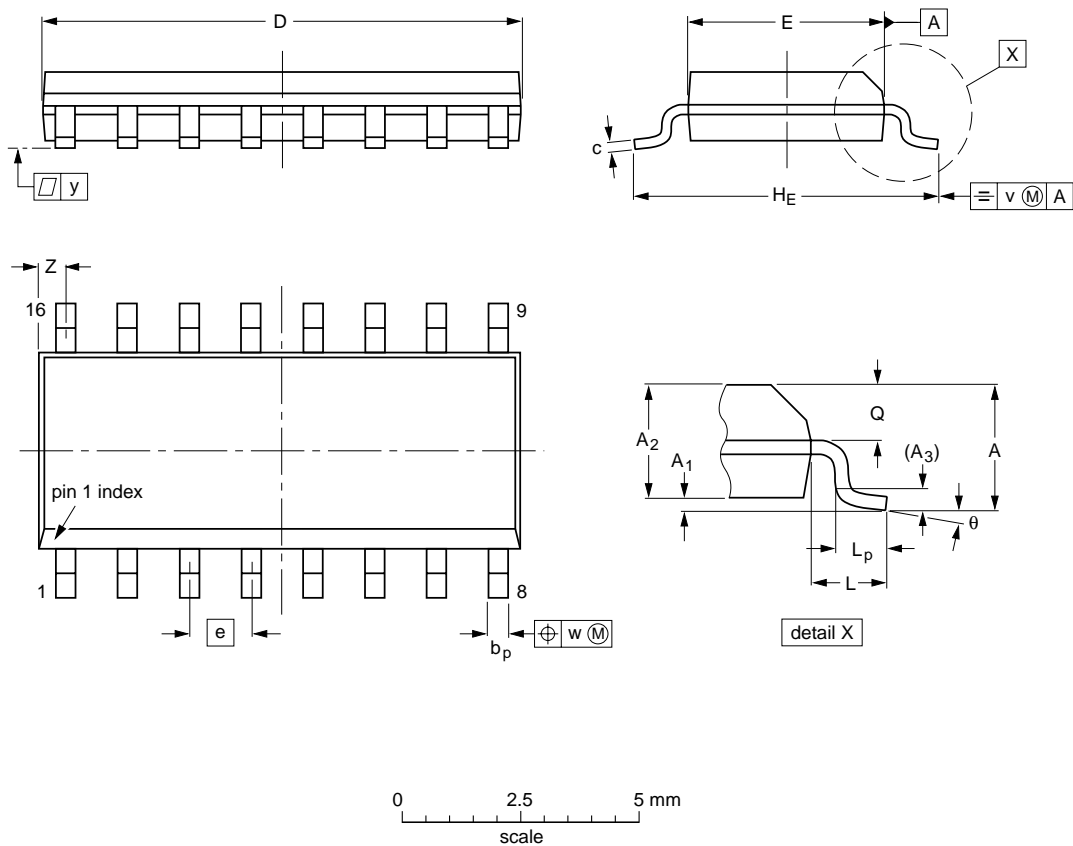
Some examples of applications for the HEF40193B are:

- Up/down difference counting
- Multistage ripple counting
- Multistage synchronous counting



SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | Z ⁽¹⁾ | θ |
|--------|--------|----------------|----------------|----------------|----------------|------------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm | 1.75 | 0.25 0.10 | 1.45 1.25 | 0.25 | 0.49 0.36 | 0.25 0.19 | 10.0 9.8 | 4.0 3.8 | 1.27 | 6.2 5.8 | 1.05 | 1.0 0.4 | 0.7 0.6 | 0.25 | 0.25 | 0.1 | 0.7 0.3 | 8° 0° |
| inches | 0.069 | 0.010 0.004 | 0.057 0.049 | 0.01 | 0.019 0.014 | 0.0100 0.0075 | 0.39 0.38 | 0.16 0.15 | 0.050 | 0.244 0.228 | 0.041 | 0.039 0.016 | 0.028 0.020 | 0.01 | 0.01 | 0.004 | 0.028 0.012 | |

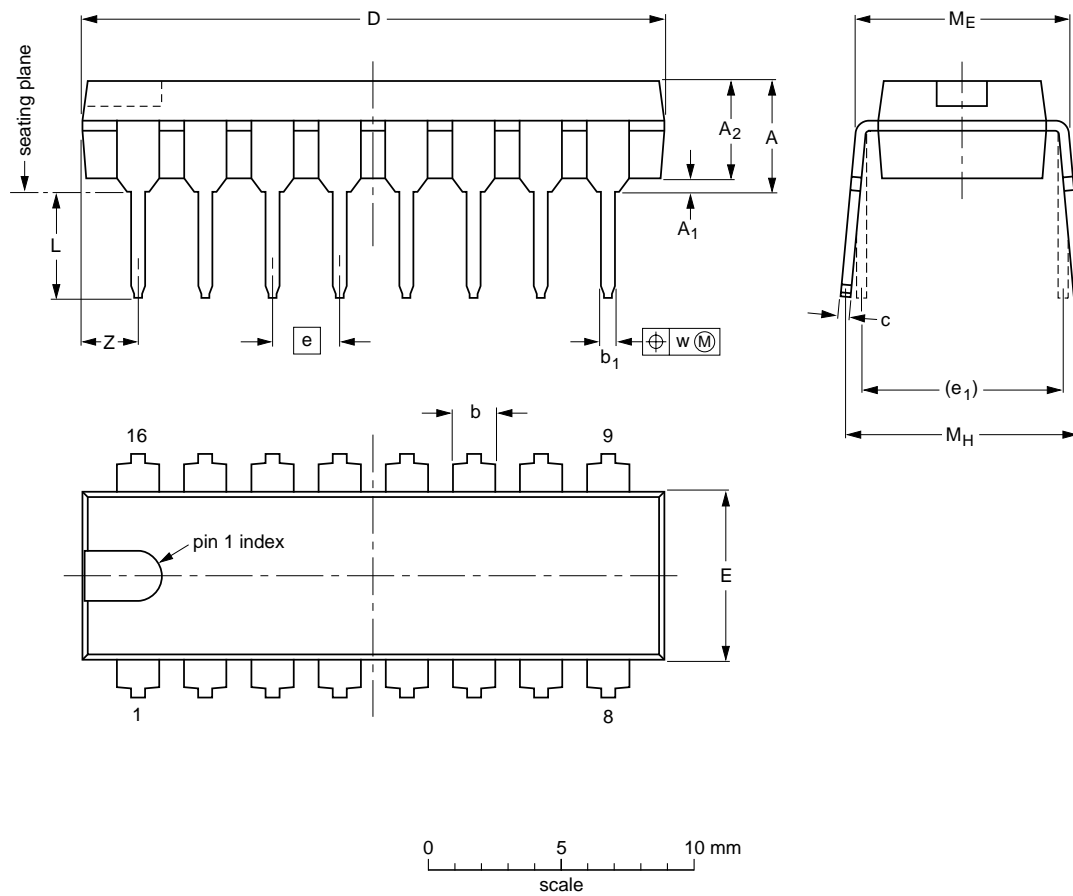
Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT109-1 | 076E07S | MS-012AC | | | | 95-01-23 97-05-22 |

DIP16: plastic dual in-line package; 16 leads (300 mil); long body

SOT38-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

| UNIT | A max. | A ₁ min. | A ₂ max. | b | b ₁ | c | D ⁽¹⁾ | E ⁽¹⁾ | e | e ₁ | L | M _E | M _H | w | Z ⁽¹⁾ max. |
|--------|--------|---------------------|---------------------|----------------|----------------|----------------|------------------|------------------|------|----------------|--------------|----------------|----------------|-------|-----------------------|
| mm | 4.7 | 0.51 | 3.7 | 1.40 1.14 | 0.53 0.38 | 0.32 0.23 | 21.8 21.4 | 6.48 6.20 | 2.54 | 7.62 | 3.9 3.4 | 8.25 7.80 | 9.5 8.3 | 0.254 | 2.2 |
| inches | 0.19 | 0.020 | 0.15 | 0.055 0.045 | 0.021 0.015 | 0.013 0.009 | 0.86 0.84 | 0.26 0.24 | 0.10 | 0.30 | 0.15 0.13 | 0.32 0.31 | 0.37 0.33 | 0.01 | 0.087 |

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT38-1 | 050G09 | MO-001AE | | | | 92-10-02 95-01-19 |