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# DATA SHEET

For a complete data sheet, please also download:

- The IC06 74HC/HCT/HCU/HCMOS Logic Family Specifications
- The IC06 74HC/HCT/HCU/HCMOS Logic Package Information
- The IC06 74HC/HCT/HCU/HCMOS Logic Package Outlines

## **74HC/HCT390** Dual decade ripple counter

Product specification  
File under Integrated Circuits, IC06

December 1990

## Dual decade ripple counter

## 74HC/HCT390

## FEATURES

- Two BCD decade or bi-quinary counters
- One package can be configured to divide-by-2, 4, 5, 10, 20, 25, 50 or 100
- Two master reset inputs to clear each decade counter individually
- Output capability: standard
- I<sub>CC</sub> category: MSI

## GENERAL DESCRIPTION

The 74HC/HCT390 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT390 are dual 4-bit decade ripple counters divided into four separately clocked sections. The counters have two divide-by-2 sections and two divide-by-5 sections. These sections are normally used in a BCD

decade or bi-quinary configuration, since they share a common master reset input (nMR). If the two master reset inputs (1MR and 2MR) are used to simultaneously clear all 8 bits of the counter, a number of counting configurations are possible within one package. The separate clocks ( $\overline{nCP_0}$  and  $\overline{nCP_1}$ ) of each section allow ripple counter or frequency division applications of divide-by-2, 4, 5, 10, 20, 25, 50 or 100.

Each section is triggered by the HIGH-to-LOW transition of the clock inputs ( $\overline{nCP_0}$  and  $\overline{nCP_1}$ ). For BCD decade operation, the nQ<sub>0</sub> output is connected to the  $\overline{nCP_1}$  input of, the divide-by-5 section. For bi-quinary decade operation, the nQ<sub>3</sub> output is connected to the  $\overline{nCP_0}$  input and nQ<sub>0</sub> becomes the decade output.

The master reset inputs (1MR and 2MR) are active HIGH asynchronous inputs to each decade counter which operates on the portion of the counter identified by the "1" and "2" prefixes in the pin configuration. A HIGH level on the nMR input overrides the clocks and sets the four outputs LOW.

## QUICK REFERENCE DATA

GND = 0 V; T<sub>amb</sub> = 25 °C; t<sub>r</sub> = t<sub>f</sub> = 6 ns

| SYMBOL                              | PARAMETER                                                       | CONDITIONS                                    | TYPICAL |     | UNIT |
|-------------------------------------|-----------------------------------------------------------------|-----------------------------------------------|---------|-----|------|
|                                     |                                                                 |                                               | HC      | HCT |      |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>n $\overline{CP_0}$ to nQ <sub>0</sub>     | C <sub>L</sub> = 15 pF; V <sub>CC</sub> = 5 V | 14      | 18  | ns   |
|                                     | n $\overline{CP_1}$ to nQ <sub>1</sub>                          |                                               | 15      | 19  | ns   |
|                                     | n $\overline{CP_1}$ to nQ <sub>2</sub>                          |                                               | 23      | 26  | ns   |
|                                     | n $\overline{CP_1}$ to nQ <sub>3</sub>                          |                                               | 15      | 19  | ns   |
|                                     | nMR to Q <sub>n</sub>                                           |                                               | 16      | 18  | ns   |
| f <sub>max</sub>                    | maximum clock frequency $\overline{nCP_0}$ , $\overline{nCP_1}$ |                                               | 66      | 61  | MHz  |
| C <sub>I</sub>                      | input capacitance                                               |                                               | 3.5     | 3.5 | pF   |
| C <sub>PD</sub>                     | power dissipation capacitance per counter                       | notes 1 and 2                                 | 20      | 21  | pF   |

## Notes

1. C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz

f<sub>o</sub> = output frequency in MHz

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs

C<sub>L</sub> = output load capacitance in pF

V<sub>CC</sub> = supply voltage in V

2. For HC the condition is V<sub>I</sub> = GND to V<sub>CC</sub>  
For HCT the condition is V<sub>I</sub> = GND to V<sub>CC</sub> – 1.5 V

Dual decade ripple counter

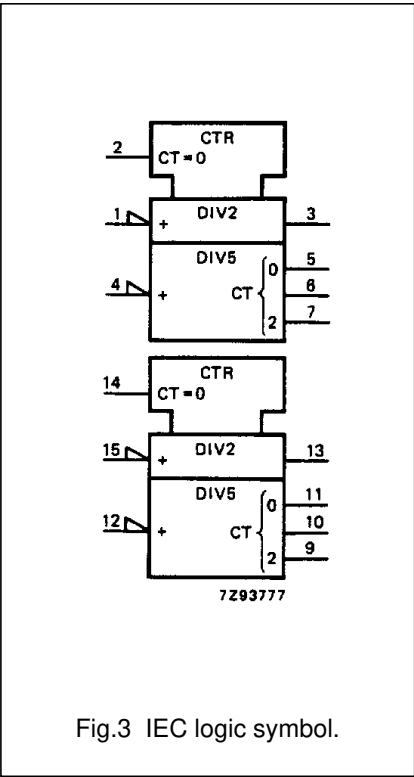
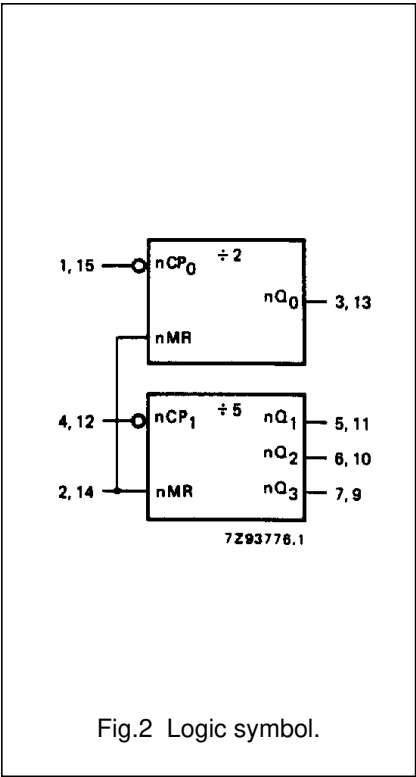
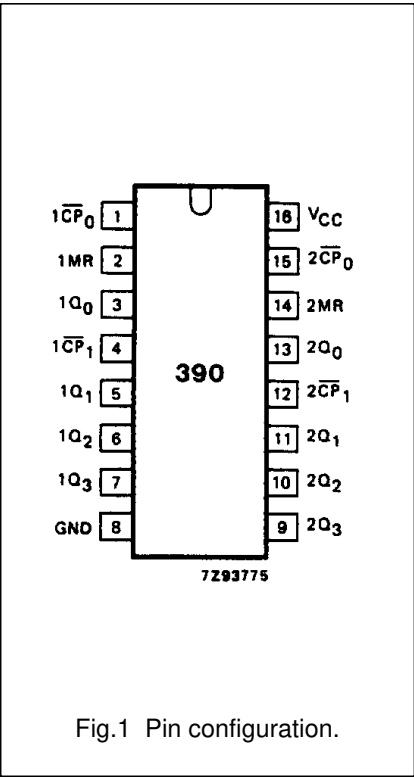
74HC/HCT390

ORDERING INFORMATION

See “74HC/HCT/HCU/HCMOS Logic Package Information”.

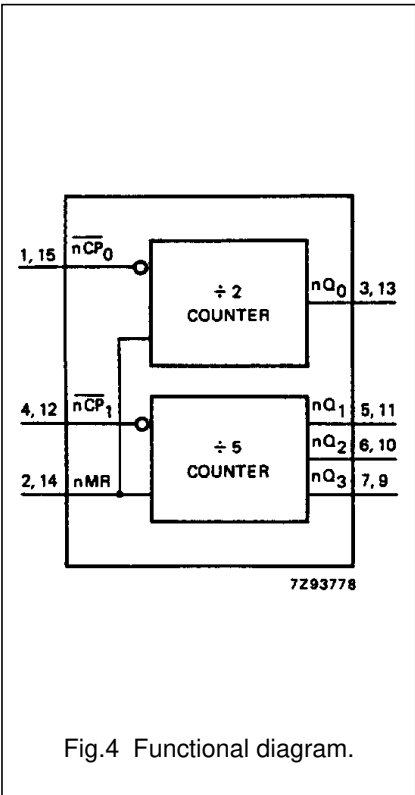
PIN DESCRIPTION

| PIN NO.       | SYMBOL                               | NAME AND FUNCTION                                             |
|---------------|--------------------------------------|---------------------------------------------------------------|
| 1, 15         | $1\overline{CP}_0, 2\overline{CP}_0$ | clock input divide-by-2 section (HIGH-to-LOW, edge-triggered) |
| 2, 14         | 1MR, 2MR                             | asynchronous master reset inputs (active HIGH)                |
| 3, 5, 6, 7    | 1Q <sub>0</sub> to 1Q <sub>3</sub>   | flip-flop outputs                                             |
| 4, 12         | $1\overline{CP}_1, 2\overline{CP}_1$ | clock input divide-by-5 section (HIGH-to-LOW, edge triggered) |
| 8             | GND                                  | ground (0 V)                                                  |
| 13, 11, 10, 9 | 2Q <sub>0</sub> to 2Q <sub>3</sub>   | flip-flop outputs                                             |
| 16            | V <sub>CC</sub>                      | positive supply voltage                                       |



Dual decade ripple counter

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BCD COUNT SEQUENCE  
FOR 1/2 THE “390”

| COUNT | OUTPUTS        |                |                |                |
|-------|----------------|----------------|----------------|----------------|
|       | Q <sub>0</sub> | Q <sub>1</sub> | Q <sub>2</sub> | Q <sub>3</sub> |
| 0     | L              | L              | L              | L              |
| 1     | H              | L              | L              | L              |
| 2     | L              | H              | L              | L              |
| 3     | H              | H              | L              | L              |
| 4     | L              | L              | H              | L              |
| 5     | H              | L              | H              | L              |
| 6     | L              | H              | H              | L              |
| 7     | H              | H              | H              | L              |
| 8     | L              | L              | L              | H              |
| 9     | H              | L              | L              | H              |

Notes

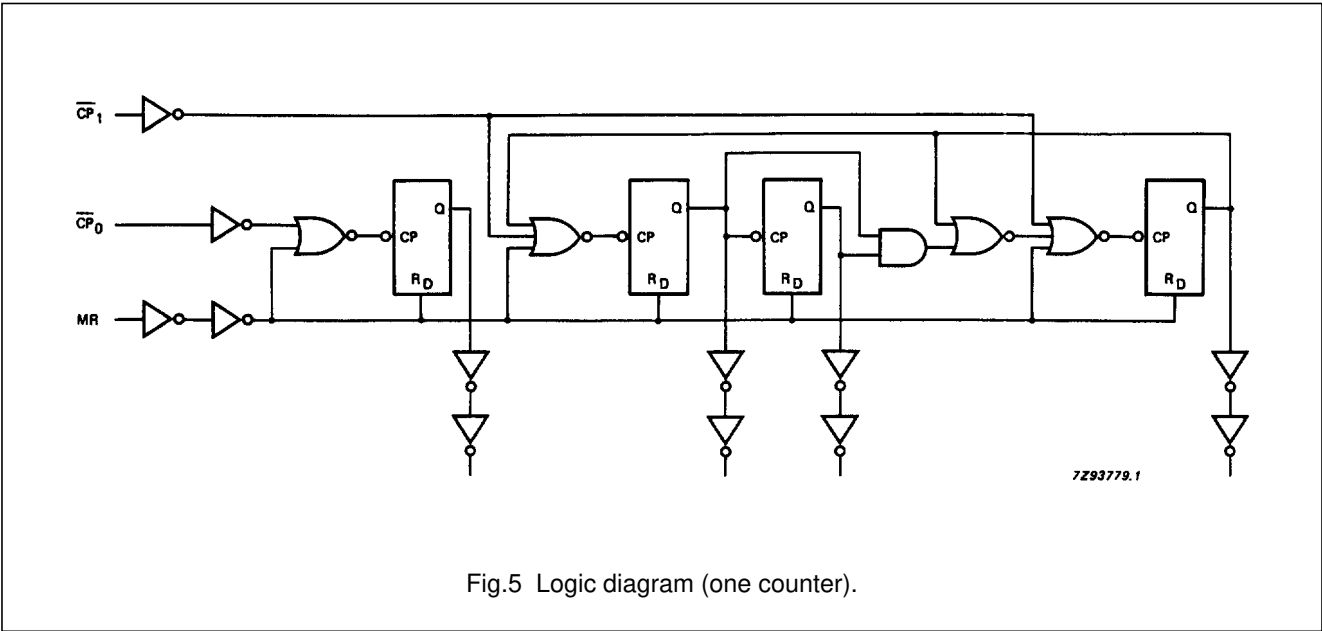
- 1. Output Q<sub>0</sub> connected to  $\overline{nCP_1}$  with counter input on  $\overline{nCP_0}$ .  
H = HIGH voltage level  
L = LOW voltage level

BI-QUINARY COUNT SEQUENCE  
FOR 1/2 THE “390”

| COUNT | OUTPUTS        |                |                |                |
|-------|----------------|----------------|----------------|----------------|
|       | Q <sub>0</sub> | Q <sub>1</sub> | Q <sub>2</sub> | Q <sub>3</sub> |
| 0     | L              | L              | L              | L              |
| 1     | L              | H              | L              | L              |
| 2     | L              | L              | H              | L              |
| 3     | L              | H              | H              | L              |
| 4     | L              | L              | L              | H              |
| 5     | H              | L              | L              | L              |
| 6     | H              | H              | L              | L              |
| 7     | H              | L              | H              | L              |
| 8     | H              | H              | H              | L              |
| 9     | H              | L              | L              | H              |

Note

- 1. Output Q<sub>3</sub> connected to  $\overline{nCP_0}$  with counter input on  $\overline{nCP_1}$ .



## Dual decade ripple counter

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**DC CHARACTERISTICS FOR 74HC**

For the DC characteristics see *"74HC/HCT/HCU/HCMOS Logic Family Specifications"*.

Output capability: standard

I<sub>CC</sub> category: MSI

**AC CHARACTERISTICS FOR 74HC**

GND = 0 V; t<sub>r</sub> = t<sub>f</sub> = 6 ns; C<sub>L</sub> = 50 pF

| SYMBOL                              | PARAMETER                                                               | T <sub>amb</sub> (°C) |                |                 |                 |                 |                 |                 | UNIT | TEST CONDITIONS        |           |
|-------------------------------------|-------------------------------------------------------------------------|-----------------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------|------------------------|-----------|
|                                     |                                                                         | 74HC                  |                |                 |                 |                 |                 |                 |      | V <sub>CC</sub><br>(V) | WAVEFORMS |
|                                     |                                                                         | +25                   |                |                 | −40 to +85      |                 | −40 to +125     |                 |      |                        |           |
|                                     |                                                                         | min.                  | typ.           | max.            | min.            | max.            | min.            | max.            |      |                        |           |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>0</sub> to nQ <sub>0</sub>                |                       | 47<br>17<br>14 | 145<br>29<br>25 |                 | 180<br>36<br>31 |                 | 220<br>44<br>38 | ns   | 2.0<br>4.5<br>6.0      | Fig.6     |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>1</sub> to nQ <sub>1</sub>                |                       | 50<br>18<br>14 | 155<br>31<br>26 |                 | 195<br>39<br>33 |                 | 235<br>47<br>40 | ns   | 2.0<br>4.5<br>6.0      | Fig.6     |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>1</sub> to nQ <sub>2</sub>                |                       | 74<br>27<br>22 | 210<br>42<br>36 |                 | 265<br>53<br>45 |                 | 315<br>63<br>54 | ns   | 2.0<br>4.5<br>6.0      | Fig.6     |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>1</sub> to nQ <sub>3</sub>                |                       | 50<br>18<br>14 | 155<br>31<br>26 |                 | 195<br>39<br>33 |                 | 235<br>47<br>40 | ns   | 2.0<br>4.5<br>6.0      | Fig.6     |
| t <sub>PHL</sub>                    | propagation delay<br>nMR to nQ <sub>n</sub>                             |                       | 52<br>19<br>15 | 165<br>33<br>28 |                 | 205<br>41<br>35 |                 | 250<br>50<br>43 | ns   | 2.0<br>4.5<br>6.0      | Fig.7     |
| t <sub>THL</sub> / t <sub>TLH</sub> | output transition time                                                  |                       | 19<br>7<br>6   | 75<br>15<br>13  |                 | 95<br>19<br>16  |                 | 110<br>22<br>19 | ns   | 2.0<br>4.5<br>6.0      | Fig.6     |
| t <sub>w</sub>                      | clock pulse width<br>nCP <sub>0</sub> , nCP <sub>1</sub>                | 80<br>16<br>14        | 19<br>7<br>6   |                 | 100<br>20<br>17 |                 | 120<br>24<br>20 |                 | ns   | 2.0<br>4.5<br>6.0      | Fig.6     |
| t <sub>w</sub>                      | master reset pulse width<br>HIGH                                        | 80<br>17<br>14        | 28<br>10<br>8  |                 | 105<br>21<br>18 |                 | 130<br>26<br>22 |                 | ns   | 2.0<br>4.5<br>6.0      | Fig.7     |
| t <sub>rem</sub>                    | removal time<br>nMR to nCP <sub>n</sub>                                 | 75<br>15<br>13        | 22<br>8<br>6   |                 | 95<br>19<br>16  |                 | 110<br>22<br>19 |                 | ns   | 2.0<br>4.5<br>6.0      | Fig.7     |
| f <sub>max</sub>                    | maximum clock pulse<br>frequency<br>nCP <sub>0</sub> , nCP <sub>1</sub> | 6.0<br>30<br>35       | 20<br>60<br>71 |                 | 4.8<br>24<br>28 |                 | 4.0<br>20<br>24 |                 | MHz  | 2.0<br>4.5<br>6.0      | Fig.6     |

## Dual decade ripple counter

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**DC CHARACTERISTICS FOR 74HCT**

For the DC characteristics see *"74HC/HCT/HCU/HCMOS Logic Family Specifications"*.

Output capability: standard

I<sub>CC</sub> category: MSI

**Note to HCT types**

The value of additional quiescent supply current ( $\Delta I_{CC}$ ) for a unit load of 1 is given in the family specifications. To determine  $\Delta I_{CC}$  per input, multiply this value by the unit load coefficient shown in the table below.

| INPUT                    | UNIT LOAD COEFFICIENT |
|--------------------------|-----------------------|
| $\overline{nCP_0}$       | 0.45                  |
| $\overline{nCP_1}$ , nMR | 0.60                  |

**AC CHARACTERISTICS FOR 74HCT**

GND = 0 V;  $t_r = t_f = 6$  ns;  $C_L = 50$  pF

| SYMBOL                              | PARAMETER                                                               | T <sub>amb</sub> (°C) |      |      |            |      |             |      | UNIT | TEST CONDITIONS        |           |
|-------------------------------------|-------------------------------------------------------------------------|-----------------------|------|------|------------|------|-------------|------|------|------------------------|-----------|
|                                     |                                                                         | 74HCT                 |      |      |            |      |             |      |      | V <sub>CC</sub><br>(V) | WAVEFORMS |
|                                     |                                                                         | +25                   |      |      | −40 to +85 |      | −40 to +125 |      |      |                        |           |
|                                     |                                                                         | min.                  | typ. | max. | min.       | max. | min.        | max. |      |                        |           |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>0</sub> to nQ <sub>0</sub>                |                       | 21   | 34   |            | 43   |             | 51   | ns   | 4.5                    | Fig.6     |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>1</sub> to nQ <sub>1</sub>                |                       | 22   | 38   |            | 48   |             | 57   | ns   | 4.5                    | Fig.6     |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>1</sub> to nQ <sub>2</sub>                |                       | 30   | 51   |            | 64   |             | 77   | ns   | 4.5                    | Fig.6     |
| t <sub>PHL</sub> / t <sub>PLH</sub> | propagation delay<br>nCP <sub>1</sub> to nQ <sub>3</sub>                |                       | 22   | 38   |            | 48   |             | 57   | ns   | 4.5                    | Fig.6     |
| t <sub>PHL</sub>                    | propagation delay<br>nMR to nQ <sub>n</sub>                             |                       | 21   | 36   |            | 45   |             | 54   | ns   | 4.5                    | Fig.7     |
| t <sub>THL</sub> / t <sub>TLH</sub> | output transition time                                                  |                       | 7    | 15   |            | 19   |             | 22   | ns   | 4.5                    | Fig.6     |
| t <sub>w</sub>                      | clock pulse width<br>nCP <sub>0</sub> , nCP <sub>1</sub>                | 18                    | 8    |      | 23         |      | 27          |      | ns   | 4.5                    | Fig.6     |
| t <sub>w</sub>                      | master reset pulse width<br>HIGH                                        | 17                    | 10   |      | 21         |      | 26          |      | ns   | 4.5                    | Fig.7     |
| t <sub>rem</sub>                    | removal time<br>nMR to nCP <sub>n</sub>                                 | 15                    | 8    |      | 19         |      | 22          |      | ns   | 4.5                    | Fig.7     |
| f <sub>max</sub>                    | maximum clock pulse<br>frequency<br>nCP <sub>0</sub> , nCP <sub>1</sub> | 27                    | 55   |      | 22         |      | 18          |      | MHz  | 4.5                    | Fig.6     |

## Dual decade ripple counter

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## AC WAVEFORMS

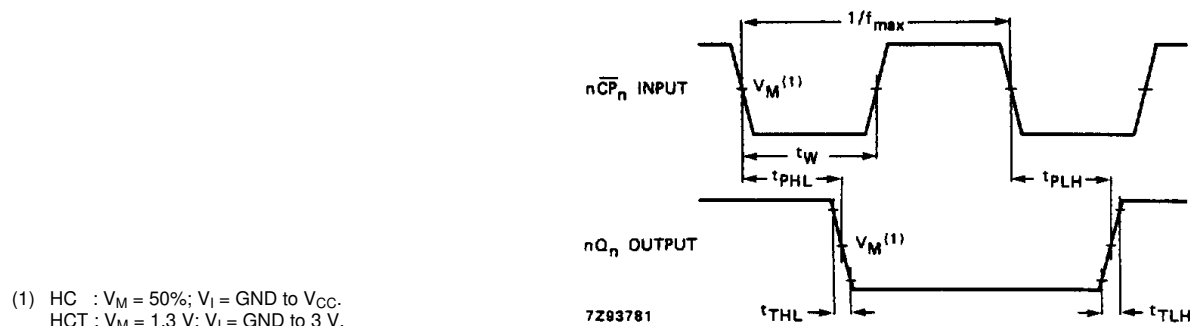


Fig.6 Waveforms showing the clock ( $\overline{nCP_n}$ ) to output ( $nQ_n$ ) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency.

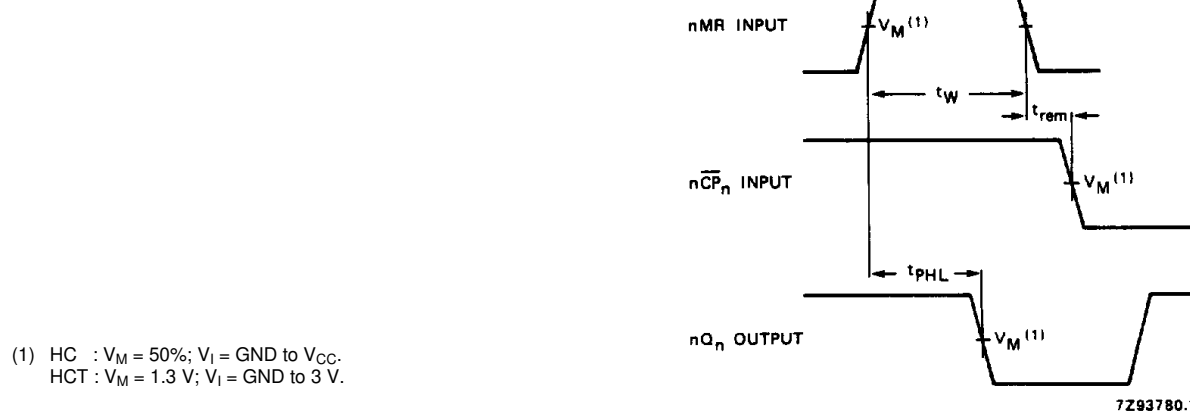


Fig.7 Waveforms showing the master reset ( $nMR$ ) pulse width, the master reset to output ( $nQ_n$ ) propagation delays and the master reset to clock ( $\overline{nCP_n}$ ) removal time.

## PACKAGE OUTLINES

See "74HC/HCT/HCU/HCMOS Logic Package Outlines".