

**MMC 4017, MMC 4022**

# COUNTER/DIVIDERS: 4017 DECADE COUNTER WITH 10 DECODED OUTPUTS 4022 OCTAL COUNTER WITH 8 DECODED OUTPUTS

## GENERAL DESCRIPTION

The MMC 4017 and MMC 4022 are 5-stage and 4 stage Johnson counters having 10 and 8 decoded outputs respectively.

The MMC 4017 and MMC 4022 are monolithic integrated circuits, fabricated in standard Al-gate CMOS technology. Are available in 16-lead dual in-line plastic package.

Inputs include a CLOCK, a RESET and a CLOCK inhibit signal. Schmitt trigger in the CLOCK input circuit provides pulse shaping that allows unlimited clock input pulse rise and fall times. These counters are 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. A high RESET signal clears the counter to its zero count. Use of the Johnson decade-counter configuration permits high-speed operation, 2-input decimal-decode gating and spike-free decoded outputs. Anti-lock gating is provided, thus assuring proper counting sequence. The

decoded outputs are normally low and go high only at their respective decoded time slot. Each decoded Output remains high for one full clock cycle. A CARRY-OUT signal completes one cycle every 10 clock input cycles in the MMC 4017 or every 8 clock input cycles in the MMC 4022 and is used to ripple-clock the succeeding device in a multi-device counting chain.

## FEATURES

- Fully static operation
- Medium speed operation — 12 MHz (typ) at  $V_{DD} = 10\text{ V}$

## APPLICATIONS

- Decade counter/decimal decode display
- Binary counter/decoder
- Frequency division
- Counter control/timers
- Divide — by — N counting.

## ABSOLUTE MAXIMUM RATINGS

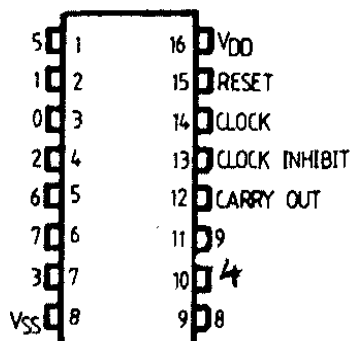
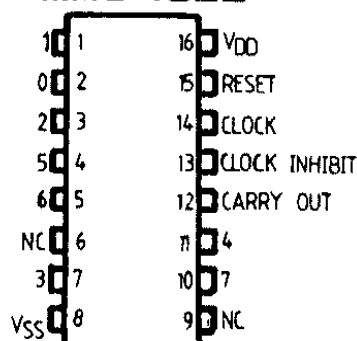
|            |                                            |                      |    |
|------------|--------------------------------------------|----------------------|----|
| $V_{DD}^*$ | Supply voltage: G and H types              | -0.5 to 20           | V  |
|            | E and F types                              | -0.5 to 18           | 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)      | 200                  | mW |
|            | Dissipation per output transistor          |                      |    |
| $T_A$      | for $T_A =$ full package-temperature range | 100                  | mW |
|            | Operating                                  |                      |    |
|            | temperature: G and H types                 | -55 to 125           | °C |
|            | E and F types                              | -40 to 85            | °C |
| $T_{sto}$  | Storage temperature                        | -65 to 150           | °C |

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

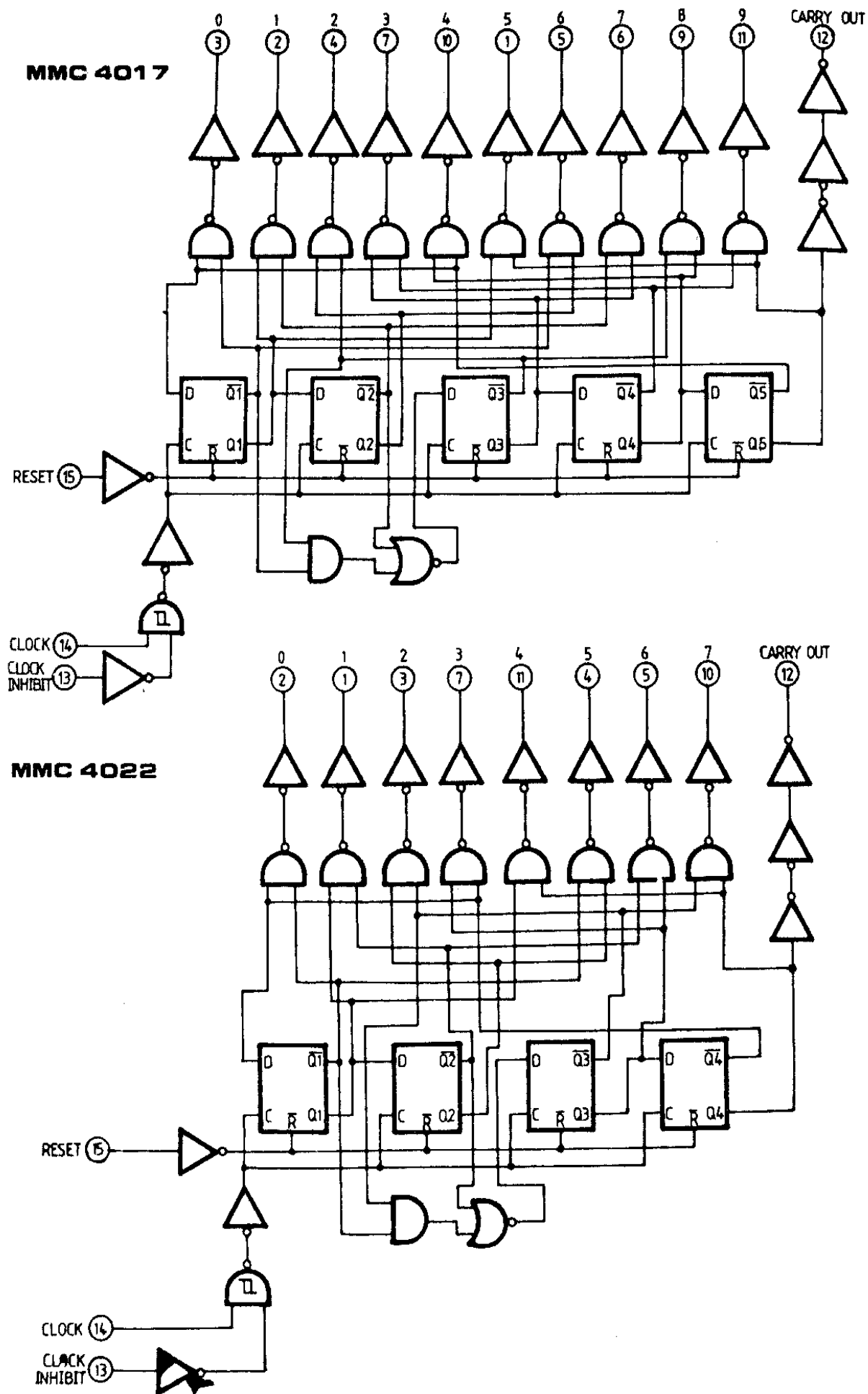
## RECOMMENDED OPERATING CONDITIONS

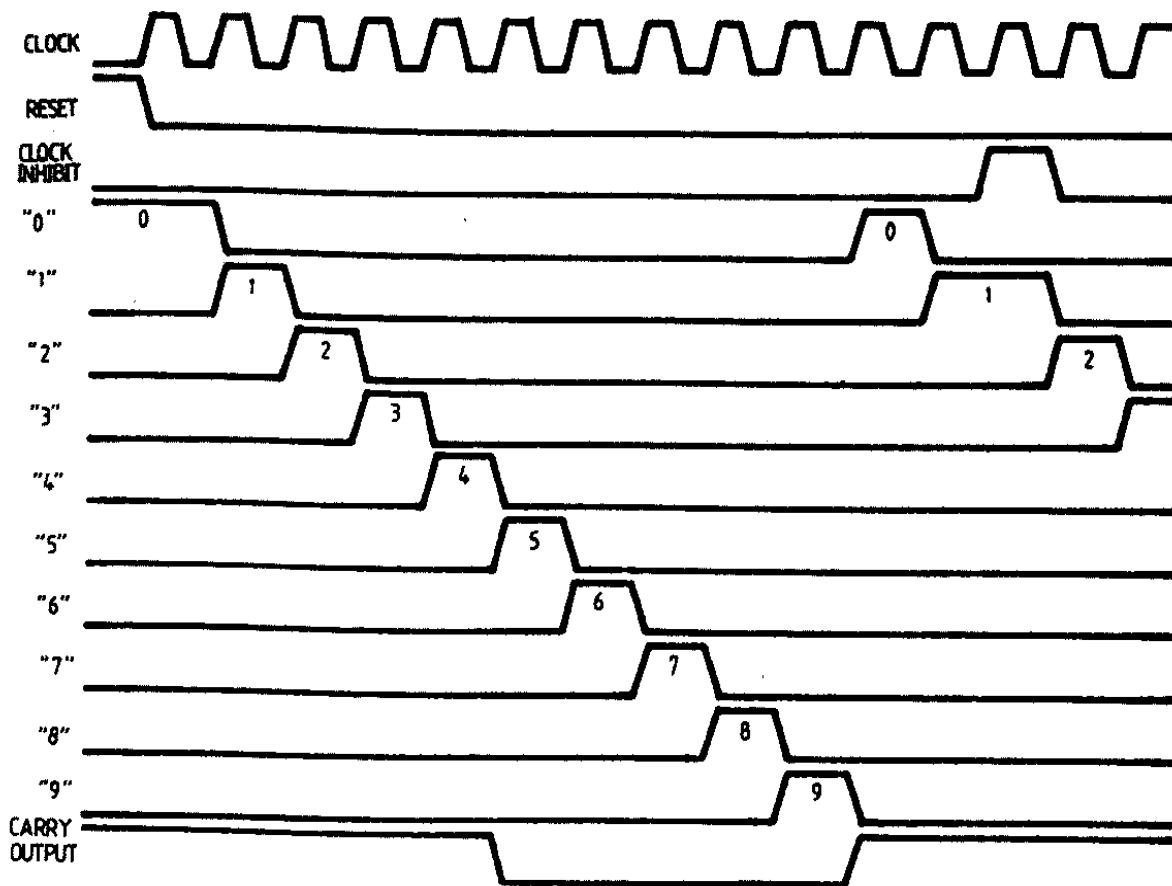
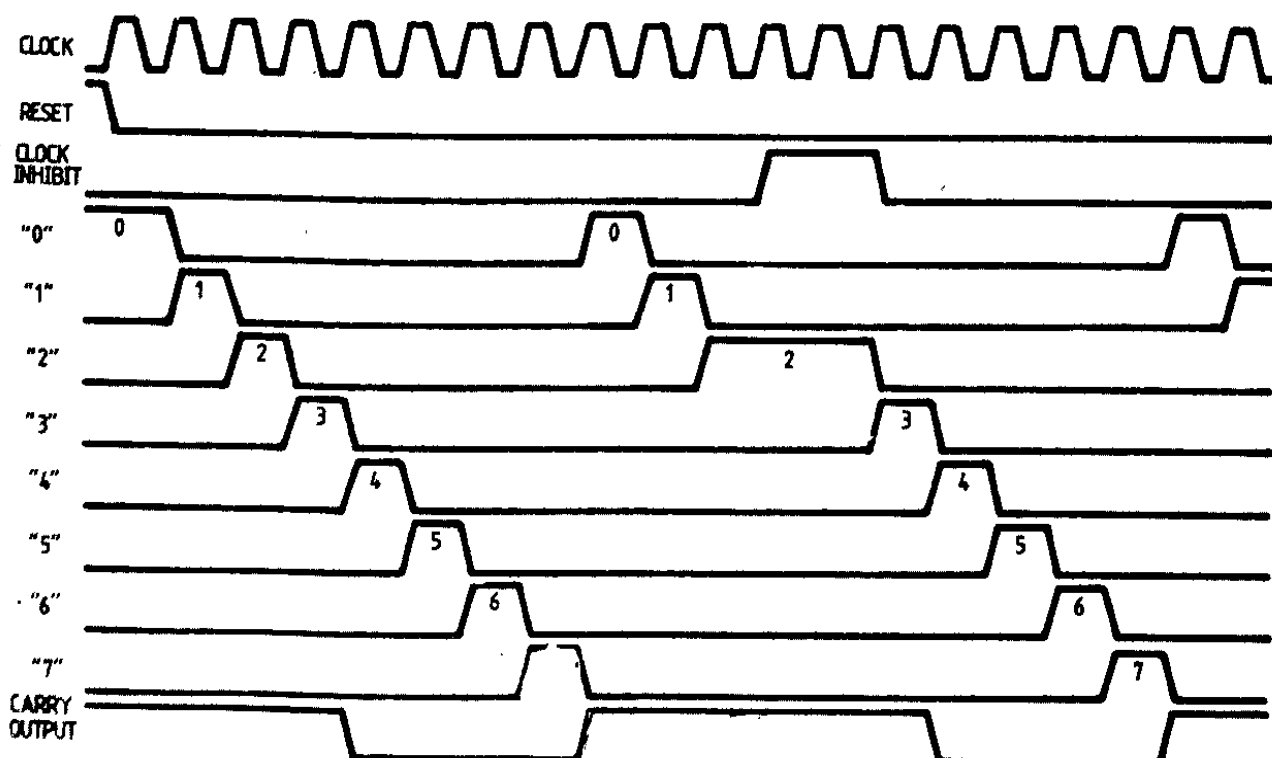
|            |                               |               |    |
|------------|-------------------------------|---------------|----|
| $V_{DD}^*$ | Supply voltage: G and H types | 3 to 18       | V  |
|            | E and F types                 | 3 to 15       | V  |
| $V_i$      | Input voltage                 | 0 to $V_{DD}$ | V  |
| $T_A$      | Operating                     |               |    |
|            | temperature: G and H types    | -55 to 125    | °C |
|            | E and F types                 | -40 to 85     | °C |

## CONNECTION DIAGRAMS

**MMC 4017****MMC 4022**

# LOGIC DIAGRAM



**TIMING DIAGRAM****MMC 4017****MMC 4022**

**STATIC ELECTRICAL CHARACTERISTICS**

(over recommended operating conditions)

| PARAMETER                         |                       |            | TEST CONDITIONS       |                       |                          |                        | VALUES           |       |       |                   |       |                   | UN   |      |
|-----------------------------------|-----------------------|------------|-----------------------|-----------------------|--------------------------|------------------------|------------------|-------|-------|-------------------|-------|-------------------|------|------|
|                                   |                       |            | V <sub>I</sub><br>(V) | V <sub>O</sub><br>(V) | I <sub>O</sub>  <br>(μA) | 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     | G, H types | 0/ 5                  |                       |                          | 5                      |                  | 5     |       | 0.04              | 5     |                   | 150  | μA   |
|                                   |                       |            | 0/10                  |                       |                          | 10                     |                  | 10    |       | 0.04              | 10    |                   | 300  |      |
|                                   |                       |            | 0/15                  |                       |                          | 15                     |                  | 20    |       | 0.04              | 20    |                   | 600  |      |
|                                   |                       |            | 0/20                  |                       |                          | 20                     |                  | 100   |       | 0.08              | 100   |                   | 3000 |      |
|                                   | E, F types            | 0/ 5       |                       |                       | 5                        |                        | 20               |       | 0.04  | 20                |       | 150               |      |      |
|                                   |                       | 0/10       |                       |                       | 10                       |                        | 40               |       | 0.04  | 40                |       | 300               |      |      |
|                                   |                       |            | 0/15                  |                       |                          | 15                     |                  | 80    |       | 0.04              | 80    |                   | 600  |      |
| 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  |                   | 0.05 | V    |
|                                   |                       |            | 10/ 0                 |                       | < 1                      | 10                     |                  | 0.05  |       |                   | 0.05  |                   | 0.05 |      |
|                                   |                       |            | 15/ 0                 |                       | < 1                      | 15                     |                  | 0.05  |       |                   | 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   |                   | 1.5  | V    |
|                                   |                       |            |                       | 9/1                   | < 1                      | 10                     |                  | 3     |       |                   | 3     |                   | 3    |      |
|                                   |                       |            |                       | 13.5/1.5              | < 1                      | 15                     |                  | 4     |       |                   | 4     |                   | 4    |      |
| I <sub>OH</sub>                   | Output drive current  | G, H 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              |      |      |
|                                   | E, F 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   | G, H 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               |      |      |
|                                   | E, F 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 | G, H types | 0/18                  | Any input             |                          | 18                     |                  | ±0.1  |       | ±10 <sup>-5</sup> | ±0.1  |                   | ±1   | μA   |
|                                   |                       | E, F types | 0/15                  |                       |                          | 15                     |                  | ±0.3  |       | ±10 <sup>-5</sup> | ±0.3  |                   | ±1   |      |
| C <sub>I</sub>                    | Input capacitance     |            |                       | Any input             |                          |                        |                  |       |       | 5                 | 7.5   |                   |      | pF   |

\* T<sub>LOW</sub> = -55°C for G, H devices; -40°C for E, F devices.\* T<sub>HIGH</sub> = +125°C for G, H devices; +85°C for E, F devices.

The Noise Margin for both "1" and "0" level is:

1 V min. with V<sub>DD</sub> = 5 V2 V min. with V<sub>DD</sub> = 10 V2.5 V min. with V<sub>DD</sub> = 15 V

**DYNAMIC ELECTRICAL CHARACTERISTICS**

$T_A = 25^\circ\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ kohm}$ , typical temperature coefficient for all  $V_{DD} = 0.3\%/^\circ\text{C}$  values, all input rise and fall times = 20 ns)

| PARAMETER                     |                               | TEST<br>CONDITIONS<br>V <sub>DD</sub> (V) | VALUES    |      |      | UNIT |
|-------------------------------|-------------------------------|-------------------------------------------|-----------|------|------|------|
|                               |                               |                                           | min.      | typ. | max. |      |
| <b>Clocked operation</b>      |                               |                                           |           |      |      |      |
| t <sub>PLH</sub>              | Propagation delay time        | 5                                         |           | 325  | 650  | ns   |
| t <sub>PHL</sub>              | Decode out                    | 10                                        |           | 135  | 270  |      |
|                               |                               | 15                                        |           | 85   | 170  |      |
|                               | Carry out                     | 5                                         |           | 300  | 600  | ns   |
|                               |                               | 10                                        |           | 125  | 250  |      |
|                               |                               | 15                                        |           | 80   | 160  |      |
| t <sub>THL</sub>              | Transition time               | 5                                         |           | 100  | 200  | ns   |
| t <sub>TLH</sub>              | Carry Out or Decoded          | 10                                        |           | 50   | 100  |      |
|                               | Out Line                      | 15                                        |           | 40   | 80   |      |
| f <sub>CL</sub>               | Maximum clock input frequency | 5                                         | 2.5       | 5    | 5    | MHz  |
|                               |                               | 10                                        | 5         | 10   |      |      |
|                               |                               | 15                                        | 5.5       | 11   |      |      |
| t <sub>w</sub>                | Minimum clock pulse width     | 5                                         |           | 100  | 200  | ns   |
|                               |                               | 10                                        |           | 45   | 90   |      |
|                               |                               | 15                                        |           | 30   | 60   |      |
| t <sub>r</sub> t <sub>f</sub> | Clock input rise or fall time | 5                                         | Unlimited |      |      | μs   |
|                               |                               | 10                                        |           |      |      |      |
|                               |                               | 15                                        |           |      |      |      |
| t <sub>setup</sub>            | Data setup time               | 5                                         |           | 115  | 230  | ns   |
|                               | Minimum clock inhibit         | 10                                        |           | 50   | 100  |      |
|                               |                               | 15                                        |           | 35   | 75   |      |

**Reset operation**

|                  |                            |    |  |     |     |    |
|------------------|----------------------------|----|--|-----|-----|----|
| $t_{PLH}$        | Propagation delay time     | 5  |  | 265 | 530 | ns |
| $t_{PHL}$        | Carry Out or Decoded       | 10 |  | 115 | 230 |    |
|                  | Out Lines                  | 15 |  | 85  | 170 |    |
| $t_w$            | Minimum reset pulse width  | 5  |  | 130 | 260 | ns |
|                  |                            | 10 |  | 55  | 110 |    |
|                  |                            | 15 |  | 30  | 60  |    |
| $t_{\text{rem}}$ | Minimum reset removal time | 5  |  | 200 | 400 | ns |
|                  |                            | 10 |  | 140 | 280 |    |
|                  |                            | 15 |  | 75  | 150 |    |

## TYPICAL APPLICATIONS

Divide by N counter ( $N \leq 10$ ) with N decoded outputs

When the  $N^{\text{th}}$  decoded output is reached ( $N^{\text{th}}$  clock pulse) the R—S flip-flop (constructed from two NOR gates of MMC 4001) generates a reset pulse which clears the MMC 4017 to its zero count. At this time, if the  $N^{\text{th}}$  decoded output is greater than or equal to 6, the  $C_{OUT}$  line goes high to clock the next MMC 4017 counter section. The "0" decoded output also goes high at this time. Coincidence of the clock low and decoded "0" output high resets the R—S flip-flop to enable the MMC 4017. If the  $N^{\text{th}}$  decoded output is less than 6, the  $C_{OUT}$  line will not go high and, therefore, cannot be used. In this case "0" decoded output may be used to perform the clocking function for the next counter.

