

## DUAL 4-STAGE STATIC SHIFT REGISTER WITH SERIAL INPUT/PARALLEL OUTPUT

### GENERAL DESCRIPTION

The MMC 4015 (G and H types) and MMC 4015 (E and F types) are monolithic integrated circuits, available in 16-lead dual in-line plastic or ceramic package.

The MMC 4015 consists of two identical, independent, 4-stage serial-input/parallel-output registers. Each register has independent CLOCK and RESET inputs as well as a single serial DATA input. "Q" outputs are available from each of the four stages on both registers. All register stages are D-type, master-slave flip-flops. The logic level present at the DATA inputs is transferred into the first register stage and shifted over one stage at each positive-going clock transition. Resetting of all stages is accomplished by a high level on the reset line. Register expansion to 8 stages using one MMC 4015 package, or to more than 8 stages using additional MMC 4015's is possible.

### FEATURES

- Medium speed operation: 12 MHz (typ.) clock rate at  $V_{DD}-V_{SS}=10\text{ V}$ .
- Fully static operation.
- 8 master-slave flip-flops plus input and output buffering
- High noise immunity

### ABSOLUTE MAXIMUM RATINGS

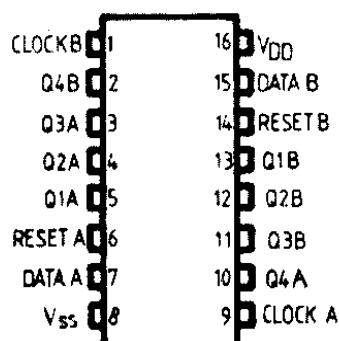
|            |  |         |              |                    |
|------------|--|---------|--------------|--------------------|
| $V_{DD}^*$ | Supply voltage: G and H types  | -0.5 to | 20           | V                  |
|            | E and F types  | -0.5 to | 18           | V                  |
| $V_i$      | 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 for $T_A =$ full package-temperature range |         | 100          | mW                 |
| $T_A$      | Operating temperature :  |         |              | $^{\circ}\text{C}$ |
|            | G and H types  | -55 to  | 125          | $^{\circ}\text{C}$ |
|            | E and F types  | -40 to  | 85           | $^{\circ}\text{C}$ |
| $T_{stg}$  | Storage temperature  | -65 to  | 150          | $^{\circ}\text{C}$ |

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

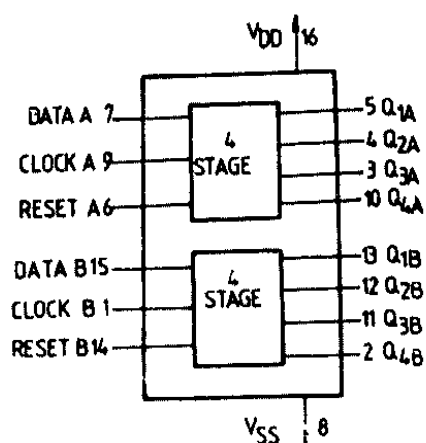
### RECOMMENDED OPERATING CONDITIONS

|            |                               |        |          |                    |
|------------|-------------------------------|--------|----------|--------------------|
| $V_{DD}^*$ | 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 :       |        |          | $^{\circ}\text{C}$ |
|            | G and H types                 | -55 to | 125      | $^{\circ}\text{C}$ |
|            | E and F types                 | -40 to | 85       | $^{\circ}\text{C}$ |

### CONNECTION DIAGRAM



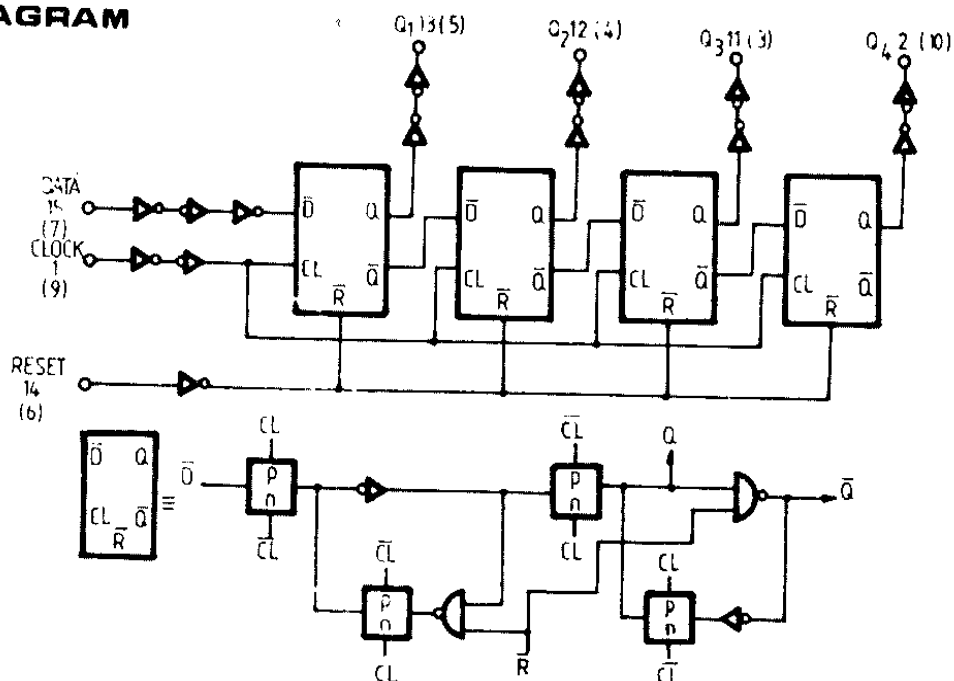
**FUNCTIONAL DIAGRAM**



**TRUTH TABLE**

| CL | D | R | Q <sub>1</sub> | Q <sub>n</sub>   |           |
|----|---|---|----------------|------------------|-----------|
|    | 0 | 0 | 0              | Q <sub>n-1</sub> |           |
|    | 1 | 0 | 1              | Q <sub>n-1</sub> |           |
|    | X | 0 | Q <sub>1</sub> | Q <sub>n</sub>   | No change |
| X  | X | 1 | 0              | 0                |           |

**LOGIC DIAGRAM**



## 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>( $\mu$ A) | V <sub>DD</sub><br>(V) | T <sub>LOW</sub> |           | 25°C  |               | T <sub>HIGH</sub> |       |         |
|                                   |                       |            |                       |                       |                                |                        | min.             | max.      |       | max.          | min.              | max.  |         |
| I <sub>L</sub>                    | Quiescent current     | G, H types | 0/ 5                  |                       |                                | 5                      |                  | 5         |       | 0.04          | 5                 |       | 150     |
|                                   |                       |            | 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              |       | V       |
|                                   |                       |            | 0/15                  |                       | < 1                            | 15                     | 14.95            |           | 14.95 |               | 14.95             |       | V       |
| V <sub>OL</sub>                   | Output low voltage    |            | 5 / 0                 |                       | < 1                            | 5                      |                  | 0.05      |       |               | 0.05              |       | V       |
|                                   |                       |            | 10/ 0                 |                       | < 1                            | 10                     |                  | 0.05      |       |               | 0.05              |       | V       |
|                                   |                       |            | 15/ 0                 |                       | < 1                            | 15                     |                  | 0.05      |       |               | 0.05              |       | V       |
| 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                 |       | V       |
|                                   |                       |            |                       | 1.5/13.5              | < 1                            | 15                     | 11               |           | 11    |               | 11                |       | V       |
| V <sub>IL</sub>                   | Input low voltage     |            |                       | 4.5/0.5               | < 1                            | 5                      |                  | 1.5       |       |               | 1.5               |       | V       |
|                                   |                       |            |                       | 9/1                   | < 1                            | 10                     |                  | 3         |       |               | 3                 |       | V       |
|                                   |                       |            |                       | 13.5/1.5              | < 1                            | 15                     |                  | 4         |       |               | 4                 |       | V       |
| I <sub>OH</sub>                   | Output drive current  | G, H types | 0/ 5                  | 2.5                   |                                | 5                      | -2               |           | -1.6  | -3.2          |                   | -1.15 |         |
|                                   |                       |            | 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  |         |
|                                   |                       |            | 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                     |                  | $\pm 0.1$ |       | $\pm 10^{-5}$ | $\pm 0.1$         |       | $\pm 1$ |
|                                   |                       | E, F types | 0/15                  |                       |                                | 15                     |                  | $\pm 0.3$ |       | $\pm 10^{-5}$ | $\pm 0.3$         |       | $\pm 1$ |
| 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 V

2 V min. with V<sub>DD</sub> = 10 V

2.5 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  $V_{DD}$  values is  $0.3\%/^\circ\text{C}$ , all input rise and fall times =  $20\text{ ns}$

| PARAMETER                | TEST CONDITIONS<br>$V_{DD}$ (V)                            | VALUES        |                 |                  | UNIT              |               |
|--------------------------|--|---------------|-----------------|------------------|-------------------|---------------|
|                          |  | min.          | typ.            | max.             |                   |               |
| <b>Clocked operation</b> |  |               |                 |                  |                   |               |
| $t_{PLH}$ ,<br>$t_{PHL}$ | Propagation delay time (Carry<br>Out or Decoded out Lines) | 5<br>10<br>15 |                 | 160<br>80<br>60  | 320<br>160<br>120 | ns            |
| $t_{THL}$ ,<br>$t_{TLH}$ | Transition time<br>(Carry Out or Decoded Out Lines)        | 5<br>10<br>15 |                 | 100<br>50<br>40  | 200<br>100<br>80  |               |
| $f_{CL}$                 | Maximum clock input frequency                              | 5<br>10<br>15 | 3<br>6<br>8.5   | 6<br>12<br>17    |                   |               |
| $t_{W.}$                 | Clock pulse width  | 5<br>10<br>15 | 180<br>80<br>50 | 90<br>40<br>25   |                   | ns            |
| $t_r$ , $t_f^*$          | Clock input rise or fall time                              | 5<br>10<br>15 |                 |                  | 15<br>15<br>15    | $\mu\text{s}$ |
| $t_{setup}$              | Data setup time  | 5<br>10<br>15 | 70<br>40<br>30  | 35<br>20<br>15   |                   | ns            |
| <b>Reset operation</b>   |  |               |                 |                  |                   |               |
| $t_{PLH}$ ,<br>$t_{PHL}$ | Propagation delay time                                     | 5<br>10<br>15 |                 | 200<br>100<br>80 | 400<br>200<br>160 | ns            |
| $t_{W.}$                 | Reset pulse width  | 5<br>10<br>15 | 200<br>80<br>60 | 100<br>40<br>30  |                   |               |

\* If more than one unit is cascaded  $t_r$ ,  $t_f$  should be made less than or equal to the sum of the transition time and the fixed propagation delay of the output of the driving stage for the estimated capacitive load.