

## BCD-TO-SEVEN SEGMENT LATCH/ DECODER/DRIVER

### GENERAL DESCRIPTION

The MMC 4511 is a monolithic integrated circuit available in 16-lead dual in-line plastic or ceramic package

The MMC 4511 type is a BCD-to-7-segment latch decoder driver constructed with COS/MOS logic and n-p-n bipolar transistor output devices on a single monolithic structure. This device combines the low quiescent power dissipation and high noise immunity features of COS/MOS with n-p-n bipolar output capable of sourcing up to 25 mA. This capability allows the MMC 4511 type to drive LED's and other displays directly. Lamp Test (LT), Blanking (BL) and Latch Enable or Strobe inputs are provided to test the display, shut off or intensity-modulate it, and store or strobe a BCD code, respectively. Several different signals may be multiplexed and displayed when external multiplexing circuitry is used.

### FEATURES

- High-output-sourcing capability (up to 25mA)
- Input latches for BCD code storage
- Lamp test and blanking capability
- 7-segment outputs blanked for BCD input codes > 1001

### APPLICATION

- Interfacing with various displays
- Driving common-cathode 7-segment LED displays
- Driving low-voltage fluorescent displays
- Driving incandescent displays.

### ABSOLUTE MAXIMUM RATINGS

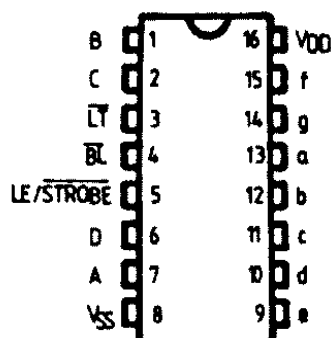
|            |  |                    |              |          |
|------------|--|--------------------|--------------|----------|
| $V_{DD}^*$ | Supply voltage: G and H types<br>E and F types   | -0.5 to<br>-0.5 to | 20<br>18     | V<br>V   |
| $V_i$      | Input voltage  | -0.5 to            | $V_{DD}+0.5$ | V        |
| $I_{IL}$   | DC input current (any one input)   |                    | $\pm 10$     | mA       |
| $P_{tot}$  | Total power dissipation (per package)<br>Dissipation per output transistor<br>for $T_A$ = full package-temperature range |                    | 200          | mW       |
| $T_A$      | Operating<br>temperature: G and H types<br>E and F types   | -55 to<br>-40 to   | 125<br>85    | °C<br>°C |
| $T_{stg}$  | Storage temperature  | -65 to             | 150          | °C       |

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

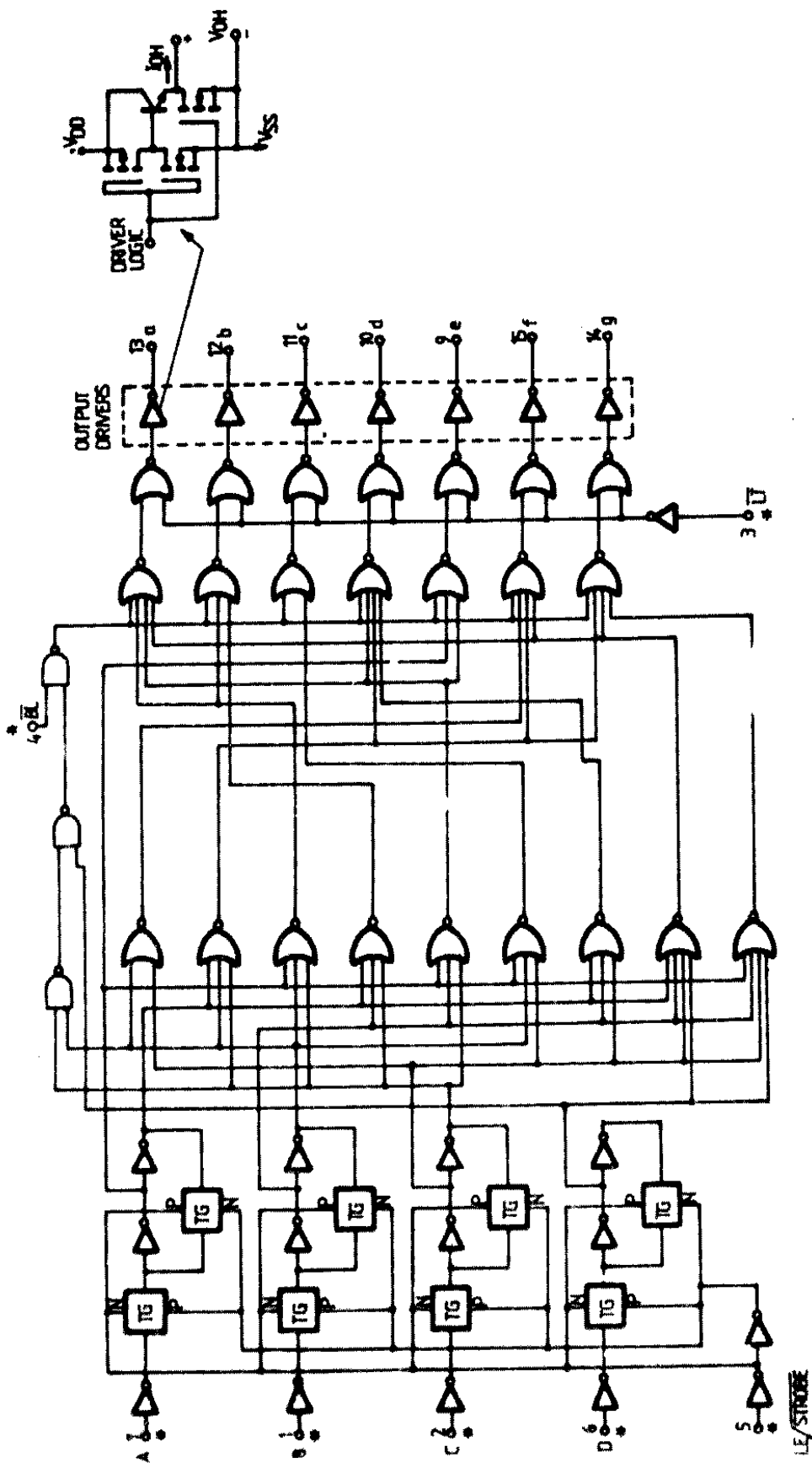
### RECOMMENDED OPERATING CONDITIONS

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

### CONNECTION DIAGRAM



LOGIC DIAGRAM



**TRUTH TABLE**

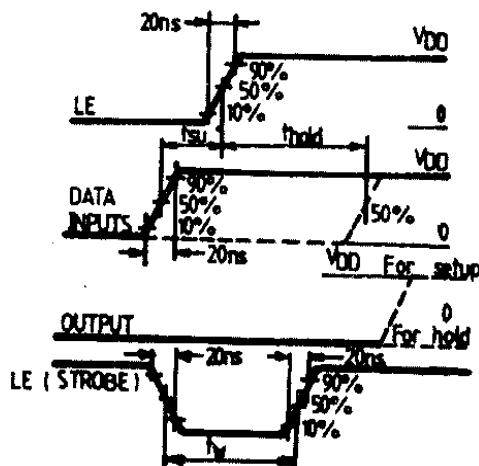
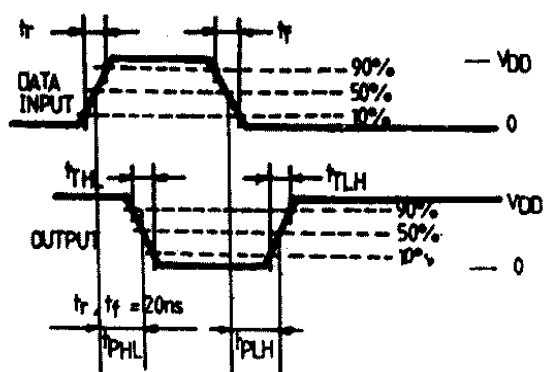
| LE | BI | LT | D | C | B | A | a | b | c | d | e | f | g | Display  |
|----|----|----|---|---|---|---|---|---|---|---|---|---|---|----------|
| X  | X  | 0  | X | X | X | X | 1 | 1 | 1 | 1 | 1 | 1 | 1 | <b>8</b> |
| X  | 0  | 1  | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank    |
| 0  | 1  | 1  | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | <b>0</b> |
| 0  | 1  | 1  | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | <b>1</b> |
| 0  | 1  | 1  | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | <b>2</b> |
| 0  | 1  | 1  | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | <b>3</b> |
| 0  | 1  | 1  | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | <b>4</b> |
| 0  | 1  | 1  | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | <b>5</b> |
| 0  | 1  | 1  | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | <b>6</b> |
| 0  | 1  | 1  | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | <b>7</b> |
| 0  | 1  | 1  | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | <b>8</b> |
| 0  | 1  | 1  | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | <b>9</b> |
| 0  | 1  | 1  | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank    |
| 0  | 1  | 1  | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank    |
| 0  | 1  | 1  | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank    |
| 0  | 1  | 1  | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank    |
| 0  | 1  | 1  | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank    |
| 0  | 1  | 1  | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank    |
| 1  | 1  | 1  | X | X | X | X |   |   |   | * |   |   |   | *        |

X = Don't care

\* = Depends on BCD code previously applied when LE = 0

Note : Display is blank for all illegal input codes (BCD > 1001)

**WAVEFORMS**



**STATIC ELECTRICAL CHARACTERISTICS**

(over recommended operating conditions)

| PARAMETER       |                      | TEST CONDITIONS       |                       |                                |                        | VALUES           |      |      |       |       |                   | UNIT |      |   |  |
|-----------------|----------------------|-----------------------|-----------------------|--------------------------------|------------------------|------------------|------|------|-------|-------|-------------------|------|------|---|--|
|                 |                      | 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. | min. | typ   | 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                  |                                |                        | 5                | 4    |      | 4.1   | 4.55  |                   | 4.2  |      | V |  |
|                 |                      |                       | 0/10                  |                                |                        | 10               | 9    |      | 9.1   | 9.55  |                   | 9.2  |      |   |  |
|                 |                      |                       | 0/15                  |                                |                        | 15               | 14   |      | 14.1  | 14.55 |                   | 14.2 |      |   |  |
| 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    |   |  |
| V <sub>OH</sub> | Output drive voltage | G, H types            |                       |                                | 0                      |                  | 4.1  |      | 4.1   | 4.55  |                   | 4.2  |      |   |  |
|                 |                      |                       |                       |                                | 5                      |                  |      |      |       | 4.25  |                   |      |      |   |  |
|                 |                      |                       |                       |                                | 10                     | 5                | 3.8  |      | 3.9   | 4.10  |                   | 3.9  |      |   |  |
|                 |                      |                       |                       |                                | 15                     |                  |      |      |       | 3.95  |                   |      |      |   |  |
|                 |                      |                       |                       |                                | 20                     |                  |      | 3.55 | 3.4   | 3.75  |                   |      |      |   |  |
|                 |                      |                       |                       |                                | 25                     |                  |      | 3.4  | 3.1   | 3.55  |                   |      |      |   |  |
|                 |                      |                       |                       |                                |                        | 0                |      | 9    |       | 9.1   | 9.55              |      | 9.2  |   |  |
|                 |                      |                       |                       |                                |                        | 5                |      |      |       |       | 9.25              |      |      |   |  |
|                 |                      |                       |                       |                                |                        | 10               | 10   | 8.85 |       | 9     | 9.15              |      |      |   |  |
|                 |                      |                       |                       |                                |                        | 15               |      |      |       |       | 9.05              |      |      |   |  |
|                 |                      |                       |                       |                                |                        | 20               |      | 8.7  |       | 8.6   | 8.9               |      | 8.4  |   |  |
|                 |                      |                       |                       |                                |                        | 25               |      | 8.6  |       | 8.3   | 8.75              |      |      |   |  |
|                 |                      |                       |                       | 0                              |                        | 14               |      | 14.1 | 14.55 |       | 14.2              |      |      |   |  |
|                 |                      |                       |                       | 5                              |                        |                  |      |      | 14.3  |       |                   |      |      |   |  |
|                 |                      |                       |                       | 10                             | 15                     | 13.9             |      | 14   | 14.2  |       | 14.0              |      |      |   |  |
|                 |                      |                       |                       | 15                             |                        |                  |      |      | 14.1  |       |                   |      |      |   |  |
|                 |                      |                       |                       | 20                             |                        | 13.75            |      | 13.7 | 13.95 |       | 13.5              |      |      |   |  |
|                 |                      |                       |                       | 25                             |                        | 13.65            |      | 13.5 | 13.8  |       | 13.1              |      |      |   |  |
|                 |                      | E, F types            |                       |                                | 0                      |                  | 4.1  |      | 4.1   | 4.57  |                   | 4.1  |      | V |  |
|                 |                      |                       |                       | 5                              |                        |                  |      |      | 4.24  |       |                   |      |      |   |  |
|                 |                      |                       |                       | 10                             | 5                      | 3.6              |      | 3.6  | 4.12  |       | 3.3               |      |      |   |  |
|                 |                      |                       |                       | 15                             |                        |                  |      |      | 3.94  |       |                   |      |      |   |  |
|                 |                      |                       |                       | 20                             |                        | 2.8              |      | 2.8  | 3.75  |       | 2.5               |      |      |   |  |
|                 |                      |                       |                       | 25                             |                        |                  |      |      | 3.54  |       |                   |      |      |   |  |
|                 |                      |                       |                       | 0                              |                        | 9.1              |      | 9.1  | 9.58  |       | 9.1               |      |      |   |  |
|                 |                      |                       |                       | 5                              |                        |                  |      |      | 9.26  |       |                   |      |      |   |  |
|                 |                      |                       |                       | 10                             | 10                     | 8.75             |      | 8.75 | 9.17  |       | 8.45              |      |      |   |  |
|                 |                      |                       |                       | 15                             |                        |                  |      |      | 9.04  |       |                   |      |      |   |  |
|                 |                      |                       |                       | 20                             |                        | 8.1              |      | 8.1  | 8.9   |       | 7.8               |      |      |   |  |
|                 |                      |                       |                       | 25                             |                        |                  |      |      | 8.75  |       |                   |      |      |   |  |

## STATIC ELECTRICAL CHARACTERISTICS

(over recommended operating conditions)

| PARAMETER                         |                       | TEST CONDITIONS       |                       |                                |                        | VALUES                |      |                       |   |               |                       | UNIT |         |         |
|-----------------------------------|-----------------------|-----------------------|-----------------------|--------------------------------|------------------------|-----------------------|------|-----------------------|---|---------------|-----------------------|------|---------|---------|
|                                   |                       | 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. | min.                  | typ.  | max.          | min.                  |      | max.    |         |
|                                   | E, F types            |                       |                       | 0<br>5<br>10<br>15<br>20<br>25 | 15                     | 14.1<br>13.75<br>13.1 |      | 14.1<br>13.75<br>13.1 | 14.59<br>14.27<br>14.18<br>14.07<br>13.95<br>13.8 |               | 14.1<br>13.45<br>12.8 |      | V       |         |
| 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                    |      | $\pm 0.1$             |   | $\pm 10^{-5}$ | $\pm 0.1$             |      | $\pm 1$ | $\mu$ A |
|                                   |                       | 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<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200 k $\Omega$ , typical temperature coefficient for all V<sub>DD</sub> values is 0.3%/°C, all input rise and fall times = 20 ns)

| PARAMETER        |  | TEST CONDITIONS | VALUES              |      |      | UNIT |
|------------------|--|-----------------|---------------------|------|------|------|
|                  |  |                 | V <sub>DD</sub> (V) | min. | typ. |      |
| t <sub>PHL</sub> | Propagation delay time (Data)              | 5               |                     | 520  | 1040 | ns   |
|                  |  | 10              |                     | 210  | 420  |      |
|                  |  | 15              |                     | 150  | 300  |      |
| t <sub>PLH</sub> | Propagation delay time (Data)              | 5               |                     | 660  | 1320 | ns   |
|                  |  | 10              |                     | 260  | 520  |      |
|                  |  | 15              |                     | 180  | 360  |      |
| t <sub>PHL</sub> | Propagation delay time ( $\overline{BL}$ ) | 5               |                     | 350  | 700  | ns   |
|                  |  | 10              |                     | 175  | 350  |      |
|                  |  | 15              |                     | 150  | 300  |      |
| t <sub>PLH</sub> | Propagation delay time ( $\overline{BL}$ ) | 5               |                     | 400  | 800  | ns   |
|                  |  | 10              |                     | 175  | 350  |      |
|                  |  | 15              |                     | 150  | 300  |      |
| t <sub>PHL</sub> | Propagation delay time ( $\overline{LT}$ ) | 5               |                     | 250  | 500  | ns   |
|                  |  | 10              |                     | 125  | 250  |      |
|                  |  | 15              |                     | 85   | 170  |      |
| t <sub>PLH</sub> | Propagation delay time ( $\overline{LT}$ ) | 5               |                     | 150  | 300  | ns   |
|                  |  | 10              |                     | 75   | 150  |      |
|                  |  | 15              |                     | 50   | 100  |      |

| PARAMETER                 | TEST CONDITIONS | VALUES |      |      | UNIT |
|---------------------------|-----------------|--------|------|------|------|
|                           |                 | VDD(V) | min. | typ. |      |
| $t_{TLH}$ Transition time | 5               |        | 40   | 80   | ns   |
|                           | 10              |        | 30   | 60   |      |
|                           | 15              |        | 20   | 50   |      |
| $t_{THL}$ Transition time | 5               |        | 125  | 310  | ns   |
|                           | 10              |        | 75   | 185  |      |
|                           | 15              |        | 65   | 160  |      |
| $t_{setup}$ Setup time    | 5               | 150    | 75   |      | ns   |
|                           | 10              | 70     | 35   |      |      |
|                           | 15              | 40     | 20   |      |      |
| $t_{hold}$ Hold time      | 5               | 0      | -75  |      | ns   |
|                           | 10              | 0      | -35  |      |      |
|                           | 15              | 0      | -20  |      |      |
| $t_w$ Strobe pulse width  | 5               | 400    | 200  |      | ns   |
|                           | 10              | 160    | 80   |      |      |
|                           | 15              | 100    | 50   |      |      |

**APPLICATION**

Driving common-cathode 7-segment LED displays

