



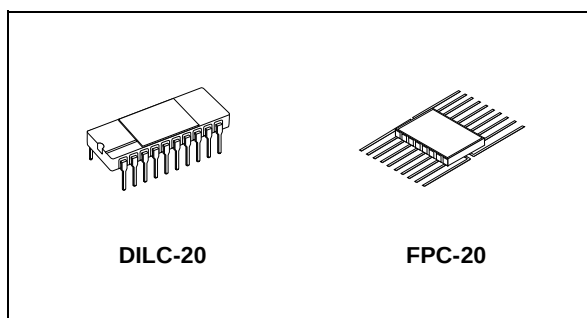
# M54HC244

## RAD-HARD OCTAL BUS BUFFER WITH 3 STATE OUTPUTS (NON INVERTED)

- HIGH SPEED:  
 $t_{PD} = 10ns$  (TYP.) at  $V_{CC} = 6V$
- LOW POWER DISSIPATION:  
 $I_{CC} = 4\mu A$  (MAX.) at  $T_A = 25^\circ C$
- HIGH NOISE IMMUNITY:  
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (MIN.)
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 6mA$  (MIN)
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \approx t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:  
 $V_{CC}$  (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE WITH 54 SERIES 244
- SPACE GRADE-1: ESA SCC QUALIFIED
- 50 krad QUALIFIED, 100 krad AVAILABLE ON REQUEST
- NO SEL UNDER HIGH LET HEAVY IONS IRRADIATION
- DEVICE FULLY COMPLIANT WITH SCC-9401-048

### DESCRIPTION

The 54HC244 is an advanced high-speed CMOS OCTAL BUS BUFFER (3-STATE) fabricated with silicon gate C<sup>2</sup>MOS technology.

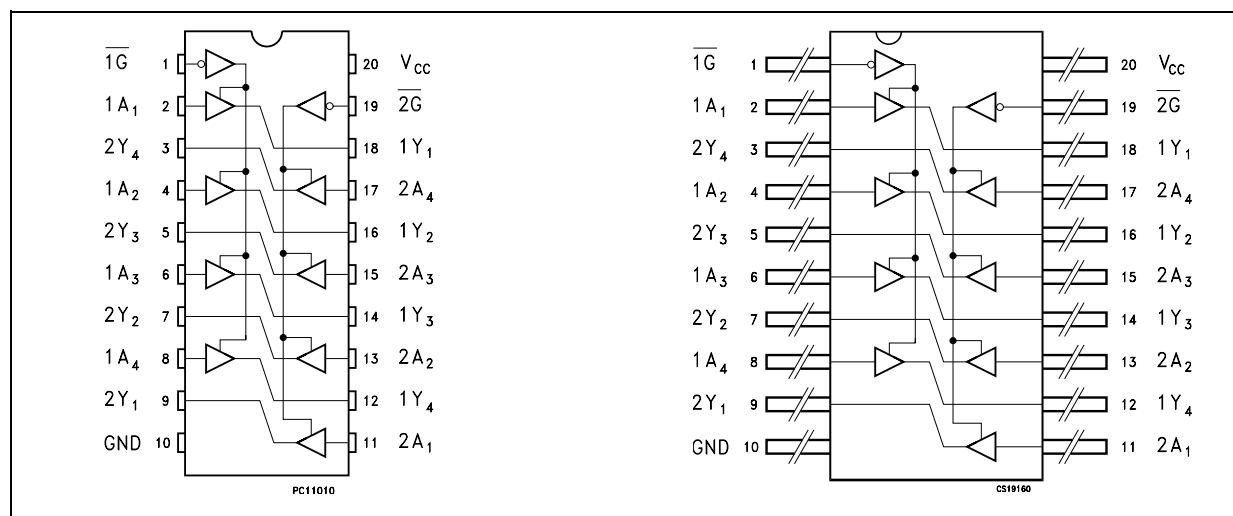


### ORDER CODES

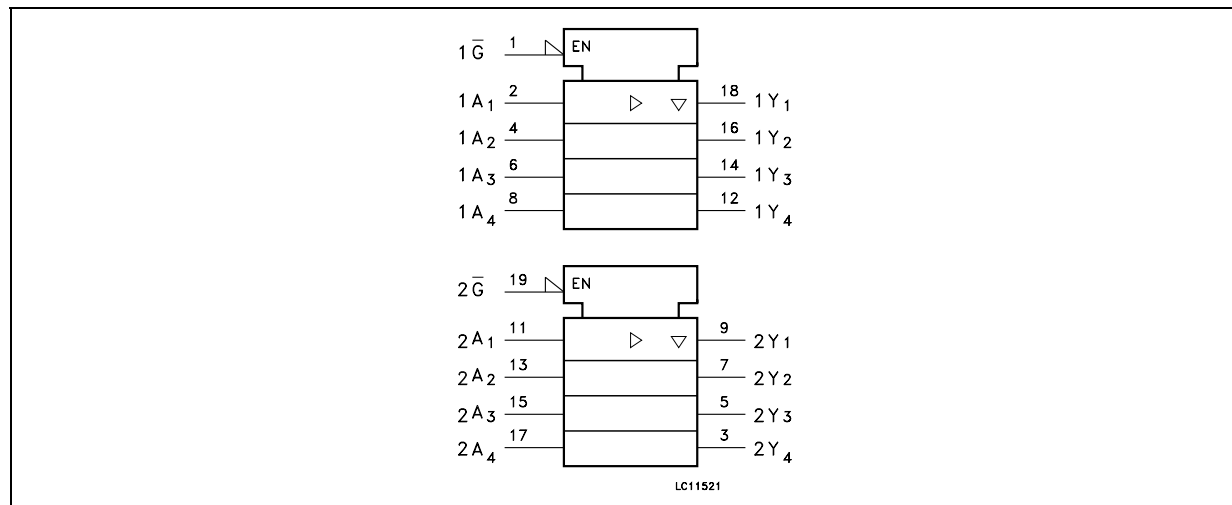
| PACKAGE | FM        | EM         |
|---------|-----------|------------|
| DILC    | M54HC244D | M54HC244D1 |
| FPC     | M54HC244K | M54HC244K1 |

$\overline{G}$  control input governs four BUS BUFFERS. This device is designed to be used with 3 state memory address drivers, etc. All inputs are equipped with protection circuits against static discharge and transient excess voltage.

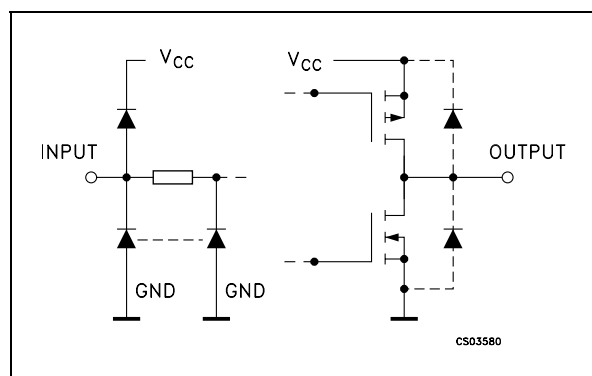
### PIN CONNECTION



## IEC LOGIC SYMBOLS



## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## PIN DESCRIPTION

| PIN N°         | SYMBOL          | NAME AND FUNCTION       |
|----------------|-----------------|-------------------------|
| 1              | 1G              | Output Enable Input     |
| 2, 4, 6, 8     | 1A1 to 1A4      | Data Inputs             |
| 9, 7, 5, 3     | 2Y1 to 2Y4      | Data Outputs            |
| 11, 13, 15, 17 | 2A1 to 2A4      | Data Inputs             |
| 18, 16, 14, 12 | 1Y1 to 1Y4      | Data Outputs            |
| 19             | 2G              | Output Enable Input     |
| 10             | GND             | Ground (0V)             |
| 20             | V <sub>CC</sub> | Positive Supply Voltage |

## TRUTH TABLE

| INPUTS         |                | OUTPUT         |
|----------------|----------------|----------------|
| $\overline{G}$ | A <sub>n</sub> | Y <sub>n</sub> |
| L              | L              | L              |
| L              | H              | H              |
| H              | X              | Z              |

X : Don't Care  
Z : High Impedance

**ABSOLUTE MAXIMUM RATINGS**

| Symbol                | Parameter                     | Value                  | Unit |
|-----------------------|-------------------------------|------------------------|------|
| $V_{CC}$              | Supply Voltage                | -0.5 to +7             | V    |
| $V_I$                 | DC Input Voltage              | -0.5 to $V_{CC} + 0.5$ | V    |
| $V_O$                 | DC Output Voltage             | -0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IK}$              | DC Input Diode Current        | $\pm 20$               | mA   |
| $I_{OK}$              | DC Output Diode Current       | $\pm 20$               | mA   |
| $I_O$                 | DC Output Current             | $\pm 35$               | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 70$               | mA   |
| $P_D$                 | Power Dissipation             | 420                    | mW   |
| $T_{stg}$             | Storage Temperature           | -65 to +150            | °C   |
| $T_L$                 | Lead Temperature (10 sec)     | 265                    | °C   |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

**RECOMMENDED OPERATING CONDITIONS**

| Symbol                          | Parameter                |                        | Value                | Unit |
|---------------------------------|--------------------------|------------------------|----------------------|------|
| V <sub>CC</sub>                 | Supply Voltage           |                        | 2 to 6               | V    |
| V <sub>I</sub>                  | Input Voltage            |                        | 0 to V <sub>CC</sub> | V    |
| V <sub>O</sub>                  | Output Voltage           |                        | 0 to V <sub>CC</sub> | V    |
| T <sub>op</sub>                 | Operating Temperature    |                        | -55 to 125           | °C   |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise and Fall Time | V <sub>CC</sub> = 2.0V | 0 to 1000            | ns   |
|                                 |                          | V <sub>CC</sub> = 4.5V | 0 to 500             | ns   |
|                                 |                          | V <sub>CC</sub> = 6.0V | 0 to 400             | ns   |

## DC SPECIFICATIONS

| Symbol          | Parameter                             | Test Conditions        |                                                                                                | Value                 |      |       |             |      |              |      | Unit |  |
|-----------------|---------------------------------------|------------------------|------------------------------------------------------------------------------------------------|-----------------------|------|-------|-------------|------|--------------|------|------|--|
|                 |                                       | V <sub>CC</sub><br>(V) |                                                                                                | T <sub>A</sub> = 25°C |      |       | -40 to 85°C |      | -55 to 125°C |      |      |  |
|                 |                                       |                        |                                                                                                | Min.                  | Typ. | Max.  | Min.        | Max. | Min.         | Max. |      |  |
| V <sub>IH</sub> | High Level Input Voltage              | 2.0                    |                                                                                                | 1.5                   |      |       | 1.5         |      | 1.5          |      | V    |  |
|                 |                                       | 4.5                    |                                                                                                | 3.15                  |      |       | 3.15        |      | 3.15         |      |      |  |
|                 |                                       | 6.0                    |                                                                                                | 4.2                   |      |       | 4.2         |      | 4.2          |      |      |  |
| V <sub>IL</sub> | Low Level Input Voltage               | 2.0                    |                                                                                                |                       |      | 0.5   |             | 0.5  |              | 0.5  | V    |  |
|                 |                                       | 4.5                    |                                                                                                |                       |      | 1.35  |             | 1.35 |              | 1.35 |      |  |
|                 |                                       | 6.0                    |                                                                                                |                       |      | 1.8   |             | 1.8  |              | 1.8  |      |  |
| V <sub>OH</sub> | High Level Output Voltage             | 2.0                    | I <sub>O</sub> =-20 μA                                                                         | 1.9                   | 2.0  |       | 1.9         |      | 1.9          |      | V    |  |
|                 |                                       | 4.5                    | I <sub>O</sub> =-20 μA                                                                         | 4.4                   | 4.5  |       | 4.4         |      | 4.4          |      |      |  |
|                 |                                       | 6.0                    | I <sub>O</sub> =-20 μA                                                                         | 5.9                   | 6.0  |       | 5.9         |      | 5.9          |      |      |  |
|                 |                                       | 4.5                    | I <sub>O</sub> =-6.0 mA                                                                        | 4.18                  | 4.31 |       | 4.13        |      | 4.10         |      |      |  |
|                 |                                       | 6.0                    | I <sub>O</sub> =-7.8 mA                                                                        | 5.68                  | 5.8  |       | 5.63        |      | 5.60         |      |      |  |
| V <sub>OL</sub> | Low Level Output Voltage              | 2.0                    | I <sub>O</sub> =20 μA                                                                          |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  | V    |  |
|                 |                                       | 4.5                    | I <sub>O</sub> =20 μA                                                                          |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |  |
|                 |                                       | 6.0                    | I <sub>O</sub> =20 μA                                                                          |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |  |
|                 |                                       | 4.5                    | I <sub>O</sub> =6.0 mA                                                                         |                       | 0.17 | 0.26  |             | 0.33 |              | 0.40 |      |  |
|                 |                                       | 6.0                    | I <sub>O</sub> =7.8 mA                                                                         |                       | 0.18 | 0.26  |             | 0.33 |              | 0.40 |      |  |
| I <sub>I</sub>  | Input Leakage Current                 | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                                        |                       |      | ± 0.1 |             | ± 1  |              | ± 1  | μA   |  |
| I <sub>OZ</sub> | High Impedance Output Leakage Current | 6.0                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = V <sub>CC</sub> or GND |                       |      | ± 0.5 |             | ± 5  |              | ± 10 | μA   |  |
| I <sub>CC</sub> | Quiescent Supply Current              | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                                        |                       |      | 4     |             | 40   |              | 80   | μA   |  |

**AC ELECTRICAL CHARACTERISTICS** ( $C_L = 50 \text{ pF}$ , Input  $t_r = t_f = 6 \text{ ns}$ )

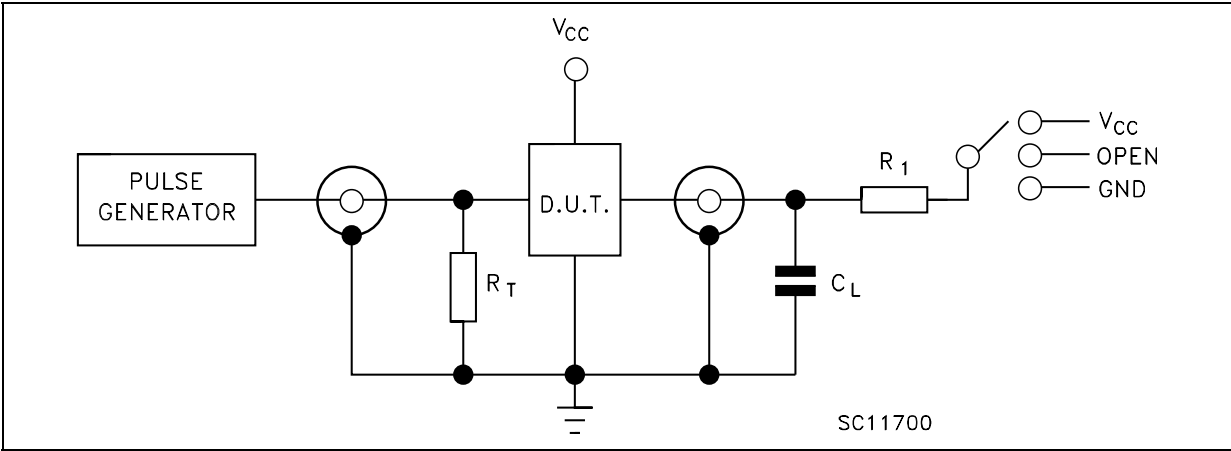
| Symbol                            | Parameter                          | Test Conditions        |                        |                       | Value                 |      |      |             |      |              |      | Unit |
|-----------------------------------|------------------------------------|------------------------|------------------------|-----------------------|-----------------------|------|------|-------------|------|--------------|------|------|
|                                   |                                    | V <sub>CC</sub><br>(V) | C <sub>L</sub><br>(pF) |                       | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                                   |                                    |                        |                        |                       | Min.                  | Typ. | Max. | Min.        | Max. | Min.         | Max. |      |
| t <sub>TLH</sub> t <sub>THL</sub> | Output Transition Time             | 2.0                    | 50                     |                       |                       | 25   | 60   |             | 75   |              | 90   | ns   |
|                                   |                                    | 4.5                    |                        |                       |                       | 7    | 12   |             | 19   |              | 18   |      |
|                                   |                                    | 6.0                    |                        |                       |                       | 6    | 10   |             | 13   |              | 15   |      |
| t <sub>PLH</sub> t <sub>PHL</sub> | Propagation Delay Time             | 2.0                    | 50                     |                       |                       | 36   | 90   |             | 115  |              | 135  | ns   |
|                                   |                                    | 4.5                    |                        |                       |                       | 12   | 18   |             | 23   |              | 27   |      |
|                                   |                                    | 6.0                    |                        |                       |                       | 10   | 15   |             | 20   |              | 23   |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
| t <sub>PZL</sub> t <sub>PZH</sub> | High Impedance Output Enable Time  | 2.0                    | 50                     | R <sub>L</sub> = 1 KΩ |                       | 48   | 125  |             | 155  |              | 190  | ns   |
|                                   |                                    | 4.5                    |                        |                       |                       | 16   | 25   |             | 31   |              | 38   |      |
|                                   |                                    | 6.0                    |                        |                       |                       | 14   | 21   |             | 25   |              | 32   |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
|                                   |                                    |                        |                        |                       |                       |      |      |             |      |              |      |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub> | High Impedance Output Disable Time | 2.0                    | 50                     | R <sub>L</sub> = 1 KΩ |                       | 32   | 125  |             | 155  |              | 190  | ns   |
|                                   |                                    | 4.5                    |                        |                       |                       | 15   | 25   |             | 31   |              | 38   |      |
|                                   |                                    | 6.0                    |                        |                       |                       | 14   | 21   |             | 26   |              | 32   |      |

**CAPACITIVE CHARACTERISTICS**

| Symbol           | Parameter                              | Test Condition         |  |  | Value                 |      |      |             |      |              | Unit |      |
|------------------|----------------------------------------|------------------------|--|--|-----------------------|------|------|-------------|------|--------------|------|------|
|                  |                                        | V <sub>CC</sub><br>(V) |  |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                  |                                        |                        |  |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| C <sub>IN</sub>  | Input Capacitance                      | 5.0                    |  |  |                       | 5    | 10   |             | 10   |              | 10   | pF   |
| C <sub>OUT</sub> | Output Capacitance                     | 5.0                    |  |  |                       | 10   |      |             |      |              |      | pF   |
| C <sub>PD</sub>  | Power Dissipation Capacitance (note 1) | 5.0                    |  |  |                       | 33   |      |             |      |              |      | pF   |

1)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8$  (per circuit)

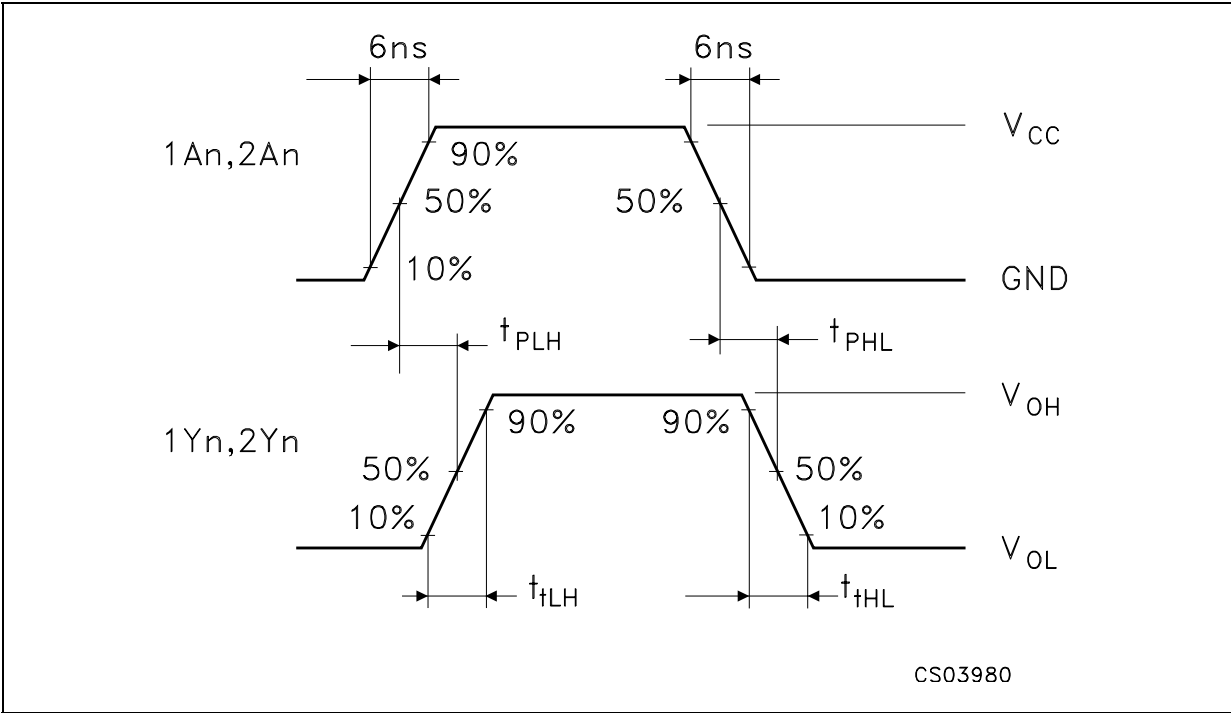
TEST CIRCUIT

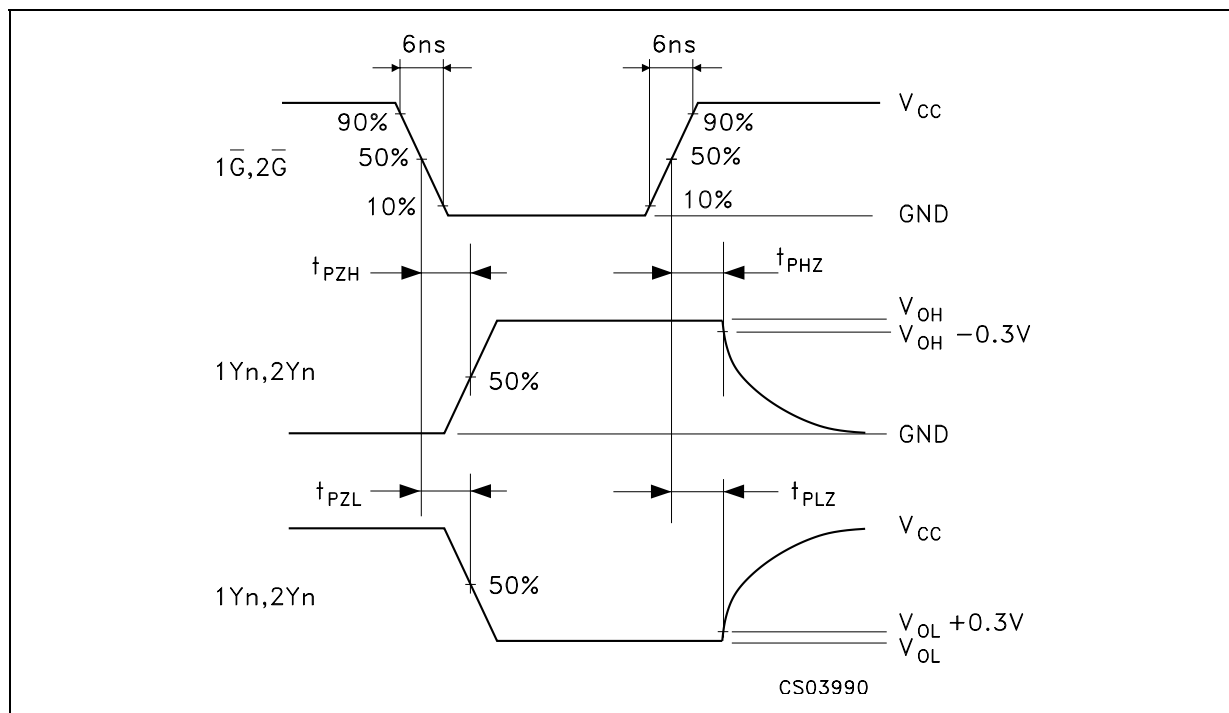


| TEST               | SWITCH   |
|--------------------|----------|
| $t_{PLH}, t_{PHL}$ | Open     |
| $t_{PZL}, t_{PLZ}$ | $V_{CC}$ |
| $t_{PZH}, t_{PHZ}$ | GND      |

$C_L$  = 50pF/150pF or equivalent (includes jig and probe capacitance)  
 $R_1$  = 1K $\Omega$  or equivalent  
 $R_T$  =  $Z_{OUT}$  of pulse generator (typically 50 $\Omega$ )

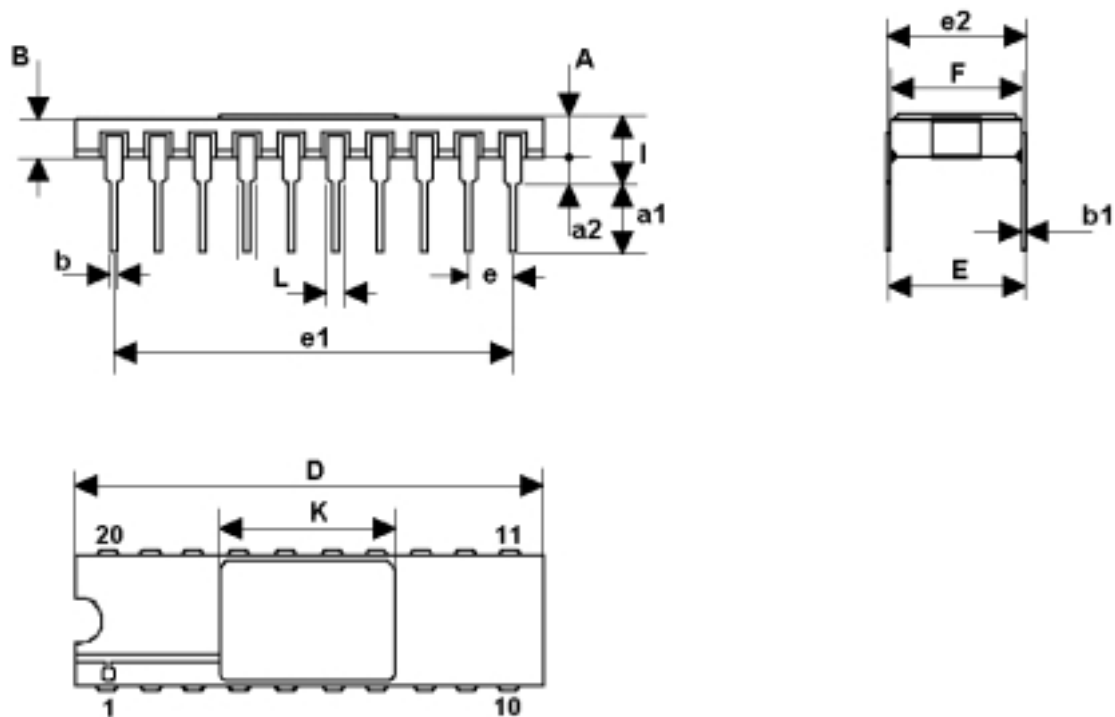
WAVEFORM 1: PROPAGATION DELAY TIMES (f=1MHz; 50% duty cycle)





## DILC-20 MECHANICAL DATA

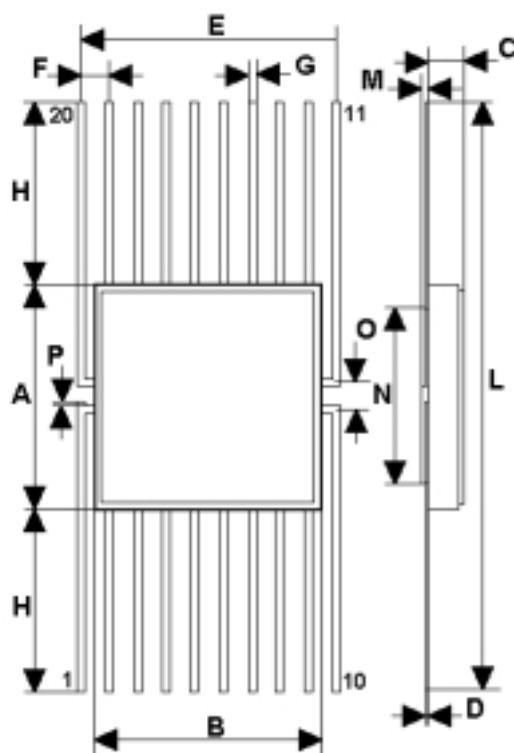
| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 2.1   |       | 2.71  | 0.083 |       | 0.107 |
| a1   | 3.00  |       | 3.70  | 0.118 |       | 0.146 |
| a2   | 0.63  | 0.88  | 1.14  | 0.025 | 0.035 | 0.045 |
| B    | 1.93  | 2.03  | 2.23  | 0.076 | 0.080 | 0.088 |
| b    | 0.40  | 0.45  | 0.50  | 0.016 | 0.018 | 0.020 |
| b1   | 0.20  | 0.254 | 0.30  | 0.008 | 0.010 | 0.012 |
| D    | 25.14 | 25.40 | 25.65 | 0.990 | 1.000 | 1.010 |
| e    | 7.36  | 7.62  | 7.87  | 0.290 | 0.300 | 0.310 |
| e1   |       | 2.54  |       |       | 0.100 |       |
| e2   | 22.73 | 22.86 | 22.99 | 0.895 | 0.900 | 0.905 |
| e3   | 7.62  | 7.87  | 8.12  | 0.300 | 0.310 | 0.320 |
| F    | 7.29  | 7.49  | 7.70  | 0.287 | 0.295 | 0.303 |
| I    |       |       | 3.86  |       |       | 0.152 |
| K    | 11.30 |       | 11.56 | 0.445 |       | 0.455 |
| L    | 1.14  | 1.27  | 1.40  | 0.045 | 0.050 | 0.055 |



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## FPC-20 MECHANICAL DATA

| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 9.98  | 10.16 | 10.34 | 0.393 | 0.400 | 0.407 |
| B    | 9.98  | 10.16 | 10.34 | 0.393 | 0.400 | 0.407 |
| C    | 1.45  | 1.61  | 1.78  | 0.57  | 0.63  | 0.070 |
| D    | 0.10  | 0.127 | 0.18  | 0.004 | 0.005 | 0.007 |
| E    | 11.30 | 11.43 | 11.56 | 0.445 | 0.450 | 0.455 |
| F    |       | 1.27  |       |       | 0.050 |       |
| G    | 0.38  | 0.43  | 0.48  | 0.015 | 0.017 | 0.019 |
| H    | 7.24  |       | 8.16  | 0.285 |       | 0.320 |
| L    | 24.46 |       | 26.67 | 0.960 |       | 1.050 |
| M    | 0.45  | 0.50  | 0.55  | 0.018 | 0.020 | 0.022 |
| N    |       | 7.87  |       |       | 0.310 |       |
| O    | 1.14  | 1.27  | 1.40  | 0.045 | 0.050 | 0.055 |
| P    | 0.10  | 0.18  | 0.25  | 0.004 | 0.007 | 0.010 |



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