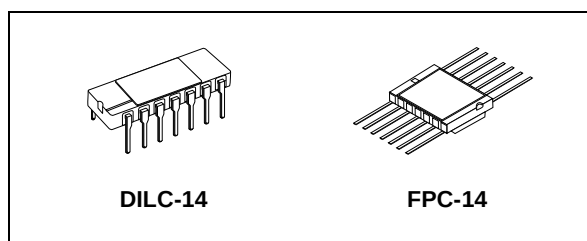


## RAD-HARD HEX INVERTER

- **HIGH SPEED:**  
 $t_{PD} = 8\text{ns}$  (TYP.) at  $V_{CC} = 6\text{V}$
- **LOW POWER DISSIPATION:**  
 $I_{CC} = 1\mu\text{A}$  (MAX.) at  $T_A = 25^\circ\text{C}$
- **HIGH NOISE IMMUNITY:**  
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (MIN.)
- **SYMMETRICAL OUTPUT IMPEDANCE:**  
 $|I_{OH}| = I_{OL} = 4\text{mA}$  (MIN) at  $V_{CC} = 4.5\text{V}$
- **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 04**
- **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-9401-033**



### ORDER CODES

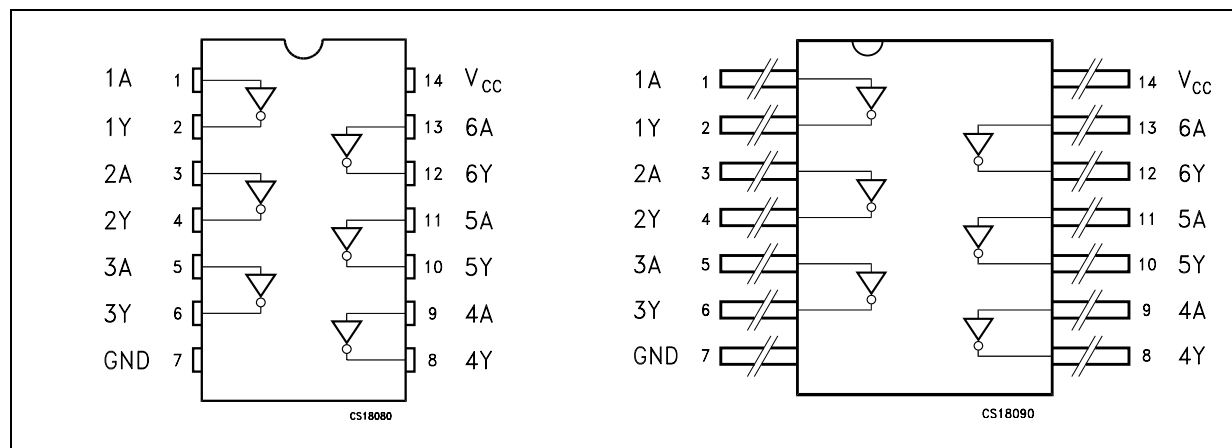
| PACKAGE | FM       | EM        |
|---------|----------|-----------|
| DILC    | M54HC04D | M54HC04D1 |
| FPC     | M54HC04K | M54HC04K1 |

The internal circuit is composed of 3 stages including buffer output, which enables high noise immunity and stable output. All inputs are equipped with protection circuits against static discharge and transient excess voltage.

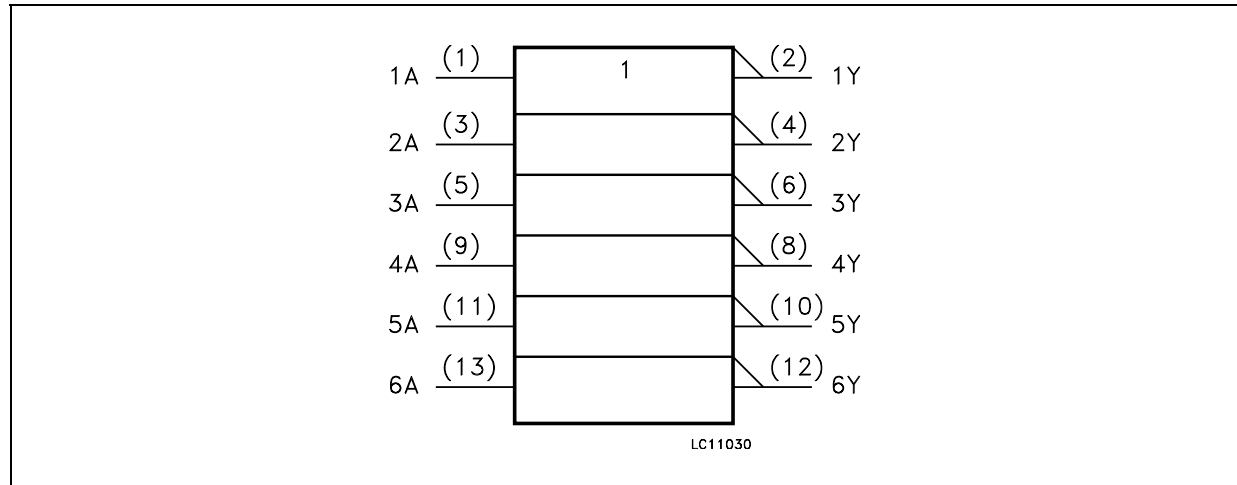
### DESCRIPTION

The M54HC04 is an high speed CMOS HEX INVERTER fabricated with silicon gate C<sup>2</sup>MOS technology.

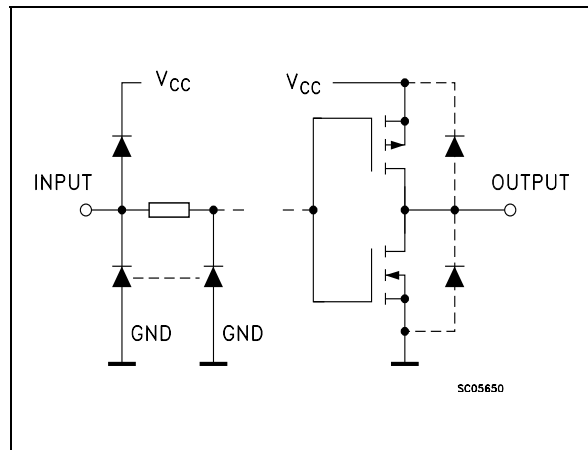
### PIN CONNECTION



## IEC LOGIC SYMBOLS



## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## PIN DESCRIPTION

| PIN N°             | SYMBOL          | NAME AND FUNCTION       |
|--------------------|-----------------|-------------------------|
| 1, 3, 5, 9, 11, 13 | 1A to 6A        | Data Inputs             |
| 2, 4, 6, 8, 10, 12 | 1Y to 6Y        | Data Outputs            |
| 7                  | GND             | Ground (0V)             |
| 14                 | V <sub>CC</sub> | Positive Supply Voltage |

## TRUTH TABLE

| A | Y |
|---|---|
| L | H |
| H | L |

## ABSOLUTE MAXIMUM RATINGS

| Symbol                              | Parameter                            | Value                         | Unit |
|-------------------------------------|--------------------------------------|-------------------------------|------|
| V <sub>CC</sub>                     | Supply Voltage                       | -0.5 to +7                    | V    |
| V <sub>I</sub>                      | DC Input Voltage                     | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| V <sub>O</sub>                      | DC Output Voltage                    | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| I <sub>IK</sub>                     | DC Input Diode Current               | ± 20                          | mA   |
| I <sub>OK</sub>                     | DC Output Diode Current              | ± 20                          | mA   |
| I <sub>O</sub>                      | DC Output Current                    | ± 25                          | mA   |
| I <sub>CC</sub> or I <sub>GND</sub> | DC V <sub>CC</sub> or Ground Current | ± 50                          | mA   |
| P <sub>D</sub>                      | Power Dissipation                    | 300                           | mW   |
| T <sub>stg</sub>                    | Storage Temperature                  | -65 to +150                   | °C   |
| T <sub>L</sub>                      | 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 |
|------------|--------------------------|-----------------|---------------|------|
| $V_{CC}$   | Supply Voltage           |                 | 2 to 6        | V    |
| $V_I$      | Input Voltage            |                 | 0 to $V_{CC}$ | V    |
| $V_O$      | Output Voltage           |                 | 0 to $V_{CC}$ | V    |
| $T_{op}$   | Operating Temperature    |                 | -55 to 125    | °C   |
| $t_r, t_f$ | Input Rise and Fall Time | $V_{CC} = 2.0V$ | 0 to 1000     | ns   |
|            |                          | $V_{CC} = 4.5V$ | 0 to 500      | ns   |
|            |                          | $V_{CC} = 6.0V$ | 0 to 400      | ns   |

## DC SPECIFICATIONS

| 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. |    |      |
| 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> =-4.0 mA                 | 4.18                  | 4.31 |       | 4.13        |      | 4.10         |      |    |      |
|                 |                           | 6.0                    | I <sub>O</sub> =-5.2 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> =4.0 mA                  |                       | 0.17 | 0.26  |             | 0.33 |              | 0.40 |    |      |
|                 |                           | 6.0                    | I <sub>O</sub> =5.2 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>CC</sub> | Quiescent Supply Current  | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND |                       |      | 1     |             | 10   |              | 20   | μA |      |

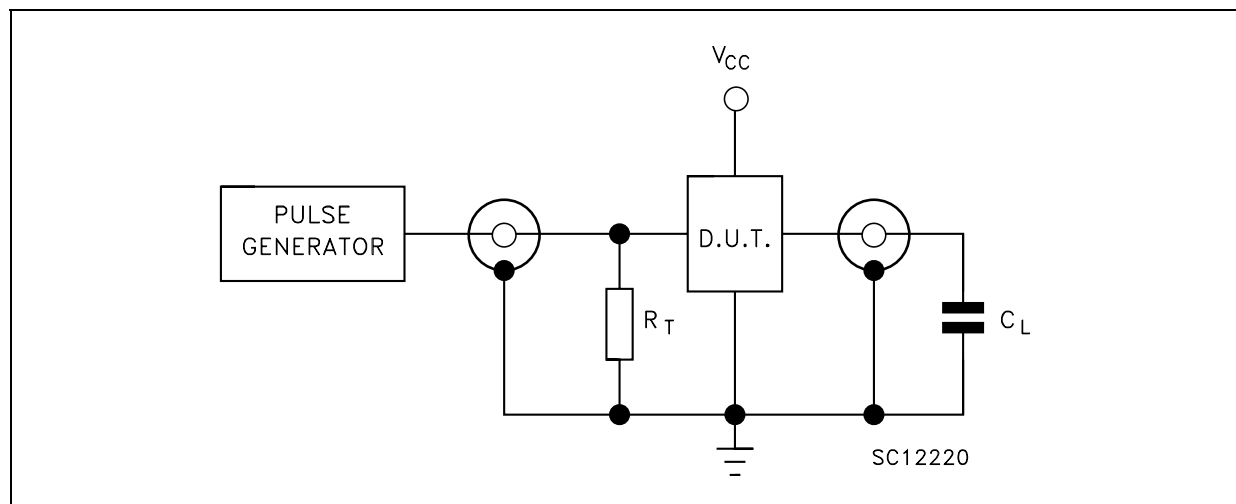
**AC ELECTRICAL CHARACTERISTICS** ( $C_L = 50 \text{ pF}$ , Input  $t_r = t_f = 6 \text{ ns}$ )

| 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. |
| t <sub>ILH</sub> t <sub>HL</sub>  | Output Transition Time | 2.0                    |  |                       | 38   | 75   |             | 95   |              | 110  | ns   |
|                                   |                        | 4.5                    |  |                       | 8    | 15   |             | 19   |              | 22   |      |
|                                   |                        | 6.0                    |  |                       | 6    | 13   |             | 16   |              | 19   |      |
| t <sub>PLH</sub> t <sub>PHL</sub> | Propagation Delay Time | 2.0                    |  |                       | 45   | 95   |             | 120  |              | 145  | ns   |
|                                   |                        | 4.5                    |  |                       | 9    | 19   |             | 24   |              | 29   |      |
|                                   |                        | 6.0                    |  |                       | 8    | 16   |             | 20   |              | 25   |      |

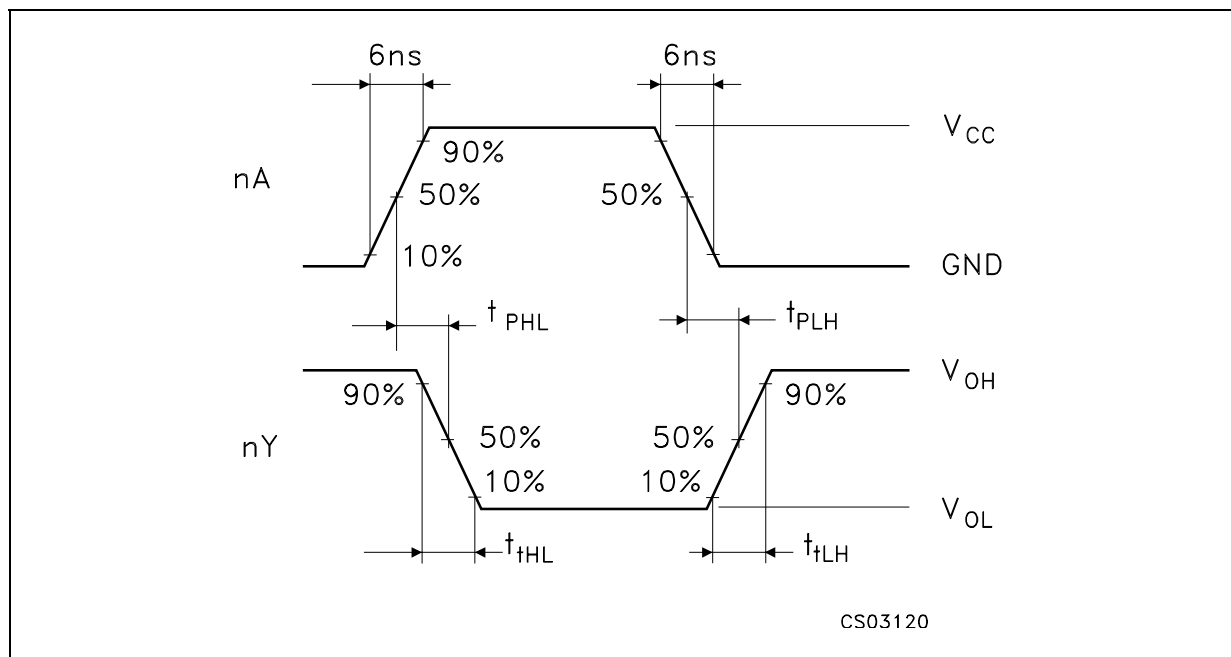
**CAPACITIVE CHARACTERISTICS**

| 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>PD</sub> | Power Dissipation Capacitance (note 1) | 5.0                    |  |                       | 22   |      |             |      |              |      | pF   |

1)  $C_{\text{PD}}$  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.  $I_{\text{CC(opr)}} = C_{\text{PD}} \times V_{\text{CC}} \times f_{\text{IN}} + I_{\text{CC}}/6$  (per Gate)

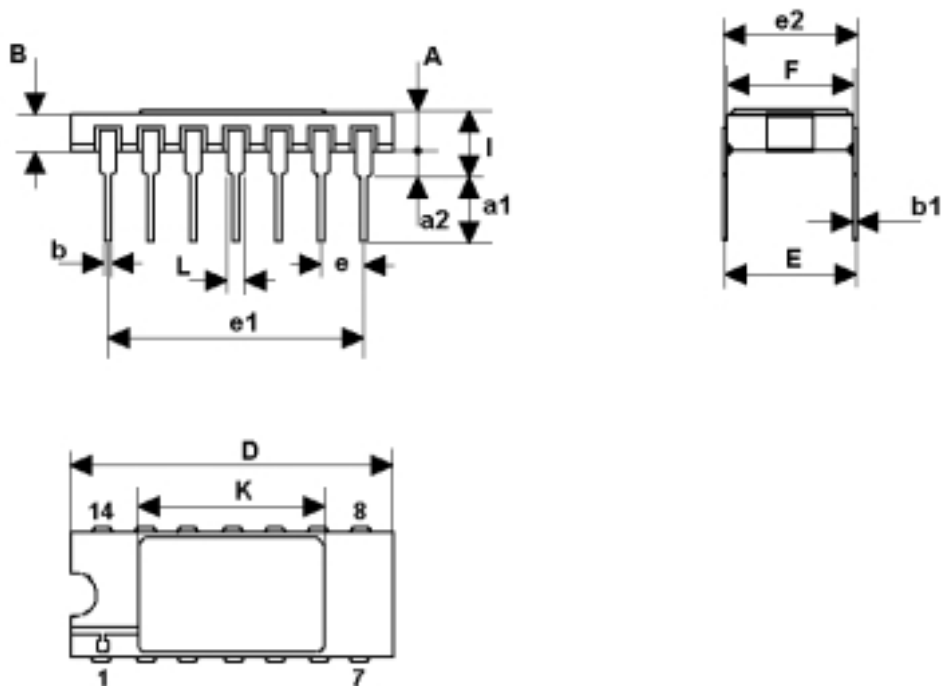
**TEST CIRCUIT**

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

**WAVEFORM: PROPAGATION DELAY TIMES** ( $f=1\text{MHz}$ ; 50% duty cycle)

## DILC-14 MECHANICAL DATA

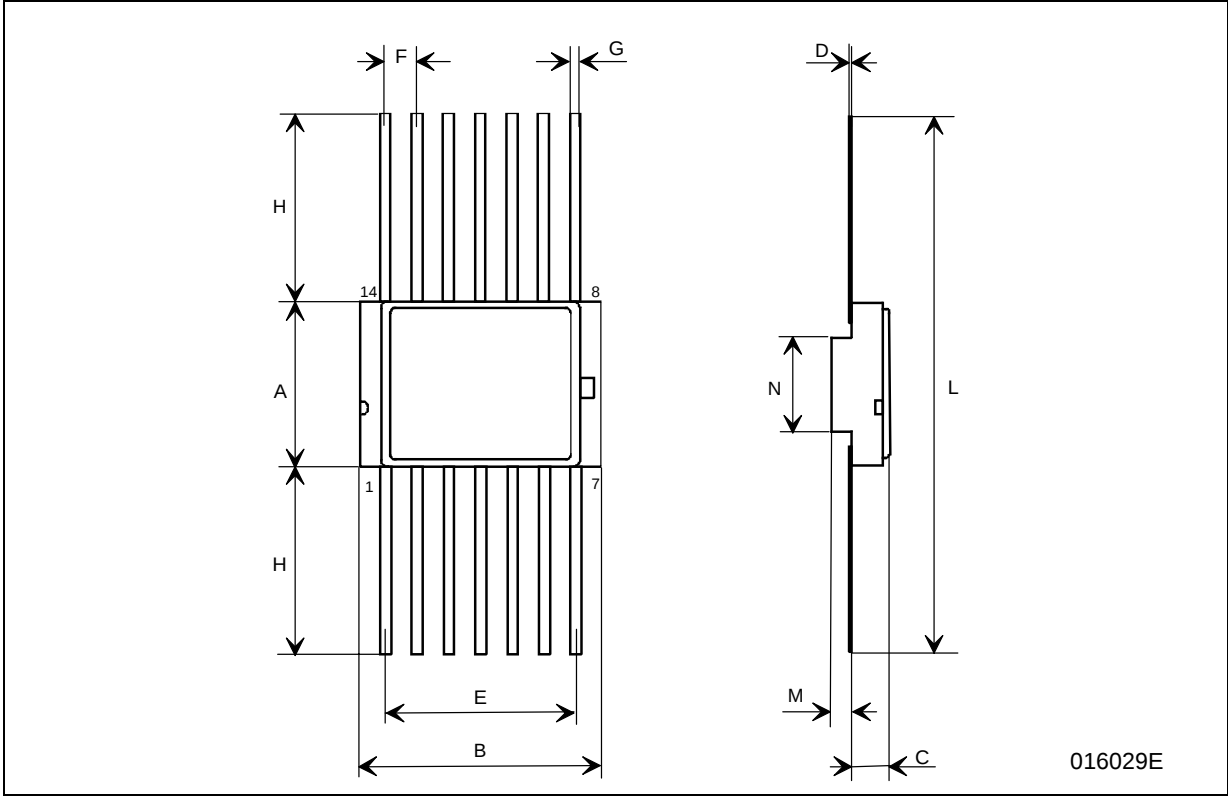
| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 2.1   |       | 22.54 | 0.083 |       | 0.100 |
| a1   | 3.00  |       | 3.70  | 0.118 |       | 0.146 |
| a2   | 0.63  | 0.88  | 1.14  | 0.025 | 0.035 | 0.045 |
| B    | 1.82  | 2.03  | 2.39  | 0.072 | 0.080 | 0.094 |
| 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    | 18.79 | 19.00 | 19.20 | 0.740 | 0.748 | 0.756 |
| e    | 7.36  | 7.62  | 7.87  | 0.290 | 0.300 | 0.310 |
| e1   |       | 2.54  |       |       | 0.100 |       |
| e2   | 15.11 | 15.24 | 15.37 | 0.595 | 0.600 | 0.605 |
| e3   | 7.62  | 7.87  | 8.12  | 0.300 | 0.310 | 0.320 |
| F    | 7.11  |       | 7.75  | 0.280 |       | 0.305 |
| I    |       |       | 3.70  |       |       | 0.146 |
| K    | 10.90 |       | 12.1  | 0.429 |       | 0.476 |
| L    | 1.14  | 1.27  | 1.5   | 0.045 | 0.050 | 0.059 |



0016173H

FPC-14 MECHANICAL DATA

| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 6.75  | 6.91  | 7.06  | 0.266 | 0.272 | 0.278 |
| B    | 9.76  | 9.95  | 10.14 | 0.384 | 0.392 | 0.399 |
| C    | 1.49  |       | 1.95  | 0.059 |       | 0.077 |
| D    | 0.10  | 0.127 | 0.15  | 0.004 | 0.005 | 0.006 |
| E    | 7.50  | 7.62  | 7.75  | 0.295 | 0.300 | 0.305 |
| F    |       | 1.27  |       |       | 0.050 |       |
| G    | 0.38  | 0.43  | 0.48  | 0.015 | 0.017 | 0.019 |
| H    |       | 6.0   |       |       | 0.236 |       |
| L    | 18.75 |       | 22.0  | 0.738 |       | 0.866 |
| M    |       | 0.38  |       |       | 0.015 |       |
| N    |       | 4.31  |       |       | 0.170 |       |



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