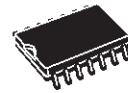


## HEX INVERTER

- HIGH SPEED:  $t_{PD} = 4.5 \text{ ns}$  (TYP.) at  $V_{CC} = 3.3\text{V}$
- COMPATIBLE WITH TTL OUTPUTS
- LOW POWER DISSIPATION:  
 $I_{CC} = 2 \mu\text{A}$  (MAX.) at  $T_A = 25^\circ\text{C}$
- LOW NOISE:  
 $V_{OLP} = 0.3 \text{ V}$  (TYP.) at  $V_{CC} = 3.3\text{V}$
- $75\Omega$  TRANSMISSION LINE DRIVING CAPABILITY
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 12 \text{ mA}$  (MIN)
- PCI BUS LEVELS GUARANTEED AT 24mA
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \equiv t_{PHL}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC}$  (OPR) = 2V to 3.6V (1.2V Data Retention)
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 04
- IMPROVED LATCH-UP IMMUNITY

### DESCRIPTION

The LVQ04 is a low voltage CMOS HEX INVERTER fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS



**M**  
(Micro Package)



**T**  
(TSSOP Package)

### ORDER CODES :

74LVQ04M

74LVQ04T

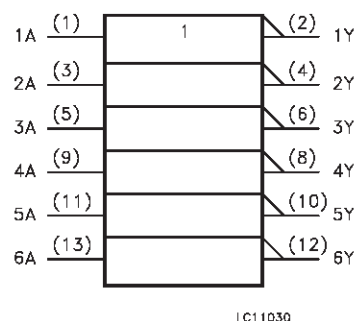
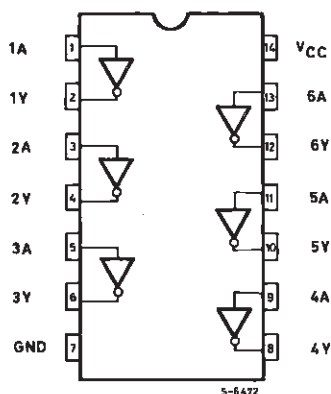
technology. It is ideal for low power and low noise 3.3V applications.

The internal circuit is composed of 3 stages including buffer output, which enables high noise immunity and stable output.

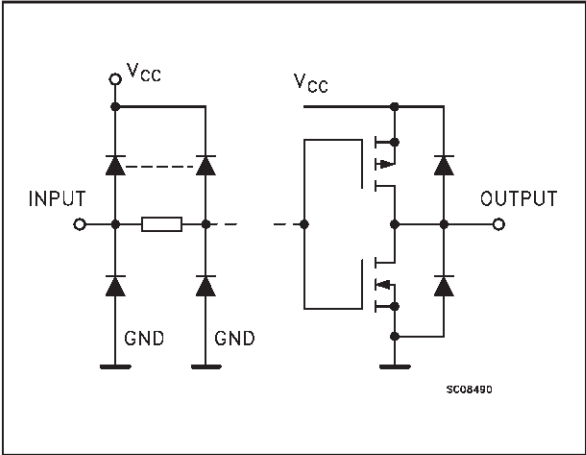
It has better speed performance at 3.3V than 5V LS-TTL family combined with the true CMOS low power consumption.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

| PIN No             | 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                 | $V_{CC}$ | Positive Supply Voltage |

TRUTH TABLE

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

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             | $\pm 50$               | mA          |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 300$              | mA          |
| $T_{stg}$             | Storage Temperature           | -65 to +150            | $^{\circ}C$ |
| $T_L$                 | Lead Temperature (10 sec)     | 300                    | $^{\circ}C$ |

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

RECOMMENDED OPERATING CONDITIONS

| Symbol   | Parameter                                           | Value         | Unit        |
|----------|-----------------------------------------------------|---------------|-------------|
| $V_{CC}$ | Supply Voltage (note 1)                             | 2 to 3.6      | V           |
| $V_I$    | Input Voltage                                       | 0 to $V_{CC}$ | V           |
| $V_O$    | Output Voltage                                      | 0 to $V_{CC}$ | V           |
| $T_{op}$ | Operating Temperature:                              | -40 to +85    | $^{\circ}C$ |
| dt/dv    | Input Rise and Fall Time ( $V_{CC} = 3V$ ) (note 2) | 0 to 10       | ns/V        |

1) Truth Table guaranteed: 1.2V to 3.6V

2)  $V_{IN}$  from 0.8V to 2V

## DC SPECIFICATIONS

| Symbol           | Parameter                 | Test Conditions        |                                                |                         | Value |       |              |      |      | Unit |
|------------------|---------------------------|------------------------|------------------------------------------------|-------------------------|-------|-------|--------------|------|------|------|
|                  |                           | V <sub>CC</sub><br>(V) |                                                | T <sub>A</sub> = 25 °C  |       |       | -40 to 85 °C |      |      |      |
|                  |                           |                        |                                                | Min.                    | Typ.  | Max.  | Min.         | Max. |      |      |
| V <sub>IH</sub>  | High Level Input Voltage  | 3.0 to 3.6             |                                                | 2.0                     |       |       | 2.0          |      | V    |      |
| V <sub>IL</sub>  | Low Level Input Voltage   |                        |                                                |                         |       | 0.8   |              | 0.8  | V    |      |
| V <sub>OH</sub>  | High Level Output Voltage | 3.0                    | V <sub>I</sub> <sup>(*) = V<sub>IL</sub></sup> | I <sub>O</sub> = -50 μA | 2.9   | 2.99  |              | 2.9  |      | V    |
|                  |                           |                        |                                                | I <sub>O</sub> = -12 mA | 2.58  |       |              | 2.48 |      |      |
|                  |                           |                        |                                                | I <sub>O</sub> = -24 mA |       |       |              | 2.2  |      |      |
| V <sub>OL</sub>  | Low Level Output Voltage  | 3.0                    | V <sub>I</sub> <sup>(*) = V<sub>IH</sub></sup> | I <sub>O</sub> = 50 μA  |       | 0.002 | 0.1          |      | 0.1  | V    |
|                  |                           |                        |                                                | I <sub>O</sub> = 12 mA  |       | 0     | 0.36         |      | 0.44 |      |
|                  |                           |                        |                                                | I <sub>O</sub> = 24 mA  |       |       |              |      | 0.55 |      |
| I <sub>I</sub>   | Input Leakage Current     | 3.6                    | V <sub>I</sub> = V <sub>CC</sub> or GND        |                         |       | ±0.1  |              | ±1   | μA   |      |
| I <sub>CC</sub>  | Quiescent Supply Current  | 3.6                    | V <sub>I</sub> = V <sub>CC</sub> or GND        |                         |       | 2     |              | 20   | μA   |      |
| I <sub>OLD</sub> | Dynamic Output Current    | 3.6                    | V <sub>OLD</sub> = 0.8 V max                   |                         |       |       | 36           |      | mA   |      |
| I <sub>OHD</sub> | (note 1, 2)               |                        | V <sub>OHD</sub> = 2 V min                     |                         |       |       | -25          |      | mA   |      |

1) Maximum test duration 2ms, one output loaded at time

2) Incident wave switching is guaranteed on transmission lines with impedances as low as 50 Ω.

(\*) All outputs loaded.

## DYNAMIC SWITCHING CHARACTERISTICS

| Symbol           | Parameter                              | Test Conditions        |                        | Value                  |      |      |              |      | Unit |
|------------------|----------------------------------------|------------------------|------------------------|------------------------|------|------|--------------|------|------|
|                  |                                        | V <sub>CC</sub><br>(V) |                        | T <sub>A</sub> = 25 °C |      |      | -40 to 85 °C |      |      |
|                  |                                        |                        |                        | Min.                   | Typ. | Max. | Min.         | Max. |      |
| V <sub>OLP</sub> | Dynamic Low Voltage                    | 3.3                    | C <sub>L</sub> = 50 pF |                        | 0.3  | 0.8  |              |      | V    |
| V <sub>OLV</sub> | Quiet Output (note 1, 2)               |                        |                        | -0.8                   | -0.3 |      |              |      |      |
| V <sub>IHD</sub> | Dynamic High Voltage Input (note 1, 3) | 3.3                    |                        |                        |      | 2    |              |      |      |
| V <sub>ILD</sub> | Dynamic Low Voltage Input (note 1, 3)  | 3.3                    |                        | 0.8                    |      |      |              |      |      |

1) Worst case package.

2) Max number of outputs defined as (n). Data inputs are driven 0V to 3.3V, (n-1) outputs switching and one output at GND.

3) Max number of data inputs (n) switching. (n-1) switching 0V to 3.3V. Inputs under test switching: 3.3V to threshold (V<sub>ILD</sub>), 0V to threshold (V<sub>IHD</sub>), f=1MHz.

**AC ELECTRICAL CHARACTERISTICS** ( $C_L = 50 \text{ pF}$ ,  $R_L = 500 \Omega$ , Input  $t_r = t_f = 3 \text{ ns}$ )

| Symbol            | Parameter                                 | Test Condition         |  | Value                  |      |      |              |      | Unit |
|-------------------|-------------------------------------------|------------------------|--|------------------------|------|------|--------------|------|------|
|                   |                                           | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25 °C |      |      | -40 to 85 °C |      |      |
|                   |                                           |                        |  | Min.                   | Typ. | Max. | Min.         | Max. |      |
| t <sub>PLH</sub>  | Propagation Delay Time                    | 2.7                    |  |                        | 5.5  | 11.0 |              | 12.0 | ns   |
| t <sub>PHL</sub>  |                                           | 3.3 <sup>(*)</sup>     |  |                        | 4.5  | 8.5  |              | 9.5  |      |
| t <sub>OSLH</sub> | Output to Output Skew<br>Time (note 1, 2) | 2.7                    |  |                        | 0.5  | 1.5  |              | 1.5  | ns   |
| t <sub>OSHL</sub> |                                           | 3.3 <sup>(*)</sup>     |  |                        | 0.5  | 1.5  |              | 1.5  |      |

1) Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW ( $t_{OSLH} = |t_{PLHm} - t_{PLHi}|$ ,  $t_{OSHL} = |t_{PHLm} - t_{PHLi}|$ )

2) Parameter guaranteed by design

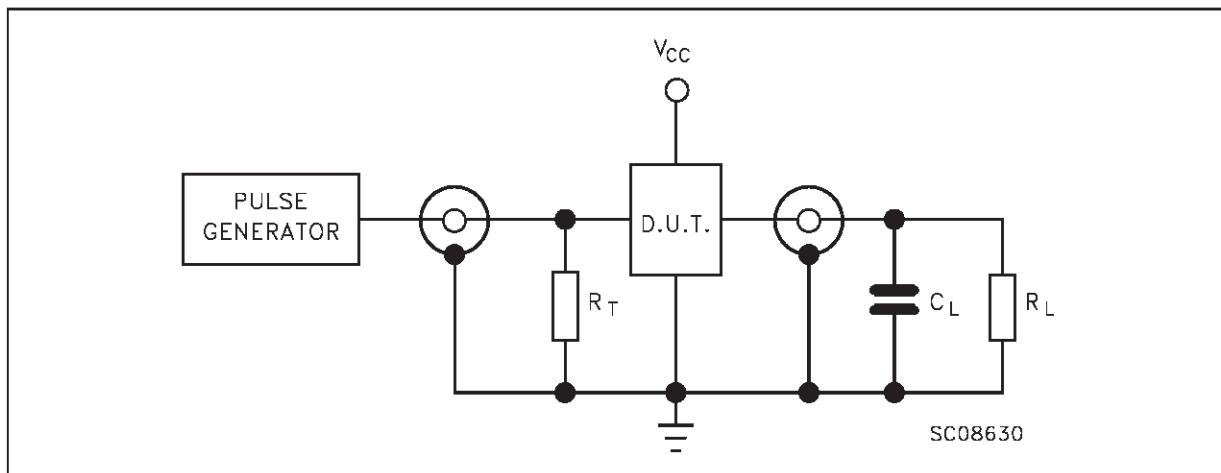
(\*) Voltage range is  $3.3\text{V} \pm 0.3\text{V}$

**CAPACITIVE CHARACTERISTICS**

| Symbol          | Parameter                              | Test Conditions        |                          | Value                  |      |      |              |      | Unit |
|-----------------|----------------------------------------|------------------------|--------------------------|------------------------|------|------|--------------|------|------|
|                 |                                        | V <sub>CC</sub><br>(V) |                          | T <sub>A</sub> = 25 °C |      |      | -40 to 85 °C |      |      |
|                 |                                        |                        |                          | Min.                   | Typ. | Max. | Min.         | Max. |      |
| C <sub>IN</sub> | Input Capacitance                      | 3.3                    |                          |                        | 4    |      |              |      | pF   |
| C <sub>PD</sub> | Power Dissipation Capacitance (note 1) | 3.3                    | f <sub>IN</sub> = 10 MHz |                        | 29   |      |              |      | pF   |

1) C<sub>PD</sub> 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.  $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC0}$  (per gate)

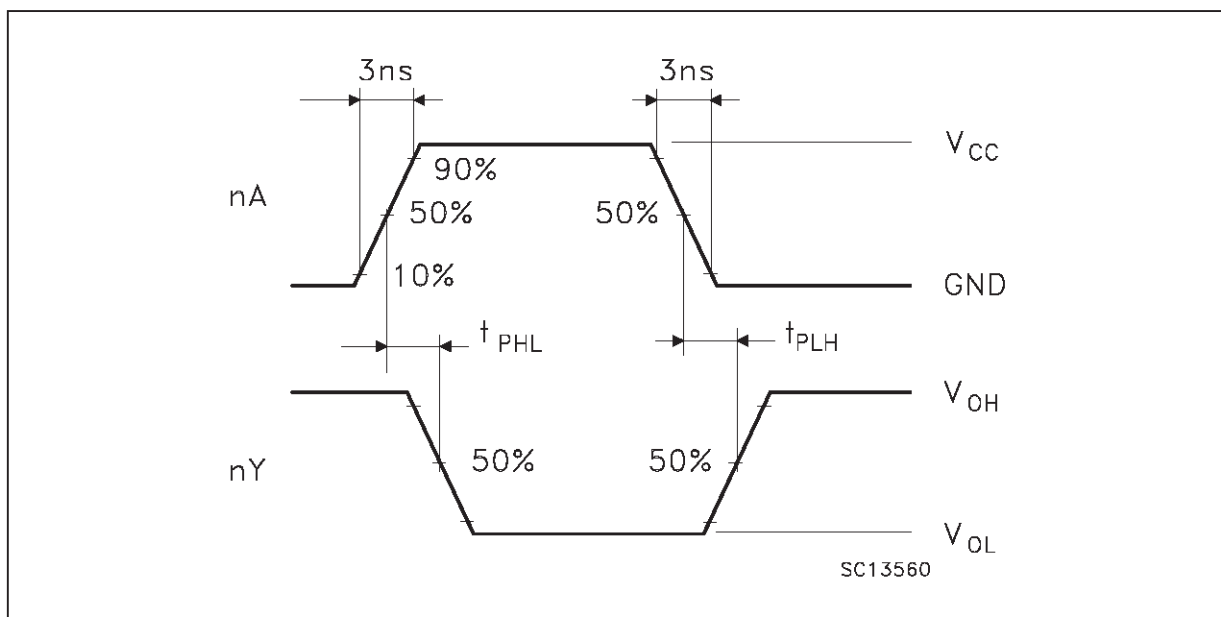
## TEST CIRCUIT



$C_L$  = 50 pF or equivalent (includes jig and probe capacitance)

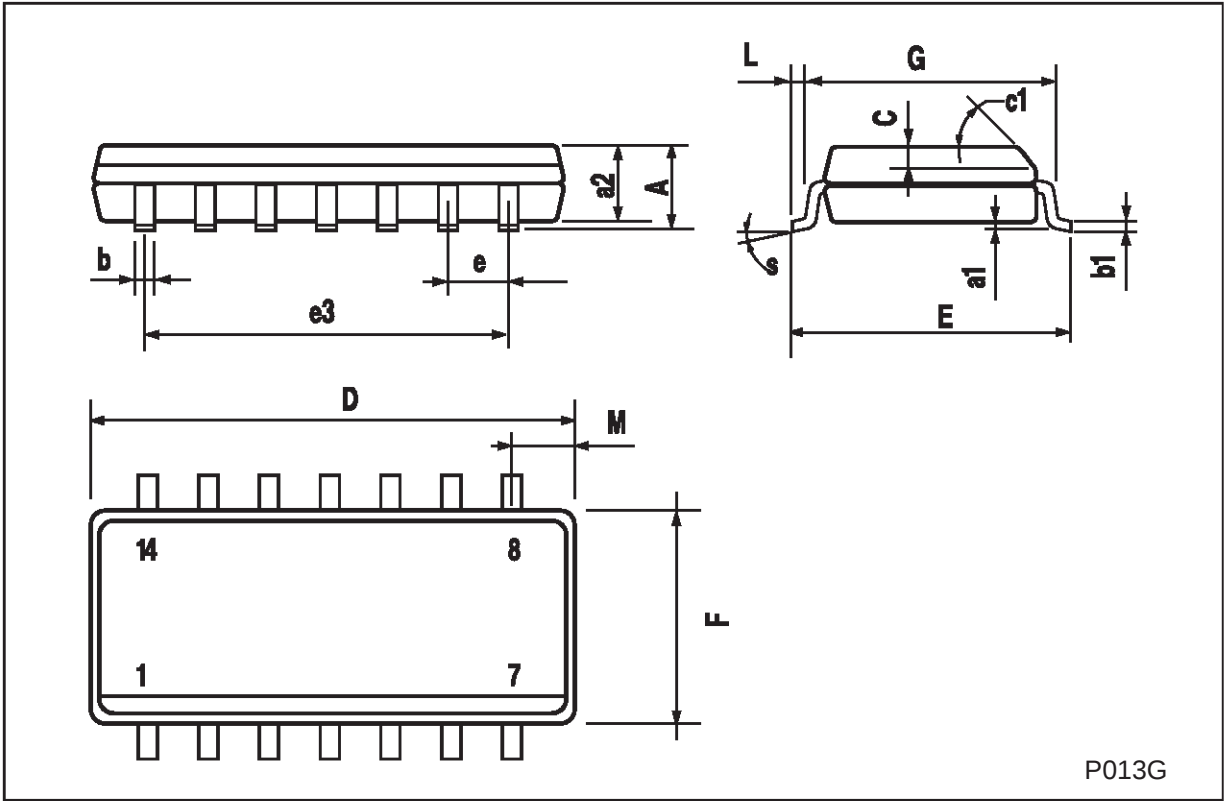
$R_L = R_1$  = 500 $\Omega$  or equivalent

$R_T$  =  $Z_{OUT}$  of pulse generator (typically 50 $\Omega$ )

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

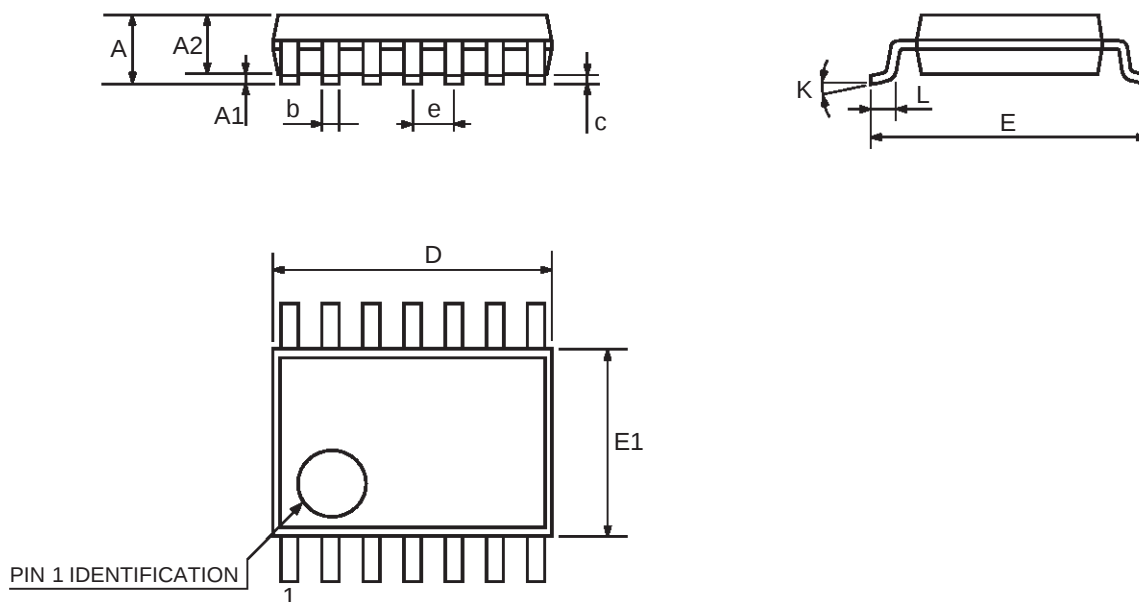
SO-14 MECHANICAL DATA

| DIM. | mm        |      |      | inch  |       |       |
|------|-----------|------|------|-------|-------|-------|
|      | MIN.      | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |           |      | 1.75 |       |       | 0.068 |
| a1   | 0.1       |      | 0.2  | 0.003 |       | 0.007 |
| a2   |           |      | 1.65 |       |       | 0.064 |
| b    | 0.35      |      | 0.46 | 0.013 |       | 0.018 |
| b1   | 0.19      |      | 0.25 | 0.007 |       | 0.010 |
| C    |           | 0.5  |      |       | 0.019 |       |
| c1   | 45 (typ.) |      |      |       |       |       |
| D    | 8.55      |      | 8.75 | 0.336 |       | 0.344 |
| E    | 5.8       |      | 6.2  | 0.228 |       | 0.244 |
| e    |           | 1.27 |      |       | 0.050 |       |
| e3   |           | 7.62 |      |       | 0.300 |       |
| F    | 3.8       |      | 4.0  | 0.149 |       | 0.157 |
| G    | 4.6       |      | 5.3  | 0.181 |       | 0.208 |
| L    | 0.5       |      | 1.27 | 0.019 |       | 0.050 |
| M    |           |      | 0.68 |       |       | 0.026 |
| S    | 8 (max.)  |      |      |       |       |       |



## TSSOP14 MECHANICAL DATA

| DIM. | mm   |          |      | inch   |            |        |
|------|------|----------|------|--------|------------|--------|
|      | MIN. | TYP.     | MAX. | MIN.   | TYP.       | MAX.   |
| A    |      |          | 1.1  |        |            | 0.433  |
| A1   | 0.05 | 0.10     | 0.15 | 0.002  | 0.004      | 0.006  |
| A2   | 0.85 | 0.9      | 0.95 | 0.335  | 0.354      | 0.374  |
| b    | 0.19 |          | 0.30 | 0.0075 |            | 0.0118 |
| c    | 0.09 |          | 0.20 | 0.0035 |            | 0.0079 |
| D    | 4.9  | 5        | 5.1  | 0.193  | 0.197      | 0.201  |
| E    | 6.25 | 6.4      | 6.5  | 0.246  | 0.252      | 0.256  |
| E1   | 4.3  | 4.4      | 4.48 | 0.169  | 0.173      | 0.176  |
| e    |      | 0.65 BSC |      |        | 0.0256 BSC |        |
| K    | 0°   | 4°       | 8°   | 0°     | 4°         | 8°     |
| L    | 0.50 | 0.60     | 0.70 | 0.020  | 0.024      | 0.028  |



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