

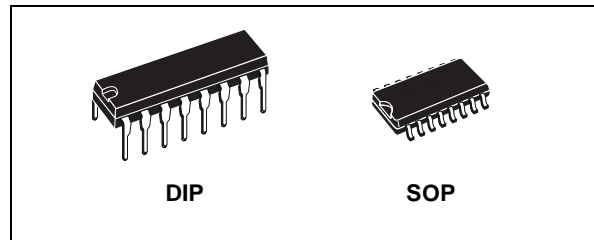


QUAD LOW-TO-HIGH VOLTAGE LEVEL SHIFTER

- INDEPENDENCE OF POWER SUPPLY SEQUENCE CONSIDERATIONS - V_{CC} CAN EXCEED V_{DD} , INPUT SIGNALS CAN EXCEED BOTH V_{CC} AND V_{DD}
- UP AND DOWN LEVEL SHIFTING CAPABILITY
- THREE-STATE OUTPUTS WITH SEPARATE ENABLE CONTROLS
- STANDARDIZED SYMMETRICAL OUTPUT CHARACTERISTICS
- QUIESCENT CURRENT SPECIFIED UP TO 20V
- 5V, 10V, AND 15V PARAMETRIC RATINGS
- INPUT LEAKAGE CURRENT
 $I_l = 100\text{nA}$ (MAX) AT $V_{DD} = 18\text{V}$ $T_A = 25^\circ\text{C}$
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC JESD13B "STANDARD SPECIFICATIONS FOR DESCRIPTION OF B SERIES CMOS DEVICES"

DESCRIPTION

HCF40109B is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor technology available in DIP and SOP packages. HCF40109B contains four low-to-high voltage level shifting circuits. Each circuit will shift a low-voltage digital-logic input signal (A, B, C, D) with logical 1 = V_{CC} and logical 0 = V_{SS} to a higher voltage output signal (E, F, G, H) with logical 1 = V_{DD} and logical 0 = V_{SS} . HCF40109B, unlike other

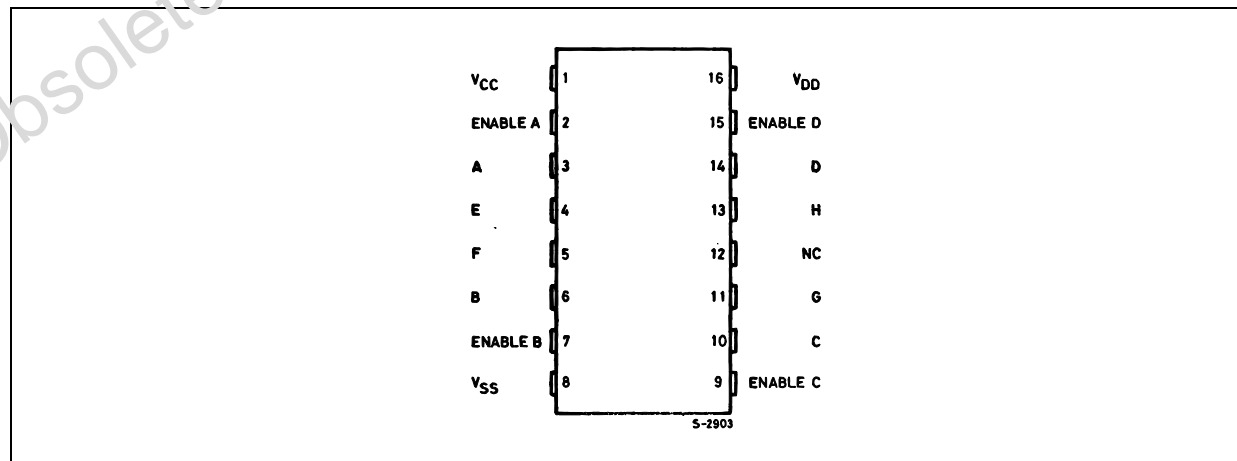


ORDER CODES

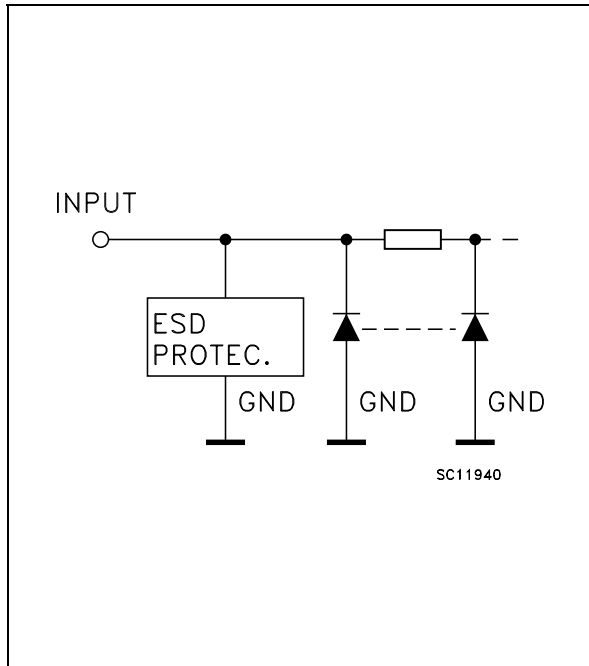
| PACKAGE | TUBE | 1 & R |
|---------|-------------|----------------|
| DIP | HCF40109BEY | |
| SOP | HCF40109BM1 | HCF40109M013TR |

low-to-high level-shifting circuits, does not require the presence of the high voltage supply (V_{DD}) before the application of either the low-voltage supply (V_{CC}) or the input signals. There are no restrictions on the sequence of application of V_{DD} , V_{CC} , or the input signals. In addition, there are no restrictions on the relative magnitudes of the supply voltages or input signals within the device maximum ratings; V_{CC} may exceed V_{DD} , and input signals may exceed V_{CC} and V_{DD} . When operated in the mode $V_{CC} = V_{DD}$, HCF40109B will operate as a high-to-low level-shifter. HCF40109B also features individual three-state output capability. A low level on any of the separately enabled three-state output controls produces a high-impedance state in the corresponding output.

PIN CONNECTION



INPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

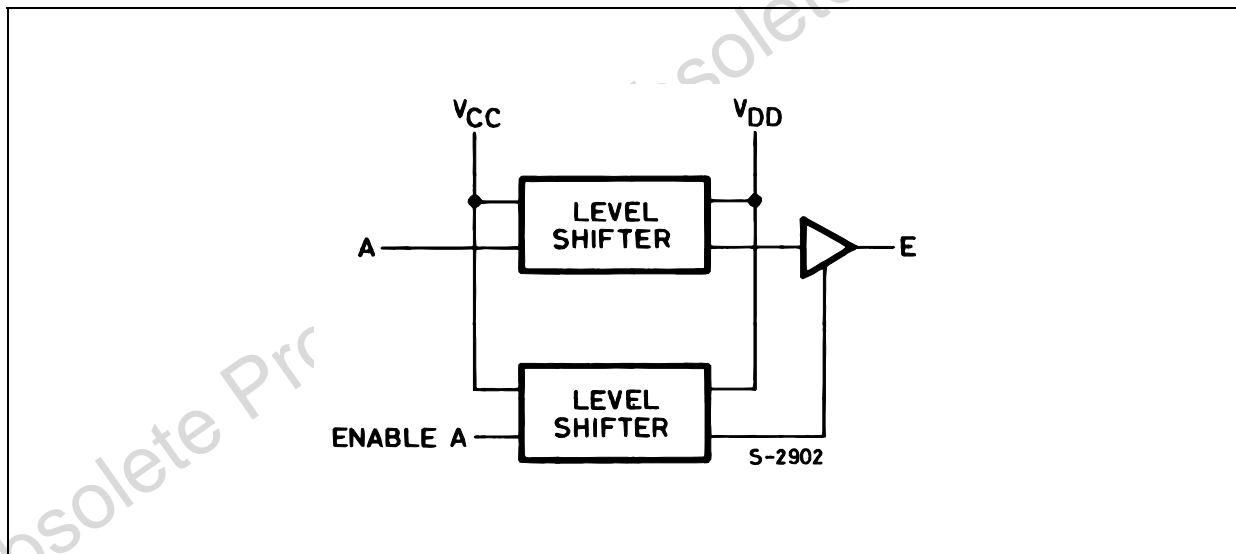
| PIN No | SYMBOL | NAME AND FUNCTION |
|--------------|-------------------|-------------------------|
| 3, 6, 10, 14 | A, B, C, D | Low Input Voltage |
| 4, 5, 11, 13 | E, F, G, H | High Input Voltage |
| 2, 7, 9, 15 | ENABLE A, B, C, D | Enable Input |
| 12 | NC | Not Connected |
| 1 | V _{CC} | Low Supply Voltage |
| 8 | V _{SS} | Negative Supply Voltage |
| 16 | V _{DD} | Positive Supply Voltage |

TRUTH TABLE

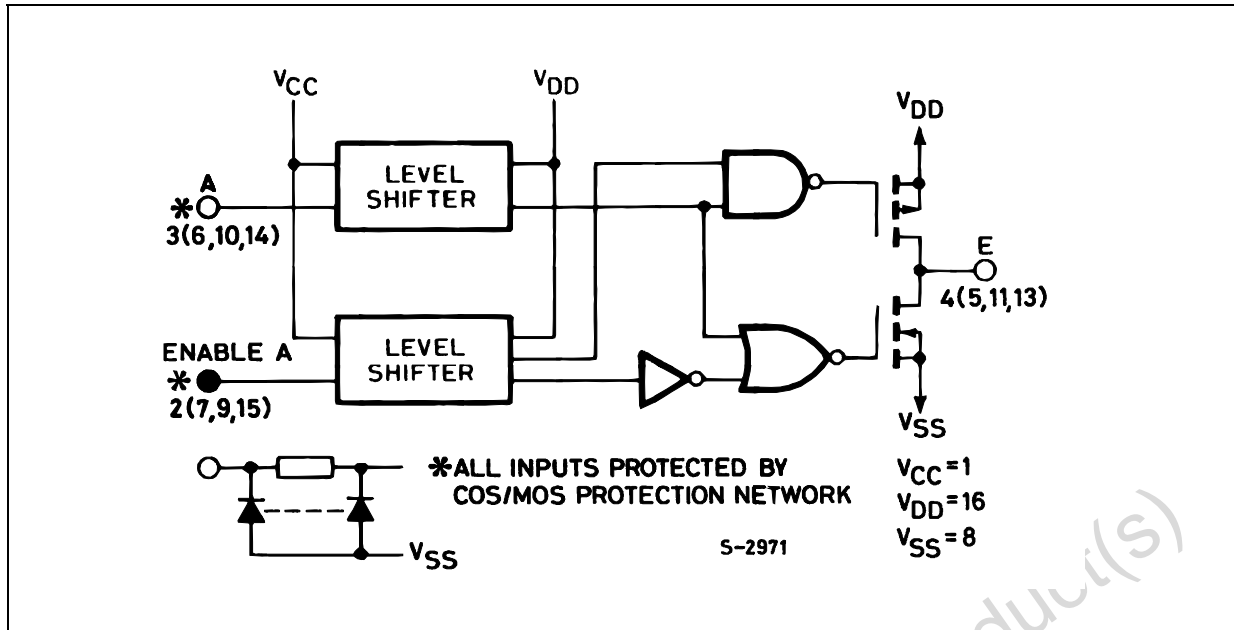
| MODE | INPUTS | | OUTPUT |
|-------------------------|------------|-------------------|------------|
| | A, B, C, D | Enable A, B, C, D | E, F, G, H |
| Low to High Level Shift | L | H | L |
| | H | H | H |
| | X | L | Z |

X : Don't Care
Z : High Impedance

FUNCTIONAL DIAGRAM



LOGIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|-----------|---|-------------|--------------------|
| V_{DD} | Supply Voltage | -0.5 to +22 | V |
| V_I | DC Input Voltage | -0.5 to +18 | V |
| I_I | DC Input Current | ± 10 | mA |
| P_D | Power Dissipation per Package | 200 | mW |
| | Power Dissipation per Output Transistor | 100 | mW |
| T_{op} | Operating Temperature | -55 to +125 | $^{\circ}\text{C}$ |
| T_{stg} | Storage Temperature | -65 to +150 | $^{\circ}\text{C}$ |

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

All voltage values are referred to V_{SS} pin voltage.

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|----------|-----------------------|-------------|--------------------|
| V_{DD} | Supply Voltage | 3 to 20 | V |
| V_I | Input Voltage | -0.5 to 15V | V |
| T_{op} | Operating Temperature | -55 to 125 | $^{\circ}\text{C}$ |

DC SPECIFICATIONS

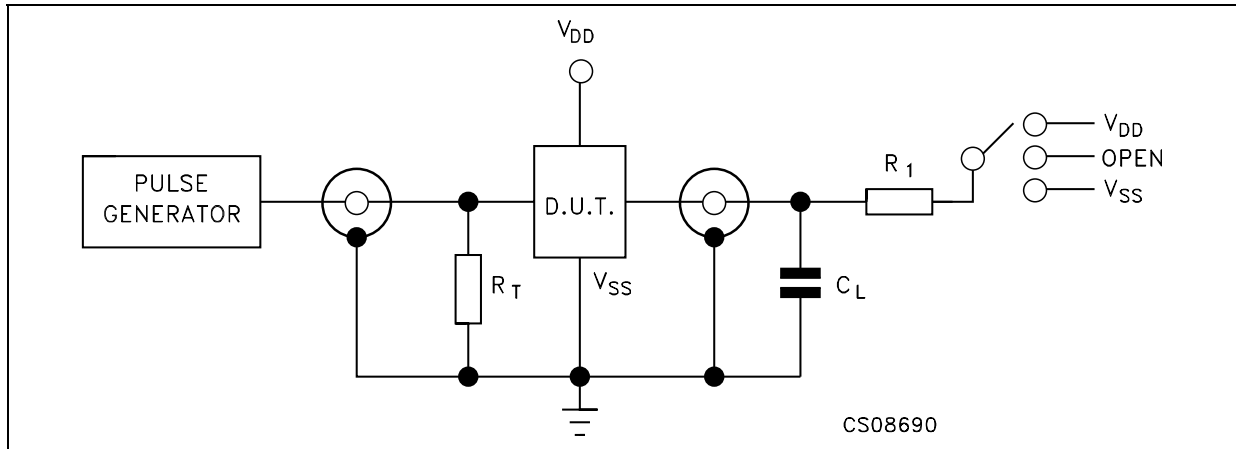
| Symbol | Parameter | Test Condition | | | | Value | | | | | | Unit | |
|-----------------|---------------------------|-----------------------|-----------------------|---------------------------------|------------------------|-----------------------|---------------|-----------|-------------|---------|--------------|---------|---------|
| | | V _I (V) | V _O (V) | I _{OL} (μ A) | V _{DD} (V) | T _A = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| I _L | Quiescent Current | 0/5 | | | 5 | | 0.02 | 1 | | 30 | | 30 | μ A |
| | | 0/10 | | | 10 | | 0.02 | 2 | | 60 | | 60 | |
| | | 0/15 | | | 15 | | 0.02 | 4 | | 120 | | 120 | |
| | | 0/20 | | | 20 | | 0.04 | 20 | | 600 | | 600 | |
| V _{OH} | High Level Output Voltage | 0/5 | | <1 | 5 | 4.95 | | | 4.95 | | 4.95 | | V |
| | | 0/10 | | <1 | 10 | 9.95 | | | 9.95 | | 9.95 | | |
| | | 0/15 | | <1 | 15 | 14.95 | | | 14.95 | | 14.95 | | |
| V _{OL} | Low Level Output 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 _{IH} | High Level Input 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 _{IL} | Low Level Input 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 | |
| I _{OH} | Output Drive Current | 0/5 | 2.5 | <1 | 5 | -1.53 | -3.2 | | -1.36 | | -1.1 | | mA |
| | | 0/5 | 4.6 | <1 | 5 | -0.52 | -1 | | -0.44 | | -0.36 | | |
| | | 0/10 | 9.5 | <1 | 10 | -1.3 | -2.6 | | -1.1 | | -0.9 | | |
| | | 0/15 | 13.5 | <1 | 15 | -3.6 | -6.8 | | -3.0 | | -2.4 | | |
| I _{OL} | Output Sink Current | 0/5 | 0.4 | <1 | 5 | 0.52 | 1 | | 0.44 | | 0.36 | | mA |
| | | 0/10 | 0.5 | <1 | 10 | 1.3 | 2.6 | | 1.1 | | 0.9 | | |
| | | 0/15 | 1.5 | <1 | 15 | 3.6 | 6.8 | | 3.0 | | 2.4 | | |
| I _I | Input Leakage Current | 0/18 | Any Input | | 18 | | $\pm 10^{-5}$ | ± 0.1 | | ± 1 | | ± 1 | μ A |
| C _I | Input Capacitance | | Any Input | | | | 5 | 7.5 | | | | | pF |

The Noise Margin for both "1" and "0" level is: 1V min. with V_{DD}=5V, 2V min. with V_{DD}=10V, 2.5V min. with V_{DD}=15V

DYNAMIC ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$, $C_L = 50\text{pF}$, $R_L = 200\text{K}\Omega$, $t_r = t_f = 20\text{ ns}$)

| Symbol | Parameter | Test Condition | | | Value (*) | | | Unit |
|--------------------|---|----------------|--------------|---------------|-----------|------|------|------|
| | | V_{CC} (V) | V_{DD} (V) | SHIFTING MODE | Min. | Typ. | Max. | |
| t_{PHL}, t_{PLH} | Propagation Delay Time : (Data input to output) High to Low Level | 5 | 10 | L - H | | 300 | 600 | ns |
| | | 5 | 15 | | | 220 | 440 | |
| | | 10 | 15 | | | 180 | 360 | |
| | | 10 | 5 | H - L | | 850 | 1600 | |
| | | 15 | 5 | | | 850 | 1600 | |
| | | 15 | 10 | | | 290 | 580 | |
| | Low to High Level | 5 | 10 | L - H | | 130 | 260 | ns |
| | | 5 | 15 | | | 120 | 240 | |
| | | 10 | 15 | | | 70 | 140 | |
| | | 10 | 5 | H - L | | 230 | 460 | |
| | | 15 | 5 | | | 230 | 460 | |
| | | 15 | 10 | | | 80 | 160 | |
| t_{PHZ} | 3-State Disable DelayTime Output High to High Impedance | 5 | 10 | L - H | | 60 | 120 | ns |
| | | 5 | 15 | | | 50 | 100 | |
| | | 10 | 15 | | | 35 | 70 | |
| | | 10 | 5 | H - L | | 120 | 240 | |
| | | 15 | 5 | | | 120 | 240 | |
| | | 15 | 10 | | | 40 | 80 | |
| t_{PZH} | High Impedance to Output High | 5 | 10 | L - H | | 320 | 640 | ns |
| | | 5 | 15 | | | 230 | 460 | |
| | | 10 | 15 | | | 180 | 360 | |
| | | 10 | 5 | H - L | | 800 | 1500 | |
| | | 15 | 5 | | | 800 | 1500 | |
| | | 15 | 10 | | | 280 | 560 | |
| t_{PLZ} | Output Low to High Impedance | 5 | 10 | L - H | | 370 | 740 | ns |
| | | 5 | 15 | | | 300 | 600 | |
| | | 10 | 15 | | | 250 | 500 | |
| | | 10 | 5 | H - L | | 850 | 1600 | |
| | | 15 | 5 | | | 850 | 1600 | |
| | | 15 | 10 | | | 350 | 700 | |
| t_{PZL} | High Impedance to Output Low | 5 | 10 | L - H | | 100 | 200 | ns |
| | | 5 | 15 | | | 80 | 160 | |
| | | 10 | 15 | | | 40 | 80 | |
| | | 10 | 5 | H - L | | 120 | 240 | |
| | | 15 | 5 | | | 120 | 240 | |
| | | 15 | 10 | | | 40 | 80 | |
| t_{THL}, t_{TLH} | Transition Time | 5 | 10 | L - H | | 50 | 100 | ns |
| | | 5 | 15 | | | 40 | 80 | |
| | | 10 | 15 | | | 40 | 80 | |
| | | 10 | 5 | H - L | | 100 | 200 | |
| | | 15 | 5 | | | 100 | 200 | |
| | | 15 | 10 | | | 50 | 100 | |

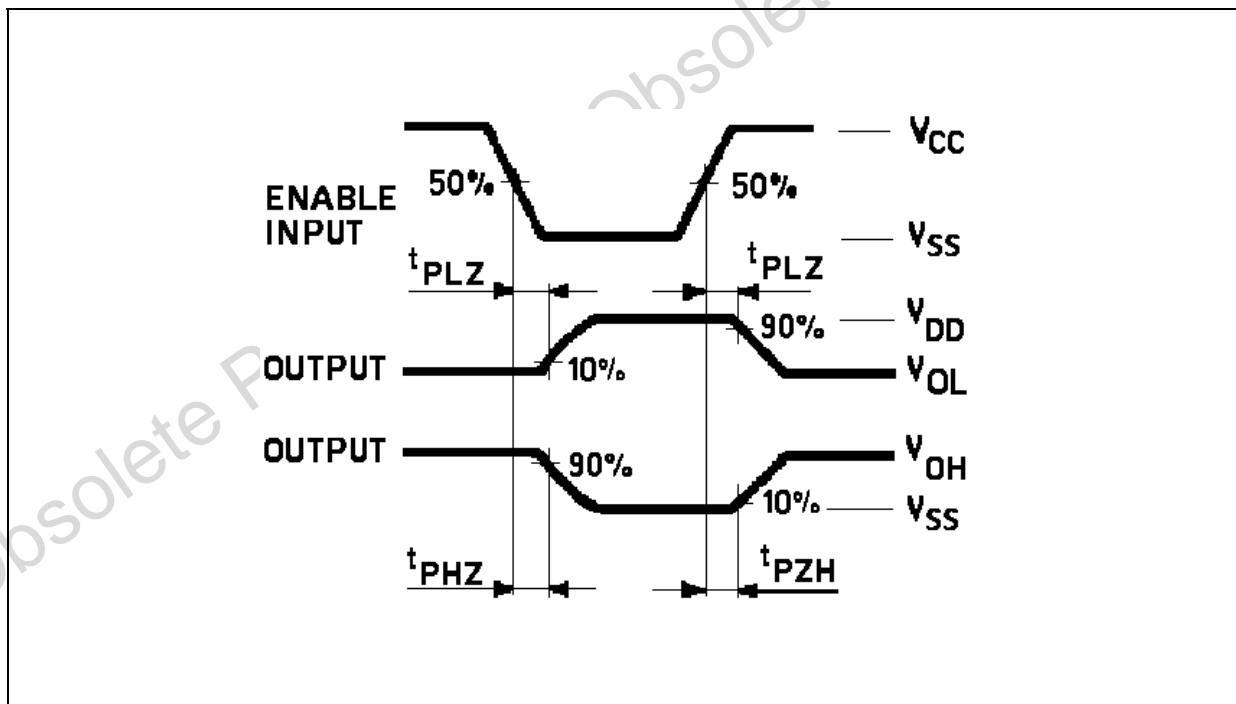
TEST CIRCUIT



| TEST | SWITCH |
|-----------------------|----------|
| t_{PLH} , t_{PHL} | Open |
| t_{PZL} , t_{PLZ} | V_{DD} |
| t_{PZH} , t_{PHZ} | V_{SS} |

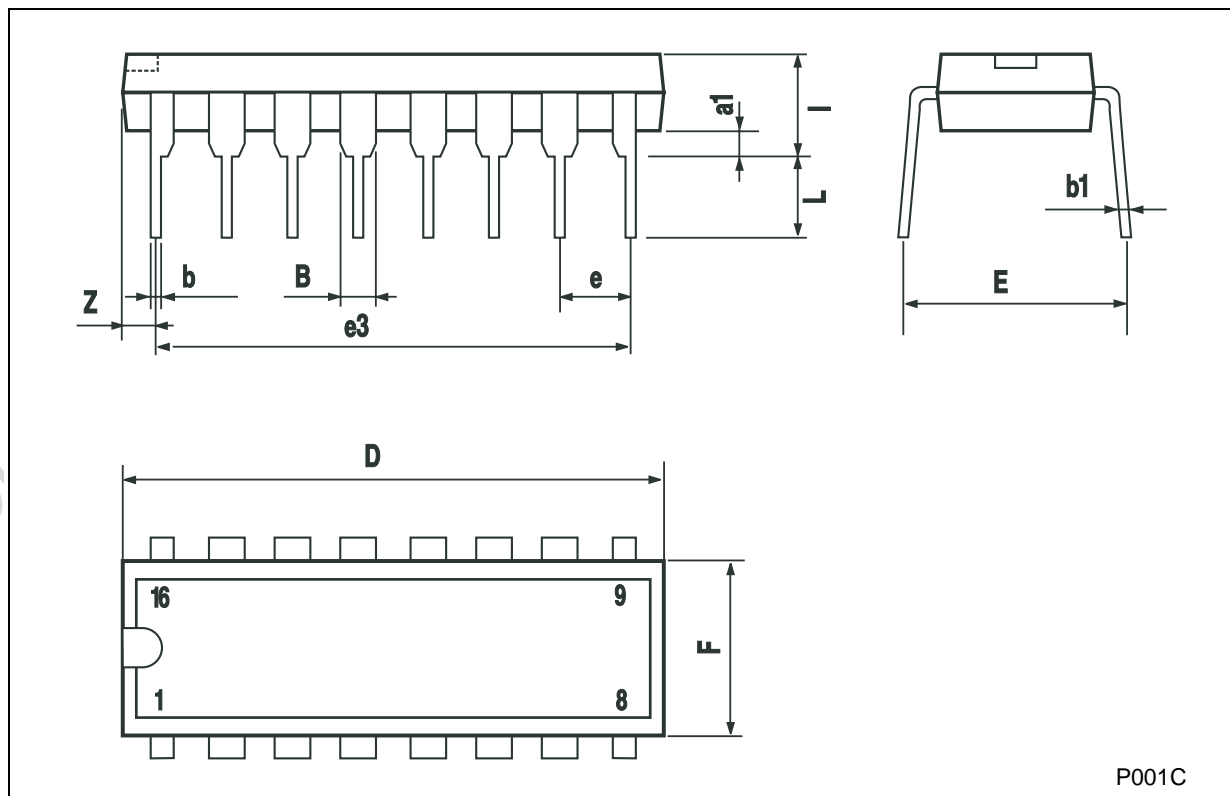
C_L = 50pF or equivalent (includes jig and probe capacitance)
 R_L = 200K Ω
 R_T = Z_{OUT} of pulse generator (typically 50 Ω)

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



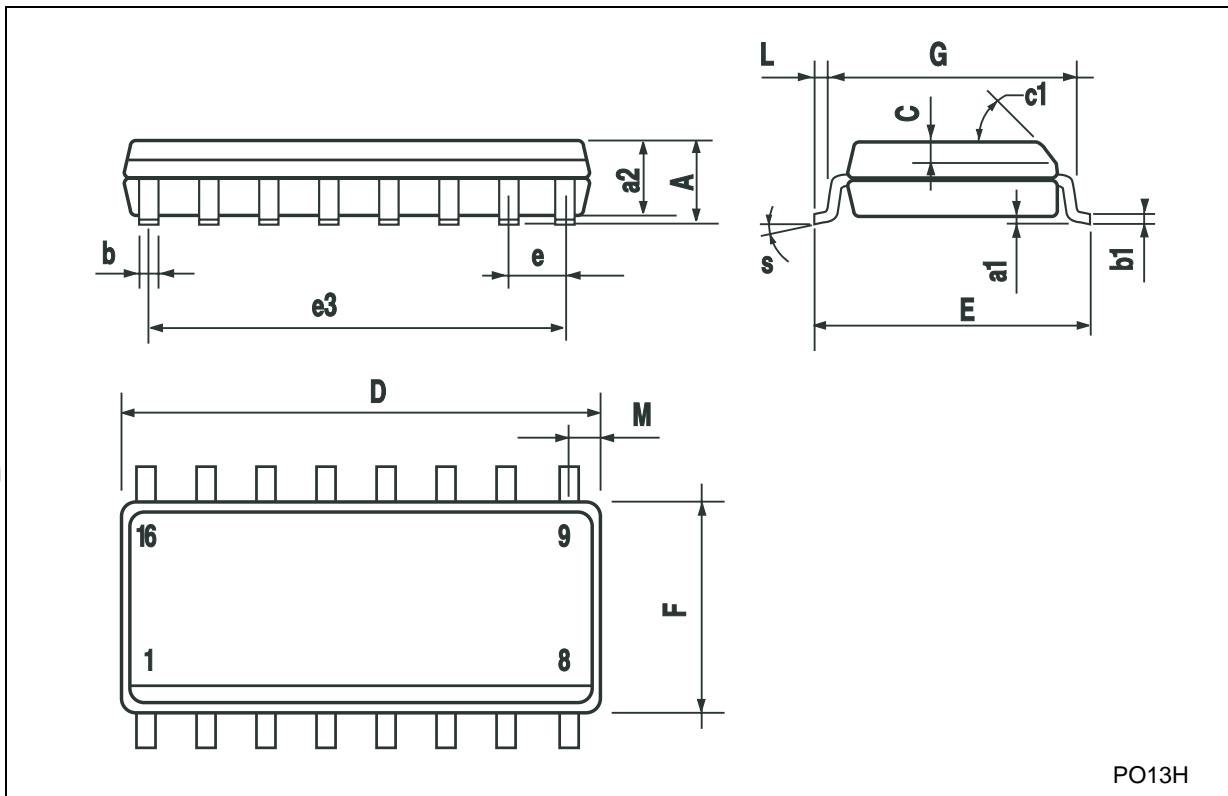
Plastic DIP-16 (0.25) MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 17.78 | | | 0.700 | |
| F | | | 7.1 | | | 0.280 |
| I | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.27 | | | 0.050 |



SO-16 MECHANICAL DATA

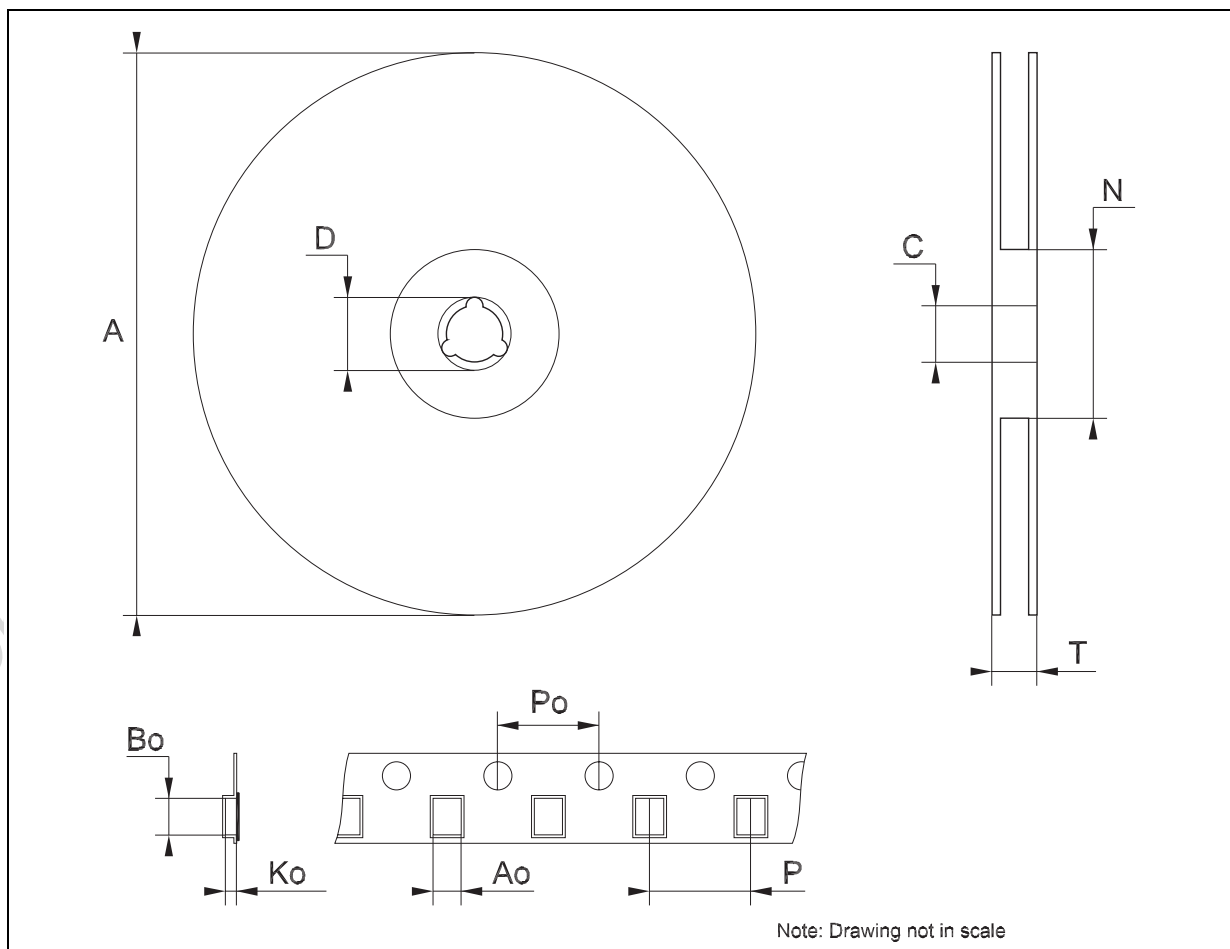
| DIM. | mm. | | | inch | | |
|------|------------|------|------|----------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.008 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| 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 | | | 0.62 | | | 0.024 |
| S | 8 | | | ° (max.) | | |



PO13H

Tape & Reel SO-16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|-----|------|-------|------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.45 | | 6.65 | 0.254 | | 0.262 |
| Bo | 10.3 | | 10.5 | 0.406 | | 0.414 |
| Ko | 2.1 | | 2.3 | 0.082 | | 0.090 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 7.9 | | 8.1 | 0.311 | | 0.319 |



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