

3 TO 8 LINE DECODER (INVERTING)

- HIGH SPEED: $t_{PD} = 5.7ns$ (TYP.) at $V_{CC} = 5V$
- 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.)
- POWER DOWN PROTECTION ON INPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OH}| = I_{OL} = 8 mA$ (MIN)
- BALANCED PROPAGATION DELAYS:
 $t_{PLH} \cong t_{PHL}$
- OPERATING VOLTAGE RANGE:
 $V_{CC}(OPR) = 2V$ to $5.5V$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 138
- IMPROVED LATCH-UP IMMUNITY

DESCRIPTION

The 74VHC138 is an advanced high-speed CMOS 3 TO 8 LINE DECODER (INVERTING) fabricated with sub-micron silicon gate and double-layer metal wiring C²MOS technology. If the device is enabled, 3 binary select (A, B, and C) determine which one of the outputs will go low. If enable input G1 is held low or either G2A or G2B is held high, the decoding function is inhibited and all the 8 outputs go to high.



Table 1: Order Codes

| PACKAGE | T & R |
|---------|-------------|
| SOP | 74VHC138MTR |
| TSSOP | 74VHC138TTR |

Tree enable inputs are provided to ease cascade connection and application of address decoders for memory systems.

Power down protection is provided on all inputs and 0 to 7V can be accepted on inputs with no regard to the supply voltage. This device can be used to interface 5V to 3V.

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

Figure 1: Pin Connection And IEC Logic Symbols

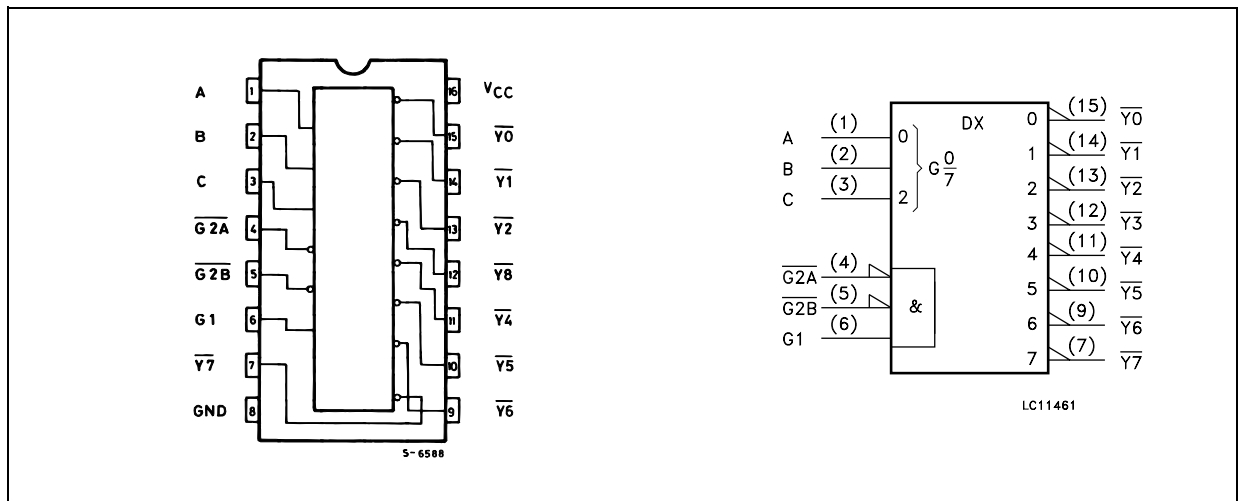


Figure 2: Input Equivalent Circuit

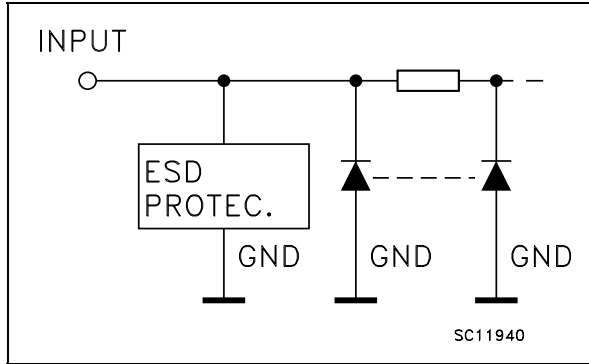


Table 2: Pin Description

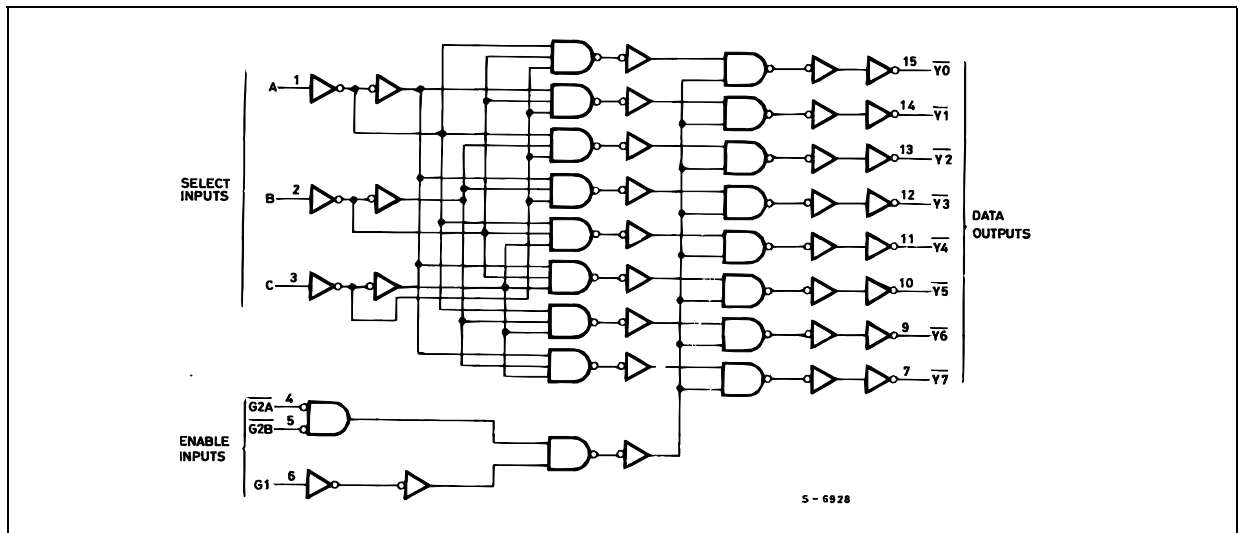
| PIN N° | SYMBOL | NAME AND FUNCTION |
|------------------------------|-----------------|-------------------------|
| 1, 2, 3 | A, B, C | Address Inputs |
| 4, 5 | G2A, G2B | Enable Inputs |
| 6 | G1 | Enable Input |
| 15, 14, 13, 12, 11, 10, 9, 7 | Y0 to Y7 | Outputs |
| 8 | GND | Ground (0V) |
| 16 | V _{CC} | Positive Supply Voltage |

Table 3: Truth Table

| INPUTS | | | | | | OUTPUTS | | | | | | | |
|------------------|------------------|----|--------|---|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| ENABLE | | | SELECT | | | | | | | | | | |
| $\overline{G2B}$ | $\overline{G2A}$ | G1 | C | B | A | $\overline{Y0}$ | $\overline{Y1}$ | $\overline{Y2}$ | $\overline{Y3}$ | $\overline{Y4}$ | $\overline{Y5}$ | $\overline{Y6}$ | $\overline{Y7}$ |
| X | X | L | X | X | X | H | H | H | H | H | H | H | H |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H |
| H | X | X | X | X | X | H | H | H | H | H | H | H | H |
| L | L | H | L | L | L | L | H | H | H | H | H | H | H |
| L | L | H | L | L | H | H | L | H | H | H | H | H | H |
| L | L | H | L | H | L | H | H | L | H | H | H | H | H |
| L | L | H | L | H | H | H | H | H | L | H | H | H | H |
| L | L | H | H | L | L | H | H | H | H | L | H | H | H |
| L | L | H | H | L | H | H | H | H | H | H | L | H | H |
| L | L | H | H | H | L | H | H | H | H | H | H | L | H |
| L | L | H | H | H | H | H | H | H | H | H | H | H | L |

X : Don't care

Figure 3: Logic Diagram



This logic diagram has not been used to estimate propagation delays

Table 4: Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|-----------------------|-------------------------------|------------------------|------|
| V_{CC} | Supply Voltage | -0.5 to +7.0 | V |
| V_I | DC Input Voltage | -0.5 to +7.0 | V |
| V_O | DC Output Voltage | -0.5 to $V_{CC} + 0.5$ | V |
| I_{IK} | DC Input Diode Current | - 20 | mA |
| I_{OK} | DC Output Diode Current | ± 20 | mA |
| I_O | DC Output Current | ± 25 | mA |
| I_{CC} or I_{GND} | DC V_{CC} or Ground Current | ± 75 | mA |
| T_{stg} | Storage Temperature | -65 to +150 | °C |
| T_L | Lead Temperature (10 sec) | 300 | °C |

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

Table 5: Recommended Operating Conditions

| Symbol | Parameter | Value | Unit |
|----------|----------------------------------------------------------------------------------------------|---------------------|------|
| V_{CC} | Supply Voltage | 2 to 5.5 | V |
| V_I | Input Voltage | 0 to 5.5 | V |
| V_O | Output Voltage | 0 to V_{CC} | V |
| T_{op} | Operating Temperature | -55 to 125 | °C |
| dt/dv | Input Rise and Fall Time (note 1) ($V_{CC} = 3.3 \pm 0.3V$) ($V_{CC} = 5.0 \pm 0.5V$) | 0 to 100 0 to 20 | ns/V |

1) V_{IN} from 30% to 70% of V_{CC}

Table 6: DC Specifications

| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|-----------------|---------------------------|------------------------|-----------------------------------------|-----------------------|------|--------------------|--------------------|--------------------|--------------------|--------------------|------|
| | | V _{CC} (V) | | T _A = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| V _{IH} | High Level Input Voltage | 2.0 | | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 3.0 to 5.5 | | 0.7V _{CC} | | | 0.7V _{CC} | | 0.7V _{CC} | | |
| V _{IL} | Low Level Input Voltage | 2.0 | | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 3.0 to 5.5 | | | | 0.3V _{CC} | | 0.3V _{CC} | | 0.3V _{CC} | |
| V _{OH} | High Level Output Voltage | 2.0 | I _O =-50 μA | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 3.0 | I _O =-50 μA | 2.9 | 3.0 | | 2.9 | | 2.9 | | |
| | | 4.5 | I _O =-50 μA | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 3.0 | I _O =-4 mA | 2.58 | | | 2.48 | | 2.4 | | |
| | | 4.5 | I _O =-8 mA | 3.94 | | | 3.8 | | 3.7 | | |
| V _{OL} | Low Level Output Voltage | 2.0 | I _O =50 μA | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 3.0 | I _O =50 μA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | I _O =50 μA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 3.0 | I _O =4 mA | | | 0.36 | | 0.44 | | 0.55 | |
| | | 4.5 | I _O =8 mA | | | 0.36 | | 0.44 | | 0.55 | |
| I _I | Input Leakage Current | 0 to 5.5 | V _I = 5.5V or GND | | | | ± 0.1 | | ± 1 | | μA |
| I _{CC} | Quiescent Supply Current | 5.5 | V _I = V _{CC} or GND | | | | 4 | | 40 | | μA |

Table 7: AC Electrical Characteristics (Input t_r = t_f = 3ns)

| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|--------------------------------------|-------------------------------------------------|------------------------|------------------------|-----------------------|------|------|-------------|------|--------------|------|------|
| | | V _{CC} (V) | C _L (pF) | T _A = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| t _{PLH} t _{PHL} | Propagation Delay Time A, B, C, to \bar{Y} | 3.3 ^(*) | 15 | | 8.2 | 11.4 | 1.0 | 13.0 | 1.0 | 13.0 | ns |
| | | 3.3 ^(*) | 50 | | 10.0 | 15.8 | 1.0 | 18.0 | 1.0 | 18.0 | |
| | | 5.0 ^(**) | 15 | | 5.7 | 8.1 | 1.0 | 9.5 | 1.0 | 9.5 | |
| | | 5.0 ^(**) | 50 | | 7.2 | 10.1 | 1.0 | 11.5 | 1.0 | 11.5 | |
| t _{PLH} t _{PHL} | Propagation Delay Time G to \bar{Y} | 3.3 ^(*) | 15 | | 8.1 | 12.8 | 1.0 | 15.0 | 1.0 | 15.0 | ns |
| | | 3.3 ^(*) | 50 | | 10.6 | 16.3 | 1.0 | 18.5 | 1.0 | 18.5 | |
| | | 5.0 ^(**) | 15 | | 5.6 | 8.1 | 1.0 | 9.5 | 1.0 | 9.5 | |
| | | 5.0 ^(**) | 50 | | 7.1 | 10.1 | 1.0 | 11.5 | 1.0 | 11.5 | |
| t _{PLH} t _{PHL} | Propagation Delay Time G2A, G2B to \bar{Y} | 3.3 ^(*) | 15 | | 8.2 | 11.4 | 1.0 | 13.5 | 1.0 | 13.5 | ns |
| | | 3.3 ^(*) | 50 | | 10.7 | 14.9 | 1.0 | 17.0 | 1.0 | 17.0 | |
| | | 5.0 ^(**) | 15 | | 5.8 | 8.1 | 1.0 | 9.5 | 1.0 | 9.5 | |
| | | 5.0 ^(**) | 50 | | 7.3 | 10.1 | 1.0 | 11.5 | 1.0 | 11.5 | |

(*) Voltage range is 3.3V ± 0.3V

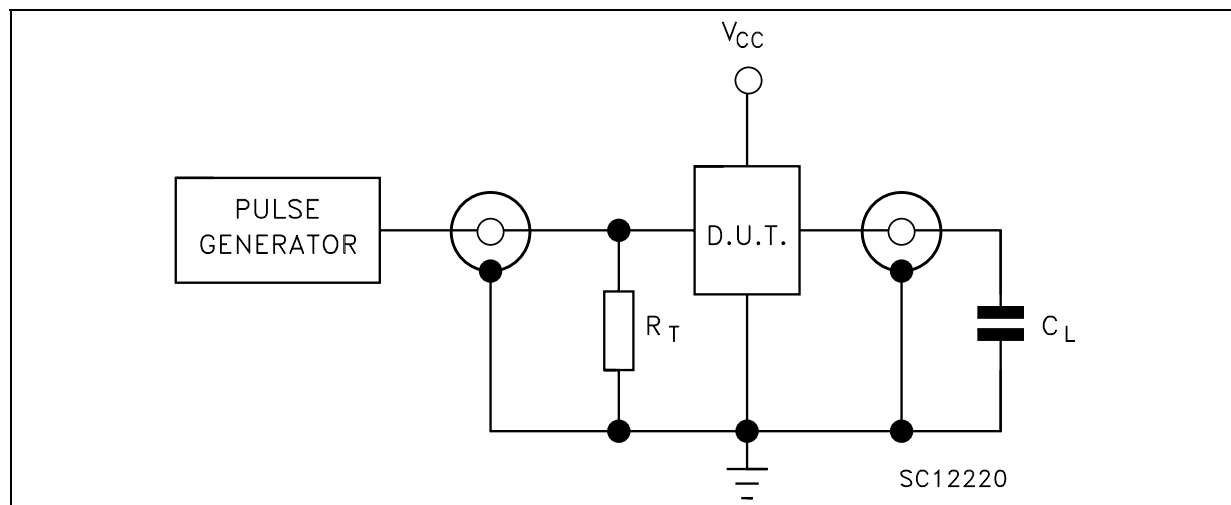
(**) Voltage range is 5.0V ± 0.5V

Table 8: Capacitive Characteristics

| Symbol | Parameter | Test Condition | Value | | | | | | Unit | |
|----------|----------------------------------------|----------------|--------------------------|------|------|------------------------------------|------|-------------------------------------|------|------|
| | | | $T_A = 25^\circ\text{C}$ | | | $-40 \text{ to } 85^\circ\text{C}$ | | $-55 \text{ to } 125^\circ\text{C}$ | | |
| | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| C_{IN} | Input Capacitance | | | 6 | 10 | | 10 | | 10 | pF |
| C_{PD} | Power Dissipation Capacitance (note 1) | | | 34 | | | | | | 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. $I_{CC(oper)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

Figure 4: Test Circuit



$C_L = 15/50\text{pF}$ or equivalent (includes jig and probe capacitance)
 $R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

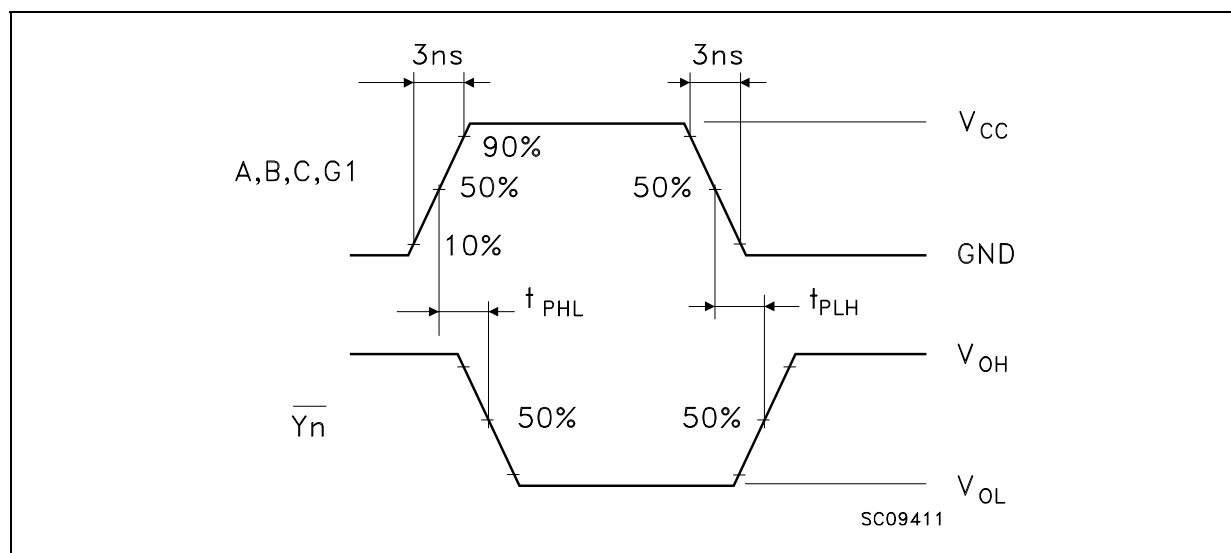
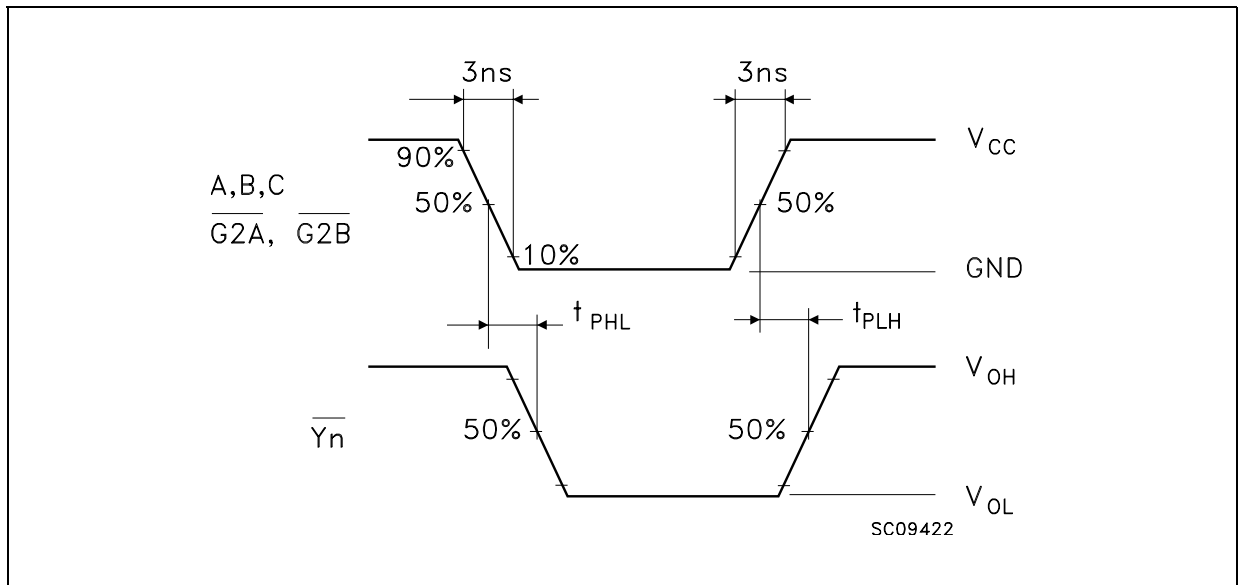
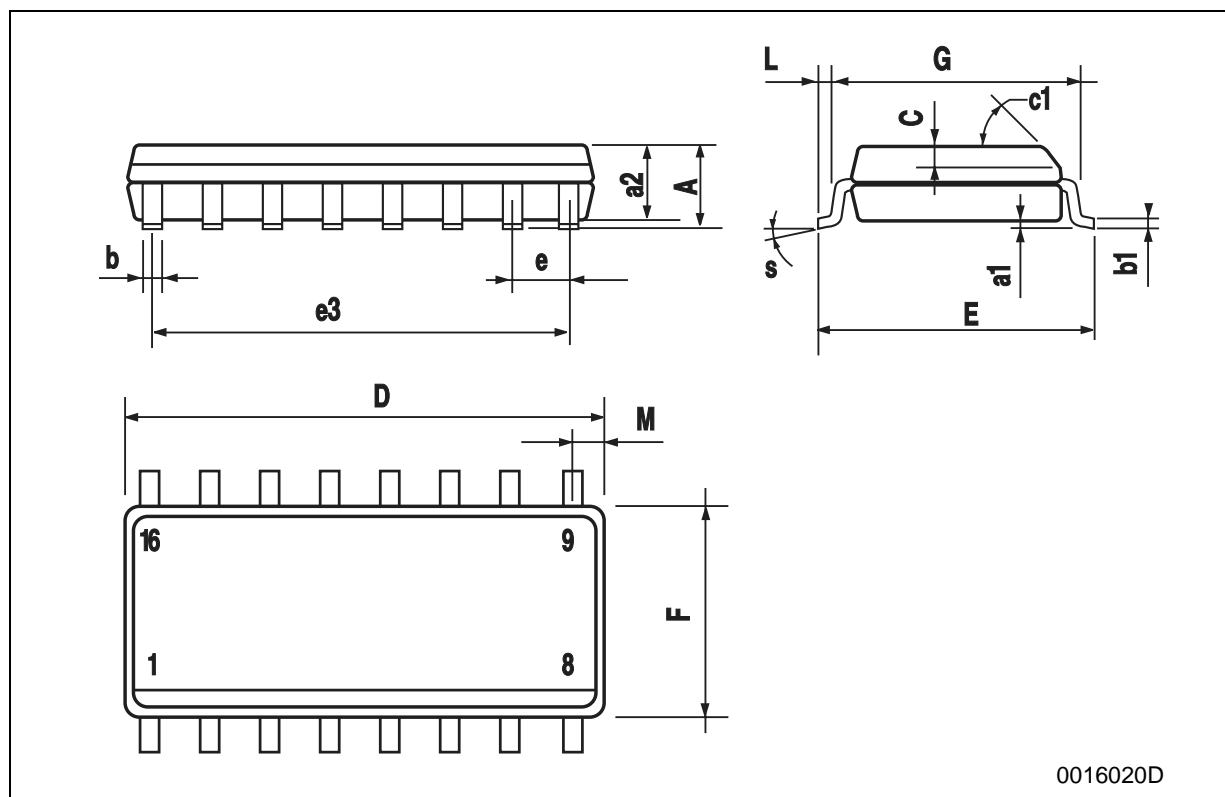
Figure 5: Waveform - Propagation Delays For Inverting Outputs ($f=1\text{MHz}$; 50% duty cycle)

Figure 6: Waveform - Propagation Delays For Non-inverting Outputs ($f=1\text{MHz}$; 50% duty cycle)

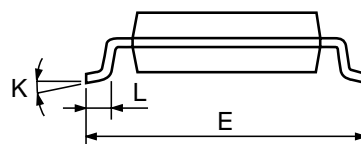
SO-16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| a2 | | | 1.64 | | | 0.063 |
| 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.) | | | | | |



TSSOP16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|----------|------|-------|------------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0079 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



0080338D

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 |



Tape & Reel TSSOP16 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 | 6.7 | | 6.9 | 0.264 | | 0.272 |
| Bo | 5.3 | | 5.5 | 0.209 | | 0.217 |
| Ko | 1.6 | | 1.8 | 0.063 | | 0.071 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 7.9 | | 8.1 | 0.311 | | 0.319 |

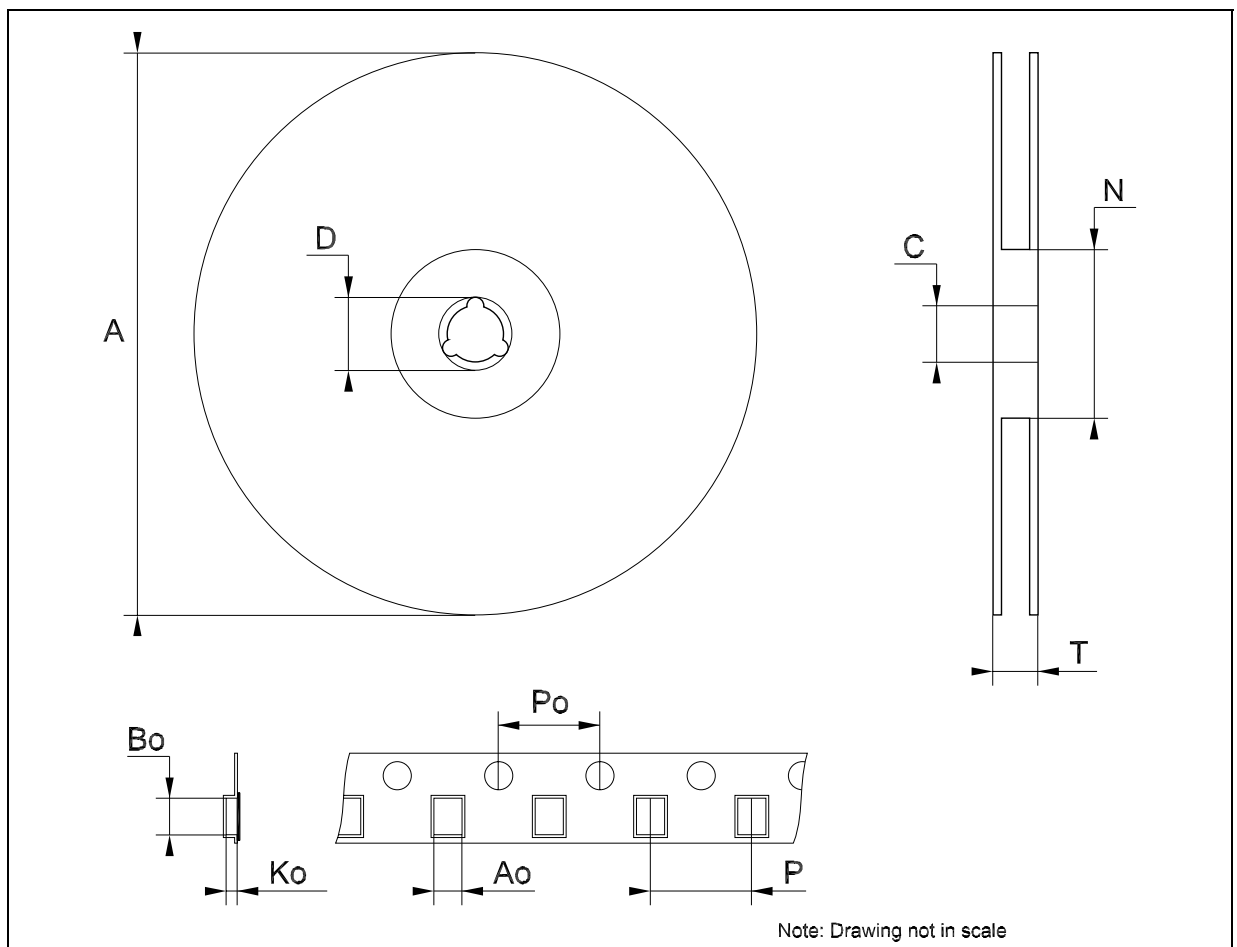


Table 9: Revision History

| Date | Revision | Description of Changes |
|-------------|----------|--------------------------------|
| 12-Nov-2004 | 4 | Order Codes Revision - pag. 1. |

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