ETL SEMICONDUCTOR

# 2–Input NAND Gate with Open Drain Output

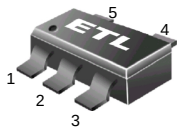
**MC74VHC1G01**

The MC74VHC1G01 is an advanced high speed CMOS 2–input NAND gate with an open drain output fabricated with silicon gate CMOS technology. It achieves high speed peration similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

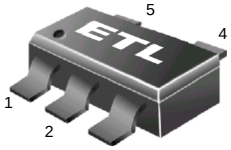
The internal circuit is composed of three stages, including an open drain output which provides the ability to set output switching level. This allows the MC74VHC1G01 to be used to interface 5 V circuits to circuits of any voltage between $V_{CC}$ and 7 V using an external resistor and power supply.

The MC74VHC1G01 input structure provides protection when voltages up to 7 V are applied, regardless of the supply voltage.

- High Speed: $t_{PD}$ = 3.7 ns (Typ) at $V_{CC}$ = 5 V
- Low Internal Power Dissipation: $I_{CC}$ = 2 mA (Max) at $T_A$ = 25°C
- Power Down Protection Provided on Inputs
- Pin and Function Compatible with Other Standard Logic Families
- Chip Complexity: FETs = 62; Equivalent Gates = 16

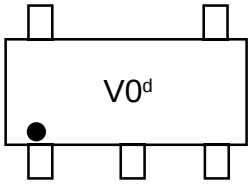



**SC–88A / SOT–353/SC–70**
**DF SUFFIX**
**CASE 419A**




**TSOP–5/SOT–23/SC–59**
**DT SUFFIX**
**CASE 483**

**MARKING DIAGRAMS**




Pin 1
d = Date Code

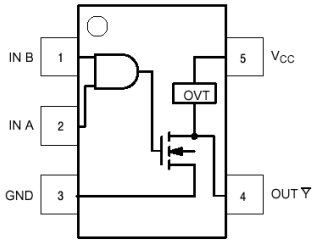
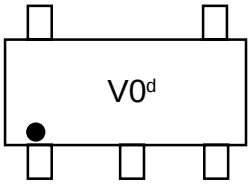



**Figure 1. Pinout** (Top View)




Pin 1
d = Date Code

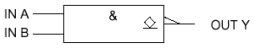



**Figure 2. Logic Symbol**

| PIN ASSIGNMENT | |
|---|---|
| 1 | IN B |
| 2 | IN A |
| 3 | GND |
| 4 | OUT $\overline{Y}$ |
| 5 | $V_{CC}$ |

**FUNCTION TABLE**

| Inputs | | Output |
|---|---|---|
| **A** | **B** | **$\overline{Y}$** |
| L | L | Z |
| L | H | Z |
| H | L | Z |
| H | H | L |

**ORDERING INFORMATION**

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

## MAXIMUM RATINGS

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | DC Supply Voltage | | – 0.5 to + 7.0 | V |
| $V_{IN}$ | DC Input Voltage | | – 0.5 to 7.0 | V |
| $V_{OUT}$ | DC Output Voltage | | – 0.5 to 7.0 | V |
| $I_{IK}$ | DC Input Diode Current | | –20 | mA |
| $I_{OK}$ | DC Output Diode Current | $V_{OUT}$ < GND; $V_{OUT}$ > $V_{CC}$ | +20 | mA |
| $I_{OUT}$ | DC Output Sink Current | | + 25 | mA |
| $I_{CC}$ | DC Supply Current per Supply Pin | | +50 | mA |
| $P_D$ | Power dissipation in still air | SC–88A, TSOP–5 | 200 | mW |
| $\theta_{JA}$ | Thermal resistance | SC–88A, TSOP–5 | 333 | °C/W |
| $T_L$ | Lead Temperature, 1 mm from Case for 10 Seconds | | 260 | °C |
| $T_J$ | Junction Temperature Under Bias | | + 150 | °C |
| $T_{stg}$ | Storage temperature | | –65 to +150 | °C |
| $V_{ESD}$ | ESD Withstand Voltage | Human Body Model (Note 2) | >2000 | V |
| | | Machine Model (Note 3) | > 200 | |
| | | Charged Device Model (Note 4) | N/A | |
| $I_{LATCH-UP}$ | Latch–Up Performance | Above $V_{CC}$ and Below GND at 125°C (Note 5) | ± 500 | mA |

1. Maximum Ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute–maximum–rated conditions is not implied. Functional operation should be restricted to the Recommended Operating Conditions.
2. Tested to EIA/JESD22–A114–A
3. Tested to EIA/JESD22–A115–A
4. Tested to JESD22–C101–A
5. Tested to EIA/JESD78

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | DC Supply Voltage | | 2.0 | 5.5 | V |
| $V_{IN}$ | DC Input Voltage | | 0.0 | 5.5 | V |
| $V_{OUT}$ | DC Output Voltage | | 0.0 | 7.0 | V |
| $T_A$ | Operating Temperature Range | | – 55 | + 125 | °C |
| $t_r$, $t_f$ | Input Rise and Fall Time | $V_{CC}$ = 3.3 ± 0.3 V | 0 | 100 | ns/V |
| | | $V_{CC}$ = 5.0 ± 0.5 V | 0 | 20 | |

### DEVICE JUNCTION TEMPERATURE VERSUS TIME TO 0.1% BOND FAILURES

| Junction Temperature °C | Time, Hours | Time, Years |
|---|---|---|
| 80 | 1,032,200 | 117.8 |
| 90 | 419,300 | 47.9 |
| 100 | 178,700 | 20.4 |
| 110 | 79,600 | 9.4 |
| 120 | 37,000 | 4.2 |
| 130 | 17,800 | 2.0 |
| 140 | 8,900 | 1.0 |

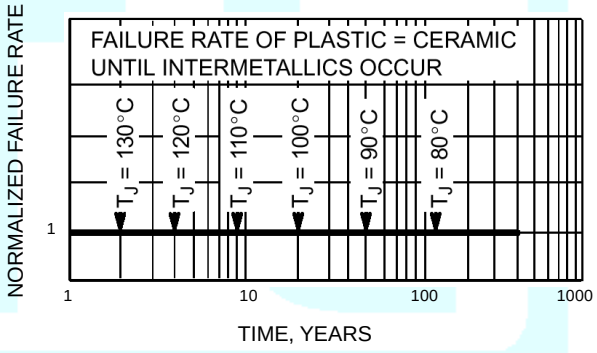



**Figure 3. Failure Rate vs. Time Junction Temperature**

## DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Conditions | $V_{CC}$ (V) | $T_A$ = 25°C Min | Typ | Max | $T_A \leq$ 85°C Min | Max | –55°C to 125°C Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Minimum High–Level Input Voltage | | 2.0 | 1.5 | | | 1.5 | | 1.5 | | V |
| | | | 3.0 | 2.1 | | | 2.1 | | 2.1 | | |
| | | | 4.5 | 3.15 | | | 3.15 | | 3.15 | | |
| | | | 5.5 | 3.85 | | | 3.85 | | 3.85 | | |
| $V_{IL}$ | Maximum Low–Level Input Voltage | | 2.0 | | | 0.5 | | 0.5 | | 0.5 | V |
| | | | 3.0 | | | 0.9 | | 0.9 | | 0.9 | |
| | | | 4.5 | | | 1.35 | | 1.35 | | 1.35 | |
| | | | 5.5 | | | 1.65 | | 1.65 | | 1.65 | |
| $V_{OH}$ | Minimum High–Level Output Voltage $V_{IN} = V_{IH}$ or $V_{IL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ $I_{OH} = -50\ \mu A$ | 2.0 | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | | 3.0 | 2.9 | 3.0 | | 2.9 | | 2.9 | | |
| | | | 4.5 | 4.4 | 4.0 | | 4.4 | | 4.4 | | |
| | | $V_{IN} = V_{IH}$ or $V_{IL}$ | | | | | | | | | |
| | | $I_{OH} = -4$ mA | 3.0 | 2.58 | | | 2.48 | | 2.34 | | |
| | | $I_{OH} = -8$ mA | 4.5 | 3.94 | | | 3.80 | | 3.66 | | |
| $V_{OL}$ | Maximum Low–Level Output Voltage $V_{IN} = V_{IH}$ or $V_{IL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ $I_{OL} = 50\ \mu A$ | 2.0 | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | | 3.0 | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | | 4.5 | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | $V_{IN} = V_{IH}$ or $V_{IL}$ | | | | | | | | | |
| | | $I_{OL} = 4$ mA | 3.0 | | | 0.36 | | 0.44 | | 0.52 | |
| | | $I_{OL} = 8$ mA | 4.5 | | | 0.36 | | 0.44 | | 0.52 | |
| $I_{IN}$ | Maximum Input Leakage Current | $V_{IN}$ = 5.5 V or GND | 0 to5.5 | | | ±0.1 | | ±1.0 | | ±1.0 | µA |
| $I_{CC}$ | Maximum Quiescent Supply Current | $V_{IN} = V_{CC}$ or GND | 5.5 | | | 2.0 | | 20 | | 40 | µA |
| $I_{OPD}$ | Maximum Off–state Leakage Current | $V_{OUT}$ = 5.5 V | 0 | | | 0.25 | | 2.5 | | 5.0 | µA |

## AC ELECTRICAL CHARACTERISTICS $C_{load}$ = 50 pF, Input $t_r = t_f$ = 3.0 ns

| Symbol | Parameter | Test Conditions | $T_A$ = 25°C Min | Typ | Max | $T_A \leq$ 85°C Min | Max | 55°C to 125°C Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| $t_{PZL}$ | Maximum Output Enable Time, Input A or B to Y | $V_{CC}$ = 3.3 ± 0.3 V $C_L$ = 15 pF | | 5.5 | 7.9 | | 9.5 | | 11.0 | ns |
| | | $R_L = R_I$ = 500 Ω $C_L$ = 50 pF | | 8.0 | 11.4 | | 13.0 | | 15.5 | |
| | | $V_{CC}$ = 5.0 ± 0.5 V $C_L$ = 15 pF | | 3.7 | 5.5 | | 6.5 | | 8.0 | |
| | | $R_L = R_I$ = 500 Ω $C_L$ = 50 pF | | 5.2 | 7.5 | | 8.5 | | 8.0 | |
| $t_{PLZ}$ | Maximum Output Disable Time | $V_{CC}$ = 3.3 ± 0.3 V $C_L$ = 50 pF $R_L = R_I$ = 500 Ω | | 8.0 | 11.4 | | 13.0 | | 15.5 | ns |
| | | $V_{CC}$ = 5.0 ± 0.5 V $C_L$ = 50 pF $R_L = R_I$ = 500 Ω | | 5.2 | 7.5 | | 8.5 | | 10.0 | |
| $C_{IN}$ | Maximum Input Capacitance | | | 4 | 10 | | 10 | | 10 | pF |

| | | Typical @ 25°C, $V_{CC}$ = 5.0 V | |
|---|---|---|---|
| $C_{PD}$ | Power Dissipation Capacitance (Note 6) | 18 | pF |

6. $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: $I_{CC(OPR)} = C_{PD} \times V_{CC} \times f_{in} + I_{CC}$. $C_{PD}$ is used to determine the no–load dynamic power consumption; $P_D = C_{PD} \times V_{CC}^2 \times f_{in} + I_{CC} \times V_{CC}$.

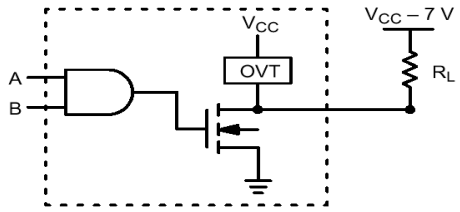



Figure 4. Output Voltage Mismatch Application

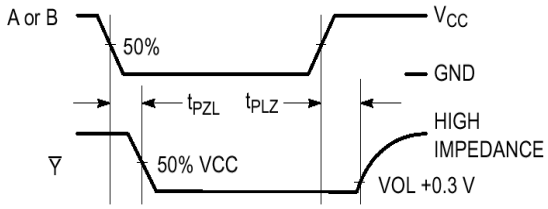
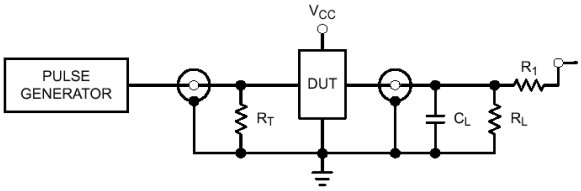



Figure 5. Switching Waveforms




C L = 50 pF equivalent (Includes jig and probe capacitance)
R L = R 1 = 500 Ω or equivalent
R T = Z OUT of pulse generator (typically 50 Ω)

Figure 6. Test Circuit

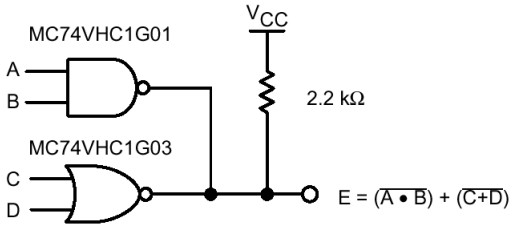



Figure 7. Complex Boolean Functions

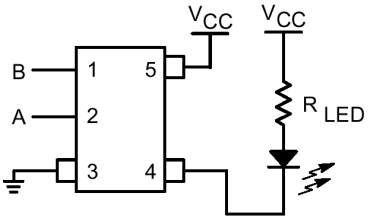



Figure 8. LED Driver

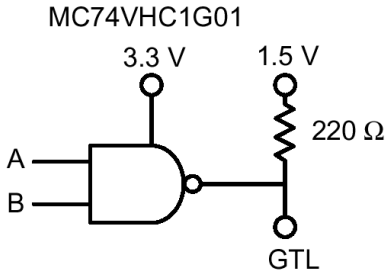



Figure 9. GTL Driver

## DEVICE ORDERING INFORMATION

| Device Nomenclature | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Device Order Number** | **Logic Circuit Indicator** | **Temp Range Identifier** | **Technology** | **Device Function** | **Package Suffix** | **Tape and Reel Suffix** | **Package Type** (Name/SOT#/ Common Name) | **Tape and Reel Size** |
| MC74VHC1G01DFT1 | MC | 74 | VHC1G | 01 | DF | T1 | SC–70/SC–88A/ SOT–353 | 178 mm (7 in) 3000 Unit |
| MC74VHC1G01DFT2 | MC | 74 | VHC1G | 01 | DF | T2 | SC–70/SC–88A/ SOT–353 | 178 mm (7 in) 3000 Unit |
| MC74VHC1G01DFT4 | MC | 74 | VHC1G | 01 | DF | T4 | SC–70/SC–88A/ SOT–353 | 330 mm (13 in) 10,000 Unit |
| MC74VHC1G01DTT1 | MC | 74 | VHC1G | 01 | DT | T1 | SOT–23/TSOPS/ SC–59 | 178 mm (7 in) 3000 Unit |
| MC74VHC1G01DTT3 | MC | 74 | VHC1G | 01 | DT | T3 | SOT–23/TSOPS/ SC–59 | 330 mm (13 in) 10,000 Unit |