FAIRCHILD SEMICONDUCTOR™

July 1999
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# 74VCX38
# Low Voltage Quad 2-Input NAND Gate with Open Drain Outputs and 3.6V Tolerant Inputs and Outputs

## General Description

The VCX38 contains four 2-input NAND gates with open drain outputs. This product is designed for low voltage (1.65V to 3.6V) $V_{CC}$ applications with I/O compatibility up to 3.6V.

The VCX38 is fabricated with advanced CMOS technology to achieve high-speed operation while maintaining CMOS low power dissipation.

## Features

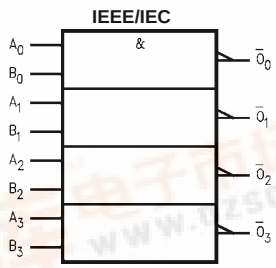
- 1.65V-3.6V $V_{CC}$ supply operation
- 3.6V tolerant inputs and outputs
- $t_{PD}$
  - 2.8 ns max for 3.0V to 3.6V $V_{CC}$
  - 3.7 ns max or 2.3V to 2.7V $V_{CC}$
  - 6.7 ns max for 1.65V to 1.95V $V_{CC}$
- Power-off high impedance inputs and outputs
- Static Drive ($I_{OL}$)
  - ±24 mA @ 3.0V $V_{CC}$
  - ±18 mA @ 2.3V $V_{CC}$
  - ±6 mA @ 1.65V $V_{CC}$
- Uses patented Quiet Series™ noise/EMI reduction circuitry
- Latchup performance exceeds 300 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 250V

## Ordering Code:

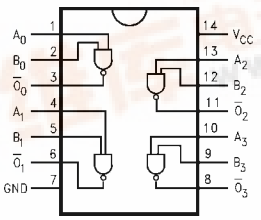
| Order Number | Package Number | Package Description |
|---|---|---|
| 74VCX38M | M14A | 14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow |
| 74VCX38MTC | MTC14 | 14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

## Logic Symbol




## Connection Diagram




## Pin Descriptions

| Pin Names | Description |
|---|---|
| $A_n$, $B_n$ | Inputs |
| $\overline{O}_n$ | Outputs |

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## Absolute Maximum Ratings (Note 1)

| | |
|---|---|
| Supply Voltage ($V_{CC}$) | −0.5V to +4.6V |
| DC Input Voltage ($V_I$) | −0.5V to +4.6V |
| Output Voltage ($V_O$) (Note 2) | −0.5V to +4.6V |
| DC Input Diode Current ($I_{IK}$) | |
| $V_I$ < 0V | −50 mA |
| DC Output Diode Current ($I_{OK}$) | |
| $V_O$ < 0V | −50 mA |
| DC Output Source/Sink Current ($I_{OL}$) | +50 mA |
| DC $V_{CC}$ or Ground Current per | ±100 mA |
| Supply Pin ($I_{CC}$ or Ground) | |
| Storage Temperature Range ($T_{stg}$) | −65°C to +150°C |

## Recommended Operating Conditions (Note 3)

| | |
|---|---|
| Power Supply | |
| Operating | 1.65V to 3.6V |
| Data Retention Only | 1.2V to 3.6V |
| Input Voltage | −0.3V to 3.6V |
| Output Voltage ($V_O$) | 0V to $V_{CC}$ |
| Output Current in $I_{OL}$ | |
| $V_{CC}$ = 3.0V to 3.6V | ±24 mA |
| $V_{CC}$ = 2.3V to 2.7V | ±18 mA |
| $V_{CC}$ = 1.65V to 2.3V | ±6 mA |
| Free Air Operating Temperature ($T_A$) | −40°C to +85°C |
| Minimum Input Edge Rate ($\Delta t/\Delta V$) | |
| $V_{in}$ = 0.8V to 2.0V, $V_{CC}$ = 3.0V | 10 ns/V |

**Note 1:** The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 2:** $I_O$ Absolute Maximum Rating must be observed.

**Note 3:** Floating or unused inputs must be held HIGH or LOW

## DC Electrical Characteristics ($2.7V < V_{CC} \leq 3.6V$)

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | Min | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IH}$ | HIGH Level Input Voltage | | 2.7–3.6 | 2.0 | | V |
| $V_{IL}$ | LOW Level Input Voltage | | 2.7–3.6 | | 0.8 | V |
| $V_{OL}$ | LOW Level Output Voltage | $I_{OL}$ = 100 μA | 2.7–3.6 | | 0.2 | V |
| | | $I_{OL}$ = 12 mA | 2.7 | | 0.4 | |
| | | $I_{OL}$ = 18 mA | 3.0 | | 0.4 | |
| | | $I_{OL}$ = 24 mA | 3.0 | | 0.55 | |
| $I_I$ | Input Leakage Current | $0 \leq V_I \leq 3.6V$ | 2.7–3.6 | | ±5.0 | μA |
| $I_{OFF}$ | Power-Off Leakage Current | $0 \leq (V_I, V_O) \leq 3.6V$ | 0 | | 10 | μA |
| $I_{CC}$ | Quiescent Supply Current | $V_I = V_{CC}$ or GND | 2.7–3.6 | | 20 | μA |
| | | $V_{CC} \leq V_I \leq 3.6V$ | 2.7–3.6 | | ±20 | |
| $\Delta I_{CC}$ | Increase in $I_{CC}$ per Input | $V_{IH} = V_{CC}$ −0.6V | 2.7–3.6 | | 750 | μA |

## DC Electrical Characteristics ($2.3V \le V_{CC} \le 2.7V$)

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | Min | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IH}$ | HIGH Level Input Voltage | | 2.3–2.7 | 1.6 | | V |
| $V_{IL}$ | LOW Level Input Voltage | | 2.3–2.7 | | 0.8 | V |
| $V_{OL}$ | LOW Level Output Voltage | $I_{OL}$ = 100 µA | 2.3–2.7 | | 0.2 | V |
| | | $I_{OL}$ = 12 mA | 2.3 | | 0.4 | |
| | | $I_{OL}$ = 18 mA | 2.3 | | 0.6 | |
| $I_I$ | Input Leakage Current | $0 \le V_I \le 3.6V$ | 2.3–2.7 | | ±5.0 | µA |
| $I_{OFF}$ | Power-Off Leakage Current | $0 \le (V_I, V_O) \le 3.6V$ | 0 | | 10 | µA |
| $I_{CC}$ | Quiescent Supply Current | $V_I = V_{CC}$ or GND | 2.3–2.7 | | 20 | µA |
| | | $V_{CC} \le V_I \le 3.6V$ | 2.3–2.7 | | ±20 | |

## DC Electrical Characteristics ($1.65V \le V_{CC} < 2.3V$)

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | Min | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IH}$ | HIGH Level Input Voltage | | 1.65–2.3 | 0.65 x $V_{CC}$ | | V |
| $V_{IL}$ | LOW Level Input Voltage | | 1.65–2.3 | | 0.35 x $V_{CC}$ | V |
| $V_{OL}$ | LOW Level Output Voltage | $I_{OL}$ = 100 µA | 1.65–2.3 | | 0.2 | V |
| | | $I_{OL}$ = 6 mA | 1.65 | | 0.3 | |
| $I_I$ | Input Leakage Current | $0 \le V_I \le 3.6V$ | 1.65–2.3 | | ±5.0 | µA |
| $I_{OFF}$ | Power-Off Leakage Current | $0 \le (V_I, V_O) \le 3.6V$ | 0 | | 10 | µA |
| $I_{CC}$ | Quiescent Supply Current | $V_I = V_{CC}$ or GND | 1.65–2.3 | | 20 | µA |
| | | $V_{CC} \le V_I \le 3.6V$ | 1.65–2.3 | | ±20 | |

## AC Electrical Characteristics (Note 4)

| Symbol | Parameter | $T_A = -40°C$ to $+85°C$, $C_L$ = 30 pF, $R_L$ = 500Ω | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ = 3.3V ±0.3V | | $V_{CC}$ = 2.5V ±0.2V | | $V_{CC}$ = 1.8V ±0.15V | | |
| | | Min | Max | Min | Max | Min | Max | |
| $t_{PZL}$ $t_{PLZ}$ | Propagation Delay | 0.6 | 2.8 | 0.8 | 3.7 | 1.0 | 6.7 | ns |
| $t_{OSHL}$ $t_{OSLH}$ | Output to Output Skew (Note 5) | | 0.5 | | 0.5 | | 0.75 | ns |

**Note 4:** For $C_L$ = 50 pF, add approximately 300 ps to the AC maximum specification.

**Note 5:** Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW ($t_{OSHL}$) or LOW-to-HIGH ($t_{OSLH}$).

## Dynamic Switching Characteristics

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A$ = +25°C Typical | Units |
|---|---|---|---|---|---|
| $V_{OLP}$ | Quiet Output Dynamic Peak $V_{OL}$ | $C_L$ = 30 pF, $V_{IH} = V_{CC}$, $V_{IL}$ = 0V | 1.8 | 0.25 | V |
| | | | 2.5 | 0.6 | |
| | | | 3.3 | 0.8 | |
| $V_{OLV}$ | Quiet Output Dynamic Valley $V_{OL}$ | $C_L$ = 30 pF, $V_{IH} = V_{CC}$, $V_{IL}$ = 0V | 1.8 | –0.25 | V |
| | | | 2.5 | –0.6 | |
| | | | 3.3 | –0.8 | |

## Capacitance

| Symbol | Parameter | Conditions | $T_A$ +25°C Typical | Units |
|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_I$ = 0v OR $V_{CC}$, $V_{CC}$ = 1.8V, 2.5V or 3.3V | 6 | pF |
| $C_{OUT}$ | Output Capacitance | $V_I$ = 0V or $V_{CC}$, $V_{CC}$ = 1.8V, 2.5V or 3.3V | 7 | pF |
| $C_{PD}$ | Power Dissipation Capacitance | $V_I$ = 0V or $V_{CC}$, f = 10 MHz, $V_{CC}$ = 1.8V, 2.5V or 3.3V | 20 | pF |

## AC Loading and Waveforms

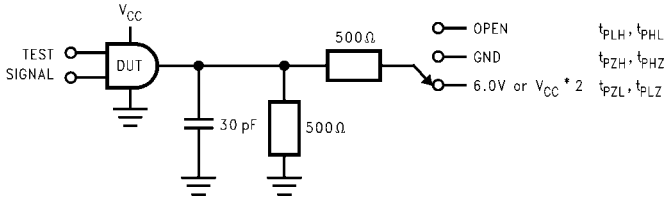



**FIGURE 1. AC Test Circuit**

| TEST | SWITCH |
|---|---|
| $t_{PZL}$, $t_{PLZ}$ | 6V at $V_{CC}$ = 3.3 ± 0.3V;<br>$V_{CC}$ × 2 at $V_{CC}$ = 2.5V ± 0.2V; 1.8V |

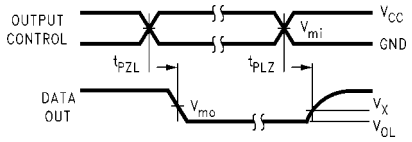
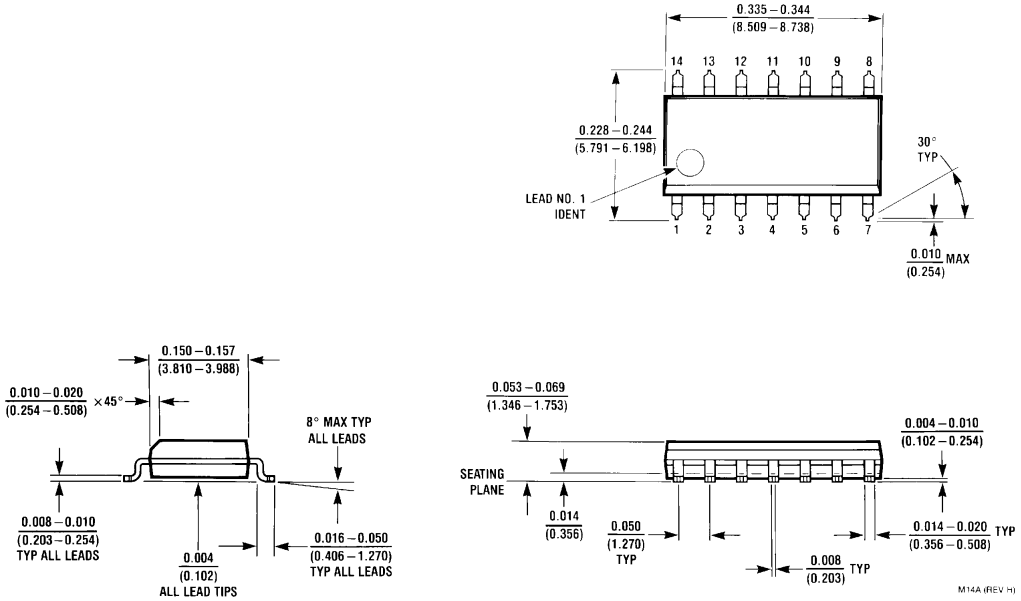



**FIGURE 2. Waveform for Open Drain, Inverting and Non-inverting Functions**

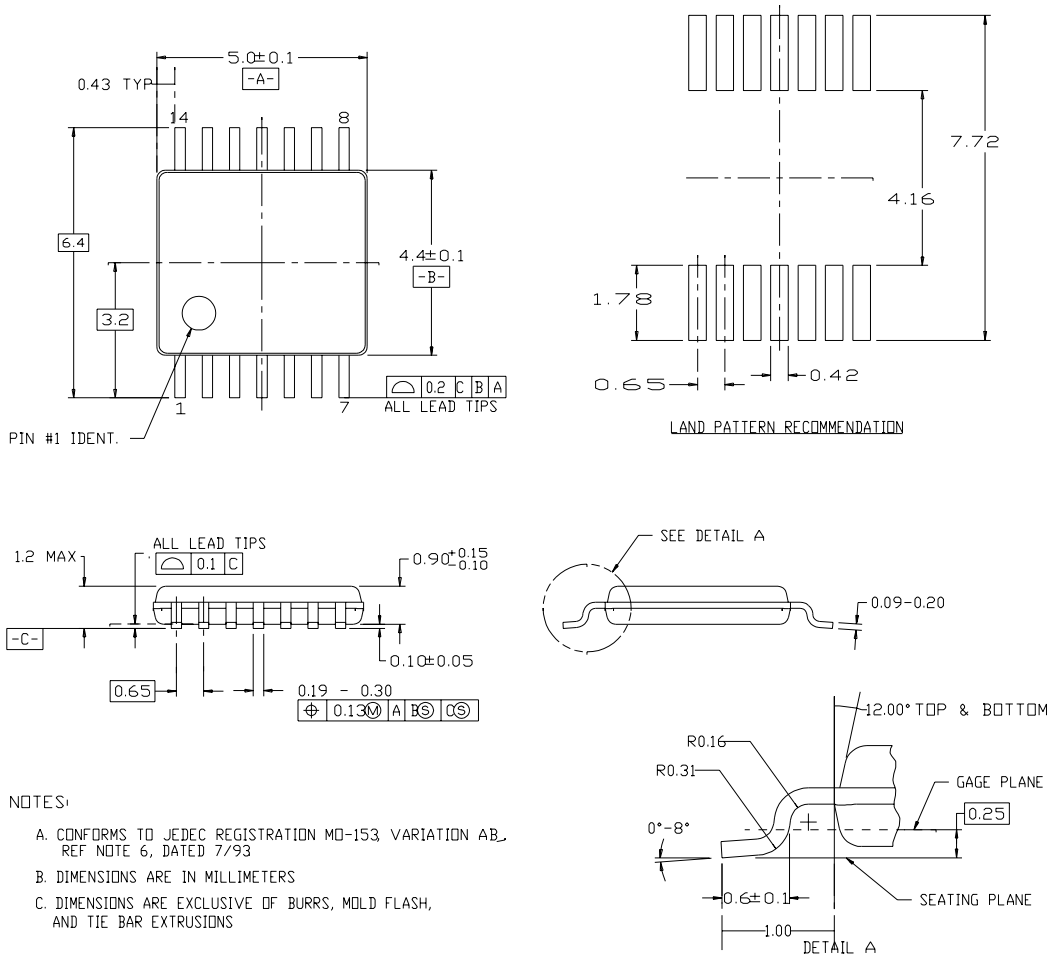
| Symbol | $V_{CC}$ | | |
|---|---|---|---|
| | **3.3V ± 0.3V** | **2.5V ± 0.2V** | **1.8V ± 0.15V** |
| $V_{mi}$ | 1.5V | $V_{CC}$/2 | $V_{CC}$/2 |
| $V_{mo}$ | 1.5V | $V_{CC}$/2 | $V_{CC}$/2 |
| $V_x$ | $V_{OL}$ + 0.3V | $V_{OL}$ + 0.15V | $V_{OL}$ + 0.15V |

## Physical Dimensions inches (millimeters) unless otherwise noted




**14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow**
**Package Number M14A**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB, REF NOTE 6, DATED 7/93

B. DIMENSIONS ARE IN MILLIMETERS

C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS

**14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide**
**Package Number MTC14**