

# MC74VHC1G09

## 2-Input AND Gate with Open Drain Output

The MC74VHC1G09 is an advanced high speed CMOS 2-input AND gate with open drain output fabricated with silicon gate CMOS technology. It achieves high speed operation 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 capability to set output switching level. This allows the MC74VHC1G09 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 MC74VHC1G09 input structure provides protection when voltages up to 7 V are applied, regardless of the supply voltage.

### Features

- High Speed:  $t_{PD} = 4.3$  ns (Typ) at  $V_{CC} = 5$  V
- Low Internal Power Dissipation:  $I_{CC} = 1$   $\mu$ A (Max) at  $T_A = 25^\circ$ C
- Power Down Protection Provided on Inputs
- Pin and Function Compatible with Other Standard Logic Families
- Chip Complexity: FETs = 62; Equivalent Gates = 16
- Pb-Free Packages are Available

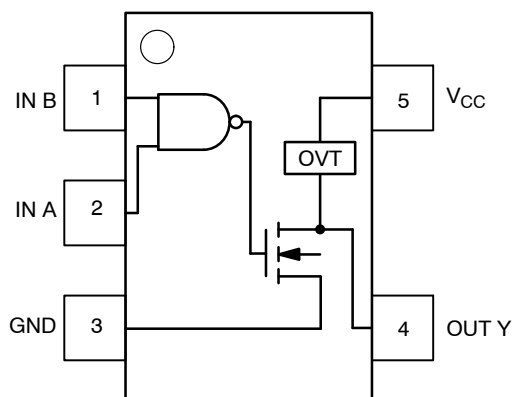


Figure 1. Pinout (Top View)

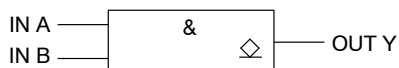


Figure 2. Logic Symbol



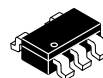
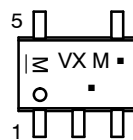
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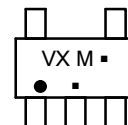
### MARKING DIAGRAMS



SC-88A / SOT-353 / SC-70  
DF SUFFIX  
CASE 419A



TSOP-5 / SOT-23 / SC-59  
DT SUFFIX  
CASE 483



VX = Device Code  
M = Date Code\*  
▪ = Pb-Free Package

(Note: Microdot may be in either location)  
\*Date Code orientation and/or position may vary depending upon manufacturing location.

### PIN ASSIGNMENT

Pin	Function
1	IN B
2	IN A
3	GND
4	OUT Y
5	$V_{CC}$

### FUNCTION TABLE

Inputs		Output
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	Z

### ORDERING INFORMATION

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

# MC74VHC1G09

## MAXIMUM RATINGS

Symbol	Characteristics	Value	Unit	
V <sub>CC</sub>	DC Supply Voltage	-0.5 to +7.0	V	
V <sub>IN</sub>	DC Input Voltage	-0.5 to +7.0	V	
V <sub>OUT</sub>	DC Output Voltage	-0.5 to 7.0	V	
I <sub>IK</sub>	Input Diode Current	-20	mA	
I <sub>OK</sub>	Output Diode Current	+20	mA	
I <sub>OUT</sub>	DC Output Current, per Pin	+25	mA	
I <sub>CC</sub>	DC Supply Current, V <sub>CC</sub> and GND	+50	mA	
P <sub>D</sub>	Power dissipation in still air	SC-88A, TSOP-5	200	mW
θ <sub>JA</sub>	Thermal resistance	SC-88A, TSOP-5	333	°C/W
T <sub>L</sub>	Lead temperature, 1 mm from case for 10 s		260	°C
T <sub>J</sub>	Junction temperature under bias		+150	°C
T <sub>stg</sub>	Storage temperature		-65 to +150	°C
MSL	Moisture Sensitivity		Level 1	
F <sub>R</sub>	Flammability Rating	Oxygen Index: 28 to 34	UL 94 V-0 @ 0.125 in	
V <sub>ESD</sub>	ESD Withstand Voltage	Human Body Model (Note 1) Machine Model (Note 2) Charged Device Model (Note 3)	> 2000 > 200 N/A	V
I <sub>Latchup</sub>	Latchup Performance	Above V <sub>CC</sub> and Below GND at 125°C (Note 4)	±500	mA

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Tested to EIA/JESD22-A114-A
2. Tested to EIA/JESD22-A115-A
3. Tested to JESD22-C101-A
4. Tested to EIA/JESD78

## RECOMMENDED OPERATING CONDITIONS

Symbol	Characteristics	Min	Max	Unit
V <sub>CC</sub>	DC Supply Voltage	2.0	5.5	V
V <sub>IN</sub>	DC Input Voltage	0.0	5.5	V
V <sub>OUT</sub>	DC Output Voltage	0.0	7.0	V
T <sub>A</sub>	Operating Temperature Range	-55	+125	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise and Fall Time V <sub>CC</sub> = 3.3 V ± 0.3 V V <sub>CC</sub> = 5.0 V ± 0.5 V	0	100 20	ns/V

## 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

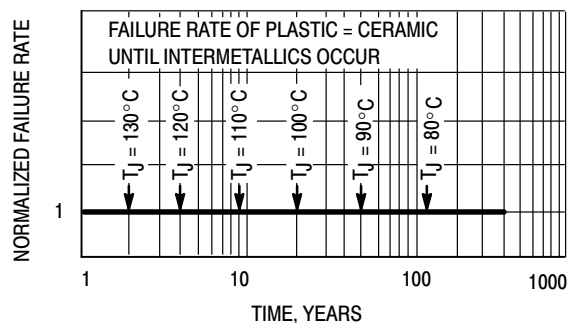


Figure 3. Failure Rate vs. Time Junction Temperature

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## DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			T <sub>A</sub> ≤ 85°C		-55 ≤ T <sub>A</sub> ≤ 125°C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
V <sub>IH</sub>	Minimum High-Level Input Voltage		2.0 3.0 4.5 5.5	1.5 2.1 3.15 3.85			1.5 2.1 3.15 3.85		1.5 2.1 3.15 3.85	V	
V <sub>IL</sub>	Maximum Low-Level Input Voltage		2.0 3.0 4.5 5.5			0.5 0.9 1.35 1.65		0.5 0.9 1.35 1.65		0.5 0.9 1.35 1.65	V
V <sub>OL</sub>	Maximum Low-Level Output Voltage V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 50 μA	2.0 3.0 4.5		0.0 0.0 0.0	0.1 0.1 0.1		0.1 0.1 0.1		0.1 0.1 0.1	V
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 4 mA I <sub>OL</sub> = 8 mA	3.0 4.5			0.36 0.36		0.44 0.44		0.52 0.52	V
I <sub>IN</sub>	Maximum Input Leakage Current	V <sub>IN</sub> = 5.5 V or GND	0 to 5.5			±0.1		±1.0		±1.0	μA
I <sub>CC</sub>	Maximum Quiescent Supply Current	V <sub>IN</sub> = V <sub>CC</sub> or GND	5.5			1.0		20		40	μA
I <sub>OFF</sub>	Power Off-Output Leakage Current	V <sub>OUT</sub> = 5.5 V V <sub>IN</sub> = 5.5 V	0			0.25		2.5		5	μA

## AC ELECTRICAL CHARACTERISTICS C<sub>load</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 3.0 ns

Symbol	Parameter	Test Conditions	T <sub>A</sub> = 25°C			T <sub>A</sub> ≤ 85°C		-55 ≤ T <sub>A</sub> ≤ 125°C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>pZL</sub>	Maximum Output Enable Time, Input A or B to Y	V <sub>CC</sub> = 3.3 ± 0.3 V C <sub>L</sub> = 15 pF R <sub>L</sub> = R <sub>I</sub> = 500 Ω C <sub>L</sub> = 50 pF		6.2 8.7	8.8 12.3		10.5 14.0		12.5 16.5	ns
		V <sub>CC</sub> = 5.0 ± 0.5 V C <sub>L</sub> = 15 pF R <sub>L</sub> = R <sub>I</sub> = 500 Ω C <sub>L</sub> = 50 pF		4.3 5.8	5.9 7.9		7.0 9.0		9.0 11.0	
t <sub>pLZ</sub>	Maximum Output Disable Time	V <sub>CC</sub> = 3.3 ± 0.3 V C <sub>L</sub> = 50 pF R <sub>L</sub> = R <sub>I</sub> = 500 Ω		8.7	12.3		14.0		16.5	ns
		V <sub>CC</sub> = 5.0 ± 0.5 V C <sub>L</sub> = 50 pF R <sub>L</sub> = R <sub>I</sub> = 500 Ω		5.8	7.9		9.0		11.0	
C <sub>IN</sub>	Maximum Input Capacitance			6.0	10		10		10	pF

C <sub>PD</sub>	Power Dissipation Capacitance (Note 5)	Typical @ 25°C, V <sub>CC</sub> = 5.0 V		pF
		18		

5. C<sub>PD</sub> 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<sub>CC(OPR)</sub> = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>in</sub> + I<sub>CC</sub>. C<sub>PD</sub> is used to determine the no-load dynamic power consumption; P<sub>D</sub> = C<sub>PD</sub> • V<sub>CC</sub><sup>2</sup> • f<sub>in</sub> + I<sub>CC</sub> • V<sub>CC</sub>.

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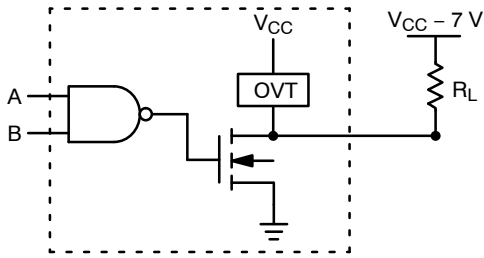


Figure 4. Output Voltage Mismatch Application

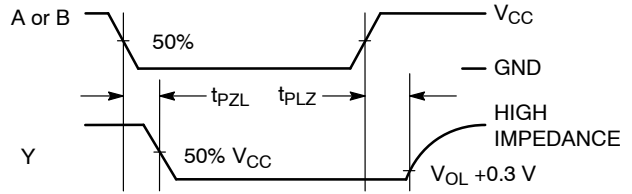
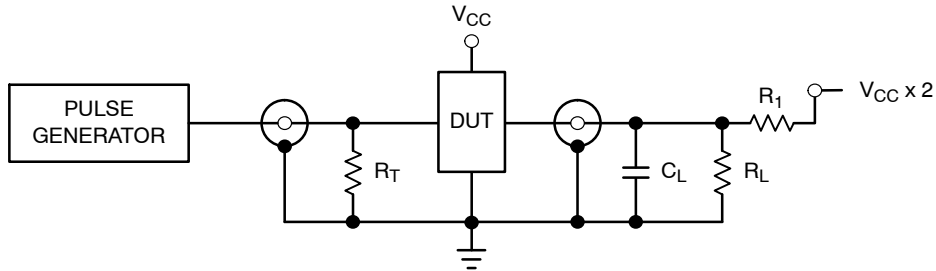


Figure 5. Switching Waveforms



$C_L = 50 \text{ pF}$  equivalent (Includes jig and probe capacitance)  
 $R_L = R_1 = 500 \Omega$  or equivalent  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50 \Omega$ )

Figure 6. Test Circuit

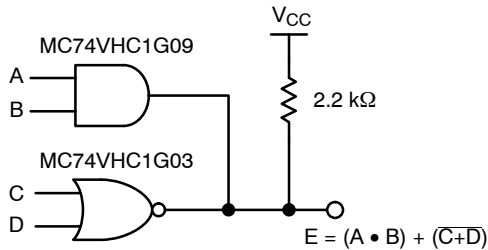


Figure 7. Complex Boolean Functions

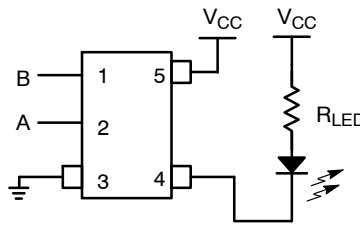


Figure 8. LED Driver

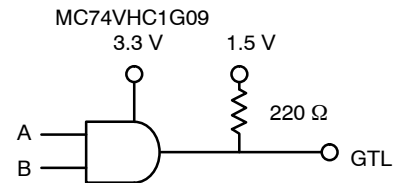


Figure 9. GTL Driver

## ORDERING INFORMATION

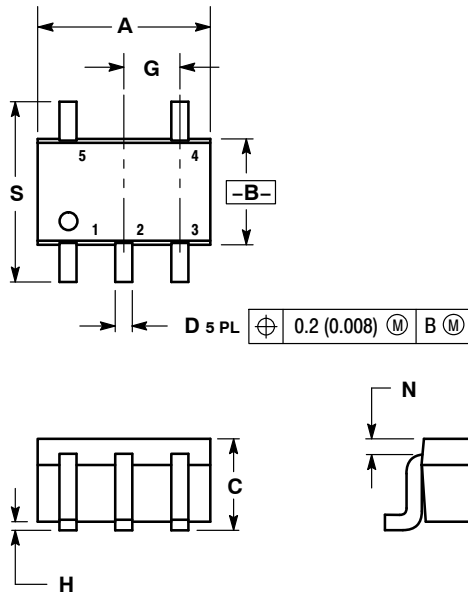
Device	Package	Shipping†
MC74VHC1G09DFT1	SC70-5 / SC-88A / SOT-353	3000/Tape & Reel
MC74VHC1G09DFT1G	SC70-5 / SC-88A / SOT-353 (Pb-Free)	
MC74VHC1G09DFT2	SC70-5 / SC-88A / SOT-353	
MC74VHC1G09DFT2G	SC70-5 / SC-88A / SOT-353 (Pb-Free)	
MC74VHC1G09DTT1	SOT23-5 / TSOP-5 / SC59-5	
MC74VHC1G09DTT1G	SOT23-5 / TSOP-5 / SC59-5 (Pb-Free)	

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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## PACKAGE DIMENSIONS

SC-88A, SOT-353, SC-70  
CASE 419A-02  
ISSUE J

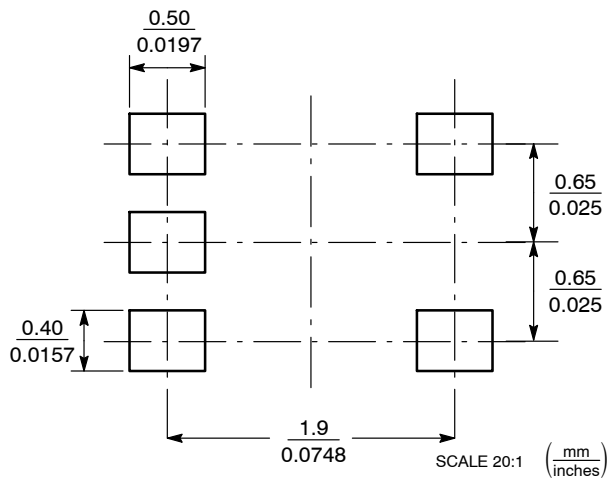


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20

### SOLDERING FOOTPRINT\*

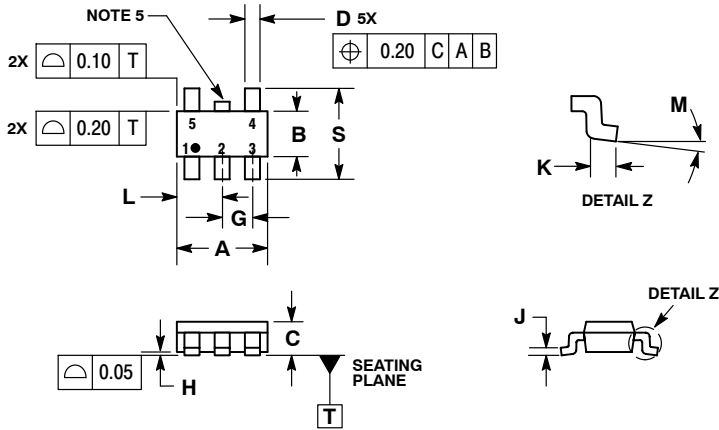


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# MC74VHC1G09

## PACKAGE DIMENSIONS

TSOP-5  
CASE 483-02  
ISSUE F

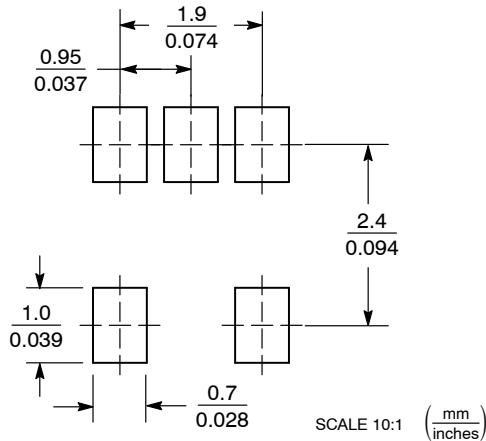


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

DIM	MILLIMETERS	
	MIN	MAX
A	3.00 BSC	
B	1.50 BSC	
C	0.90	1.10
D	0.25	0.50
G	0.95 BSC	
H	0.01	0.10
J	0.10	0.26
K	0.20	0.60
L	1.25	1.55
M	0°	10°
S	2.50	3.00

### SOLDERING FOOTPRINT\*



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