# Inverting Buffer / CMOS Logic Level Shifter LSTTL-Compatible Inputs

The MC74VHC1GT04 is a single gate inverting buffer fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

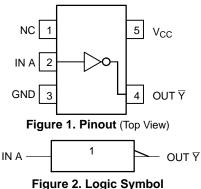
The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output.

The device input is compatible with TTL-type input thresholds and the output has a full 5 V CMOS level output swing. The input protection circuitry on this device allows overvoltage tolerance on the input, allowing the device to be used as a logic-level translator from 3 V CMOS logic to 5 V CMOS Logic or from 1.8 V CMOS logic to 3 V CMOS Logic while operating at the high-voltage power supply.

The MC74VHC1GT04 input structure provides protection when voltages up to 7.0 V are applied, regardless of the supply voltage. This allows the MC74VHC1GT04 to be used to interface 5 V circuits to 3 V circuits. The output structures also provide protection when  $V_{\rm CC}=0$  V. These input and output structures help prevent device destruction caused by supply voltage — input/output voltage mismatch, battery backup, hot insertion, etc.

#### **Features**

- High Speed:  $t_{PD} = 3.8 \text{ ns}$  (Typ) at  $V_{CC} = 5 \text{ V}$
- Low Power Dissipation:  $I_{CC} = 1 \mu A \text{ (Max)}$  at  $T_A = 25 \text{°C}$
- TTL-Compatible Inputs:  $V_{IL} = 0.8 \text{ V}$ ;  $V_{IH} = 2 \text{ V}$
- CMOS–Compatible Outputs:  $V_{OH} > 0.8 V_{CC}$ ;  $V_{OL} < 0.1 V_{CC}$  @ Load
- Power Down Protection Provided on Inputs and Outputs
- Balanced Propagation Delays
- Pin and Function Compatible with Other Standard Logic Families
- Chip Complexity: FETs = 105; Equivalent Gates = 26
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb–Free, Halogen Free/BFR Free and are RoHS Compliant



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#### MARKING DIAGRAMS



SC-88A DF SUFFIX CASE 419A





TSOP-5 DT SUFFIX CASE 483



VK = 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				
1	NC			
2	IN A			
3	GND			
4	OUT ₹			
5	V <sub>CC</sub>			

#### **FUNCTION TABLE**

A Input	▼ Output
L	Н
Н	L

#### **ORDERING INFORMATION**

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

#### **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 $V_{CC} = 0$ High or Low State	-0.5 to 7.0 -0.5 to V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	Input Diode Current	-20	mA
I <sub>OK</sub>	Output Diode Current $V_{OUT} < GND; V_{OUT} > V_{CC}$	+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
$\theta_{\sf JA}$	Thermal resistance SC-88A, TSOP-5	333	°C/W
T <sub>L</sub>	Lead temperature, 1 mm from case for 10 s	260	°C
TJ	Junction temperature under bias	+150	°C
T <sub>stg</sub>	Storage temperature	-65 to +150	°C
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)	±100	mA

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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	CI	aracteristics	Min	Max	Unit
V <sub>CC</sub>	DC Supply Voltage		3.0	5.5	V
V <sub>IN</sub>	DC Input Voltage		0.0	5.5	V
V <sub>OUT</sub>	DC Output Voltage	$V_{CC} = 0$ High or Low State	0.0 0.0	5.5 V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature Range		-55	+125	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise and Fall Time	$V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ $V_{CC} = 5.0 \text{ V} \pm 0.5 \text{ V}$	0 0	100 20	ns/V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

#### **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

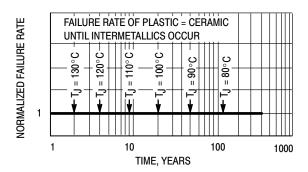


Figure 3. Failure Rate vs. Time Junction Temperature

#### DC ELECTRICAL CHARACTERISTICS

			v <sub>cc</sub>	Т	A = 25°	С	T <sub>A</sub> ≤	85°C	-55 ≤ T <sub>A</sub>	≤ 125°C	
Symbol	Parameter	Test Conditions	(V)	Min	Тур	Max	Min	Max	Min	Max	Unit
V <sub>IH</sub>	Minimum High-Level Input Voltage		3.0 4.5 5.5	1.4 2.0 2.0			1.4 2.0 2.0		1.4 2.0 2.0		V
V <sub>IL</sub>	Maximum Low–Level Input Voltage		3.0 4.5 5.5			0.53 0.8 0.8		0.53 0.8 0.8		0.53 0.8 0.8	V
V <sub>OH</sub>	Minimum High–Level Output Voltage	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $I_{OH} = -50 \mu A$	3.0 4.5	2.9 4.4	3.0 4.5		2.9 4.4		2.9 4.4		V
	$V_{IN} = V_{IH}$ or $V_{IL}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $I_{OH} = -4$ mA $I_{OH} = -8$ mA	3.0 4.5	2.58 3.94			2.48 3.80		2.34 3.66		V
V <sub>OL</sub>	Maximum Low–Level Output Voltage	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $I_{OL} = 50 \mu A$	3.0 4.5		0.0 0.0	0.1 0.1		0.1 0.1		0.1 0.1	V
	$V_{IN} = V_{IH}$ or $V_{IL}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $I_{OL} = 4.0 \text{ mA}$ $I_{OL} = 8.0 \text{ mA}$	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	$V_{IN} = 5.5 \text{ V or GND}$	0 to 5.5			±0.1		±1.0		±1.0	μΑ
I <sub>CC</sub>	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND	5.5			1.0		20		40	μΑ
I <sub>CCT</sub>	Quiescent Supply Current	Input: V <sub>IN</sub> = 3.4 V	5.5			1.35		1.50		1.65	mA
I <sub>OPD</sub>	Output Leakage Current	V <sub>OUT</sub> = 5.5 V	0.0			0.5		5.0		10	μΑ

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

#### AC ELECTRICAL CHARACTERISTICS $C_{load}$ = 50 pF, Input $t_{r}$ = $t_{f}$ = 3.0 ns

			7	T <sub>A</sub> = 25°	С	T <sub>A</sub> ≤	85°C	-55 ≤ T <sub>A</sub>	≤ 125°C	
Symbol	Parameter	Test Conditions	Min	Тур	Max	Min	Max	Min	Max	Unit
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Input A to ₹	$V_{CC} = 3.3 \pm 0.3 \text{ V}$ $C_L = 15 \text{ p}$ $C_L = 50 \text{ p}$		5.0 6.2	10.0 13.5		11.0 15.0		13.0 17.5	ns
		$V_{CC} = 5.0 \pm 0.5 \text{ V}$ $C_L = 15 \text{ p}$ $C_L = 50 \text{ p}$		3.8 4.2	6.7 7.7		7.5 8.5		8.5 9.5	
C <sub>IN</sub>	Maximum Input Capacitance			5.0	10		10		10	pF

		Typical @ 25°C, V <sub>CC</sub> = 5.0 V	
$C_{PD}$	Power Dissipation Capacitance (Note 5)	10	pF

<sup>5.</sup> 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>.

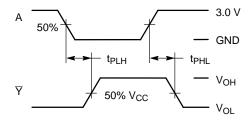
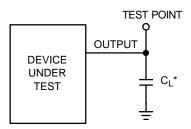


Figure 4. Switching Waveforms



<sup>\*</sup>Includes all probe and jig capacitance

Figure 5. Test Circuit

#### ORDERING INFORMATION

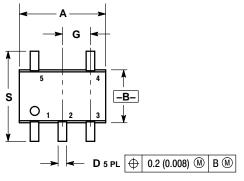
Device	Package Type	Package <sup>†</sup>
M74VHC1GT04DFT1G		
NLVVHC1GT04DFT1G*	SC-88A (Pb-Free)	
M74VHC1GT04DFT2G		
NLVVHC1GT04DFT2G*		3000 / Tape & Reel
M74VHC1GT04DFT3G		
M74VHC1GT04DTT1G	TSOP-5	
NLVVHC1GT04DTT1G*	(Pb-Free)	

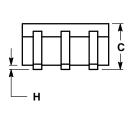
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

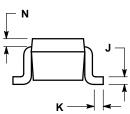
<sup>\*</sup>NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC–Q100 Qualified and PPAP Capable.

#### **PACKAGE DIMENSIONS**

### SC-88A (SC-70-5/SOT-353) CASE 419A-02 ISSUE L



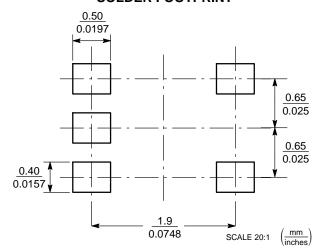




- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
  4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

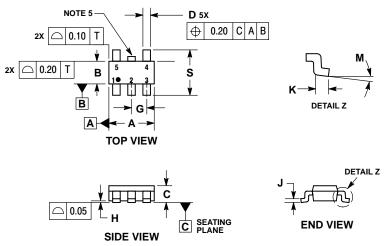
	INCHES		MILLIN	IETERS	
DIM	MIN	MIN MAX		MAX	
Α	0.071	0.087	1.80	2.20	
В	0.045	0.053	1.15	1.35	
С	0.031	0.043	0.80	1.10	
D	0.004	0.012	0.10	0.30	
G	0.026	BSC	0.65 BSC		
Н		0.004		0.10	
J	0.004	0.010	0.10	0.25	
K	0.004	0.012	0.10	0.30	
N	0.008 REF		0.20	REF	
S	0.079	0.087	2.00	2.20	

#### **SOLDER FOOTPRINT**



#### PACKAGE DIMENSIONS

#### TSOP-5 **CASE 483 ISSUE M**



#### NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994. CONTROLLING DIMENSION: MILLIMETERS.
- MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
- MINIMUM HIGNESS OF BASE MATERIAL.

  DIMENSIONS A AND B DO NOT INCLUDE MOLD

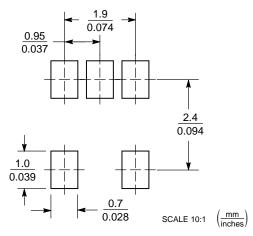
  FLASH, PROTRUSIONS, OR GATE BURRS. MOLD

  FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT

  EXCEED 0.15 PER SIDE. DIMENSION A.
- OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION.
  TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

	MILLIMETERS			
DIM	MIN	MAX		
Α	2.85	3.15		
В	1.35	1.65		
C	0.90	1.10		
D	0.25	0.50		
G	0.95	BSC		
Н	0.01	0.10		
7	0.10	0.26		
K	0.20	0.60		
М	0 °	10°		
S	2.50	3.00		

#### **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.

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