

# MC74VHC1GT04

## Inverting Buffer / CMOS Logic Level Shifter with 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 3.0 V CMOS logic to 5.0V CMOS Logic or from 1.8 V CMOS logic to 3.0 V CMOS Logic while operating at the high-voltage power supply.

The MC74VHC1GT04 input structure provides protection when voltages up to 7 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  $V_{CC} = 0$  V. These input and output structures help prevent device destruction caused by supply voltage – input/output voltage mismatch, battery backup, hot insertion, etc.

- High Speed:  $t_{PD} = 3.8$  ns (Typ) at  $V_{CC} = 5$  V
- Low Power Dissipation:  $I_{CC} = 2$   $\mu$ A (Max) at  $T_A = 25^\circ\text{C}$
- TTL-Compatible Inputs:  $V_{IL} = 0.8$  V;  $V_{IH} = 2.0$  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

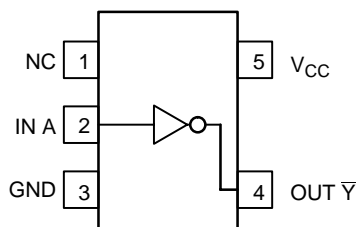


Figure 1. Pinout (Top View)

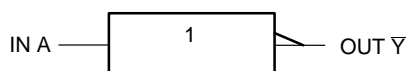


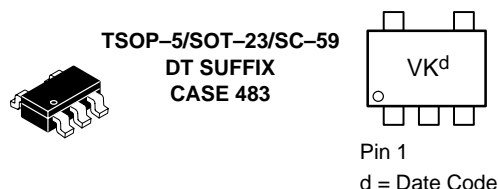
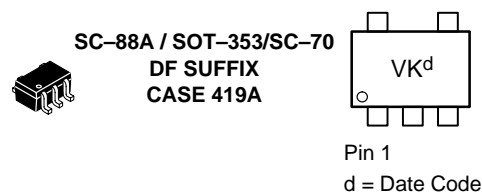
Figure 2. Logic Symbol



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### MARKING DIAGRAMS



### PIN ASSIGNMENT

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

### FUNCTION TABLE

A Input	Y Output
L	H
H	L

### ORDERING INFORMATION

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

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## MAXIMUM RATINGS (Note 1.)

Symbol	Characteristics	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 $V_{CC} = 0$ High or Low State	-0.5 to 7.0 -0.5 to $V_{CC} + 0.5$	V
$I_{IK}$	Input Diode Current	-20	mA
$I_{OK}$	Output Diode Current $V_{OUT} < GND$ ; $V_{OUT} > V_{CC}$	+20	mA
$I_{OUT}$	DC Output Current, per Pin	+25	mA
$I_{CC}$	DC Supply Current, $V_{CC}$ and GND	+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 s	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.) Machine Model (Note 3.) Charged Device Model (Note 4.)	> 1500 > 200 N/A	V
$I_{Latch-Up}$	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	Characteristics	Min	Max	Unit
$V_{CC}$	DC Supply Voltage	3.0	5.5	V
$V_{IN}$	DC Input Voltage	0.0	5.5	V
$V_{OUT}$	DC Output Voltage $V_{CC} = 0$ High or Low State	0.0 0.0	5.5 $V_{CC}$	V
$T_A$	Operating Temperature Range	-55	+125	°C
$t_r, t_f$	Input Rise and Fall Time $V_{CC} = 3.3 V \pm 0.3 V$ $V_{CC} = 5.0 V \pm 0.5 V$	0 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

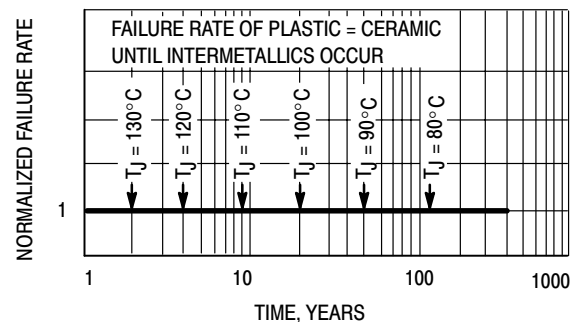


Figure 3. Failure Rate vs. Time Junction Temperature

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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		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 <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>OH</sub> = -50 μA	3.0 4.5	2.9 4.4	3.0 4.5		2.9 4.4		2.9 4.4		V
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = -4 mA I <sub>OH</sub> = -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 <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	3.0 4.5		0.0 0.0	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			2.0		20		40	μA
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	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>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Input A to Y	V <sub>CC</sub> = 3.3 ± 0.3 V    C <sub>L</sub> = 15 pF C <sub>L</sub> = 50 pF V <sub>CC</sub> = 5.0 ± 0.5 V    C <sub>L</sub> = 15 pF C <sub>L</sub> = 50 pF		5.0 6.2	10.0 13.5		11.0 15.0		13.0 17.5	ns
C <sub>IN</sub>	Maximum Input Capacitance			5	10		10		10	pF

C <sub>PD</sub>	Power Dissipation Capacitance (Note 6.)	Typical @ 25°C, V <sub>CC</sub> = 5.0 V	pF
		10	

6. 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>.

# MC74VHC1GT04

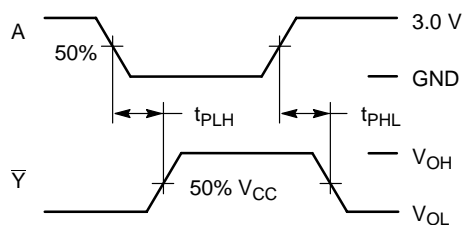
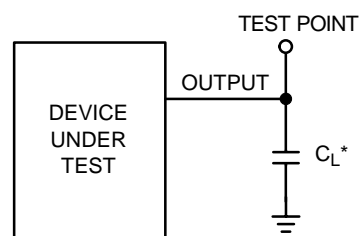


Figure 4. Switching Waveforms



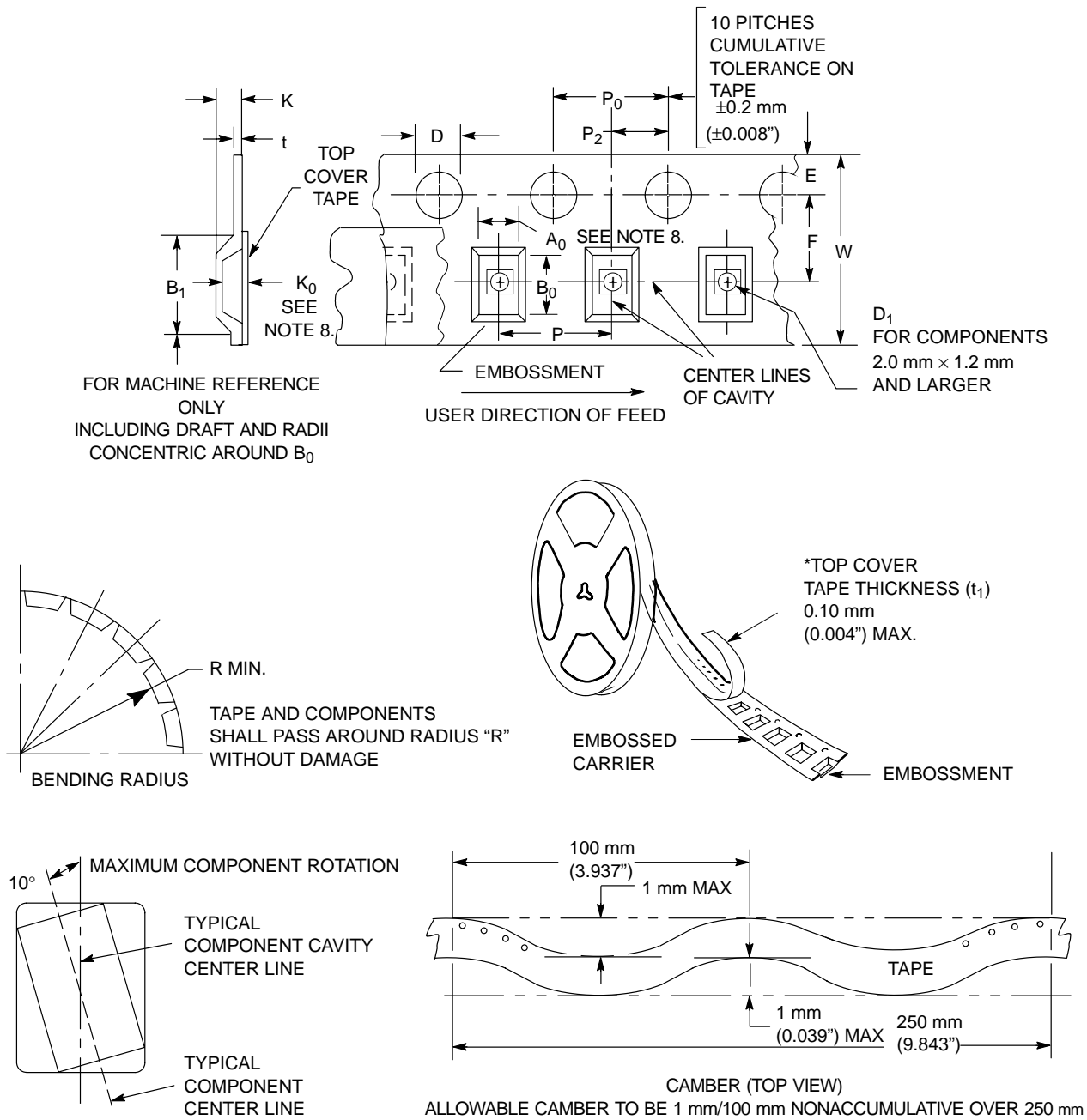
\*Includes all probe and jig capacitance

Figure 5. Test Circuit

## DEVICE ORDERING INFORMATION

Device Order Number	Device Nomenclature						Package Type (Name/SOT#/ Common Name)	Tape and Reel Size
	Circuit Indicator	Temp Range Identifier	Technology	Device Function	Package Suffix	Tape & Reel Suffix		
MC74VHC1GT04DFT1	MC	74	VHC1G	T04	DF	T1	SC-88A / SOT-353 / SC-70	178 mm (7") 3000 Unit
MC74VHC1GT04DFT2	MC	74	VHC1G	T04	DF	T2	SC-88A / SOT-353 / SC-70	178 mm (7") 3000 Unit
MC74VHC1GT04DFT4	MC	74	VHC1G	T04	DF	T4	SC-88A / SOT-353 / SC-70	330 mm (13") 10,000 Unit
MC74VHC1GT04DTT1	MC	74	VHC1G	T04	DT	T1	TSOPS / SOT-23 / SC-59	178 mm (7") 3000 Unit
MC74VHC1GT04DTT3	MC	74	VHC1G	T04	DT	T3	TSOPS / SOT-23 / SC-59	330 mm (13") 10,000 Unit

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**Figure 6. Carrier Tape Specifications**

## EMBOSSED CARRIER DIMENSIONS (See Notes 7. and 8.)

Tape Size	$B_1$ Max	D	$D_1$	E	F	K	P	$P_0$	$P_2$	R	T	W
8 mm	4.35 mm (0.171")	1.5 +0.1/-0.0 mm (0.059 +0.004/-0.0")	1.0 mm Min (0.039")	1.75 $\pm 0.1$ mm (0.069 $\pm 0.004$ ")	3.5 $\pm 0.5$ mm (1.38 $\pm 0.002$ ")	2.4 mm (0.094")	4.0 $\pm 0.10$ mm (0.157 $\pm 0.004$ ")	4.0 $\pm 0.1$ mm (0.156 $\pm 0.004$ ")	2.0 $\pm 0.1$ mm (0.079 $\pm 0.002$ ")	25 mm (0.98")	0.3 $\pm 0.05$ mm (0.01 $\pm 0.0038$ /-0.0002")	8.0 $\pm 0.3$ mm (0.315 $\pm 0.012$ ")

7. Metric Dimensions Govern—English are in parentheses for reference only.

8.  $A_0$ ,  $B_0$ , and  $K_0$  are determined by component size. The clearance between the components and the cavity must be within 0.05 mm min to 0.50 mm max. The component cannot rotate more than 10° within the determined cavity

# MC74VHC1GT04

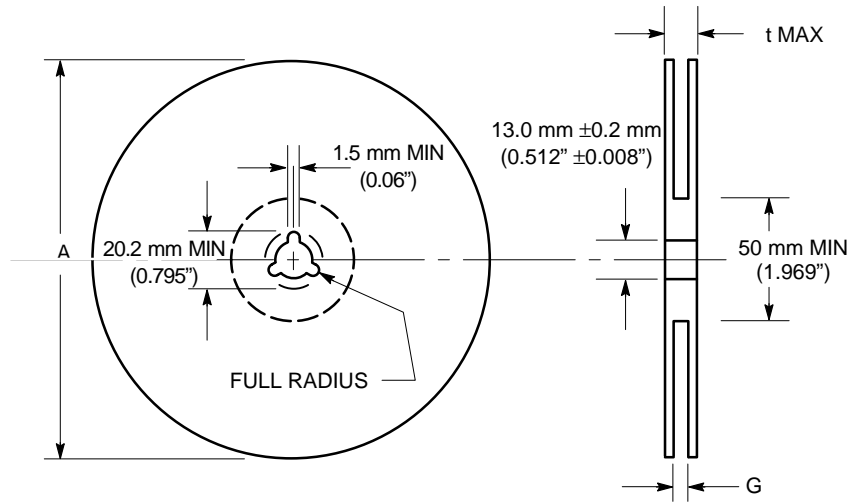


Figure 7. Reel Dimensions

## REEL DIMENSIONS

Tape Size	T&R Suffix	A Max	G	t Max
8 mm	T1, T2	178 mm (7")	8.4 mm, +1.5 mm, -0.0 (0.33" + 0.059", -0.00)	14.4 mm (0.56")
8 mm	T3, T4	330 mm (13")	8.4 mm, +1.5 mm, -0.0 (0.33" + 0.059", -0.00)	14.4 mm (0.56")

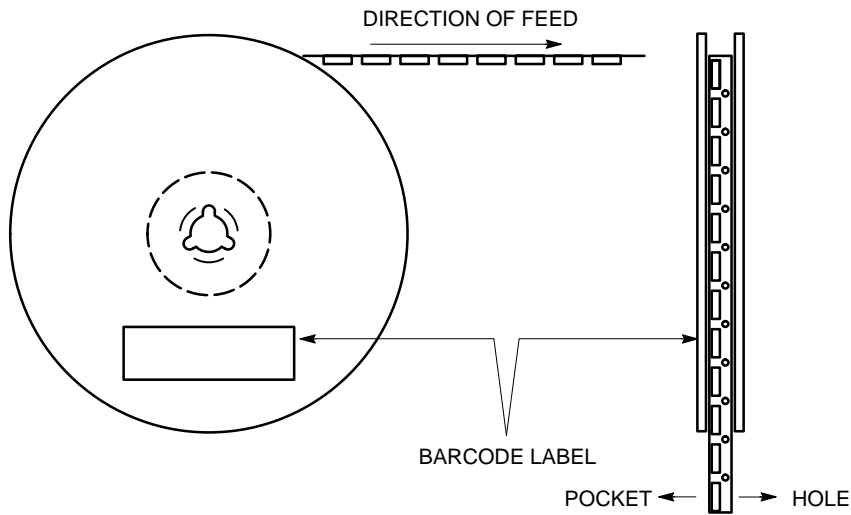
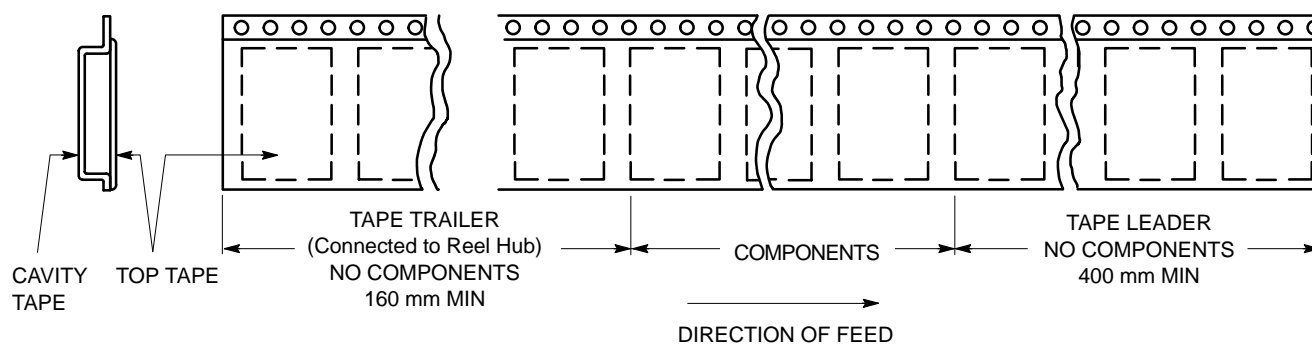
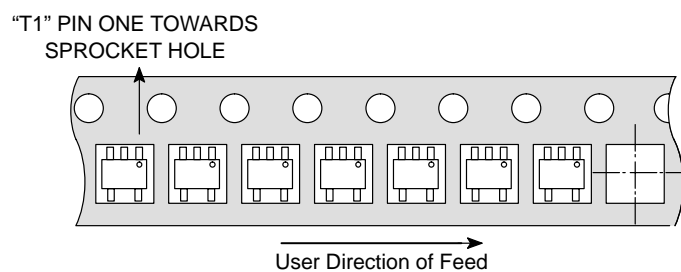


Figure 8. Reel Winding Direction

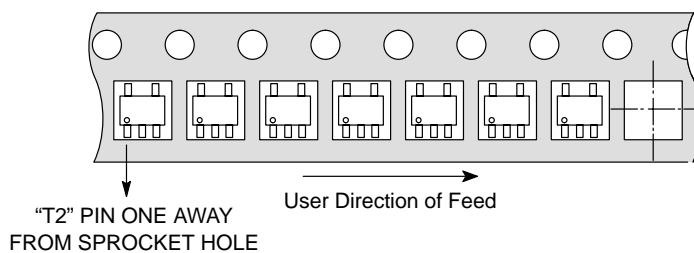
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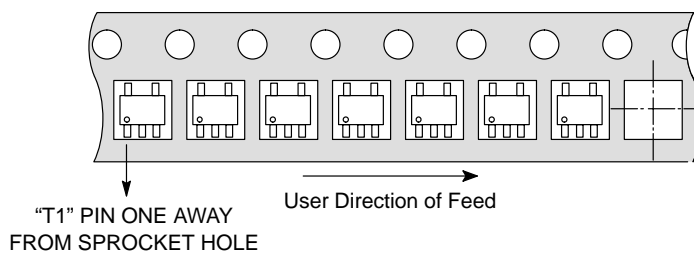
**Figure 9. Tape Ends for Finished Goods**



**Figure 10. DFT1 (SC88A) Reel Configuration/Orientation**



**Figure 11. DFT2 and DFT4 (SC88A) Reel Configuration/Orientation**

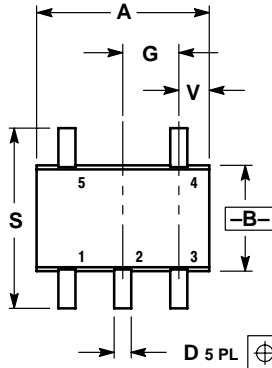


**Figure 12. DTT1 and DTT3 (TSOP5) Reel Configuration/Orientation**

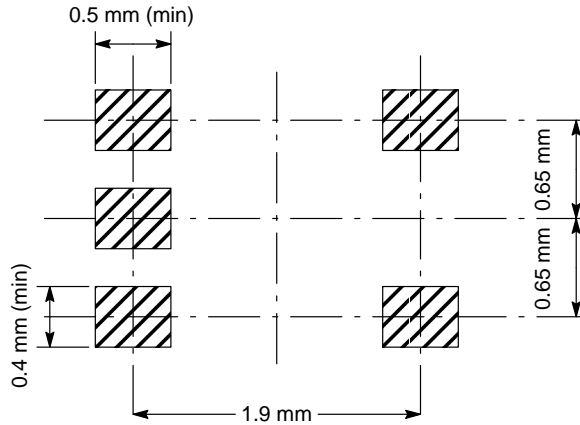
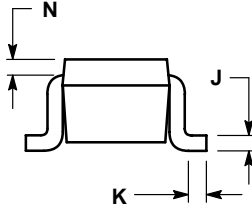
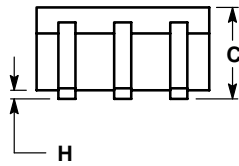
# MC74VHC1GT04

## PACKAGE DIMENSIONS

SC-88A / SOT-353 / SC-70  
DF SUFFIX  
5-LEAD PACKAGE  
CASE 419A-01  
ISSUE E



D 5 PL  $\oplus$  0.2 (0.008)  $\textcircled{M}$  B  $\textcircled{M}$



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

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
V	0.012	0.016	0.30	0.40



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## PACKAGE DIMENSIONS

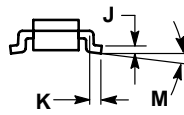
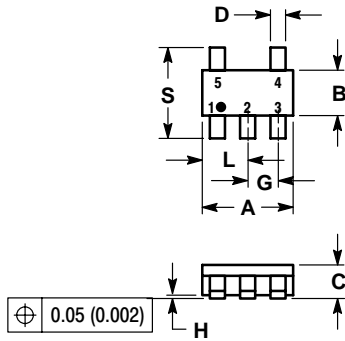
TSOP-5 / SOT-23 / SC-59

DT SUFFIX

5-LEAD PACKAGE

CASE 483-01

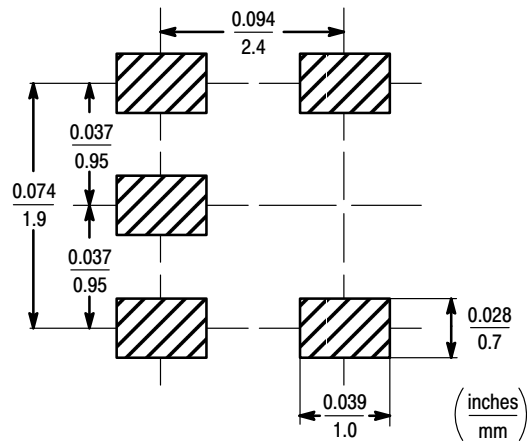
ISSUE A



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.90	3.10	0.1142	0.1220
B	1.30	1.70	0.0512	0.0669
C	0.90	1.10	0.0354	0.0433
D	0.25	0.50	0.0098	0.0197
G	0.85	1.00	0.0335	0.0413
H	0.013	0.100	0.0005	0.0040
J	0.10	0.26	0.0040	0.0102
K	0.20	0.60	0.0079	0.0236
L	1.25	1.55	0.0493	0.0610
M	0°	10°	0°	10°
S	2.50	3.00	0.0985	0.1181



## **Notes**

## **Notes**

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