FAIRCHILD SEMICONDUCTOR®

October 2001
Revised February 2003

NC7SP04
TinyLogic® ULP Inverter

General Description

The NC7SP04 is a single inverter from Fairchild's Ultra Low Power (ULP) Series of TinyLogic®. Ideal for applications where battery life is critical, this product is designed for ultra low power consumption within the V_{CC} operating range of 0.9V to 3.6V.

The internal circuit is composed of a minimum of inverter stages including the output buffer, to enable ultra low static and dynamic power.

The NC7SP04, for lower drive requirements, is uniquely designed for optimized power and speed, and is fabricated with an advanced CMOS technology to achieve best in class speed operation while maintaining extremely low CMOS power dissipation.

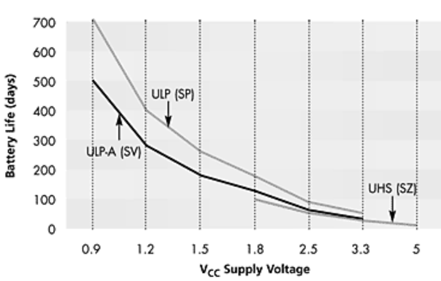
Features

- 0.9V to 3.6V V_{CC} supply operation
- 3.6V overvoltage tolerant I/O's at V_{CC} from 0.9V to 3.6V
- t_{PD}
  - 4.0 ns typ for 3.0V to 3.6V V_{CC}
  - 5.0 ns typ for 2.3V to 2.7V V_{CC}
  - 6.0 ns typ for 1.65V to 1.95V V_{CC}
  - 7.0 ns typ for 1.40V to 1.60V V_{CC}
  - 11.0 ns typ for 1.10V to 1.30V V_{CC}
  - 27.0 ns typ for 0.90V V_{CC}
- Power-Off high impedance inputs and outputs
- Static Drive (I_{OH}/I_{OL})
  - ±2.6 mA @ 3.00V V_{CC}
  - ±2.1 mA @ 2.30V V_{CC}
  - ±1.5 mA @ 1.65V V_{CC}
  - ±1.0 mA @ 1.40V V_{CC}
  - ±0.5 mA @ 1.10V V_{CC}
  - ±20 µA @ 0.9V V_{CC}
- Uses patented Quiet Series™ noise/EMI reduction circuitry
- Ultra small MicroPak™ leadfree package
- Ultra low dynamic power

Ordering Code:

Order Number	Package Number	Product Code Top Mark	Package Description	Supplied As
NC7SP04P5X	MAA05A	P04	5-Lead SC70, EIAJ SC-88a, 1.25mm Wide	3k Units on Tape and Reel
NC7SP04L6X	MAC06A	J6	6-Lead MicroPak, 1.0mm Wide	5k Units on Tape and Reel

Battery Life vs. V_{CC} Supply Voltage



TinyLogic ULP and ULP-A with up to 50% less power consumption can extend your battery life significantly.

Battery Life = ($V_{battery}$ *$I_{battery}$*.9) / (P_{device}) / 24hrs/day

Where, $P_{device} = (I_{CC} * V_{CC}) + (C_{PD} + C_L) * V_{CC}^2 * f$

Assumes ideal 3.6V Lithium Ion battery with current rating of 900mAH and derated 90% and device frequency at 10MHz, with C_L = 15 pF load

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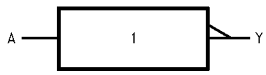
Logic Symbol

IEEE/IEC



Pin Descriptions

Pin Names	Description
A	Input
Y	Output
NC	No Connect

Function Table

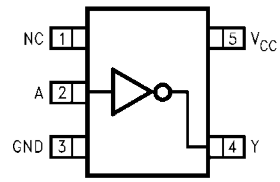
$$Y = \overline{A}$$

Inputs	Output
A	**Y**
L	H
H	L

H = HIGH Logic Level
L = LOW Logic Level

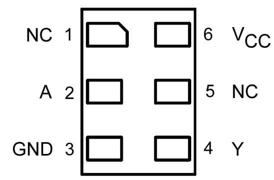
Connection Diagrams

Pin Assignments for SC70



(Top View)

Pad Assignments for MicroPak



(Top Thru View)

Absolute Maximum Ratings (Note 1)

Supply Voltage (V_{CC})	−0.5V to +4.6V
DC Input Voltage (V_{IN})	−0.5V to +4.6V
DC Output Voltage (V_{OUT})	
HIGH or LOW State (Note 2)	−0.5V to V_{CC} +0.5V
V_{CC} = 0V	−0.5V to 4.6V
DC Input Diode Current (I_{IK}) V_{IN} < 0V	±50 mA
DC Output Diode Current (I_{OK})	
V_{OUT} < 0V	−50 mA
V_{OUT} > V_{CC}	+50 mA
DC Output Source/Sink Current (I_{OH}/I_{OL})	± 50 mA
DC V_{CC} or Ground Current per Supply Pin (I_{CC} or Ground)	± 50 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C

Recommended Operating Conditions (Note 3)

Supply Voltage	0.9V to 3.6V
Input Voltage (V_{IN})	0V to 3.6V
Output Voltage (V_{OUT})	
HIGH or LOW State	0V to V_{CC}
V_{CC} = 0V	0V to 3.6V
Output Current in I_{OH}/I_{OL}	
V_{CC} = 3.0V to 3.6V	±2.6 mA
V_{CC} = 2.3V to 2.7V	± 2.1 mA
V_{CC} = 1.65V to 1.95V	± 1.5 mA
V_{CC} = 1.40V to 1.60V	± 1 mA
V_{CC} = 1.10V to 1.30V	±0.5 mA
V_{CC} = 0.9V	±20 μA
Free Air Operating Temperature (T_A)	−40°C to +85°C
Minimum Input Edge Rate (Δt/ΔV)	
V_{IN} = 0.8V to 2.0V, V_{CC} = 3.0V	10 ns/V

Note 1: 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: Unused inputs must be held HIGH or LOW. They may not float.

DC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	T_A = +25°C Min	T_A = +25°C Max	T_A = −40°C to +85°C Min	T_A = −40°C to +85°C Max	Units	Conditions
V_{IH}	HIGH Level Input Voltage	0.90	0.65 x V_{CC}		0.65 x V_{CC}		V	
		1.10 ≤ V_{CC} ≤ 1.30	0.65 x V_{CC}		0.65 x V_{CC}			
		1.40 ≤ V_{CC} ≤ 1.60	0.65 x V_{CC}		0.65 x V_{CC}			
		1.65 ≤ V_{CC} ≤ 1.95	0.65 x V_{CC}		0.65 x V_{CC}			
		2.30 ≤ V_{CC} ≤ 2.70	1.6		1.6			
		3.00 ≤ V_{CC} ≤ 3.60	2.1		2.1			
V_{IL}	LOW Level Input Voltage	0.90		0.35 x V_{CC}		0.35 x V_{CC}	V	
		1.10 ≤ V_{CC} ≤ 1.30		0.35 x V_{CC}		0.35 x V_{CC}		
		1.40 ≤ V_{CC} ≤ 1.60		0.35 x V_{CC}		0.35 x V_{CC}		
		1.65 ≤ V_{CC} ≤ 1.95		0.35 x V_{CC}		0.35 x V_{CC}		
		2.30 ≤ V_{CC} ≤ 2.70		0.7		0.7		
		3.00 ≤ V_{CC} ≤ 3.60		0.9		0.9		
V_{OH}	HIGH Level Output Voltage	0.90	V_{CC} − 0.1		V_{CC} − 0.1		V	I_{OH} = −20 μA
		1.10 ≤ V_{CC} ≤ 1.30	V_{CC} − 0.1		V_{CC} − 0.1			
		1.40 ≤ V_{CC} ≤ 1.60	V_{CC} − 0.1		V_{CC} − 0.1			
		1.65 ≤ V_{CC} ≤ 1.95	V_{CC} − 0.1		V_{CC} − 0.1			
		2.30 ≤ V_{CC} ≤ 2.70	V_{CC} − 0.1		V_{CC} − 0.1			
		3.00 ≤ V_{CC} ≤ 3.60	V_{CC} − 0.1		V_{CC} − 0.1			
		1.10 ≤ V_{CC} ≤ 1.30	0.75 x V_{CC}		0.70 x V_{CC}			I_{OH} = −0.5 mA
		1.40 ≤ V_{CC} ≤ 1.60	1.07		0.99			I_{OH} = −1 mA
		1.65 ≤ V_{CC} ≤ 1.95	1.24		1.22			I_{OH} = −1.5 mA
		2.30 ≤ V_{CC} ≤ 2.70	1.95		1.87			I_{OH} = −2.1 mA
		3.00 ≤ V_{CC} ≤ 3.60	2.61		2.55			I_{OH} = −2.6 mA

DC Electrical Characteristics (Continued)

Symbol	Parameter	V_{CC} (V)	$T_A = +25°C$ Min	$T_A = +25°C$ Max	$T_A = -40°C$ to $+85°C$ Min	$T_A = -40°C$ to $+85°C$ Max	Units	Conditions
V_{OL}	LOW Level Output Voltage	0.90		0.1		0.1	V	$I_{OL} = 20\ \mu A$
		$1.10 \leq V_{CC} \leq 1.30$		0.1		0.1		
		$1.40 \leq V_{CC} \leq 1.60$		0.1		0.1		
		$1.65 \leq V_{CC} \leq 1.95$		0.1		0.1		
		$2.30 \leq V_{CC} \leq 2.70$		0.1		0.1		
		$3.00 \leq V_{CC} \leq 3.60$		0.1		0.1		
		$1.10 \leq V_{CC} \leq 1.30$		0.30 x V_{CC}		0.30 x V_{CC}		$I_{OL} = 0.5$ mA
		$1.40 \leq V_{CC} \leq 1.60$		0.31		0.37		$I_{OL} = 1$ mA
		$1.65 \leq V_{CC} \leq 1.95$		0.31		0.35		$I_{OL} = 1.5$ mA
		$2.30 \leq V_{CC} \leq 2.70$		0.31		0.33		$I_{OL} = 2.1$ mA
		$3.00 \leq V_{CC} \leq 3.60$		0.31		0.33		$I_{OL} = 2.6$ mA
I_{IN}	Input Leakage Current	0.90 to 3.60		±0.1		±0.9	µA	$0 \leq V_I \leq 3.6V$
I_{OFF}	Power Off Leakage Current	0		1		5	µA	$0 \leq (V_I, V_O) \leq 3.6V$
I_{CC}	Quiescent Supply Current	0.90 to 3.60		0.9		5.0	µA	$V_I = V_{CC}$ or GND

AC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	$T_A = +25°C$ Min	$T_A = +25°C$ Typ	$T_A = +25°C$ Max	$T_A = -40°C$ to $+85°C$ Min	$T_A = -40°C$ to $+85°C$ Max	Units	Conditions	Figure Number
t_{PHL}, t_{PLH}	Propagation Delay	0.90		27				ns	$C_L = 10$ pF, $R_L = 1\ M\Omega$	Figures 1, 2
		$1.10 \leq V_{CC} \leq 1.30$	3.5	11	21.8	3.0	34.3			
		$1.40 \leq V_{CC} \leq 1.60$	2.5	7	14.8	2.0	15.0			
		$1.65 \leq V_{CC} \leq 1.95$	2.0	6	12.0	1.5	12.2			
		$2.30 \leq V_{CC} \leq 2.70$	1.5	5	9.4	1.0	9.9			
		$3.00 \leq V_{CC} \leq 3.60$	1.0	4	8.3	1.0	9.0			
t_{PHL}, t_{PLH}	Propagation Delay	0.90		30				ns	$C_L = 15$ pF, $R_L = 1\ M\Omega$	Figures 1, 2
		$1.10 \leq V_{CC} \leq 1.30$	4.0	11	22.8	3.5	37.3			
		$1.40 \leq V_{CC} \leq 1.60$	3.0	8	15.5	2.5	16.5			
		$1.65 \leq V_{CC} \leq 1.95$	2.5	6	12.6	2.0	13.6			
		$2.30 \leq V_{CC} \leq 2.70$	2.0	5	9.9	1.5	10.8			
		$3.00 \leq V_{CC} \leq 3.60$	1.5	4	8.7	1.0	9.5			
t_{PHL}, t_{PLH}	Propagation Delay	0.90		32				ns	$C_L = 30$ pF, $R_L = 1\ M\Omega$	Figures 1, 2
		$1.10 \leq V_{CC} \leq 1.30$	5.0	13	25.9	4.0	46.3			
		$1.40 \leq V_{CC} \leq 1.60$	4.0	9	17.8	3.5	18.2			
		$1.65 \leq V_{CC} \leq 1.95$	3.0	7	14.4	2.0	15.9			
		$2.30 \leq V_{CC} \leq 2.70$	2.0	6	11.3	1.5	12.8			
		$3.00 \leq V_{CC} \leq 3.60$	1.5	5	9.2	1.0	10.7			
C_{IN}	Input Capacitance	0		2.0				pF		
C_{OUT}	Output Capacitance	0		4.0				pF		
C_{PD}	Power Dissipation Capacitance	0.9 to 3.60		8				pF	$V_I = 0V$ or V_{CC}, f = 10 MHz	

AC Loading and Waveforms

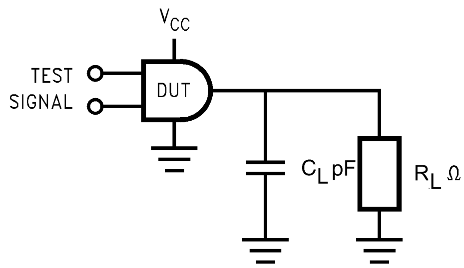


FIGURE 1. AC Test Circuit

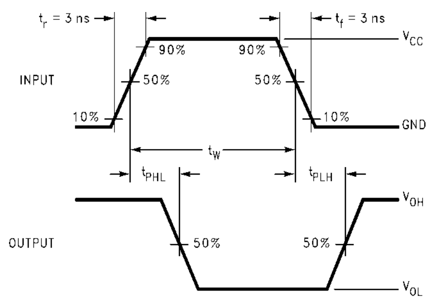


FIGURE 2. AC Waveforms

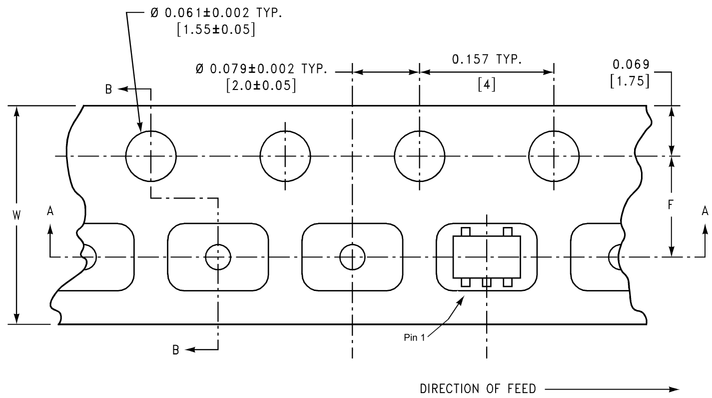
Symbol	V_{CC}					
	3.3V ± 0.3V	**2.5V ± 0.2V**	**1.8V ± 0.15V**	**1.5V ± 0.10V**	**1.2V ± 0.10V**	**0.9V**
V_{mi}	1.5V	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$
V_{mo}	1.5V	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$

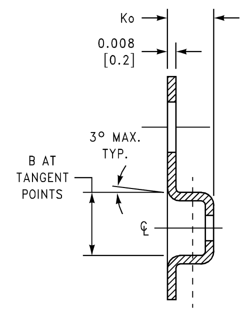
Tape and Reel Specification

TAPE FORMAT for SC70

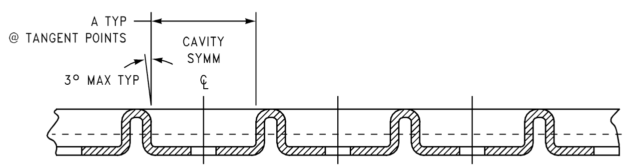
Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
P5X	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	3000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

TAPE DIMENSIONS inches (millimeters)

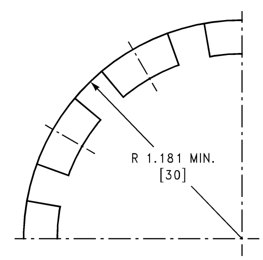




SECTION B-B



SECTION A-A



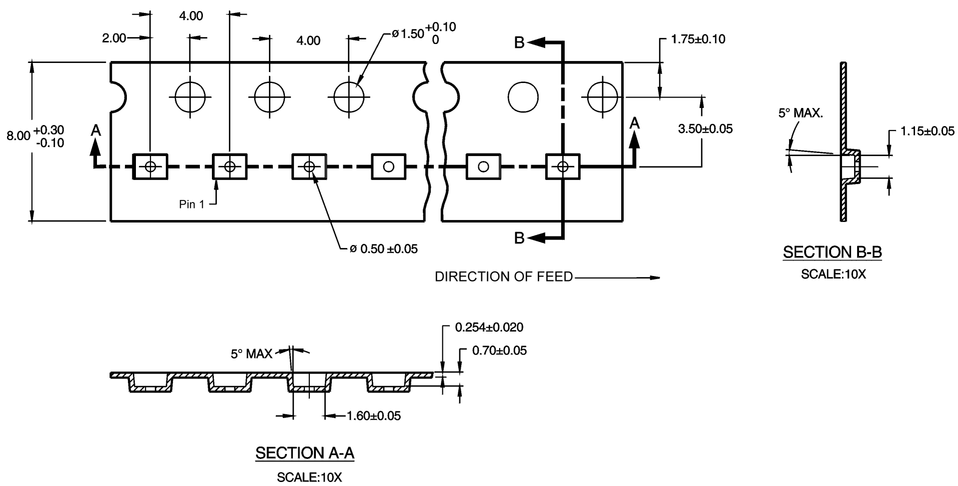
BEND RADIUS NOT TO SCALE

Tape and Reel Specification (Continued)

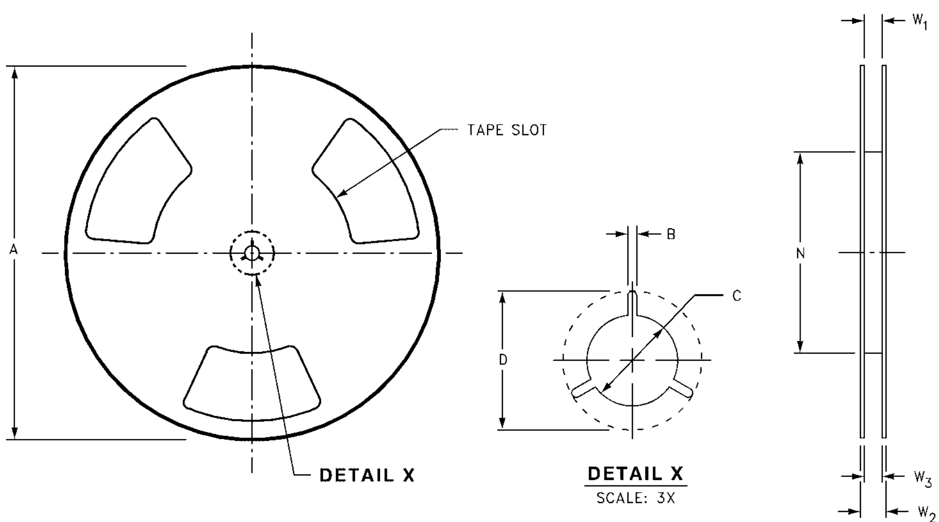
TAPE FORMAT for MicroPak

Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
L6X	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	5000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

TAPE DIMENSIONS inches (millimeters)

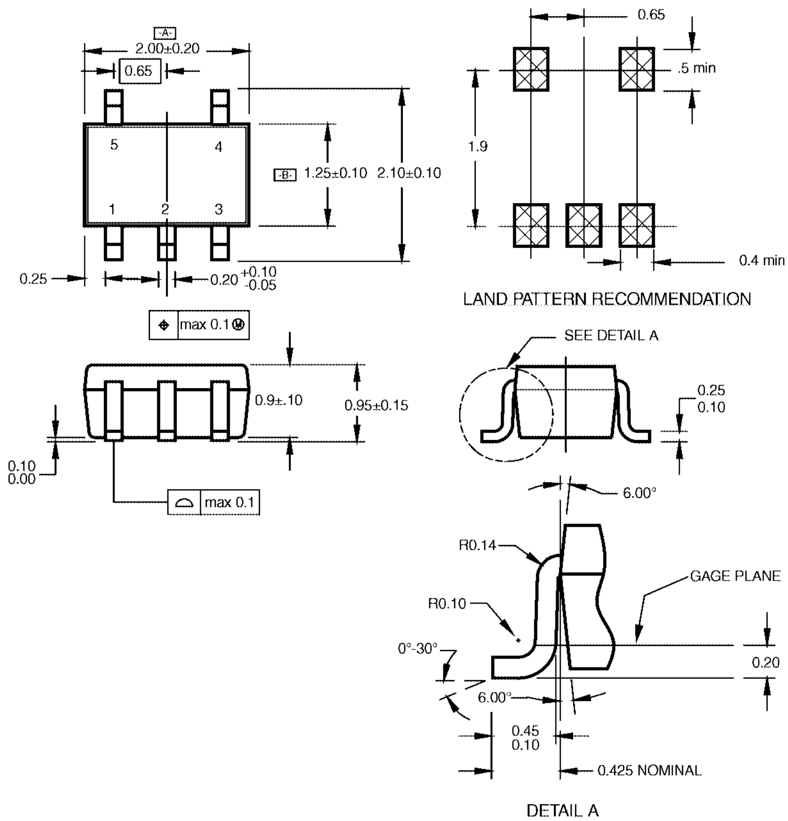


REEL DIMENSIONS inches (millimeters)



Tape Size	A	B	C	D	N	W1	W2	W3
8 mm	7.0 (177.8)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	2.165 (55.00)	0.331 + 0.059/–0.000 (8.40 + 1.50/–0.00)	0.567 (14.40)	W1 + 0.078/–0.039 (W1 + 2.00/–1.00)

Physical Dimensions inches (millimeters) unless otherwise noted



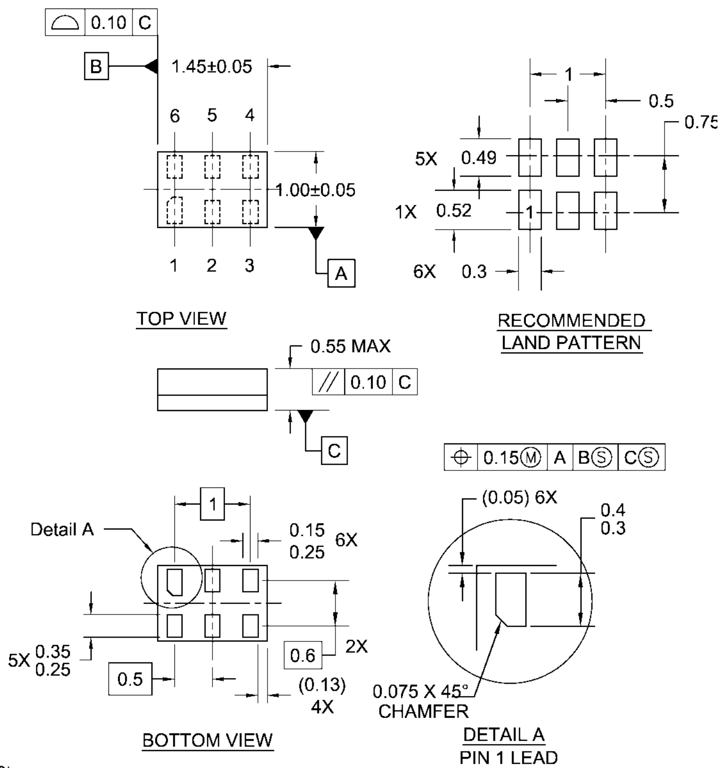
NOTES:

A. CONFORMS TO EIAJ REGISTERED OUTLINE DRAWING SC88A.
B. DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH.
C. DIMENSIONS ARE IN MILLIMETERS.

MAA05ARevC

5-Lead SC70, EIAJ SC-88a, 1.25mm Wide
Package Number MAA05A

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



Notes:

1. JEDEC PACKAGE REGISTRATION IS ANTICIPATED
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-1994

MAC06ARevB

6-Lead MicroPak, 1.0mm Wide
Package Number MAC06A