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June 2002 Revised March 2004

NC7SPU04

TinyLogic® ULP Unbuffered Inverter

General Description

The NC7SPU04 is a single unbuffered 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 $V_{CC}. \label{eq:cc}$

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

The NC7SPU04, 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 $V_{\rm CC}$

- 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 $V_{\mbox{\footnotesize CC}}$

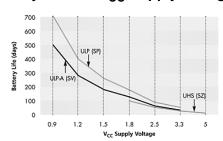
 $\pm 10~\mu A$ ~ @ 0.9V V_{CC}

- Uses proprietary 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
NC7SPU04P5X	MAA05A	PU4	5-Lead SC70, EIAJ SC-88a, 1.25mm Wide	3k Units on Tape and Reel
NC7SPU04L6X	MAC06A	N3	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 = $(V_{battery} *l_{battery} *l_{battery}$

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

Pin Descriptions

Pin Names	Description
Α	Input
Y	Output
NC	No Connect

Function Table

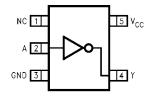
		_
Υ	=	Α

Input	Output
Α	Y
L	Н
Н	L

H = HIGH Logic Level L = LOW Logic Level

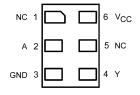
Connection Diagrams

Pin Assignments for SC70



(Top View)

Pad Assignments for MicroPak



(Top Thru View)

Absolute Maximum Ratings(Note 1)

 $\begin{array}{lll} \mbox{Supply Voltage (V$_{CC}$)} & -0.5 \mbox{V to } +4.6 \mbox{V} \\ \mbox{DC Input Voltage (V$_{IN}$)} & -0.5 \mbox{V to } +4.6 \mbox{V} \\ \end{array}$

DC Output Voltage (V_{OUT})

 $\label{eq:VCC} \begin{array}{ll} \mbox{HIGH or LOW State (Note 2)} & -0.5\mbox{V to V}_{CC} + 0.5\mbox{V} \\ \mbox{V}_{CC} = 0\mbox{V} & -0.5\mbox{V to 4.6\mbox{V}} \\ \mbox{DC Input Diode Current (I}_{IK})\mbox{V}_{IN} < 0\mbox{V} & \pm 50\mbox{ mA} \\ \end{array}$

DC Output Diode Current (I_{OK})

 $\begin{array}{c} \rm V_{OUT} > 0V & -50~mA \\ \\ \rm V_{OUT} < V_{CC} & +50~mA \\ \\ \rm DC~Output~Source/Sink~Current~(I_{OH}/I_{OL}) & \pm~50~mA \\ \end{array}$

 $\operatorname{DC}\operatorname{V}_{\operatorname{CC}}$ or Ground Current per

Supply Pin (I_{CC} or Ground) \pm 50 mA Storage Temperature Range (T_{STG}) -65° C to +150 $^{\circ}$ 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 $$\rm OV\ to\ V_{CC}$$ $\rm V_{CC}=\rm OV$ $\rm OV\ to\ 3.6V$

Output Current in I_{OH}/I_{OL}

 $\begin{array}{lll} {\rm V_{CC}} = 3.0 {\rm V} \; {\rm to} \; 3.6 {\rm V} & & \pm 2.6 \; {\rm mA} \\ {\rm V_{CC}} = 2.3 {\rm V} \; {\rm to} \; 2.7 {\rm V} & & \pm 2.1 \; {\rm mA} \\ {\rm V_{CC}} = 1.65 {\rm V} \; {\rm to} \; 1.95 {\rm V} & & \pm 1.5 \; {\rm mA} \\ \end{array}$

 $\begin{array}{lll} V_{CC} = 1.40 V \ to \ 1.60 V & \pm 1 \ mA \\ \\ V_{CC} = 1.10 V \ to \ 1.30 V & \pm 0.5 \ mA \\ \\ V_{CC} = 0.9 V & \pm 20 \ \mu A \end{array}$

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: IO 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}	T _A = -	⊦25°C	$^{\circ}$ C $T_{A} = -40^{\circ}$ C to $+85^{\circ}$ C		Units	Conditions
Symbol		(V)	Min	Max	Min	Max	Units	Conditions
V _{IH}	HIGH Level	0.90	0.8 x V _{CC}		0.8 x V _{CC}			
	Input Voltage	$1.10 \le V_{CC} \le 1.30$	0.8 x V _{CC}		0.8 x V _{CC}			
		$1.40 \le V_{CC} \le 1.60$	0.8 x V _{CC}		0.8 x V _{CC}		V	
		$1.65 \le V_{CC} \le 1.95$	0.8 x V _{CC}		0.8 x V _{CC}		v	
		$2.30 \leq V_{CC} \leq 2.70$	0.8 x V _{CC}		0.8 x V _{CC}			
		$3.00 \leq V_{CC} \leq 3.60$	0.8 x V _{CC}		0.8 x V _{CC}			
V _{IL}	LOW Level	0.90		0.2 x V _{CC}		0.2 x V _{CC}		
	Input Voltage	$1.10 \leq V_{CC} \leq 1.30$		$0.2 \times V_{\rm CC}$		$0.2 \times V_{\rm CC}$		
		$1.40 \leq V_{CC} \leq 1.60$		$0.2 \times V_{CC}$		$0.2 \times V_{\rm CC}$	V	
		$1.65 \leq V_{CC} \leq 1.95$		$0.2 \times V_{CC}$		$0.2 \times V_{\rm CC}$	v	
		$2.30 \leq V_{CC} \leq 2.70$		$0.2 \times V_{CC}$		$0.2 \times V_{\rm CC}$		
		$3.00 \leq V_{CC} \leq 3.60$		$0.2 \times V_{\rm CC}$		$0.2 \times V_{\rm CC}$		
V _{OH}	HIGH Level	0.90	V _{CC} - 0.2		V _{CC} - 0.2			$I_{OH} = -10 \mu A$
	Output Voltage	$1.10 \le V_{CC} \le 1.30$	V _{CC} - 0.2		V _{CC} - 0.2			
		$1.40 \leq V_{CC} \leq 1.60$	$V_{CC} - 0.2$		V _{CC} - 0.2			
		$1.65 \le V_{CC} \le 1.95$	$V_{CC} - 0.2$		V _{CC} - 0.2			$I_{OH} = -20 \mu A$
		$2.30 \le V_{CC} \le 2.70$	$V_{CC} - 0.2$		V _{CC} - 0.2			
		$3.00 \le V_{CC} \le 3.60$	$V_{CC} - 0.2$		V _{CC} - 0.2		V	
		$1.10 \le V_{CC} \le 1.30$	0.75 x V _{CC}		0.70 x V _{CC}			$I_{OH} = -0.5 \text{ mA}$
		$1.40 \le V_{CC} \le 1.60$	1.07		0.99			$I_{OH} = -1 \text{ mA}$
		$1.65 \le V_{CC} \le 1.95$	1.24		1.22			$I_{OH} = -1.5 \text{ mA}$
		$2.30 \le V_{CC} \le 2.70$	1.95		1.87			$I_{OH} = -2.1 \text{ mA}$
		$3.00 \le V_{CC} \le 3.60$	2.61		2.55			I _{OH} = -2.6 mA

DC Electrical Characteristics (Continued)

Symbol	Parameter	V _{CC}	$T_A = +$	$T_A = +25^{\circ}C$		$T_A = -40^{\circ}C \text{ to } +85^{\circ}C$		Conditions
		(V)	Min	Max	Min	Max	Units	Conditions
V _{OL}	LOW Level	0.90		0.1		0.1		$I_{OL} = 10 \mu A$
	Output Voltage	$1.10 \le V_{CC} \le 1.30$		0.1		0.1		
		$1.40 \le V_{CC} \le 1.60$		0.1		0.1		
		$1.65 \leq V_{CC} \leq 1.95$		0.1		0.1		$I_{OL} = 20 \ \mu A$
		$2.30 \leq V_{CC} \leq 2.70$		0.1		0.1		
		$3.00 \leq V_{CC} \leq 3.60$		0.1		0.1	V	
		$1.10 \le V_{CC} \le 1.30$		0.30 x V _{CC}		0.30 x V _{CC}		$I_{OL} = 0.5 \text{ mA}$
		$1.40 \le V_{CC} \le 1.60$		0.31		0.37		I _{OL} = 1 mA
		$1.65 \le V_{CC} \le 1.95$		0.31		0.35		I _{OL} = 1.5 mA
		$2.30 \le V_{CC} \le 2.70$		0.31		0.33		I _{OL} = 2.1 mA
		$3.00 \le V_{CC} \le 3.60$		0.31		0.33		I _{OL} = 2.6 mA
I _{IN}	Input Leakage Current	0.90 to 3.60		±0.1		±0.5	μΑ	$0 \le V_I \le 3.6V$
I _{CC}	Quiescent Supply Current	0.90 to 3.60		0.9		0.9	μΑ	$V_I = V_{CC}$ or GND

AC Electrical Characteristics

Symbol	Parameter	V _{cc}	$T_A = +25^{\circ}C$		$T_A = -40^{\circ}C \text{ to } +85^{\circ}C$		Units	Conditions	Figure		
Symbol		(V)	Min	Тур	Max	Min	Max	Units	Conditions	Number	
t _{PHL}	Propagation Delay	0.90		27							
t _{PLH}		$1.10 \le V_{CC} \le 1.30$	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	ns	C _L = 10 pF	Figures	
		$1.65 \le V_{CC} \le 1.95$	2.0	6	12.0	1.5	12.2	115	$R_L = 1 M\Omega$	1, 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}	Propagation Delay	0.90		30							
t _{PLH}		$1.10 \le V_{CC} \le 1.30$	4.0	11	22.8	3.5	37.3			Figures 1, 2	
		$1.40 \leq V_{CC} \leq 1.60$	3.0	8	15.5	2.5	16.5	ns	C _L = 15 pF		
		$1.65 \leq V_{CC} \leq 1.95$	2.5	6	12.6	2.0	13.6	115	$R_L = 1 M\Omega$		
		$2.30 \leq V_{CC} \leq 2.70$	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}	Propagation Delay	0.90		32							
t _{PLH}		$1.10 \le V_{CC} \le 1.30$	5.0	13	25.9	4.0	46.3				
		$1.40 \le V_{CC} \le 1.60$	4.0	9	17.8	3.5	18.2	ns	C _L = 30 pF	Figures	
		$1.65 \leq V_{CC} \leq 1.95$	3.0	7	14.4	2.0	15.9	115	$R_L = 1 M\Omega$	1, 2	
		$2.30 \leq V_{CC} \leq 2.70$	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	0.9 to 3.60		8				pF	$V_I = 0V \text{ or } V_{CC}$		
	Capacitance	0.0 10 0.00		<u> </u>				Pi	f = 10 MHz		

AC Loading and Waveforms

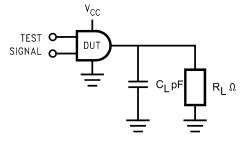


FIGURE 1. AC Test Circuit

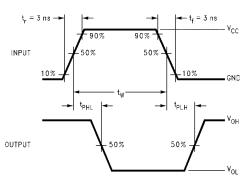
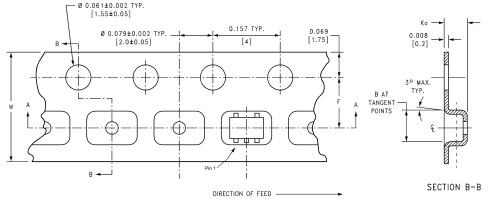
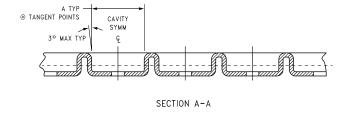


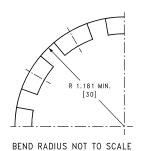
FIGURE 2. AC Waveforms

Symbol	V _{CC}									
0,	$3.3V \pm 0.3V$	2.5V ± 0.2V 1.8	$1.8V \pm 0.15V$	$1.5V \pm 0.10V$	1.2V \pm 0.10V	0.9V				
V _{mi}	1.5V	V _{CC} /2								
V _{mo}	1.5V	V _{CC} /2								

Tape and Reel Specification TAPE FORMAT for SC70 Package Tape Number Cavity Cover Tape Designator Section Cavities Status Status Leader (Start End) 125 (typ) Empty Sealed P5X 3000 Filled Sealed Carrier Trailer (Hub End) Sealed 75 (typ) Empty TAPE DIMENSIONS inches (millimeters) Ø 0.061±0.002 TYP. [1.55±0.05]







Tape and Reel Specification (Continued) TAPE FORMAT for MicroPak Package Tape Number Cavity Cover Tape Status Designator Section Cavities Status Leader (Start End) Sealed 125 (typ) Empty L6X Carrier 5000 Filled Sealed Trailer (Hub End) 75 (typ) **Empty** Sealed TAPE DIMENSIONS inches (millimeters) 1.75±0.10 3.50±0.05 8.00 +0.30 -0.10 1.15±0.05 -ø 0.50 ±0.05 SECTION B-B DIRECTION OF FEED-SCALE:10X 0.254±0.020 ┌ 0.70±0.05 5° MAX 1.60±0.05 SECTION A-A SCALE:10X **REEL DIMENSIONS** inches (millimeters) TAPE SLOT **DETAIL X DETAIL X** SCALE: 3X В N W1 W2 W3 Tape С D Α Size 7.0 0.059 0.512 0.795 2.165 0.331 + 0.059/-0.000 0.567 W1 + 0.078/-0.039 8 mm (177.8) (1.50)(13.00)(20.20) (55.00) (8.40 + 1.50/-0.00) (W1 + 2.00/-1.00)(14.40)

Physical Dimensions inches (millimeters) unless otherwise noted 0.65 0.65 0.20 0.05 0.25 0.20 0.20 0.20 0.30 0.30 0.4 min LAND PATTERN RECOMMENDATION SEE DETAIL A 0.25 0.10 0.30 0.45 0.45 0.45 0.425 NOMINAL

NOTES:

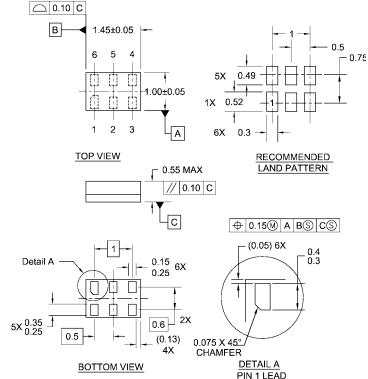
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- B. DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH.
- C. DIMENSIONS ARE IN MILLIMETERS.

MAA05ARevC

DETAIL A

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

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74LVC06ADTR2G 74LVC04ADR2G NLV37WZ04USG NLX3G14FMUTCG NL17SZ04P5T5G NLV17SG14DFT2G 74ACT14SC
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