

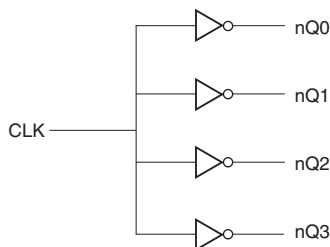
**GENERAL DESCRIPTION**

The 8304-01 is a low skew, 1-to-4 Inverting Fanout Buffer. The 8304-01 is characterized at full 3.3V for input  $V_{DD}$ , and mixed 3.3V and 2.5V for output operating supply modes ( $V_{DDO}$ ). Guaranteed output and part-to-part skew characteristics make the 8304-01 ideal for those clock distribution applications demanding well defined performance and repeatability.

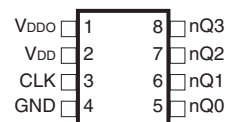
**FEATURES**

- 4 LVCMOS / LVTTTL outputs
- LVCMOS/LVTTTL clock input
- Maximum output frequency: 166MHz
- Output skew: 50ps (maximum)
- Part-to-part skew: 600ps (maximum)
- Small 8 lead SOIC package saves board space
- 3.3V input, outputs may be either 3.3V or 2.5V supply modes
- 0°C to 70°C ambient operating temperature
- Lead-Free package fully RoHS compliant
- **For functional replacement part use 8304AMLF**

**BLOCK DIAGRAM**



**PIN ASSIGNMENT**



**8304-01**  
**8-Lead SOIC**  
 3.8mm x 4.8mm x 1.47mm package body  
**M Package**  
 Top View

**TABLE 1. PIN DESCRIPTIONS**

Number	Name	Type		Description
1	$V_{DDO}$	Power		Output supply pin.
2	$V_{DD}$	Power		Core supply pin.
3	CLK	Input	Pulldown	LVC MOS / LV TTL clock input.
4	GND	Power		Power supply ground.
5	nQ0	Output		Inverted version of clock input. LVC MOS / LV TTL interface levels.
6	nQ1	Output		Inverted version of clock input. LVC MOS / LV TTL interface levels.
7	nQ2	Output		Inverted version of clock input. LVC MOS / LV TTL interface levels.
8	nQ3	Output		Inverted version of clock input. LVC MOS / LV TTL interface levels.

NOTE: *Pulldown* refers to internal input resistors. See Table 2, Pin Characteristics, for typical values.

**TABLE 2. PIN CHARACTERISTICS**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$C_{IN}$	Input Capacitance			4		pF
$C_{PD}$	Power Dissipation Capacitance (per output)	$V_{DD}, V_{DDO} = 3.465V$			15	pF
$R_{PULLDOWN}$	Input Pulldown Resistor			51		k $\Omega$
$R_{OUT}$	Output Impedance			7		$\Omega$

### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_{DDx}$	4.6V
Inputs, $V_{DD}$	-0.5V to $V_{DD} + 0.5V$
Outputs, $V_{DDO}$	-0.5V to $V_{DDO} + 0.5V$
Package Thermal Impedance, $\theta_{JA}$	112.7°C/W (0 lfpm)
Storage Temperature, $T_{STG}$	-65°C to 150°C

NOTE: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

**TABLE 3A. POWER SUPPLY DC CHARACTERISTICS,  $V_{DD} = V_{DDO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{DD}$	Core Supply Voltage		3.135	3.3	3.465	V
$V_{DDO}$	Output Power Supply Voltage		3.135	3.3	3.465	V
$I_{DD}$	Power Supply Current				15	mA
$I_{DDO}$	Output Supply Current				8	mA

**TABLE 3B. LVCMOS / LVTTL DC CHARACTERISTICS,  $V_{DD} = V_{DDO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage		2		$V_{DD} + 0.3$	V
$V_{IL}$	Input Low Voltage		-0.3		1.3	V
$I_{IH}$	Input High Current	$V_{DD} = V_{IN} = 3.465V$			150	$\mu A$
$I_{IL}$	Input Low Current	$V_{DD} = 3.465V, V_{IN} = 0V$	-5			$\mu A$
$V_{OH}$	Output High Voltage; NOTE 1		2.6			V
$V_{OL}$	Output Low Voltage; NOTE 1				0.5	V

NOTE 1: Outputs terminated with 50 to  $V_{DDO}/2$ . See Parameter Measurement Information Section”, “3.3V Output Load Test Circuit”.

**TABLE 4A. AC CHARACTERISTICS,  $V_{DD} = V_{DDO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Output Frequency				166	MHz
$t_{PD}$	Propagation Delay; NOTE 1	$f \leq 166MHz$	2.3		3.5	ns
tsk(o)	Output Skew; NOTE 2, 4				50	ps
tsk(pp)	Part-to-Part Skew; NOTE 3, 4				600	ps
$t_R$	Output Rise Time	30% to 70%	250		500	ps
$t_F$	Output Fall Time	30% to 70%	250		500	ps
odc	Output Duty Cycle	$f \leq 166MHz$	40		60	%

All parameters measured at 166MHz unless noted otherwise.

NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDO}/2$  of the output. Measured from the rising edge of the input to the falling edge of the output.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDO}/2$ .

NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{DDO}/2$ .

NOTE 4: This parameter is defined in accordance with JEDEC Standard 65.

**TABLE 3C. POWER SUPPLY DC CHARACTERISTICS,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{DD}$	Core Supply Voltage		3.135	3.3	3.465	V
$V_{DDO}$	Output Supply Voltage		2.375	2.5	2.625	V
$I_{DD}$	Power Supply Current				15	mA
$I_{DDO}$	Output Supply Current				8	mA

**TABLE 3D. LVCMOS / LVTTTL DC CHARACTERISTICS,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage		2		$V_{DD} + 0.3$	V
$V_{IL}$	Input Low Voltage		-0.3		1.3	V
$I_{IH}$	Input High Current	$V_{DD} = V_{IN} = 3.465V$			150	$\mu A$
$I_{IL}$	Input Low Current	$V_{DD} = 3.465V, V_{IN} = 0V$	-5			$\mu A$
$V_{OH}$	Output High Voltage; NOTE 1		2.1			V
$V_{OL}$	Output Low Voltage; NOTE 1				0.5	V

NOTE 1: Outputs terminated with  $50 \Omega$  to  $V_{DDO}/2$ . See Parameter Measurement Information Section, "3.3V/2.5V Output Load Test Circuit".

**TABLE 4B. AC CHARACTERISTICS,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Maximum Output Frequency				166	MHz
$t_{PD}$	Propagation Delay; NOTE 1	$f \leq 166MHz$	2.5		3.6	ns
tsk(o)	Output Skew; NOTE 2, 4				50	ps
tsk(pp)	Part-to-Part Skew; NOTE 3, 4				600	ps
$t_R$	Output Rise Time	30% to 70%	250		500	ps
$t_F$	Output Fall Time	30% to 70%	250		500	ps
odc	Output Duty Cycle	$f \leq 166MHz$	40		60	%

All parameters measured at 166MHz unless noted otherwise.

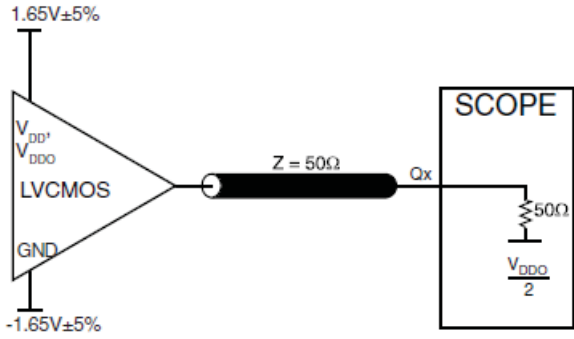
NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDO}/2$  of the output. Measured from the rising edge of the input to the falling edge of the output.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDO}/2$ .

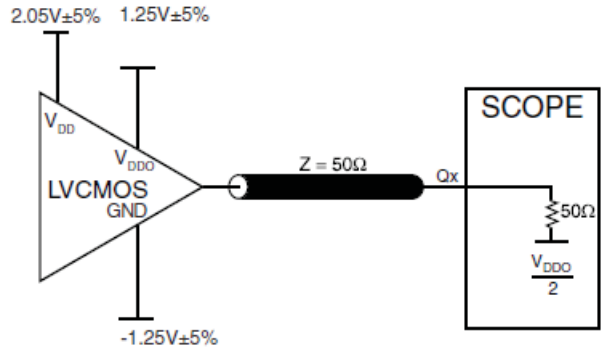
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{DDO}/2$ .

NOTE 4: This parameter is defined in accordance with JEDEC Standard 65.

## PARAMETER MEASUREMENT INFORMATION



**3.3V OUTPUT LOAD AC TEST CIRCUIT**



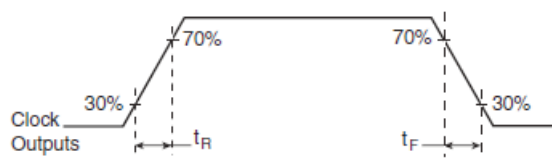
**3.3V/2.5V OUTPUT LOAD AC TEST CIRCUIT**



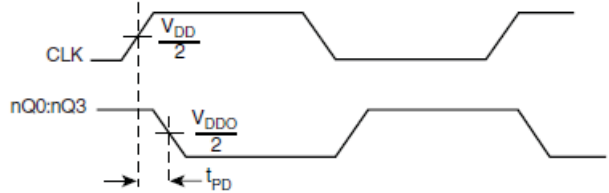
**OUTPUT SKEW**



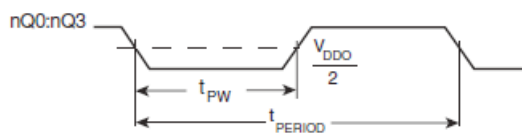
**PART-TO-PART SKEW**



**OUTPUT RISE/FALL TIME**



**PROPAGATION DELAY**



**OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD**

## RELIABILITY INFORMATION

TABLE 5.  $\theta_{JA}$  VS. AIR FLOW TABLE FOR 8 LEAD SOIC

$\theta_{JA}$ by Velocity (Linear Feet per Minute)			
	0	200	500
Single-Layer PCB, JEDEC Standard Test Boards	153.3°C/W	128.5°C/W	115.5°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	112.7°C/W	103.3°C/W	97.1°C/W

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

### TRANSISTOR COUNT

The transistor count for 8304-01 is: 416

PACKAGE OUTLINE - SUFFIX M FOR 8 LEAD SOIC

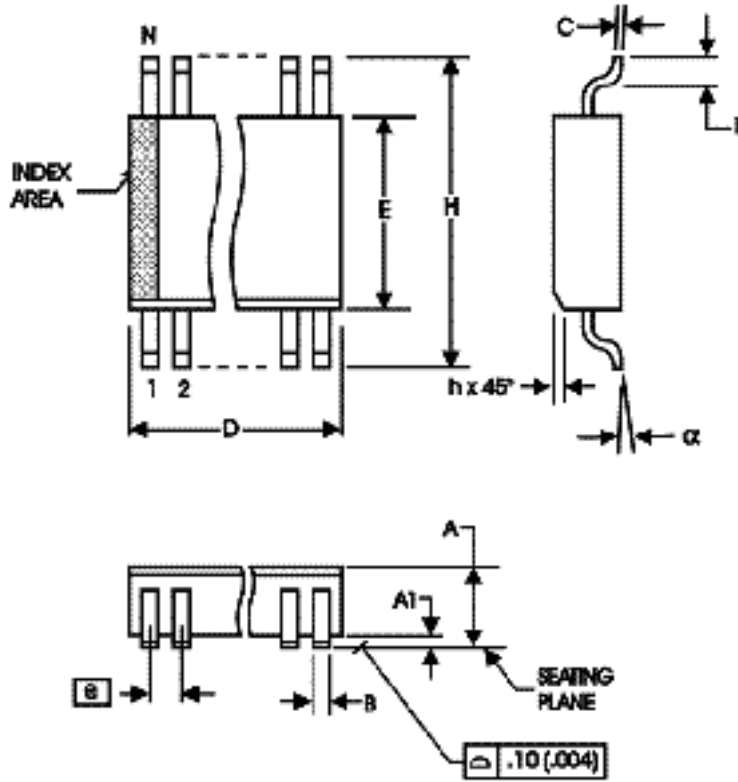


TABLE 6. PACKAGE DIMENSIONS - SUFFIX M

SYMBOL	Millimeters	
	MINIMUM	MAXIMUM
N	8	
A	1.35	1.75
A1	0.10	0.25
B	0.33	0.51
C	0.19	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BASIC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.27
$\alpha$	0°	8°

Reference Document: JEDEC Publication 95, MS-012

**TABLE 6. ORDERING INFORMATION**

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
8304AM-01LF	8304A01L	8 lead "Lead-Free" SOIC	tube	0°C to 70°C
8304AM-01LFT	8304A01L	8 lead "Lead-Free" SOIC	tape & reel	0°C to 70°C

NOTE: Parts that are ordered with an "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.



REVISION HISTORY SHEET				
Rev	Table	Page	Description of Change	Date
B	4A	3	AC Characteristics Table - revised $t_{pLH}$ row to $t_{pD}$ and revised NOTE 1.	4/9/02
	4B	4	Deleted $t_{pHL}$ row.	
	6 & 7	4	AC Characteristics Table - revised $t_{pLH}$ row to $t_{pD}$ and revised NOTE 1. Deleted $t_{pHL}$ row. Updated Figures.	
C	4A	3	AC Characteristics Table - changed $t_{sk(pp)}$ Part-to-Part Skew from 250ps Max. to 600ps Max.	5/20/02
	4B	4	AC Characteristics Table - changed $t_{sk(pp)}$ Part-to-Part Skew from 250ps Max. to 600ps Max.	
C	6	10	Ordering Information, updated marking from 8304-01 to 8304AM01	6/17/02
D	T1	2	Pin Descripton Table - revised $V_{DD}$ description to read "Core supply pin." (Also changed in Power Supply tables.) Deleted Pullup from note.	3/1/04
	T2	2	Pin Characteristics Table - $C_{IN}$ changed 4pF max. to 4pF typical. Deleted $R_{PULLUP}$ row.	
	T6	10	Ordering Information Table - changed Part/Order number ICS8304M-01/-01T to ICS8304AM-01/-01T. Updated format throughout data sheet.	
D	T6	1	Features Section - added Lead-Free bullet.	5/23/05
		8	Ordering Information Table - add Lead-Free parts.	
D	T6	8	Updated datasheet's header/footer with IDT from ICS.	7/29/10
		10	Removed ICS prefix from Part/Order Number column. Added Contact Page.	
D	T6	8	Ordering Information - removed leaded devices. Updated data sheet format.	3/19-15
D			Product Discontinuation Notice - ILast time buy expires May 6, 2017. PDN CQ-16-01.	5/9/16



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