



Integrated
Circuit
Systems, Inc.

ICS8344I-01

Low SKEW, 1-TO-24

DIFFERENTIAL-TO-LVCMOS FANOUT BUFFER

GENERAL DESCRIPTION

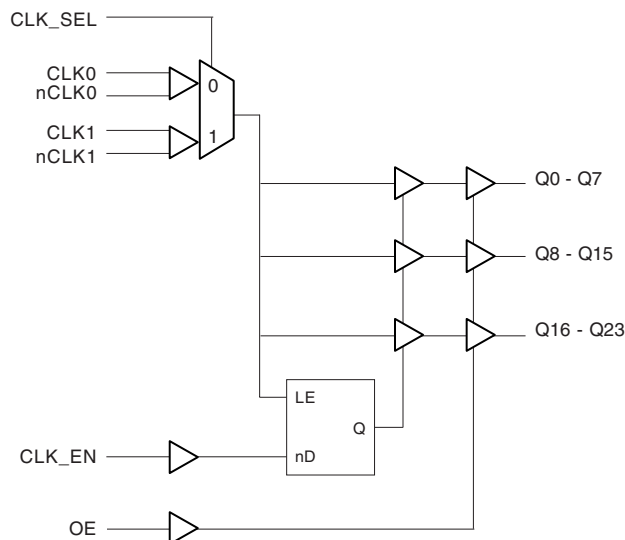
The ICS8344I-01 is a low voltage, low skew fanout buffer and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The ICS8344I-01 has two selectable clock inputs. The CLKx, nCLKx pairs can accept most standard differential input levels. The ICS8344I-01 is designed to translate any differential signal level to LVCMOS levels. The low impedance LVCMOS outputs are designed to drive 50Ω series or parallel terminated transmission lines. The effective fanout can be increased to 48 by utilizing the ability of the outputs to drive two series terminated lines. Redundant clock applications can make use of the dual clock inputs, which also facilitate board level testing. The clock enable is internally synchronized to eliminate runt pulses on the outputs during asynchronous assertion/deassertion of the clock enable pin. The outputs are driven low when disabled. The ICS8344I-01 is characterized at full 3.3V, full 2.5V and mixed 3.3V input and 2.5V output operating supply modes.

Guaranteed output and part-to-part skew characteristics make the ICS8344I-01 ideal for those clock distribution applications demanding well defined performance and repeatability.

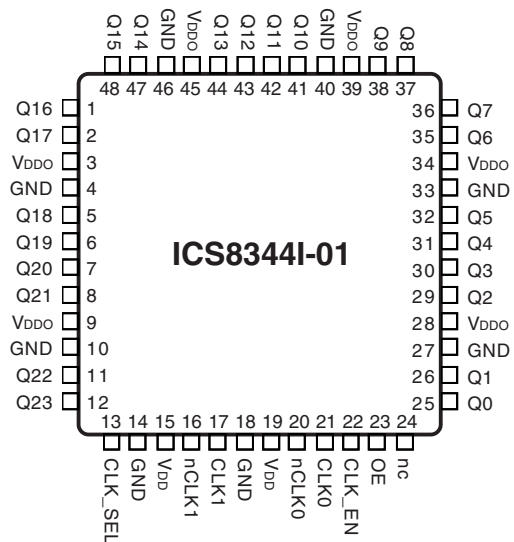
FEATURES

- 24 LVCMOS outputs, 7Ω typical output impedance
- 2 selectable CLKx, nCLKx inputs
- CLK0, nCLK0 and CLK1, nCLK1 pairs can accept the following input levels: LVDS, LVPECL, LVHSTL, SSTL, HCSL
- Output frequency up to 200MHz
- Translates any single ended input signal to LVCMOS with resistor bias on nCLK input
- Synchronous clock enable
- Output skew: 250ps (maximum)
- Part-to-part skew: 1ns (maximum)
- Bank skew: 125ps (maximum)
- Propagation delay: 5.25ns (maximum)
- 3.3V, 2.5V or mixed 3.3V, 2.5V operating supply modes
- -40°C to 85°C Industrial ambient operating temperature

BLOCK DIAGRAM



PIN ASSIGNMENT



48-Lead LQFP

7mm x 7mm x 1.4mm

Y Package

Top View

The Preliminary Information presented herein represents a product in prototyping or pre-production. The noted characteristics are based on initial product characterization. Integrated Circuit Systems, Incorporated (ICS) reserves the right to change any circuitry or specifications without notice.



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TABLE 1. PIN DESCRIPTIONS

Number	Name	Type		Description
1, 2, 5, 6 7, 8, 11, 12	Q16, Q17, Q18, Q19 Q20, Q21, Q22, Q23	Output		Q16 thru Q23 outputs. 7 Ω typical output impedance.
3, 9, 28, 34, 39, 45	V _{DDO}	Power		Output supply pins. Connect 3.3V or 2.5V.
4, 10, 14, 18, 27, 33, 40, 46	GND	Power		Power supply ground. Connect to ground.
13	CLK_SEL	Input	Pulldown	Clock select input. When HIGH, selects CLK1, nCLK inputs, When LOW, selects CLK0, nCLK0 inputs. LVCMOS / LVTTTL interface levels.
15, 19	V _{DD}	Power		Positive supply pins. Connect 3.3V or 2.5V.
16	nCLK1	Input	Pullup	Inverting differential LVPECL clock input.
17	CLK1	Input	Pulldown	Non-inverting differential LVPECL clock input.
20	nCLK0	Input	Pullup	Inverting differential LVPECL clock input.
21	CLK0	Input	Pulldown	Non-inverting differential LVPECL clock input.
22	CLK_EN	Input	Pullup	Synchronizing control for enabling and disabling clock outputs. LVCMOS interface levels.
23	OE	Input	Pullup	Output enable. Controls enabling and disabling of outputs Q0 thru Q23.
24	nc	Unused		No connect.
25, 26, 29, 30 31, 32, 35, 36	Q0, Q1, Q2, Q3 Q4, Q5, Q6, Q7	Output		Q0 thru Q7 outputs. 7 Ω typical output impedance.
37, 38, 41, 42 43, 44, 47, 48	Q8, Q9, Q10, Q11 Q12, Q13, Q14, Q15	Output		Q8 thru Q15 outputs. 7 Ω typical output impedance.

NOTE: *Pullup* and *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)					pF
R _{PULLUP}	Input Pullup Resistor			51		K Ω
R _{PULLDOWN}	Input Pulldown Resistor			51		K Ω
R _{OUT}	Output Impedance			7		Ω



TABLE 3A. OUPUT ENABLE FUNCTION TABLE

Bank 1		Bank 2		Bank 3	
Input	Output	Input	Output	Input	Output
OE	Q0-Q7	OE	Q8-Q15	OE	Q16-Q23
0	Hi-Z	0	Hi-Z	0	Hi-Z
1	Enabled	1	Enabled	1	Enabled

TABLE 3B. CLOCK SELECT FUNCTION TABLE

Control Input	Clock	
CLK_SEL	CLK0, nCLK0	CLK1, nCLK1
0	Selected	De-selected
1	De-selected	Selected

TABLE 3C. CLOCK INPUT FUNCTION TABLE

Inputs			Outputs	Input to Output Mode	Polarity
OE	CLK0, CLK1	nCLK0, nCLK1	Q0 thru Q23		
1	0	1	LOW	Differential to Single Ended	Non Inverting
1	1	0	HIGH	Differential to Single Ended	Non Inverting
1	0	Biased; NOTE 1	LOW	Single Ended to Differential	Non Inverting
1	1	Biased; NOTE 1	HIGH	Single Ended to Differential	Non Inverting
1	Biased; NOTE 1	0	HIGH	Single Ended to Differential	Inverting
1	Biased; NOTE 1	1	LOW	Single Ended to Differential	Inverting

NOTE 1: Please refer to the Application Information section on page 11, Figure 8, which discusses wiring the differential input to accept single ended levels.



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Supply Voltage, V_{DDx}	4.6V
Inputs, V_I	-0.5V to $V_{DD} + 0.5V$
Outputs, V_O	-0.5V to $V_{DDO} + 0.5V$
Package Thermal Impedance, θ_{JA}	47.9°C/W (0 lfpm)
Storage Temperature, T_{STG}	-65°C to 150°C

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 4A. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ TO $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		3.135	3.3	3.465	V
I_{DD}	Core Power Supply Current				70	mA
I_{DDO}	Output Power Supply Current				25	mA

TABLE 4B. LVCMOS DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ TO $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	CLK_SEL, CLK_EN, OE	2		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage	CLK_SEL, CLK_EN, OE	-0.3		0.8	V
I_{IH}	Input High Current	CLK_EN, OE	$V_{DD} = V_{IN} = 3.465V$		5	μA
		CLK_SEL	$V_{DD} = V_{IN} = 3.465V$		150	μA
I_{IL}	Input Low Current	CLK_EN, OE	$V_{DD} = 3.465V, V_{IN} = 0V$	-150		μA
		CLK_SEL	$V_{DD} = 3.465V, V_{IN} = 0V$	-5		μA
V_{OH}	Output High Voltage	$V_{DD} = V_{DDO} = 3.135V$ $I_{OH} = -36mA$	2.6			V
V_{OL}	Output Low Voltage	$V_{DD} = V_{DDO} = 3.135V$ $I_{OL} = 36mA$			0.5	V

TABLE 4C. DIFFERENTIAL DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ TO $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	nCLK0, nCLK1	$V_{DD} = V_{IN} = 3.465V$		5	μA
		CLK0, CLK1	$V_{DD} = V_{IN} = 3.465V$		150	μA
I_{IL}	Input Low Current	nCLK0, nCLK1	$V_{DD} = 3.465V, V_{IN} = 0V$	-150		μA
		CLK0, CLK1	$V_{DD} = 3.465V, V_{IN} = 0V$	-5		μA
V_{PP}	Peak-to-Peak Input Voltage		0.15		1.3	V
V_{CMR}	Common Mode Input Voltage: NOTE 1, 2		GND + 0.5		$V_{DD} - 0.85$	V

NOTE 1: For single ended applications, the maximum input voltage for CLK0, nCLK0 and CLK1, nCLK1 is $V_{DD} + 0.3V$.

NOTE 2: Common mode voltage is defined as V_{IH} .



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TABLE 4D. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Core Power Supply Current				70	mA
I_{DDO}	Output Power Supply Current				25	mA

TABLE 4E. LVCMOS DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	CLK_SEL, CLK_EN, OE	2		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage	CLK_SEL, CLK_EN, OE	-0.3		0.8	V
I_{IH}	Input High Current	CLK_EN, OE	$V_{DD} = V_{IN} = 3.465V$		5	μA
		CLK_SEL	$V_{DD} = V_{IN} = 3.465V$		150	μA
I_{IL}	Input Low Current	CLK_EN, OE	$V_{DD} = 3.465V, V_{IN} = 0V$	-150		μA
		CLK_SEL	$V_{DD} = 3.465V, V_{IN} = 0V$	-5		μA
V_{OH}	Output High Voltage	$V_{DD} = 3.135V$ $V_{DDO} = 2.375V$ $I_{OH} = -27\text{mA}$	1.8			V
V_{OL}	Output Low Voltage	$V_{DD} = 3.135V$ $V_{DDO} = 2.375V$ $I_{OL} = 27\text{mA}$			0.5	V

TABLE 4F. DIFFERENTIAL DC CHARACTERISTICS, $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	nCLK0, nCLK1	$V_{DD} = V_{IN} = 3.465V$		5	μA
		CLK0, CLK1	$V_{DD} = V_{IN} = 3.465V$		150	μA
I_{IL}	Input Low Current	nCLK0, nCLK1	$V_{DD} = 3.465V,$ $V_{IN} = 0V$	-150		μA
		CLK0, CLK1	$V_{DD} = 3.465V,$ $V_{IN} = 0V$	-5		μA
V_{PP}	Peak-to-Peak Input Voltage		0.15		1.3	V
V_{CMR}	Common Mode Input Voltage; NOTE 1, 2		GND + 0.5		$V_{DD} - 0.85$	V

NOTE 1: For single ended applications, the maximum input voltage for CLK0, nCLK0 and CLK1, nCLK1 is $V_{DD} + 0.3V$.

NOTE 2: Common mode voltage is defined as V_{IH} .



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TABLE 4G. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive Supply Voltage		2.375	2.5	2.625	V
V_{DDO}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Core Power Supply Current				70	mA
I_{DDO}	Output Power Supply Current				25	mA

TABLE 4H. LVCMOS DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	CLK_SEL, CLK_EN, OE	2		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage	CLK_SEL, CLK_EN, OE	-0.3		0.8	V
I_{IH}	Input High Current	CLK_EN, OE	$V_{DD} = V_{IN} = 2.625V$		5	μA
		CLK_SEL	$V_{DD} = V_{IN} = 2.625V$		150	μA
I_{IL}	Input Low Current	CLK_EN, OE	$V_{DD} = 2.625V, V_{IN} = 0V$			μA
		CLK_SEL	$V_{DD} = 2.625V, V_{IN} = 0V$			μA
V_{OH}	Output High Voltage	$V_{DD} = V_{DDO} = 2.375V$ $I_{OH} = -27\text{mA}$	1.8			V
V_{OL}	Output Low Voltage	$V_{DD} = V_{DDO} = 2.375V$ $I_{OL} = 27\text{mA}$			0.5	V

TABLE 4I. DIFFERENTIAL DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	nCLK0, nCLK1	$V_{DD} = V_{IN} = 2.625V$		5	μA
		CLK0, CLK1	$V_{DD} = V_{IN} = 2.625V$		150	μA
I_{IL}	Input Low Current	nCLK0, nCLK1	$V_{DD} = 2.625V, V_{IN} = 0V$			μA
		CLK0, CLK1	$V_{DD} = 2.625V, V_{IN} = 0V$			μA
V_{PP}	Peak-to-Peak Input Voltage		0.15		1.3	V
V_{CMR}	Common Mode Input Voltage; NOTE 1, 2		GND + 0.5		$V_{DD} - 0.85$	V

NOTE 1: For single ended applications, the maximum input voltage for CLK0, nCLK0 and CLK1, nCLK1 is $V_{DD} + 0.3V$.

NOTE 2: Common mode voltage is defined as V_{IH} .



TABLE 5. AC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$; $V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$;
 $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ TO 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency					200	MHz
t_{PD}	Propagation Delay, NOTE 1		$f \leq 200\text{MHz}$	2.5		5.25	ns
$tsk(b)$	Bank Skew; NOTE 2, 6	Q0 - Q7	Measured on the rising edge of $V_{DDO}/2$			125	ps
		Q8 - Q15				200	ps
		Q16 - Q23				175	ps
$tsk(o)$	Output Skew; NOTE 3, 6		Measured on the rising edge of $V_{DDO}/2$			250	ps
$tsk(pp)$	Part-to-Part Skew; NOTE 4, 6		Measured on the rising edge of $V_{DDO}/2$			1	ns
t_R	Output Rise Time; NOTE 5		30% to 70%	200		800	ps
t_F	Output Fall Time; NOTE 5		30% to 70%	200		800	ps
odc	Output Duty Cycle		$f \leq 200\text{MHz}$	40%		60%	%
t_{EN}	Output Enable Time; NOTE 5		$f = 10\text{MHz}$			5	ns
t_{DIS}	Output Disable Time; NOTE 5		$f = 10\text{MHz}$			4	ns

All parameters measured at 200MHz and VPptyp unless noted otherwise.

NOTE 1: Measured from the differential input crossing point to $V_{DDO}/2$.

NOTE 2: Defined as skew within a bank of outputs at the same voltages and with equal load conditions.

NOTE 3: Defined as skew across banks of outputs at the same supply voltages and with equal load conditions.

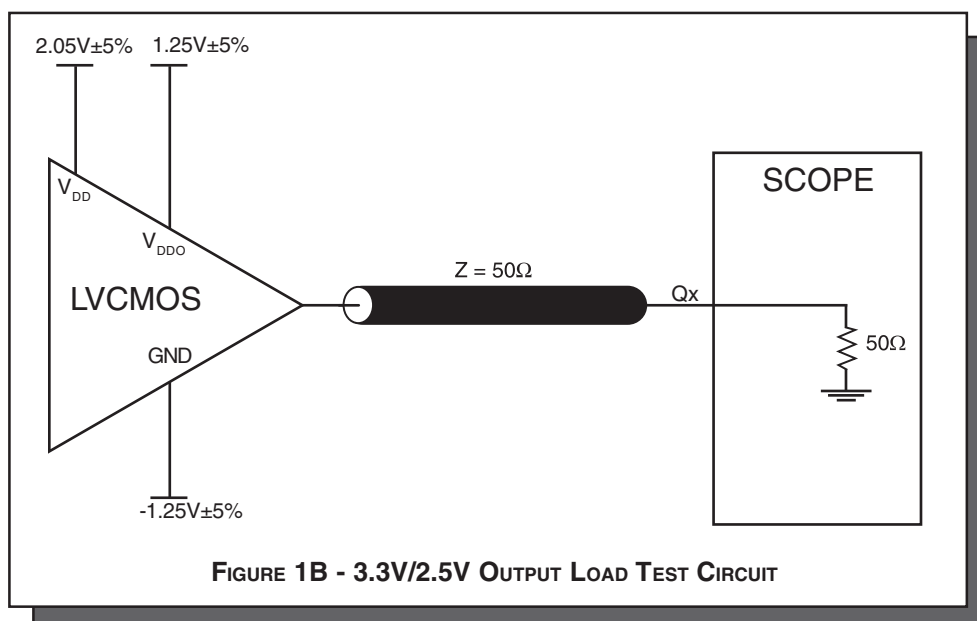
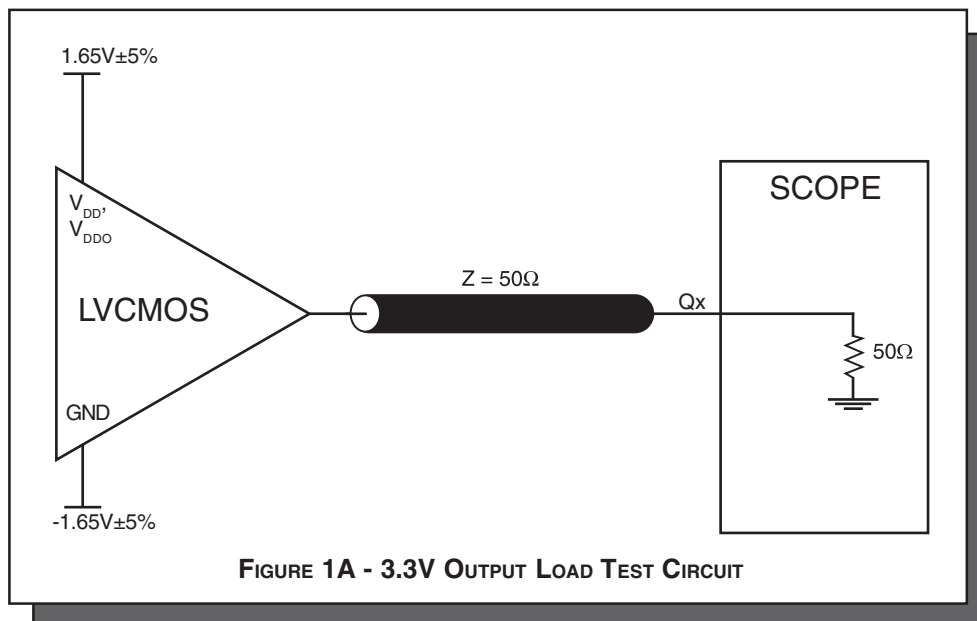
NOTE 4: Defined as between outputs at the same supply voltages and with equal load conditions. Measured at $V_{DDO}/2$.

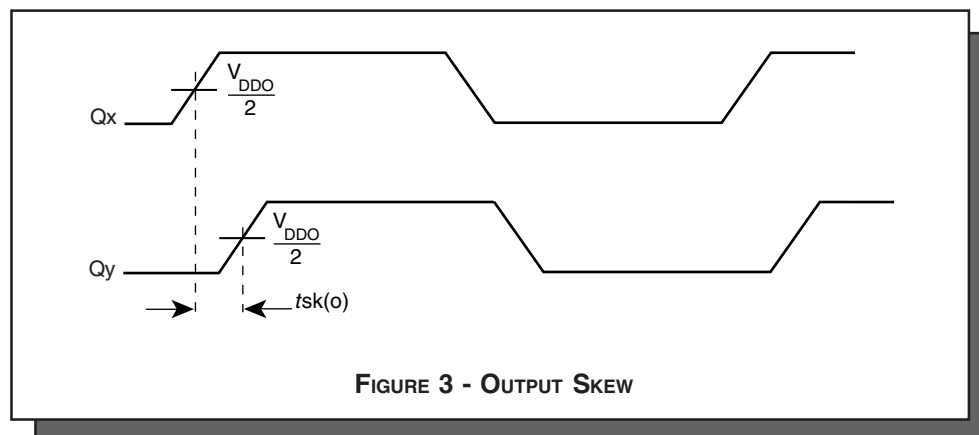
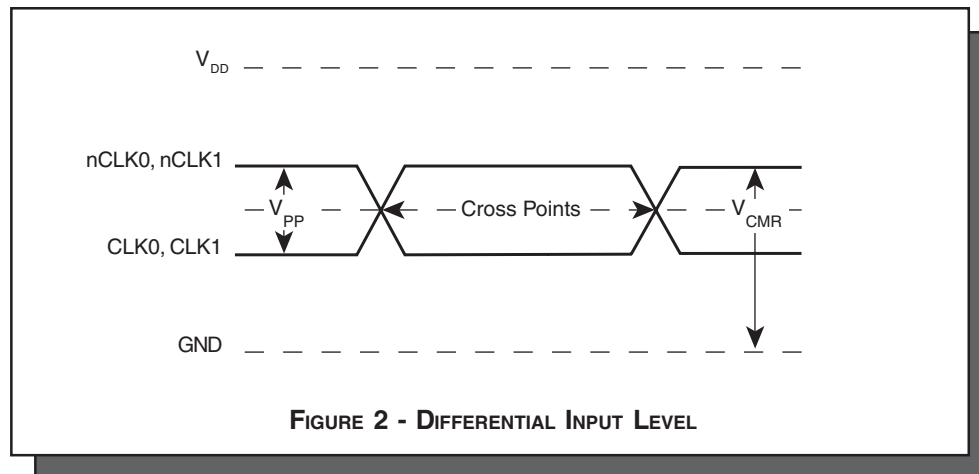
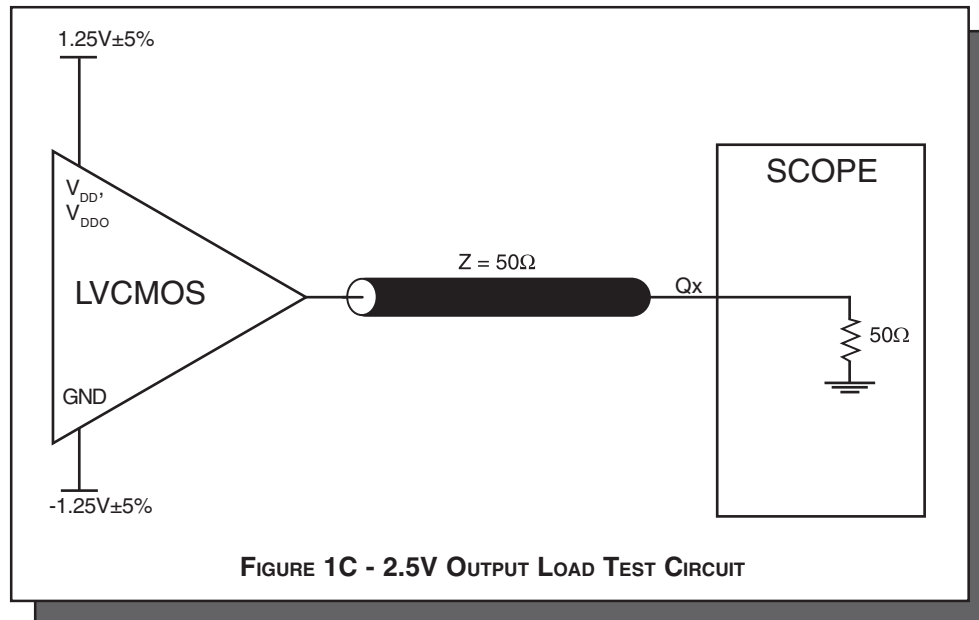
NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

NOTE 6: This parameter is defined in accordance with JEDEC Standard 65.



PARAMETER MEASUREMENT INFORMATION





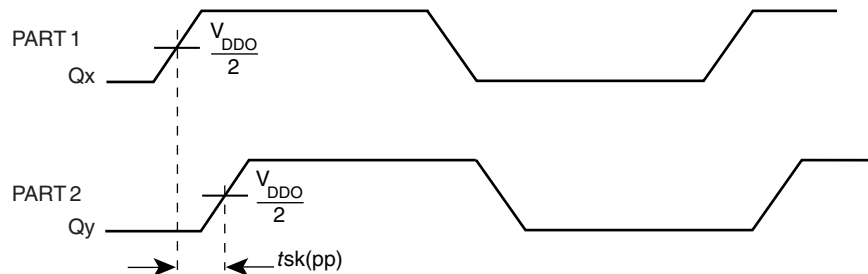


FIGURE 4 - PART-TO-PART SKEW

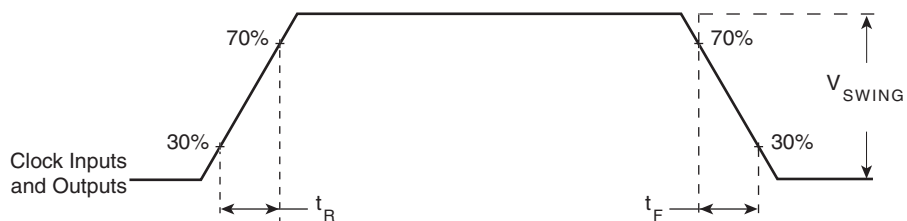


FIGURE 5 - INPUT AND OUTPUT RISE AND FALL TIME

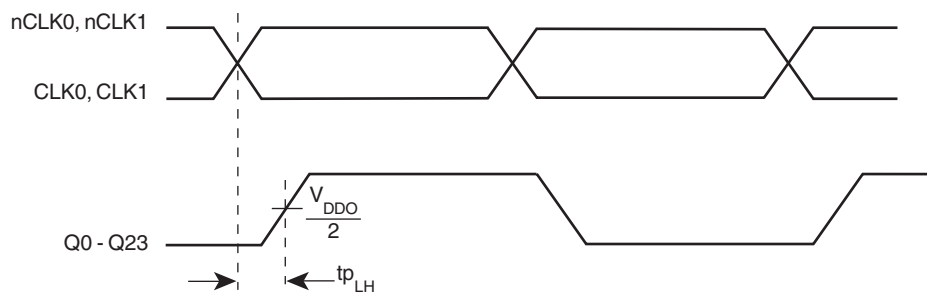


FIGURE 6 - PROPAGATION DELAY

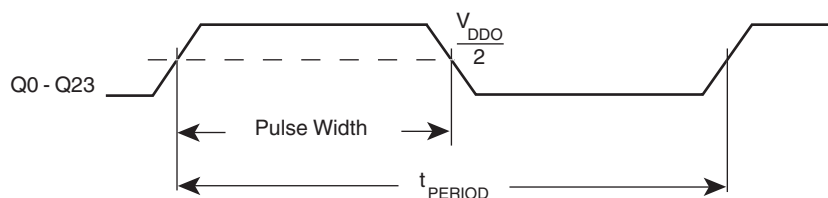


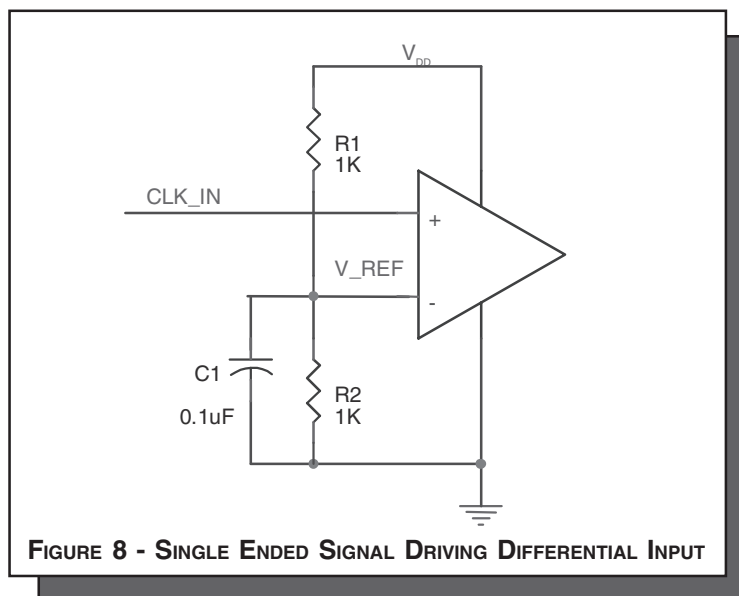
FIGURE 7 - odc & t_{PERIOD}



APPLICATION INFORMATION

WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 8 shows how the differential input can be wired to accept single ended levels. The reference voltage $V_{REF} \approx V_{DD}/2$ is generated by the bias resistors R1, R2 and C1. This bias circuit should be located as close as possible to the input pin. The ratio of R1 and R2 might need to be adjusted to position the V_{REF} in the center of the input voltage swing. For example, if the input clock swing is only 2.5V and $V_{DD} = 3.3V$, V_{REF} should be 1.25V and $R2/R1 = 0.609$.





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RELIABILITY INFORMATION

TABLE 6. θ_{JA} VS. AIR FLOW TABLE

θ_{JA} by Velocity (Linear Feet per Minute)			
	0	200	500
Single-Layer PCB, JEDEC Standard Test Boards	67.8°C/W	55.9°C/W	50.1°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	47.9°C/W	42.1°C/W	39.4°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 ICS8344I-01 is: 1503



PACKAGE OUTLINE - Y SUFFIX

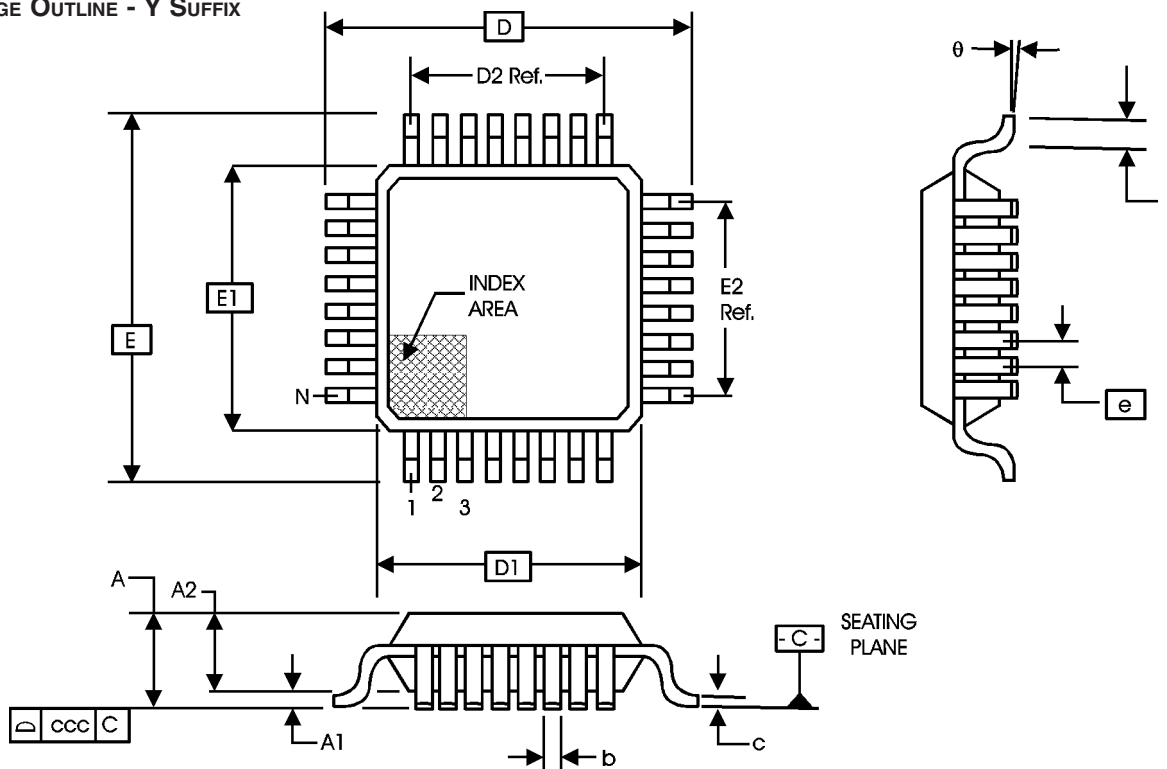


TABLE 7. PACKAGE DIMENSIONS

JEDEC VARIATION ALL DIMENSIONS IN MILLIMETERS			
SYMBOL	BBC		
	MINIMUM	NOMINAL	MAXIMUM
N	48		
A	--	--	1.60
A1	0.05	--	0.15
A2	1.35	1.40	1.45
b	0.17	0.22	0.27
c	0.09	--	0.20
D	9.00 BASIC		
D1	7.00 BASIC		
D2	5.50 Ref.		
E	9.00 BASIC		
E1	7.00 BASIC		
E2	5.50 Ref.		
e	0.50 BASIC		
L	0.45	0.60	0.75
theta	0°	--	7°
ccc	--	--	0.08

Reference Document: JEDEC Publication 95, MS-026



TABLE 8. ORDERING INFORMATION

Part/Order Number	Marking	Package	Count	Temperature
ICS8344AYI-01	ICS8344AYI-01	48 Lead LQFP	250 per tray	-40°C to 85°C
ICS8344AYI-01T	ICS8344AYI-01	48 Lead LQFP on Tape and Reel	1000	-40°C to 85°C

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