



# ICS83947I-147

## LOW SKEW, 1-TO-9 LVCMOS/LVTTL FANOUT BUFFER

### GENERAL DESCRIPTION

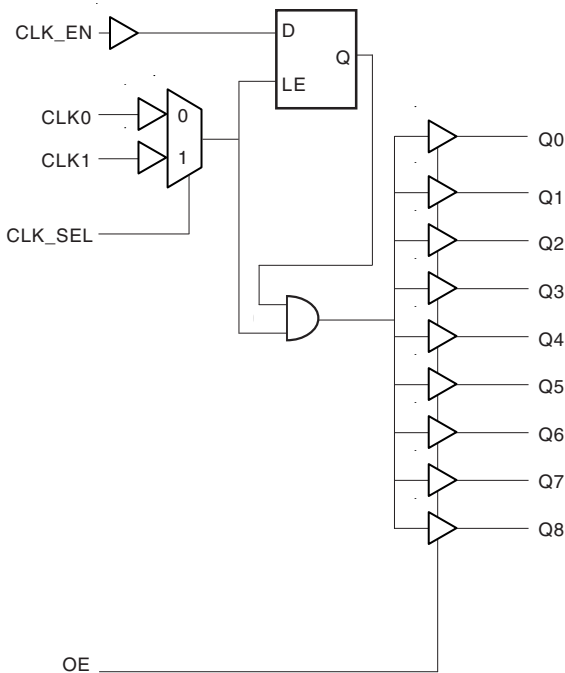
The ICS83947I-147 is a low skew, 1-to-9 LVCMOS/LVTTL Fanout Buffer. The low impedance LVCMOS/LVTTL outputs are designed to drive 50Ω series or parallel terminated transmission lines. The effective fanout can be increased from 9 to 18 by utilizing the ability of the outputs to drive two series terminated lines.

Guaranteed output and part-to-part skew characteristics make the ICS83947I-147 ideal for high performance, 3.3V or 2.5V single ended applications.

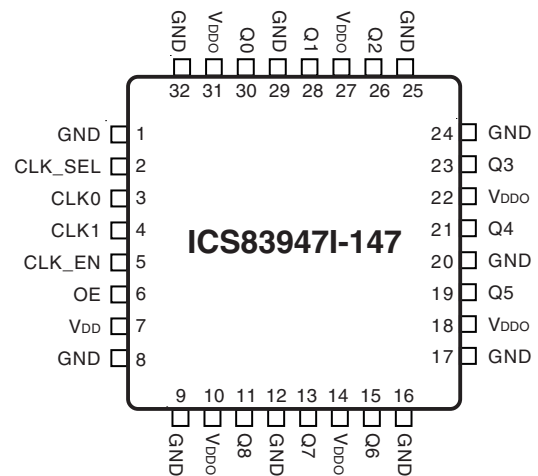
### FEATURES

- 9 LVCMOS/LVTTL outputs
- Selectable CLK0 and CLK1 can accept the following input levels: LVCMOS and LVTTL
- Maximum output frequency: 250MHz
- Output skew: 115ps (maximum)
- Part-to-part skew: 500ps (maximum)
- Additive phase jitter, RMS: 0.02ps (typical) @ 3.3V
- Full 3.3V or 2.5V operating supply
- -40°C to 85°C ambient operating temperature

### BLOCK DIAGRAM



### PIN ASSIGNMENT



**32-Lead LQFP**  
7mm x 7mm x 1.4mm package body  
**Y Package**  
Top View



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LOW SKEW, 1-TO-9  
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**TABLE 1. PIN DESCRIPTIONS**

Number	Name	Type		Description
1, 8, 9, 12, 16, 17, 20, 24, 25, 29, 32	GND	Power		Power supply ground.
2	CLK_SEL	Input	Pullup	Clock select input. When HIGH, selects CLK1. When LOW, selects CLK0. LVCMOS / LVTTL interface levels.
3, 4	CLK0, CLK1	Input	Pullup	Reference clock inputs. LVCMOS / LVTTL interface levels.
5	CLK_EN	Input	Pullup	Clock enable. LVCMOS / LVTTL interface levels.
6	OE	Input	Pullup	Output enable. LVCMOS / LVTTL interface levels.
7	V <sub>DD</sub>	Power		Core supply pin.
10, 14, 18, 22, 27, 31	V <sub>DDO</sub>	Power		Output supply pins.
11, 13, 15, 19, 21, 23, 26, 28, 30	Q8, Q7, Q6, Q5, Q4, Q3, Q2, Q1, Q0	Output		Q0 thru Q8 clock outputs. LVCMOS / LVTTL interface levels.

NOTE: *Pullup* 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 <sub>IN</sub>	Input Capacitance			4		pF
C <sub>PD</sub>	Power Dissipation Capacitance (per output)			12		pF
R <sub>PULLUP</sub>	Input Pullup Resistor			51		KΩ
R <sub>OUT</sub>	Output Impedance			7		Ω

**TABLE 3. OUTPUT ENABLE AND CLOCK ENABLE FUNCTION TABLE**

Control Inputs		Output
OE	CLK_EN	Q0:Q8
0	X	Hi-Z
1	0	LOW
1	1	Follows CLK input



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### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_{DD}$	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, $\theta_{JA}$	47.9°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 4A. POWER SUPPLY DC CHARACTERISTICS,  $V_{DD} = V_{DDO} = 3.3V \pm 0.3V$  OR  $2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{DD}$	Core Supply Voltage		3.0	3.3	3.6	V
			2.375	2.5	2.625	V
$V_{DDO}$	Output Supply Voltage		3.0	3.3	3.6	V
			2.375	2.5	2.625	V
$I_{DD}$	Input Supply Current				50	mA
$I_{DDO}$	Output Supply Current				9	mA

**TABLE 4B. LVCMOS/LVTTL DC CHARACTERISTICS,  $V_{DD} = V_{DDO} = 3.3V \pm 0.3V$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage		2		3.6	V
$V_{IL}$	Input Low Voltage				0.8	V
$I_{IN}$	Input Current	CLK0, CLK1, OE, CLK_SEL, CLK_EN	-100			$\mu A$
$V_{OH}$	Output High Voltage; NOTE 1	$I_{OH} = -20mA$	2.5			V
$V_{OL}$	Output Low Voltage; NOTE 1	$I_{OL} = 20mA$			0.4	V

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

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

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage		2		$V_{DD} + 0.3$	V
$V_{IL}$	Input Low Voltage	CLK0, CLK1	-0.3		1.3	V
		CLK_SEL, CLK_EN, OE	-0.3		0.8	V
$I_{IH}$	Input High Current	CLK0, CLK1, OE, CLK_SEL, CLK_EN	$V_{DD} = V_{IN} = 2.625V$		5	$\mu A$
$I_{IL}$	Input Low Current	CLK0, CLK1, OE, CLK_SEL, CLK_EN	$V_{DD} = 32.625V,$ $V_{IN} = 0V$	-150		$\mu A$
$V_{OH}$	Output High Voltage; NOTE 1		1.8			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, *2.5V Output Load Test Circuit Diagram*.



# ICS83947I-147

## LOW SKEW, 1-TO-9 LVCMOS/LVTTL FANOUT BUFFER

**TABLE 5A. AC CHARACTERISTICS,  $V_{DD} = V_{DDO} = 3.3V \pm 0.3V$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay, NOTE 1	$f \leq 250\text{MHz}$	2		4.2	ns
$tsk(o)$	Output Skew; NOTE 2, 5	Measured on rising edge @ $V_{DDO}/2$			115	ps
$tsk(pp)$	Part-to-Part Skew; NOTE 3, 5	Measured on rising edge @ $V_{DDO}/2$			500	ps
$t_{jit}(\emptyset)$	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section	(12KHz to 20MHz)		0.2		ps
$t_R / t_F$	Output Rise/Fall Time	0.8V to 2.0V	0.2		1	ns
$t_{PW}$	Output Pulse Width	$f > 133\text{MHz}$	$t_{Period}/2 - 1$		$t_{Period}/2 + 1$	ns
odc	Output Duty Cycle	$f \leq 133\text{MHz}$	40		60	%
$t_{EN}$	Output Enable Time; NOTE 4				10	ns
$t_{DIS}$	Output Disable Time; NOTE 4				10	ns
$t_S$	Clock Enable Setup Time		0			ns
$t_{SH}$	Clock Enable Hold Time		1			ns

All parameters measured at frequencies less than or equal to 250MHz unless noted otherwise.

NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDO}/2$  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: These parameters are guaranteed by characterization. Not tested in production.

NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.

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

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay, NOTE 1	$f \leq 250\text{MHz}$	2.4		4.5	ns
$tsk(o)$	Output Skew; NOTE 2, 5	Measured on rising edge @ $V_{DDO}/2$			130	ps
$tsk(pp)$	Part-to-Part Skew; NOTE 3, 5	Measured on rising edge @ $V_{DDO}/2$			600	ps
$f_{jit}(\emptyset)$	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section	(12KHz to 20MHz)		0.1		ps
$t_R / t_F$	Output Rise/Fall Time	20% - 80%	300		800	ps
$t_{PW}$	Output Pulse Width		$t_{Period}/2 - 1.2$		$t_{Period}/2 + 1.2$	ns
$t_{EN}$	Output Enable Time; NOTE 4				10	ns
$t_{DIS}$	Output Disable Time; NOTE 4				10	ns
$t_S$	Clock Enable Setup Time		0			ns
$t_{SH}$	Clock Enable Hold Time		1			ns

All parameters measured at frequencies less than or equal to 250MHz unless noted otherwise.

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

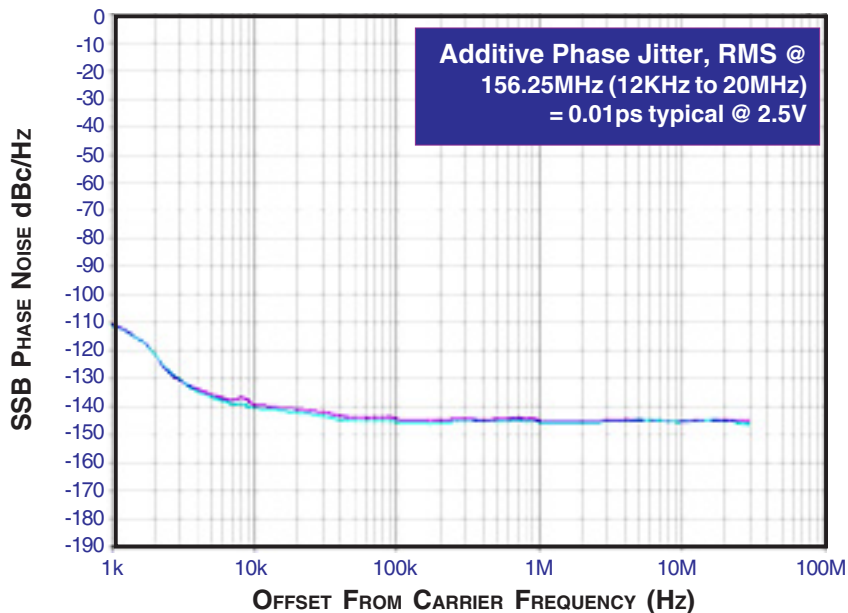
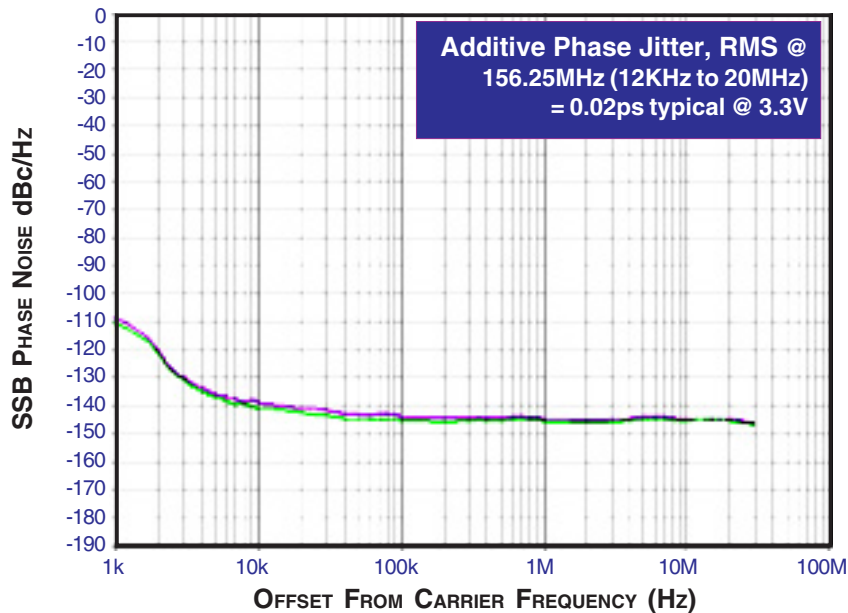
NOTE 4: These parameters are guaranteed by characterization. Not tested in production.

NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.

### ADDITIVE PHASE JITTER

The spectral purity in a band at a specific offset from the fundamental compared to the power of the fundamental is called the ***dBc Phase Noise***. This value is normally expressed using a Phase noise plot and is most often the specified plot in many applications. Phase noise is defined as the ratio of the noise power present in a 1Hz band at a specified offset from the fundamental frequency to the power value of the fundamental. This ratio is expressed in decibels (dBm) or a ratio of the power in

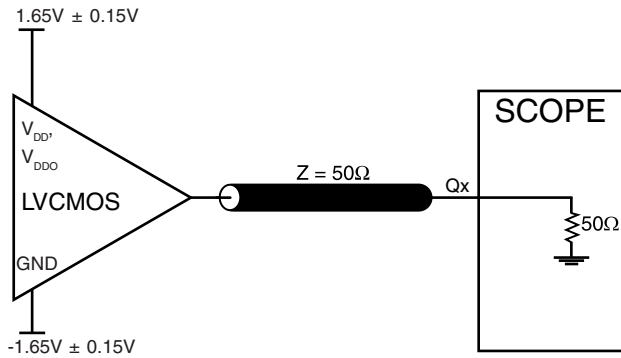
the 1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a ***dBc*** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects on the desired application over the entire time record of the signal. It is mathematically possible to calculate an expected bit error rate given a phase noise plot.



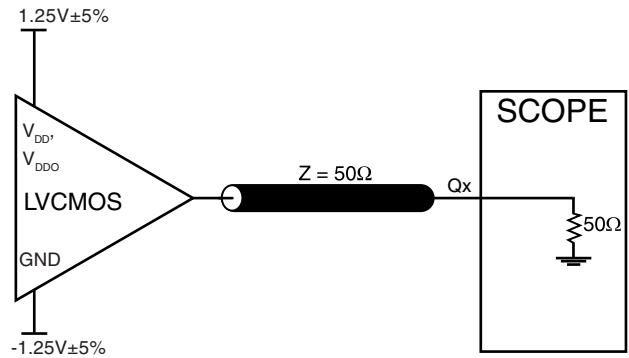
As with most timing specifications, phase noise measurements have issues. The primary issue relates to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This is illustrated above. The de-

vice meets the noise floor of what is shown, but can actually be lower. The phase noise is dependant on the input source and measurement equipment.

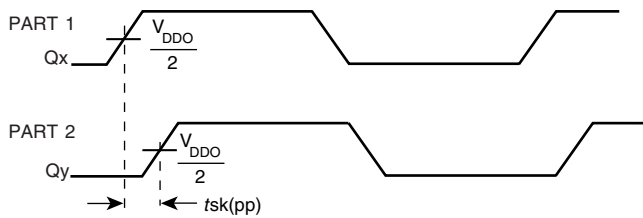
## PARAMETER MEASUREMENT INFORMATION



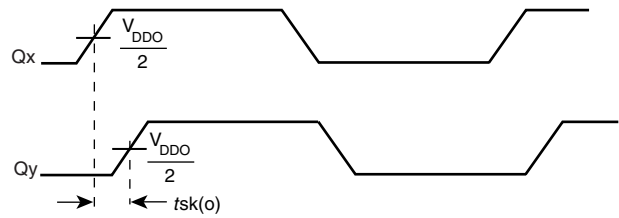
3.3V OUTPUT LOAD AC TEST CIRCUIT



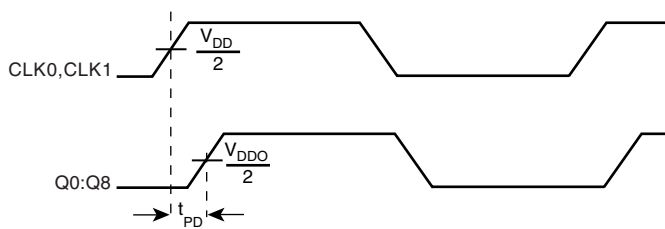
2.5V OUTPUT LOAD AC TEST CIRCUIT



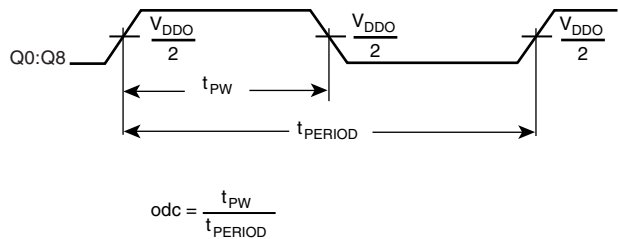
PART-TO-PART SKEW



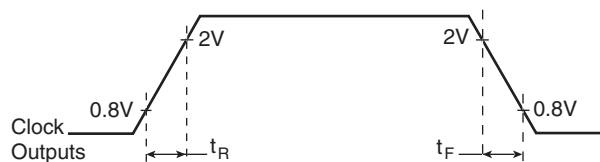
OUTPUT SKEW



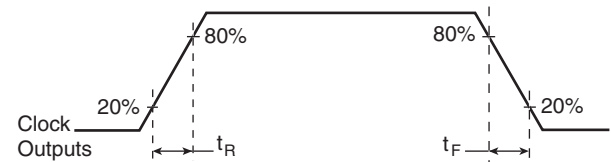
PROPAGATION DELAY



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



3.3V OUTPUT RISE/FALL TIME



2.5V OUTPUT RISE/FALL TIME

## APPLICATION SCHEMATIC EXAMPLE

Figure 1 shows an example of ICS83947I-147 application schematic. In this example, the device is operated at  $V_{CC}=3.3V$ . The decoupling capacitors should be located as close as possible to the power pin. The input is driven by a 3.3V LVCMOS driver.

For the LVCMOS output drivers, only one termination example is shown in this schematic. Additional termination approaches are shown in the LVCMOS Termination Application Note (refer to ICS website).

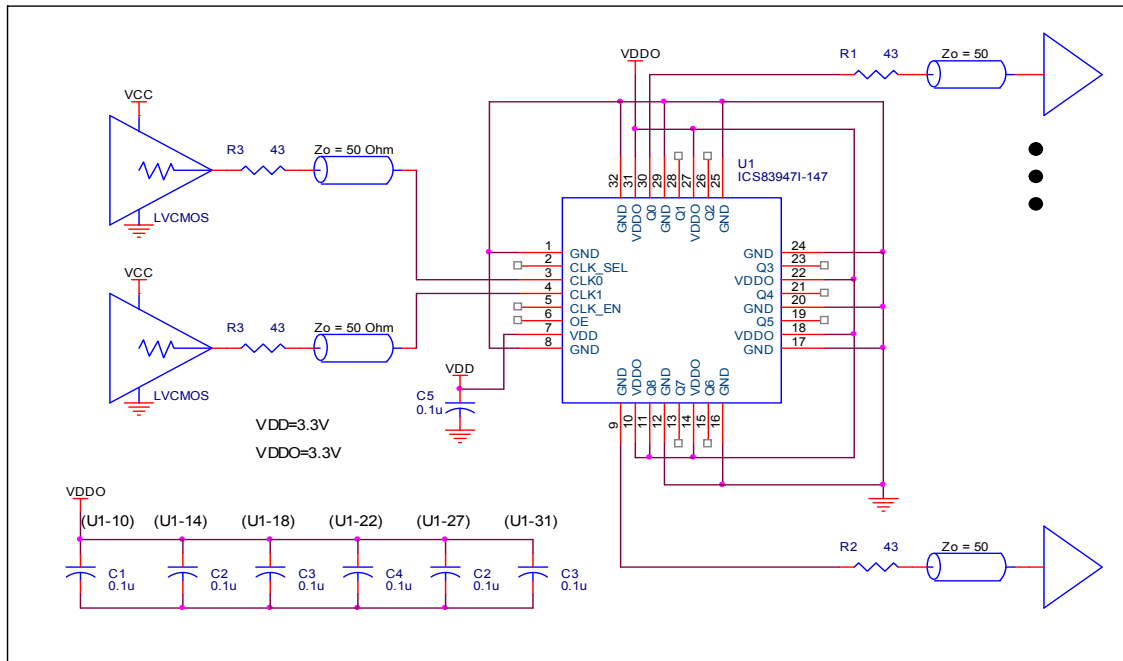


FIGURE 1. ICS83947I-147 SCHEMATIC LAYOUT



## RELIABILITY INFORMATION

TABLE 6.  $\theta_{JA}$  vs. AIR FLOW TABLE FOR 32 LEAD LQFP

$\theta_{JA}$ 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 ICS83947I-147 is: 1040



PACKAGE OUTLINE - Y SUFFIX FOR 32 LEAD LQFP

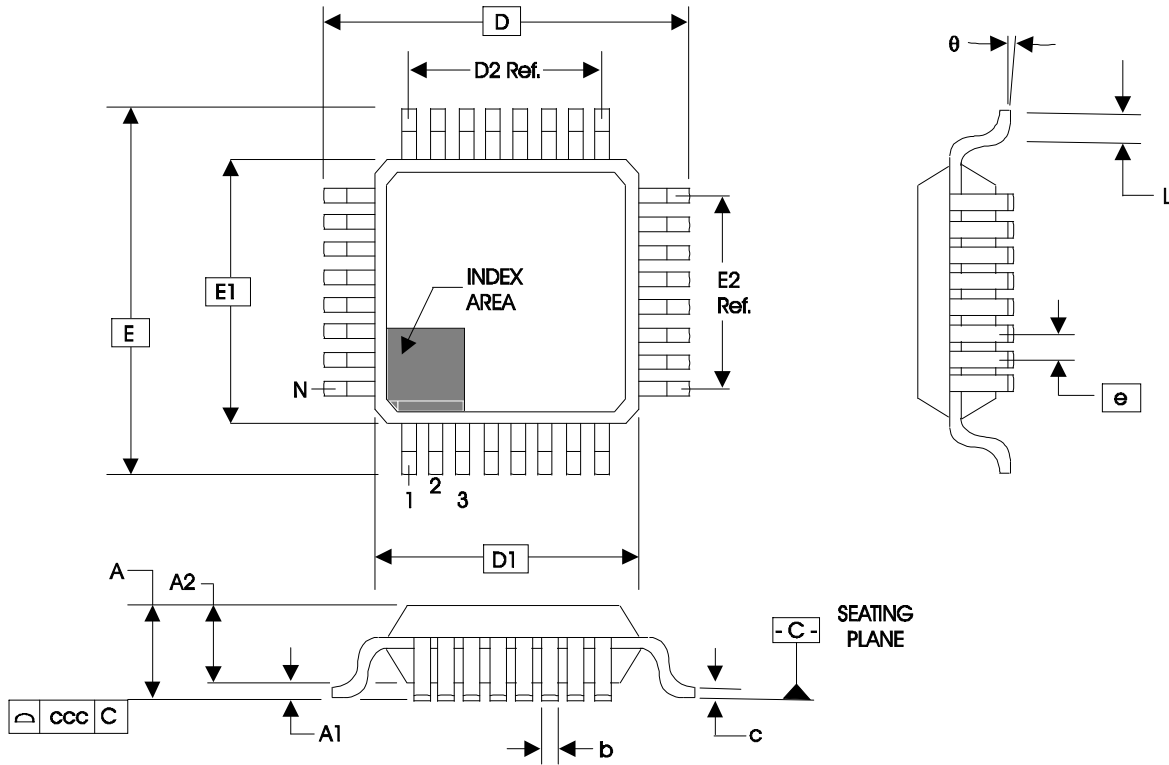


TABLE 7. PACKAGE DIMENSIONS

JEDEC VARIATION ALL DIMENSIONS IN MILLIMETERS			
SYMBOL	BBA		
	MINIMUM	NOMINAL	MAXIMUM
N	32		
A	--	--	1.60
A1	0.05	--	0.15
A2	1.35	1.40	1.45
b	0.30	0.37	0.45
c	0.09	--	0.20
D	9.00 BASIC		
D1	7.00 BASIC		
D2	5.60 Ref.		
E	9.00 BASIC		
E1	7.00 BASIC		
E2	5.60 Ref.		
e	0.80 BASIC		
L	0.45	0.60	0.75
theta	0°	--	7°
ccc	--	--	0.10

Reference Document: JEDEC Publication 95, MS-026



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**TABLE 8. ORDERING INFORMATION**

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
83947AYI-147	ICS83947AI147	32 Lead LQFP	tray	-40°C to 85°C
83947AYI-147T	ICS83947AI147	32 Lead LQFP on Tape and Reel	1000	-40°C to 85°C

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REVISION HISTORY SHEET				
Rev	Table	Page	Description of Change	Date
A	T8	10 12	Updated datasheet's header/footer with IDT from ICS. Removed ICS prefix from Part/Order Number column. Added Contact Page.	8/12/10



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