

General Description



The ICS87946I-147 is a low skew, ÷1, ÷2 LVCMOS/LVTTL Clock Generator and a member of the HiPerClockS™ family of High Performance Clock Solutions from IDT. The ICS87946I-147 has two selectable single ended clock inputs. The single ended clock inputs accept LVCMOS or LVTTL input levels. The low impedance LVCMOS/LVTTL outputs are designed to drive 50Ω series or parallel terminated transmission lines. The effective fanout can be increased from 10 to 20 by utilizing the ability of the outputs to drive two series terminated lines.

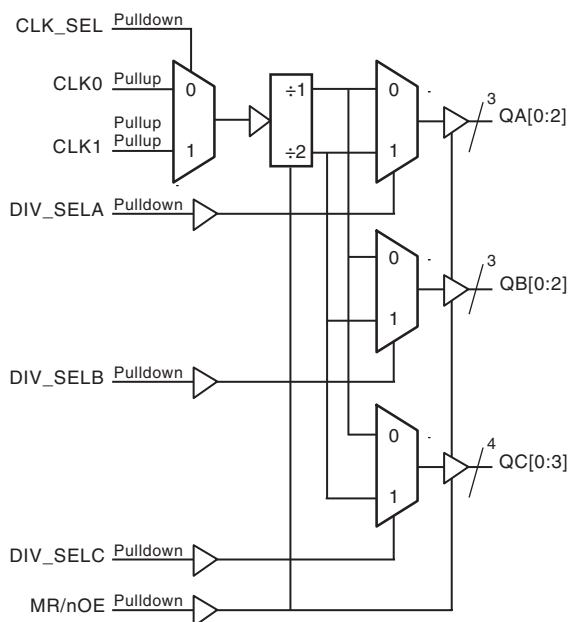
The divide select inputs, DIV_SELx, control the output frequency of each bank. The outputs can be utilized in the ÷1, ÷2 or a combination of ÷1 and ÷2 modes. The master reset input, MR/nOE, resets the internal frequency dividers and also controls the active and high impedance states of all outputs.

The ICS87946I-147 is characterized at full 3.3V for input V_{DD}, and mixed 3.3V and 2.5V for output operating supply mode. Guaranteed bank, output and part-to-part skew characteristics make the ICS87946I-147 ideal for those clock distribution applications demanding well defined performance and repeatability.

Features

- Ten single ended LVCMOS/LVTTL outputs, 7Ω typical output impedance
- Selectable LVCMOS/LVTTL CLK0 and CLK1 inputs
- CLK0 and CLK1 can accept the following input levels: LVCMOS and LVTTL
- Maximum input frequency: 250MHz
- Bank skew: 30ps (maximum)
- Output skew: 175ps (maximum)
- Part-to-part skew: 850ps (maximum)
- Multiple frequency skew: 200ps (maximum)
- 3.3V core, 3.3V or 2.5V output supply modes
- -40°C to 85°C ambient operating temperature
- Available in both standard (RoHS 5) and lead-free (RoHS 6) packages

Block Diagram



Pin Assignment

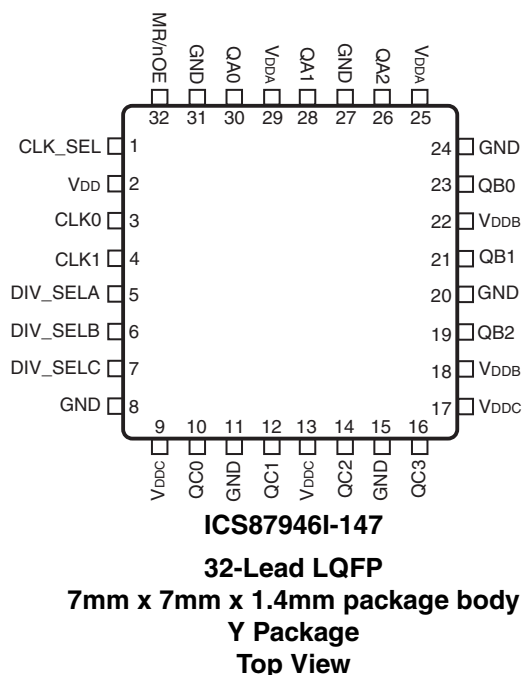


Table 1. Pin Descriptions

Number	Name	Type		Description
1	CLK_SEL	Input	Pulldown	Clock select input. When HIGH, selects CLK1. When LOW, selects CLK0. LVCMOS / LVTTL interface levels.
2	V _{DD}	Power		Positive supply pin.
3, 4	CLK0, CLK1	Input	Pullup	Single-ended clock inputs. LVCMOS/LVTTL interface levels.
5	DIV_SELA	Input	Pulldown	Controls frequency division for Bank A outputs. See Table 3 LVCMOS/LVTTL interface levels.
6	DIV_SELB	Input	Pulldown	Controls frequency division for Bank B outputs. See Table 3. LVCMOS/LVTTL interface levels.
7	DIV_SELC	Input	Pulldown	Controls frequency division for Bank C outputs. See Table 3. LVCMOS/LVTTL interface levels.
8, 11, 15, 20, 24, 27, 31	GND	Power		Power supply ground.
9, 13, 17	V _{DDC}	Power		Output supply pins for Bank C outputs.
10, 12, 14, 16	QC0, QC1, QC2, QC3	Output		Single-ended Bank C clock outputs. LVCMOS/LVTTL interface levels. 7Ω typical output impedance.
18, 22	V _{DDB}	Power		Output supply pins for Bank B outputs.
19, 21, 23	QB2, QB1, QB0	Output		Single-ended Bank B clock outputs. LVCMOS/LVTTL interface levels. 7Ω typical output impedance.
25, 29	V _{DDA}	Power		Output supply pins for Bank A outputs.
26, 28, 30	QA2, QA1, QA0	Output		Single-ended Bank A clock outputs. LVCMOS/LVTTL interface levels. 7Ω typical output impedance.
32	MR/nOE	Input	Pulldown	Active HIGH Master Reset. Active LOW Output Enable. When logic HIGH, the internal dividers are reset and the outputs are (High-Impedance). When logic LOW, the internal dividers and the outputs are enabled. See Table 3. LVCMOS/LVTTL interface levels.

NOTE: Pullup and Pulldown refer 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	V _{DD} = V _{DDA} = V _{DDB} = V _{DDC} = 3.6V		25		pF
R _{PULLUP}	Input Pullup Resistor			51		kΩ
R _{PULLDOWN}	Input Pulldown Resistor			51		kΩ
R _{OUT}	Output Impedance			7		Ω

Function Tables

Table 3. Clock Input Function Table

Inputs				Outputs		
MR/nOE	DIV_SELA	DIV_SELB	DIV_SELC	QA0:QA2	QB0:QB2	QC0:QC3
1	X	X	X	High-Impedance	High-Impedance	High-Impedance
0	0	X	X	$f_{IN}/1$	Active	Active
0	1	X	X	$f_{IN}/2$	Active	Active
0	X	0	X	Active	$f_{IN}/1$	Active
0	X	1	X	Active	$f_{IN}/2$	Active
0	X	X	0	Active	Active	$f_{IN}/1$
0	X	X	1	Active	Active	$f_{IN}/2$

Absolute Maximum Ratings

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.

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

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, $V_{DD} = V_{DDA} = V_{DDB} = V_{DDC} = 3.3V \pm 0.3V$, $T_A = -40^\circ\text{C}$ to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive Supply Voltage		3.0	3.3	3.6	V
V_{DDA} , V_{DDB} , V_{DDC}	Output Supply Voltage		3.0	3.3	3.6	V
I_{DD}	Power Supply Current				55	mA
I_{DDA} , I_{DDB} , I_{DDC}	Output Supply Current				23	mA

Table 4B. Power Supply DC Characteristics, $V_{DD} = 3.3V \pm 5\%$, $V_{DDA} = V_{DDB} = V_{DDC} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive Supply Voltage		3.135	3.3	3.465	V
V_{DDA} , V_{DDB} , V_{DDC}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Power Supply Current				55	mA
I_{DDA} , I_{DDB} , I_{DDC}	Output Supply Current				22	mA

Table 4C. LVCMOS/LVTTL DC Characteristics, $V_{DD} = V_{DDA} = V_{DDB} = V_{DDC} = 3.3V \pm 0.3V$, $T_A = -40^\circ\text{C}$ to 85°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	MR/nOE, DIV_SELA, DIV_SELB, DIV_SELC, CLK_SEL	-0.3		0.8	V
		CLK0, CLK1	-0.3		1.3	V
I_{IH}	Input High Current	MR/nOE, DIV_SELA, DIV_SELB, DIV_SELC, CLK_SEL $V_{DD} = V_{IN} = 3.6V$			150	μA
		CLK0, CLK1 $V_{DD} = V_{IN} = 3.6V$			5	μA
I_{IL}	Input Low Current	MR/nOE, DIV_SELA, DIV_SELB, DIV_SELC, CLK_SEL $V_{DD} = 3.6V, V_{IN} = 0V$	-5			μA
		CLK0, CLK1 $V_{DD} = 3.6V, V_{IN} = 0V$	-150			μA
V_{OH}	Output High Voltage; NOTE 1	$V_{DDA} = V_{DDB} = V_{DDC} = 3.6V$	2.6			V
V_{OL}	Output Low Voltage; NOTE 1	$V_{DDA} = V_{DDB} = V_{DDC} = 3.63V$			0.5	V
I_{OZL}	Output Hi-Z Current Low	$V_{DDA} = V_{DDB} = V_{DDC} = 3.63V$	-5			μA
I_{OZH}	Output Hi-Z Current High	$V_{DDA} = V_{DDB} = V_{DDC} = 3.63V$			5	μA

NOTE 1: Outputs terminated with 50Ω to $V_{DDX}/2$. See Parameter Measurement Information section. *Load Test Circuit diagrams.*

Table 4D. LVCMOS/LVTTL DC Characteristics, $V_{DD} = 3.3V \pm 5\%$, $V_{DDA} = V_{DDB} = V_{DDC} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage		2		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage	MR/nOE, DIV_SELA, DIV_SELB, DIV_SEL, CLK_SEL	-0.3		0.8	V
		CLK0, CLK1	-0.3		1.3	V
I_{IH}	Input High Current	MR/nOE, DIV_SELA, DIV_SELB, DIV_SEL, CLK_SEL	$V_{DD} = V_{IN} = 3.465V$		150	μA
		CLK0, CLK1	$V_{DD} = V_{IN} = 3.465V$		5	μA
I_{IL}	Input Low Current	MR/nOE, DIV_SELA, DIV_SELB, DIV_SEL, CLK_SEL	$V_{DD} = 3.465V, V_{IN} = 0V$	-5		μA
		CLK0, CLK1	$V_{DD} = 3.465V, V_{IN} = 0V$	-150		μA
V_{OH}	Output High Voltage; NOTE 1	$V_{DDA} = V_{DDB} = V_{DDC} = 2.625V$	1.8			V
V_{OL}	Output Low Voltage; NOTE 1	$V_{DDA} = V_{DDB} = V_{DDC} = 2.625V$			0.5	V
I_{OZL}	Output Hi-Z Current Low	$V_{DDA} = V_{DDB} = V_{DDC} = 2.625V$	-5			μA
I_{OZH}	Output Hi-Z Current High	$V_{DDA} = V_{DDB} = V_{DDC} = 2.625V$			5	μA

NOTE 1: Outputs terminated with 50Ω to $V_{DDx}/2$. See Parameter Measurement Information section. *Load Test Circuit diagrams.*

AC Electrical Characteristics

Table 5A. AC Characteristics, $V_{DD} = V_{DDA} = V_{DDB} = V_{DDC} = 3.3V \pm 0.3V$, $T_A = -40^{\circ}C$ to $85^{\circ}C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency				250	MHz
t_{PD}	Propagation Delay; NOTE 1	$f \leq 250MHz$	2		5	ns
$t_{sk}(b)$	Bank Skew, NOTE 2, 7	Measured on rising edge at $V_{DDX}/2$			30	ps
$t_{sk}(o)$	Output Skew; NOTE 3, 7	Measured on rising edge at $V_{DDX}/2$			175	ps
$t_{sk}(w)$	Multiple Frequency Skew; NOTE 4, 7	Measured on rising edge at $V_{DDX}/2$			275	ps
$t_{sk}(pp)$	Part-to-Part Skew; NOTE 5, 7	Measured on rising edge at $V_{DDX}/2$			850	ps
t_R / t_F	Output Rise/Fall Time; NOTE 6	20% to 80%	400		950	ps
t_{PW}	Output Pulse Width		$t_{PERIOD}/2 - 1$	$t_{PERIOD}/2$	$t_{PERIOD}/2 + 1$	%
t_{EN}	Output Enable Time; NOTE 6	$f = 10MHz$			3	ns
t_{DIS}	Output Disable Time; NOTE 6	$f = 10MHz$			3	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

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

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

NOTE 3: Defined as skew across banks of outputs at the same supply voltage and with equal load conditions. Measured at $V_{DDX}/2$.

NOTE 4: Defined as skew across banks of outputs operating at different frequencies with the same supply voltage and equal load conditions.

NOTE 5: Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at $V_{DDX}/2$.

NOTE 6: These parameters are guaranteed by characterization. Not tested in production.

NOTE 7: This parameter is defined in accordance with JEDEC Standard 65.

Table 5B. AC Characteristics, $V_{DD} = 3.3V \pm 5\%$, $V_{DDA} = V_{DDB} = V_{DDC} = 2.5V \pm 5\%$, $T_A = -40^\circ\text{C}$ to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency				250	MHz
t_{PD}	Propagation Delay; NOTE 1	$f \leq 250\text{MHz}$	2		5	ns
$t_{sk(b)}$	Bank Skew, NOTE 2, 7	Measured on rising edge at $V_{DDX}/2$			35	ps
$t_{sk(o)}$	Output Skew; NOTE 3, 7	Measured on rising edge at $V_{DDX}/2$			175	ps
$t_{sk(w)}$	Multiple Frequency Skew; NOTE 4, 7	Measured on rising edge at $V_{DDX}/2$			200	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 5, 7	Measured on rising edge at $V_{DDX}/2$			875	ps
t_R / t_F	Output Rise/Fall Time; NOTE 6	20% to 80%	400		950	ps
t_{PW}	Output Pulse Width		$t_{PERIOD}/2 - 1$	$t_{PERIOD}/2$	$t_{PERIOD}/2 + 1$	%
t_{EN}	Output Enable Time; NOTE 6	$f = 10\text{MHz}$			3	ns
t_{DIS}	Output Disable Time; NOTE 6	$f = 10\text{MHz}$			3	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

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

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

NOTE 3: Defined as skew across banks of outputs at the same supply voltage and with equal load conditions. Measured at $V_{DDX}/2$.

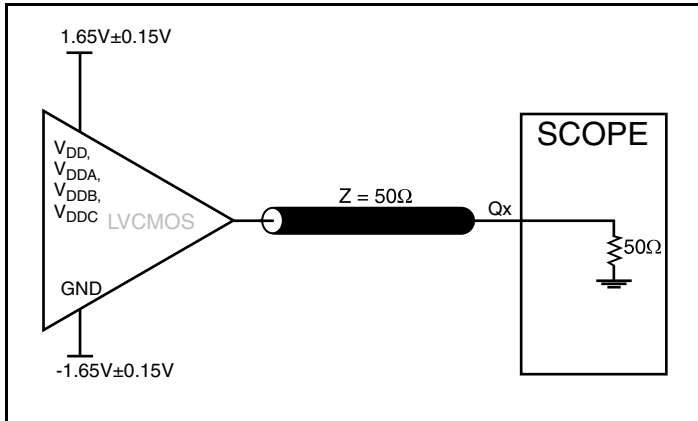
NOTE 4: Defined as skew across banks of outputs operating at different frequencies with the same supply voltage and equal load conditions.

NOTE 5: Defined as skew between outputs on different devices operating at the same supply voltage and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at $V_{DDX}/2$.

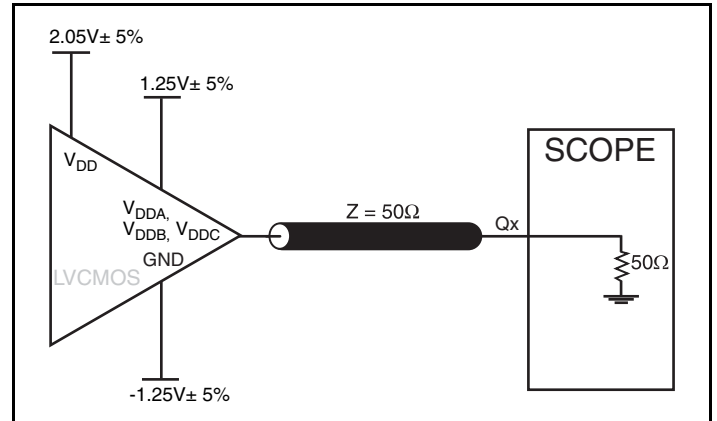
NOTE 6: These parameters are guaranteed by characterization. Not tested in production.

NOTE 7: This parameter is defined in accordance with JEDEC Standard 65.

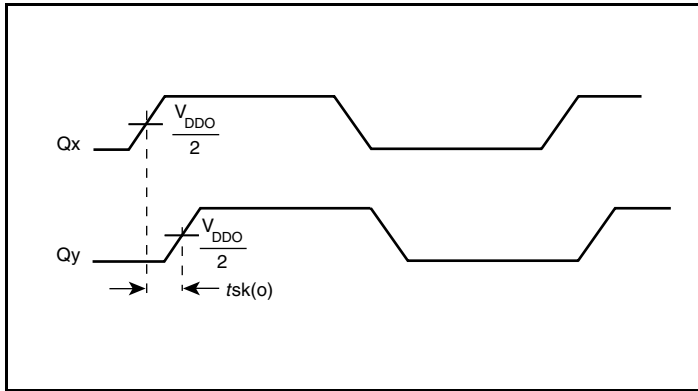
Parameter Measurement Information



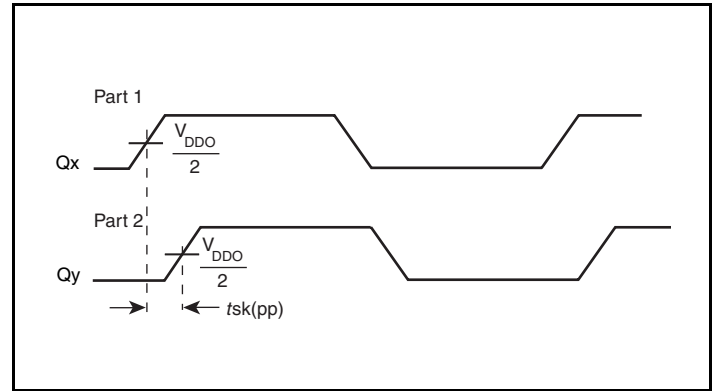
3.3V Core/3.3V Output Load AC Test Circuit



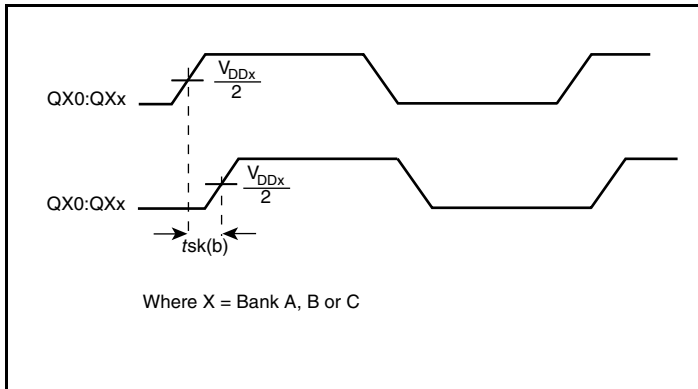
3.3V Core/2.5V Output Load AC Test Circuit



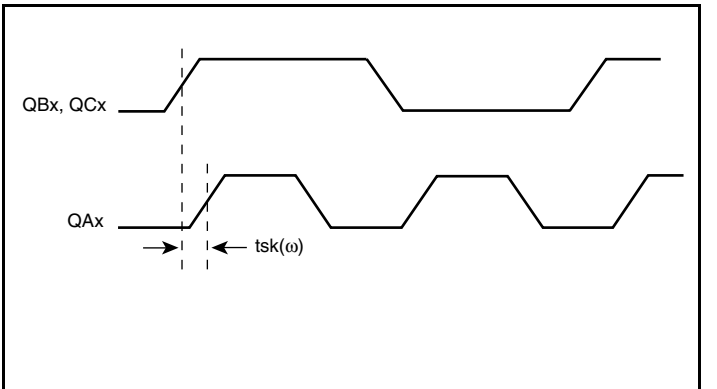
Output Skew



Part-to-Part Skew

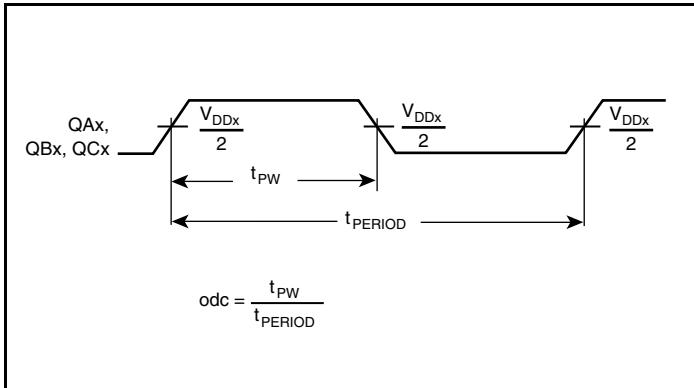


Bank Skew

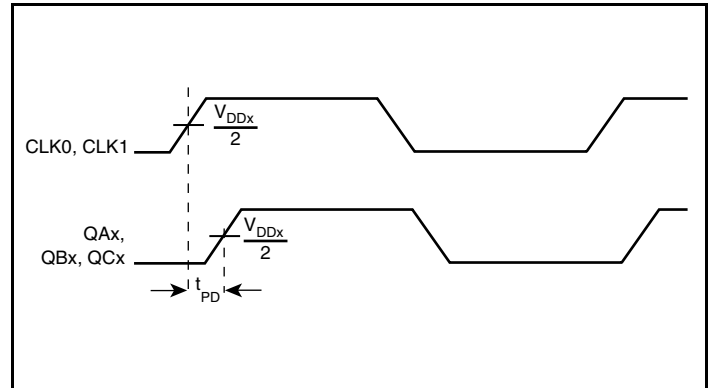


Multiple Frequency Skew

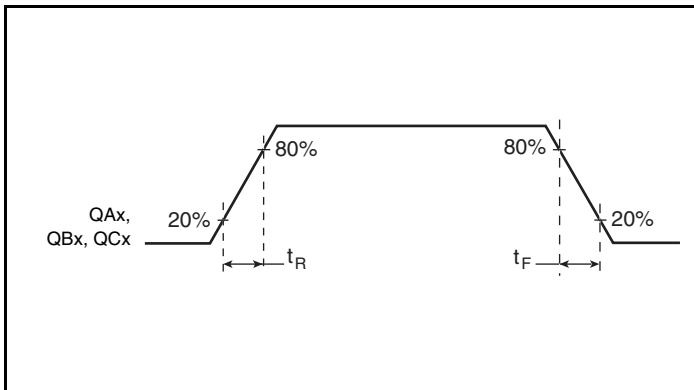
Parameter Measurement Information, continued



t_{PW} & t_{PERIOD}



Propagation Delay



Output Rise/Fall Time

Application Information

Recommendations for Unused Input and Output Pins

Inputs:

LVCMOS Control Pins

All control pins have internal pulldowns; additional resistance is not required but can be added for additional protection. A 1k Ω resistor can be used.

CLK Inputs

For applications not requiring the use of a clock input, it can be left floating. Though not required, but for additional protection, a 1k Ω resistor can be tied from the CLK input to ground.

Outputs:

LVCMOS Outputs

All unused LVCMOS output can be left floating. There should be no trace attached.

Reliability Information

Table 6. θ_{JA} vs. Air Flow Table for a 32 Lead LQFP

θ_{JA} vs. Air Flow			
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 ICS87946I-147 is: 1204
Pin compatible to the MPC9446 and MPC946

Package Outline and Package Dimensions

Package Outline - Y Suffix for 32 Lead LQFP

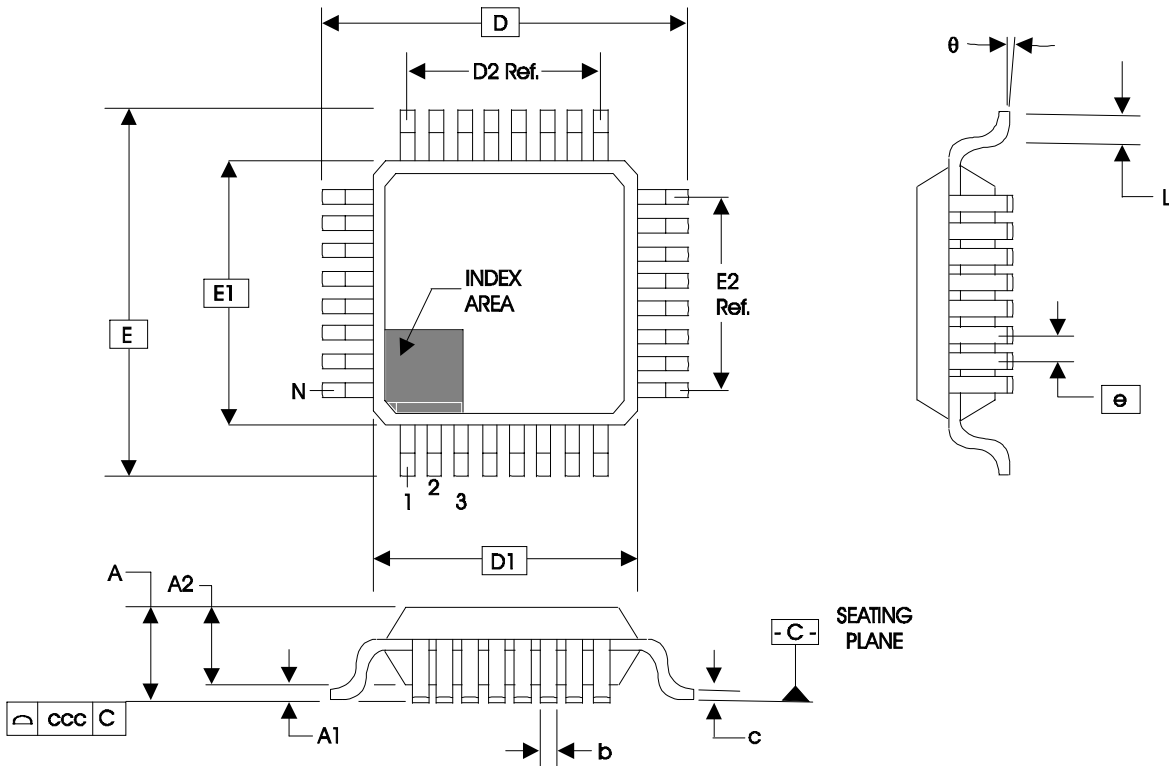


Table 7. Package Dimensions for 32 Lead LQFP

JEDEC Variation: BBC - HD			
All Dimensions in Millimeters			
Symbol	Minimum	Nominal	Maximum
N	32		
A			1.60
A1	0.05	0.10	0.15
A2	1.35	1.40	1.45
b	0.30	0.37	0.45
c	0.09		0.20
D & E	9.00 Basic		
D1 & E1	7.00 Basic		
D2 & E2	5.60 Ref.		
e	0.80 Basic		
L	0.45	0.60	0.75
θ	0°		7°
ccc			0.10

Reference Document: JEDEC Publication 95, MS-026

Ordering Information

Table 8. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
87946AYI-147	ICS87946AI147	32 Lead LQFP	Tray	-40°C to 85°C
87946AYI-147T	ICS87946AI147	32 Lead LQFP	1000 Tape & Reel	-40°C to 85°C
87946AYI-147LF	ICS7946AI147L	"Lead-Free" 32 Lead LQFP	Tray	-40°C to 85°C
87946AYI-147LFT	ICS7946AI147L	"Lead-Free" 32 Lead LQFP	1000 Tape & Reel	-40°C to 85°C

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

While the information presented herein has been checked for both accuracy and reliability, Integrated Device Technology (IDT) assumes no responsibility for either its use or for the infringement of any patents or other rights of third parties, which would result from its use. No other circuits, patents, or licenses are implied. This product is intended for use in normal commercial and industrial applications. Any other applications, such as those requiring high reliability or other extraordinary environmental requirements are not recommended without additional processing by IDT. IDT reserves the right to change any circuitry or specifications without notice. IDT does not authorize or warrant any IDT product for use in life support devices or critical medical instruments.

Revision History Sheet

Rev	Table	Page	Description of Change	Date
A	T2 T8	1 2 8 10 12	Features section added <i>Lead-Free</i> bullet. Pin Description Table - corrected description for V_{DDA} , V_{DDB} and V_{DDC} . Parameter Measurement Information Section - added part-to-part skew, bank skew, and multiple frequency skew diagrams. Application Section - added <i>Recommendations for Unused Input and Output Pins</i> . Ordering Information Table - added lead-free marking. Updated format throughout the datasheet.	7/22/08
A	T5A - T5B T8	6 - 7 12	AC Tables - added thermal note. Ordering Information Table - corrected the Part/Order Numbers and corrected the non-LF marking. Updated Header/Footer of the datasheet.	8/7/09



www.IDT.com

6024 Silver Creek Valley Road
San Jose, California 95138

Sales
800-345-7015 (inside USA)
+408-284-8200 (outside USA)
Fax: 408-284-2775
www.IDT.com/go/contactIDT

Technical Support
netcom@idt.com
+480-763-2056

DISCLAIMER Integrated Device Technology, Inc. (IDT) and its subsidiaries reserve the right to modify the products and/or specifications described herein at any time and at IDT's sole discretion. All information in this document, including descriptions of product features and performance, is subject to change without notice. Performance specifications and the operating parameters of the described products are determined in the independent state and are not guaranteed to perform the same way when installed in customer products. The information contained herein is provided without representation or warranty of any kind, whether express or implied, including, but not limited to, the suitability of IDT's products for any particular purpose, an implied warranty of merchantability, or non-infringement of the intellectual property rights of others. This document is presented only as a guide and does not convey any license under intellectual property rights of IDT or any third parties.

IDT's products are not intended for use in life support systems or similar devices where the failure or malfunction of an IDT product can be reasonably expected to significantly affect the health or safety of users. Anyone using an IDT product in such a manner does so at their own risk, absent an express, written agreement by IDT.

Integrated Device Technology, IDT and the IDT logo are registered trademarks of IDT. Other trademarks and service marks used herein, including protected names, logos and designs, are the property of IDT or their respective third party owners.

Copyright 2009. All rights reserved.