

GENERAL DESCRIPTION

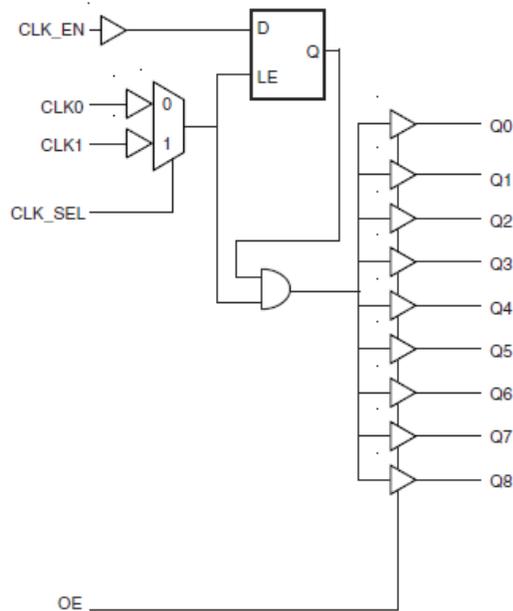
The 83947I-147 is a low skew, 1-to-9 LVCMOS/LVTTL Fanout Buffer. The low impedance LVCMOS/LVTTL outputs are designed to drive 50Ω series or parallel terminated transmission lines. The effective fanout can be increased from 9 to 18 by utilizing the ability of the outputs to drive two series terminated lines.

Guaranteed output and part-to-part skew characteristics make the 83947I-147 ideal for high performance, 3.3V or 2.5V single ended applications.

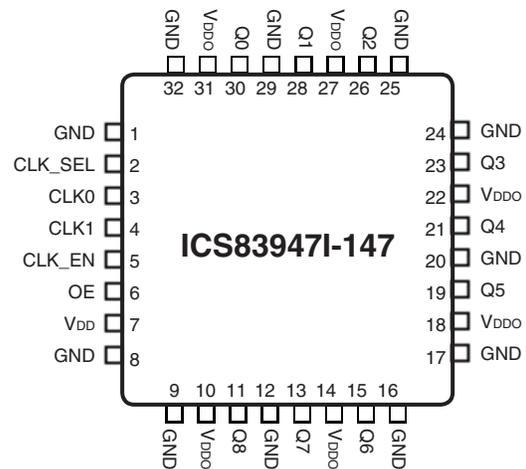
FEATURES

- Nine 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
- Lead-free (RoHS 6) packaging

BLOCK DIAGRAM



PIN ASSIGNMENT



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

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 / LVTTTL interface levels. |
| 3, 4 | CLK0, CLK1 | Input | Pullup | Reference clock inputs. LVCMOS / LVTTTL interface levels. |
| 5 | CLK_EN | Input | Pullup | Clock enable. LVCMOS / LVTTTL interface levels. |
| 6 | OE | Input | Pullup | Output enable. LVCMOS / LVTTTL interface levels. |
| 7 | V _{DD} | Power | | Core supply pin. |
| 10, 14, 18, 22, 27, 31 | V _{DDO} | 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 / LVTTTL 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 _{IN} | Input Capacitance | | | 4 | | pF |
| C _{PD} | Power Dissipation Capacitance (per output) | | | 12 | | pF |
| R _{PULLUP} | Input Pullup Resistor | | | 51 | | KΩ |
| R _{OUT} | 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 |

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, θ_{JA} | 47.9°C/W (0 lfm) |
| 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 | | | μA |
| 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 50Ω 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 | μA |
| I_{IL} | Input Low Current | CLK0, CLK1, OE, CLK_SEL, CLK_EN $V_{DD} = 32.625V$, $V_{IN} = 0V$ | -150 | | | μA |
| 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 50Ω to $V_{DDO}/2$. See Parameter Measurement Information Section, *2.5V Output Load Test Circuit Diagram*.

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 | $f \leq 250MHz$ | 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 |
| $tjit(\emptyset)$ | 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 | $f > 133MHz$ | $t_{Period}/2 - 1$ | | $t_{Period}/2 + 1$ | ns |
| odc | Output Duty Cycle | $f \leq 133MHz$ | 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_S | 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 | $f \leq 250MHz$ | 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 |
| $tjit(\emptyset)$ | 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_S | 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 $V_{DDO}/2$.

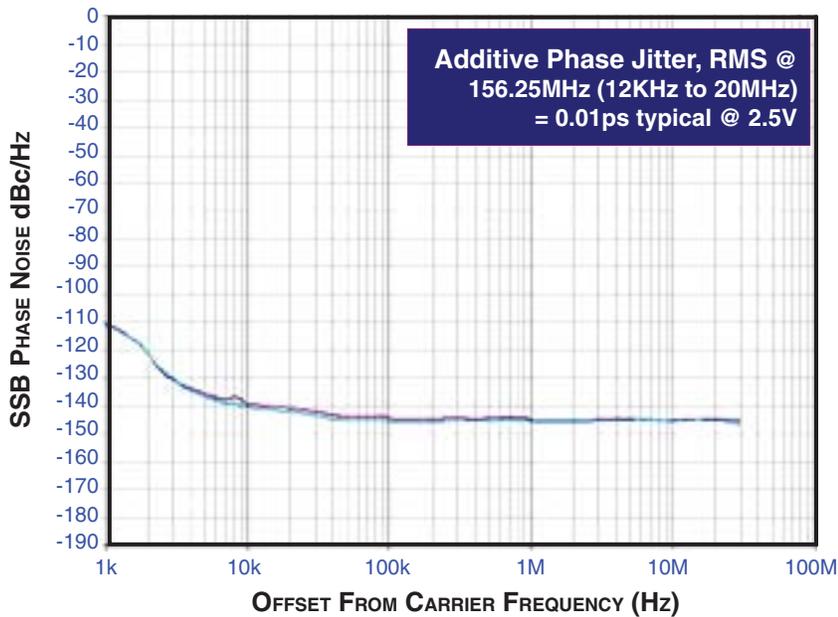
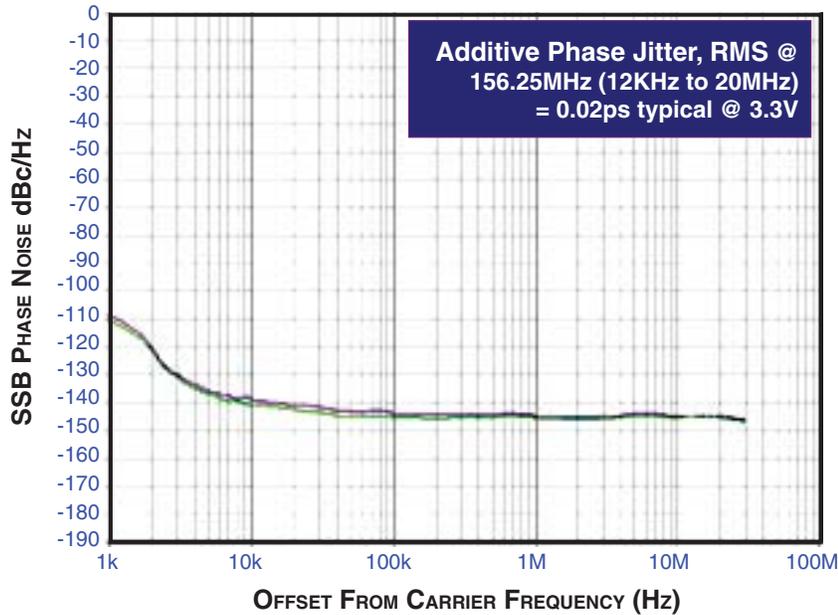
NOTE 4: These parameters are guaranteed by characterization. Not tested in production.

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

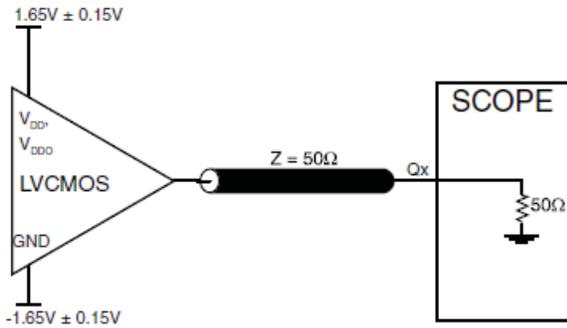
1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a ***dBc*** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects on the desired 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.



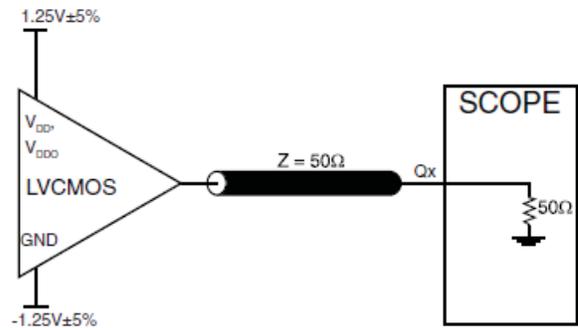
As with most timing specifications, phase noise measurements have issues. The primary issue relates to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This is illustrated above. The

device 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



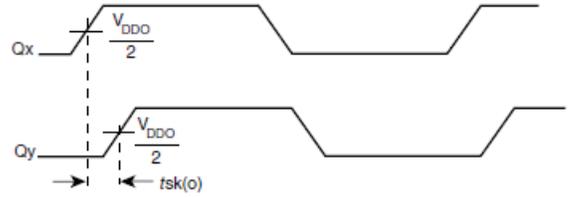
3.3V OUTPUT LOAD AC TEST CIRCUIT



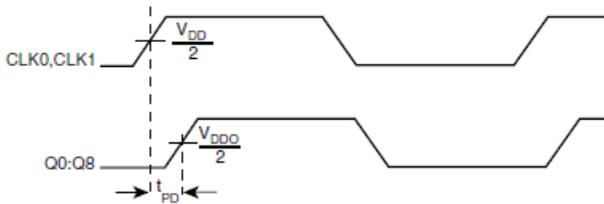
2.5V OUTPUT LOAD AC TEST CIRCUIT



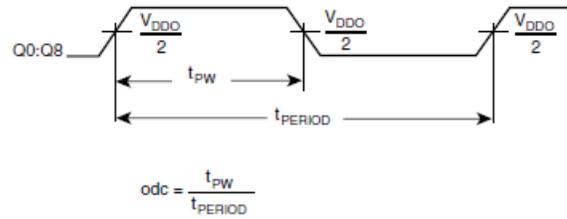
PART-TO-PART SKEW



OUTPUT SKEW



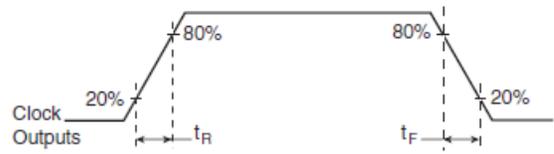
PROPAGATION DELAY



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 839471-147 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).

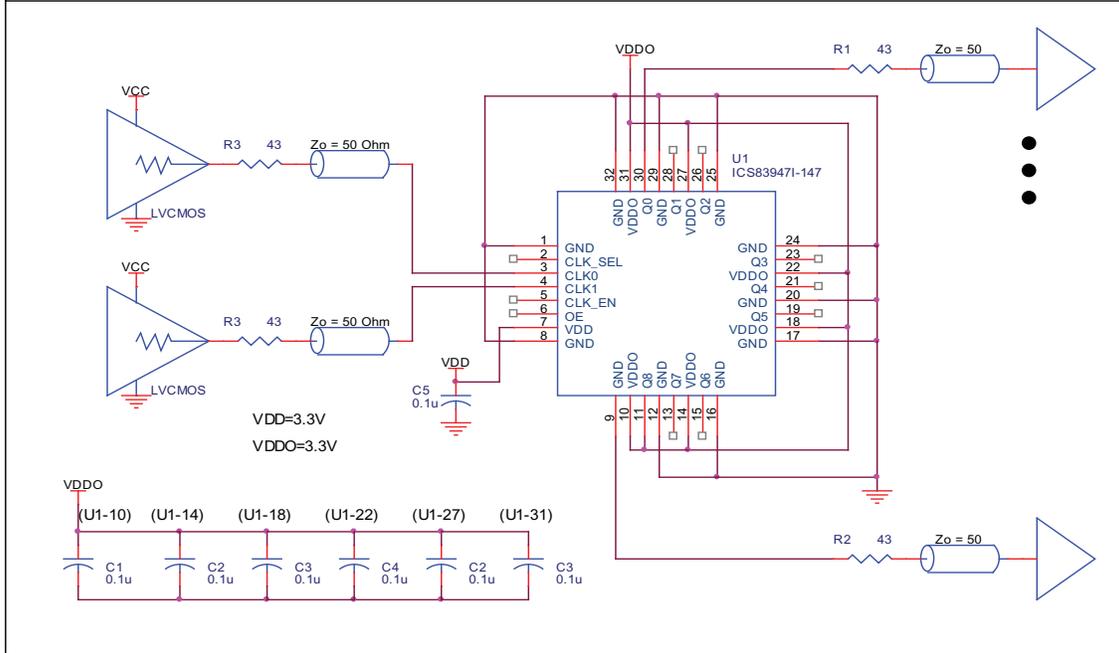


FIGURE 1. 839471-147 SCHEMATIC LAYOUT

RELIABILITY INFORMATION

TABLE 6. θ_{JA} VS. AIR FLOW TABLE FOR 32 LEAD LQFP

| 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 83947I-147 is: 1040

PACKAGE OUTLINE -Y SUFFIX FOR 32 LEAD LQFP

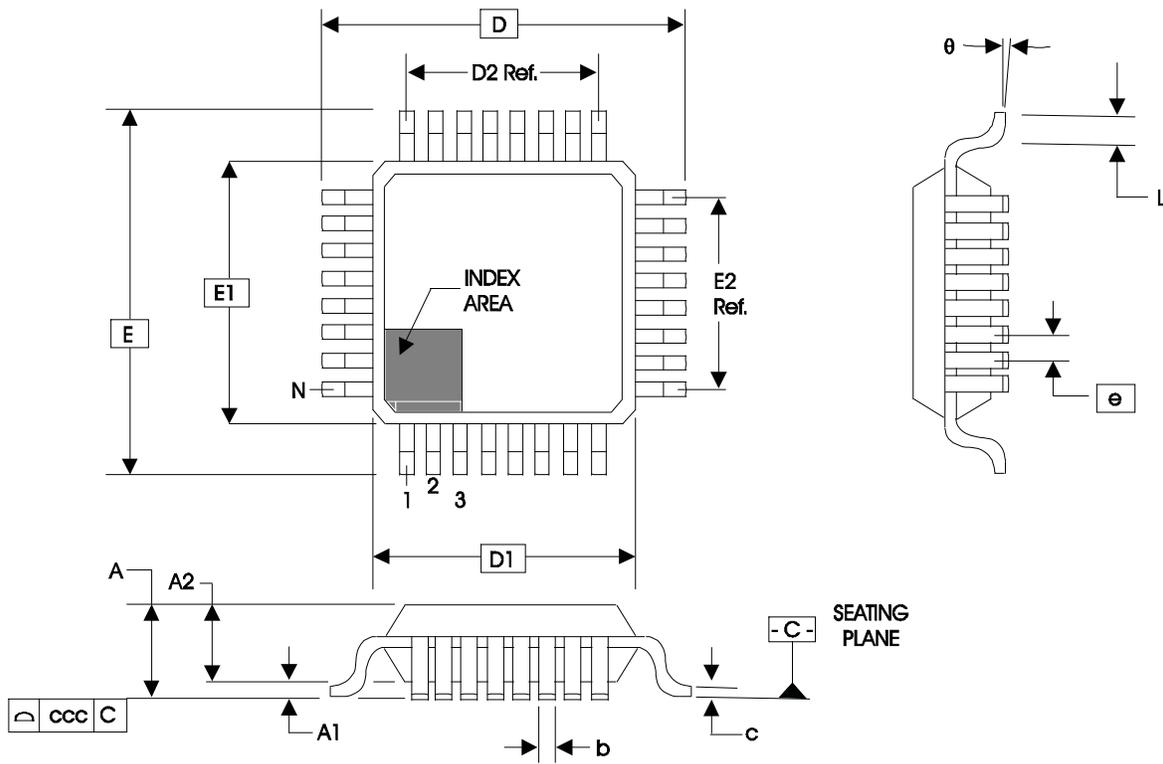


TABLE 7. PACKAGE DIMENSIONS

| 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 |
| θ | 0° | -- | 7° |
| ccc | -- | -- | 0.10 |

Reference Document: JEDEC Publication 95, MS-026

TABLE 8. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|--------------------------|----------------|-------------------------|---------------------------|--------------------|
| 83947AYI-147LF | ICS947AI147L | Lead-Free, 32 Lead LQFP | Tray | -40°C to 85°C |
| 83947AYI-147LFT | ICS947AI147L | Lead-Free, 32 Lead LQFP | Tape & Reel | -40°C to 85°C |

| 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 |
| A | T8 | 10 | Ordering Information Table - added lead-free ordering information. Deleted non lead-free ordering information. Deleted tape & reel count. | 2/27/13 |
| A | | | Removed ICS from part numbers where needed. Updated header and footer. | 3/18/16 |

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.