



## CDCLVP1212 LVPECL Output, High-Performance Clock Buffer

### 1 Features

- 2:12 Differential Buffer
- Selectable Clock Inputs Through Control Terminal
- Universal Inputs Accept LVPECL, LVDS, and LVCMOS/LVTTL
- 12 LVPECL Outputs
- Maximum Clock Frequency: 2 GHz
- Maximum Core Current Consumption: 88 mA
- Very Low Additive Jitter: <100 fs, rms in 10-kHz to 20-MHz Offset Range:
  - 57 fs, rms (typ) @ 122.88 MHz
  - 48 fs, rms (typ) @ 156.25 MHz
  - 30 fs, rms (typ) @ 312.5 MHz
- 2.375-V to 3.6-V Device Power Supply
- Maximum Propagation Delay: 550 ps
- Maximum Output Skew: 25 ps
- LVPECL Reference Voltage,  $V_{AC\_REF}$ , Available for Capacitive-Coupled Inputs
- Industrial Temperature Range:  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$
- ESD Protection Exceeds 2 kV (HBM)
- Supports  $105^{\circ}\text{C}$  PCB Temperature (Measured with a Thermal Pad)
- Available in 6-mm × 6-mm QFN-40 (RHA) Package

### 2 Applications

- Wireless Communications
- Telecommunications/Networking
- Medical Imaging
- Test and Measurement Equipment

### 3 Description

The CDCLVP1212 is a highly versatile, low additive jitter buffer that can generate 12 copies of LVPECL clock outputs from one of two selectable LVPECL, LVDS, or LVCMOS inputs for a variety of communication applications. It has a maximum clock frequency up to 2 GHz. The CDCLVP1212 features an on-chip multiplexer (MUX) for selecting one of two inputs that can be easily configured solely through a control terminal. The overall additive jitter performance is less than 0.1 ps, RMS from 10 kHz to 20 MHz, and overall output skew is as low as 25 ps, making the device a perfect choice for use in demanding applications.

The CDCLVP1212 clock buffer distributes one of two selectable clock inputs (IN0, IN1) to 12 pairs of differential LVPECL clock outputs (OUT0, OUT11) with minimum skew for clock distribution. The CDCLVP1212 can accept two clock sources into an input multiplexer. The inputs can be LVPECL, LVDS, or LVCMOS/LVTTL.

The CDCLVP1212 is specifically designed for driving 50-Ω transmission lines. When driving the inputs in single-ended mode, the LVPECL bias voltage ( $V_{AC\_REF}$ ) should be applied to the unused negative input terminal. However, for high-speed performance up to 2 GHz, differential mode is strongly recommended.

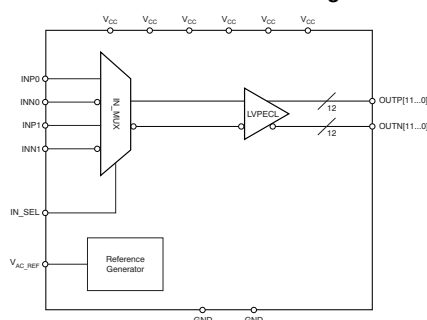
The CDCLVP1212 is packaged in a small 40-terminal, 6-mm × 6-mm QFN package and is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

#### Device Information<sup>(1)</sup>

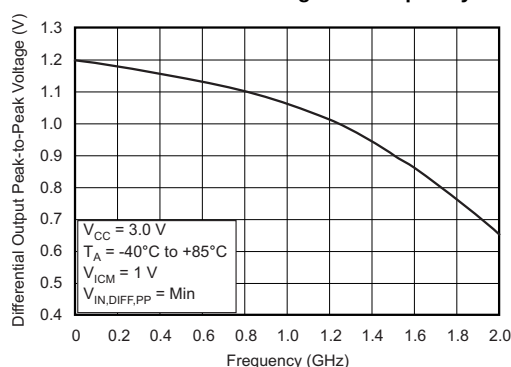
| PART NUMBER | PACKAGE  | BODY SIZE (NOM)   |
|-------------|----------|-------------------|
| CDCLVP1212  | QFN (40) | 6.00 mm x 6.00 mm |

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Functional Block Diagram



Peak-to-Peak Voltage vs. Frequency



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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision D (September 2014) to Revision E                                                                                                                             | Page |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| • Changed <i>Handling Ratings</i> to <i>ESD Ratings</i> ; moved $T_J$ and $T_{stg}$ to <i>Absolute Maximum Ratings</i>                                                             | 6    |
| • Added PCB temperature in <i>Recommended Operating Conditions</i>                                                                                                                 | 6    |
| • Added $V_{OH}$ specification for $T_{PCB} \leq 105^\circ\text{C}$ in <i>Electrical Characteristics: LVPECL Output, at <math>V_{CC} = 2.375\text{ V to }2.625\text{ V}</math></i> | 7    |
| • Added $V_{OL}$ specification for $T_{PCB} \leq 105^\circ\text{C}$ in <i>Electrical Characteristics: LVPECL Output, at <math>V_{CC} = 2.375\text{ V to }2.625\text{ V}</math></i> | 7    |
| • Added $I_{EE}$ specification for $T_{PCB} \leq 105^\circ\text{C}$ in <i>Electrical Characteristics: LVPECL Output, at <math>V_{CC} = 2.375\text{ V to }2.625\text{ V}</math></i> | 8    |
| • Added $I_{CC}$ specification for $T_{PCB} \leq 105^\circ\text{C}$ in <i>Electrical Characteristics: LVPECL Output, at <math>V_{CC} = 2.375\text{ V to }2.625\text{ V}</math></i> | 8    |
| • Added $V_{OH}$ specification for $T_{PCB} \leq 105^\circ\text{C}$ in <i>Electrical Characteristics: LVPECL Output, at <math>V_{CC} = 3\text{ V to }3.6\text{ V}</math></i>       | 9    |
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| • Added $I_{EE}$ specification for $T_{PCB} \leq 105^\circ\text{C}$ in <i>Electrical Characteristics: LVPECL Output, at <math>V_{CC} = 3\text{ V to }3.6\text{ V}</math></i>       | 10   |
| • Added $I_{CC}$ specification for $T_{PCB} \leq 105^\circ\text{C}$ in <i>Electrical Characteristics: LVPECL Output, at <math>V_{CC} = 3\text{ V to }3.6\text{ V}</math></i>       | 10   |
| • Added <i>Thermal Considerations</i> section                                                                                                                                      | 23   |
| • Added <i>Community Resources</i> section                                                                                                                                         | 24   |

| Changes from Revision C (June 2014) to Revision D                            | Page |
|------------------------------------------------------------------------------|------|
| • Added "NOTE" at the beginning of "Applications and Implementation" section | 20   |
| • Changed JEDEC symbol to $R_{\theta JA}$                                    | 23   |

| Changes from Revision B (August 2011) to Revision C                                                                                                                                                                                                                                                 | Page |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| • Changed data sheet flow and layout to conform with new TI standards. Added the following sections: <i>Application and Implementation</i> ; <i>Power Supply Recommendations</i> ; <i>Layout</i> ; <i>Device and Documentation Support</i> ; <i>Mechanical, Packaging, and Ordering Information</i> | 1    |

- Added  $f_{IN} = 125\text{ MHz}$ ,  $312.5\text{ MHz}$  for  $V_{OUT, DIFF, PP}$  ..... 7
- Added Typical values, Max values, and footnotes for 122.88 MHz, 156.25 MHz, and 312.5 MHz test conditions corresponding to Random Additive Jitter in Electrical Characteristics: LVPECL Output, At  $V_{CC} = 2.375\text{ V}$  to  $2.625\text{ V}$  ..... 8
- Added Typical values, Max values, and footnotes for 122.88 MHz, 156.25 MHz, and 312.5 MHz test conditions corresponding to Random Additive Jitter in Electrical Characteristics: LVPECL Output, at  $V_{CC} = 3.0\text{ V}$  to  $3.6\text{ V}$  ..... 10

**Changes from Revision A (May 2010) to Revision B**
**Page**

- Revised description of pin 7 ..... 5
- Corrected  $V_{IL}$  parameter description in *Electrical Characteristics* table for LVCMOS inputs ..... 7
- Added footnote (2) to *Electrical Characteristics* table for LVPECL Output,  $V_{CC} = 2.375\text{ V}$  to  $2.625\text{ V}$  ..... 7
- Added footnote (2) to *Electrical Characteristics* table for LVPECL Output,  $V_{CC} = 2.375\text{ V}$  to  $2.625\text{ V}$  ..... 8
- Changed resistor values in [Figure 12](#) ..... 16
- Changed resistor values in [Figure 16](#) ..... 18

**Changes from Original (August 2009) to Revision A**
**Page**

- Corrected package designators in orderable device names in the Device Comparison Table ..... 4
- Changed description of INP1, INP0 and INN1, INN0 pins in [Pin Descriptions](#) table ..... 4
- Changed descriptions of all output pins in [Pin Descriptions](#) table ..... 4

## CDCLVP1212

SCAS886E –AUGUST 2009–REVISED DECEMBER 2015

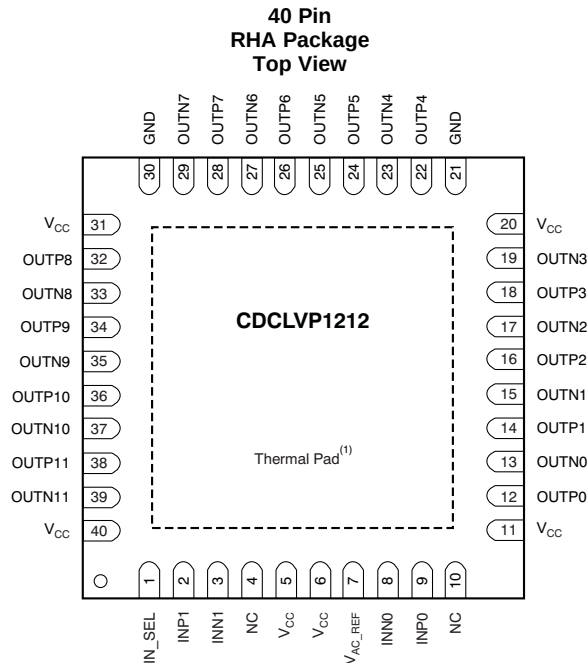
www.ti.com

## 5 Device Comparison Table<sup>(1)</sup>

| PACKAGED DEVICES | T <sub>A</sub> | FEATURES                                           |
|------------------|----------------|----------------------------------------------------|
| CDCLVP1212RHAT   | –40°C to 85°C  | 40 terminal QFN (RHA) package, small tape and reel |
| CDCLVP1212RHAR   | –40°C to 85°C  | 40 terminal QFN (RHA) package, tape and reel       |

(1) For the most current specifications and package information, see the Package Option Addendum located at the end of this data sheet or refer to our web site at [www.ti.com](http://www.ti.com).

## 6 Pin Configuration and Functions



(1) Thermal pad must be soldered to ground.

### Pin Functions

| PIN             |                      | TYPE   | PULL-UP/<br>PULLDOWN | DESCRIPTION                                                                                      |
|-----------------|----------------------|--------|----------------------|--------------------------------------------------------------------------------------------------|
| NAME            | NUMBER               |        |                      |                                                                                                  |
| V <sub>CC</sub> | 5, 6, 11, 20, 31, 40 | Power  | —                    | 2.5-V to 3.3-V supplies for the device                                                           |
| GND             | 21, 30               | Ground | —                    | Device grounds                                                                                   |
| INP0, INN0      | 9, 8                 | Input  | —                    | Differential input pair or single-ended input. Unused input pair can be left floating.           |
| INP1, INN1      | 2, 3                 | Input  | —                    | Redundant differential input pair or single-ended input. Unused input pair can be left floating. |
| OUTP11, OUTN11  | 38, 39               | Output | —                    | Differential LVPECL output pair no. 11. Unused output pair can be left floating.                 |
| OUTP10, OUTN10  | 36, 37               | Output | —                    | Differential LVPECL output pair no. 10. Unused output pair can be left floating.                 |
| OUTP9, OUTN9    | 34, 35               | Output | —                    | Differential LVPECL output pair no. 9. Unused output pair can be left floating.                  |
| OUTP8, OUTN8    | 32, 33               | Output | —                    | Differential LVPECL output pair no. 8. Unused output pair can be left floating.                  |
| OUTP7, OUTN7    | 28, 29               | Output | —                    | Differential LVPECL output pair no. 7. Unused output pair can be left floating.                  |

**Pin Functions (continued)**

| PIN                 |        | TYPE   | PULL-UP/<br>PULLDOWN                                   | DESCRIPTION                                                                                                                                                                                                                        |
|---------------------|--------|--------|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                | NUMBER |        |                                                        |                                                                                                                                                                                                                                    |
| OUTP6,<br>OUTN6     | 26, 27 | Output | —                                                      | Differential LVPECL output pair no. 6. Unused output pair can be left floating.                                                                                                                                                    |
| OUTP5,<br>OUTN5     | 24, 25 | Output | —                                                      | Differential LVPECL output pair no. 5. Unused output pair can be left floating.                                                                                                                                                    |
| OUTP4,<br>OUTN4     | 22, 23 | Output | —                                                      | Differential LVPECL output pair no. 4. Unused output pair can be left floating.                                                                                                                                                    |
| OUTP3,<br>OUTN3     | 18, 19 | Output | —                                                      | Differential LVPECL output pair no. 3. Unused output pair can be left floating.                                                                                                                                                    |
| OUTP2,<br>OUTN2     | 16, 17 | Output | —                                                      | Differential LVPECL output pair no. 2. Unused output pair can be left floating.                                                                                                                                                    |
| OUTP1,<br>OUTN1     | 14, 15 | Output | —                                                      | Differential LVPECL output pair no. 1. Unused output pair can be left floating.                                                                                                                                                    |
| OUTP0,<br>OUTN0     | 12, 13 | Output | —                                                      | Differential LVPECL output pair no. 0. Unused output pair can be left floating.                                                                                                                                                    |
| IN_SEL              | 1      | Input  | Pulldown<br>(see <a href="#">Pin Characteristics</a> ) | MUX select input for input choice (see <a href="#">Table 1</a> )                                                                                                                                                                   |
| V <sub>AC_REF</sub> | 7      | Output | —                                                      | Bias voltage output for capacitive coupled inputs. Do not use V <sub>AC_REF</sub> at V <sub>CC</sub> < 3.0 V. If used, it is recommended to use a 0.1-μF capacitor to GND on this terminal. The output current is limited to 2 mA. |
| NC                  | 4, 10  | —      | —                                                      | Do not connect                                                                                                                                                                                                                     |

**Table 1. Input Selection Table**

| IN_SEL | ACTIVE CLOCK INPUT |
|--------|--------------------|
| 0      | INP0, INN0         |
| 1      | INP1, INN1         |

## 7 Specifications

### 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

|                  |                                                   | MIN  | MAX                   | UNIT |
|------------------|---------------------------------------------------|------|-----------------------|------|
| V <sub>CC</sub>  | Supply voltage range <sup>(2)</sup>               | –0.5 | 4.6                   | V    |
| V <sub>IN</sub>  | Input voltage range <sup>(3)</sup>                | –0.5 | V <sub>CC</sub> + 0.5 | V    |
| V <sub>OUT</sub> | Output voltage range <sup>(3)</sup>               | –0.5 | V <sub>CC</sub> + 0.5 | V    |
| I <sub>IN</sub>  | Input current                                     |      | 20                    | mA   |
| I <sub>OUT</sub> | Output current                                    |      | 50                    | mA   |
| T <sub>A</sub>   | Specified free-air temperature range (no airflow) | –40  | 85                    | °C   |
| T <sub>stg</sub> | Storage temperature range                         | –65  | 150                   | °C   |
| T <sub>J</sub>   | Maximum junction temperature                      |      | 125                   | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All supply voltages must be supplied simultaneously.
- (3) The input and output negative voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

### 7.2 ESD Ratings

|                                   |                                                                             | MIN | MAX  | UNIT |
|-----------------------------------|-----------------------------------------------------------------------------|-----|------|------|
| V <sub>(ESD)</sub> <sup>(1)</sup> | Electrostatic discharge                                                     |     | 2000 | V    |
|                                   | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(2)</sup> |     |      |      |

- (1) Electrostatic discharge (ESD) to measure device sensitivity and immunity to damage caused by assembly line electrostatic discharges in to the device.
- (2) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

### 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                  |                                           | MIN   | TYP       | MAX  | UNIT |
|------------------|-------------------------------------------|-------|-----------|------|------|
| V <sub>CC</sub>  | Supply voltage                            | 2.375 | 2.50/3.30 | 3.60 | V    |
| T <sub>A</sub>   | Ambient temperature                       | –40   |           | 85   | °C   |
| T <sub>PCB</sub> | PCB temperature (measured at thermal pad) |       |           | 105  | °C   |

### 7.4 Thermal Information

| THERMAL METRIC <sup>(1)(2)(3)</sup> |                                              | VALUE   | UNIT                |
|-------------------------------------|----------------------------------------------|---------|---------------------|
| R <sub>θJA</sub>                    | Thermal resistance, junction-to-ambient      | 0 LFM   | 36.1 <sup>(4)</sup> |
|                                     |                                              | 150 LFM | 30.2 <sup>(4)</sup> |
|                                     |                                              | 400 LFM | 28.2 <sup>(4)</sup> |
| R <sub>θJC(top)</sub>               | Junction-to-case (top) thermal resistance    | 23.7    | °C/W                |
| R <sub>θJP</sub> <sup>(5)</sup>     | Thermal resistance, junction-to-pad          | 3.58    | °C/W                |
| ψ <sub>JT</sub>                     | Junction-to-top characterization parameter   | 0.5     | °C/W                |
| ψ <sub>JB</sub>                     | Junction-to-board characterization parameter | 10.0    | °C/W                |
| R <sub>θJC(bot)</sub>               | Junction-to-case (bottom) thermal resistance | 3.8     | °C/W                |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report ([SPRA953](#)).
- (2) The package thermal resistance is calculated in accordance with JESD 51 and JEDEC 2S2P (high-K board).
- (3) Connected to GND with 16 thermal vias (0.3-mm diameter).
- (4) 4 x 4 vias on Pad
- (5) θ<sub>JP</sub> (junction-to-pad) is used for the QFN package, because the primary heat flow is from the junction to the GND pad of the QFN package.

## 7.5 Electrical Characteristics: LVCMOS Input

at  $V_{CC} = 2.375\text{ V}$  to  $3.6\text{ V}$  and  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  and  $T_{PCB} \leq 105^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                           | TEST CONDITIONS                                           | MIN            | TYP | MAX            | UNIT          |
|-------------------------------------|-----------------------------------------------------------|----------------|-----|----------------|---------------|
| $f_{IN}$ Input frequency            |                                                           |                |     | 200            | MHz           |
| $V_{th}$ Input threshold voltage    | External threshold voltage applied to complementary input | 1.1            |     | 1.8            | V             |
| $V_{IH}$ Input high voltage         |                                                           | $V_{th} + 0.1$ |     | $V_{CC}$       | V             |
| $V_{IL}$ Input low voltage          |                                                           | 0              |     | $V_{th} - 0.1$ | V             |
| $I_{IH}$ Input high current         | $V_{CC} = 3.6\text{ V}$ , $V_{IH} = 3.6\text{ V}$         |                |     | 40             | $\mu\text{A}$ |
| $I_{IL}$ Input low current          | $V_{CC} = 3.6\text{ V}$ , $V_{IL} = 0\text{ V}$           |                |     | -40            | $\mu\text{A}$ |
| $\Delta V/\Delta T$ Input edge rate | 20% to 80%                                                | 1.5            |     |                | V/ns          |
| $I_{CAP}$ Input capacitance         |                                                           |                | 5   |                | pF            |

(1) Figure 6 and Figure 7 show DC test setup.

## 7.6 Electrical Characteristics: Differential Input

at  $V_{CC} = 2.375\text{ V}$  to  $3.6\text{ V}$  and  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  and  $T_{PCB} \leq 105^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                                               | TEST CONDITIONS                                   | MIN | TYP | MAX            | UNIT          |
|---------------------------------------------------------|---------------------------------------------------|-----|-----|----------------|---------------|
| $f_{IN}$ Input frequency                                | Clock input                                       |     |     | 2000           | MHz           |
| $V_{IN, DIFF, PP}$ Differential input peak-peak voltage | $f_{IN} \leq 1.5\text{ GHz}$                      | 0.1 |     | 1.5            | V             |
|                                                         | $1.5\text{ GHz} \leq f_{IN} \leq 2\text{ GHz}$    | 0.2 |     | 1.5            | V             |
| $V_{ICM}$ Input common-mode level                       |                                                   | 1.0 |     | $V_{CC} - 0.3$ | V             |
| $I_{IH}$ Input high current                             | $V_{CC} = 3.6\text{ V}$ , $V_{IH} = 3.6\text{ V}$ |     |     | 40             | $\mu\text{A}$ |
| $I_{IL}$ Input low current                              | $V_{CC} = 3.6\text{ V}$ , $V_{IL} = 0\text{ V}$   |     |     | -40            | $\mu\text{A}$ |
| $\Delta V/\Delta T$ Input edge rate                     | 20% to 80%                                        | 1.5 |     |                | V/ns          |
| $I_{CAP}$ Input capacitance                             |                                                   |     | 5   |                | pF            |

(1) Figure 5 and Figure 8 show DC test setup. Figure 9 shows AC test setup.

## 7.7 Electrical Characteristics: LVPECL Output, At $V_{CC} = 2.375\text{ V}$ to $2.625\text{ V}$

$T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  and  $T_{PCB} \leq 105^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                                                 | TEST CONDITIONS                                                         | MIN             | TYP  | MAX             | UNIT |
|-----------------------------------------------------------|-------------------------------------------------------------------------|-----------------|------|-----------------|------|
| $V_{OH}$ Output high voltage                              | $T_A \leq 85^\circ\text{C}$                                             | $V_{CC} - 1.26$ |      | $V_{CC} - 0.9$  | V    |
|                                                           | $T_{PCB} \leq 105^\circ\text{C}$                                        | $V_{CC} - 1.26$ |      | $V_{CC} - 0.83$ |      |
| $V_{OL}$ Output low voltage                               | $T_A \leq 85^\circ\text{C}$                                             | $V_{CC} - 1.7$  |      | $V_{CC} - 1.3$  | V    |
|                                                           | $T_{PCB} \leq 105^\circ\text{C}$                                        | $V_{CC} - 1.7$  |      | $V_{CC} - 1.25$ |      |
| $V_{OUT, DIFF, PP}$ Differential output peak-peak voltage | $f_{IN} \leq 2\text{ GHz}$                                              | 0.5             |      | 1.35            | V    |
|                                                           | $f_{IN} = 125\text{ MHz}$ , $312.5\text{ MHz}$                          |                 | 1.15 |                 |      |
| $V_{AC\_REF}$ Input bias voltage <sup>(2)</sup>           | $I_{AC\_REF} = 2\text{ mA}$                                             | $V_{CC} - 1.6$  |      | $V_{CC} - 1.1$  | V    |
| $t_{PD}$ Propagation delay                                | $V_{IN, DIFF, PP} = 0.1\text{ V}$                                       |                 |      | 550             | ps   |
|                                                           | $V_{IN, DIFF, PP} = 0.3\text{ V}$                                       |                 |      | 550             | ps   |
| $t_{SK, PP}$ Part-to-part skew                            |                                                                         |                 |      | 150             | ps   |
| $t_{SK, O}$ Output skew                                   |                                                                         |                 |      | 25              | ps   |
| $t_{SK, P}$ Pulse skew (with 50% duty cycle input)        | Crossing-point-to-crossing-point distortion, $f_{OUT} = 100\text{ MHz}$ | -50             |      | 50              | ps   |

(1) Figure 10 and Figure 11 show DC and AC test setup.

(2) Internally generated bias voltage ( $V_{AC\_REF}$ ) is for 3.3 V operation only. It is recommended to apply externally generated bias voltage for  $V_{CC} < 3.0\text{ V}$ .

**Electrical Characteristics: LVPECL Output, At  $V_{CC} = 2.375\text{ V}$  to  $2.625\text{ V}$  (continued)**
 $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  and  $T_{PCB} \leq 105^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER  | TEST CONDITIONS                                                                                               | MIN                                                                                        | TYP   | MAX   | UNIT    |
|------------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------|-------|---------|
| $t_{RJIT}$ | Random additive jitter (with 50% duty cycle input) <sup>(3)</sup>                                             |                                                                                            |       |       |         |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,SE} = V_{CC}$ , $V_{th} = 1.25\text{ V}$ , 10 kHz to 20 MHz               |                                                                                            | 0.11  |       | ps, RMS |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,SE} = 0.9\text{ V}$ , $V_{th} = 1.1\text{ V}$ , 10 kHz to 20 MHz          |                                                                                            | 0.128 |       | ps, RMS |
|            | $f_{OUT} = 2\text{ GHz}$ , $V_{IN,DIFF,PP} = 0.2\text{ V}$ , $V_{ICM} = 1\text{ V}$ , 10 kHz to 20 MHz        |                                                                                            | 0.053 |       | ps, RMS |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,DIFF,PP} = 0.15\text{ V}$ , $V_{ICM} = 1\text{ V}$ , 10 kHz to 20 MHz     |                                                                                            | 0.093 |       | ps, RMS |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,DIFF,PP} = 1\text{ V}$ , $V_{ICM} = 1\text{ V}$ , 10 kHz to 20 MHz        |                                                                                            | 0.092 |       | ps, RMS |
|            | $f_{OUT} = 122.88\text{ MHz}$ , <sup>(4)(5)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 12 kHz to 20 MHz |                                                                                            | 0.057 | 0.088 | ps, RMS |
|            | $f_{OUT} = 122.88\text{ MHz}$ , <sup>(4)(5)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 10 kHz to 20 MHz |                                                                                            | 0.057 | 0.088 | ps, RMS |
|            | $f_{OUT} = 122.88\text{ MHz}$ , <sup>(4)(5)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 1 kHz to 40 MHz  |                                                                                            | 0.086 | 0.121 | ps, RMS |
|            | $f_{OUT} = 156.25\text{ MHz}$ , <sup>(5)(6)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 12 kHz to 20 MHz |                                                                                            | 0.048 | 0.071 | ps, RMS |
|            | $f_{OUT} = 156.25\text{ MHz}$ , <sup>(5)(6)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 10 kHz to 20 MHz |                                                                                            | 0.048 | 0.071 | ps, RMS |
|            | $f_{OUT} = 156.25\text{ MHz}$ , <sup>(5)(6)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 1 kHz to 40 MHz  |                                                                                            | 0.068 | 0.097 | ps, RMS |
|            | $f_{OUT} = 312.5\text{ MHz}$ , <sup>(5)(7)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 12 kHz to 20 MHz  |                                                                                            | 0.030 | 0.048 | ps, RMS |
| $t_R/t_F$  | Output rise/fall time                                                                                         | 20% to 80%                                                                                 |       | 200   | ps      |
|            |                                                                                                               |                                                                                            |       |       |         |
| $I_{EE}$   | Supply internal current                                                                                       | Outputs unterminated<br>$T_A \leq 85^\circ\text{C}$                                        |       | 88    | mA      |
|            |                                                                                                               | Outputs unterminated<br>$T_{PCB} \leq 105^\circ\text{C}$                                   |       | 89    |         |
| $I_{CC}$   | Output and internal supply current                                                                            | All outputs terminated,<br>50 $\Omega$ to $V_{CC} - 2$<br>$T_A \leq 85^\circ\text{C}$      |       | 468   | mA      |
|            |                                                                                                               | All outputs terminated,<br>50 $\Omega$ to $V_{CC} - 2$<br>$T_{PCB} \leq 105^\circ\text{C}$ |       | 516   |         |

(3) Parameter is specified by characterization. Not tested in production.

(4) Input source: 122.88-MHz Rohde & Schwarz SMA100A Signal Generator.

(5) Input source RMS Jitter ( $t_{RJIT\_IN}$ ) and Total RMS Jitter ( $t_{RJIT\_OUT}$ ) measured using Agilent E5052 Phase Noise Analyzer. Buffer device random additive jitter computed as:  $t_{RJIT} = \text{SQRT}[(t_{RJIT\_OUT})^2 - (t_{RJIT\_IN})^2]$ .

(6) Input source: 156.25-MHz Rohde & Schwarz SMA100A Signal Generator.

(7) Input source: 312.5-MHz Rohde & Schwarz SMA100A Signal Generator.



## 7.8 Electrical Characteristics: LVPECL Output, at $V_{CC} = 3.0\text{ V}$ to $3.6\text{ V}$

 $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  and  $T_{PCB} \leq 105^{\circ}\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER                  |                                        | TEST CONDITIONS                                                         | MIN             | TYP             | MAX            | UNIT |
|----------------------------|----------------------------------------|-------------------------------------------------------------------------|-----------------|-----------------|----------------|------|
| $V_{OH}$                   | Output high voltage                    | $T_A \leq 85^{\circ}\text{C}$                                           | $V_{CC} - 1.26$ | $V_{CC} - 0.9$  |                | V    |
|                            |                                        | $T_{PCB} \leq 105^{\circ}\text{C}$                                      | $V_{CC} - 1.26$ | $V_{CC} - 0.85$ |                |      |
| $V_{OL}$                   | Output low voltage                     | $T_A \leq 85^{\circ}\text{C}$                                           | $V_{CC} - 1.7$  | $V_{CC} - 1.3$  |                | V    |
|                            |                                        | $T_{PCB} \leq 105^{\circ}\text{C}$                                      | $V_{CC} - 1.7$  | $V_{CC} - 1.3$  |                |      |
| $V_{OUT, \text{DIFF, PP}}$ | Differential output peak-peak voltage  | $f_{IN} \leq 2\text{ GHz}$                                              | 0.65            |                 | 1.35           | V    |
| $V_{AC, \text{REF}}$       | Input bias voltage                     | $I_{AC, \text{REF}} = 2\text{ mA}$                                      | $V_{CC} - 1.6$  |                 | $V_{CC} - 1.1$ | V    |
| $t_{PD}$                   | Propagation delay                      | $V_{IN, \text{DIFF, PP}} = 0.1\text{ V}$                                |                 |                 | 550            | ps   |
|                            |                                        | $V_{IN, \text{DIFF, PP}} = 0.3\text{ V}$                                |                 |                 | 550            | ps   |
| $t_{SK, PP}$               | Part-to-part skew                      |                                                                         |                 |                 | 150            | ps   |
| $t_{SK, O}$                | Output skew                            |                                                                         |                 |                 | 25             | ps   |
| $t_{SK, P}$                | Pulse skew (with 50% duty cycle input) | Crossing-point-to-crossing-point distortion, $f_{OUT} = 100\text{ MHz}$ | -50             |                 | 50             | ps   |

(1) [Figure 10](#) and [Figure 11](#) show DC and AC test setup.

**Electrical Characteristics: LVPECL Output, at  $V_{CC} = 3.0\text{ V}$  to  $3.6\text{ V}$  (continued)**
 $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  and  $T_{PCB} \leq 105^\circ\text{C}$  (unless otherwise noted) <sup>(1)</sup>

| PARAMETER  | TEST CONDITIONS                                                                                               | MIN                                                                                        | TYP   | MAX | UNIT    |
|------------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------|-----|---------|
| $t_{RJIT}$ | Random additive jitter (with 50% duty cycle input) <sup>(2)</sup>                                             |                                                                                            |       |     |         |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,SE} = V_{CC}$ , $V_{th} = 1.65\text{ V}$ , 10 kHz to 20 MHz               |                                                                                            | 0.101 |     | ps, RMS |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,SE} = 0.9\text{ V}$ , $V_{th} = 1.1\text{ V}$ , 10 kHz to 20 MHz          |                                                                                            | 0.130 |     | ps, RMS |
|            | $f_{OUT} = 2\text{ GHz}$ , $V_{IN,DIFF,PP} = 0.2\text{ V}$ , $V_{ICM} = 1\text{ V}$ , 10 kHz to 20 MHz        |                                                                                            | 0.069 |     | ps, RMS |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,DIFF,PP} = 0.15\text{ V}$ , $V_{ICM} = 1\text{ V}$ , 10 kHz to 20 MHz     |                                                                                            | 0.094 |     | ps, RMS |
|            | $f_{OUT} = 100\text{ MHz}$ , $V_{IN,DIFF,PP} = 1\text{ V}$ , $V_{ICM} = 1\text{ V}$ , 10 kHz to 20 MHz        |                                                                                            | 0.094 |     | ps, RMS |
|            | $f_{OUT} = 122.88\text{ MHz}$ , <sup>(3)(4)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 12 kHz to 20 MHz |                                                                                            | 0.057 |     | ps, RMS |
|            | $f_{OUT} = 122.88\text{ MHz}$ , <sup>(3)(4)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 10 kHz to 20 MHz |                                                                                            | 0.057 |     | ps, RMS |
|            | $f_{OUT} = 122.88\text{ MHz}$ , <sup>(3)(4)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 1 kHz to 40 MHz  |                                                                                            | 0.086 |     | ps, RMS |
|            | $f_{OUT} = 156.25\text{ MHz}$ , <sup>(4)(5)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 12 kHz to 20 MHz |                                                                                            | 0.048 |     | ps, RMS |
|            | $f_{OUT} = 156.25\text{ MHz}$ , <sup>(4)(5)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 10 kHz to 20 MHz |                                                                                            | 0.048 |     | ps, RMS |
|            | $f_{OUT} = 156.25\text{ MHz}$ , <sup>(4)(5)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 1 kHz to 40 MHz  |                                                                                            | 0.068 |     | ps, RMS |
|            | $f_{OUT} = 312.5\text{ MHz}$ , <sup>(4)(6)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 12 kHz to 20 MHz  |                                                                                            | 0.030 |     | ps, RMS |
|            | $f_{OUT} = 312.5\text{ MHz}$ , <sup>(4)(6)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 10 kHz to 20 MHz  |                                                                                            | 0.030 |     | ps, RMS |
|            | $f_{OUT} = 312.5\text{ MHz}$ , <sup>(4)(6)</sup><br>Square Wave, $V_{IN,PP} = 1\text{ V}$ , 1 kHz to 40 MHz   |                                                                                            | 0.045 |     | ps, RMS |
| $t_R/t_F$  | Output rise/fall time                                                                                         | 20% to 80%                                                                                 |       | 200 | ps      |
| $I_{EE}$   | Supply internal current                                                                                       | Outputs unterminated<br>$T_A \leq 85^\circ\text{C}$                                        |       | 88  | mA      |
|            |                                                                                                               | $T_{PCB} \leq 105^\circ\text{C}$                                                           |       | 89  |         |
| $I_{CC}$   | Output and internal supply current                                                                            | All outputs terminated,<br>50 $\Omega$ to $V_{CC} - 2$<br>$T_A \leq 85^\circ\text{C}$      |       | 468 | mA      |
|            |                                                                                                               | All outputs terminated,<br>50 $\Omega$ to $V_{CC} - 2$<br>$T_{PCB} \leq 105^\circ\text{C}$ |       | 516 |         |

(2) Parameter is specified by characterization. Not tested in production.

(3) Input source: 122.88-MHz Rohde & Schwarz SMA100A Signal Generator.

(4) Input source RMS Jitter ( $t_{RJIT\_IN}$ ) and Total RMS Jitter ( $t_{RJIT\_OUT}$ ) measured using Agilent E5052 Phase Noise Analyzer. Buffer device random additive jitter computed as:  $t_{RJIT} = \sqrt{t_{RJIT\_OUT}^2 - (t_{RJIT\_IN})^2}$ .

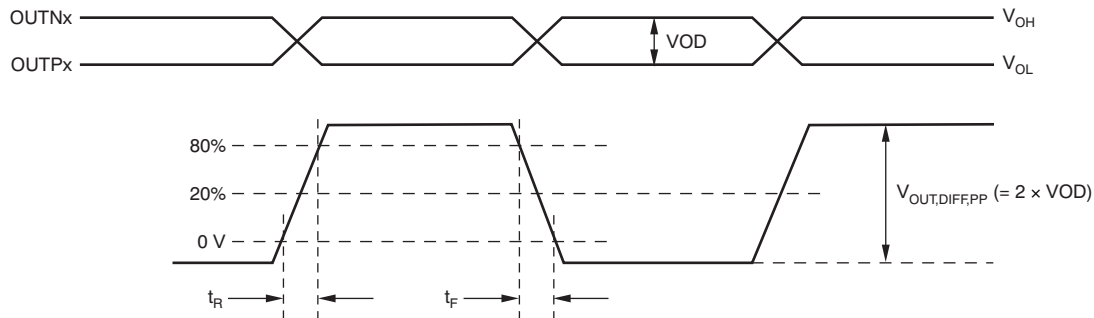
(5) Input source: 156.25-MHz Rohde & Schwarz SMA100A Signal Generator.

(6) Input source: 312.5-MHz Rohde & Schwarz SMA100A Signal Generator.

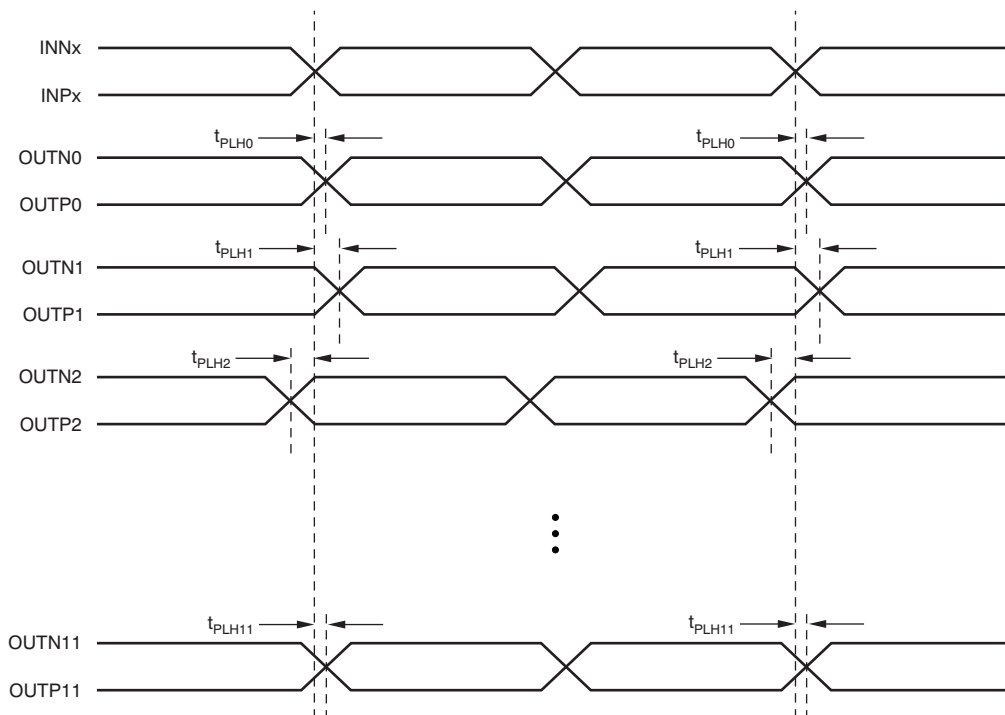
## 7.9 Pin Characteristics

| PARAMETER                              | MIN | TYP | MAX | UNIT       |
|----------------------------------------|-----|-----|-----|------------|
| $R_{PULLDOWN}$ Input pulldown resistor |     | 150 |     | k $\Omega$ |

## 7.10 Timing Requirements



**Figure 1. Output Voltage and Rise/Fall Time**

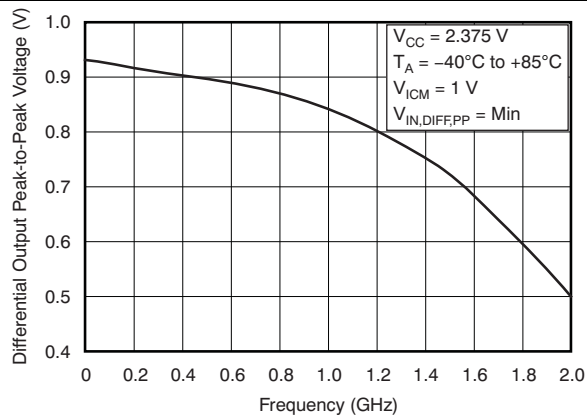


- (1) Output skew is calculated as the greater of the following: As the difference between the fastest and the slowest  $t_{PLHn}$  ( $n = 0, 1, 2, \dots, 11$ ), or as the difference between the fastest and the slowest  $t_{PHLn}$  ( $n = 0, 1, 2, \dots, 11$ ).
- (2) Part-to-part skew is calculated as the greater of the following: As the difference between the fastest and the slowest  $t_{PLHn}$  ( $n = 0, 1, 2, \dots, 11$ ) across multiple devices, or the difference between the fastest and the slowest  $t_{PHLn}$  ( $n = 0, 1, 2, \dots, 11$ ) across multiple devices.

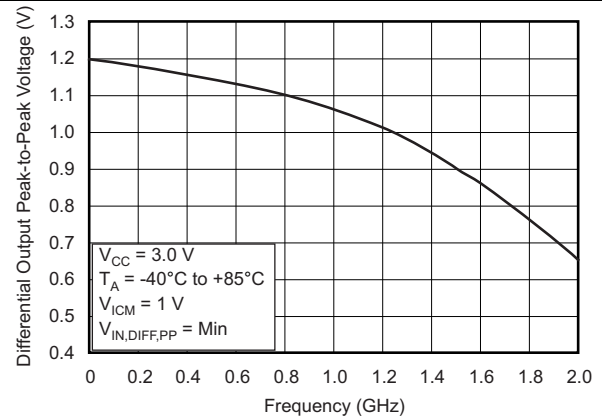
**Figure 2. Output and Part-To-Part Skew**

## 7.11 Typical Characteristics

at  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  (unless otherwise noted)



**Figure 3. Differential Output Peak-To-Peak Voltage Vs Frequency**

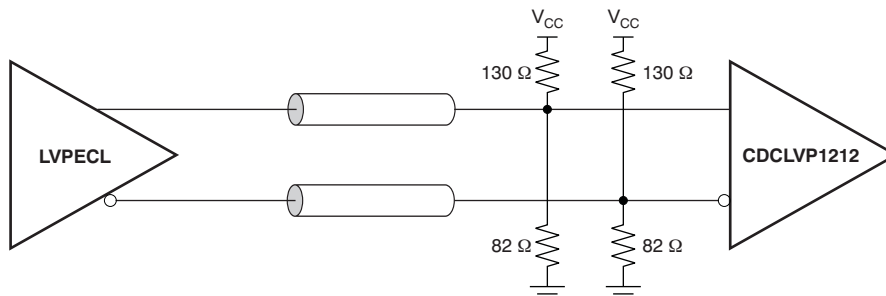


**Figure 4. Differential Output Peak-To-Peak Voltage Vs Frequency**

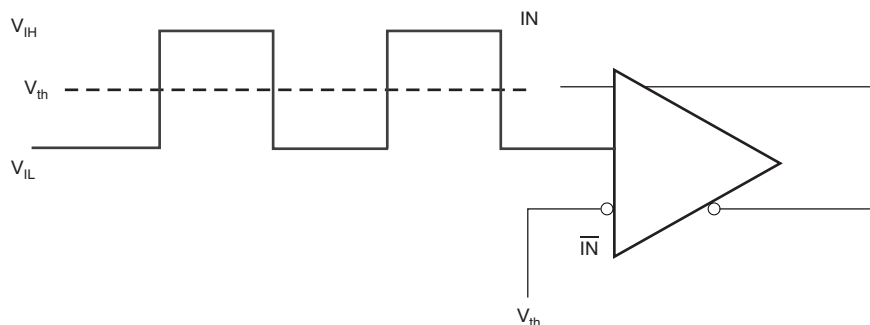
## 8 Parameter Measurement Information

### 8.1 Test Configurations

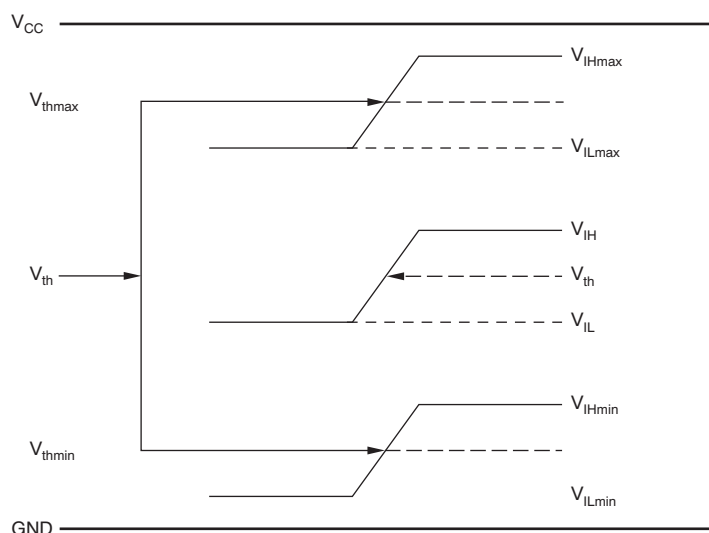
This section describes the function of each block for the CDCLVP1212. Figure 6 through Figure 11 illustrate how the device should be set up for a variety of test configurations.



**Figure 5. DC-Coupled LVPECL Input During Device Test**

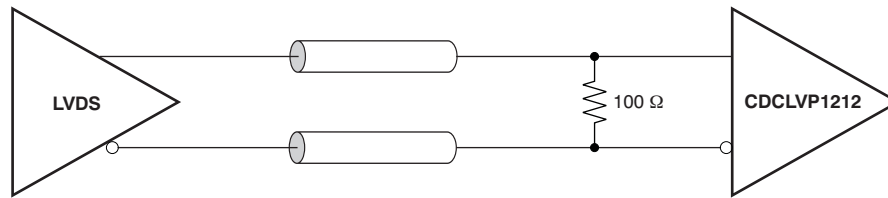


**Figure 6. DC-Coupled LVCMOS Input During Device Test**

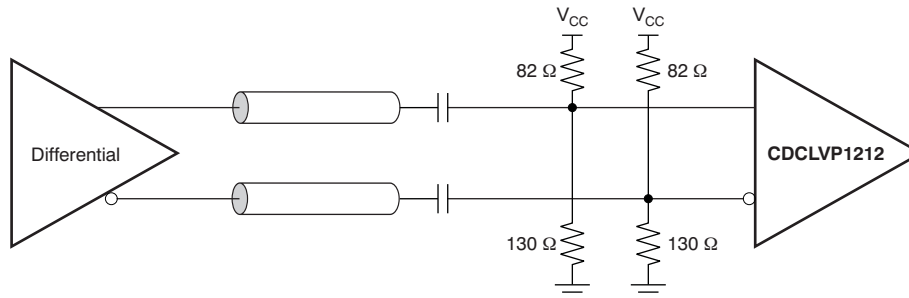


**Figure 7. Voltage Variation Over LVCMOS  $V_{th}$  Levels**

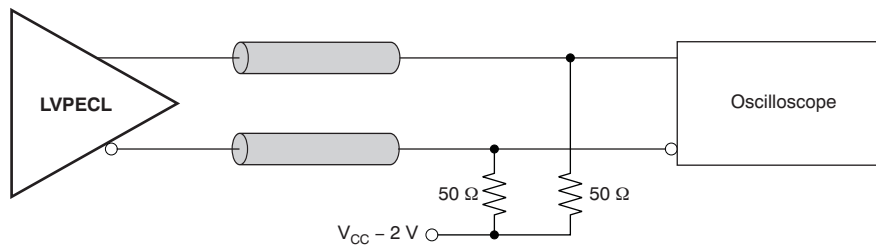
## Test Configurations (continued)



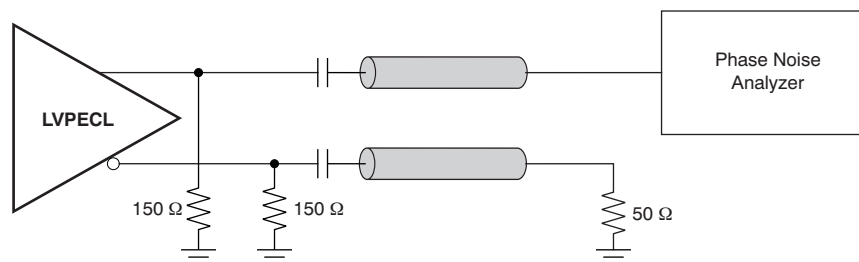
**Figure 8. DC-Coupled LVDS Input During Device Test**



**Figure 9. AC-Coupled Differential Input To Device**



**Figure 10. LVPECL Output DC Configuration During Device Test**



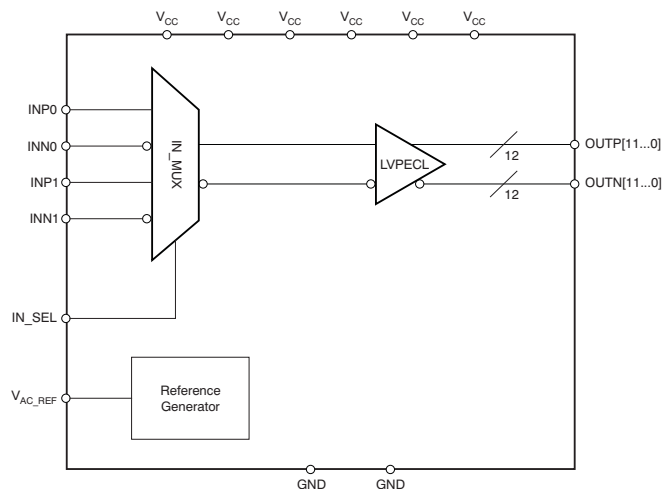
**Figure 11. LVPECL Output AC Configuration During Device Test**

## 9 Detailed Description

### 9.1 Overview

The CDCLVP1212 uses an open emitter follower stage for its LVPECL outputs. Therefore, proper output biasing and termination are required to ensure correct operation of the device and to maximize output signal integrity. The proper termination for LVPECL outputs is a  $50\ \Omega$  to  $(V_{CC} - 2)\text{ V}$ , but this DC voltage is not readily available on PCB. Therefore, a Thevenin equivalent circuit is worked out for the LVPECL termination in both direct-coupled (DC) and AC-coupled configurations. These configurations are shown in [Figure 12](#) (a and b) for  $V_{CC} = 2.5\text{ V}$  and [Figure 13](#) (a and b) for  $V_{CC} = 3.3\text{ V}$ , respectively. It is recommended to place all resistive components close to either the driver end or the receiver end. If the supply voltage for the driver and receiver is different, AC coupling is required.

### 9.2 Functional Block Diagram



### 9.3 Feature Description

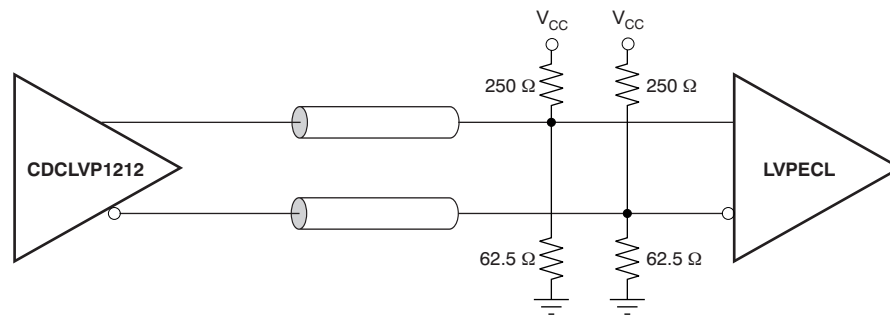
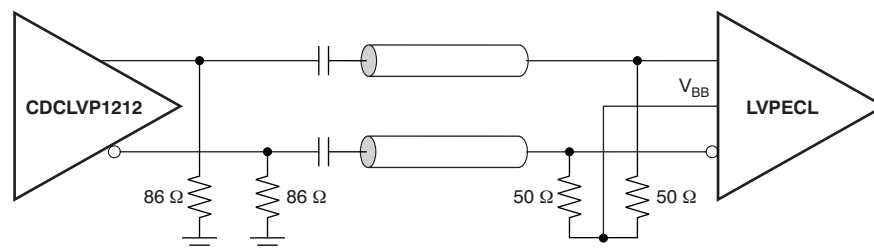
The CDCLVP1212 is a low additive jitter universal to LVPECL fan out buffer with 2 selectable inputs. The small package, low output skew, and low additive jitter make for a flexible device in demanding applications.

### 9.4 Device Functional Modes

The two inputs of the CDCLVP1212 are internally muxed together and can be selected via the control pin. Unused inputs and outputs can be left floating to reduce overall component cost. Both AC and DC coupling schemes can be used with the CDCLVP1212 to provide greater system flexibility.

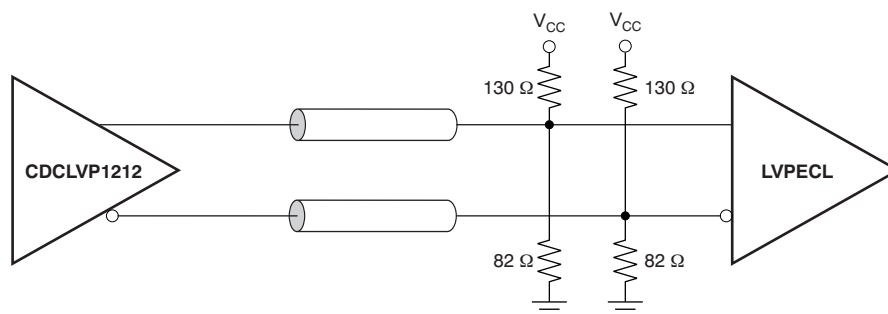
#### 9.4.1 LVPECL Output Termination

The CDCLVP1212 is an open emitter for LVPECL outputs. Therefore, proper biasing and termination are required to ensure correct operation of the device and to minimize signal integrity. The proper termination for LVPECL outputs is a  $50\ \Omega$  to  $(V_{CC} - 2)\text{ V}$ , but this DC voltage is not readily available on PCB. Therefore, a Thevenin equivalent circuit is worked out for the LVPECL termination in both direct-coupled (DC) and AC-coupled configurations. These configurations are shown in [Figure 12](#) (a and b) for  $V_{CC} = 2.5\text{ V}$  and [Figure 13](#) (a and b) for  $V_{CC} = 3.3\text{ V}$ , respectively. It is recommended to place all resistive components close to either the driver end or the receiver end. If the supply voltage for the driver and receiver is different, AC coupling is required.

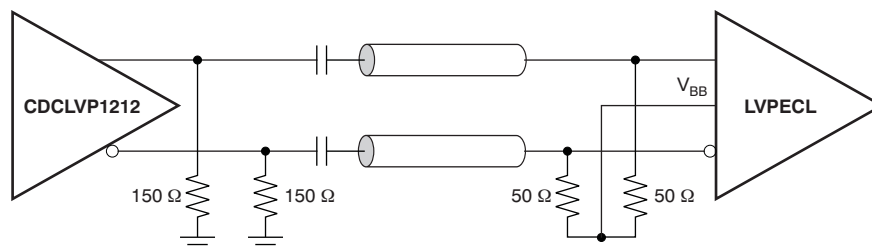
**Device Functional Modes (continued)**

**(a) Output DC Termination**

**(b) Output AC Termination**
**Figure 12. LVPECL Output DC and AC Termination For  $V_{CC} = 2.5\text{ V}$**



## Device Functional Modes (continued)



(a) Output DC Termination



(b) Output AC Termination

Figure 13. LVPECL Output DC and AC Termination For  $V_{CC} = 3.3\text{ V}$

### 9.4.2 Input Termination

The CDCLVP1212 inputs can be interfaced with LVPECL, LVDS, or LVCMOS drivers. Figure 14 illustrates how to DC couple an LVCMOS input to the CDCLVP1212. The series resistance ( $R_S$ ) should be placed close to the LVCMOS driver; its value is calculated as the difference between the transmission line impedance and the driver output impedance.

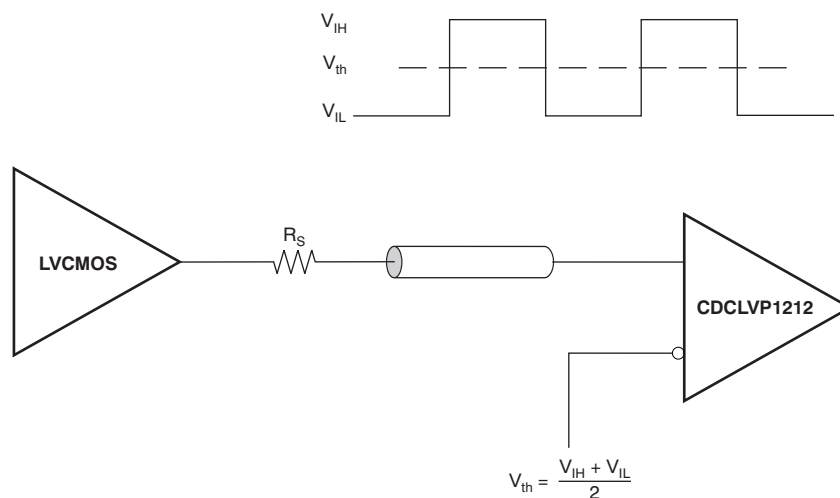
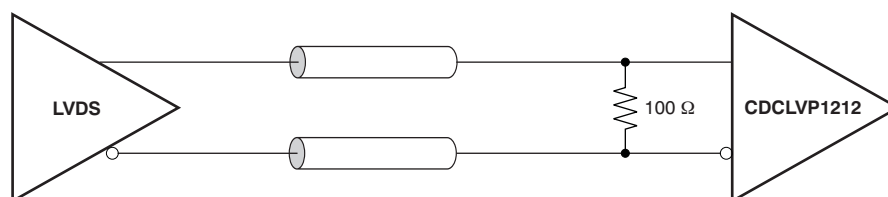


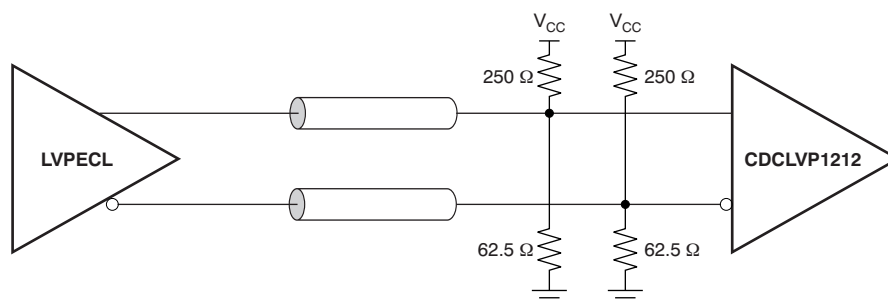
Figure 14. DC-Coupled LVCMOS Input to CDCLVP1212

## Device Functional Modes (continued)

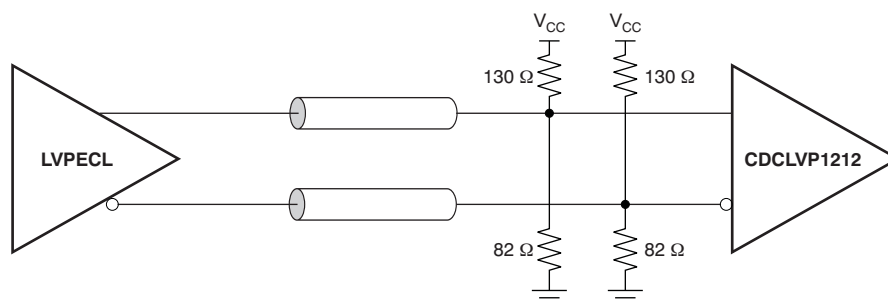
Figure 15 shows how to DC couple LVDS inputs to the CDCLVP1212. Figure 16 and Figure 17 describe the method of DC coupling LVPECL inputs to the CDCLVP1212 for  $V_{CC} = 2.5\text{ V}$  and  $V_{CC} = 3.3\text{ V}$ , respectively.



**Figure 15. DC-Coupled LVDS Inputs to CDCLVP1212**



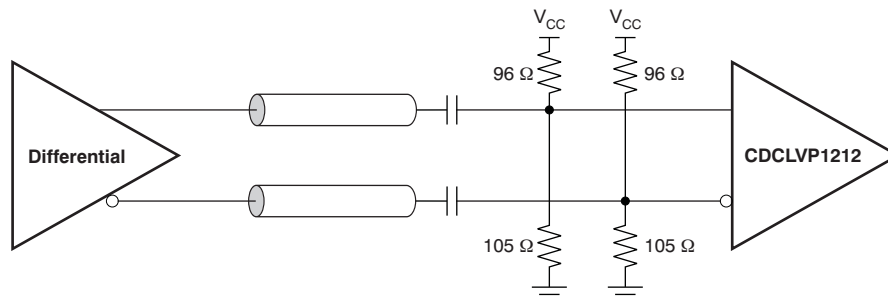
**Figure 16. DC-Coupled LVPECL Inputs to CDCLVP1212 ( $V_{CC} = 2.5\text{ V}$ )**



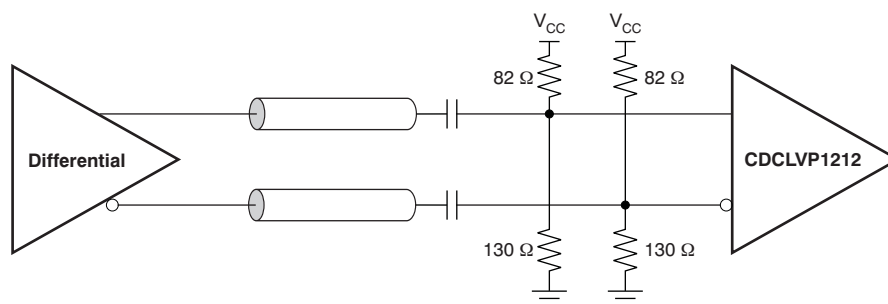
**Figure 17. DC-Coupled LVPECL Inputs to CDCLVP1212 ( $V_{CC} = 3.3\text{ V}$ )**

## Device Functional Modes (continued)

Figure 18 and Figure 19 show the technique of AC coupling differential inputs to the CDCLVP1212 for  $V_{CC} = 2.5\text{ V}$  and  $V_{CC} = 3.3\text{ V}$ , respectively. It is recommended to place all resistive components close to either the driver end or the receiver end. If the supply voltages of the driver and receiver are different, AC coupling is required.



**Figure 18. AC-Coupled Differential Inputs to CDCLVP1212 ( $V_{CC} = 2.5\text{ V}$ )**



**Figure 19. AC-Coupled Differential Inputs to CDCLVP1212 ( $V_{CC} = 3.3\text{ V}$ )**

## 10 Application and Implementation

### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 10.1 Application Information

The CDCLVP1212 is a low additive jitter LVPECL fanout buffer that can generate four copies of two selectable LVPECL, LVDS, or LVC MOS inputs. The CDCLVP1212 can accept reference clock frequencies up to 2 GHz while providing low output skew.

### 10.2 Typical Application

#### 10.2.1 Fanout Buffer for Line Card Application

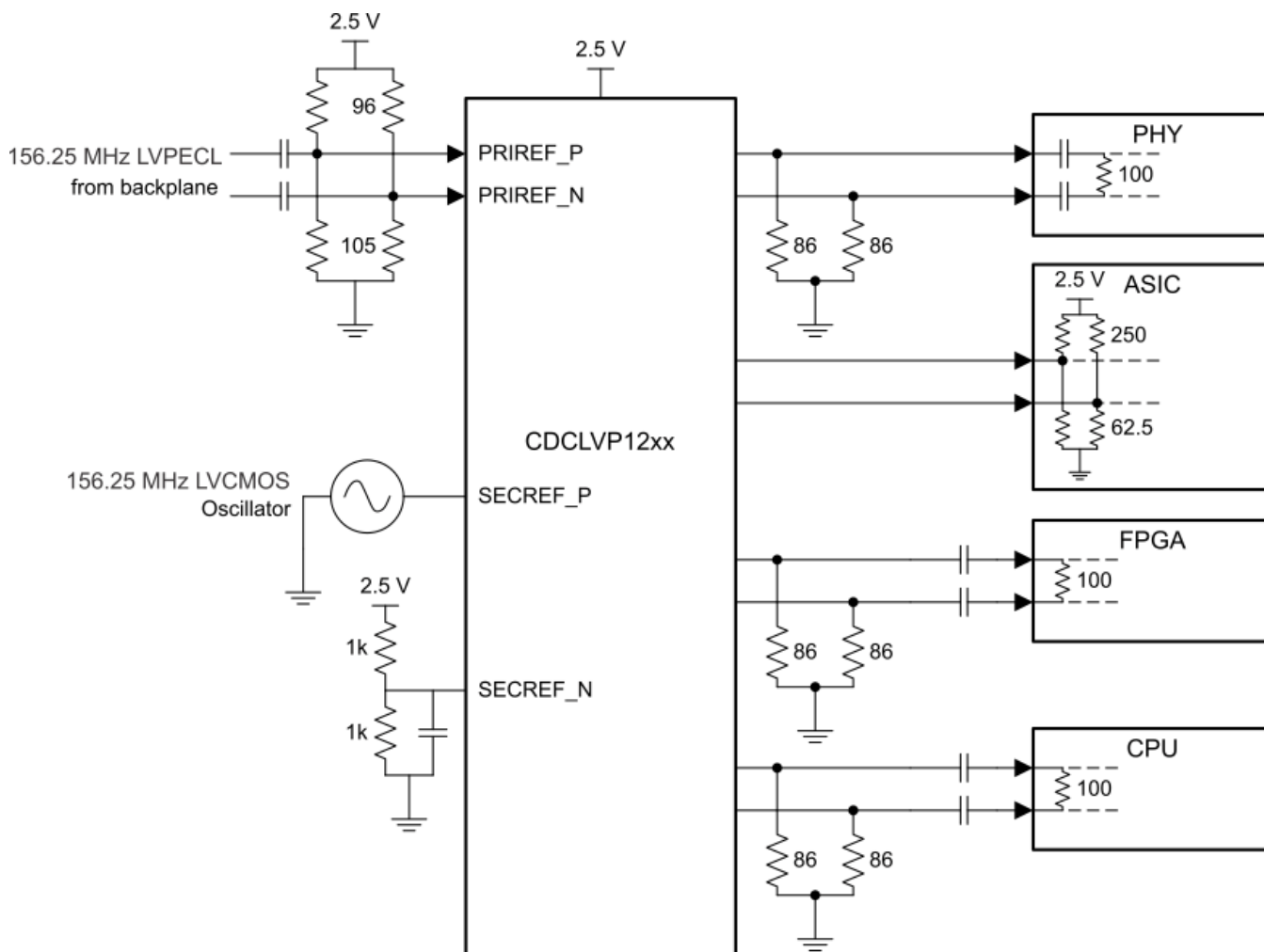


Figure 20. CDCLVP1212 Block Diagram

## Typical Application (continued)

### 10.2.1.1 Design Requirements

The CDCLVP1212 shown in Figure 20 is configured to be able to select two inputs, a 156.25-MHz LVPECL clock from the backplane, or a secondary 156.25-MHz LVCMOS 2.5-V oscillator. Either signal can be then fanned out to desired devices, as shown.

The configuration example is driving 4 LVPECL receivers in a line card application with the following properties:

- The PHY device has internal AC coupling and appropriate termination and biasing. The CDCLVP1212 will need to be provided with 86-Ω emitter resistors near the driver for proper operation.
- The ASIC is capable of DC coupling with a 2.5-V LVPECL driver such as the CDCLVP1212. This ASIC features internal termination so no additional components are needed.
- The FPGA requires external AC coupling but has internal termination. Again, 86-Ω emitter resistors are placed near the CDCLVP1212 and 0.1-μF capacitors are placed to provide AC coupling. Similarly, the CPU is internally terminated and requires external AC coupling capacitors.

### 10.2.1.2 Detailed Design Procedure

Refer to [Input Termination](#) for proper input terminations, dependent on single ended or differential inputs.

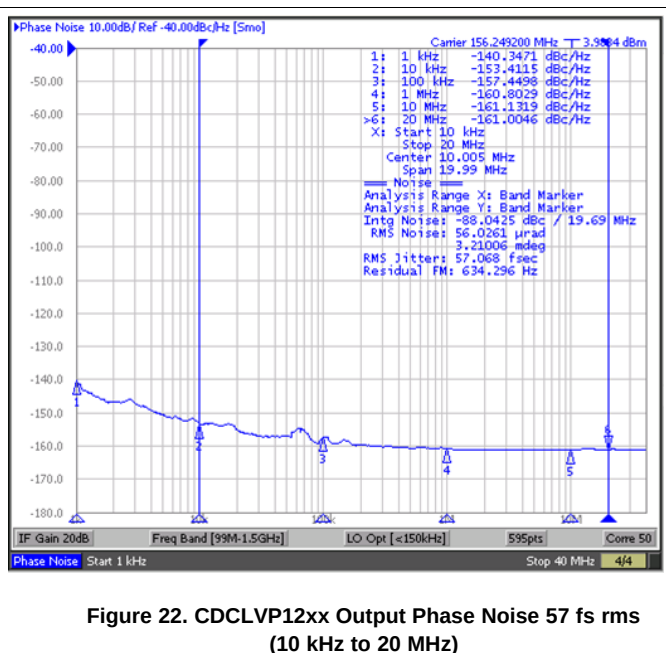
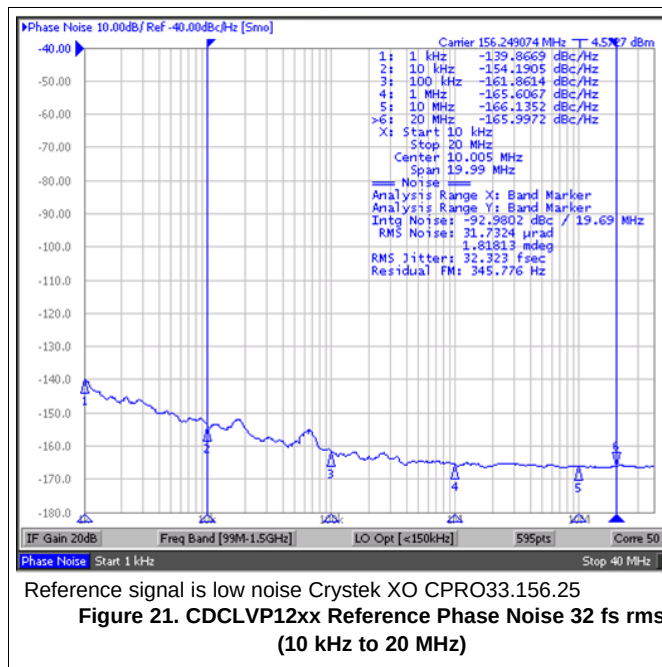
Refer to [LVPECL Output Termination](#) for output termination schemes depending on the receiver application.

Unused outputs can be left floating.

In this example, the PHY, ASIC, and FPGA/CPU require different schemes. Power supply filtering and bypassing is critical for low noise applications.

See [Power Supply Recommendations](#) for recommended filtering techniques. A reference layout is provided on the CDCLVP1212 Evaluation Module at [SCAU036](#).

### 10.2.1.3 Application Curves



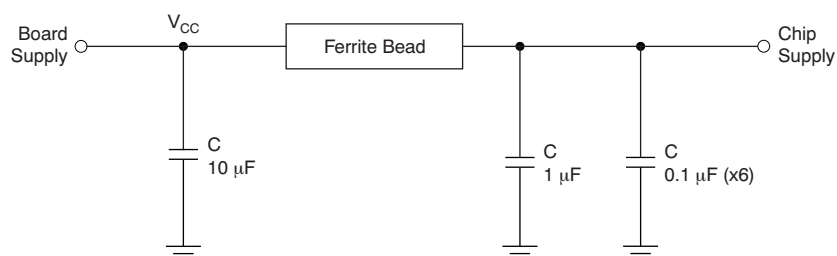
The low additive noise of the CDCLVP12xx can be shown in this line card application. The low noise 156.25-MHz XO with 32-fs RMS jitter drives the CDCLVP12xx, resulting in 57-fs RMS when integrated from 10 kHz to 20 MHz. The resultant additive jitter is a low 47-fs RMS for this configuration.

## 11 Power Supply Recommendations

High-performance clock buffers are sensitive to noise on the power supply, which can dramatically increase the additive jitter of the buffer. Thus, it is essential to reduce noise from the system power supply, especially when jitter or phase noise is very critical to applications.

Filter capacitors are used to eliminate the low-frequency noise from the power supply, where the bypass capacitors provide the very low impedance path for high-frequency noise and guard the power-supply system against the induced fluctuations. These bypass capacitors also provide instantaneous current surges as required by the device and should have low equivalent series resistance (ESR). To properly use the bypass capacitors, they must be placed very close to the power-supply terminals and laid out with short loops to minimize inductance. It is recommended to add as many high-frequency (for example, 0.1  $\mu\text{F}$ ) bypass capacitors as there are supply terminals in the package. It is recommended, but not required, to insert a ferrite bead between the board power supply and the chip power supply that isolates the high-frequency switching noises generated by the clock driver; these beads prevent the switching noise from leaking into the board supply. It is imperative to choose an appropriate ferrite bead with very low DC resistance in order to provide adequate isolation between the board supply and the chip supply, as well as to maintain a voltage at the supply terminals that is greater than the minimum voltage required for proper operation.

Figure 23 illustrates this recommended power-supply decoupling method.



**Figure 23. Power-Supply Decoupling**

### 11.1 Thermal Management

Power consumption of the CDCLVP1212 can be high enough to require attention to thermal management. For reliability and performance reasons, the die temperature should be limited to a maximum of 125°C. That is, as an estimate, ambient temperature ( $T_A$ ) plus device power consumption times  $R_{\theta JA}$  should not exceed 125°C.

The device package has an exposed pad that provides the primary heat removal path to the printed circuit board (PCB). To maximize the heat dissipation from the package, a thermal landing pattern including multiple vias to a ground plane must be incorporated into the PCB within the footprint of the package. The exposed pad must be soldered down to ensure adequate heat conduction out of the package. Figure 24 shows a recommended land and via pattern.

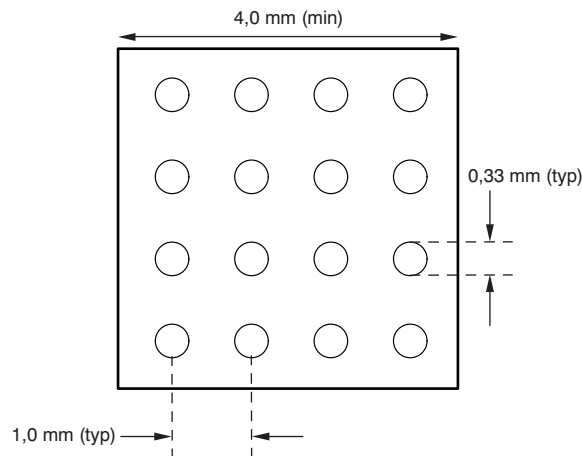
## 12 Layout

### 12.1 Layout Guidelines

Power consumption of the CDCLVP1212 can be high enough to require attention to thermal management. For reliability and performance reasons, the die temperature should be limited to a maximum of 125°C. That is, as an estimate, ambient temperature (TA) plus device power consumption times should not exceed 125°C.

The device package has an exposed pad that provides the primary heat removal path to the printed circuit board (PCB). To maximize the heat dissipation from the package, a thermal landing pattern including multiple vias to a ground plane must be incorporated into the PCB within the footprint of the package. The exposed pad must be soldered down to ensure adequate heat conduction out of the package. [Figure 24](#) shows a recommended land and via pattern.

### 12.2 Layout Example



**Figure 24. Recommended PCB Layout**

### 12.3 Thermal Considerations

The CDCLVP1212 supports high temperatures on the printed circuit board (PCB) measured at the thermal pad. The system designer needs to ensure that the maximum junction temperature is not exceeded.  $\Psi_{jb}$  can allow the system designer to measure the board temperature with a fine gauge thermocouple and back calculate the junction temperature using [Equation 1](#). Note that  $\Psi_{jb}$  is close to  $R\theta_{JB}$  as 75% to 95% of the heat of a device is dissipated by the PCB. For further information, refer to [SPRA953](#) and [SLUA566](#).

$$T_{\text{junction}} = T_{\text{PCB}} + (\Psi_{jb} \times \text{Power}) \quad (1)$$

#### Example:

Calculation of the junction-lead temperature with a 4-layer JEDEC test board using four thermal vias:

$$T_{\text{PCB}} = 105^{\circ}\text{C}$$

$$\Psi_{jb} = 10.0^{\circ}\text{C/W}$$

$$\text{Power}_{\text{inclTerm}} = I_{\text{max}} \times V_{\text{max}} = 516 \text{ mA} \times 3.6 \text{ V} = 1857.6 \text{ mW (max power consumption including termination resistors)}$$

$$\text{Power}_{\text{exclTerm}} = 1404.6 \text{ mW (max power consumption excluding termination resistors; see [SLYT127](#) for further details)}$$

$$\Delta T_{\text{Junction}} = \Psi_{jb} \times \text{Power}_{\text{exclTerm}} = 10.0^{\circ}\text{C/W} \times 1404.6 \text{ mW} = 14.05^{\circ}\text{C}$$

$$T_{\text{Junction}} = \Delta T_{\text{Junction}} + T_{\text{Chassis}} = 14.05^{\circ}\text{C} + 105^{\circ}\text{C} = 119^{\circ}\text{C (the maximum junction temperature of } 125^{\circ}\text{C is not violated)}$$

## 13 Device and Documentation Support

### 13.1 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At [e2e.ti.com](http://e2e.ti.com), you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 13.2 Trademarks

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 13.3 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 13.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 14 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



## PACKAGING INFORMATION

| Orderable part number          | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|--------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">CDCLVP1212RHAR</a> | Active        | Production           | VQFN (RHA)   40 | 2500   LARGE T&R      | Yes         | NIPDAUAG                             | Level-3-260C-168 HR               | -40 to 85    | CDCLVP<br>1212      |
| CDCLVP1212RHAR.B               | Active        | Production           | VQFN (RHA)   40 | 2500   LARGE T&R      | Yes         | NIPDAUAG                             | Level-3-260C-168 HR               | -40 to 85    | CDCLVP<br>1212      |
| <a href="#">CDCLVP1212RHAT</a> | Active        | Production           | VQFN (RHA)   40 | 250   SMALL T&R       | Yes         | NIPDAUAG                             | Level-3-260C-168 HR               | -40 to 85    | CDCLVP<br>1212      |
| CDCLVP1212RHAT.B               | Active        | Production           | VQFN (RHA)   40 | 250   SMALL T&R       | Yes         | NIPDAUAG                             | Level-3-260C-168 HR               | -40 to 85    | CDCLVP<br>1212      |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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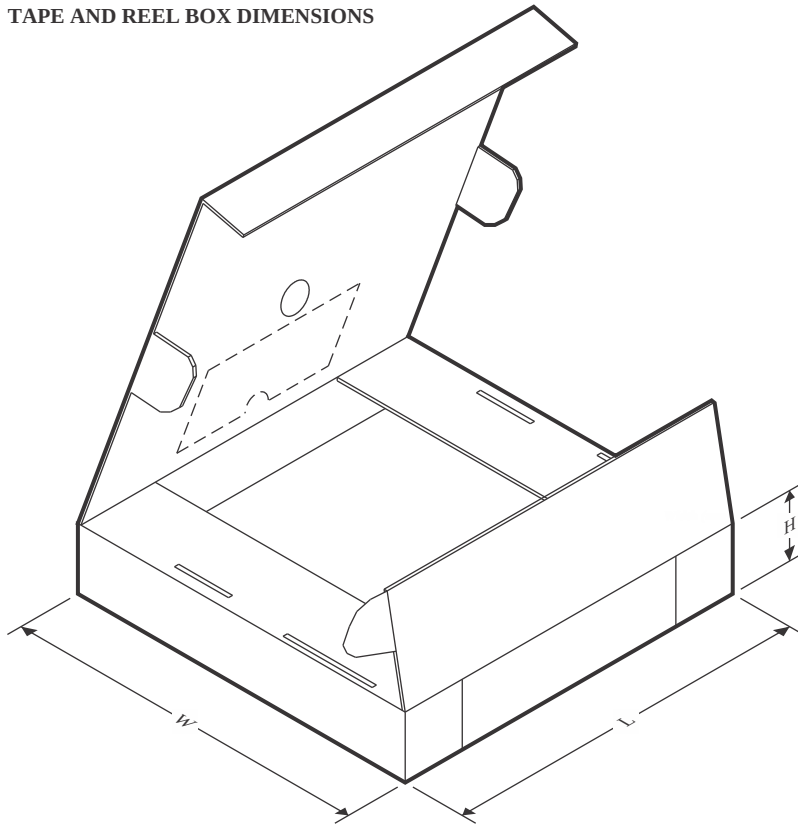
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CDCLVP1212RHAR | VQFN         | RHA             | 40   | 2500 | 330.0              | 16.4               | 6.3     | 6.3     | 1.5     | 12.0    | 16.0   | Q2            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CDCLVP1212RHAR | VQFN         | RHA             | 40   | 2500 | 350.0       | 350.0      | 43.0        |

## GENERIC PACKAGE VIEW

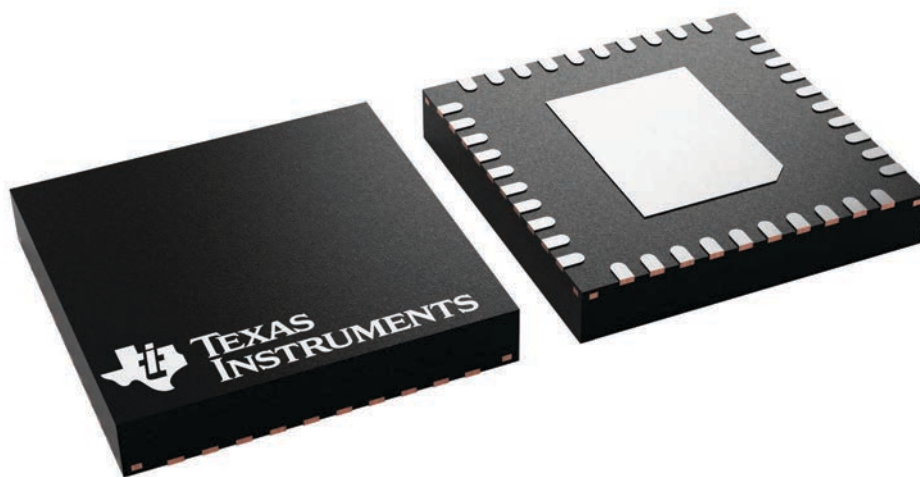
**RHA 40**

**VQFN - 1 mm max height**

6 x 6, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



### VQFN - 1 mm max height

The drawing illustrates the mechanical specifications of a square microchip package. The top view shows a square body with a central square cavity. Key dimensions include a total width of 6.1 (5.9 for the body, 0.2 for the lead frame) and a total height of 6.1 (5.9 for the body, 0.2 for the lead frame). A 'PIN 1 INDEX AREA' is indicated on the left side. The side view shows the package's profile with a maximum height of 1.0 and a lead height of 0.05. The detail view shows the lead frame with a width of 0.5 and a height of 0.3. The side wall detail shows the optional metal thickness of 0.08. The bottom view shows the package's footprint with dimensions 4.5 x 4.5 and 4.5 ± 0.1. It includes labels for 'EXPOSED THERMAL PAD', 'SYMM', 'PIN 1 ID (OPTIONAL)', and 'SEE SIDE WALL DETAIL'.

**Top View Dimensions:**

- Overall Width: 6.1 (5.9 for body, 0.2 for lead frame)
- Overall Height: 6.1 (5.9 for body, 0.2 for lead frame)
- Pin 1 Index Area: Indicated on the left side.

**Side View Dimensions:**

- Maximum Height: 1.0
- Lead Height: 0.05

**Detail View Dimensions:**

- Lead Width: 0.5
- Lead Height: 0.3

**Side Wall Detail:**

- Optional Metal Thickness: 0.08

**Bottom View Dimensions:**

- Overall Width: 4.5
- Overall Height: 4.5 ± 0.1
- Pin 1 ID (Optional): Indicated on the left side.
- Exposed Thermal Pad: Indicated on the right side.
- Symmetry: Indicated by a dashed line.
- See Side Wall Detail: Indicated by a dashed circle.

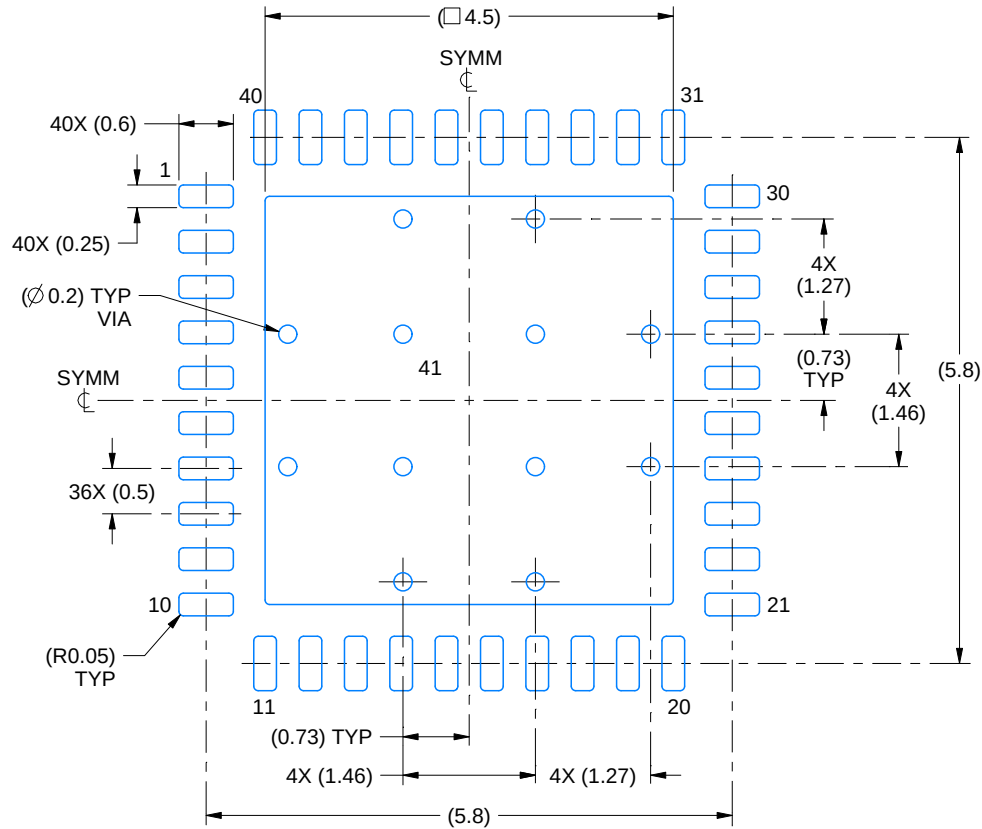
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

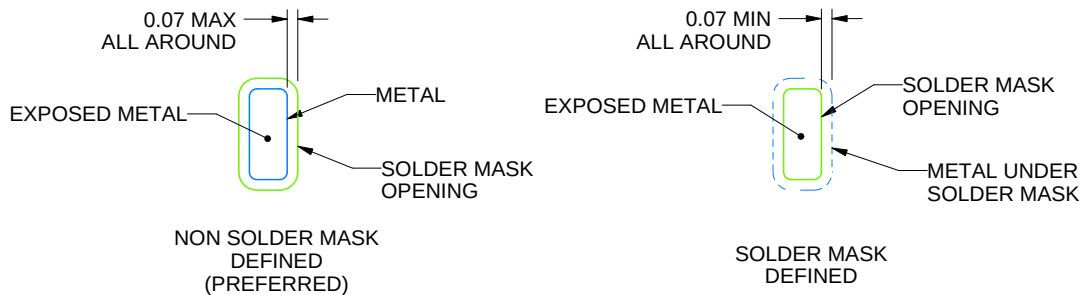
RHA0040H

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:12X



SOLDER MASK DETAILS

4219055/B 08/22/2019

NOTES: (continued)

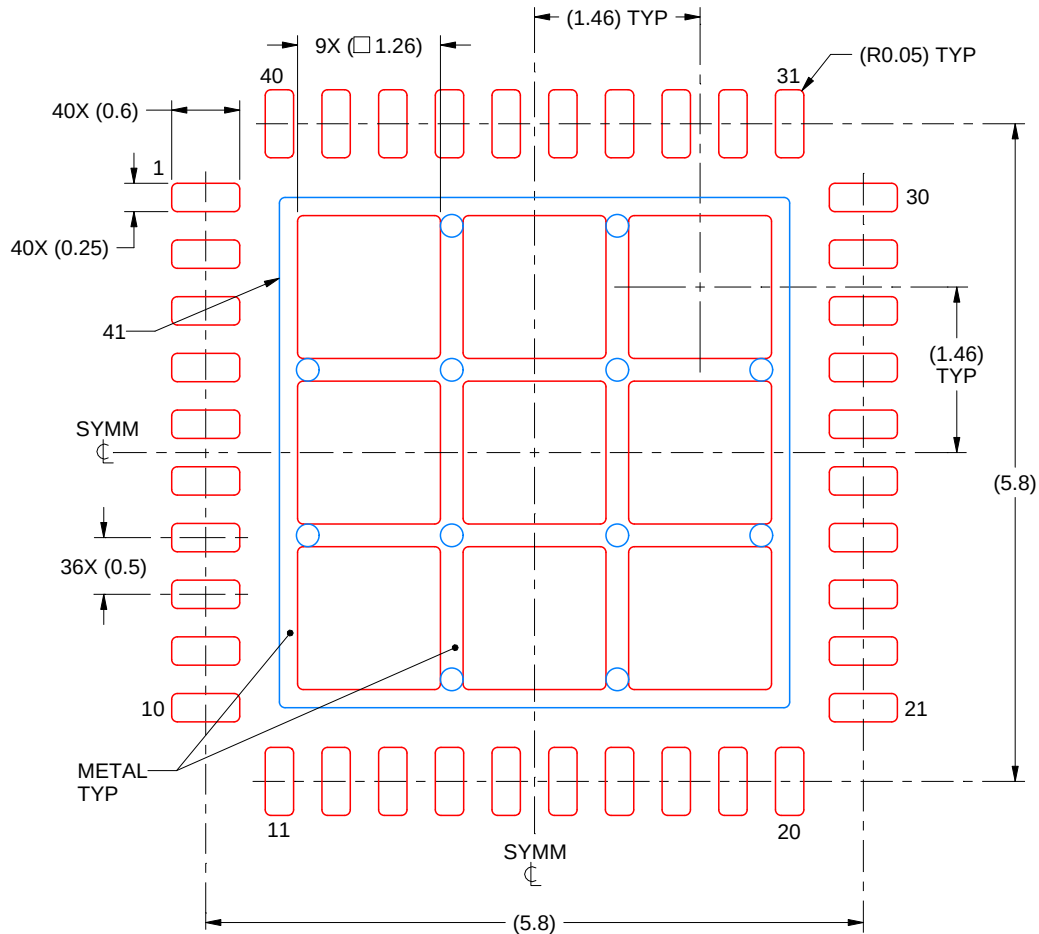
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RHA0040H

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



**SOLDER PASTE EXAMPLE**  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 41:  
70% PRINTED SOLDER COVERAGE BY AREA  
SCALE:15X

4219055/B 08/22/2019

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



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