

PROGRAMMABLE LOW-VOLTAGE 1:10 LVDS CLOCK DRIVER

Check for Samples: [CDCLVD110A](#)

FEATURES

- Low-Output Skew <30 ps (Typical) for Clock-Distribution Applications
- Distributes One Differential Clock Input to 10 LVDS Differential Clock Outputs
- V_{CC} range 2.5 V \pm 5%
- Typical Signaling Rate Capability of Up to 1.1 GHz
- Configurable Register (SI/CK) Individually Enables Disables Outputs, Selectable CLK0, CLK1 or CLK1, CLK1 Inputs
- Full Rail-to-Rail Common-Mode Input Range
- Receiver Input Threshold \pm 100 mV
- Available in 32-Pin LQFP and QFN Package
- Fail-Safe I/O-Pins for $V_{DD} = 0$ V (Power Down)

APPLICATIONS

- General purpose Industrial, Communication and Consumer Applications

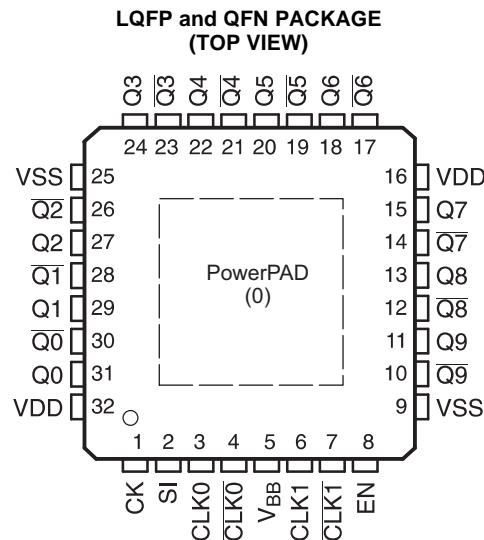
DESCRIPTION

The CDCLVD110A clock driver distributes one pair of differential LVDS clock inputs (either CLK0 or CLK1) to 10 pairs of differential clock outputs (Q0–Q9) with minimum skew for clock distribution. The CDCLVD110A is specifically designed to drive 50- Ω transmission lines.

When the control enable is high ($EN = 1$), the 10 differential outputs are programmable in that each output can be individually enabled/disabled (3-stated) according to the first 10 bits loaded into the shift register. Once the shift register is loaded, the last bit selects either CLK0 or CLK1 as the clock input. However, when $EN = 0$, the outputs are not programmable and all outputs are enabled.

The CDCLVD110A has an improved startup circuit that minimizes enabling time in AC- and DC-coupled systems.

The CDCLVD110A is characterized for operation from -40°C to 85°C .



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PowerPAD is a trademark of Texas Instruments.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

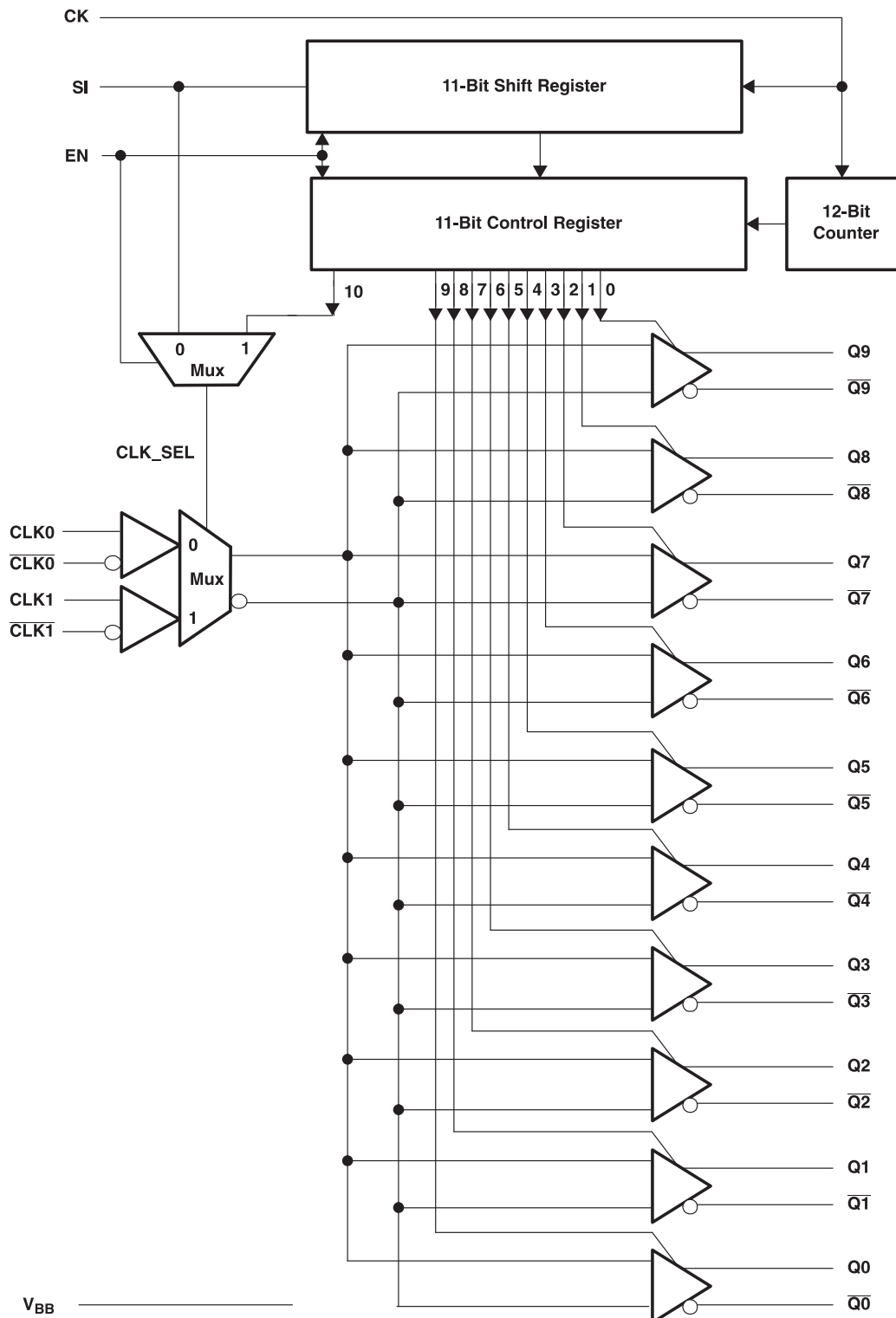
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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

FUNCTIONAL BLOCK DIAGRAM



PIN FUNCTIONS

| PIN | | I/O | DESCRIPTION |
|----------------------------|--|-----|--|
| NAME | NO. | | |
| CK | 1 | I | Control register input clock, features a 120-k. pullup resistor |
| SI | 2 | I | Control register serial input/CLK Select, features a 120-k. pulldown resistor |
| CLK0 | 3 | I | True differential input, LVDS |
| $\overline{\text{CLK0}}$ | 4 | I | Complementary differential input, LVDS |
| V _{BB} | 5 | O | Reference voltage output |
| CLK1 | 6 | I | True differential input, LVDS |
| $\overline{\text{CLK1}}$ | 7 | I | Complementary differential input, LVDS |
| EN | 8 | I | Control enable (for programmability), features a 120-k. pulldown resistor, input |
| V _{SS} | 9, 25 | | Device ground |
| V _{DD} | 16, 32 | | Supply voltage |
| Q [9:0] | 11, 13, 15, 18, 20, 22, 24, 27, 29, 31 | O | Clock outputs, these outputs provide low-skew copies of CLKIN |
| $\overline{\text{Q[9:0]}}$ | 10, 12, 14, 17, 19, 21, 23, 26, 28, 30 | O | Complementary clock outputs, these outputs provide low-skew copies of CLKIN |
| PowerPAD™ | 0 | I/O | The PowerPAD of the QFN32 package is thermally connected to the die to improve the heat transfer out of the package. This pad is connected to GND. |

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| | | VALUE | UNIT |
|------------------|---|---------------------------------|------|
| V _{DD} | Supply voltage | –0.3 to 2.8 | V |
| V _I | Input voltage | –0.2 to (V _{DD} + 0.2) | V |
| V _O | VI Output voltage | –0.2 to (V _{DD} + 0.2) | V |
| I _{OSD} | Driver short circuit current, Q _n , $\overline{\text{Qn}}$ | Continuous | |
| ESD | Electrostatic discharge (HBM 1.5 k Ω , 100 pF) | >2000 | V |

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

| | | MIN | NOM | MAX | UNIT |
|-----------------|------------------------------------|---------------------|-----|---------------------------------------|------|
| V _{DD} | Supply voltage | 2.375 | 2.5 | 2.625 | V |
| V _{IC} | Receiver common-mode input voltage | 0.5 V _{ID} | | V _{DD} – 0.5 V _{ID} | V |
| T _A | Operating free-air temperature | –40 | | 85 | °C |

ELECTRICAL CHARACTERISTICS

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT | |
|------------------|--|--|---|------|------|------|----|
| DRIVER | | | | | | | |
| V _{OD} | Differential output voltage | R _L = 100Ω | 250 | 450 | 600 | mV | |
| ΔV _{OD} | V _{OD} magnitude change | | | | 50 | mV | |
| V _{OS} | Offset voltage | −40°C to 85°C | 0.95 | 1.2 | 1.45 | V | |
| ΔV _{OS} | V _{OS} magnitude change | | | | 350 | mV | |
| I _{OS} | Output short circuit current | V _O = 0 V | | | −20 | mA | |
| | | V _{OD} = 0 V | | | 20 | | |
| V _{BB} | Reference output voltage | V _{DD} = 2.5 V, I _{BB} = −100 μA | 1.15 | 1.25 | 1.35 | V | |
| C _O | Output capacitance | V _O = V _{DD} or GND | | 3 | | pF | |
| RECEIVER | | | | | | | |
| V _{IDH} | Input threshold high | | | | 100 | mV | |
| V _{IDL} | Input threshold low | | −100 | | | mV | |
| V _{ID} | Input differential voltage | | 200 | | | mV | |
| I _{IH} | Input current, CLK0/ $\overline{\text{CLK0}}$, CLK1/ $\overline{\text{CLK1}}$ | V _I = V _{DD} | −5 | | 5 | μA | |
| I _{IL} | | V _I = 0 V | | | | | |
| C _I | Input capacitance | V _I = V _{DD} or GND | | 3 | | pF | |
| SUPPLY CURRENT | | | | | | | |
| I _{DD} | Supply current | Full loaded | All outputs enabled and loaded, R _L = 100 Ω, f = 100 MHz | | 100 | 110 | mA |
| | | | All outputs enabled and loaded, R _L = 100 Ω, f = 800 MHz | | 150 | 160 | |
| | | No load | Outputs enabled, no output load, f = 0 Hz | | | 35 | |
| I _{DDZ} | 3-State | All outputs 3-state by control logic, f = 0 Hz | | | 35 | | |

JITTER CHARACTERISTICS

characterized with CDCLVD110 performance EVM, $V_{DD} = 3.3\text{ V}$, OUTPUTS NOT UNDER TEST are terminated to 50Ω

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------------------|---|--|-----|-----|-----|--------|
| $t_{\text{jitterLVDS}}$ | Additive phase jitter from input to LVDS output Q3 and Q3 | 12 kHz to 5 MHz, $f_{\text{out}} = 30.72\text{ MHz}$ | | 281 | | fs rms |
| | | 12 kHz to 20 MHz, $f_{\text{out}} = 125\text{ MHz}$ | | 111 | | |

LVDS — SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, $V_{DD} = 2.5\text{ V} \pm 5\%$

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | MIN | TYP | MAX | UNIT |
|--------------|---|--|---------------------------|-----|------|-----|------|
| t_{PLH} | Propagation delay low-to-high | CLK0, $\overline{\text{CLK0}}$ CLK1, $\overline{\text{CLK1}}$ | $Q_n, \overline{Q_n}$ | | 2 | 3 | ns |
| t_{PHL} | Propagation delay high-to-low | CLK0, $\overline{\text{CLK0}}$ CLK1, $\overline{\text{CLK1}}$ | $Q_n, \overline{Q_n}$ | | 2 | 3 | ns |
| t_{duty} | Duty cycle | CLK0, $\overline{\text{CLK0}}$ CLK1, $\overline{\text{CLK1}}$ | $Q_n, \overline{Q_n}$ | 45% | | 55% | |
| $t_{sk(o)}$ | Output skew | | Any $Q_n, \overline{Q_n}$ | | 30 | | ps |
| $t_{sk(p)}$ | Pulse skew | | Any $Q_n, \overline{Q_n}$ | | | 50 | ps |
| $t_{sk(pp)}$ | Part-to-part skew | | Any $Q_n, \overline{Q_n}$ | | | 600 | ps |
| t_r | Output rise time, 20% to 80%, $R_L = 100\ \Omega$, $C_L = 5\text{ pF}$ | | Any $Q_n, \overline{Q_n}$ | | | 350 | ps |
| t_f | Output fall time, 20% to 80%, $R_L = 100\ \Omega$, $C_L = 5\text{ pF}$ | | Any $Q_n, \overline{Q_n}$ | | | 350 | ps |
| f_{clk} | Max input frequency | CLK0, $\overline{\text{CLK0}}$ CLK1, $\overline{\text{CLK1}}$ | Any $Q_n, \overline{Q_n}$ | 900 | 1100 | | MHz |

CONTROL REGISTER CHARACTERISTICS

over recommended operating free-air temperature range, $V_{DD} = 2.5\text{ V} \pm 5\%$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------|---------------------------------------|-------------------------|-----|-----|-----|---------------|
| f_{MAX} | Maximum frequency of shift register | | 100 | 150 | | MHz |
| t_{su} | Setup time, clock to SI | | | | 2 | ns |
| t_h | Hold time, clock to SI | | | | 1.5 | ns |
| $t_{removal}$ | Removal time, enable to clock | | | | 1.5 | ns |
| $t_{startup}$ | Startup time after disable through SI | | | | 1.0 | μs |
| t_w | Clock pulse width, minimum | | 3 | | | ns |
| V_{IH} | Logic input high | $V_{DD} = 2.5\text{ V}$ | 2 | | | V |
| V_{IL} | Logic input low | $V_{DD} = 2.5\text{ V}$ | | | 0.8 | V |
| I_{IH} | Input current, CK pin | $V_I = V_{DD}$ | -5 | | 5 | μA |
| | Input current, SI and EN pins | | 10 | | -30 | |
| I_{IL} | Input current, CK pin | $V_I = \text{GND}$ | -10 | | 30 | μA |
| | Input current, SI and EN pins | | -5 | | 5 | |

SPECIFICATION OF CONTROL REGISTER

The CDCLVD110A has an 11-bit, serial-in shift register and an 11-bit control register. The control Register enables/disables each output clock, and selects either CLK0 or CLK1 as the input clock. The CDCLVD110A has two modes of operation:

Programmable Mode (EN=1)

The shift register uses a serial input (SI) and a clock input (CK). Once the shift register is loaded with 11 clock pulses, the 12th clock pulse loads the control register. The first bit (bit 0) on SI enables the Q9-Q9 output pair, and the 10th bit (bit 9) enables the Q0-Q0 pair. The 11th bit (bit 10) on SI selects either CLK0 or CLK1 as the input clock; a bit value of 0 selects CLK0, whereas a bit value of 1 selects CLK1. To restart the control register configuration, a reset of the state machine must be done with a clock pulse on CK (shift register clock input) and EN set to low. The control register can be configured only once after each reset.

Standard Mode (EN=0)

In this mode, the CDCLVD110A is not programmable and all the clock outputs are enabled. The clock input (CLK0 or CLK1) is selected with the SI pin, as is shown in the table entitled control register.

| STATE-MACHINE INPUTS | | | |
|----------------------|----|----|--|
| EN | SI | CK | OUTPUT |
| L | L | X | All outputs enabled, CLK0 selected, control register disabled, default state |
| L | H | X | All outputs enabled, CLK1 selected, control register disabled |
| H | L | ↑ | First stage stores L, other stage stores data of previous stage |
| H | H | | First stage stores H, other stage stores data of previous stage |
| L | X | | Reset of state machine, shift and control registers |

| CONTROL REGISTER | | |
|------------------|------------|----------------------|
| BIT 10 | BITS [0-9] | Q _N [0-9] |
| L | H | CLK0 |
| H | H | CLK1 |
| X | L | Outputs disabled |

| SERIAL INPUT (SI) SEQUENCE | | | | | | | | | | |
|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
| CLK_SEL | Q0 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 |

| TRUTH TABLE FOR CONTROL LOGIC | | | | | | | | | |
|-------------------------------|----|----|----------------|------|------|------|--------|--------|--------|
| CK | EN | SI | CLK0 | CLK0 | CLK1 | CLK1 | Q(0-9) | Q(0-9) | Q(0-9) |
| L | L | L | L | H | X | X | L | H | |
| L | L | L | H | L | X | X | H | L | |
| L | L | L | Open | Open | X | X | L | H | |
| L | L | H | X | X | L | H | L | H | |
| L | L | H | X | X | H | L | H | L | |
| L | L | H | X | X | Open | Open | L | H | |
| All outputs enabled | | | X = Don't care | | | | | | |

APPLICATION INFORMATION

Fall-Safe Information

For $V_{DD} = 0$ V (power-down mode) the CDCLVD110A has fail-safe input and output pins. In power-on mode, fail-safe biasing at input pins can be accomplished with a 10-k Ω pullup resistor from CLK0/CLK1 to VDD and a 10-k Ω pulldown resistor from CLK0/CLK1 to GND.

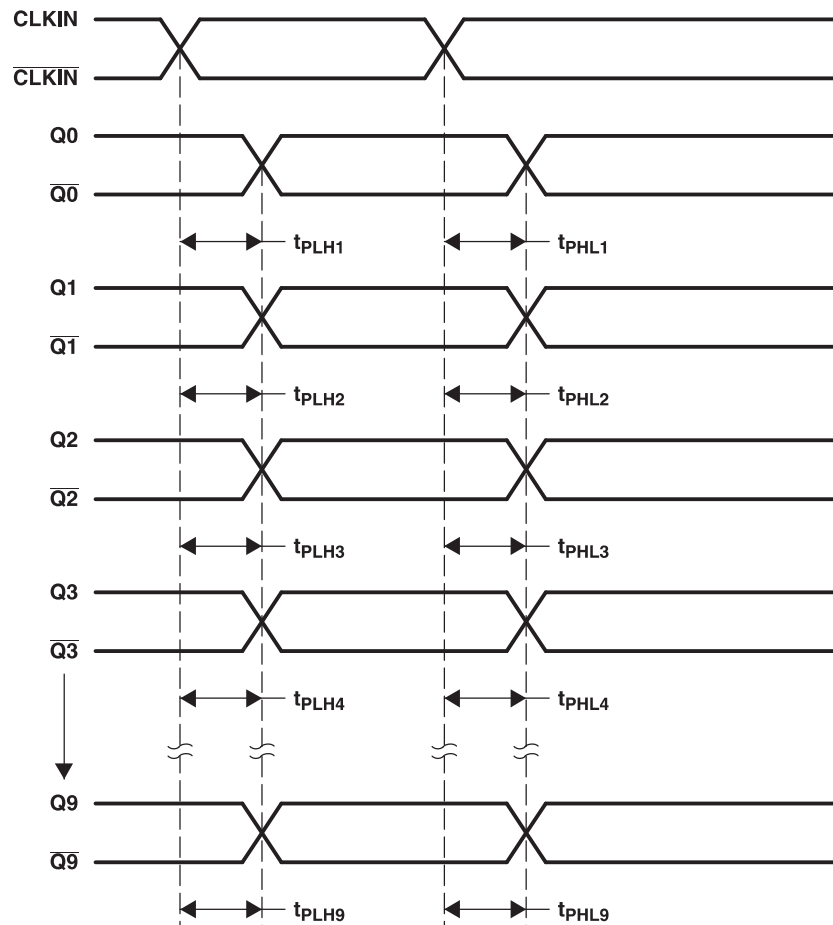
LVDS Receiver Input Termination

The LVDS receiver inputs require 100- Ω termination resistors placed as close as possible across the input pins.

Control Inputs Termination

No external termination is required. The CK control input has an internal 120-k Ω pullup resistor, while the SI- and EN-control inputs each have an internal 120-k Ω pulldown resistor. If the control pins are left open per the default, all outputs are enabled, CLK0, CLK0 is selected, and the control register is disabled.

PARAMETER MEASUREMENT INFORMATION



- A. Output skew, $t_{sk(o)}$, is calculated as the greater of:
 - The difference between the fastest and the slowest t_{PLHn} ($n = 1, 2, \dots, 10$)
 - The difference between the fastest and the slowest t_{PHLn} ($n = 1, 2, \dots, 10$)
- B. Part-to-part skew, $t_{sk(pp)}$, is calculated as the greater of:
 - The difference between the fastest and the slowest t_{PLHn} ($n = 1, 2, \dots, 10$) across multiple devices
 - The difference between the fastest and the slowest t_{PHLn} ($n = 1, 2, \dots, 10$) across multiple devices
- C. Pulse skew, $t_{sk(p)}$, is calculated as the magnitude of the absolute time difference between the high-to-low (t_{PHL}) and the low-to-high (t_{PLH}) propagation delays when a single switching input causes one or more outputs to switch, $t_{sk(p)} = |t_{PHL} - t_{PLH}|$. Pulse skew is sometimes referred to as pulse-width distortion or duty-cycle skew.

Figure 1. Waveforms for Calculation of $t_{sk(o)}$ and $t_{sk(pp)}$

PARAMETER MEASUREMENT INFORMATION (continued)

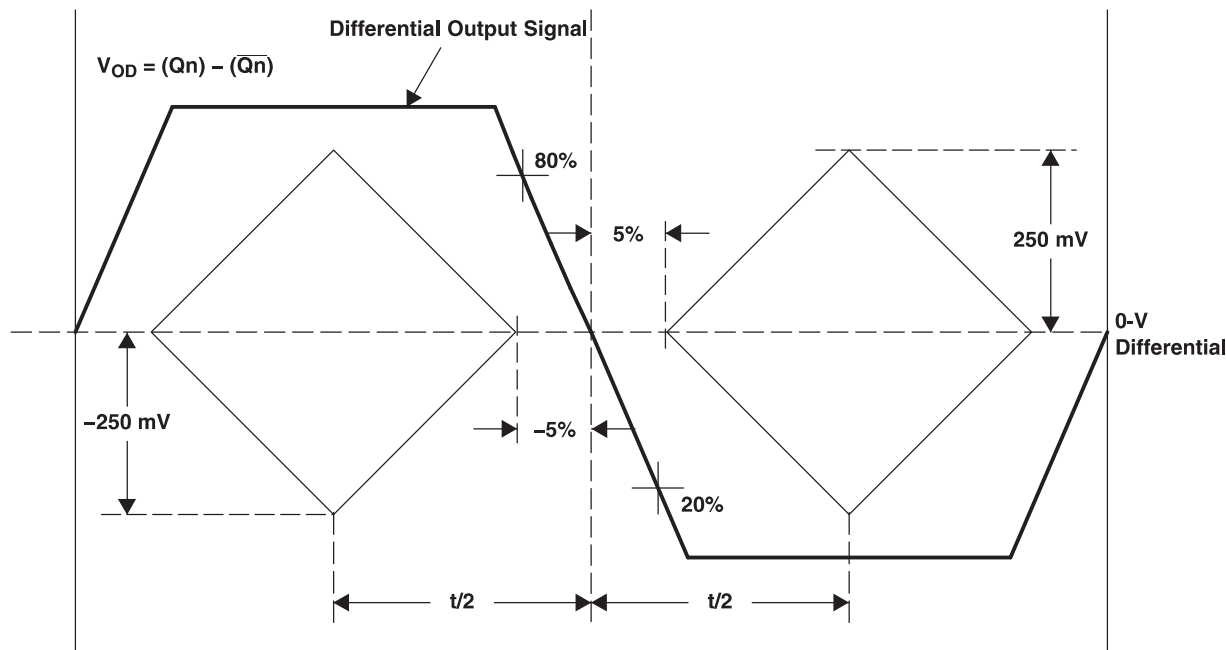


Figure 2. Test Criteria for f_{clk} , Duty Cycle, t_r , t_f , V_{OD}

REVISION HISTORY

| Changes from Original (February 2007) to Revision A | Page |
|---|------|
| <ul style="list-style-type: none"> Changed Pinout Package title From: TQFP PACKAGE and QFN PACKAGE To: LQFP PACKAGE and QFN PACKAGE 1 | 1 |
| Changes from Revision A (January 2008) to Revision B | Page |
| <ul style="list-style-type: none"> Changed Feature From: Available in 32-Pin LQFP Package To: Available in 32-Pin LQFP and QFN Package 1 Added Applications 1 | 1 |
| Changes from Revision B (October 2008) to Revision C | Page |
| <ul style="list-style-type: none"> Added PowerPAD information to the Pinout Package 1 Added PowerPAD information to the Pin FUNCTIONS table 3 | 3 |

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| CDCLVD110ARHBR | ACTIVE | QFN | RHB | 32 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| CDCLVD110ARHBRG4 | ACTIVE | QFN | RHB | 32 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| CDCLVD110ARHBT | ACTIVE | QFN | RHB | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| CDCLVD110ARHBTG4 | ACTIVE | QFN | RHB | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| CDCLVD110AVF | ACTIVE | LQFP | VF | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CDCLVD110AVFG4 | ACTIVE | LQFP | VF | 32 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CDCLVD110AVFR | ACTIVE | LQFP | VF | 32 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CDCLVD110AVFRG4 | ACTIVE | LQFP | VF | 32 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

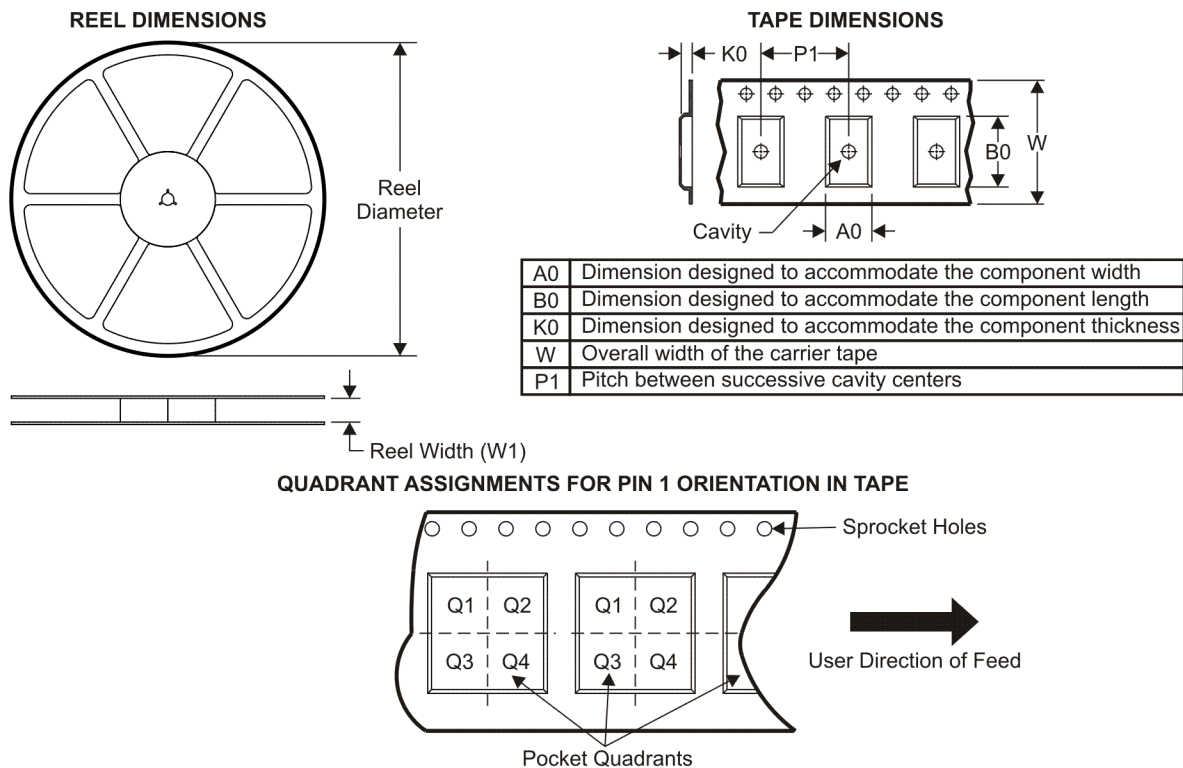
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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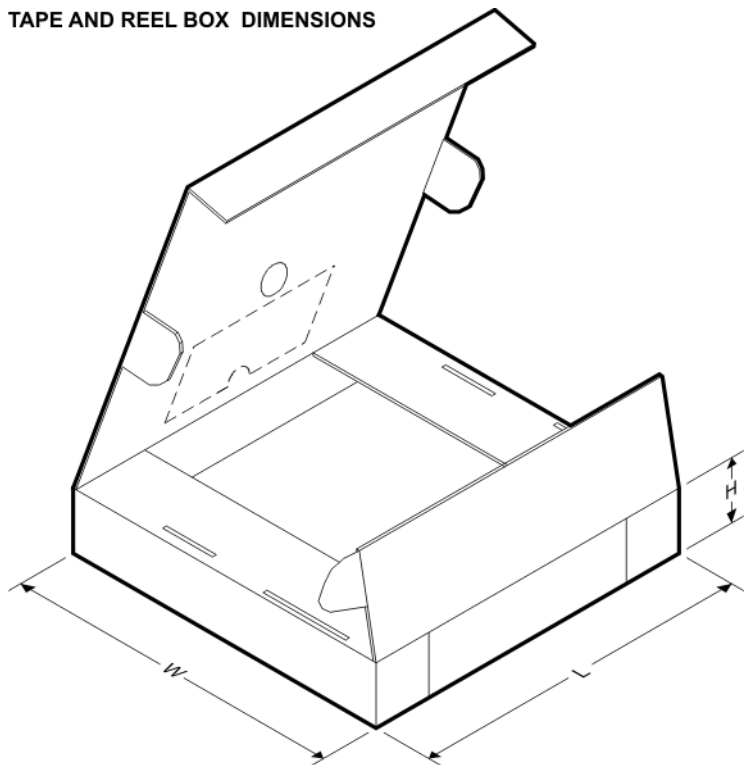
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TAPE AND REEL INFORMATION


*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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CDCLVD110ARHBR | QFN | RHB | 32 | 3000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.5 | 8.0 | 12.0 | Q2 |
| CDCLVD110ARHBT | QFN | RHB | 32 | 250 | 330.0 | 12.4 | 5.3 | 5.3 | 1.5 | 8.0 | 12.0 | Q2 |
| CDCLVD110AVFR | LQFP | VF | 32 | 1000 | 330.0 | 16.4 | 9.6 | 9.6 | 1.9 | 12.0 | 16.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS

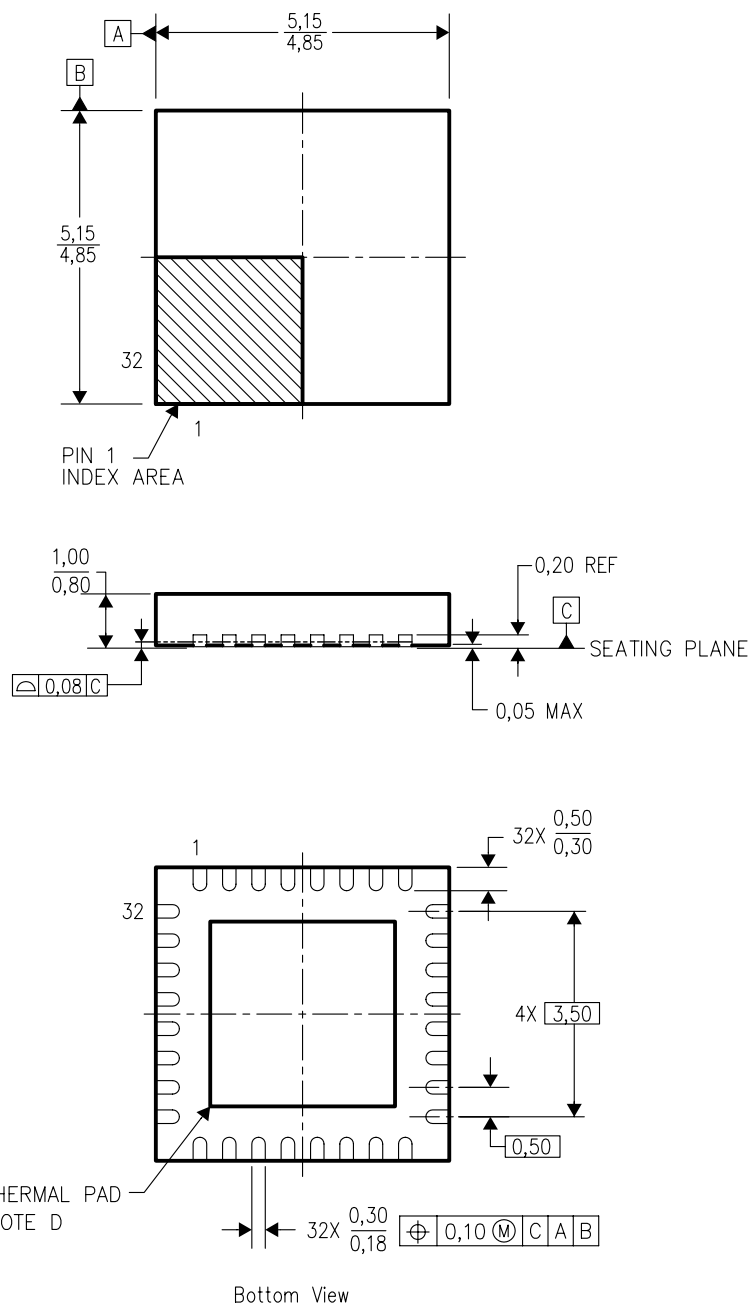


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CDCLVD110ARHBR | QFN | RHB | 32 | 3000 | 340.5 | 333.0 | 20.6 |
| CDCLVD110ARHBT | QFN | RHB | 32 | 250 | 340.5 | 333.0 | 20.6 |
| CDCLVD110AVFR | LQFP | VF | 32 | 1000 | 333.2 | 345.9 | 28.6 |

RHB (S-PQFP-N32)

PLASTIC QUAD FLATPACK



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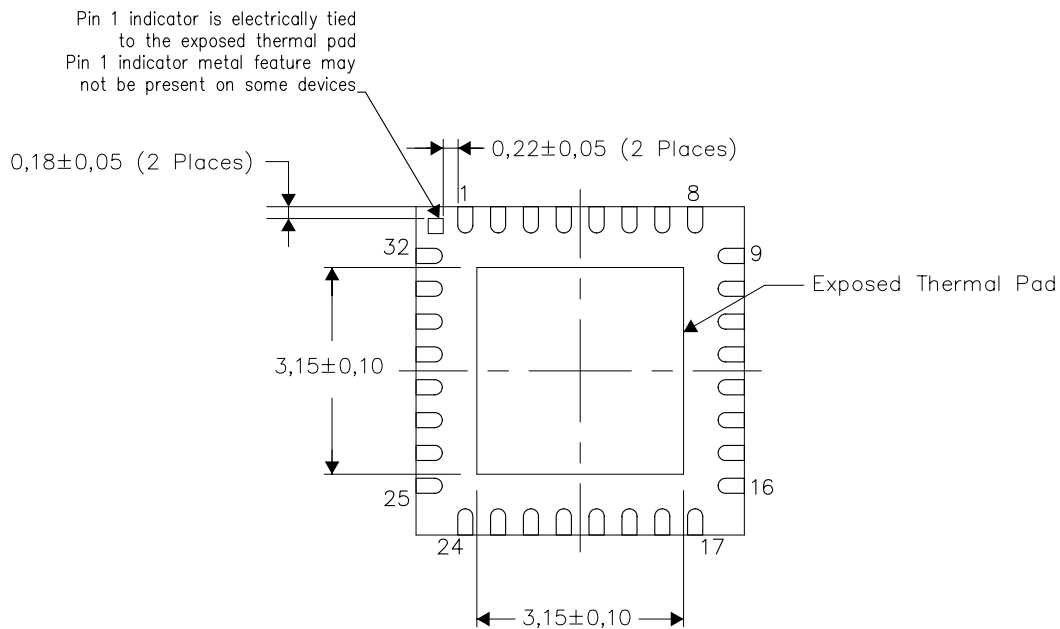
- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - QFN (Quad Flatpack No-Lead) Package configuration.
 - The Package thermal pad must be soldered to the board for thermal and mechanical performance. See product data sheet for details regarding the exposed thermal pad dimensions.
 - Falls within JEDEC MO-220.

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.

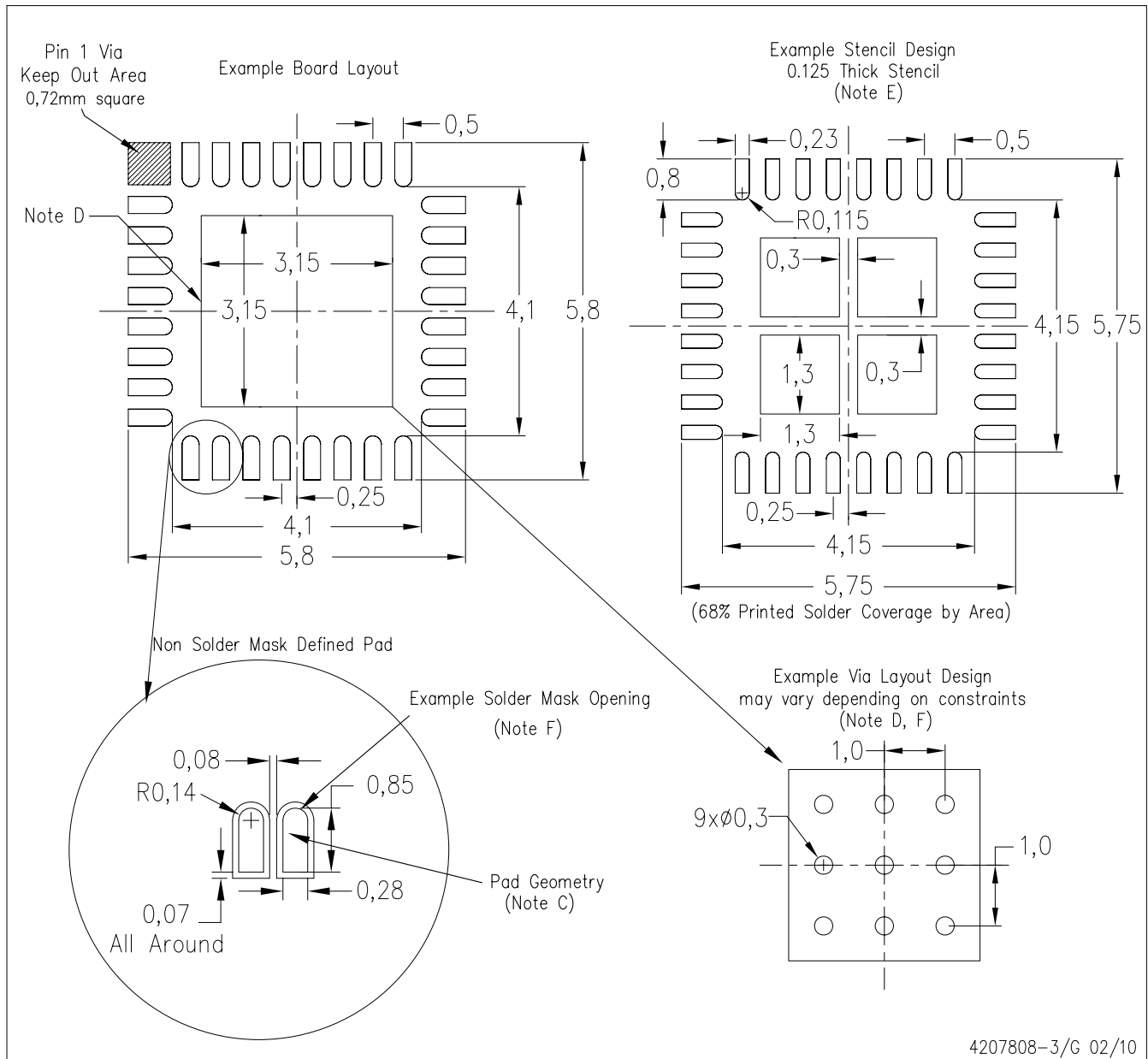


Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

RHB (S-PVQFN-N32)

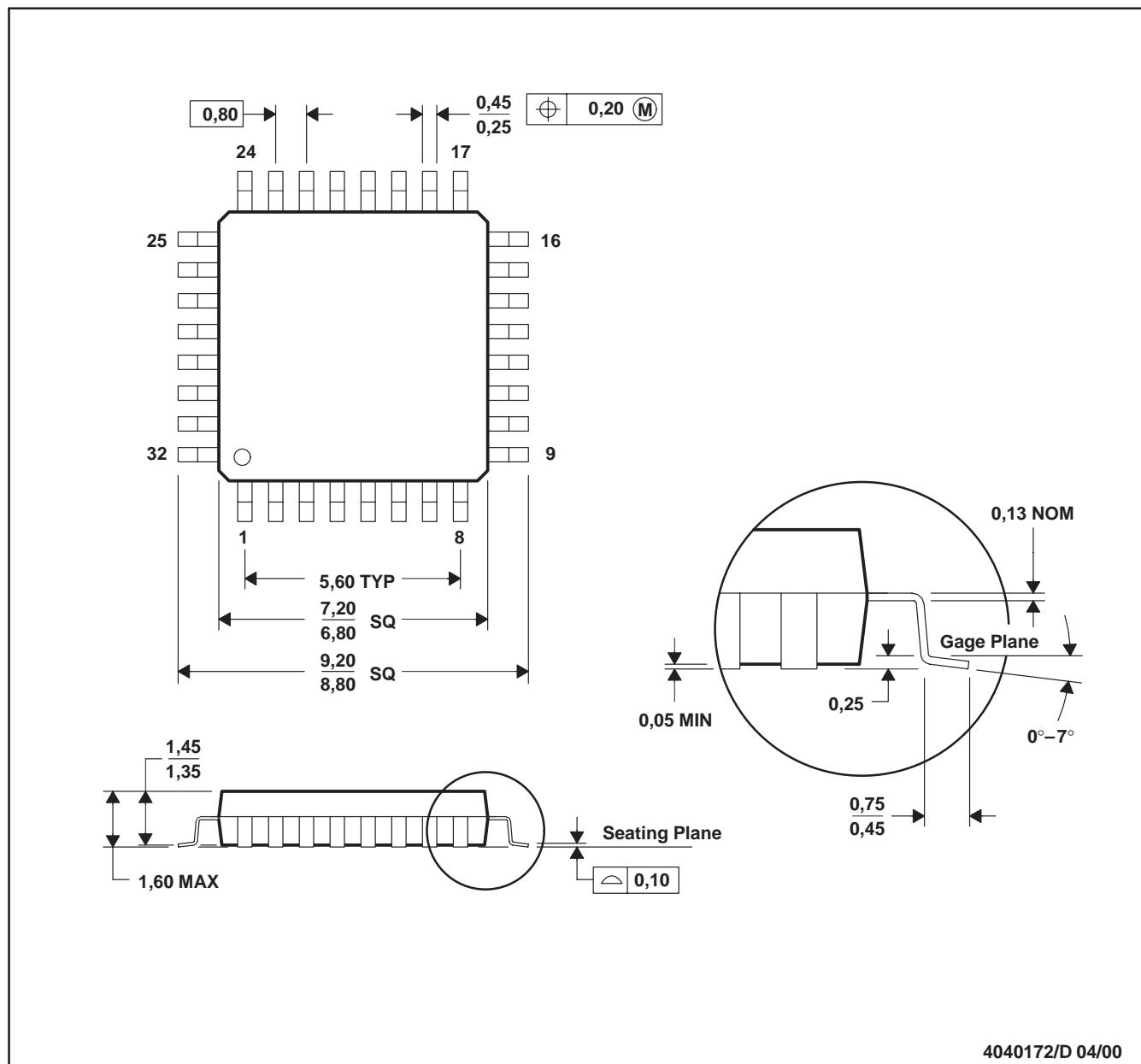


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- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
 - Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

VF (S-PQFP-G32)

PLASTIC QUAD FLATPACK



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