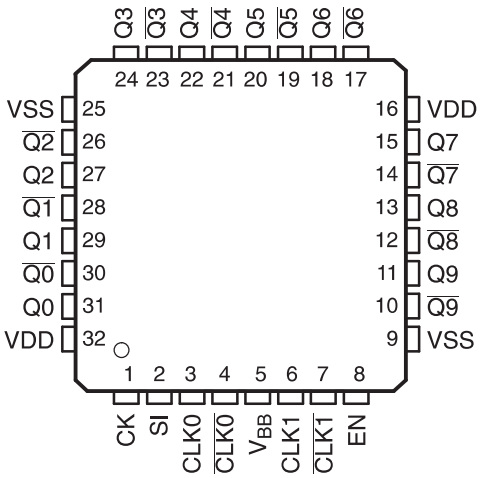
PROGRAMMABLE LOW-VOLTAGE 1:10 LVDS CLOCK DRIVER

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 ±5%**
- **Typical Signaling Rate Capability of Up to 1.1 GHz**
- **Configurable Register (SI/CK) Individually Enables Disables Outputs, Selectable CLK0, $\overline{CLK0}$ or CLK1, $\overline{CLK1}$ Inputs**
- **Full Rail-to-Rail Common-Mode Input Range**
- **Receiver Input Threshold ±100 mV**
- **Available in 32-Pin LQFP and QFN Package**
- **Fail-Safe I/O-Pins for V_{DD} = 0 V (Power Down)**

LQFP and QFN PACKAGE
(TOP VIEW)



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.

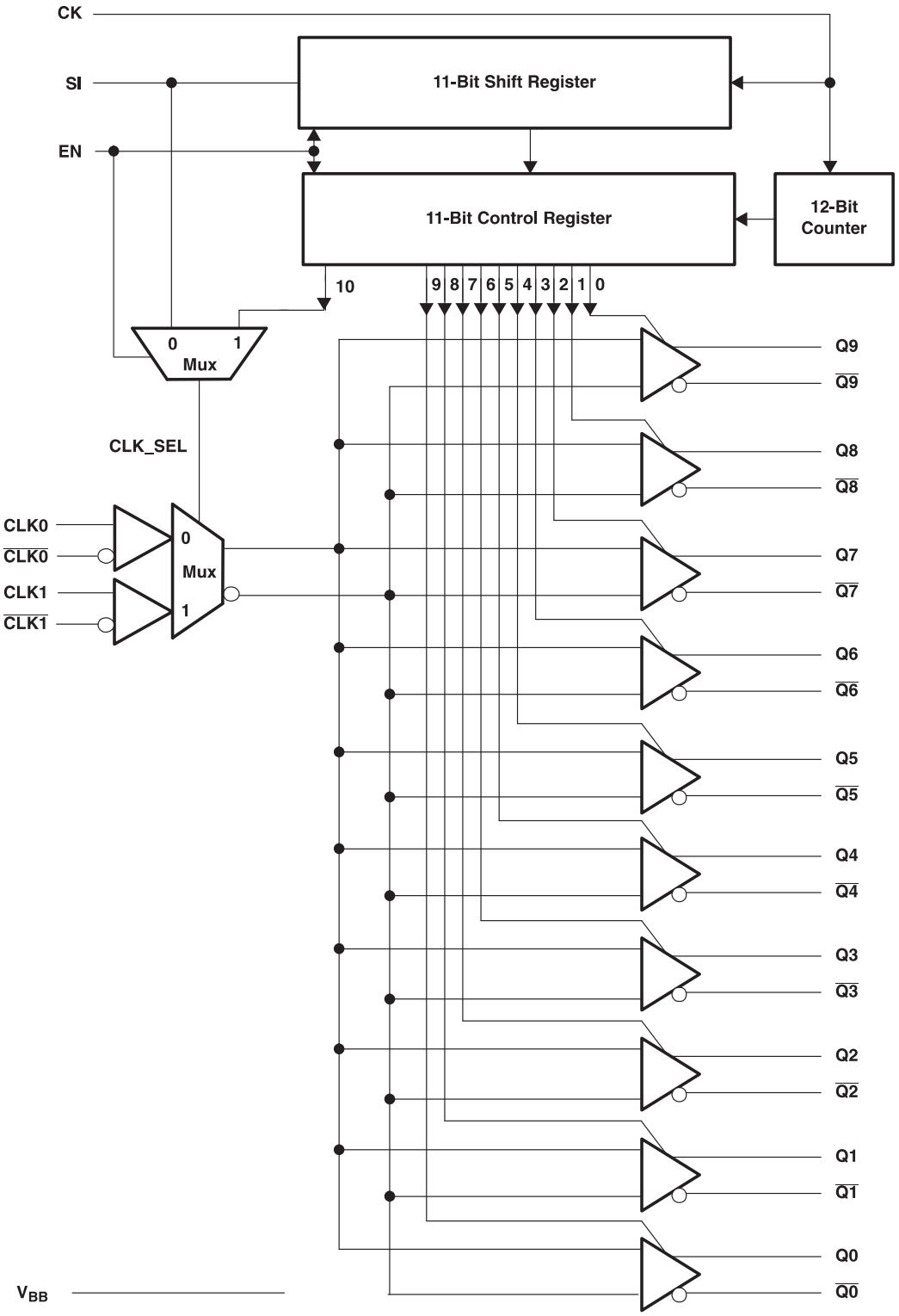
When the control enable is high (EN = 1), the 10 differential outputs are programmable in that each output can be individually enabled/disabled (3-stated) according to the first 10 bits loaded into the shift register. Once the shift register is loaded, the last bit selects either CLK0 or CLK1 as the 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.

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.

FUNCTIONAL BLOCK DIAGRAM



TERMINAL FUNCTIONS

TERMINAL		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
$\overline{CLK0}$	4	I	Complementary differential input, LVDS
V_{BB}	5	O	Reference voltage output
CLK1	6	I	True differential input, LVDS
$\overline{CLK1}$	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
$\overline{Q[9:0]}$	10, 12, 14, 17, 19, 21,23, 26, 28, 30	O	Complementary clock outputs, these outputs provide low-skew copies of CLKIN

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, Qn, $\overline{Qn}$	Continuous	
ESD	Electrostatic discharge (HBM 1.5 kΩ, 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 V, OUTPUTS NOT UNDER TEST are terminated to 50Ω

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

LVDS — SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, V_{DD} = 2.5 V ±5%

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

CONTROL REGISTER CHARACTERISTICS

over recommended operating free-air temperature range, V_{DD} = 2.5 V ±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 V	2			V
V_{IL}	Logic input low	V_{DD} = 2.5 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 = 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-$\overline{Q9}$ output pair, and the 10th bit (bit 9) enables the Q0-$\overline{Q0}$ 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**	**$\overline{CLK0}$**	**CLK1**	**$\overline{CLK1}$**	**Q(0-9)**	**$\overline{Q(0-9)}$**
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-kΩ pullup resistor from CLK0/CLK1 to VDD and a 10-kΩ pulldown resistor from CLK0/CLK1 to GND.

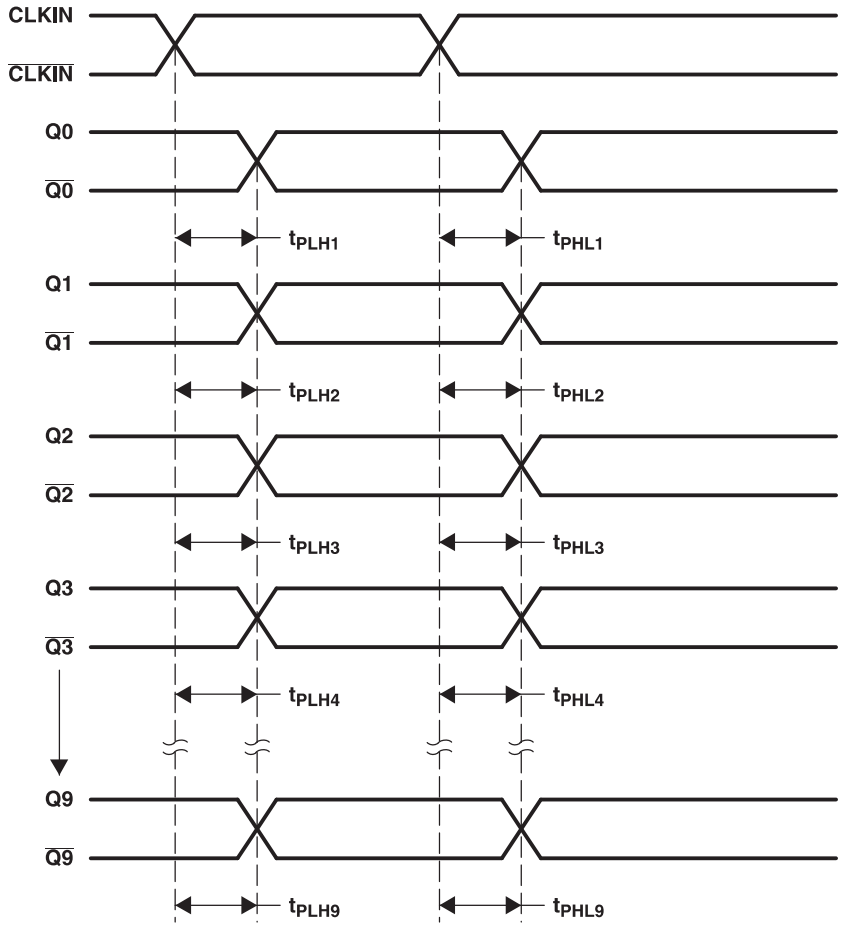
LVDS Receiver Input Termination

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-kΩ pullup resistor, while the SI– and EN–control inputs each have an internal 120-kΩ 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,...10)
   – The difference between the fastest and the slowest t_{PHLn} (n = 1, 2,...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,...10) across multiple devices
   – The difference between the fastest and the slowest t_{PHLn} (n = 1, 2,...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)

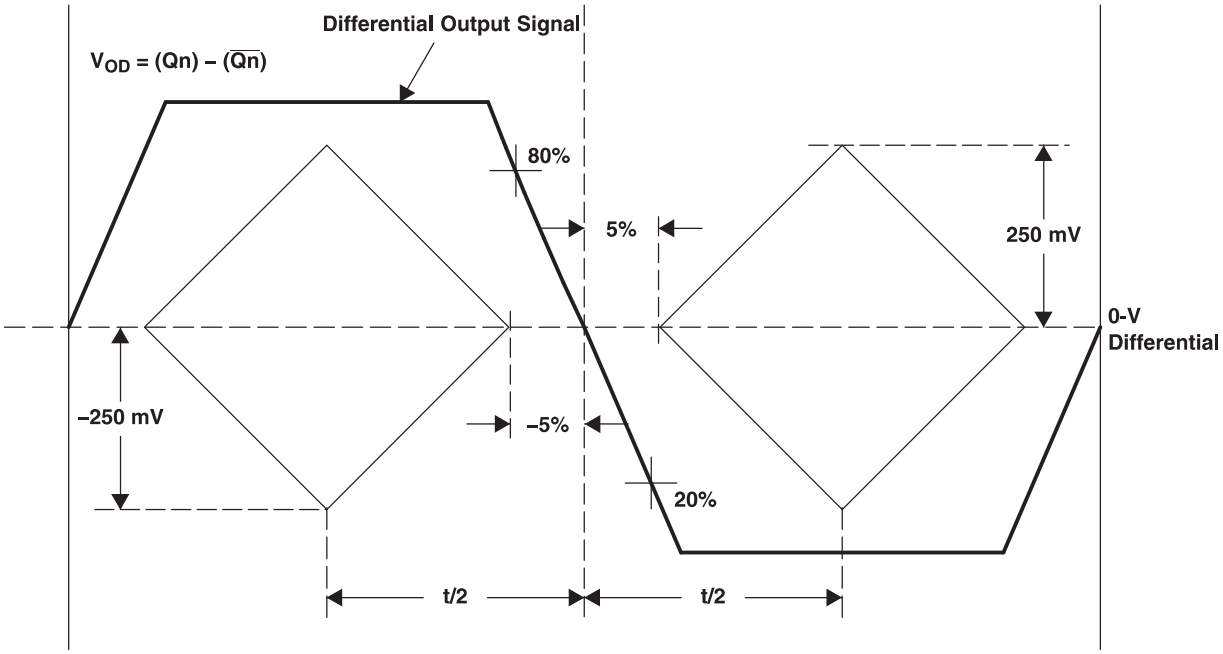


Figure 2. Test Criteria for f_{clk}, Duty Cycle, t_r, t_f, V_{OD}

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

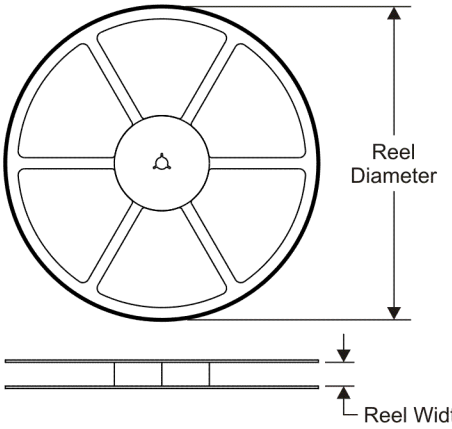
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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.
OBSOLETE: 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)

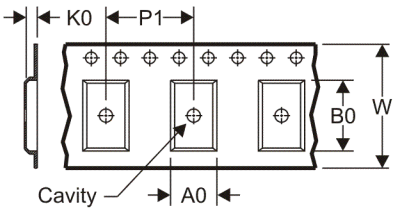
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

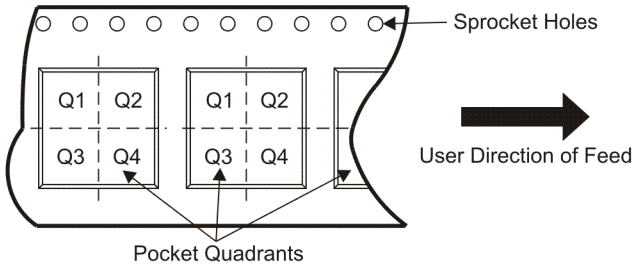


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

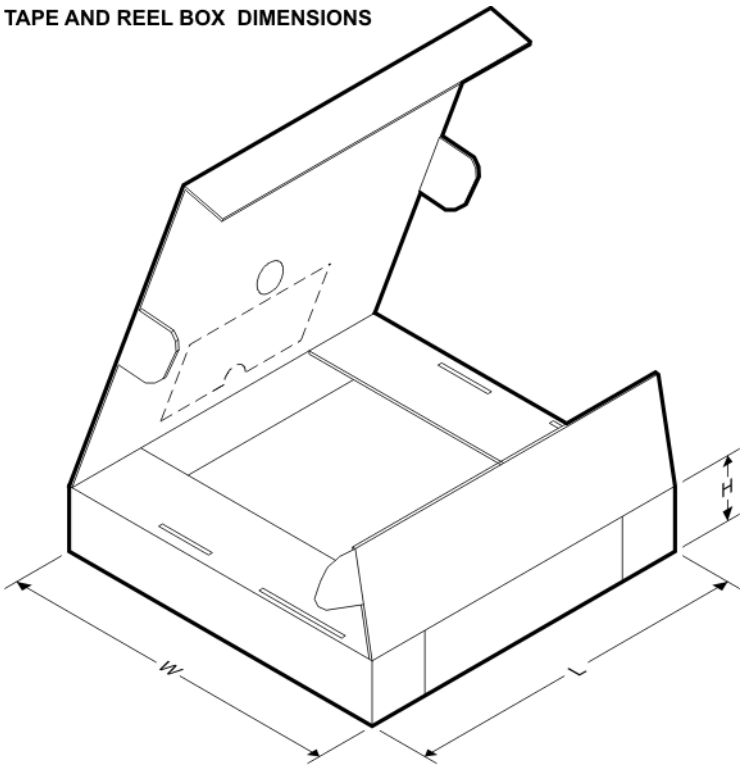
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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

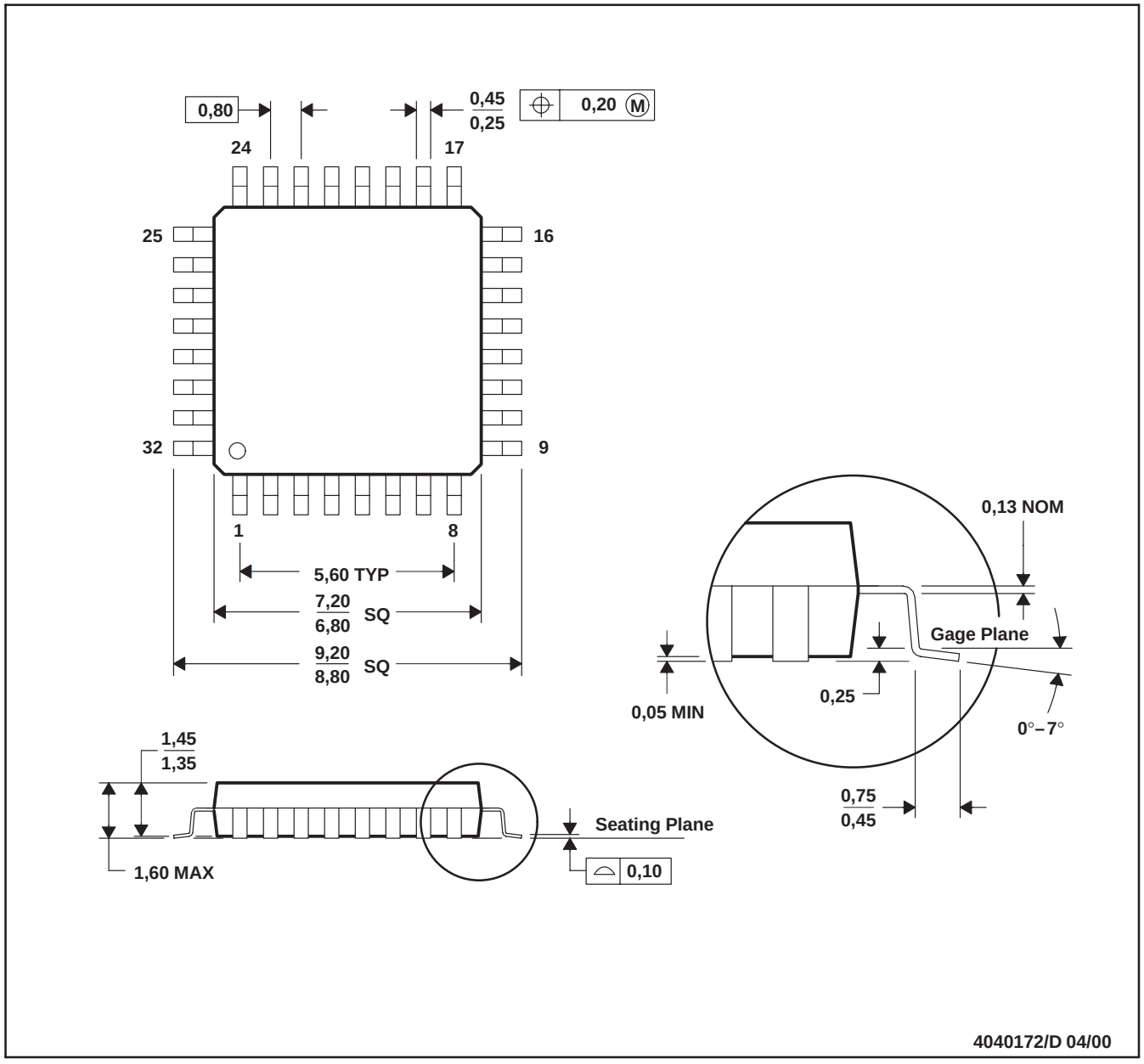


*All dimensions are nominal

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

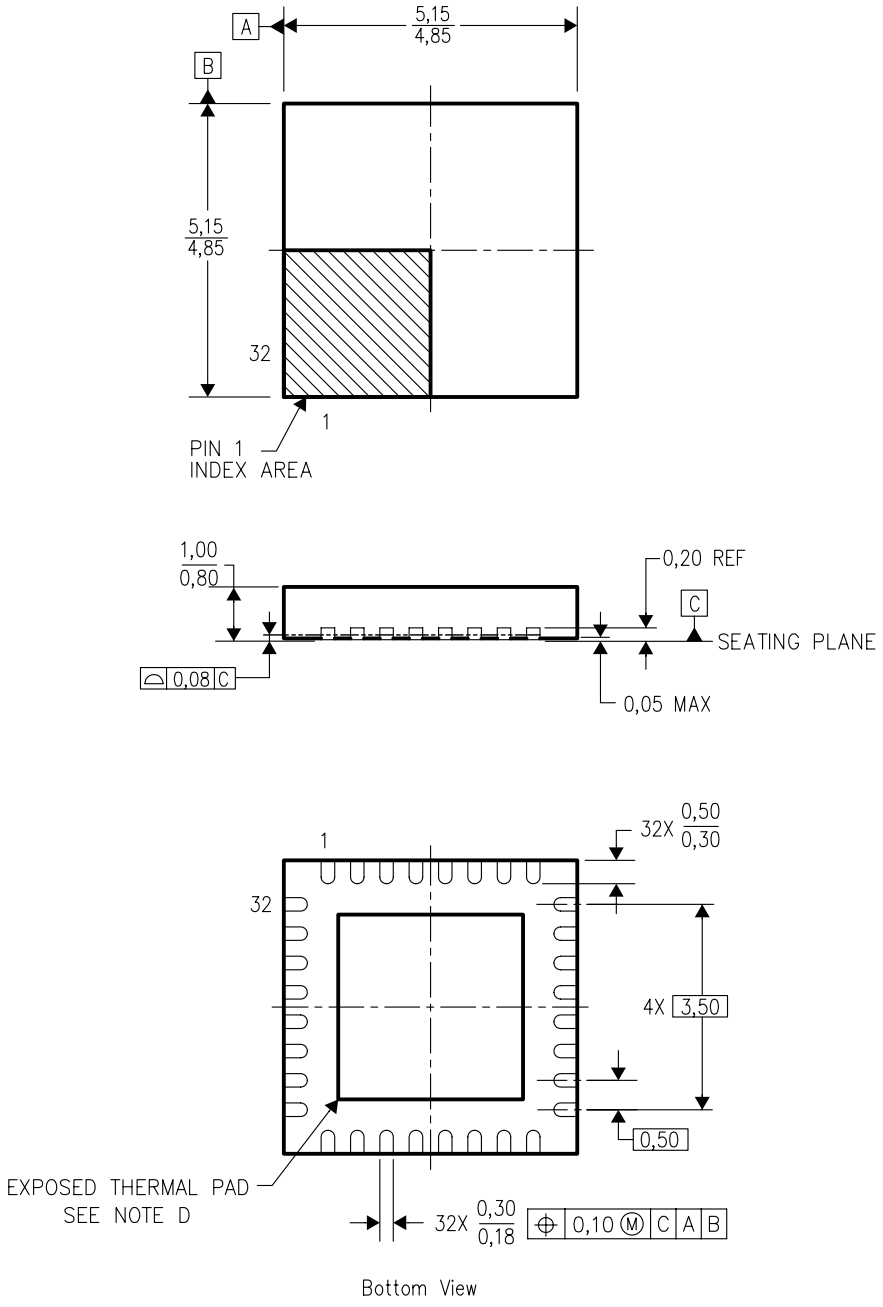
MTQF002B – JANUARY 1995 – REVISED MAY 2000

VF (S-PQFP-G32) **PLASTIC QUAD FLATPACK**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.

RHB (S–PQFP–N32) PLASTIC QUAD FLATPACK



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NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) Package configuration.
D 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.
E. Falls within JEDEC MO–220.

THERMAL PAD MECHANICAL DATA

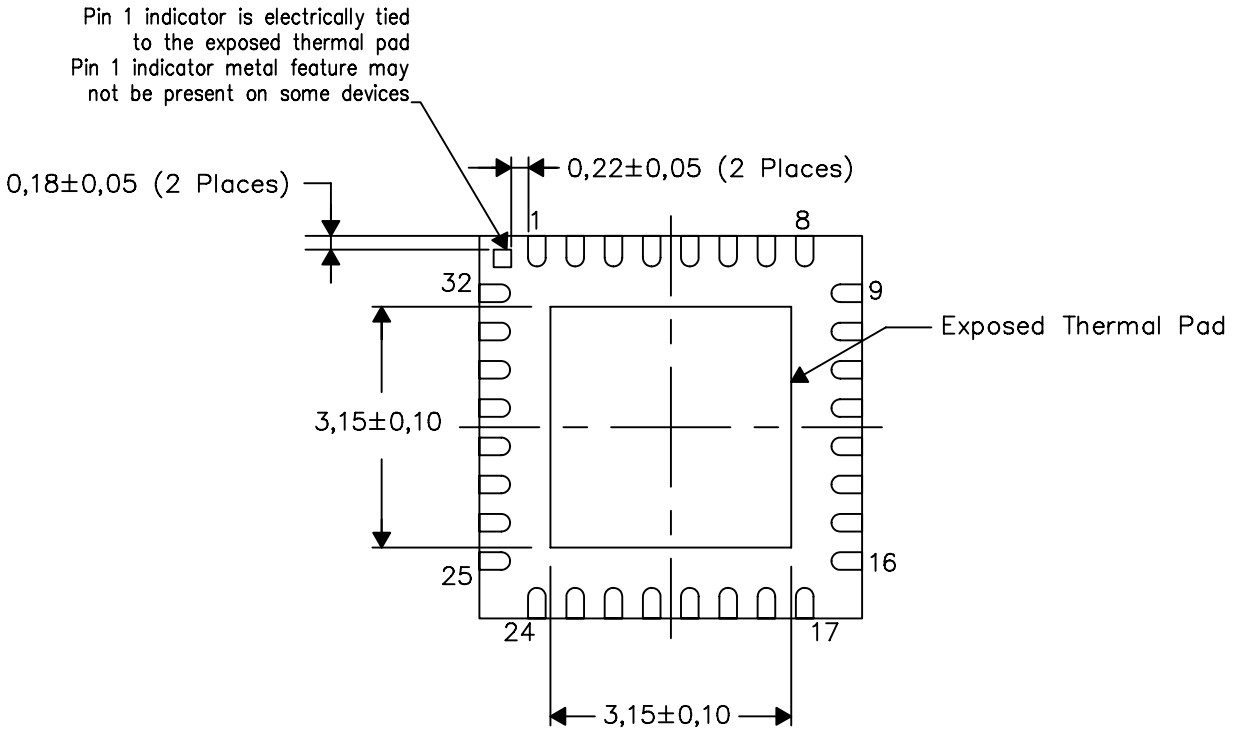
RHB (S–PVQFN–N32)

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.

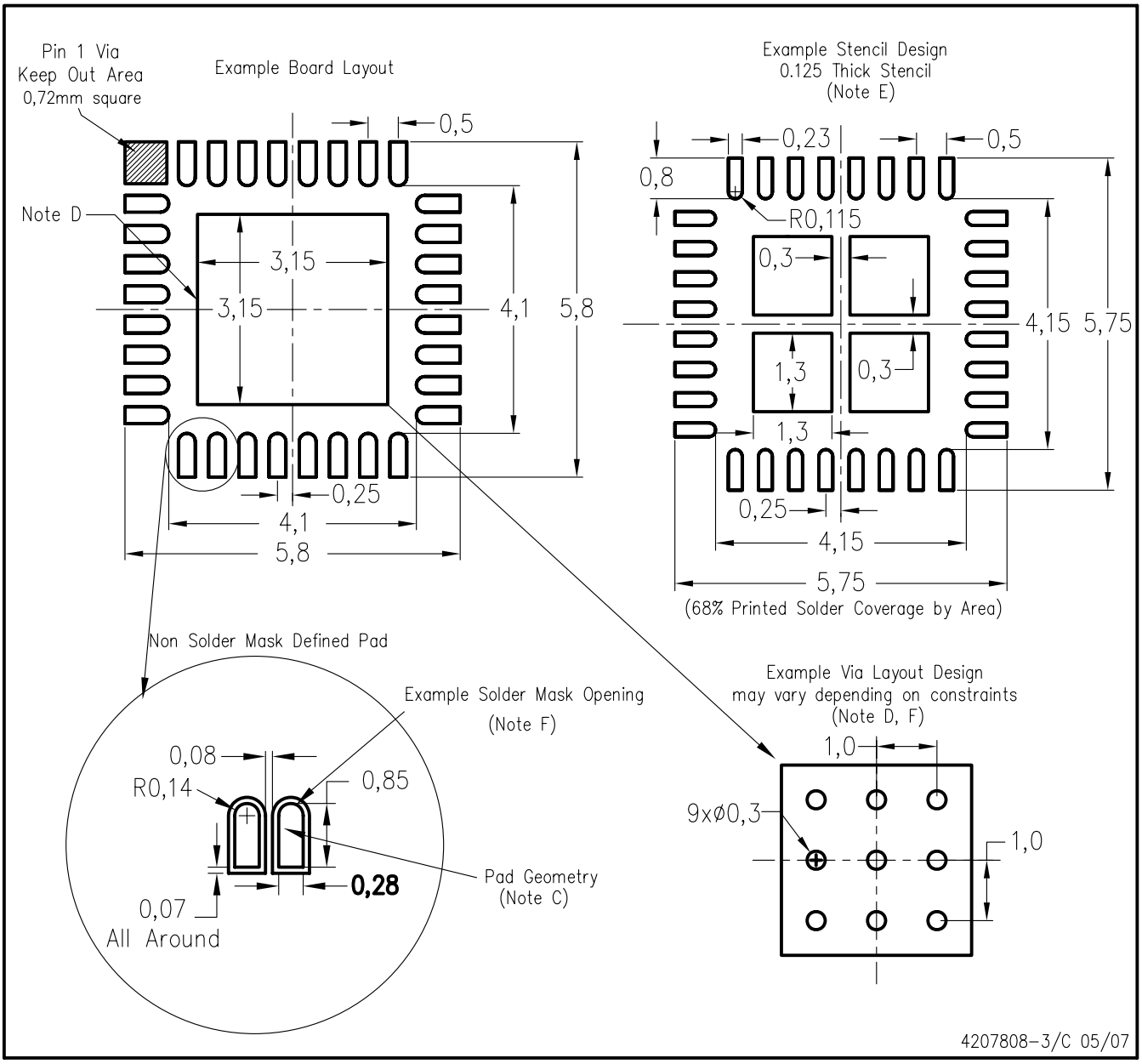


Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

RHB (S–PQFP–N32)



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. 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. SCBA017, 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>.
E. 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.
F. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

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