

1.8-V PHASE LOCK LOOP CLOCK DRIVER

SCAS688D–JUNE 2005–REVISED JULY 2007

FEATURES

- 1.8-V Phase Lock Loop Clock Driver for Double Data Rate (DDR II) Applications
- Spread Spectrum Clock Compatible
- Operating Frequency: 10 MHz to 400 MHz
- Low Current Consumption: <135 mA
- Low Jitter (Cycle-Cycle): ± 30 ps
- Low Output Skew: 35 ps
- Low Period Jitter: ± 20 ps
- Low Dynamic Phase Offset: ± 15 ps
- Low Static Phase Offset: ± 50 ps
- Distributes One Differential Clock Input to Ten Differential Outputs
- 52-Ball μ BGA (MicroStar™ Junior BGA, 0,65-mm pitch) and 40-Pin MLF
- External Feedback Pins (FBIN, $\overline{\text{FBIN}}$) are Used to Synchronize the Outputs to the Input Clocks
- Meets or Exceeds JESD82-8 PLL Standard for PC2-3200/4300
- Fail-Safe Inputs

DESCRIPTION

The CDCU877 is a high-performance, low-jitter, low-skew, zero-delay buffer that distributes a differential clock input pair (CK, $\overline{\text{CK}}$) to ten differential pairs of clock outputs (Yn, $\overline{\text{Yn}}$) and to one differential pair of feedback clock outputs (FBOUT, $\overline{\text{FBOUT}}$). The clock outputs are controlled by the input clocks (CK, $\overline{\text{CK}}$), the feedback clocks (FBIN, $\overline{\text{FBIN}}$), the LVCMOS control pins (OE, OS), and the analog power input (AV_{DD}). When OE is low, the clock outputs, except FBOUT/ $\overline{\text{FBOUT}}$, are disabled while the internal PLL continues to maintain its locked-in frequency. OS (output select) is a program pin that must be tied to GND or V_{DD}. When OS is high, OE functions as previously described. When OS and OE are both low, OE has no effect on Y7/ $\overline{\text{Y7}}$, they are free running. When AV_{DD} is grounded, the PLL is turned off and bypassed for test purposes.

When both clock inputs (CK, $\overline{\text{CK}}$) are logic low, the device enters in a low power mode. An input logic detection circuit on the differential inputs, independent from input buffers, detects the logic low level and performs in a low power state where all outputs, the feedback, and the PLL are off. When the clock inputs transition from being logic low to being differential signals, the PLL turns back on, the inputs and the outputs are enabled, and the PLL obtains phase lock between the feedback clock pair (FBIN, $\overline{\text{FBIN}}$) and the clock input pair (CK, $\overline{\text{CK}}$) within the specified stabilization time.

The CDCU877 is able to track spread spectrum clocking (SSC) for reduced EMI. This device operates from -40°C to 85°C .

ORDERING INFORMATION

T _A	52-BALL BGA ⁽¹⁾	40-Pin MLF
-40°C to 85°C	CDCU877ZQL	CDCU877RHA
	CDCU877AZQL	CDCU877ARHA
	CDCU877GQL	CDCU877RTB
	CDCU877AGQL	CDCU877ARTB

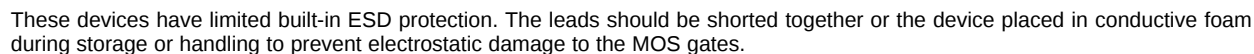
- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.



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The diagram shows a 6-pin package with the following pin connections:

- Pin 1:** Y1
- Pin 2:** Y0
- Pin 3:** GND
- Pin 4:** Y0
- Pin 5:** Y5
- Pin 6:** Y6

Internal connections and labels within the package include:

- Top Row:** A, B, C, D, E, F, G, H, J, K
- Bottom Row:** Y1, Y0, GND, Y0, GND, Y5, Y6
- Left Side:** Y1, GND, Y2, Y2, V_{DDQ}, CK, V_{DDQ}, CK, V_{DDQ}, AGND, V_{DDQ}, AV_{DD}, GND, Y3, GND
- Right Side:** Y6, GND, Y7, GND, Y7, OS, V_{DDQ}, FBIN, V_{DDQ}, FBIN, OE, FBOUT, V_{DDQ}, FBOUT, GND, Y8, GND

Notes: Pins 3 and 4 are connected to GND. Pins 5 and 6 are connected to Y5 and Y6 respectively. Pins 7 and 8 are connected to Y7 and Y8 respectively. Pins 9 and 10 are connected to Y9 and Y10 respectively. Pins 11 and 12 are connected to Y11 and Y12 respectively. Pins 13 and 14 are connected to Y13 and Y14 respectively. Pins 15 and 16 are connected to Y15 and Y16 respectively. Pins 17 and 18 are connected to Y17 and Y18 respectively. Pins 19 and 20 are connected to Y19 and Y20 respectively. Pins 21 and 22 are connected to Y21 and Y22 respectively. Pins 23 and 24 are connected to Y23 and Y24 respectively. Pins 25 and 26 are connected to Y25 and Y26 respectively. Pins 27 and 28 are connected to Y27 and Y28 respectively. Pins 29 and 30 are connected to Y29 and Y30 respectively. Pins 31 and 32 are connected to Y31 and Y32 respectively. Pins 33 and 34 are connected to Y33 and Y34 respectively. Pins 35 and 36 are connected to Y35 and Y36 respectively. Pins 37 and 38 are connected to Y37 and Y38 respectively. Pins 39 and 40 are connected to Y39 and Y40 respectively. Pins 41 and 42 are connected to Y41 and Y42 respectively. Pins 43 and 44 are connected to Y43 and Y44 respectively. Pins 45 and 46 are connected to Y45 and Y46 respectively. Pins 47 and 48 are connected to Y47 and Y48 respectively. Pins 49 and 50 are connected to Y49 and Y50 respectively. Pins 51 and 52 are connected to Y51 and Y52 respectively. Pins 53 and 54 are connected to Y53 and Y54 respectively. Pins 55 and 56 are connected to Y55 and Y56 respectively. Pins 57 and 58 are connected to Y57 and Y58 respectively. Pins 59 and 60 are connected to Y59 and Y60 respectively. Pins 61 and 62 are connected to Y61 and Y62 respectively. Pins 63 and 64 are connected to Y63 and Y64 respectively. Pins 65 and 66 are connected to Y65 and Y66 respectively. Pins 67 and 68 are connected to Y67 and Y68 respectively. Pins 69 and 70 are connected to Y69 and Y70 respectively. Pins 71 and 72 are connected to Y71 and Y72 respectively. Pins 73 and 74 are connected to Y73 and Y74 respectively. Pins 75 and 76 are connected to Y75 and Y76 respectively. Pins 77 and 78 are connected to Y77 and Y78 respectively. Pins 79 and 80 are connected to Y79 and Y80 respectively. Pins 81 and 82 are connected to Y81 and Y82 respectively. Pins 83 and 84 are connected to Y83 and Y84 respectively. Pins 85 and 86 are connected to Y85 and Y86 respectively. Pins 87 and 88 are connected to Y87 and Y88 respectively. Pins 89 and 90 are connected to Y89 and Y90 respectively. Pins 91 and 92 are connected to Y91 and Y92 respectively. Pins 93 and 94 are connected to Y93 and Y94 respectively. Pins 95 and 96 are connected to Y95 and Y96 respectively. Pins 97 and 98 are connected to Y97 and Y98 respectively. Pins 99 and 100 are connected to Y99 and Y100 respectively.

- A. NC = No Connection
B. NB = No Ball

40-pin HP-VFQFP-N (6,0 x 6,0 mm Body Size, 0,5 mm Pitch, M0#220, Variation VJJD-2, E2 = D2 = 2,9 mm $\pm$ 0,15 mm) Package Pinouts

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TERMINAL FUNCTIONS

TERMINAL		RHA/RTB	I/O	DESCRIPTION
NAME	GQL/ZQL			
AGND	G1	7		Analog ground
AV _{DD}	H1	8		Analog power
CK	E1	4	I	Clock input with a (10 kΩ to 100 kΩ) pulldown resistor
$\overline{\text{CK}}$	F1	5	I	Complementary clock input with a (10 kΩ to 100 kΩ) pulldown resistor
FBIN	E6	27	I	Feedback clock input
$\overline{\text{FBIN}}$	F6	26	I	Complementary feedback clock input
FBOU _T	H6	24	O	Feedback clock output
$\overline{\text{FBOU}}\overline{\text{T}}$	G6	25	O	Complementary feedback clock output
OE	F5	22	I	Output enable (asynchronous)
OS	D5	21	I	Output select (tied to GND or V _{DD})
GND	B2, B3, B4, B5, C2, C5, H2, H5, J2, J3, J4, J5	10		Ground
V _{DDQ}	D2, D3, D4, E2, E5, F2, G2, G3, G4, G5	1, 6, 9, 15, 20, 23, 28, 31, 36		Logic and output power
Y[0:9]	A2, A1, D1, J1, K3, A5, A6, D6, J6, K4	3, 11, 14, 16, 19, 29, 33, 34, 38, 39	O	Clock outputs
$\overline{\text{Y}}[0:9]$	A3, B1, C1, K1, K2, A4, B6, C6, K6, K5	2, 12, 13, 18, 17, 30, 32, 35, 37, 40	O	Complementary clock outputs

FUNCTION TABLE

INPUTS					OUTPUTS				
AVDD	OE	OS	CK	$\overline{\text{CK}}$	Y	$\overline{\text{Y}}$	FBOU _T	$\overline{\text{FBOU}}\overline{\text{T}}$	PLL
GND	H	X	L	H	L	H	L	H	Bypassed/Off
GND	H	X	H	L	H	L	H	L	Bypassed/Off
GND	L	H	L	H	L _Z	L _Z	L	H	Bypassed/Off
GND	L	L	H	L	L _Z Y7 Active	L _Z $\overline{\text{Y}}7$ Active	H	L	Bypassed/Off
1.8 V Nominal	L	H	L	H	L _Z	L _Z	L	H	On
1.8 V Nominal	L	L	H	L	L _Z Y7 Active	L _Z $\overline{\text{Y}}7$ Active	H	L	On
1.8 V Nominal	H	X	L	H	L	H	L	H	On
1.8 V Nominal	H	X	H	L	H	L	H	L	On
1.8 V Nominal	X	X	L	L	L _Z	L _Z	L _Z	L _Z	Off
X	X	X	H	H	Reserved				

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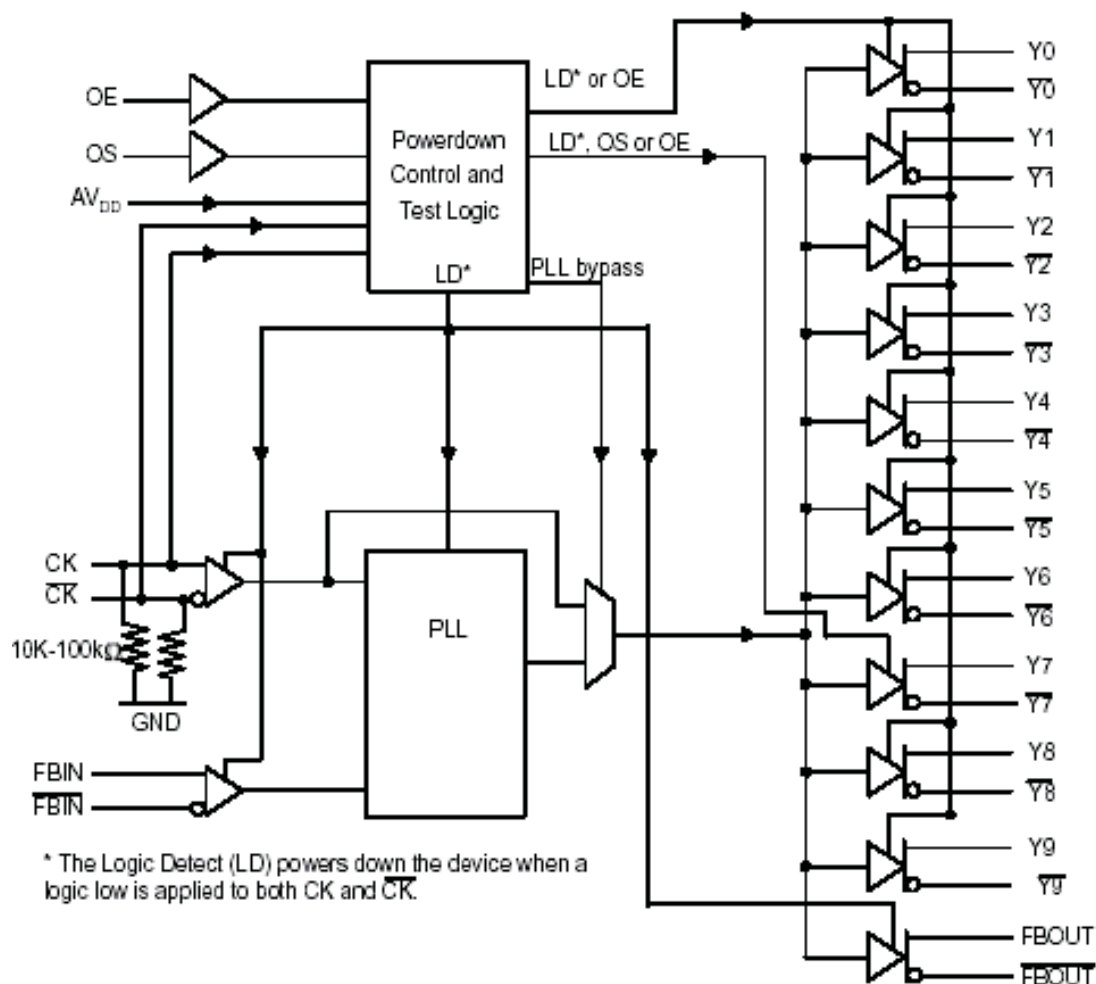


Figure 1. LOGIC DIAGRAM (POSITIVE LOGIC)

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Absolute Maximum Ratings⁽¹⁾

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

			MIN	MAX	UNIT
V _{CC}	Supply voltage range	V _{DDQ} or AV _{DD}	–0.5	2.5	V
V _I	Input voltage range ⁽²⁾⁽³⁾		–0.5	V _{DDQ} + 0.5	V
V _O	Output voltage range ⁽²⁾⁽³⁾		–0.5	V _{DDQ} + 0.5	V
I _{IK}	Input clamp current	V _I < 0 or V _I > V _{DDQ}		±50	mA
I _{OK}	Output clamp current	V _O < 0 or V _O > V _{DDQ}		±50	mA
I _O	Continuous output current	V _O = 0 to V _{DDQ}		±50	mA
	Continuous current through each V _{DDQ} or GND			±100	mA
T _{stg}	Storage temperature range		–65	150	°C

- (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.
- (2) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- (3) This value is limited to 2.5 V maximum.

Recommended Operating Conditions

			MIN	NOM	MAX	UNIT
V _{CC}	Output supply voltage, V _{DDQ}		1.7	1.8	1.9	V
	Supply Voltage, AV _{DD} ⁽¹⁾			V _{DDQ}		V
V _{IL}	Low-level input voltage ⁽²⁾	OE, OS			0.35 × V _{DDQ}	V
V _{IH}	High-level input voltage ⁽²⁾	CK, $\overline{\text{CK}}$	0.65 × V _{DDQ}			V
I _{OH}	High-level output current (see Figure 2)				–9	mA
I _{OL}	Low-level output current (see Figure 2)				9	mA
V _{IX}	Input differential-pair cross voltage		(V _{DDQ} /2) – 0.15		(V _{DDQ} /2) + 0.15	V
V _I	Input voltage level		–0.3		V _{DDQ} + 0.3	V
V _{ID}	Input differential voltage ⁽²⁾ (see Figure 9)	DC	0.3		V _{DDQ} + 0.4	V
		AC	0.6		V _{DDQ} + 0.4	V
T _A	Operating free-air temperature		–40		85	°C

- (1) The PLL is turned off and bypassed for test purposes when AV_{DD} is grounded. During this test mode, V_{DDQ} remains within the recommended operating conditions and no timing parameters are specified.
- (2) V_{ID} is the magnitude of the difference between the input level on CK and the input level on $\overline{\text{CK}}$, see Figure 9 for definition. The CK and $\overline{\text{CK}}$, V_{IH} and V_{IL} limits define the dc low and high levels for the logic detect state.

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Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	AV_{DD}, V_{DDQ}	MIN	TYP ⁽¹⁾	MAX	UNIT
V_{IK}	Input	$I_I = 18 \text{ mA}$	1.7			-1.2	V
V_{OH}	High-level output voltage	$I_{OH} = -100 \mu\text{A}$	1.7 to 1.9	$V_{DDQ} - 0.2$			V
		$I_{OH} = -9 \text{ mA}$	1.7	1.1			
V_{OL}	Low-level output voltage	$I_{OL} = 100 \mu\text{A}$				0.1	V
		$I_{OL} = 9 \text{ mA}$	1.7			0.6	
$I_{O(DL)}$	Low-level output current, dissabled	$V_{O(DL)} = 100 \text{ mV}, OE = L$	1.7	100			μA
V_{OD}	Differential output voltage ⁽¹⁾		1.7	0.5			V
I_I	Input current	CK, $\overline{\text{CK}}$	1.9			± 250	μA
		OE, OS, FBIN, $\overline{\text{FBIN}}$	1.9			± 10	
$I_{DD(LD)}$	Supply current, static ($I_{DDQ} + I_{ADD}$)	CK and $\overline{\text{CK}} = L$	1.9			500	μA
I_{DD}	Supply current, dynamic ($I_{DDQ} + I_{ADD}$) (see Note ⁽²⁾ for CPD calculation)	CK and $\overline{\text{CK}} = 270 \text{ MHz}$. All outputs are open (not connected to a PCB)	1.9			135	mA
		All outputs are loaded with 2 pF and 120- Ω termination resistor	1.9			235	
C_I	Input capacitance	CK, $\overline{\text{CK}}$	1.8	2		3	pF
		FBIN, $\overline{\text{FBIN}}$	1.8	2		3	
$C_{I(\Delta)}$	Change in input current	CK, $\overline{\text{CK}}$	1.8			0.25	
		FBIN, $\overline{\text{FBIN}}$	1.8			0.25	

(1) V_{OD} is the magnitude of the difference between the true and complimentary outputs. See Figure 9 for a definition.(2) Total $I_{DD} = I_{DDQ} + I_{ADD} = f_{CK} \times C_{PD} \times V_{DDQ}$, solving for $C_{PD} = (I_{DDQ} + I_{ADD}) / (f_{CK} \times V_{DDQ})$ where f_{CK} is the input frequency, V_{DDQ} is the power supply, and C_{PD} is the power dissipation capacitance.

Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted)⁽¹⁾

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
f_{CK}	Clock frequency (operating) ⁽¹⁾⁽²⁾	$AV_{DD}, V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$	10	400	MHz
	Clock frequency (application) ⁽¹⁾⁽³⁾		160	340	MHz
t_{DC}	Duty cycle, input clock		40%	60%	
t_L	Stabilization time ⁽⁴⁾			12	μs

(1) The PLL must be able to handle spread spectrum induced skew.

(2) Operating clock frequency indicates a range over which the PLL must be able to lock, but in which it is not required to meet the other timing parameters (used for low speed system debug).

(3) Application clock frequency indicates a range over which the PLL must meet all timing parameters.

(4) Stabilization time is the time required for the integrated PLL circuit to obtain phase lock of its feedback signal to its reference signal after power up. During normal operation, the stabilization time is also the time required for the integrated PLL circuit to obtain phase lock of its feedback signal to its reference signal when CK and $\overline{\text{CK}}$ go to a logic low state, enter the power-down mode and later return to active operation. CK and $\overline{\text{CK}}$ may be left floating after they have been driven low for one complete clock cycle.

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Switching Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (see ⁽¹⁾) AV_{DD} , $V_{DD} = 1.8\text{ V} \pm 0.1\text{ V}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{en}	Enable time, OE to any $\overline{Y}/\overline{Y}$	See Figure 11			8	ns
t_{dis}	Disable time, OE to any $\overline{Y}/\overline{Y}$	See Figure 11			8	ns
$t_{jit(cc+)}$	Cycle-to-cycle period jitter ⁽²⁾	160 MHz to 190 MHz, see Figure 4	0		40	ps
$t_{jit(cc-)}$			0		-40	
$t_{jit(cc+)}$	Cycle-to-cycle period jitter ⁽²⁾	160 MHz to 340 MHz, see Figure 4	0		30	ps
$t_{jit(cc-)}$			0		-30	
$t_{(w)}$	Static phase offset time ⁽³⁾	See Figure 5	-50		50	ps
$t_{(w)dyn}$	Dynamic phase offset time	See Figure 10	-15		15	ps
$t_{sk(o)}$	Output clock skew	See Figure 6			35	ps
$t_{jit(per)}$	Period jitter ⁽⁴⁾⁽²⁾	160 MHz to 190 MHz, see Figure 7	-30		30	ps
		190 MHz to 340 MHz, see Figure 7	-20		20	
$t_{jit(hper)}$	Half-period jitter ⁽⁴⁾⁽²⁾	160 MHz to 190 MHz, see Figure 8	-115		115	ps
		190 MHz to 250 MHz, see Figure 8	-70		70	
		250 MHz to 300 MHz, see Figure 8	-40		40	
		300 MHz to 340 MHz, see Figure 8	-60		60	
SR	Slew rate, OE	See Figure 3 and Figure 9	0.5			V/ns
	Input clock slew rate	See Figure 3 and Figure 9	1	2.5	4	
	Output clock slew rate ⁽⁵⁾⁽⁶⁾ (no load)	See Figure 3 and Figure 9	1.5	2.5	3	
V_{OX}	Output differential-pair cross voltage ⁽⁷⁾	CDCU877, See Figure 2	$(V_{DDQ}/2) - 0.1$		$(V_{DDQ}/2) + 0.1$	V
		CDCU877A ⁽⁸⁾ , See Figure 2 (0 - 85°C)	$(V_{DDQ}/2) - 0.1$		$(V_{DDQ}/2) + 0.1$	
	SSC modulation frequency		30		33	kHz
	SSC clock input frequency deviation		0%		-0.5%	
	PLL loop bandwidth		2			MHz

- (1) There are two different terminations that are used with the following tests. The load/board in [Figure 2](#) is used to measure the input and output differential-pair cross voltage only. The load/board in [Figure 3](#) is used to measure all other tests. For consistency, equal length cables must be used.
- (2) This parameter is specified by design and characterization.
- (3) Phase static offset time does not include jitter.
- (4) Period jitter, half-period jitter specifications are separate specifications that must be met independently of each other.
- (5) The output slew rate is determined from the IBIS model with a 120-Ω load only.
- (6) To eliminate the impact of input slew rates on static phase offset, the input skew rates of reference clock input CK and $\overline{CK}$ and feedback clock inputs FBIN and $\overline{FBIN}$ are recommended to be nearly equal. The 2.5-V/ns skew rates are shown as a recommended target. Compliance with these typical values is not mandatory if it can adequately shown that alternative characteristics meet the requirements of the registered DDR2 DIMM application.
- (7) Output differential-pair cross voltage specified at the DRAM clock input or the test load.
- (8) V_{OX} of CDCU877A is on average 30 mV lower than that of CDCU877 for the same application.

PARAMETER MEASUREMENT INFORMATION

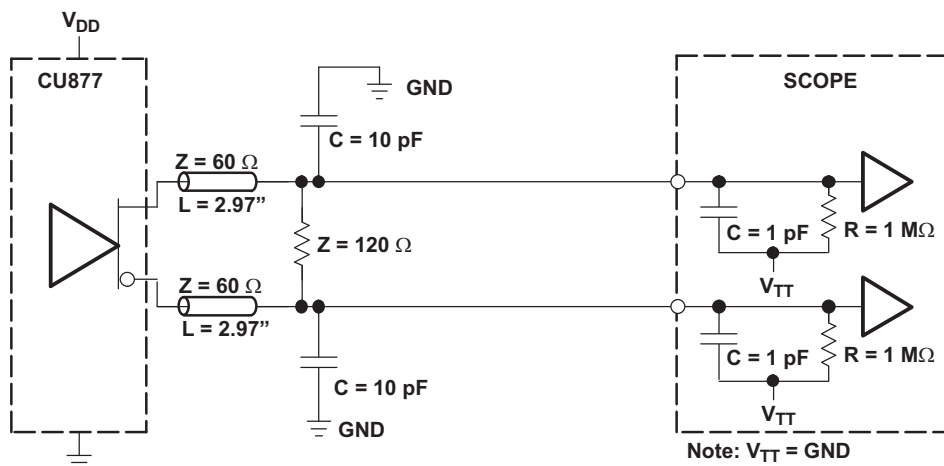


Figure 2. Output Load Test Circuit 1

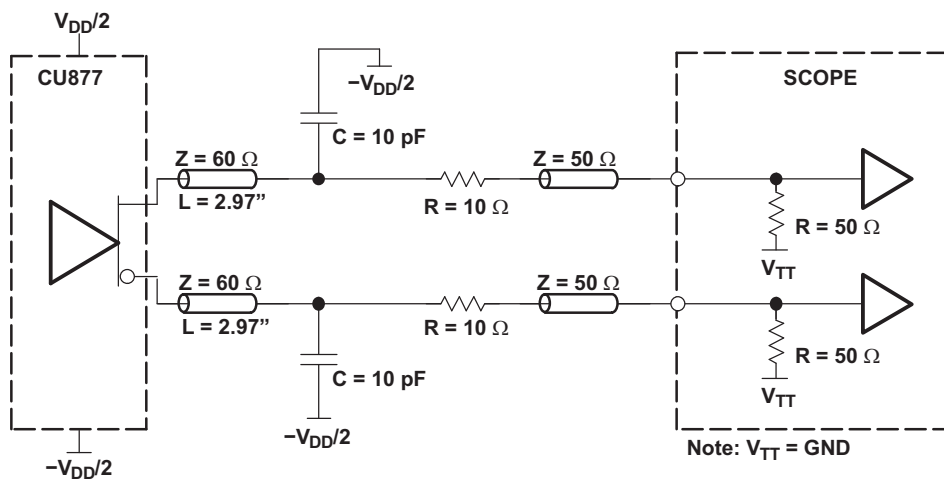


Figure 3. Output Load Test Circuit 2

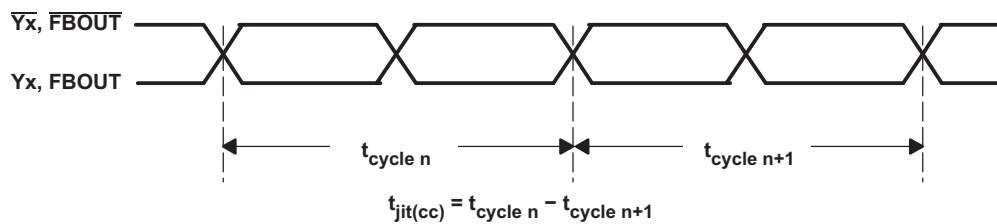


Figure 4. Cycle-To-Cycle Period Jitter

PARAMETER MEASUREMENT INFORMATION (continued)

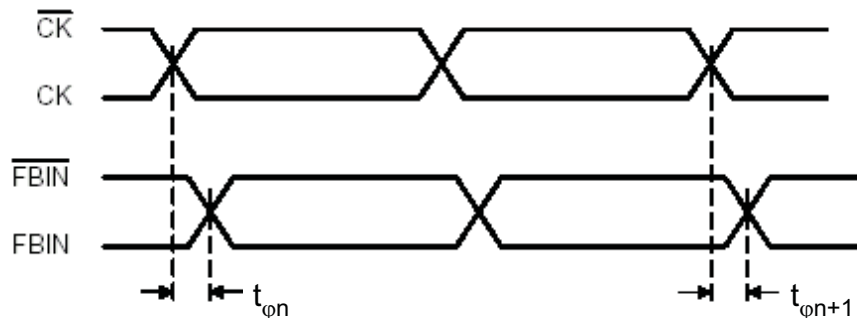


Figure 5. Static Phase Offset

$$t_{\phi} = \frac{\sum_{n=1}^N t_{\phi n}}{N}$$

(N is the large number of samples)

(N > 1000 samples)

(1)

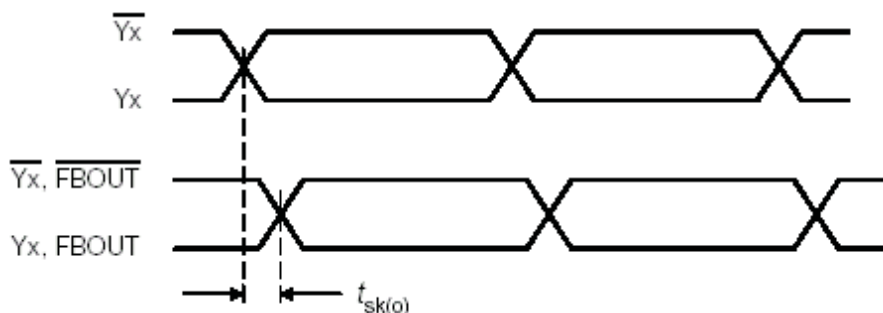


Figure 6. Output Skew

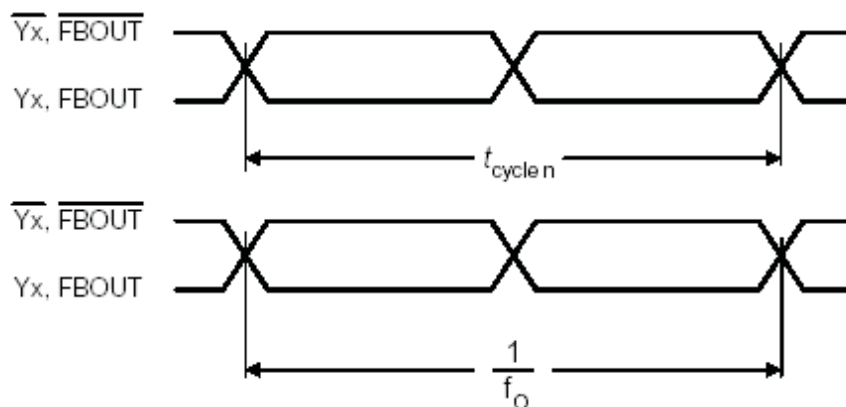


Figure 7. Period Jitter

$$t_{jit(per)} = t_{cycle\ n} - \frac{1}{f_o}$$

(f_o average input frequency measured at CK/ $\overline{CK}$)

(2)

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PARAMETER MEASUREMENT INFORMATION (continued)

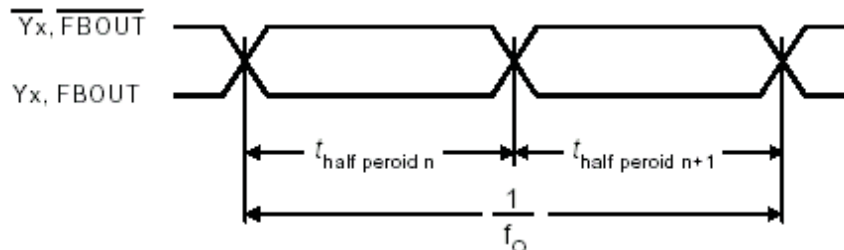


Figure 8. Half-Period Jitter

$$t_{jit(hper)} = t_{half\ period\ n} - \frac{1}{2 \times f_O}$$

n = any half cycle

(f_O average input frequency measured at CK/ $\overline{CK}$)

(3)

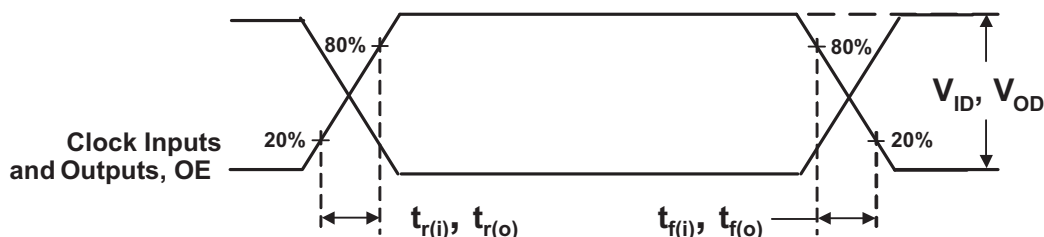


Figure 9. Input and Output Slew Rates

$$slrr_{(i/o)} = \frac{V_{80\%} - V_{20\%}}{t_{r(i/o)}}$$

$$slrf_{(i/o)} = \frac{V_{80\%} - V_{20\%}}{t_{f(i/o)}}$$

(4)

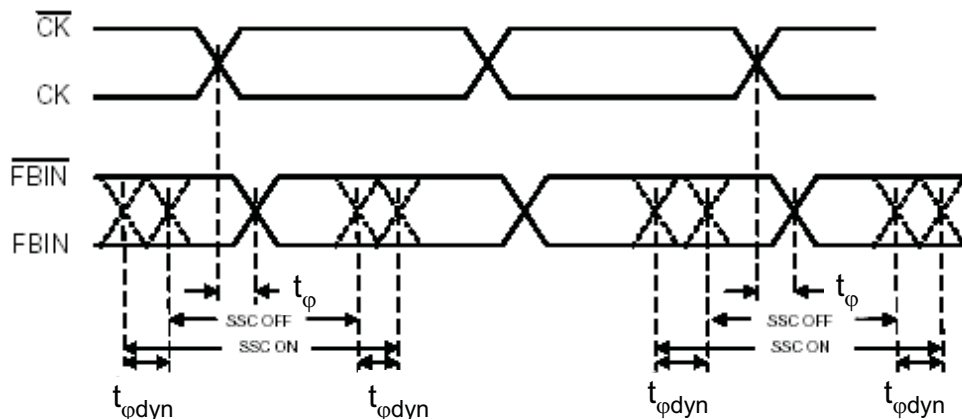


Figure 10. Dynamic Phase Offset

PARAMETER MEASUREMENT INFORMATION (continued)

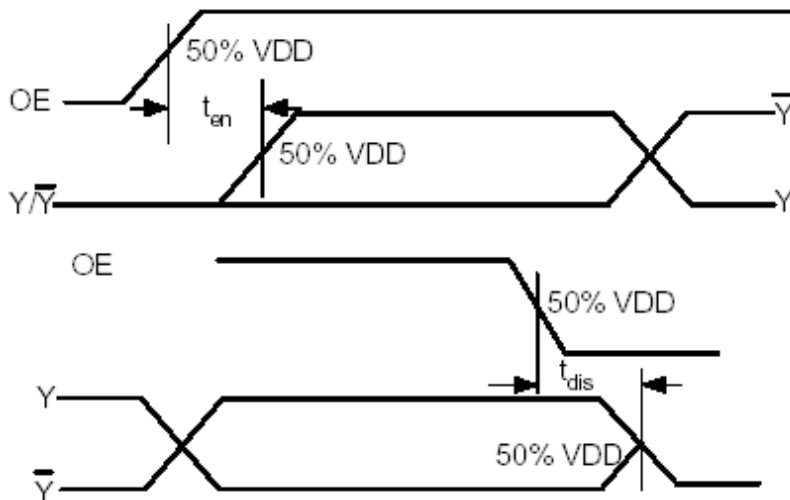
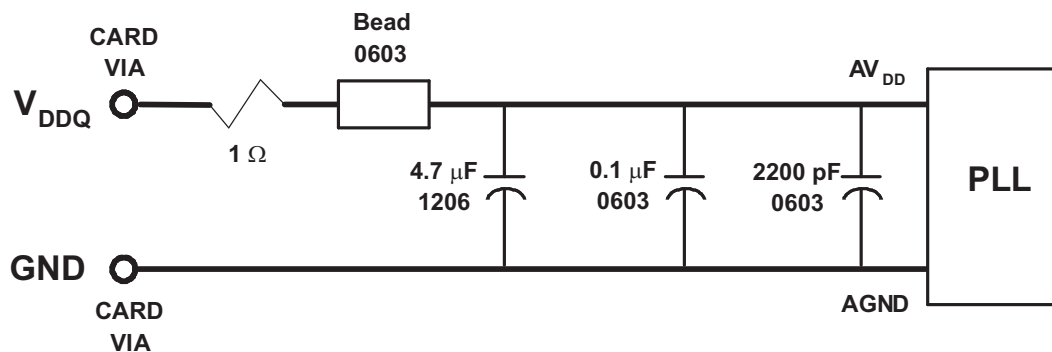


Figure 11. Time Delay Between OE and Clock Output (Y, $\bar{Y}$)

RECOMMENDED AV_{DD} FILTERING



- Place the 2200-pF capacitor close to the PLL.
- Use a wide trace for the PLL analog power and ground. Connect PLL and capacitors to AGND trace and connect trace to one GND via (farthest from the PLL).
- Recommended bead: Fair-Rite PN 2506036017Y0 or equivalent ($0.8\ \Omega$ dc maximum, $600\ \Omega$ at 100 MHz).

Figure 12. Recommended AV_{DD} Filtering

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CDCU877ARHAR	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877A	Samples
CDCU877ARHARG4	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877A	Samples
CDCU877ARHAT	ACTIVE	VQFN	RHA	40	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877A	Samples
CDCU877AZQLR	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	52	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-2-260C-1 YEAR	-40 to 85	CDCU877A	Samples
CDCU877AZQLT	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	52	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-2-260C-1 YEAR	-40 to 85	CDCU877A	Samples
CDCU877GQLR	LIFEBUY	BGA MICROSTAR JUNIOR	GQL	52	1000	TBD	SNPB	Level-2-235C-1 YEAR	-40 to 85	CDCU877	
CDCU877GQLT	LIFEBUY	BGA MICROSTAR JUNIOR	GQL	52	250	TBD	SNPB	Level-2-235C-1 YEAR	-40 to 85	CDCU877	
CDCU877RHAR	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	Samples
CDCU877RHARG4	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	Samples
CDCU877RHAT	ACTIVE	VQFN	RHA	40	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	Samples
CDCU877RHATG4	ACTIVE	VQFN	RHA	40	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	Samples
CDCU877RTBR	ACTIVE	VQFN	RHA	40	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	Samples
CDCU877ZQLR	LIFEBUY	BGA MICROSTAR JUNIOR	ZQL	52	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-2-260C-1 YEAR	-40 to 85	CDCU877	
CDCU877ZQLT	LIFEBUY	BGA MICROSTAR JUNIOR	ZQL	52	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-2-260C-1 YEAR	-40 to 85	CDCU877	

⁽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⁾ **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm threshold requirement.

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

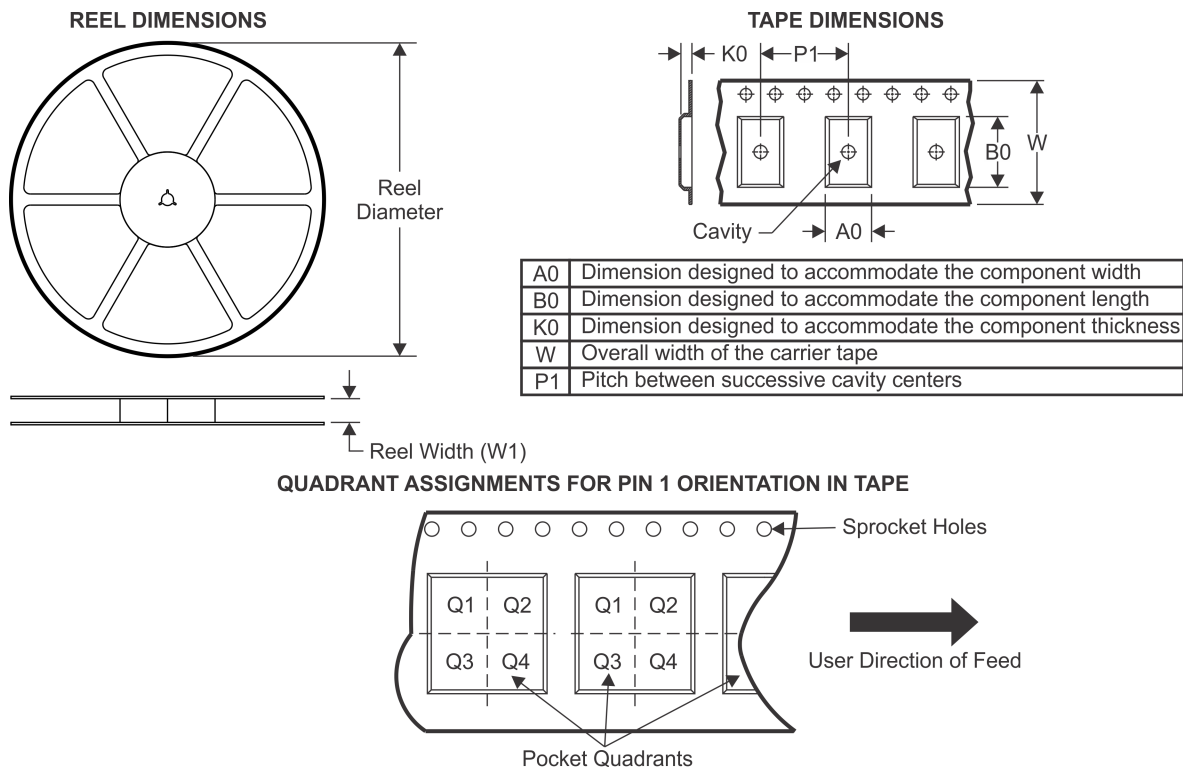
⁽⁴⁾ There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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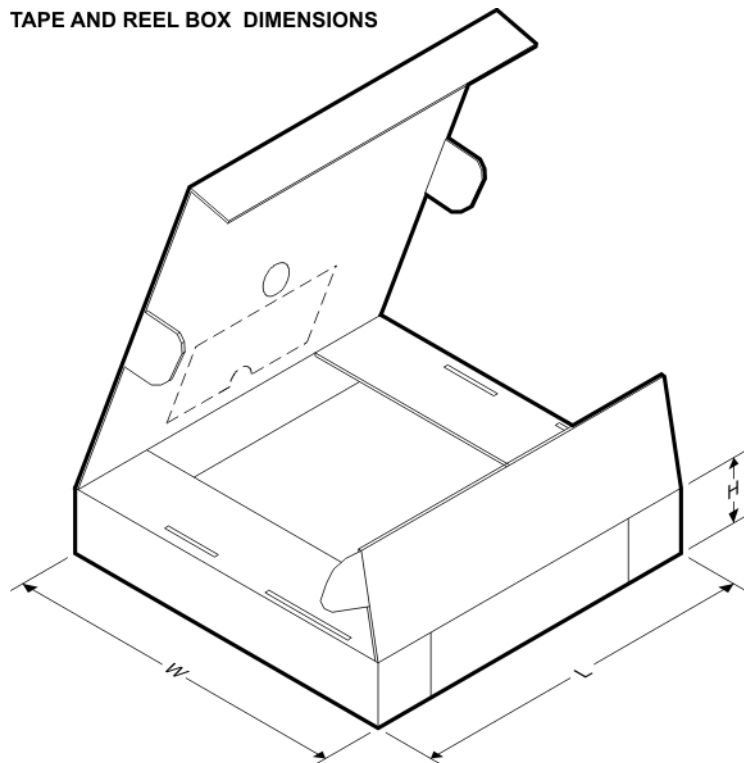
TAPE AND REEL INFORMATION


*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
CDCU877ARHAR	VQFN	RHA	40	2500	330.0	16.4	6.3	6.3	1.1	12.0	16.0	Q2
CDCU877ARHAT	VQFN	RHA	40	250	180.0	16.4	6.3	6.3	1.1	12.0	16.0	Q2
CDCU877AZQLR	BGA MICROSTAR JUNIOR	ZQL	52	1000	330.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1
CDCU877AZQLT	BGA MICROSTAR JUNIOR	ZQL	52	250	180.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1
CDCU877GQLR	BGA MICROSTAR JUNIOR	GQL	52	1000	330.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1
CDCU877GQLT	BGA MICROSTAR JUNIOR	GQL	52	250	180.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1
CDCU877RHAR	VQFN	RHA	40	2500	330.0	16.4	6.3	6.3	1.1	12.0	16.0	Q2
CDCU877RHAT	VQFN	RHA	40	250	180.0	16.4	6.3	6.3	1.1	12.0	16.0	Q2
CDCU877ZQLR	BGA MICROSTAR	ZQL	52	1000	330.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1

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
	R JUNIOR											
CDCU877ZQLT	BGA MICROSTAR JUNIOR	ZQL	52	250	180.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



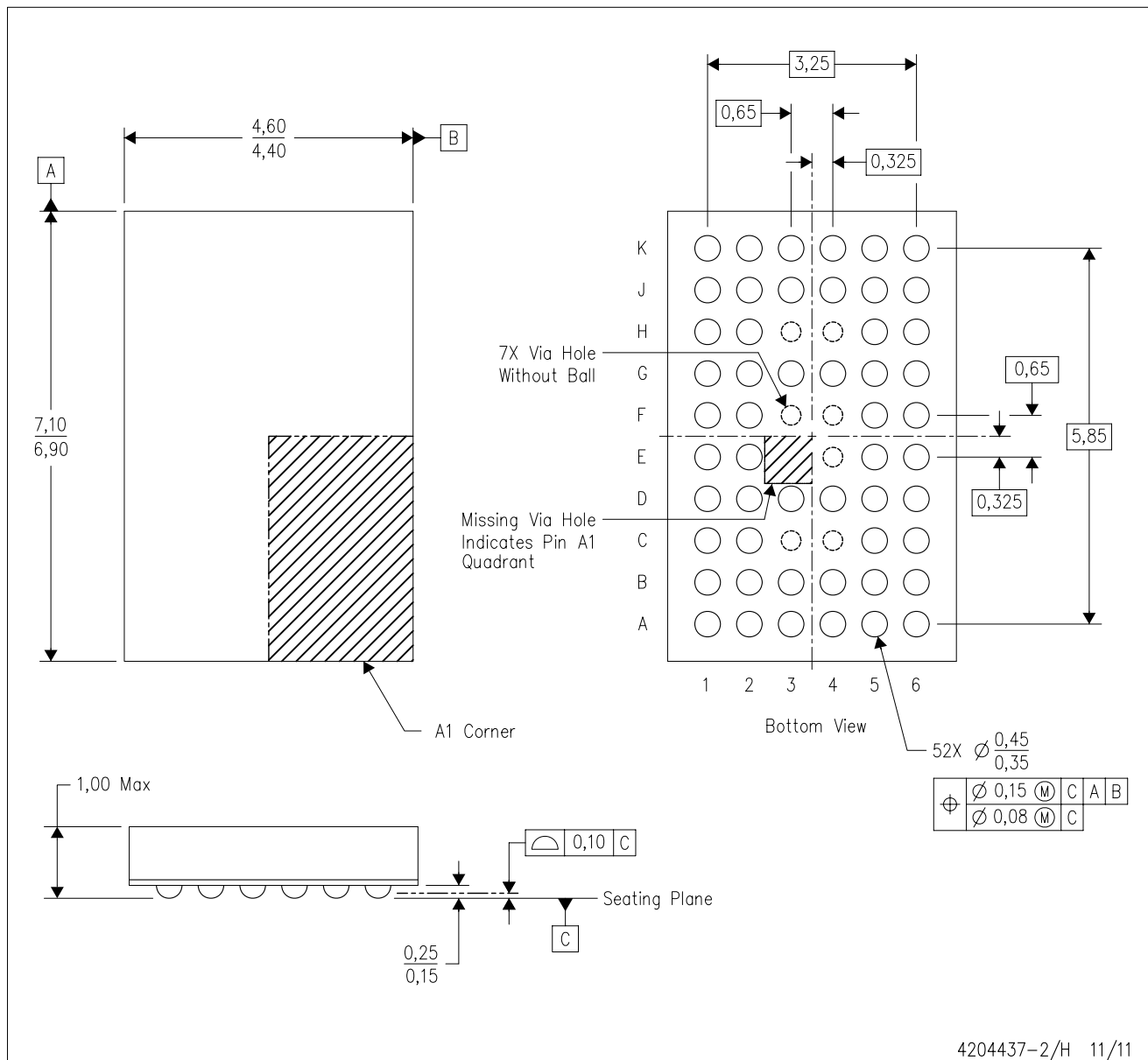
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CDCU877ARHAR	VQFN	RHA	40	2500	367.0	367.0	38.0
CDCU877ARHAT	VQFN	RHA	40	250	210.0	185.0	35.0
CDCU877AZQLR	BGA MICROSTAR JUNIOR	ZQL	52	1000	350.0	350.0	43.0
CDCU877AZQLT	BGA MICROSTAR JUNIOR	ZQL	52	250	213.0	191.0	55.0
CDCU877GQLR	BGA MICROSTAR JUNIOR	GQL	52	1000	350.0	350.0	43.0
CDCU877GQLT	BGA MICROSTAR JUNIOR	GQL	52	250	213.0	191.0	55.0
CDCU877RHAR	VQFN	RHA	40	2500	367.0	367.0	38.0
CDCU877RHAT	VQFN	RHA	40	250	210.0	185.0	35.0
CDCU877ZQLR	BGA MICROSTAR	ZQL	52	1000	350.0	350.0	43.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
	JUNIOR						
CDCU877ZQLT	BGA MICROSTAR JUNIOR	ZQL	52	250	213.0	191.0	55.0

ZQL (R-PBGA-N52)

PLASTIC BALL GRID ARRAY

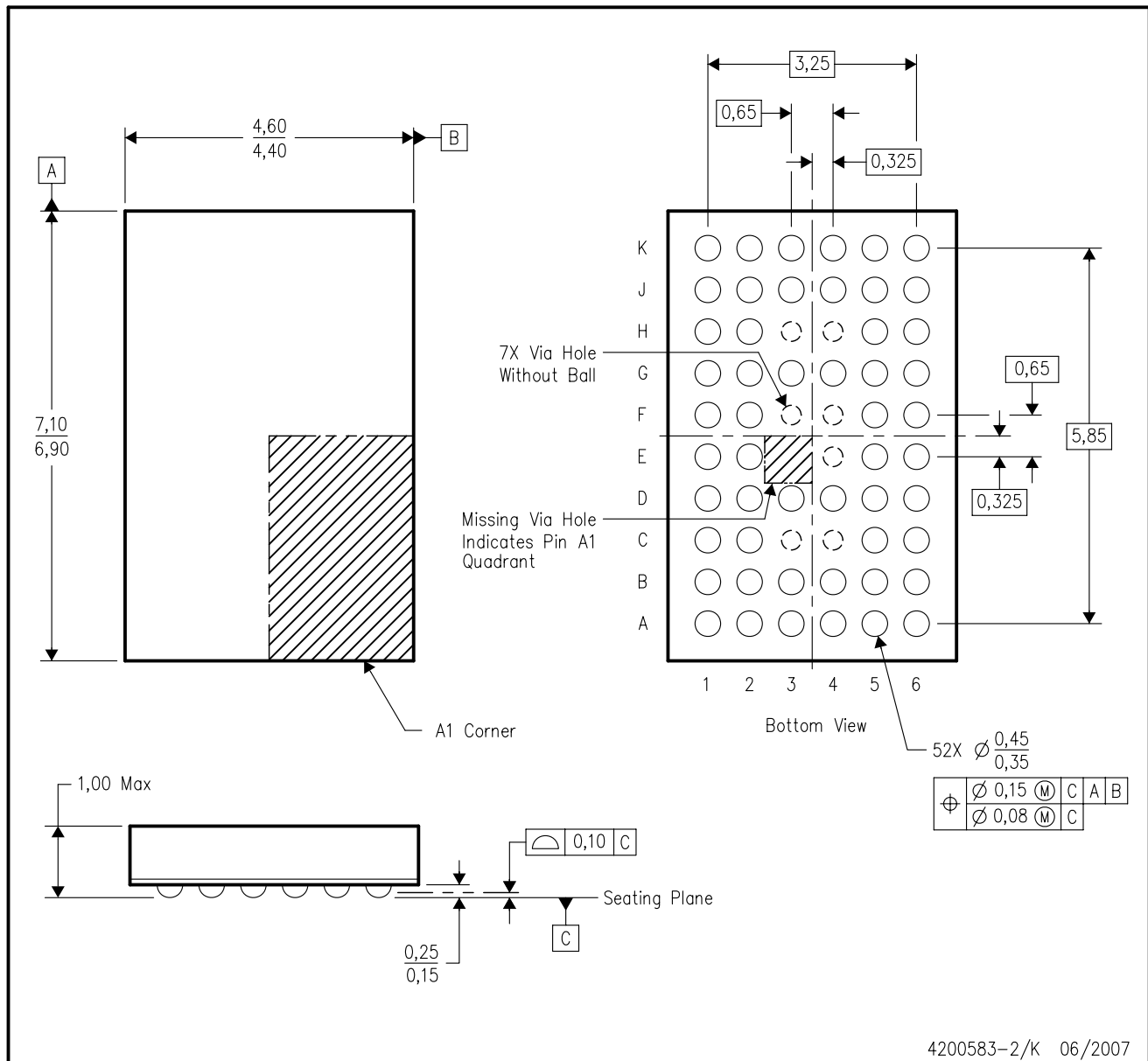


4204437-2/H 11/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-285 variation BA-2.
 - D. This package is Pb-free. Refer to the 52 GQL package (drawing 4200583) for tin-lead (SnPb).

GQL (R-PBGA-N52)

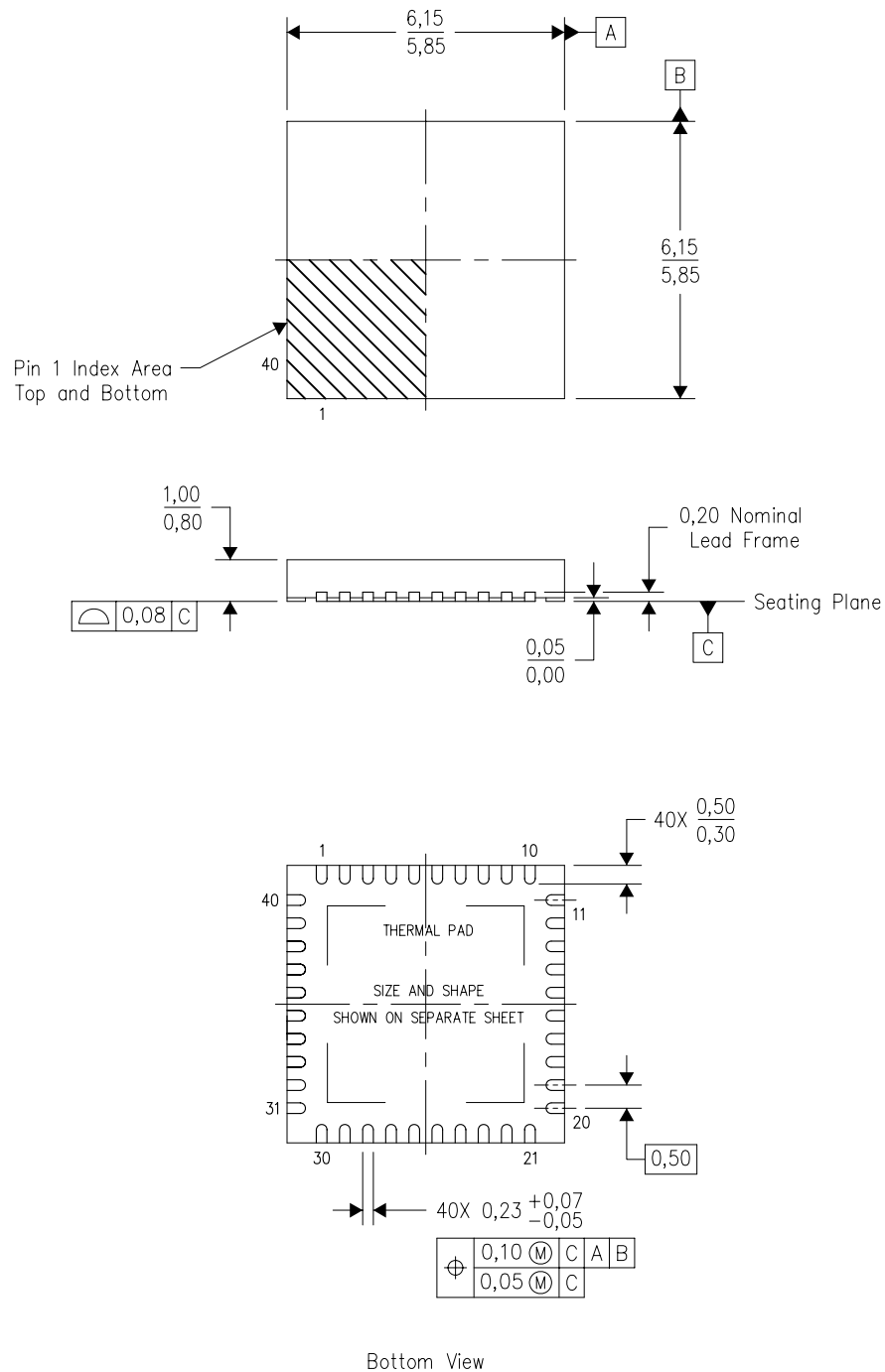
PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-285 variation BA-2.
 - D. This package is tin-lead (SnPb). Refer to the 52 ZQL package (drawing 4204437) for lead-free.

RHA (S-PVQFN-N40)

PLASTIC QUAD FLATPACK NO-LEAD



4204276/E 06/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - 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.
 - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
 - F. Package complies to JEDEC MO-220 variation VJJD-2.

RHA (S-PVQFN-N40)

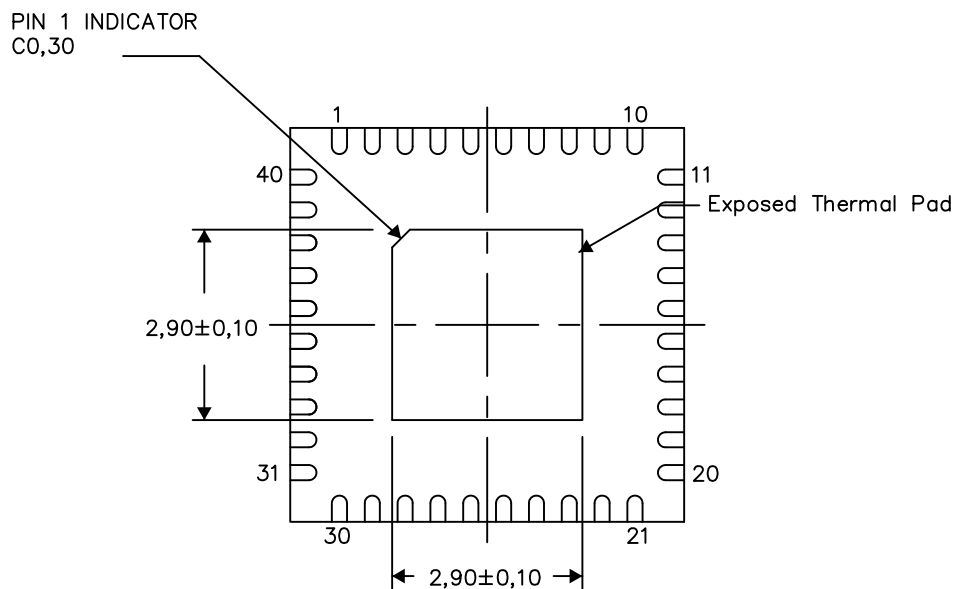
PLASTIC QUAD FLATPACK NO-LEAD

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

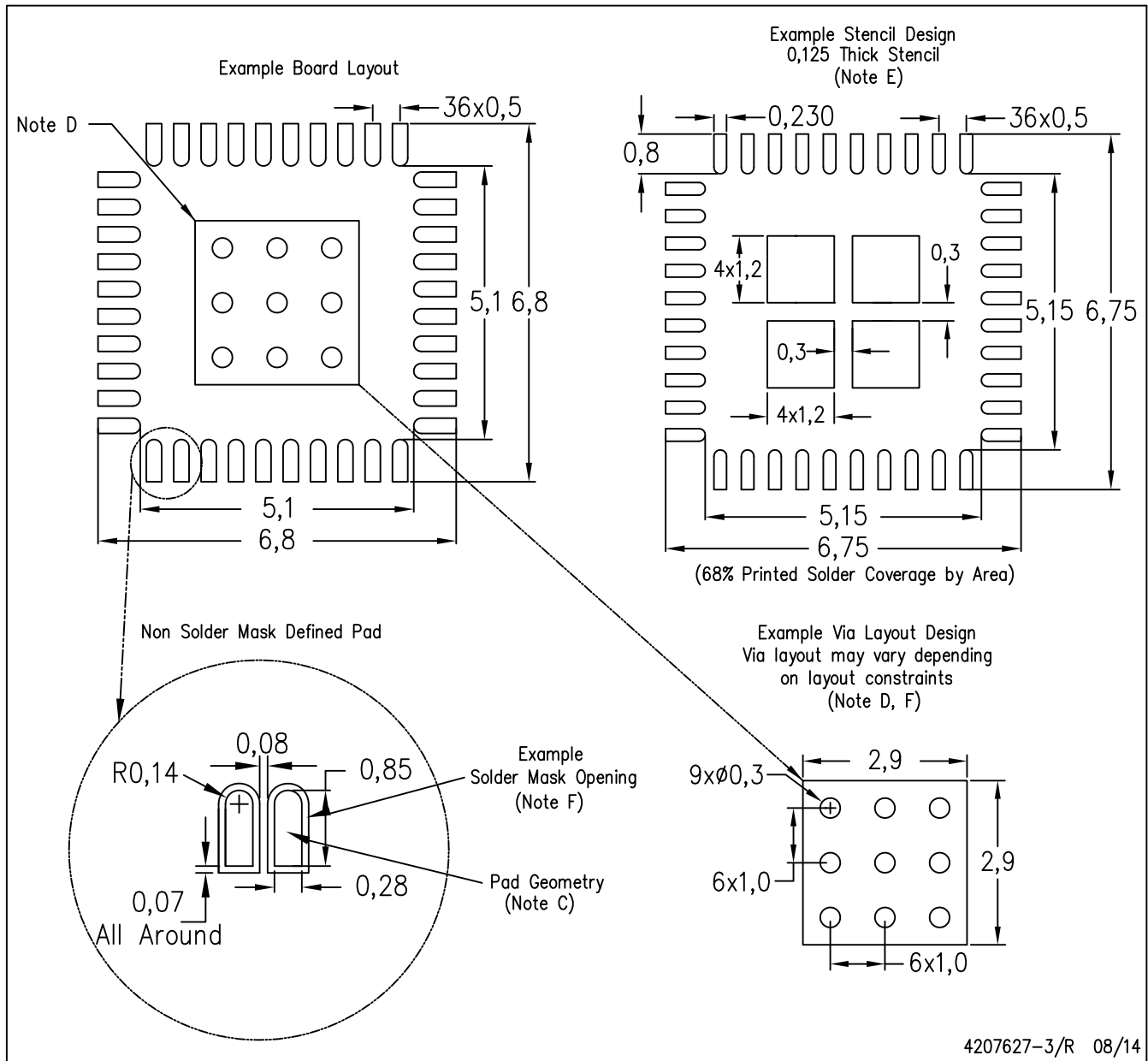
Exposed Thermal Pad Dimensions

4206355-3/X 08/14

NOTES: A. All linear dimensions are in millimeters

RHA (S-PVQFN-N40)

PLASTIC QUAD FLATPACK NO-LEAD



- 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.

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