

**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):  $\pm 30$  ps
- Low Output Skew: 35 ps
- Low Period Jitter:  $\pm 20$  ps
- Low Dynamic Phase Offset:  $\pm 15$  ps
- Low Static Phase Offset:  $\pm 50$  ps
- Distributes One Differential Clock Input to Ten Differential Outputs
- 52-Ball  $\mu$ 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<sub>DD</sub>). 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<sub>DD</sub>. 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<sub>DD</sub> 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  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

**ORDERING INFORMATION**

T <sub>A</sub>	52-BALL BGA <sup>(1)</sup>	40-Pin MLF
$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$	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](http://www.ti.com).



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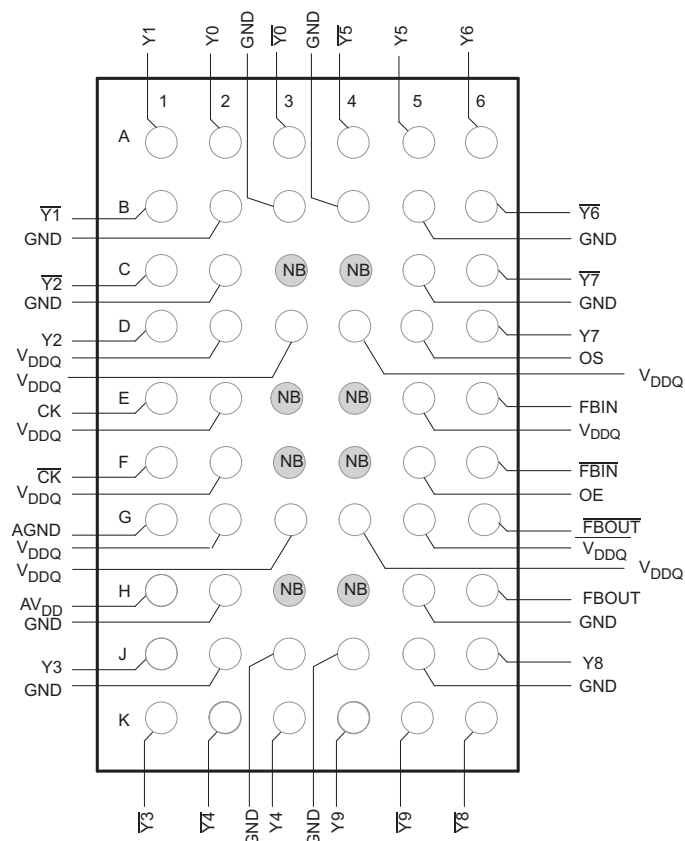
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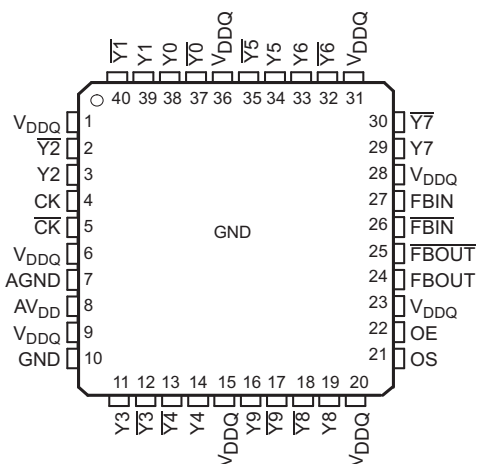
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

**MicroStar Junior (ZQL) Package  
(TOP VIEW)**



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

**RHA/RTB Package (MLF Package  
(TOP VIEW)**



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 ± 0,15 mm) Package Pinouts

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**TERMINAL FUNCTIONS**

TERMINAL		I/O	DESCRIPTION
NAME	GQL/ZQL		
AGND	G1	7	Analog ground
AV <sub>DD</sub>	H1	8	Analog power
CK	E1	4	Clock input with a (10 kΩ to 100 kΩ) pulldown resistor
$\overline{\text{CK}}$	F1	5	Complementary clock input with a (10 kΩ to 100 kΩ) pulldown resistor
FBIN	E6	27	Feedback clock input
$\overline{\text{FBIN}}$	F6	26	Complementary feedback clock input
FBOU <sub>T</sub>	H6	24	Feedback clock output
$\overline{\text{FBOU}}_{\text{T}}$	G6	25	Complementary feedback clock output
OE	F5	22	Output enable (asynchronous)
OS	D5	21	Output select (tied to GND or V <sub>DD</sub> )
GND	B2, B3, B4, B5, C2, C5, H2, H5, J2, J3, J4, J5	10	Ground
V <sub>DDQ</sub>	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	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	Complementary clock outputs

**FUNCTION TABLE**

INPUTS					OUTPUTS				
AVDD	OE	OS	CK	$\overline{\text{CK}}$	Y	$\overline{\text{Y}}$	FBOU <sub>T</sub>	$\overline{\text{FBOU}}_{\text{T}}$	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 <sub>Z</sub>	L <sub>Z</sub>	L	H	Bypassed/Off
GND	L	L	H	L	L <sub>Z</sub> Y7 Active	L <sub>Z</sub> $\overline{\text{Y7}}$ Active	H	L	Bypassed/Off
1.8 V Nominal	L	H	L	H	L <sub>Z</sub>	L <sub>Z</sub>	L	H	On
1.8 V Nominal	L	L	H	L	L <sub>Z</sub> Y7 Active	L <sub>Z</sub> $\overline{\text{Y7}}$ 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 <sub>Z</sub>	L <sub>Z</sub>	L <sub>Z</sub>	L <sub>Z</sub>	Off
X	X	X	H	H	Reserved				

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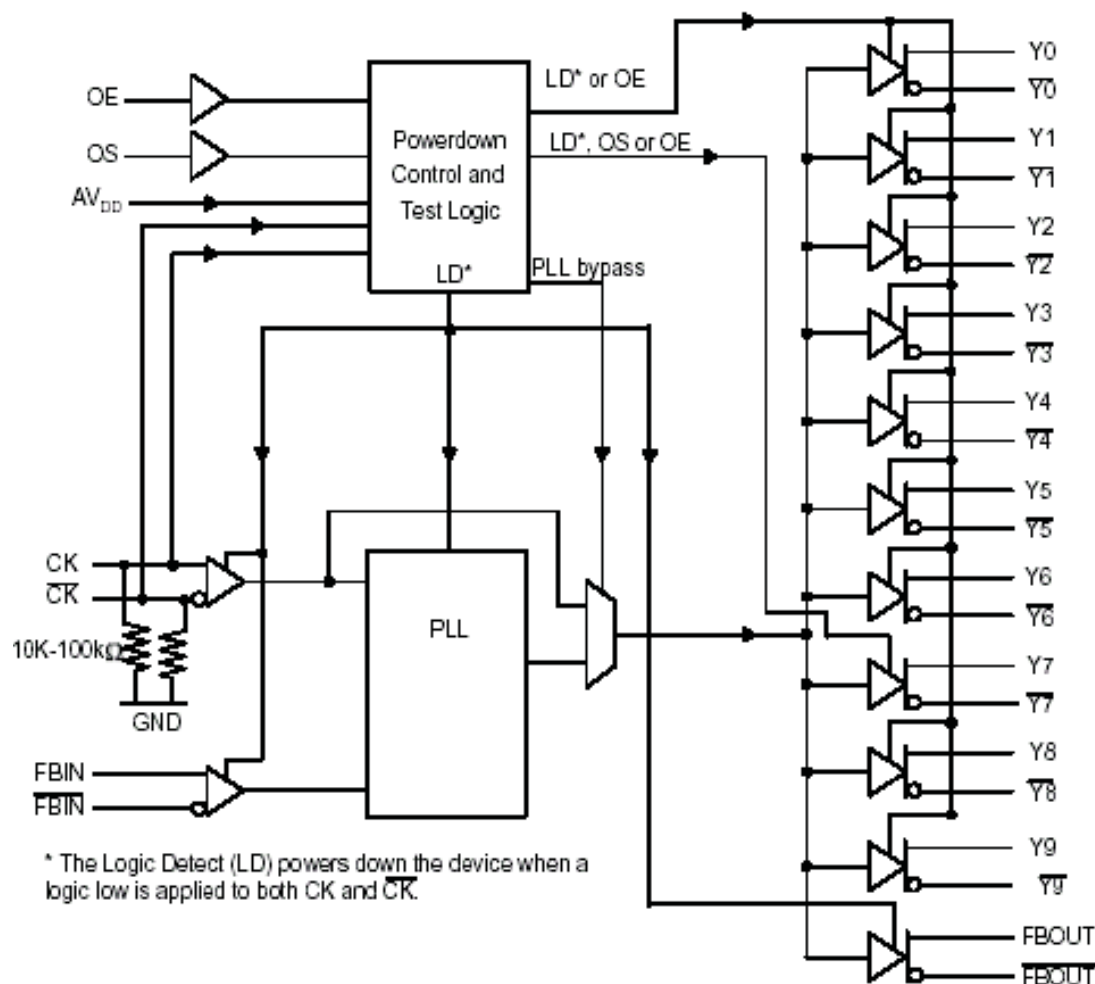


Figure 1. LOGIC DIAGRAM (POSITIVE LOGIC)

**1.8-V PHASE LOCK LOOP CLOCK DRIVER**

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**Absolute Maximum Ratings<sup>(1)</sup>**

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

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range	V <sub>DDQ</sub> or AV <sub>DD</sub>	–0.5	2.5	V
V <sub>I</sub>	Input voltage range <sup>(2)(3)</sup>		–0.5	V <sub>DDQ</sub> + 0.5	V
V <sub>O</sub>	Output voltage range <sup>(2)(3)</sup>		–0.5	V <sub>DDQ</sub> + 0.5	V
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0 or V <sub>I</sub> > V <sub>DDQ</sub>		±50	mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0 or V <sub>O</sub> > V <sub>DDQ</sub>		±50	mA
I <sub>O</sub>	Continuous output current	V <sub>O</sub> = 0 to V <sub>DDQ</sub>		±50	mA
	Continuous current through each V <sub>DDQ</sub> or GND			±100	mA
T <sub>stg</sub>	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 <sub>CC</sub>	Output supply voltage, V <sub>DDQ</sub>		1.7	1.8	1.9	V
	Supply Voltage, AV <sub>DD</sub> <sup>(1)</sup>			V <sub>DDQ</sub>		V
V <sub>IL</sub>	Low-level input voltage <sup>(2)</sup>	OE, OS			0.35 x V <sub>DDQ</sub>	V
V <sub>IH</sub>	High-level input voltage <sup>(2)</sup>	CK, $\overline{\text{CK}}$	0.65 x V <sub>DDQ</sub>			V
I <sub>OH</sub>	High-level output current (see Figure 2)				–9	mA
I <sub>OL</sub>	Low-level output current (see Figure 2)				9	mA
V <sub>IX</sub>	Input differential-pair cross voltage		(V <sub>DDQ</sub> /2) – 0.15		(V <sub>DDQ</sub> /2) + 0.15	V
V <sub>I</sub>	Input voltage level		–0.3		V <sub>DDQ</sub> + 0.3	V
V <sub>ID</sub>	Input differential voltage <sup>(2)</sup> (see Figure 9)	DC	0.3		V <sub>DDQ</sub> + 0.4	V
		AC	0.6		V <sub>DDQ</sub> + 0.4	V
T <sub>A</sub>	Operating free-air temperature		–40		85	°C

- (1) The PLL is turned off and bypassed for test purposes when AV<sub>DD</sub> is grounded. During this test mode, V<sub>DDQ</sub> remains within the recommended operating conditions and no timing parameters are specified.
- (2) V<sub>ID</sub> 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<sub>IH</sub> and V<sub>IL</sub> 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	$V_{DD}, V_{DDQ}$	MIN	TYP <sup>(1)</sup>	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			$\mu\text{A}$
$V_{OD}$	Differential output voltage <sup>(1)</sup>		1.7	0.5			V
$I_I$	Input current	CK, $\overline{\text{CK}}$	1.9			$\pm 250$	$\mu\text{A}$
		OE, OS, FBIN, $\overline{\text{FBIN}}$	1.9			$\pm 10$	
$I_{DD(LD)}$	Supply current, static ( $I_{DDQ} + I_{ADD}$ )	CK and $\overline{\text{CK}} = L$	1.9			500	$\mu\text{A}$
$I_{DD}$	Supply current, dynamic ( $I_{DDQ} + I_{ADD}$ ) (see Note <sup>(2)</sup> 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- $\Omega$ termination resistor	1.9			235	
$C_I$	Input capacitance	CK, $\overline{\text{CK}}$	$V_I = V_{DD}$ or GND	1.8	2	3	pF
		FBIN, $\overline{\text{FBIN}}$		1.8	2	3	
$C_{I(\Delta)}$	Change in input current	CK, $\overline{\text{CK}}$	$V_I = V_{DD}$ or GND	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)<sup>(1)</sup>

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

(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 <sup>(1)</sup>)  $AV_{DD}$ ,  $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$ 

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 <sup>(2)</sup>	160 MHz to 190 MHz, see Figure 4	0		40	ps
$t_{jit(cc-)}$			0		-40	
$t_{jit(cc+)}$	Cycle-to-cycle period jitter <sup>(2)</sup>	160 MHz to 340 MHz, see Figure 4	0		30	ps
$t_{jit(cc-)}$			0		-30	
$t_{(w)}$	Static phase offset time <sup>(3)</sup>	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 <sup>(4)(2)</sup>	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 <sup>(4)(2)</sup>	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 <sup>(5)(6)</sup> (no load)	See Figure 3 and Figure 9	1.5	2.5	3	
$V_{OX}$	Output differential-pair cross voltage <sup>(7)</sup>	CDCU877, See Figure 2	$(V_{DDQ}/2) - 0.1$		$(V_{DDQ}/2) + 0.1$	V
		CDCU877A <sup>(8)</sup> , 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

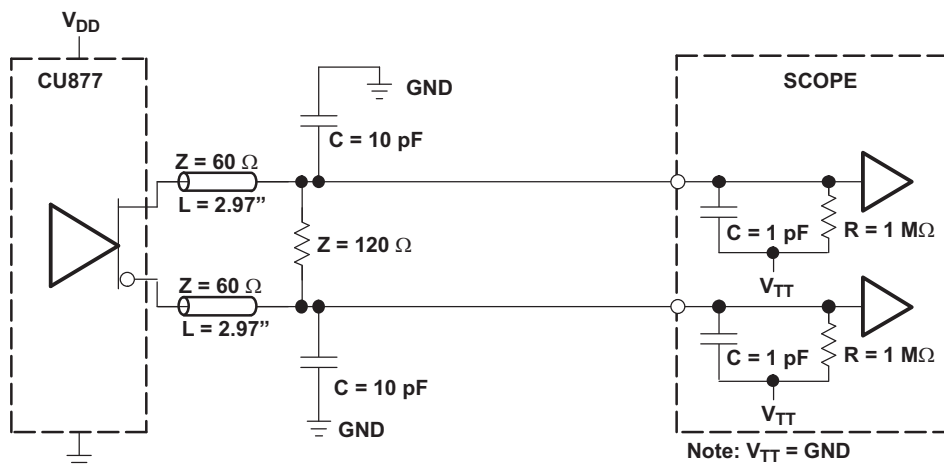


Figure 2. Output Load Test Circuit 1

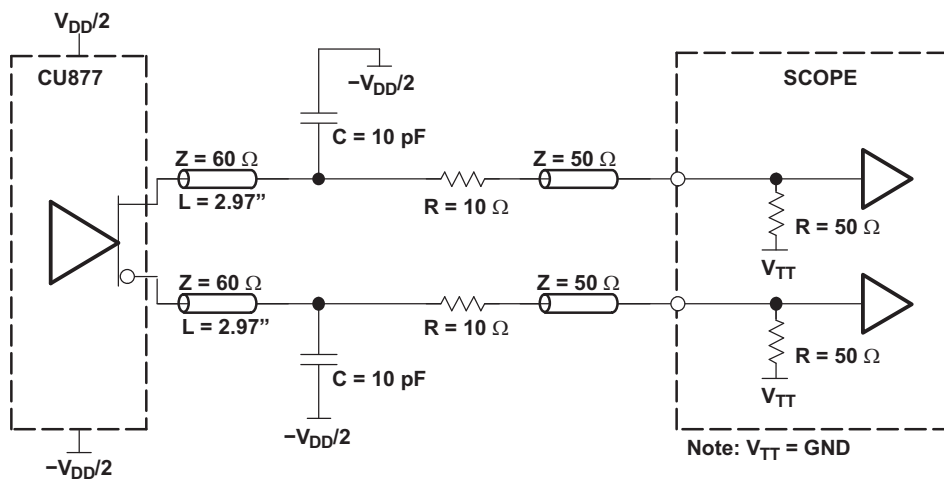


Figure 3. Output Load Test Circuit 2

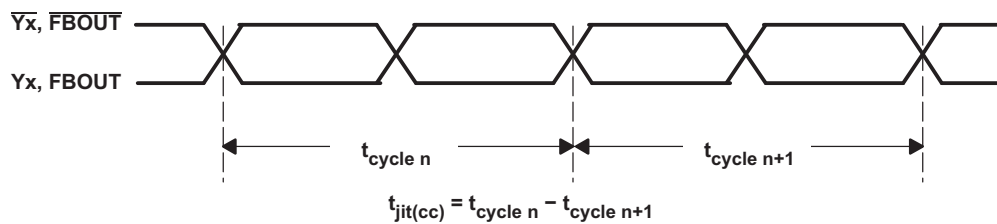


Figure 4. Cycle-To-Cycle Period Jitter



PARAMETER MEASUREMENT INFORMATION (continued)

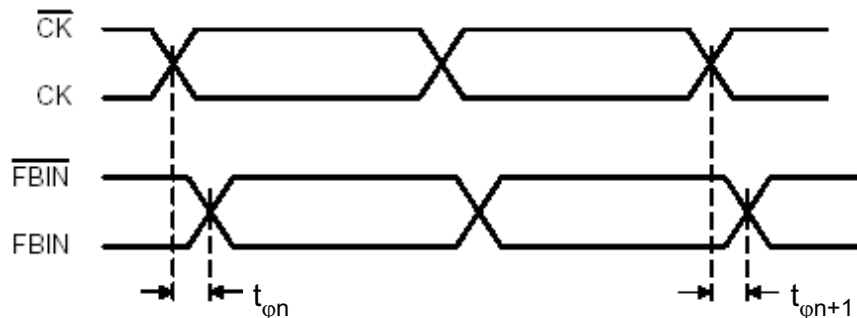


Figure 5. Static Phase Offset

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

(N is the large number of samples)

(N > 1000 samples)

(1)

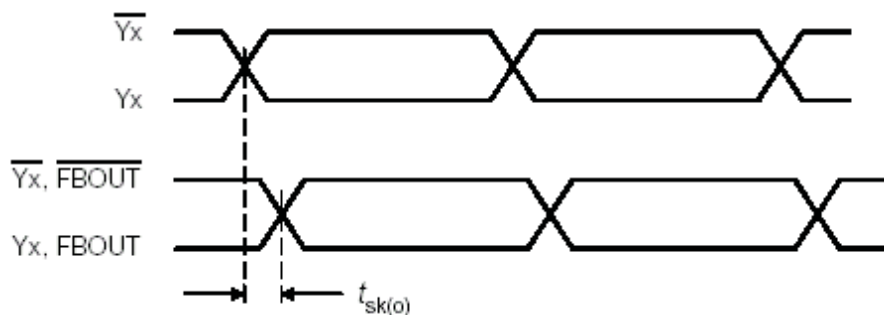


Figure 6. Output Skew

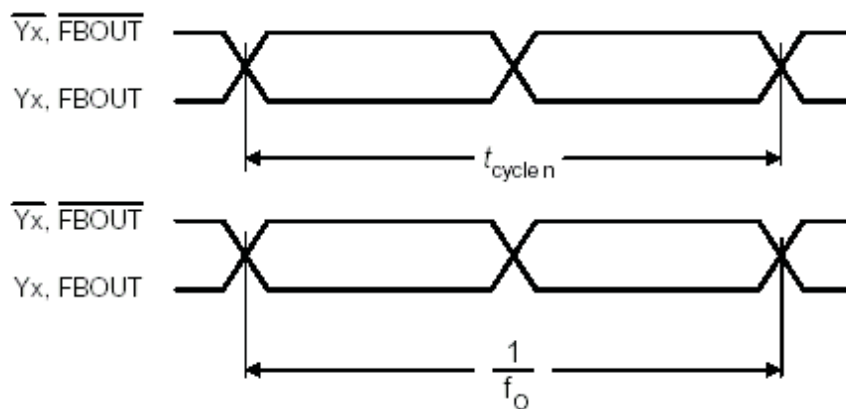


Figure 7. Period Jitter

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

( $f_o$  average input frequency measured at CK/CK-bar)

(2)

## PARAMETER MEASUREMENT INFORMATION (continued)

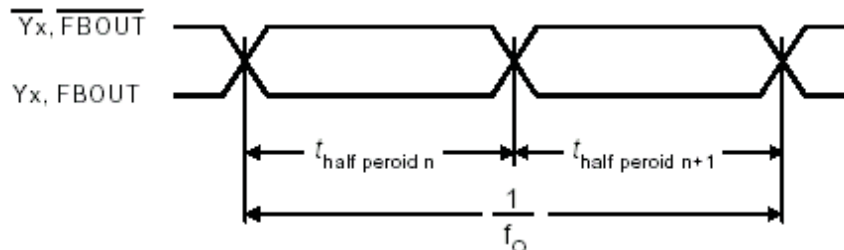


Figure 8. Half-Period Jitter

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

n = any half cycle

(f<sub>O</sub> average input frequency measured at CK/ $\overline{CK}$ )

(3)

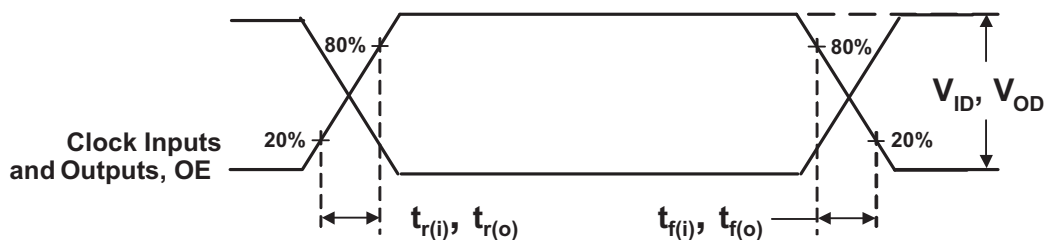


Figure 9. Input and Output Slew Rates

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

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

(4)

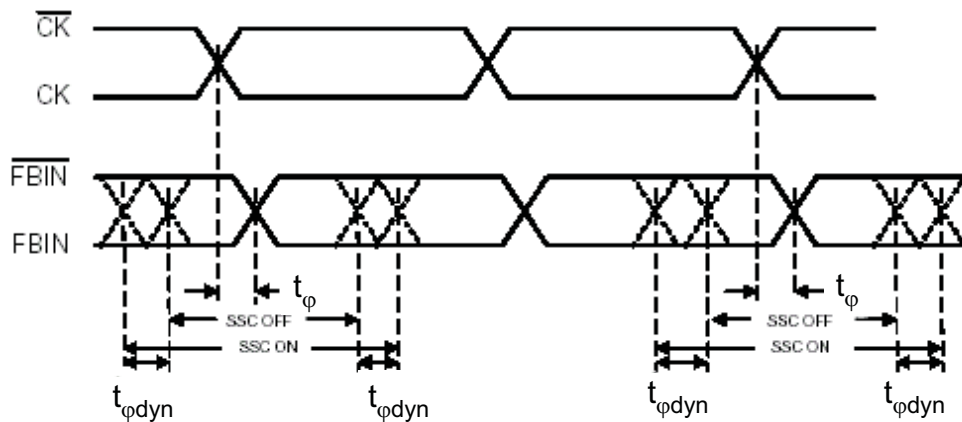


Figure 10. Dynamic Phase Offset

PARAMETER MEASUREMENT INFORMATION (continued)

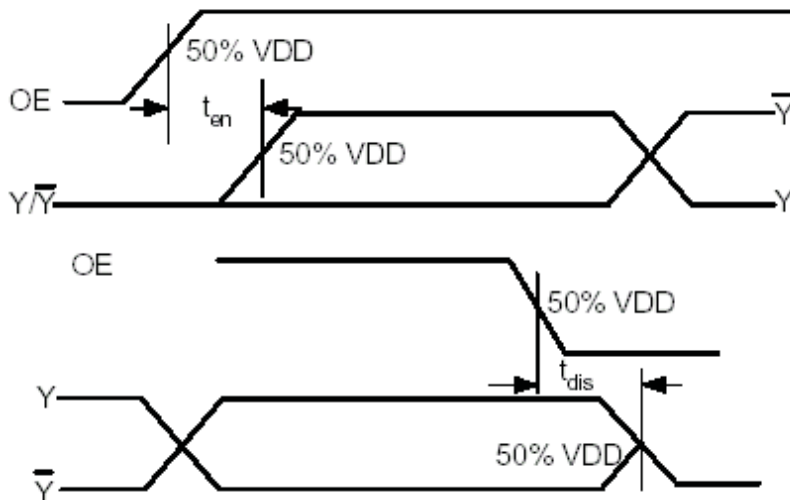
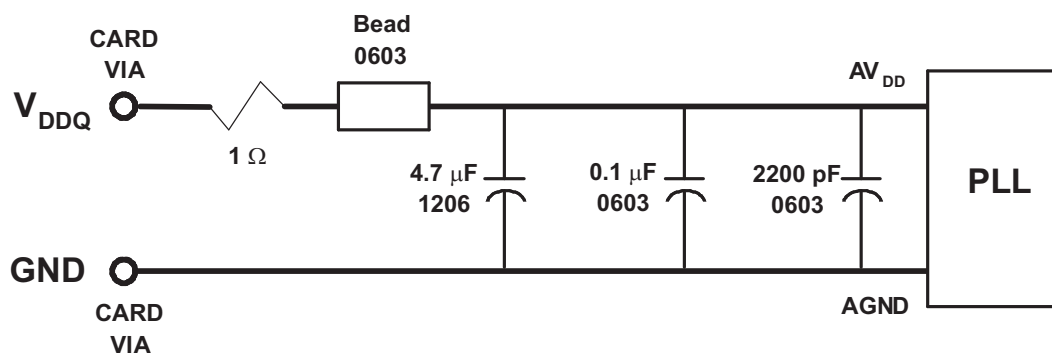


Figure 11. Time Delay Between OE and Clock Output (Y,  $\bar{Y}$ )

RECOMMENDED AV<sub>DD</sub> 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 Ω dc maximum, 600 Ω at 100 MHz).

Figure 12. Recommended AV<sub>DD</sub> Filtering

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CDCU877ANMKR	ACTIVE	NFBGA	NMK	52	1000	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	CDCU877A	<a href="#">Samples</a>
CDCU877ANMKT	ACTIVE	NFBGA	NMK	52	250	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	CDCU877A	<a href="#">Samples</a>
CDCU877ARHAR	ACTIVE	VQFN	RHA	40	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877A	<a href="#">Samples</a>
CDCU877ARHARG4	ACTIVE	VQFN	RHA	40	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877A	<a href="#">Samples</a>
CDCU877ARHAT	ACTIVE	VQFN	RHA	40	250	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877A	<a href="#">Samples</a>
CDCU877AZQLR	NRND	BGA MICROSTAR JUNIOR	ZQL	52	1000	RoHS & Green	SNAGCU	Level-2-260C-1 YEAR	-40 to 85	CDCU877A	
CDCU877AZQLT	NRND	BGA MICROSTAR JUNIOR	ZQL	52	250	RoHS & Green	SNAGCU	Level-2-260C-1 YEAR	-40 to 85	CDCU877A	
CDCU877RHAR	ACTIVE	VQFN	RHA	40	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	<a href="#">Samples</a>
CDCU877RHARG4	ACTIVE	VQFN	RHA	40	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	<a href="#">Samples</a>
CDCU877RHAT	ACTIVE	VQFN	RHA	40	250	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	<a href="#">Samples</a>
CDCU877RHATG4	ACTIVE	VQFN	RHA	40	250	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	<a href="#">Samples</a>
CDCU877RTBR	ACTIVE	VQFN	RHA	40	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	CDCU877	<a href="#">Samples</a>

(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  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

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

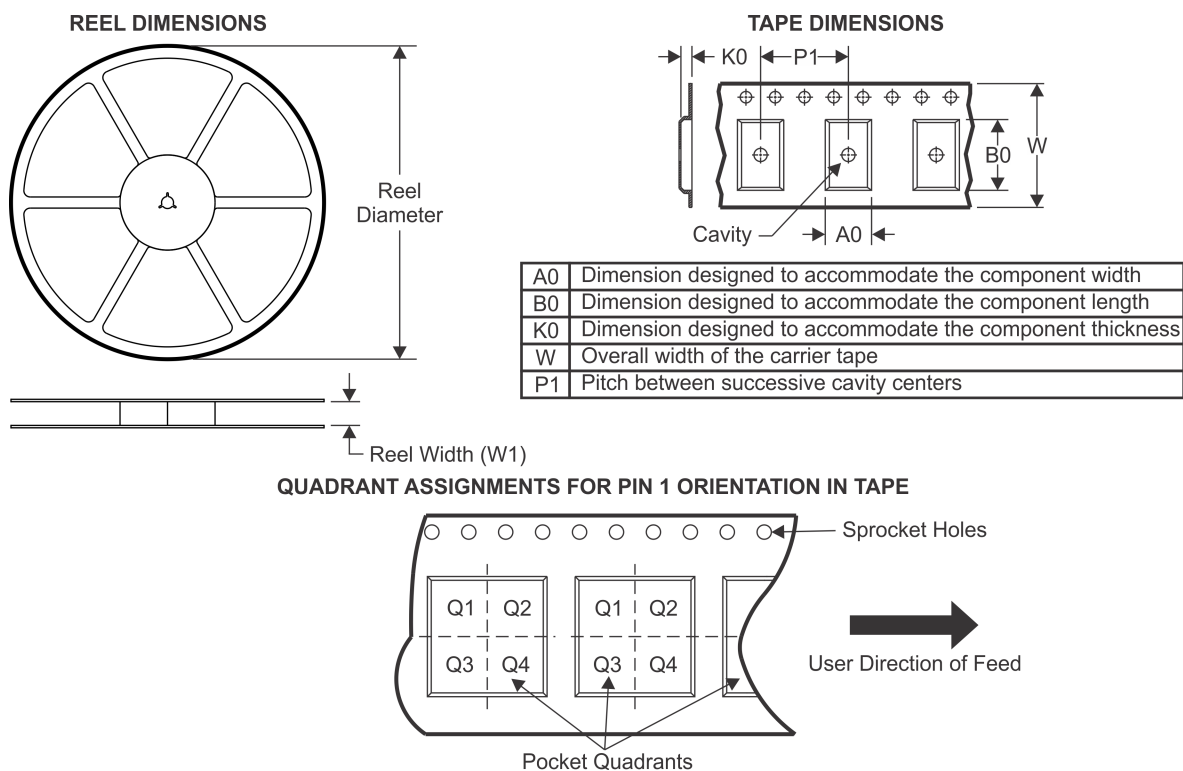
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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 finish/Ball material - Orderable Devices 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.

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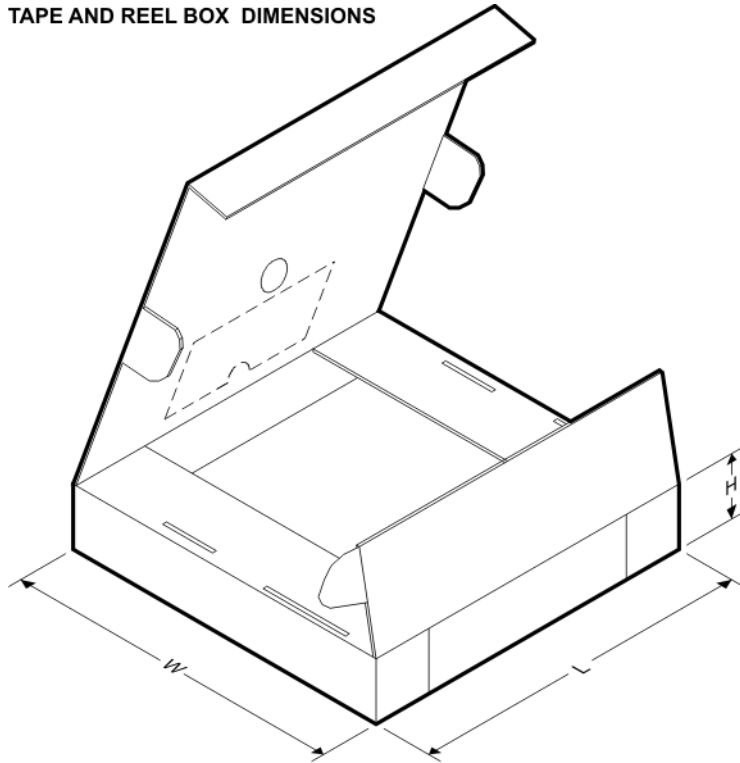
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

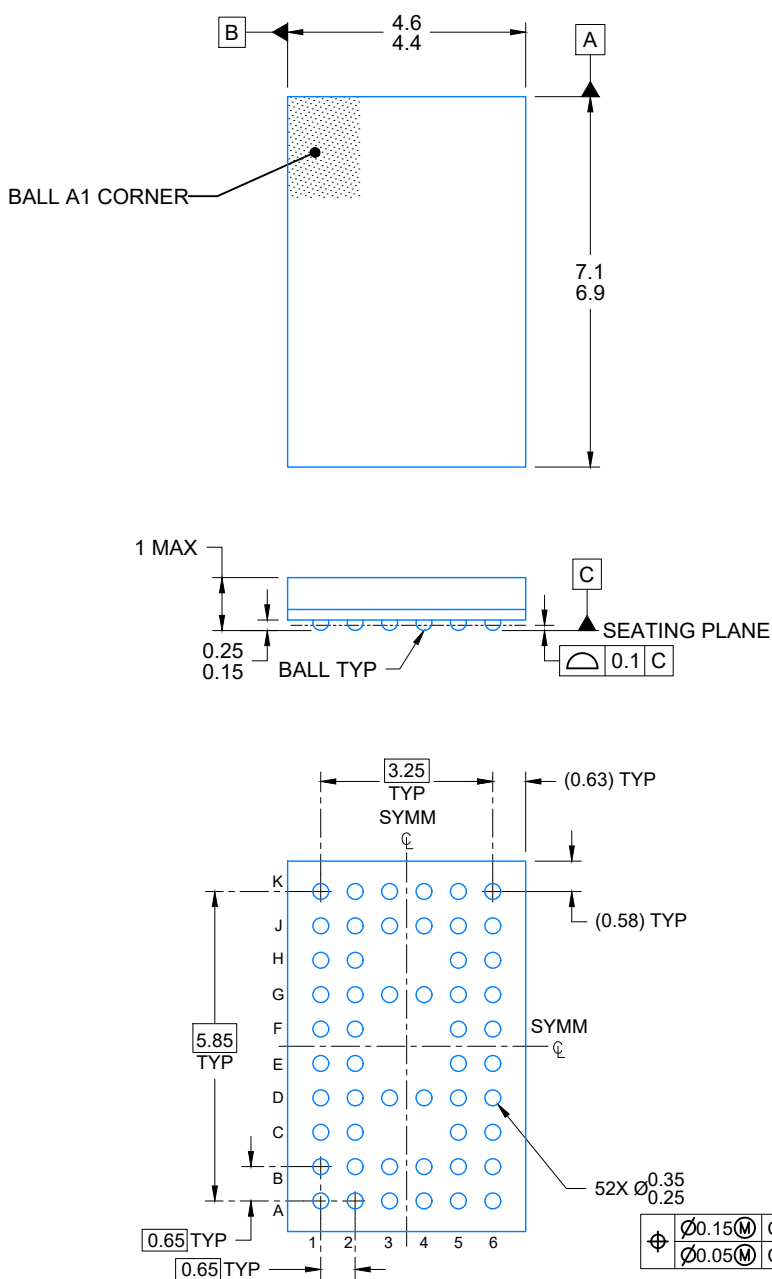
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CDCU877ANMKR	NFBGA	NMK	52	1000	330.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1
CDCU877ANMKT	NFBGA	NMK	52	250	180.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1
CDCU877ARHAR	VQFN	RHA	40	2500	330.0	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
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

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CDCU877ANMKR	NFBGA	NMK	52	1000	336.6	336.6	28.6
CDCU877ANMKT	NFBGA	NMK	52	250	213.0	191.0	55.0
CDCU877ARHAR	VQFN	RHA	40	2500	853.0	449.0	35.0
CDCU877ARHAT	VQFN	RHA	40	250	853.0	449.0	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
CDCU877RHAR	VQFN	RHA	40	2500	853.0	449.0	35.0
CDCU877RHAT	VQFN	RHA	40	250	853.0	449.0	35.0



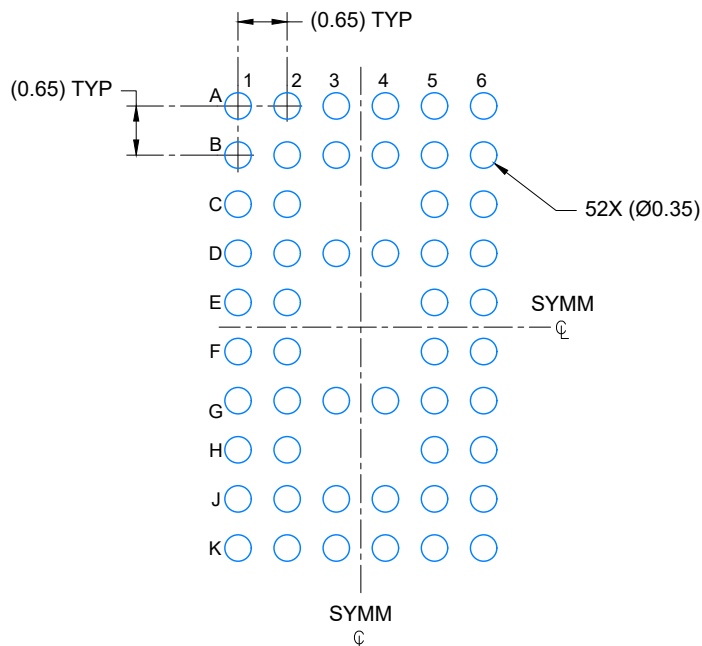
4225135/A 08/2019

NOTES:

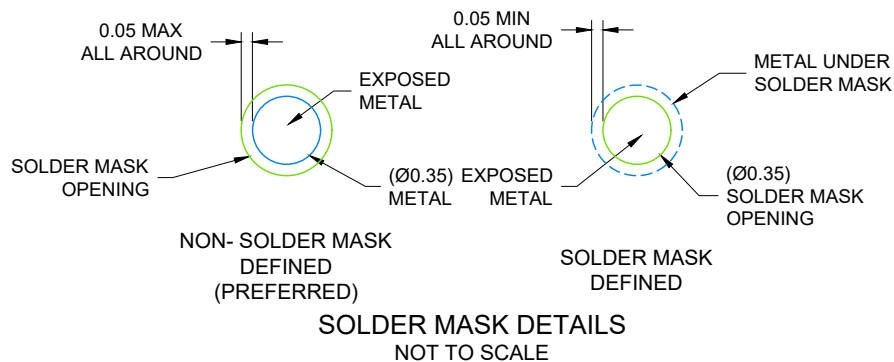
NanoFree is a trademark of Texas Instruments.

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.





LAND PATTERN EXAMPLE  
SCALE: 10X



SOLDER MASK DETAILS  
NOT TO SCALE

4225135/A 08/2019

NOTES: (continued)

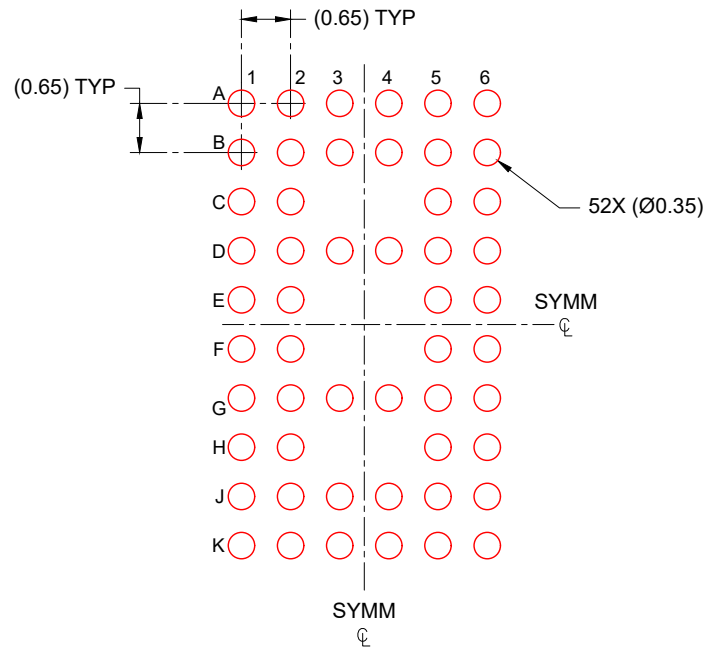
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. Refer to Texas Instruments Literature number SNVA009 ([www.ti.com/lit/snva009](http://www.ti.com/lit/snva009)).

# EXAMPLE STENCIL DESIGN

NMK0052A

NFBGA - 1 mm max height

PLASTIC BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

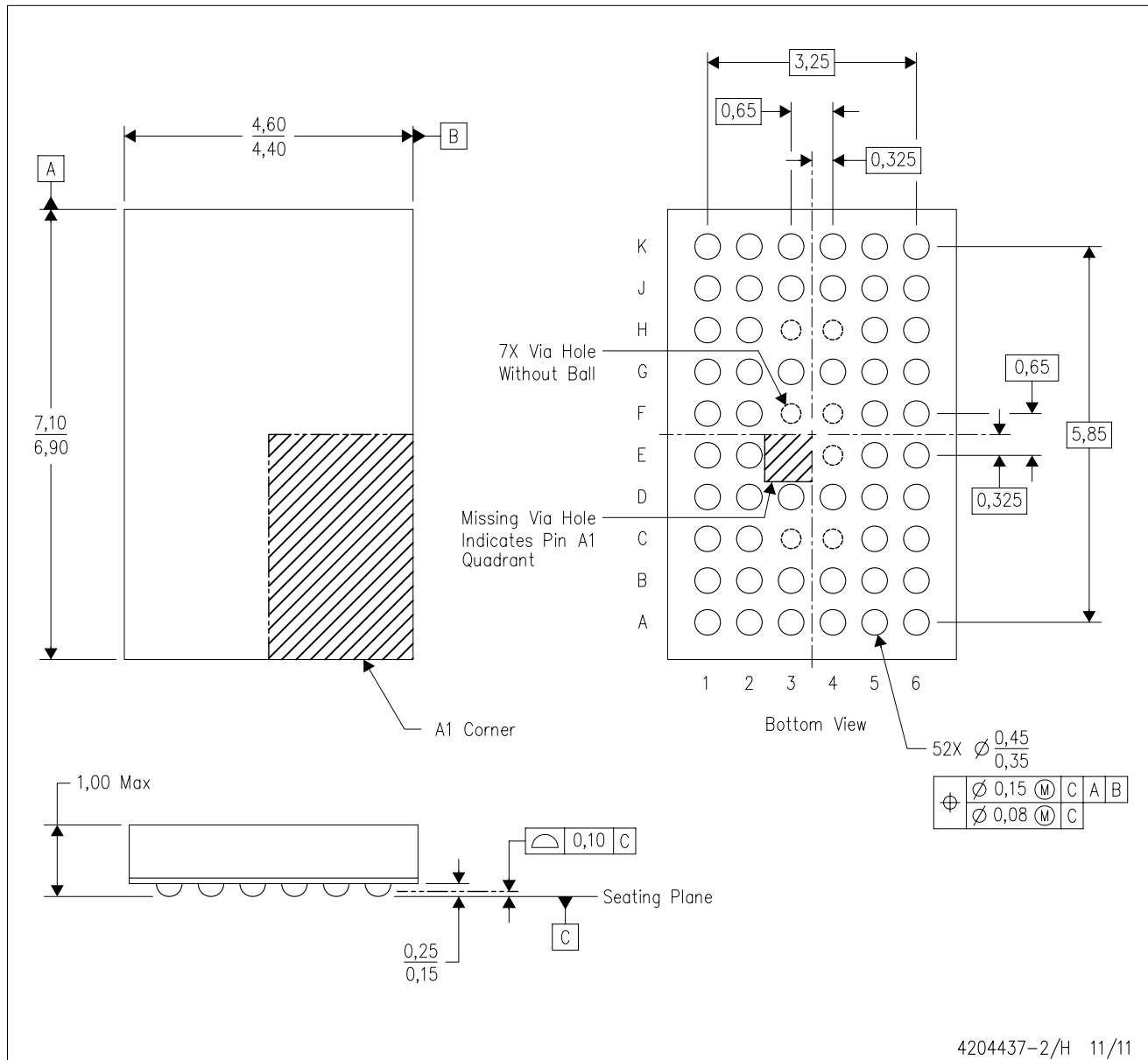
4225135/A 08/2019

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

ZQL (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 Pb-free. Refer to the 52 GQL package (drawing 4200583) for tin-lead (SnPb).

## GENERIC PACKAGE VIEW

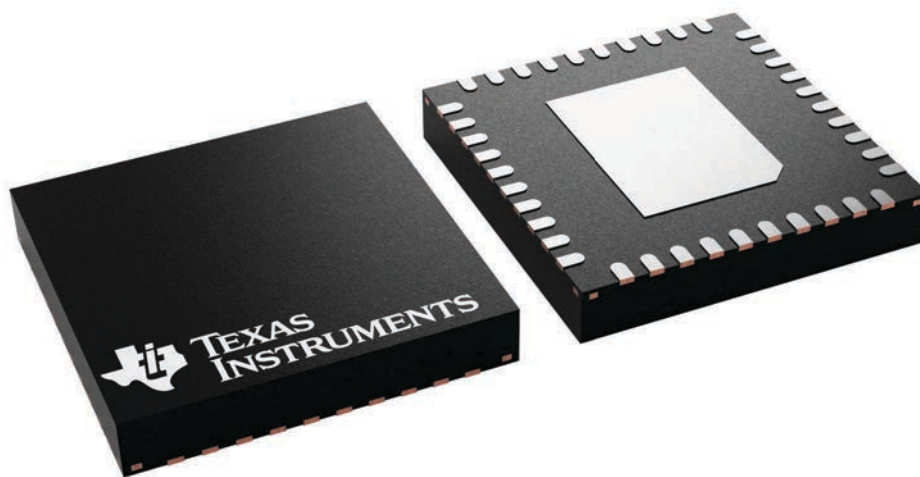
**RHA 40**

**VQFN - 1 mm max height**

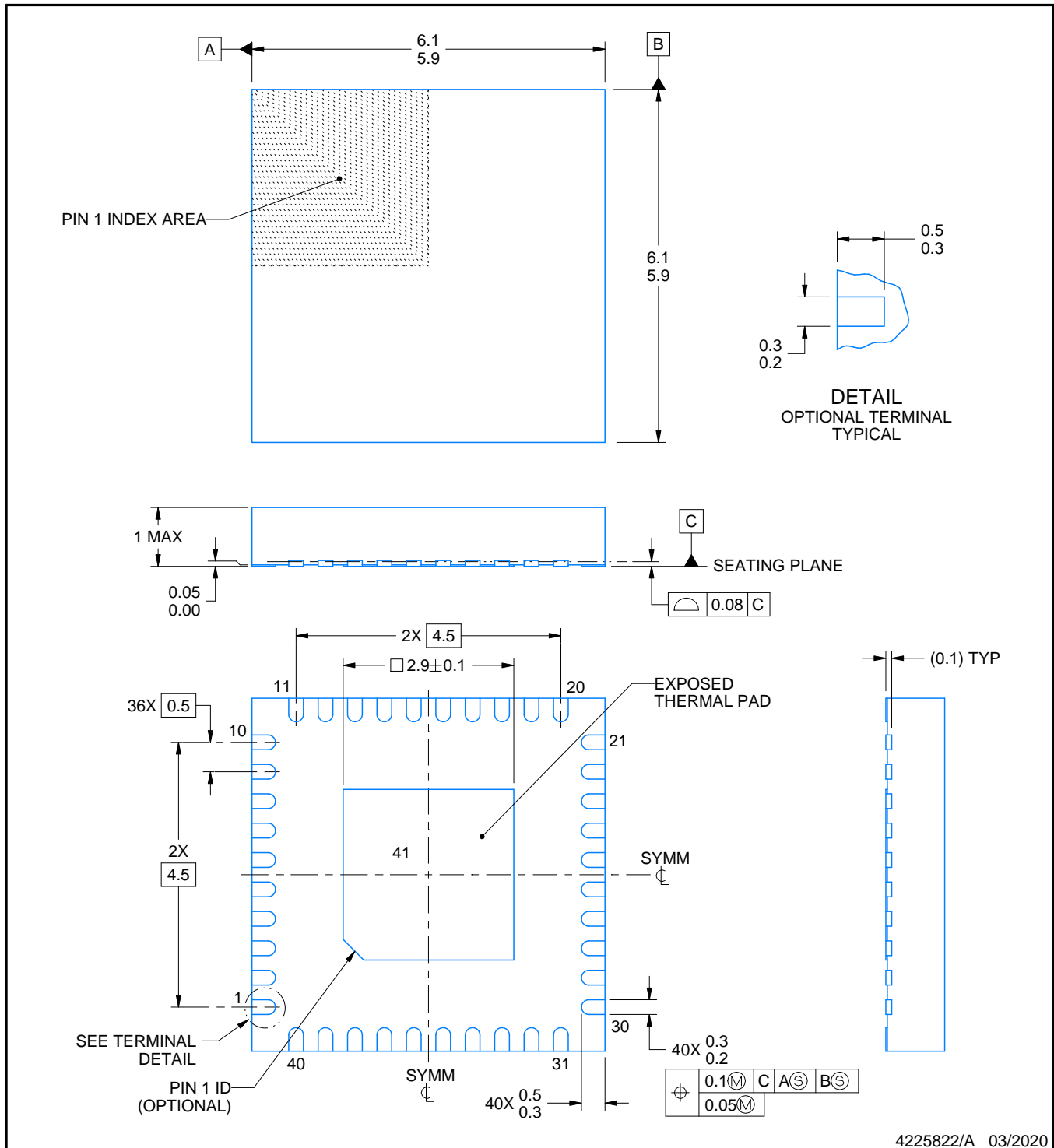
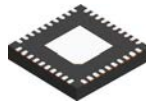
6 x 6, 0.5 mm pitch

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.



4225870/A



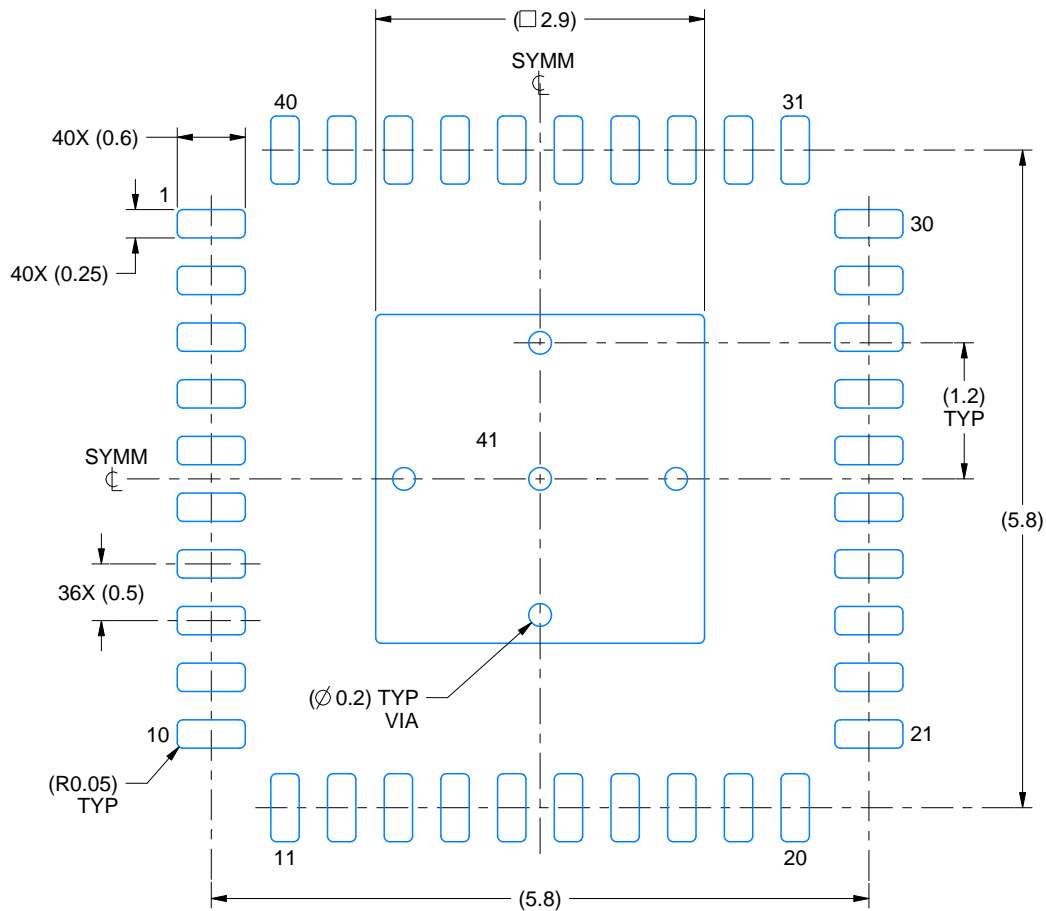
## NOTES:

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.

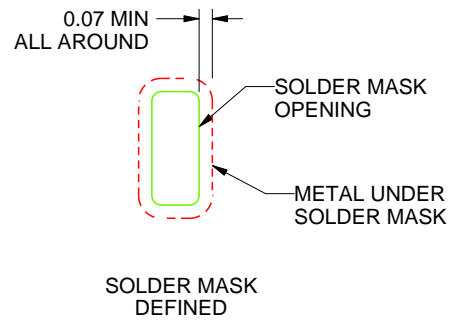
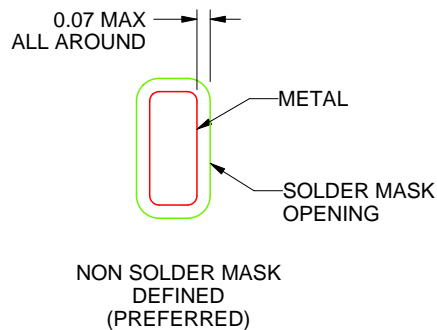
# RHA0040D

## VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:15X



## SOLDER MASK DETAILS

4225822/A 03/2020

NOTES: (continued)

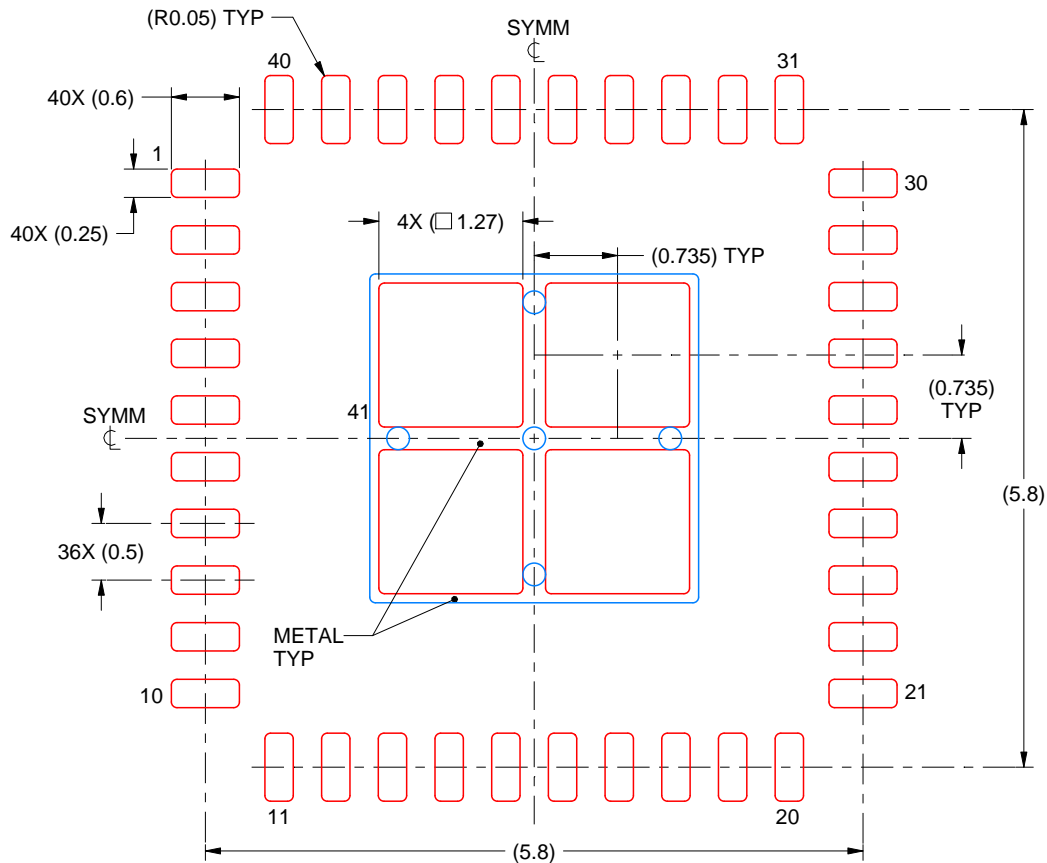
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sl原因271](http://www.ti.com/lit/sl原因271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view.

# EXAMPLE STENCIL DESIGN

RHA0040D

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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

EXPOSED PAD 41:  
76.46% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:15X

4225822/A 03/2020

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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