SN54ABTH32316, SN74ABTH32316
16-BIT TRI-PORT UNIVERSAL BUS EXCHANGERS

- **Members of the Texas Instruments *Widebus+*™ Family**

- **State-of-the-Art *EPIC*-II*B*™ BiCMOS Design Significantly Reduces Power Dissipation**

- ***UBE*™ (Universal Bus Exchanger) Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, Clocked, or Clock-Enabled Mode**

- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015**

- **Latch-Up Performance Exceeds 500 mA Per JEDEC Standard JESD-17**

- **Typical V_{OLP} (Output Ground Bounce) < 0.8 V at V_{CC} = 5 V, T_A = 25°C**

- **High-Impedance State During Power Up and Power Down**

- **Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise**

- **High-Drive Outputs (–32-mA I_{OH}, 64-mA I_{OL})**

- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**

- **Package Options Include 80-Pin Plastic Thin Quad Flat (PN) Package With 12 × 12-mm Body Using 0.5-mm Lead Pitch and 84-Pin Ceramic Quad Flat (HT) Package**

'ABTH32316 . . . PN PACKAGE
(TOP VIEW)
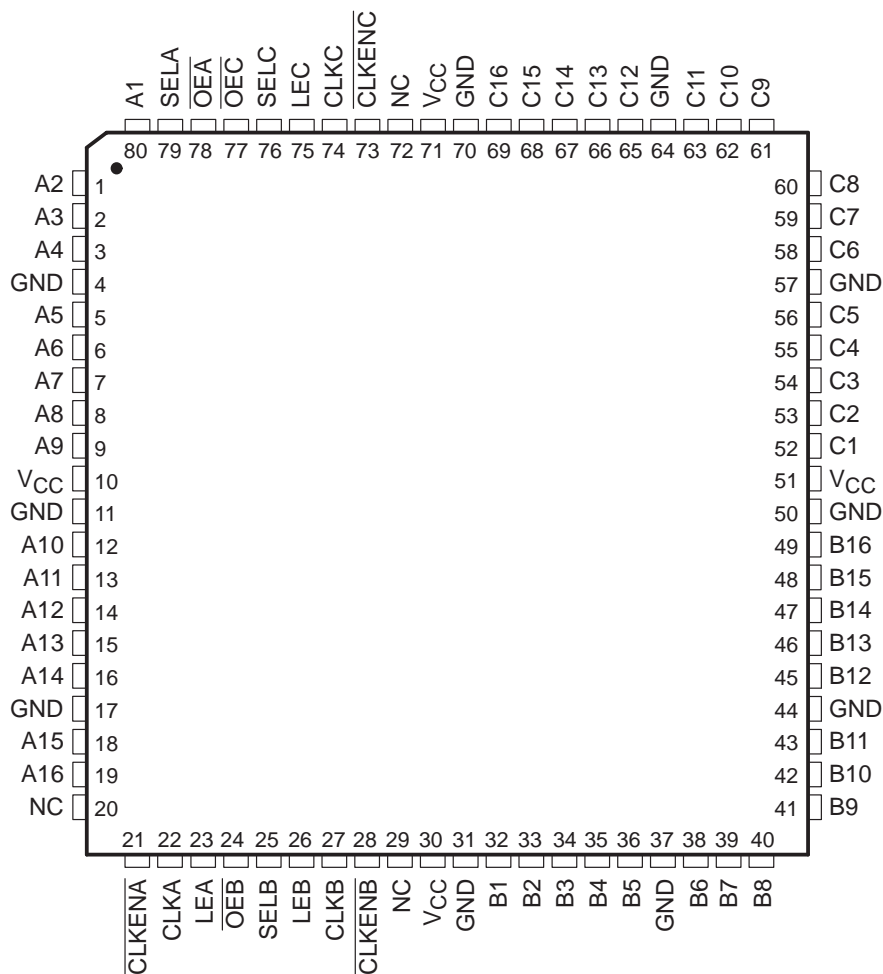
NC – No internal connection

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TEXAS INSTRUMENTS

SN54ABTH32316 . . . HT PACKAGE
(TOP VIEW)
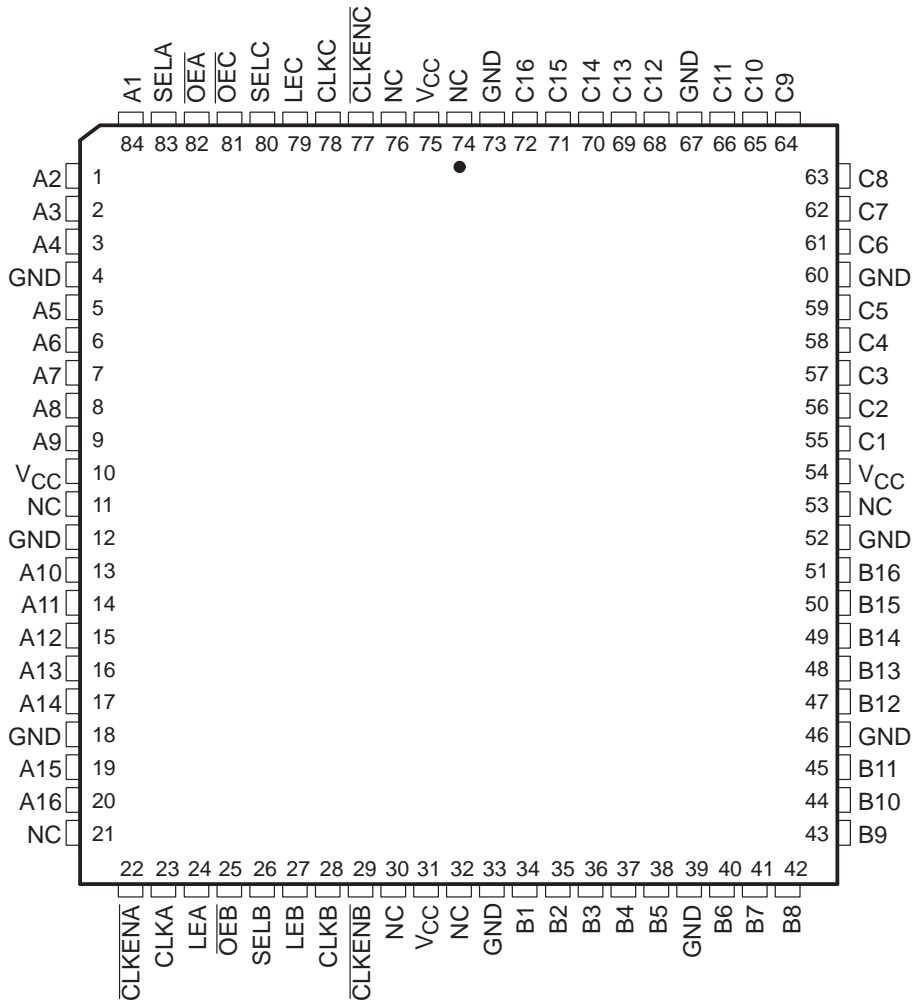
NC – No internal connection

description

The 'ABTH32316 consist of three 16-bit registered input/output (I/O) ports. These registers combine D-type latches and flip-flops to allow data flow in transparent, latch, and clock modes. Data from one input port can be exchanged to one or more of the other ports. Because of the universal storage element, multiple combinations of real-time and stored data can be exchanged among the three ports.

Data flow in each direction is controlled by the output-enable ($\overline{OEA}$, $\overline{OEB}$, and $\overline{OEC}$), select-control (SELA, SELB, and SELC), latch-enable (LEA, LEB, and LEC), and clock (CLKA, CLKB, and CLKC) inputs. The A data register operates in the transparent mode when LEA is high. When LEA is low, data is latched if CLKA is held at a high or low logic level. If LEA and clock-enable A ($\overline{CLKENA}$) are low, data is stored on the low-to-high transition of CLKA. Output data selection is accomplished by the select-control pins. All three ports have active-low output enables, so when the output-enable input is low, the outputs are active; when the output-enable input is high, the outputs are in the high-impedance state.

When V_{CC} is between 0 and 2.1 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 2.1 V, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

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description (continued)

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

The SN54ABTH32316 is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74ABTH32316 is characterized for operation from –40°C to 85°C.

Function Tables

STORAGE[†]

INPUTS				OUTPUT
$\overline{\text{CLKENA}}$	CLKA	LEA	A	
H	X	L	X	Q_0[‡]
L	↑	L	L	L
L	↑	L	H	H
X	H	L	X	Q_0[‡]
X	L	L	X	Q_0[‡]
X	X	H	L	L
X	X	H	H	H

[†] A-port register shown. B and C ports are similar but use $\overline{\text{CLKENB}}$, $\overline{\text{CLKENC}}$, CLKB, CLKC, LEB, and LEC.

[‡] Output level before the indicated steady-state input conditions were established

A-PORT OUTPUT

INPUTS		OUTPUT A
$\overline{\text{OEA}}$	SELA	
H	X	Z
L	H	Output of C register
L	L	Output of B register

B-PORT OUTPUT

INPUTS		OUTPUT B
$\overline{\text{OEB}}$	SELB	
H	X	Z
L	H	Output of A register
L	L	Output of C register

C-PORT OUTPUT

INPUTS		OUTPUT C
$\overline{\text{OEC}}$	SELC	
H	X	Z
L	H	Output of B register
L	L	Output of A register

TEXAS INSTRUMENTS

logic diagram (positive logic)
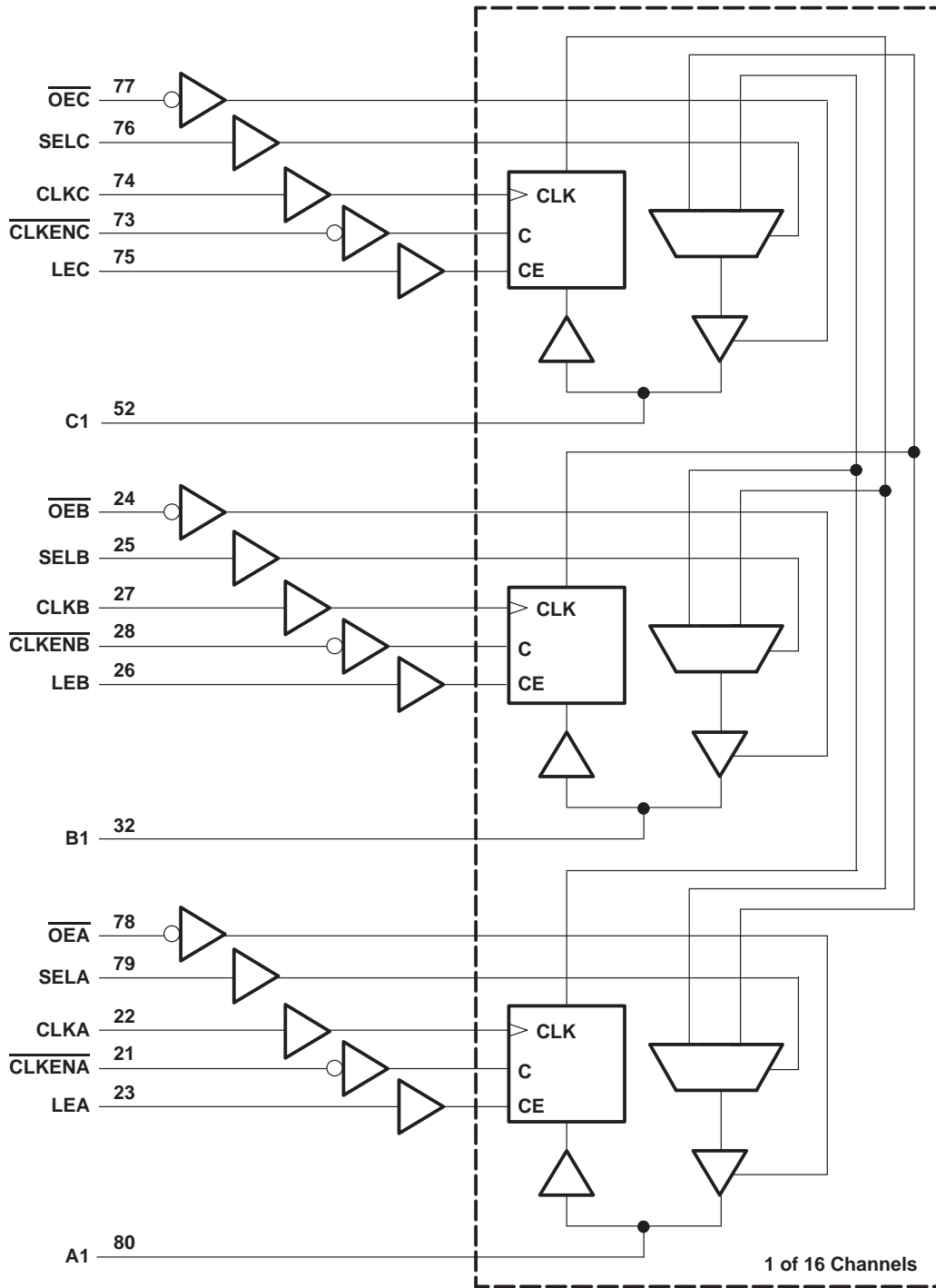
Pin numbers shown are for the PN package.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC} .... –0.5 V to 7 V
Input voltage range, V_I (except I/O ports) (see Note 1) .... –0.5 V to 7 V
Voltage range applied to any output in the high or power-off state, V_O .... –0.5 V to 5.5 V
Current into any output in the low state, I_O: SN54ABTH32316 .... 96 mA
SN74ABTH32316 .... 128 mA
Input clamp current, I_{IK} ($V_I < 0$) .... –18 mA
Output clamp current, I_{OK} ($V_O < 0$) .... –50 mA
Package thermal impedance, θ_{JA} (see Note 2): PN package .... 62°C/W
Storage temperature range, T_{stg} .... –65°C to 150°C

† 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.

NOTES: 1.   The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
 2.   The package thermal impedance is calculated in accordance with EIA/JEDEC Std JESD51.

recommended operating conditions (see Note 3)

			SN54ABTH32316		SN74ABTH32316		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		4.5	5.5	4.5	5.5	V
V_{IH}	High-level input voltage		2		2		V
V_{IL}	Low-level input voltage			0.8		0.8	V
V_I	Input voltage		0	V_{CC}	0	V_{CC}	V
I_{OH}	High-level output current			–24		–32	mA
I_{OL}	Low-level output current			48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200		200		µs/V
T_A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 3:   Unused control pins must be held high or low to prevent them from floating.

TEXAS INSTRUMENTS

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

PARAMETER		TEST CONDITIONS		SN54ABTH32316			SN74ABTH32316			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 4.5 V,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}		V_{CC} = 4.5 V,	I_{OH} = −3 mA	2.5			2.5			V
		V_{CC} = 5 V,	I_{OH} = −3 mA	3			3			
		V_{CC} = 4.5 V	I_{OH} = −24 mA	2						
			I_{OH} = −32 mA				2			
V_{OL}		V_{CC} = 4.5 V	I_{OL} = 48 mA			0.55				V
			I_{OL} = 64 mA						0.55	
V_{hys}					100			100		mV
I_I	Control inputs	V_{CC} = 0 to 5.5 V,	V_I = V_{CC} or GND			±1			±1	µA
	A, B, or C ports	V_{CC} = 2.1 V to 5.5 V,	V_I = V_{CC} or GND			±100			±20	
$I_{I(hold)}$	A, B, or C ports	V_{CC} = 4.5 V	V_I = 0.8 V	100			100			µA
			V_I = 2 V	−100			−100			
I_{OZPU}‡		V_{CC} = 0 to 2.1 V, V_O = 0.5 V to 2.7 V, $\overline{OE}$ = X				±50			±50	µA
I_{OZPD}‡		V_{CC} = 2.1 V to 0, V_O = 0.5 V to 2.7 V, $\overline{OE}$ = X				±50			±50	µA
I_{off}		V_{CC} = 0,	V_I or V_O ≤ 4.5 V			±100			±100	µA
I_{CEX}		V_{CC} = 5.5 V, V_O = 5.5 V	Outputs high			50			50	µA
I_O§		V_{CC} = 5.5 V,	V_O = 2.5 V	−50	−100	−180	−50	−100	−180	mA
I_{CC}		V_{CC} = 5.5 V, I_O = 0, V_I = V_{CC} or GND	Outputs high			2			2	mA
			Outputs low			40			40	
			Outputs disabled			1			1	
ΔI_{CC}¶		V_{CC} = 5.5 V, One input at 3.4 V, Other inputs at V_{CC} or GND				1			0.5	mA
C_i	Control inputs	V_I = 2.5 V or 0.5 V			3			3		pF
C_{io}	A, B, or C ports	V_O = 2.5 V or 0.5 V			11.5			11.5		pF

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ This parameter is specified by characterization.
§ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.
¶ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

|			SN54ABTH32316		SN74ABTH32316		UNIT
			MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		0	150	0	150	MHz
t_w	Pulse duration	LE high	3.3		3.3		ns
		CLK high or low	3.3		3.3		
t_{su}	Setup time	A, B, or C before CLK↑	2.6		2.4		ns
		A or B before LE↓	2.5		2.1		
		$\overline{CLKEN}$ before CLK↑	3.5		3.2		
t_h	Hold time	A, B, or C after CLK↑	1.8		1.4		ns
		A or B after LE↓	2.4		2.1		
		$\overline{CLKEN}$ after CLK↑	1.5		1.1		

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 50 pF (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ABTH32316		SN74ABTH32316		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			150		150		MHz
t_{PLH}	A, B, or C	C, B, or A	0.8	6.5	1.4	6.1	ns
t_{PHL}			0.5	6.8	1.1	6.6	
t_{PLH}	SEL	A, B, or C	0.8	6.7	1.4	6.5	ns
t_{PHL}			0.8	6.8	1.8	6.5	
t_{PLH}	LE	A, B, or C	1.5	8	2.6	7.5	ns
t_{PHL}			1.5	7.4	2.6	6.9	
t_{PLH}	CLK	A, B, or C	1.5	8	2.5	7.5	ns
t_{PHL}			1.5	7.2	2.5	6.7	
t_{PZH}	$\overline{OE}$	A, B, or C	0.8	6.7	1.5	6.4	ns
t_{PZL}			1.5	7.1	2.4	6.8	
t_{PHZ}	$\overline{OE}$	A, B, or C	0.8	7.2	1.5	6	ns
t_{PLZ}			0.8	6.4	1.9	6.1	

![Texas Instruments logo]

PARAMETER MEASUREMENT INFORMATION
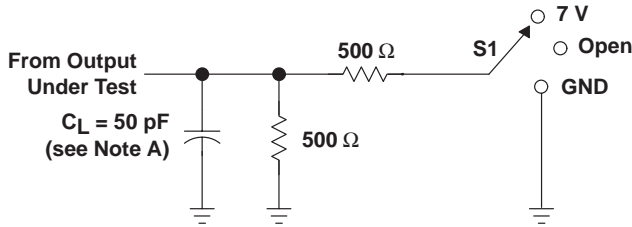
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	7 V
t_{PHZ}/t_{PZH}	Open

LOAD CIRCUIT
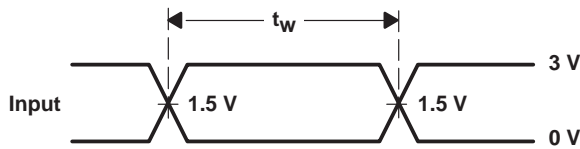
VOLTAGE WAVEFORMS
PULSE DURATION
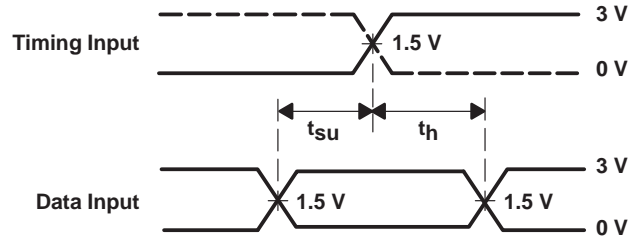
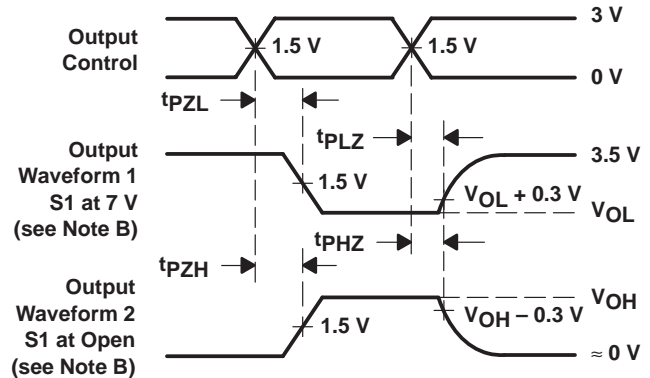**VOLTAGE WAVEFORMS**
SETUP AND HOLD TIMES
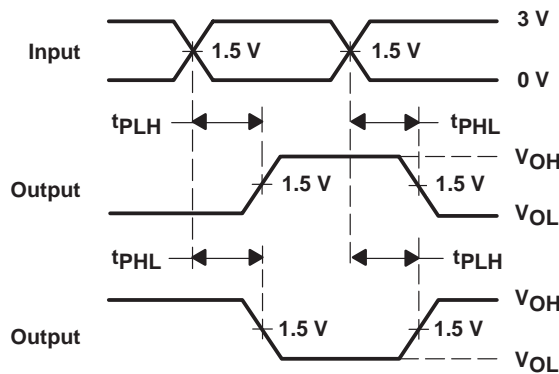
VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS

VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control.
Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
5962-9680801QXA	Active	Production	CFP (HT) | 84	250 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9680801QXA SNJ54ABTH32316 HT
SN74ABTH32316PN	Active	Production	LQFP (PN) | 80	119 | JEDEC TRAY (10+1)	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	ABTH32316
SN74ABTH32316PN.B	Active	Production	LQFP (PN) | 80	119 | JEDEC TRAY (10+1)	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	ABTH32316
SNJ54ABTH32316HT	Active	Production	CFP (HT) | 84	250 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9680801QXA SNJ54ABTH32316 HT

(1) **Status:** For more details on status, see our product life cycle.

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

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

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

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

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

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

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OTHER QUALIFIED VERSIONS OF SN54ABTH32316, SN74ABTH32316 :

● Catalog : SN74ABTH32316

● Military : SN54ABTH32316
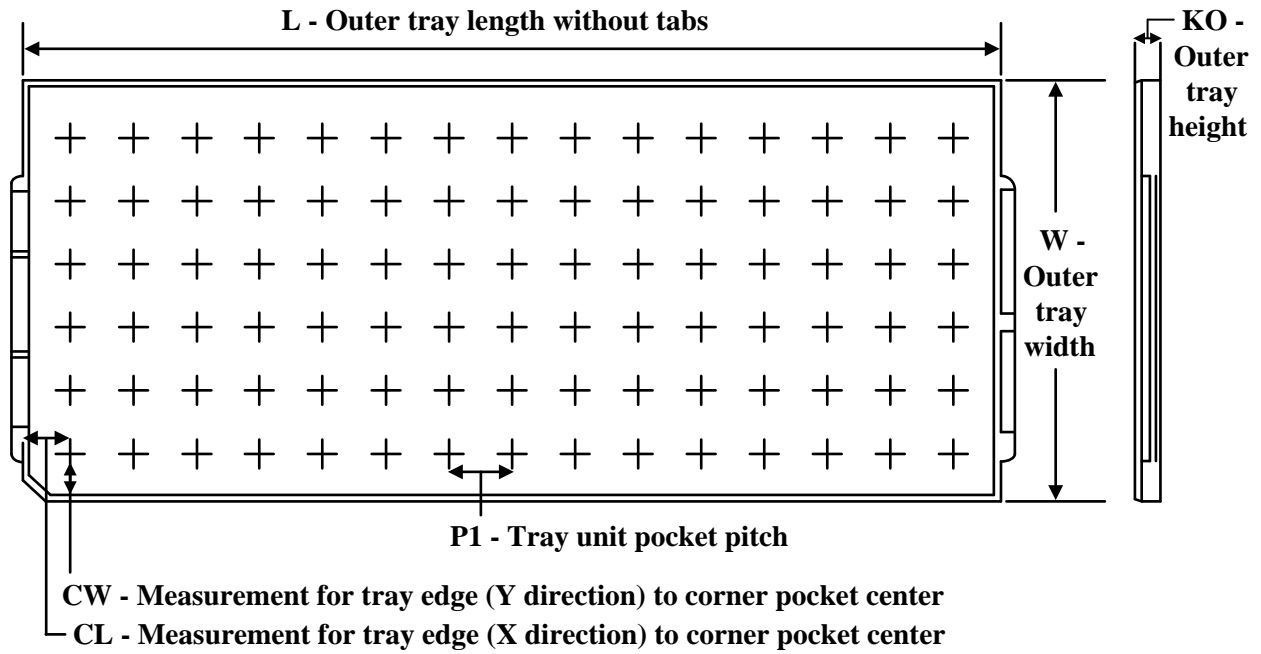
NOTE: Qualified Version Definitions:

    ● Catalog - TI's standard catalog product

    ● Military - QML certified for Military and Defense Applications

PACKAGE MATERIALS INFORMATION

TUBE

T - Tube height

L - Tube length

W - Tube width

B - Alignment groove width

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
5962-9680801QXA	HT	CFP	84	250	506.98	17.91	12570	5.46
SNJ54ABTH32316HT	HT	CFP	84	250	506.98	17.91	12570	5.46

TRAY

L - Outer tray length without tabs

KO - Outer tray height

W - Outer tray width

P1 - Tray unit pocket pitch

CW - Measurement for tray edge (Y direction) to corner pocket center

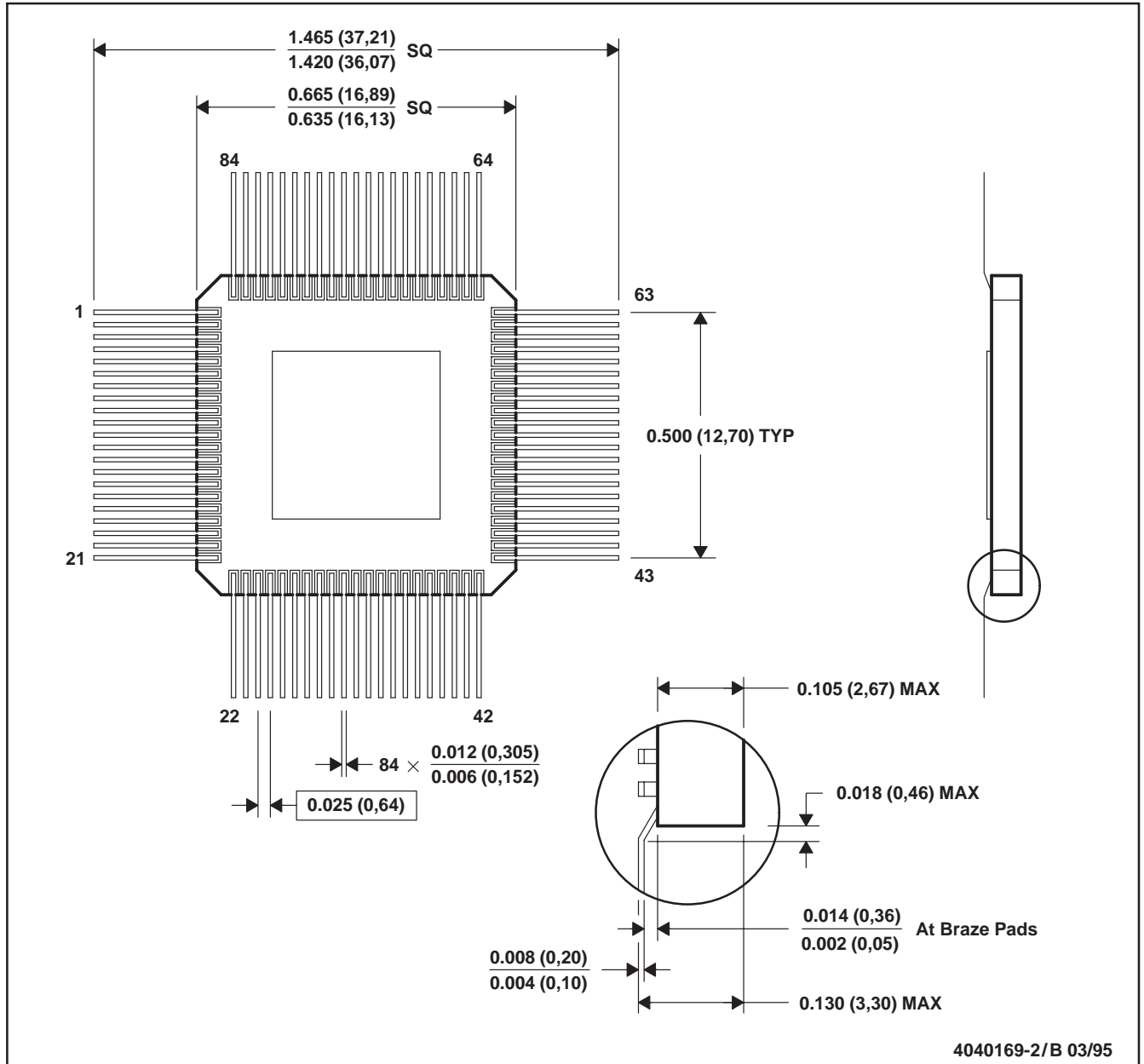**CL - Measurement for tray edge (X direction) to corner pocket center**

Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
SN74ABTH32316PN	PN	LQFP	80	119	7 x 17	150	315	135.9	7620	17.9	14.3	13.95
SN74ABTH32316PN.B	PN	LQFP	80	119	7 x 17	150	315	135.9	7620	17.9	14.3	13.95

HT (S-CQFP-F84)   CERAMIC QUAD FLATPACK

$\dfrac{1.465\ (37,21)}{1.420\ (36,07)}$ SQ

$\dfrac{0.665\ (16,89)}{0.635\ (16,13)}$ SQ

84   64

63

1

21

0.500 (12,70) TYP

43

22   42

84 × $\dfrac{0.012\ (0,305)}{0.006\ (0,152)}$

0.025 (0,64)

0.105 (2,67) MAX

0.018 (0,46) MAX

$\dfrac{0.014\ (0,36)}{0.002\ (0,05)}$ At Braze Pads

$\dfrac{0.008\ (0,20)}{0.004\ (0,10)}$

0.130 (3,30) MAX

4040169-2 / B 03/95

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a metal lid.
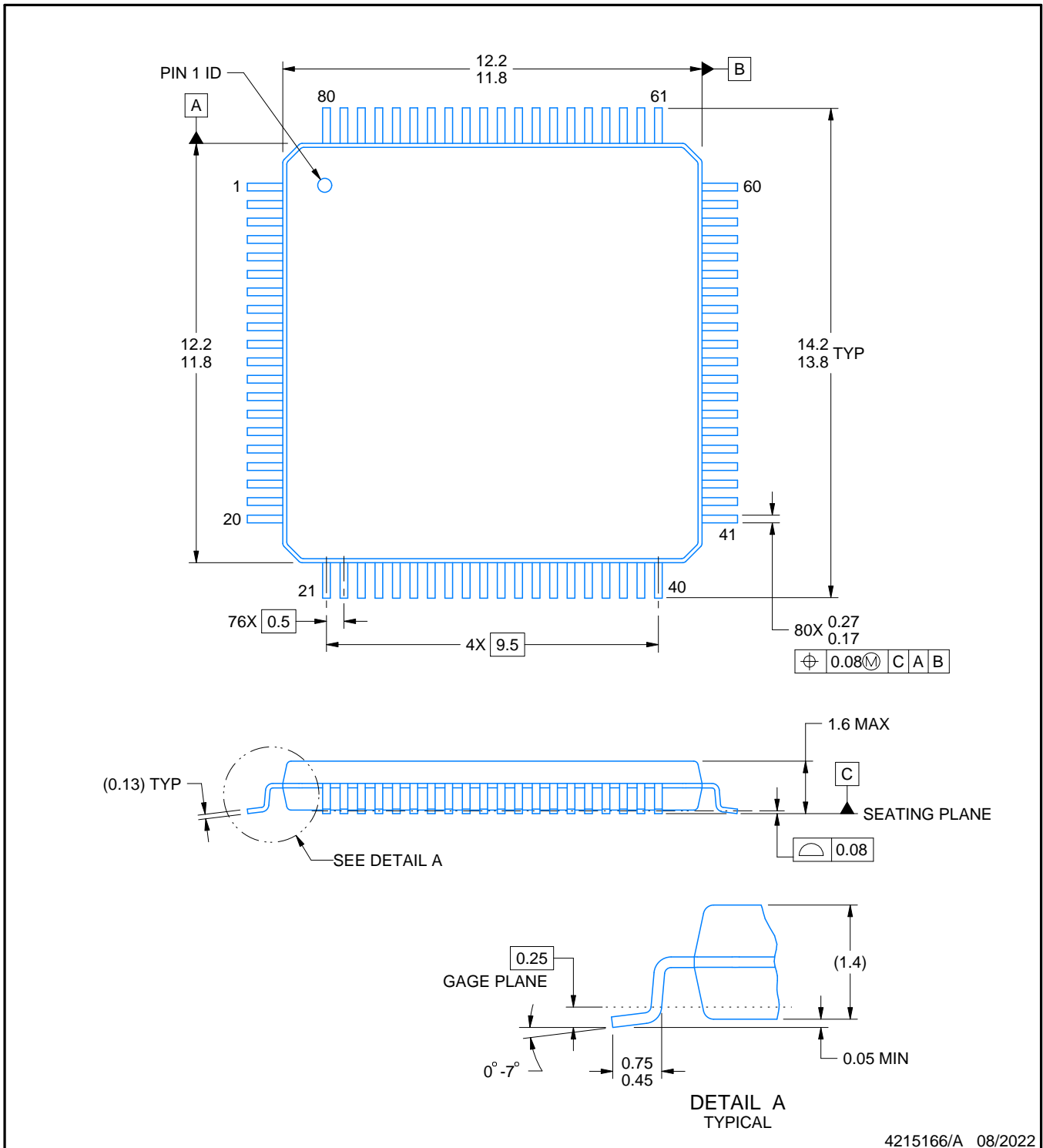D. The terminals are gold plated.
E. Falls within JEDEC MO-090 AA

PIN 1 ID

A

B

12.2
11.8

80   61

1   60

12.2
11.8

14.2
13.8 TYP

20

41

21   40

76X 0.5

4X 9.5

80X 0.27
0.17

⊕ 0.08Ⓜ C A B

1.6 MAX

(0.13) TYP

C

SEATING PLANE

⌒ 0.08

SEE DETAIL A

0.25

GAGE PLANE

(1.4)

0° -7°

0.75
0.45

0.05 MIN

DETAIL A
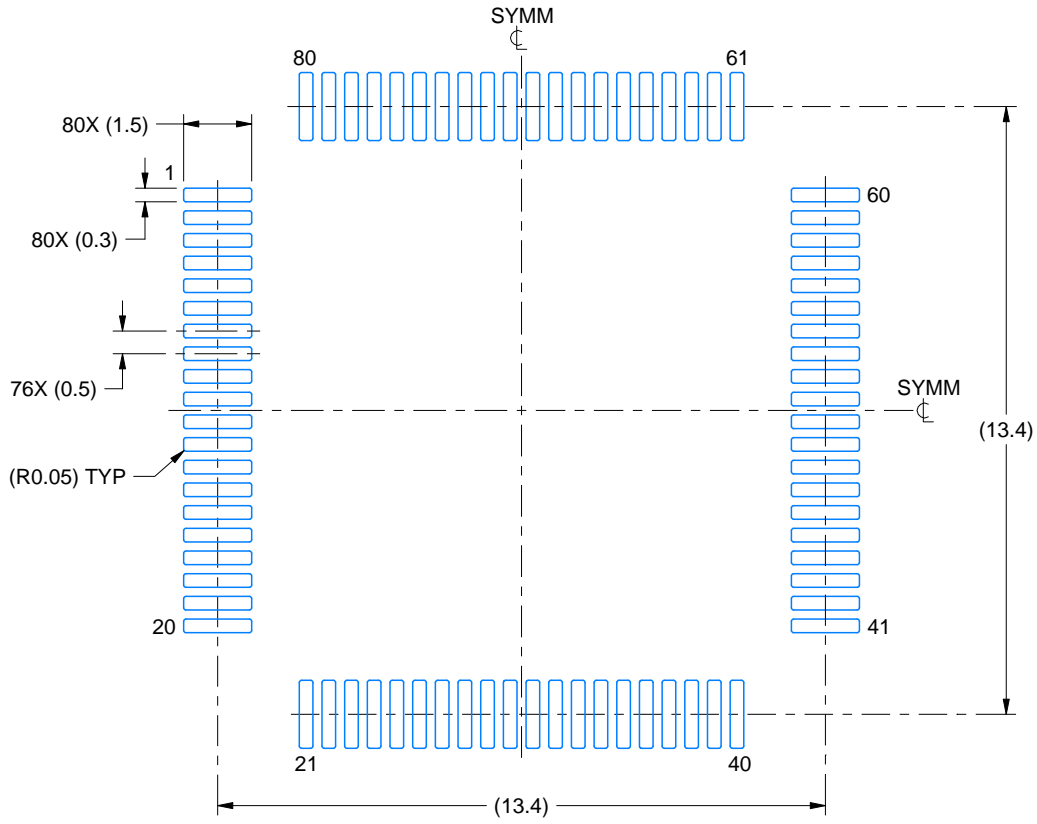TYPICAL
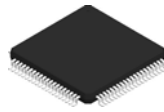
4215166/A   08/2022

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. Reference JEDEC registration MS-026.

**TEXAS
INSTRUMENTS**
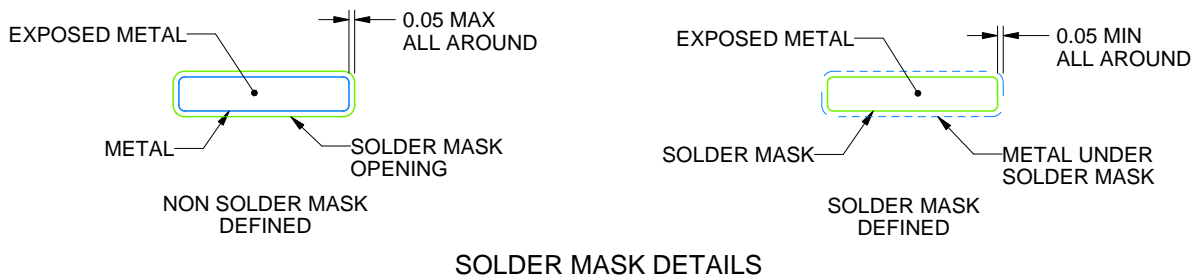www.ti.com

SYMM

80
61

80X (1.5)

1

80X (0.3)

76X (0.5)

60

(R0.05) TYP

SYMM

(13.4)

20

41

21
40

(13.4)

LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:6X

EXPOSED METAL

0.05 MAX
ALL AROUND

METAL

SOLDER MASK
OPENING

**NON SOLDER MASK
DEFINED**

EXPOSED METAL

0.05 MIN
ALL AROUND

SOLDER MASK

METAL UNDER
SOLDER MASK

**SOLDER MASK
DEFINED**

SOLDER MASK DETAILS

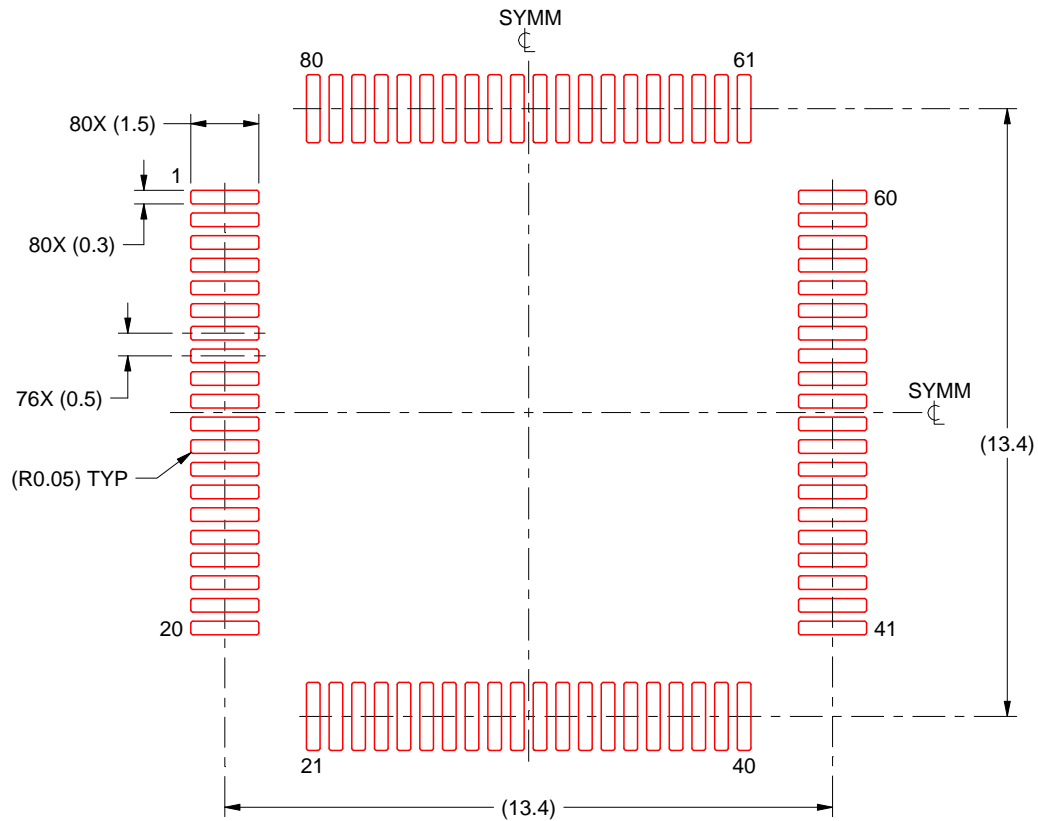4215166/A   08/2022

NOTES: (continued)

4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
6. For more information, see Texas Instruments literature number SLMA004 (www.ti.com/lit/slma004).

SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:6X

4215166/A   08/2022

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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