'46A, '47A, 'LS47 feature

- **Open-Collector Outputs Drive Indicators Directly**
- **Lamp-Test Provision**
- **Leading/Trailing Zero Suppression**

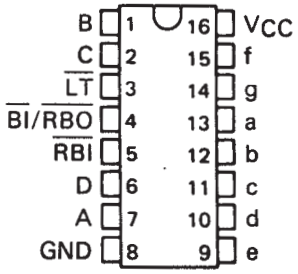
'48, 'LS48 feature

- **Internal Pull-Ups Eliminate Need for External Resistors**
- **Lamp-Test Provision**
- **Leading/Trailing Zero Suppression**

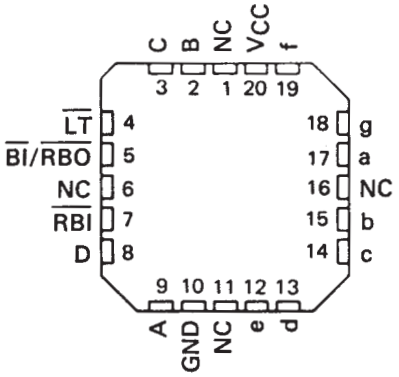
'LS49 feature

- **Open-Collector Outputs**
- **Blanking Input**

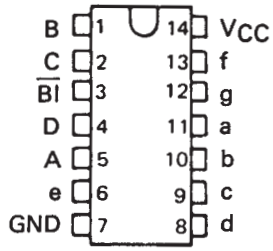
SN5446A, SN5447A, SN54LS47, SN5448, SN54LS48 . . . J PACKAGE
SN7446A, SN7447A, SN7448 . . . N PACKAGE
SN74LS47, SN74LS48 . . . D OR N PACKAGE
(TOP VIEW)



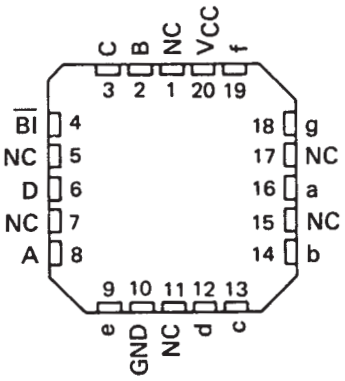
SN54LS47, SN54LS48 . . . FK PACKAGE
(TOP VIEW)



SN54LS49 . . . J OR W PACKAGE
SN74LS49 . . . D OR N PACKAGE
(TOP VIEW)



SN54LS49 . . . FK PACKAGE
(TOP VIEW)



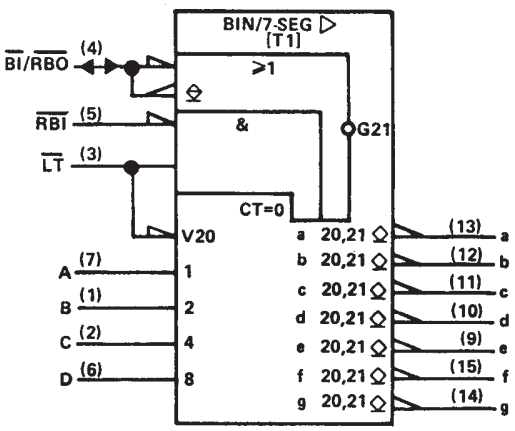
NC — No internal connection

- All Circuit Types Feature Lamp Intensity Modulation Capability

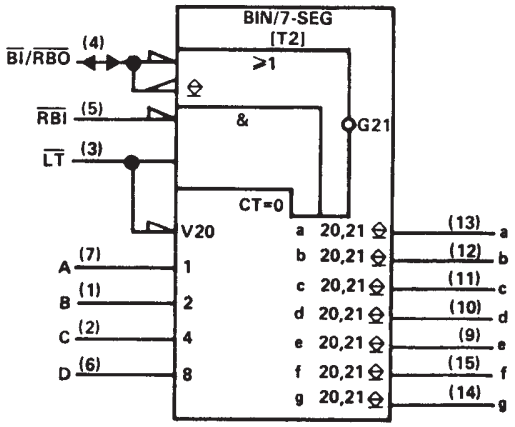
TYPE	DRIVER OUTPUTS				TYPICAL POWER DISSIPATION	PACKAGES
	ACTIVE LEVEL	OUTPUT CONFIGURATION	SINK CURRENT	MAX VOLTAGE		
SN5446A	low	open-collector	40 mA	30 V	320 mW	J, W
SN5447A	low	open-collector	40 mA	15 V	320 mW	J, W
SN5448	high	2-kΩ pull-up	6.4 mA	5.5 V	265 mW	J,W
SN54LS47	low	open-collector	12 mA	15 V	35 mW	J, W
SN54LS48	high	2-kΩ pull-up	2 mA	5.5 V	125 mW	J, W
SN54LS49	high	open-collector	4 mA	5.5 V	40 mW	J, W
SN7446A	low	open-collector	40 mA	30 V	320 mW	J, N
SN7447A	low	open-collector	40 mA	15 V	320 mW	J, N
SN7448	high	2-kΩ pull-up	6.4 mA	5.5 V	265 mW	J, N
SN74LS47	low	open-collector	24 mA	15 V	35 mW	J, N
SN74LS48	high	2-kΩ pull-up	6 mA	5.5 V	125 mW	J, N
SN74LS49	high	open-collector	8 mA	5.5 V	40 mW	J, N

logic symbols†

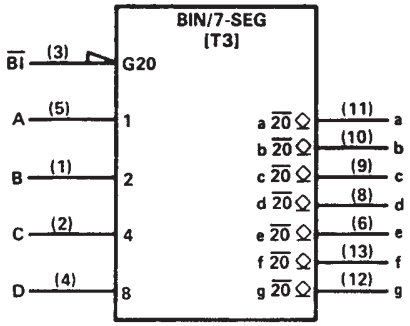
'46A, '47A, 'LS47



'48, 'LS48



'LS49



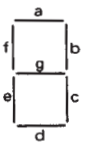
†These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, N, and W packages.

description

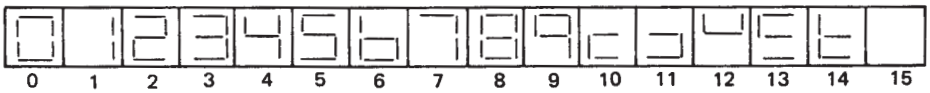
The '46A, '47A, and 'LS47 feature active-low outputs designed for driving common-anode LEDs or incandescent indicators directly. The '48, 'LS48, and 'LS49 feature active-high outputs for driving lamp buffers or common-cathode LEDs. All of the circuits except 'LS49 have full ripple-blanking input/output controls and a lamp test input. The 'LS49 circuit incorporates a direct blanking input. Segment identification and resultant displays are shown below. Display patterns for BCD input counts above 9 are unique symbols to authenticate input conditions.

The '46A, '47A, '48, 'LS47, and 'LS48 circuits incorporate automatic leading and/or trailing-edge zero-blanking control ($\overline{RBI}$ and $\overline{RBO}$). Lamp test ($\overline{LT}$) of these types may be performed at any time when the $\overline{BI}/\overline{RBO}$ node is at a high level. All types (including the '49 and 'LS49) contain an overriding blanking input ($\overline{BI}$), which can be used to control the lamp intensity by pulsing or to inhibit the outputs. Inputs and outputs are entirely compatible for use with TTL logic outputs.

The SN54246/SN74246 and '247 and the SN54LS247/SN74LS247 and 'LS248 compose the 6 and the 9 with tails and were designed to offer the designer a choice between two indicator fonts.



SEGMENT IDENTIFICATION



NUMERICAL DESIGNATIONS AND RESULTANT DISPLAYS

'46A, '47A, 'LS47 FUNCTION TABLE (T1)

DECIMAL OR FUNCTION	INPUTS						$\overline{BI}/\overline{RBO}$†	OUTPUTS							NOTE
	$\overline{LT}$	$\overline{RBI}$	D	C	B	A		a	b	c	d	e	f	g	
0	H	H	L	L	L	L	H	ON	ON	ON	ON	ON	ON	OFF	1
1	H	X	L	L	L	H	H	OFF	ON	ON	OFF	OFF	OFF	OFF	
2	H	X	L	L	H	L	H	ON	ON	OFF	ON	ON	OFF	ON	
3	H	X	L	L	H	H	H	ON	ON	ON	ON	OFF	OFF	ON	
4	H	X	L	H	L	L	H	OFF	ON	ON	OFF	OFF	ON	ON	
5	H	X	L	H	L	H	H	ON	OFF	ON	ON	OFF	ON	ON	
6	H	X	L	H	H	L	H	OFF	OFF	ON	ON	ON	ON	ON	
7	H	X	L	H	H	H	H	ON	ON	ON	OFF	OFF	OFF	OFF	
8	H	X	H	L	L	L	H	ON	ON	ON	ON	ON	ON	ON	
9	H	X	H	L	L	H	H	ON	ON	ON	OFF	OFF	ON	ON	
10	H	X	H	L	H	L	H	OFF	OFF	OFF	ON	ON	OFF	ON	
11	H	X	H	L	H	H	H	OFF	OFF	ON	ON	OFF	OFF	ON	
12	H	X	H	H	L	L	H	OFF	ON	OFF	OFF	OFF	ON	ON	
13	H	X	H	H	L	H	H	ON	OFF	OFF	ON	OFF	ON	ON	
14	H	X	H	H	H	L	H	OFF	OFF	OFF	ON	ON	ON	ON	
15	H	X	H	H	H	H	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF	
BI	X	X	X	X	X	X	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	2
RBI	H	L	L	L	L	L	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	3
LT	L	X	X	X	X	X	H	ON	ON	ON	ON	ON	ON	ON	4

H = high level, L = low level, X = irrelevant

NOTES:
1. The blanking input ($\overline{BI}$) must be open or held at a high logic level when output functions 0 through 15 are desired. The ripple-blanking input ($\overline{RBI}$) must be open or high if blanking of a decimal zero is not desired.
2. When a low logic level is applied directly to the blanking input ($\overline{BI}$), all segment outputs are off regardless of the level of any other input.
3. When ripple-blanking input ($\overline{RBI}$) and inputs A, B, C, and D are at a low level with the lamp test input high, all segment outputs go off and the ripple-blanking output ($\overline{RBO}$) goes to a low level (response condition).
4. When the blanking input/ripple blanking output ($\overline{BI}/\overline{RBO}$) is open or held high and a low is applied to the lamp-test input, all segment outputs are on.

†$\overline{BI}/\overline{RBO}$ is wire AND logic serving as blanking input ($\overline{BI}$) and/or ripple-blanking output ($\overline{RBO}$).

'48, 'LS48
FUNCTION TABLE (T2)

DECIMAL OR FUNCTION	INPUTS						$\overline{BI}/\overline{RBO}$†	OUTPUTS							NOTE
	$\overline{LT}$	$\overline{RBI}$	D	C	B	A		a	b	c	d	e	f	g	
0	H	H	L	L	L	L	H	H	H	H	H	H	H	L	1
1	H	X	L	L	L	H	H	L	H	H	L	L	L	L	
2	H	X	L	L	H	L	H	H	H	L	H	H	L	H	
3	H	X	L	L	H	H	H	H	H	H	H	L	L	H	
4	H	X	L	H	L	L	H	L	H	H	L	L	H	H	
5	H	X	L	H	L	H	H	H	L	H	H	L	H	H	
6	H	X	L	H	H	L	H	L	L	H	H	H	H	H	
7	H	X	L	H	H	H	H	H	H	H	L	L	L	L	
8	H	X	H	L	L	L	H	H	H	H	H	H	H	H	
9	H	X	H	L	L	H	H	H	H	H	L	L	H	H	
10	H	X	H	L	H	L	H	L	L	L	H	H	L	H	
11	H	X	H	L	H	H	H	L	L	H	H	L	L	H	
12	H	X	H	H	L	L	H	L	H	L	L	L	H	H	
13	H	X	H	H	L	H	H	H	L	L	H	L	H	H	
14	H	X	H	H	H	L	H	L	L	L	H	H	H	H	
15	H	X	H	H	H	H	H	L	L	L	L	L	L	L	
BI	X	X	X	X	X	X	L	L	L	L	L	L	L	L	2
RBI	H	L	L	L	L	L	L	L	L	L	L	L	L	L	3
LT	L	X	X	X	X	X	H	H	H	H	H	H	H	H	4

H = high level, L = low level, X = irrelevant

NOTES: 1. The blanking input ($\overline{BI}$) must be open or held at a high logic level when output functions 0 through 15 are desired. The ripple-blanking input ($\overline{RBI}$) must be open or high, if blanking of a decimal zero is not desired.
2. When a low logic level is applied directly to the blanking input ($\overline{BI}$), all segment outputs are low regardless of the level of any other input.
3. When ripple-blanking input ($\overline{RBI}$) and inputs A, B, C, and D are at a low level with the lamp-test input high, all segment outputs go low and the ripple-blanking output ($\overline{RBO}$) goes to a low level (response condition).
4. When the blanking input/ripple-blanking output ($\overline{BI}/\overline{RBO}$) is open or held high and a low is applied to the lamp-test input, all segment outputs are high.

†$\overline{BI}/\overline{RBO}$ is wire-AND logic serving as blanking input ($\overline{BI}$) and/or ripple-blanking output ($\overline{RBO}$).

'LS49
FUNCTION TABLE (T3)

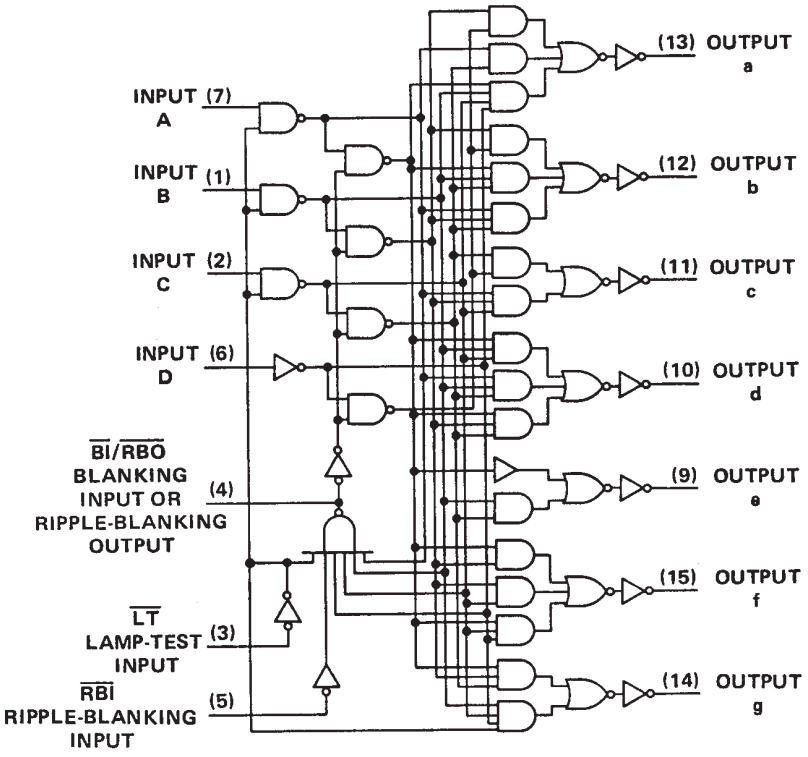
DECIMAL OR FUNCTION	INPUTS					OUTPUTS							NOTE
	D	C	B	A	$\overline{BI}$	a	b	c	d	e	f	g	
0	L	L	L	L	H	H	H	H	H	H	H	L	1
1	L	L	L	H	H	L	H	H	L	L	L	L	
2	L	L	H	L	H	H	H	L	H	H	L	H	
3	L	L	H	H	H	H	H	H	H	L	L	H	
4	L	H	L	L	H	L	H	H	L	L	H	H	
5	L	H	L	H	H	H	L	H	H	L	H	H	
6	L	H	H	L	H	L	L	H	H	H	H	H	
7	L	H	H	H	H	H	H	H	L	L	L	L	
8	H	L	L	L	H	H	H	H	H	H	H	H	
9	H	L	L	H	H	H	H	H	L	L	H	H	
10	H	L	H	L	H	L	L	L	H	H	L	H	
11	H	L	H	H	H	L	L	H	H	L	L	H	
12	H	H	L	L	H	L	H	L	L	L	H	H	
13	H	H	L	H	H	H	L	L	H	L	H	H	
14	H	H	H	L	H	L	L	L	H	H	H	H	
15	H	H	H	H	H	L	L	L	L	L	L	L	
BI	X	X	X	X	L	L	L	L	L	L	L	L	2

H = high level, L = low level, X = irrelevant

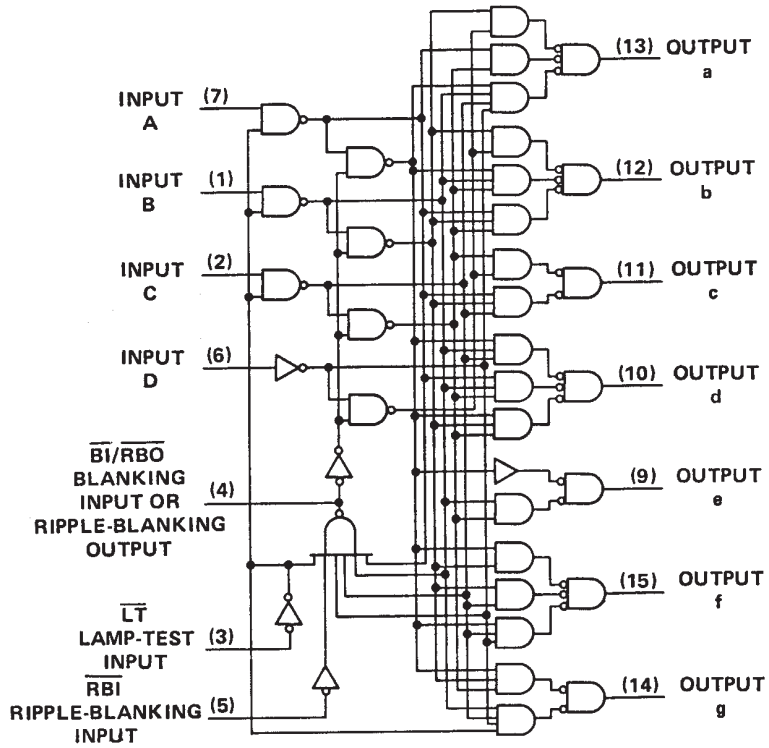
NOTES: 1. The blanking input ($\overline{BI}$) must be open or held at a high logic level when output functions 0 through 15 are desired.
2. When a low logic level is applied directly to the blanking input ($\overline{BI}$), all segment outputs are low regardless of the level of any other input.

logic diagrams (positive logic)

'46A, '47A, 'LS47

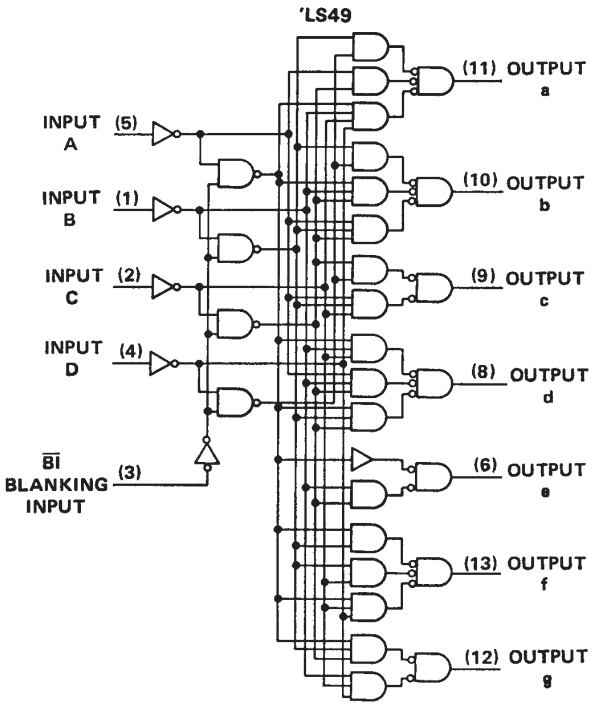


'48, 'LS48



Pin numbers shown are for D, J, N, and W packages.

logic diagrams (continued)

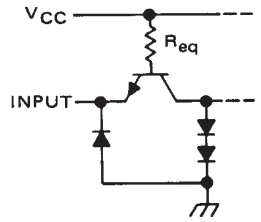


Pin numbers shown are for D, J, N, and W packages.

schematics of inputs and outputs

’46A, ’47A, ’48

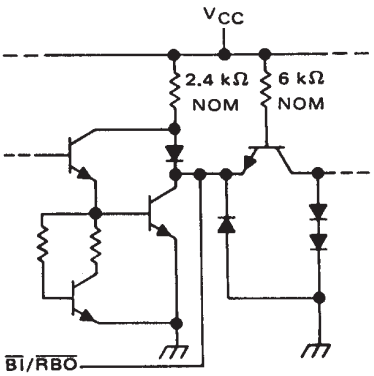
EQUIVALENT OF EACH INPUT EXCEPT $\overline{BI}/\overline{RBO}$



SN54’/SN74’: R_{eq} = 6 kΩ NOM
SN54L’/SN74L’: R_{eq} = 8 kΩ NOM

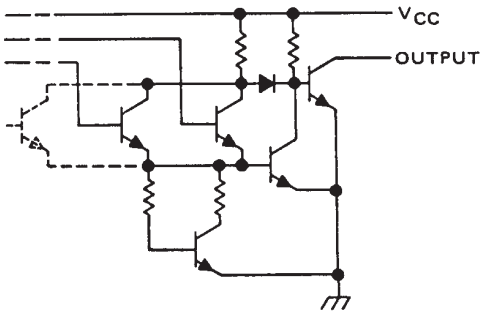
’46A, ’47A, ’48

EQUIVALENT OF $\overline{BI}/\overline{RBO}$



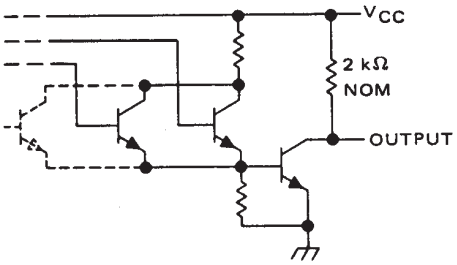
’46A, ’47A

TYPICAL OF OUTPUTS a THRU g



’48

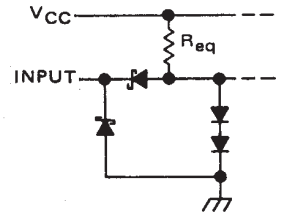
TYPICAL OF OUTPUTS a THRU g



schematics of inputs and outputs

'LS47, 'LS48, 'LS49

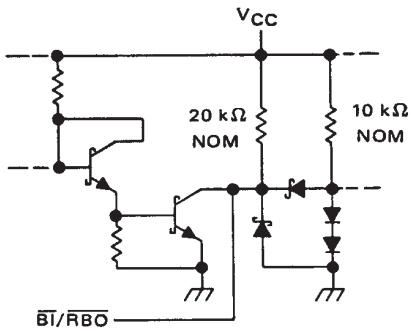
EQUIVALENT OF EACH INPUT EXCEPT $\overline{BI}/\overline{RBO}$



$\overline{LT}$ and $\overline{RBI}$ ('LS47, 'LS48): R_{eq} = 20 kΩ NOM
$\overline{BI}$ ('LS49): R_{eq} = 20 kΩ NOM
A, B, C, and D: R_{eq} = 25 kΩ NOM

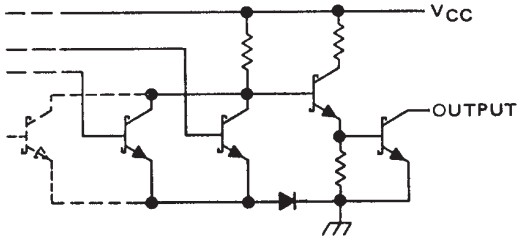
'LS47, 'LS48, 'LS49

EQUIVALENT OF $\overline{BI}/\overline{RBO}$



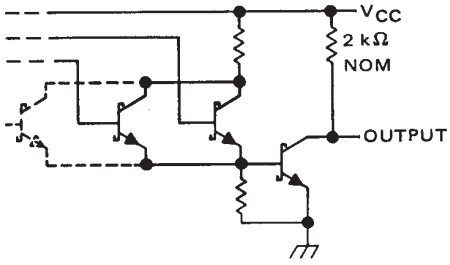
'LS47

TYPICAL OF OUTPUTS a THRU g



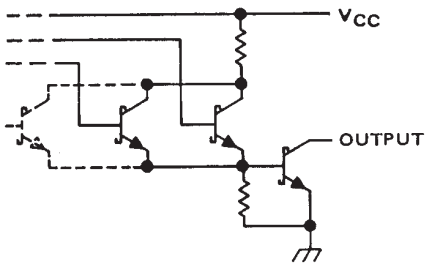
'LS48

TYPICAL OF OUTPUTS a THRU g



'LS49

TYPICAL OF OUTPUTS a THRU g



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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Current forced into any output in the off state . . . . . 1 mA
Operating free-air temperature range: SN5446A, SN5447A . . . . . –55°C to 125°C
SN7446A, SN7447A . . . . . 0°C to 70°C
Storage temperature range . . . . . –65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN5446A			SN5447A			SN7446A			SN7447A			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.5	5	5.5	4.75	5	5.25	4.75	5	5.25	V
Off-state output voltage, $V_{O(off)}$	a thru g			30			15			30			15	V
On-state output current, $I_{O(on)}$	a thru g			40			40			40			40	mA
High-level output current, I_{OH}	$\overline{BI}/\overline{RBO}$			–200			–200			–200			–200	μA
Low-level output current, I_{OL}	$\overline{BI}/\overline{RBO}$			8			8			8			8	mA
Operating free-air temperature, T_A		–55		125	–55		125	0		70	0		70	°C

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

PARAMETER			TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = –12 mA				–1.5	V
V_{OH}	High-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = –200 μA		2.4	3.7		V
V_{OL}	Low-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 8 mA			0.27	0.4	V
$I_{O(off)}$	Off-state output current	a thru g	V_{CC} = MAX, V_{IH} = 2 V, V_{IL} = 0.8 V, $V_{O(off)}$ = MAX				250	μA
$V_{O(on)}$	On-state output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, $I_{O(on)}$ = 40 mA			0.3	0.4	V
I_I	Input current at maximum input voltage	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 5.5 V				1	mA
I_{IH}	High-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 2.4 V				40	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 0.4 V				–1.6	mA
		$\overline{BI}/\overline{RBO}$					–4	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX				–4	mA
I_{CC}	Supply current		V_{CC} = MAX, See Note 2	SN54'		64	85	mA
				SN74'		64	103	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{off}	Turn-off time from A input	C_L = 15 pF, R_L = 120 Ω, See Note 3			100	ns
t_{on}	Turn-on time from A input				100	
t_{off}	Turn-off time from $\overline{RBI}$ input				100	ns
t_{on}	Turn-on time from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Operating free-air temperature range: SN5448 . . . . . −55°C to 125°C
SN7448 . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN5448			SN7448			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}	a thru g			−400			−400	μA
	$\overline{BI}/\overline{RBO}$			−200			−200	
Low-level output current, I_{OL}	a thru g			6.4			6.4	mA
	$\overline{BI}/\overline{RBO}$			8			8	
Operating free-air temperature, T_A		−55		125	0		70	°C

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

PARAMETER			TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = −12 mA				−1.5	V
V_{OH}	High-level output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = MAX		2.4	4.2		V
		$\overline{BI}/\overline{RBO}$			2.4	3.7		
I_O	Output current	a thru g	V_{CC} = MIN, V_O = 0.85 V, Input conditions as for V_{OH}		−1.3	−2		mA
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = MAX			0.27	0.4	V
I_I	Input current at maximum input voltage	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 5.5 V				1	mA
I_{IH}	High-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 2.4 V				40	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 0.4 V				−1.6	mA
		$\overline{BI}/\overline{RBO}$					−4	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX				−4	mA
I_{CC}	Supply current		V_{CC} = MAX, See Note 2	SN5448		53	76	mA
				SN7448		53	90	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from A input	C_L = 15 pF, R_L = 1 kΩ See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from A input				100	
t_{PHL}	Propagation delay time, high-to-low-level output from $\overline{RBI}$ input				100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 7 V
Peak output current ($t_w \leq 1$ ms, duty cycle $\leq 10\%$) . . . . . 200 mA
Current forced into any output in the off state . . . . . 1 mA
Operating free-air temperature range: SN54LS47 . . . . . −55°C to 125°C
SN74LS47 . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS47			SN74LS47			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Off-state output voltage, $V_{O(off)}$	a thru g			15			15	V
On-state output current, $I_{O(on)}$	a thru g			12			24	mA
High-level output current, I_{OH}	$\overline{BI}/\overline{RBO}$			−50			−50	μA
Low-level output current, I_{OL}	$\overline{BI}/\overline{RBO}$			1.6			3.2	mA
Operating free-air temperature, T_A		−55		125	0		70	°C

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

PARAMETER			TEST CONDITIONS†		SN54LS47			SN74LS47			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage				2			2			V
V_{IL}	Low-level input voltage						0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA			−1.5			−1.5	V
V_{OH}	High-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = −50 μA	2.4	4.2		2.4	4.2		V
V_{OL}	Low-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 1.6 mA		0.25	0.4		0.25	0.4	V
				I_{OL} = 3.2 mA					0.35	0.5	
$I_{O(off)}$	Off-state output current	a thru g	V_{CC} = MAX, V_{IL} = V_{IL} max,	V_{IH} = 2 V, $V_{O(off)}$ = 15 V			250			250	μA
$V_{O(on)}$	On-state output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	$I_{O(on)}$ = 12 mA		0.25	0.4		0.25	0.4	V
				$I_{O(on)}$ = 24 mA					0.35	0.5	
I_I	Input current at maximum input voltage		V_{CC} = MAX,	V_I = 7 V			0.1			0.1	mA
I_{IH}	High-level input current		V_{CC} = MAX,	V_I = 2.7 V			20			20	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX,	V_I = 0.4 V			−0.4			−0.4	mA
		$\overline{BI}/\overline{RBO}$					−1.2			−1.2	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX		−0.3		−2	−0.3		−2	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 2		7	13		7	13	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{off}	Turn-off time from A input	C_L = 15 pF, R_L = 665 Ω, See Note 3			100	ns
t_{on}	Turn-on time from A input				100	
t_{off}	Turn-off time from $\overline{RBI}$ input, outputs (a-f) only				100	ns
t_{on}	Turn-on time from $\overline{RBI}$ input, outputs (a-f) only				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 7 V
Operating free-air temperature range: SN54LS48 . . . . . −55°C to 125°C
SN74LS48 . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS48			SN74LS48			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}	a thru g			−100			−100	μA
	$\overline{BI}/\overline{RBO}$			−50			−50	
Low-level output current, I_{OL}	a thru g			2			6	mA
	$\overline{BI}/\overline{RBO}$			1.6			3.2	
Operating free-air temperature, T_A		−55		125	0		70	°C

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

PARAMETER			TEST CONDITIONS†		SN54LS48			SN74LS48			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage				2			2			V
V_{IL}	Low-level input voltage						0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA			−1.5			−1.5	V
V_{OH}	High-level output voltage	a thru g and $\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = MAX	2.4	4.2		2.4	4.2		V
I_O	Output current	a thru g	V_{CC} = MIN, Input conditions as for V_{OH}	V_O = 0.85 V,	−1.3	−2		−1.3	−2		mA
V_{OL}	Low-level output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 2 mA		0.25	0.4		0.25	0.4	V
				I_{OL} = 6 mA					0.35	0.5	
		$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 1.6 mA		0.25	0.4		0.25	0.4	V
				I_{OL} = 3.2 mA					0.35	0.5	
I_I	Input current at maximum input voltage	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX,	V_I = 7 V			0.1			0.1	mA
I_{IH}	High-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX,	V_I = 2.7 V			20			20	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX,	V_I = 0.4 V			−0.4			−0.4	mA
		$\overline{BI}/\overline{RBO}$					−1.2			−1.2	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX		−0.3		−2	−0.3		−2	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 2		25	38		25	38	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from A input	C_L = 15 pF, R_L = 4 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from A input				100	
t_{PHL}	Propagation delay time, high-to-low-level output (a-f only) from $\overline{RBI}$ input	C_L = 15 pF, R_L = 6 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output (a-f only) from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 7 V
Current forced into any output in the off state . . . . . 1 mA
Operating free-air temperature range: SN54LS49 . . . . . −55°C to 125°C
SN74LS49 . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

	SN54LS49			SN74LS49			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, V_{OH}			5.5			5.5	V
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†		SN54LS49			SN74LS49			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage			2			2			V
V_{IL}	Low-level input voltage					0.7			0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA			−1.5			−1.5	V
I_{OH}	High-level output current	V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, V_{OH} = 5.5 V			250			250	µA
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
			I_{OL} = 8 mA					0.35	0.5	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V			0.1			0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V			20			20	µA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V			−0.4			−0.4	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 2		8	15		8	15	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from A input	C_L = 15 pF, R_L = 4 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from A input				100	
t_{PHL}	Propagation delay time, high-to-low-level output (a-f only) from $\overline{RBI}$ input	C_L = 15 pF, R_L = 6 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output (a-f only) from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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)
5962-9856401QEA	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9856401QEA SNJ5447AJ
5962-9856401QFA	Active	Production	CFP (W) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9856401QFA SNJ5447AW
7604501EA	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	7604501EA SNJ54LS47J
SN5447AJ	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN5447AJ
SN5447AJ.A	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN5447AJ
SN54LS47J	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN54LS47J
SN54LS47J.A	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN54LS47J
SN54LS49J	Active	Production	CDIP (J) | 14	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN54LS49J
SN54LS49J.A	Active	Production	CDIP (J) | 14	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN54LS49J
SN7447AN	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN7447AN
SN7447AN.A	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN7447AN
SN7447ANE4	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN7447AN
SN74LS47D	Active	Production	SOIC (D) | 16	40 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS47
SN74LS47D.A	Active	Production	SOIC (D) | 16	40 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS47
SN74LS47DR	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-	LS47
SN74LS47DR.A	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	LS47
SN74LS47N	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN74LS47N
SN74LS47N.A	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN74LS47N
SN74LS47NE4	Active	Production	PDIP (N) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	SN74LS47N
SN74LS47NSR	Active	Production	SOP (NS) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	74LS47
SN74LS47NSR.A	Active	Production	SOP (NS) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	74LS47
SNJ5447AJ	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9856401QEA SNJ5447AJ

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)
SNJ5447AJ.A	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9856401QE A SNJ5447AJ
SNJ5447AW	Active	Production	CFP (W) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9856401QF A SNJ5447AW
SNJ5447AW.A	Active	Production	CFP (W) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9856401QF A SNJ5447AW
SNJ54LS47FK	Active	Production	LCCC (FK) | 20	55 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SNJ54LS 47FK
SNJ54LS47FK.A	Active	Production	LCCC (FK) | 20	55 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SNJ54LS 47FK
SNJ54LS47J	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	7604501EA SNJ54LS47J
SNJ54LS47J.A	Active	Production	CDIP (J) | 16	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	7604501EA SNJ54LS47J
SNJ54LS49J	Active	Production	CDIP (J) | 14	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SNJ54LS49J
SNJ54LS49J.A	Active	Production	CDIP (J) | 14	25 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SNJ54LS49J

(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.

OTHER QUALIFIED VERSIONS OF SN5447A, SN54LS47, SN7447A, SN74LS47 :

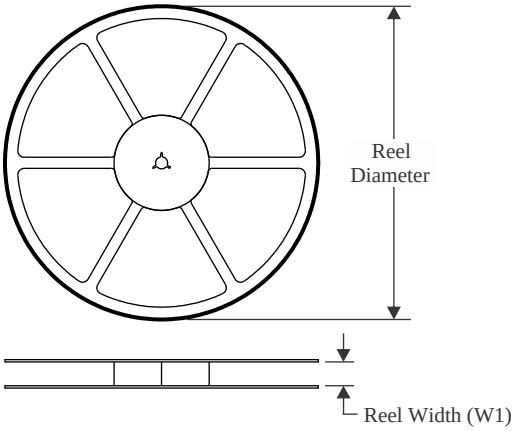
- Catalog : SN7447A, SN74LS47
- Military : SN5447A, SN54LS47

NOTE: Qualified Version Definitions:

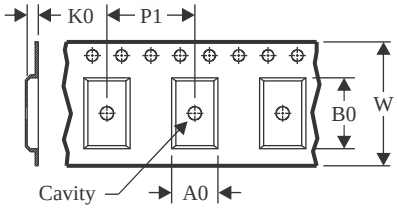
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

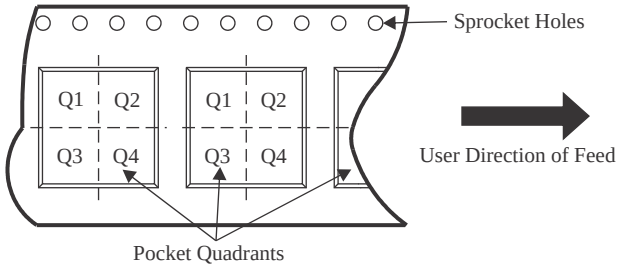


TAPE DIMENSIONS



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

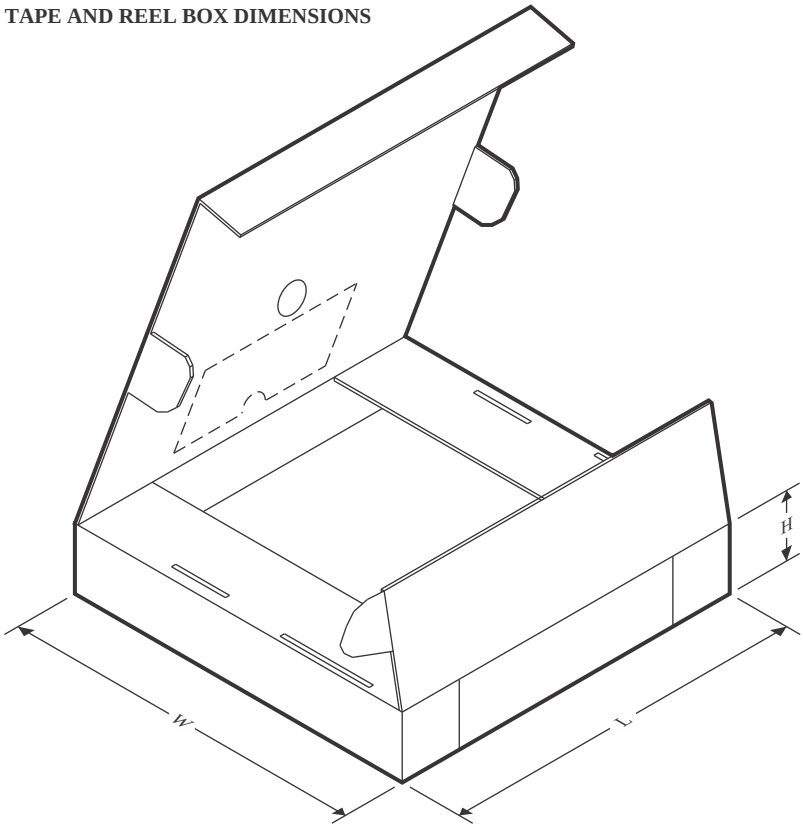
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74LS47DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
SN74LS47NSR	SOP	NS	16	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1
SN74LS47NSR	SOP	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1

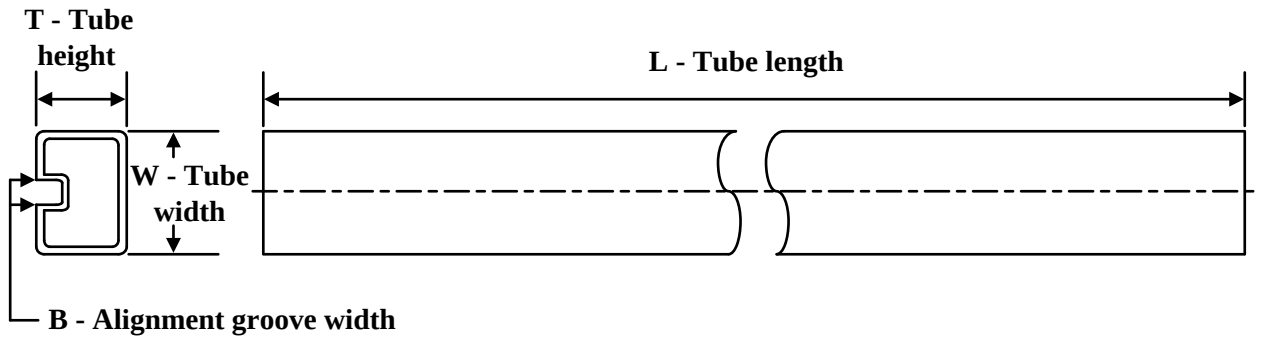
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

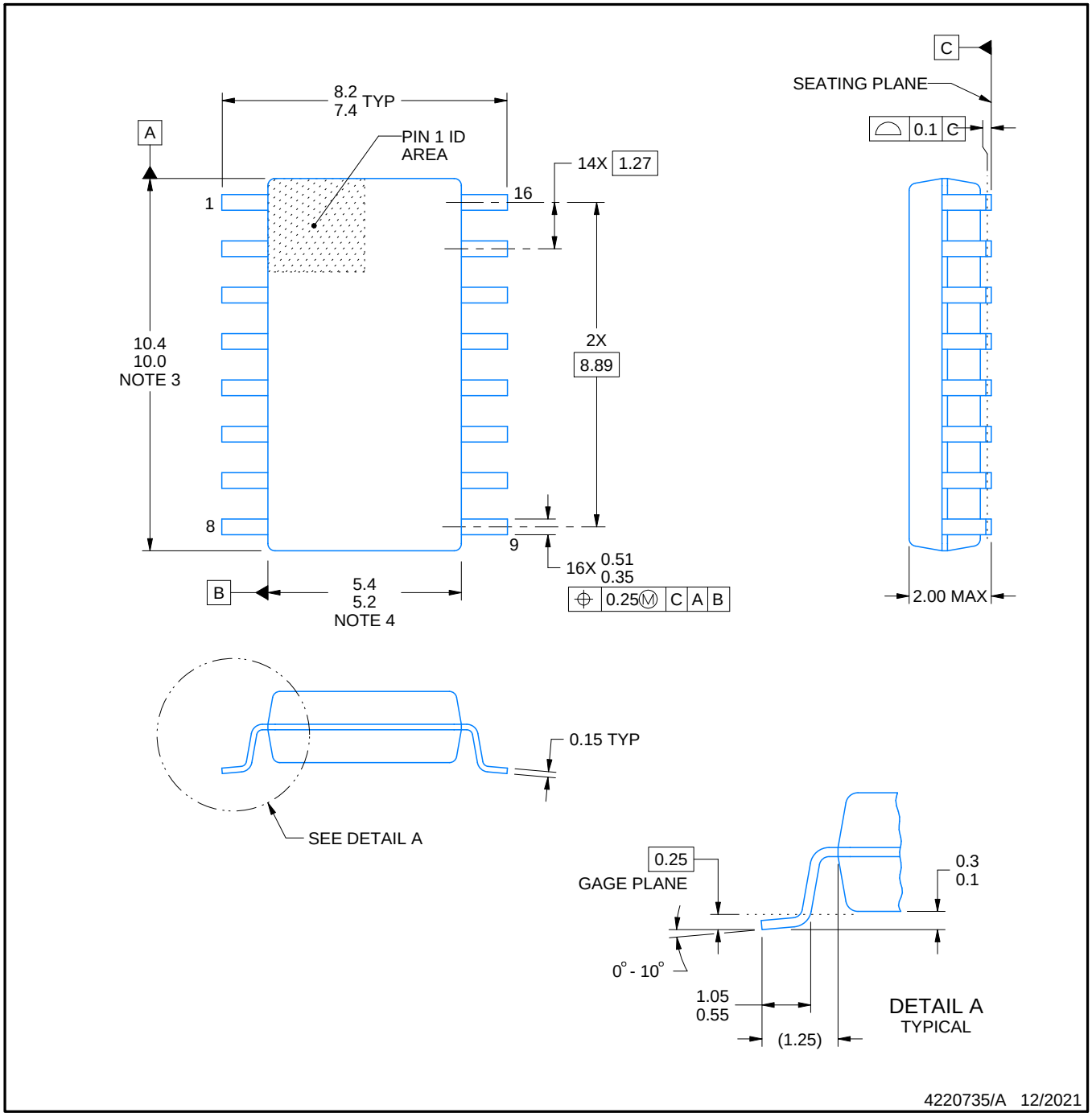
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LS47DR	SOIC	D	16	2500	353.0	353.0	32.0
SN74LS47NSR	SOP	NS	16	2000	356.0	356.0	35.0
SN74LS47NSR	SOP	NS	16	2000	353.0	353.0	32.0

TUBE



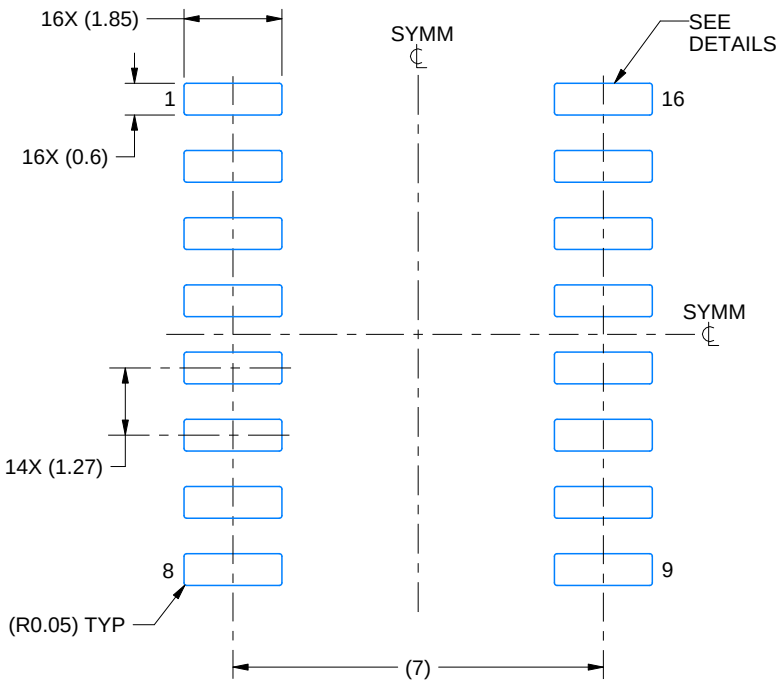
*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
5962-9856401QFA	W	CFP	16	25	506.98	26.16	6220	NA
SN7447AN	N	PDIP	16	25	506	13.97	11230	4.32
SN7447AN	N	PDIP	16	25	506	13.97	11230	4.32
SN7447AN.A	N	PDIP	16	25	506	13.97	11230	4.32
SN7447AN.A	N	PDIP	16	25	506	13.97	11230	4.32
SN7447ANE4	N	PDIP	16	25	506	13.97	11230	4.32
SN7447ANE4	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS47D	D	SOIC	16	40	507	8	3940	4.32
SN74LS47D.A	D	SOIC	16	40	507	8	3940	4.32
SN74LS47N	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS47N	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS47N.A	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS47N.A	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS47NE4	N	PDIP	16	25	506	13.97	11230	4.32
SN74LS47NE4	N	PDIP	16	25	506	13.97	11230	4.32
SNJ5447AW	W	CFP	16	25	506.98	26.16	6220	NA
SNJ5447AW.A	W	CFP	16	25	506.98	26.16	6220	NA
SNJ54LS47FK	FK	LCCC	20	55	506.98	12.06	2030	NA
SNJ54LS47FK.A	FK	LCCC	20	55	506.98	12.06	2030	NA

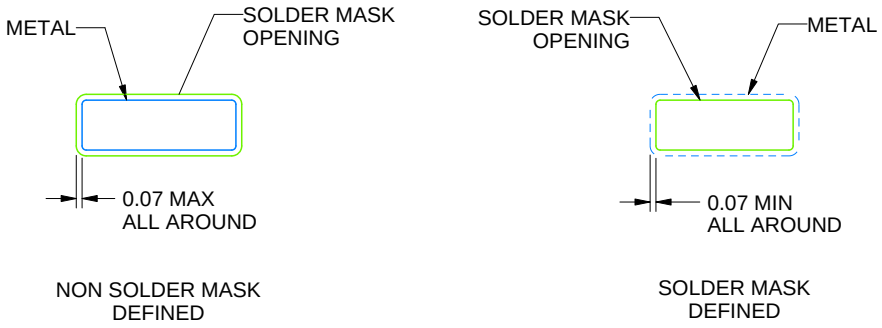


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.



LAND PATTERN EXAMPLE
SCALE:7X

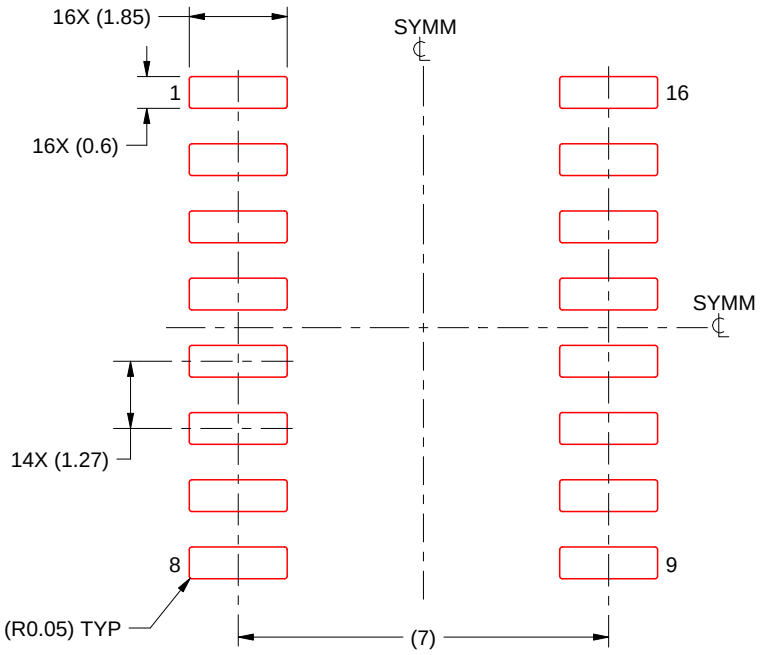


SOLDER MASK DETAILS

4220735/A 12/2021

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



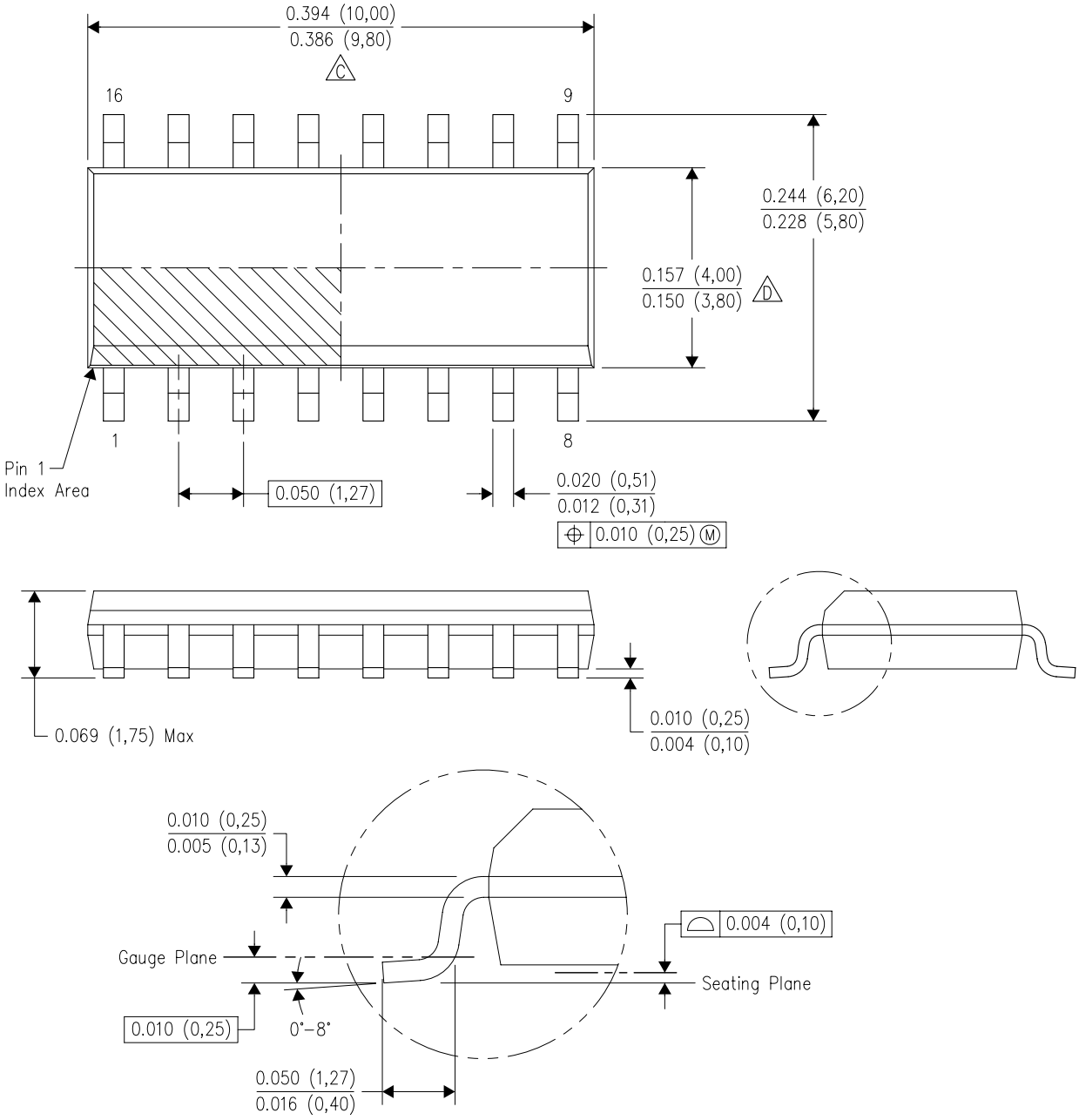
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220735/A 12/2021

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.

D (R–PDSO–G16) PLASTIC SMALL OUTLINE

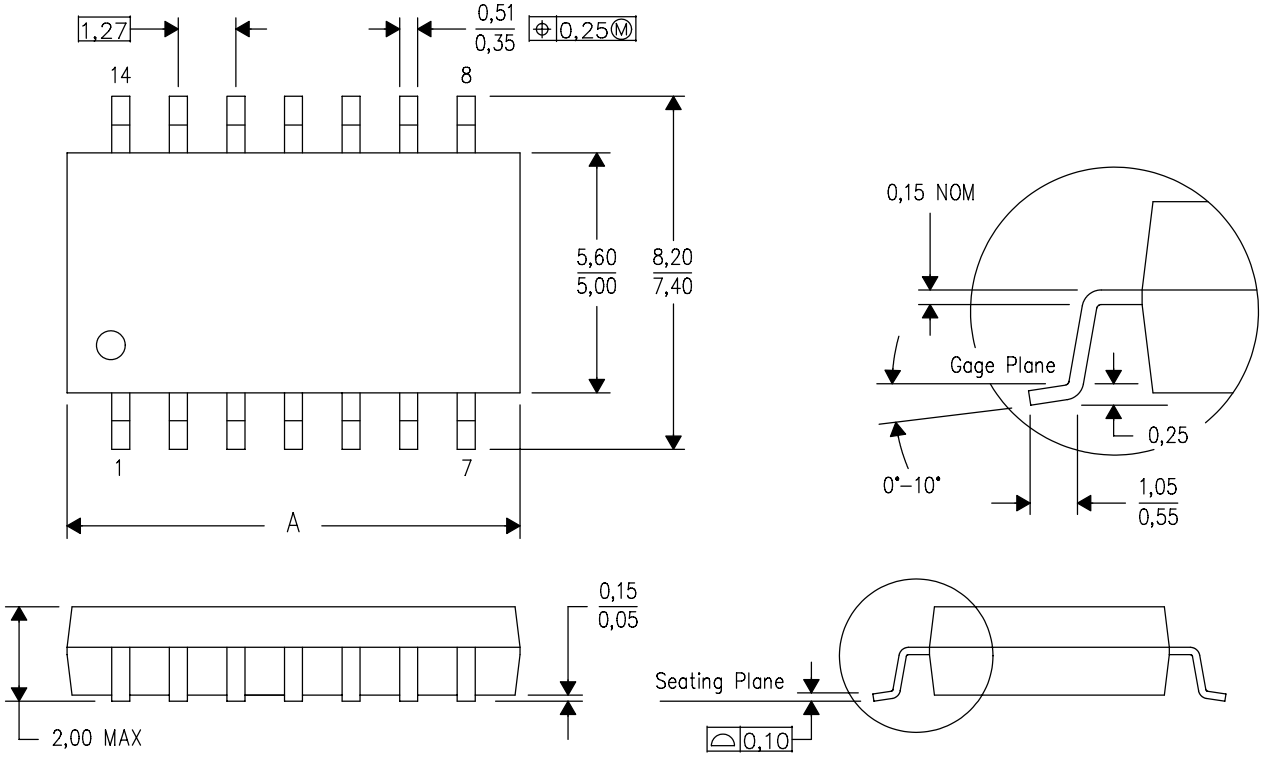


NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AC.

MECHANICAL DATA

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14-PINS SHOWN

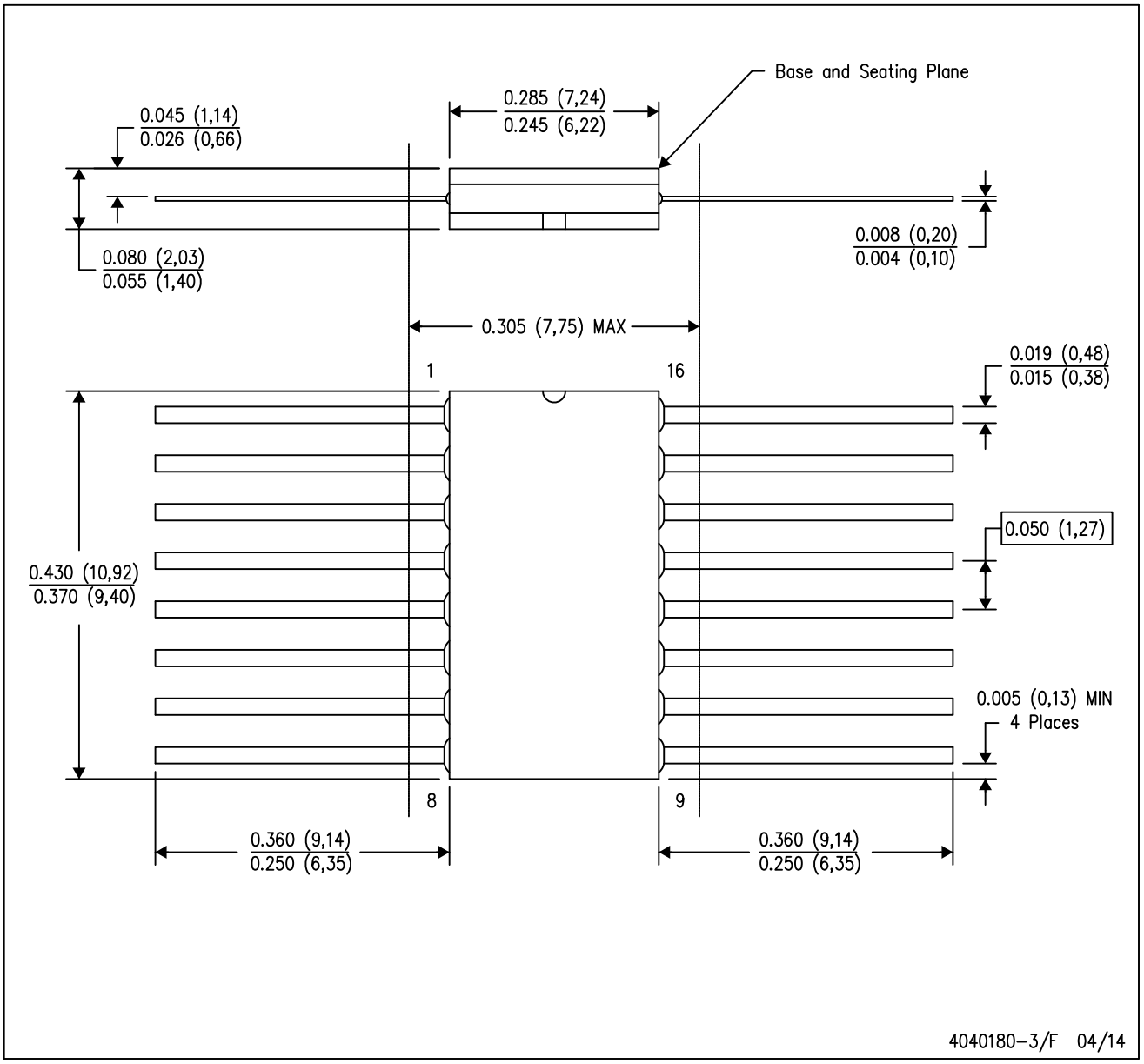


DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

W (R–GDFP–F16) CERAMIC DUAL FLATPACK



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL STD 1835 GDFP2–F16

GENERIC PACKAGE VIEW

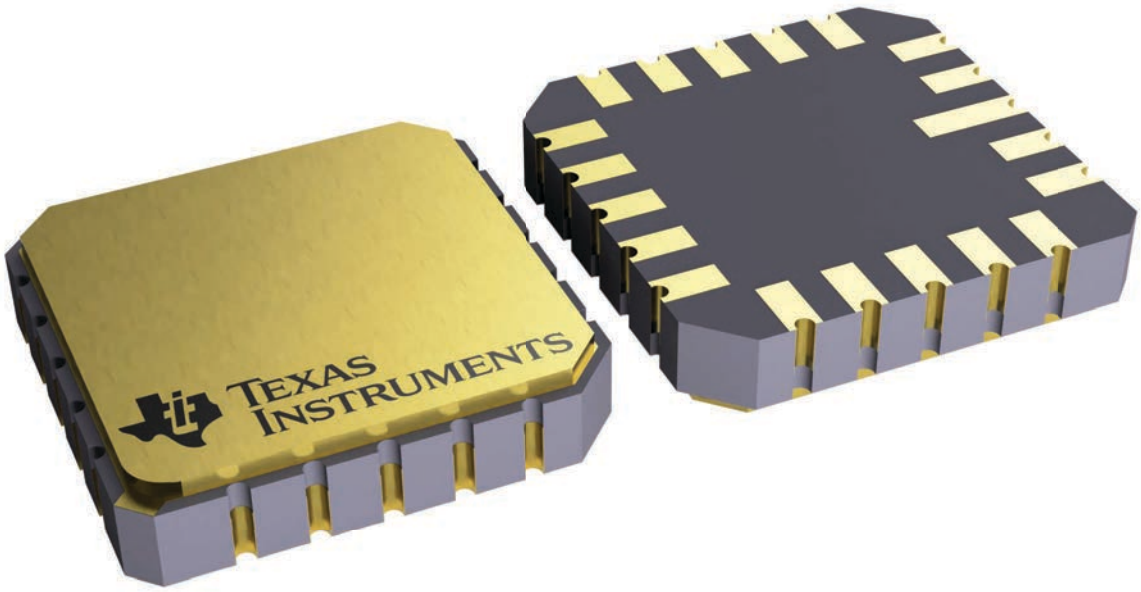
FK 20

LCCC - 2.03 mm max height

8.89 x 8.89, 1.27 mm pitch

LEADLESS CERAMIC CHIP CARRIER

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

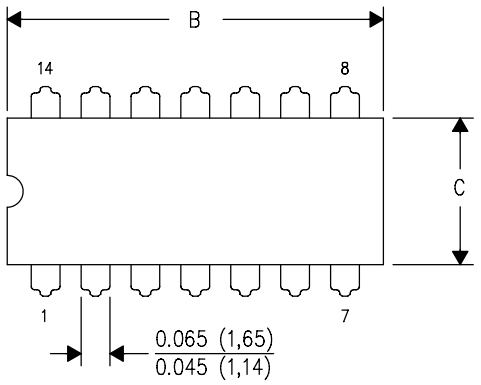


4229370VA\

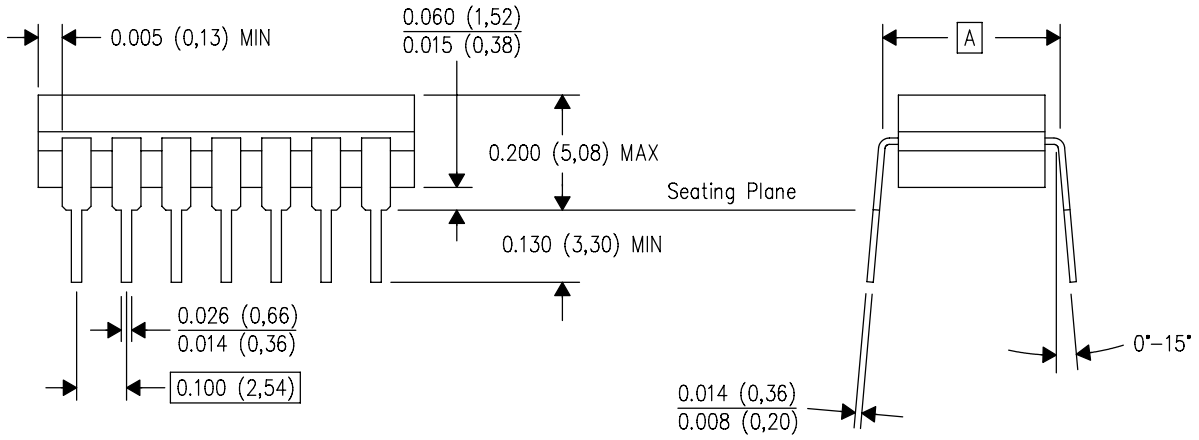
J (R–GDIP–T**)

14 LEADS SHOWN

CERAMIC DUAL IN–LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



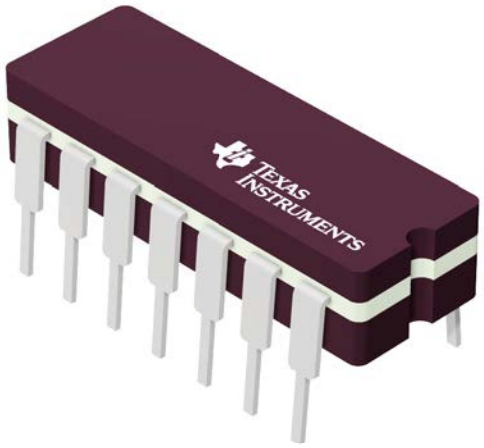
4040083/F 03/03

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 ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

GENERIC PACKAGE VIEW

J 14 CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

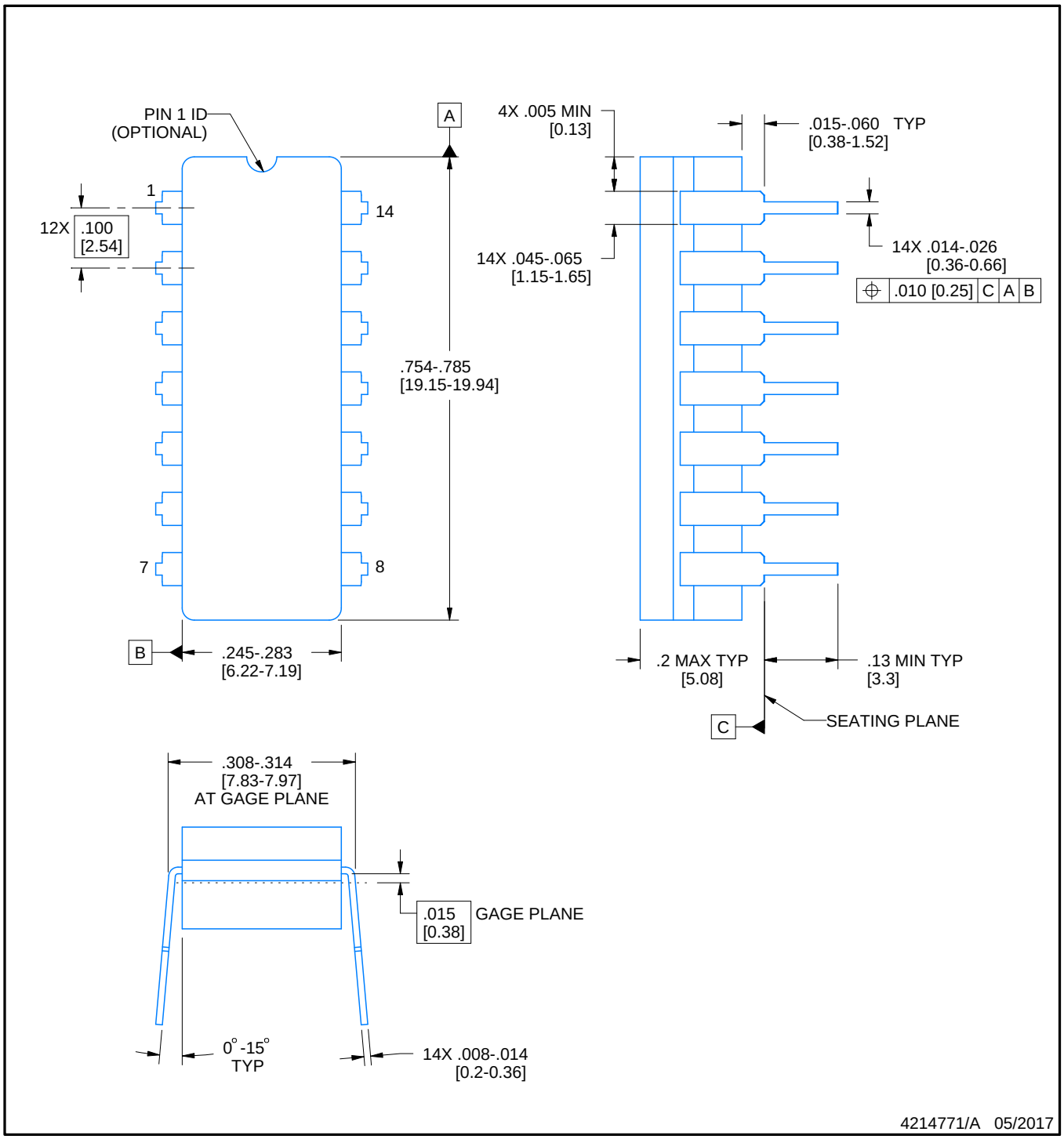
4040083-5/G

PACKAGE OUTLINE

J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



NOTES:

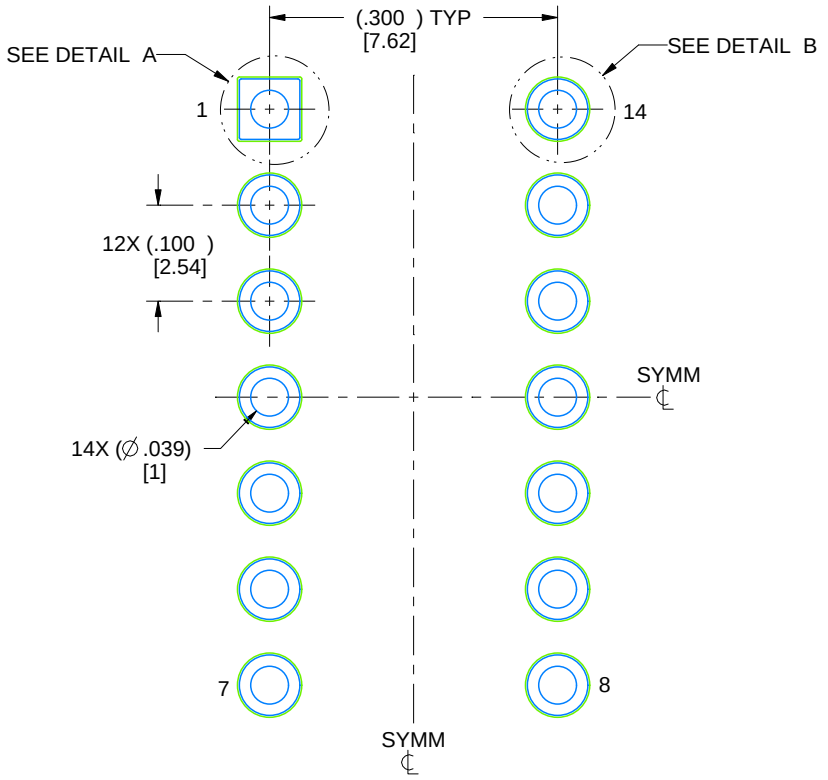
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermitically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.

EXAMPLE BOARD LAYOUT

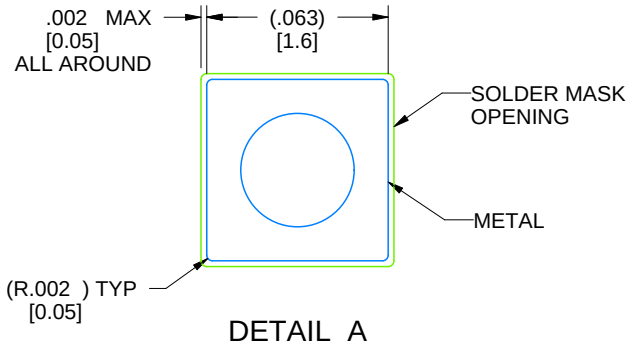
J0014A

CDIP - 5.08 mm max height

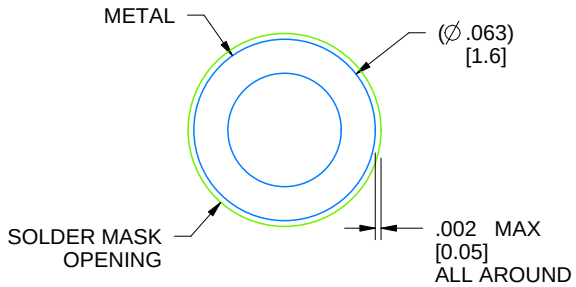
CERAMIC DUAL IN LINE PACKAGE



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE: 5X



DETAIL A
SCALE: 15X



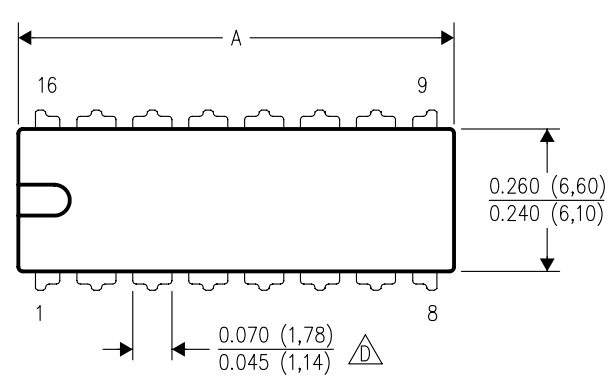
DETAIL B
13X, SCALE: 15X

4214771/A 05/2017

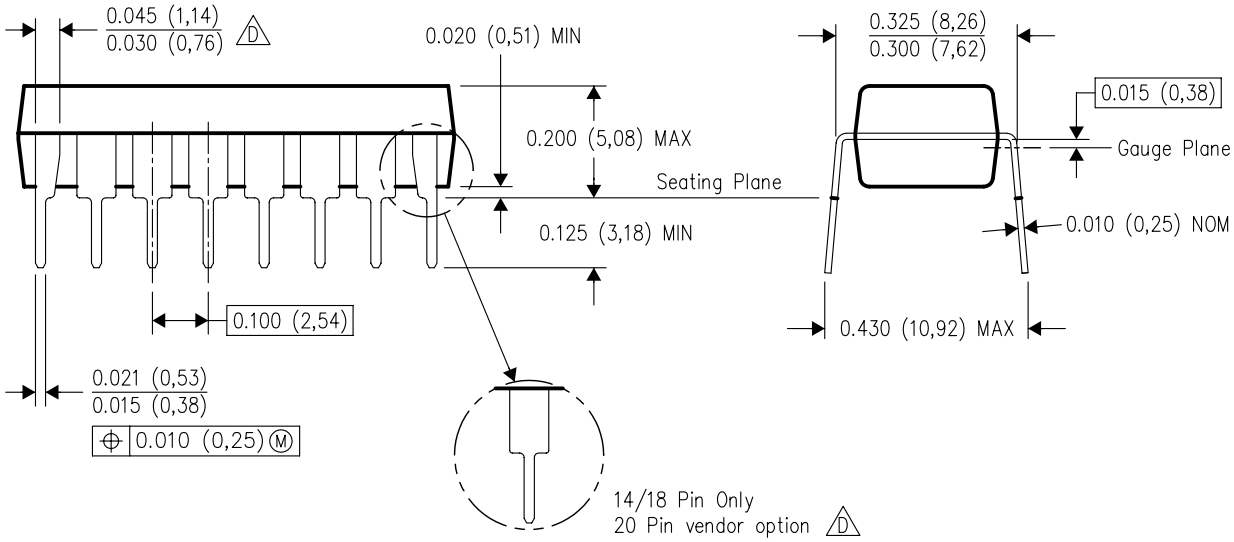
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265