

# LP324, LP2902

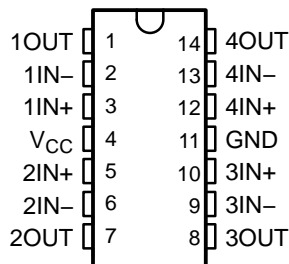
## ULTRA-LOW-POWER QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS460A—MARCH 2005—REVISED MAY 2005

### FEATURES

- Low Supply Current . . . 85  $\mu$ A Typ
- Low Offset Voltage . . . 2 mV Typ
- Low Input Bias Current . . . 2 nA Typ
- Input Common Mode to GND
- Wide Supply Voltage . . . 3 V <  $V_{CC}$  < 32 V
- Pin Compatible With LM324
- Applications
  - LCD Displays
  - Portable Instrumentation
  - Sensor/Metering Equipment
  - Consumer Electronics (MP3 Players, Toys, Etc.)
  - Power Supplies

D, N, OR PW PACKAGE  
(TOP VIEW)



### DESCRIPTION/ORDERING INFORMATION

The LP324 and LP2902 are quadruple low-power operational amplifiers especially suited for battery-operated applications. Good input specifications and wide supply-voltage range still are achieved, despite the ultra-low supply current. Single-supply operation is achieved with an input common-mode range that includes GND.

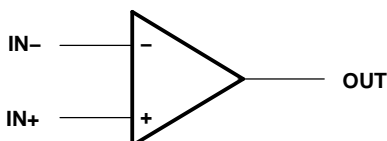
The LP324 and LP2902 are ideal in applications where wide supply voltage and low power are more important than speed and bandwidth. These applications include portable instrumentation, LCD displays, consumer electronics (MP3 players, toys, etc.), and power supplies.

### ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP – N	Tube of 25	LP324N	LP324N
	SOIC – D	Tube of 50	LP324D	LP324
		Reel of 2500	LP324DR	
	TSSOP – PW	Tube of 90	LP324PW	LP324
		Reel of 2000	LP324PWR	
	–40°C to 85°C	PDIP – N	Tube of 25	LP2902N
SOIC – D		Tube of 50	LP2902D	LP2902
		Reel of 2500	LP2902DR	
TSSOP – PW		Tube of 50	LP2902PW	LP2902
		Reel of 2500	LP2902PWR	

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

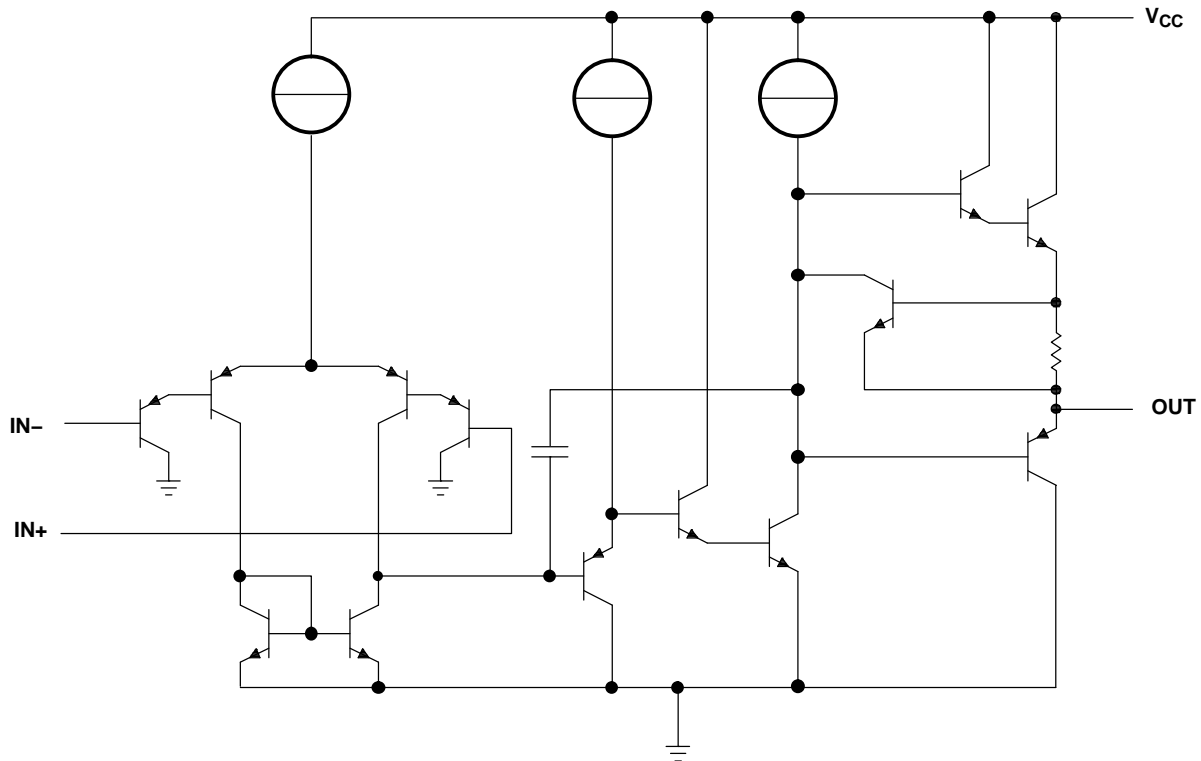
### SYMBOL (EACH AMPLIFIER)



# LP324, LP2902 ULTRA-LOW-POWER QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS460A—MARCH 2005—REVISED MAY 2005

**SCHEMATIC (EACH AMPLIFIER)**



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

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

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage range <sup>(2)</sup>		$\pm 16$ or 32	V
$V_{ID}$	Differential input voltage <sup>(3)</sup>		$\pm 32$	V
$V_I$	Input voltage (either input)	-0.3	32	V
	Duration of output short circuit (one amplifier) to ground at (or below) $T_A = 25^\circ\text{C}$ , $V_{CC} \leq 15\text{ V}$ <sup>(4)</sup>		Unlimited	
$\theta_{JA}$	Package thermal impedance <sup>(5)(6)</sup>		D package	86
			N package	80
			PW package	113
$T_J$	Operating virtual junction temperature		150	$^\circ\text{C}$
$T_{stg}$	Storage temperature range	-65	150	$^\circ\text{C}$

- (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) All voltage values (except differential voltages and  $V_{CC}$  specified for the measurement of  $I_{OS}$ ) are with respect to the network GND.
- (3) Differential voltages are at IN+, with respect to IN-.
- (4) Short circuits from outputs to  $V_{CC}$  can cause excessive heating and eventual destruction.
- (5) Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of  $150^\circ\text{C}$  can affect reliability.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

## ESD Protection

TEST CONDITIONS	TYP	UNIT
Human-Body Model	$\pm 2$	kV

# LP324, LP2902

## ULTRA-LOW-POWER QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS460A—MARCH 2005—REVISED MAY 2005

### Electrical Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{IC} = V_{CC}/2$ ,  $R_L = 100\text{ k}\Omega$  to GND (unless otherwise noted)

PARAMETER	TEST CONDITIONS <sup>(1)</sup>	$T_A$ <sup>(2)</sup>	LP324		LP2902		UNIT
			MIN	TYP <sup>(3)</sup>	MAX	MIN	
$V_{IO}$ Input offset voltage		25°C	2	4	2	4	mV
		Full range		9		10	
$I_{IB}$ Input bias current		25°C	2	10	2	20	nA
		Full range		20		40	
$I_{IO}$ Input offset current		25°C	0.2	2	0.5	4	nA
		Full range		4		8	
$A_V$ Large-signal voltage gain	$R_L = 10\text{ k}\Omega$ to GND, $V_{CC} = 30\text{ V}$	25°C	50	100	40	70	V/mV
		Full range	40		30		
CMRR Common-mode rejection ratio	$V_{CC} = 30\text{ V}$ , $V_{IC} = 0\text{ V}$ to $V_{CC} - 1.5\text{ V}$	25°C	80	90	80	90	dB
		Full range	75		75		
$k_{VSR}$ Power-supply rejection ratio	$V_{CC} = 5\text{ V}$ to $30\text{ V}$	25°C	80	90	80	90	V
		Full range	75		75		
$I_{CC}$ Supply current	$R_L = \infty$	25°C	85	150	85	150	$\mu\text{A}$
		Full range		250		275	
$V_{OH}$ Output voltage swing (high)	$I_L = 0.35\text{ mA}$ to GND, $V_{IC} = 0\text{ V}$	25°C	3.4	3.6	3.4	3.6	V
		Full range	$V_{CC} - 1.9$		$V_{CC} - 1.9$		
$V_{OL}$ Output voltage swing (low)	$I_L = 0.35\text{ mA}$ from $V_{CC}$ , $V_{IC} = 0\text{ V}$	25°C	0.82	0.7	0.82	0.7	V
		Full range	1		1		
$I_O$ Output source current	$V_O = 3\text{ V}$ , $V_{ID} = 1\text{ V}$	25°C	7	10	7	10	mA
		Full range	4		4		
$I_O$ Output sink current	$V_O = 1.5\text{ V}$ , $V_{ID} = -1\text{ V}$	25°C	4	5	4	5	mA
		Full range	3		3		
	$V_O = 1.5\text{ V}$ , $V_{ID} = -1\text{ V}$ , $V_{IC} = 0\text{ V}$	25°C	2	4	2	4	
		Full range	1		1		
$I_{OS,GND}$ Output short to GND	$V_{ID} = 1\text{ V}$	25°C	20	35	20	35	mA
		Full range		40		40	
$I_{OS,VCC}$ Output short to $V_{CC}$	$V_{ID} = -1\text{ V}$	25°C	15	30	15	30	mA
		Full range		45		45	
$\infty V_{IO}$ Input offset voltage drift		25°C	10		10	$\mu\text{V}/^\circ\text{C}$	
$\infty I_{IO}$ Input offset current drift		25°C	10		10	$\text{pA}/^\circ\text{C}$	

(1) For full-range temperature limits:  $V_{CC} = 3\text{ V}$  to  $32\text{ V}$ ,  $V_{ICR} = 0\text{ V}$  to  $V_{CC} - 1.5\text{ V}$  (unless otherwise noted)

(2) Full range is  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for LP324 and  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for LP2902.

(3) All typical values are at  $T_A = 25^\circ\text{C}$ .

### Operating Conditions

$V_{CC} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER		TYP	UNIT
GBW	Gain bandwidth product	100	kHz
SR	Slew rate	50	V/ms

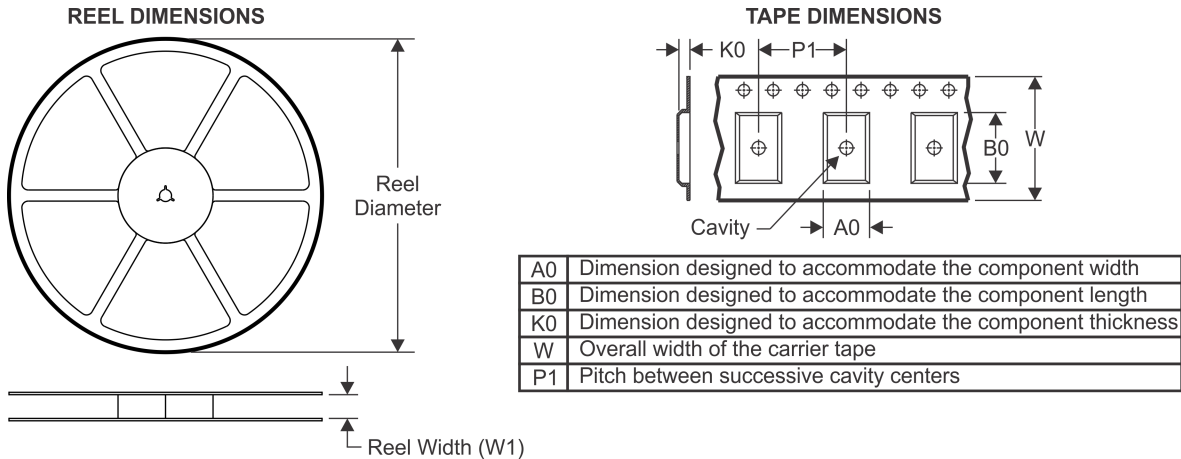
# PACKAGE OPTION ADDENDUM

10-Jun-2014

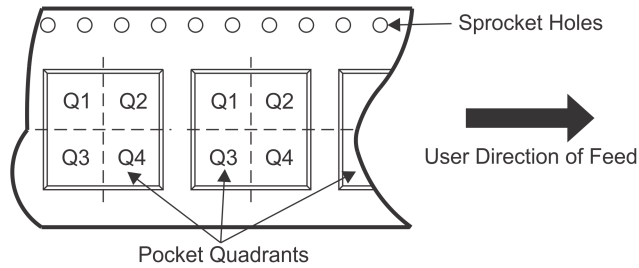
## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LP2902D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2902	<a href="#">Samples</a>
LP2902DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2902	<a href="#">Samples</a>
LP2902N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	LP2902N	<a href="#">Samples</a>
LP2902PW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2902	<a href="#">Samples</a>
LP2902PWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2902	<a href="#">Samples</a>
LP2902PWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2902	<a href="#">Samples</a>
LP324D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU   CU SN	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	LP324N	<a href="#">Samples</a>
LP324NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	LP324N	<a href="#">Samples</a>
LP324PW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324PWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324PWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>
LP324PWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP324	<a href="#">Samples</a>

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



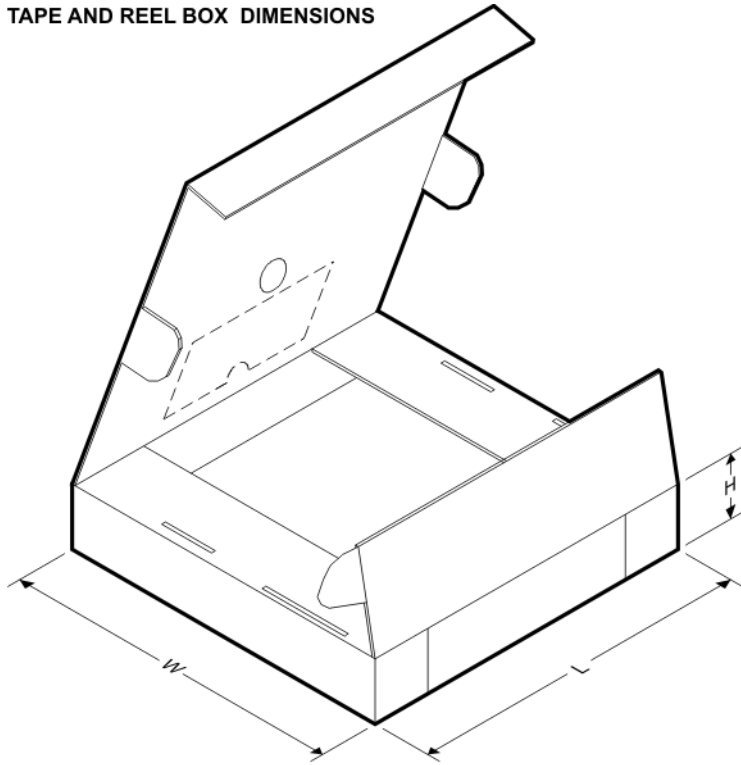
\*All dimensions are nominal

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
LP2902DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LP2902PWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
LP324DR	SOIC	D	14	2500	330.0	16.8	6.5	9.5	2.3	8.0	16.0	Q1
LP324DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LP324DRG4	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LP324PWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

# PACKAGE MATERIALS INFORMATION

11-Oct-2013

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LP2902DR	SOIC	D	14	2500	333.2	345.9	28.6
LP2902PWR	TSSOP	PW	14	2000	367.0	367.0	35.0
LP324DR	SOIC	D	14	2500	364.0	364.0	27.0
LP324DR	SOIC	D	14	2500	333.2	345.9	28.6
LP324DRG4	SOIC	D	14	2500	333.2	345.9	28.6
LP324PWR	TSSOP	PW	14	2000	367.0	367.0	35.0

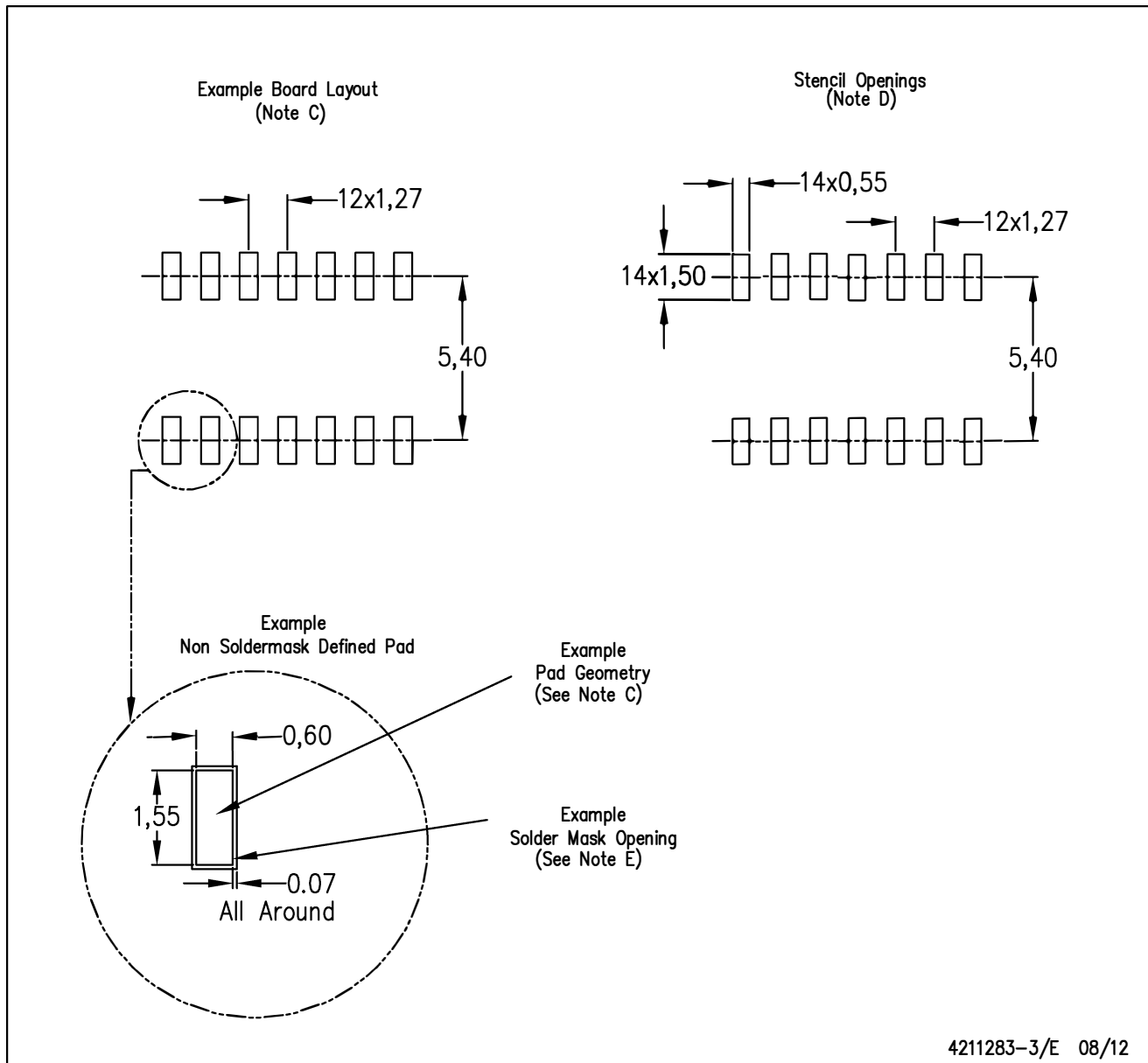






D (R-PDSO-G14)

PLASTIC SMALL OUTLINE

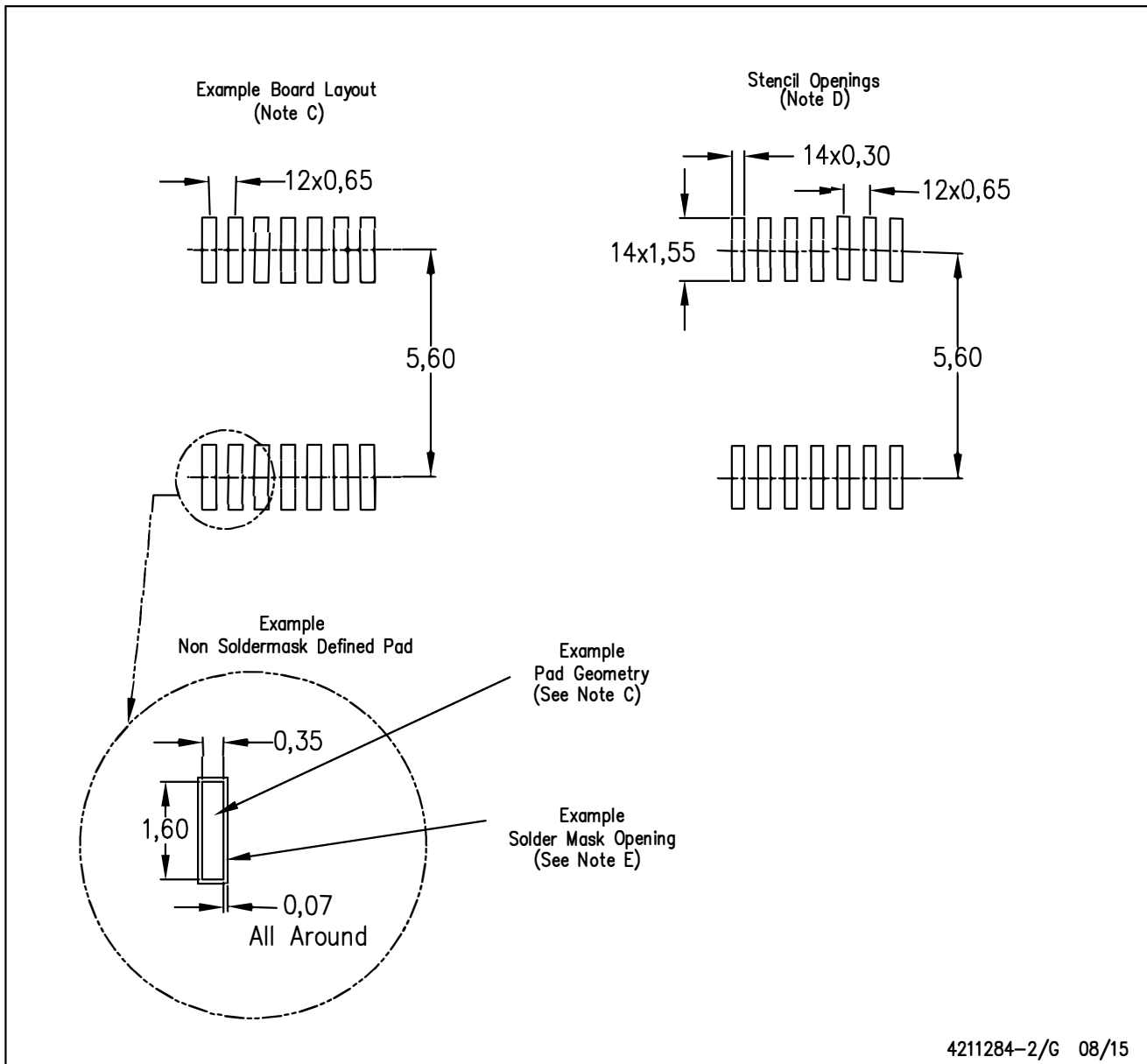


- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.