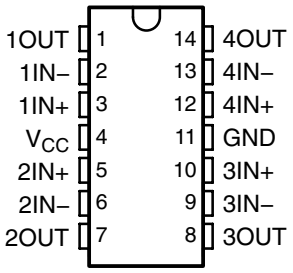
- **Qualified for Automotive Applications**
- **ESD Protection <500 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0); 1500 V Using Charged Device Model**
- **ESD Human Body Model >2 kV Machine Model >200 V and Charge Device Model = 2 kV For K-Suffix Devices.**
- **Low Supply-Current Drain Independent of Supply Voltage . . . 0.8 mA Typ**
- **Low Input Bias and Offset Parameters:**
  - **Input Offset Voltage . . . 3 mV Typ**
  - **Input Offset Current . . . 2 nA Typ**
  - **Input Bias Current . . . 20 nA Typ**
- **Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground**
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage:**
  - **Non-V devices . . . 26 V**
  - **V-Suffix devices . . . 32 V**
- **Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

D OR PW PACKAGE
(TOP VIEW)



description/ordering information

This device consists of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is possible when the difference between the two supplies is 3 V to 26 V (3 V to 32 V for V-suffixed devices), and V_{CC} is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational-amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, the LM2902 can be operated directly from the standard 5-V supply that is used in digital systems and easily provides the required interface electronics without requiring additional ±15-V supplies.

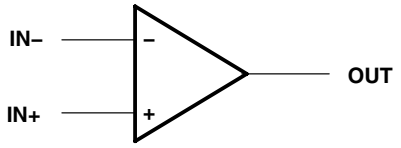
ORDERING INFORMATION†

T_A	V_{IO} max AT 25°C	MAX V_{CC}	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	7 mV	26 V	SOIC (D)	Reel of 2500	LM2902QDRQ1	2902Q1
			TSSOP (PW)	Reel of 2000	LM2902QPWRQ1	2902Q1
	7 mV	32 V	SOIC (D)	Reel of 2500	LM2902KVQDRQ1	2902KVQ
			TSSOP (PW)	Reel of 2000	LM2902KVQPWRQ1	2902KVQ
	2 mV	32 V	SOIC (D)	Reel of 2500	LM2902KAVQDRQ1	2902KAQ
			TSSOP (PW)	Reel of 2000	LM2902KAVQPWRQ1	2902KAQ

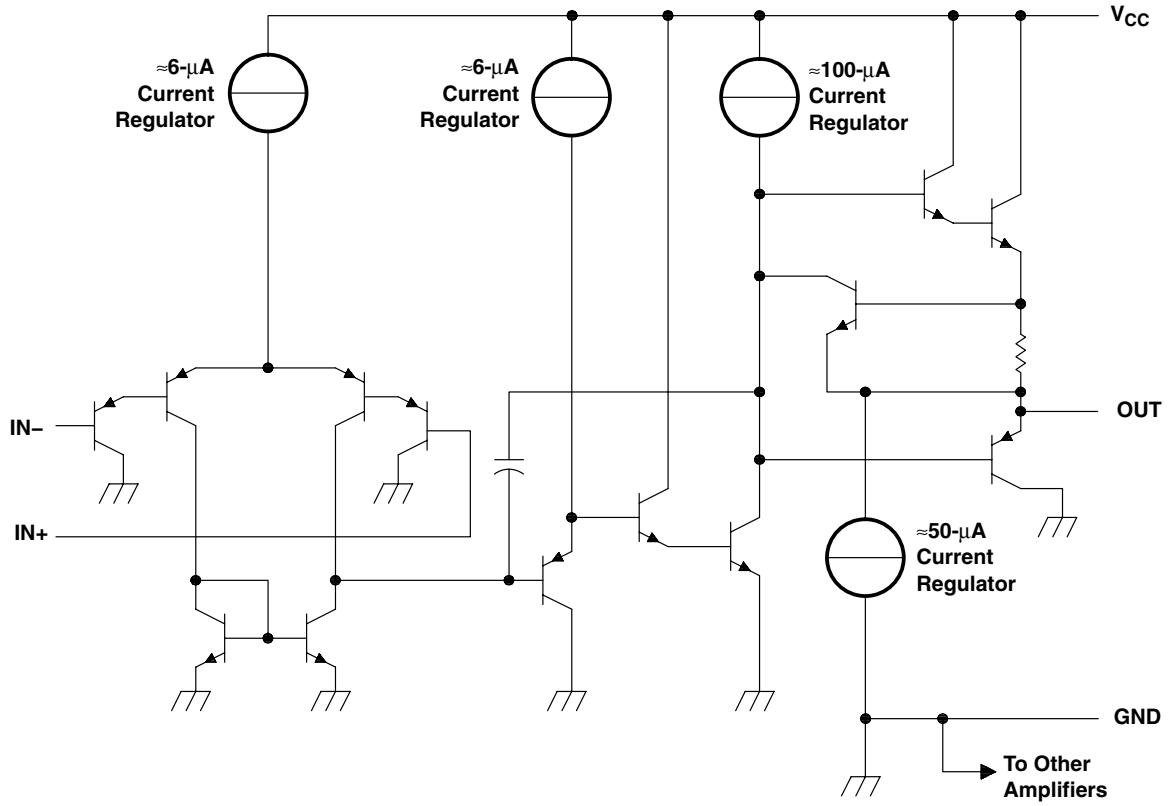
† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at http://www.ti.com.

‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.

symbol (each amplifier)



schematic (each amplifier)



COMPONENT COUNT (TOTAL DEVICE)	
Epi-FET	1
Transistors	95
Diodes	4
Resistors	11
Capacitors	4

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

		LM2902-Q1	LM2902KV-Q1	UNIT
Supply voltage, V_{CC} (see Note 1)		26	32	V
Differential input voltage, V_{ID} (see Note 2)		±26	±32	V
Input voltage, V_I (either input)		–0.3 to 26	–0.3 to 32	V
Duration of output short circuit (one amplifier) to ground at (or below) T_A = 25°C, V_{CC} ≤ 15 V (see Note 3)		Unlimited	Unlimited	
Package thermal impedance, θ_{JA} (see Notes 4 and 5)	D package (0 LFPM)	101	101	°C/W
	PW package	113	113	
Operating virtual junction temperature, T_J		142	142	°C
Storage temperature range, T_{stg}		–65 to 150	–65 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. All voltage values, except differential voltages and V_{CC} specified for the measurement of I_{OS}, are with respect to the network GND.
2. Differential voltages are at IN+ with respect to IN–.
3. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.
4. Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 142°C can affect reliability.
5. The package thermal impedance is calculated in accordance with JESD 51-7.

electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	T_A‡	LM2902-Q1			UNIT
				MIN	TYP§	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to 26 V, $V_{IC} = V_{ICR}$min, V_O = 1.4 V	25°C		3	7	mV
			Full range			10	
I_{IO}	Input offset current	V_O = 1.4 V	25°C		2	50	nA
			Full range			300	
I_{IB}	Input bias current	V_O = 1.4 V	25°C		–20	–250	nA
			Full range			–500	
V_{ICR}	Common-mode input voltage range	V_{CC} = 5 V to 26 V	25°C	0 to V_{CC} – 1.5			V
			Full range	0 to V_{CC} – 2			
V_{OH}	High-level output voltage	R_L = 10 kΩ	25°C	V_{CC} – 1.5			V
		V_{CC} = 26 V, R_L = 2 kΩ	Full range	22			
		V_{CC} = 26 V, R_L ≥ 10 kΩ	Full range	23	24		
V_{OL}	Low-level output voltage	R_L ≤ 10 kΩ	Full range		5	20	mV
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V, V_O = 1 V to 11 V, R_L ≥ 2 kΩ	25°C		100		V/mV
			Full range	15			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min	25°C	50	80		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)		25°C	50	100		dB
V_{O1}/V_{O2}	Crosstalk attenuation	f = 1 kHz to 20 kHz	25°C		120		dB
I_O	Output current	V_{CC} = 15 V, V_{ID} = 1 V, V_O = 0	25°C	–20	–30	–60	mA
			Full range	–10			
		V_{CC} = 15 V, V_{ID} = –1 V, V_O = 15 V	25°C	10	20		
			Full range	5			
		V_{ID} = –1 V, V_O = 200 mV	25°C		30		μA
I_{OS}	Short-circuit output current	V_{CC} at 5 V, V_O = 0, GND at –5 V	25°C		±40	±60	mA
I_{CC}	Supply current (four amplifiers)	V_O = 2.5 V, No load	Full range		0.7	1.2	mA
		V_{CC} = 26 V, V_O = 0.5 V_{CC}, No load	Full range		1.4	3	

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
‡ Full range is –40°C to 125°C.
§ All typical values are at T_A = 25°C.

electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS†		T_A‡	LM2902KV-Q1			UNIT
					MIN	TYP§	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to 32 V, $V_{IC} = V_{ICR}$min, V_O = 1.4 V	Non-A devices	25°C		3	7	mV
				Full range			10	
			A-suffix devices	25°C		1	2	
				Full range			4	
$\Delta V_{IO}/\Delta T$	Temperature drift	R_S = 0 Ω		Full range		7		µV/°C
I_{IO}	Input offset current	V_O = 1.4 V		25°C		2	50	nA
				Full range			150	
$\Delta I_{IO}/\Delta T$	Temperature drift			Full range		10		pA/°C
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–20	–250	nA
				Full range			–500	
V_{ICR}	Common-mode input voltage range	V_{CC} = 5 V to 32 V		25°C	0 to V_{CC} – 1.5			V
				Full range	0 to V_{CC} – 2			
V_{OH}	High-level output voltage	R_L = 10 kΩ		25°C	V_{CC} – 1.5			V
		V_{CC} = 32 V,	R_L = 2 kΩ	Full range	26			
		V_{CC} = 32 V,	$R_L \geq$ 10 kΩ	Full range	27			
V_{OL}	Low-level output voltage	$R_L \leq$ 10 kΩ		Full range		5	20	mV
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V, V_O = 1 V to 11 V, $R_L \geq$ 2 kΩ		25°C	25	100		V/mV
				Full range	15			
	Amplifier-to-amplifier coupling¶	f = 1 kHz to 20 kHz, input referred		25°C		120		dB
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min		25°C	60	80		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)			25°C	60	100		dB
V_{O1}/V_{O2}	Crosstalk attenuation	f = 1 kHz to 20 kHz		25°C		120		dB
I_O	Output current	V_{CC} = 15 V_O = 0	V_{ID} = 1 V,	25°C	–20	–30	–60	mA
				Full range	–10			
		V_{CC} = 15 V_O = 15 V	V_{ID} = –1 V,	25°C	10	20		
				Full range	5			
		V_{ID} = –1 V,	V_O = 200 mV	25°C	12	40		µA
I_{OS}	Short-circuit output current	V_{CC} at 5 V, GND at –5 V	V_O = 0,	25°C		±40	±60	mA
I_{CC}	Supply current (four amplifiers)	V_O = 2.5 V,	No load	Full range		0.7	1.2	mA
		V_{CC} = 32 V V_O = 0.5 V_{CC},	No load	Full range		1.4	3	

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
‡ Full range is –40°C to 125°C.
§ All typical values are at T_A = 25°C.
¶ Due to proximity of external components, ensure that coupling is not originating via stray capacitance between these external parts. Typically, this can be detected, as this type of coupling increases at higher frequencies.

operating conditions, V_{CC} = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	R_L = 1 MΩ, C_L = 30 pF, V_I = ±10 V (see Figure 1)	0.5	V/μs
B_1	Unity-gain bandwidth	R_L = 1 MΩ, C_L = 20 pF (see Figure 1)	1.2	MHz
V_n	Equivalent input noise voltage	R_S = 100 Ω, V_I = 0 V, f = 1 kHz (see Figure 2)	35	nV/√Hz

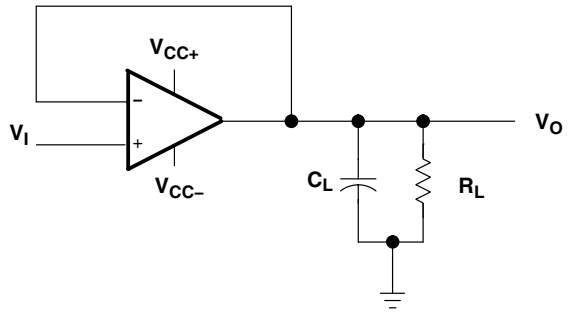


Figure 1. Unity-Gain Amplifier

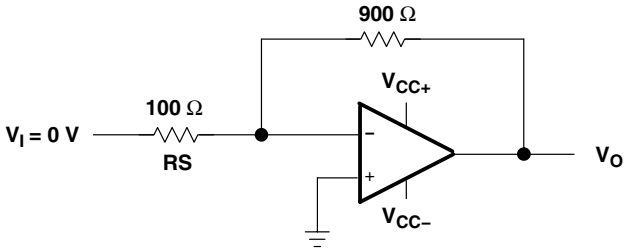


Figure 2. Noise-Test Circuit

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
LM2902KAVQDRQ1	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902KAQ	Samples
LM2902KAVQPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902KAQ	Samples
LM2902KAVQPWRQ1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902KAQ	Samples
LM2902KVQDRQ1	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902KVQ	Samples
LM2902KVQPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902KVQ	Samples
LM2902KVQPWRQ1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902KVQ	Samples
LM2902QDRG4Q1	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902Q1	Samples
LM2902QDRQ1	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902Q1	Samples
LM2902QPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902Q1	Samples
LM2902QPWRQ1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2902Q1	Samples

(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 <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm 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.

OTHER QUALIFIED VERSIONS OF LM2902-Q1 :

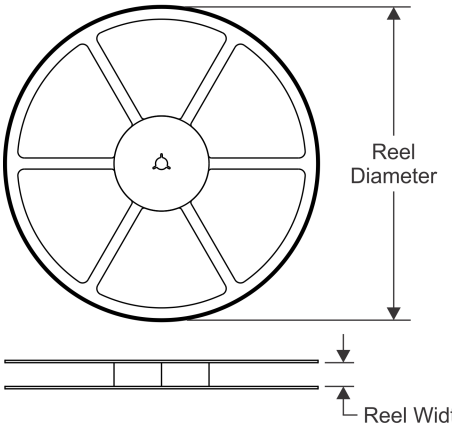
- Catalog: LM2902
- Enhanced Product: LM2902-EP

NOTE: Qualified Version Definitions:

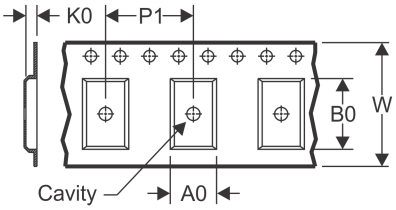
- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

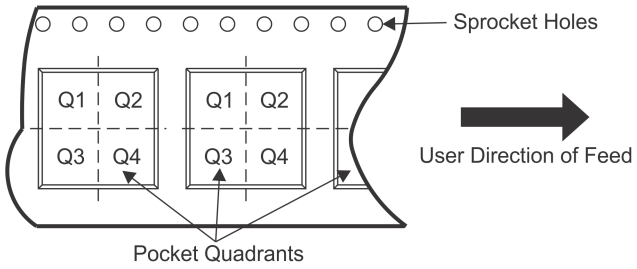


TAPE DIMENSIONS



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

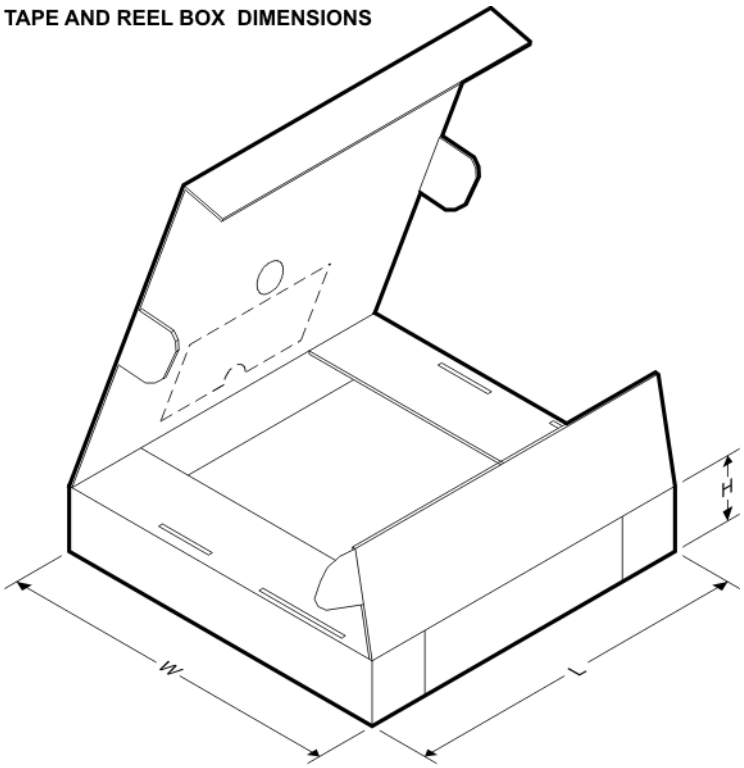
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM2902KAVQPWRG4Q1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
LM2902KAVQPWRQ1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
LM2902KVQPWRG4Q1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
LM2902KVQPWRQ1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
LM2902QPWRG4Q1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
LM2902QPWRQ1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

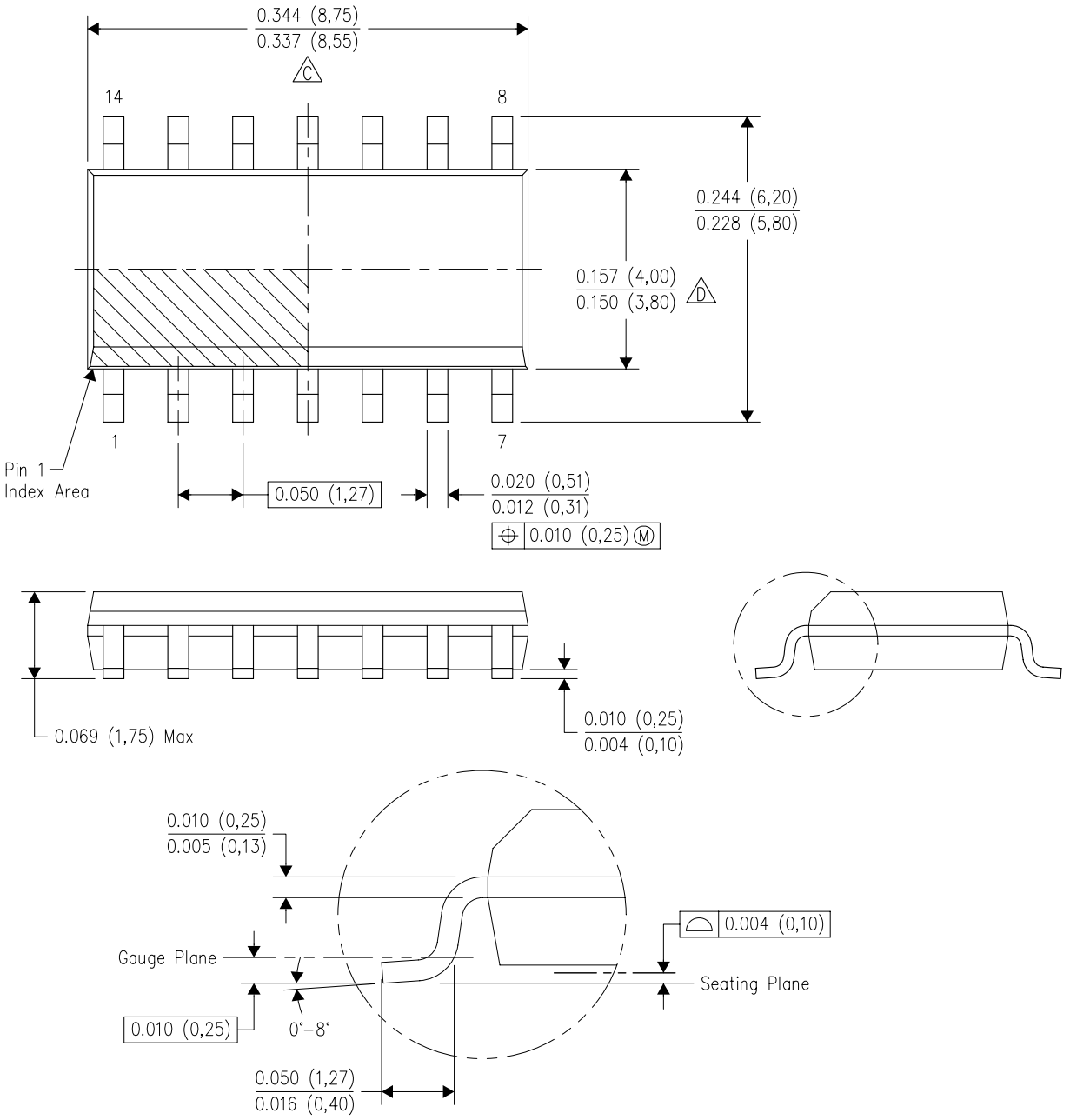
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2902KAVQPWRG4Q1	TSSOP	PW	14	2000	367.0	367.0	35.0
LM2902KAVQPWRQ1	TSSOP	PW	14	2000	367.0	367.0	35.0
LM2902KVQPWRG4Q1	TSSOP	PW	14	2000	367.0	367.0	35.0
LM2902KVQPWRQ1	TSSOP	PW	14	2000	853.0	449.0	35.0
LM2902QPWRG4Q1	TSSOP	PW	14	2000	853.0	449.0	35.0
LM2902QPWRQ1	TSSOP	PW	14	2000	853.0	449.0	35.0

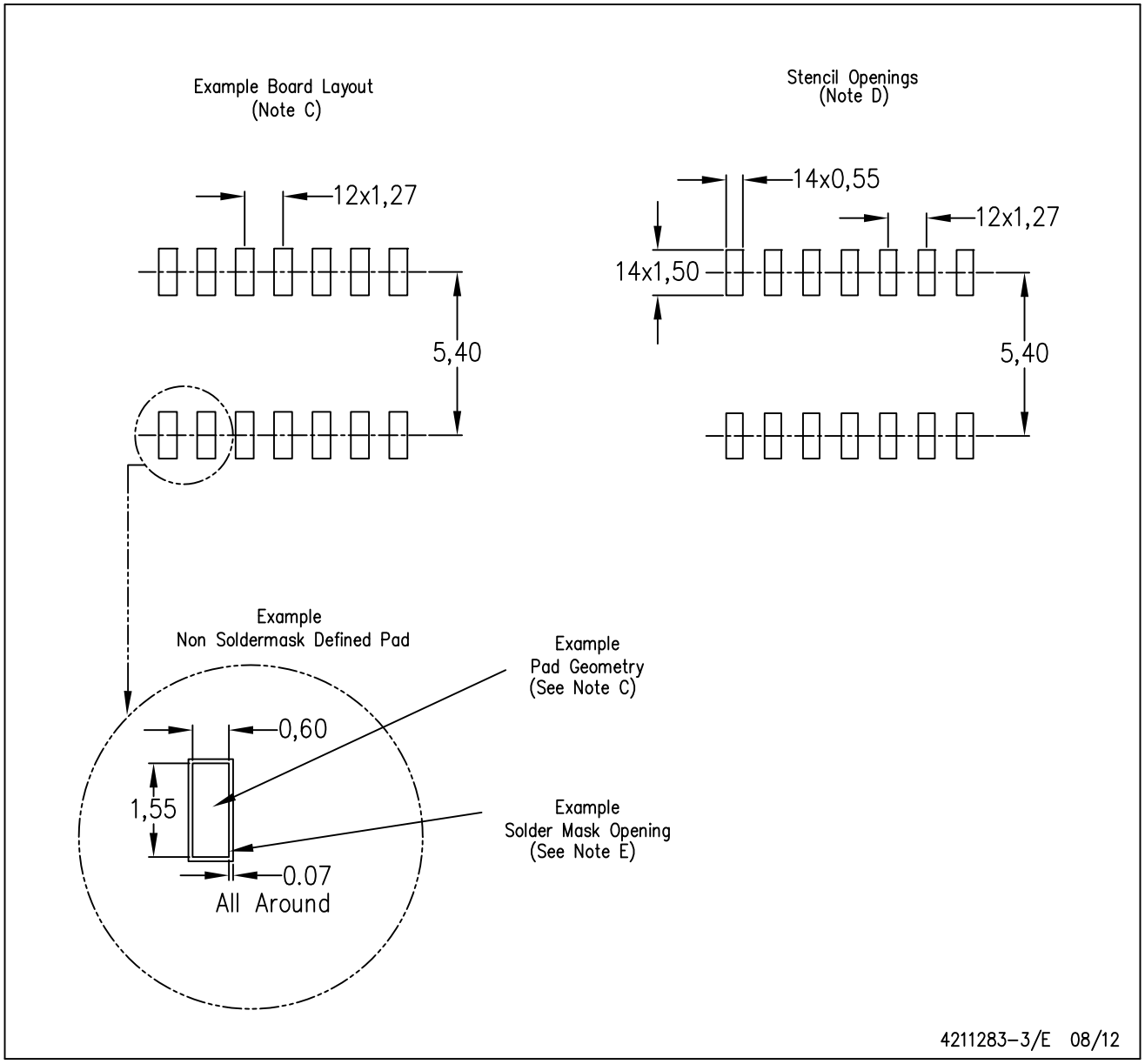
D (R–PDSO–G14) PLASTIC SMALL OUTLINE



4040047–5/M 06/11

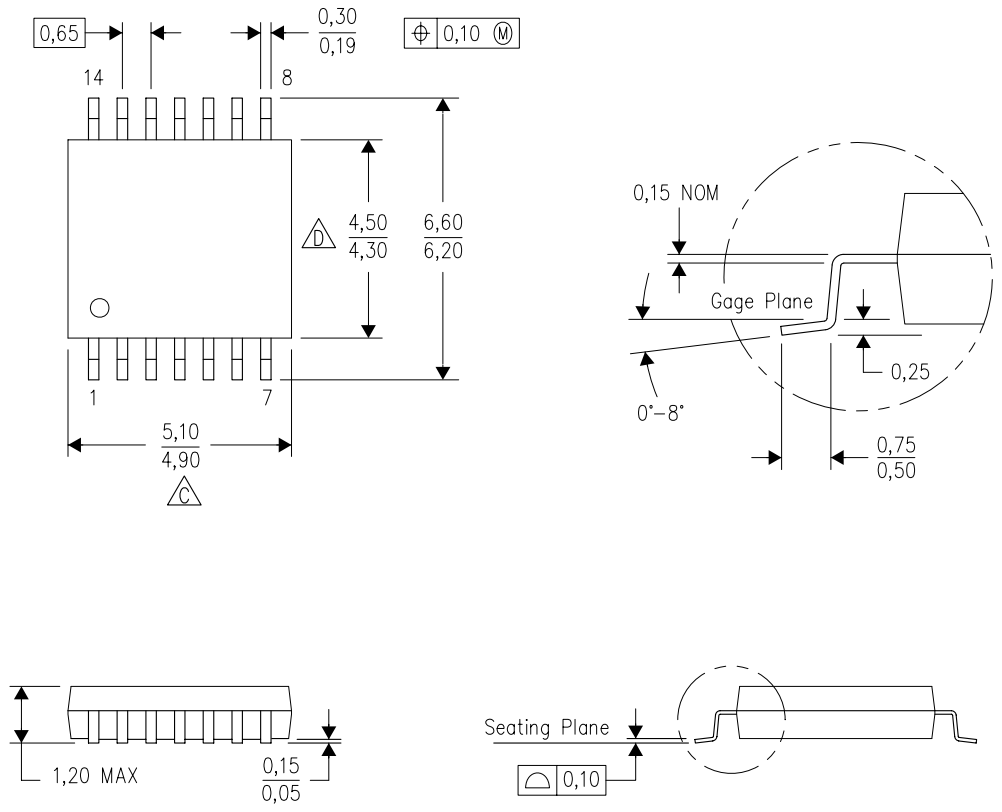
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead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

D (R–PDSO–G14) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. 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.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

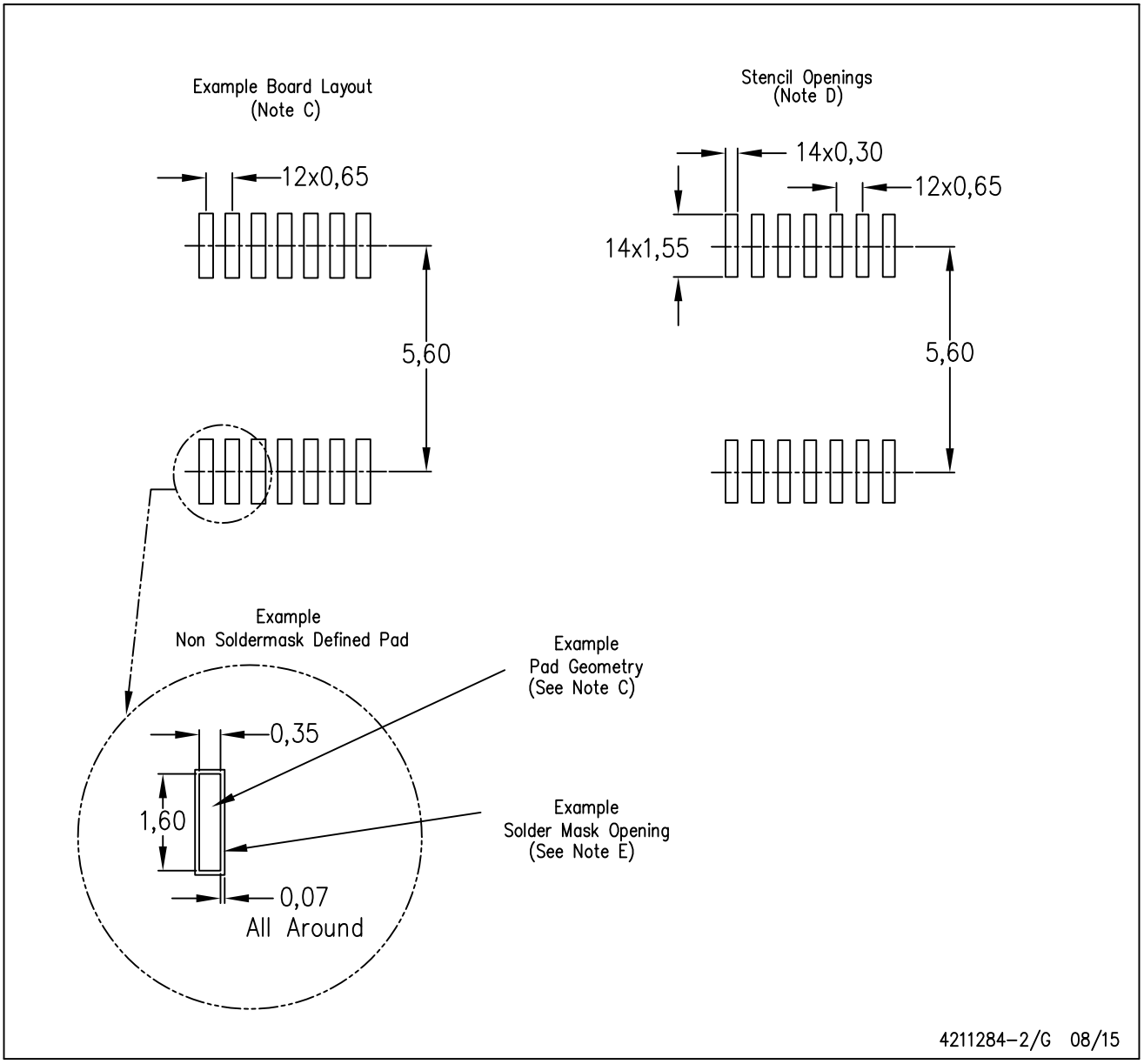
PW (R–PDSO–G14) PLASTIC SMALL OUTLINE



4040064–3/G 02/11

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

PW (R–PDSO–G14) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. 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.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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