QUADRUPLE OPERATIONAL AMPLIFIER

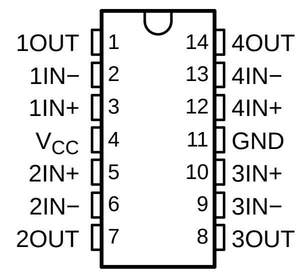
FEATURES

- **Controlled Baseline**
  - **– One Assembly/Test Site, One Fabrication Site**
- **Extended Temperature Performance of -55°C to 125°C**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree**

(1) Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

- **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**
- **V-Suffix devices . . . 32 V D Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

D OR PW PACKAGE
(TOP VIEW)



DESCRIPTION

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.

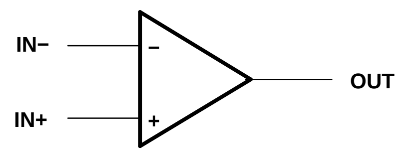
Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational-amplifier circuits that now can be more easily implemented in single-supply voltage systems. For example, the LM2902 can be operated directly from the standard 5-V supply that is used in digital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

ORDERING INFORMATION

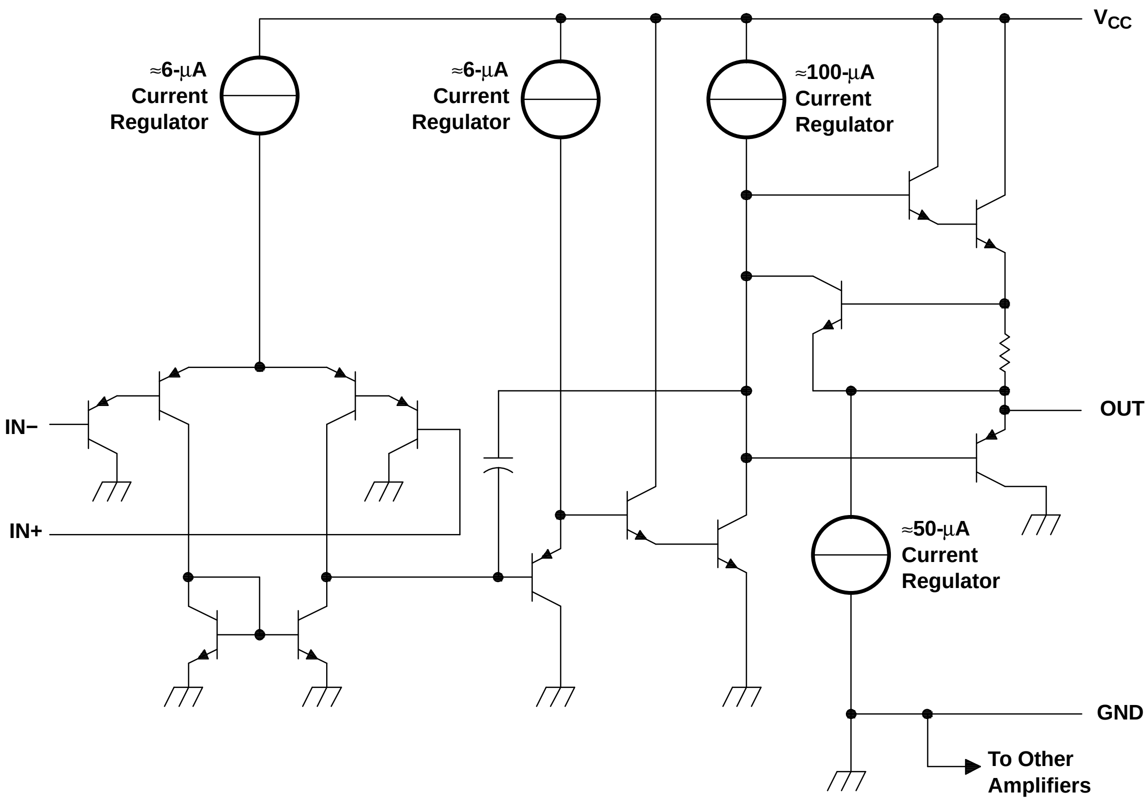
T_A	V_{IO} max AT 25°C	MAX V_{CC}	PACKAGE[(1)]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	7 mV	26 V	SOIC (D)	Reel of 2500	LM2902QDREP[(2)]	2902EP
			TSSOP(PW)	Reel of 2500	LM2902QPWREP[(2)]	2902EP
	7 mV	32 V	SOIC (D)	Reel of 2500	LM2902KVQDREP[(2)]	2902KVE
			TSSOP(PW)	Reel of 2500	LM2902KVQPWREP[(2)]	2902KVE
	3 mV	32 V	SOIC (D)	Reel of 2500	LM2902KAVQDREP[(2)]	LM2902E
			TSSOP(PW)	Reel of 2500	LM2902KAVQPWREP	LM2902E
–55°C to 125°C	7 mV	26 V	SOIC (D)	Reel of 2500	LM2902MDREP[(2)]	2902ME
			TSSOP(PW)	Reel of 2000	LM2902MPWREP[(2)]	2902ME
	7 mV	32 V	SOIC (D)	Reel of 2500	LM2902KVMDREP[(2)]	2902KME
			TSSOP(PW)	Reel of 2000	LM2902KVMPWREP[(2)]	2902KME
	3 mV	32 V	SOIC (D)	Reel of 2500	LM2902KAVMDREP[(2)]	2902KAE
			TSSOP(PW)	Reel of 2000	LM2902KAVMPWREP[(2)]	2902KAE

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
(2) Product Preview

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)[1]

			LM2902-EP	LM2902KV-EP	UNIT
V_{CC}	Supply voltage[2]		26	32	V
V_{ID}	Differential input voltage[3]		±26	±32	V
V_I	Input voltage (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, $V_{CC} \leq$ 15 V[4]		Unlimited	Unlimited	
θ_{JA}	Package thermal impedance[5][6]	D package (0 LFPM)	101	101	°C/W
		PW package	113	113	
T_J	Operating virtual junction temperature		142	142	°C
T_{stg}	Storage temperature range[7]		–65 to 150	–65 to 150	°C

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) 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(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta J_A$. Operating at the absolute maximum T_J of 142°C can affect reliability.
(6) The package thermal impedance is calculated in accordance with JESD 51-7.
(7) Long term high-temperature storage and/or extended use at maximum recommended operating conditions may result in reduction of overall device life. See http://www.ti.com/ep_quality for additional information on enhanced plastic packaging.

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS(1)	T_A(2)	LM2902-EP MIN	TYP(3)	MAX	UNIT
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	25°C	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		mA
			Full range	–10			
		V_{CC} = 15 V, V_{ID} = –1 V, V_O = 15 V	25°C	10	20		mA
			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	

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
(2) Full range is –55°C to 125°C.
(3) All typical values are at T_A = 25°C.

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS[1]		T_A[2]	LM2902KV-EP			UNIT
					MIN	TYP[3]	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	3	
				Full range			4.5	
$\Delta V_{IO}/\Delta T$	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	
$\Delta V_{IO}/\Delta T$	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 = 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[4]	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_{ID} = 1 V,	V_O = 0	25°C	–20	–30		mA
				Full range	–10			
		V_{CC} = 15 V, V_{ID} = -1 V,	V_O = 15 V	25°C	10	20		mA
				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	

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
(2) Full range is –55°C to 125°C.
(3) All typical values are at T_A = 25°C.
(4) 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

$V_{CC} = \pm 15$ 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/$\sqrt{Hz}$

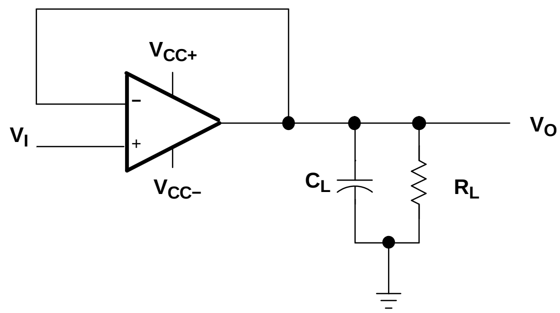


Figure 1. Unity-Gain Amplifier

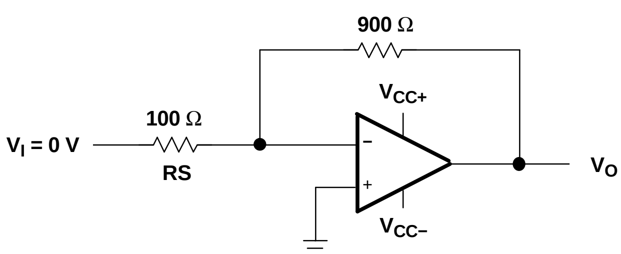
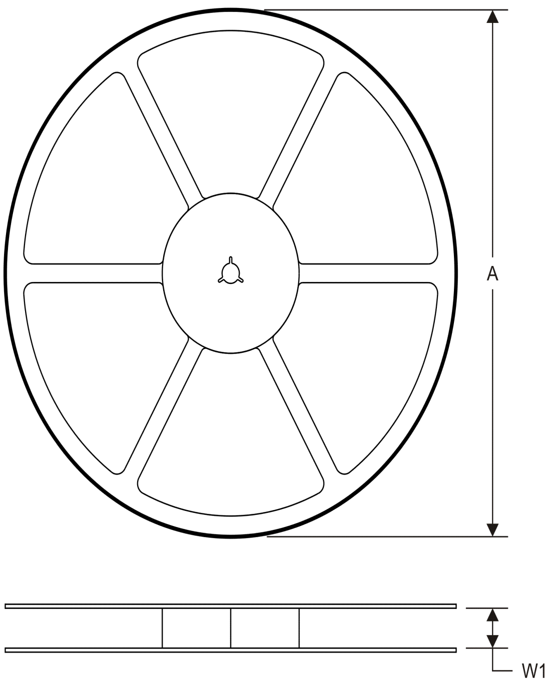


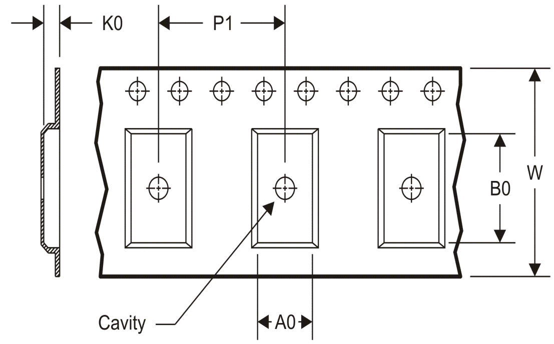
Figure 2. Noise-Test Circuit

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



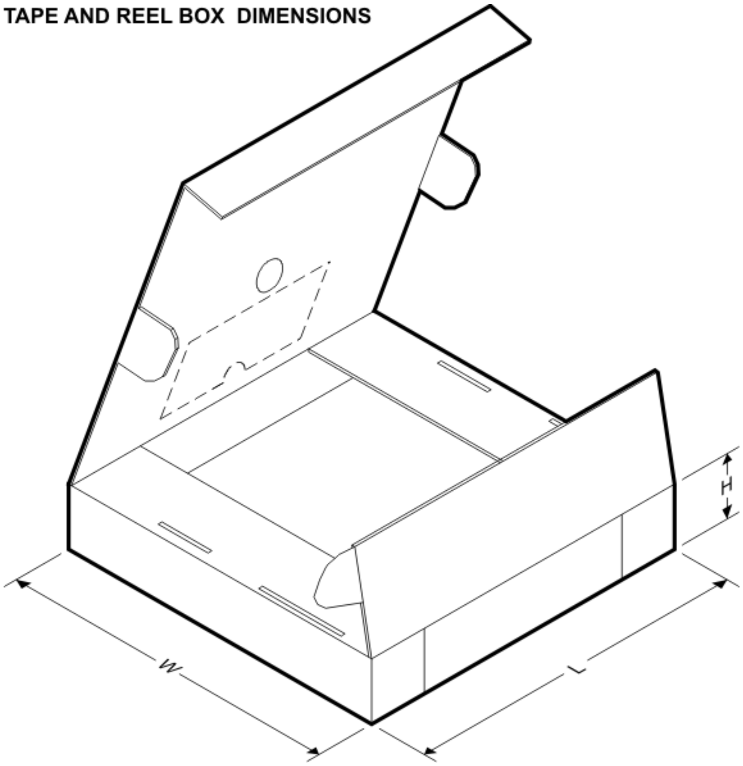
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM2902KAVMPWREP	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
LM2902KAVQPWREP	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

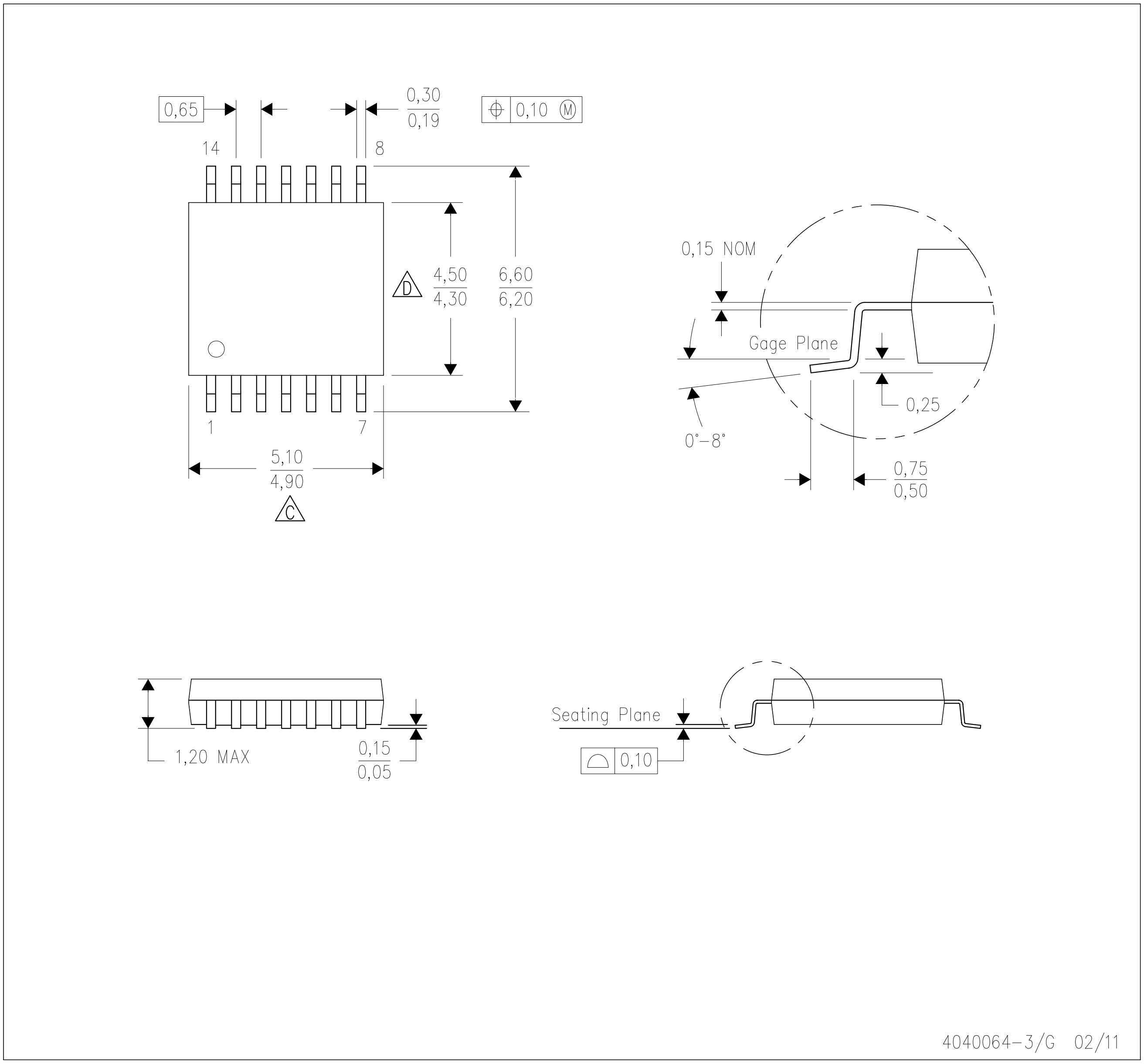
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

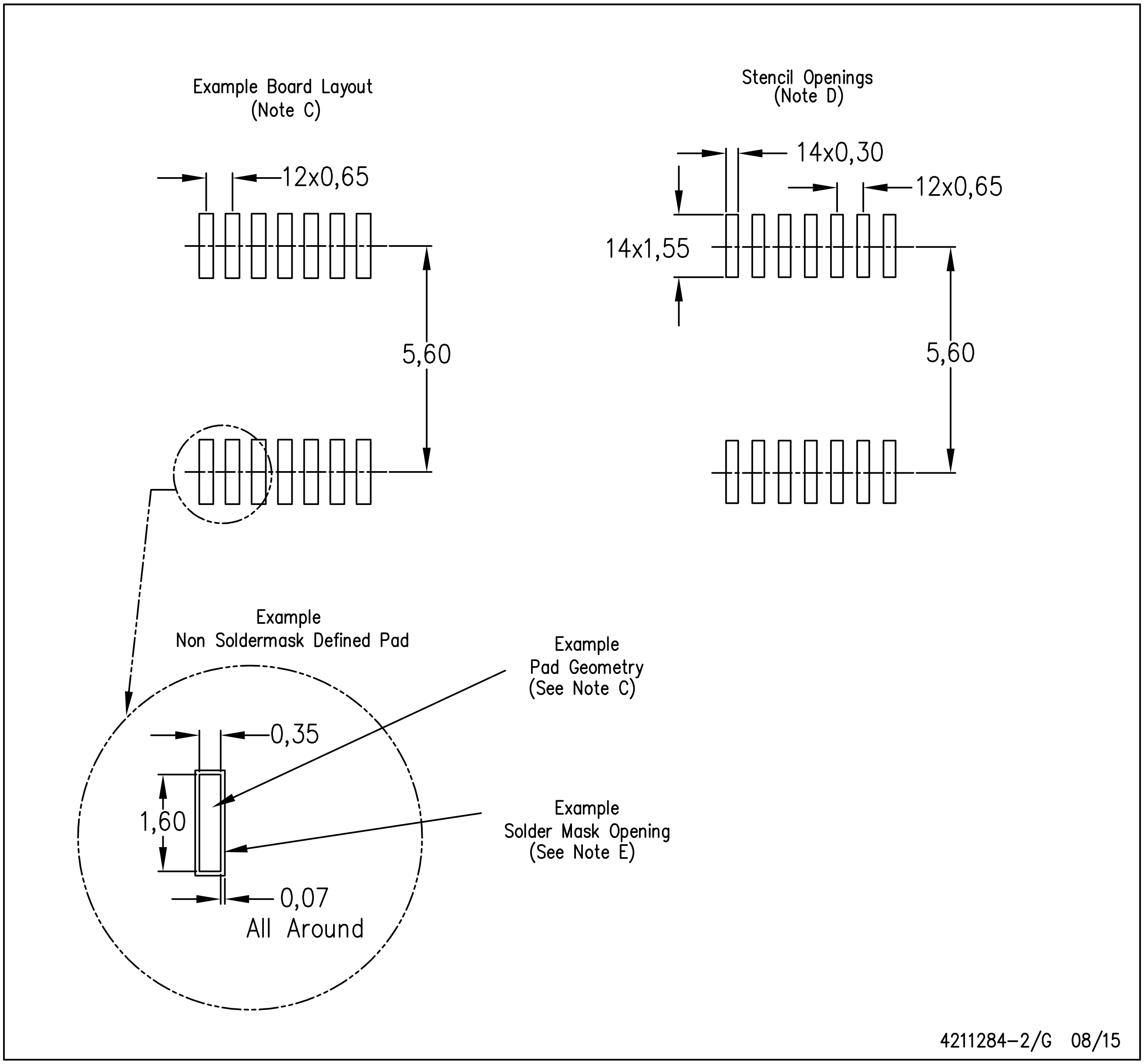
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2902KAVMPWREP	TSSOP	PW	14	2000	367.0	367.0	35.0
LM2902KAVQPWREP	TSSOP	PW	14	2000	367.0	367.0	35.0

PW (R–PDSO–G14) PLASTIC SMALL OUTLINE



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.