

## QUADRUPLE OPERATIONAL AMPLIFIER

### FEATURES

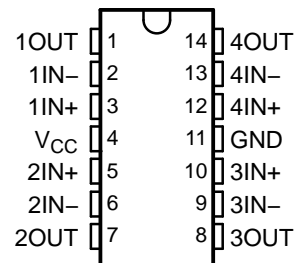
- **Controlled Baseline**
  - One Assembly/Test Site, One Fabrication Site
- **Extended Temperature Performance of -55°C to 125°C**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree**

(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<sub>CC</sub> 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.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

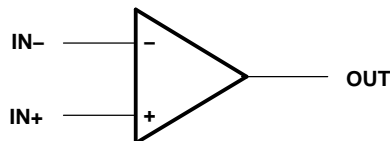
**ORDERING INFORMATION**

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

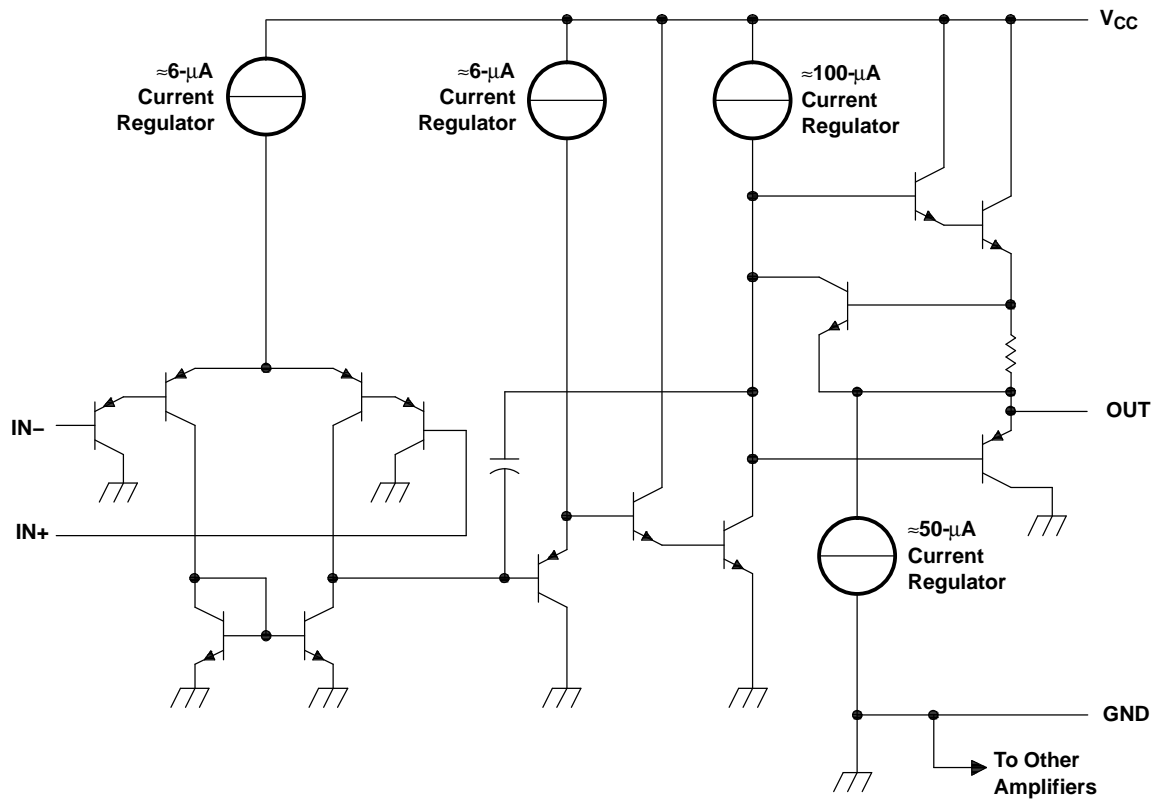
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

(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)<sup>(1)</sup>

		LM2902-EP	LM2902KV-EP	UNIT
V <sub>CC</sub>	Supply voltage <sup>(2)</sup>	26	32	V
V <sub>ID</sub>	Differential input voltage <sup>(3)</sup>	±26	±32	V
V <sub>I</sub>	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 <sub>A</sub> = 25°C, V <sub>CC</sub> ≤ 15 V <sup>(4)</sup>		Unlimited	Unlimited	
θ <sub>JA</sub>	Package thermal impedance <sup>(5)(6)</sup>	D package (0 LFPM)	101	°C/W
		PW package	113	
T <sub>J</sub>	Operating virtual junction temperature	142	142	°C
T <sub>stg</sub>	Storage temperature range <sup>(7)</sup>	–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<sub>CC</sub> specified for the measurement of I<sub>OS</sub>, are with respect to the network GND.
- (3) Differential voltages are at IN+ with respect to IN–.
- (4) Short circuits from outputs to V<sub>CC</sub> can cause excessive heating and eventual destruction.
- (5) Maximum power dissipation is a function of T<sub>J</sub>(max), θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J</sub>(max) – T<sub>A</sub>)/θ<sub>JA</sub>. Operating at the absolute maximum T<sub>J</sub> 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](http://www.ti.com/ep_quality) for additional information on enhanced plastic packaging.

**ELECTRICAL CHARACTERISTICS**

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

PARAMETER	TEST CONDITIONS <sup>(1)</sup>	$T_A$ <sup>(2)</sup>	LM2902-EP			UNIT
			MIN	TYP <sup>(3)</sup>	MAX	
$V_{IO}$ Input offset voltage	$V_{CC} = 5\text{ V to } 26\text{ V}$ , $V_{IC} = V_{ICRmin}$ , $V_O = 1.4\text{ V}$	25°C		3	7	mV
		Full range			10	
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$	25°C		2	50	nA
		Full range			300	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$	25°C		-20	-250	nA
		Full range			-500	
$V_{ICR}$ Common-mode input voltage range	$V_{CC} = 5\text{ V to } 26\text{ V}$	25°C		0 to $V_{CC}-1.5$		V
		Full range		0 to $V_{CC}-2$		
$V_{OH}$ High-level output voltage	$R_L = 10\text{ k}\Omega$	25°C		$V_{CC}-1.5$		V
	$V_{CC} = 26\text{ V}$ , $R_L = 2\text{ k}\Omega$	Full range		22		
	$V_{CC} = 26\text{ V}$ , $R_L \geq 10\text{ k}\Omega$	25°C		23	24	
$V_{OL}$ Low-level output voltage	$R_L \leq 10\text{ k}\Omega$	Full range		5	20	mV
$A_{VD}$ Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$ , $V_O = 1\text{ V to } 11\text{ V}$ , $R_L \geq 2\text{ k}\Omega$	25°C		100		V/mV
		Full range		15		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	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	$f = 1\text{ kHz to } 20\text{ kHz}$	25°C		120		dB
$I_O$ Output current	$V_{CC} = 15\text{ V}$ , $V_{ID} = 1\text{ V}$ , $V_O = 0$	25°C		-20	-30	mA
		Full range		-10		
	$V_{CC} = 15\text{ V}$ , $V_{ID} = -1\text{ V}$ , $V_O = 15\text{ V}$	25°C		10	20	mA
		Full range		5		
$I_{OS}$ Short-circuit output current	$V_{CC}$ at 5 V, $V_O = 0$ , GND at -5 V	25°C		$\pm 40$	$\pm 60$	mA
		Full range		0.7	1.2	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load	Full range		1.4	3	mA
	$V_{CC} = 26\text{ V}$ , $V_O = 0.5 V_{CC}$ , No load	Full range				

(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  $T_A = 25^\circ\text{C}$ .

**ELECTRICAL CHARACTERISTICS**at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS <sup>(1)</sup>		$T_A$ <sup>(2)</sup>	LM2902KV-EP			UNIT
				MIN	TYP <sup>(3)</sup>	MAX	
$V_{IO}$ Input offset voltage	$V_{CC} = 5\text{ V to }32\text{ V}$ , $V_{IC} = V_{ICR\text{min}}$ , $V_O = 1.4\text{ V}$	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	$R_S = 0\ \Omega$	Full range		7		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$		25°C	2	50	nA	
			Full range		150		
$\Delta V_{IO}/\Delta T$ Temperature drift		Full range		10		$\text{pA}/^\circ\text{C}$	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$		25°C	-20	-250	nA	
			Full range		-500		
$V_{ICR}$ Common-mode input voltage range	$V_{CC} = 5\text{ V to }32\text{ V}$		25°C	0 to $V_{CC} - 1.5$		V	
			Full range	0 to $V_{CC} - 2$			
$V_{OH}$ High-level output voltage	$R_L = 10\text{ k}\Omega$ $V_{CC} = 32\text{ V}$ , $R_L = 2\text{ k}\Omega$ $V_{CC} = 32\text{ V}$ , $R_L \geq 10\text{ k}\Omega$		25°C	$V_{CC} - 1.5$		V	
			Full range	26			
			Full range	27			
$V_{OL}$ Low-level output voltage	$R_L = 10\text{ k}\Omega$	Full range		5	20	mV	
$A_{VD}$ Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$ , $V_O = 1\text{ V to }11\text{ V}$ , $R_L \geq 2\text{ k}\Omega$		25°C	25	100	V/mV	
			Full range	15			
	Amplifier-to-amplifier coupling <sup>(4)</sup>	$f = 1\text{ kHz to }20\text{ kHz}$ , input referred	25°C		120	dB	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}$		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		$f = 1\text{ kHz to }20\text{ kHz}$	25°C		120	dB	
$I_O$ Output current	$V_{CC} = 15\text{ V}$ , $V_{ID} = 1\text{ V}$ , $V_O = 0$		25°C	-20	-30	mA	
			Full range	-10			
	$V_{CC} = 15\text{ V}$ , $V_{ID} = -1\text{ V}$ , $V_O = 15\text{ V}$		25°C	10	20	mA	
			Full range	5			
	$V_{ID} = -1\text{ V}$ , $V_O = 200\text{ mV}$		25°C	12	40	$\mu\text{A}$	
$I_{OS}$ Short-circuit output current	$V_{CC}$ at 5 V, GND at -5 V	$V_O = 0$ ,	25°C		$\pm 40$ $\pm 60$	mA	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , $V_{CC} = 32\text{ V}$ , $V_O = 0.5 V_{CC}$	No load	Full range	0.7	1.2	mA	
		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.

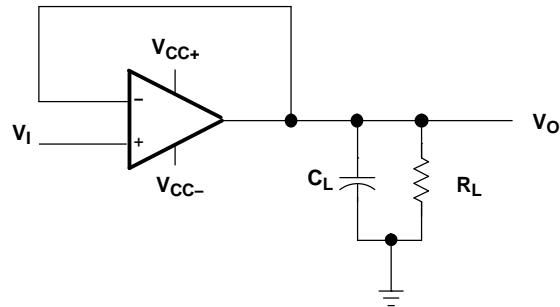
(2) Full range is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .(3) All typical values are at  $T_A = 25^\circ\text{C}$ .

(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.

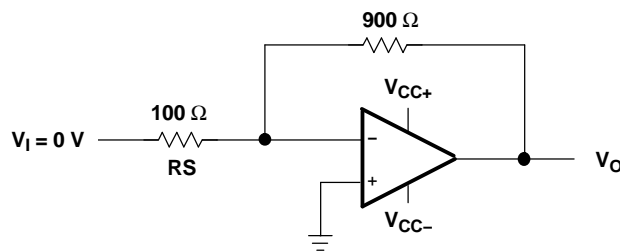
**OPERATING CONDITIONS**

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

PARAMETER	TEST CONDITIONS	TYP	UNIT
SR Slew rate at unity gain	$R_L = 1\text{ M}\Omega$ , $C_L = 30\text{ pF}$ , $V_I = \pm 10\text{ V}$ (see Figure 1)	0.5	$\text{V}/\mu\text{s}$
$B_1$ Unity-gain bandwidth	$R_L = 1\text{ M}\Omega$ , $C_L = 20\text{ pF}$ (see Figure 1)	1.2	MHz
$V_n$ Equivalent input noise voltage	$R_S = 100\ \Omega$ , $V_I = 0\text{ V}$ , $f = 1\text{ kHz}$ (see Figure 2)	35	$\text{nV}/\sqrt{\text{Hz}}$



**Figure 1. Unity-Gain Amplifier**



**Figure 2. Noise-Test Circuit**

**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
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	356.0	356.0	35.0
LM2902KAVQPWREP	TSSOP	PW	14	2000	356.0	356.0	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

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