

LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V, LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV QUADRUPLE OPERATIONAL AMPLIFIERS

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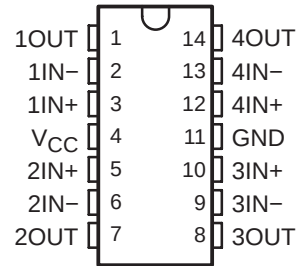
- 2-kV ESD Protection for:
 - LM224K, LM224KA
 - LM324K, LM324KA
 - LM2902K, LM2902KV, LM2902KAV
- Wide Supply Ranges
 - Single Supply . . . 3 V to 32 V
(26 V for LM2902)
 - Dual Supplies . . . ± 1.5 V to ± 16 V
(± 13 V for LM2902)
- Low Supply-Current Drain Independent of Supply Voltage . . . 0.8 mA Typ
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters
 - Input Offset Voltage . . . 3 mV Typ
A Versions . . . 2 mV Typ
 - Input Offset Current . . . 2 nA Typ
 - Input Bias Current . . . 20 nA Typ
A Versions . . . 15 nA Typ
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . . 32 V
(26 V for LM2902)
- Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ
- Internal Frequency Compensation

description/ordering information

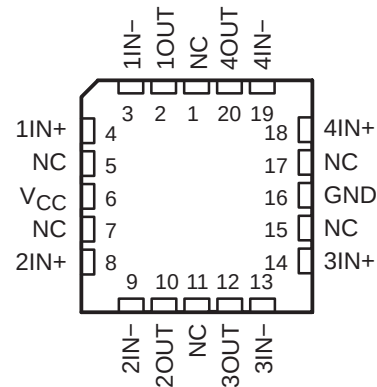
These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V (3 V to 26 V for the LM2902), 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 LM124 can be operated directly from the standard 5-V supply that is used in digital systems and provides the required interface electronics, without requiring additional ± 15 -V supplies.

LM124 . . . D, J, OR W PACKAGE
LM124A . . . J PACKAGE
LM224, LM224A, LM224K, LM224KA . . . D OR N PACKAGE
LM324, LM324K . . . D, N, NS, OR PW PACKAGE
LM324A . . . D, DB, N, NS, OR PW PACKAGE
LM324KA . . . D, N, NS, OR PW PACKAGE
LM2902 . . . D, N, NS, OR PW PACKAGE
LM2902K . . . D, DB, N, NS, OR PW PACKAGE
LM2902KV, LM2902KAV . . . D OR PW PACKAGE
(TOP VIEW)



LM124, LM124A . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV
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description/ordering information (continued)

ORDERING INFORMATION

T_A	V_{IOmax} AT 25°C	MAX TESTED V_{CC}	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	7 mV	30 V	PDIP (N)	Tube of 25	LM324N	LM324N
					LM324KN	LM324KN
			SOIC (D)	Tube of 50	LM324D	LM324
				Reel of 2500	LM324DR	
				Tube of 50	LM324KD	LM324K
				Reel of 2500	LM324KDR	
			SOP (NS)	Reel of 2000	LM324NSR	LM324
				Tube of 50	LM324KNS	LM324K
				Reel of 2000	LM324KNSR	
			TSSOP (PW)	Tube of 90	LM324PW	L324
				Reel of 2000	LM324PWR	
				Tube of 90	LM324KPW	L324K
				Reel of 2000	LM324KPWR	
	3 mV	30 V	PDIP (N)	Tube of 25	LM324AN	LM324AN
				Tube of 25	LM324KAN	LM324KAN
			SOIC (D)	Tube of 50	LM324AD	LM324A
				Reel of 2500	LM324ADR	
				Tube of 50	LM324KAD	LM324KA
				Reel of 2500	LM324KADR	
			SOP (NS)	Reel of 2000	LM324ANSR	LM324A
				Tube of 50	LM324KANS	LM324KA
				Reel of 2000	LM324KANSR	
			SSOP (DB)	Reel of 2000	LM324ADBR	LM324A
			TSSOP (PW)	Tube of 90	LM324APW	L324A
				Reel of 2000	LM324APWR	
				Tube of 90	LM324KAPW	L324KA
				Reel of 2000	LM324KAPWR	
–25°C to 85°C	5 mV	30 V	PDIP (N)	Tube of 25	LM224N	LM224N
					LM224KN	LM224KN
			SOIC (D)	Tube of 50	LM224D	LM224
				Reel of 2500	LM224DR	
				Tube of 50	LM224KD	LM224K
				Reel of 2500	LM224KDR	
	3 mV	30 V	PDIP (N)	Tube of 25	LM224AN	LM224AN
				Tube of 25	LM224KAN	LM224KAN
			SOIC (D)	Tube of 50	LM224AD	LM224A
				Reel of 2500	LM224ADR	
				Tube of 50	LM224KAD	LM224KA
				Reel of 2500	LM224KADR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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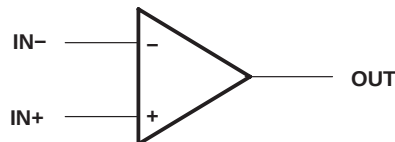
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ORDERING INFORMATION (CONTINUED)

T_A	V_{IOmax} AT 25°C	MAX TESTED V_{CC}	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	7 mV	26 V	PDIP (N)	Tube of 25	LM2902N	LM2902N
				Tube of 25	LM2902KN	LM2902KN
			SOIC (D)	Tube of 50	LM2902D	LM2902
				Reel of 2500	LM2902DR	
				Tube of 50	LM2902KD	LM2902K
				Reel of 2500	LM2902KDR	
			SOP (NS)	Reel of 2000	LM2902NSR	LM2902
				Tube of 50	LM2902KNS	LM2902K
				Reel of 2000	LM2902KNSR	
			SSOP (DB)	Tube of 80	LM2902KDB	L2902K
				Reel of 2000	LM2902KDBR	
			TSSOP (PW)	Tube of 90	LM2902PW	L2902
				Reel of 2000	LM2902PWR	
				Tube of 90	LM2902KPW	L2902K
				Reel of 2000	LM2902KPWR	
–55°C to 125°C	5 mV	30 V	SOIC (D)	Reel of 2500	LM2902KVQDR	L2902KV
			TSSOP (PW)	Reel of 2000	LM2902KVQPWR	L2902KV
			SOIC (D)	Reel of 2500	LM2902KAVQDR	L2902KA
			TSSOP (PW)	Reel of 2000	LM2902KAVQPWR	L2902KA
	2 mV	30 V	CDIP (J)	Tube of 25	LM124J	LM124J
			LCCC (FK)	Tube of 55	LM124AFK	LM124AFK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

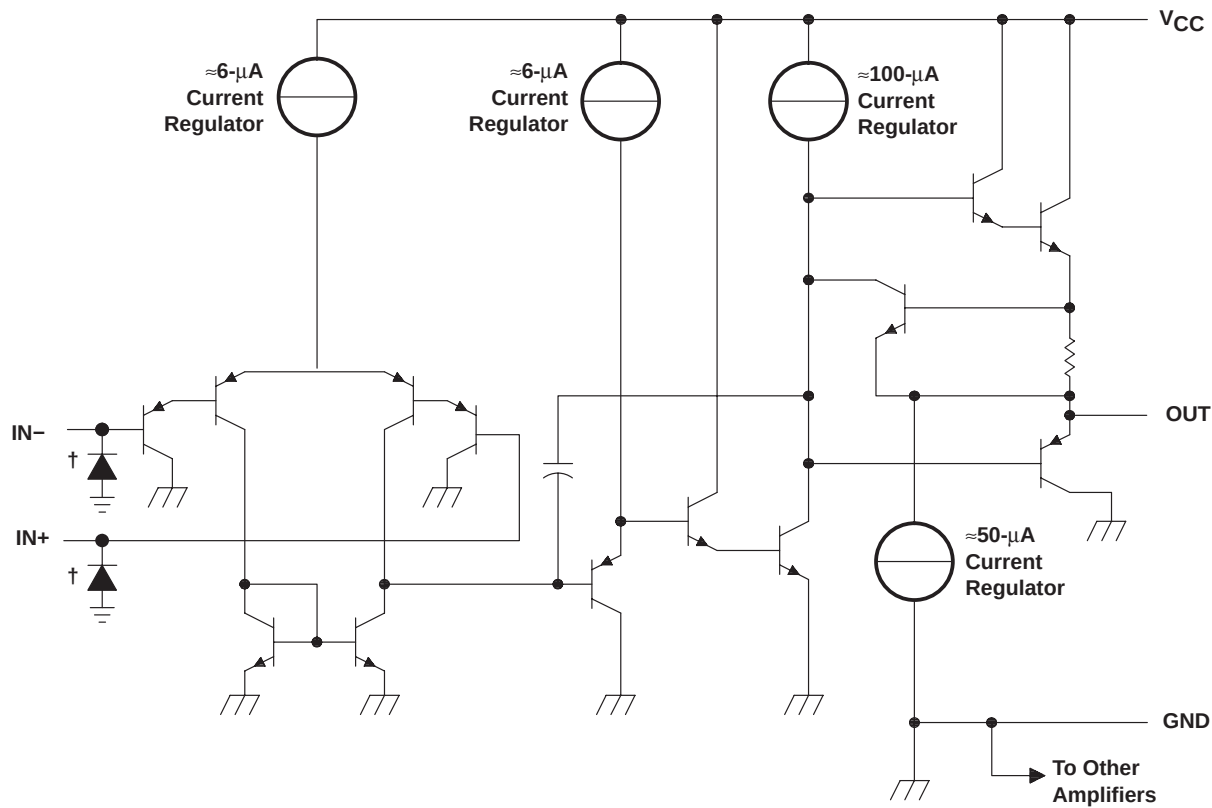
symbol (each amplifier)



LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV
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schematic (each amplifier)



COMPONENT COUNT (total device)	
Epi-FET	1
Transistors	95
Diodes	4
Resistors	11
Capacitors	4

† ESD protection cells - available on LM324K and LM324KA only

LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V, LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV QUADRUPLE OPERATIONAL AMPLIFIERS

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

		LM2902	ALL OTHER DEVICES	UNIT
Supply voltage, V_{CC} (see Note 1)		±13 or 26	±16 or 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) $T_A = 25^\circ\text{C}$, $V_{CC} \leq 15\text{ V}$ (see Note 3)		Unlimited	Unlimited	
Package thermal impedance, θ_{JA} (see Notes 4 and 5)	D package	86	86	$^\circ\text{C/W}$
	DB package	96	96	
	N package	80	80	
	NS package	76	76	
	PW package	113	113	
Package thermal impedance, θ_{JC} (see Notes 6 and 7)	FK package		5.61	$^\circ\text{C/W}$
	J package		15.05	
	W package		14.65	
Operating virtual junction temperature, T_J		150	150	$^\circ\text{C}$
Case temperature for 60 seconds	FK package		260	$^\circ\text{C}$
Lead temperature 1.6 mm (1/16 inch) from case for 60 seconds	J or W package	300	300	$^\circ\text{C}$
Storage temperature range, T_{Stg}		–65 to 150	–65 to 150	$^\circ\text{C}$

[†] 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 $T_J(\text{max})$, θ_{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°C can affect reliability.
 5. The package thermal impedance is calculated in accordance with JESD 51-7.
 6. Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JC} , and T_C . The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_J(\text{max}) - T_C)/\theta_{JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
 7. The package thermal impedance is calculated in accordance with MIL-STD-883.

ESD protection

TEST CONDITIONS		TYP	UNIT
Human-Body Model	LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV	±2	kV



LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V, LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV QUADRUPLE OPERATIONAL AMPLIFIERS

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

PARAMETER		TEST CONDITIONS†		T _A ‡	LM124 LM224			LM324 LM324K			UNIT
					MIN	TYP§	MAX	MIN	TYP§	MAX	
V _{IO}	Input offset voltage	V _{CC} = 5 V to MAX, V _{IC} = V _{ICRmin} , V _O = 1.4 V		25°C	3		5	3		7	mV
				Full range	7						
I _{IO}	Input offset current	V _O = 1.4 V		25°C	2		30	2		50	nA
				Full range	100						
I _{IB}	Input bias current	V _O = 1.4 V		25°C	–20		–150	–20		–250	nA
				Full range	–300						
V _{ICR}	Common-mode input voltage range	V _{CC} = 5 V to MAX		25°C	0 to V _{CC} – 1.5			0 to V _{CC} – 1.5			V
				Full range	0 to V _{CC} – 2			0 to V _{CC} – 2			
V _{OH}	High-level output voltage	R _L = 2 kΩ		25°C	V _{CC} – 1.5			V _{CC} – 1.5			V
		R _L = 10 kΩ		25°C							
		V _{CC} = MAX	R _L = 2 kΩ	Full range	26		26				
			R _L ≥ 10 kΩ	Full range	27 28		27 28				
V _{OL}	Low-level output voltage	R _L ≤ 10 kΩ		Full range	5		20	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	50		100	25		100	V/mV
				Full range	25		15				
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICRmin}		25°C	70		80	65		80	dB
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC} /ΔV _{IO})			25°C	65		100	65		100	dB
V _{O1} /V _{O2}	Crosstalk attenuation	f = 1 kHz to 20 kHz		25°C	120			120			dB
I _O	Output current	V _{CC} = 15 V, V _{ID} = 1 V, V _O = 0	Source	25°C	–20	–30	–60	–20	–30	–60	mA
				Full range	–10		–10				
		V _{CC} = 15 V, V _{ID} = –1 V, V _O = 15 V	Sink	25°C	10		20	10		20	
				Full range	5		5				
		V _{ID} = –1 V, V _O = 200 mV		25°C	12		30	12		30	
I _{OS}	Short-circuit output current	V _{CC} at 5 V, GND at –5 V	V _O = 0,	25°C	±40		±60	±40		±60	mA
I _{CC}	Supply current (four amplifiers)	V _O = 2.5 V,	No load	Full range	0.7		1.2	0.7		1.2	mA
		V _{CC} = MAX, V _O = 0.5 V _{CC} ,	No load	Full range	1.4		3	1.4		3	

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 26 V for LM2902 and 30 V for the others.

‡ Full range is –55°C to 125°C for LM124, –25°C to 85°C for LM224, and 0°C to 70°C for LM324.

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



**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV**
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		T _A ‡	LM2902			LM2902V			UNIT	
					MIN	TYP§	MAX	MIN	TYP§	MAX		
V _{IO}	Input offset voltage	V _{CC} = 5 V to MAX, V _{IC} = V _{ICRmin} , V _O = 1.4 V	Non-A-suffix devices	25°C		3	7		3	7	mV	
				Full range			10		10			
		A-suffix devices	25°C					1	2			
			Full range						4			
ΔV _{IO} /ΔT	Input offset voltage 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		2	50	nA	
				Full range			300		150			
ΔI _{IO} /ΔT	Input offset current temperature drift			Full range					10		pA/°C	
I _{IB}	Input bias current	V _O = 1.4 V		25°C		–20	–250		–20	–250	nA	
				Full range			–500		–500			
V _{ICR}	Common-mode input voltage range	V _{CC} = 5 V to MAX		25°C		0 to V _{CC} – 1.5		0 to V _{CC} – 1.5		V		
				Full range		0 to V _{CC} – 2		0 to V _{CC} – 2				
V _{OH}	High-level output voltage	R _L = 2 kΩ		25°C						V		
		R _L = 10 kΩ		25°C		V _{CC} – 1.5		V _{CC} – 1.5				
		V _{CC} = MAX	R _L = 2 kΩ	Full range		22		26				
			R _L ≥ 10 kΩ	Full range		23	24		27			
V _{OL}	Low-level output voltage	R _L ≤ 10 kΩ		Full range		5	20		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		25	100		25	100	V/mV	
				Full range		15			15			
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICRmin}		25°C		50	80		60	80	dB	
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC} /ΔV _{IO})			25°C		50	100		60	100	dB	
V _{O1} /V _{O2}	Crosstalk attenuation	f = 1 kHz to 20 kHz		25°C			120			120	dB	
I _O	Output current	V _{CC} = 15 V, V _{ID} = 1 V, V _O = 0	Source	25°C		–20	–30	–60	–20	–30	–60	mA
				Full range		–10			–10			
		V _{CC} = 15 V, V _{ID} = –1 V, V _O = 15 V	Sink	25°C		10	20		10	20		
				Full range		5			5			
		V _{ID} = –1 V, V _O = 200 mV		25°C			30		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		±40	±60	mA	
I _{CC}	Supply current (four amplifiers)	V _O = 2.5 V,	No load	Full range		0.7	1.2		0.7	1.2	mA	
		V _{CC} = MAX, V _O = 0.5 V _{CC} ,	No load	Full range		1.4	3		1.4	3		

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 26 V for LM2902 and 32 V for LM2902V.

‡ Full range is -40°C to 125°C for LM2902.

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

LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V, LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV QUADRUPLE OPERATIONAL AMPLIFIERS

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

PARAMETER	TEST CONDITIONS†	T _A ‡	LM124A			LM224A			LM324A, LM324KA			UNIT
			MIN	TYP§	MAX	MIN	TYP§	MAX	MIN	TYP§	MAX	
V _{IO} Input offset voltage	V _{CC} = 5 V to 30 V, V _{IC} = V _{ICRmin} , V _O = 1.4 V	25°C			2			2			3	mV
		Full range			4			4			5	
I _{IO} Input offset current	V _O = 1.4 V	25°C			10			2			30	nA
		Full range			30			30			75	
I _{IB} Input bias current	V _O = 1.4 V	25°C			–50			–15			–80	nA
		Full range			–100			–100			–200	
V _{ICR} Common-mode input voltage range	V _{CC} = 30 V	25°C	0 to V _{CC} – 1.5			0 to V _{CC} – 1.5			0 to V _{CC} – 1.5			V
		Full range	0 to V _{CC} – 2			0 to V _{CC} – 2			0 to V _{CC} – 2			
V _{OH} High-level output voltage	R _L = 2 kΩ V _{CC} = 30 V	25°C										V
		Full range	26			26			26			
V _{OL} Low-level output voltage	R _L ≤ 10 kΩ V _{CC} = 30 V	Full range	27			27			27			mV
		Full range			20			5			20	
A _{VD} Large-signal differential voltage amplification	V _{CC} = 15 V, V _O = 1 V to 11 V, R _L ≥ 2 kΩ	25°C	50	100		50	100		25	100		V/mV
		Full range	25			25			15			
CMRR Common-mode rejection ratio	V _{IC} = V _{ICRmin}	25°C	70			70	80		65	80		dB
k _{SVR} Supply-voltage rejection ratio (ΔV _{CC} /ΔV _{IO})		25°C	65			65	100		65	100		dB
V _{O1} /V _{O2} Crosstalk attenuation	f = 1 kHz to 20 kHz	25°C		120			120			120		dB
I _O Output current	V _{CC} = 15 V, V _{ID} = 1 V, V _O = 0	Source	–20			–20	–30	–60	–20	–30	–60	mA
		Full range	–10			–10			–10			
	V _{CC} = 15 V, V _{ID} = –1 V, V _O = 15 V	Sink	10			10	20		10	20		
		Full range	5			5			5			
I _{OS} Short-circuit output current	V _{CC} at 5 V, V _O = 0	25°C	12			12	30		12	30		μA
		Full range			±60			±60			±60	
I _{CC} Supply current (four amplifiers)	V _O = 2.5 V, V _{CC} = 30 V, No load	25°C	0.7	1.2		0.7	1.2		0.7	1.2		mA
		Full range	1.4	3		1.4	3		1.4	3		

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.

‡ Full range is –55°C to 125°C for LM124A, –25°C to 85°C for LM224A, and 0°C to 70°C for LM324A.

§ All typical values are at T_A = 25°C.

**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV**
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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	$R_S = 100\text{ }\Omega$, $V_I = 0\text{ V}$, $f = 1\text{ kHz}$ (see Figure 2)	35	$\text{nV}/\sqrt{\text{Hz}}$

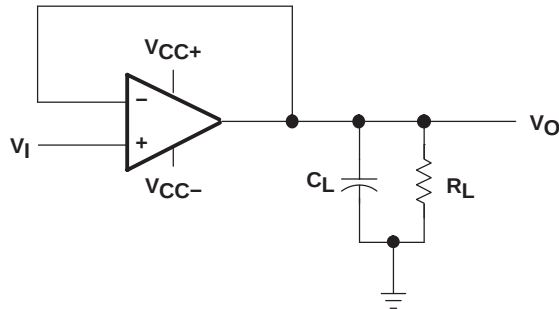


Figure 1. Unity-Gain Amplifier

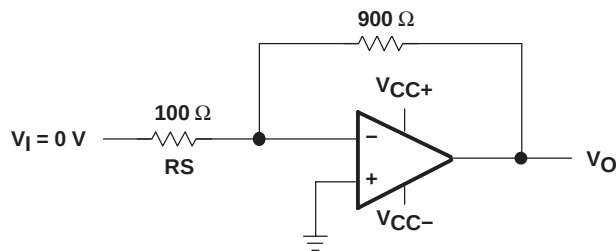
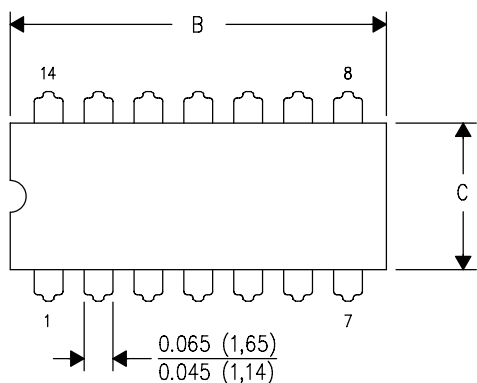


Figure 2. Noise-Test Circuit

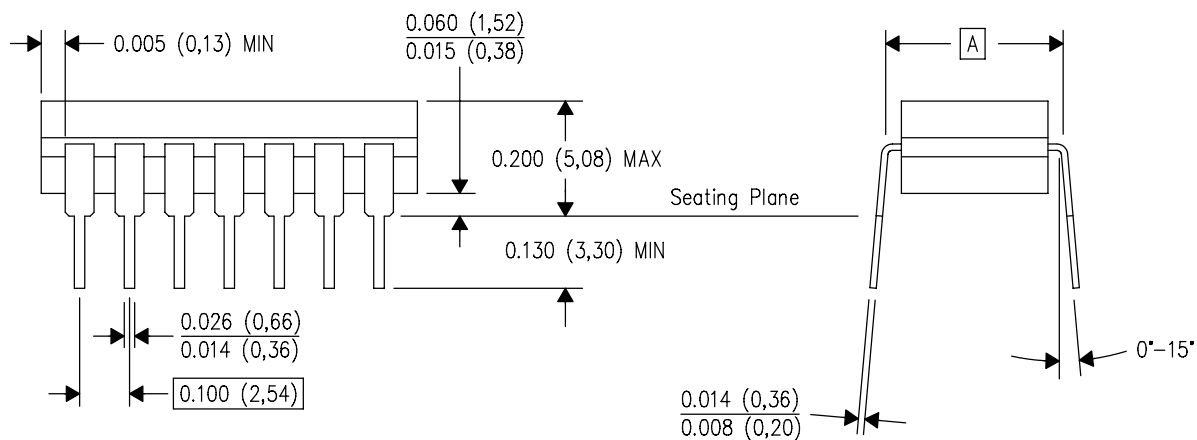
J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



PINS ** DIM	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)

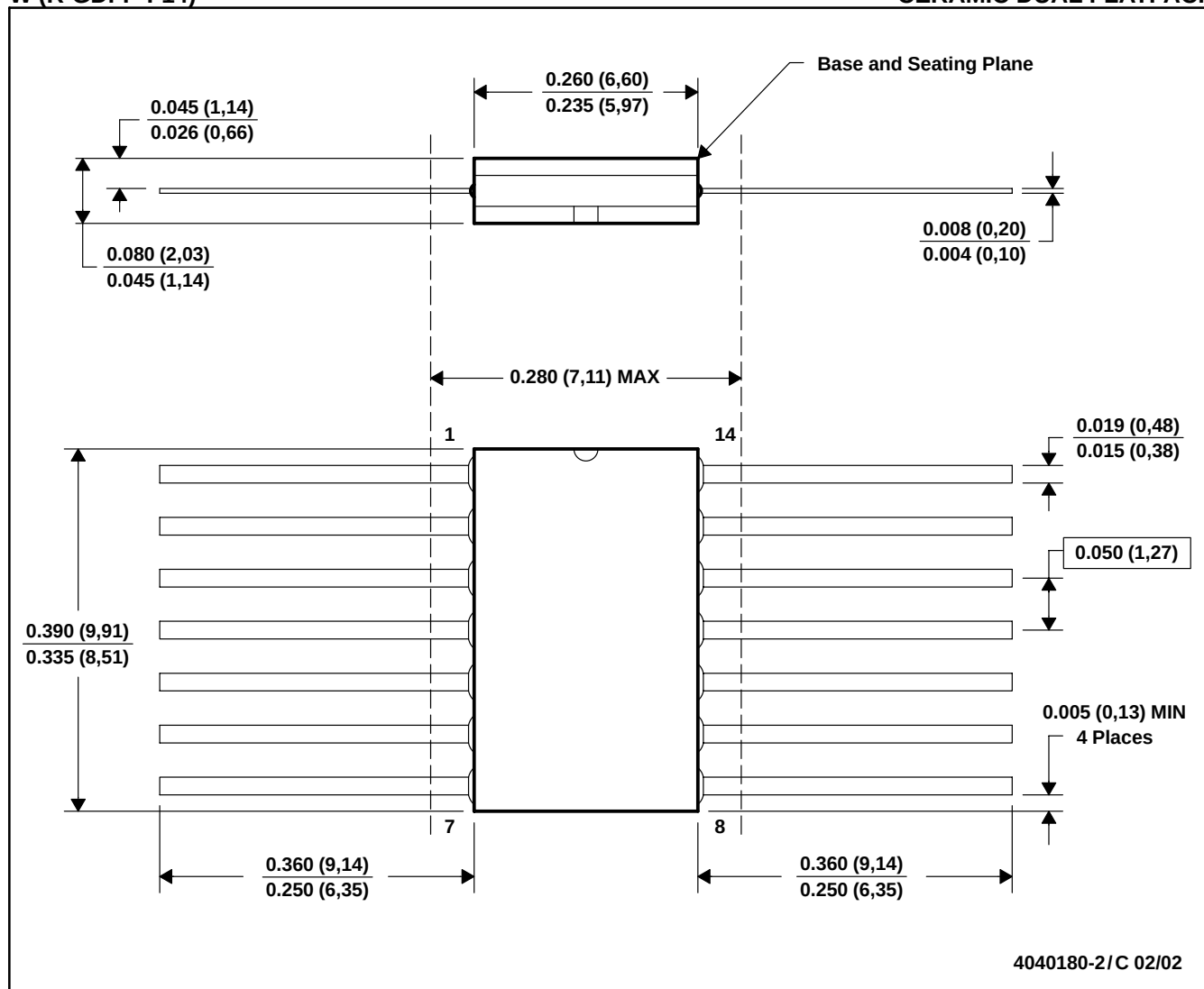


4040083/F 03/03

- 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.

W (R-GDFP-F14)

CERAMIC DUAL FLATPACK

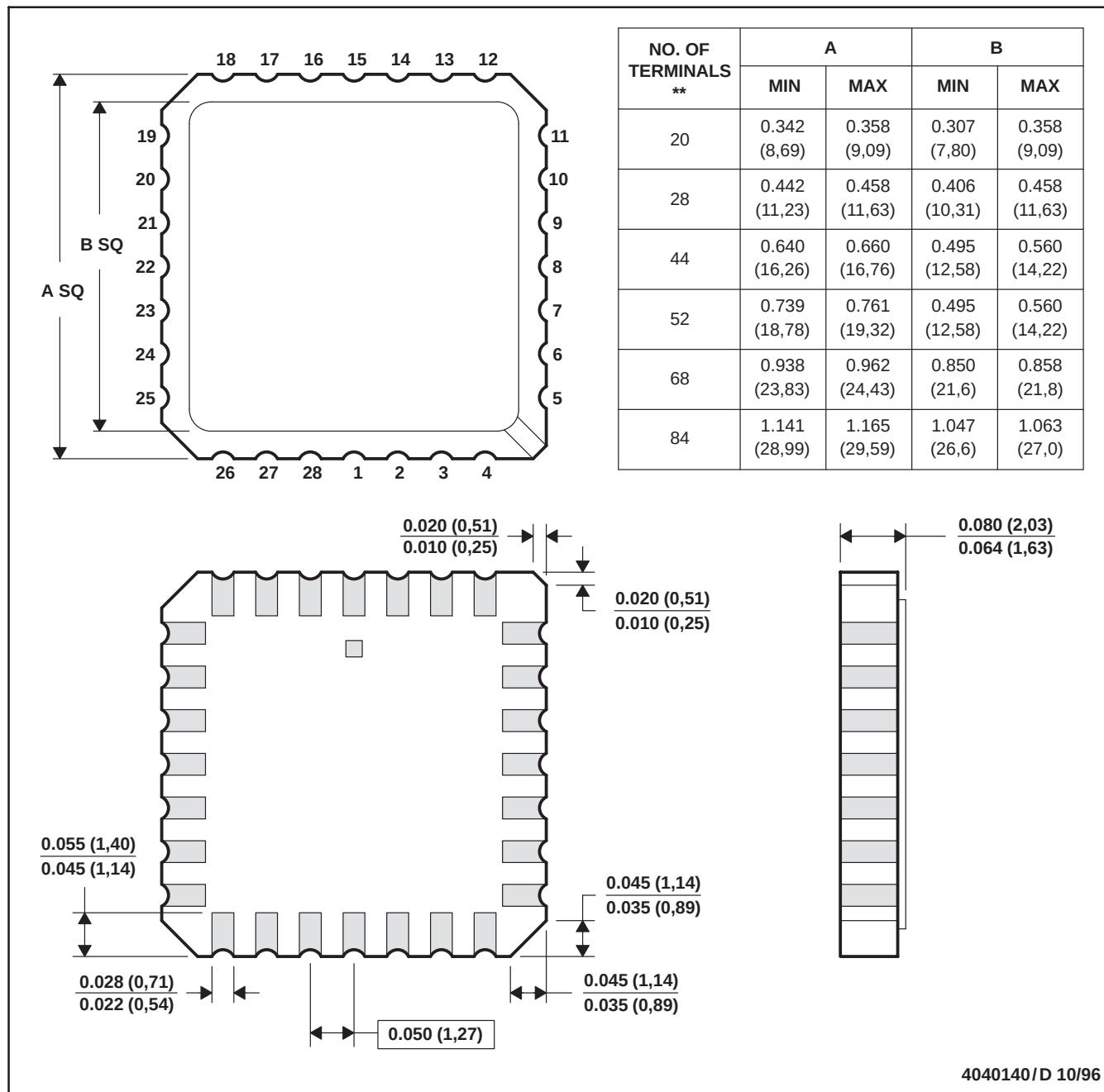


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification only.
 E. Falls within MIL STD 1835 GDFP1-F14 and JEDEC MO-092AB

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

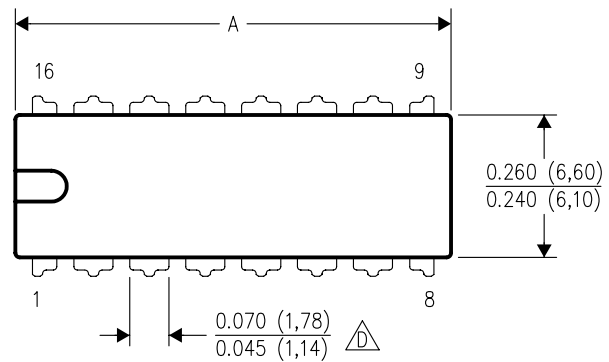


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a metal lid.
 - D. The terminals are gold plated.
 - E. Falls within JEDEC MS-004

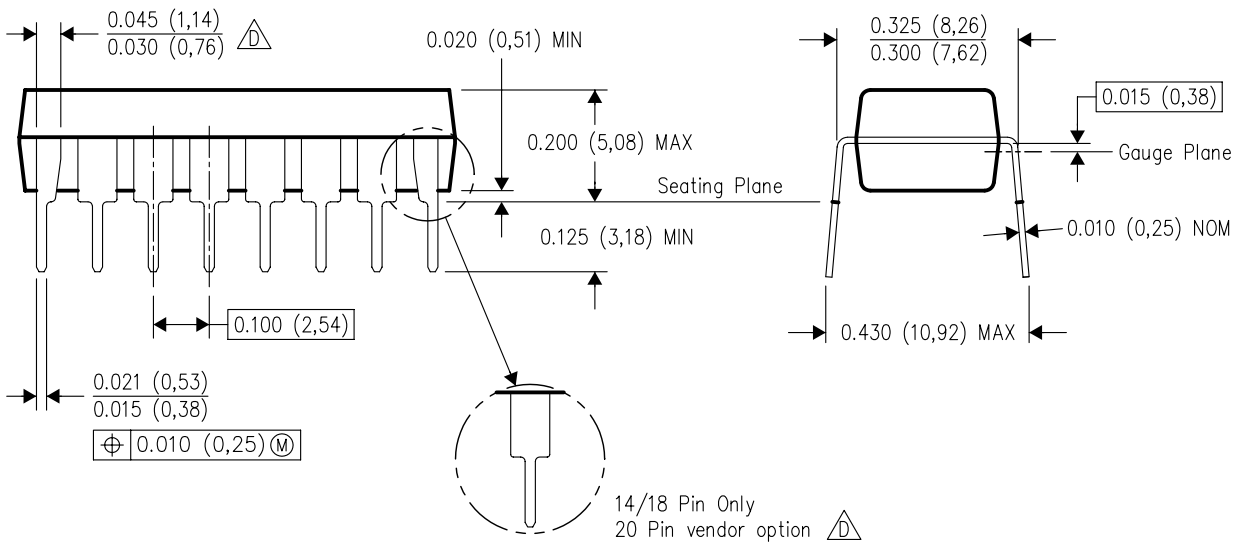
N (R-PDIP-T**)

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



PINS **	14	16	18	20
DIM				
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	AA	BB	AC	AD

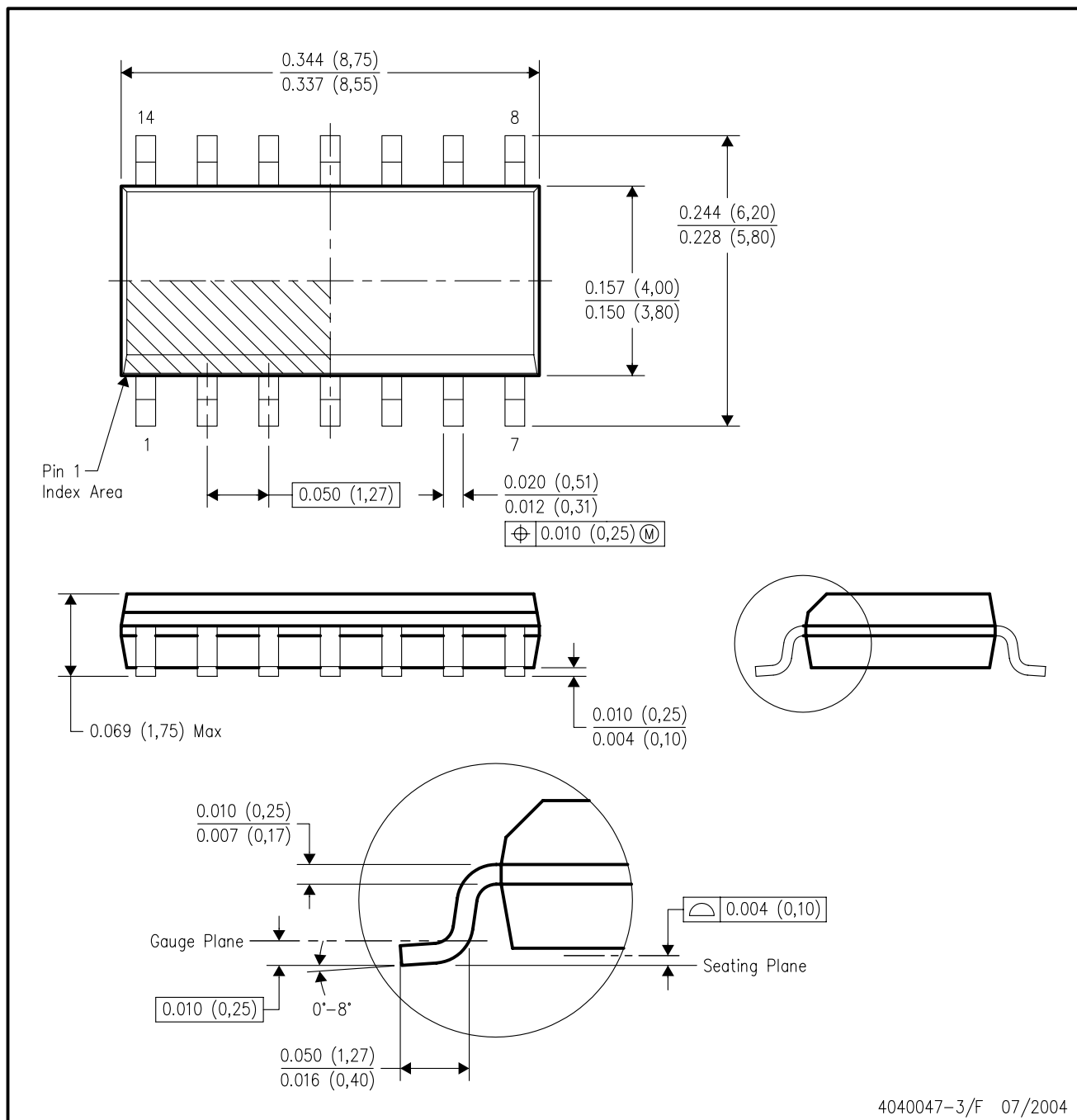


4040049/E 12/2002

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

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-3/F 07/2004

NOTES:

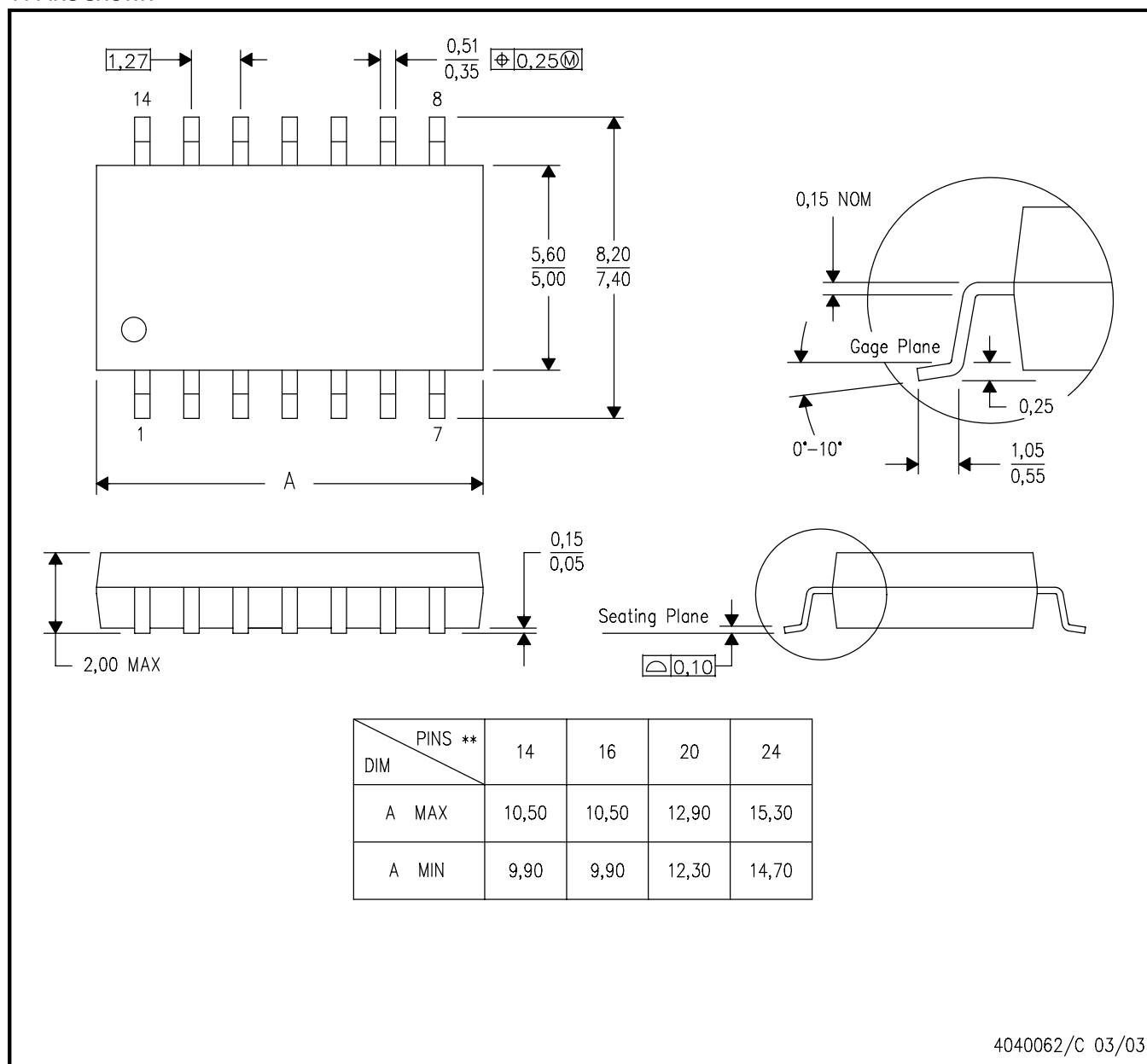
- All linear dimensions are in inches (millimeters).
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- Falls within JEDEC MS-012 variation AB.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN

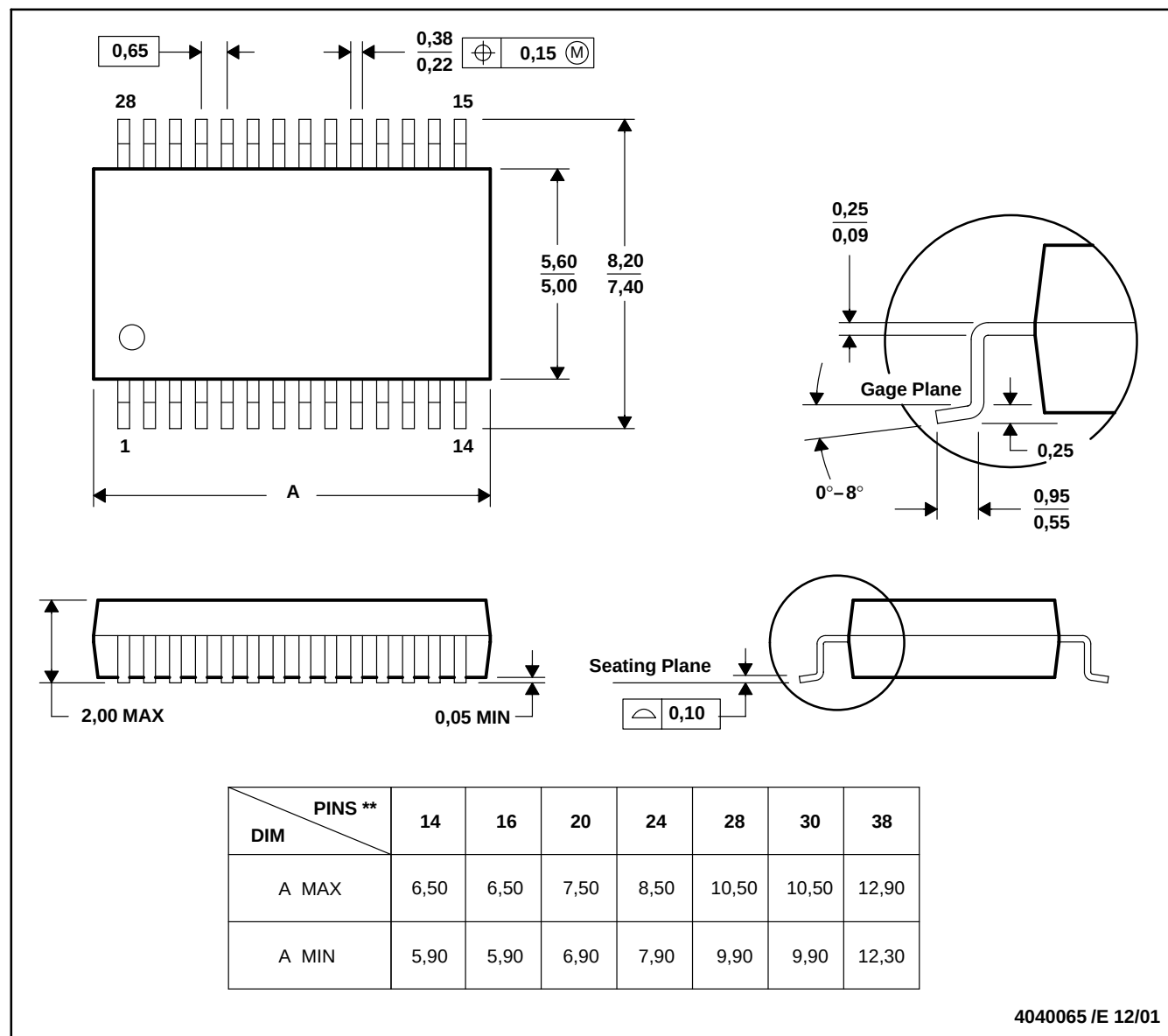


- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN

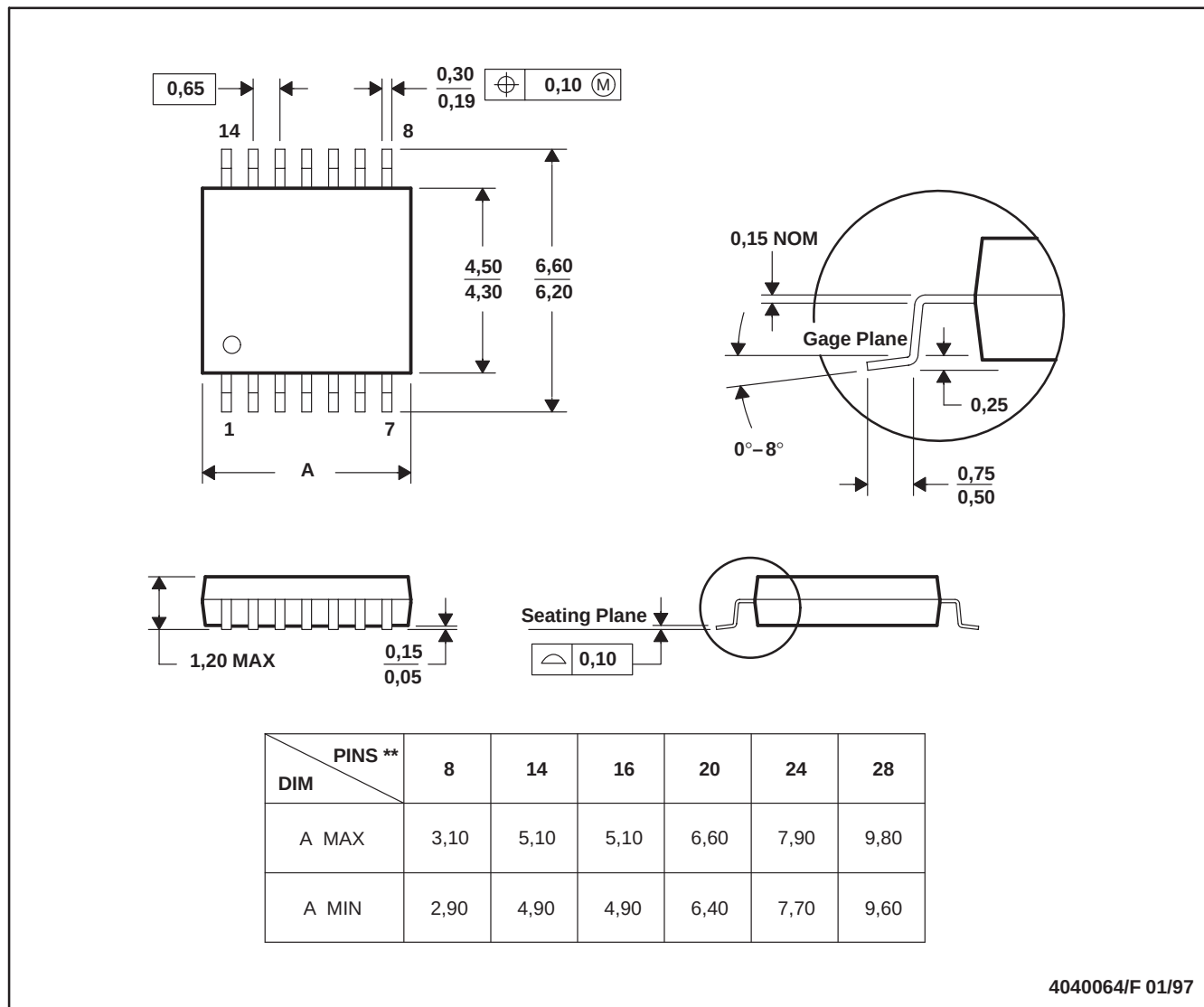


- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-150

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- 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.
 D. Falls within JEDEC MO-153

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