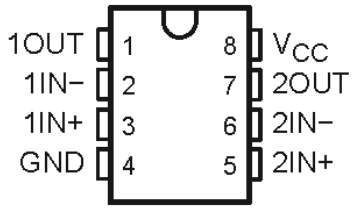
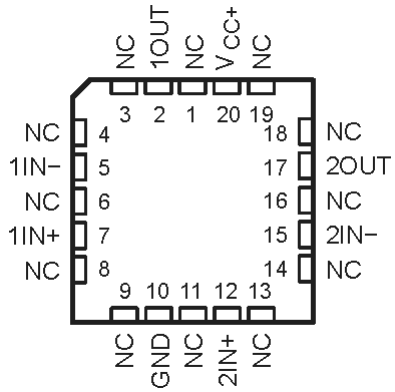
- **Wide Supply Range:**
  - **Single Supply…3V to 32V (26V for LM2904)**
  - **or Dual Supplies …±1.5V to ±16V (±13V for LM2904)**
- **Low Supply-Current Drain, Independent of Supply Voltage… 0.7mA Typ**
- **Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground**
- **Low Input Bias and Offset Parameters:**
  - **Input Offset Voltage…3mV Typ**
  - **A versions…2mV Typ**
  - **Input Offset Current…2nA Typ**
  - **Input Bias Current…20nA Typ**
  - **A Versions…15nA Typ**
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage…32V (26V for LM2904)**
- **Open-Loop Differential Voltage Amplification…100 V/mV Typ**
- **Internal Frequency Compensation**

LM158, LM158A … JG PACKAGE
LM258, LM258A … D, DGK, OR P PACKAGE
LM358 … D, DGK, P , PS, OR PW PACKAGE
LM358A … D, DGK, P , OR PW PACKAGE
LM2904 … D, DGK, P , PS, OR PW PACKAGE
(TOP VIEW)



LM158,LM158A … FW PACKAGE
(TOP VIEW)



NC-No internal connection

Description/ordering information

These devices consist of two independent, high-gain, frequency-compensated operational amplifiers designed 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 3V to 32V (3V to 26V for the LM2904), and V_{CC} is at least 1.5V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

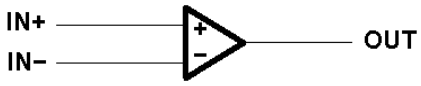
Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational amplifier circuits that now be implemented more easily in single-supply-voltage systems. For example, these devices can be operated directly from the standard 5-V supply used in digital systems and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

Description/ordering information (continued)

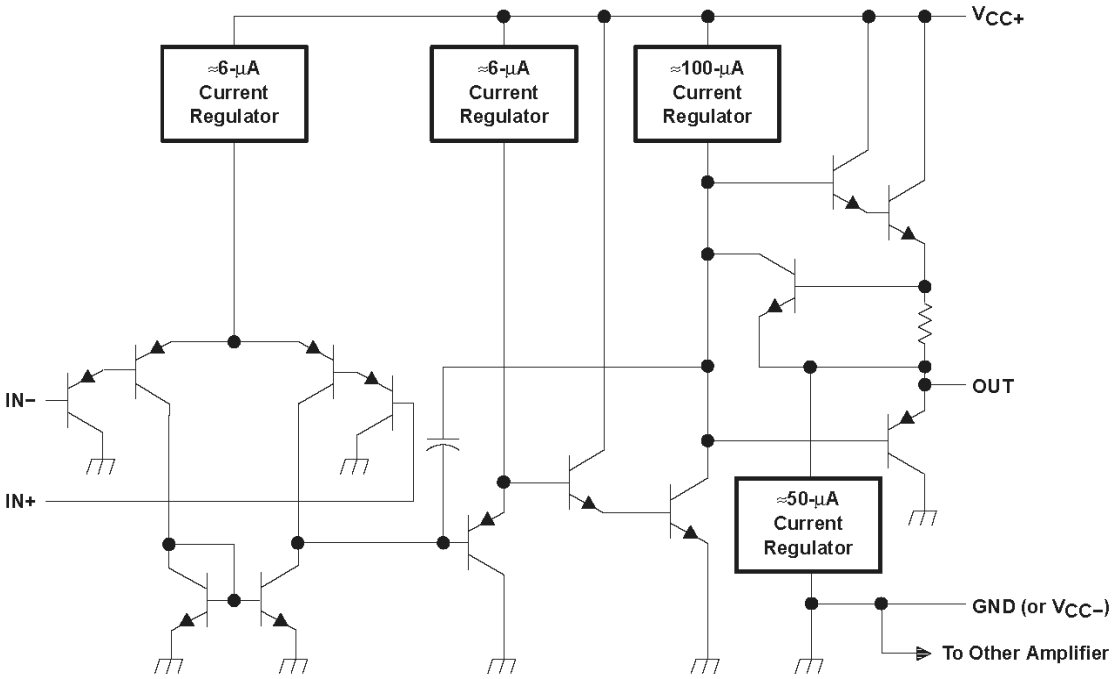
ORDERING INFORMATION

TA	V_{IO}max AT 25°C	MAX TESTED V_{CC}	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	7mV	30V	PDIP (P)	Tube of 50	LM358P	LM358P
			SOIC (D)	Tube of 75	LM358D	LM358
				Reel of 2500	LM358D	
			SOP (PS)	Reel of 2000	LM358PSR	L358
			TSSOP (PW)	Tube of 150	LM358PW	L358
				Reel of 2000	LM358PWR	
			MSOP/VSSOP (DGK)	Reel of 2500	LM358DGKR	M5_‡
	3mV	30V	PDIP (P)	Tube of 50	LM358AP	LM358AP
			SOIC(D)	Tube of 75	LM358AD	LM358A
				Reel of 2500	LM358ADR	
			TSSOP(PW)	Tube of 150	LM358APW	L358A
				Reel of 2000	LM358APWR	
			MSOP/VSSOP(DGK)	Reel of 2500	LM358ADGKR	M6_‡
-25°C to 85°C	5mV	30V	PDIP (P)	Tube of 50	LM258P	LM258P
			SOIC (D)	Tube of 75	LM258D	LM258
				Reel of 2500	LM258DR	
			MSOP/VSSOP (DGK)	Reel of 2500	LM258DGKG	M2_‡
	3mV	30V	PDIP(P)	Tube of 50	LM258AP	LM258AP
			SOIC (D)	Tube of 75	LM258AD	LM258A
				Reel of 2500	LM258ADR	
			MSOP/VSSOP (DGK)	Reel of 2500	LM258ADGKR	M3_‡
-40°C to 125°C	7mV	26V	PDIP (P)	Tube of 50	LM2904P	LM2904P
			SOIC (D)	Tube of 75	LM2904D	LM2904
				Reel of 2500	LM2904DR	
			SOP (PS)	Reel of 2000	LM2904PSR	L2904
			TSSOP (PW)	Tube of 150	LM2904PW	L2904
				Reel of 2000	LM2904PWR	MB_‡
			MSOP/VSSOP (DGK)	Reel of 2500	LM2904DGKR	L2904V
	7mV	32V	SOIC (D)	Reel of 2500	LM2904VQDR	L2904V
			TSSOP (PW)	Reel of 2000	LM2904VQPWR	L2904V
	2mV	32V	SOIC (D)	Reel of 2500	LM2904AVQDR	L2904AV
			TSSOP (PW)	Reel of 2000	LM2904AVQPWR	L2904AV
-55°C to 125°C	5mV	30V	CDIP (JG)	Tube of 50	LM158JG	LM158JG
			LCCC (FK)	Tube of 55	LM158FK	LM158FK
	2mV	30V	CDIP (JG)	Tube of 50	LM158AJG	LM158AJG
			LCCC (FK)	Tube of 55	LM158AFK	LM158AFK

Symbol (each amplifier)



schematic (each amplifier)



COMPONENT COUNT	
Epi -FET	1
Diodes	2
Resistors	7
Transistors	51
Capacitors	2

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

		LM158, LM158A LM258,LM258A LM358,LM358A LM2904V	LM2904	UNIT
Supply voltage. V_{CC} (see Note 1)		±16 or 32	±13 or 26	V
Differential input voltage. V_{ID} (see Note 2)		±32	±26	V
Input voltage, V_I (either input)		-0.3 to 32	-0.3 to 26	V
Duration of output short circuit (one amplifier) to ground At (or below) 25°C free-air temperature (V_{CC} ≤15V) (see Notes 3)		Unlimited	unlimited	
Package thermal impedance, Θ_{JA} (see Notes 4 and 5)	D package	97	97	°C/W
	DGK package	172	172	
	P package	85	85	
	PS package	95	95	
	PW package	149	149	
Package thermal impedance, Θ_{JA} (see Notes 6 and 7)	FK package	5.61		°C/W
	JG package	14.5		
Operating free-air temperature range, T_A	LM158, LM158A	-55 to 125		°C
	LM258, LM258A	-25 to 85		
	LM358, LM358A	0 to 70		
	LM2904	-40 to 125	-40 to 125	
Operating virtual junction temperature, T_J		150	150	°C
Case temperature for 60 seconds	FK package	260		°C
Lead temperature 1,6mm (1/16 inch) from case for 60 seconds	JG package	300	300	°C
Storage temperature range, T_{stg}		-60 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.

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

PARAMETER		TEST CONDITIONS†		T_A‡	LM158 LM258			LM358			UNIT
					MIN	TYP§	MAX	MIN	TYP§	MAX	
V_{IO}	Input offset voltage	V_{CC}=5V to MAX. V_{IC} = V_{ICR} (min). V_O=1.4V		25°C		3	5		3	7	mV
				Full range			7			9	
a_{VIO}	Average temperature coefficient of input offset voltage			Full range		7			7		μV/°C
I_{IO}	Input offset current	V_O=1.4V		25°C		2	30		2	50	nA
				Full range			100			150	
a_{IIO}	Average temperature coefficient of input offset current			Full range		10			10		pA/°C
I_{IB}	Input bias current	V_O=1.4V		25°C		-20	-150		-20	-250	nA
				Full range			-300			-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≥2KΩ		25°C	V_{CC}-1.5			V_{CC}-1.5			V
		R_L≥10KΩ		25°C							
		VCC=MAX	R_L=2KΩ	Full range	26			26			
			R_L≥10KΩ	Full range	27	28		27	28		
V_{OH}	Low-level Output voltage	R_L≤10kΩ		Full range		5	20		5	20	mV
AVD	Large-signal differential Voltage amplification	VCC=1.5V, VO=1V to 11V, R_L≥2kΩ		25°C	50	100		25	100		V/mV
				Full range	25			15			
CMRR	Common-mode Rejection ratio	V_{CC}=5V to MAX V_{IC}=V_{ICR}(min)		25°C	70	80		65	80		dB
K_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{CC}=5V to MAX		25°C	65	100		65	100		dB
V_{O1}/V_{O2}	Crosstalk attenuation	F=1kHz to 20kHz		25°C		120			120		dB
I_O	Output current	V_{CC}=15V V_{ID}=1V V_O=0	Source	25°C	-20	-30		-20	-30		mA
				Full range	-10			-10			
		V_{CC}=15V V_{ID}=-1V V_O=15V	Sink	25°C	10	20		10	20		
				Full range	5			5			
I_{OS}	Output current	V_{ID} = -1V,V_O=200mV		25°C	12	30		12	30		μA
I_{OS}	Short-circuit Output current	V_{CC} at 5V, GND at –5V V_O=0		25°C		±40	±60		±40	±60	mA
I_{CC}	Supply current (two amplifiers)	V_O=2.5V,No load		Full range		0.7	1.2		0.7	1.2	mA
		V_{CC} =MAX, V_O=0.5V No load		Full range		1	2		1	2	

†All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 26V for the LM2904 and 30V for others.

‡Full range is -55°C to 125°C for LM158, -25°C to 85°C for LM258, 0°C to 70°C for LM358, and -40°C to 125°C for LM2904.

§All typical values are at T_A=25°C.

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

PARAMETER		TEST CONDITIONS†		TA‡	LM2904			UNIT
					MIN	TYP§	MAX	
V_{IO}	Input offset voltage	V_{CC}=5V to MAX, $V_{IC}=V_{ICR}$(min), V_O=1.4V	Non-A devices	25°C		3	7	mV
				Full range			10	
			A-suffix devices	25°C		1	2	
				Full range			4	
a_{VIO}	Average temperature coefficient of input offset voltage			Full range		7		μV/°C
I_{IO}	Input offset current	V_O=1.4V	Non-V device	25°C		2	50	nA
				Full range			300	
			V-suffix device	25°C		2	50	
				Full range			150	
a_{IIO}	Average temperature coefficient of input offset current			Full range		10		pA/°C
I_{IB}	Input bias current	V_O =1.4V		25°C		-20	-250	nA
				Full range			-500	
V_{ICR}	Common-mode input voltage range	V_{CC}=5V to MAX		25°C	0 to V_{CC} – 1.5			V
				Full range	0 to V_{CC} -2			
V_{OH}	High-level output voltage	R_L≥10KΩ		25°C	V_{CC} –1.5			V
		V_{CC}=MAX, Non-V device	R_L=2kΩ	Full range	22			
			R_L≥10kΩ	Full range	23	24		
		V_{CC}=MAX, V-suffix device	R_L=2kΩ	Full range	26			
			R_L≥10kΩ	Full range	27	28		
V_{OL}	Low-level output voltage	R_L≤10KΩ		Full range		5	20	mV
A_{VD}	Large-signal differential Voltage amplification	V_{CC}=15V,V_O=1V to 11V R_L≤2kΩ		25°C	25	100		V/mV
				Full range	15			
CMRR	Common-mode rejection ratio	V_{CC}=5V to MAX, $V_{IC}=V_{ICR}$(min)	Non-V device	25°C	50	80		dB
			V-suffix device	25°C	65	80		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{CC}=5V to MAX		25°C	65	100		dB
V_{O1}/V_{O2}	Crosstalk attenuation	f=1kHz to 20kHz		25°C		120		dB
I_O	Output current	V_{CC}=15V, V_{ID}=1V, V_O=0	Source	25°C	-20	-30		mA
				Full range	-10			
		V_{CC}=15V, V_{ID}=-1V, V_O=15V	Sink	25°C	10	20		
				Full range	5			
		V_{ID}=-1V, V_O=200mV	Non-V device	25°C		30		μA
			V-suffix device	25°C	12	40		
IOS	Short-circuit output current	V_{CC} at 5V, GND at –5V, V_O=0		25°C		±40	±60	mA
I_{CC}	Supply current (two amplifiers)	V_O=2.5V, No load		Full range		0.7	1.2	mA
		V_{CC}=MAX, V_O=0.5V, No load		Full range		1	2	

†All characteristics are measured under open-loop conditions, with zero common-mode input voltage. Unless otherwise specified. MAX V_{CC} for testing purposes is 26V for the LM2904, 32V for the LM2904V, and 30V for others.
‡Full range is -55°C to 125°C for LM158, -25°C to 85°C for LM258, 0°C to 70°C for LM358, and -40°C to 125°C for LM2904.
§All typical values are at T_A=25°C

Electrical characteristics at specified free-air temperature, Vcc=5V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		T_A‡	LM158A			LM258A			UNIT
					MIN	TYP§	MAX	MIN	TYP§	MAX	
V_{IO}	Input offset voltage	V_{CC}=5V to 30V, $V_{IC}=V_{ICR(min)}$, V_O=1.4V		25°C			2		2	3	mV
				Full range			4			4	
a_{VIO}	Average temperature coefficient of input offset voltage			Full range		7	15*		7	15	μV/°C
I_{IO}	Input offset current	V_O=1.4V		25°C		2	10		2	15	nA
				Full range			30			30	
a_{VIO}	Average temperature coefficient of input offset voltage			Full range		10	200		10	200	pA/°C
I_{IB}	Input bias current	V_O=1.4V		25°C		-15	-50		-15	-80	nA
				Full range			-100			-100	
V_{ICR}	Common-mode Input voltage range	V_{CC}=30V		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≥2kΩ		25°C	V_{CC} –1.5			V_{CC} –1.5			V
		V_{CC}=30V	R_L=2kΩ	Full range	26			26			
			R_L≥10kΩ	Full range	27	28		27	28		
V_{OL}	Low-level Output voltage	R_L≤10kΩ		Full range		5	20		5	20	mV
A_{VD}	Large-signal differential Voltage amplification	V_{CC}=15V, V_O=1V to 11V, R_L≥2kΩ		25°C	50	100		50	100		V/mV
				Full range	25			25			
CMRR	Common-mode Rejection ratio			25°C	70	80		70	80		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)			25°C	65	100		65	100		dB
V_{01}/V_{02}	Crosstalk attenuation	f=1 kHz to 20kHz		25°C		120			120		dB
I_O	Output current	V_{CC}=15V, V_{ID}=1V, V_O=0	Source	25°C	-20	-30	-60	-20	-30	-60	
				Full range	-10			-10			mA
		V_{CC}=15V, V_{ID}=-1V, V_O=15	Sink	25°C	10	20		10	20		
				Full range	5			5			
		V_{ID}=-1V, V_O=200mV		25°C	12	30		12	30		
Ios	Short-circuit output current	V_{CC} at 5V, GND at –5V, V_O=0		25°C		±40	±60		±40	±60	mA
I_{CC}	Supply current (two amplifiers)	V_O=2.5V, No load		Full range		0.7	1.2		0.7	1.2	mA
		V_{CC}=MAX, VO=0.5V, No load		Full range		1	2		1	2	

*On products compliant to MIL-PRF-38535, this parameter is not production tested.

†All characteristics are measured under open-loop conditions. With zero common-mode input voltage. Unless otherwise specified. Max Vcc for testing purposes is 26V for LM2904 and 30V for others.

‡Full range is -55°C for LM158A, -25°C to 85°C for LM258A, and 0°C to 70°C for LM358A.

§All typical values are at T_A =25°C,

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

PARAMETER	TEST CONDITIONS†		T_A‡	LM358A			UNIT
				MIN	TYP§	MAX	
V_{IO} Input offset voltage	V_{CC}=5V to 30V, V_{IC}=$V_{ICR(min)}$, V_O=1.4V		25°C		2	3	mV
			Full range			5	
a_{VIO} Average temperature coefficient of input offset voltage			Full range		7	20	μV/°C
I_{IO} Input offset current	V_O=1.4V		25°C		2	30	nA
			Full range			75	
a_{VIO} Average temperature coefficient of input offset voltage			Full range		10	300	pA/°C
I_{IB} Input bias current	V_O=1.4V		25°C		-15	-100	nA
			Full range			-200	
V_{ICR} Common-mode Input voltage range	V_{CC}=30V		25°C	0 to V_{CC} –1.5			V
			Full range	0 to V_{CC} –2			
V_{OH} High-level Output voltage	R_L≥2kΩ		25°C	V_{CC} –1.5			V
	V_{CC}=30V	R_L=2kΩ	Full range	26			
		R_L≥10kΩ	Full range	27	28		
V_{OL} Low-level output voltage	R_L≤10kΩ		Full range		5	20	mV
A_{VD} Large-signal differential Voltage amplification	V_{CC}=15V,V_O=1V to 11V, R_L≥2kΩ		25°C	50	100		V/mV
			Full range	15			
CMRR Common-mode Rejection ratio			25°C	65	80		dB
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)			25°C	65	100		dB
V_{01}/V_{02} Crosstalk attenuation	f=1 kHz to 20kHz		25°C		120		dB
I_O Output current	V_{CC}=15V, V_{ID}=1V, V_O=0	Source	25°C	-20	-30	-60	mA
			Full range	-10			
	V_{CC}=15V, V_{ID}=-1V, V_O=15	Sink	25°C	10	20		
			Full range	5			
	V_{ID}=-1V, V_O=200mV		25°C		30		
Ios Short-circuit output current	V_{CC} at 5V, GND at –5V,V_O=0		25°C		±40	±60	mA
I_{CC} Supply current (two amplifiers)	V_O=2.5V, No load		Full range		0.7	1.2	mA
	V_{CC}=MAX, VO=0.5V,No load		Full range		1	2	

†All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.MAX Vcc for testing purposes is 26V for LM2904 and 30V for others.

‡Full range is -55°C to 125°C for LM158A, -25°C to 85°C for LM258A, and 0°C to 70°C for LM358A,

§All typical values are at T_A=25°C.

Operating conditions, V_{CC} =±15V, T_A=25℃

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	R_L=1MΩ,CL =30pF, V_I =±10V (see Figure 1)	0.3	V/μs
B1	Unity-gain bandwidth	R_L=1MΩ,CL =20pF, (see Figure 1)	0.7	MHz
Vn	Equivalent input noise voltage	R_L=1MΩ, V_I =±10V,f=1kHz (see Figure 2)	40	NV/√Hz

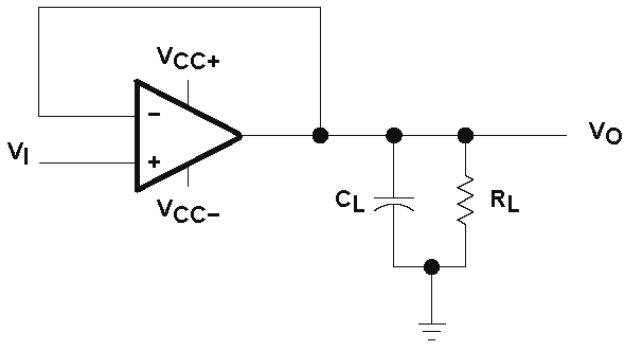


Figure 1. Unity-Gain Amplifier

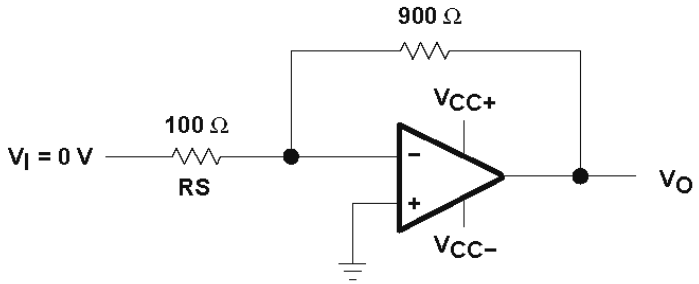
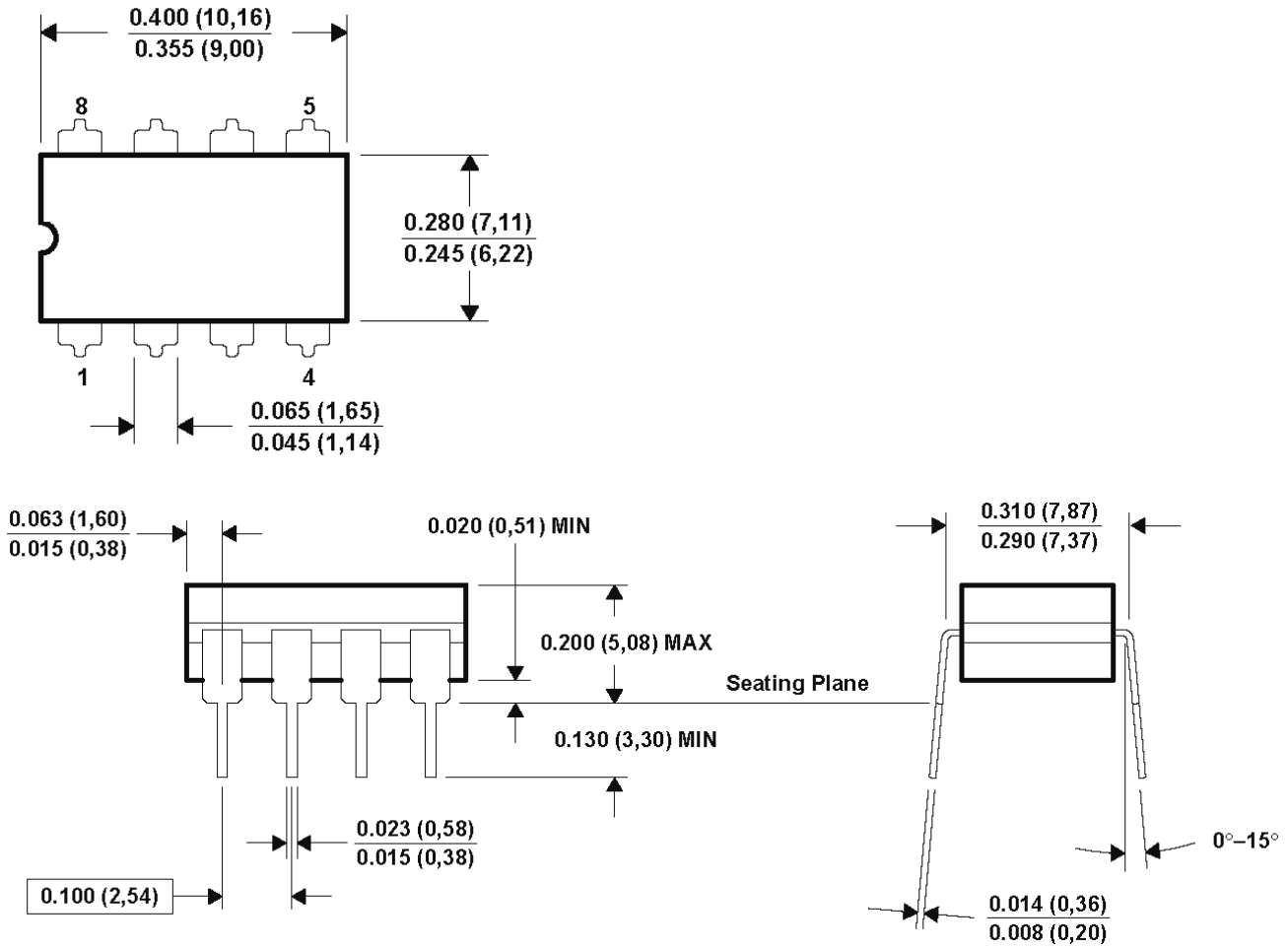


Figure 2. Noise-Test Circuit

JG (R-GDIP-T8) **CERAMIC DUAL-IN-LINE**



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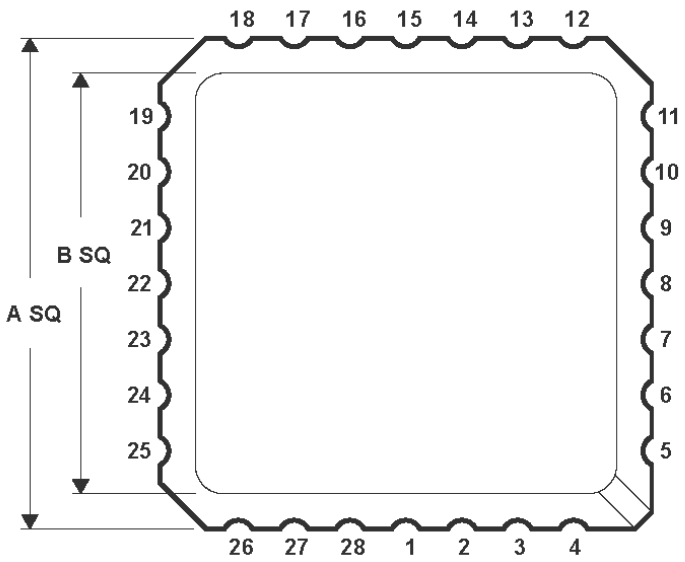
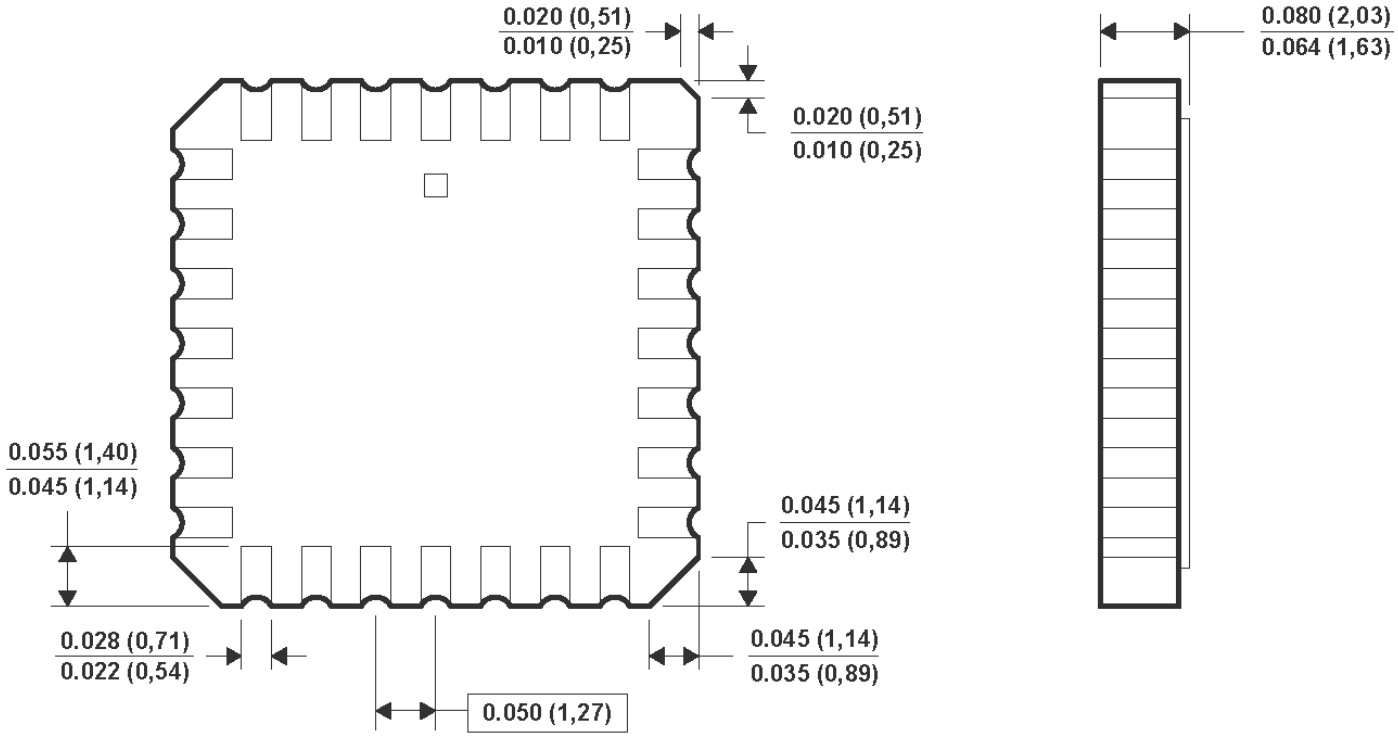
FK (S-CQCC-N)** **LEADLESS CERAMIC CHIP CARRIER**

28 TERMINAL SHOWN

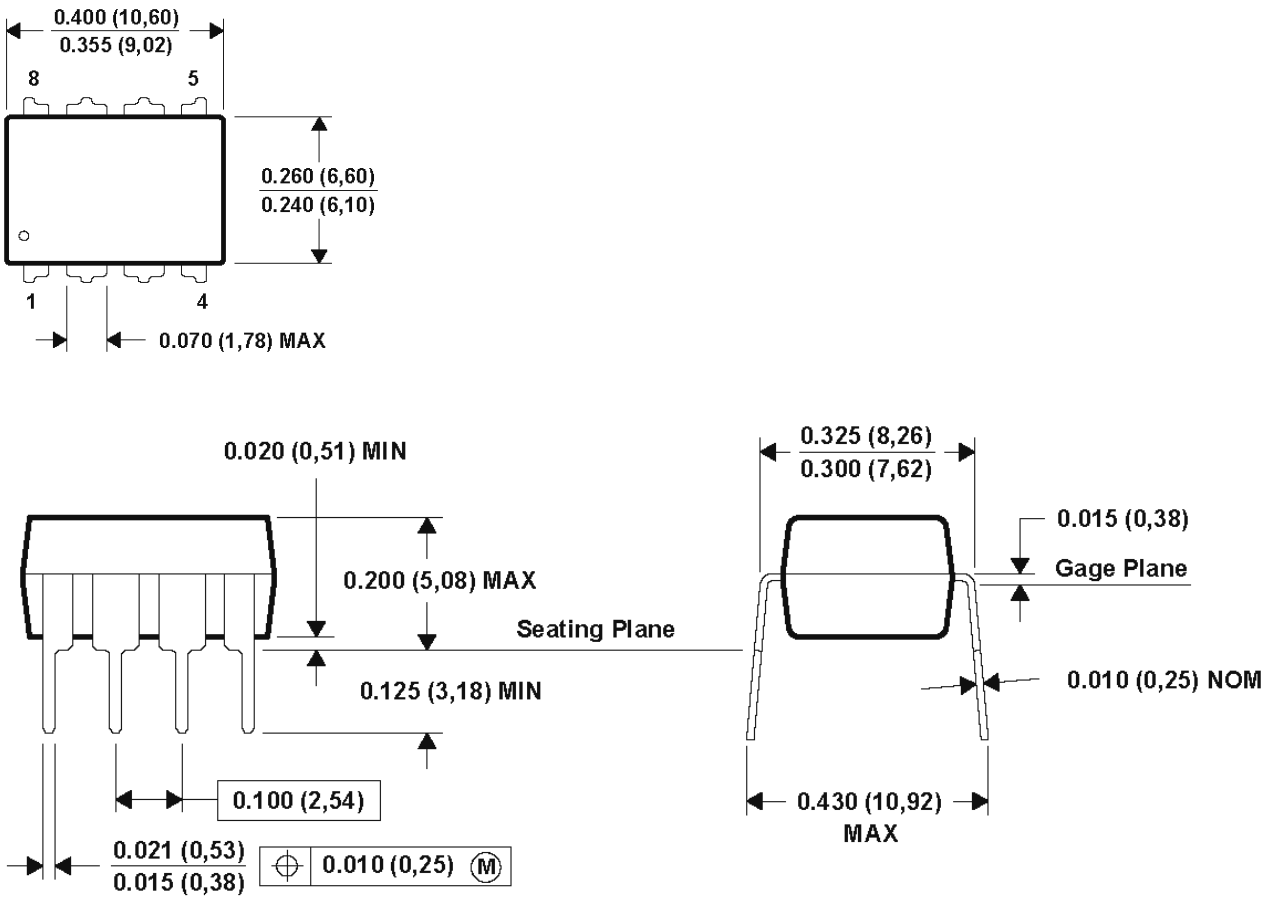


NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.739 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 10/96

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE**



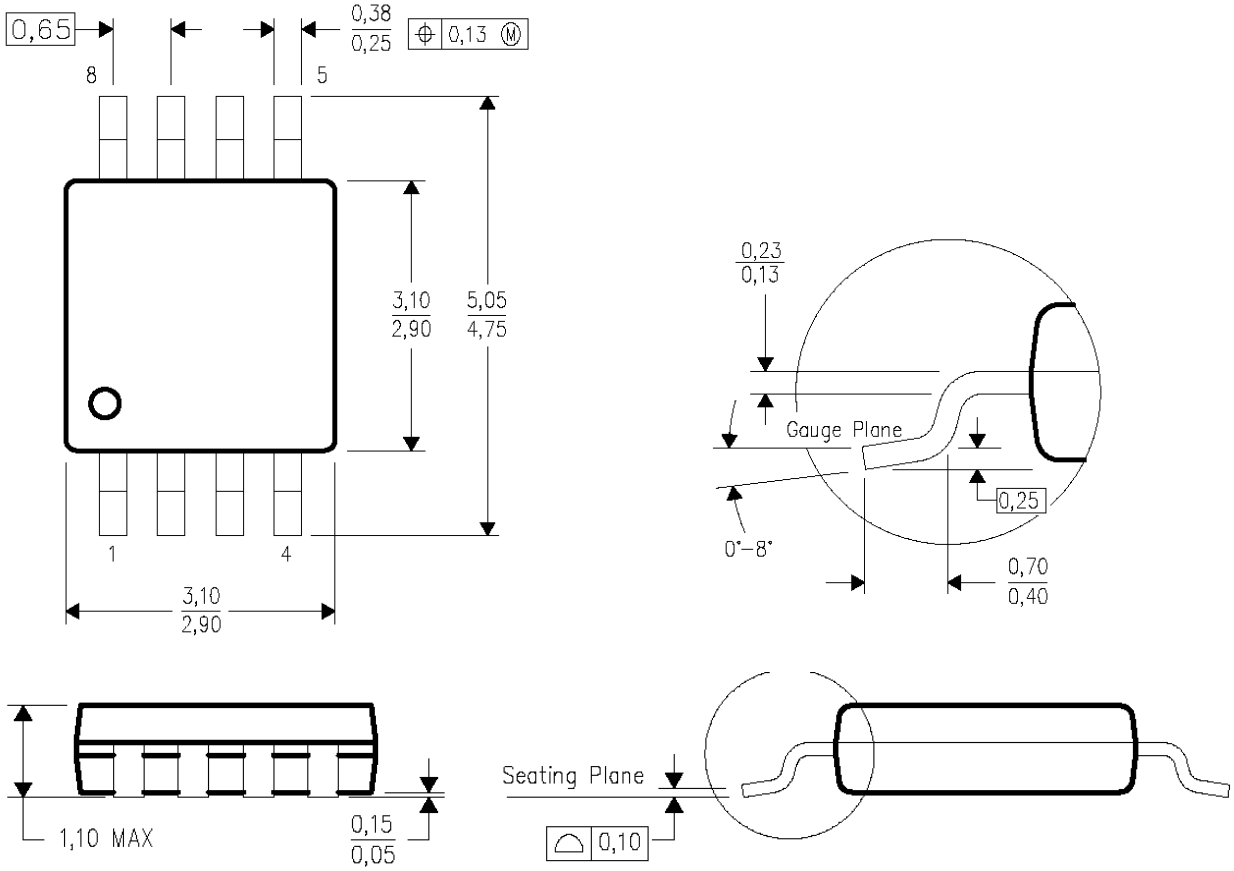
4040082/D 05/98

NOTES: A. All linear dimensions are in inches (millimeters).

B. This drawing is subject to change without notice.

C. Falls within JEDEC MS-001

DGK (S-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



4073329/D 12/03

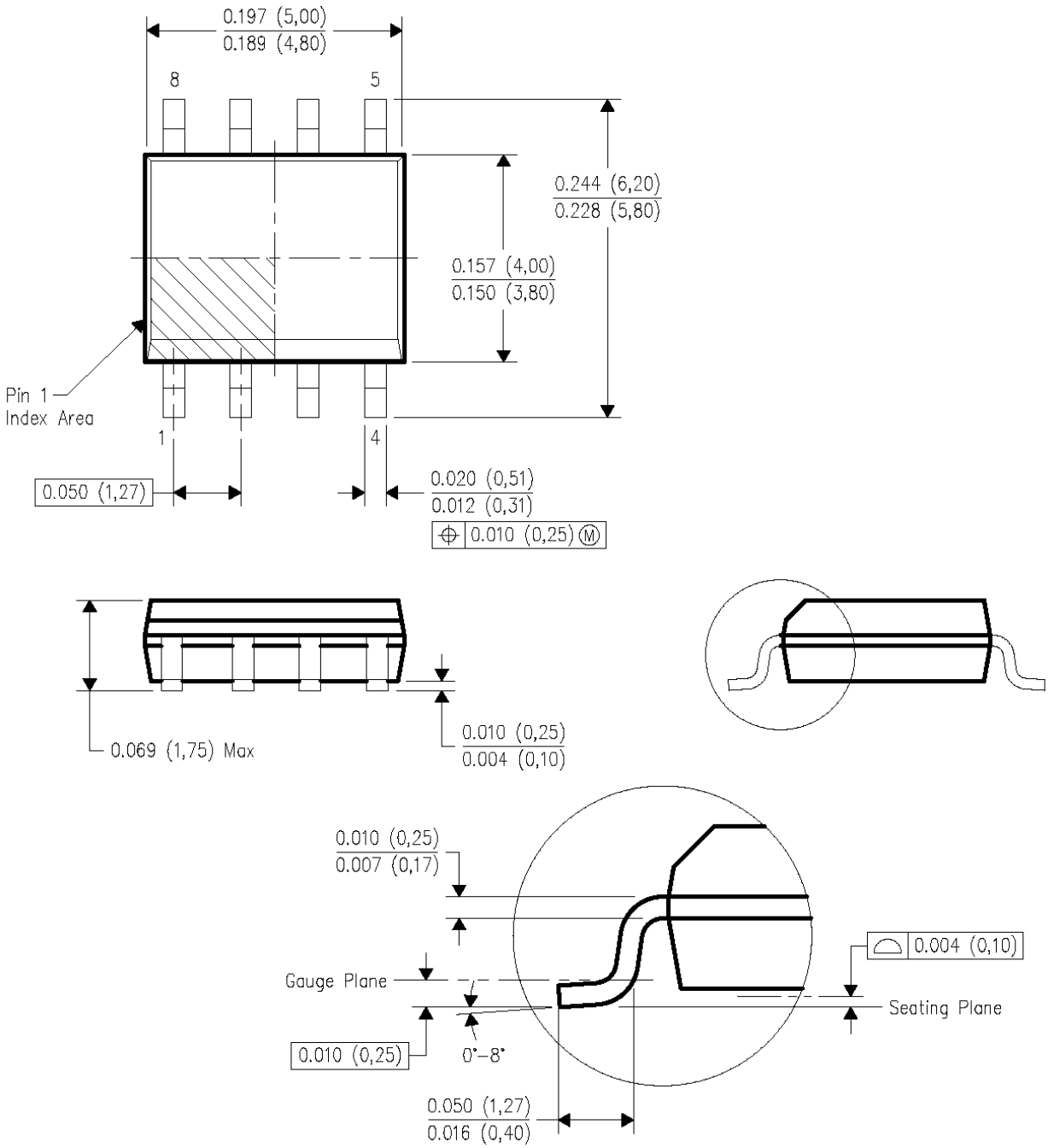
NOTES: A. All linear dimensions are in millimeters.

B. This drawing is subject to change without notice.

C. Body dimensions do not include mold flash or protrusion.

D. Falls within JEDEC MO-187 variation AA.

D (R-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



4040047-2/F 07/2004

NOTES: A. All linear dimensions are in inches (millimeters).

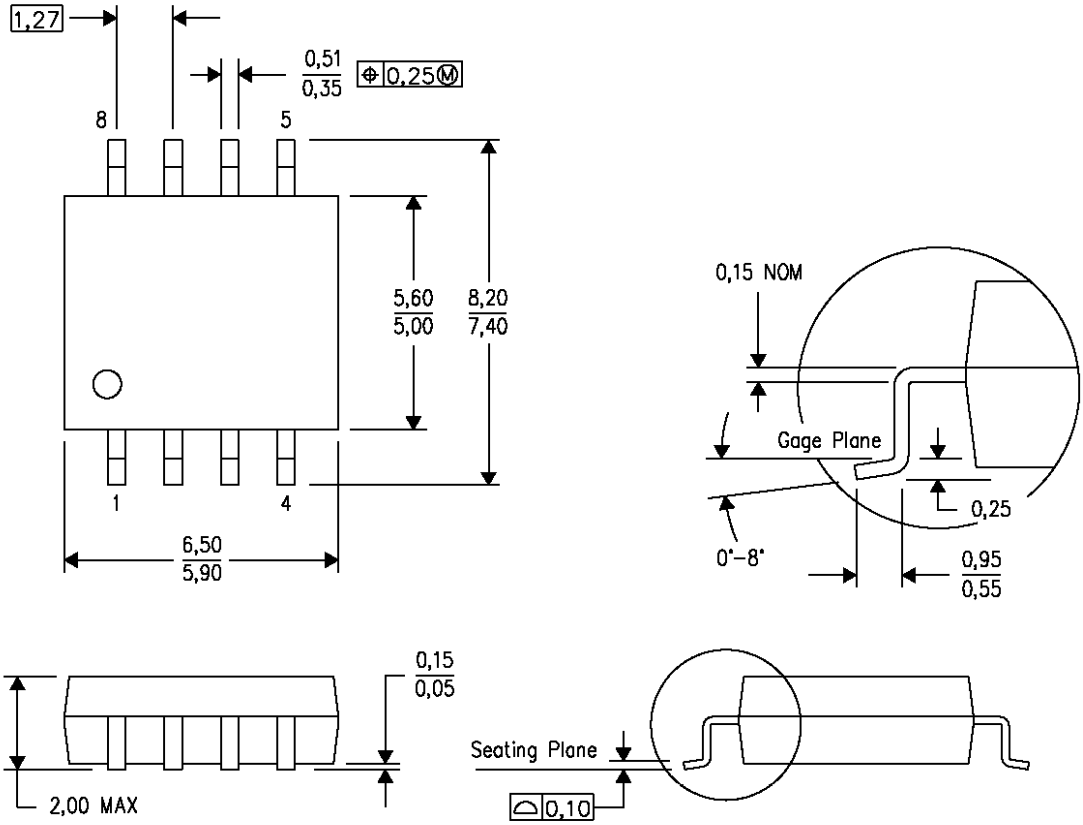
B. This drawing is subject to change without notice.

C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0.15).

D. Falls within JEDEC MS-012 variation AA.

MECHANICAL DATA

PS (R-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



4040063/C 03/03

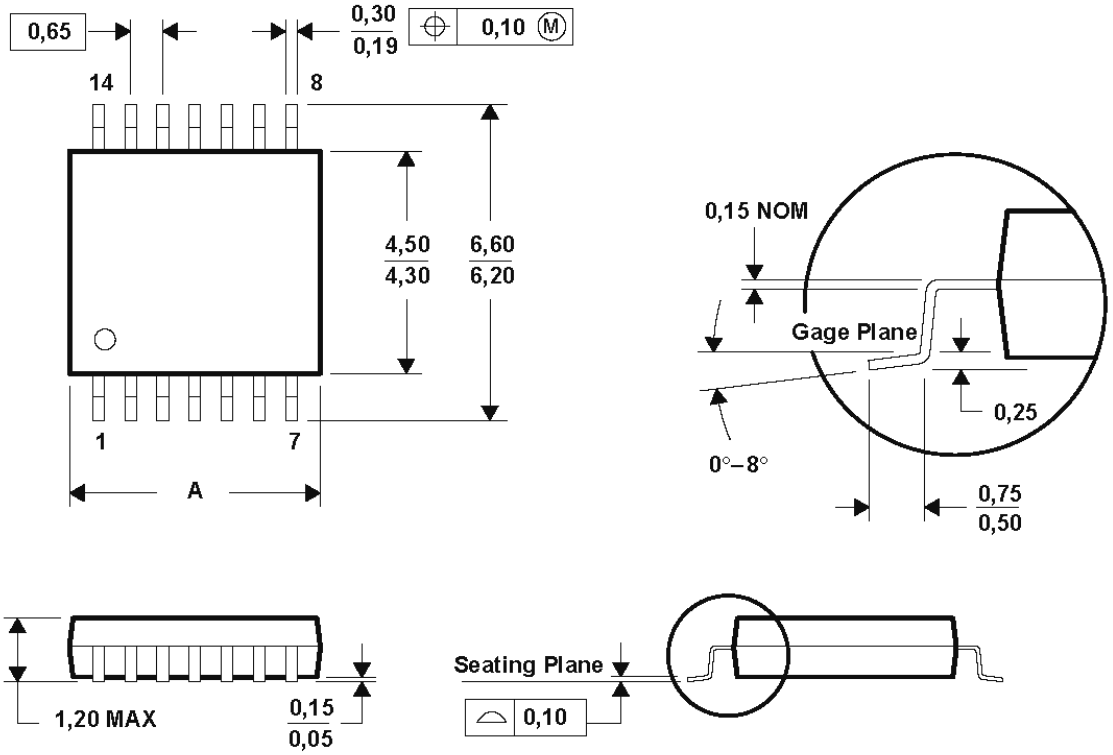
NOTES: **A. All linear dimensions are in millimeters.**

B. This drawing is subject to change without notice.

C. Body dimensions do not include mold flash or protrusion, not to exceed 0.15.

PS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

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