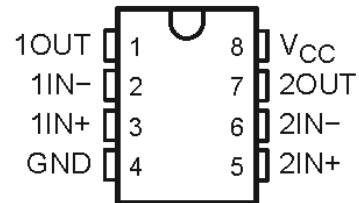
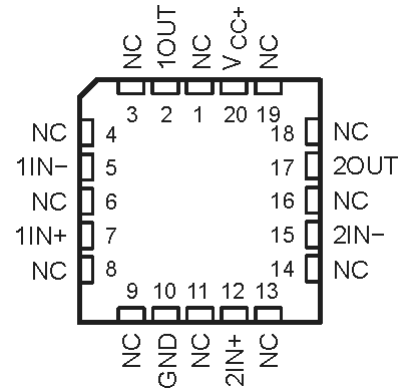


- **Wide Supply Range:**
 - Single Supply...3V to 32V
(26V for LM2904)
 - or Dual Supplies ... $\pm 1.5V$ to $\pm 16V$
($\pm 13V$ for LM2904)
- **Low Supply-Current Drain, Independent of Supply Voltage... 0.7mA Typ**
- **Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground**
- **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.

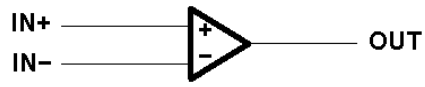
Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational amplifier circuits that now be implemented more easily in single-supply-voltage systems. For example, these devices can be operated directly from the standard 5-V supply used in digital systems and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

Description/ordering information (continued)

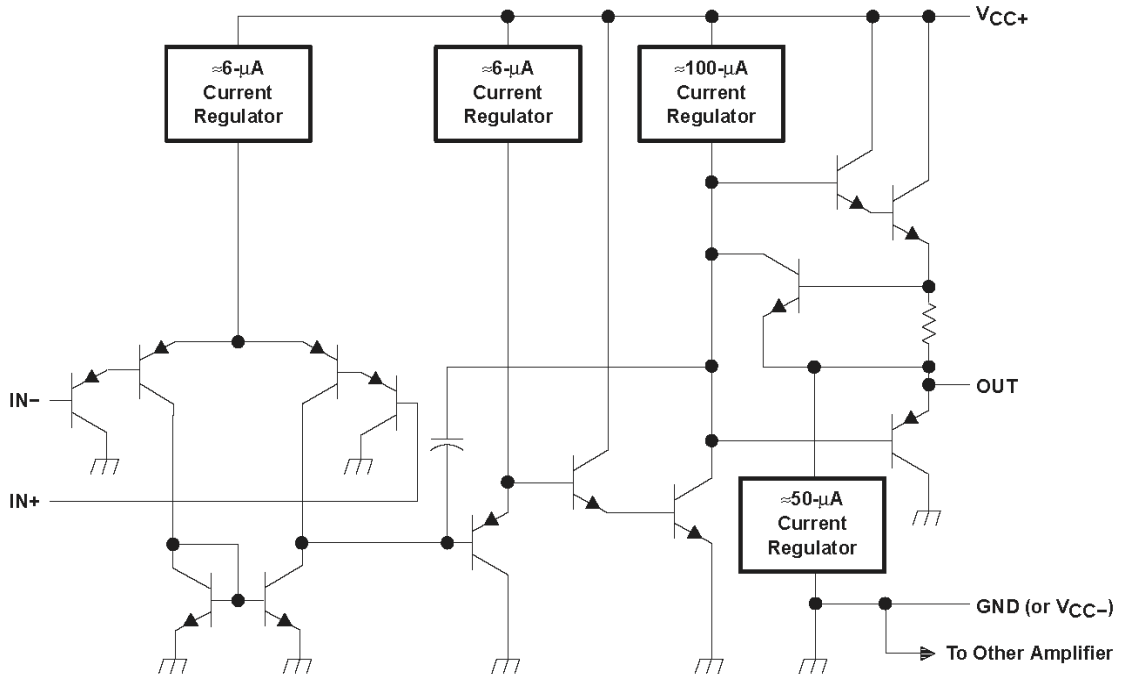
ORDERING INFORMATION

TA	V _{IO} max AT 25	MAX TESTED V _{CC}	PACKAGE [†]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0 to 70	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 to 85	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 to 125	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	
SOIC (D)			Reel of 2500	LM2904AVQDR	L2904AV	
2mV	32V	TSSOP (PW)	Reel of 2000	LM2904AVQPWR	L2904AV	
		CDIP (JG)	Tube of 50	LM158JG	LM158JG	
-55 to 125	5mV	30V	LCCC (FK)	Tube of 55	LM158FK	LM158FK
			CDIP (JG)	Tube of 50	LM158AJG	LM158AJG
	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 ($V_{CC} \leq 15V$) (see Notes 3)		Unlimited	unlimited	
Package thermal impedance, Θ_{JA} (see Notes 4 and 5)	D package	97	97	/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		/W
	JG package	14.5		
Operating free-air temperature range, T_A	LM158, LM158A	-55 to 125		
	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	
Case temperature for 60 seconds	FK package	260		
Lead temperature 1,6mm (1/16 inch) from case for 60 seconds	JG package	300	300	
Storage temperature range, T_{stg}		-60 to 150	-65 to 150	

† 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	3 5		3 7		mV		
		Full range	7		9				
$a_{V_{IO}}$ Average temperature coefficient of input offset voltage		Full range	7		7		$\mu V/$		
I_{IO} Input offset current	$V_O=1.4V$	25	2	30	2	50	nA		
		Full range	100		150				
$a_{I_{IO}}$ Average temperature coefficient of input offset current		Full range	10		10		pA/		
I_{IB} Input bias current	$V_O=1.4V$	25	-20	-150	-20	-250	nA		
		Full range	-300		-500				
V_{ICR} Common-mode Input voltage range	$V_{CC}=5 V$ to MAX	25	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	$R_L \geq 2K\Omega$	25	$V_{CC}-1.5$		$V_{CC}-1.5$		V		
	$R_L \geq 10K\Omega$	25							
	$V_{CC}=\text{MAX}$	$R_L=2K\Omega$	Full range	26		26			
		$R_L \geq 10K\Omega$	Full range	27	28	27		28	
V_{OH} Low-level Output voltage	$R_L \leq 10k\Omega$	Full range	5	20	5	20	mV		
AVD Large-signal differential Voltage amplification	$V_{CC}=1.5V$, $V_O=1V$ to 11V, $R_L \geq 2k\Omega$	25	50	100	25	100	V/mV		
		Full range	25		15				
CMRR Common-mode Rejection ratio	$V_{CC}=5V$ to MAX $V_{IC}=V_{ICR}(\text{min})$	25	70	80	65	80	dB		
K_{SVR} Supply-voltage rejection ratio (V_{DD}/V_{IO})	$V_{CC}=5V$ to MAX	25	65	100	65	100	dB		
V_{O1}/V_{O2} Crosstalk attenuation	$F=1\text{kHz}$ to 20kHz	25	120		120		dB		
I_O Output current	$V_{CC}=15V$ $V_{ID}=1V$ $V_O=0$	Source	25	-20	-30	-20	-30	mA	
			Full range	-10		-10			
	Sink	25	10	20	10	20			
		Full range	5		5				
I_{OS} Output current	$V_{ID} = -1V, V_O=200mV$	25	12	30	12	30	μA		
I_{OS} Short-circuit Output current	V_{CC} at 5V, GND at -5V $V_O=0$	25	± 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		
	$V_{CC} = \text{MAX}$, $V_O=0.5V$ 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 to 125 for LM158, -25 to 85 for LM258, 0 to 70 for LM358, and -40 to 125 for LM2904.

§All typical values are at $T_A=25$.

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	3		7	mV
			Full range	10			
		A-suffix devices	25	1		2	
			Full range	4			
a _{VIO} Average temperature coefficient of input offset voltage			Full range	7		μV/	
I _{IO} Input offset current	V _O =1.4V	Non-V device	25	2	50		nA
			Full range	300			
		V-suffix device	25	2		50	
			Full range	150			
a _{IIO} Average temperature coefficient of input offset current			Full range	10		pA/	
I _{IB} Input bias current	V _O =1.4V			25	-20	-250	nA
				Full range	-500		
V _{ICR} Common-mode input voltage range	V _{CC} =5V to MAX			25	0 to V _{CC} - 1.5		V
				Full range	0 to V _{CC} - 2		
V _{OH} High-level output voltage	R _L ≥10KΩ		25	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	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	50	80		dB
		V-suffix device	25	65	80		
k _{SVR} Supply-voltage rejection ratio (V _{DD} /V _{IO})	V _{CC} =5V to MAX		25	65	100		dB
V _{O1} /V _{O2} Crosstalk attenuation	f=1kHz to 20kHz		25	120		dB	
I _O Output current	V _{CC} =15V, V _{ID} =1V, V _O =0	Source	25	-20	-30		mA
			Full range	-10			
	V _{CC} =15V, V _{ID} =-1V, V _O =15V	Sink	25	10	20		
			Full range	5			
V _{ID} =-1V, V _O =200mV	Non-V device	25	30			μA	
	V-suffix device	25	12	40			
I _{OS} Short-circuit output current	V _{CC} at 5V, GND at -5V, V _O =0		25	±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 to 125 for LM158, -25 to 85 for LM258, 0 to 70 for LM358, and -40 to 125 for LM2904.

[§]All typical values are at T_A=25

Electrical characteristics at specified free-air temperature, V_{CC}=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	2			2 3			mV
			Full range	4			4			
a _{VIO} Average temperature coefficient of input offset voltage			Full range	7 15*			7 15			µV/
I _{IO} Input offset current	V _O =1.4V		25	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/
I _{IB} Input bias current	V _O =1.4V		25	-15 -50			-15 -80			nA
			Full range	-100			-100			
V _{ICR} Common-mode Input voltage range	V _{CC} =30V		25	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	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	50 100			50 100			V/mV
			Full range	25			25			
CMRR Common-mode Rejection ratio			25	70 80			70 80			dB
k _{SVR} Supply-voltage rejection ratio (V _{DD} /V _{IO})			25	65 100			65 100			dB
V _{O1} /V _{O2} Crosstalk attenuation	f=1 kHz to 20kHz		25	120			120			dB
I _O Output current	V _{CC} =15V, V _{ID} =1V, V _O =0	Source	25	-20 -30 -60			-20 -30 -60			mA
			Full range	-10			-10			
	V _{CC} =15V, V _{ID} =-1V, V _O =15	Sink	25	10 20			10 20			
			Full range	5			5			
V _{ID} =-1V, V _O =200mV		25	12 30			12 30				
I _{OS} Short-circuit output current	V _{CC} at 5V, GND at -5V, V _O =0		25	±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			

*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 V_{CC} for testing purposes is 26V for LM2904 and 30V for others.

‡Full range is -55 for LM158A, -25 to 85 for LM258A, and 0 to 70 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	2		3	mV		
		Full range	5					
$a_{V_{IO}}$ Average temperature coefficient of input offset voltage		Full range	7		20	$\mu V/$		
I_{IO} Input offset current	$V_O=1.4V$	25	2		30	nA		
		Full range	75					
$a_{V_{IO}}$ Average temperature coefficient of input offset voltage		Full range	10		300	$\mu A/$		
I_{IB} Input bias current	$V_O=1.4V$	25	-15		-100	nA		
		Full range	-200					
V_{ICR} Common-mode Input voltage range	$V_{CC}=30V$	25	0 to $V_{CC}-1.5$			V		
		Full range	0 to $V_{CC}-2$					
V_{OH} High-level Output voltage	$R_L \geq 2k\Omega$	25	$V_{CC}-1.5$			V		
	$V_{CC}=30V$	$R_L=2k\Omega$	26					
		$R_L \geq 10k\Omega$	27					
Full range	27		28					
V_{OL} Low-level output voltage	$R_L \leq 10k\Omega$	Full range	5		20	mV		
A_{VD} Large-signal differential Voltage amplification	$V_{CC}=15V, V_O=1V$ to $11V$, $R_L \geq 2k\Omega$	25	50		100	V/mV		
		Full range	15					
CMRR Common-mode Rejection ratio		25	65		80	dB		
k_{SVR} Supply-voltage rejection ratio (V_{DD}/V_{IO})		25	65		100	dB		
V_{O1}/V_{O2} Crosstalk attenuation	$f=1$ kHz to 20 kHz	25			120	dB		
I_O Output current	$V_{CC}=15V$, $V_{ID}=1V$, $V_O=0$	Source	25	-20		-30	-60	mA
		Full range	-10					
	Sink	25	10		20			
		Full range	5					
$V_{ID}=-1V, V_O=200mV$	25	30						
I_{OS} Short-circuit output current	V_{CC} at $5V$, GND at $-5V, V_O=0$	25	± 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 LM2904 and $30V$ for others.

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

[§]All typical values are at $T_A=25$.

Operating conditions, $V_{CC} = \pm 15V$, $T_A = 25$

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	$R_L = 1M\Omega, C_L = 30pF, V_I = \pm 10V$ (see Figure 1)	0.3	$V/\mu s$
B1	Unity-gain bandwidth	$R_L = 1M\Omega, C_L = 20pF$, (see Figure 1)	0.7	MHz
Vn	Equivalent input noise voltage	$R_L = 1M\Omega, V_I = \pm 10V, f = 1kHz$ (see Figure 2)	40	NV/\sqrt{Hz}

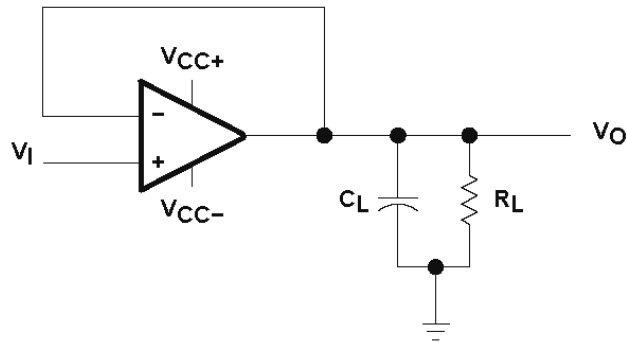


Figure 1. Unity-Gain Amplifier

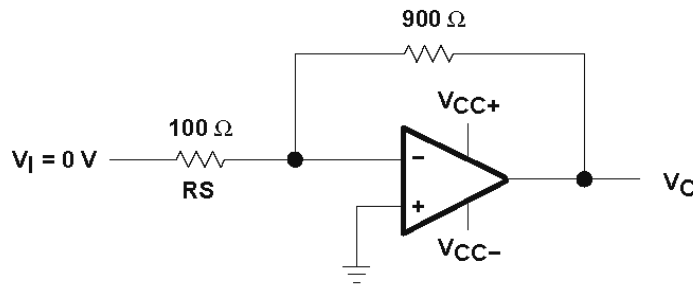
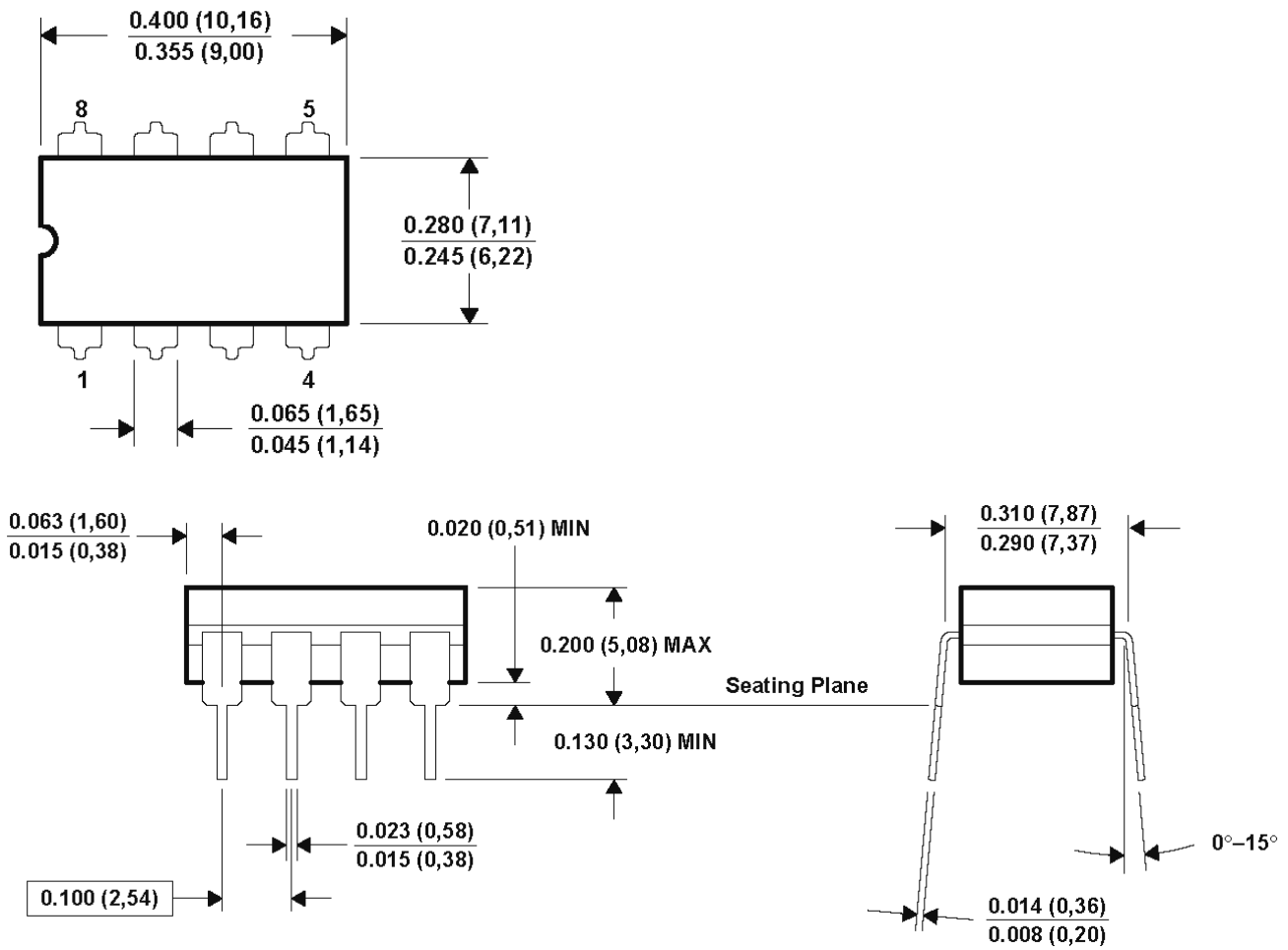


Figure 2. Noise-Test Circuit

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE

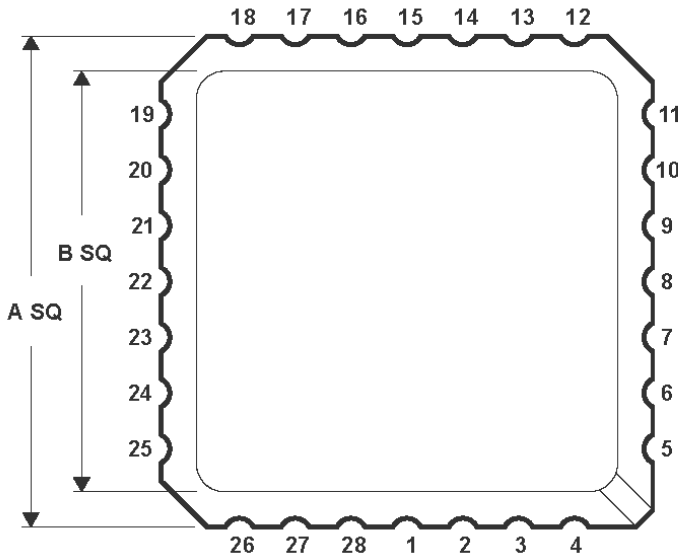


4040107/C 08/96

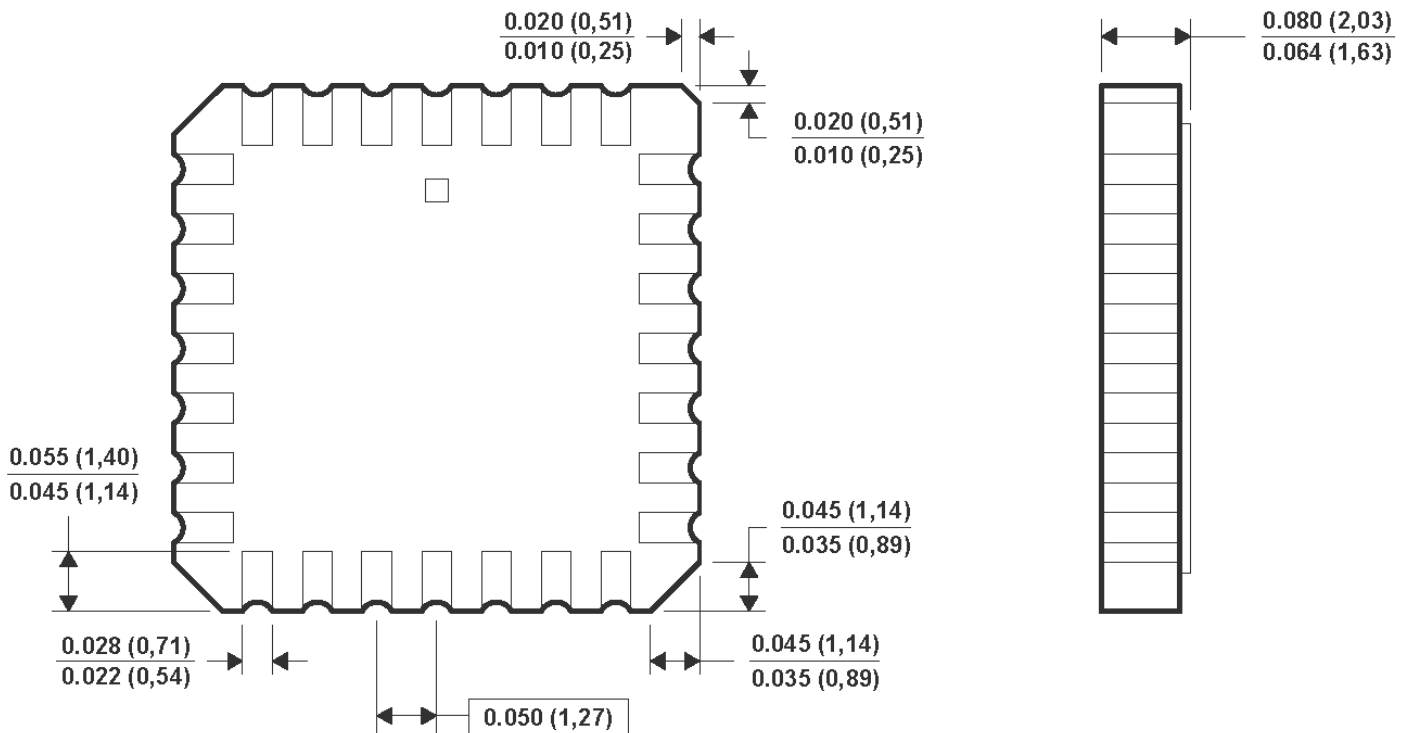
FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



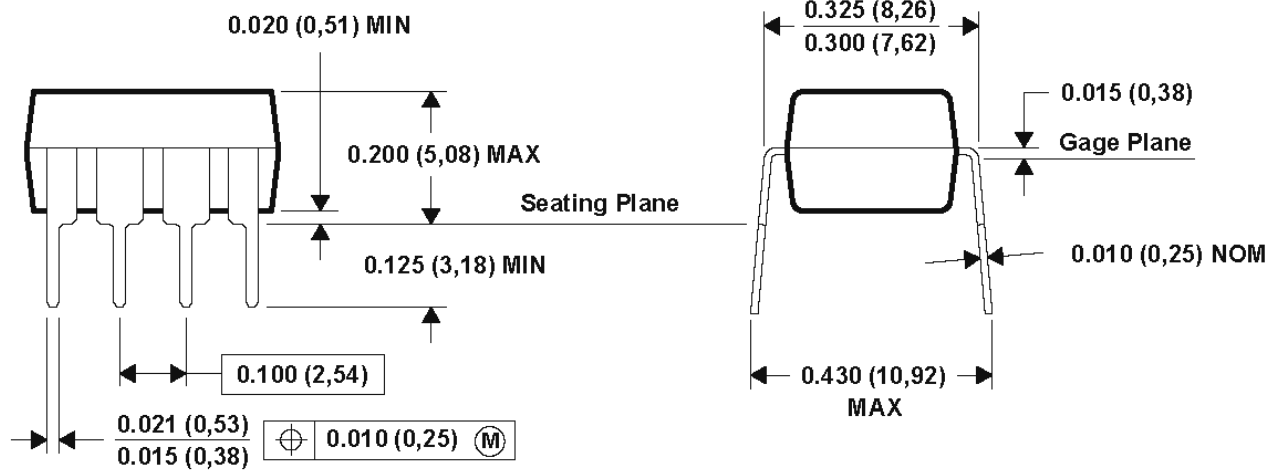
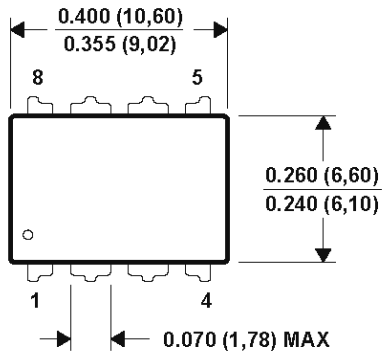
NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.739 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)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

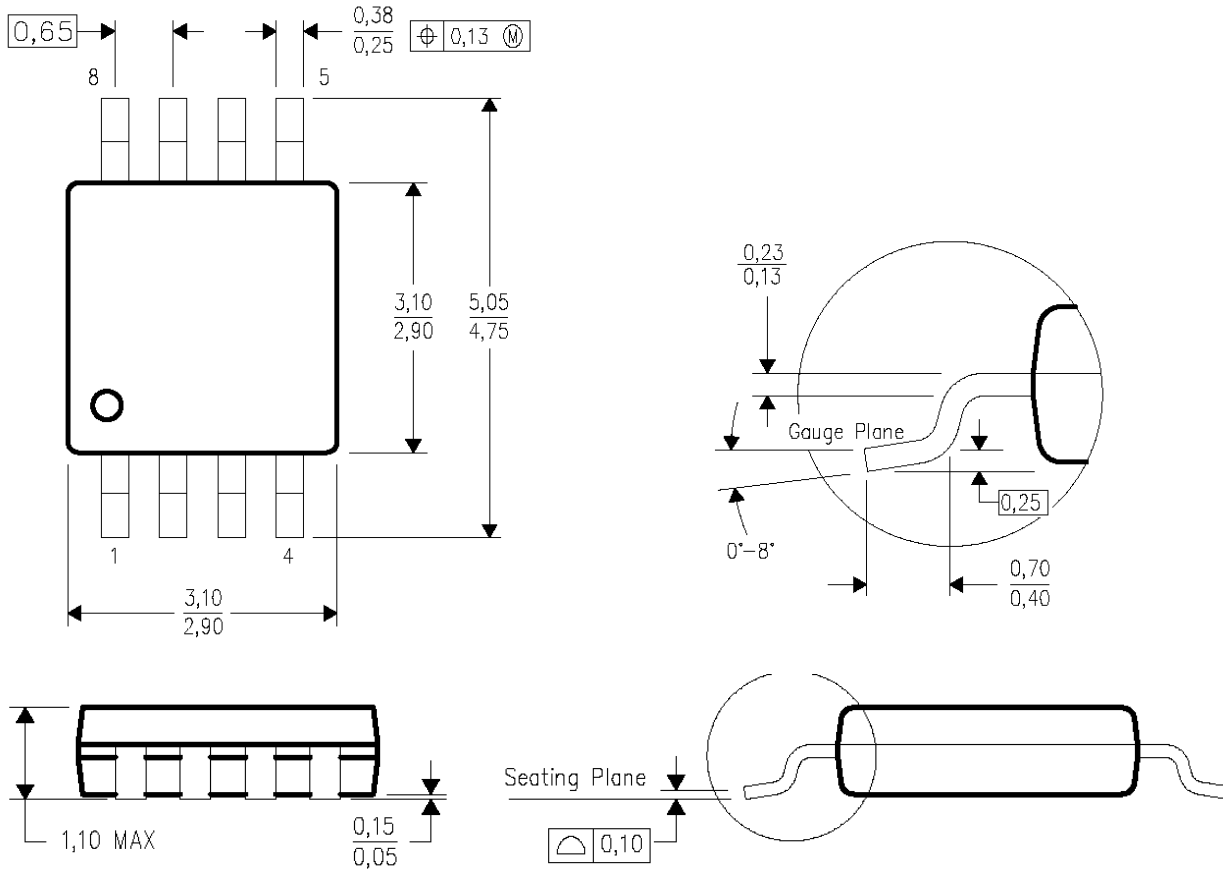


4040082/D 05/98

- 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

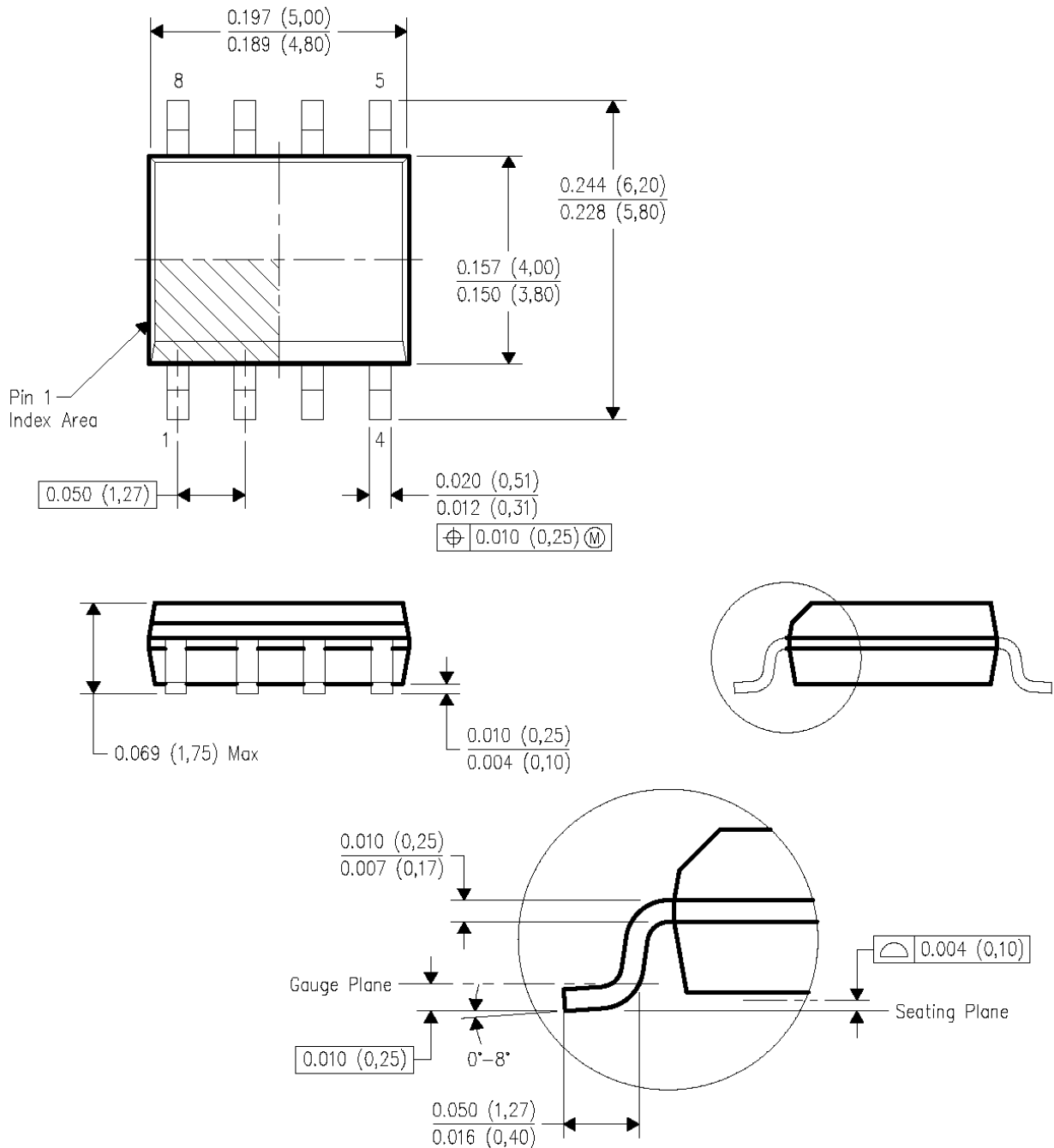


4073329/D 12/03

- 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



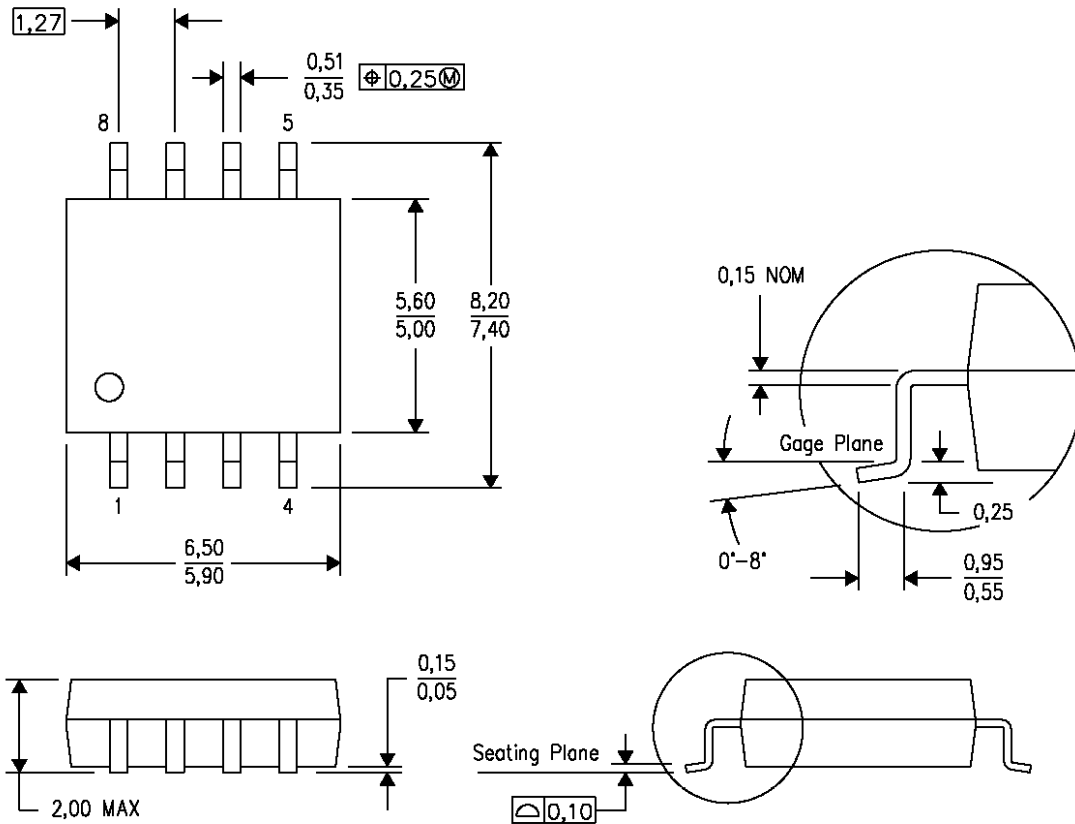
4040047-2/F 07/2004

- 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

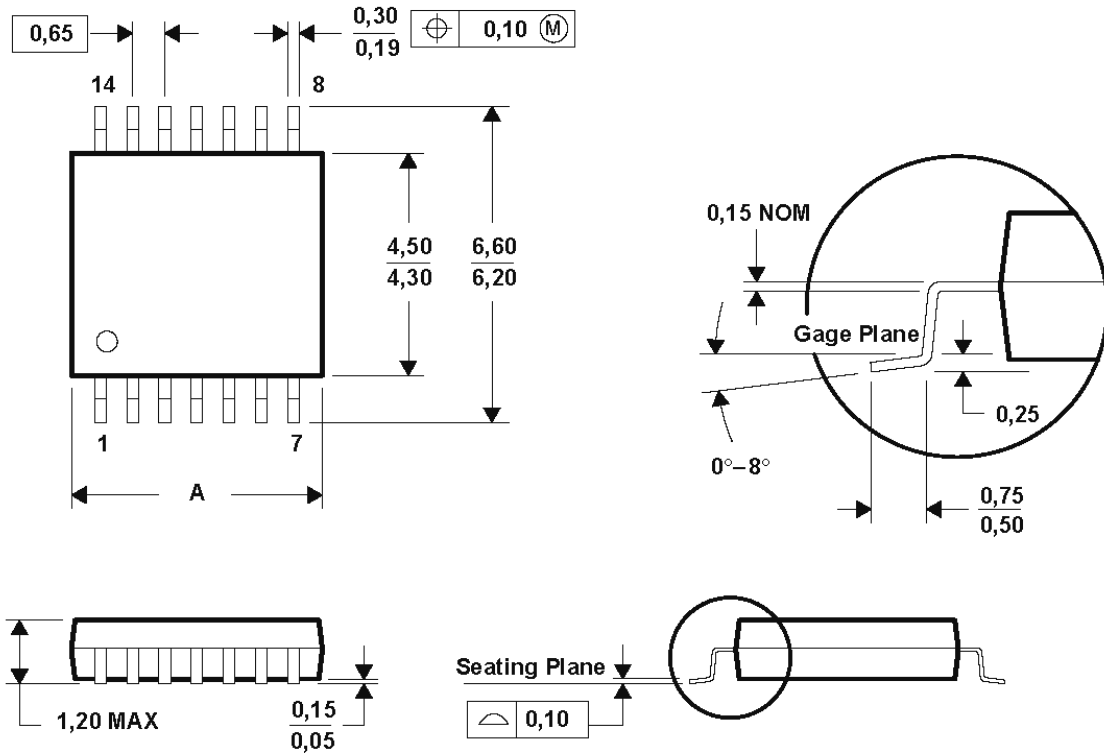


4040063/C 03/03

- 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**)
14 PINS SHOWN

PLASTIC SMALL-OUTLINE PACKAGE



DIM \ PINS **	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