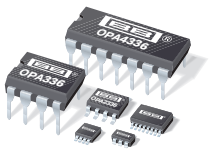


OPA336
OPA2336
OPA4336

SBOS068C – JANUARY 1997 – REVISED JANUARY 2005

SINGLE-SUPPLY, *micro*Power CMOS OPERATIONAL AMPLIFIERS
*micro*Amplifier™ Series

FEATURES

- SINGLE-SUPPLY OPERATION
- RAIL-TO-RAIL OUTPUT (within 3mV)
- *micro*POWER: I_Q = 20μA/Amplifier
- *micro*SIZE PACKAGES
- LOW OFFSET VOLTAGE: 125μV max
- SPECIFIED FROM V_S = 2.3V to 5.5V
- SINGLE, DUAL, AND QUAD VERSIONS

APPLICATIONS

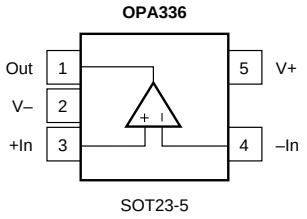
- BATTERY-POWERED INSTRUMENTS
- PORTABLE DEVICES
- HIGH-IMPEDANCE APPLICATIONS
- PHOTODIODE PRE-AMPS
- PRECISION INTEGRATORS
- MEDICAL INSTRUMENTS
- TEST EQUIPMENT

DESCRIPTION

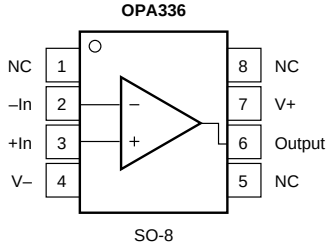
OPA336 series *micro*Power CMOS operational amplifiers are designed for battery-powered applications. They operate on a single supply with operation as low as 2.1V. The output is rail-to-rail and swings to within 3mV of the supplies with a 100kΩ load. The common-mode range extends to the negative supply—ideal for single-supply applications. Single, dual, and quad versions have identical specifications for maximum design flexibility.

In addition to small size and low quiescent current (20μA/amplifier), they feature low offset voltage (125μV max), low input bias current (1pA), and high open-loop gain (115dB). Dual and quad designs feature completely independent circuitry for lowest crosstalk and freedom from interaction.

OPA336 packages are the tiny SOT23-5 surface mount and SO-8 surface-mount. OPA2336 come in the miniature MSOP-8 surface-mount, SO-8 surface-mount, and DIP-8 packages. The OPA4336 package is the space-saving SSOP-16 surface-mount. All are specified from –40°C to +85°C and operate from –55°C to +125°C. A macromodel is available for download (at www.ti.com) for design analysis.

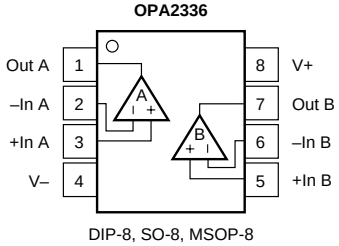


SOT23-5

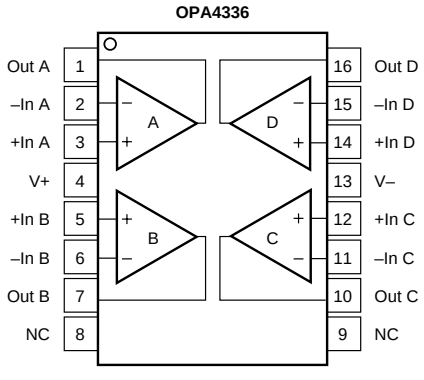


SO-8

NC = No Connection



DIP-8, SO-8, MSOP-8



SSOP-16

NC = No Connection

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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PACKAGE/ORDERING INFORMATION[1]

PRODUCT	PACKAGE-LEAD	PACKAGE DRAWING DESIGNATOR	PACKAGE MARKING
Single			
OPA336N	SOT23-5	DBV	A36[2]
OPA336NA	SOT23-5	DBV	A36[2]
OPA336NJ	SOT23-5	DBV	J36
OPA336U	SO-8 Surface-Mount	D	OPA336U
OPA336UA	SO-8 Surface-Mount	D	OPA336UA
OPA336UJ	SO-8 Surface-Mount	D	OPA336UJ
Dual			
OPA2336E	MSOP-8 Surface-Mount	DGK	B36[2]
OPA2336EA	MSOP-8 Surface-Mount	DGK	B36[2]
OPA2336P	DIP-8	P	OPA2336P
OPA2336PA	DIP-8	P	OPA2336PA
OPA2336U	SO-8 Surface-Mount	D	OPA2336U
OPA2336UA	SO-8 Surface-Mount	D	OPA2336UA
Quad			
OPA4336EA	SSOP-16 Surface-Mount	DBQ	OPA4336EA

NOTES: (1) For the most current package and ordering information, see the package option addendum at the end of this data sheet. (2) Grade will be marked on the Reel.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage	7.5V
Signal Input Terminals, Voltage[2]	(V–) –0.3V to (V+) +0.3V
Current[2]	10mA
Output Short-Circuit[3]	Continuous
Operating Temperature	–55°C to +125°C
Storage Temperature	–55°C to +125°C
Junction Temperature	150°C
Lead Temperature (soldering, 10s)	300°C
ESD Rating:	
Charged Device Model, OPA336 NJ and UJ only (CDM)[4]	1000V
Human Body Model (HBM)[4]	500V
Machine Model (MM)[4]	100V

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only. Functional operation of the device at these conditions, or beyond the specified operating conditions, is not implied. (2) Input terminals are diode-clamped to the power supply rails. Input signals that can swing more than 0.3V beyond the supply rails should be current-limited to 10mA or less. (3) Short-circuit to ground, one amplifier per package. (4) OPA336 NJ and UJ have been tested to CDM of 1000V. All other previous package versions have been tested using HBM and MM. Results are shown.

ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ELECTRICAL CHARACTERISTICS: V_S = 2.3V to 5.5V

Boldface limits apply over the specified temperature range, T_A = –40°C to +85°C.

At T_A = +25°C, V_S = +5V, and R_L = 25kΩ connected to V_S/2, unless otherwise noted.

PARAMETER		CONDITION	OPA336N, U OPA2336E, P, U			OPA336NA, UA OPA2336EA, PA, UA OPA4336EA			OPA336NJ, UJ			UNITS
			MIN	TYP[1]	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OFFSET VOLTAGE												
Input Offset Voltage	V_{OS}			±60	±125		*	±500		±500	±2500	µV
vs Temperature	dV_{OS}/dT			**±1.5**			*			*		**µV/°C**
vs Power Supply	PSRR	V_S = 2.3V to 5.5V		25	100		*	*	*	*	*	µV/V
Over Temperature		V_S = 2.3V to 5.5V			**130**			*	*		*	**µV/V**
Channel Separation, dc				0.1			*			*		µV/V
INPUT BIAS CURRENT												
Input Bias Current	I_B			±1	±10		*	*		*	*	pA
Over Temperature					**±60**			*			*	**pA**
Input Offset Current	I_{OS}			±1	±10		*	*		*	*	pA
NOISE												
Input Voltage Noise, f = 0.1 to 10Hz				3			*			*		µVp-p
Input Voltage Noise Density, f = 1kHz	e_n			40			*			*		$nV/\sqrt{Hz}$
Current Noise Density, f = 1kHz	i_n			30			*			*		$fA/\sqrt{Hz}$
INPUT VOLTAGE RANGE												
Common-Mode Voltage Range	V_{CM}		–0.2		(V+) –1	*		*	*		*	V
Common-Mode Rejection Ratio	CMRR	–0.2V < V_{CM} < (V+) –1V	80	90		76	86		76	86		dB
Over Temperature		–0.2V < V_{CM} < (V+) –1V	**76**			**74**			**74**			**dB**
INPUT IMPEDANCE												
Differential				10^{13} || 2			*			*		Ω || pF
Common-Mode				10^{13} || 4			*			*		Ω || pF
OPEN-LOOP GAIN												
Open-Loop Voltage Gain	A_{OL}	R_L = 25kΩ, 100mV < V_O < (V+) – 100mV	100	115		90	*		90	*		dB
Over Temperature		R_L = 25kΩ, 100mV < V_O < (V+) – 100mV	**100**			**90**			**90**			**dB**
		R_L = 5kΩ, 500mV < V_O < (V+) – 500mV	90	106		*	*		*	*		dB
Over Temperature		R_L = 5kΩ, 500mV < V_O < (V+) – 500mV	**90**			*			*			**dB**
FREQUENCY RESPONSE												
Gain-Bandwidth Product	GBW	V_S = 5V, G = 1		100			*			*		kHz
Slew Rate	SR	V_S = 5V, G = 1		0.03			*			*		V/µs
Overload Recovery Time		V_{IN} • G = V_S		100			*			*		µs
OUTPUT												
Voltage Output Swing from Rail[2]		R_L = 100kΩ, A_{OL} ≥ 70dB		3			*			*		mV
		R_L = 25kΩ, A_{OL} ≥ 90dB		20	100		*	*		*	*	mV
Over Temperature		R_L = 25kΩ, A_{OL} ≥ 90dB			**100**			*			*	**mV**
		R_L = 5kΩ, A_{OL} ≥ 90dB		70	500		*	*		*	*	mV
Over Temperature		R_L = 5kΩ, A_{OL} ≥ 90dB			**500**			*			*	**mV**
Short-Circuit Current	I_{SC}			±5			*			*		mA
Capacitive Load Drive	C_{LOAD}			See Text			*			*		pF
POWER SUPPLY												
Specified Voltage Range	V_S		2.3		5.5	*		*	*		*	V
Minimum Operating Voltage				2.1			*			*		V
Quiescent Current (per amplifier)	I_Q	I_O = 0		20	32		*	*		23	38	µA
Over Temperature		I_O = 0			**36**			*			**42**	**µA**
TEMPERATURE RANGE												
Specified Range			–40		+85	*		*	*		*	°C
Operating Range			–55		+125	*		*	*		*	°C
Storage Range			–55		+125	*		*	*		*	°C
Thermal Resistance	θ_{JA}											
SOT-23-5 Surface-Mount				200			*			*		°C/W
MSOP-8 Surface-Mount				150			*					°C/W
SO-8 Surface-Mount				150			*			*		°C/W
DIP-8				100			*					°C/W
SSOP-16 Surface-Mount				100			*					°C/W
DIP-14				80			*					°C/W

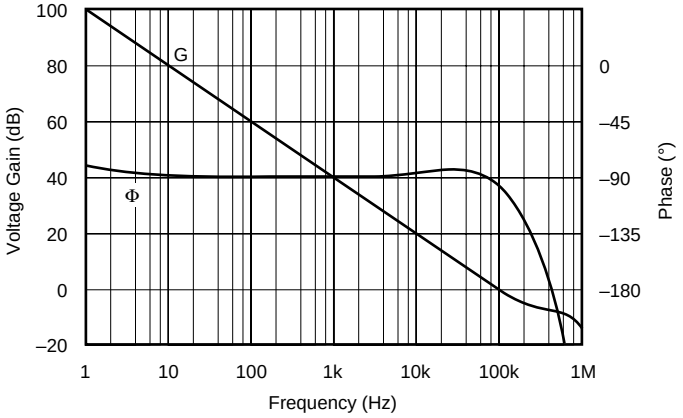
*Specifications same as OPA2336E, P, U.

NOTES: (1) V_S = +5V. (2) Output voltage swings are measured between the output and positive and negative power-supply rails.

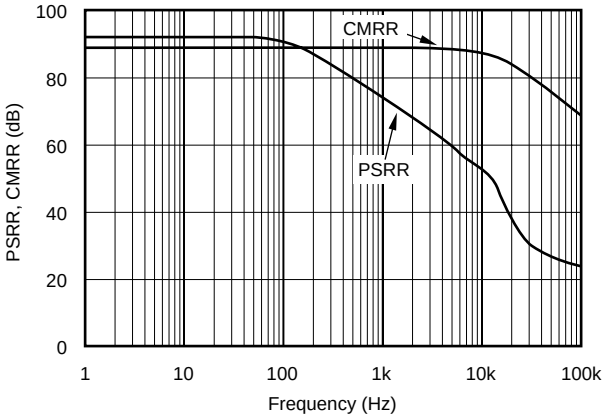
TYPICAL CHARACTERISTICS

At T_A = +25°C, V_S = +5V, and R_L = 25kΩ connected to V_S/2, unless otherwise noted.

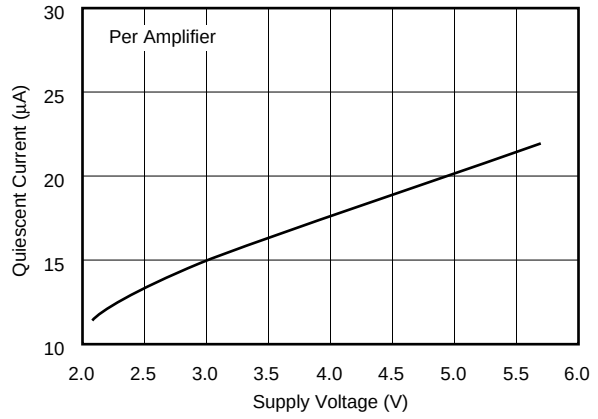
OPEN-LOOP GAIN/PHASE vs FREQUENCY



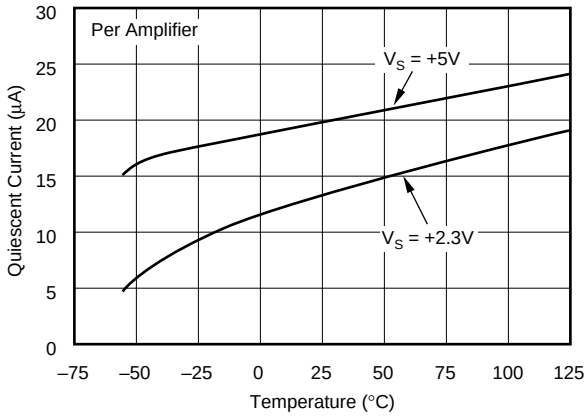
POWER-SUPPLY and COMMON-MODE REJECTION RATIO vs FREQUENCY



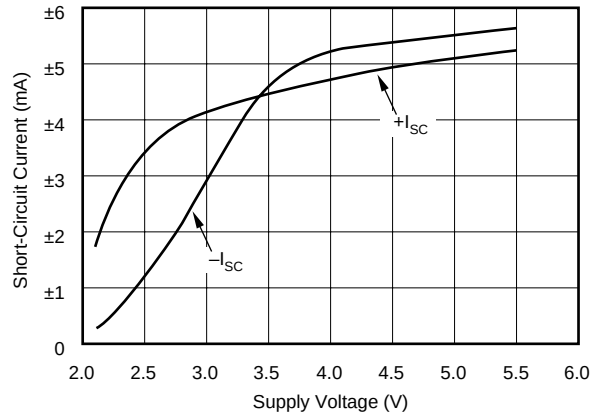
QUIESCENT CURRENT vs SUPPLY VOLTAGE



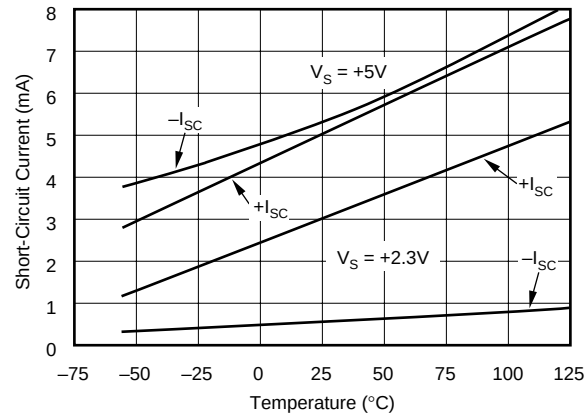
QUIESCENT CURRENT vs TEMPERATURE



SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE



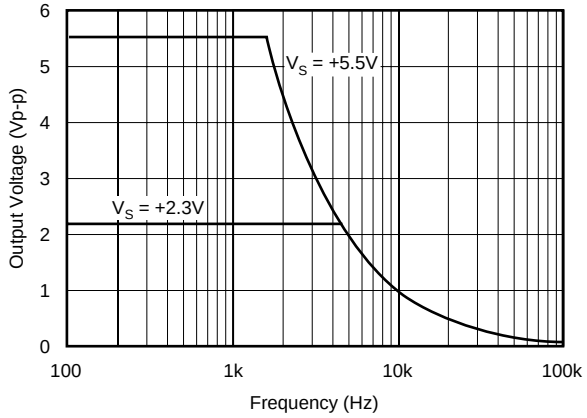
SHORT-CIRCUIT CURRENT vs TEMPERATURE



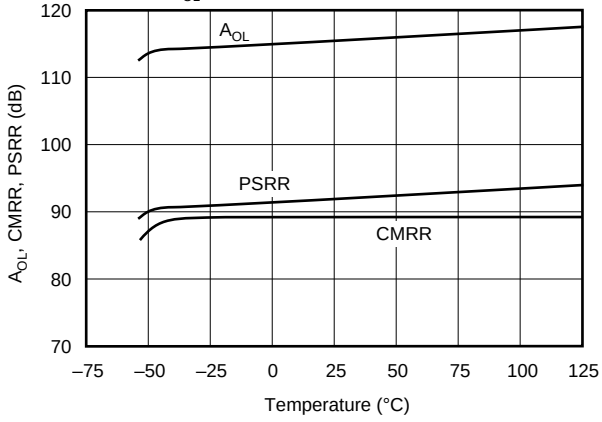
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = +5V, and R_L = 25kΩ connected to V_S/2, unless otherwise noted.

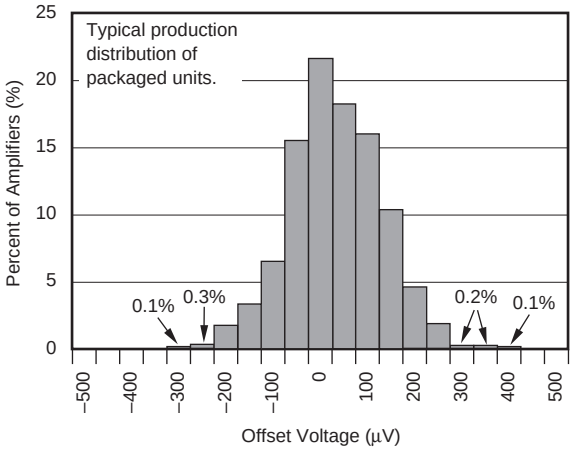
MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



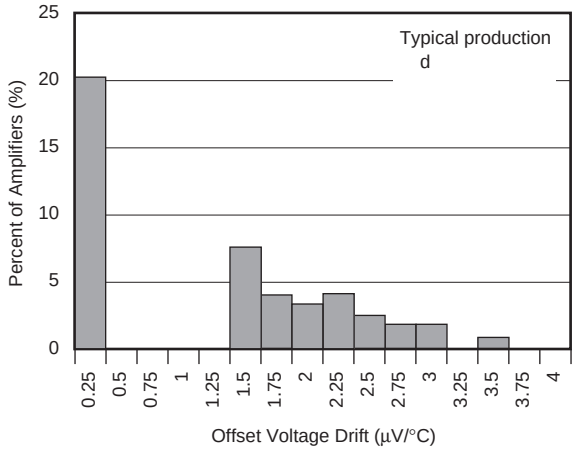
A_{OL}, CMRR, PSRR vs TEMPERATURE



OFFSET VOLTAGE
PRODUCTION DISTRIBUTION

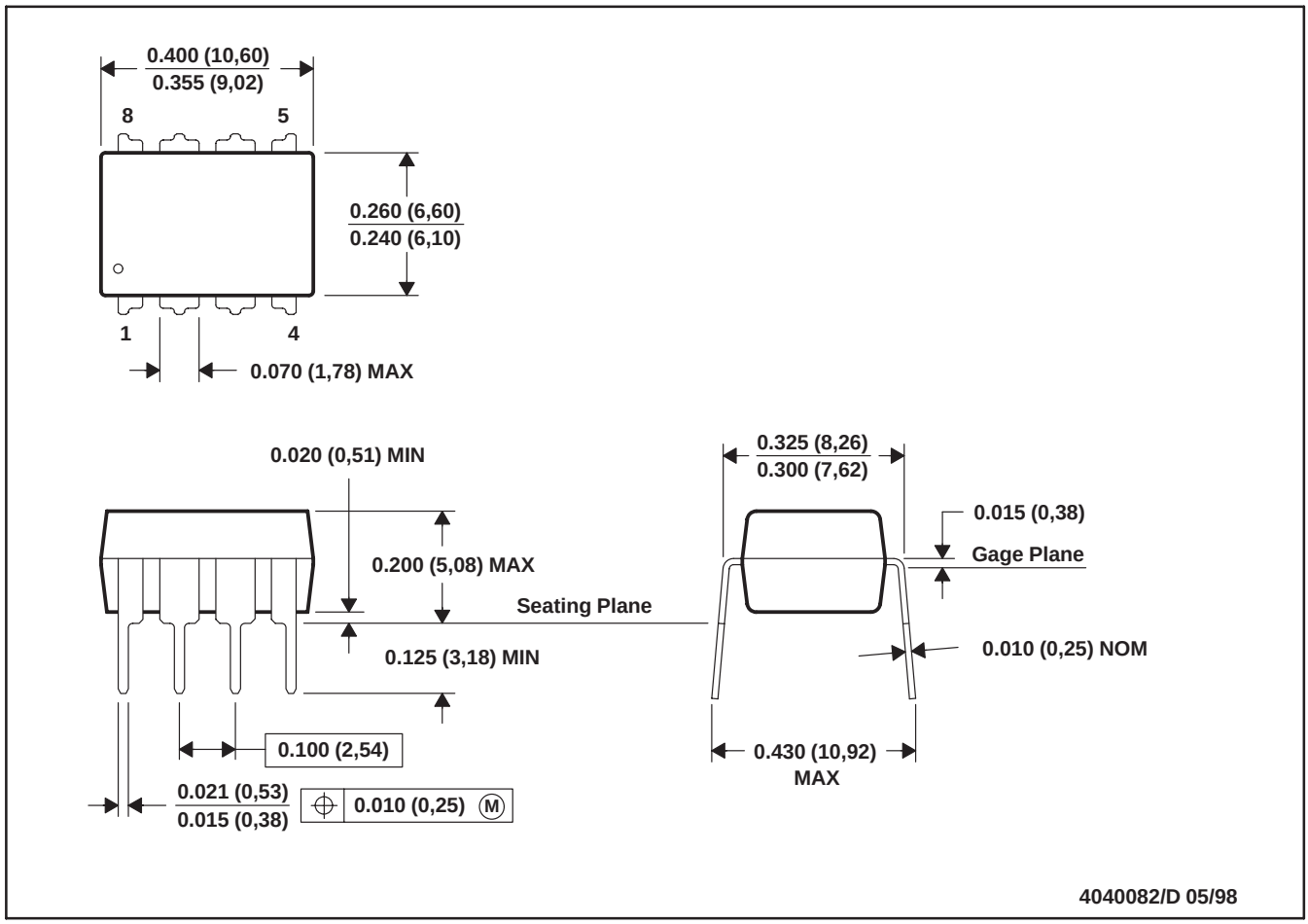


OFFSET VOLTAGE DRIFT MAGNITUDE
PRODUCTION DISTRIBUTION



MPDI001A – JANUARY 1995 – REVISED JUNE 1999

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



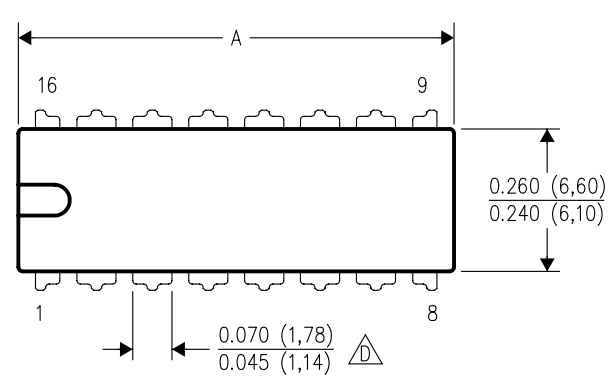
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

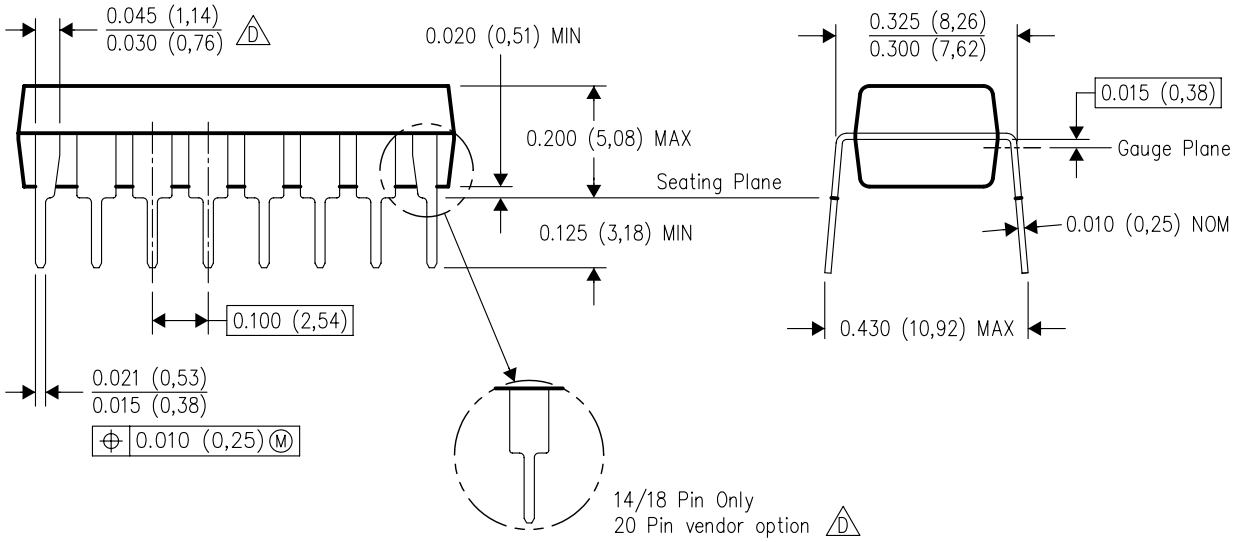
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



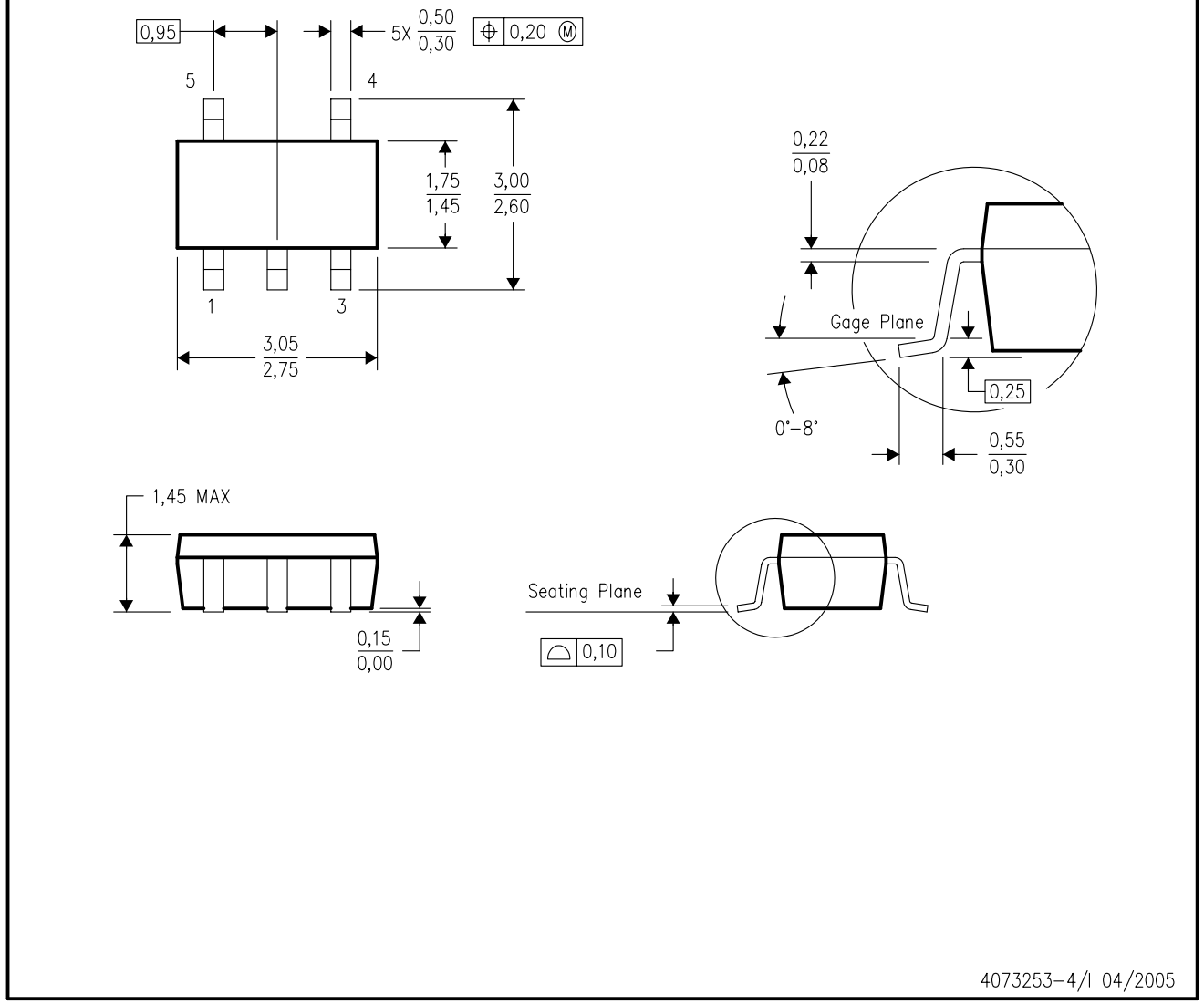
DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

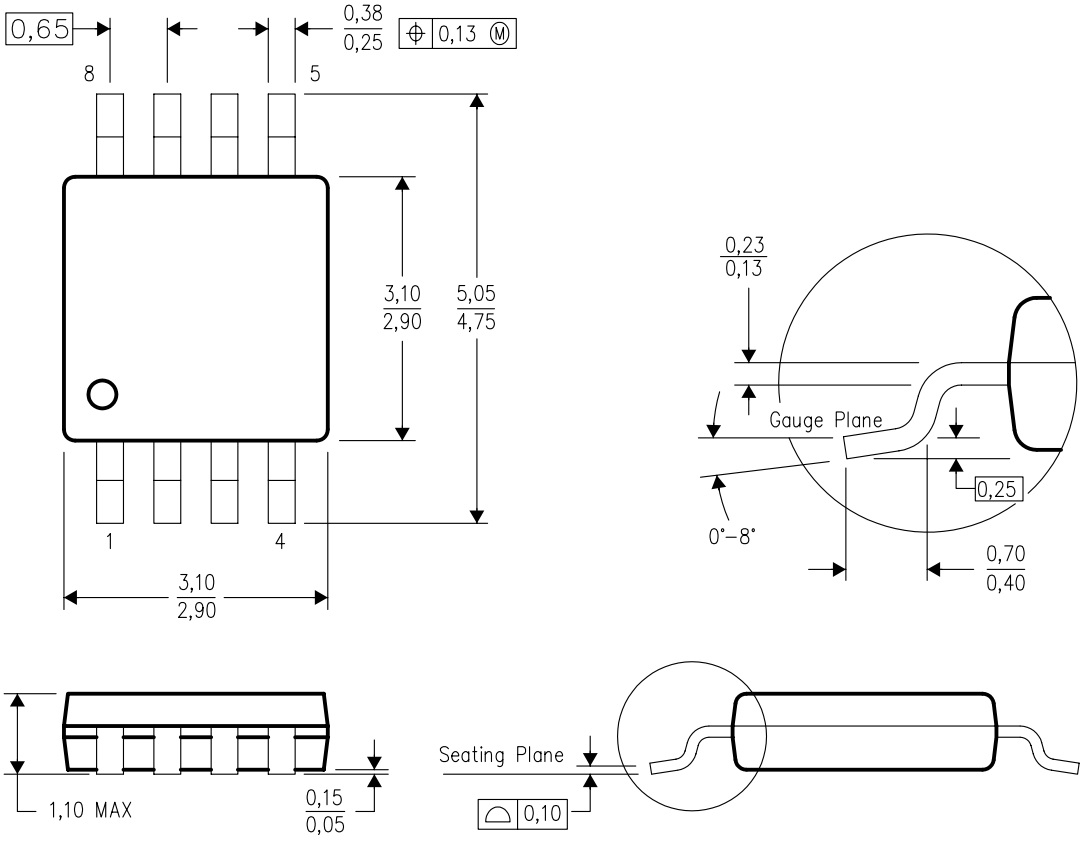
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



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–178 Variation AA.

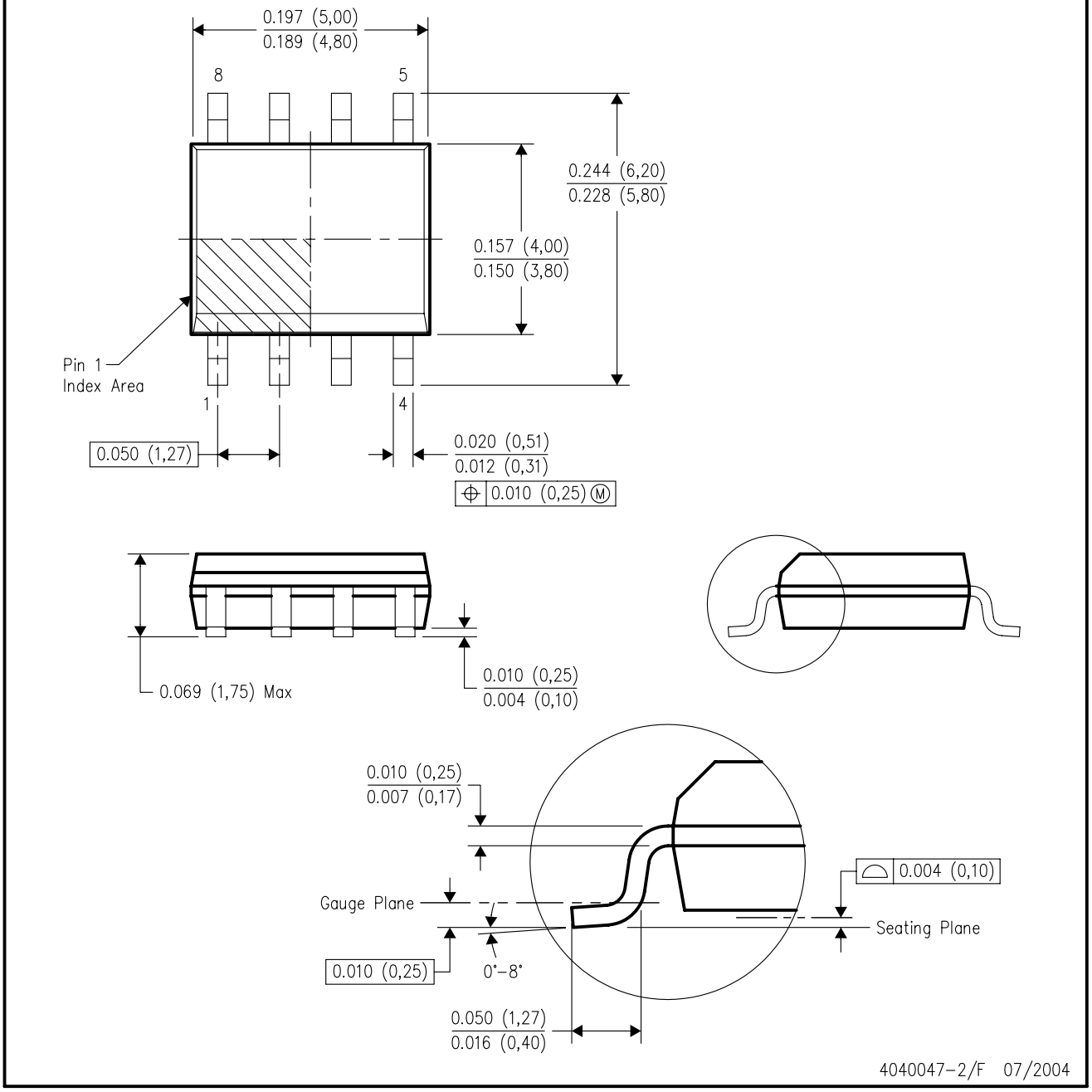
DGK (S–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



4073329/D 12/03

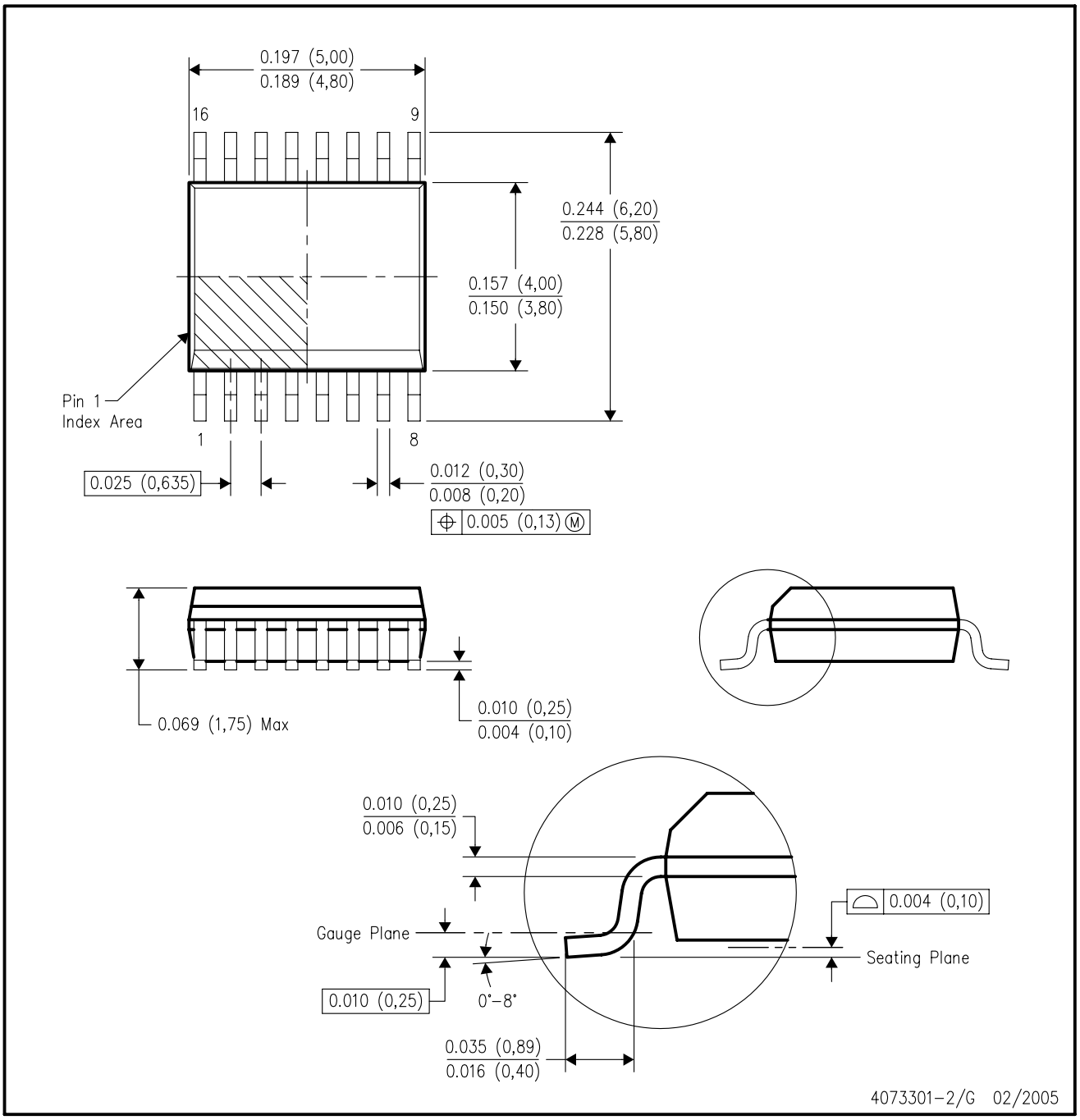
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO–187 variation AA.

D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



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.

DBQ (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



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) per side.
D. Falls within JEDEC MO–137 variation AB.

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