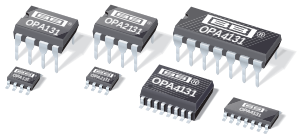


OPA131
OPA2131
OPA4131

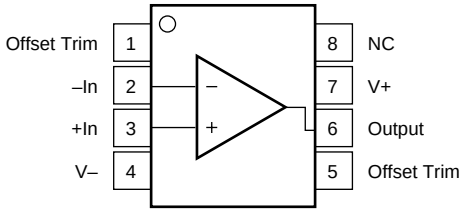
SBOS040A – NOVEMBER 1994 – REVISED DECEMBER 2002

General-Purpose FET-INPUT OPERATIONAL AMPLIFIERS

FEATURES

- **FET INPUT: I_B = 50pA max**
- **LOW OFFSET VOLTAGE: 750μV max**
- **WIDE SUPPLY RANGE: ±4.5V to ±18V**
- **SLEW RATE: 10V/μs**
- **WIDE BANDWIDTH: 4MHz**
- **EXCELLENT CAPACITIVE LOAD DRIVE**
- **SINGLE, DUAL, QUAD VERSIONS**

OPA131



DIP-8, SO-8

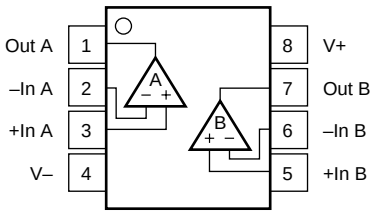
DESCRIPTION

The OPA131 series of FET-input op amps provides high performance at low cost. Single, dual, and quad versions in industry-standard pinouts allow cost-effective design options.

The OPA131 series offers excellent general-purpose performance, including low offset voltage, drift, and good dynamic characteristics.

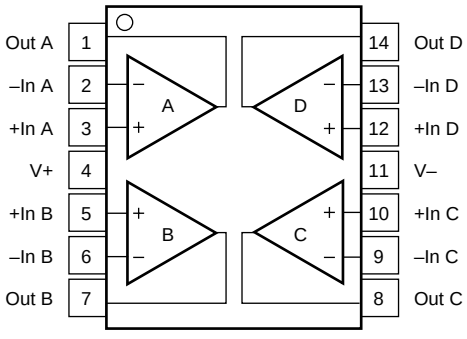
Single, dual, and quad versions are available in DIP and SO packages. Performance grades include commercial and industrial temperature ranges.

OPA2131



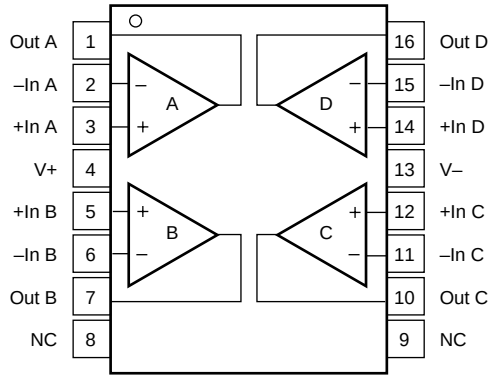
DIP-8, SO-8

OPA4131



DIP-14, SO-14

OPA4131



NC = No Connection

SOL-16

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage, V+ to V–	36V
Input Voltage	(V–) – 0.7V to (V+) + 0.7V
Output Short-Circuit[2]	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

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) Short-circuit to ground, one amplifier per package.

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.

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR[1]	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
Single						
OPA131	SO-8	D	–40°C to +85°C	OPA131UJ	OPA131UJ	Rails, 100
"	"	"	"	"	OPA131UJ/2K5	Tape and Reel, 2500
OPA131	SO-8	D	–40°C to +85°C	OPA131UA	OPA131UA	Rails, 100
"	"	"	"	"	OPA131UA/2K5	Tape and Reel, 2500
OPA131	SO-8	D	–40°C to +85°C	OPA131U	OPA131U	Rails, 100
"	"	"	"	"	OPA131U/2K5	Tape and Reel, 2500
Dual						
OPA2131	SO-8	D	–40°C to +85°C	OPA2131UJ	OPA2131UJ	Rails, 100
"	"	"	"	"	OPA2131UJ/2K5	Tape and Reel, 2500
OPA2131	SO-8	D	–40°C to +85°C	OPA2131UA	OPA2131UA	Rails, 100
"	"	"	"	"	OPA2131UA/2K5	Tape and Reel, 2500
Quad						
OPA4131	DIP-14	N	–40°C to +85°C	OPA4131PJ	OPA4131PJ	Rails, 25
"	"	"	"	OPA4131PA	OPA4131PA	Rails, 25
OPA4131	SOL-16	DW	–40°C to +85°C	OPA4131UA	OPA4131UA	Rails, 48
"	"	"	"	"	OPA4131UA/1K	Tape and Reel, 1000
OPA4131	SOL-14	D	–40°C to +85°C	OPA4131NJ	OPA4131NJ	Rails, 58
"	"	"	"	OPA4131NA	OPA4131NA	Rails, 58

NOTE: (1) For the most current specifications and package information, refer to our web site at www.ti.com.

ELECTRICAL CHARACTERISTICS

At T_A = +25°C, V_S = ±15V, and R_L = 2kΩ, unless otherwise noted.

PARAMETER	CONDITION	OPA131UA OPA2131UA OPA4131PA, UA, NA			OPA131UJ OPA2131UJ OPA4131PJ, NJ			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
OFFSET VOLTAGE								
Input Offset Voltage			±0.2	±1		*	±1.5	mV
OPA131U model only			±0.2	0.75				mV
vs Temperature[1]	Operating Temperature Range		±2	±10		*	*	µV/°C
vs Power Supply	V_S = ±4.5V to ±18V		50	200		*	*	µV/V
OPA131U model only			50	100				µV/V
INPUT BIAS CURRENT[2]								
Input Bias Current	V_{CM} = 0V		+5	±50		*	*	pA
vs Temperature			See Typical Characteristic			*		
Input Offset Current	V_{CM} = 0V		±1	±50		*	*	pA
NOISE								
Input Voltage Noise								
Noise Density, f = 10Hz			21			*		nV/√Hz
f = 100Hz			16			*		nV/√Hz
f = 1kHz			15			*		nV/√Hz
f = 10kHz			15			*		nV/√Hz
Current Noise Density, f = 1kHz			3			*		fA/√Hz
INPUT VOLTAGE RANGE								
Common-Mode Voltage Range		(V–) + 3		(V+) – 1	*		*	V
Common-Mode Rejection	V_{CM} = –12V to +14V	70	80		*	*		dB
OPA131U model only		80	86					dB
INPUT IMPEDANCE								
Differential			10^{10} || 1			*		Ω || pF
Common-Mode	V_{CM} = 0V		10^{12} || 3			*		Ω || pF
OPEN-LOOP GAIN								
Open-Loop Voltage Gain	V_O = –12V to +12V	94	110		*	*		dB
OPA131U model only		100	110					dB
FREQUENCY RESPONSE								
Gain-Bandwidth Product			4			*		MHz
Slew Rate			10			*		V/µs
Settling Time 0.1%	G = –1, 10V Step, C_L = 100pF		1.5			*		µs
0.01%	G = –1, 10V Step, C_L = 100pF		2			*		µs
Total Harmonic Distortion + Noise	1kHz, G = 1, V_O = 3.5Vrms		0.0008			*		%
OUTPUT								
Voltage Output, Positive		(V+) – 3	(V+) – 2.5		*	*		V
Negative		(V–) + 3	(V–) + 2.5		*	*		V
Short-Circuit Current			±25			*		mA
POWER SUPPLY								
Specified Operating Voltage			±15			*		V
Operating Voltage Range		±4.5		±18	*		*	V
Quiescent Current (per amplifier)	I_O = 0		±1.5	±1.75		*	±2	mA
TEMPERATURE RANGE								
Operating Range		–55		+125	–55		+125	°C
Storage		–55		+125	*		*	°C
Thermal Resistance, θ_{JA}								
DIP-8			100			*		°C/W
SO-8			150			*		°C/W
DIP-14			80			*		°C/W
SO-14, SOL-16			110			*		°C/W

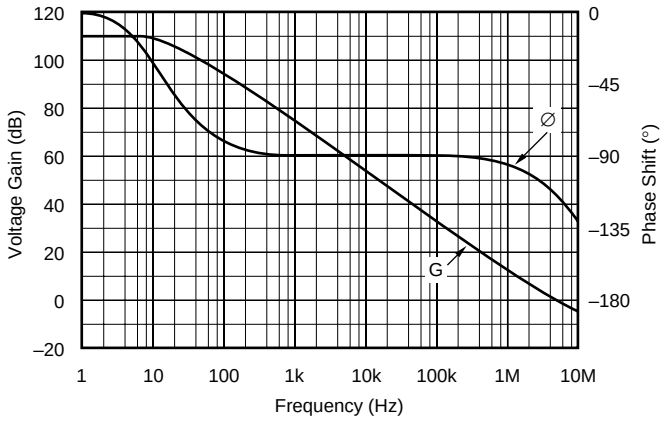
* Specifications same as OPA131UA.

NOTES: (1) Ensured by wafer test. (2) High-speed test at T_J = 25°C.

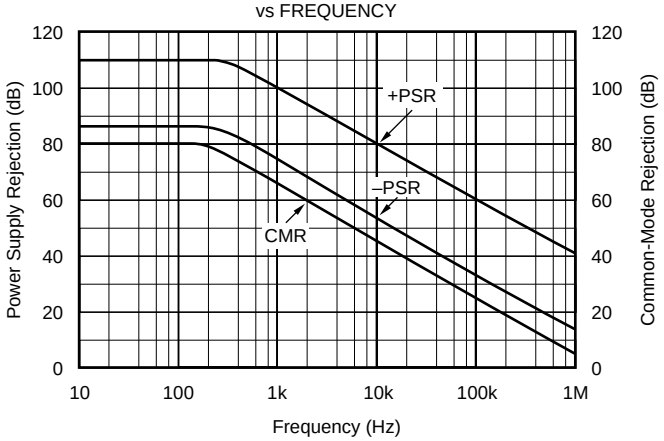
TYPICAL CHARACTERISTICS

At T_A = +25°C, V_S = ±15V, and R_L = 2kΩ, unless otherwise noted.

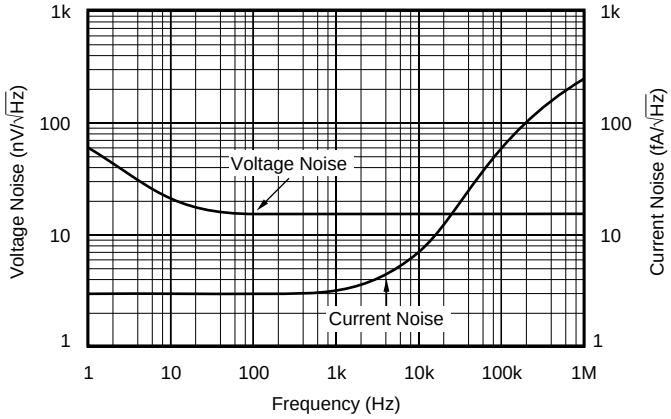
OPEN-LOOP GAIN/PHASE vs FREQUENCY



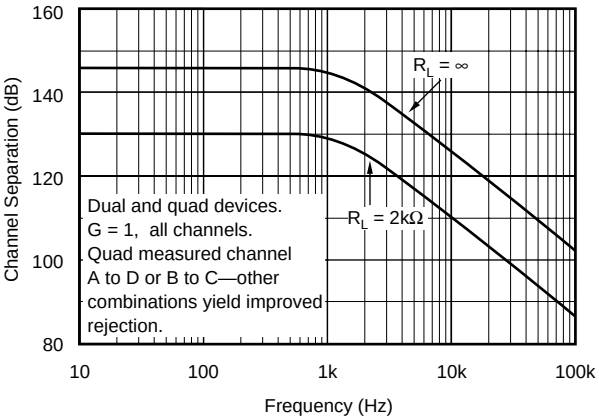
POWER SUPPLY AND COMMON-MODE REJECTION vs FREQUENCY



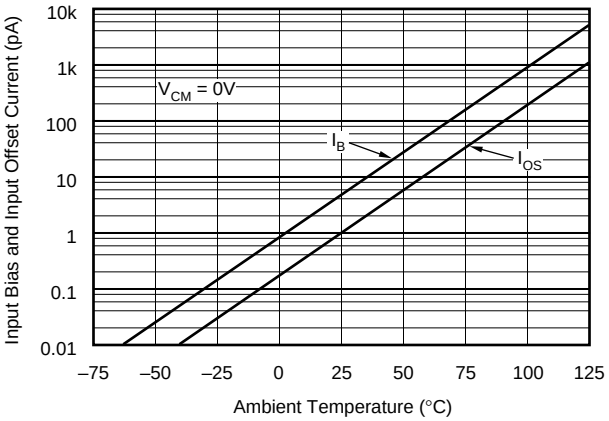
INPUT VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



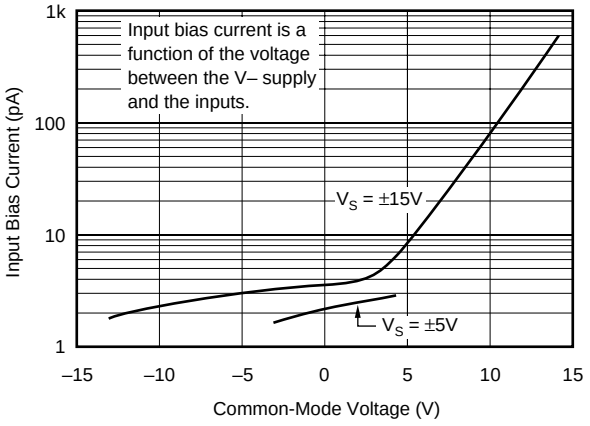
CHANNEL SEPARATION vs FREQUENCY



INPUT BIAS AND INPUT OFFSET CURRENT vs TEMPERATURE



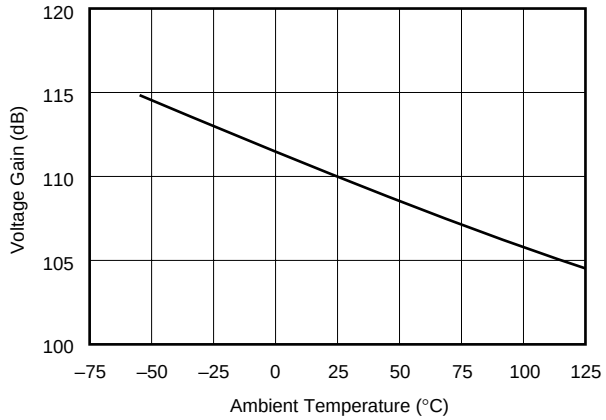
INPUT BIAS CURRENT vs INPUT COMMON-MODE VOLTAGE



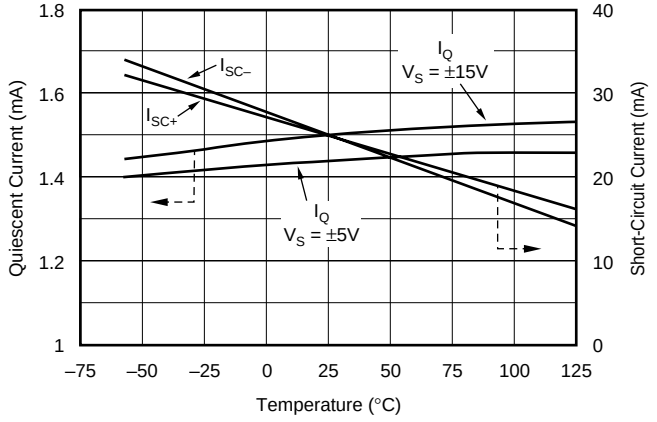
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = ±15V, and R_L = 2kΩ, unless otherwise noted.

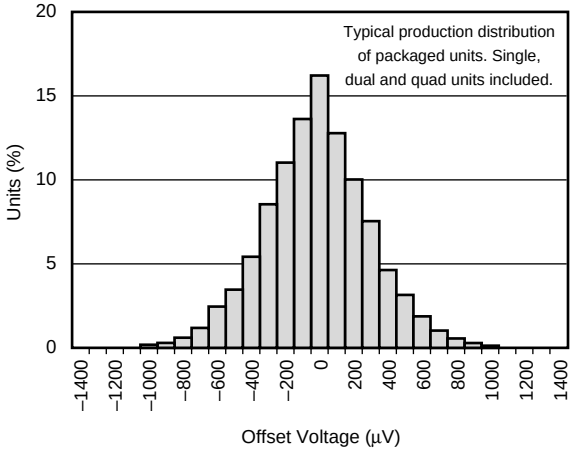
OPEN-LOOP GAIN vs TEMPERATURE



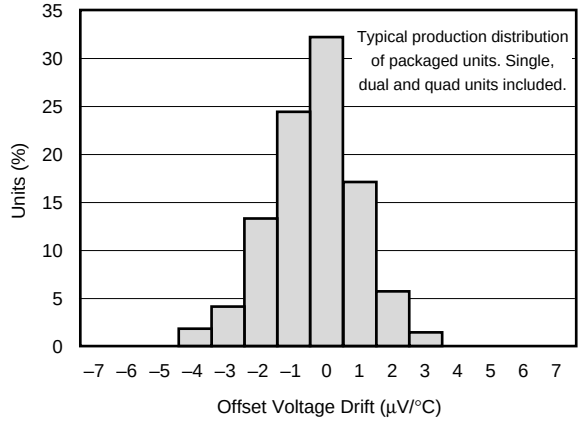
QUIESCENT CURRENT AND SHORT-CIRCUIT CURRENT vs TEMPERATURE



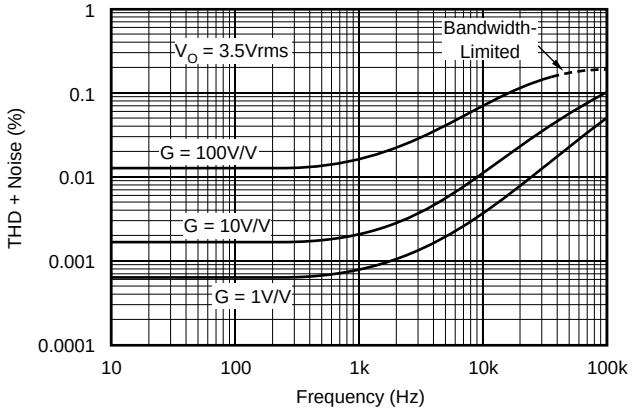
OFFSET VOLTAGE PRODUCTION DISTRIBUTION



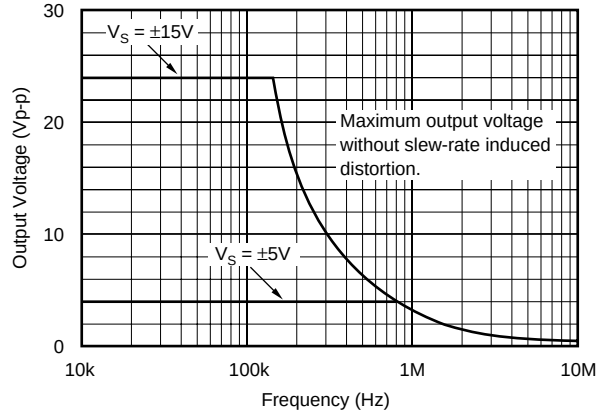
OFFSET VOLTAGE DRIFT PRODUCTION DISTRIBUTION



TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY



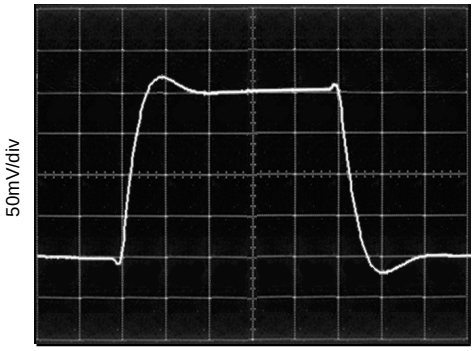
MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



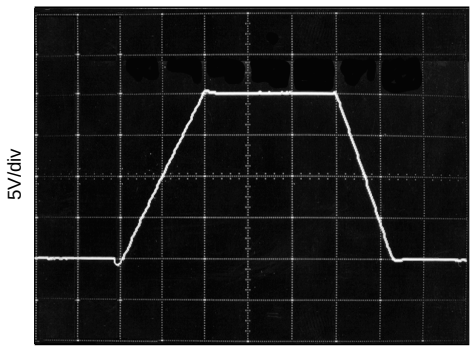
TYPICAL CHARACTERISTICS (Cont.)

At T_{CASE} = +25°C, V_S = ±15V, and R_L = 2kΩ, unless otherwise noted.

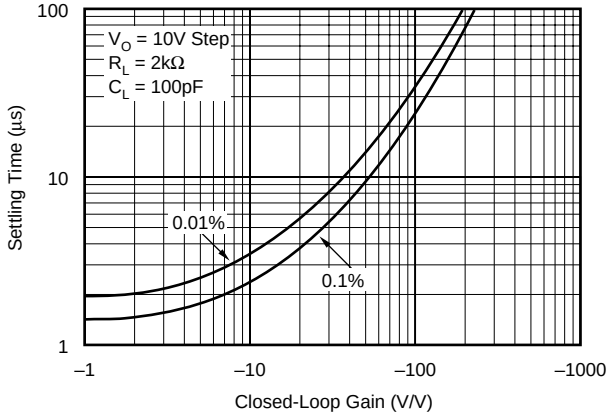
SMALL-SIGNAL STEP RESPONSE
G =1, C_L = 300pF



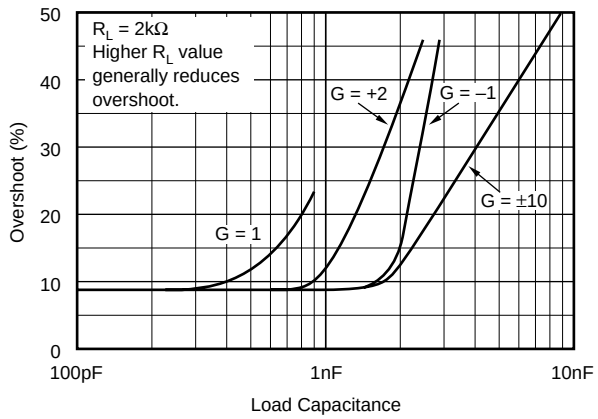
LARGE-SIGNAL STEP RESPONSE
G = 1, C_L = 300pF



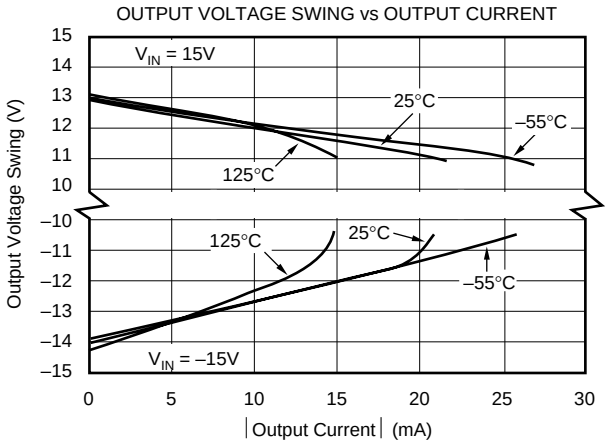
SETTLING TIME vs CLOSED-LOOP GAIN



SMALL-SIGNAL OVERSHOOT
vs LOAD CAPACITANCE



OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



APPLICATIONS INFORMATION

The OPA131 series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. Power-supply pins should be bypassed with 10nF ceramic capacitors or larger.

The OPA131 series op amps are free from unexpected output phase-reversal common with FET op amps. Many FET-input op amps exhibit phase-reversal of the output when the input common-mode voltage range is exceeded. This can occur in voltage-follower circuits, causing serious problems in control-loop applications. All circuitry is completely independent in dual and quad versions, assuring normal behavior when one amplifier in a package is overdriven or short-circuited.

OFFSET VOLTAGE TRIM

The OPA131 (single op amp version) provides offset voltage trim connections on pins 1 and 5. Offset voltage can be adjusted by connecting a potentiometer as shown in Figure 1. This adjustment should be used only to null the offset of the op amp, not system offset or offset produced by the signal source.

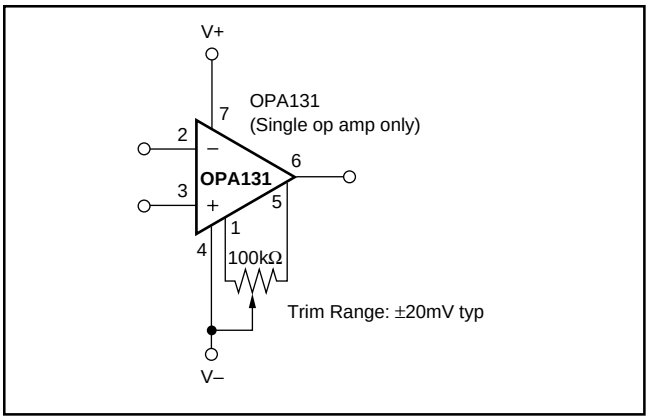


FIGURE 1. OPA131 Offset Voltage Trim Circuit.

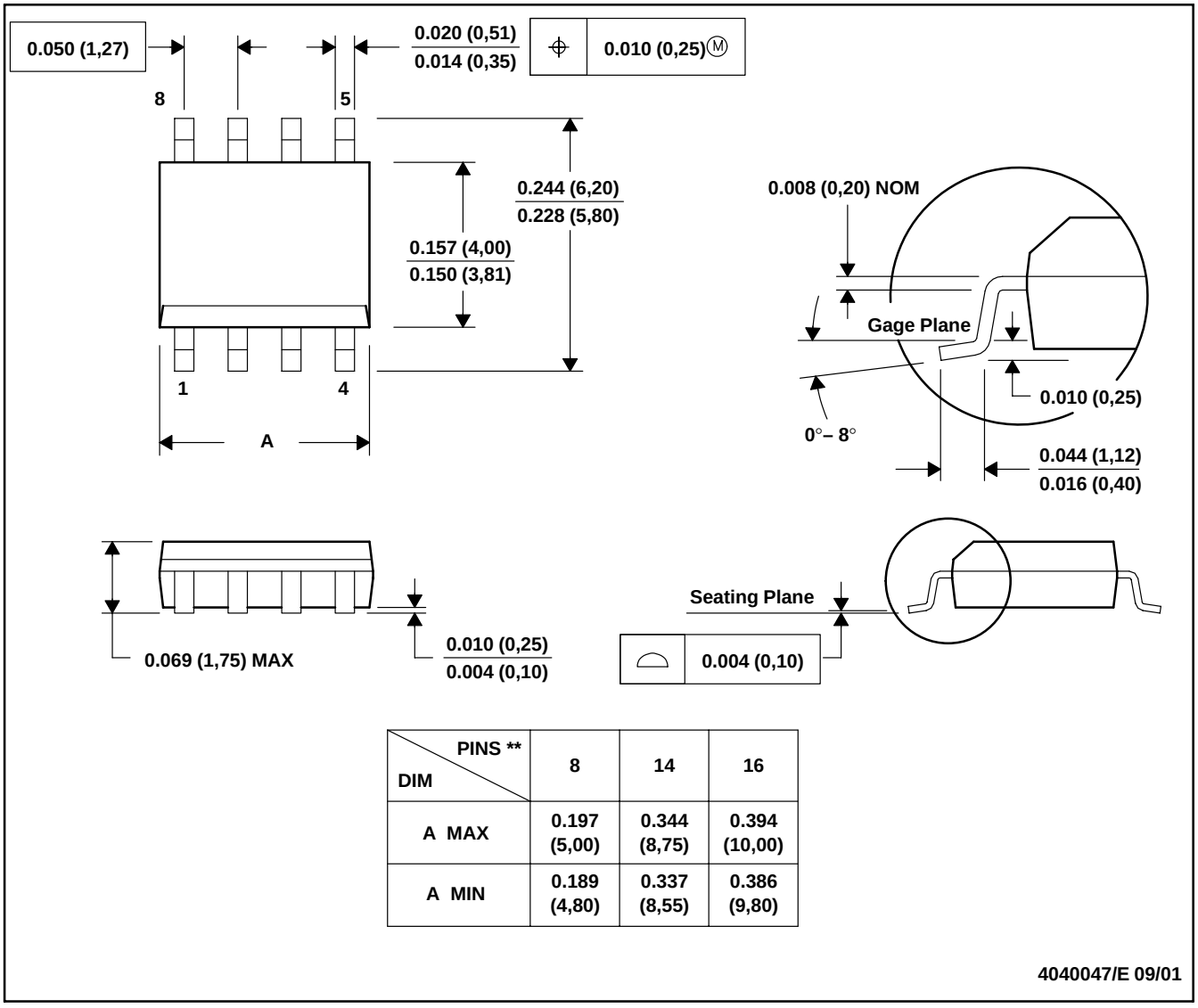
INPUT BIAS CURRENT

The input bias current is approximately 5pA at room temperature and increases with temperature as shown in the typical characteristic “Input Bias Current vs Temperature.”

Input bias current also varies with common-mode voltage and power supply voltage. This variation is dependent on the voltage between the negative power supply and the common-mode input voltage. The effect is shown in the typical curve “Input Bias Current vs Common-Mode Voltage.”

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

8 PINS SHOWN



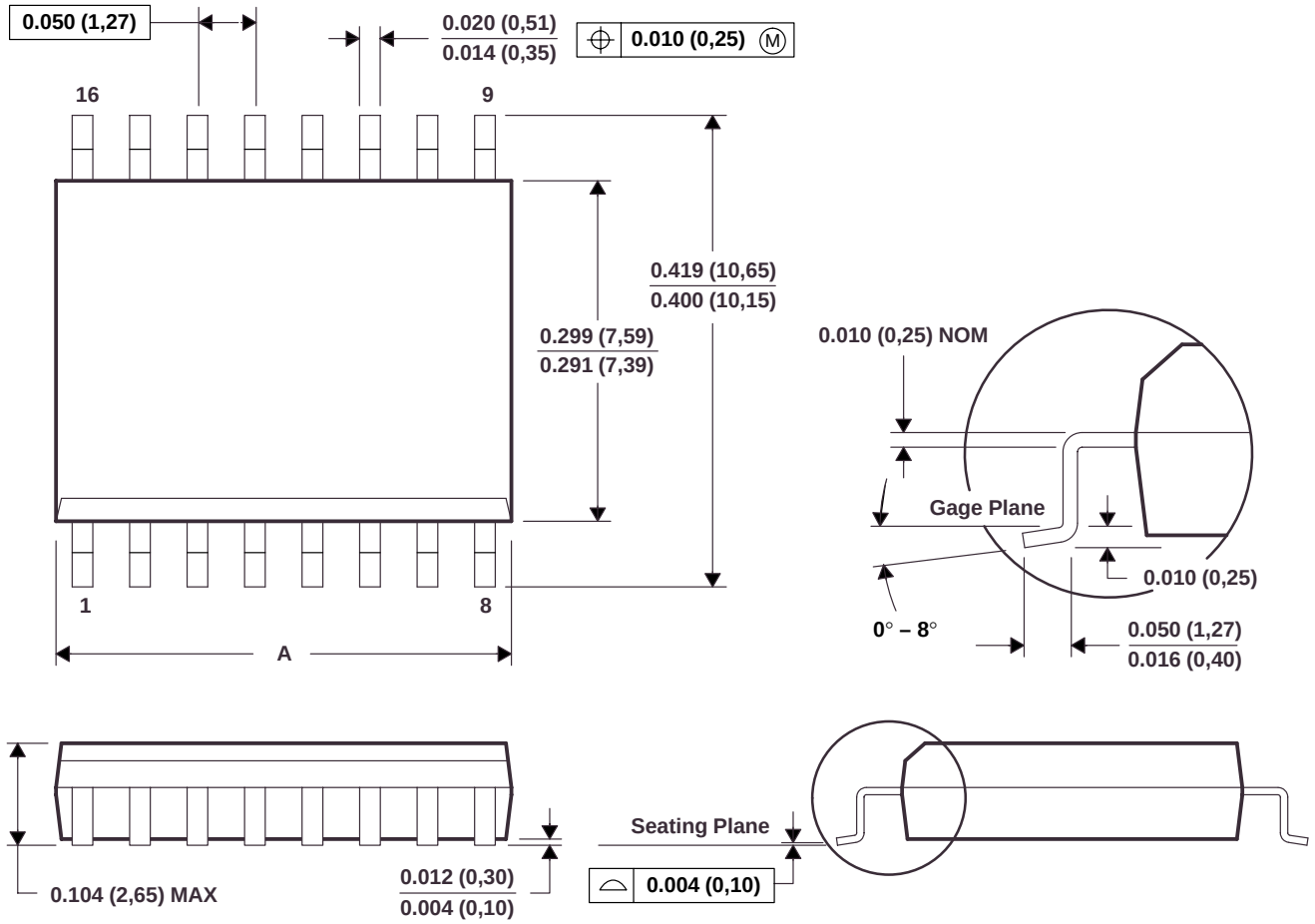
DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/E 09/01

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

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

16 PINS SHOWN



DIM \ PINS **	16	18	20	24	28
A MAX	0.410 (10,41)	0.462 (11,73)	0.510 (12,95)	0.610 (15,49)	0.710 (18,03)
A MIN	0.400 (10,16)	0.453 (11,51)	0.500 (12,70)	0.600 (15,24)	0.700 (17,78)

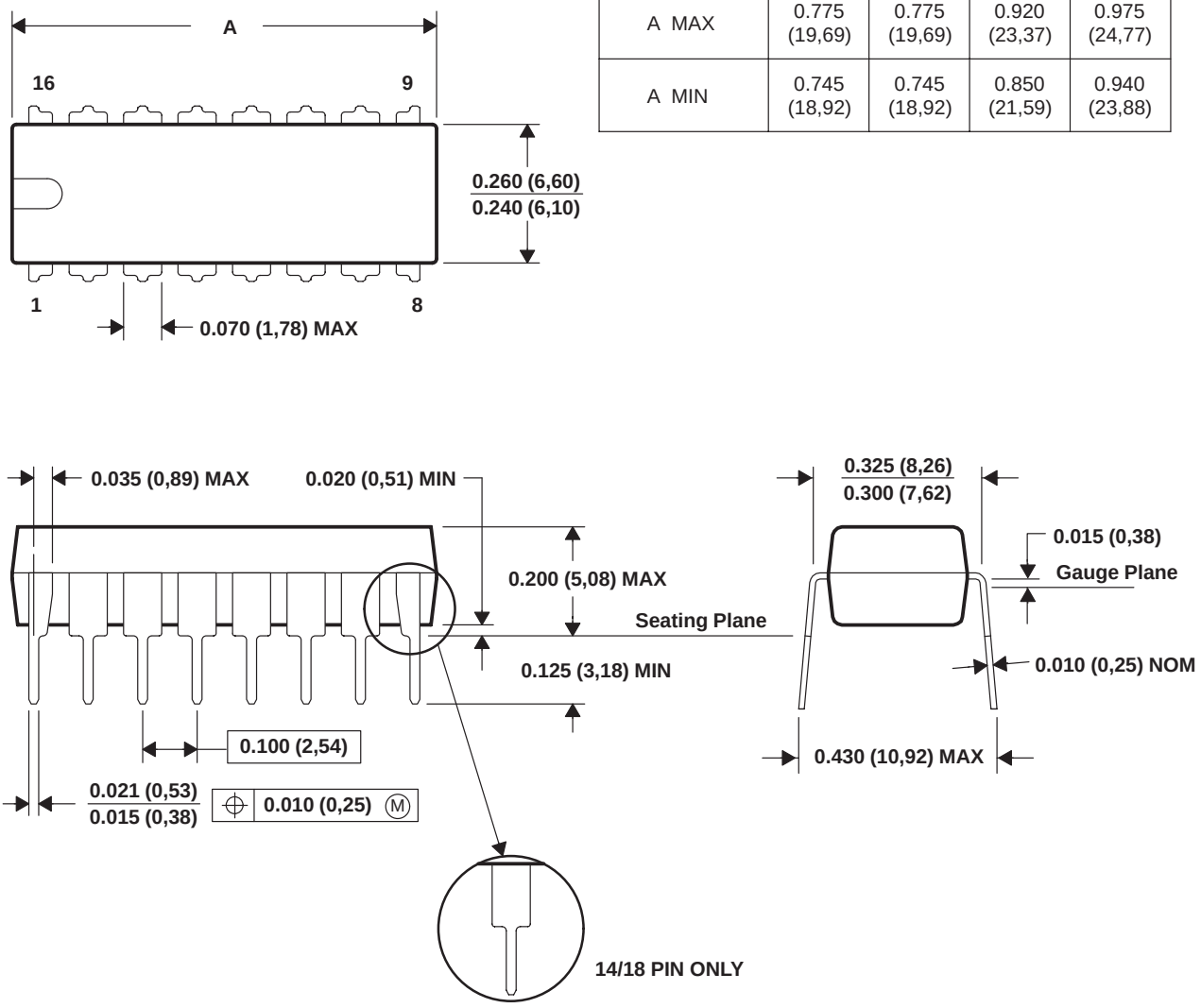
4040000 / E 08/01

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-013

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)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001 (20-pin package is shorter than MS-001).

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
OPA131P	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA131PA	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA131PJ	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA131U	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-2-220C-1 YEAR
OPA131U/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-2-220C-1 YEAR
OPA131UA	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-2-220C-1 YEAR
OPA131UA/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-3-235C-168 HR
OPA131UJ	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-3-235C-168 HR
OPA131UJ/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-3-235C-168 HR
OPA2131PA	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA2131PJ	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA2131UA	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-3-220C-168 HR
OPA2131UA/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-3-220C-168 HR
OPA2131UJ	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-3-220C-168 HR
OPA2131UJ/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-3-220C-168 HR
OPA4131NA	ACTIVE	SOIC	D	14	58	None	CU SNPB	Level-3-220C-168 HR
OPA4131NJ	ACTIVE	SOIC	D	14	58	None	CU SNPB	Level-3-235C-168 HR
OPA4131PA	ACTIVE	PDIP	N	14	25	None	Call TI	Level-NA-NA-NA
OPA4131PJ	ACTIVE	PDIP	N	14	25	None	Call TI	Level-NA-NA-NA
OPA4131UA	ACTIVE	SOIC	DW	16	48	None	CU SNPB	Level-3-260C-168 HR
OPA4131UA/1K	ACTIVE	SOIC	DW	16	1000	None	CU SNPB	Level-3-260C-168 HR

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

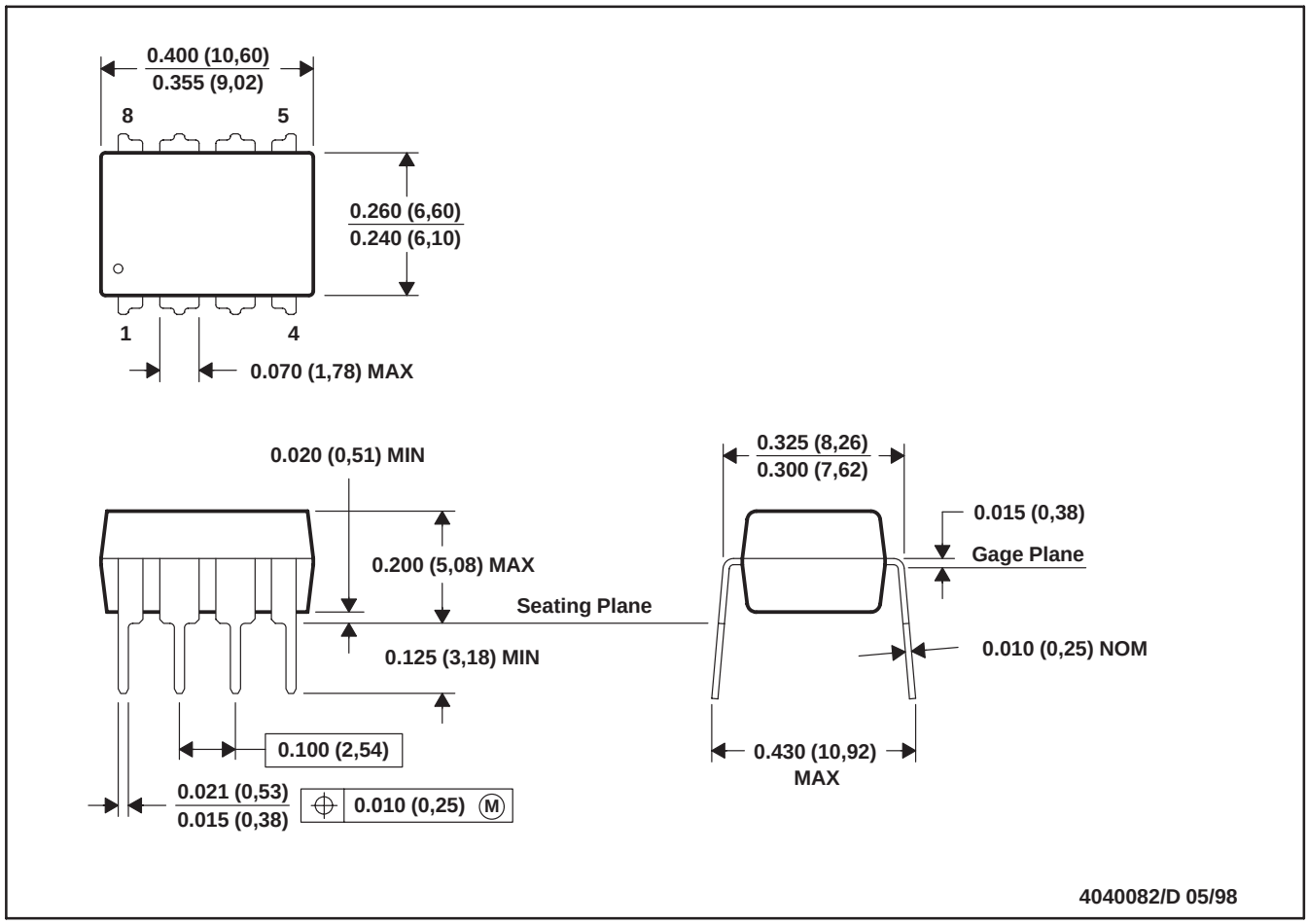
[2] Eco Plan - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
None: Not yet available Lead (Pb-Free).
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

MPDI001A – JANUARY 1995 – REVISED JUNE 1999

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



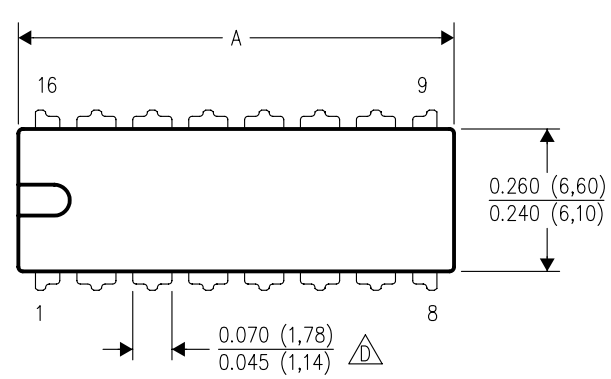
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

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

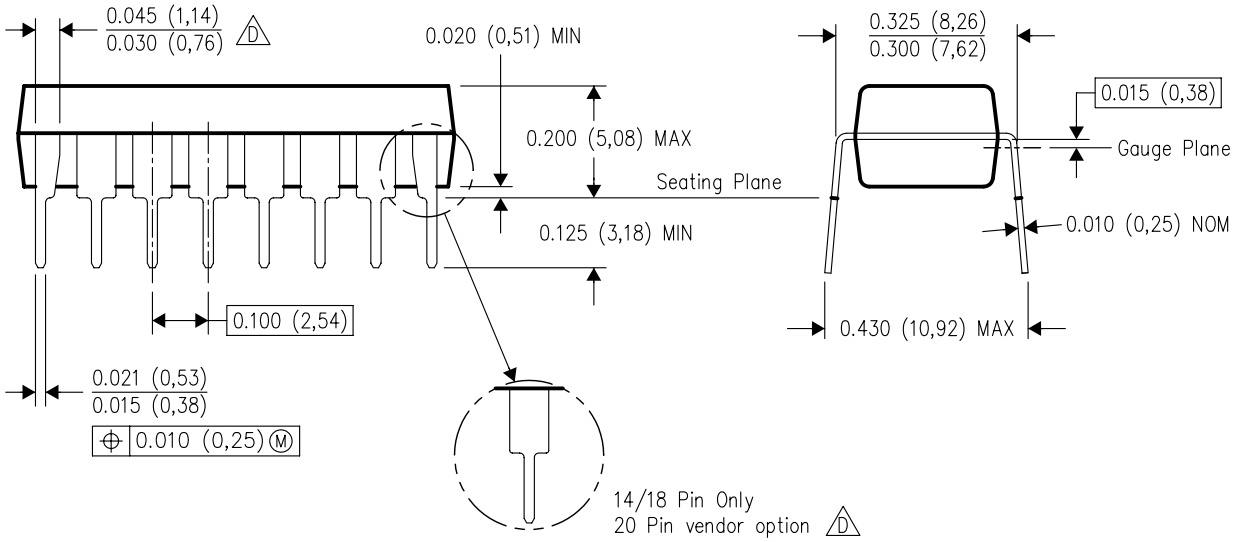
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



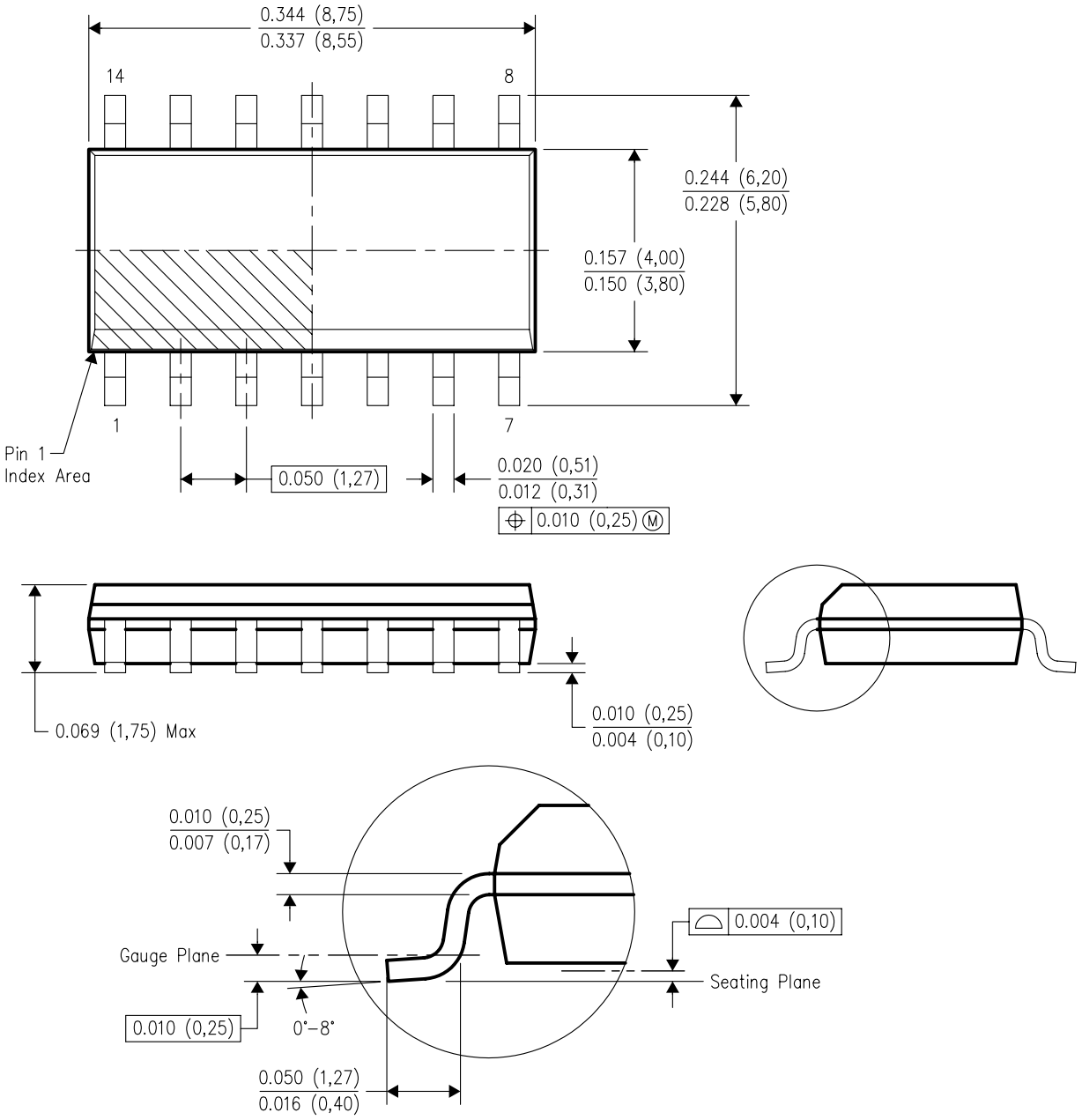
DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

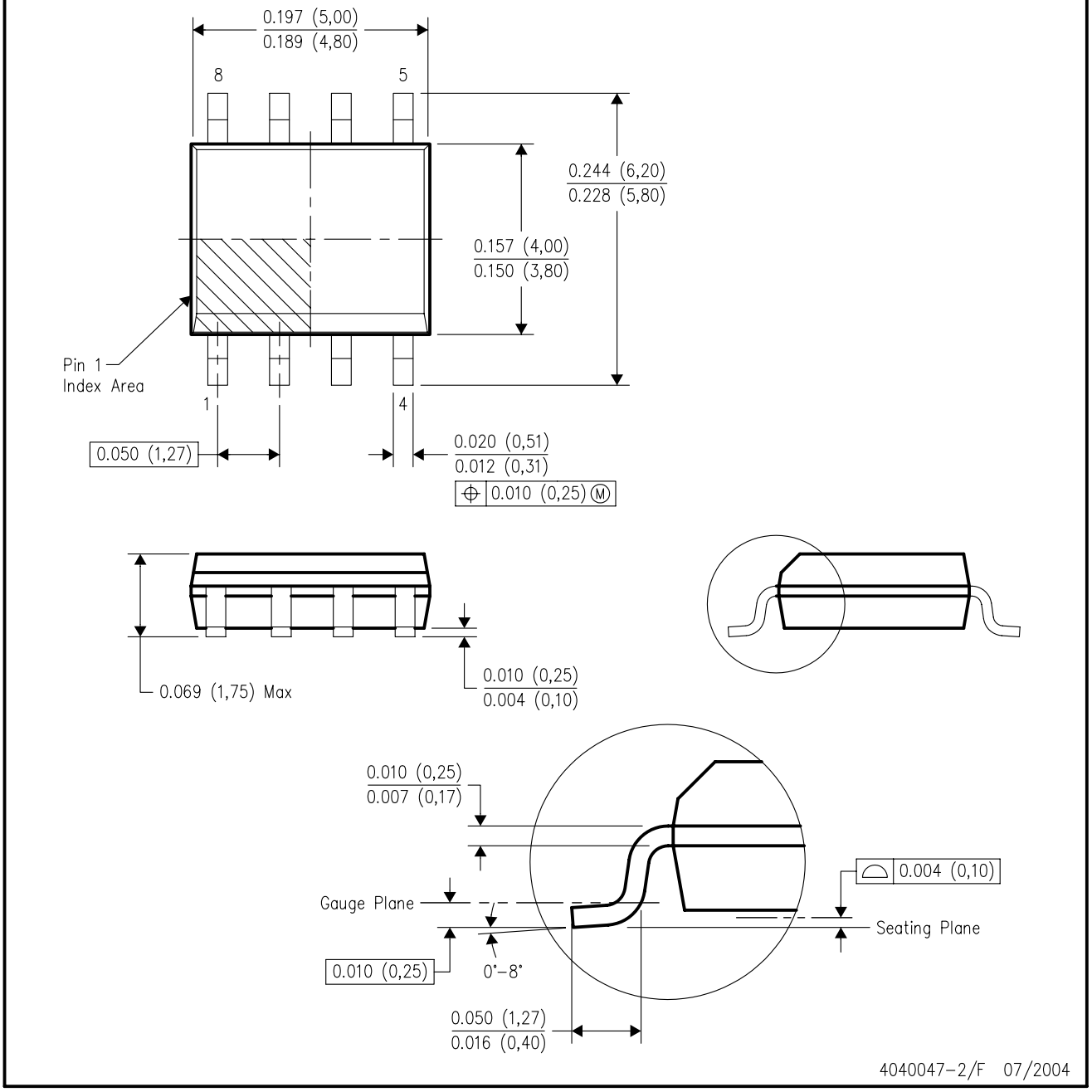
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R–PDSO–G14) PLASTIC SMALL–OUTLINE PACKAGE



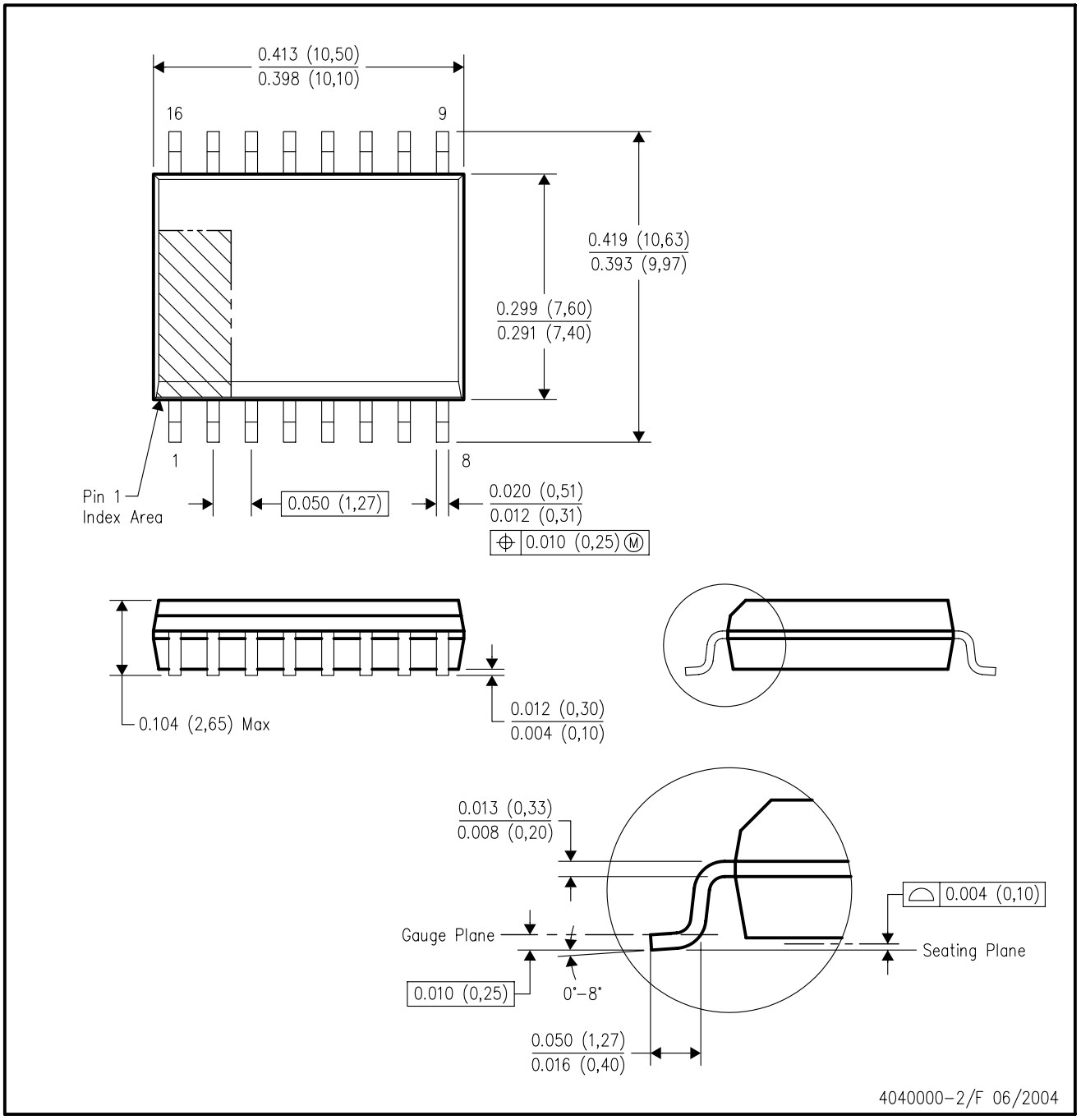
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AB.

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.

DW (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).
D. Falls within JEDEC MS–013 variation AA.

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