OPA234
OPA2234
OPA4234

SBOS055A – MAY 1996 – REVISED JUNE 2004

Low-Power, Precision SINGLE-SUPPLY OPERATIONAL AMPLIFIERS

FEATURES

- **WIDE SUPPLY RANGE:**
  Single Supply: V_S = +2.7V to +36V
  Dual Supply: V_S = ±1.35V to ±18V
- **SPECIFIED PERFORMANCE:**
  +2.7V, +5V, and ±15V
- **LOW QUIESCENT CURRENT: 250µA/amp**
- **LOW INPUT BIAS CURRENT: 25nA max**
- **LOW OFFSET VOLTAGE: 100µV max**
- **HIGH CMRR, PSRR, and A_{OL}**
- **SINGLE, DUAL, and QUAD VERSIONS**

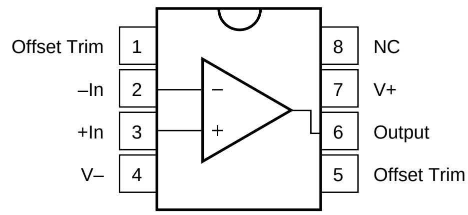
DESCRIPTION

The OPA234 series low-cost op amps are ideal for single-supply, low-voltage, low-power applications. The series provides lower quiescent current than older "1013"-type products and comes in current industry-standard packages and pinouts. The combination of low offset voltage, high common-mode rejection, high power-supply rejection, and a wide supply range provides excellent accuracy and versatility. Single, dual, and quad versions have identical specifications for maximum design flexibility. These general-purpose op amps are ideal for portable and battery-powered applications.

The OPA234 series op amps operate from either single or dual supplies. In single-supply operation, the input common-mode range extends below ground and the output can swing to within 50mV of ground. Excellent phase margin makes the OPA234 series ideal for demanding applications, including high load capacitance. Dual and quad designs feature completely independent circuitry for lowest crosstalk and freedom from interaction.

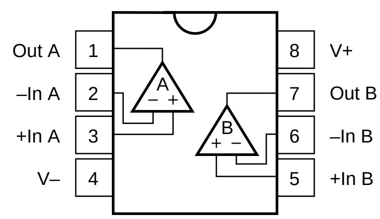
Single version packages are in an SO-8 surface-mount and a space-saving MSOP-8 surface-mount. Dual packages are in an SO-8 surface-mount. Quad packages are in an SO-14 surface-mount. All are specified for –40°C to +85°C operation.

OPA234



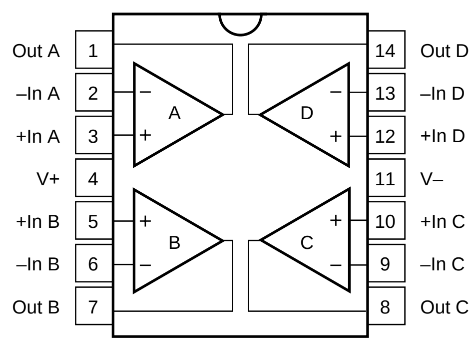
SO-8, MSOP-8

OPA2234



SO-8

OPA4234



SO-14

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

ELECTRICAL CHARACTERISTICS: V_S = +5V

At T_A = 25°C, V_S = +5V, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.

			OPA234U, E OPA2234U			OPA234UA, EA OPA2234UA OPA4234UA, U			
PARAMETER		**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OFFSET VOLTAGE									
Input Offset Voltage	V_{OS}	V_{CM} = 2.5V		±40	±100		∗	±250	µV
OPA234E, EA				±100	±150		∗	±350	µV
vs Temperature(1)	dV_{OS}/dT	Operating Temperature Range		±0.5	±3		∗	∗	µV/°C
vs Power Supply	PSRR	V_S = +2.7V to +30V, V_{CM} = 1.7V		3	10		∗	20	µV/V
vs Time				0.2			∗		µV/mo
Channel Separation (Dual, Quad)				0.3			∗		µV/V
INPUT BIAS CURRENT									
Input Bias Current(2)	I_B	V_{CM} = 2.5V		–15	–30		∗	–50	nA
Input Offset Current	I_{OS}	V_{CM} = 2.5V		±1	±5		∗	∗	nA
NOISE		f = 1kHz							
Input Voltage Noise Density	v_n			25			∗		nV/√Hz
Current Noise Density	i_n			80			∗		fA/√Hz
INPUT VOLTAGE RANGE									
Common-Mode Voltage Range			–0.1		(V+) –1	∗		∗	V
Common-Mode Rejection	CMRR	V_{CM} = –0.1V to 4V	91	106		86	∗		dB
INPUT IMPEDANCE									
Differential				10^7 || 5			∗		Ω || pF
Common-Mode		V_{CM} = 2.5V		10^{10} || 6			∗		Ω || pF
OPEN-LOOP GAIN		V_O = 0.25V to 4V							
Open-Loop Voltage Gain	A_{OL}	R_L = 10kΩ	108	120		100	∗		dB
		R_L = 2kΩ	86	96œ86	∗		dB		
FREQUENCY RESPONSE									
Gain-Bandwidth Product	GBW	C_L = 100pF		0.35			∗		MHz
Slew Rate	SR			0.2			∗		V/µs
Settling Time: 0.1%		G = 1, 3V Step, C_L = 100pF		15			∗		µs
0.01%		G = 1, 3V Step, C_L = 100pF		25			∗		µs
Overload Recovery Time		(V_{IN}) (Gain) = V_S		16			∗		µs
OUTPUT									
Voltage Output: Positive		R_L = 10kΩ to V_S/2	(V+) –1	(V+) –0.65		∗	∗		V
Negative		R_L = 10kΩ to V_S/2	0.25	0.05		∗	∗		V
Positive		R_L = 10kΩ to Ground	(V+) –1	(V+) –0.65		∗	∗		V
Negative		R_L = 10kΩ to Ground	0.1	0.05		∗	∗		V
Short-Circuit Current	I_{SC}			±11			∗		mA
Capacitive Load Drive (Stable Operation)(3)		G = +1		1000			∗		pF
POWER SUPPLY									
Specified Operating Voltage				+5			∗		V
Operating Voltage Range			+2.7		+36	∗		∗	V
Quiescent Current (per amplifier)	I_Q	I_O = 0		250	300		∗	∗	µA
TEMPERATURE RANGE									
Specified Range			–40		+85	∗		∗	°C
Operating Range			–40		+125	∗		∗	°C
Storage			–55		+125	∗		∗	°C
Thermal Resistance	θ_{JA}								
8-Pin DIP				100			∗		°C/W
SO-8 Surface-Mount				150			∗		°C/W
MSOP-8 Surface-Mount				220			∗		°C/W
14-Pin DIP				80			∗		°C/W
SO-14 Surface-Mount				110			∗		°C/W

∗ Specifications same as OPA234U, E.

NOTES: (1) Wafer-level tested to 95% confidence level. (2) Positive conventional current flows into the input terminals. (3) See *Small-Signal Overshoot vs Load Capacitance* typical curve.

ELECTRICAL CHARACTERISTICS: V_S = +2.7V

At T_A = 25°C, V_S = +2.7V, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.

			OPA234U, E OPA2234U			OPA234UA, EA OPA2234UA OPA4234UA, U			
PARAMETER		**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OFFSET VOLTAGE									
Input Offset Voltage	V_{OS}	V_{CM} = 1.35V		±40	±100		*	±250	µV
OPA234E, EA				±100	±150		*	±350	µV
vs Temperature(1)	dV_{OS}/dT	Operating Temperature Range		±0.5	±3		*	*	µV/°C
vs Power Supply	PSRR	V_S = +2.7V to +30V, V_{CM} = 1.7V		3	10		*	20	µV/V
vs Time				0.2			*		µV/mo
Channel Separation (Dual, Quad)				0.3			*		µV/V
INPUT BIAS CURRENT									
Input Bias Current(2)	I_B	V_{CM} = 1.35V		–15	–30		*	–50	nA
Input Offset Current	I_{OS}	V_{CM} = 1.35V		±1	±5		*	*	n
NOISE		f = 1kHz							
Input Voltage Noise Density	v_n			25			*		nV/√Hz
Current Noise Density	i_n			80			*		fA/√Hz
INPUT VOLTAGE RANGE									
Common-Mode Voltage Range			–0.1		(V+) –1	*		*	V
Common-Mode Rejection	CMRR	V_{CM} = –0.1V to 1.7V	91	106		86	*		dB
INPUT IMPEDANCE									
Differential				10^7 || 5			*		Ω || pF
Common-Mode		V_{CM} = 1.35V		10^{10} || 6			*		Ω || pF
OPEN-LOOP GAIN		V_O = 0.25V to 1.7V							
Open-Loop Voltage Gain	A_{OL}	R_L = 10kΩ	108	125		100	*		dB
		R_L = 2kΩ	86	96		86	*		dB
FREQUENCY RESPONSE									
Gain-Bandwidth Product	GBW	C_L = 100pF		0.35			*		MHz
Slew Rate	SR			0.2			*		V/µs
Settling Time: 0.1%		G = 1, 1V Step, C_L = 100pF		6			*		µs
0.01%		G = 1, 1V Step, C_L = 100pF		16			*		µs
Overload Recovery Time		(V_{IN}) (Gain) = V_S		8			*		µs
OUTPUT									
Voltage Output: Positive		R_L = 10kΩ to V_S/2	(V+) –1	(V+) –0.6		*	*		V
Negative		R_L = 10kΩ to V_S/2	0.25	0.05		*	*		V
Positive		R_L = 10kΩ to Ground	(V+) –1	(V+) –0.65		*	*		V
Negative		R_L = 10kΩ to Ground	0.1	0.05		*	*		V
Short-Circuit Current	I_{SC}			±8			*		mA
Capacitive Load Drive (Stable Operation)(3)		G = +1		1000			*		pF
POWER SUPPLY									
Specified Operating Voltage				+2.7			*		V
Operating Voltage Range			+2.7		+36	*		*	V
Quiescent Current (per amplifier)	I_Q	I_O = 0		250	300		*	*	µA
TEMPERATURE RANGE									
Specified Range			–40		+85	*		*	°C
Operating Range			–40		+125	*		*	°C
Storage			–55		+125	*		*	°C
Thermal Resistance	θ_{JA}								
8-Pin DIP				100			*		°C/W
SO-8 Surface-Mount				150			*		°C/W
MSOP-8 Surface-Mount				220			*		°C/W
14-Pin DIP				80			*		°C/W
SO-14 Surface-Mount				110			*		°C/W

* Specifications same as OPA234U, E.

NOTES: (1) Wafer-level tested to 95% confidence level. (2) Positive conventional current flows into the input terminals. (3) See *Small-Signal Overshoot vs Load Capacitance* typical curve.

ELECTRICAL CHARACTERISTICS: $V_S = \pm15V$

At T_A = 25°C, V_S = ±15V, and R_L = 10kΩ connected to ground, unless otherwise noted.

			OPA234U, E OPA2234U			OPA234UA, EA OPA2234UA OPA4234UA, U			
PARAMETER		**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OFFSET VOLTAGE									
Input Offset Voltage	V_{OS}	V_{CM} = 0V		±70	±250		∗	±500	µV
OPA4234U Model							±70	±250	µV
vs Temperature(1)	dV_{OS}/dT	Operating Temperature Range		±0.5	±5		∗	∗	µV/°C
vs Power Supply	PSRR	V_S = ±1.35V to ±18V, V_{CM} = 0V		3	10		∗	20	µV/V
vs Time				0.2			∗		µV/mo
Channel Separation (Dual, Quad)				0.3			∗		µV/V
INPUT BIAS CURRENT									
Input Bias Current(2)	I_B	V_{CM} = 0V		–12	–25		∗	–50	nA
Input Offset Current	I_{OS}	V_{CM} = 0V		±1	±5		∗	∗	nA
NOISE		f = 1kHz							
Input Voltage Noise Density	v_n			25			∗		nV/$\sqrt{Hz}$
Current Noise Density	i_n			80			∗		fA/$\sqrt{Hz}$
INPUT VOLTAGE RANGE									
Common-Mode Voltage Range			(V–)		(V+) –1	∗		∗	V
Common-Mode Rejection	CMRR	V_{CM} = –15V to 14V	91	106		86	∗		dB
INPUT IMPEDANCE									
Differential				$10^7 \parallel 5$			∗		Ω $\parallel$ pF
Common-Mode		V_{CM} = 0V		$10^{10} \parallel 6$			∗		Ω $\parallel$ pF
OPEN-LOOP GAIN									
Open-Loop Voltage Gain	A_{OL}	V_O = –14.5V to 14V	110	120		100	∗		dB
FREQUENCY RESPONSE									
Gain-Bandwidth Product	GBW	C_L = 100pF		0.35			∗		MHz
Slew Rate	SR			0.2			∗		V/µs
Settling Time: 0.1%		G = 1, 10V Step, C_L = 100pF		41			∗		µs
0.01%		G = 1, 10V Step, C_L = 100pF		47			∗		µs
Overload Recovery Time		(V_{IN}) (Gain) = V_S		22			∗		µs
OUTPUT									
Voltage Output: Positive			(V+) –1	(V+) –0.7		∗	∗		V
Negative			(V–) +0.5	(V–) +0.15		∗	∗		V
Short-Circuit Current	I_{SC}			±22			∗		mA
Capacitive Load Drive (Stable Operation)(3)		G = +1		1000			∗		pF
POWER SUPPLY									
Specified Operating Voltage				±15			∗		V
Operating Voltage Range			±1.35		±18	∗		∗	V
Quiescent Current (per amplifier)	I_Q	I_O = 0		±275	±350		∗	∗	µA
TEMPERATURE RANGE									
Specified Range			–40		+85	∗		∗	°C
Operating Range			–40		+125	∗		∗	°C
Storage			–55		+125	∗		∗	°C
Thermal Resistance	θ_{JA}								
8-Pin DIP				100			∗		°C/W
SO-8 Surface-Mount				150			∗		°C/W
MSOP-8 Surface-Mount				220			∗		°C/W
14-Pin DIP				80			∗		°C/W
SO-14 Surface-Mount				110			∗		°C/W

∗ Specifications same as OPA234U, E.

NOTES: (1) Wafer-level tested to 95% confidence level. (2) Positive conventional current flows into the input terminals. (3) See *Small-Signal Overshoot vs Load Capacitance* typical curve.

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 INFORMATION

PRODUCT	PACKAGE	PACKAGE MARKING
Single		
OPA234EA	MSOP-8 Surface-Mount	A34
OPA234E	"	"
OPA234UA	SO-8 Surface-Mount	OPA234UA
OPA234U	"	OPA234U
Dual		
OPA2234UA	SO-8 Surface-Mount	OPA2234UA
OPA2234U	"	OPA2234U
Quad		
OPA4234UA	SO-8 Surface-Mount	OPA4234UA
OPA4234U	"	OPA4234U

NOTE: (1) For the most current package and ordering information, see the Package Option Addendum located at the end of this data sheet.

ABSOLUTE MAXIMUM RATINGS

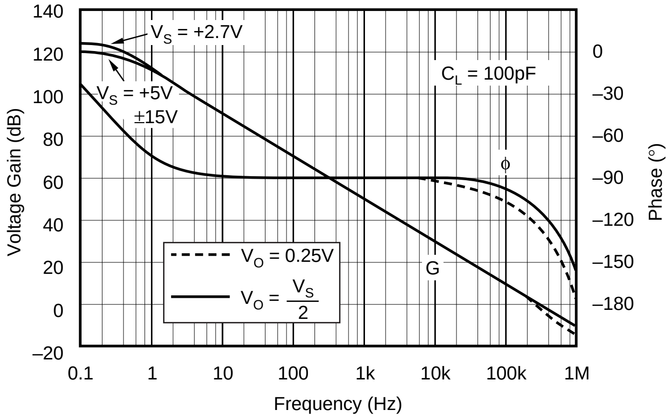
Supply Voltage, V+ to V– 36V
Input Voltage .... (V–) –0.7V to (V+) +0.7V
Output Short-Circuit(1) .... Continuous
Operating Temperature .... –40°C to +125°C
Storage Temperature .... –55°C to +125°C
Junction Temperature .... 150°C
Lead Temperature (soldering, 10s) .... 300°C

NOTE: (1) Short-circuit to ground, one amplifier per package.

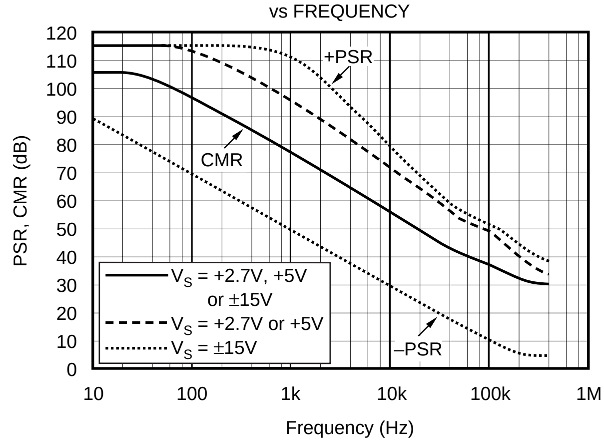
TYPICAL CHARACTERISTIC CURVES

At $T_A = +25°C$ and $R_L = 10k\Omega$, unless otherwise noted.

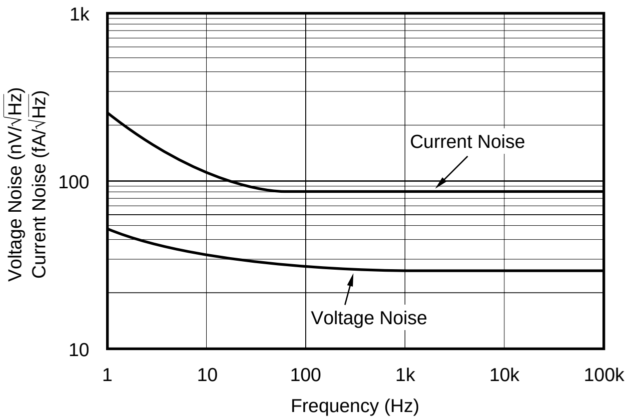
OPEN-LOOP GAIN/PHASE vs FREQUENCY



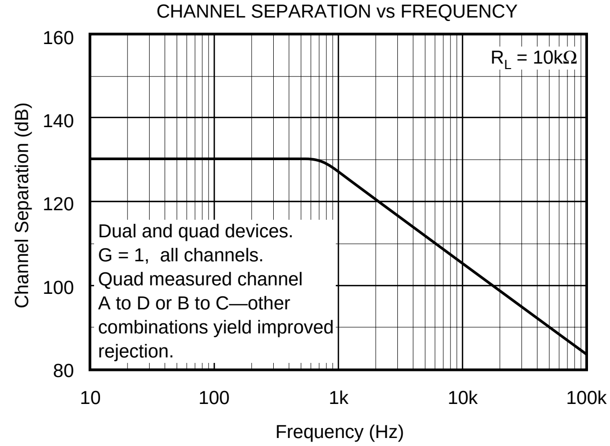
POWER-SUPPLY AND COMMON-MODE REJECTION vs FREQUENCY



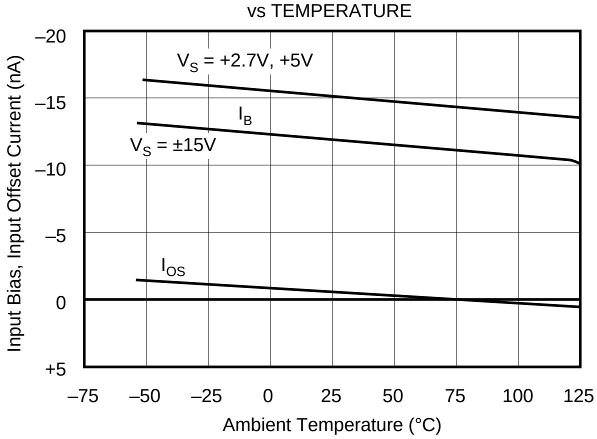
INPUT NOISE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



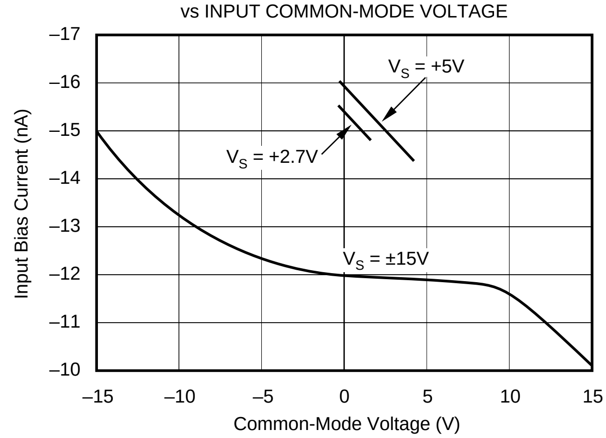
CHANNEL SEPARATION vs FREQUENCY



INPUT BIAS AND INPUT OFFSET CURRENT vs TEMPERATURE

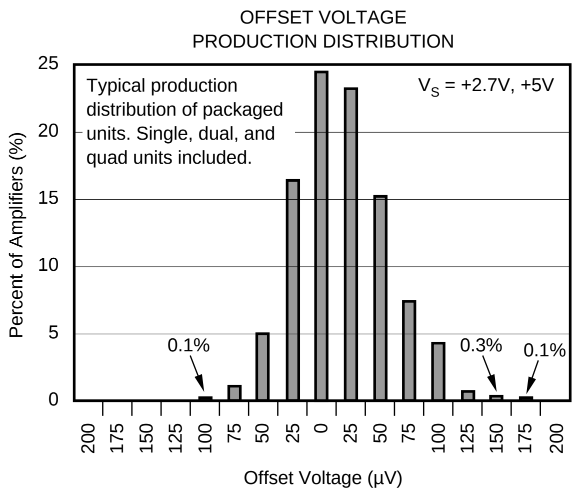


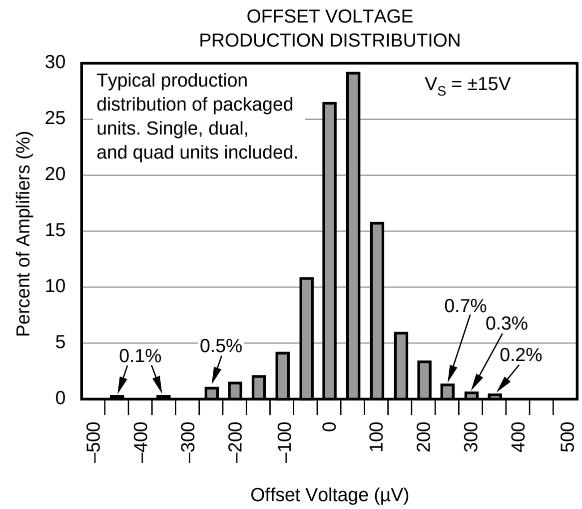
INPUT BIAS CURRENT vs INPUT COMMON-MODE VOLTAGE

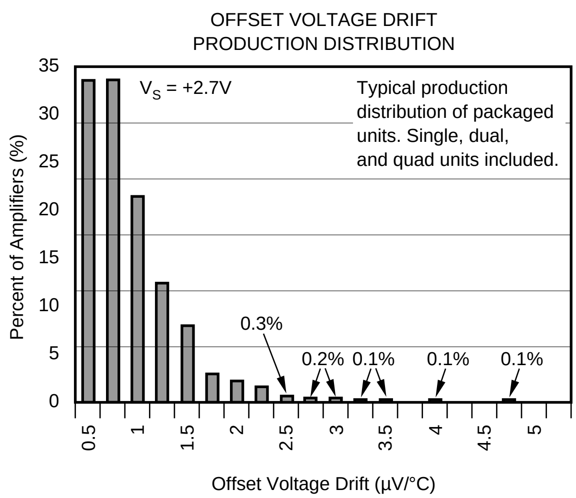


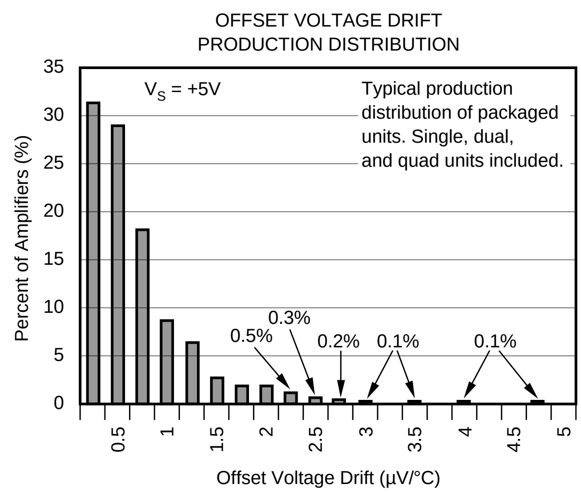
TYPICAL CHARACTERISTIC CURVES (Cont.)

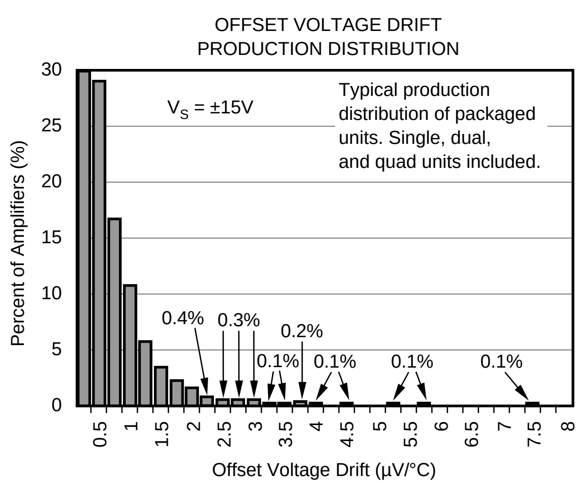
At T_A = +25°C and R_L = 10kΩ, unless otherwise noted.

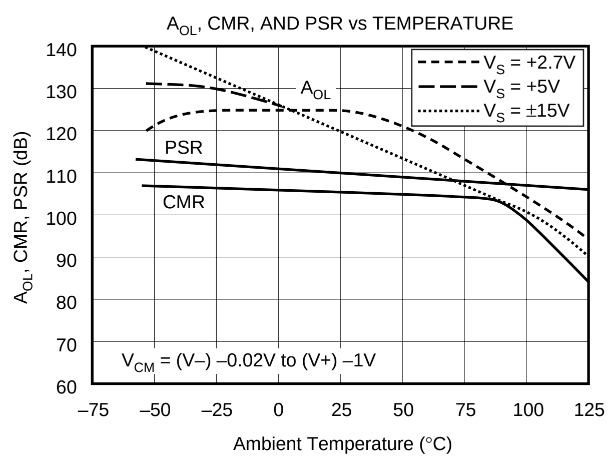








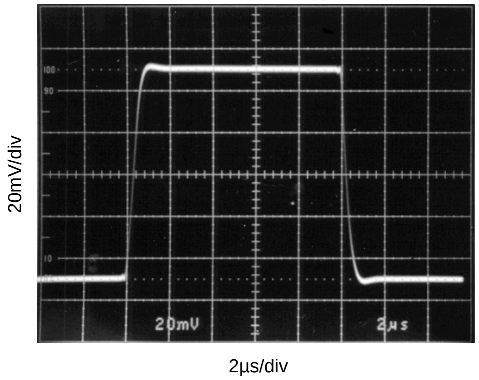




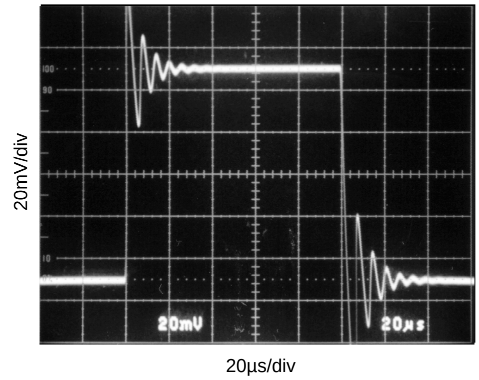
TYPICAL CHARACTERISTIC CURVES (Cont.)

At T_A = +25°C and R_L = 10kΩ, unless otherwise noted.

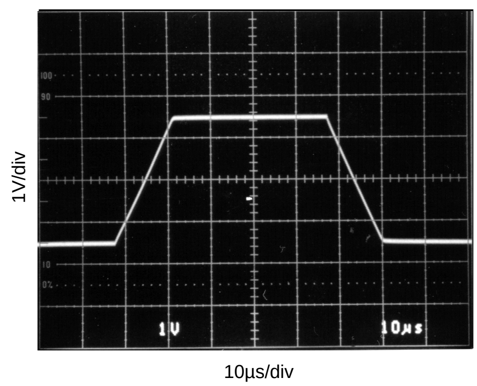
SMALL-SIGNAL STEP RESPONSE
G = 1, C_L = 100pF, V_S = +5V



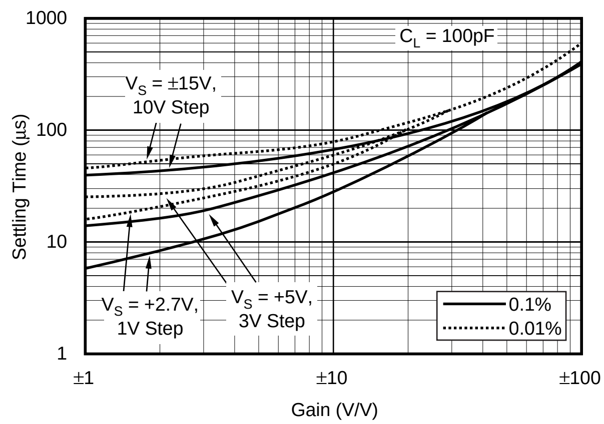
SMALL-SIGNAL STEP RESPONSE
G = 1, C_L = 10,000pF, V_S = +5V



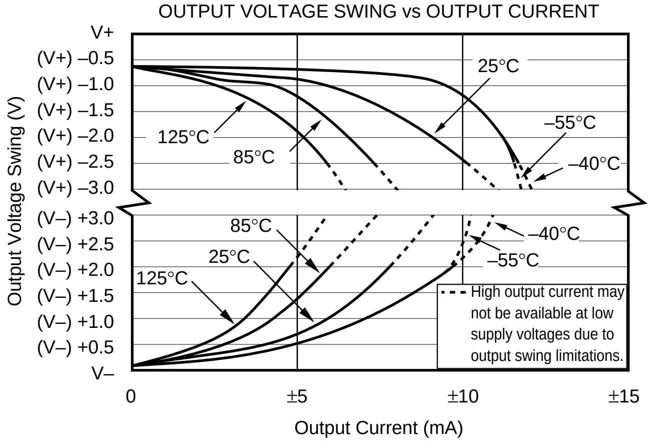
LARGE-SIGNAL STEP RESPONSE
G = 1, C_L = 100pF, V_S = +5V



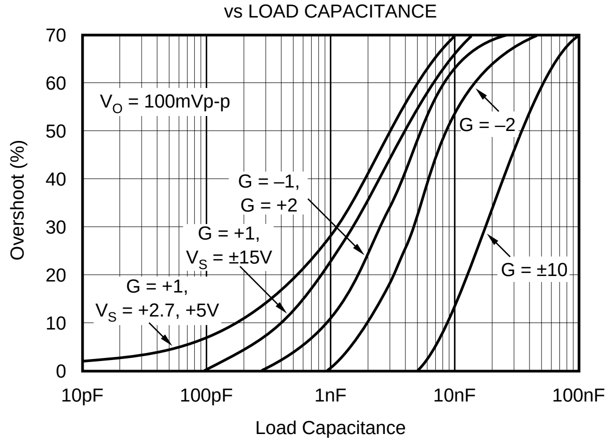
SETTLING TIME vs CLOSED-LOOP GAIN



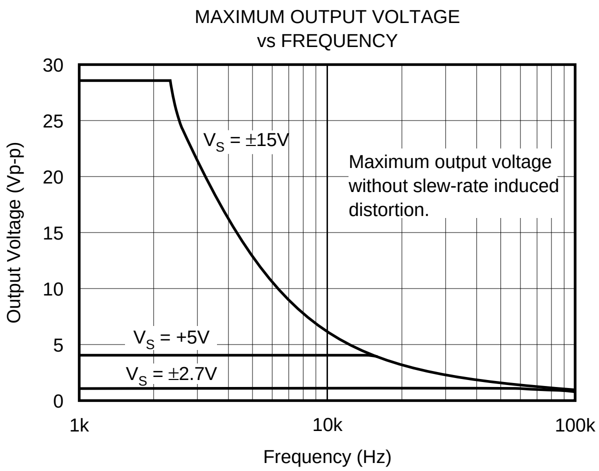
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT

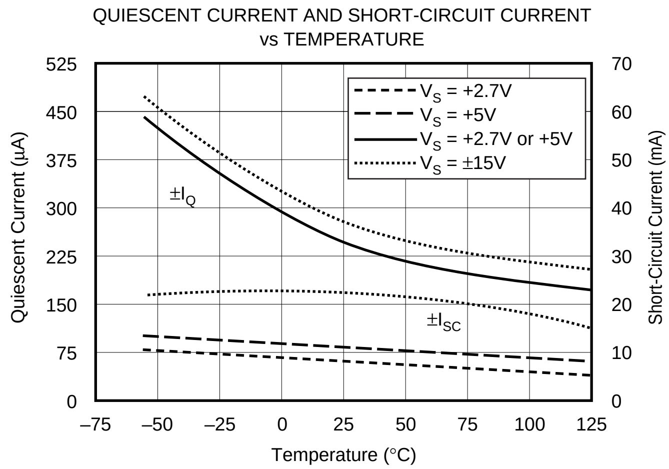


SMALL-SIGNAL OVERSHOOT
vs LOAD CAPACITANCE



At $T_A = +25°C$ and $R_L = 10k\Omega$, unless otherwise noted.





APPLICATIONS INFORMATION

The OPA234 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.

OPERATING VOLTAGE

The OPA234 series op amps operate from single (+2.7V to +36V) or dual (±1.35V to ±18V) supplies with excellent performance. Specifications are production tested with +2.7V, +5V, and ±15V supplies. Most behavior remains unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltage are shown in the Typical Characterisitc curves.

OFFSET VOLTAGE TRIM

Offset voltage of the OPA234 series amplifiers is laser trimmed and usually requires no user adjustment. The OPA234 (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 to adjust system offset or offset produced by the signal source. Nulling offset could degrade the offset drift behavior of the op amp. While it is not possible to predict the exact change in drift, the effect is usually small.

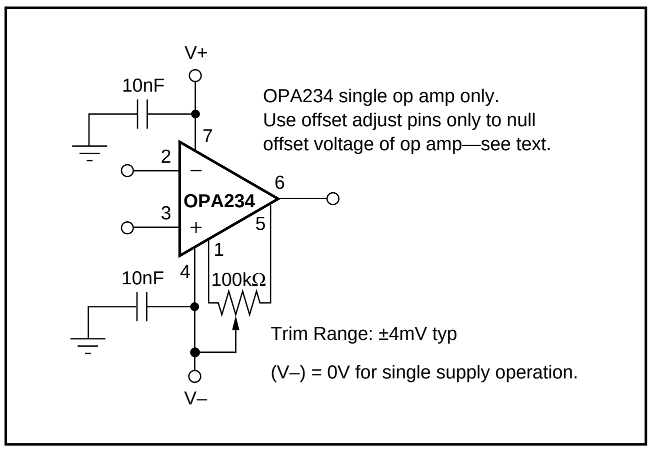


FIGURE 1. OPA234 Offset Voltage Trim Circuit.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
OPA2234P	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA2234PA	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA2234U	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-3-235C-168 HR
OPA2234U/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-3-235C-168 HR
OPA2234UA	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-3-235C-168 HR
OPA2234UA/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-3-235C-168 HR
OPA234E/250	ACTIVE	MSOP	DGK	8	250	None	Call TI	Level-1-220C-UNLIM
OPA234E/2K5	ACTIVE	MSOP	DGK	8	2500	None	Call TI	Level-1-220C-UNLIM
OPA234EA/250	ACTIVE	MSOP	DGK	8	250	None	Call TI	Level-1-220C-UNLIM
OPA234EA/2K5	ACTIVE	MSOP	DGK	8	2500	None	Call TI	Level-1-220C-UNLIM
OPA234P	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA234PA	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
OPA234U	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-3-235C-168 HR
OPA234U/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-3-235C-168 HR
OPA234UA	ACTIVE	SOIC	D	8	100	None	CU SNPB	Level-2-220C-1 YEAR
OPA234UA/2K5	ACTIVE	SOIC	D	8	2500	None	CU SNPB	Level-2-220C-1 YEAR
OPA4234PA	OBSOLETE	PDIP	N	14		None	Call TI	Call TI
OPA4234U	ACTIVE	SOIC	D	14	58	None	Call TI	Level-3-220C-168 HR
OPA4234U/2K5	ACTIVE	SOIC	D	14	2500	None	Call TI	Level-3-220C-168 HR
OPA4234UA	ACTIVE	SOIC	D	14	58	None	CU SNPB	Level-3-220C-168 HR
OPA4234UA/2K5	ACTIVE	SOIC	D	14	2500	None	CU SNPB	Level-3-220C-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.

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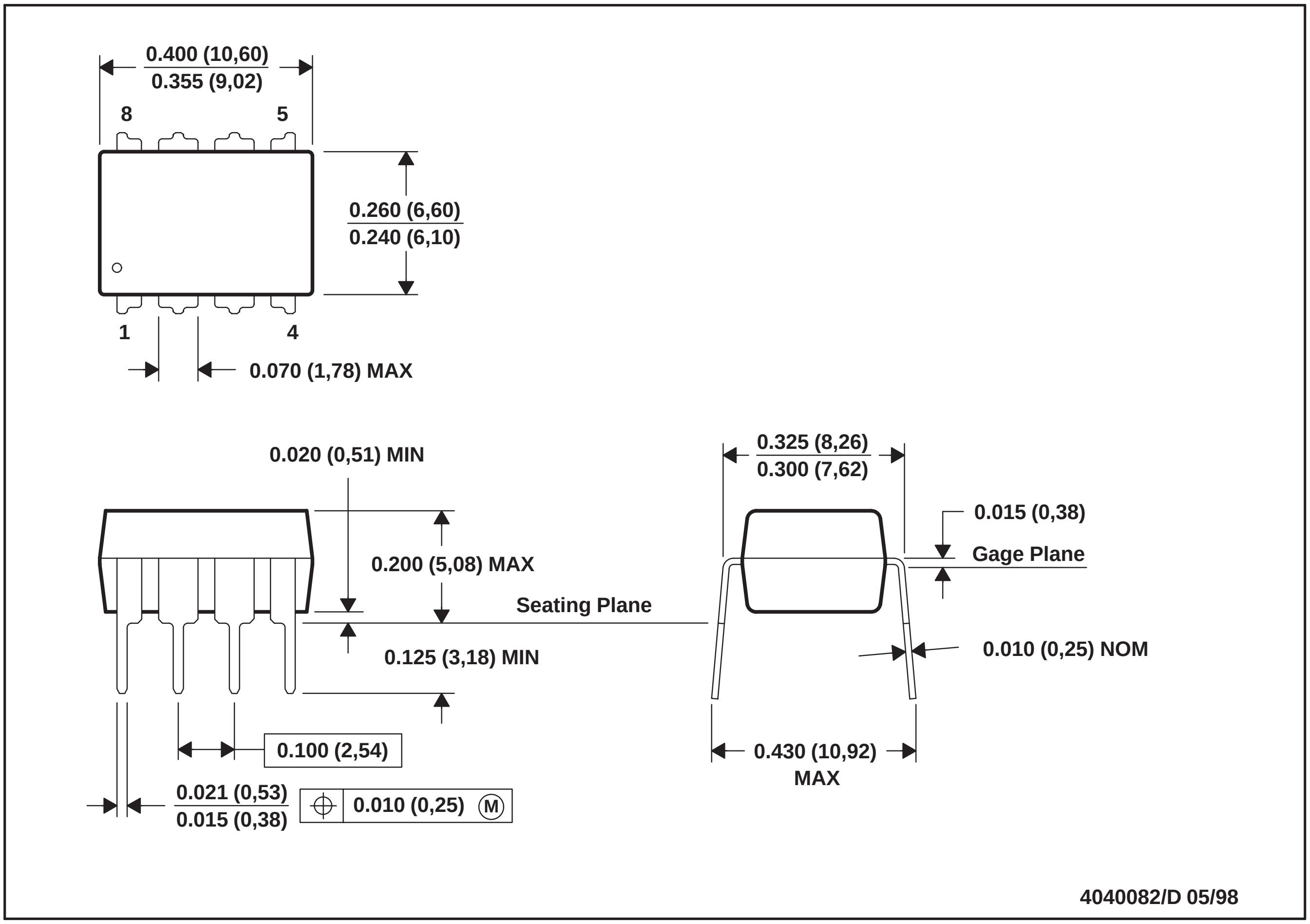
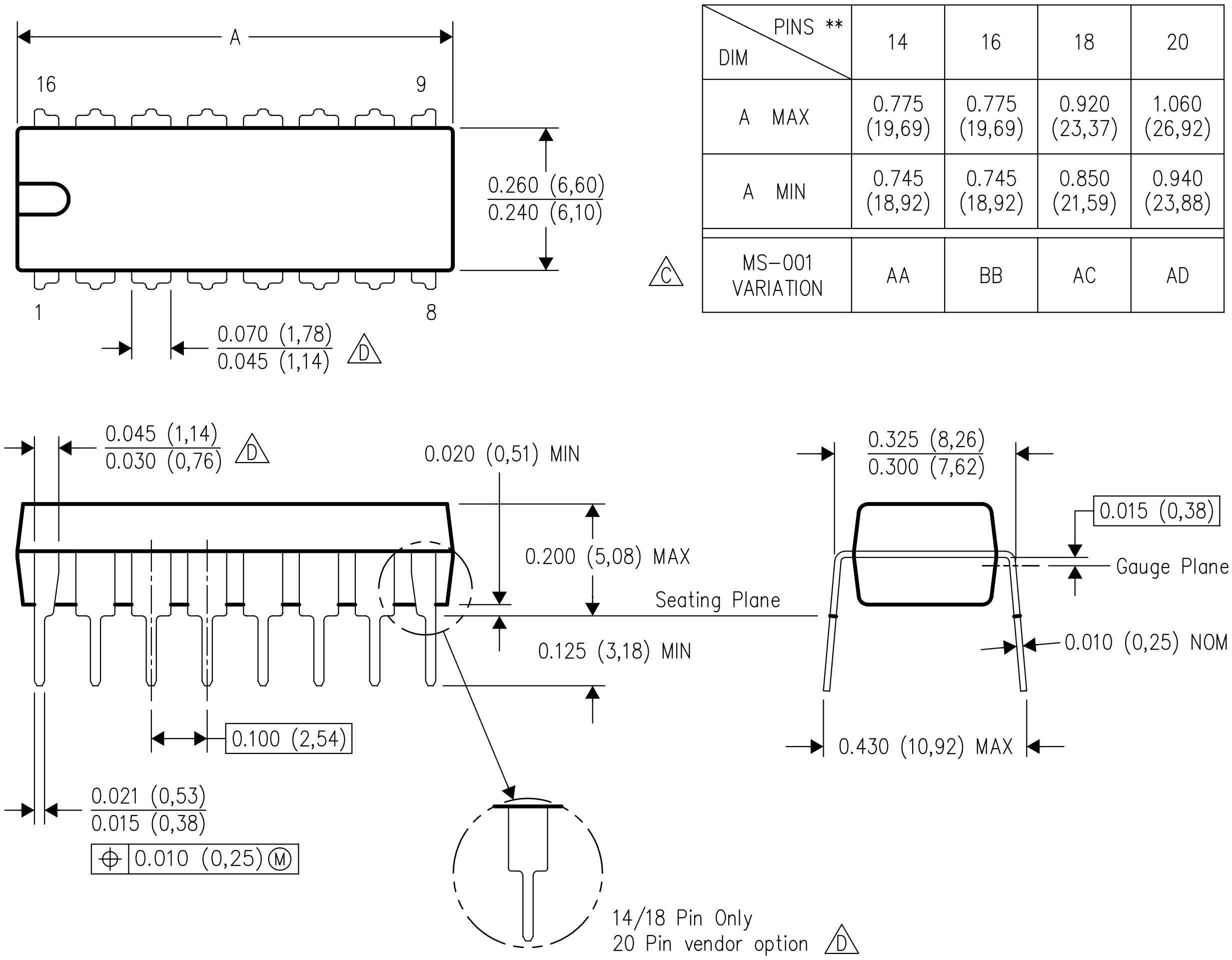
P (R-PDIP-T8) PLASTIC DUAL-IN-LINE



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

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	AA	BB	AC	AD

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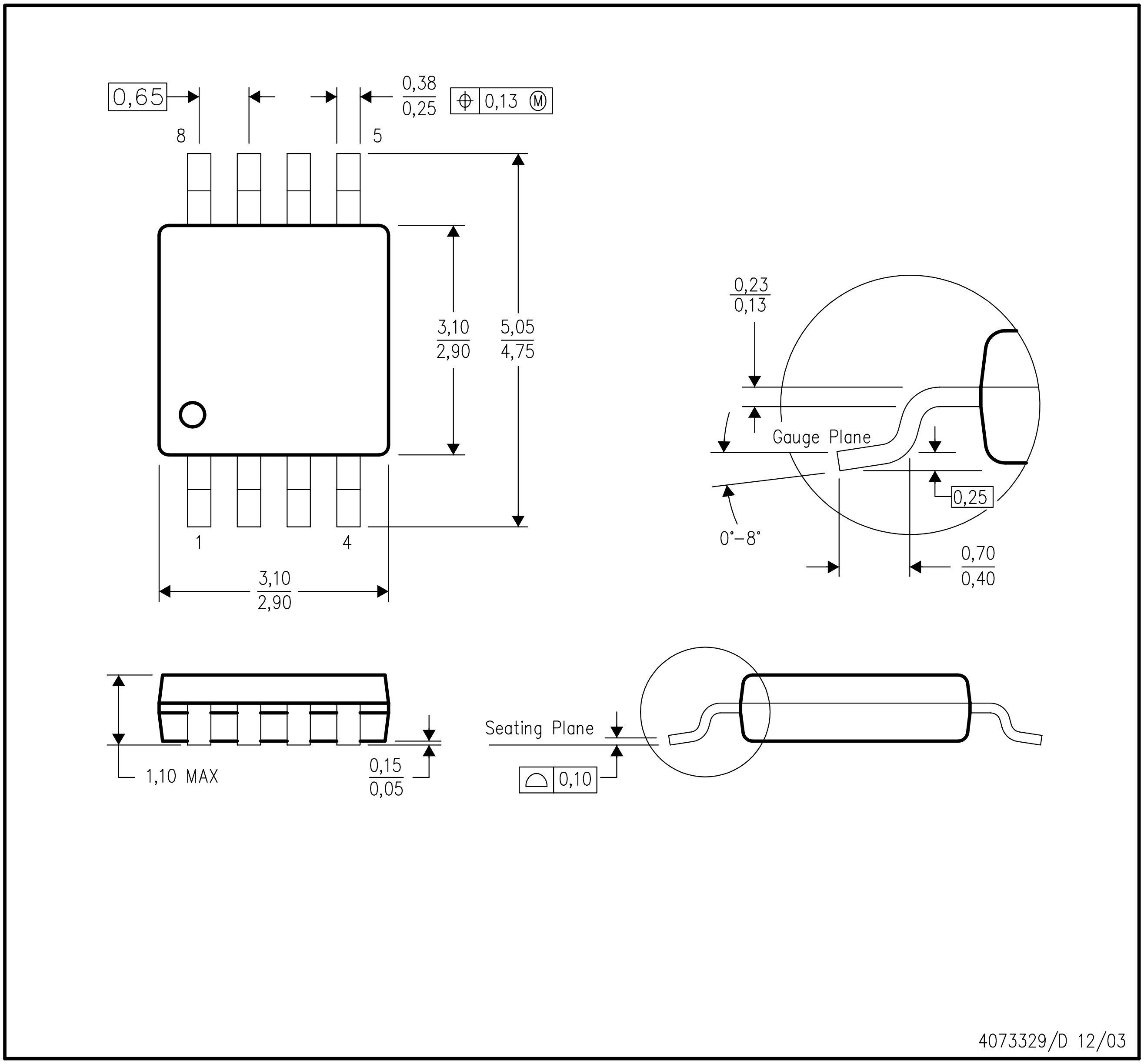
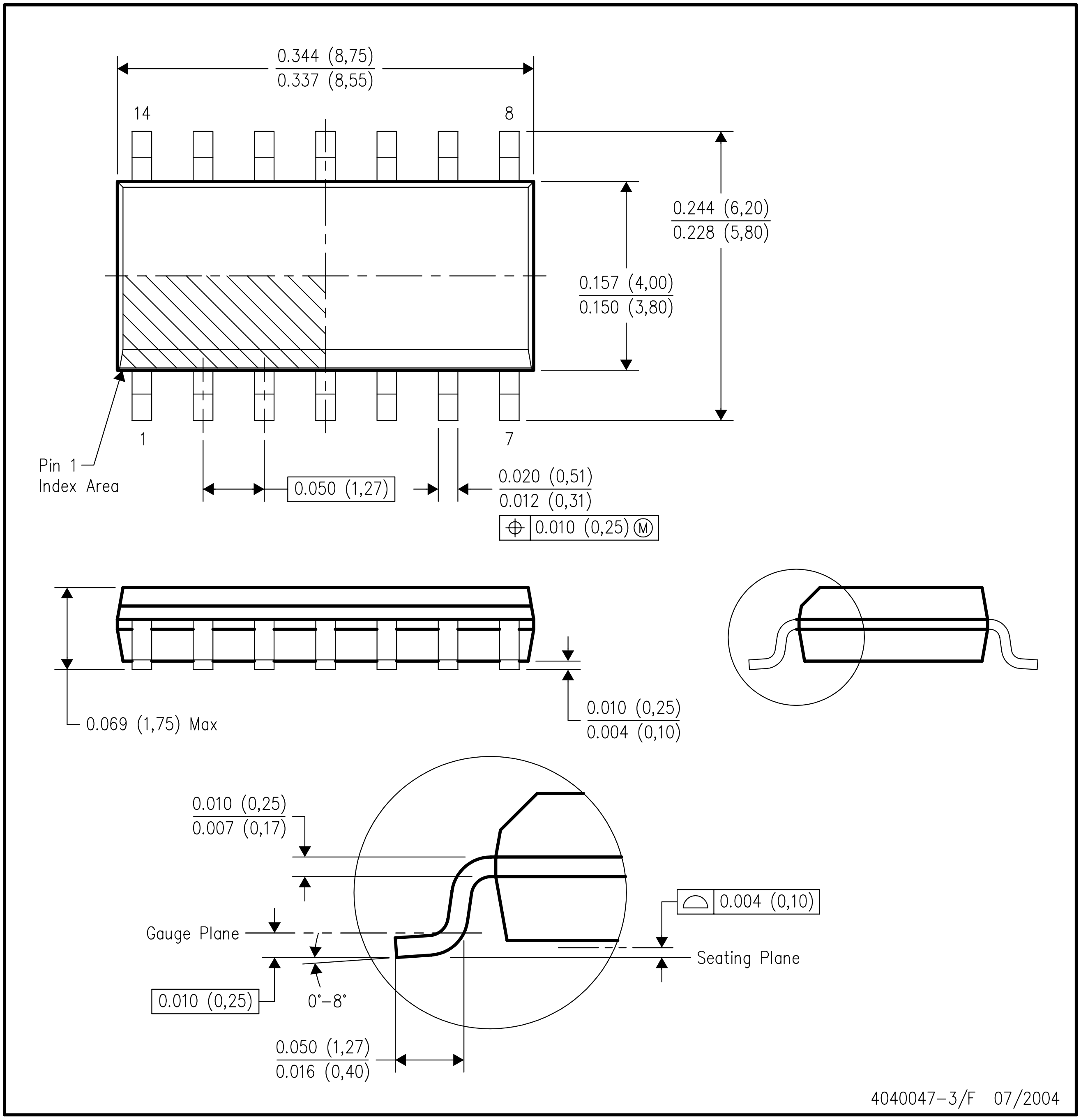
NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
- D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

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



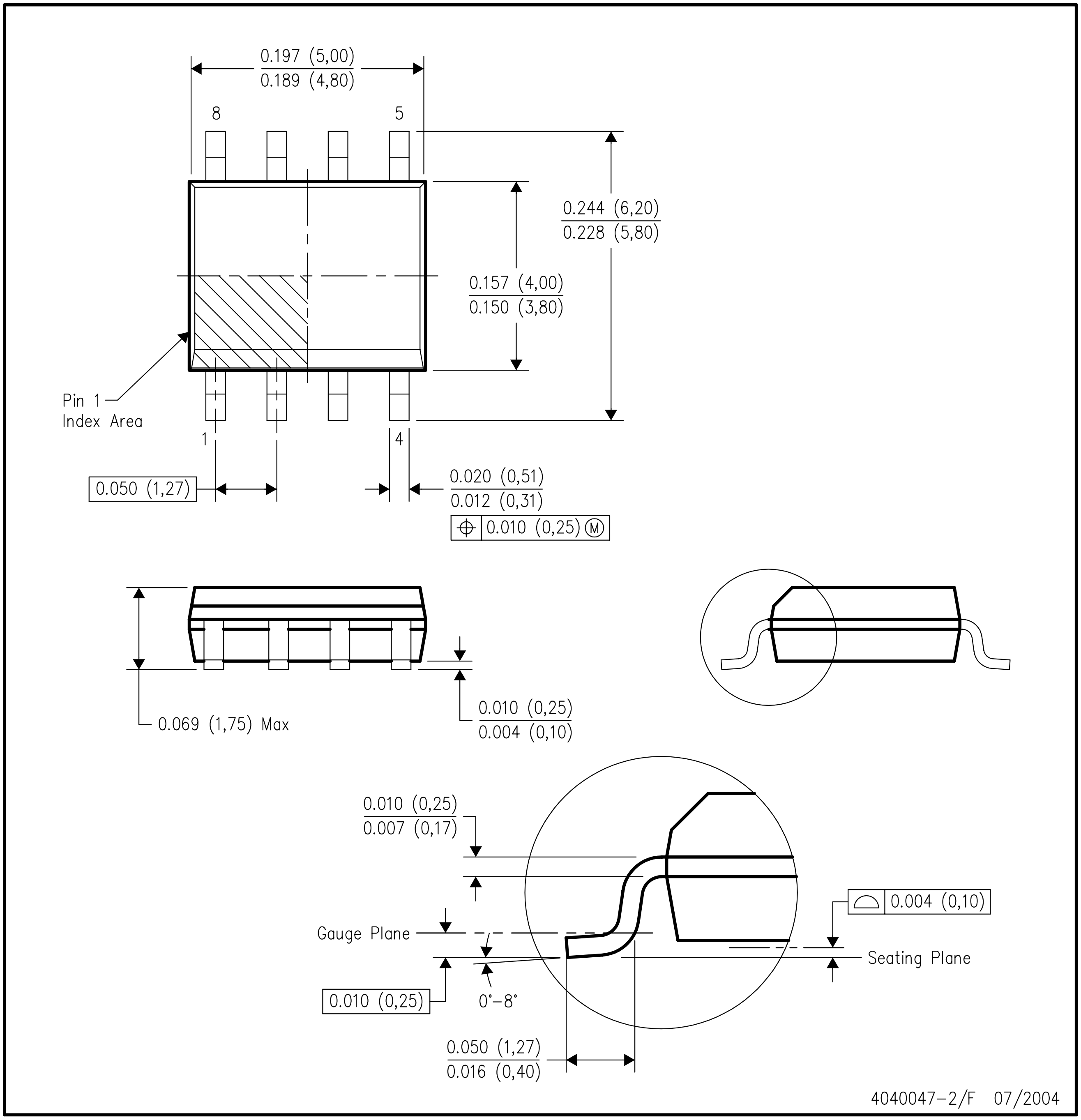
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO-187 variation AA.

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.