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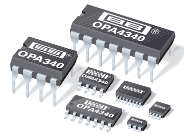


OPA340
OPA2340
OPA4340

SBOS073A – SEPTEMBER 1997 – REVISED APRIL 2007

SINGLE-SUPPLY, RAIL-TO-RAIL OPERATIONAL AMPLIFIERS
MicroAmplifier™ Series

FEATURES

- RAIL-TO-RAIL INPUT
- RAIL-TO-RAIL OUTPUT (within 1mV)
- *Micro*SIZE PACKAGES
- WIDE BANDWIDTH: 5.5MHz
- HIGH SLEW RATE: 6V/μs
- LOW THD+NOISE: 0.0007% (f = 1kHz)
- LOW QUIESCENT CURRENT: 750μA/channel
- SINGLE, DUAL, AND QUAD VERSIONS

APPLICATIONS

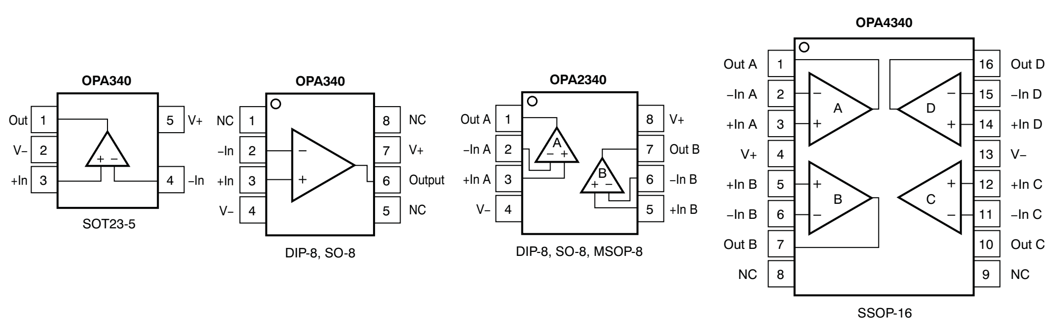
- DRIVING A/D CONVERTERS
- PCMCIA CARDS
- DATA ACQUISITION
- PROCESS CONTROL
- AUDIO PROCESSING
- COMMUNICATIONS
- ACTIVE FILTERS
- TEST EQUIPMENT

DESCRIPTION

OPA340 series rail-to-rail CMOS operational amplifiers are optimized for low-voltage, single-supply operation. Rail-to-rail input/output and high-speed operation make them ideal for driving sampling analog-to-digital (A/D) converters. They are also well-suited for general purpose and audio applications as well as providing I/V conversion at the output of digital-to-analog (D/A) converters. Single, dual, and quad versions have identical specifications for design flexibility.

The OPA340 series operate on a single supply as low as 2.5V with an input common-mode voltage range that extends 500mV below ground and 500mV above the positive supply. Output voltage swing is to within 1mV of the supply rails with a 100kΩ load. They offer excellent dynamic response (BW = 5.5MHz, SR = 6V/μs), yet quiescent current is only 750μA. Dual and quad designs feature completely independent circuitry for lowest crosstalk and freedom from interaction.

The single (OPA340) packages are the tiny 5-lead SOT23-5 surface mount, SO-8 surface mount, and DIP-8. The dual (OPA2340) comes in the miniature MSOP-8 surface mount, SO-8 surface mount, and DIP-8 packages. The quad (OPA4340) packages are the space-saving SSOP-16 surface mount and SO-14 surface mount. All are specified from –40°C to +85°C and operate from –55°C to +125°C. A SPICE macromodel is available for design analysis.



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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.

ABSOLUTE MAXIMUM RATINGS(1)

	VALUE	UNIT
Supply Voltage	5.5	V
Signal Input Terminals		
Voltage(2)	(V–) – 0.5 to (V+) + 0.5	V
Current(2)	10	mA
Output Short-Circuit(3)	Continuous	
Operating Temperature	–55 to +125	°C
Storage Temperature	–55 to +125	°C
Junction Temperature	+150	°C

(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, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.
(3) Short-circuit to ground, one amplifier per package.

PACKAGE/ORDERING INFORMATION(1)

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER(2)	TRANSPORT MEDIA, QUANTITY
Single						
OPA340NA	5-Lead SOT-23-5	DBV	–40°C to +85°C	A40	OPA340NA/250 OPA340NA/3K	Tape and Reel
OPA340PA	8-Pin DIP	P	–40°C to +85°C	OPA340PA	OPA340PA	Rails
OPA340UA	SO-8 Surface-Mount	D	–40°C to +85°C	OPA340UA	OPA340UA OPA340UA/2K5	Rails(3)
Dual						
OPA2340EA	MSOP-8 Surface-Mount	DGK	–40°C to +85°C	A40A	OPA2340EA/250 OPA2340EA/2K5	Tape and Reel
OPA2340PA	8-Pin DIP	P	–40°C to +85°C	OPA2340PA	OPA2340PA	Rails
OPA2340UA	SO-8 Surface-Mount	D	–40°C to +85°C	OPA2340UA	OPA2340UA	Rails(3)
Quad						
OPA4340EA	SSOP-16 Surface-Mount	DBQ	–40°C to +85°C	OPA4340EA	OPA4340EA/250 OPA4340EA/2K5	Tape and Reel
OPA4340UA	SO-14 Surface Mount	D	–40°C to +85°C	OPA4340UA	OPA4340UA OPA4340UA/2K5	Rails(3)

(1) For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Models with /250, /2500, and /3K are available only in tape and reel in the quantities indicated (e.g., **/250** indicates 250 devices per reel). Ordering 3000 pieces of *OPA340NA/3K* will get a single 3000 piece tape and reel.
(3) SO-8 and SO-14 models also available in tape and reel.

ELECTRICAL CHARACTERISTICS: V_S = 2.7V to 5V

BOLDFACE limits apply over the specified temperature range, **T_A = –40°C to +85°C. V_S = 5V**.
At T_A = +25°C, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.

PARAMETER		CONDITIONS	OPA340NA, PA, UA OPA2340EA, PA, UA OPA4340EA, UA MIN	TYP(1)	MAX	UNIT
OFFSET VOLTAGE						
Input Offset Voltage	V_{OS}	V_S = 5V		±150	±500	µV
vs Temperature	**dV_{OS}/dT**			**±2.5**		**µV/°C**
vs Power Supply	PSRR	V_S = 2.7V to 5.5V, V_{CM} = 0V		30	120	µV/V
Over Temperature		**V_S = 2.7V to 5.5V, V_{CM} = 0V**			**120**	**µV/V**
Channel Separation, dc				0.2		µV/V
INPUT BIAS CURRENT						
Input Bias Current	I_B			±0.2	±10	pA
Over Temperature					**±60**	**pA**
Input Offset Current	I_{OS}			±0.2	±10	pA
NOISE						
Input Voltage Noise, f = 0.1kHz to 50kHz				8		µVrms
Input Voltage Noise Density, f = 1kHz	e_n			25		nV/√Hz
Current Noise Density, f = 1kHz	i_n			3		fA/√Hz
INPUT VOLTAGE RANGE						
Common-Mode Voltage Range	V_{CM}		–0.3		(V+) + 0.3	V
Common-Mode Rejection Ratio	CMRR	–0.3V < V_{CM} < (V+) – 1.8V	80	92		dB
		V_S = 5V, –0.3V < V_{CM} < 5.3V	70	84		dB
		V_S = 2.7V, –0.3V < V_{CM} < 3V	66	80		dB
INPUT IMPEDANCE						
Differential				10^{13} ∥ 3		Ω ∥ pF
Common-Mode				10^{13} ∥ 6		Ω ∥ pF
OPEN-LOOP GAIN						
Open-Loop Voltage Gain	A_{OL}	R_L = 100kΩ, 5mV < V_O < (V+) – 5mV	106	124		dB
Over Temperature		**R_L = 100kΩ, 5mV < V_O < (V+) – 5mV**	**106**			**dB**
		R_L = 10kΩ, 5mV < V_O < (V+) – 50mV	100	120		dB
Over Temperature		**R_L = 10kΩ, 5mV < V_O < (V+) – 50mV**	**100**			**dB**
		R_L = 2kΩ, 200mV < V_O < (V+) – 200mV	94	114		dB
Over Temperature		**R_L = 2kΩ, 200mV < V_O < (V+) – 200mV**	**94**			**dB**
FREQUENCY RESPONSE						
Gain-Bandwidth Product	GBW	G = 1		5.5		MHz
Slew Rate	SR	V_S = 5V, G = 1, C_L = 100pF		6		V/µs
Settling Time, 0.1%		V_S = 5V, 2V Step, C_L = 100pF		1		µs
Settling Time, 0.01%		V_S = 5V, 2V Step, C_L = 100pF		1.6		µs
Overload Recovery Time		V_{IN} • G = V_S		0.2		µs
Total Harmonic Distortion + Noise	THD+N	V_S = 5V, V_O = $3V_{PP}$(2), G = 1, f = 1kHz		0.0007		%

(1) V_S = +5V.
(2) V_{OUT} = 0.25V to 3.25V.

ELECTRICAL CHARACTERISTICS: V_S = 2.7V to 5V (continued)

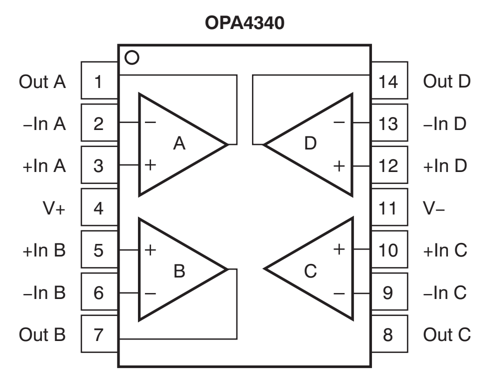
BOLDFACE limits apply over the specified temperature range, **T_A = –40°C to +85°C. V_S = 5V**.
At T_A = +25°C, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.

PARAMETER		CONDITIONS	OPA340NA, PA, UA OPA2340EA, PA, UA OPA4340EA, UA MIN	TYP(1)	MAX	UNIT
OUTPUT						
Voltage Output Swing from Rail(2)		R_L = 100kΩ, A_{OL} ≥ 106dB		1	5	mV
Over Temperature		**R_L = 100kΩ, A_{OL} ≥ 106dB**			**5**	**mV**
		R_L = 10kΩ, A_{OL} ≥ 100dB		10	50	mV
Over Temperature		**R_L = 10kΩ, A_{OL} ≥ 100dB**			**50**	**mV**
		R_L = 2kΩ, A_{OL} ≥ 94dB		40	200	mV
Over Temperature		**R_L = 2kΩ, A_{OL} ≥ 94dB**			**200**	**mV**
Short-Circuit Current	I_{SC}			±50		mA
Capacitive Load Drive	C_{LOAD}			See Typical Characteristics		
POWER SUPPLY						
Specified Voltage Range	V_S		2.7		5	V
Operating Voltage Range				2.5 to 5.5		V
Quiescent Current (per amplifier)	I_Q	I_O = 0, V_S = +5V		750	950	µA
Over Temperature		**I_O = 0, V_S = +5V**			**1100**	**µA**
TEMPERATURE RANGE						
Specified Range			–40		+85	°C
Operating Range			–55		+125	°C
Storage Range			–55		+125	°C
Thermal Resistance	Θ_{JA}					
SOT23-5 Surface Mount				200		°C/W
MSOP-8 Surface Mount				150		°C/W
SO-8 Surface Mount				150		°C/W
DIP-8 Surface Mount				100		°C/W
SSOP-16 Surface Mount				100		°C/W
SO-14 Surface Mount				100		°C/W

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

PIN CONFIGURATION

SO
(TOP VIEW)



TYPICAL CHARACTERISTICS

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

OPEN-LOOP GAIN/PHASE vs FREQUENCY

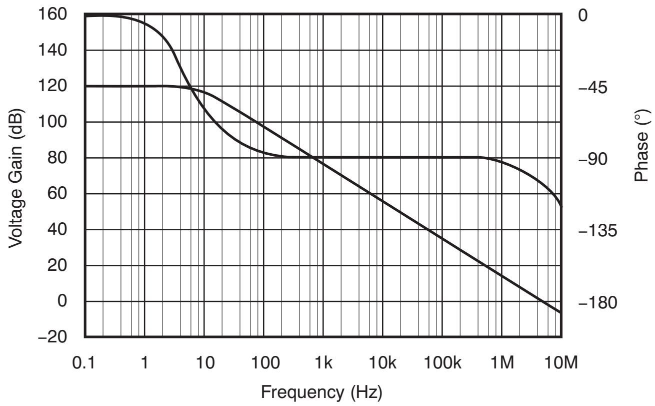


Figure 1.

POWER-SUPPLY AND COMMON-MODE REJECTION vs FREQUENCY

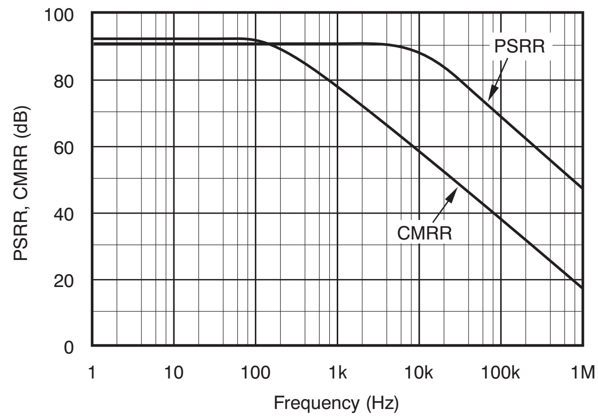


Figure 2.

INPUT VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY

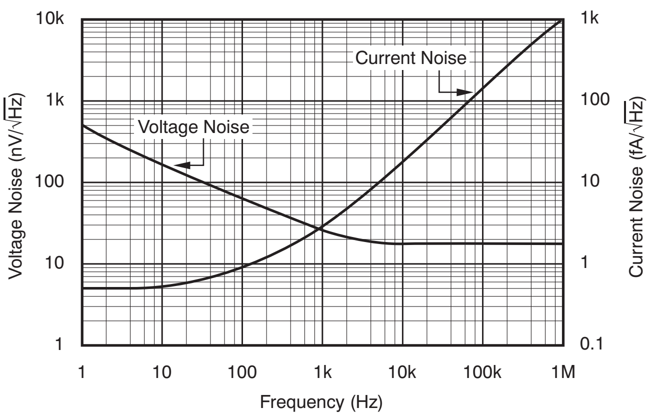


Figure 3.

CHANNEL SEPARATION vs FREQUENCY

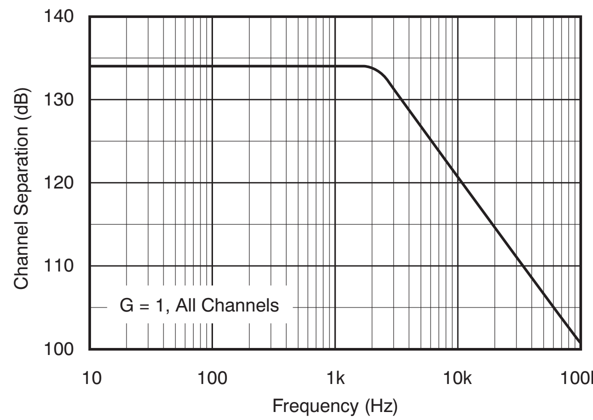


Figure 4.

TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY

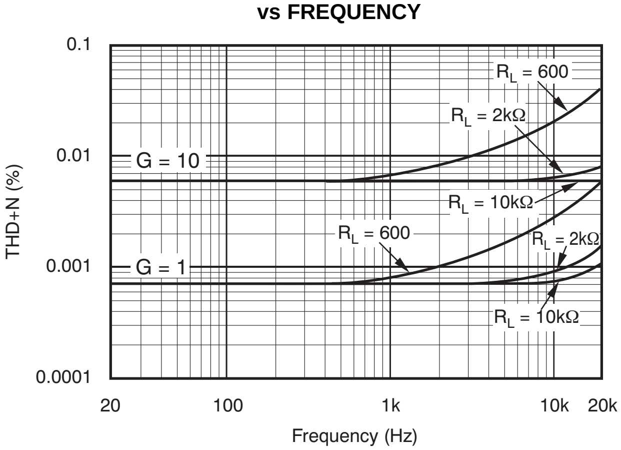


Figure 5.

CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY

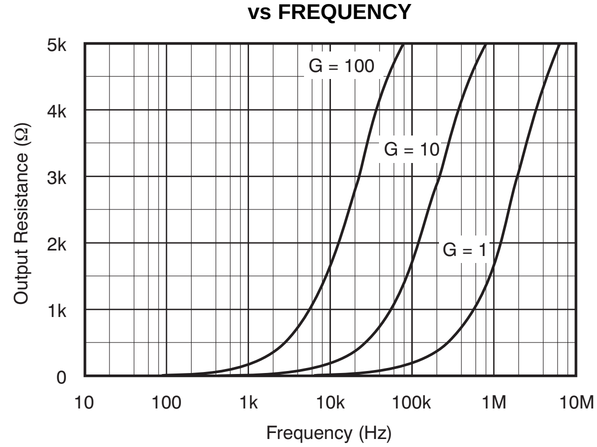


Figure 6.

TYPICAL CHARACTERISTICS (continued)

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

OPEN-LOOP GAIN AND POWER-SUPPLY REJECTION vs TEMPERATURE

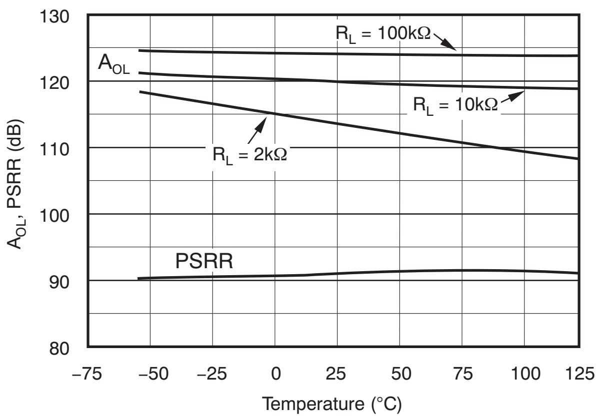


Figure 7.

COMMON-MODE REJECTION vs TEMPERATURE

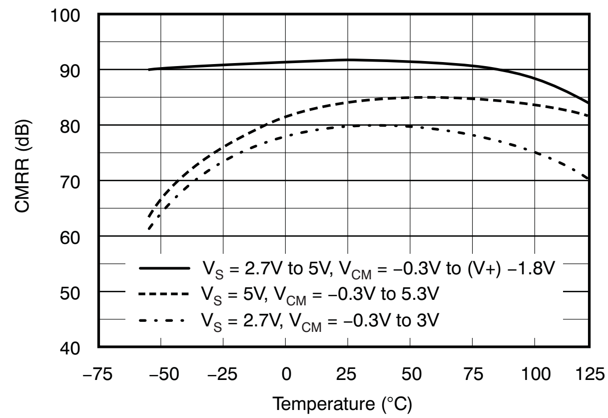


Figure 8.

QUIESCENT CURRENT vs TEMPERATURE

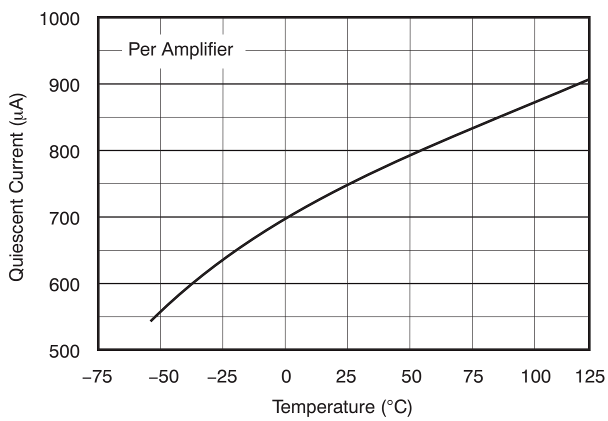


Figure 9.

QUIESCENT CURRENT vs SUPPLY VOLTAGE

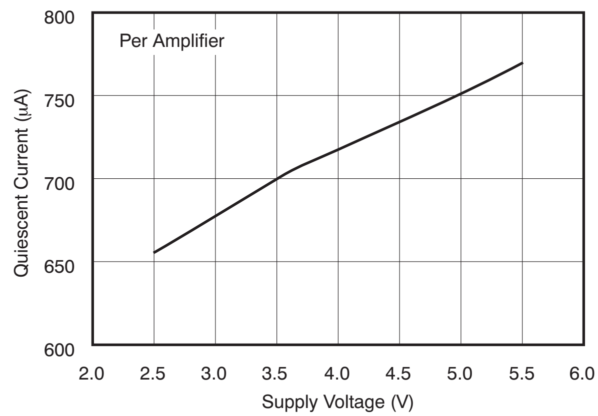


Figure 10.

SHORT-CIRCUIT CURRENT vs TEMPERATURE

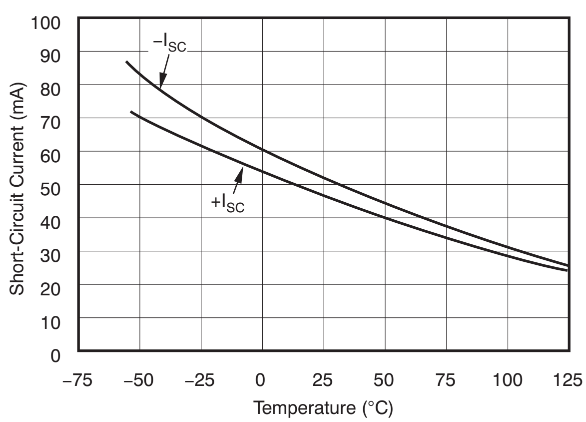


Figure 11.

SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE

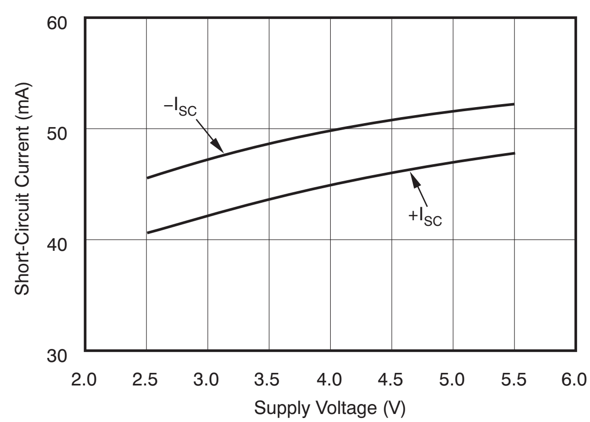


Figure 12.

TYPICAL CHARACTERISTICS (continued)

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

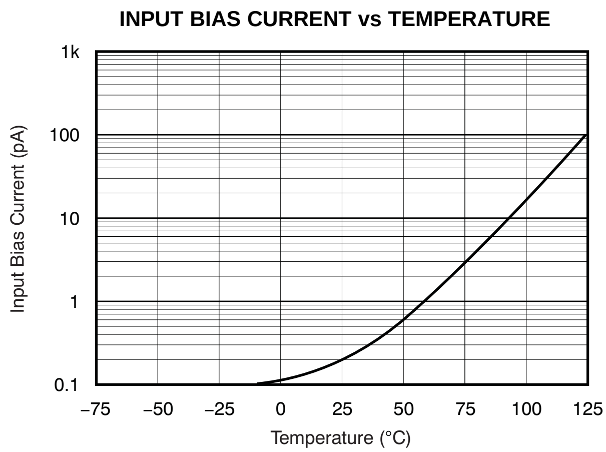


Figure 13.

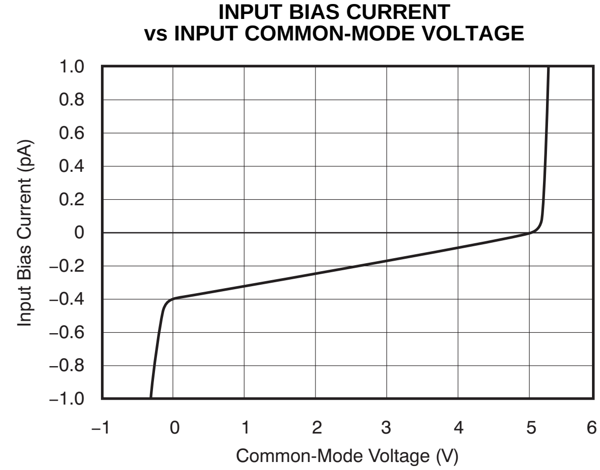


Figure 14.

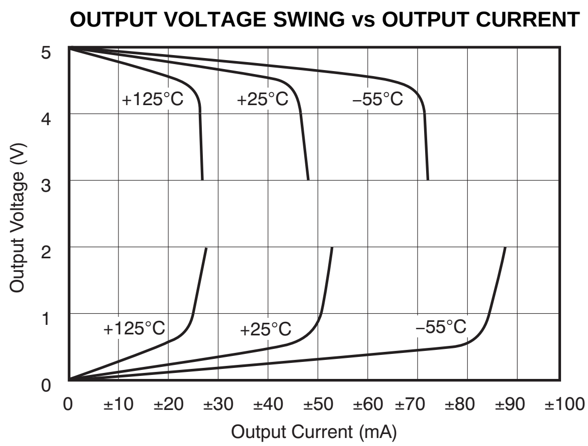


Figure 15.

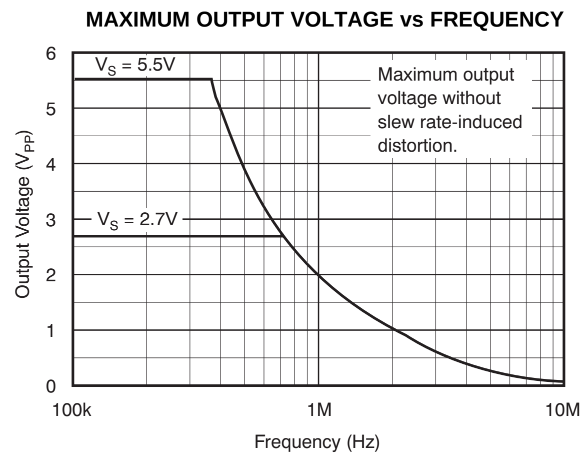


Figure 16.

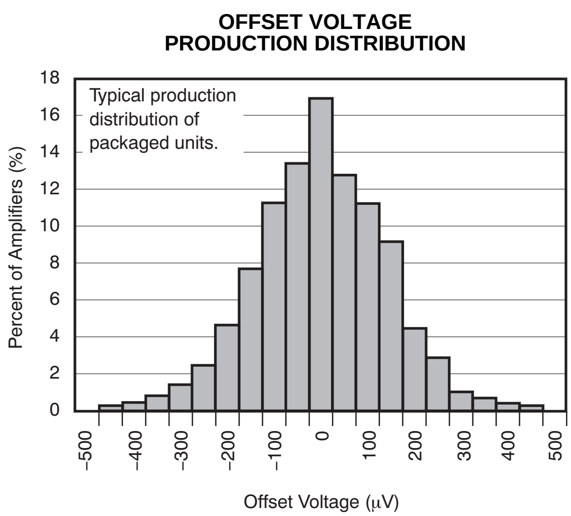


Figure 17.

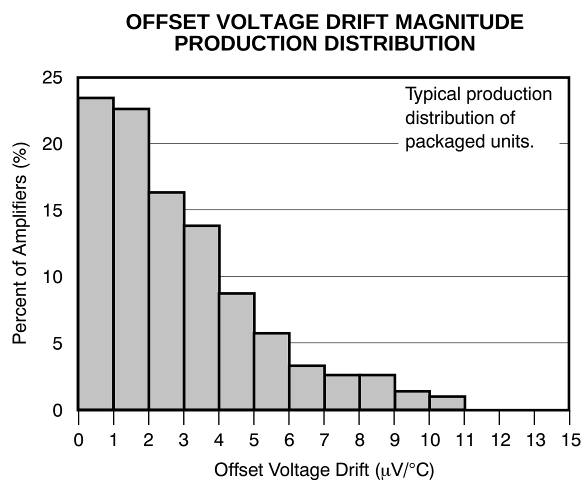


Figure 18.

TYPICAL CHARACTERISTICS (continued)

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

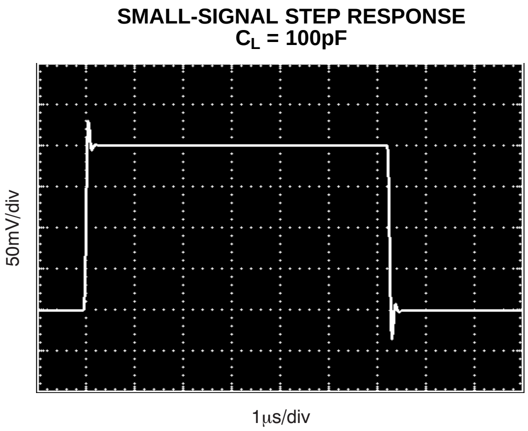


Figure 19.

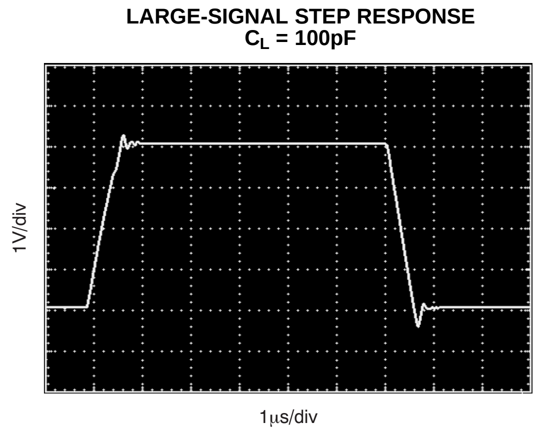


Figure 20.

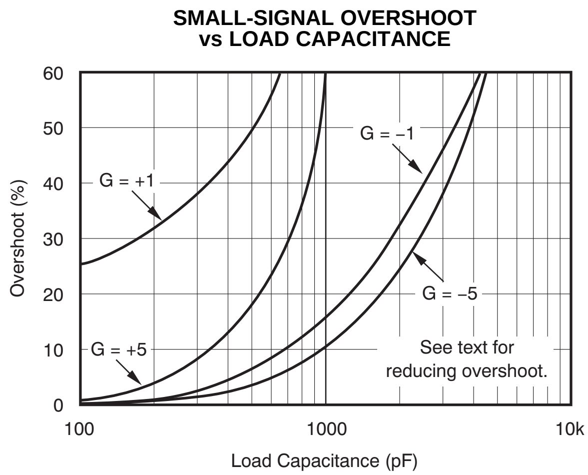


Figure 21.

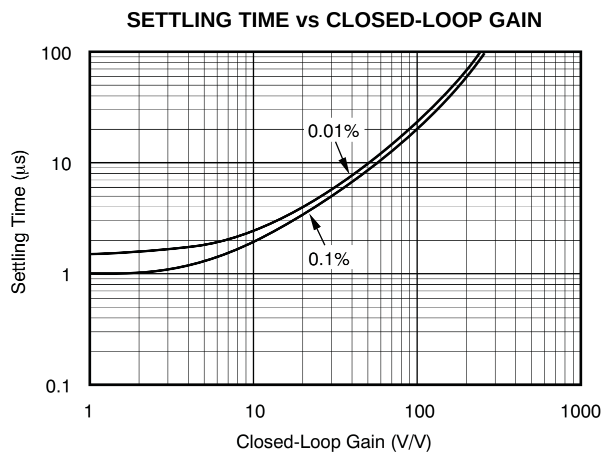


Figure 22.

APPLICATIONS INFORMATION

OPA340 series op amps are fabricated on a state-of-the-art, 0.6 micron CMOS process. They are unity-gain stable and suitable for a wide range of general-purpose applications. Rail-to-rail input/output make them ideal for driving sampling A/D converters. In addition, excellent ac performance makes them well-suited for audio applications. The class AB output stage is capable of driving 600Ω loads connected to any point between V+ and ground.

Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications. Figure 23 shows the input and output waveforms for the OPA340 in unity-gain configuration. Operation is from a single +5V supply with a 10kΩ load connected to $V_S/2$. The input is a $5V_{PP}$ sinusoid. Output voltage is approximately $4.98V_{PP}$.

Power-supply pins should be bypassed with 0.01μF ceramic capacitors.

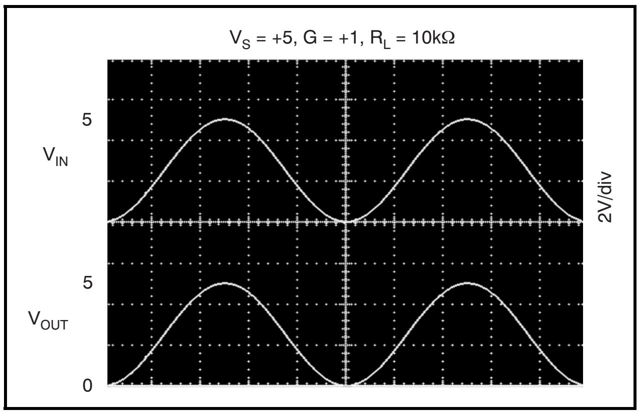


Figure 23. Rail-to-Rail Input and Output

OPERATING VOLTAGE

OPA340 series op amps are fully specified from +2.7V to +5V. However, supply voltage may range from +2.5V to +5.5V. Parameters are ensured over the specified supply range—a unique feature of the OPA340 series. In addition, many specifications apply from –40°C to +85°C. Most behavior remains virtually unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltages or temperature are shown in the Typical Characteristics.

RAIL-TO-RAIL INPUT

The input common-mode voltage range of the OPA340 series extends 500mV beyond the supply rails. This is achieved with a complementary input stage—an N-channel input differential pair in parallel with a P-channel differential pair (as shown in Figure 24). The N-channel pair is active for input voltages close to the positive rail, typically (V+) – 1.3V to 500mV above the positive supply, while the P-channel pair is on for inputs from 500mV below the negative supply to approximately (V+) – 1.3V. There is a small transition region, typically (V+) – 1.5V to (V+) – 1.1V, in which both pairs are on. This 400mV transition region can vary ±300mV with process variation. Thus, the transition region (both stages on) can range from (V+) – 1.8V to (V+) – 1.4V on the low end, up to (V+) – 1.2V to (V+) – 0.8V on the high end.

OPA340 series op amps are laser-trimmed to the reduce offset voltage difference between the N-channel and P-channel input stages, resulting in improved common-mode rejection and a smooth transition between the N-channel pair and the P-channel pair. However, within the 400mV transition region PSRR, CMRR, offset voltage, offset drift, and THD may be degraded compared to operation outside this region.

A double-folded cascode adds the signal from the two input pairs and presents a differential signal to the class AB output stage. Normally, input bias current is approximately 200fA; however, input voltages exceeding the power supplies by more than 500mV can cause excessive current to flow in or out of the input pins. Momentary voltages greater than 500mV beyond the power supply can be tolerated if the current on the input pins is limited to 10mA. This is easily accomplished with an input resistor, as shown in Figure 25. Many input signals are inherently current-limited to less than 10mA; therefore, a limiting resistor is not required.

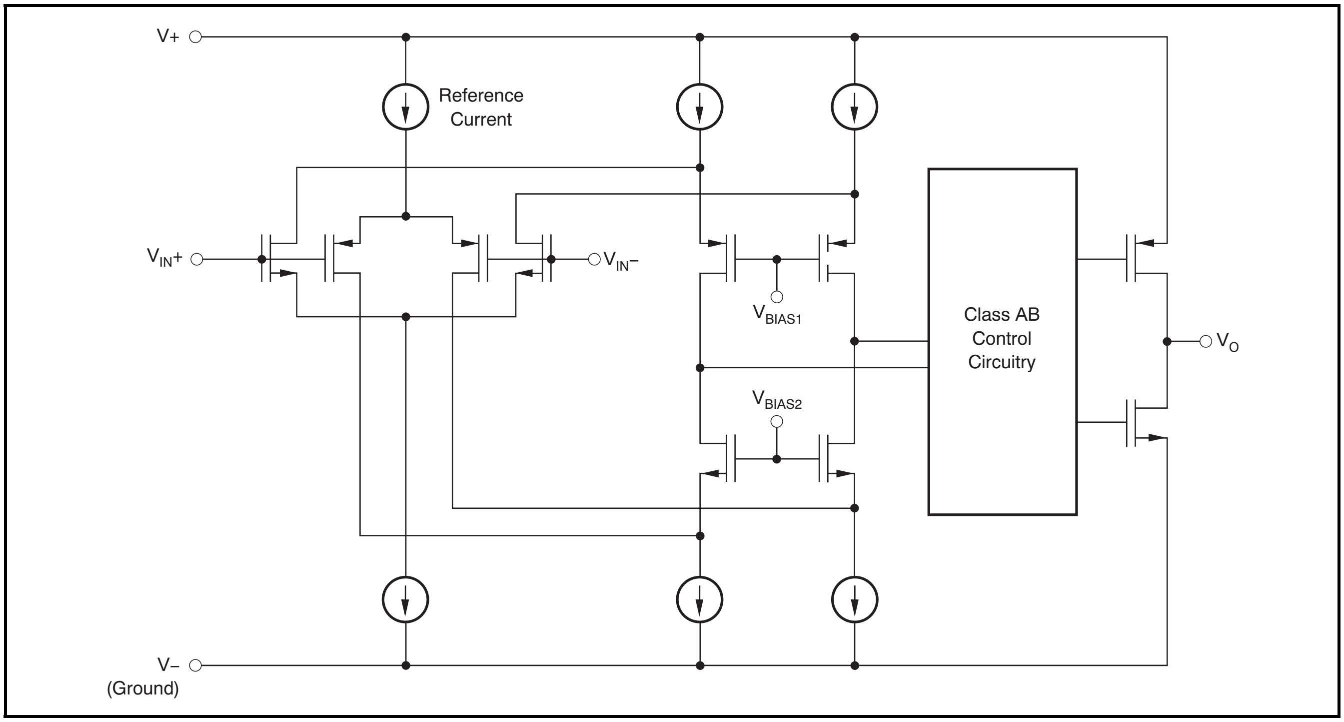


Figure 24. Simplified Schematic

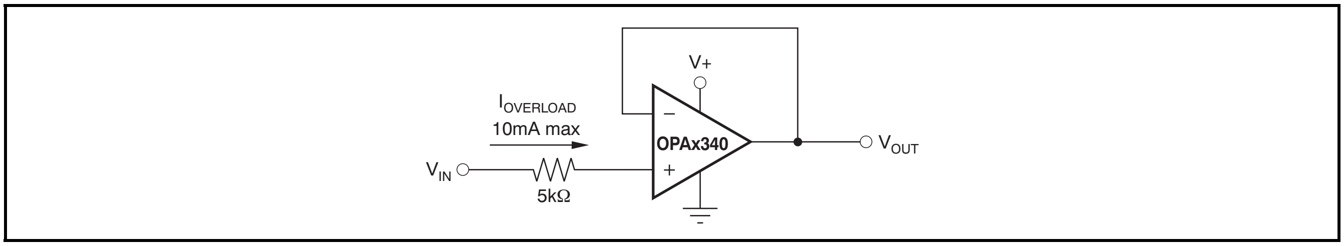


Figure 25. Input Current Protection for Voltages Exceeding the Supply Voltage

RAIL-TO-RAIL OUTPUT

A class AB output stage with common-source transistors is used to achieve rail-to-rail output. For light resistive loads (> 50kΩ), the output voltage is typically a few millivolts from the supply rails. With moderate resistive loads (2kΩ to 50kΩ), the output can swing to within a few tens of millivolts from the supply rails and maintain high open-loop gain. See the typical characteristic curve *Output Voltage Swing vs Output Current.*

CAPACITIVE LOAD AND STABILITY

OPA340 series op amps can drive a wide range of capacitive loads. However, all op amps under certain conditions may become unstable. Op amp configuration, gain, and load value are just a few of the factors to consider when determining stability. An op amp in unity gain configuration is most susceptible to the effects of capacitive load. The capacitive load reacts with the op amp's output resistance, along with any additional load resistance, to create a pole in the small-signal response which degrades the phase margin. In unity gain, OPA340 series op amps perform well, with a pure capacitive load up to approximately 1000pF. Increasing gain enhances the amplifier's ability to drive more capacitance. See the typical performance curve *Small-Signal Overshoot vs Capacitive Load.*

One method of improving capacitive load drive in the unity gain configuration is to insert a 10Ω to 20Ω resistor in series with the output, as shown in Figure 26. This significantly reduces ringing with large capacitive loads. However, if there is a resistive load in parallel with the capacitive load, it creates a voltage divider introducing a dc error at the output and slightly reduces output swing. This error may be insignificant. For instance, with R_L = 10kΩ and R_S = 20Ω, there is only about a 0.2% error at the output.

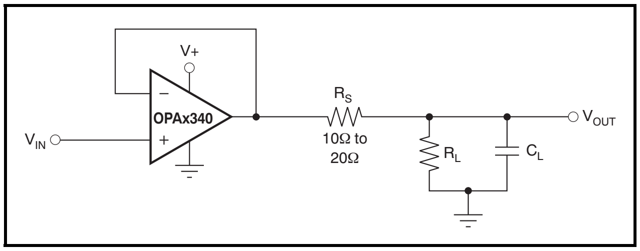


Figure 26. Series Resistor in Unity-Gain Configuration Improves Capacitive Load Drive

DRIVING A/D CONVERTERS

OPA340 series op amps are optimized for driving medium speed (up to 100kHz) sampling A/D converters. However, they also offer excellent performance for higher speed converters. The OPA340 series provides an effective means of buffering the A/D's input capacitance and resulting charge injection while providing signal gain. Figure 27 and Figure 28 show the OPA340 driving an ADS7816. The ADS7816 is a 12-bit, micro-power sampling converter in the tiny MSOP-8 package. When used with the miniature package options of the OPA340 series, the combination is ideal for space-limited and low-power applications. For further information consult the ADS7816 data sheet. With the OPA340 in a noninverting configuration, an RC network at the amplifier's output can be used to filter high-frequency noise in the signal (see Figure 27). In the inverting configuration, filtering may be accomplished with a capacitor across the feedback resistor (see Figure 28).

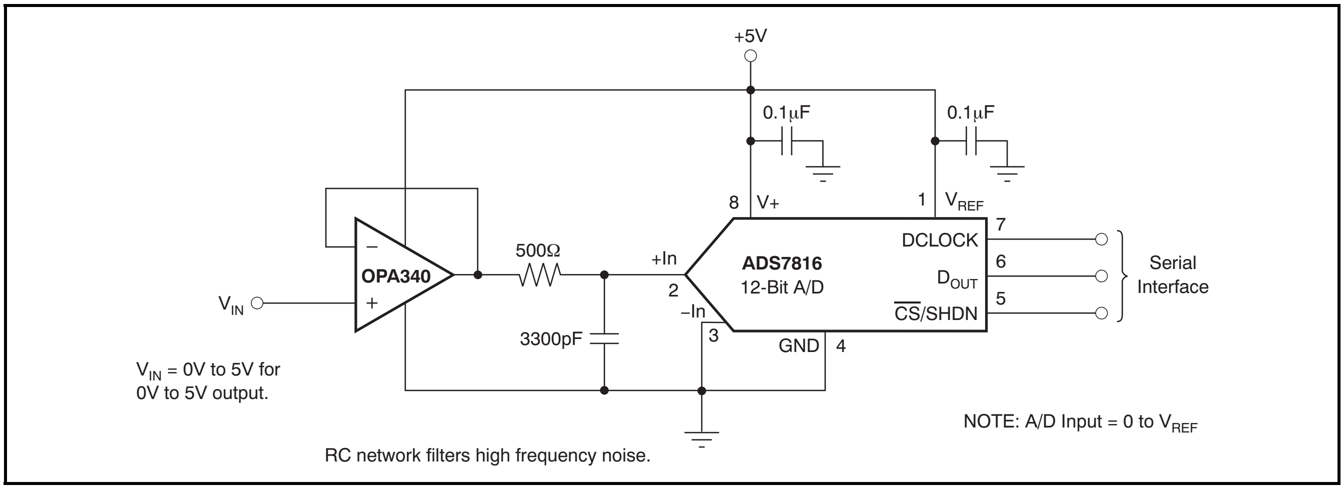


Figure 27. OPA340 in Noninverting Configuration Driving ADS7816

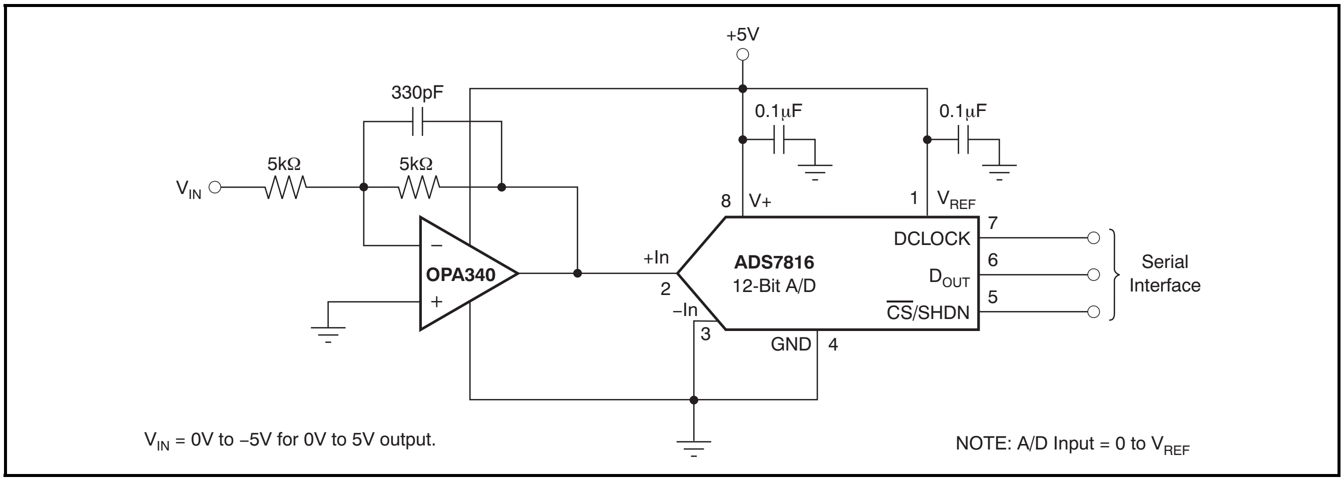


Figure 28. OPA340 in Inverting Configuration Driving ADS7816

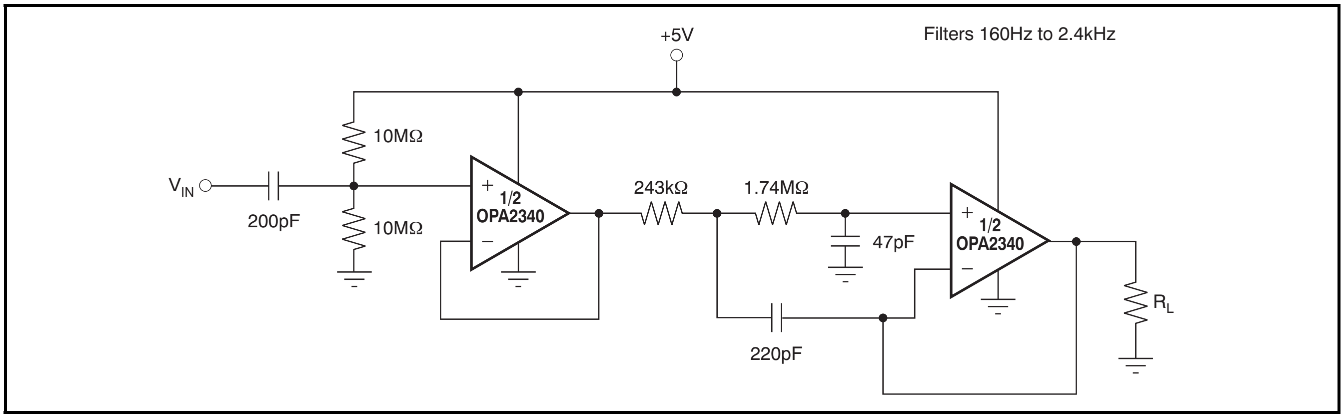


Figure 29. Speech Bandpass Filter

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
OPA2340EA/250	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2340EA/250G4	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2340EA/2K5	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2340EA/2K5G4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2340PA	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA2340PAG4	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA2340UA	ACTIVE	SOIC	D	8	100	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2340UA/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2340UA/2K5G4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2340UAG4	ACTIVE	SOIC	D	8	100	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340NA/250	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340NA/250G4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340NA/3K	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340NA/3KG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340PA	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA340PAG4	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
OPA340UA	ACTIVE	SOIC	D	8	100	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340UA/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340UA/2K5G4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA340UAG4	ACTIVE	SOIC	D	8	100	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4340EA/250	ACTIVE	SSOP/ QSOP	DBQ	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4340EA/250G4	ACTIVE	SSOP/ QSOP	DBQ	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4340EA/2K5	ACTIVE	SSOP/ QSOP	DBQ	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4340EA/2K5G4	ACTIVE	SSOP/ QSOP	DBQ	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4340PA	OBSOLETE	PDIP	N	14		TBD	Call TI	Call TI

Orderable Device	Status [(1)]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [(2)]	Lead/Ball Finish	MSL Peak Temp [(3)]
OPA4340UA	ACTIVE	SOIC	D	14	58	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA4340UA/2K5	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA4340UA/2K5G4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA4340UAG4	ACTIVE	SOIC	D	14	58	Green (RoHS & no Sb/Br)	CU NIPDAU	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 - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
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.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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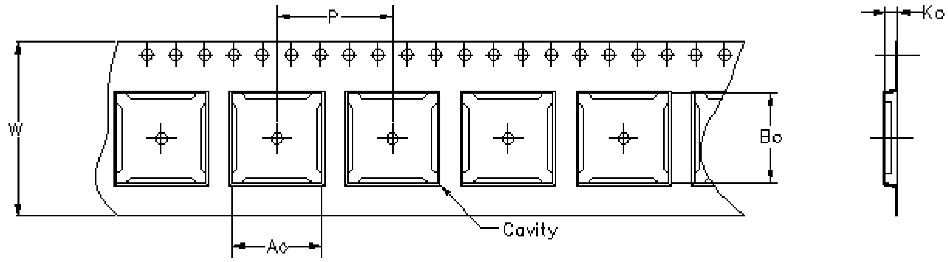
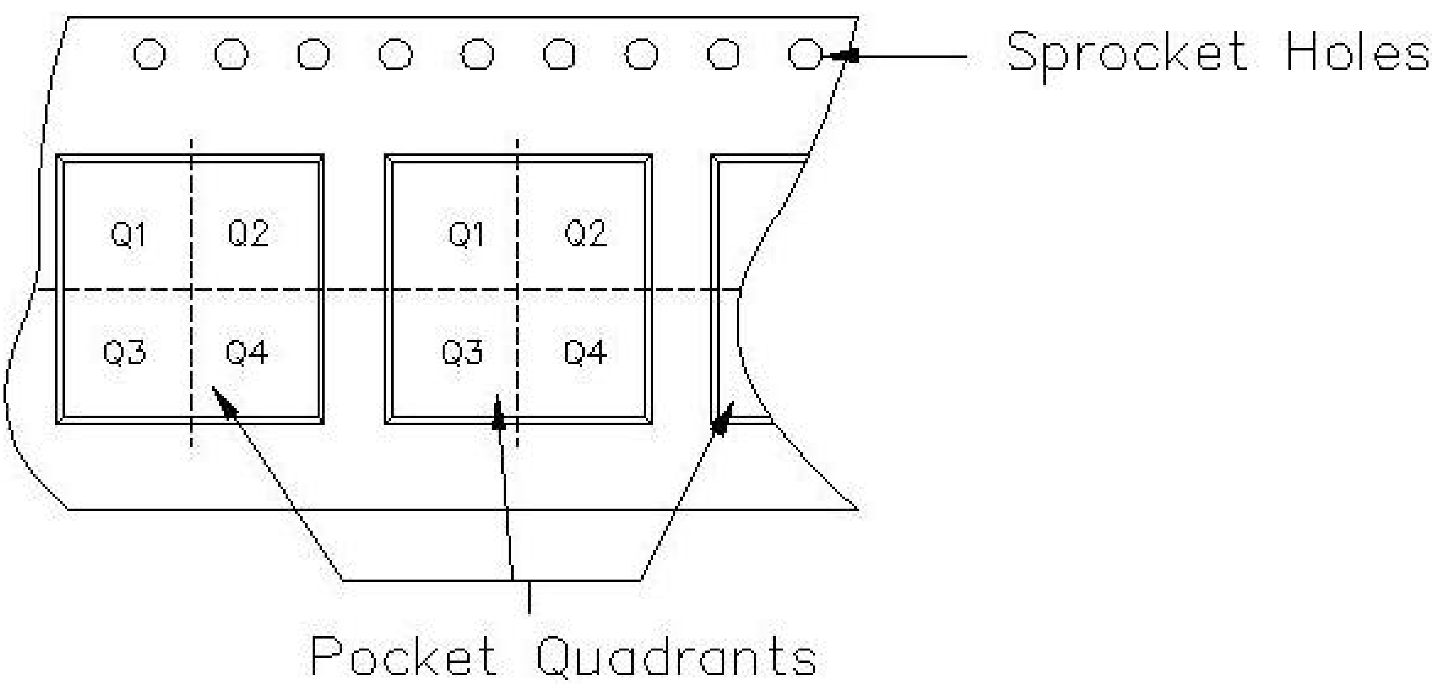


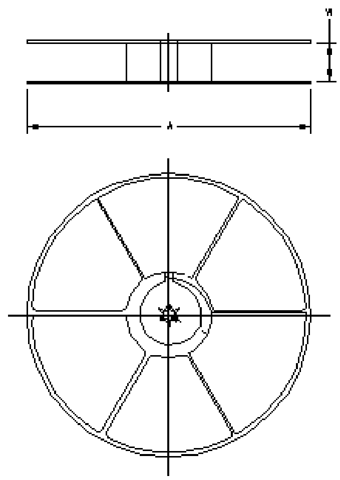
Carrier tape design is defined largely by the component lentgh, width, and thickness.

Ao =	Dimension designed to accommodate the component width.
Bo =	Dimension designed to accommodate the component length.
Ko =	Dimension designed to accommodate the component thickness.
W =	Overall width of the carrier tape.
P =	Pitch between successive cavity centers.



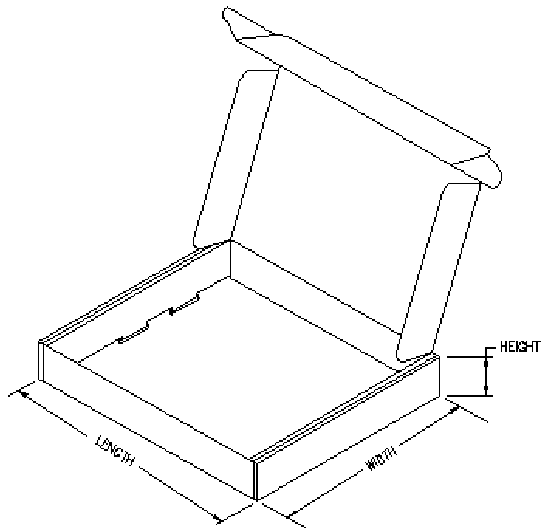
TAPE AND REEL INFORMATION

Device	Package	Pins	Site	Reel Diameter (mm)	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
OPA2340EA/2K5	DGK	8	HNT	330	8	5.3	3.4	1.4	8	12	Q1
OPA2340UA/2K5	D	8	MLA	330	12	6.4	5.2	2.1	8	12	Q1
OPA340NA/250	DBV	5	NSE	177	8	3.2	3.2	1.4	4	8	NONE
OPA340NA/3K	DBV	5	NSE	177	8	3.2	3.2	1.4	4	8	NONE

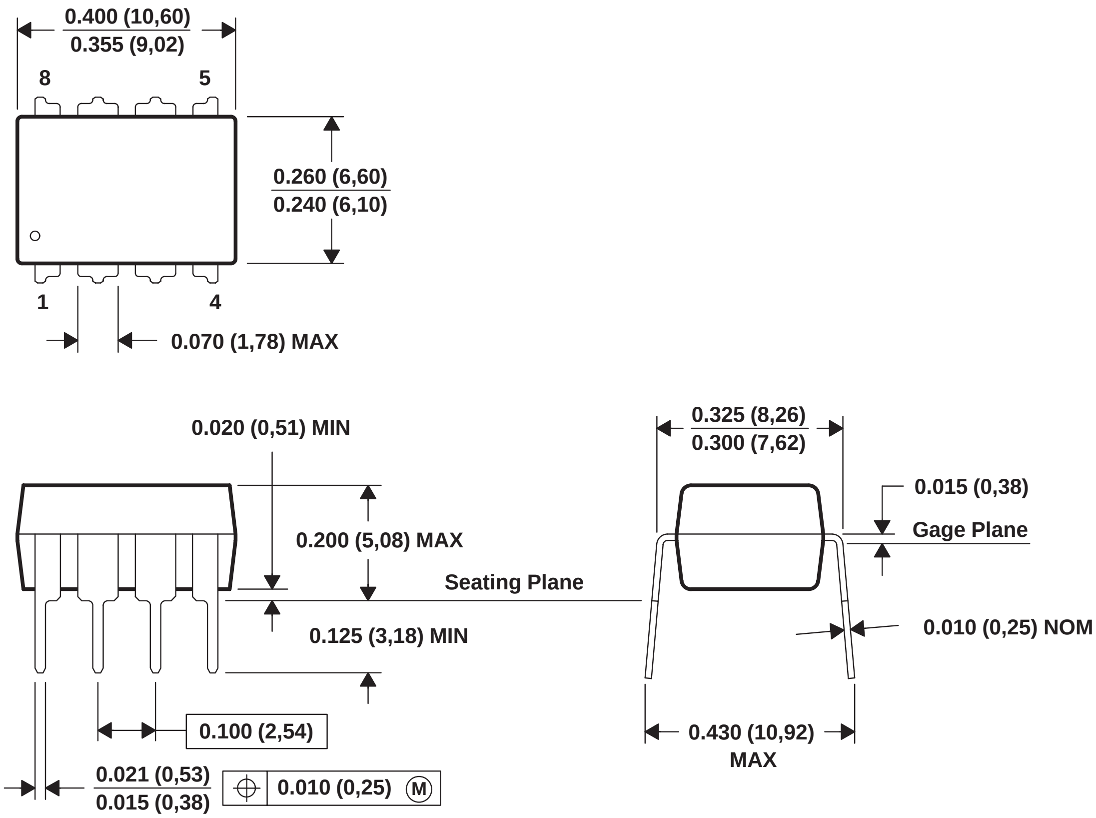


TAPE AND REEL BOX INFORMATION

Device	Package	Pins	Site	Length (mm)	Width (mm)	Height (mm)
OPA2340EA/2K5	DGK	8	HNT	358.0	335.0	35.0
OPA2340UA/2K5	D	8	MLA	346.0	346.0	29.0
OPA340NA/250	DBV	5	NSE	195.0	200.0	45.0
OPA340NA/3K	DBV	5	NSE	195.0	200.0	45.0


HEIGHT
LENGTH
WIDTH

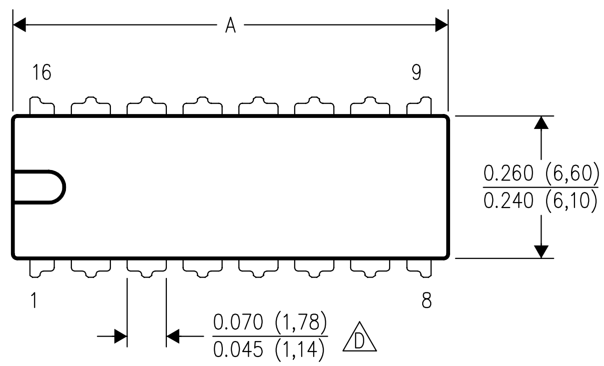
P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE**



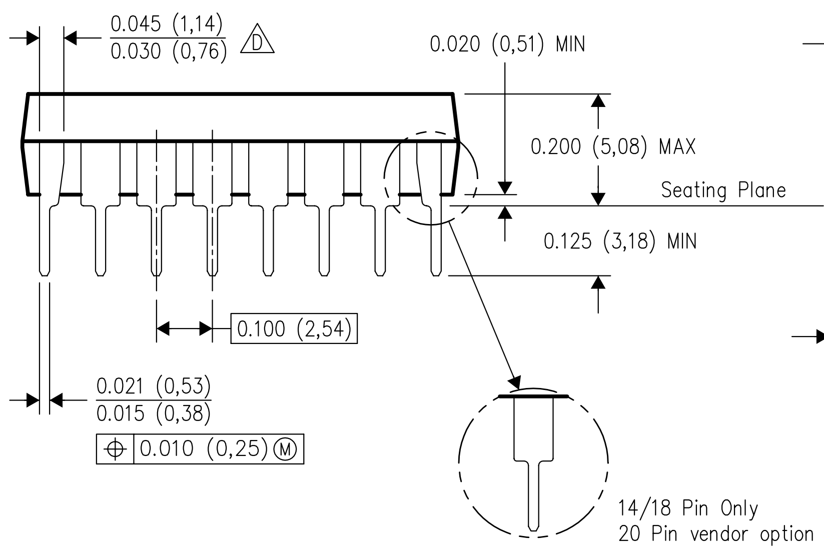
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

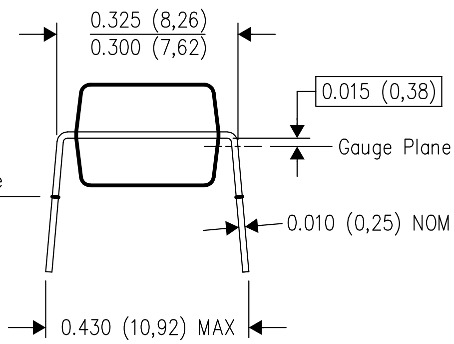
N (R–PDIP–T**) PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



PINS ** / DIM	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)
(C) MS–001 VARIATION	AA	BB	AC	AD





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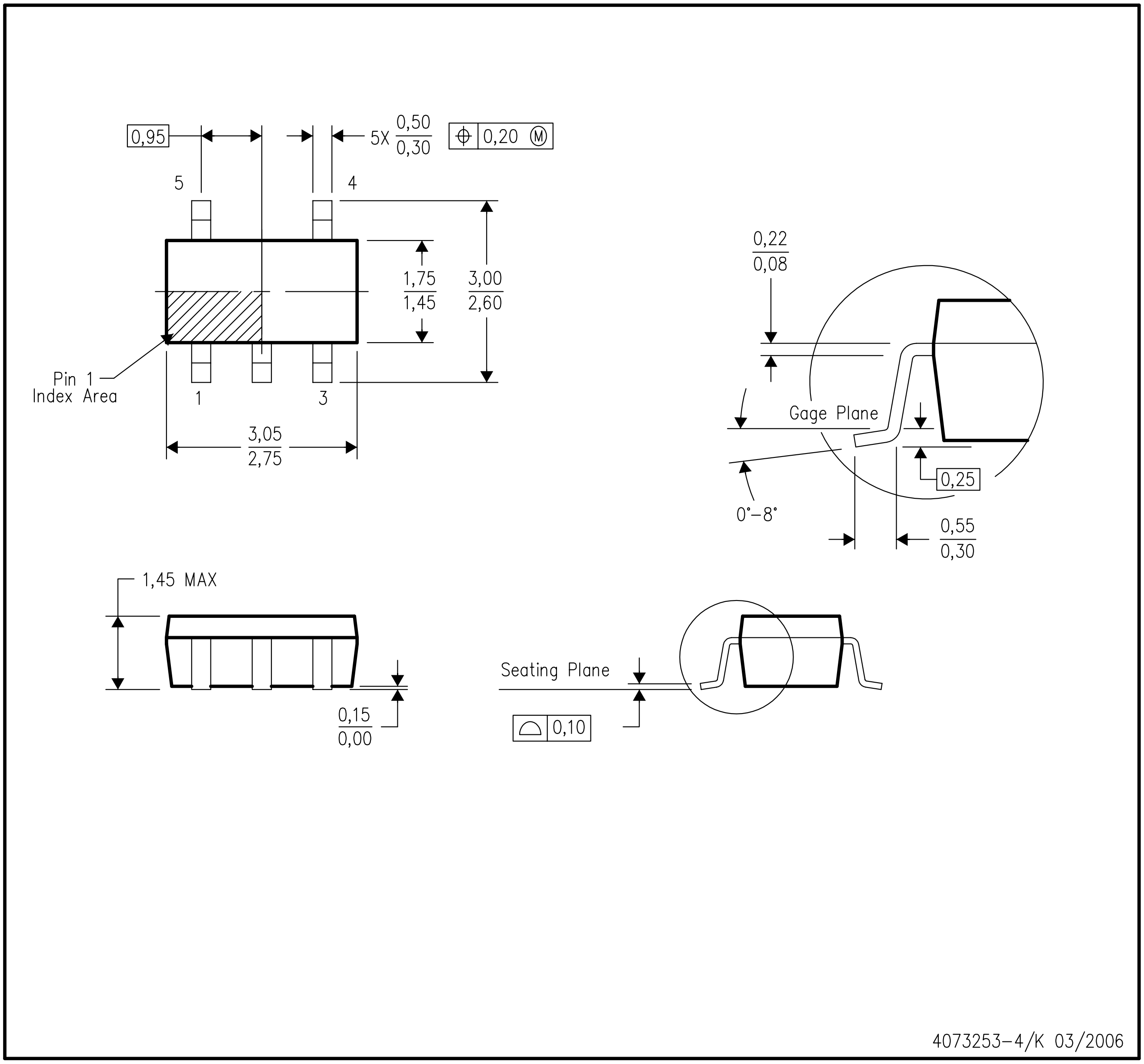
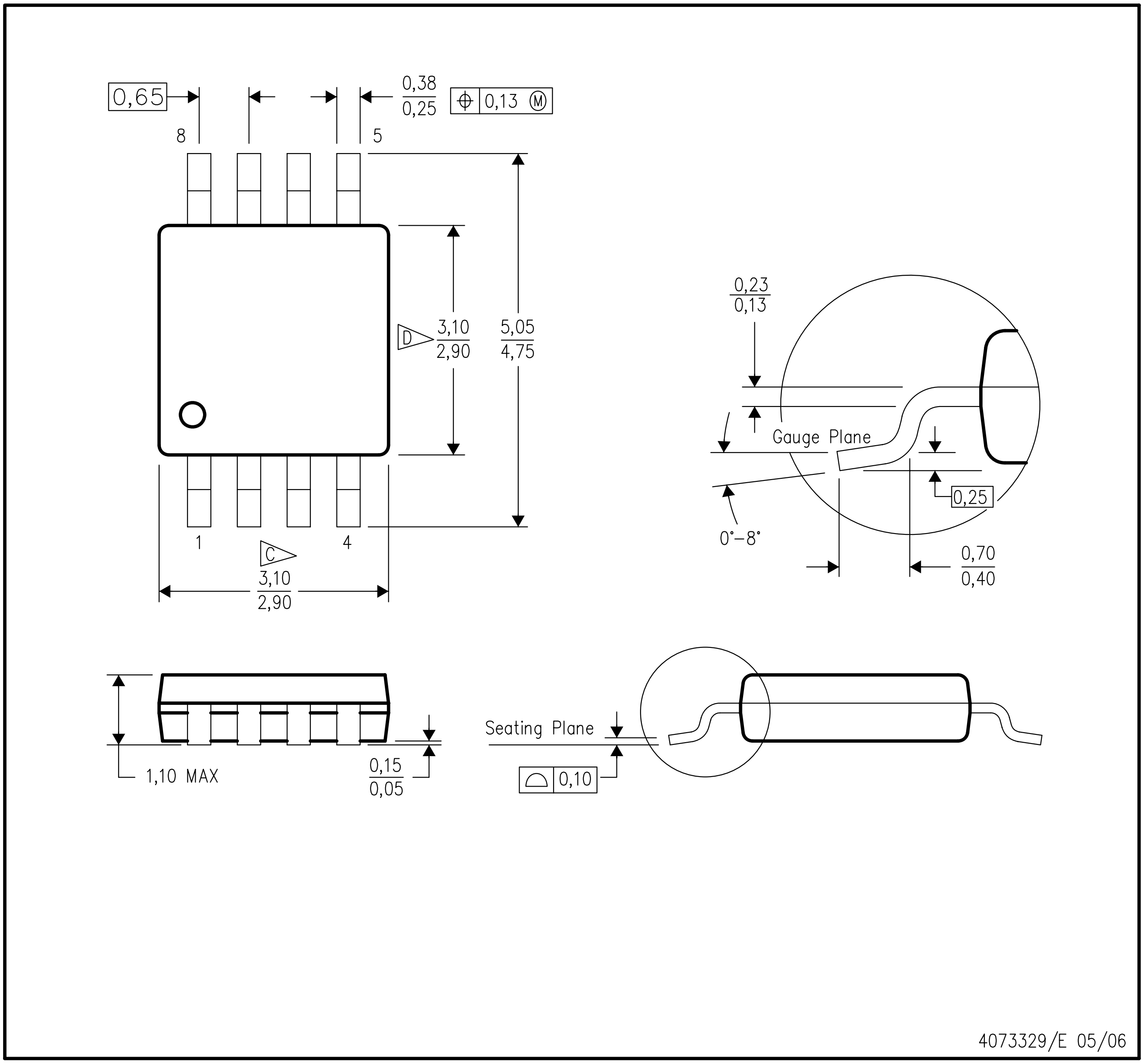
NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- (C) Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
- (D) The 20 pin end lead shoulder width is a vendor option, either half or full width.

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



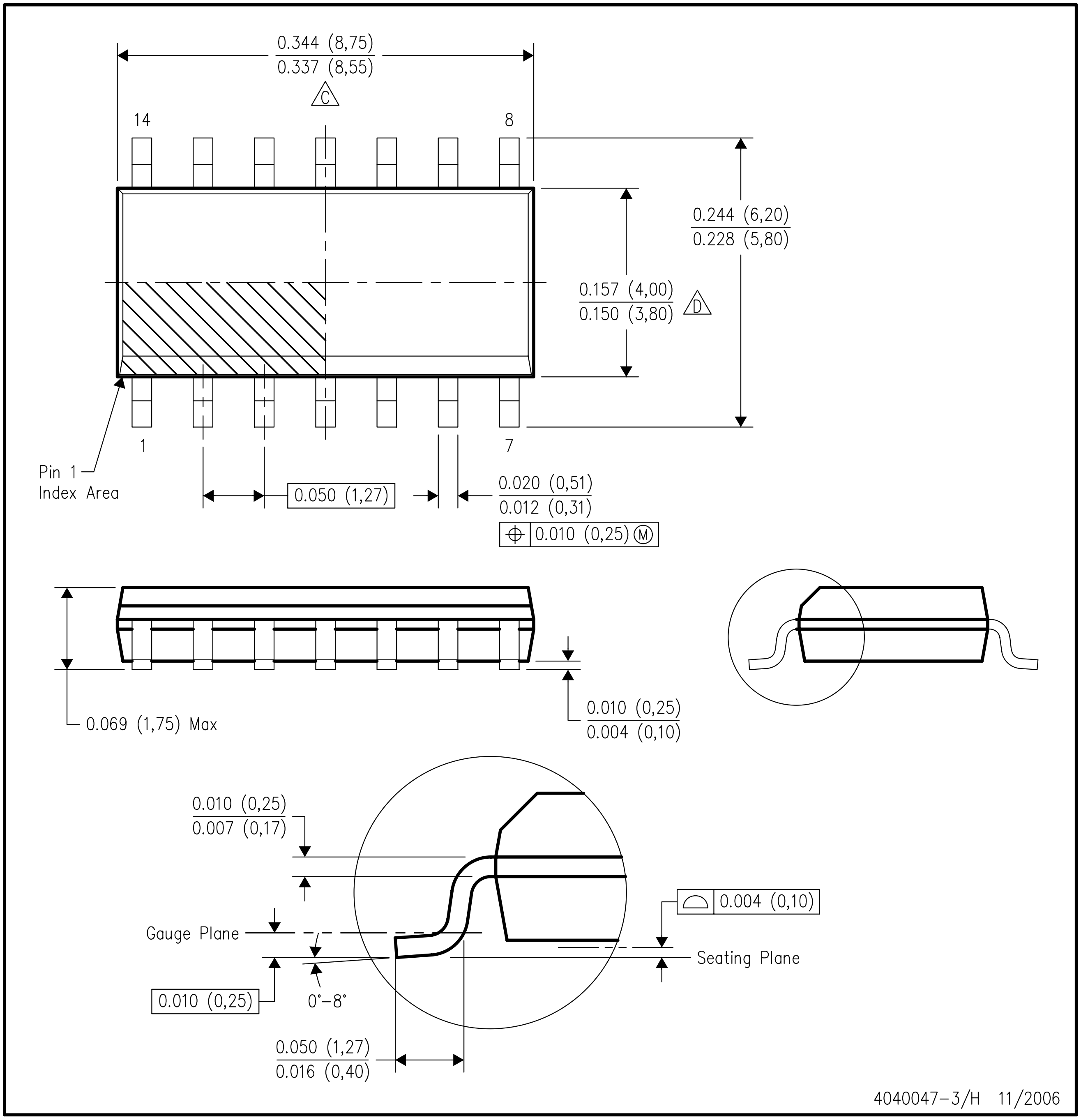
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO-178 Variation AA.

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



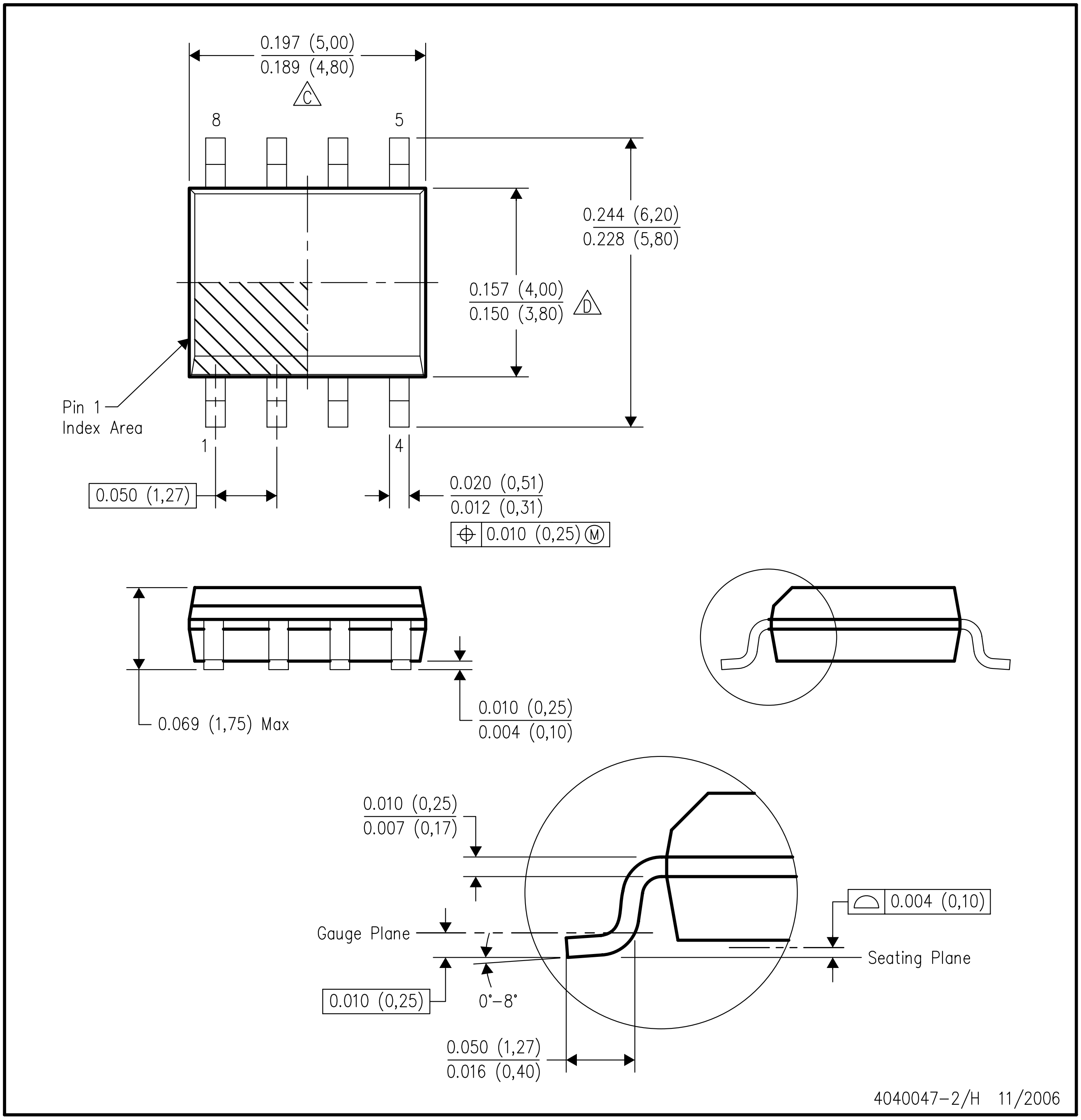
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
E. Falls within JEDEC MO-187 variation AA, except interlead flash.

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



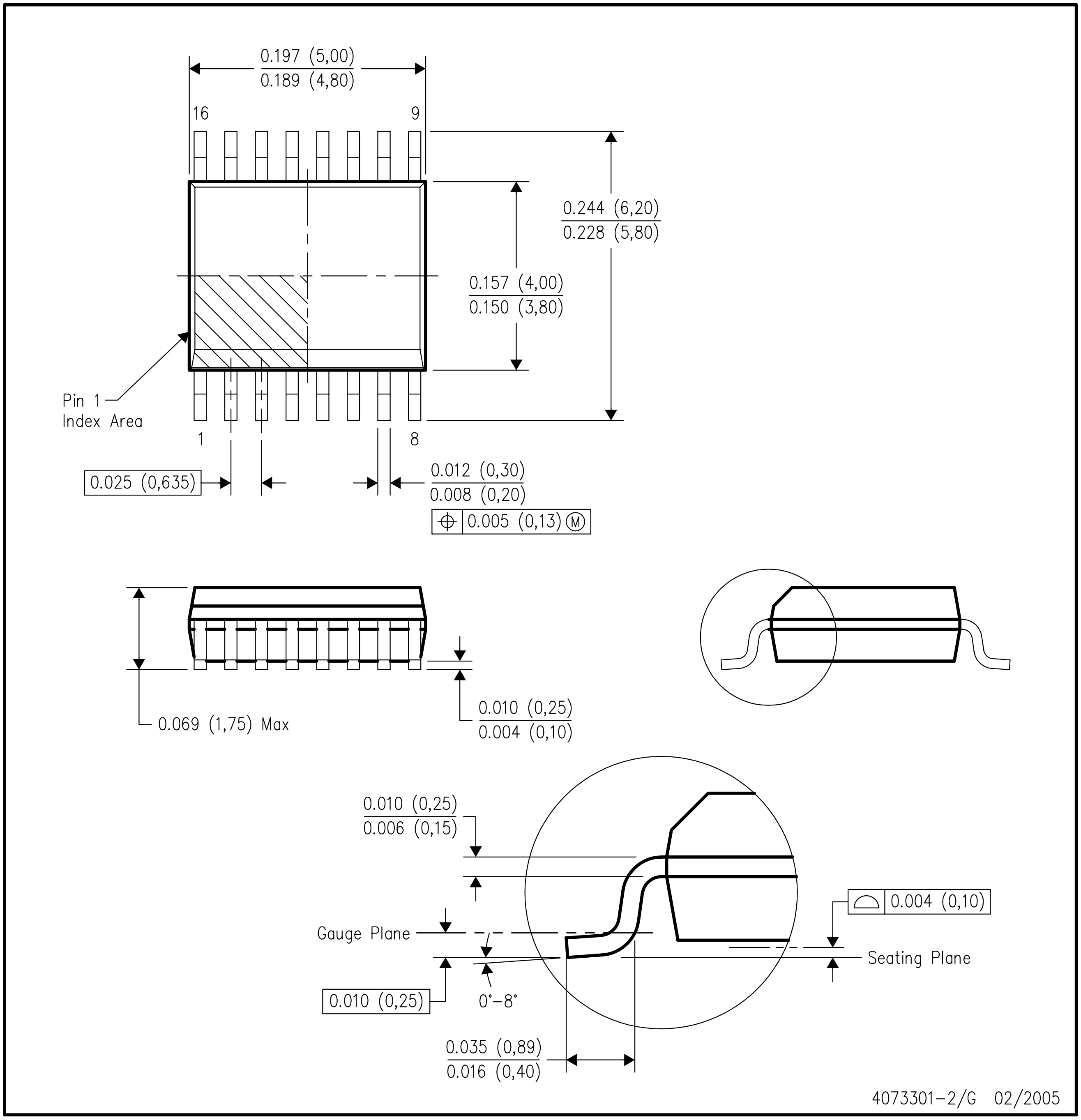
NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
- D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
- E. Reference 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 length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
- D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
- E. Reference 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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