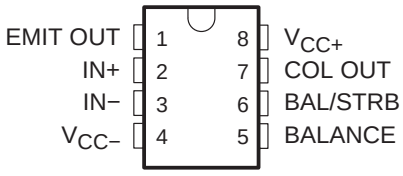
- **Low Power Drain . . . 900 μW Typical With 5-V Supply**
- **Operates From ±15 V or From a Single Supply as Low as 3 V**
- **Output Drive Capability of 25 mA**
- **Emitter Output Can Swing Below Negative Supply**
- **Response Time . . . 1.2 μs Typ**
- **Low Input Currents:**
  Offset Current . . . 2 nA Typ
  Bias Current . . . 15 nA Typ
- **Wide Common-Mode Input Range:**
  −14.5 V to 13.5 V Using ±15-V Supply
- **Offset Balancing and Strobe Capability**
- **Same Pinout as LM211, LM311**
- **Designed To Be Interchangeable With Industry-Standard LP311**

LP211 . . . D PACKAGE
LP311 . . . D, P, OR PS PACKAGE
(TOP VIEW)



description/ordering information

The LP211 and LP311 devices are low-power versions of the industry-standard LM211 and LM311 devices. They take advantage of stable, high-value, ion-implanted resistors to perform the same function as the LM311 series, with a 30:1 reduction in power consumption, but only a 6:1 slowdown in response time. They are well suited for battery-powered applications and all other applications where fast response times are not needed. They operate over a wide range of supply voltages, from ±18 V down to a single 3-V supply with less than 300-μA current drain, but are still capable of driving a 25-mA load. The LP211 and LP311 are quite easy to apply free of oscillation if ordinary precautions are taken to minimize stray coupling from the output to either input or to the trim pins. In addition, offset balancing is available to minimize input offset voltage. Strobe capability also is provided to turn off the output (regardless of the inputs) by pulling the strobe pin low.

The LP211 is characterized for operation from −25°C to 85°C. The LP311 is characterized for operation from 0°C to 70°C.

ORDERING INFORMATION

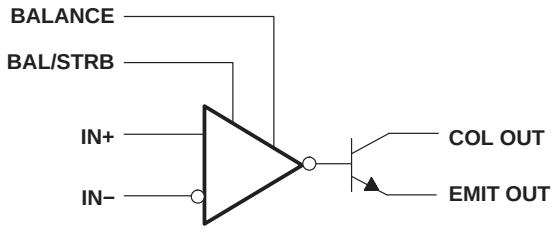
T_A	V_{IO} max AT 25°C	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−0°C to 70°C	7.5 mV	PDIP (P)	Tube of 50	LP311P	LP311P
		SOIC (D)	Tube of 75	LP311D	LP311
			Reel of 2500	LP311DR	
		SOP (PS)	Reel of 2000	LP311PSR	L311
−25°C to 85°C	7.5 mV	SOIC (D)	Tube of 75	LP211D	LP211
			Reel of 2500	LP211DR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

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.

Copyright © 2003, Texas Instruments Incorporated

functional block diagram



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage (see Note 1): V_{CC+} . . . . . 18 V
V_{CC-} . . . . . −18 V
Differential input voltage, V_{ID} (see Note 2) . . . . . ±30 V
Input voltage, V_I (either input, see Notes 1 and 3) . . . . . ±15 V
Voltage from emitter output to V_{CC-} . . . . . 30 V
Voltage from collector output to V_{CC-} . . . . . 40 V
Voltage from collector output to emitter output . . . . . 40 V
Duration of output short circuit (see Note 4) . . . . . 40 V
Package thermal impedance, θ_{JA} (see Notes 5 and 6): D package . . . . . 97°C/W
P package . . . . . 85°C/W
PS package . . . . . 95°C/W
Operating virtual junction temperature, T_J . . . . . 150°C
Storage temperature range, T_{stg} . . . . . −65°C to 150°C

† Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the recommended operating conditions section of this specification is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, unless otherwise noted, are with respect to the midpoint between V_{CC+} and V_{CC-}.
2. Differential input voltages are at IN+ with respect to IN−.
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage of ±15 V, whichever is less.
4. The output may be shorted to ground or to either power supply.
5. Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
6. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

		MIN	MAX	UNIT
($\lvert V_{CC\pm}\rvert \le 15$ V)	Input voltage	V_{CC-} + 0.5	V_{CC+} − 1.5	V
$V_{CC+} - V_{CC-}$	Supply voltage	3.5	30	V

electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP†	MAX	UNIT
V_{ID}	Input offset voltage	RS < 100 kΩ,	See Note 7	25°C		2	7.5	mV
				Full range			10	
V_{OL}	Low-level output voltage	V_{ID} < −10 mV, See Note 8	I_{OL} = 25 mA,	25°C		0.4	1.5	V
		V_{CC} = 4.5 V, V_{ID} < −10 mV, See Note 8	V_{CC-} = 0, I_{OL} = 1.6 mA,	Full range		0.1	0.4	
I_{IO}	Input offset current	See Note 7		25°C		2	25	nA
				Full range			35	
I_{IB}	Input bias current			25°C		15	100	nA
				Full range			150	
	Low-level strobe current	$V_{(strobe)}$ = 0.3 V, See Note 9	V_{ID} < −10 mV,	25°C		100	300	μA
$I_{O(off)}$	Output off-state current	V_{ID} > 10 mV,	V_{CE} = 35 V	25°C		0.2	100	nA
A_{VD}	Large-signal differential-voltage amplification	R_L = 5 kΩ		25°C	40	100		V/mV
I_{CC+}	Supply current from V_{CC+}	V_{ID} = −50 mV,	R_L = ∞	Full range		150	300	μA
I_{CC-}	Supply current from V_{CC-}	V_{ID} = 50 mV,	R_L = ∞	Full range		− 80	− 180	μA

† All typical values are at $V_{CC\pm}$ = ±15 V, T_A = 25°C.

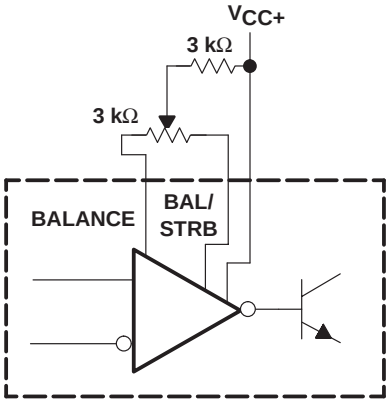
NOTES: 7. The offset voltages and offset currents given are the maximum values required to drive the output within 1 V of either supply with a 1-mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and input impedance.
8. Voltages are with respect to EMIT OUT and V_{CC-} tied together.
9. The strobe should not be shorted to ground; it should be current driven at 100 μA to 300 μA.

switching characteristics, $V_{CC\pm}$ = ±5 V, T_A = 25°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TYP	UNIT
Response time	See Note 10	1.2	μs

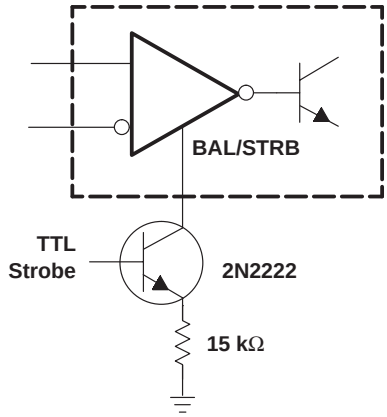
NOTE 10: The response time is specified for a 100-mV input step with 5-mV overdrive.

TYPICAL APPLICATION CIRCUIT



NOTE: If offset balancing is not used, the BALANCE and BAL/STRB pins should be shorted together.

Figure 1. Offset Balancing



NOTE: Do not connect strobe pin directly to ground, because the output is turned off whenever current is pulled from the strobe pin.

Figure 2. Strobing

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
Low Power Wireless	www.ti.com/lpw	Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2007, Texas Instruments Incorporated

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
LP211D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP211DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP211DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP211DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP211DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP211DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP211P	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
LP311D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP311DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP311DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP311DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP311DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP311DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP311P	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LP311PE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LP311PWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI

(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)

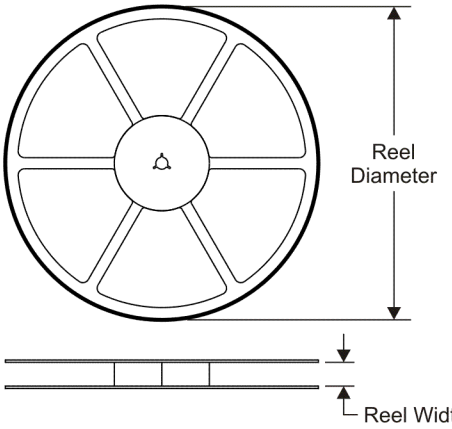
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

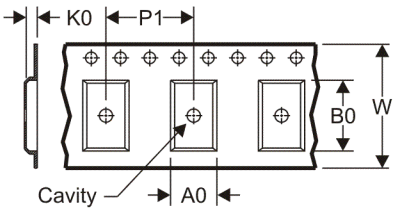
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

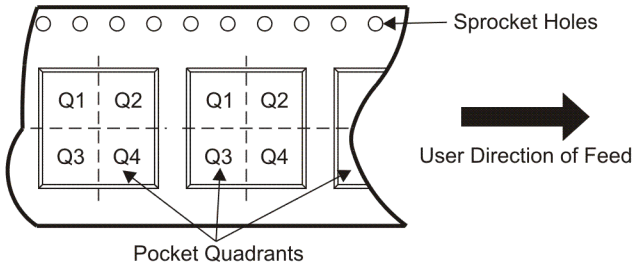


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

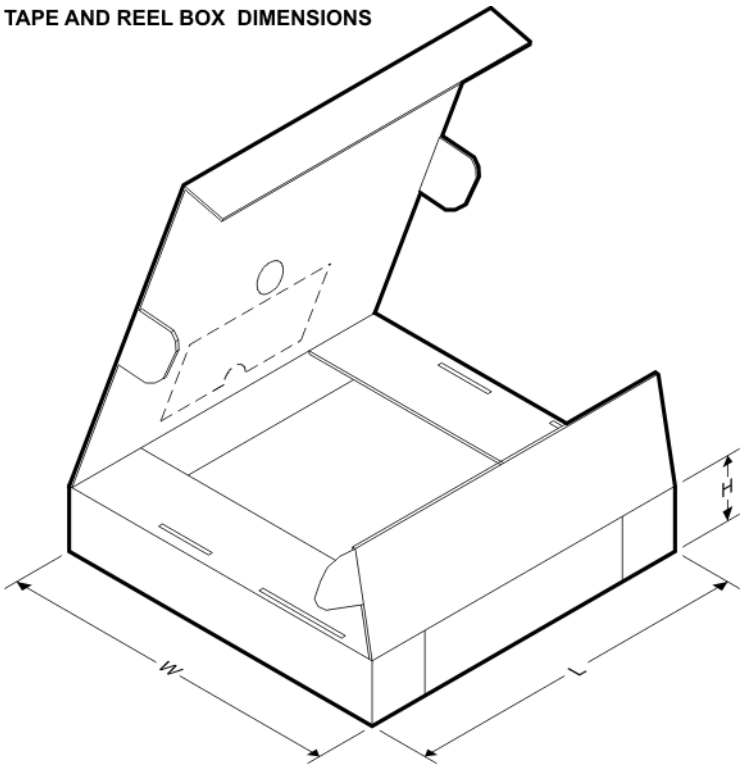
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LP211DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LP311DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

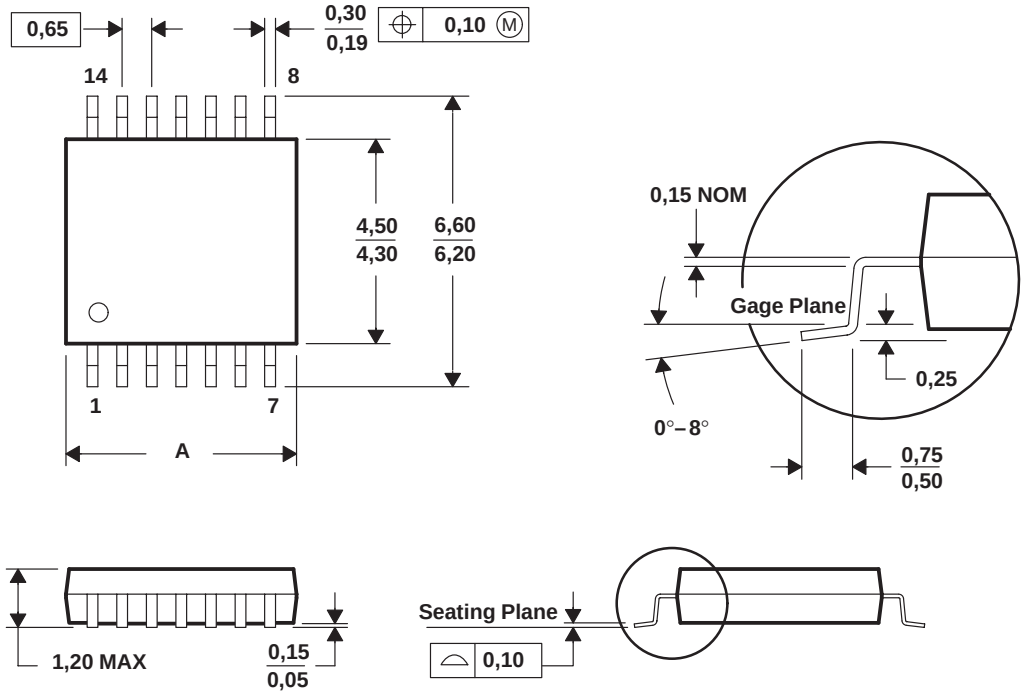


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LP211DR	SOIC	D	8	2500	340.5	338.1	20.6
LP311DR	SOIC	D	8	2500	340.5	338.1	20.6

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

14 PINS SHOWN

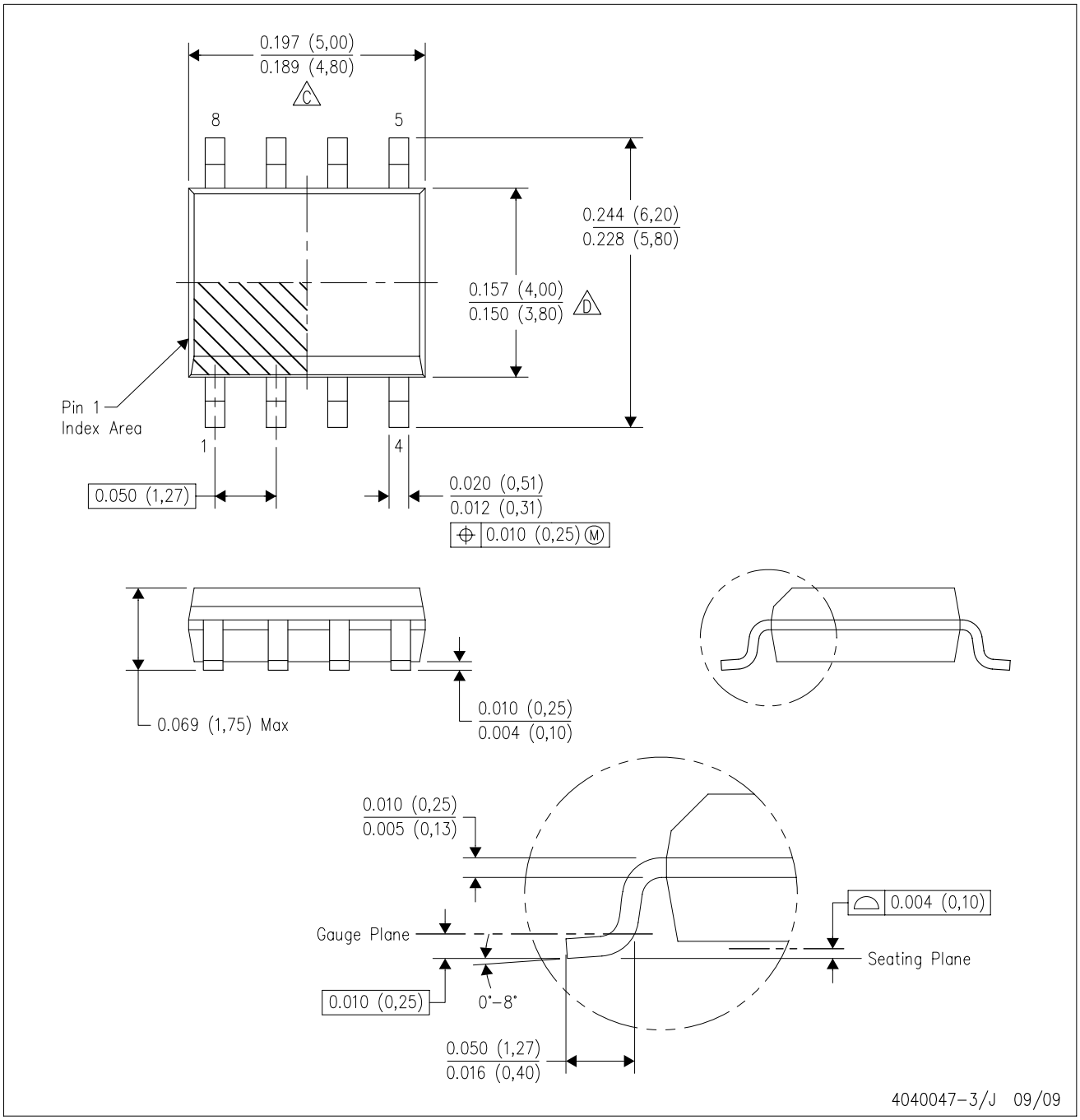


DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

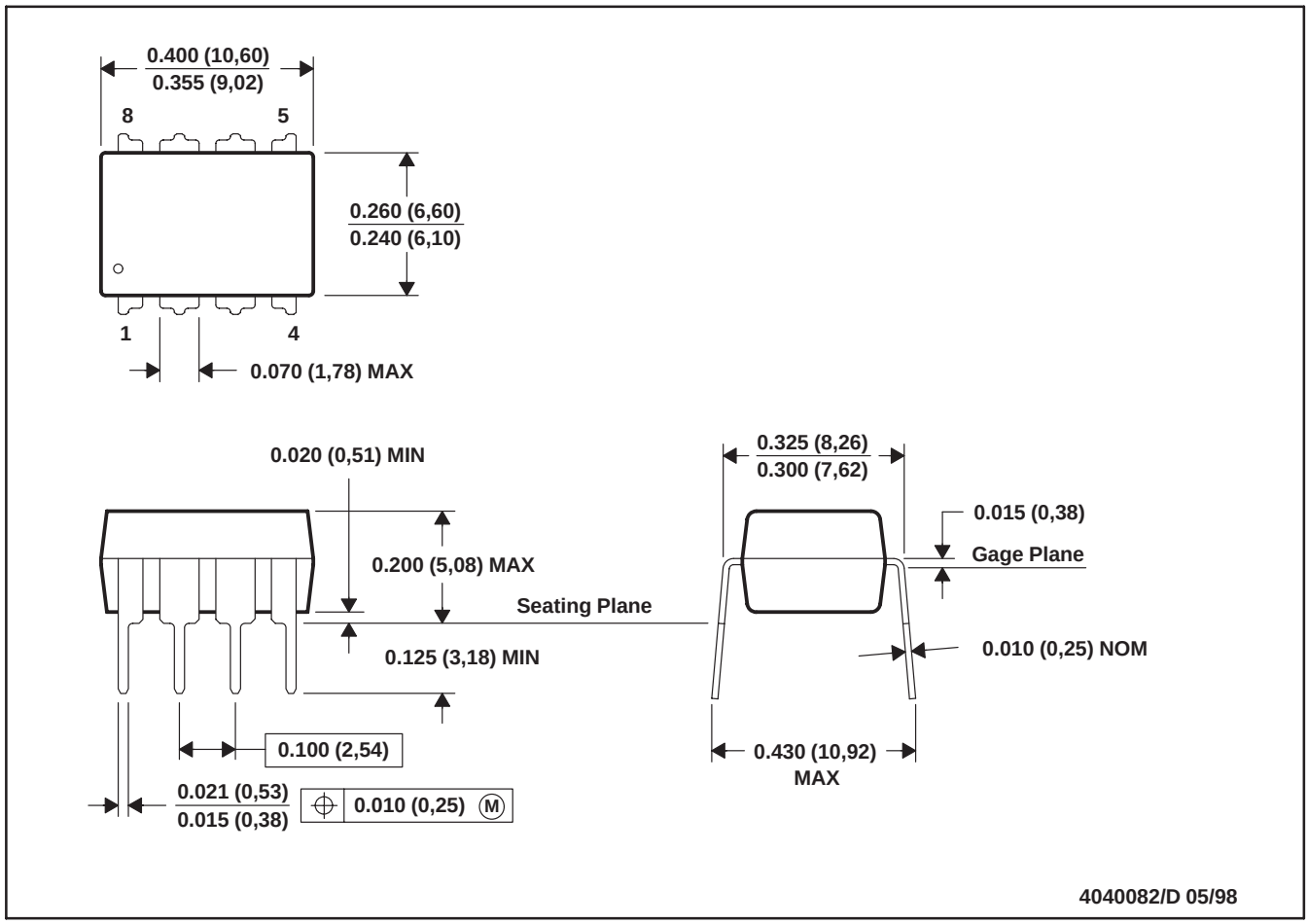
D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



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.

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