

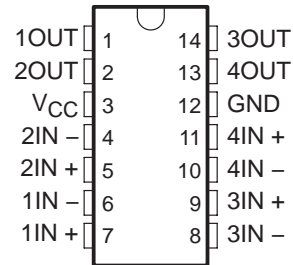
# LP239, LP339, LP2901 LOW-POWER QUAD DIFFERENTIAL COMPARATORS

SLCS004B – OCTOBER 1987 – REVISED SEPTEMBER 2004

The LP239 is obsolete  
and is no longer supplied.

- Wide Supply-Voltage Range . . . 3 V to 30 V
- Ultralow Power Supply Current Drain . . . 60  $\mu$ A Typ
- Low Input Biasing Current . . . 3 nA
- Low Input Offset Current . . .  $\pm 0.5$  nA
- Low Input Offset Voltage . . .  $\pm 2$  mV
- Common-Mode Input Voltage Includes Ground
- Output Voltage Compatible With MOS and CMOS Logic
- High Output Sink-Current Capability (30 mA at  $V_O = 2V$ )
- Power Supply Input Reverse-Voltage Protected
- Single-Power-Supply Operation
- Pin-for-Pin Compatible With LM239, LM339, LM2901

D OR N PACKAGE  
(TOP VIEW)



## description/ordering information

The LP239, LP339, LP2901 are low-power quadruple differential comparators. Each device consists of four independent voltage comparators designed specifically to operate from a single power supply and typically to draw 60- $\mu$ A drain current over a wide range of voltages. Operation from split power supplies also is possible and the ultra-low power-supply drain current is independent of the power-supply voltage.

Applications include limit comparators, simple analog-to-digital converters, pulse generators, squarewave generators, time-delay generators, voltage-controlled oscillators, multivibrators, and high-voltage logic gates. The LP239, LP339, LP2901 were designed specifically to interface with the CMOS logic family. The ultra-low power-supply current makes these products desirable in battery-powered applications.

The LP239 is characterized for operation from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LP339 is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The LP2901 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

## ORDERING INFORMATION

$T_A$	$V_{IO\text{MAX}}$ AT $25^{\circ}\text{C}$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
$0^{\circ}\text{C}$ to $70^{\circ}\text{C}$	$\pm 5$ mV	PDIP (N)	Tube of 25	LP339N	LP339N
		SOIC (D)	Tube of 50	LP339D	
			Reel of 2500	LP339DR	LP339
$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$	$\pm 5$ mV	PDIP (N)	Tube of 25	LP2901N	LP2901N
		SOIC (D)	Tube of 50	LP2901D	LP2901
			Reel of 2500	LP2901DR	

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



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.

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.

 **TEXAS  
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

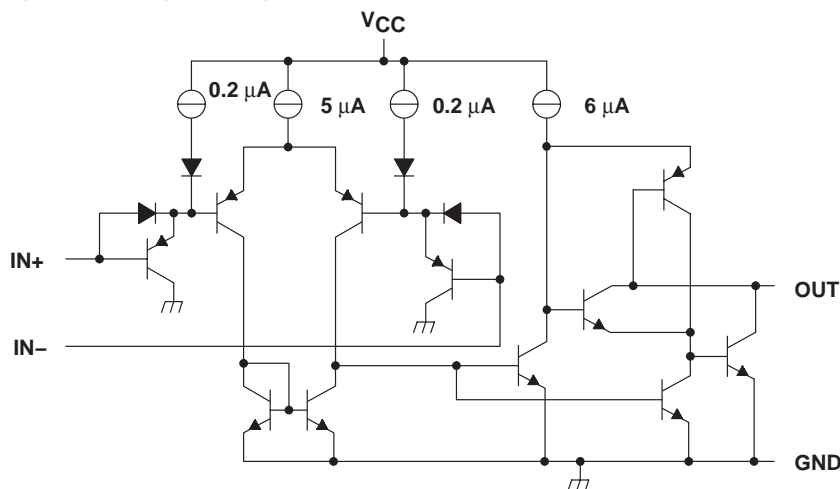
Copyright © 2004, Texas Instruments Incorporated

# LP239, LP339, LP2901 LOW-POWER QUAD DIFFERENTIAL COMPARATORS

The LP239 is obsolete  
and is no longer supplied.

SLCS004B – OCTOBER 1987 – REVISED SEPTEMBER 2004

## schematic diagram (each comparator)



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

Supply voltage, $V_{CC}$ (see Note 1)	36 V
Differential input voltage, $V_{ID}$ (see Note 2)	$\pm 36$ V
Input voltage range, $V_I$ (either input)	-0.3 V to 36 V
Input current, $V_I \leq -0.3$ V (see Note 3)	-50 mA
Duration of output short-circuit to ground (see Note 4)	Unlimited
Continuous total dissipation (see Note 5)	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : LP239	-25°C to 85°C
LP339	0°C to 70°C
LP2901	-40°C to 85°C
Package thermal impedance, $\theta_{JA}$ (see Notes 6 and 7): D package	86°C/W
N package	80°C/W
Operating virtual junction temperature, $T_J$	150°C
Lead temperature range 1,6 mm (1/16 inch) from case for 60 seconds: J package	300°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 is not implied.

Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
- All voltage values, except differential voltages, are with respect to the network ground.
  - Differential voltages are at IN+ with respect to IN-.
  - This input current only exists when the voltage at any of the inputs is driven negative. The current flows through the collector-base junction of the input clamping device. In addition to the clamping device action, there is lateral n-p-n parasitic transistor action. This action is not destructive, and normal output states are reestablished when the input voltage returns to a value more positive than -0.3 V at  $T_A = 25^\circ\text{C}$ .
  - Short circuits between outputs to  $V_{CC}$  can cause excessive heating and eventual destruction.
  - If the output transistors are allowed to saturate, the low-bias dissipation and the on-off characteristics of the outputs keep the dissipation very small (usually less than 100 mW).
  - Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can impact reliability.
  - The package thermal impedance is calculated in accordance with JESD 51-7.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING
J	1025 mW	8.2 mW/°C	656 mW	533 mW



# LP239, LP339, LP2901 LOW-POWER QUAD DIFFERENTIAL COMPARATORS

The LP239 is obsolete  
and is no longer supplied.

SLCS004B – OCTOBER 1987 – REVISED SEPTEMBER 2004

## recommended operating conditions

		LP239		LP339		LP2901		UNIT	
		MIN	MAX	MIN	MAX	MIN	MAX		
$V_{CC}$	Supply voltage	3	30	3	30	3	30	V	
$V_{IC}$	Common-mode input voltage	$V_{CC} = 5\text{ V}$	0	3	0	3	0	3	V
		$V_{CC} = 30\text{ V}$	0	28	0	28	0	28	V
$V_I$	Input voltage	$V_{CC} = 5\text{ V}$	0	3	0	3	0	3	V
		$V_{CC} = 30\text{ V}$	0	28	0	28	0	28	V
$T_A$	Operating free-air temperature	-25	85	0	70	-40	85	°C	

## electrical characteristics, $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		$T_A^\dagger$	MIN	TYP	MAX	UNIT		
$V_{IO}$	Input offset voltage	$V_{CC} = 5\text{ V to } 30\text{ V}$ , $R_S = 0$ ,	$V_O = 2\text{ V}$ , See Note 6	25°C	$\pm 2$	$\pm 5$	mV		
				Full range		$\pm 9$			
$I_{IO}$	Input offset current			25°C	$\pm 0.5$	$\pm 5$	nA		
				Full range	$\pm 1$	$\pm 15$			
$I_{IB}$	Input bias current	See Note 7		25°C	-2.5	-25	nA		
				Full range	-4	-40			
$V_{ICR}$	Common-mode input voltage range	Single supply		25°C	0 to $V_{CC} - 1.5$		V		
				Full range	0 to $V_{CC} - 2$				
$A_{VD}$	Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$ ,	$R_L = 15\text{ k}\Omega$		500		V/mV		
	Output sink current	$V_{I-} = 1\text{ V}$ , $V_{I+} = 0$	$V_O = 2\text{ V}$ , See Note 8	25°C	20	30	mA		
				Full range	15				
				$V_O = 0.4\text{ V}$	25°C	0.2		0.7	
	Output leakage current	$V_{I+} = 1\text{ V}$ , $V_{I-} = 0$	$V_O = 5\text{ V}$	25°C		0.1	nA		
				Full range	$V_O = 30\text{ V}$			1	$\mu\text{A}$
$V_{ID}$	Differential input voltage	$V_I \leq 0$ (or $V_{CC-}$ on split supplies)				36	V		
$I_{CC}$	Supply current	$R_L = \infty$ all comparators			60	100	$\mu\text{A}$		

$^\dagger$  Full range is  $-25^\circ\text{C}$  to  $85^\circ\text{C}$  for the LP239,  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for the LP339, and  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for the LP2901.

NOTES: 8.  $V_{IO}$  is measured over the full common-mode input voltage range.

9. Because of the p-n-p input stage, the direction of the current is out of the device. This current essentially is constant (i.e., independent of the output state). No loading change exists on the reference or input lines as long as the common-mode input voltage range is not exceeded.

10. The output sink current is a function of the output voltage. These devices have a bimodal output section that allows them to sink (via a Darlington connection) large currents at output voltages greater than 1.5 V, and smaller currents at output voltages less than 1.5 V.

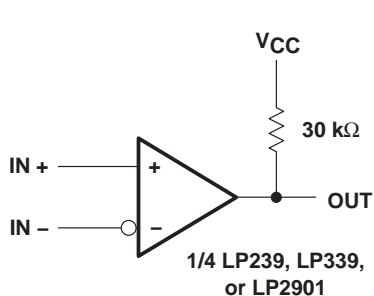
## switching characteristics, $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$ , $R_L$ connected to 5 V through 5.1 k $\Omega$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Large-signal response time	TTL logic swing, $V_{Ref} = 1.4\text{ V}$		1.3		$\mu\text{s}$
Response time			8		

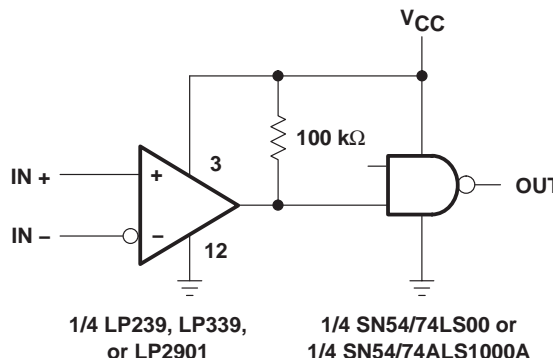


**APPLICATION INFORMATION**

Figure 1 shows the basic configuration for using the LP239, LP339, or LP2901 comparator. Figure 2 shows the diagram for using one of these comparators as a CMOS driver.



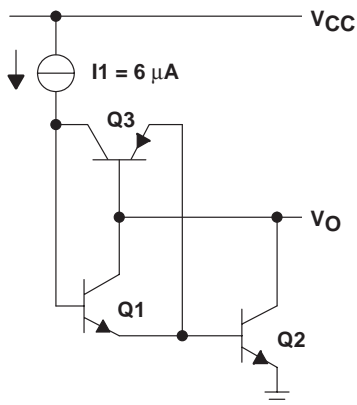
**Figure 1. Basic Comparator**



**Figure 2. CMOS Driver**

All pins of any unused comparators should be grounded. The bias network of the LP239, LP339, and LP2901 establishes a drain current that is independent of the magnitude of the power-supply voltage over the range of 2 V to 30 V. It usually is necessary to use a bypass capacitor across the power supply line.

The differential input voltage may be larger than  $V_{CC}$  without damaging the device. Protection should be provided to prevent the input voltages from going negative by more than  $-0.3$  V. The output section has two distinct modes of operation: a Darlington mode and ground-emitter mode. This unique drive circuit permits the device to sink 30 mA at  $V_O = 2$  V in the Darlington mode and 700  $\mu$ A at  $V_O = 0.4$  V in the ground-emitter mode. Figure 3 is a simplified schematic diagram of the output section. The output section is configured in a Darlington connection (ignoring Q3). If the output voltage is held high enough (above 1 V), Q1 is not saturated and the output current is limited only by the product of the  $h_{FE}$  of Q1, the  $h_{FE}$  of Q2, and I1 and the 60- $\Omega$  saturation resistance of Q2. The devices are capable of driving LEDs, relays, etc. in this mode while maintaining an ultra-low power-supply current of 60  $\mu$ A, typically.



**Figure 3. Output-Section Schematic Diagram**

The LP239 is obsolete  
and is no longer supplied.

---

### APPLICATION INFORMATION

Without transistor Q3, if the output voltage were allowed to drop below 0.8 V, transistor Q1 would saturate, and the output current would drop to zero. The circuit would be unable to pull low current loads down to ground or the negative supply, if used. Transistor Q3 has been included to bypass transistor Q1 under these conditions and apply the current  $I_1$  directly to the base of Q2. The output sink current now is approximately  $I_1$  times the  $h_{FE}$  of Q2 (700  $\mu$ A at  $V_O = 0.4$  V). The output of the devices exhibits a bimodal characteristic, with a smooth transition between modes.

In both cases, the output is an uncommitted collector. Several outputs can be tied together to provide a dot logic function. An output pullup resistor can be connected to any available power-supply voltage within the permitted power-supply range, and there is no restriction on this voltage, based on the magnitude of the voltage that is supplied to  $V_{CC}$  of the package.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LP239D	OBSOLETE	SOIC	D	14		TBD	Call TI	Call TI	-25 to 85		
LP239N	OBSOLETE	PDIP	N	14		TBD	Call TI	Call TI	-25 to 85		
LP2901D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2901	<a href="#">Samples</a>
LP2901DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2901	<a href="#">Samples</a>
LP2901DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2901	<a href="#">Samples</a>
LP2901DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2901	<a href="#">Samples</a>
LP2901DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2901	<a href="#">Samples</a>
LP2901DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LP2901	<a href="#">Samples</a>
LP2901N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	LP2901N	<a href="#">Samples</a>
LP2901NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	LP2901N	<a href="#">Samples</a>
LP339D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP339	<a href="#">Samples</a>
LP339DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP339	<a href="#">Samples</a>
LP339DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP339	<a href="#">Samples</a>
LP339DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP339	<a href="#">Samples</a>
LP339DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP339	<a href="#">Samples</a>
LP339DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LP339	<a href="#">Samples</a>
LP339N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	LP339N	<a href="#">Samples</a>
LP339NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	LP339N	<a href="#">Samples</a>

(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.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

**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.

#### **OTHER QUALIFIED VERSIONS OF LP2901 :**

- Automotive: [LP2901-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## TAPE AND REEL INFORMATION



### 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
LP2901DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LP2901DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LP339DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LP339DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LP339DRG4	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1



**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LP2901DR	SOIC	D	14	2500	333.2	345.9	28.6
LP2901DR	SOIC	D	14	2500	367.0	367.0	38.0
LP339DR	SOIC	D	14	2500	367.0	367.0	38.0
LP339DR	SOIC	D	14	2500	333.2	345.9	28.6
LP339DRG4	SOIC	D	14	2500	333.2	345.9	28.6

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

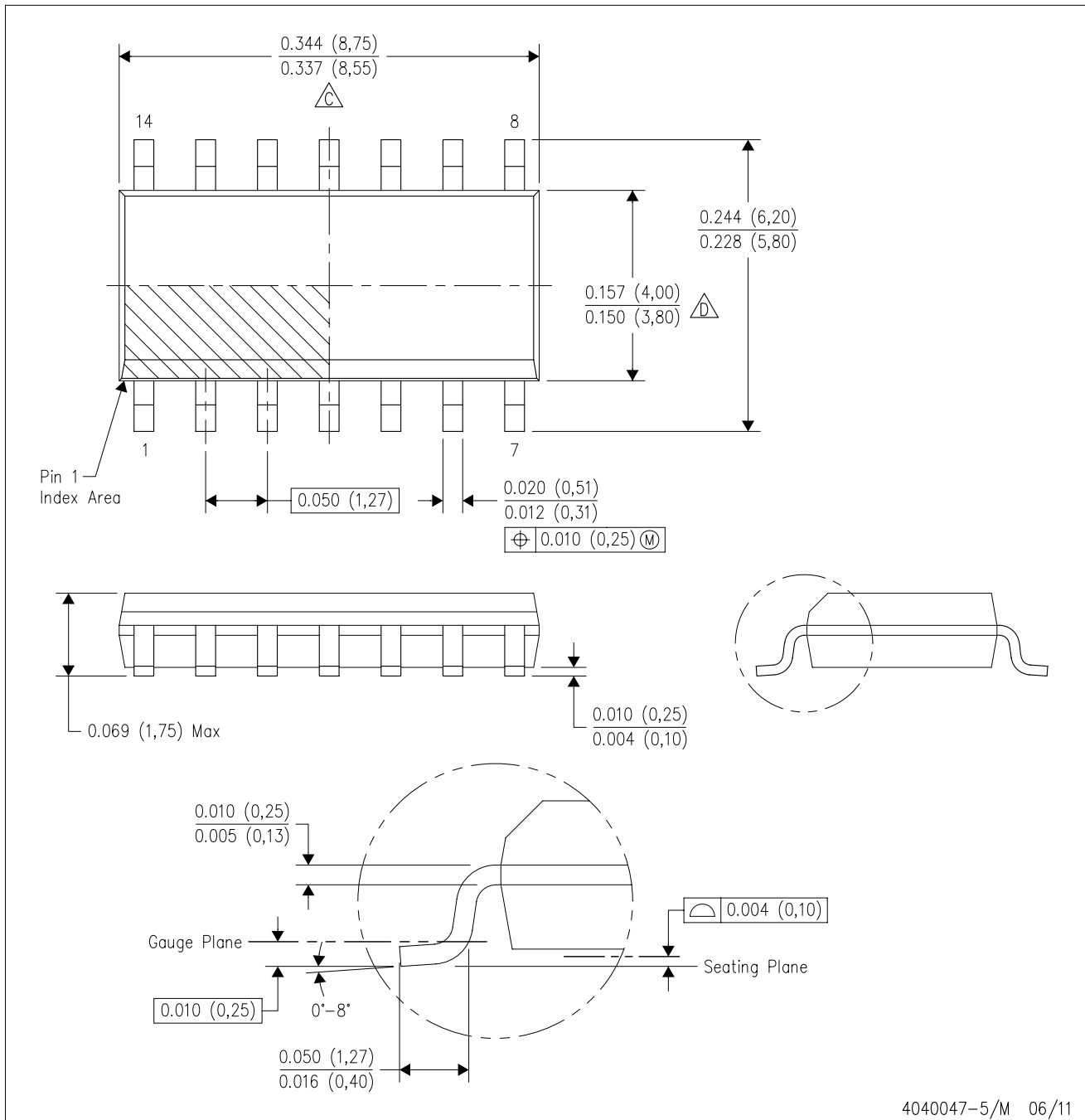


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - (C) Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - (D) The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  -  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AB.

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions of TI 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)