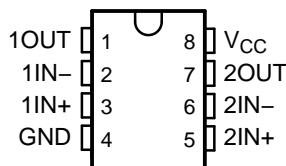


## FEATURES

- Low Supply Current . . . 85  $\mu$ A Typ
- Low Offset Voltage . . . 2 mV Typ
- Low Input Bias Current . . . 2 nA Typ
- Input Common Mode to GND
- Wide Supply Voltage . . . 3 V <  $V_{CC}$  < 32 V
- Pin Compatible With LM358

**D OR DGK PACKAGE  
(TOP VIEW)**



## APPLICATIONS

- LCD Displays
- Portable Instrumentation
- Sensor/Metering Equipment
- Consumer Electronics (MP3 Players, Toys)
- Power Supplies

## DESCRIPTION/ORDERING INFORMATION

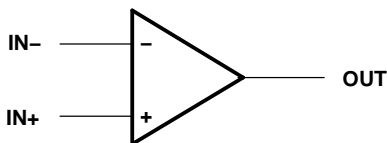
The LP358 and LP2904 are dual low-power operational amplifiers especially suited for battery-operated applications. Good input specifications and wide supply-voltage range still are achieved, despite the ultra-low supply current. Single-supply operation is achieved with an input common-mode range that includes GND.

The LP358 and LP2904 are ideal in applications where wide supply voltage and low power are more important than speed and bandwidth. These applications include portable instrumentation, LCD displays, consumer electronics (MP3 players, toys, etc.), and power supplies.

### ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SOIC – D	Tube of 75	LP358D	LP358
		Reel of 2500	LP358DR	
	VSSOP – DGK	Tube of 100	LP358DGK	PREVIEW
		Reel of 250	LP358DGKT	
–40°C to 85°C	SOIC – D	Tube of 100	LP358DGKR	PREVIEW
		Reel of 2500	LP358DGKRT	
	VSSOP – DGK	Tube of 100	LP2904D	PREVIEW
		Reel of 2500	LP2904DR	
–40°C to 85°C	SOIC – D	Tube of 100	LP2904DGK	PREVIEW
		Reel of 250	LP2904DGKT	
	VSSOP – DGK	Tube of 100	LP2904DGKR	PREVIEW
		Reel of 2500	LP2904DGKRT	

### SYMBOL (EACH AMPLIFIER)

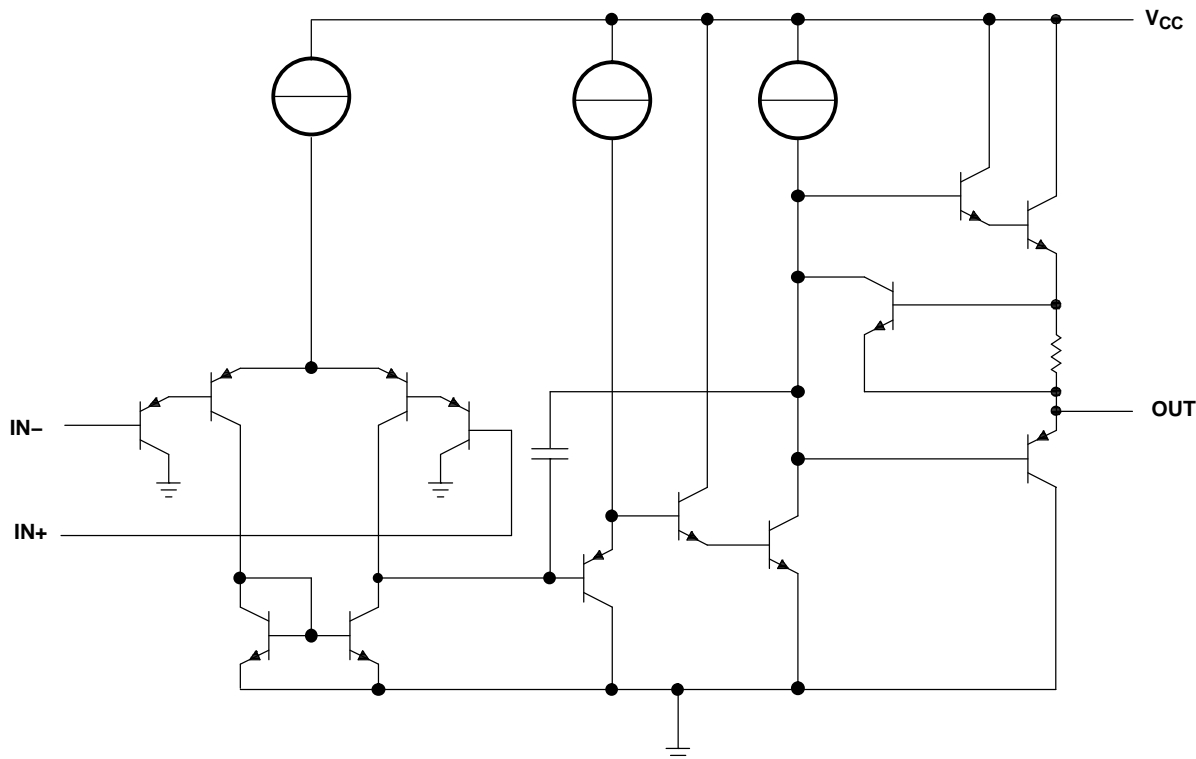


(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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.

SCHEMATIC (EACH AMPLIFIER)



## Absolute Maximum Ratings<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage range <sup>(2)</sup>		$\pm 16$ or 32	V
$V_{ID}$	Differential input voltage <sup>(3)</sup>		$\pm 32$	V
$V_I$	Input voltage (either input)	-0.3	32	V
Duration of output short circuit (one amplifier) to ground at (or below) $T_A = 25^\circ\text{C}$ , $V_{CC} \leq 15\text{ V}$ <sup>(4)</sup>			Unlimited	
$\theta_{JA}$	Package thermal impedance <sup>(5)(6)</sup>	D package		97
		DGK package		172
$T_J$	Operating virtual junction temperature		150	$^\circ\text{C}$
$T_{stg}$	Storage temperature range	-65	150	$^\circ\text{C}$

- (1) 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 under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values (except differential voltages and  $V_{CC}$  specified for the measurement of  $I_{OS}$ ) are with respect to the network GND.
- (3) Differential voltages are at IN+, with respect to IN-.
- (4) Short circuits from outputs to  $V_{CC}$  can cause excessive heating and eventual destruction.
- (5) 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  $150^\circ\text{C}$  can affect reliability.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

## ESD Protection

TEST CONDITIONS	TYP	UNIT
Human-Body Model	$\pm 2$	kV

## Electrical Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{IC} = V_{CC}/2$ ,  $R_L = 100\text{ k}\Omega$  to GND (unless otherwise noted)

PARAMETER		TEST CONDITIONS <sup>(1)</sup>	T <sub>A</sub> <sup>(2)</sup>	LP358			LP2904			UNIT
				MIN	TYP <sup>(3)</sup>	MAX	MIN	TYP <sup>(3)</sup>	MAX	
V <sub>IO</sub>	Input offset voltage		25°C		2	4		2	4	mV
			Full range			9		10		
I <sub>IB</sub>	Input bias current		25°C		2	10		2	20	nA
			Full range			20		40		
I <sub>IO</sub>	Input offset current		25°C		0.2	2		0.5	4	nA
			Full range			4		8		
A <sub>V</sub>	Large-signal voltage gain	R <sub>L</sub> = 10 kΩ to GND, V <sub>CC</sub> = 30 V	25°C		50	100		40	70	V/mV
			Full range		40			30		
CMRR	Common-mode rejection ratio	V <sub>CC</sub> = 30 V, V <sub>IC</sub> = 0 V to V <sub>CC</sub> – 1.5 V	25°C		80	90		80	90	dB
			Full range		75			75		
k <sub>VSR</sub>	Power-supply rejection ratio	V <sub>CC</sub> = 5 V to 30 V	25°C		80	90		80	90	V
			Full range		75			75		
I <sub>CC</sub>	Supply current	R <sub>L</sub> = ∞	25°C		85	150		85	150	μA
			Full range			250			275	
V <sub>OH</sub>	Output voltage swing (high)	I <sub>L</sub> = 0.35 mA to GND, V <sub>IC</sub> = 0 V	25°C		3.4	3.6		3.4	3.6	V
			Full range		V <sub>CC</sub> – 1.9			V <sub>CC</sub> – 1.9		
V <sub>OL</sub>	Output voltage swing (low)	I <sub>L</sub> = 0.35 mA from V <sub>CC</sub> , V <sub>IC</sub> = 0 V	25°C		0.82	0.7		0.82	0.7	V
			Full range		1			1		
I <sub>O</sub>	Output source current	V <sub>O</sub> = 3 V, V <sub>ID</sub> = 1 V	25°C		7	10		7	10	mA
			Full range		4			4		
I <sub>O</sub>	Output sink current	V <sub>O</sub> = 1.5 V, V <sub>ID</sub> = –1 V	25°C		4	5		4	5	mA
			Full range		3			3		
		V <sub>O</sub> = 1.5 V, V <sub>ID</sub> = –1 V, V <sub>IC</sub> = 0 V	25°C		2	4		2	4	
			Full range		1			1		
I <sub>OS,GND</sub>	Output short to GND	V <sub>ID</sub> = 1 V	25°C		20	35		20	35	mA
			Full range			40			40	
I <sub>OS,VCC</sub>	Output short to V <sub>CC</sub>	V <sub>ID</sub> = –1 V	25°C		15	30		15	30	mA
			Full range			45			45	
αV <sub>IO</sub>	Input offset voltage drift		25°C		10			10		μV/°C
αI <sub>IO</sub>	Input offset current drift		25°C		10			10		pA/°C

(1) For full-range temperature limits:  $V_{CC} = 3\text{ V}$  to  $32\text{ V}$ ,  $V_{ICR} = 0\text{ V}$  to  $V_{CC} - 1.5\text{ V}$  (unless otherwise noted)

(2) Full range is  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for LP358 and  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for LP2904.

(3) All typical values are at  $T_A = 25^\circ\text{C}$ .

## Operating Conditions

$V_{CC} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER		TYP	UNIT
GBW	Gain bandwidth product	100	kHz
SR	Slew rate	50	V/ms

## 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

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</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>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

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

## PACKAGING INFORMATION

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LP2904D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP2904DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP2904DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP2904DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP2904DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP358D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP358DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP358DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP358DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP358DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LP358DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

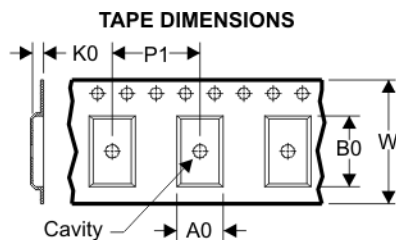
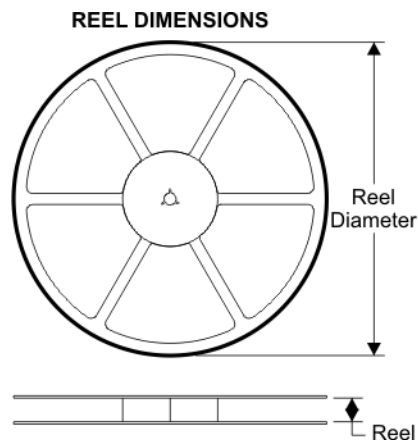
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**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

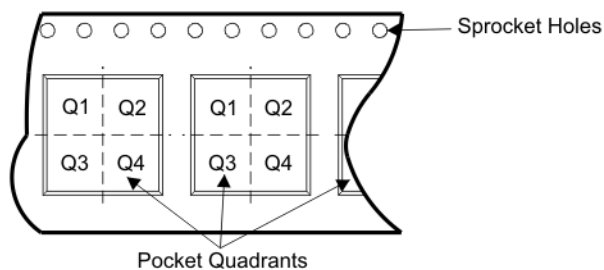
to Customer on an annual basis.

**TAPE AND REEL BOX INFORMATION**



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**



Device	Package	Pins	Site	Reel Diameter (mm)	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LP2904DR	D	8	SITE 27	330	12	6.4	5.2	2.1	8	12	Q1
LP358DR	D	8	SITE 27	330	12	6.4	5.2	2.1	8	12	Q1

## TAPE AND REEL BOX DIMENSIONS

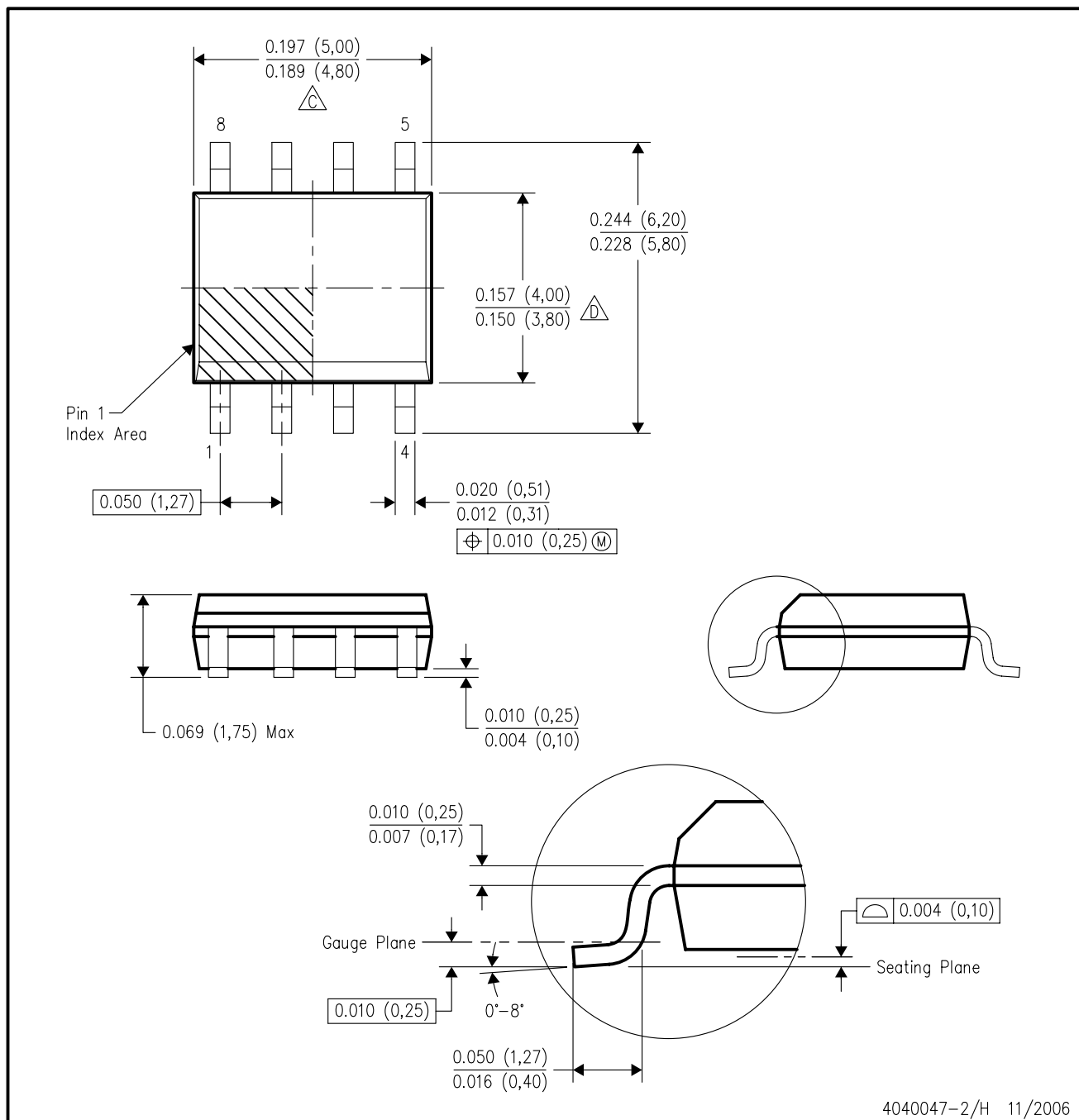




Device	Package	Pins	Site	Length (mm)	Width (mm)	Height (mm)
LP2904DR	D	8	SITE 27	342.9	336.6	20.64
LP358DR	D	8	SITE 27	342.9	336.6	20.64



## 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.



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

**Телефон:** 8 (812) 309 58 32 (многоканальный)

**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.