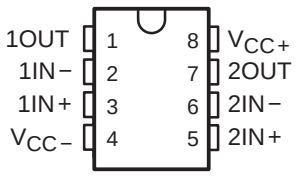
- **Wide Range of Supply Voltages; Single Supply . . . 3 V to 36 V, or Dual Supplies**
- **Class AB Output Stage**
- **High-Impedance N-Channel-JFET Input Stage . . . 10^{12} Ω Typ**
- **Internal Frequency Compensation**
- **Short-Circuit Protection**
- **Input Common Mode Includes V_{CC-}**
- **Low Input Offset Current . . . 50 pA**
- **Low Input Bias Current . . . 200 pA Typ**

PS PACKAGE
(TOP VIEW)



description

The TL092 JFET-input operational amplifier is similar in performance to the MC3403 family, but with much higher input impedance derived from a FET input stage. The N-channel-JFET input stage allows a common-mode input voltage range that includes the negative supply voltage and offers a typical input impedance of 10^{12} Ω, a typical input offset current of 50 pA, and a typical input bias current of 200 pA. This device is designed to operate from a single supply over a range of 3 V to 36 V. Operation from split supplies also is possible, provided the difference between the two supplies is 3 V to 36 V. Output voltage range is from V_{CC-} to V_{CC+} − 1.3 V, with a load resistor to V_{CC-}.

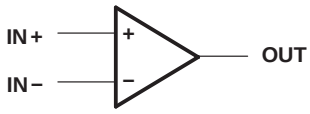
The TL092 is characterized for operation from 0°C to 70°C.

AVAILABLE OPTIONS

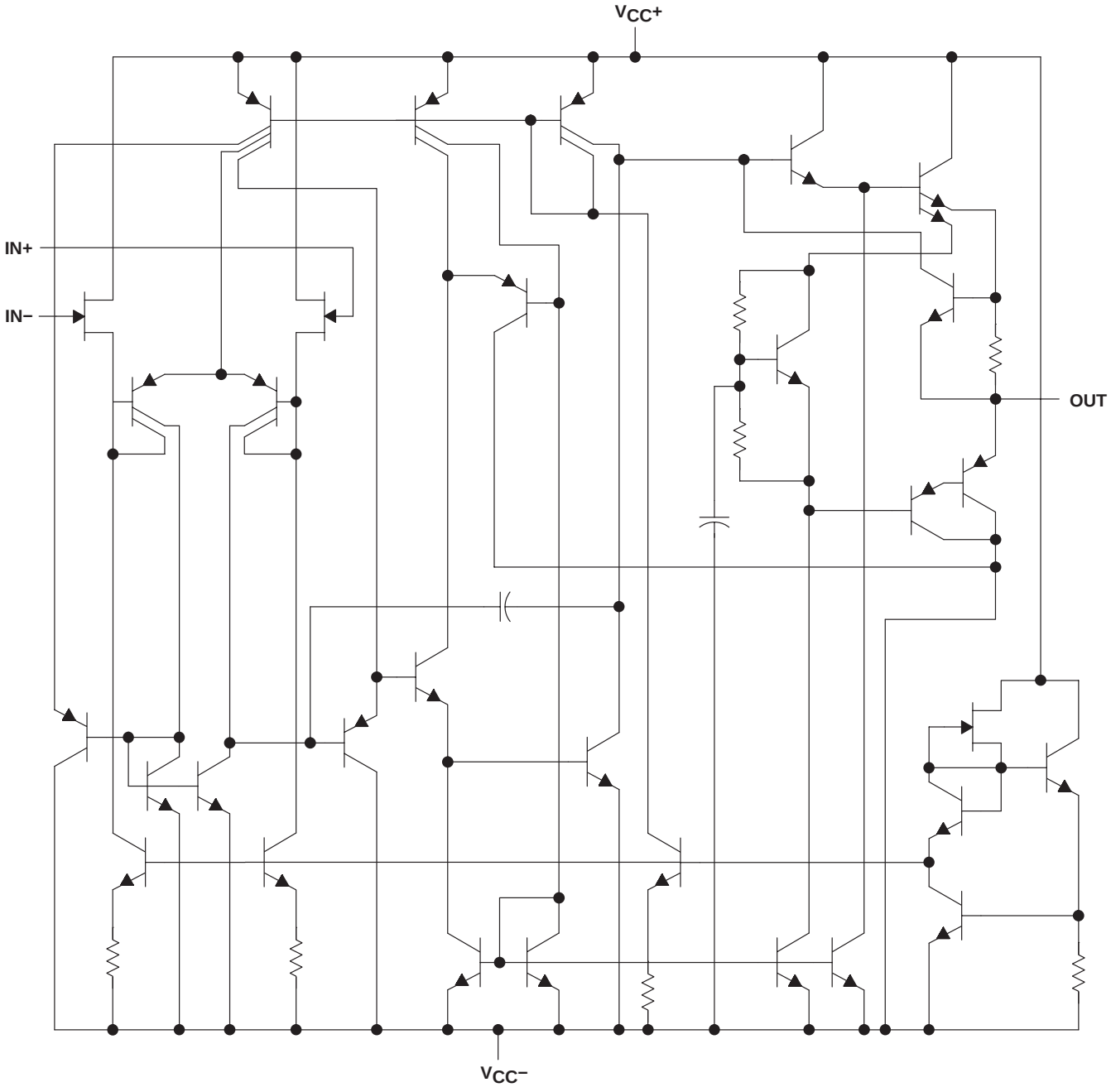
T_A	PACKAGED DEVICE
	PLASTIC SMALL OUTLINE (PS)
0°C to 70°C	TL092CPSR

The PS package is only available taped and reeled. Add the suffix R to device type for ordering (e.g., TL092CPSR).

symbol



schematic



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

Supply voltage: V_{CC+} (see Note 1) . . . . . 18 V
V_{CC-} (see Note 1) . . . . . −18 V
V_{CC+} with respect to V_{CC-} . . . . . 36 V
Differential input voltage, V_{ID} (see Note 2) . . . . . ±36 V
Input voltage, V_I (see Notes 1 and 3) . . . . . ±18 V
Package thermal impedance, θ_{JA} (see Notes 4 and 5) . . . . . 95°C/W
Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds . . . . . 260°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 under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.
2. Differential voltages are at the noninverting input with respect to the inverting input.
3. Neither input must ever be more positive than V_{CC+} or more negative than V_{CC-} − 0.3 V.
4. 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 impact reliability.
5. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

		MIN	MAX	UNIT
$V_{CC\pm}$	Supply voltage	3	36	V
T_A	Operating free-air temperature range	0	70	°C

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

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP†	MAX	UNIT
V_{IO}	Input offset voltage	R_S = 50 Ω		25°C		5	15	mV
				Full range			20	
αV_{IO}	Temperature coefficient of input offset voltage			25°C		10		µV/°C
I_{IO}‡	Input offset current			25°C		50	200	pA
				Full range			5	nA
I_{IB}‡	Input bias current			25°C		200	400	pA
				Full range			10	nA
V_{ICR}	Common-mode input voltage range			25°C	V_{CC-} to 12	V_{CC-} to 13		V
$V_{O(PP)}$	Peak output voltage swing	R_L = 2 kΩ		25°C	±10	±13		V
		R_L = 10 kΩ		25°C	±12	±13.5		
		R_L = 2 kΩ		Full range	±10			
A_{VD}	Large-signal differential voltage amplification	R_L = 2 kΩ,	V_O = ±10 V	25°C	20	200		V/mV
				Full range	15			
B_{OM}	Maximum output swing bandwidth	R_L = 2 kΩ, A_{VD} = 1,	$V_{O(PP)}$ = 20 V, THD < 5%	25°C		9		kHz
B_1	Unity gain bandwidth	R_L = 10 kΩ,	V_O = 50 mV	25°C		1		MHz
ϕ_m	Phase margin	R_L = 2 kΩ,	C_L = 200 pF	25°C		60°		
r_i	Input resistance	f = 20 Hz		25°C		10^{12}		Ω
r_o	Output resistance	f = 20 Hz		25°C		75		Ω
CMRR	Common-mode rejection ratio	R_S = 50 Ω,	V_{IC} = V_{ICR}	25°C	70	90		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	R_S = 50 Ω,	$V_{CC\pm}$ = ±3 V to ±15 V	25°C	75	90		dB
I_{OS}	Short-circuit output current			25°C		40		mA
I_{CC}	Supply current (per amplifier)	V_O = 0,	No load	25°C		1.5	2.5	mA

† All typical values are at T_A = 25°C.

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques that maintain the junction temperature as close to the ambient temperature as possible must be used.

electrical characteristics at specified free-air temperature, V_{CC+} = 5 V, V_{CC-} = 0 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IO}	Input offset voltage	R_S = 50 Ω,	V_O = 2.5 V		5	15	mV
I_{IO}	Input offset current	V_O = 2.5 V			50	200	pA
I_{IB}	Input bias current	V_O = 2.5 V			200	400	pA
$V_{O(PP)}$	Peak output voltage swing	R_L = 10 kΩ		3.3	3.5		V
		R_L = 10 kΩ,	V_{CC+} = 5 V to 30 V	V_{CC+}−1.7			V
A_{VD}	Large-signal differential voltage amplification	R_L = 2 kΩ,	ΔV_O =1.6 V	20	200		V/mV
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	R_S = 50 Ω,	$V_{CC\pm}$ = ±3 V to ±15 V	75			dB
I_{CC}	Supply current (per amplifier)	V_O = 2.5 V,	No load		1.5	2.5	mA
V_{O1}/V_{O2}	Channel separation	f = 1 kHz to 20 kHz			120		dB

† All typical values are at T_A = 25°C.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_I = ±10 V (see Figure 1),	C_L = 100 pF,	R_L = 2 kΩ		0.6		V/μs
t_r	Rise time	ΔV_O = 50 mV (see Figure 1),	C_L = 100 pF,	R_L = 2 kΩ		0.2		μs
t_f	Fall time	ΔV_O = 50 mV (see Figure 1),	C_L = 100 pF,	R_L = 2 kΩ		0.2		μs
	Overshoot factor	ΔV_O = 50 mV (see Figure 1),	C_L = 100 pF,	R_L = 2 kΩ		20%		
	Crossover distortion	V_{IPP} = 30 mV, $V_{O(PP)}$ = 2 V,	f = 10 kHz			1%		
V_n	Equivalent input noise voltage	R_S = 100 Ω,	f = 1 kHz			34		nV/√Hz

PARAMETER MEASUREMENT INFORMATION

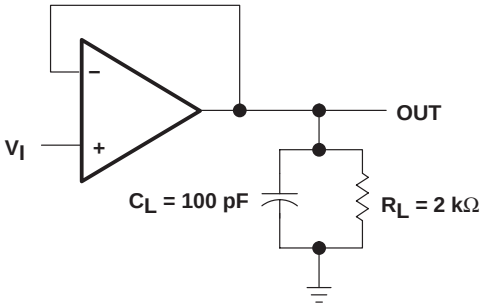


Figure 1. Unity-Gain Amplifier

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TL092CPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL092CPSRE4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

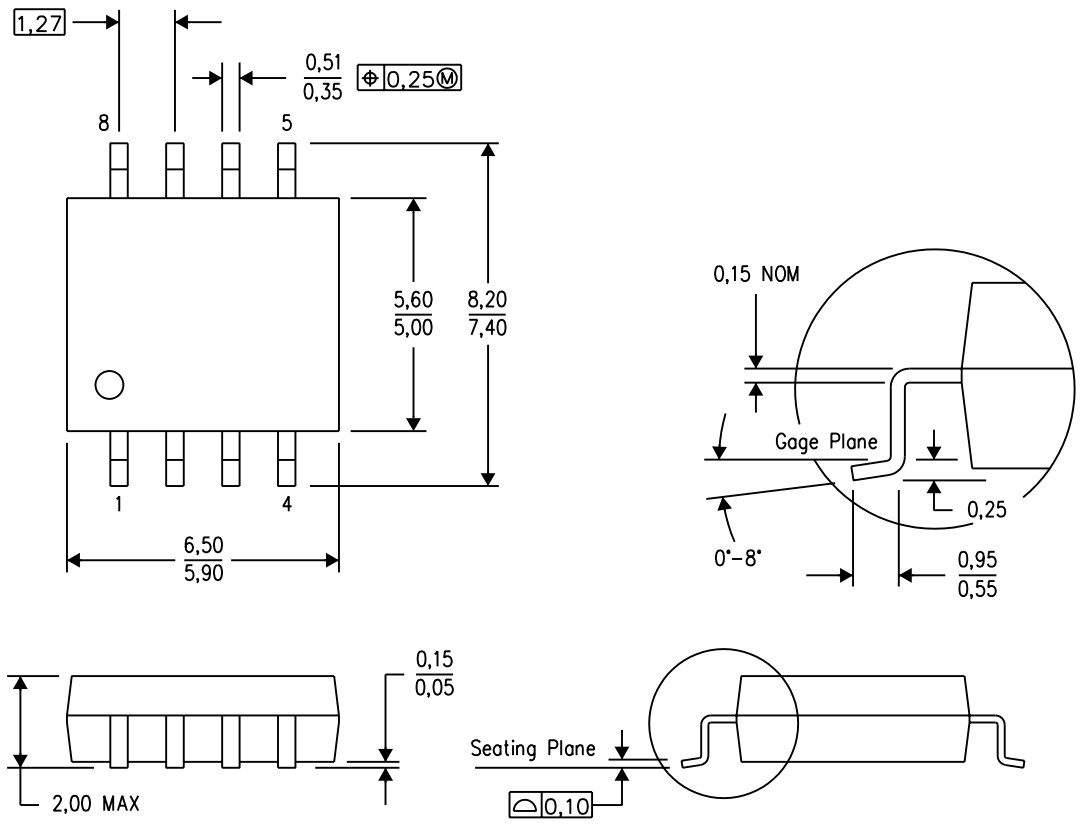
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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.

MECHANICAL DATA

PS (R-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



4040063/C 03/03

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.

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.

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
		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