

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC4093

### J-FET INPUT LOW-OFFSET OPERATIONAL AMPLIFIER

The  $\mu$ PC4093 operational amplifier is a high-speed version of the  $\mu$ PC4091. NEC's unique high-speed PNP transistor ( $f_T = 300$  MHz) in the output stage realizes a high slew rate of  $25$  V/ $\mu$ s under voltage-follower conditions without an oscillation problem. Zener-zap resistor trimming in the input stage produces excellent offset voltage and temperature drift characteristics.

With AC performance characteristics that are two times better than conventional bi-FET operation amplifiers, the  $\mu$ PC4093 is ideal for fast integrators, active filters, and other high-speed circuit applications.

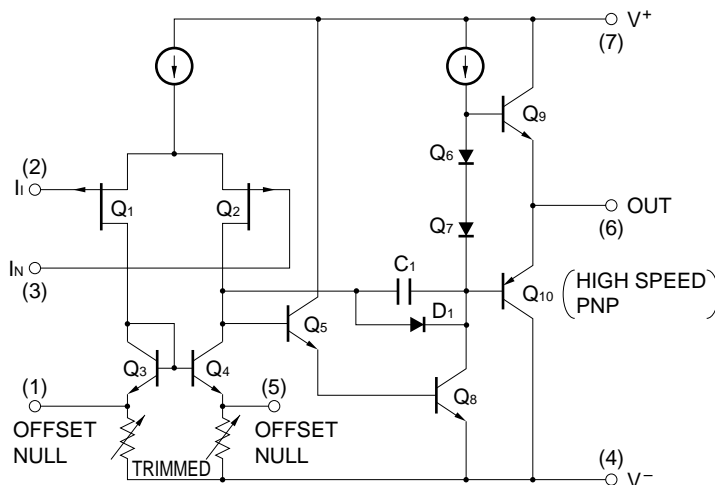
#### FEATURES

- Stable operation with 220 pF capacitive load
- Low input offset voltage and offset voltage null capability  
 $\pm 2.5$  mV (MAX.)  
 $\pm 7$   $\mu$ V/ $^{\circ}$ C (TYP.) temperature drift
- Very low input bias and offset currents
- Low noise :  $e_n = 19$  nV/ $\sqrt{\text{Hz}}$  (TYP.)
- Output short circuit protection
- High input impedance ... J-FET Input Stage
- Internal frequency compensation
- High slew rate:  $25$  V/ $\mu$ s (TYP.)

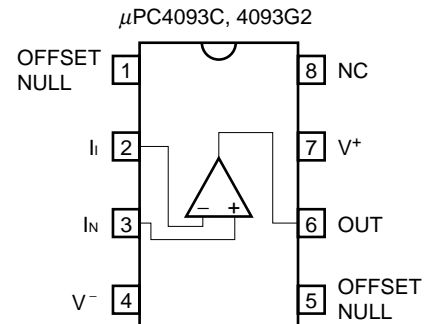
#### ORDERING INFORMATION

Part Number	Package
$\mu$ PC4093C	8-pin plastic DIP (300 mil)
$\mu$ PC4093G2	8-pin plastic SOP (225 mil)

#### EQUIVALENT CIRCUIT



#### PIN CONFIGURATION (Top View)



Remark NC : No Connection

The information in this document is subject to change without notice.

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25 °C)**

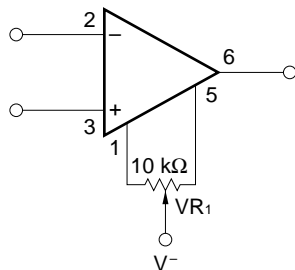
Parameter		Symbol	Ratings	Unit
Voltage between V <sup>+</sup> and V <sup>-</sup> <sup>Note 1</sup>		V <sup>+</sup> - V <sup>-</sup>	-0.3 to +36	V
Differential Input Voltage		V <sub>ID</sub>	±30	V
Input Voltage <sup>Note 2</sup>		V <sub>I</sub>	V <sup>-</sup> -0.3 to V <sup>+</sup> +0.3	V
Output Voltage <sup>Note 3</sup>		V <sub>O</sub>	V <sup>-</sup> -0.3 to V <sup>+</sup> +0.3	V
Power Dissipation	C Package <sup>Note 4</sup>	P <sub>T</sub>	350	mW
	G2 Package <sup>Note 5</sup>		440	mW
Output Short Circuit Duration <sup>Note 6</sup>			Indefinite	sec
Operating Ambient Temperature		T <sub>A</sub>	-20 to +80	°C
Storage Temperature		T <sub>stg</sub>	-55 to +125	°C

- Notes**
- Reverse connection of supply voltage can cause destruction.
  - The input voltage should be allowed to input without damage or destruction. Even during the transition period of supply voltage, power on/off etc., this specification should be kept. The normal operation will establish when the both inputs are within the Common Mode Input Voltage Range of electrical characteristics.
  - This specification is the voltage which should be allowed to supply to the output terminal from external without damage or destructive. Even during the transition period of supply voltage, power on/off etc., this specification should be kept. The output voltage of normal operation will be the Output Voltage Swing of electrical characteristics.
  - Thermal derating factor is -5.0 mV/°C when operating ambient temperature is higher than 55 °C.
  - Thermal derating factor is -4.4 mV/°C when operating ambient temperature is higher than 25 °C.
  - Pay careful attention to the total power dissipation not to exceed the absolute maximum ratings, Note 4 and Note 5.

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	V <sup>±</sup>	±5		±16	V
Output Current	I <sub>o</sub>			±10	mA
Capacitive Load (A <sub>v</sub> = +1, R <sub>f</sub> = 0 Ω)	C <sub>L</sub>			220	pF

**OFFSET VOLTAGE NULL CIRCUIT**



**Remark** The OFFSET NULL pins should be left open or connected to V<sup>-</sup> via a resistor as shown in the left figure. Don't connect to any lines other than V<sup>-</sup>, otherwise malfunction, degradation, or failure may occur.

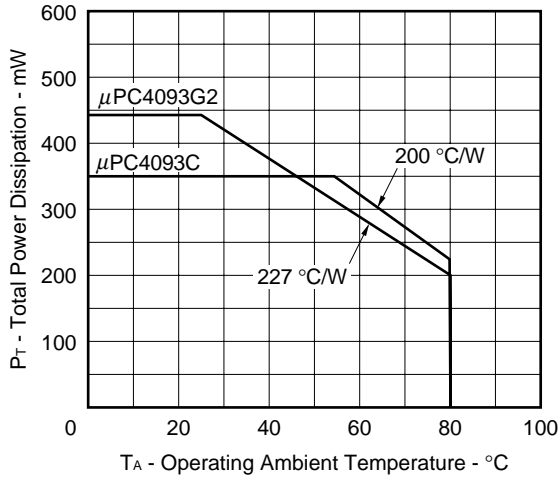
**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, V<sup>±</sup> = ±15 V)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Offset Voltage	V <sub>IO</sub>	R <sub>s</sub> ≤ 50 Ω		±1	±2.5	mV
Input Offset Current <sup>Note 7</sup>	I <sub>IO</sub>			±25	±100	pA
Input Bias Current <sup>Note 7</sup>	I <sub>B</sub>			50	200	pA
Large Signal Voltage Gain	A <sub>v</sub>	R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V	25000	200000		
Supply Current	I <sub>CC</sub>	I <sub>o</sub> = 0 A		2.5	3.4	mA
Common Mode Rejection Ratio	CMR		70	100		dB
Supply Voltage Rejection Ratio	SVR		70	100		dB
Output Voltage Swing	V <sub>om</sub>	R <sub>L</sub> ≥ 10 kΩ	±12	+14.0 -13.3		V
		R <sub>L</sub> ≥ 2 kΩ	±10	+13.5 -12.8		V
Common Model Input Voltage Range	V <sub>ICM</sub>		±11	+14 -12		V
Slew Rate	SR	A <sub>v</sub> = 1		25		V/μs
Unity Gain Frequency	f <sub>unity</sub>			6		MHz
Input Equivalent Noise Voltage Density	e <sub>n</sub>	R <sub>s</sub> = 100 Ω, f = 1 kHz		19		nV/√Hz
Input Offset Voltage	V <sub>IO</sub>	R <sub>s</sub> ≤ 50 Ω, T <sub>A</sub> = -20 to +70 °C			±5	mV
Average V <sub>IO</sub> Temperature Drift	ΔV <sub>IO</sub> /ΔT	T <sub>A</sub> = -20 to +70 °C		±7		μV/°C
Input Offset Current <sup>Note 7</sup>	I <sub>IO</sub>	T <sub>A</sub> = -20 to +70 °C			±2	nA
Input Bias Current <sup>Note 7</sup>	I <sub>B</sub>	T <sub>A</sub> = -20 to +70 °C			7	nA

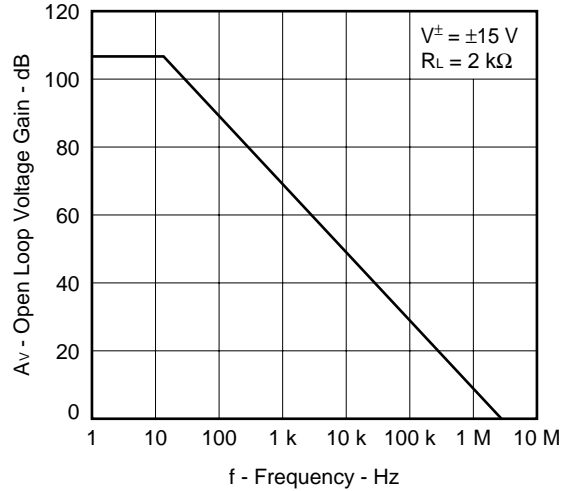
**Notes 7.** Input bias currents flow into IC. Because each currents are gate leak current of P-channel J-FET on input stage. And that are temperature sensitive. Short time measuring method is recommendable to maintain the junction temperature close to the operating ambient temperature.

TYPICAL PERFORMANCE CHARACTERISTICS ( $T_A = 25\text{ }^\circ\text{C}$ , TYP.)

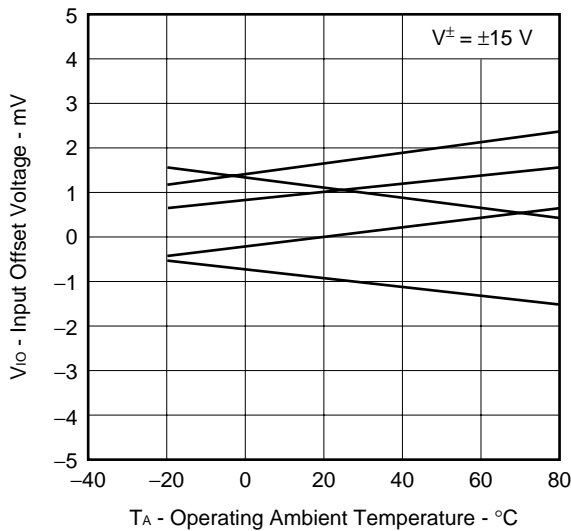
POWER DISSIPATION



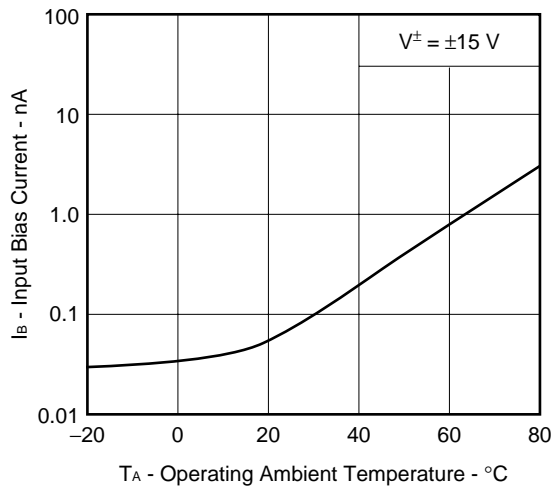
OPEN LOOP FREQUENCY RESPONSE



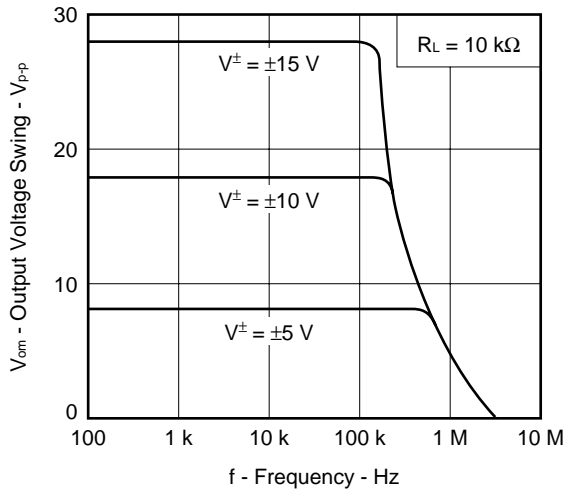
INPUT OFFSET VOLTAGE



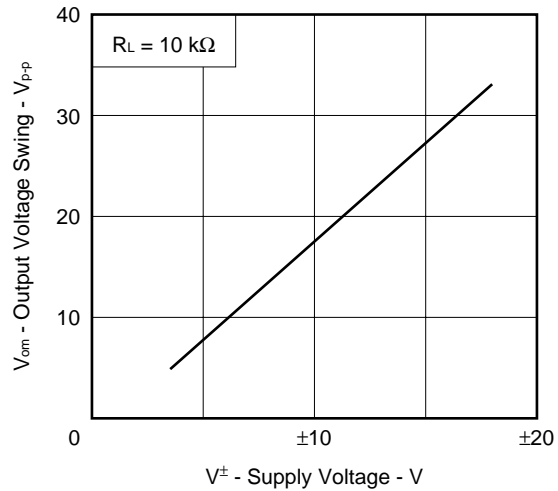
INPUT BIAS CURRENT

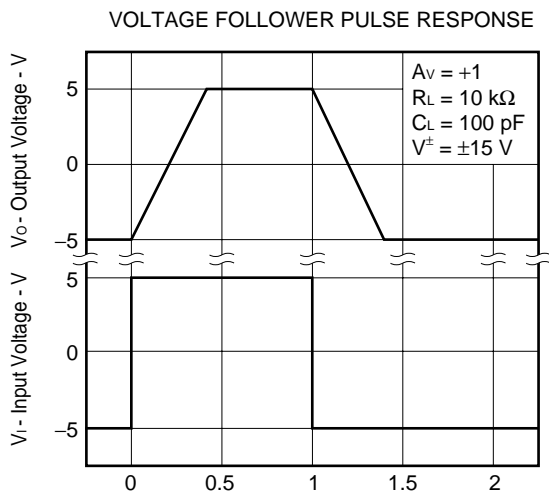
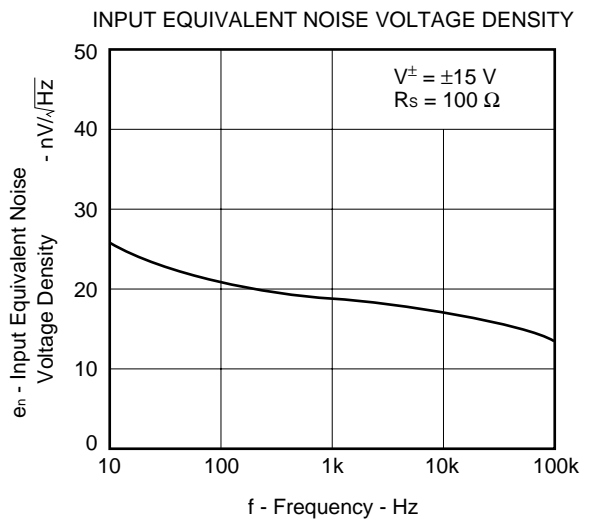
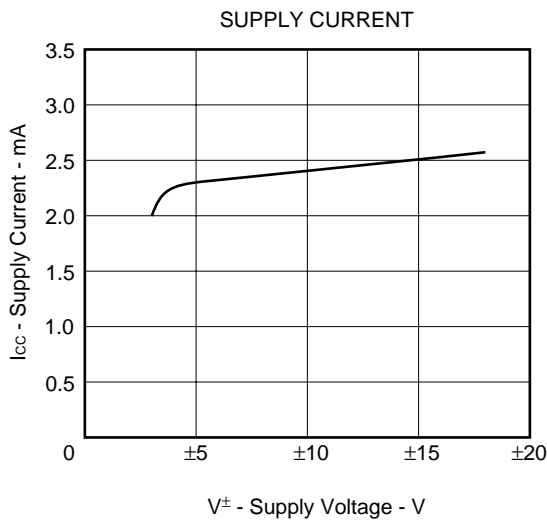
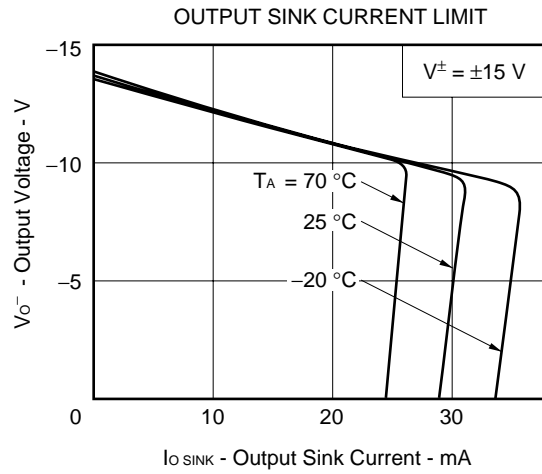
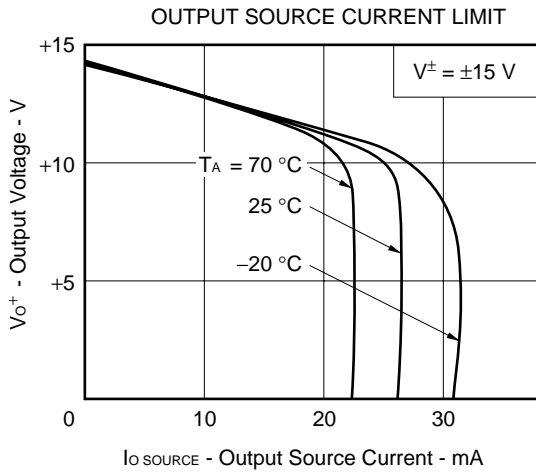


LARGE SIGNAL FREQUENCY RESPONSE



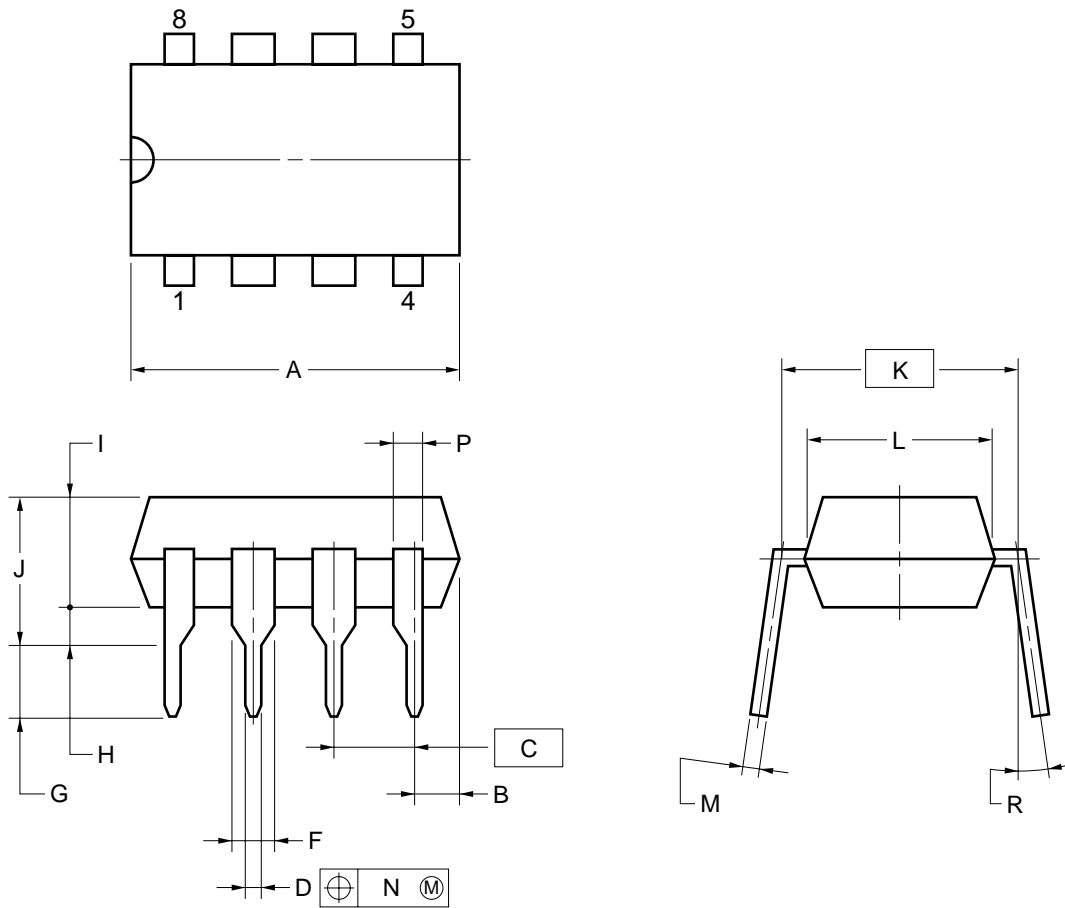
OUTPUT VOLTAGE SWING





PACKAGE DRAWINGS

8PIN PLASTIC DIP (300 mil)



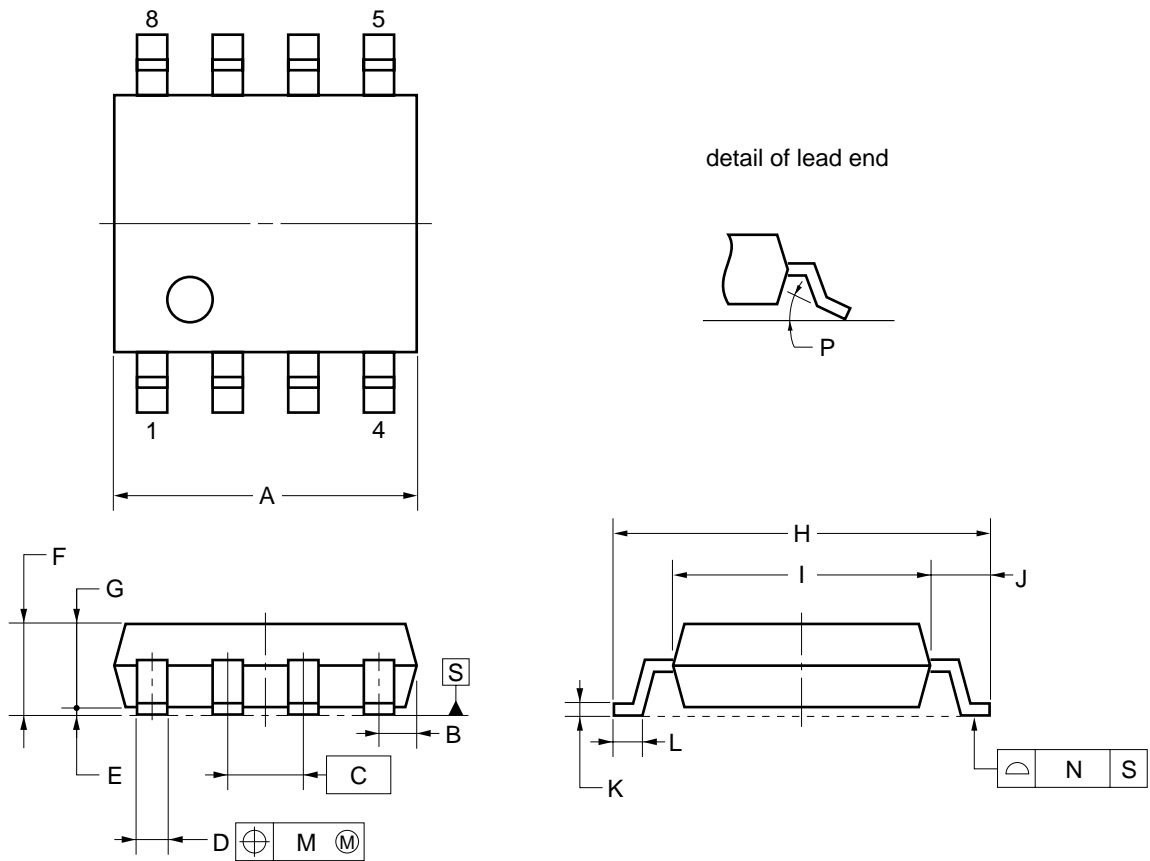
NOTES

- 1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.
- 2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	10.16 MAX.	0.400 MAX.
B	1.27 MAX.	0.050 MAX.
C	2.54 (T.P.)	0.100 (T.P.)
D	0.50±0.10	0.020 <sup>+0.004</sup> <sub>-0.005</sub>
F	1.4 MIN.	0.055 MIN.
G	3.2±0.3	0.126±0.012
H	0.51 MIN.	0.020 MIN.
I	4.31 MAX.	0.170 MAX.
J	5.08 MAX.	0.200 MAX.
K	7.62 (T.P.)	0.300 (T.P.)
L	6.4	0.252
M	0.25 <sup>+0.10</sup> <sub>-0.05</sub>	0.010 <sup>+0.004</sup> <sub>-0.003</sub>
N	0.25	0.01
P	0.9 MIN.	0.035 MIN.
R	0~15°	0~15°

P8C-100-300B,C-1

8 PIN PLASTIC SOP (225 mil)



**NOTE**  
 Each lead centerline is located within 0.12 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	5.2 <sup>+0.17</sup> <sub>-0.20</sub>
B	0.78 MAX.
C	1.27 (T.P.)
D	0.42 <sup>+0.08</sup> <sub>-0.07</sub>
E	0.1±0.1
F	1.59±0.21
G	1.49
H	6.5±0.3
I	4.4±0.15
J	1.1±0.2
K	0.17 <sup>+0.08</sup> <sub>-0.07</sub>
L	0.6±0.2
M	0.12
N	0.10
P	3° <sup>+7°</sup> <sub>-3°</sub>

S8GM-50-225B-5

**RECOMMENDED SOLDERING CONDITIONS**

When soldering this product, it is highly recommended to observe the conditions as shown below. If other soldering processes are used, or if the soldering is performed under different conditions, please make sure to consult with our sales offices.

For more details, refer to our document "**SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL**"(C10535E).

**Type of Surface Mount Device**

**μPC4093G2: 8-pin plastic SOP (225 mil)**

Process	Conditions	Symbol
Infrared Ray Reflow	Peak temperature: 230 °C or below (Package surface temperature), Reflow time: 30 seconds or less (at 210 °C or higher), Maximum number of reflow processes: 1 time.	IR30-00-1
Vapor Phase Soldering	Peak temperature: 215 °C or below (Package surface temperature), Reflow time: 40 seconds or less (at 200 °C or higher), Maximum number of reflow processes: 1 time.	VP15-00-1
Wave Soldering	Solder temperature: 260 °C or below, Flow time: 10 seconds or less, Maximum number of flow processes: 1 time, Pre-heating temperature: 120 °C or below (Package surface temperature).	WS60-00-1
Partial Heating Method	Pin temperature: 300 °C or below, Heat time: 3 seconds or less (Per each side of the device).	—

**Caution** Apply only one kind of soldering condition to a device, except for "partial heating method", or the device will be damaged by heat stress.

**Type of Through-hole Device**

**μPC4093C: 8-pin plastic DIP (300 mil)**

Process	Conditions
Wave Soldering (only to leads)	Solder temperature: 260 °C or below, Flow time: 10 seconds or less.
Partial Heating Method	Pin temperature: 300 °C or below, Heat time: 3 seconds or less (per each lead).

**Caution** For through-hole device, the wave soldering process must be applied only to leads, and make sure that the package body does not get jet soldered.



**REFERENCE DOCUMENTS**

QUALITY GRADES ON NEC SEMICONDUCTOR DEVICES	C11531E
SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL	C10535E
NEC IC PACKAGE MANUAL (CD-ROM)	C13388E
GUIDE TO QUALITY ASSURANCE FOR SEMICONDUCTOR DEVICES	MEI-1202
SEMICONDUCTORS SELECTION GUIDE	X10679E
NEC SEMICONDUCTOR DEVICE RELIABILITY/QUALITY CONTROL SYSTEM (STANDARD LINEAR IC)	IEI-1212

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The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

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"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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Anti-radioactive design is not implemented in this product.