BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC1093

ADJUSTABLE PRECISION SHUNT REGULATORS

DESCRIPTION

The μPC1093 are adjustable precision shunt regulators with guaranteed thermal stability. The output voltage can be set to any value between reference voltage (2.495 V) and 36 V by two external resistors.

These ICs can apply to error amplifier of switching regulators.

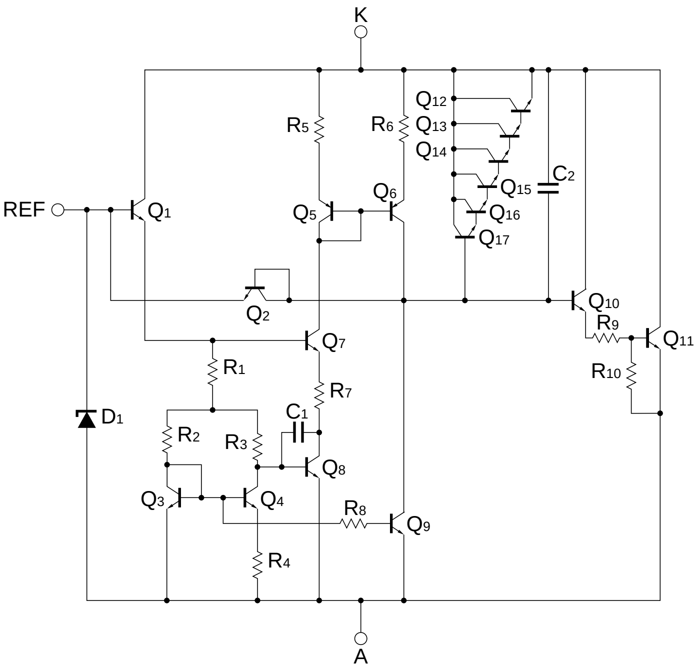
FEATURES

• High Accuracy	V_{REF} = 2.495 V ± 2 %
• Low Temperature Coefficient	$\Delta V_{REF}/\Delta T \leq 100$ ppm/°C
• Adjustable Output Voltage by two External Resistors	$V_{REF} \leq V_O \leq 36$ V
• Low Dynamic Impedance	$\lvert Z_{KA} \rvert = 0.1\ \Omega$TYP.

ORDERING INFORMATION

	Part Number	Package
	μPC1093J	3-pin plastic SIP (TO-92)
	μPC1093G	8-pin plastic SOP (225 mil)
★	μPC1093T	Power mini mold (SOT-89)
★	μPC1093TA	5-pin plastic mini mold (SC-74A)

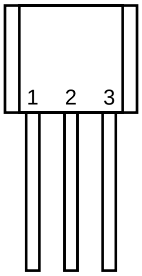
EQUIVALENT CIRCUIT



PIN CONFIGURATION (Marking Side)

3-pin plastic SIP (TO-92)

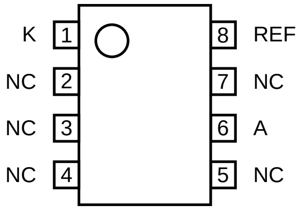
- **μPC1093J**



1 : REF
2 : A
3 : K

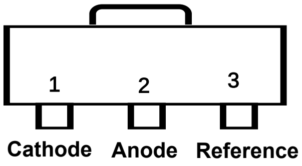
8-pin plastic SOP (225 mil)

- **μPC1093G**



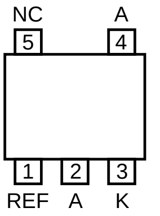
★ Power mini mold (SOT-89)

- **μPC1093T**



★ 5-pin plastic mini mold (SC-74A)

- **μPC1093TA**



REF : Reference
A : Anode
K : Cathode
NC : No Connection

ABSOLUTE MAXIMUM RATING (T_A = 25 °C, unless otherwise specified.)

	Parameter		Symbol	Ratings	Unit
	Cathode Voltage		V_{KA}	37	V
	Cathode Current		I_K	150	mA
	Cathode-Anode Reverse Current		$-I_K$	–100	mA
	Reference Voltage		V_{REF}	7	V
	Reference Input Current		I_{REF}	50	μA
	Reference-Anode Reverse Current		$-I_{REF}$	–10	mA
	Power Dissipation	μPC1093J	P_T	700	mW
		μPC1093G		480	
★		μPC1093T		400/2 000^Note 1^	
★		μPC1093TA		180/510^Note 2^	
	Operating Ambient Temperature		T_A	–20 ~ +85	°C
	Storage Temperature		T_{stg}	–65 ~ +150	°C

Notes 1. with 16 cm^2 × 0.7 mm ceramic substrate

2. with 75 mm^2 × 0.7 mm ceramic substrate

Caution Exposure to Absolute Maximum Ratings for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The parameters apply independently. The device should be operated within the limits specified under DC and AC Characteristics.

RECOMMENDED OPERATING CONDITIONS

	Parameter		Symbol	MIN.	TYP.	MAX.	Unit
	Cathode Voltage		V_{KA}	V_{REF}	5	36	V
	Cathode Current		I_K	1	10	100	mA
	Power Dissipation	μPC1093J	P_T		50	220	mW
★		μPC1093G			50	150	
★		μPC1093T			50	125/640^Note 1^	
★		μPC1093TA			50	58/160^Note 2^	
	Operating Ambient Temperature		T_A	–20		+85	°C

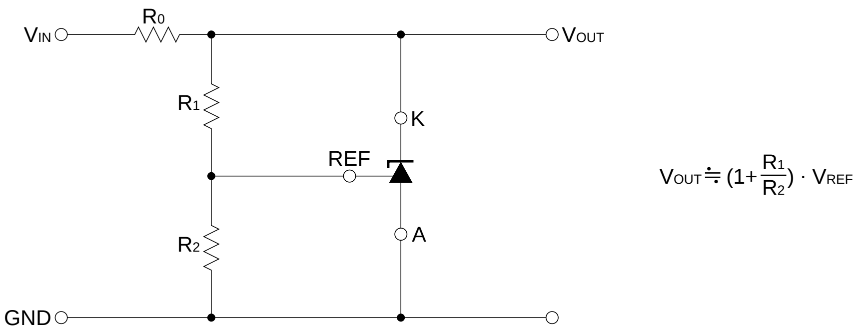
Notes 1. with 16 cm^2 × 0.7 mm ceramic substrate

2. with 75 mm^2 × 0.7 mm ceramic substrate

ELECTRICAL CHARACTERISTICS (T_A = 25 °C, I_K = 10 mA, unless otherwise specified.)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Reference Voltage	V_{REF}	$V_{KA} = V_{REF}$	2.440	2.495	2.550	V
Reference Voltage Deviation Over Temperature	ΔV_{REF}	0 °C ≤ T_A ≤ 70 °C, $V_{KA} = V_{REF}$		7	17	mV
Reference Voltage Deviation Over Cathode Voltage	$\Delta V_{REF}/\Delta V$	$\lvert V_{REF} \rvert \leq V_{KA} \leq 10$ V		1.2	2.7	mV/V
		10 V ≤ V_{KA} ≤ 36 V		0.7	2	mV/V
Reference Input Current	I_{REF}	$V_{KA} = V_{REF}$, R_1 = 10 kΩ, $R_2 = \infty$		1	4	μA
Reference Input Current Deviation Over Temperature	ΔI_{REF}	0 °C ≤ T_A ≤ 70 °C, $V_{KA} = V_{REF}$, R_1 = 10 kΩ, $R_2 = \infty$		0.4	1.2	μA
Minimum Cathode Current	$I_{K\ min.}$	$V_{KA} = V_{REF}$, ΔV_{REF} = 2 %		0.4	1	mA
Off-state Cathode Current	$I_{K\ off}$	V_{KA} = 36 V, V_{REF} = 0		0.1	1	μA
Dynamic Impedance	$\lvert Z_{KA} \rvert$	$V_{KA} = V_{REF}$, f ≤ 1 kHz 1 mA ≤ I_K ≤ 100 mA		0.1	0.5	Ω

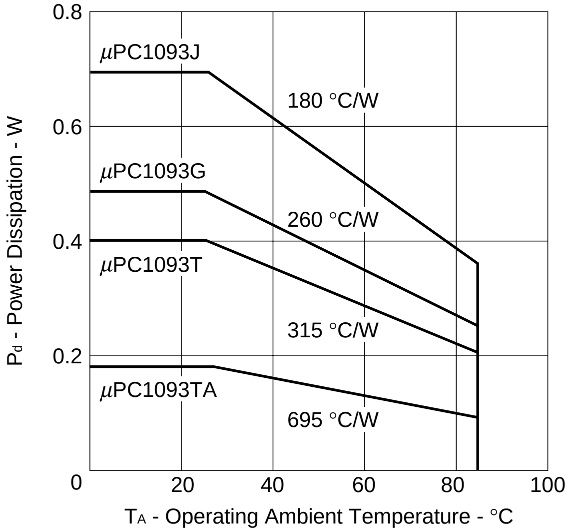
TEST AND APPLICATION CIRCUIT



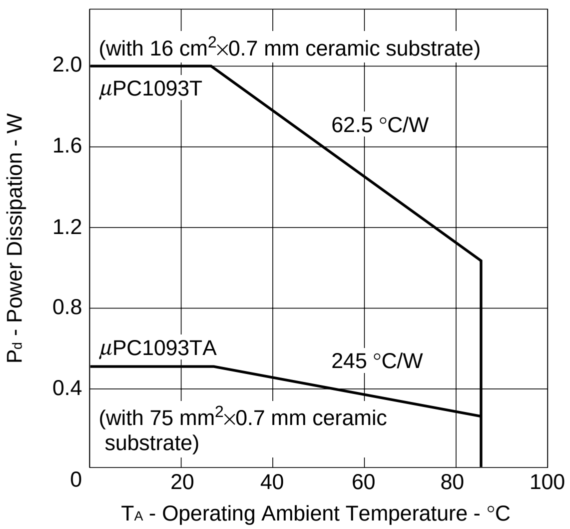
$$V_{OUT} \fallingdotseq \left(1+\frac{R_1}{R_2}\right) \cdot V_{REF}$$

TYPICAL CHARACTERISTICS

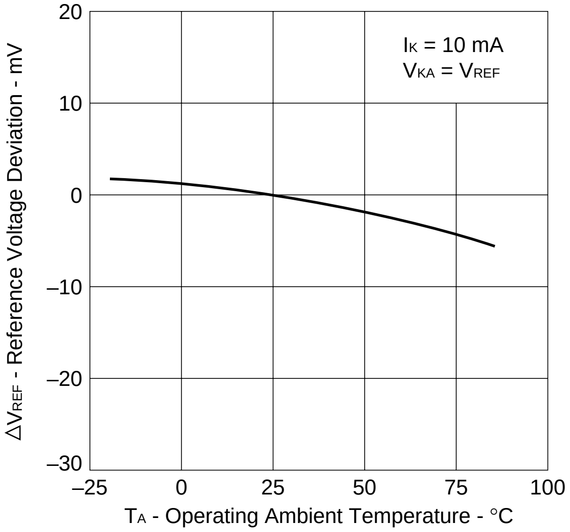
★ P_d vs T_A (I)



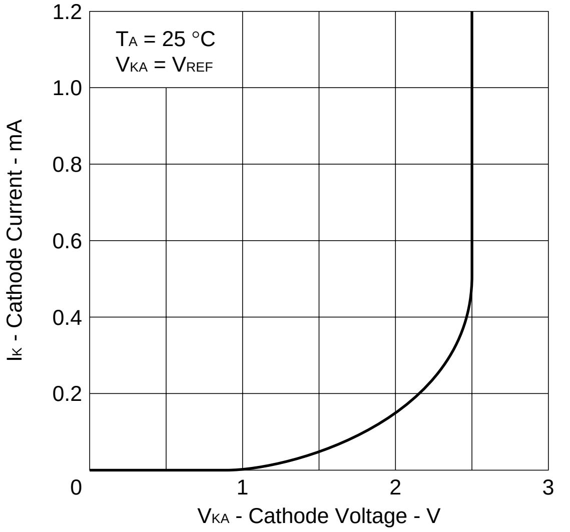
★ P_d vs T_A (II)



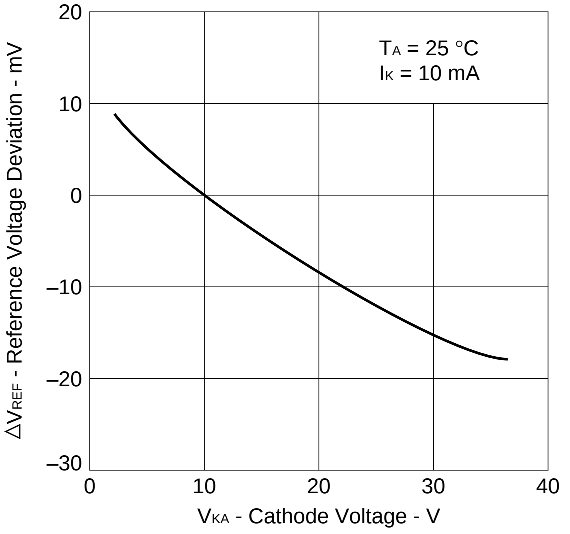
ΔV_{REF} vs T_A



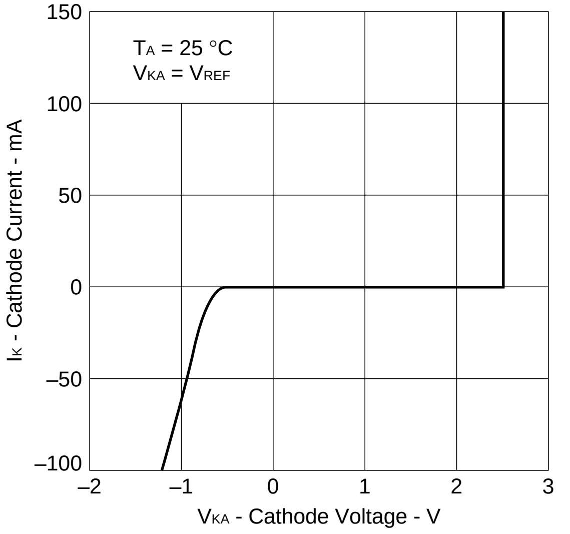
I_K vs V_{KA} (I)



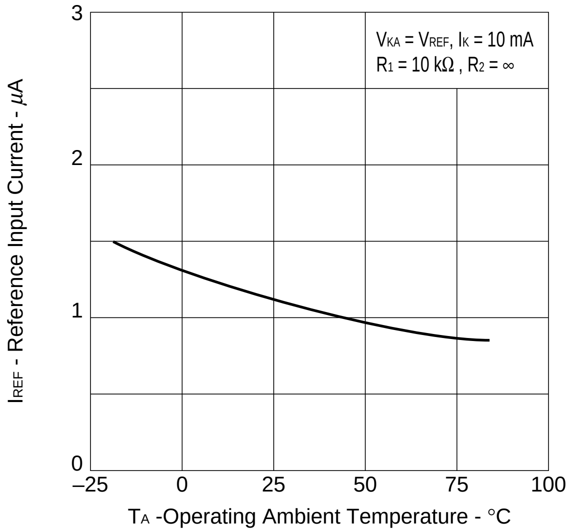
ΔV_{REF} vs V_{KA}



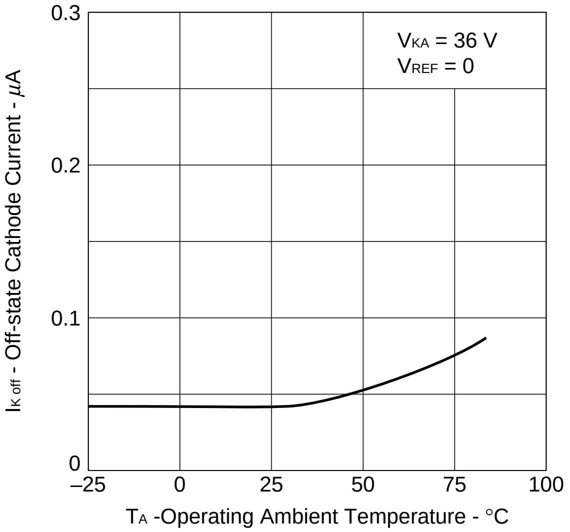
I_K vs V_{KA} (II)



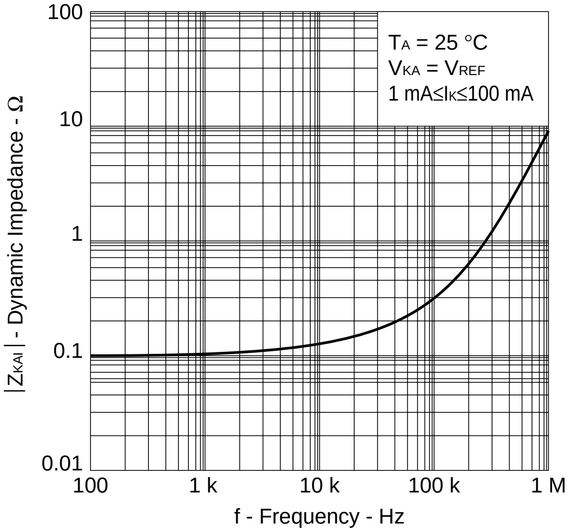
I_{REF} vs T_A



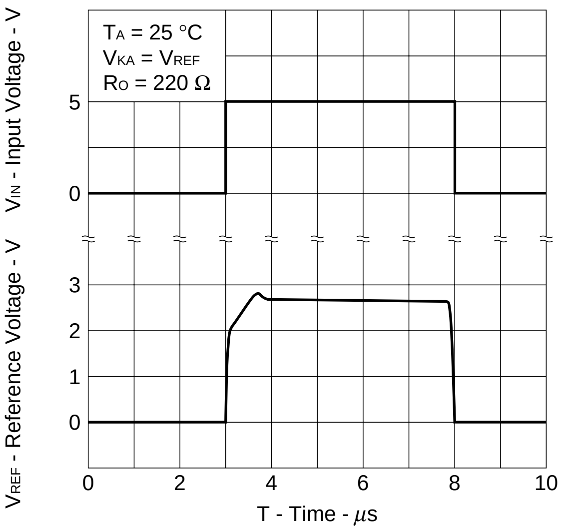
$I_{K\,off}$ vs T_A



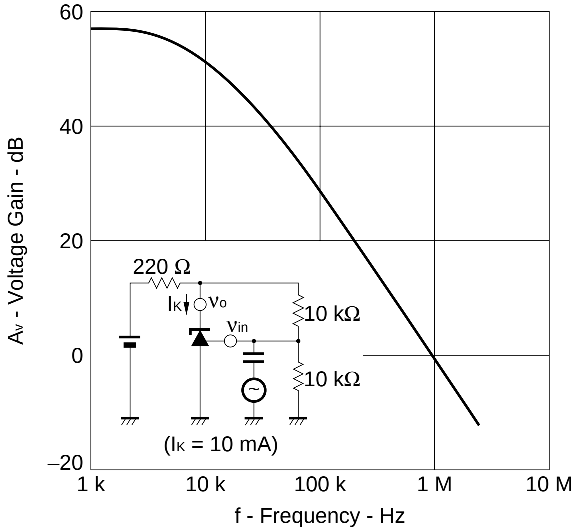
|Z_{KA}| vs f



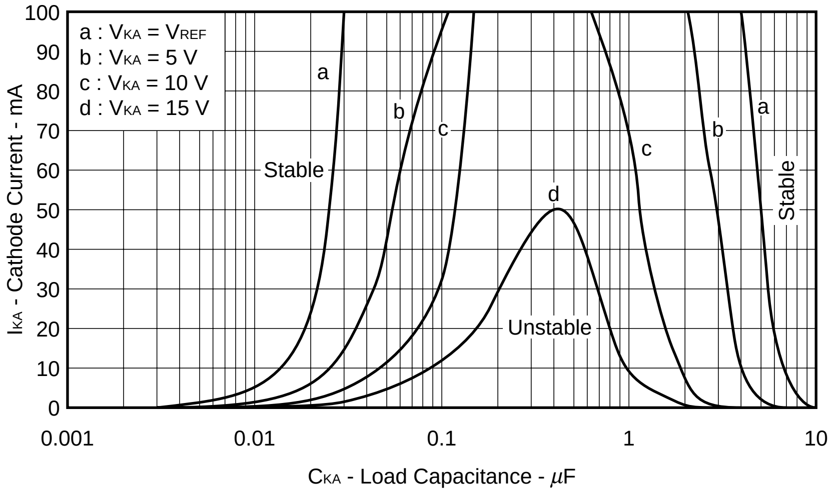
Pulse Response



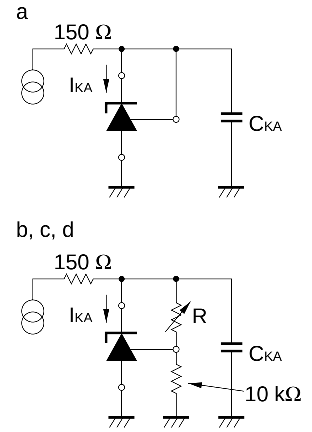
A_v vs f



★ **STABILITY AREA**



★ **TEST CIRCUIT**



C_{KA} : Monolithic Ceramic Capacitors

★ **Caution of Stability Area**

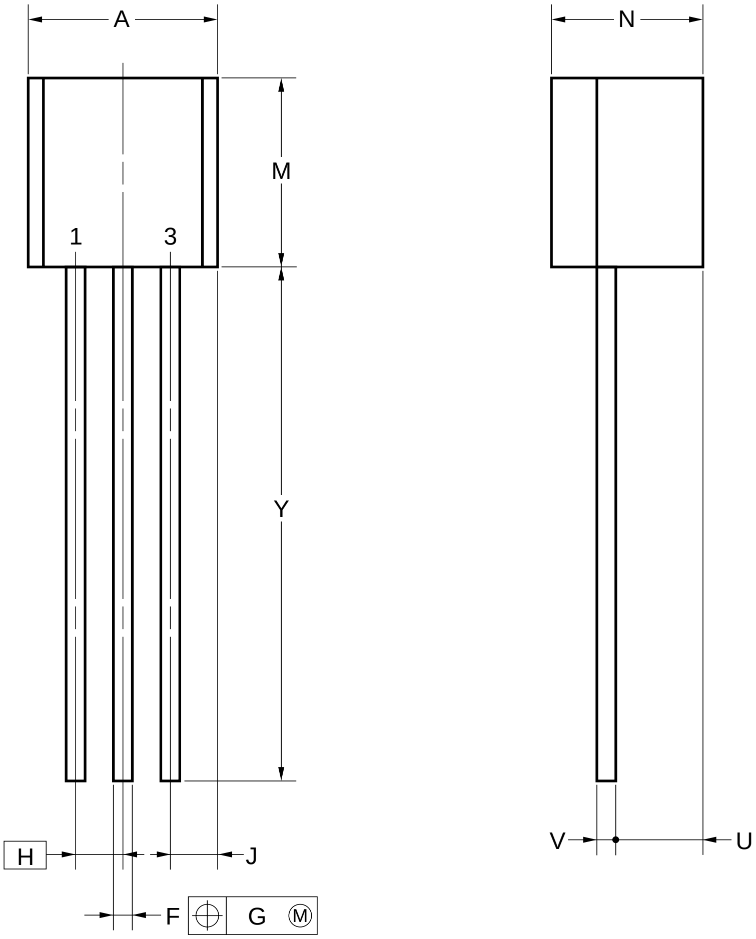
If the Aluminum electrolytic capacitor is used, it should be kept $C_{KA} \geq 2.2$ μF.

When using plural different types of capacitors, each capacitor is needed to be stable independently.

When designing a circuit, take the characteristic variation among devices into consideration, so that the designed circuit has an enough characteristic margin supporting the standard specifications described above.

PACKAGE DRAWINGS

3 PIN PLASTIC SIP (TO-92)



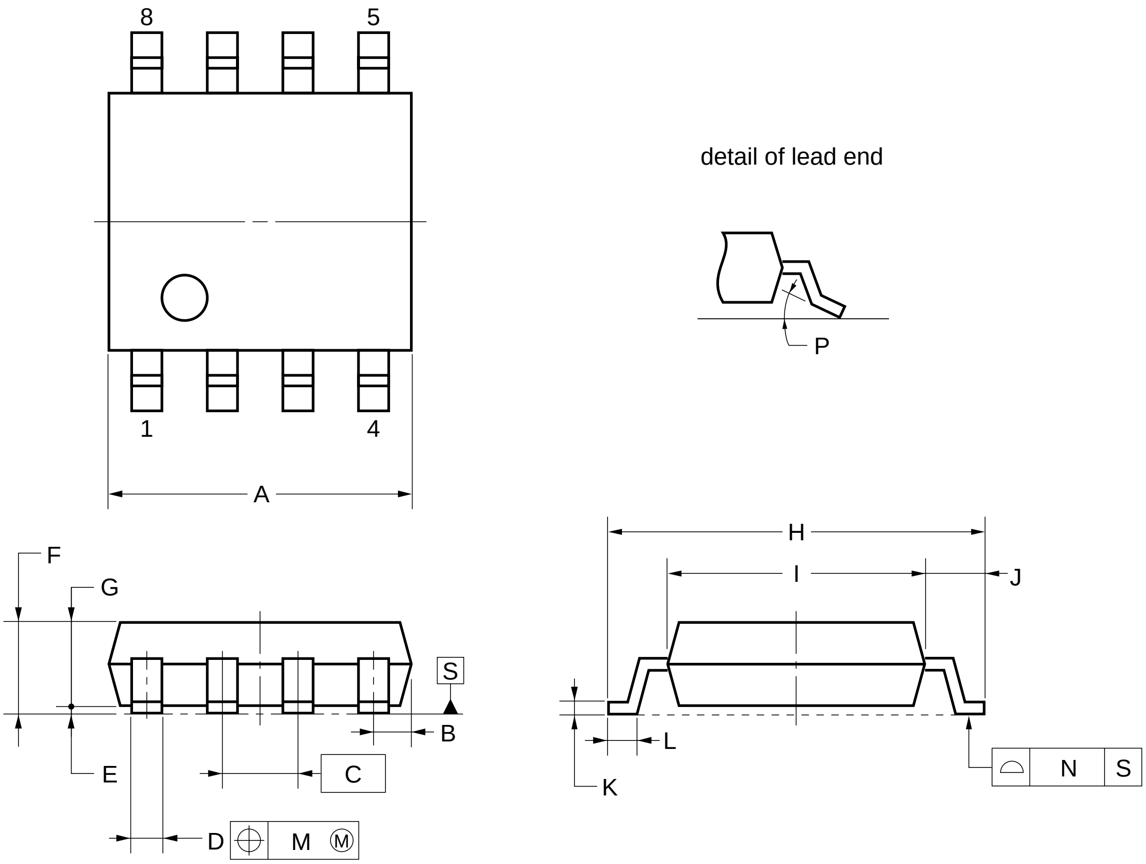
NOTE

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

ITEM	MILLIMETERS
A	5.0±0.2
F	$0.5^{+0.3}_{-0.1}$
G	0.12
H	1.27
J	1.33 MAX.
M	5.0±0.5
N	4.0±0.2
U	2.8 MAX.
V	0.5±0.1
Y	15.0±0.7

P3J-127B-2

8 PIN PLASTIC SOP (225 mil)



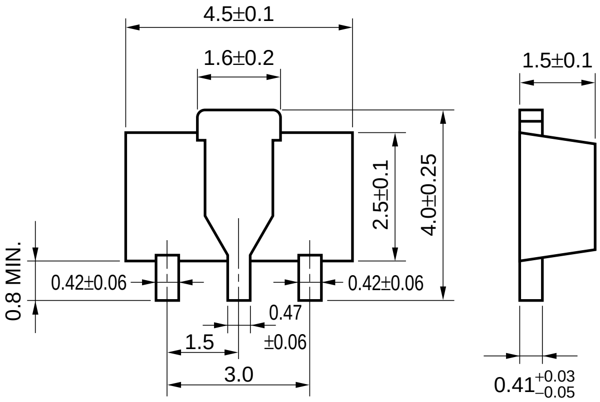
NOTE

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

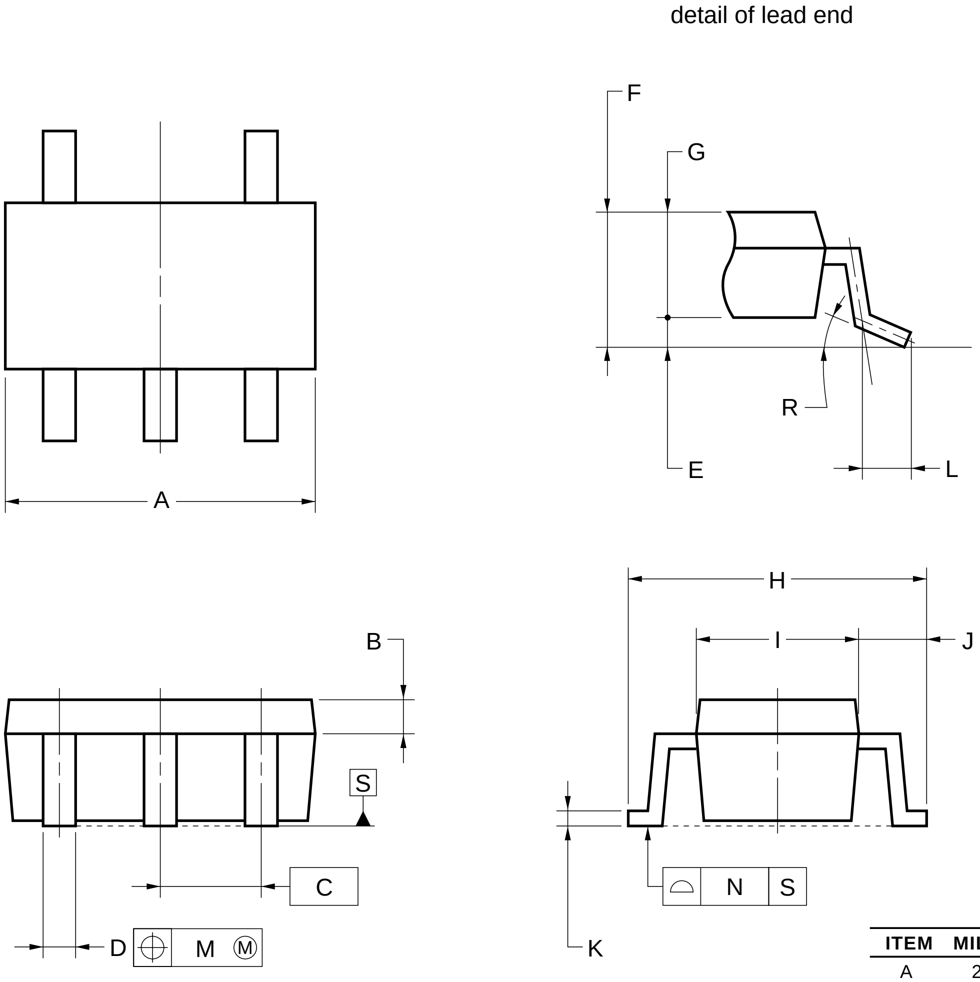
ITEM	MILLIMETERS
A	$5.2^{+0.17}_{-0.20}$
B	0.78 MAX.
C	1.27 (T.P.)
D	$0.42^{+0.08}_{-0.07}$
E	0.1±0.1
F	1.59±0.21
G	1.49
H	6.5±0.3
I	4.4±0.15
J	1.1±0.2
K	$0.17^{+0.08}_{-0.07}$
L	0.6±0.2
M	0.12
N	0.10
P	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$

S8GM-50-225B-5

★ POWER MINI MOLD (SOT-89) (Unit: mm)



★ 5 PIN PLASTIC MINI MOLD



ITEM	MILLIMETERS
A	2.9±0.2
B	0.3
C	0.95 (T.P.)
D	$0.32^{+0.05}_{-0.02}$
E	0.05±0.05
F	1.4 MAX.
G	$1.1^{+0.2}_{-0.1}$
H	2.8±0.2
I	$1.5^{+0.2}_{-0.1}$
J	$0.65^{+0.1}_{-0.15}$
K	$0.16^{+0.1}_{-0.06}$
L	0.4±0.2
M	0.19
N	0.1
R	5°±5°

S5TA-95-15A

★ 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)**.

Through-hole device

μPC1093J: 3-pin plastic SIP (TO-92)

Process	Conditions
Wave soldering (only to leads)	Solder temperature: 260 °C or below, Flow time: 10 seconds or less.

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.

Surface mount devices

μPC1093G: 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
VPS	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

Caution Apply only one kind of soldering condition to a device, or the device will be damaged by heat stress.

μPC1093T: Power mini mold (SOT-89)

Process	Conditions	Symbol
Infrared ray reflow	Peak temperature: 235 °C or below (Package surface temperature), Reflow time: 30 seconds or less (at 210 °C or higher), Maximum number of reflow processes: 2 times.	IR35-00-2
VPS	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: 2 times.	VP15-00-2
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

Caution Apply only one kind of soldering condition to a device, or the device will be damaged by heat stress.

μPC1093TA: 5-pin plastic mini mold (SC-74A)

Process	Conditions	Symbol
Infrared ray reflow	Peak temperature: 235 °C or below (Package surface temperature), Reflow time: 30 seconds or less (at 210 °C or higher), Maximum number of reflow processes: 3 times.	IR35-00-3
VPS	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: 3 times.	VP15-00-3
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

Caution Apply only one kind of soldering condition to a device, or the device will be damaged by heat stress.

★ REFERENCE DOCUMENTS

Quality Grades on NEC Semiconductor Devices	C11531E
Semiconductor Device Mounting Technology Manual	C10535E
IC Package Manual	C10943X
Semiconductors Selection Guide	X10679E
NEC Semiconductor Device Reliability/Quality Control System -Three Terminal Regulator	IEI-1212

★ REMARK OF THE PACKAGE MARK

The package marks of the μPC1093T and the μPC1093TA are the symbols as follows.

Part Number	Mark
μPC1093T	93
μPC1093TA	K93