

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC24A00 Series

## THREE TERMINAL LOW DROPOUT VOLTAGE REGULATOR

### DESCRIPTION

The  $\mu$ PC24A00 series is a low dropout voltage three terminal regulator that has realized a minimum voltage differential between the I/O of no more than 1 V when the output current is 2 A through the employment of a PNP transistor at the output stage.

Due to its ability to achieve a greater reduction in the power loss compared with conventional three-terminal regulators, the  $\mu$ PC24A00 series is ideal for use as the secondary side smoothing circuit of a power supply.

### FEATURES

- Output current in excess of 2 A
- High accuracy output voltage:  $\Delta V_o = \pm 2\%$  MAX. ( $T_J = 25^\circ\text{C}$ ,  $I_o = 1\text{ A}$ )
- Low dropout voltage:  $V_{DIF} = 1\text{ V}$  MAX. ( $I_o = 2\text{ A}$ )
- On-chip thermal shut down circuit, over-current protection circuit and safe operating area protection circuit

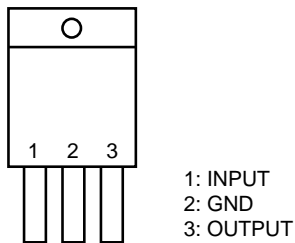
### ORDERING INFORMATION

Part Number	Package	Output Voltage
$\mu$ PC24A05HF	3-pin plastic SIP (MP-45G) (Isolated TO-220)	5 V
$\mu$ PC24A12HF	3-pin plastic SIP (MP-45G) (Isolated TO-220)	12 V
$\mu$ PC24A15HF	3-pin plastic SIP (MP-45G) (Isolated TO-220)	15 V

### PIN CONFIGURATION (Marking Side)

3-pin plastic SIP (MP-45G)

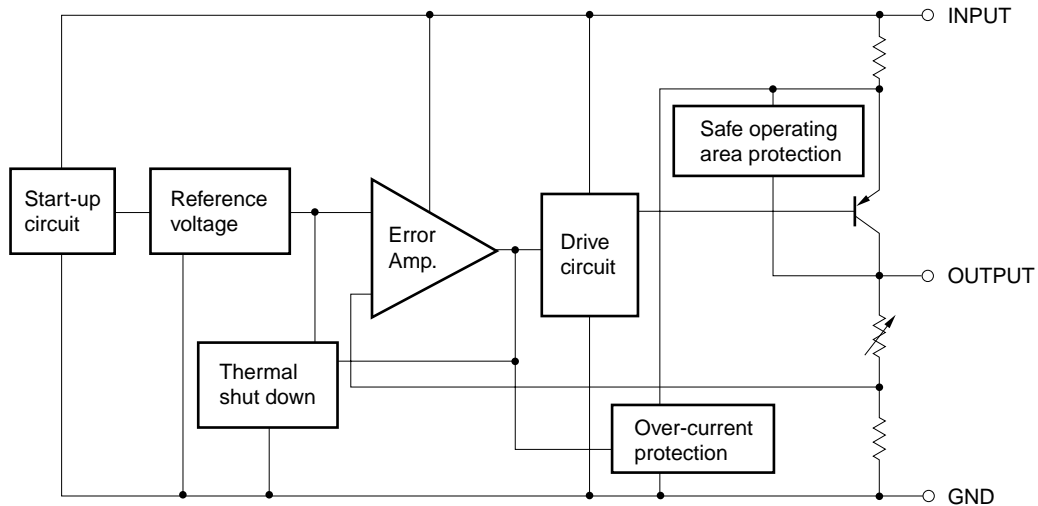
$\mu$ PC24A05HF, 24A12HF, 24A15HF



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**BLOCK DIAGRAM**



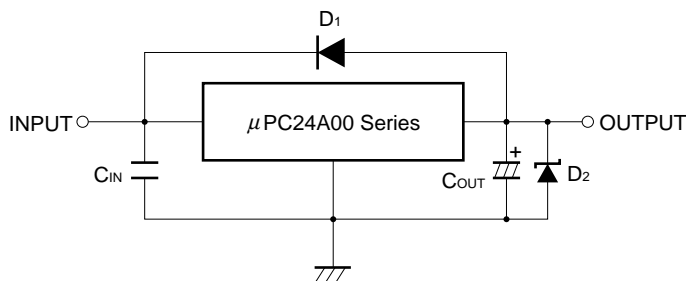
**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C, unless otherwise specified)**

Parameter	Symbol	Rating	Unit
Input Voltage	V <sub>IN</sub>	-0.3 to +36	V
Internal Power Dissipation	P <sub>T</sub>	20 <sup>Note</sup>	W
Operating Ambient Temperature	T <sub>A</sub>	-20 to +85	°C
Operating Junction Temperature	T <sub>J</sub>	-20 to +150	°C
Storage Temperature	T <sub>stg</sub>	-55 to +150	°C
Thermal Resistance (Junction to Case)	R <sub>th(J-C)</sub>	5	°C/W
Thermal Resistance (Junction to Ambient)	R <sub>th(J-A)</sub>	65	°C/W

**Note** Internally limited. When the operating junction temperature rises up to 150°C, the internal circuit shuts down the output voltage.

**Caution** Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

TYPICAL CONNECTION



C<sub>IN</sub>: 0.1  $\mu$ F or higher. Set this value according to the length of the line between the regulator and INPUT pin. Be sure to connect C<sub>IN</sub> to prevent parasitic oscillation. Use of a film capacitor or other capacitor with excellent voltage and temperature characteristics is recommended. If using a laminated ceramic capacitor, it is necessary to ensure that C<sub>IN</sub> is 0.1  $\mu$ F or higher for the voltage and temperature range to be used.

- ★ C<sub>OUT</sub>: 47  $\mu$ F or higher. Be sure to connect C<sub>OUT</sub> to prevent oscillation and improve excessive load regulation. Place C<sub>IN</sub> and C<sub>OUT</sub> as close as possible to the IC pins (within 2 cm). Also, use an electrolytic capacitor with low impedance characteristics if considering use at sub-zero temperatures.

D<sub>1</sub>: If the OUTPUT pin has a higher voltage than the INPUT pin, connect a diode.

D<sub>2</sub>: If the OUTPUT pin has a lower voltage than the GND pin, connect a Schottky barrier diode.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Input Voltage	V <sub>IN</sub>	$\mu$ PC24A05HF	6	9	15	V
		$\mu$ PC24A12HF	13	18	22	V
		$\mu$ PC24A15HF	16	22	25	V
Output Current	I <sub>O</sub>	All	0		2	A
Operating Junction Temperature	T <sub>J</sub>	All	-20		+125	°C

**Caution** The recommended operating range may be exceeded without causing any problems provided that the absolute maximum ratings are not exceeded. However, if the device is operated in a way that exceeds the recommended operating conditions, the margin between the actual conditions of use and the absolute maximum ratings is small, and therefore thorough evaluation is necessary. The recommended operating conditions do not imply that the device can be used with all values at their maximum values.

**ELECTRICAL CHARACTERISTICS**

**$\mu$ PC24A05 ( $T_J = 25^\circ\text{C}$ ,  $V_{IN} = 9\text{ V}$ ,  $I_o = 1\text{ A}$ , unless otherwise specified)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Output Voltage	$V_o$		4.9	5.0	5.1	V
		$0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , $6\text{ V} \leq V_{IN} \leq 15\text{ V}$ , $5\text{ mA} \leq I_o \leq 2\text{ A}$	4.85		5.15	V
Line Regulation	$REG_{IN}$	$6\text{ V} \leq V_{IN} \leq 15\text{ V}$		6	50	mV
Load Regulation	$REG_L$	$5\text{ mA} \leq I_o \leq 2\text{ A}$		3	50	mV
Quiescent Current	$I_{BIAS}$	$I_o = 0\text{ A}$		3	5.0	mA
		$I_o = 2\text{ A}$		15	30	mA
Quiescent Current Change	$\Delta I_{BIAS}$	$6\text{ V} \leq V_{IN} \leq 15\text{ V}$ , $I_o = 2\text{ A}$			20	mA
Output Noise Voltage	$V_n$	$10\text{ Hz} \leq f \leq 100\text{ kHz}$		150		$\mu\text{V r.m.s.}$
Ripple Rejection	$R \cdot R$	$f = 120\text{ Hz}$ , $6.5\text{ V} \leq V_{IN} \leq 16.5\text{ V}$	50	60		dB
Dropout Voltage	$V_{DIF}$	$0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , $I_o = 2\text{ A}$			1.0	V
Peak Output Current	$I_{opeak}$	$V_{IN} = 9\text{ V}$	2.8	3.5	4.2	A
Short Circuit Current	$I_{short}$	$V_{IN} = 15\text{ V}$		1.3		A
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$	$0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , $I_o = 5\text{ mA}$		0.5		mV/ $^\circ\text{C}$

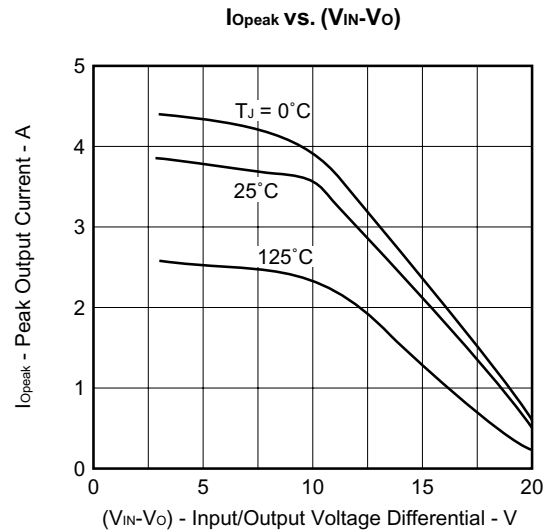
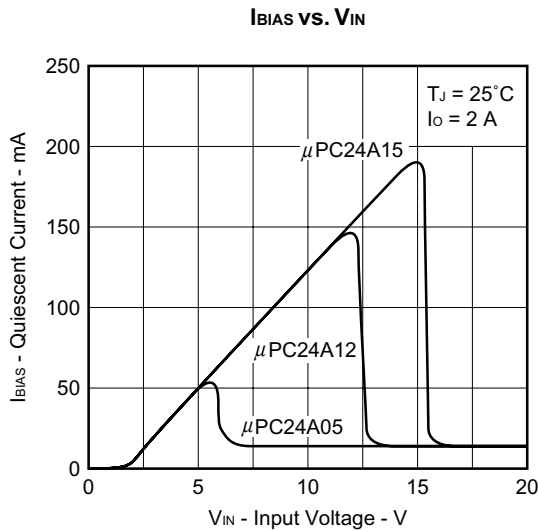
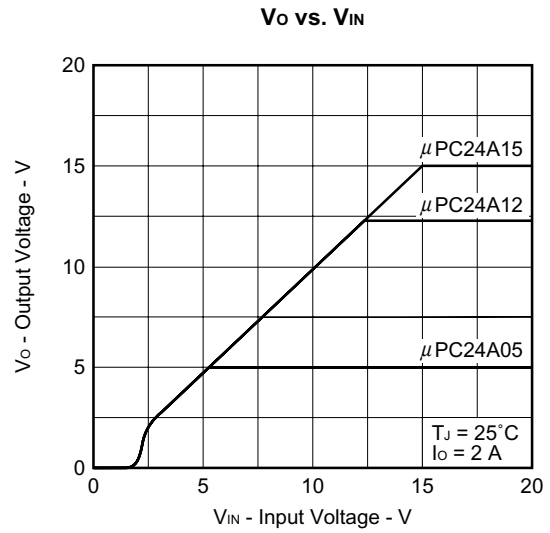
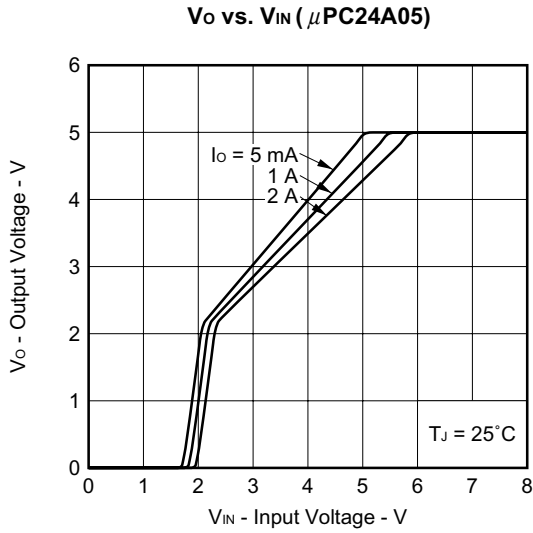
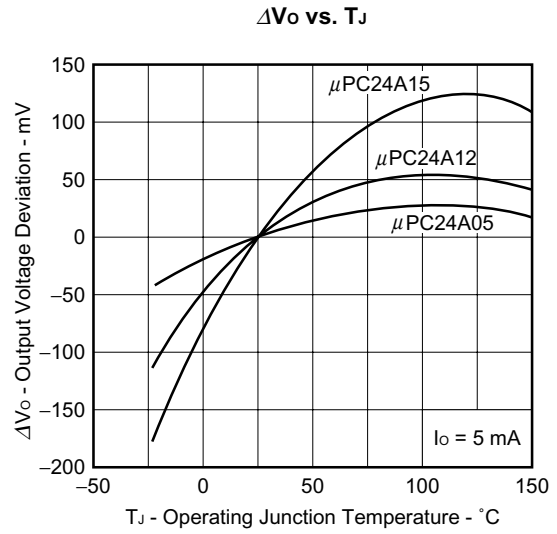
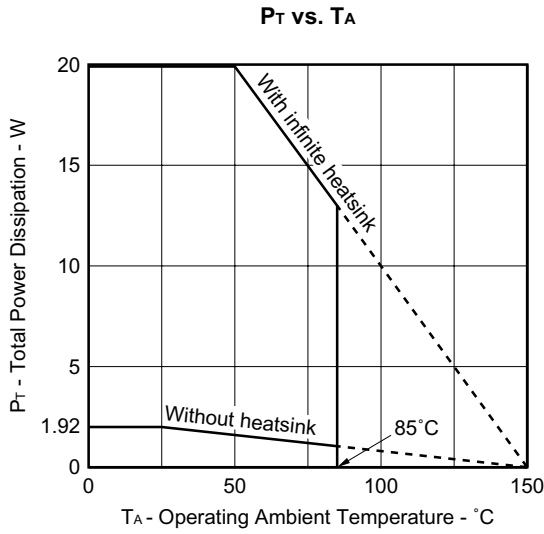
**$\mu$ PC24A12 ( $T_J = 25^\circ\text{C}$ ,  $V_{IN} = 18\text{ V}$ ,  $I_o = 1\text{ A}$ , unless otherwise specified)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Output Voltage	$V_o$		11.75	12.0	12.25	V
		$0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , $13\text{ V} \leq V_{IN} \leq 22\text{ V}$ , $5\text{ mA} \leq I_o \leq 2\text{ A}$	11.65		12.35	V
Line Regulation	$REG_{IN}$	$13\text{ V} \leq V_{IN} \leq 22\text{ V}$		12	100	mV
Load Regulation	$REG_L$	$5\text{ mA} \leq I_o \leq 2\text{ A}$		6	100	mV
Quiescent Current	$I_{BIAS}$	$I_o = 0\text{ A}$		3	5.0	mA
		$I_o = 2\text{ A}$		15	30	mA
Quiescent Current Change	$\Delta I_{BIAS}$	$13\text{ V} \leq V_{IN} \leq 22\text{ V}$ , $I_o = 2\text{ A}$			20	mA
Output Noise Voltage	$V_n$	$10\text{ Hz} \leq f \leq 100\text{ kHz}$		220		$\mu\text{V r.m.s.}$
Ripple Rejection	$R \cdot R$	$f = 120\text{ Hz}$ , $13.5\text{ V} \leq V_{IN} \leq 23.5\text{ V}$	43	50		dB
Dropout Voltage	$V_{DIF}$	$0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , $I_o = 2\text{ A}$			1.0	V
Peak Output Current	$I_{opeak}$	$V_{IN} = 18\text{ V}$	2.8	3.5	4.2	A
Short Circuit Current	$I_{short}$	$V_{IN} = 15\text{ V}$		1.4		A
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$	$0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , $I_o = 5\text{ mA}$		1.0		mV/ $^\circ\text{C}$

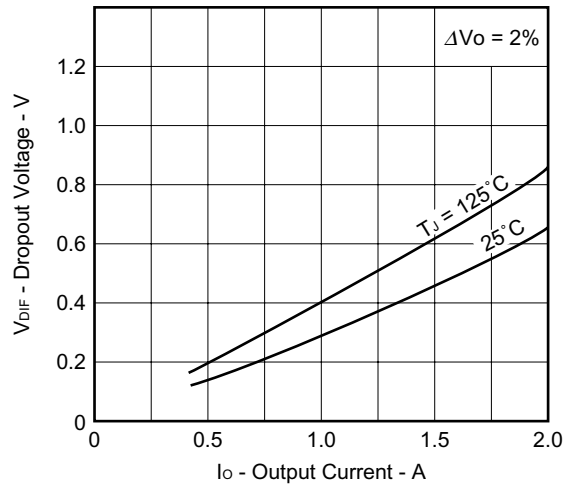
μPC24A15 (T<sub>J</sub> = 25°C, V<sub>IN</sub> = 22 V, I<sub>o</sub> = 1 A, unless otherwise specified)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Output Voltage	V <sub>o</sub>		14.7	15.0	15.3	V
		0°C ≤ T <sub>J</sub> ≤ 125°C, 16 V ≤ V <sub>IN</sub> ≤ 25 V, 5 mA ≤ I <sub>o</sub> ≤ 2 A	14.55		15.45	V
Line Regulation	REG <sub>IN</sub>	17 V ≤ V <sub>IN</sub> ≤ 25 V		18	150	mV
Load Regulation	REG <sub>L</sub>	5 mA ≤ I <sub>o</sub> ≤ 2 A		10	150	mV
Quiescent Current	I <sub>BIAS</sub>	I <sub>o</sub> = 0 A		3	5.0	mA
		I <sub>o</sub> = 2 A		15	30	mA
Quiescent Current Change	ΔI <sub>BIAS</sub>	17 V ≤ V <sub>IN</sub> ≤ 25 V, I <sub>o</sub> = 2 A			20	mA
Output Noise Voltage	V <sub>n</sub>	10 Hz ≤ f ≤ 100 kHz		260		μV <sub>r.m.s.</sub>
Ripple Rejection	R•R	f = 120 Hz, 17 V ≤ V <sub>IN</sub> ≤ 27 V	40	48		dB
Dropout Voltage	V <sub>DIF</sub>	0°C ≤ T <sub>J</sub> ≤ 125°C, I <sub>o</sub> = 2 A			1.0	V
Peak Output Current	I <sub>opeak</sub>	V <sub>IN</sub> = 22 V	2.8	3.5	4.2	A
Short Circuit Current	I <sub>oshort</sub>	V <sub>IN</sub> = 16 V		1.4		A
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT	0°C ≤ T <sub>J</sub> ≤ 125°C, I <sub>o</sub> = 5 mA		1.6		mV/°C

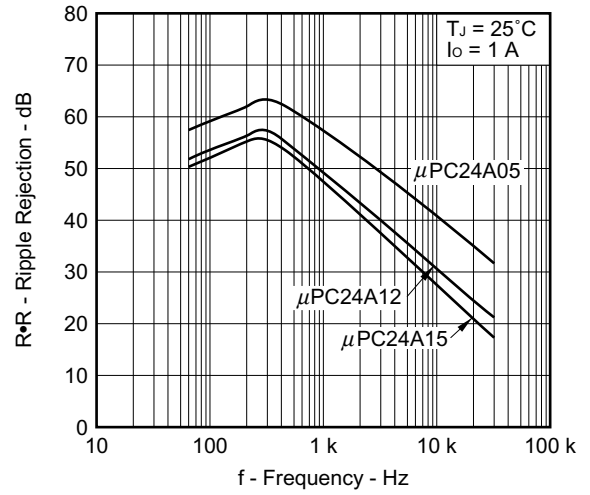
TYPICAL CHARACTERISTICS (Reference Values)



V<sub>DIF</sub> vs. I<sub>o</sub>

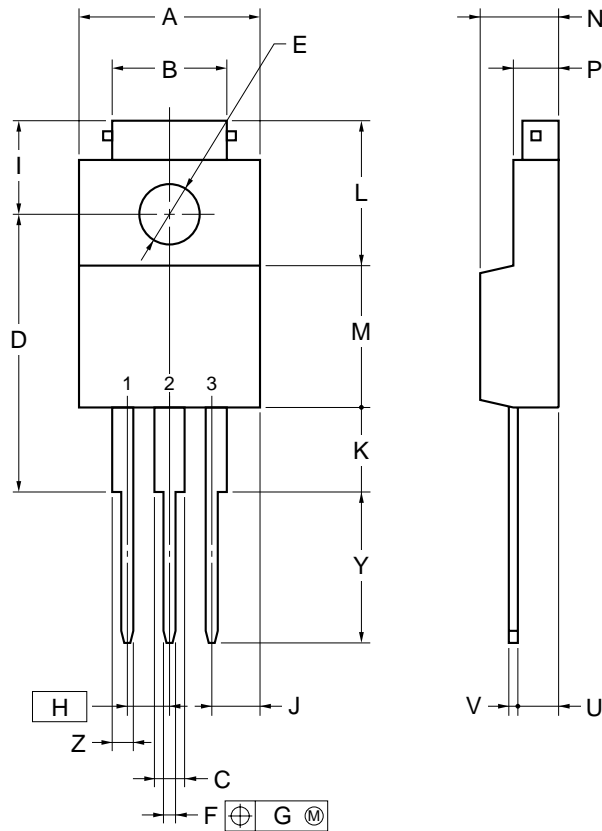


R•R vs. f



PACKAGE DRAWING (Unit: mm)

3PIN PLASTIC SIP (MP-45G)



NOTE

Each lead centerline is located within 0.25 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	10.0±0.2
B	7.0±0.2
C	1.50±0.2
D	17.0±0.3
E	φ3.3±0.2
F	0.75±0.10
G	0.25
H	2.54 (T.P.)
I	5.0±0.3
J	2.46±0.2
K	5.0±0.2
L	8.5±0.2
M	8.5±0.2
N	4.5±0.2
P	2.8±0.2
U	2.4±0.5
V	0.65±0.10
Y	8.9±0.7
Z	1.30±0.2

P3HF-254B-4



**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 below our document.

**"Semiconductor Device Mounting Technology Manual (C10535E)"**

**Type of Through-Hole Device**

**μPC24A05HF, μPC24A12HF, μPC24A15HF: 3-PIN PLASTIC SIP (MP-45G) (Isolated TO-220)**

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

**Caution** Apply wave soldering only to the pins and be careful not to bring solder into direct contact with the package.

**CAUTION ON USE**

- The  $\mu$ PC24A00 series, if the output is short-circuited at  $V_{IN} \geq 20$  V, the output may not be restored after the short-circuit is cancelled. In this case, restore the output by lowering and then reapplying  $V_{IN}$ .
- If a lower than recommended input voltage is used in the  $\mu$ PC24A00 series, a large circuit current will flow due to the saturation of the output stage transistor (refer to the  $I_{BIAS}$  vs.  $V_{IN}$  curves in TYPICAL CHARACTERISTICS). The capacitance for the input side power supply therefore needs to be only enough to enable the current to flow in this circuit at startup. Note also that a resistor cannot be inserted at the GND pin to adjust the output voltage.

## REFERENCE DOCUMENTS

- Quality Grades on NEC Semiconductor Devices (C11531E)
- Semiconductor Device Mounting Technology Manual (C10535E)
- Semiconductors Selection Guide (X10679E)
- Semiconductor Selection Guide -Products and Packages- (X13769X)

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