AN77xxSP Series

3-pin, positive output, low dropout voltage regulator (1.2 A type)

■ Overview

The AN77xxSP series is stabilized constant-voltage power supplies with small difference between I/O voltages (0.5 V typ.). It is suitable for low-voltage, battery-driven equipment, and home appliances and industrial equipment with great fluctuation of the supply voltage.

The output voltage ranges: 3.3 V, 5 V, 7 V, 9 V and 12 V

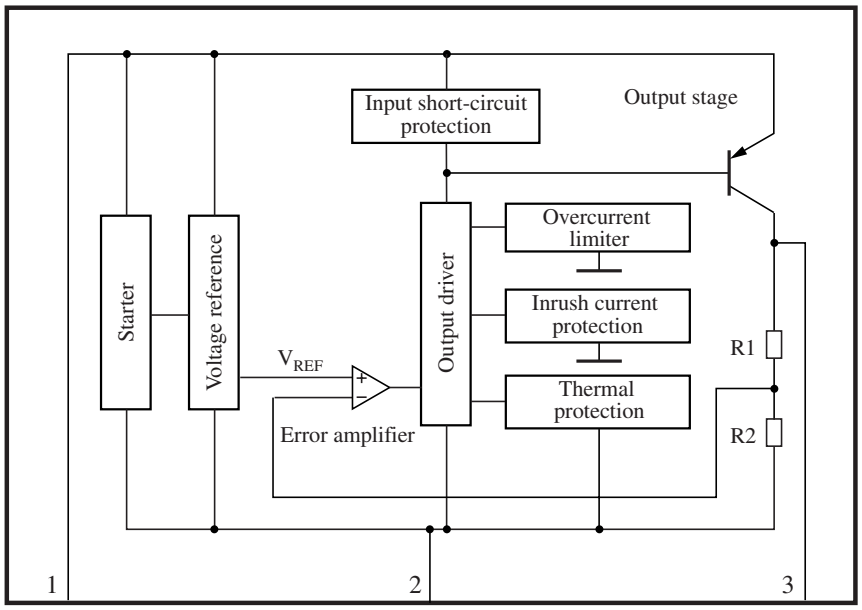
■ Features

- Minimum I/O voltage difference: 0.5 V typ.
- On-chip overcurrent limiter
- On-chip thermal protection circuit
- On-chip inrush current protection circuit at the time of input voltage start-up
- On-chip input short-circuit protection circuit
  (When the input pin is short-circuited to the ground, the circuit between pins 1 and 3 is shut down to prevent current flow.)

■ Applications

- Power supply equipment

■ Block Diagram



■ Pin Descriptions

Pin No.	Description
1	Input pin (In)
2	Ground pin (COM)
3	Output pin (Out)

■ Absolute Maximum Ratings at T_a = 25°C

Parameter	Symbol	Rating	Unit
Supply voltage *2	V_{IN}	30	V
Supply current *3	I_{IN}	2.4	A
Power dissipation *4	P_D	5.0	W
Operating ambient temperature *1	T_{opr}	−30 to +85	°C
Storage temperature *1	T_{stg}	−55 to +150	°C

Note) ∗1: Expect for the operating ambient temperature and storage temperature, all ratings are for T_a = 25°C.

∗2: At the application of V_{IN} = 30 V, the overvoltage protection may be operated by the ASO protection circuit, leading to the output shut down.

∗3: The current value does not exceed this criterion because of the on-chip current limiter.

∗4: The internal circuit shuts off the output when $T_j \geq 150°C$ (designed value). The relationship between the IC power dissipation and ambient temperature shall conform to the derating curve (■ Main Characteristics P_D — T_a).

■ Recommended Operating Conditions at I_{OUT} = 500 mA, T_a = 25°C

Part No.	Output voltage	Operating supply voltage range (V_{IN})	Unit
AN77033SP	3.3	4.3 to 14	V
AN7705SP	5	6 to 16	V
AN7707SP	7	8 to 18	V
AN7709SP	9	10 to 20	V
AN7712SP	12	13 to 23	V

■ Electrical Characteristics at T_a = 25°C

• AN77033SP (3.3 V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_{OUT}	V_{IN} = 4.3 V, I_{OUT} = 500 mA, T_j = 25°C	3.20	3.30	3.40	V
Line regulation	REG_{IN}	V_{IN} = 4.3 V to 14.3 V, I_{OUT} = 500 mA, T_j = 25°C	—	3	35	mV
Load regulation	REG_{LOA}	V_{IN} = 4.3 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	15	70	mV
Input dependency of bias current	$\Delta I_{Bias(IN)}$	V_{IN} = 4.3 V to 14.3 V, I_{OUT} = 500 mA, T_j = 25°C	—	1	10	mA
Load dependency of bias current	$\Delta I_{Bias(LOA)}$	V_{IN} = 4.3 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	10	50	mA
Bias current at no load	I_{Bias}	V_{IN} = 4.3 V, I_{OUT} = 0 mA	—	2.6	5.0	mA
Bias current before the regulation starts	I_{rush}	V_{IN} = 3.0 V, I_{OUT} = 0 mA	—	3	5	mA
Minimum I/O voltage difference 1	$V_{DIF(min)1}$	V_{IN} = 3.7 V, I_{OUT} = 500 mA, T_j = 25°C	—	0.4	0.6	V
Minimum I/O voltage difference 2	$V_{DIF(min)2}$	V_{IN} = 3.7 V, I_{OUT} = 1 200 mA, T_j = 25°C	—	0.5	1.0	V
Peak output current 1 *	$I_{O(Peak)1}$	V_{IN} = 4.3 V, T_j = 25 °C	1.2	1.8	2.4	A
Ripple rejection ratio	RR	V_{IN} = 4.3 V to 8.0 V, I_{OUT} = 100 mA, f = 120 Hz	53	74	—	dB

Note) *: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

• Design reference data

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Peak output current 2 *	$I_{O(Peak)2}$	V_{IN} = 13.3 V, T_j = 25°C	—	1.5	—	A
Peak output current 3 *	$I_{O(Peak)3}$	V_{IN} = 18.3 V, T_j = 25°C	—	1.0	—	A
Output short-circuit current	$I_{O(Short)}$	V_{IN} = 30 V, T_j = 25°C The load is shorted.	—	10	—	mA
Thermal protection operating temperature	$T_{j(TH)}$	V_{IN} = 4.3 V	—	150	—	°C
Output voltage temperature coefficient	a	V_{IN} = 4.3 V, T_j = 25°C to 125°C	—	–40	—	ppm/°C

Note) *: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

■ Electrical Characteristics at T_a = 25°C (continued)

• AN7705SP (5 V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_{OUT}	V_{IN} = 6 V, I_{OUT} = 500 mA, T_j = 25°C	4.85	5.00	5.15	V
Line regulation	REG_{IN}	V_{IN} = 6 V to 16 V, I_{OUT} = 500 mA, T_j = 25°C	—	5	50	mV
Load regulation	REG_{LOA}	V_{IN} = 6 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	25	100	mV
Input dependency of bias current	$\Delta I_{Bias(IN)}$	V_{IN} = 6 V to 16 V, I_{OUT} = 500 mA, T_j = 25°C	—	1	10	mA
Load dependency of bias current	$\Delta I_{Bias(LOA)}$	V_{IN} = 6 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	10	50	mA
Bias current at no load	I_{Bias}	V_{IN} = 6 V, I_{OUT} = 0 mA	—	2.6	5	mA
Bias current before the regulation starts	I_{rush}	V_{IN} = 4.5 V, I_{OUT} = 0 mA	—	3	5	mA
Minimum I/O voltage difference 1	$V_{DIF(min)1}$	V_{IN} = 4.5 V, I_{OUT} = 500 mA, T_j = 25°C	—	0.4	0.6	V
Minimum I/O voltage difference 2	$V_{DIF(min)2}$	V_{IN} = 4.5 V, I_{OUT} = 1 200 mA, T_j = 25°C	—	0.5	1.0	V
Peak output current 1 *	$I_{O(Peak)1}$	V_{IN} = 6 V, T_j = 25°C	1.2	1.8	2.4	A
Ripple rejection ratio	RR	V_{IN} = 6 V to 8 V, I_{OUT} = 100 mA, f = 120 Hz	50	70	—	dB

Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

• Design reference data

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Peak output current 2 *	$I_{O(Peak)2}$	V_{IN} = 15 V, T_j = 25°C	—	1.5	—	A
Peak output current 3 *	$I_{O(Peak)3}$	V_{IN} = 20 V, T_j = 25°C	—	1.0	—	A
Output short-circuit current	$I_{O(Short)}$	V_{IN} = 30 V, T_j = 25°C The load is shorted.	—	10	—	mA
Thermal protection operating temperature	$T_{j(TH)}$	V_{IN} = 6 V	—	150	—	°C
Output voltage temperature coefficient	a	V_{IN} = 6 V, T_j = 25°C to 125°C	—	−40	—	ppm/°C

Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

■ Electrical Characteristics at T_a = 25°C (continued)

• AN7707SP (7 V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_{OUT}	V_{IN} = 8 V, I_{OUT} = 500 mA, T_j = 25°C	6.79	7.00	7.21	V
Line regulation	REG_{IN}	V_{IN} = 8 V to 18 V, I_{OUT} = 500 mA, T_j = 25°C	—	7	70	mV
Load regulation	REG_{LOA}	V_{IN} = 8 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	35	140	mV
Input dependency of bias current	$\Delta I_{Bias(IN)}$	V_{IN} = 8 V to 18 V, I_{OUT} = 500 mA, T_j = 25°C	—	1	10	mA
Load dependency of bias current	$\Delta I_{Bias(LOA)}$	V_{IN} = 8 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	10	50	mA
Bias current at no load	I_{Bias}	V_{IN} = 8 V, I_{OUT} = 0 mA	—	2.6	5.0	mA
Bias current before the regulation starts	I_{rush}	V_{IN} = 6.3 V, I_{OUT} = 0 mA	—	3	5	mA
Minimum I/O voltage difference 1	$V_{DIF(min)1}$	V_{IN} = 6.3 V, I_{OUT} = 500 mA, T_j = 25°C	—	0.4	0.6	V
Minimum I/O voltage difference 2	$V_{DIF(min)2}$	V_{IN} = 6.3 V, I_{OUT} = 1 200 mA, T_j = 25°C	—	0.5	1.0	V
Peak output current 1 *	$I_{O(Peak)1}$	V_{IN} = 8 V, T_j = 25°C	1.2	1.8	2.4	A
Ripple rejection ratio	RR	V_{IN} = 8 V to 10 V, I_{OUT} = 100 mA, f = 120 Hz	47	67	—	dB

Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

• Design reference data

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Peak output current 2 *	$I_{O(Peak)2}$	V_{IN} = 17 V, T_j = 25°C	—	1.5	—	A
Peak output current 3 *	$I_{O(Peak)3}$	V_{IN} = 22 V, T_j = 25°C	—	1.0	—	A
Output short-circuit current	$I_{O(Short)}$	V_{IN} = 30 V, T_j = 25°C The load is shorted.	—	10	—	mA
Thermal protection operating temperature	$T_{j(TH)}$	V_{IN} = 8 V	—	150	—	°C
Output voltage temperature coefficient	a	V_{IN} = 8 V, T_j = 25°C to 125°C	—	–40	—	ppm/°C

Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

■ Electrical Characteristics at T_a = 25°C (continued)

• AN7709SP (9 V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_{OUT}	V_{IN} = 10 V, I_{OUT} = 500 mA, T_j = 25°C	8.73	9.00	9.27	V
Line regulation	REG_{IN}	V_{IN} = 10 V to 20 V, I_{OUT} = 500 mA, T_j = 25°C	—	9	90	mV
Load regulation	REG_{LOA}	V_{IN} = 10 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	45	180	mV
Input dependency of bias current	$\Delta I_{Bias(IN)}$	V_{IN} = 10 V to 20 V, I_{OUT} = 500 mA, T_j = 25°C	—	1	10	mA
Load dependency of bias current	$\Delta I_{Bias(LOA)}$	V_{IN} = 10 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	10	50	mA
Bias current at no load	I_{Bias}	V_{IN} = 10 V, I_{OUT} = 0 mA	—	2.6	5.0	mA
Bias current before the regulation starts	I_{rush}	V_{IN} = 8.1 V, I_{OUT} = 0 mA	—	3	5	mA
Minimum I/O voltage difference 1	$V_{DIF(min)1}$	V_{IN} = 8.1 V, I_{OUT} = 500 mA, T_j = 25°C	—	0.4	0.6	V
Minimum I/O voltage difference 2	$V_{DIF(min)2}$	V_{IN} = 8.1 V, I_{OUT} = 1 200 mA, T_j = 25°C	—	0.5	1.0	V
Peak output current 1 *	$I_{O(Peak)1}$	V_{IN} = 10 V, T_j = 25°C	1.2	1.8	2.4	A
Ripple rejection ratio	RR	V_{IN} = 10 V to 12 V, I_{OUT} = 100 mA, f = 120 Hz	45	65	—	dB

Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

• Design reference data

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Peak output current 2 *	$I_{O(Peak)2}$	V_{IN} = 19 V, T_j = 25°C	—	1.5	—	A
Peak output current 3 *	$I_{O(Peak)3}$	V_{IN} = 24 V, T_j = 25°C	—	1.0	—	A
Output short-circuit current	$I_{O(Short)}$	V_{IN} = 30 V, T_j = 25°C The load is shorted.	—	10	—	mA
Thermal protection operating temperature	$T_{j(TH)}$	V_{IN} = 10 V	—	150	—	°C
Output voltage temperature coefficient	a	V_{IN} = 10 V, T_j = 25°C to 125°C	—	−40	—	ppm/°C

Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

■ Electrical Characteristics at T_a = 25°C (continued)

• AN7712SP (12 V type)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output voltage	V_{OUT}	V_{IN} = 13 V, I_{OUT} = 500 mA, T_j = 25°C	11.64	12.00	12.36	V
Line regulation	REG_{IN}	V_{IN} = 13 V to 23 V, I_{OUT} = 500 mA, T_j = 25°C	—	12	120	mV
Load regulation	REG_{LOA}	V_{IN} = 13 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	60	240	mV
Input dependency of bias current	$\Delta I_{Bias(IN)}$	V_{IN} = 13 V to 23 V, I_{OUT} = 500 mA, T_j = 25°C	—	1	10	mA
Load dependency of bias current	$\Delta I_{Bias(LOA)}$	V_{IN} = 13 V, I_{OUT} = 0 mA to 1 200 mA, T_j = 25°C	—	10	50	mA
Bias current at no load	I_{Bias}	V_{IN} = 13 V, I_{OUT} = 0 mA	—	2.6	5.0	mA
Bias current before the regulation starts	I_{rush}	V_{IN} = 10.8 V, I_{OUT} = 0 mA	—	3	5	mA
Minimum I/O voltage difference 1	$V_{DIF(min)1}$	V_{IN} = 10.8 V, I_{OUT} = 500 mA, T_j = 25°C	—	0.4	0.6	V
Minimum I/O voltage difference 2	$V_{DIF(min)2}$	V_{IN} = 10.8 V, I_{OUT} = 1 200 mA, T_j = 25°C	—	0.5	1.0	V
Peak output current 1 *	$I_{O(Peak)1}$	V_{IN} = 13 V, T_j = 25°C	1.2	1.8	2.4	A
Ripple rejection ratio	RR	V_{IN} = 13 V to 15 V, I_{OUT} = 100 mA, f = 120 Hz	42	62	—	dB

Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

• Design reference data

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Peak output current 2 *	$I_{O(Peak)2}$	V_{IN} = 22 V, T_j = 25°C	—	1.5	—	A
Peak output current 3 *	$I_{O(Peak)3}$	V_{IN} = 27 V, T_j = 25°C	—	1.0	—	A
Output short-circuit current	$I_{O(Short)}$	V_{IN} = 30 V, T_j = 25°C The load is shorted.	—	10	—	mA
Thermal protection operating temperature	$T_{j(TH)}$	V_{IN} = 13 V	—	150	—	°C
Output voltage temperature coefficient	a	V_{IN} = 13 V, T_j = 25°C to 125°C	—	–40	—	ppm/°C

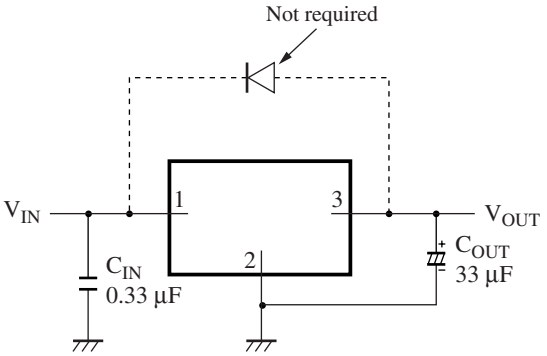
Note) ∗: This current exceeds $P_{D(max)}$ because it is a parameter during abnormal (overcurrent) operation. However, normally, it shall conform to the derating curve (■ Main Characteristics P_D — T_a).

■ Usage Notes

1. Input short-circuit protection circuit

When the DC input pin (pin 1) and the ground pin (pin 2) of our conventional three-pin regulators (AN78xxNSP series, etc.) were short-circuited at normal use conditions in some cases, the voltage of the output pin (pin 3) becomes higher than that of the DC input pin and electrons charged in the output capacitor C_{OUT} flow into the input side, resulting in break of the element.

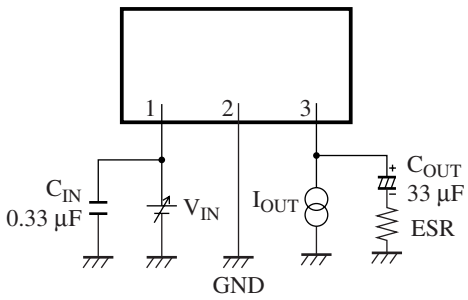
In those cases, it was necessary for you to connect a general silicon diode as shown in the figure on the right. In the AN77xxSP series, however, it is not necessary to connect the protection diode because these series have a built-in protection circuit to safeguard the element from discharge current.



2. Capacitor for external compensation

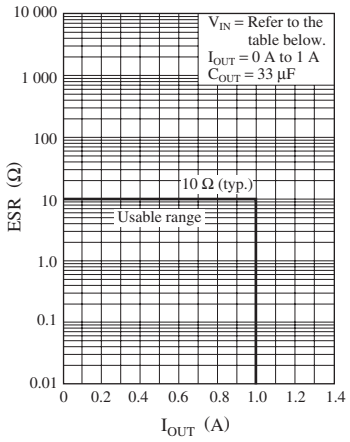
To maintain the stability, insert a 33 mF capacitor as close to pin 3 and pin 2 as possible. In case of using at low temperature, decrease in capacity of the aluminum electrolytic capacitor and increase of ESR of this capacitor may lead to oscillation.

In the AN77xxSP series, for the output capacitor C_{OUT} , it is recommended to use an aluminum electrolytic capacitor or tantalum capacitor whose equivalent series resistance (ESR) has the temperature characteristic within the recommended area shown on the right.



Output capacitor ESR

(Equivalent series resistance) T_a = 25°C



3. Others

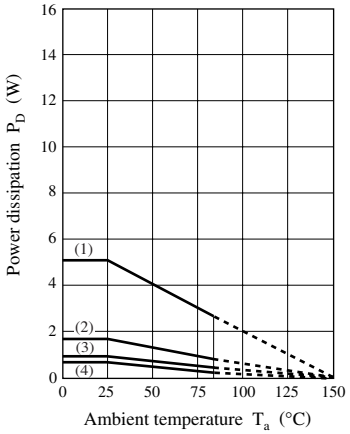
Cautions for the input voltage that exceeds the operating supply voltage:

1) The overvoltage protection is activated with the ASO protection circuit when V_{IN} = 30 V is applied, and the output shuts down occasionally. (3 V type to 10 V type)
2) Please note that at I_{OUT} < 2 mA, the output voltage rises and may exceed the maximum of the operation range. (12 V type to 24 V type)

Part No.	V_{IN}
AN77033SP	4.3 V to 14 V
AN7705SP	6 V to 16 V
AN7707SP	8 V to 18 V
AN7709SP	10 V to 20 V
AN7712SP	13 V to 23 V

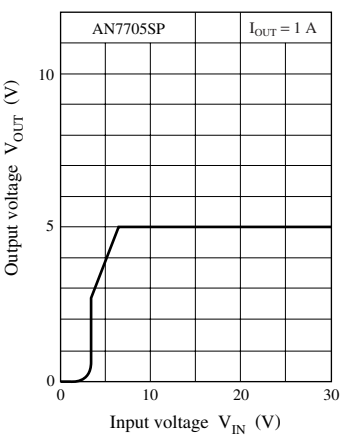
■ Main Characteristics

P_D — T_a

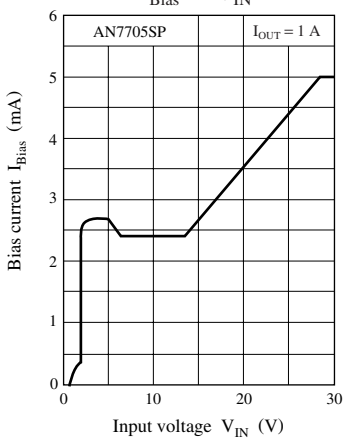


(1) When AL board is mounted
(Basic size : 50 × 50 × t2.0 mm³)
$R_{th(j-a)}$ = 25.0°C/W
(2) When glass epoxy is mounted 2
(Basic size : 50 × 50 × t1.5 mm³)
$R_{th(j-a)}$ = 89.3°C/W
(3) When glass epoxy is mounted 1
(Basic size : 50 × 50 × t1.7 mm³)
$R_{th(j-a)}$ = 147.0°C/W
(4) Without heat sink
$R_{th(j-a)}$ = 178.0°C/W

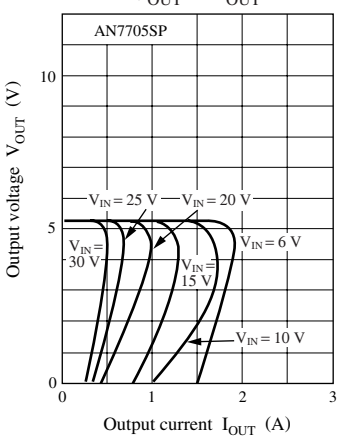
V_{OUT} — V_{IN}



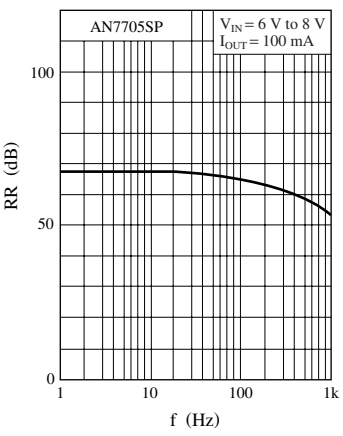
I_{Bias} — V_{IN}



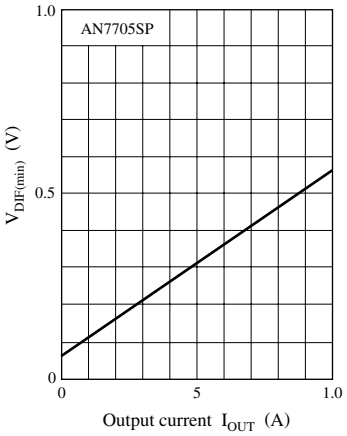
V_{OUT} — I_{OUT}



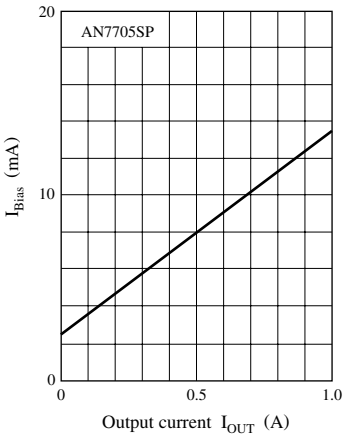
RR — f



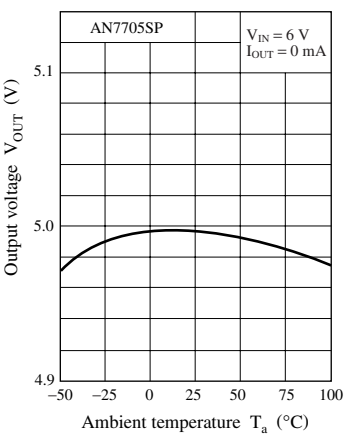
$V_{DIF(min)}$ — I_{OUT}



I_{Bias} — I_{OUT}

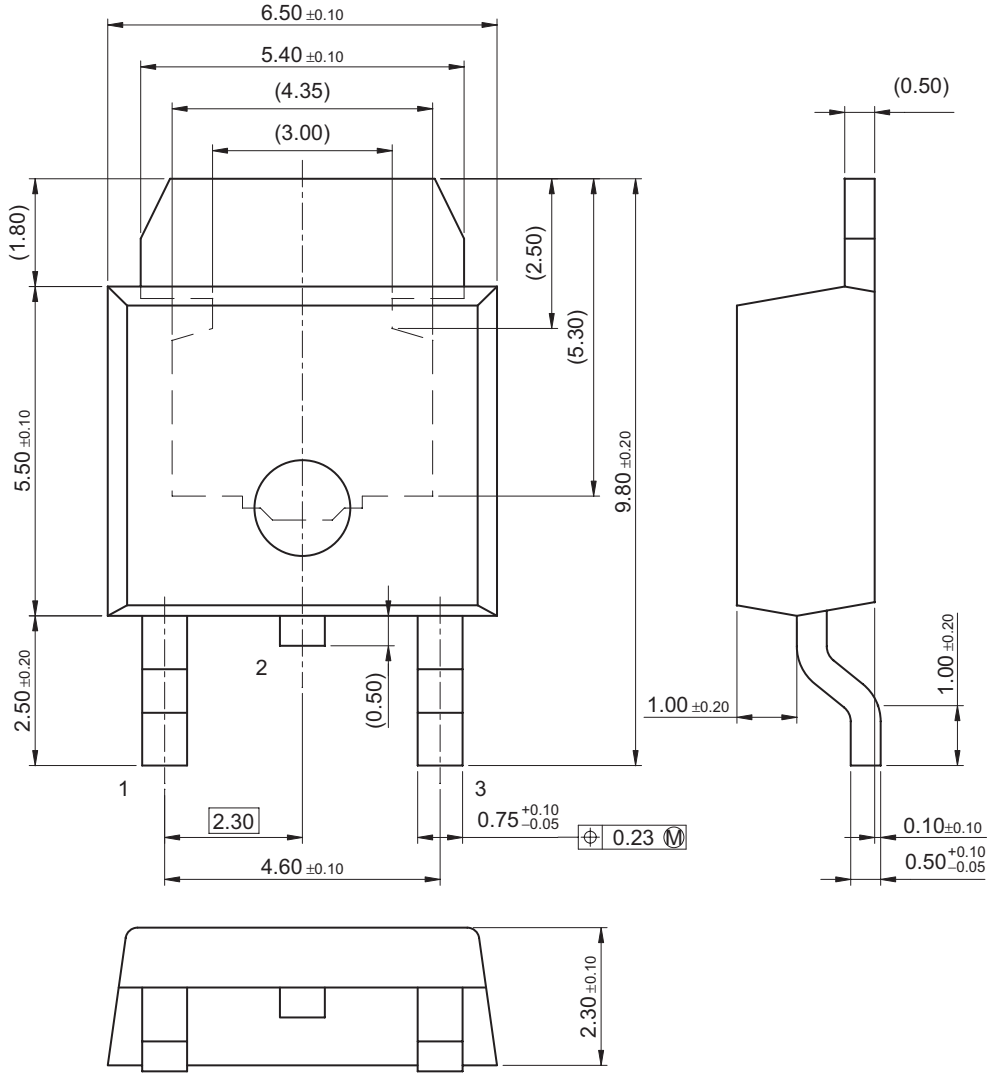


V_{OUT} — T_a



■ Package Dimensions (Unit: mm)

• SP-3SUA



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- Special applications (such as for airplanes, aerospace, automobiles, traffic control equipment, combustion equipment, life support systems and safety devices) in which exceptional quality and reliability are required, or if the failure or malfunction of the products may directly jeopardize life or harm the human body.
- Any applications other than the standard applications intended.

(4) The products and product specifications described in this book are subject to change without notice for modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.

(5) When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.
Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.

(6) Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.