Regulator ICs

Regulator, low drop-out type with ON/OFF switch

BA○○ST / BA○○SFP series

The BA○○ST and BA○○SFP series are variable, fixed output low drop-out type voltage regulators with an ON/OFF switch.
These regulators are used to provide a stabilized output voltage from a fluctuating DC input voltage.
Fixed output voltages are 3.3V, 5V, 6V(SFP), 7V, 8V, 9V, 10V(ST), 12V(ST). The maximum current capacity is 1 A for each of the above voltages.

●Application
Constant voltage power supply

●Features
1) Built-in overvoltage protection circuit, overcurrent protection circuit and thermal shutdown circuit
2) TO220FP-5, TO252-5 standard packages can be accomodated in wide application.
3) 0µA (design value) circuit current when switch is off
4) Richly diverse lineup.
5) Low minimum I/O voltage differential.

●Product codes

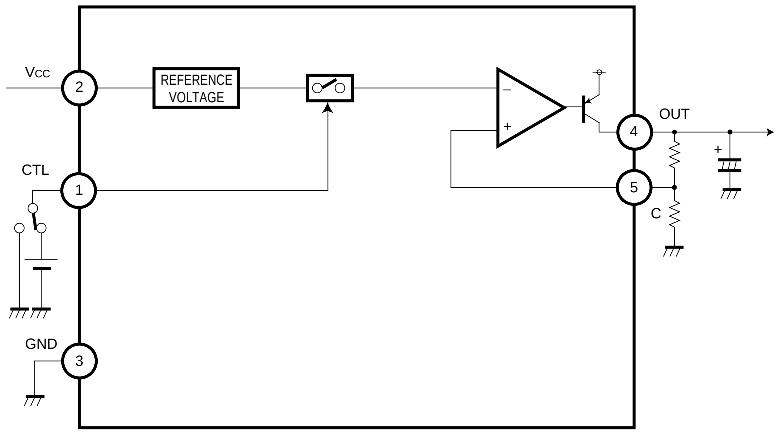
Output voltage (V)	Product No.	Output voltage (V)	Product No.
Variable	BA00AST / ASFP	8.0	BA08ST / SFP
3.3	BA033ST / SFP	9.0	BA09ST / SFP
5.0	BA05ST / SFP	10.0	BA10ST
6.0	BA06SFP	12.0	BA12ST
7.0	BA07ST / SFP		

●Absolute maximum ratings (Ta=25°C)

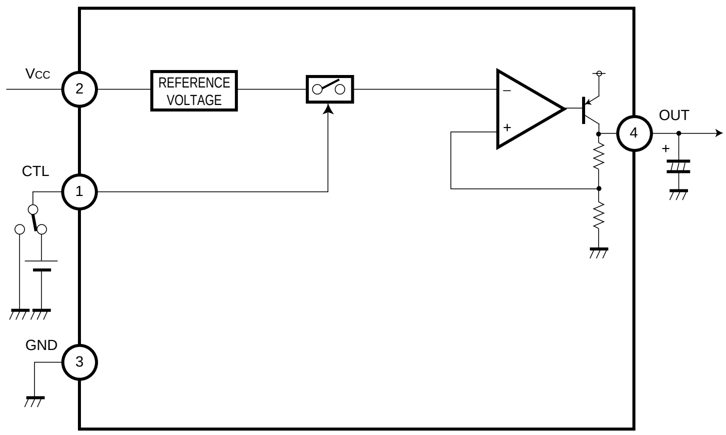
Parameter		Symbol	Limits	Unit
Power supply voltage		V_{CC}	35	V
Power dissipation	TO220FP-5	Pd	2000 *1	mW
	TO252-5		1000 *2	
Operating temperature		Topr	-40~+85	˚C
Storage temperature		Tstg	-55~+150	˚C
Peak applied voltage		Vsurge	50 *3	V

*1 Reduced by 16mW for each increase in Ta of 1˚C over 25˚C.
*2 Reduced by 8mW for each increase in Ta of 1˚C over 25˚C.
*3 Voltage application time : 200 msec. or less

●Block diagram



Variable output type (BA00AST / ASFP)



Fixed output type

●Pin descriptions

Pin No.	Pin name	Function
1	CTL	Output ON/OFF
2	Vcc	Power supply input
3	GND	Ground
4	OUT	Output
5	C	Reference power supply pin for setting voltage with the BA00AST/ASFP.
	N.C.	In the BAOOST/SFP Series, these are NC pins, except for the BA00AST/ASFP.

●Recommended operating conditions

BA00AST / ASFP

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	4	25	V
Output current	I_O	-	1	A

BA033ST / SFP

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	4.3	25	V
Output current	I_O	-	1	A

BA05ST / SFP

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	6	25	V
Output current	I_O	-	1	A

BA06SFP

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	7	25	V
Output current	I_O	-	1	A

BA07ST / SFP

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	8	25	V
Output current	I_O	-	1	A

BA08ST / SFP

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	9	25	V
Output current	I_O	-	1	A

BA09ST / SFP

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	10	25	V
Output current	I_O	-	1	A

BA10ST

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	11	25	V
Output current	I_O	-	1	A

BA12ST

Parameter	Symbol	Min.	Max.	Unit
Input voltage	V_{CC}	13	25	V
Output current	I_O	-	1	A

●Electrical characteristics

BA00AST / ASFP (unless otherwise noted, Ta=25°C, Vcc=10V, Io=500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Reference voltage	V_{ref}	1.200	1.225	1.250	V		Fig.1
Power save current	Ist	-	0	10	µA	OFF mode	Fig.4
Output voltage	V_O	-	5.0	-	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=6→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.01	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=0.95V_O	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	µA	CTL=5V, I_O=0mA	Fig.6

BA033ST / SFP (unless otherwise noted, Ta=25°C, Vcc=8 V, Io=500 mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	µA	OFF mode	Fig.4
Output voltage	V_{O1}	3.13	3.3	3.47	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=4=.3→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=0.95V_O	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	µA	CTL=5V, I_O=0mA	Fig.6

BA05ST / SFP (unless otherwise noted, Ta=25°C, Vcc=10 V, Io=500 mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	µA	OFF mode	Fig.4
Output voltage	V_{O1}	4.75	5.0	5.25	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=6→2=5V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=4.75V	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	µA	CTL=5V, I_O=0mA	Fig.6

BA06SFP (unless otherwise noted, Ta=25°C, Vcc=11 V, Io=500 mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	µA	OFF mode	Fig.4
Output voltage	V_{O1}	5.7	6.0	6.3	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=7→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=5.7V	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	µA	CTL=5V, I_O=0mA	Fig.6

BA07ST / SFP (unless otherwise noted, Ta=25°C, Vcc=12 V, Io=500 mA) (under development)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	μA	OFF mode	Fig.4
Output voltage	V_{O1}	6.65	7.0	7.35	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=8→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=6.65V	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	μA	CTL=5V, I_O=0mA	Fig.6

BA08ST / SFP (unless otherwise noted, Ta=25°C, Vcc=13 V, Io=500 mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	μA	OFF mode	Fig.4
Output voltage	V_{O1}	7.6	8.0	8.4	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}9→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=0.95V_O	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	μA	CTL=5V, I_O=0mA	Fig.6

BA09ST / SFP (unless otherwise noted, Ta=25°C, Vcc=14 V, Io=500 mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	μA	OFF mode	Fig.4
Output voltage	V_{O1}	8.55	9.0	9.45	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=10→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=0.95V_O	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	μA	CTL=5V, I_O=0mA	Fig.6

BA10ST (unless otherwise noted, Ta=25°C, Vcc=15 V, Io=500 mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	µA	OFF mode	Fig.4
Output voltage	V_{O1}	9.5	10	10.5	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=11→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=0.95V_O	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	µA	CTL=5V, I_O=0mA	Fig.6

BA12ST (unless otherwise noted, Ta=25°C, Vcc=17 V, Io=500 mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save current	I_{ST}	-	0	10	µA	OFF mode	Fig.4
Output voltage	V_{O1}	11.4	12	12.6	V		Fig.1
Input stability	Reg.I	-	20	100	mV	V_{CC}=13→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	-	dB	e_{IN}=1Vrms, f=120Hz, I_O=100mA	Fig.2
Load regulation	Reg.L	-	50	150	mV	I_O=5mA→1A	Fig.1
Temperature coefficient of output voltage	T_{CVO}	-	±0.02	-	% / ˚C	I_O=5mA, Tj=0~125˚C	Fig.1
Minimum I/O voltage differential	V_d	-	0.3	0.5	V	V_{CC}=0.95V_O	Fig.3
Bias current	I_b	-	2.5	5.0	mA	I_O=0mA	Fig.4
Peak output current	I_O	1.0	1.5	-	A	Tj=25˚C	Fig.1
Output short-circuit current	I_{OS}	-	0.4	-	A	V_{CC}=25V	Fig.5
ON mode voltage	Vth1	2.0	-	-	V	Output Active mode, I_O=0mA	Fig.6
OFF mode voltage	Vth2	-	-	0.8	V	Output OFF mode, I_O=0mA	Fig.6
Input high level current	I_{IN}	100	200	300	µA	CTL=5V, I_O=0mA	Fig.6

●**Measurement circuits**

(The C pin only exists on the BA00AST / ASFP, for the BA00AST / ASFP, place a 6.8kΩ resistor between the OUT and C pins, and a 2.2kΩ resisitor between the C and pins.)

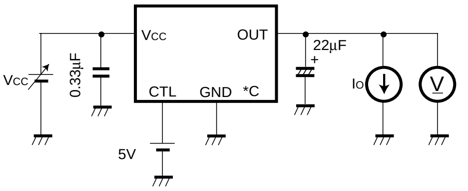
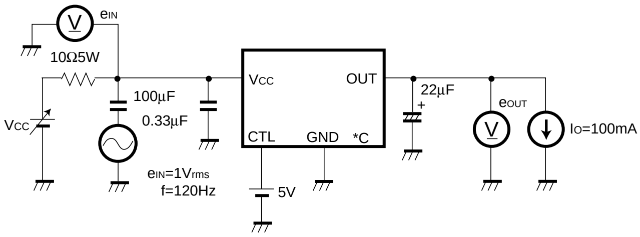


Fig.1 Measurement circuit for output voltage, input stability, load regulation, and temperature coefficient of output voltage



Ripple rejection ratio R.R. = 20 log $\left(\frac{|e_{IN}|}{|e_{OUT}|}\right)$

Fig.2 Measurement circuit for ripple rejection ratio

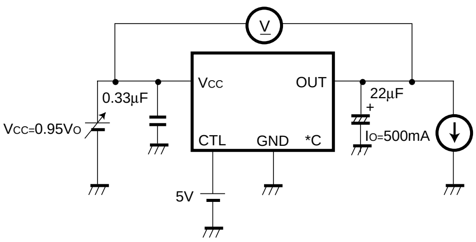


Fig.3 Measurement circuit for minimum I/O voltage differential

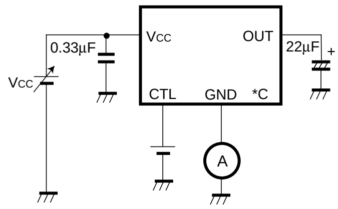


Fig.4 Measurement circuit for bias current, power save current measurement circuit

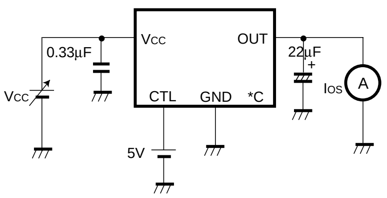


Fig.5 Measurement circuit for output short-circuit current

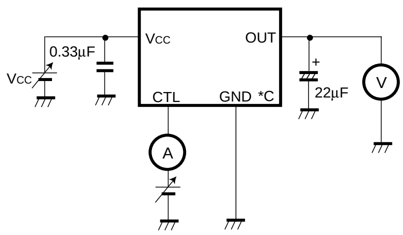


Fig.6 Measurement circuit for ON/OFF mode voltage, input high level current

●Operation notes

(1) Operating power supply voltage

When operating within the normal voltage range and within the ambient operating temperature range, most circuit functions are guaranteed. The rated values cannot be guaranteed for the electrical characteristics, but there are no sudden changes of the characteristics within these ranges.

(2) Power dissipation

Heat attenuation characteristics are noted on a separate page and can be used as a guide in judging power dissipation. If these ICs are used in such a way that the allowable power dissipation level is exceeded, an increase in the chip temperature could cause a reduction in the current capability or could otherwise adversely affect the performance of the IC. Make sure a sufficient margin is allowed so that the allowable power dissipation value is not exceeded.

(3) Output oscillation prevention and bypass capacitor

Be sure to connect a capacitor between the output pin and GND to prevent oscillation. Since fluctuations in the valve of the capacitor due to temperature changes may cause oscillations, a tantalum electrolytic capacitor with a small internal series resistance (ESR) is recommended.

A 22µF capacitor is recommended; however, be aware that if an extremely large capacitance is used (1000µF or greater), then oscillations may occur at low frequencies. Therefore, be sure to perform the appropriate verifications before selecting the capacitor.

Also, we recommend connecting a 0.33µF bypass capacitor as close as possible between the input pin and GND.

(4) Current overload protection circuit

A current overload protection circuit is built into the outputs, to prevent IC destruction if the load is shorted.

This protection circuit limits the current in the shape of a fall back characteristics. It is designed with a high margin, so that even if a large current suddenly flows through the large capacitor in the IC, the current is restricted and latching is prevented.

However, these protection circuits are only good for pre-venting damage from sudden accidents. The design should take this into consideration, so that the protection circuit is not made to operate continuously (for instance, clamping at an output of $1V_F$ or greater; below $1V_F$, the short mode circuit operates). Note that the capacitor has negative temperature characteristics, and the design should take this into consideration.

(5) Thermal overload circuit

A built-in thermal overload circuit prevents damage from overheating. When the thermal circuit is activated, the various outputs are in the OFF state. When the temperature drops back to a constant level, the circuit is restored.

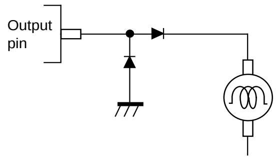
(6) Internal circuits could be damaged if there are modes in which the electric potential of the application’s input (V_{CC}) and GND are the opposite of the electric potential of the various outputs. Use of a diode or other such bypass path is recommended.

(7) Although the manufacture of this product includes rigorous quality assurance procedures, the product may be damaged if absolute maximum ratings for voltage or operating temperature are exceeded. If damage has occurred, special modes (such as short circuit mode or open circuit mode) cannot be specified. If it is possible that such special modes may be needed, please consider using a fuse or some other mechanical safety measure.

(8) When used within a strong magnetic field, be aware that there is a slight possibility of malfunction.

(9) When the connected load which contains a big inductance component in an output terminal is connected and the occurrence of a reverse electromotive force can be considered at the time of and power-output OFF at the time of starting, I ask the insertion of protection diode of you.

(Example)



(10) Although it is sure that the example of an application circuit should be recommended, in a usage, I fully ask the validation of a property of you.

In addition, when you alter the circuit constant with outside and you become a usage, please see and decide sufficient margin in consideration of the dispersion in an external component and IC of our company etc. not only including the static characteristic but including a transient characteristic.

This IC is monolithic IC and has P+ isolation and P substrate for an isolation between each element.

A P-N junction is formed by these P layers and N layers of each element, and various kinds of parasitic elements are formed. For example, when the resistor and the transistor are connected with the pin like the example of a simple architecture,

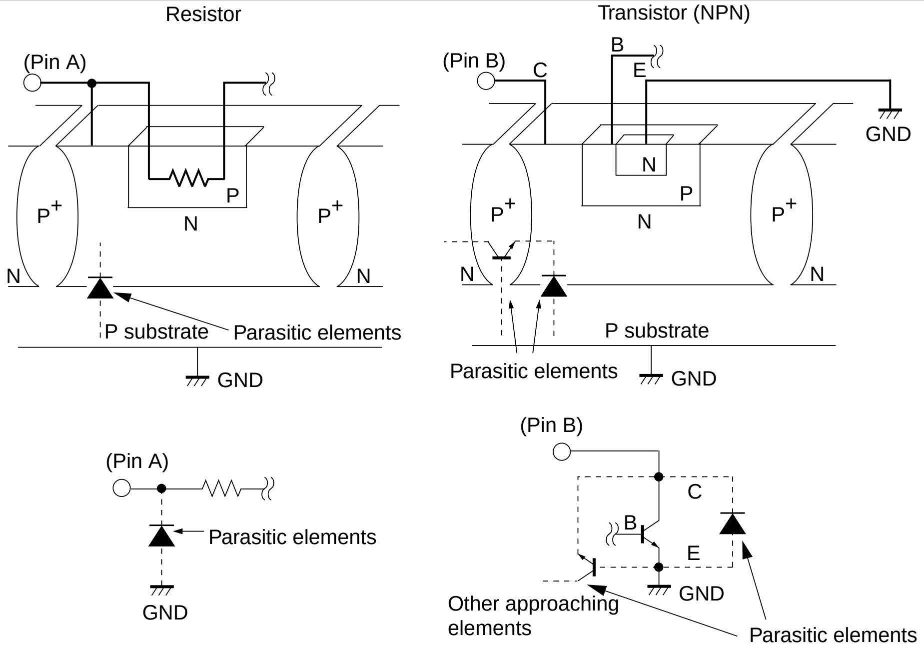
•At a resistor, it is at the time of GND > (PIN A), at a transistor (NPN), it is at the time of GND > (PIN B),
A P-N junction operates as parasitism diode.

•At a transistor (NPN), it is at the time of GND > (PIN B),
The NPN transistor of a parasitic element operates by N layers of other elements which approach with the above-mentioned parasitism diode.

A parasitic element is inevitably made according to a potential relation on the architecture of IC.

When a parasitic element operates, the interference of a circuit operation is caused and the cause of a malfunction, as a result a destructive is obtained.

Therefore, please be fully careful of impressing a voltage lower than GND(P substrate) to an input/output terminal etc. not to carry out usage with which a parasitic element operates.



The example of a simple architecture of bipolar IC

●Electrical characteristic curves

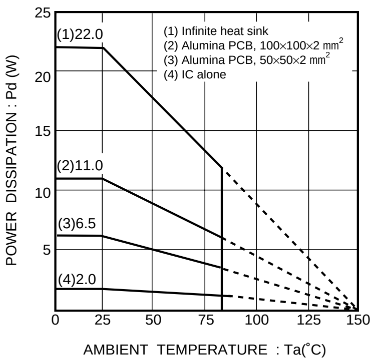


Fig. 7 Thermal derating curves (TO220FP-5)

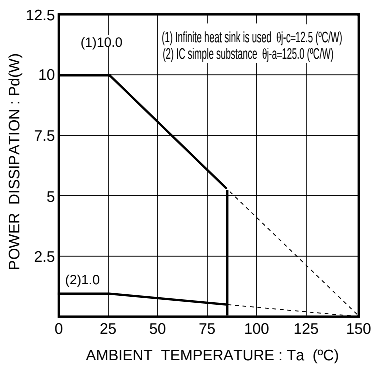


Fig.8 Thermal derating curves (TO252-5)

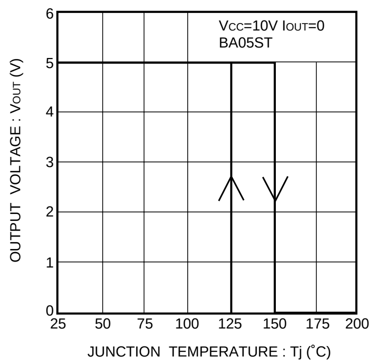


Fig.9 Thermal cutoff circuit characteristics

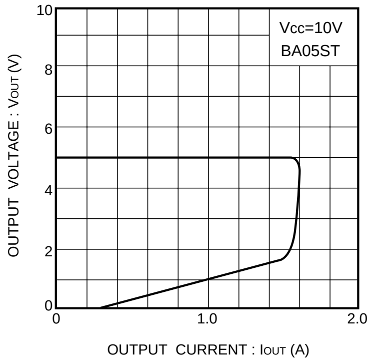


Fig.10 Current limit characteristics

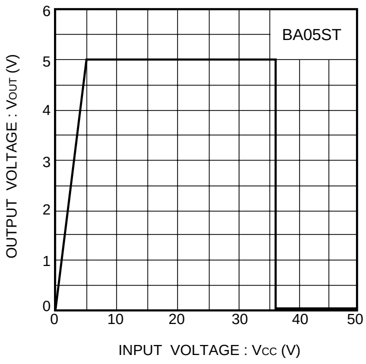


Fig.11 Over voltage protection characteristics

●**External Dimensions** (Units: mm)