Low saturation voltage type 3-pin regulator

BA○○T / FP series

The BA○○T / FP series are fixed positive output low drop-out type, 3-pin voltage regulators with positive output. These regulators are used to provide a stabilized output voltage from a fluctuating DC input voltage.
There are 10 fixed output voltages, as follows:3V, 3.3V, 5V, 6V*, 7V, 8V, 9V, 10V, 12V and 15V. The maximum current capacity is 1A for each of the above voltages. (Items marked with an asterisk are under development.)

●Applications

Constant voltage power supply

●Features

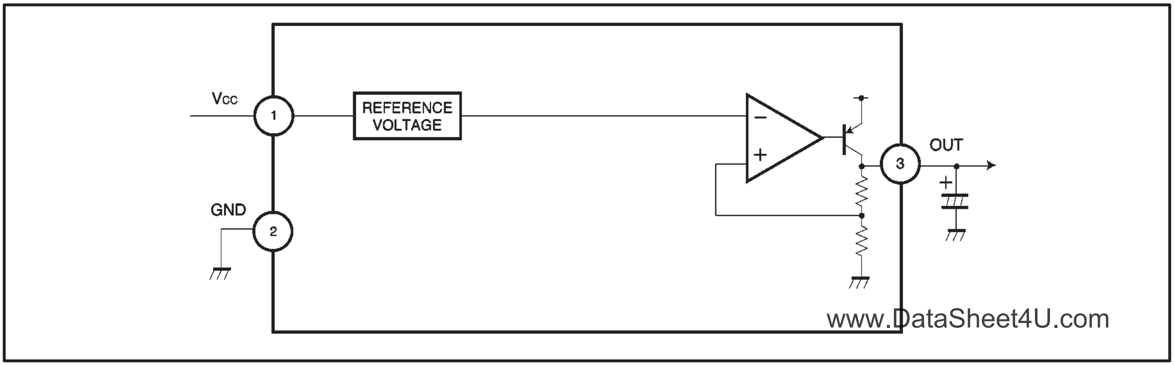
1) Built-in overvoltage protection circuit, overcurrent protection circuit and thermal shutdown circuit.
2) TO220FP and TO252-3 packages are available to cover a wide range of applications.
3) Compatible with the BA178○○ series.
4) Richly diverse lineup.
5) Low minimum I / O voltage differential.

●Product codes

Output voltage (V)	Product No.	Output voltage (V)	Product No.
3.0	BA03T / FP	8.0	BA08T / FP
3.3	BA033T / FP	9.0	BA09T / FP
5.0	BA05T / FP	10.0	BA10T / FP
6.0	BA06T* / FP*	12.0	BA12T / FP
7.0	BA07T / FP	15.0	BA15T / FP

* : Under development.

●Block diagram



●Absolute maximum ratings (Ta = 25°C)

Parameter		Symbol	Limits	Unit
Power supply voltage		Vcc	35	V
Power dissipation	TO220FP	Pd	2000 *1	mW
	TO252 - 3		1000 *2	
Operating temperature		Topr	−40～85	℃
Storage temperature		Tstg	−55～150	℃
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

●Recommended operating conditions

BA03T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	4	—	25	V
Output current	Io	—	—	1	A

BA033T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	4.3	—	25	V
Output current	Io	—	—	1	A

BA05T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	6	—	25	V
Output current	Io	—	—	1	A

BA06T/FP (under development)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	7	—	25	V
Output current	Io	—	—	1	A

BA07T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	8	—	25	V
Output current	Io	—	—	1	A

BA08T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	9	—	25	V
Output current	Io	—	—	1	A

BA09T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	10	—	25	V
Output current	Io	—	—	1	A

BA10T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	11	—	25	V
Output current	Io	—	—	1	A

BA12T/FP

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	13	—	25	V
Output current	Io	—	—	1	A

BA15T/FP (under development)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	16	—	25	V
Output current	Io	—	—	1	A

●Electrical characteristics

BA03T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 8V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	2.85	3.0	3.15	V	−	Fig.1
Input stability	Reg.I	−	20	100	mV	V_{IN}=4→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	−	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	−	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	−	±0.02	−	% / ℃	Io=5mA, Tj=0～125℃	Fig.1
Dropout voltage	V_d	−	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	−	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	I_{O-P}	1.0	1.5	−	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	−	0.4	−	A	Vcc=25V	Fig.5

BA033T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 8V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	3.13	3.3	3.47	V	−	Fig.1
Input stability	Reg.I	−	20	100	mV	V_{IN}=4.3→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	−	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	−	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	−	±0.02	−	% / ℃	Io=5mA, Tj=0～125℃	Fig.1
Dropout voltage	V_d	−	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	−	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	I_{O-P}	1.0	1.5	−	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	−	0.4	−	A	Vcc=25V	Fig.5

BA05T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 10V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions−	Measurement circuit
Output voltage	V_{O1}	4.75	5.0	5.25	V	−	Fig.1
Input stability	Reg.I	−	20	100	mV	V_{IN}=6→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	−	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	−	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	−	±0.02	−	% / ℃	Io=5mA, Tj=0～125℃	Fig.1
Dropout voltage	V_d	−	0.3	0.5	V	Vcc=4.75V	Fig.3
Bias current	I_b	−	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	I_{O-P}	1.0	1.5	−	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	−	0.4	−	A	Vcc=25V	Fig.5

BA06T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 11V, Io = 500mA) (under development)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	5.7	6.0	6.3	V	−	Fig.1
Input stability	Reg.I	−	20	100	mV	V_{IN}=7→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	−	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	−	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	−	±0.02	−	% / ℃	Io=5mA, Tj=0〜125℃	Fig.1
Dropout voltage	V_d	−	0.3	0.5	V	Vcc=0.95V	Fig.3
Bias current	I_b	−	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	$I_{O\text{-}P}$	1.0	1.5	−	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	−	0.4	−	A	Vcc=25V	Fig.5

BA07T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 12V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	6.65	7.0	7.35	V	−	Fig.1
Input stability	Reg.I	−	20	100	mV	V_{IN}=8→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	−	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	−	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	−	±0.02	−	% / ℃	Io=5mA, Tj=0〜125℃	Fig.1
Dropout voltage	V_d	−	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	−	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	$I_{O\text{-}P}$	1.0	1.5	−	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	−	0.4	−	A	Vcc=25V	Fig.5

BA08T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 13V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
Output voltage	V_{O1}	7.6	8.0	8.4	V	−	Fig.1
Input stability	Reg.I	−	20	100	mV	V_{IN}=9→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	−	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	−	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	−	±0.02	−	% / ℃	Io=5mA, Tj=0〜125℃	Fig.1
Dropout voltage	V_d	−	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	−	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	$I_{O\text{-}P}$	1.0	1.5	−	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	−	0.4	−	A	Vcc=25V	Fig.5

BA09T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 14V, Io = 500mA) (under development)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	8.45	9.0	9.45	V	–	Fig.1
Input stability	Reg.I	–	20	100	mV	V_{IN}=10→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	–	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	–	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	–	±0.02	–	% / ℃	Io=5mA, Tj=0～125℃	Fig.1
Dropout voltage	V_d	–	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	–	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	$I_{O\text{-}P}$	1.0	1.5	–	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	–	0.4	–	A	Vcc=25V	Fig.5

BA10T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 15V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	9.5	10	10.5	V	–	Fig.1
Input stability	Reg.I	–	20	100	mV	V_{IN}=11→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	–	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	–	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	–	±0.02	–	% / ℃	Io=5mA, Tj=0～125℃	Fig.1
Dropout voltage	V_d	–	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	–	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	$I_{O\text{-}P}$	1.0	1.5	–	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	–	0.4	–	A	Vcc=25V	Fig.5

BA12T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 17V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	11.4	12	12.6	V	–	Fig.1
Input stability	Reg.I	–	20	100	mV	V_{IN}=13→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	–	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	–	50	150	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	–	±0.02	–	% / ℃	Io=5mA, Tj=0～125℃	Fig.1
Dropout voltage	V_d	–	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	–	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	$I_{O\text{-}P}$	1.0	1.5	–	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	–	0.4	–	A	Vcc=25V	Fig.5

BA15T / FP (unless otherwise noted, Ta = 25°C, V_{CC} = 20V, Io = 500mA)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Output voltage	V_{O1}	14.25	15	15.75	V	—	Fig.1
Input stability	Reg.I	—	20	100	mV	V_{IN}=6→25V	Fig.1
Ripple rejection ratio	R.R.	45	55	—	dB	e_{IN}=1V_{rms}, f=120Hz, Io=100mA	Fig.2
Load regulation	Reg.L	—	90	200	mV	Io=5mA→1A	Fig.1
Temperature coefficient of output voltage	Tcvo	—	±0.02	—	% / ℃	Io=5mA, Tj=0～125℃	Fig.1
Dropout voltage	V_d	—	0.3	0.5	V	Vcc=0.95V_O	Fig.3
Bias current	I_b	—	2.5	5.0	mA	Io=0mA	Fig.4
Peak output current	I_{O-P}	1.0	1.5	—	A	Tj=25℃	Fig.1
Output short-circuit current	Ios	—	0.4	—	A	Vcc=30V	Fig.5

●Measurement circuits

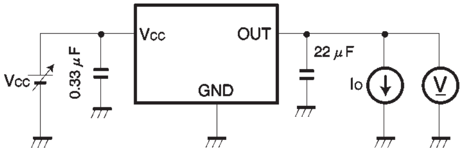
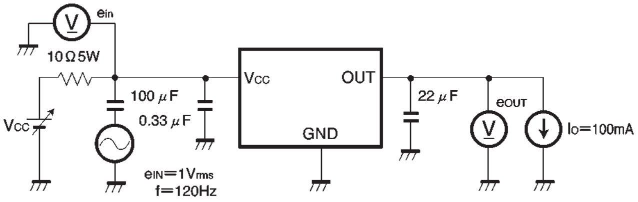


Fig. 1 Measurement circuit for output voltage, input stability, load regulation, temperature coefficient of output voltage



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

Fig. 2 Measurement circuit for ripple rejection ratio

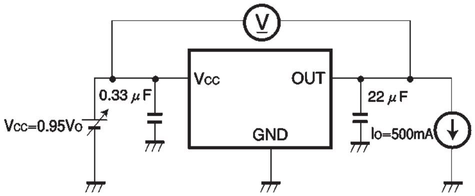


Fig. 3 Measurement circuit for minimum I/O voltage differential

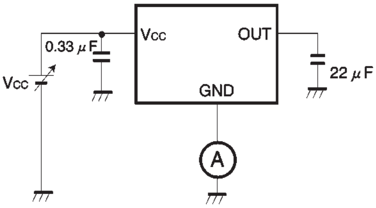


Fig. 4 Measurement circuit for bias current

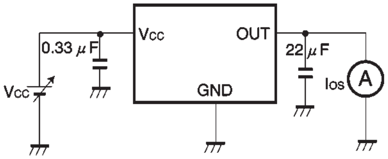


Fig. 5 Measurement circuit for output short-circuit current

●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 22µ F capacitor is recommended; however, be aware that if an extremely large capacitance is used (1000µ F 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 0.33µ F bypass capacitor as close as possible between the input pin and GND.

(4) Overcurrent protection circuit

An overcurrent protection circuit is built into the outputs, to prevent destruction of the IC in the even the load is shorted.

This protection circuit limits the current in the shape of a ’7’. This circuit is designed with a high margin, so that that current is restricted and latching is prevented, even if a high-capacitance capacitator causes a large amount of current to temporary flow through the IC.

However, these protection circuits are only good for preventing damage from sudden accidents and should not be used for continuous protection (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

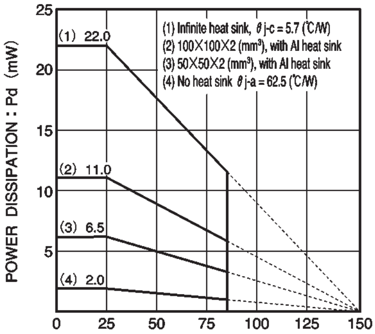
A built-in thermal overload circuit prevents damage from overheating. When the thermal circuit is activated, the outputs are turned OFF. When the temperature drops back to a constant level, the circuit is restored.

(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 normally used by each of the 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 the possibility of malfunction exists.

●Electrical characteristic curves



(Note) When Al thermal plate is used: Tightening torque: 6 (kg-cm) Apply silicon grease

Fig.6 Ta - power dissipation characteristics (TO220FP)

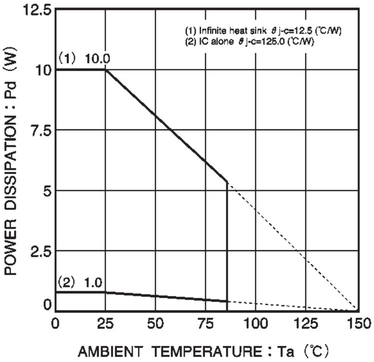


Fig. 7 Ta - power dissipation characteristics (TO 252-3)

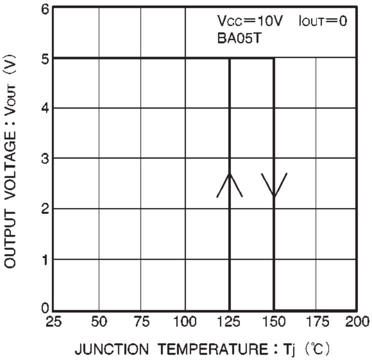


Fig. 8 Thermal cutoff circuit characteristics

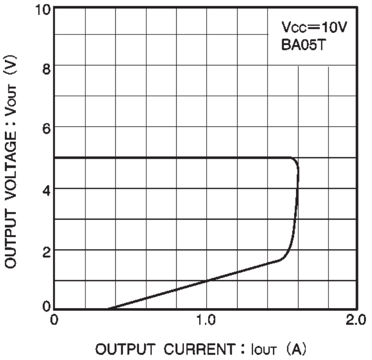


Fig. 9 Current limit characteristics

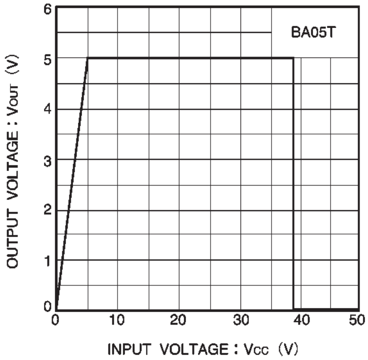
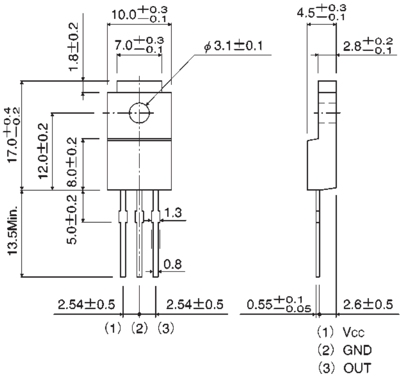


Fig. 10 Over voltage protection characteristics

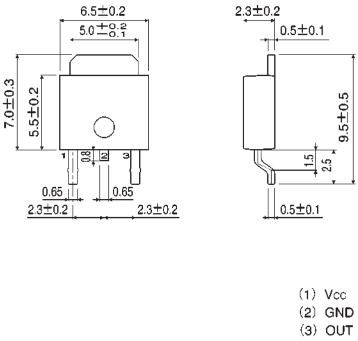
●External dimensions (Units: mm)

BA○○T Series



TO220FP

BA○○FP Series



TO252-3