

# Dual output voltage regulator with power saving

## BA51W12ST

The BA51W12ST is a general-purpose, low saturation power supply with two outputs : 9V, 1A and 5V, 500mA. The IC is available in a compact TO220FP-5 package. The outputs can be turned off during the power saving state with the built-in switch. Also built in the IC is an overcurrent protection circuit, an overvoltage protection circuit, and a thermal shutdown circuit.

### ●Applications

Car audio systems, VCRs, facsimiles, air conditioners, and other household and industrial equipment

### ●Features

- 1) Minimum I / O voltage differential is 0.5V or less.
- 2) Built-in protection circuits against overcurrent, over-voltage, and overheat.
- 3) Available in a compact TO220FP-5 package (pins are bendable).
- 4) Zero power saving current. (Typ.)

### ●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V <sub>CC</sub>	35	V
Power dissipation	P <sub>d</sub>	2000*1	mW
Operating temperature	T <sub>opr</sub>	-40~+85	°C
Storage temperature	T <sub>stg</sub>	-55~+150	°C
Peak applied voltage	V <sub>surge</sub>	50*2	V

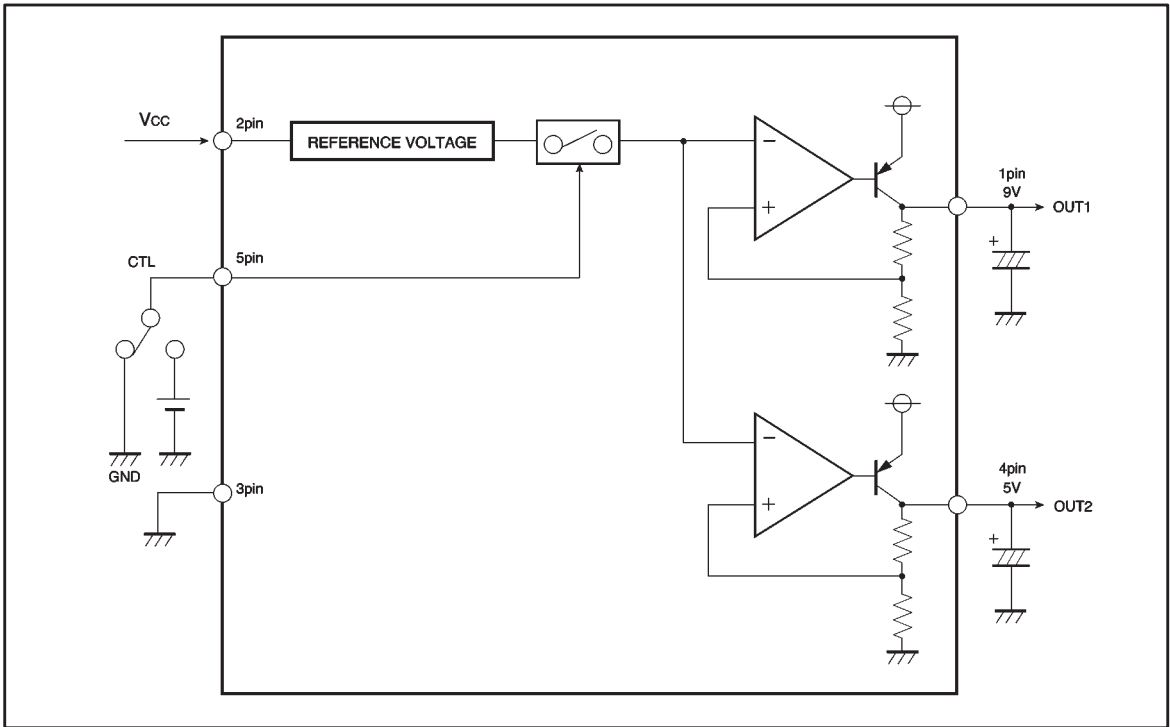
\*1 Reduced by 16 mW for each increase in Ta of 1°C over 25°C.

\*2 Applied time is less than 200 ms (tr ≥ 1 ms).

### ●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>CC</sub>	10	14	25	V

## ● Block diagram

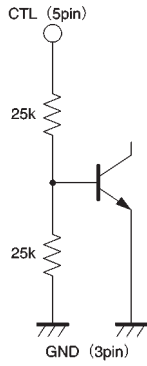


## ● Pin descriptions

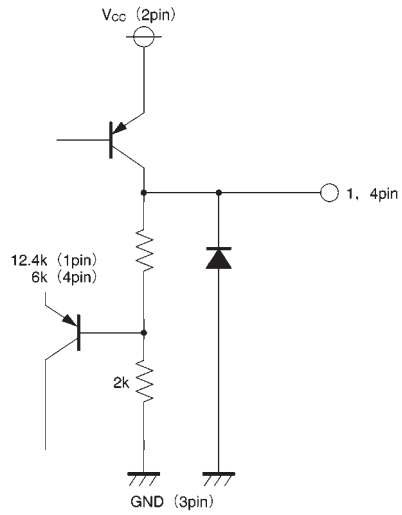
Pin No.	Pin name	Function
1	OUT1	Output 1 (9V, 1A)
2	V <sub>CC</sub>	Power supply
3	GND	Ground
4	OUT2	Output 2 (5 V, 500 mA)
5	CTL	ON/OFF switch

● Input / output circuits

CTL



OUT1, 2



● Electrical characteristics (unless otherwise noted,  $T_a = 25^\circ\text{C}$  and  $V_{CC} = 14.0\text{V}$ )

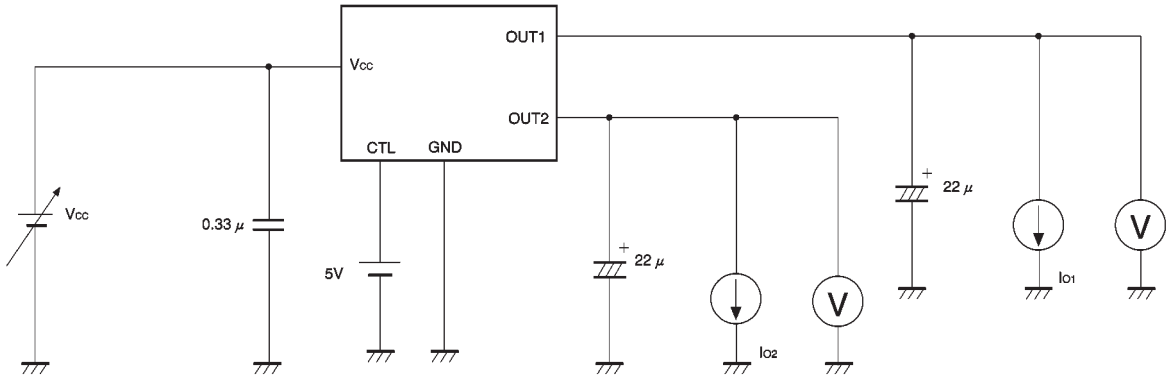
Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Power save supply current	$I_{ST}$	—	0	10	$\mu\text{A}$	OFF mode	Fig.4
Bias current	$I_b$	—	3.0	5.0	mA	ON mode	Fig.4
〈9V output section〉							
Output voltage 1	$V_{O1}$	8.55	9.0	9.45	V	$I_{O1}=500\text{mA}$	Fig.1
Minimum I/O voltage differential 1	$\Delta V_{O1}$	—	0.3	0.5	V	$I_{O1}=500\text{mA}$ $V_{CC}=0.95V_{O1}$	Fig.3
Output current capacity 1	$I_{O1}$	1.0	—	—	A		Fig.1
Ripple rejection ratio 1	R.R1	—	55	—	dB	$I_{O1}=500\text{mA}$ , $f=120\text{Hz}$ $e_{IN}=1V_{rms}$	Fig.2
Input stability 1	Reg.I1	—	50	100	mV	$V_{CC}=10\rightarrow 25\text{V}$ , $I_O=500\text{mA}$	Fig.1
Load regulation 1	Reg.L1	—	100	150	mV	$I_O=5\text{mA}\rightarrow 1\text{A}$	Fig.1
Output short-circuit current 1	$I_{OS1}$	—	150	—	mA	$V_{CC}=25\text{V}$	Fig.5
〈5V output section〉							
Output voltage 2	$V_{O2}$	4.75	5.0	5.25	V	$I_{O2}=350\text{mA}$	Fig.1
Minimum I/O voltage differential 2	$\Delta V_{O2}$	—	0.3	0.5	V	$I_{O2}=350\text{mA}$ $V_{CC}=0.95V_{O2}$	Fig.3
Output current capacity 2	$I_{O2}$	500	—	—	mA		Fig.1
Ripple rejection ratio 2	R.R2	—	60	—	dB	$I_{O2}=350\text{mA}$ , $f=120\text{Hz}$ $e_{IN}=1V_{rms}$	Fig.2
Input stability 2	Reg.I2	—	50	100	mV	$V_{CC}=6\rightarrow 25\text{V}$ , $I_O=350\text{mA}$	Fig.1
Load regulation 2	Reg.L2	—	50	100	mV	$I_O=5\text{mA}\rightarrow 500\text{mA}$	Fig.1
Output short-circuit current 2	$I_{OS2}$	—	100	—	mA	$V_{CC}=25\text{V}$	Fig.5
〈Switch section〉							
ON mode voltage	$V_{TH1}$	2.0	—	—	V	Output ACTIVE mode	Fig.6
OFF mode voltage	$V_{TH2}$	—	—	0.8	V	Output OFF mode	Fig.6
Input high level current	$I_{IN}$	—	150	—	$\mu\text{A}$	$V_{TH}=5\text{V}$	Fig.7

© Not designed for radiation resistance.

Note: All the characteristic values are measured with a  $0.33\ \mu\text{F}$ -capacitor connected to the input pin and  $22\ \mu\text{F}$ -capacitor connected to the output pin.

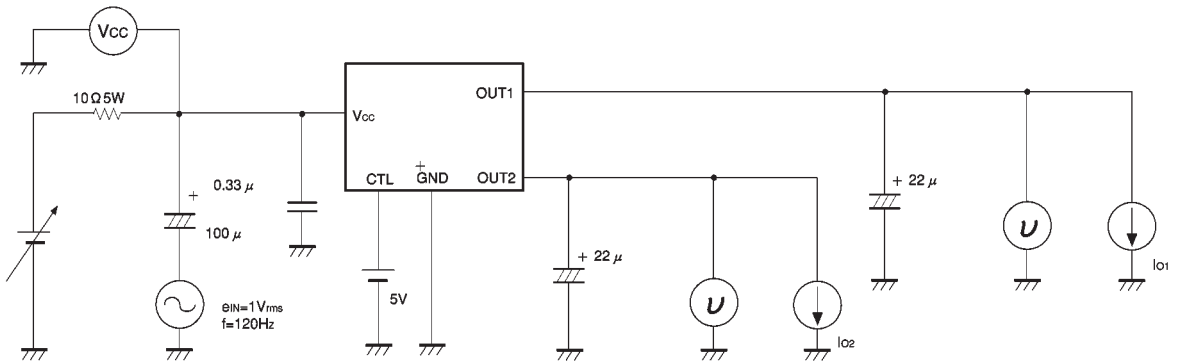
Measurements are made by using a pulse in all cases but noise voltage and the ripple rejection ratio.

● Measurement circuits



- |  |  |  |
|--|--|--|
| $V_{CC} = 14\text{ V,}$                | $I_{O1} = 500\text{ mA}$                         | when measuring output voltage 1          |
| $V_{CC} = 14\text{ V,}$                | $I_{O2} = 350\text{ mA}$                         | when measuring output voltage 2          |
| $V_{CC} = 10 \rightarrow 25\text{ V,}$ | $I_{O1} = 500\text{ mA}$                         | when measuring input stability 1         |
| $V_{CC} = 6 \rightarrow 25\text{ V,}$  | $I_{O2} = 350\text{ mA}$                         | when measuring input stability 2         |
| $V_{CC} = 14\text{ V,}$                | $I_{O1} = 5\text{ mA} \rightarrow 1\text{ A}$    | when measuring load regulation 1         |
| $V_{CC} = 14\text{ V,}$                | $I_{O2} = 5\text{ mA} \rightarrow 500\text{ mA}$ | when measuring load regulation 2         |
| $V_{CC} = 14\text{ V}$                 |  | when measuring output current capacity 1 |
| $V_{CC} = 14\text{ V}$                 |  | when measuring output current capacity 2 |

Fig.1 Circuit for measuring output voltage, input stability, load regulation, and output current capacity



- |                         |                          |   |
|-------------------------|--------------------------|---|
| $V_{CC} = 14\text{ V,}$ | $I_{O1} = 500\text{ mA}$ | when measuring the ripple rejection ratio 1 |
| $V_{CC} = 14\text{ V,}$ | $I_{O2} = 350\text{ mA}$ | when measuring the ripple rejection ratio 2 |

Fig.2 Circuit for measuring ripple rejection ratio

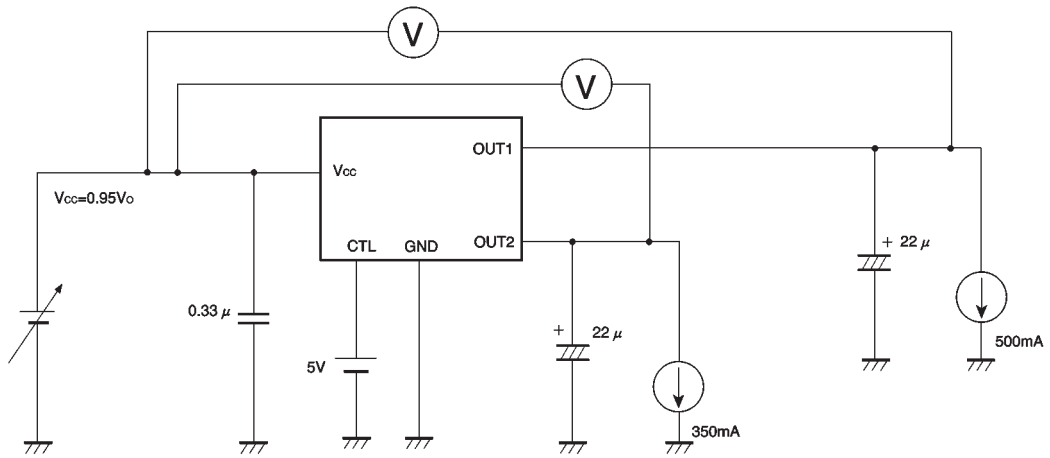
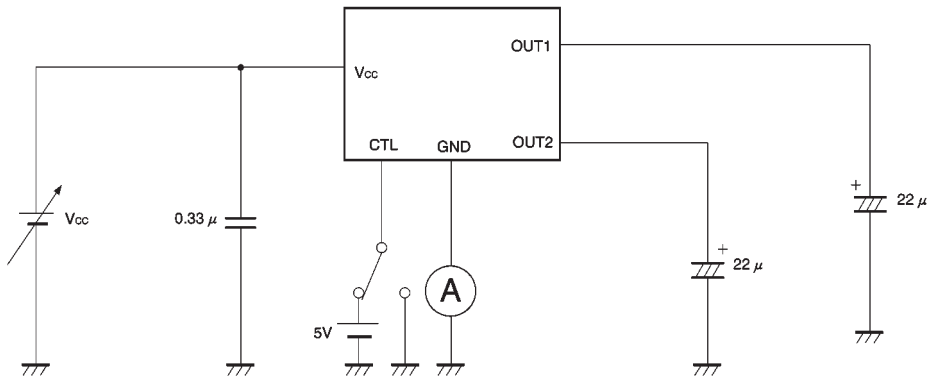


Fig.3 Circuit for measuring Minimum I/O out voltage differential



$V_{cc} = 14\text{ V}$ ,  $I_o = 0\text{ mA}$ ,  $V_{CTL} = 5\text{ V}$  when measuring bias current  
 $V_{cc} = 14\text{ V}$ ,  $I_o = 0\text{ mA}$ ,  $V_{CTL} = 0\text{ V}$  when measuring power save current

Fig.4 Circuit for measuring bias current power supply current

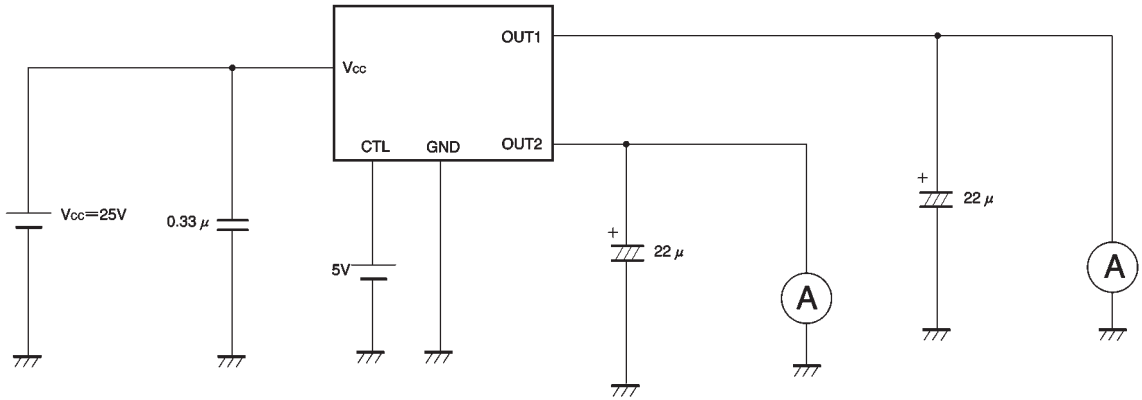


Fig.5 Circuit for measuring output short-circuit current

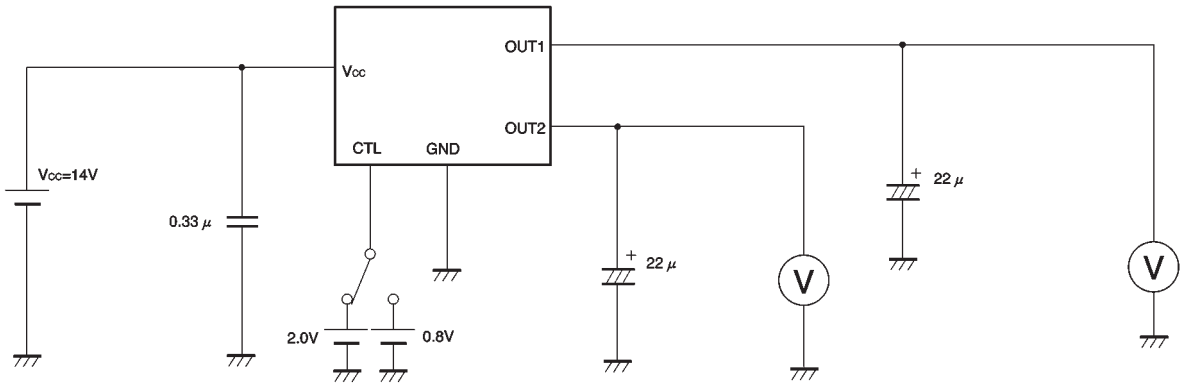


Fig.6 Circuit for measuring mode switching voltage

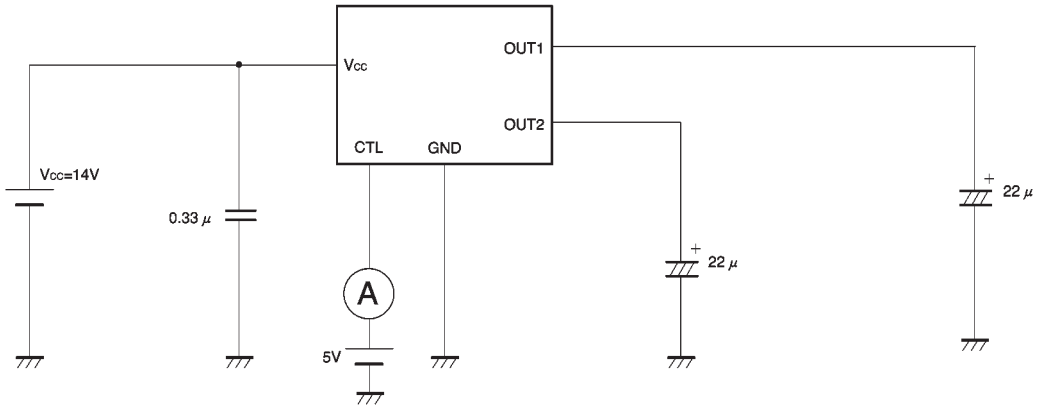


Fig.7 Circuit for measuring input high level current

●Application example

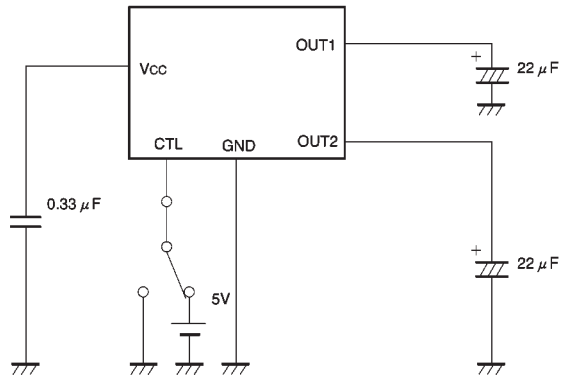


Fig.8



**● Operation notes**

(1) Although the circuit examples included in this handbook are highly recommendable for general use, you should be thoroughly familiar with circuit characteristics as they relate to your own use conditions. If you intend to change the number of external circuits, leave an ample margin, taking into account discrepancies in both static and dynamic characteristics of external parts and Rohm ICs. In addition, please be advised that Rohm cannot provide complete assurance regarding patent rights.

**(2) Operating power supply voltage**

When operating within the proper ranges of power supply voltage and ambient temperature, most circuit functions are guaranteed. Although the rated values of electrical characteristics cannot be absolutely guaranteed, characteristic values do not change drastically within the proper ranges.

**(3) Power dissipation (Pd)**

Refer to the power dissipation characteristics in Fig. 10. If power dissipation exceeds the allowable limit, the functionality of the IC will be degraded (such as reduction of current capacity by increased chip temperature). Make sure to use the IC within the allowable range of power dissipation with a sufficient margin.

**(4) Preventing oscillation at each output and bypass capacitor**

To stop output oscillation, make sure to connect a capacitor between GND and each output pin (capacitance of at least 10 $\mu$ F over the whole operating temperature range is recommended). Oscillation can occur if capacitance is susceptible to temperature. We recommend using a tantalum electrolytic capacitor with minimal changes in capacitance. Also, output can be further stabilized by connecting a bypass capacitor of about 0.33 $\mu$ F between the input pin and GND. Place the capacitor as near as possible to the input pin.

**(5) Overcurrent protection circuit**

An overcurrent protection circuit is installed in each output system, based on the respective output current. This prevents IC destruction due to overcurrent, by limiting the current with a curve shape of "7" in the voltage-current graph. The IC is designed with margins so that current flow will be restricted and latching will be prevented even if a large current suddenly flows through a large capacitor. Note that these protection circuits are only good for preventing damage from sudden accidents. Make sure your design does not cause the protection circuit to oper-

ate continuously under transitional conditions (for instance, if output is clamped at 1V<sub>F</sub> or higher, short mode circuit operates at 1V<sub>F</sub> or lower). Note that the circuit ability is negatively correlated with temperature.

**(6) Thermal protection circuit**

A built-in thermal protection circuit prevents thermal damage to the IC. All outputs are turned off when the circuit operates, and revert to the original state when the temperature drops to a certain level.

(7) We recommend installing a bypass line with a diode in your application if there is a mode where potential difference between each output and input (V<sub>CC</sub>) or GND is reversed from the normal state. A reversed mode may cause damage to the IC.

(8) Although the quality of this IC is rigorously controlled, the IC may be destroyed when the applied voltage or the operating temperature exceeds its absolute maximum rating. Because short mode or open mode cannot be specified when the IC is destroyed, be sure to take physical safety measures, such as fusing, if any of the absolute maximum ratings might be exceeded.

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

●Electrical characteristic curves

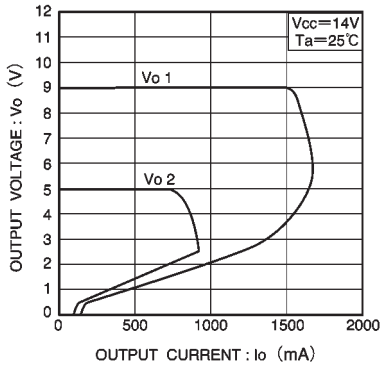


Fig.9 Output current capacity characteristics (Typ.)

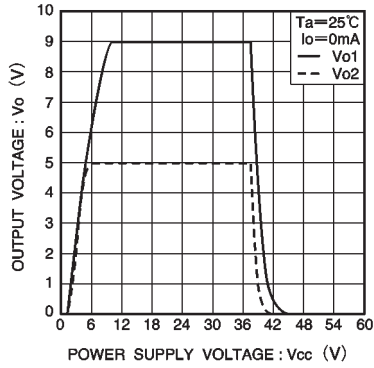


Fig.10 Output voltage characteristics (Typ.)

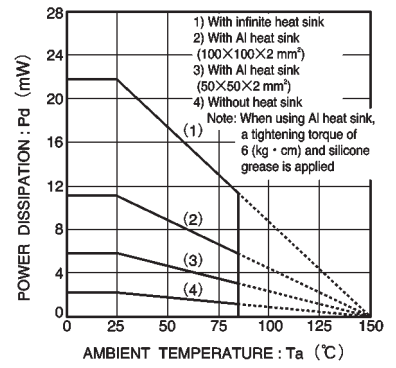


Fig.11 Thermal derating characteristics

●External dimensions (Units: mm)

