

DC / DC converter

BP5020 / BP5021 / BP5022

The BP5020, BP5021, and BP5022 are DC / DC converter units that use a pulse width modulation (PWM) system. They contain control circuits, switching devices, rectifiers, and coils, and operate by only connecting an I / O smoothing capacitor. With a high efficiency of power conversion, the ICs are available in stand-alone 9-pin SIP packages with no heat sink required. They can be applied to various purposes by fine-adjusting the output control and output voltage. With a wide range of input voltage, the ICs are best suited for obtaining a stable local power source from a main power supply with a large voltage variation.

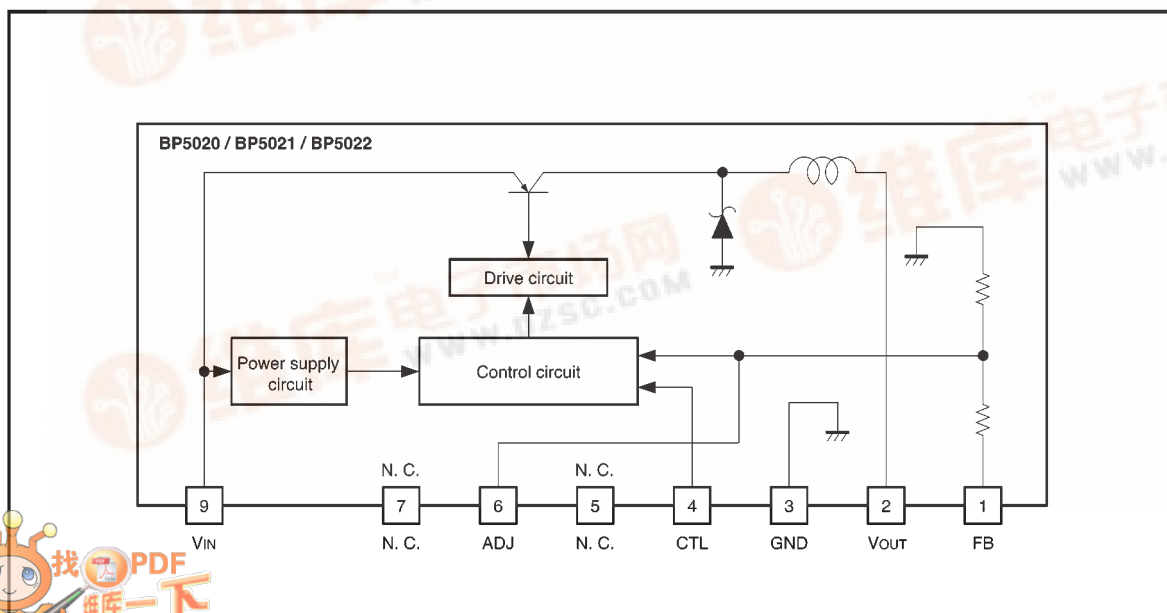
●Applications

Power supplies for copiers, personal computers, word processors, measuring instruments, vending machines, security devices, registers, industrial equipment, and maintenance tools

●Features

- 1) Wide range of input voltage.
- 2) High power conversion efficiency.
- 3) Applicable to various purposes by fine-adjusting the output control and output voltage with external circuits.
- 4) Small number of external components required.
- 5) Heat sink unnecessary.
- 6) Compact SIP 9-pin package.

●Block diagram



●List of the BP502-series

Parameter	BP5020	BP5021	BP5022	Unit
Input voltage	8~38	8~38	15~38	V
Output voltage	5	5	12	V
Output current	1	0.5	0.5	A
Power conversion efficiency	85 ($V_{IN}=15V$)	84 ($V_{IN}=15V$)	90 ($V_{IN}=20V$)	%

●Absolute maximum ratings ($T_a = 25^{\circ}C$)

Parameter	Symbol	Limits			Unit	Conditions
		BP5020	BP5021	BP5022		
Input voltage	V_I	8~38	8~38	15~38	V	
Output current	I_o	1	0.5	0.5	A	*1
Operating temperature	T_{opr}	-20~+70			$^{\circ}C$	
Storage temperature	T_{stg}	-25~+80			$^{\circ}C$	

*1 Derating required according to the input voltage and ambient temperature.

Regulator ICs

BP5020 / BP5021 / BP5022

●Electrical characteristics

BP5020 (unless otherwise noted, $V_i = 15V$, $I_o = 0.5A$, $SW = 1$, $T_a = 25^\circ C$)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input voltage	V_i	8	—	38	V	
Output voltage	V_o	4.75	5	5.25	V	
Output current	I_o	—	—	1	A	$V_i < 30V^{*1}$
Line regulation	ΔV_{O1}	—	27	80	mV	$V_i = 8V \sim 38V$
Load regulation	ΔV_{O2}	—	13	80	mV	$I_o = 0.1A \sim 1A$
Output ripple voltage	ν_r	—	22	70	mV _{P-P}	*2
Power conversion efficiency	η	75	85	—	%	$I_o = 1A$
Switching frequency	f_{SW}	—	190	—	kHz	*2
CTL pin ON resistance	R_{ON}	—	—	4.7	k Ω	$V_o > 4.75V$
CTL pin OFF resistance	R_{OFF}	200	—	—	k Ω	$V_o < 0.1V$, Select $SW = 2$

BP5021 (unless otherwise noted, $V_i = 15V$, $I_o = 0.25A$, $SW = 1$, $T_a = 25^\circ C$)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input voltage	V_i	8	—	38	V	
Output voltage	V_o	4.75	5	5.25	V	
Output current	I_o	—	—	0.5	A	*1
Line regulation	ΔV_{O1}	—	13	50	mV	$V_i = 8V \sim 38V$
Load regulation	ΔV_{O2}	—	3	50	mV	$I_o = 0.05A \sim 0.5A$
Output ripple voltage	ν_r	—	25	70	mV _{P-P}	*2
Power conversion efficiency	η	70	84	—	%	$I_o = 0.5A$
Switching frequency	f_{SW}	—	190	—	kHz	*2
CTL pin ON resistance	R_{ON}	—	—	4.7	k Ω	$V_o > 4.75V$
CTL pin OFF resistance	R_{OFF}	200	—	—	k Ω	$V_o < 0.1V$, Select $SW = 2$

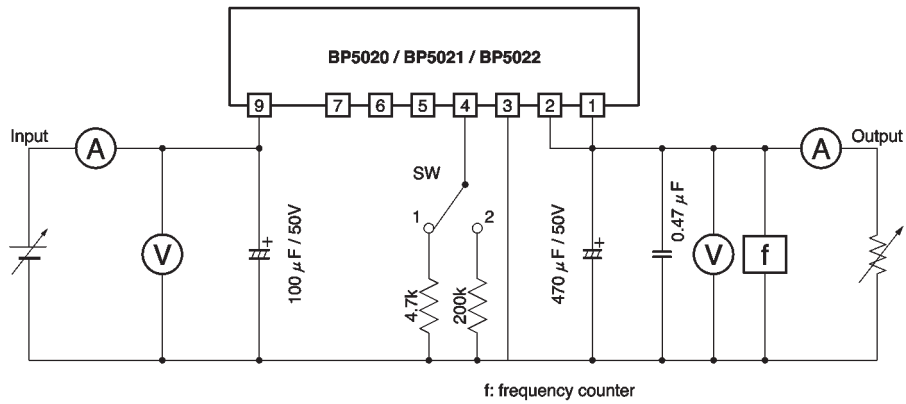
BP5022 (unless otherwise noted, $V_i = 20V$, $I_o = 0.25A$, $SW = 1$, $T_a = 25^\circ C$)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input voltage	V_i	15	—	38	V	
Output voltage	V_o	11.2	12	12.8	V	
Output current	I_o	—	—	0.5	A	*1
Line regulation	ΔV_{O1}	—	22	50	mV	$V_i = 15V \sim 38V$
Load regulation	ΔV_{O2}	—	18	50	mV	$I_o = 0.05A \sim 0.5A$
Output ripple voltage	ν_r	—	29	70	mV _{P-P}	*2
Power conversion efficiency	η	75	90	—	%	$I_o = 0.5A$
Switching frequency	f_{SW}	—	190	—	kHz	*2
CTL pin ON resistance	R_{ON}	—	—	4.7	k Ω	$V_o > 11.2V$
CTL pin OFF resistance	R_{OFF}	200	—	—	k Ω	$V_o < 0.1V$, Select $SW = 2$

*1 Derating required according to the input voltage and ambient temperature.

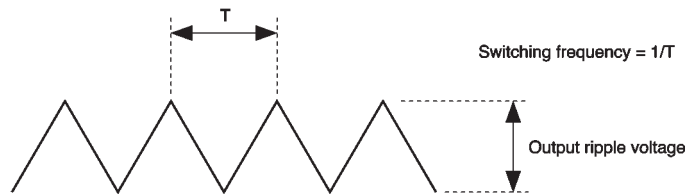
*2 Pulse noise not included.

● Measurement circuit



100 μF / 50V and 470 μF / 50V capacitors: NICHICON PL-series (low impedance type)

Fig. 1



Note that the output ripple voltage depends on the type and characteristics of the output capacitor.

●Circuit operation

The switching transistor in the hybrid IC can be forcedly turned off by putting pin 4 to the open state (high impedance). The output voltage can be fine-adjusted by connecting a capacitor to pin 6, which is connected to the output voltage sensing circuit.

●Application example

Application 1: DC / DC converter with a protection circuit

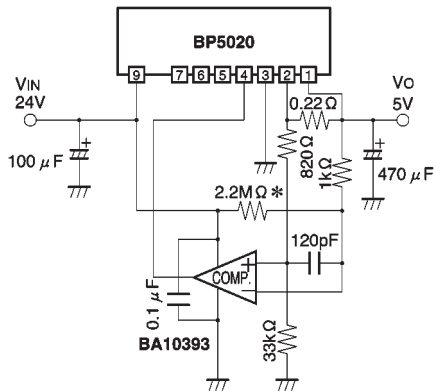


Fig.3

*A resistor to secure the rise of output at power on. The resistance to be selected depends on the input voltage. This is a standard application. Because the control cur-

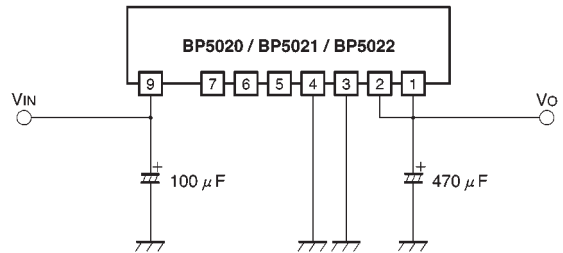


Fig.2

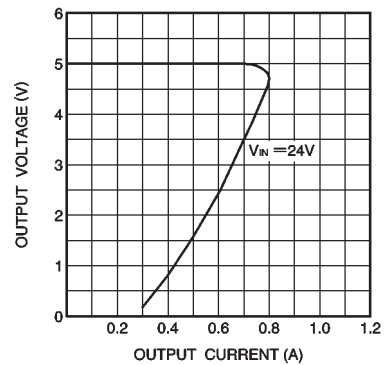


Fig.4

rent fluctuates with variations in circuits and components, set the control current by adding a sufficient margin to the normal current level.

Application 2: Output ON / OFF control

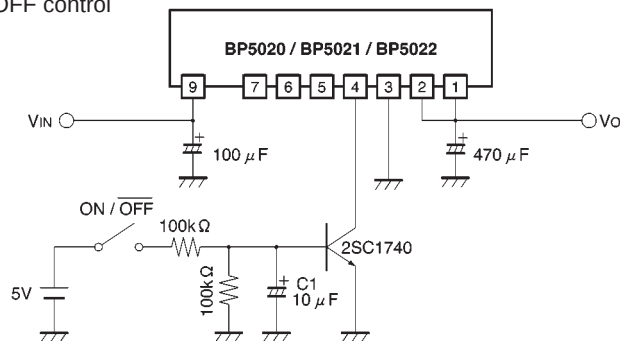


Fig.5

C1 is a slow-start capacitor for mitigating the excessive rush current that flows into the hybrid IC when the switch is turned on.

Application 3: Output voltage fine adjustment

i) When reducing the output voltage

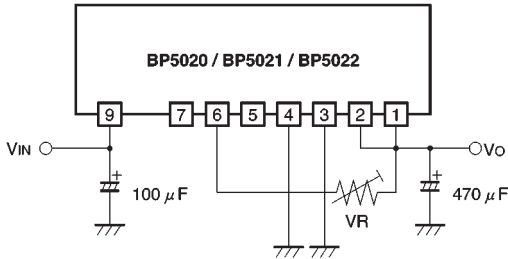


Fig.6

ii) When increasing the output voltage

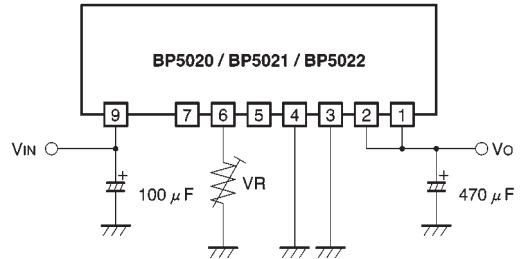


Fig.7

VR value setting equations (the output voltage after adjustment is denoted as V_o)

i) When reducing the output voltage

$$\text{BP5020 / BP5021} \quad R = (V_o - 1.281) / (0.0278 - 0.00556V_o) \text{ (k}\Omega\text{)}$$

$$\text{BP5022} \quad R = (V_o - 1.281) / (0.1196 - 0.01V_o) \text{ (k}\Omega\text{)}$$

ii) When increasing the output voltage

$$\text{BP5020 / BP5021} \quad R = 11160 / (48.4V_o - 242) \text{ (k}\Omega\text{)}$$

$$\text{BP5022} \quad R = 1200 / (9.368V_o - 112) \text{ (k}\Omega\text{)}$$

To make full use of the ability of the hybrid IC, we recommend the output voltage be adjustment within $\pm 20\%$ of the output voltage rating. When the output voltage is increased by 20%, for instance, the minimum input voltage is also increased by 20 %.

(Example: When the output voltage is changed from 5V to 6V in the BP5020, the minimum input voltage is changed from 8V to 9.6V.)

Application 4: Slow start

The slow start circuit mitigates the pulse load on the internal switching transistor when input voltage is applied, and rises the output voltage gradually by starting the switching operation slowly.

This application is useful for preventing the malfunction of an external protection circuit due to a rush current, and can serve as a countermeasure against the operation outside the safe operation range.

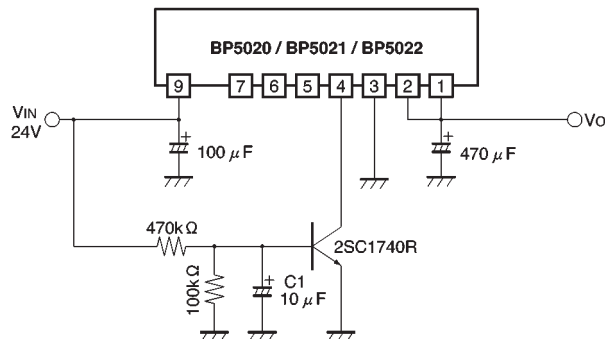


Fig.8

C1 is a slow-start capacitor for mitigating the excessive rush current that flows into the hybrid IC when the switch is turned on.

● Pin noise voltage

Results obtained with the measurement circuit of Fig. 10 is shown in Fig. 9.

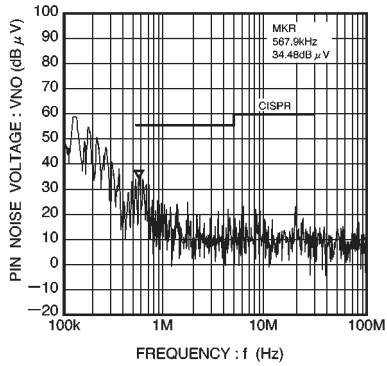


Fig.9 Pin noise voltage

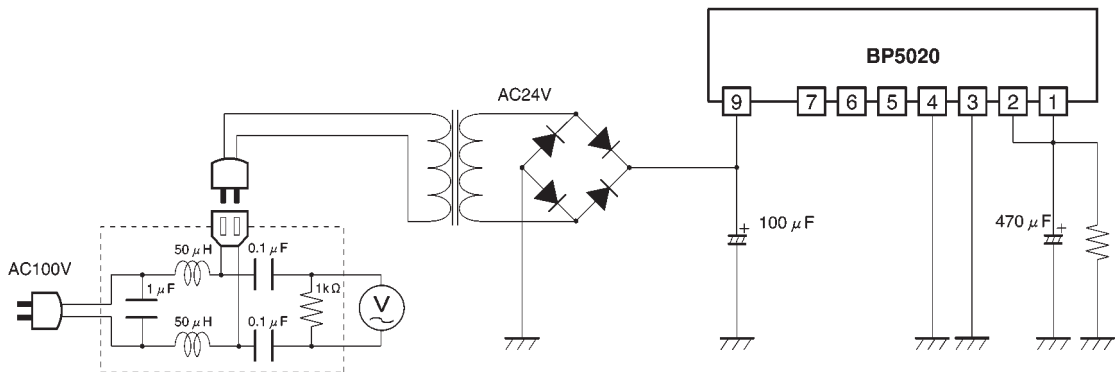


Fig.10 Measurement circuit

●Operation notes

- (1) The output current should be reduced according to an increase in the input voltage or ambient temperature. Use the IC within the derating curve range.
- (2) Pins 5 and 7 are not used.
- (3) No circuit is installed in the IC to protect against excessive output currents. Take physical safety measures such as fusing if short-circuit loading is probable.
- (4) A large rush current may flow in the IC when the input voltage is applied or the output ON / OFF is controlled with pin 4 without a capacitor such as C1 in application 2. Comply with the safe operation ranges shown in Figs. 13, 16, and 19.

The safe operation range of the IC is determined by the safe operation range of the internal switching transistor. The amount of rush current depends on the output impedance of the input power supply and capacitors connected to the IC outputs. The pulse load on the internal switching transistor at the start of operation can be reduced by using the protection circuit of application 1 or the slow start circuit of application 4.

●Electrical characteristic curves

For the BP5020

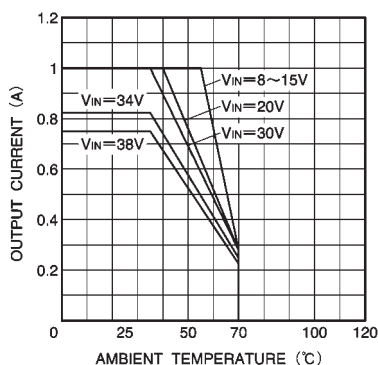


Fig.11 Derating curves

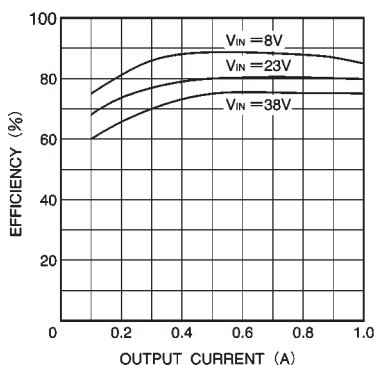


Fig.12 Efficiency

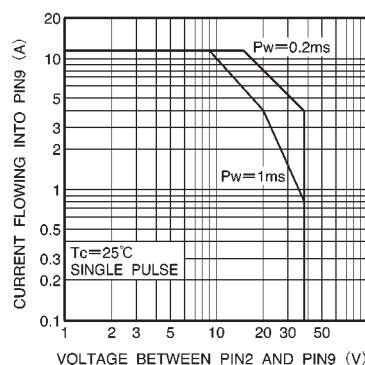


Fig.13 Safe operation range (ASO)

For the BP5021

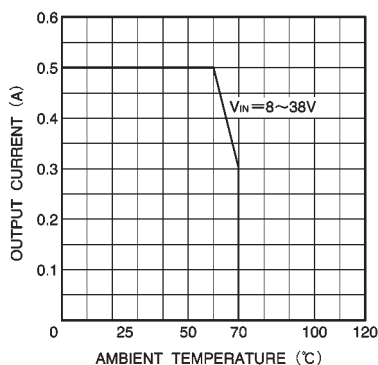


Fig.14 Derating curve

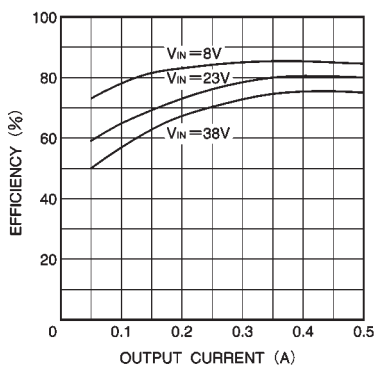


Fig.15 Efficiency

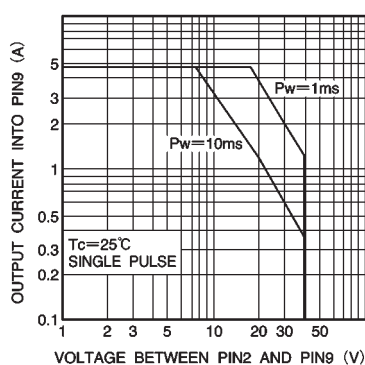


Fig.16 Safe operation range (ASO)

For the BP5022

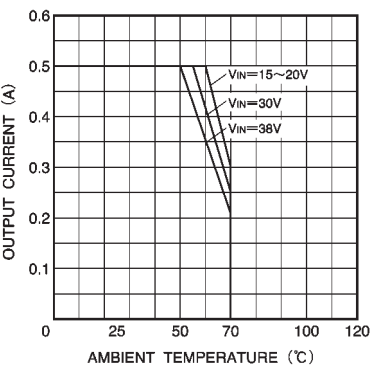


Fig.17 Derating curves

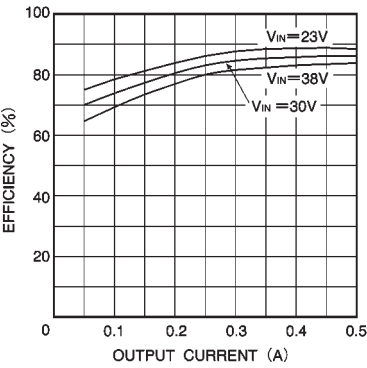


Fig.18 Efficiency

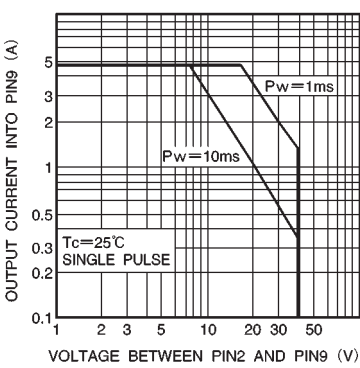


Fig.19 Safe operation range (ASO)

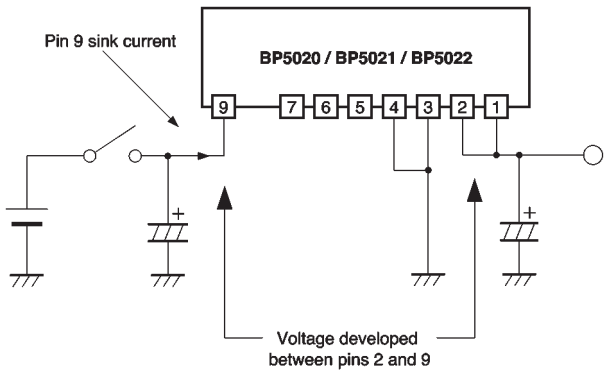
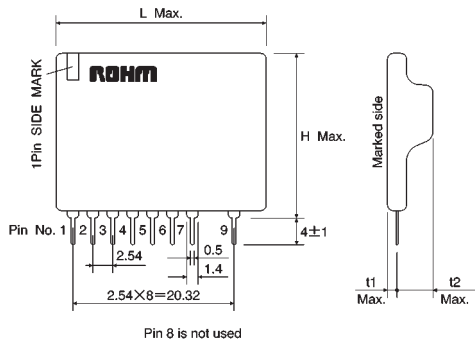


Fig. 20 ASO measurement circuit

●External dimensions (Units: mm)



	BP5020	BP5021 / 22
L	28.2	26.2
H	24.0	24.0
t1	4.3	3.5
t2	8.4	8.1