Single-chip Type with Built-in FET Switching Regulator Series

Simple Step-down Switching Regulators with Built-in Power MOSFET

BD9701FP/CP-V5/T/T-V5, BD9703FP/CP-V5/T/T-V5,BD9702CP-V5/T/T-V5   No.09027EBT01

● Description
   The BD9701/BD9703/BD9702 are single-channel step-down switching regulator capable of PWM operation.
   The Pch MOS FET is built in for high efficiency in small load area.Lower electricity consumption of operating current 4mA (Typ) and stand-by current 0uA(Typ) is realized by adopting Bi-CMOS process.

● Features
   1) Maximum switching current: 1.5A(BD9701/BD9703),   3A(BD9702)
   2) Built-in Pch FET ensures high efficiency
   3) Output voltage adjustable via external resistors
   4) High switching frequency: 100kHz (BD9701), 300kHz(BD9703), 110kHz(BD9702)
   5) Overcurrent and thermal shutdown protection circuits built in
   6) ON/OFF control via STBY pin
   7) Small surface mount TO252-5 package (only BD9701FP, BD9703FP)

● Applications
   TVs, printers, DVD players, projectors, gaming devices, PCs, car audio/navigation systems, ETCs, communication equipment, AV products, office equipment, industrial devices, and more.

● Line Up

	BD9701FP/CP-V5/T/T-V5	BD9703FP/CP-V5/T/T-V5	BD9702CP-V5/T/T-V5
Output Current	1.5A		3.0A
Input Voltage	8 or Vo+3 ～ 36V		
Switching Frequency	100kHz (fixed)	300kHz (fixed)	110kHz (fixed)
External Synchronization	×		
Stand-by Function	○		
Operating Temperature	-40 ～ +85℃		
Package	TO252-5/TO220CP-V5/TO220FP-5/TO220FP-5 (V5)		TO220CP-V5/TO220FP-5/TO220FP-5 (V5)

●Absolute Maximum Ratings (Ta＝25℃)

Parameter		Symbol	Ratings	Unit
Supply Voltage (VCC-GND)		VCC	36	V
STBY-GND		V_{STBY}	36	V
OUT-GND		V_O	36	V
INV-GND		V_{INV}	10	V
Maximum Switching Current	BD9701/BD9703	Iout	1.5	A
	BD9702		3	
Power Dissipation	TO252	Pd	0.8 [*1]	W
	TO220		2 [*2]	
Operating Temperature		Topr	-40～+85	℃
Storage Temperature		Tstg	-55～+150	℃

*1 Without external heat sink, the power dissipation reduces by 6.4mW/℃ over 25℃.
*2 Without external heat sink, the power dissipation reduces by 16.0mW/℃ over 25℃.
Reduced by 160mW/℃, when mounted on Infinity size heatsink.

●Operating Conditions(Ta=-40～+85℃)

Parameter	Symbol	Limit			Unit
		MIN	TYP	MAX	
Input Voltage	VCC	8.0 or Vo+3 [*3]	-	35.0	V
Output Voltage	Vo	1.0	-	32	V

*3The minimum value of an input voltage is the higher either 8.0V or Vo+3

●Electrical Characteristics
○BD9701FP/CP-V5/T/T-V5 (Unless otherwise noted, Ta=25℃,VCC=12V,Vo=5V,STBY=3V)

Parameter		Symbol	Limit			Unit	Conditions
			MIN	TYP	MAX		
Output ON Resistance		Ron	-	1.0	1.5	Ω	design guarantee
Efficiency		η	-	86	-	%	Io＝0.5A design guarantee
Switching Frequency		fosc	80	100	120	kHz	
Load Regulation		ΔVOLOAD	-	10	40	mV	VCC=20V,Io=0.5～1.5A
Line Regulation		ΔVOLINE	-	40	100	mV	VCC=10～30V,Io=1.0A
Over Current Protection Limit		Iocp	1.6	-	-	A	
INV Pin Threshold Voltage		VINV	0.98	1.00	1.02	V	
INV Pin Threshold Voltage Thermal Variation		ΔVINV	-	±0.5	-	%	Tj=0～85℃ design guarantee
INV Pin Input Current		IINV	-	1	-	μA	VINV=1.0V
STBY Pin Threshold Voltage	ON	VSTBYON	2.0	-	36	V	
	OFF	VSTBYOFF	-0.3	-	0.3	V	
STBY Pin Input Current		Istby	5	25	50	μA	STBY=3V
Circuit Current		Icc	-	4	12	mA	
Stand-by Current		Ist	-	0	5	μA	STBY＝0V

This product is not designed to be resistant to radiation.

●Electrical Characteristics
　○BD9703FP/CP-V5/T/T-V5 (Unless otherwise noted, Ta=25℃,VCC=12V,Vo=5V,STBY=3V)

Parameter		Symbol	Limit			Unit	Conditions
			MIN	TYP	MAX		
Output ON Resistance		Ron	-	1.0	1.5	Ω	design guarantee
Efficiency		η	-	86	-	%	Io＝0.5A design guarantee
Switching Frequency		fosc	270	300	330	kHz	
Load Regulation		ΔVOLOAD	-	10	40	mV	VCC=20V,Io=0.5～1.5A
Line Regulation		ΔVOLINE	-	40	100	mV	VCC=10～30V,Io=1.0A
Over Current Protection Limit		Iocp	1.6	-	-	A	
INV Pin Threshold Voltage		VINV	0.98	1.00	1.02	V	
INV Pin Threshold Voltage Thermal Variation		ΔVINV	-	±0.5	-	%	Tj=0～85℃ design guarantee
INV Pin Input Current		IINV	-	1	-	µA	VINV=1.0V
STBY Pin Threshold Voltage	ON	VSTBYON	2.0	-	36	V	
	OFF	VSTBYOFF	-0.3	-	0.3	V	
STBY Pin Input Current		Istby	5	25	50	µA	STBY=3V
Circuit Current		Icc	-	5	12	mA	
Stand-by Current		Ist	-	0	5	µA	STBY＝0V

●Electrical Characteristics
　○BD9702FP/CP-V5/T/T-V5 (Unless otherwise noted, Ta=25℃,VCC=12V,Vo=5V,STBY=3V)

Parameter		Symbol	Limit			Unit	Conditions
			MIN	TYP	MAX		
Output ON Resistance		Ron	-	0.5	1.5	Ω	design guarantee
Efficiency		η	-	86	-	%	Io＝1A design guarantee
Switching Frequency		fosc	88	110	132	kHz	
Load Regulation		ΔVOLOAD	-	10	40	mV	VCC=20V,Io=1～3A
Line Regulation		ΔVOLINE	-	40	100	mV	VCC=10～30V,Io=1.0A
Over Current Protection Limit		Iocp	3.2	-	-	A	
INV Pin Threshold Voltage		VINV	0.98	1.00	1.02	V	
INV Pin Threshold Voltage Thermal Variation		ΔVINV	-	±0.5	-	%	Tj=0～85℃ design guarantee
INV Pin Input Current		IINV	-	1	-	µA	VINV=1.0V
STBY Pin Threshold Voltage	ON	VSTBYON	2.0	-	36	V	
	OFF	VSTBYOFF	-0.3	-	0.3	V	
STBY Pin Input Current		Istby	5	25	50	µA	STBY=3V
Circuit Current		Icc	-	4	12	mA	
Stand-by Current		Ist	-	0	5	µA	STBY＝0V

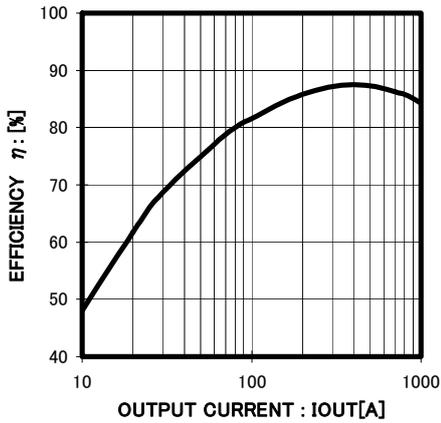● Characteristic Data
　○BD9701FP/CP-V5/T/T-V5
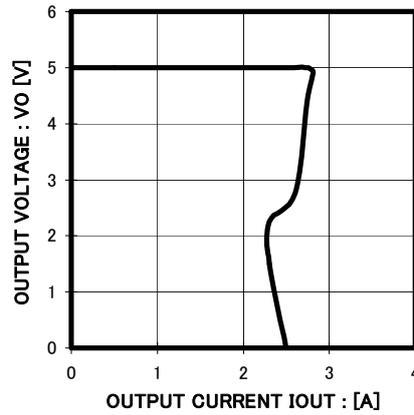

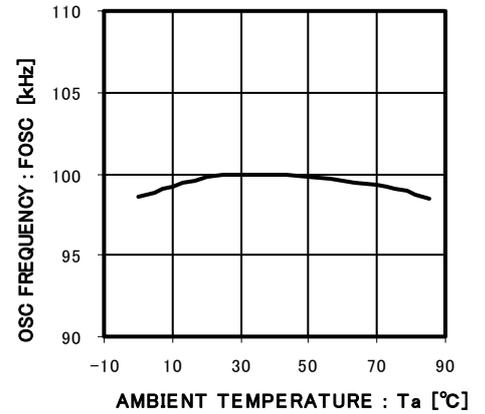Fig.1
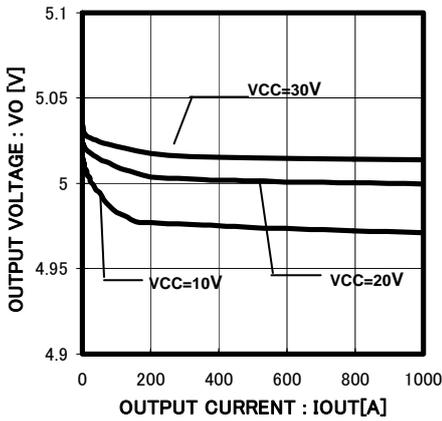EFFICIENCY-LOAD CURRENT

Fig.2
OCP VCC=20V

Fig.3
fosc-Ta

Fig.4
OUTPUT VOLTAGE-LOAD CURRENT

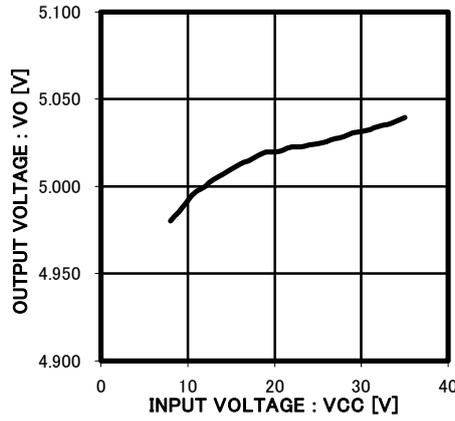
Fig.5
OUTPUT VOLTAGE-INPUT VOLTAGE
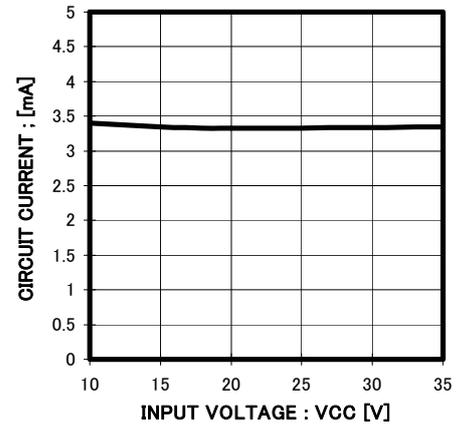(Vo=5V,Ro=5ohm)
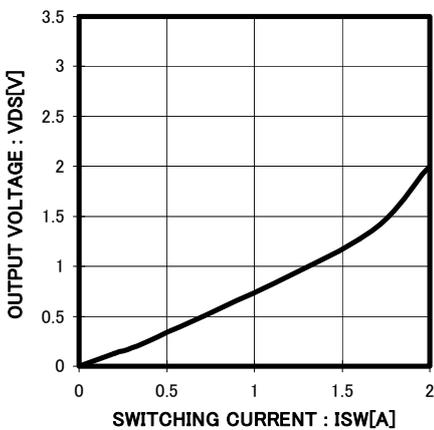

Fig.6
CIRCUIT CURRENT-INPUT VOLTAGE
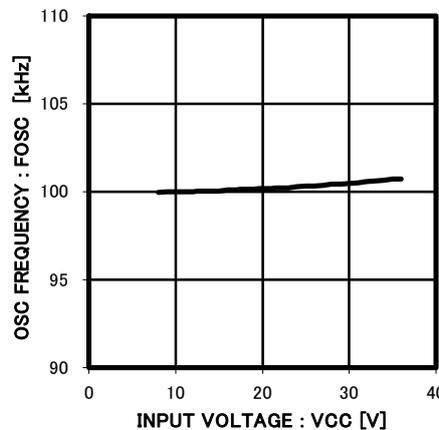NO LOAD

Fig.7
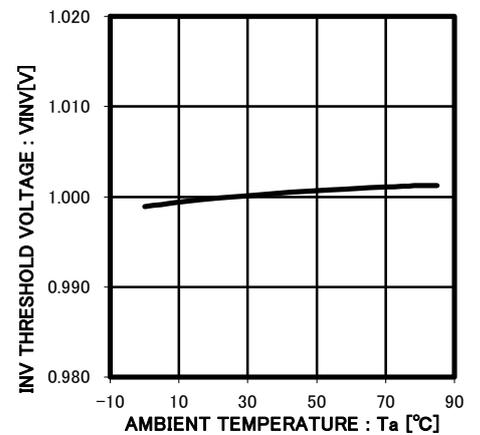VOUT～OUT VOLTAGE-DRAIN CURRENT

Fig.8
fosc-INPUT VOLTAGE

Fig.9
INV THRESHOLD VOLTAGE-Ta
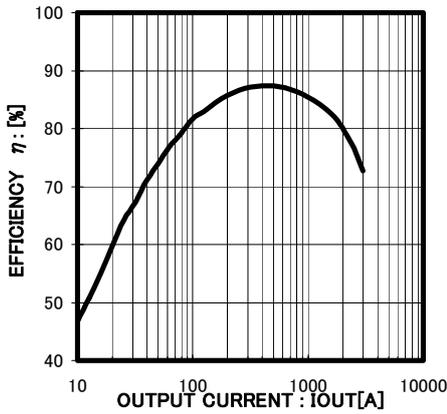
●Characteristic Data
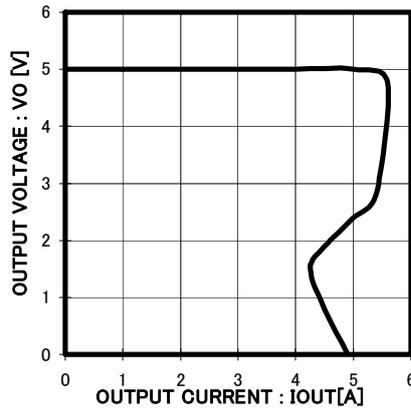○BD9702FP/CP-V5/T/T-V5
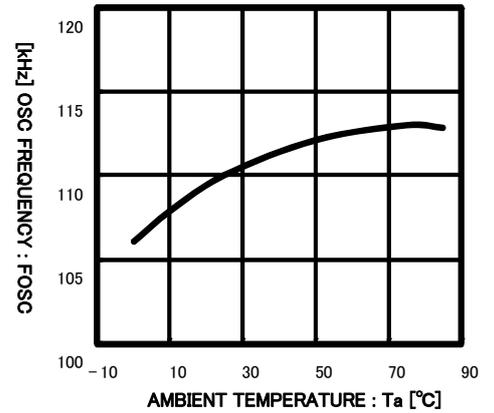

Fig.10
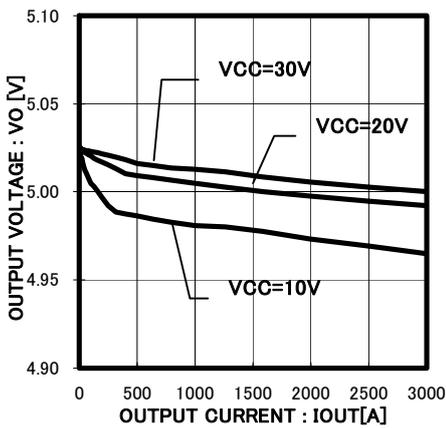EFFICIENCY-LOAD CURRENT

Fig.11
OCP VCC=20V
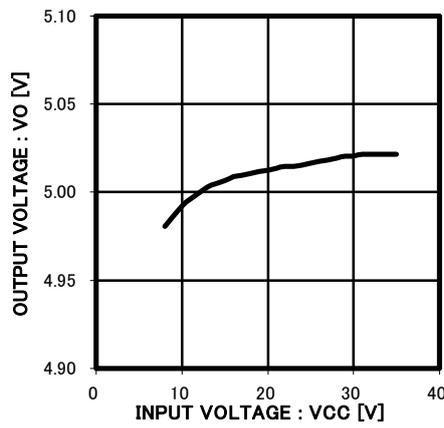
Fig.12
fosc-Ta

Fig.13
OUTPUT VOLTAGE-LOAD CURRENT

Fig.14
OUTPUT VOLTAGE-INPUT VOLTAGE
(Vo=5V,Ro=5ohm)

Fig.15
CIRCUIT CURRENT-
INPUT VOLTAGE NO LOAD

Fig.16
VOUT～OUT VOLTAGE-DRAIN CURRENT

Fig.17
fosc-INPUT VOLTAGE
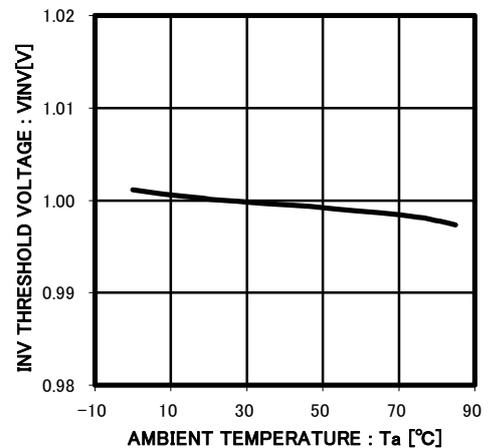
Fig.18
INV THRESHOLD VOLTAGE-Ta

●Characteristic Data
   ○BD9703FP/CP-V5/T/T-V5
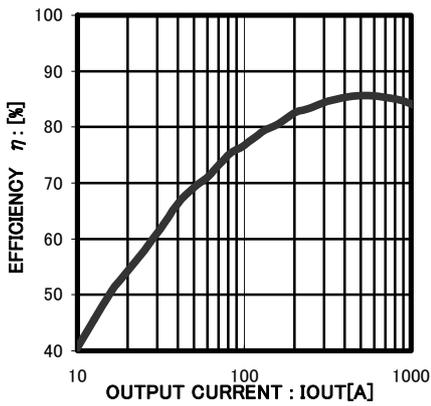
Fig.19
EFFICIENCY-LOAD CURRENT
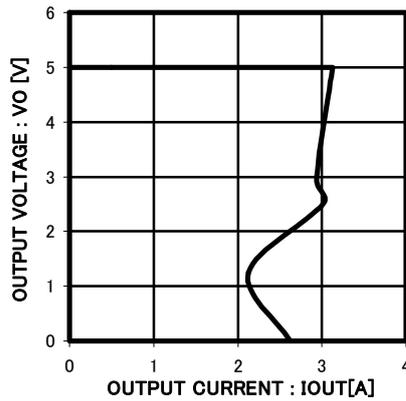
Fig.20
OCP VCC=20V
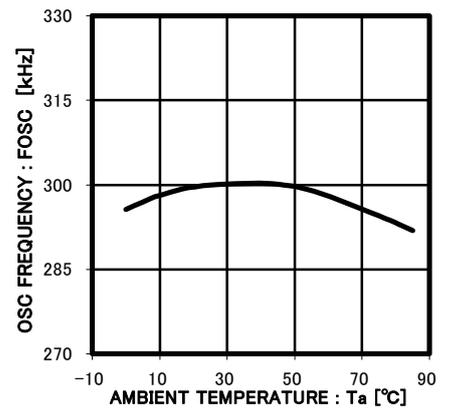
Fig.21
fosc-Ta
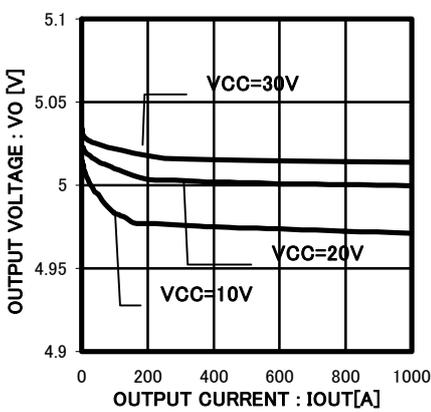
Fig.22
OUTPUT VOLTAGE-LOAD CURRENT
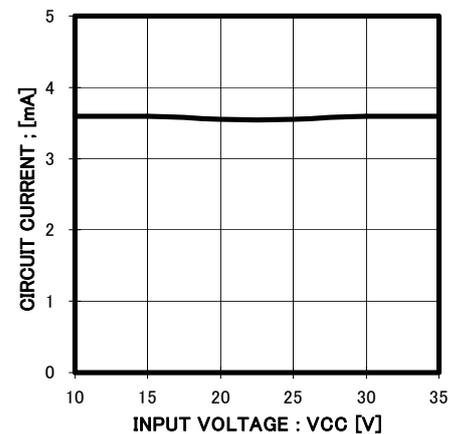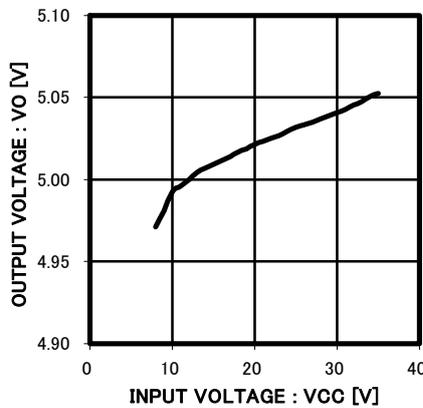
Fig.23
OUTPUT VOLTAGE-INPUT
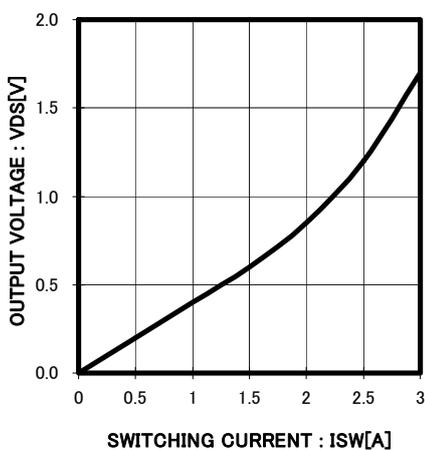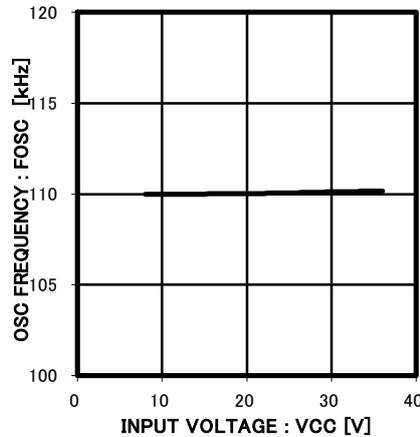VOLTAGE (Vo=5V,Ro=5ohm)
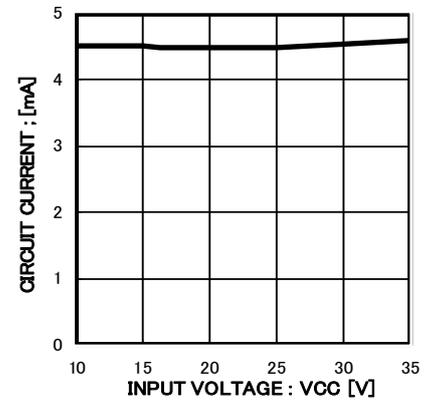
Fig.24
CIRCUIT CURRENT-INPUT
VOLTAGE NO LOAD
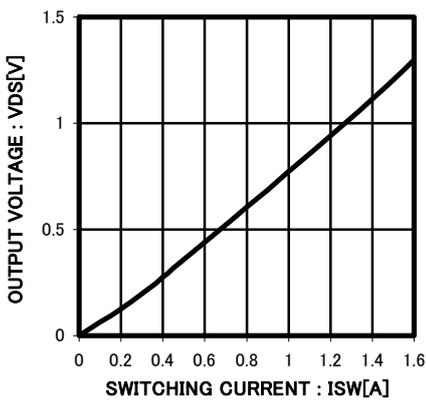
Fig.25
VOUT～OUT
VOLTAGE-DRAIN CURRENT
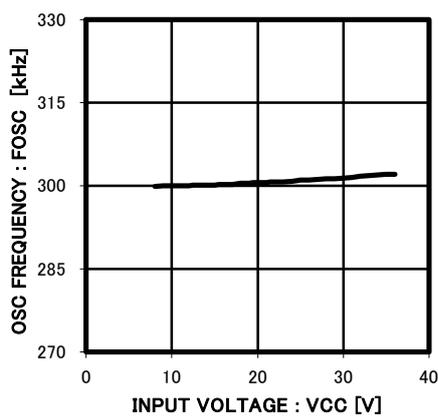
Fig.26
fosc-INPUT VOLTAGE
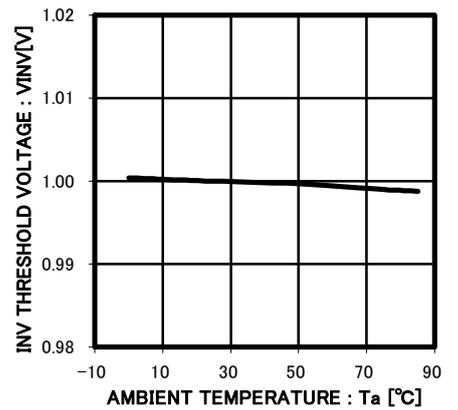
Fig.27
INV THRESHOLD VOLTAGE-Ta

●Block Diagram
    BD9701FP/CP-V5/T/T-V5, BD9703FP/CP-V5/T-V5, BD9702CP-V5/T/T-V5

TO252-5 Package Dimensions (mm)

TO220CP-V5 Package Dimensions (mm)

Fig.28   Block Diagram

●Pin Description

Pin No.	Pin Name	Function
1	VCC	Input Power Supply Pin
2	OUT	Internal Pch FET Drain Pin
3,FIN(*2)	GND	Ground
4	INV	Output Voltage Feedback Pin
5	STBY	ON/OFF Control Pin

(*2)FIN is assigned in the case of TO252-5.

TO220FP-5 Package Dimensions (mm)

TO220FP-5(V5) Package Dimensions (mm)

●Block Function Explanations

・VREF
　Generates the regulated voltage from VCC input, compensated for temperature.

・OSC
　Generates the triangular wave oscillation frequency using an internal resistors and capacitor. Used for PWM comparator input.

・Error AMP
　This block, via the INV pin, detects the resistor-divided output voltage, compares this with the reference voltage, then amplifies and outputs the difference.

・PWM COMP
　Outputs PWM signals to the Driver block, which converts the error amp output voltage to PWM form.

・DRIVER
　This push-pull FET driver powers the internal Pch MOSFET, which accepts direct PWM input.

・STBY
　Controls ON/OFF operation via the STBY pin. The output is ON when STBY is High.

・Thermal Shutdown (TSD)
　This circuit protects the IC against thermal runaway and damage due to excessive heat. A thermal sensor detects the junction temperature and switches the output OFF once the temperature exceeds a threshold value (175deg). Hysteresis is built in (15deg) in order to prevent malfunctions due to temperature fluctuations.

・Over Current Protection (OCP)
　The OCP circuit detects the voltage difference between VCC and OUT by measuring the current through the internal Pch MOSFET and switches the output OFF once the voltage reaches the threshold value. The OCP block is a self-recovery type (not latch).

●Timing Chart

Fig.29　　Timing Chart

2009.04- Rev.B

●Notes for PCB layout

Fig.30 Layout

- Place capacitors between VCC and Ground, and the Schottky diode as close as possible to the IC to reduce noise and maximize efficiency.
- Connect resistors between INV and Ground, and the output capacitor filter at the same Ground potential in order to stabilize the output voltage.

●Application component selection and settings

Inductor L1

If the winding resistance of the choke coil is too high, the efficiency may deteriorate.
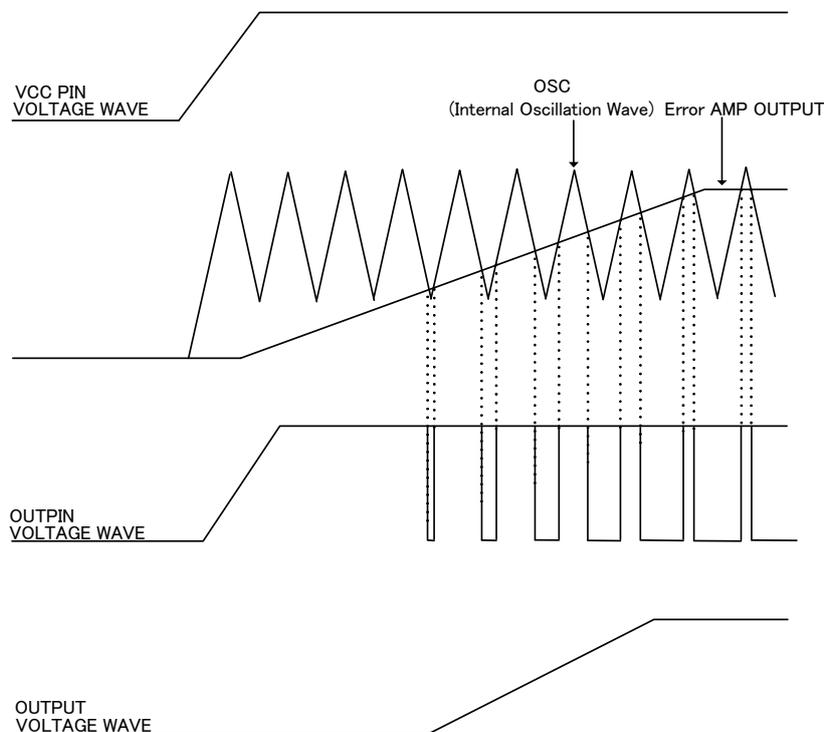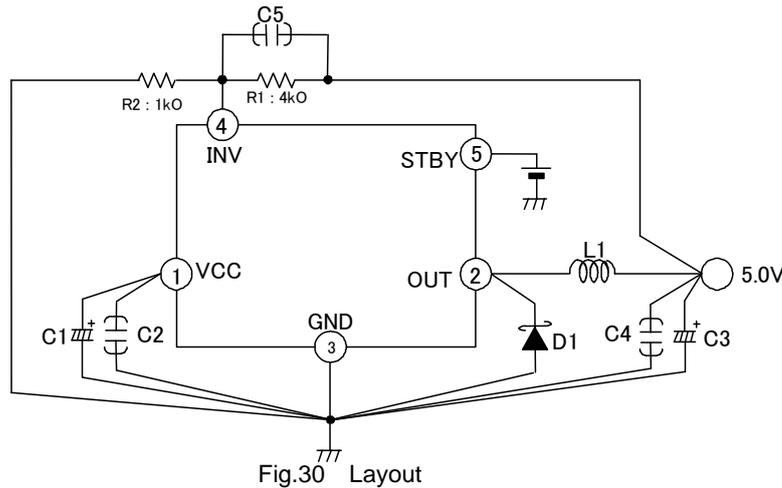As the overcurrent protection operates over minimum 1.6A (BD9701FP/CP-V5/T/T-V5, BD9703FP/CP-V5/T-V5) or 3.2A minimum (BD9701CP-V5/T/T-V5), attention must be paid to the heating of the inductor due to overload of short-circulated load.
Note that the current rating for the coil should be higher than $I_{OUT}(MAX)+\triangle IL$. Iout (MAX): maximum load current
If you flow more than maximum current rating, coil will become overload, and cause magnetic saturation, and those account for efficiency deterioration. Select from enough current rating of coil which doesn't over peak current.

$$\triangle IL = \frac{(VCC-VOUT)}{L1} \times \frac{VOUT}{VCC} \times \frac{1}{fosc}$$

L1:inductor value, VCC:maximum input voltage, VOUT:output voltage, $\triangle IL$:coil ripple current value, fosc:oscillation frequency

Shottky Barrier Diodes D1

A Schottky diode with extremely low forward voltage should be used. Selection should be based on the following guidelines regarding maximum forward current, reverse voltage, and power dissipation:
・The maximum current rating is higher than the combined maximum load current and coil ripple current ($\triangle I_L$).
・The reverse voltage rating is higher than the VIN value.
・Power dissipation for the selected diode must be within the rated level.
The power dissipation of the diode is expressed by the following formula:
Pdi=Iout(MAX)×Vf×(1-VOUT/VCC)
Iout (MAX): maximum load current, Vf: forward voltage, VOUT: output voltage, VCC: input voltage

Capacitor C1,C2,C3,C4,C5

As large ripple currents flow across C1 and C3 capacitors, high frequency and low impedance capacitor for a switching regulator must be used. The ceramic capacitor C2 must be connected. If not, noise may cause an abnormal operation. If the ripple voltage of input and output is large, C4 selected among ceramic , tantalum and OS capacitor with low ESR may decrease the ripple, however if the only low ESR capacitor is used, an oscillation or unstable operation may be caused. C5 is the capacitor for phase compensation and normally not used. If you need to improve the stability of feedback network, connect C5 between INV and OUTPUT.

Feed back resistance R1,R2

The offset of output voltage is determined by both Feed back resistance and INV pin input current.
VOUT=(R1+R2) VINV/R2 (VINV pin Threshold Votage)
If Feed back resistance is high, the setting of output voltage will be move.
Recommended : Resistance between INV pin and GND = less than 10kΩ.

●Recommended Circuit
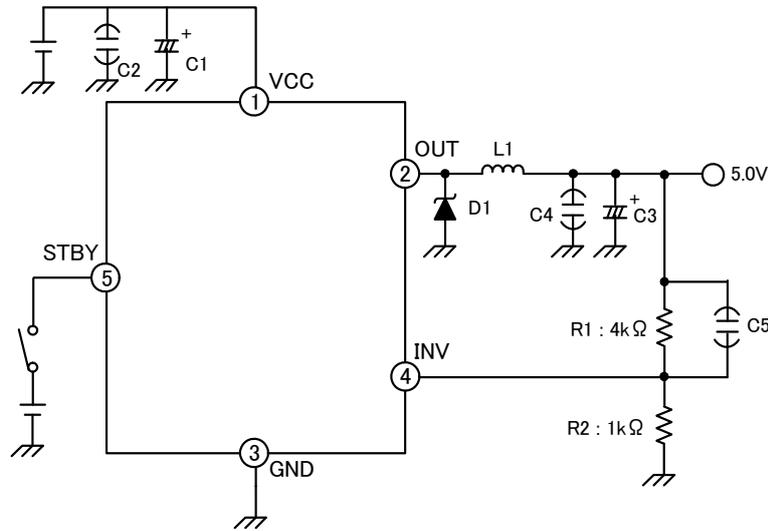
Fig.31 Recommended Circuit Output Voltage 5V : Application cicuit example

(BD9701FP/CP-V5/T/T-V5)

＜Recommended Components (Example)＞
Inductor   L1＝100μH   :CDRH127/LD   (sumida)
Schottky Diode   D1   :RB050LA-40   (ROHM)
Capacitor   C1＝100μF(50V)   :Al electric capacitor UHD1H101MPT (nichicon)
                    C2＝OPEN
                    C3＝220μF(25V)   :Al electric capacitor UHD1E221MPT (nichicon)
                    C4＝OPEN
                    C5＝OPEN

＜Recommended Components example 2＞
Inductor   L1＝100μH   :CDRH127/LD   (sumida)
Schotky Diode   D1   :RB050LA-40 (ROHM)
Capacitor   C1＝220μF(25V)   :Al electric capacitor UVR1H221MPA (nichicon)
                    C2＝1.0μF(50V)   :ceramic cap UMK212F105ZG (TAIYO YUDEN)
                    C3＝470μF(16V)   :Al electric capacitor UVR1E471MPA (nichicon)
                    C4＝150μF(20V)   :OS capacitor 20SVP150M (SANYO)
                    C3＝OPEN

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(BD9703FP/CP-V5/T/T-V5)

　　＜Recommended Components＞
　　Inductor　　　　　　　　　L1＝47μH　　　　　　　:CDRH127/LD　(sumida)
　　Schotky Diode　　　　　　D1　　　　　　　　　　:RB050LA-40 (ROHM)
　　Capacitor　　　　　　　　C1＝100μF(50V)　　　　:Al electric capacitor UHD1H101MPT (nichicon)
　　　　　　　　　　　　　　C2＝2.2μF(50V)　　　　:ceramic cap CM43X7R225K50A (KYOCERA)
　　　　　　　　　　　　　　C3＝470μF(25V)　　　　:Al electric capacitor UHD1E471MPT (nichicon)
　　　　　　　　　　　　　　C4＝OPEN
　　　　　　　　　　　　　　C3＝OPEN

(BD9702CP-V5/T/T-V5)

　　＜Recommended Components＞
　　Inductor　　　　　　　　　L1＝47μH　　　　　　　:CDRH127/LD　(sumida)
　　Schotky Diode　　　　　　D1　　　　　　　　　　:RB050LA-40　(ROHM)
　　Capacitor　　　　　　　　C1＝1000μF(50V)　　　:Al electric capacitor UHD1H102MPT (nichicon)
　　　　　　　　　　　　　　C2＝OPEN
　　　　　　　　　　　　　　C3＝1000μF(25V)　　　:Al electric capacitor UHD1E102MPT (nichicon)
　　　　　　　　　　　　　　C4＝OPEN
　　　　　　　　　　　　　　C3＝OPEN

●Test Circuit

Fig.32   Input Output Measurement Circuit

●I/O Equivalent Circuit

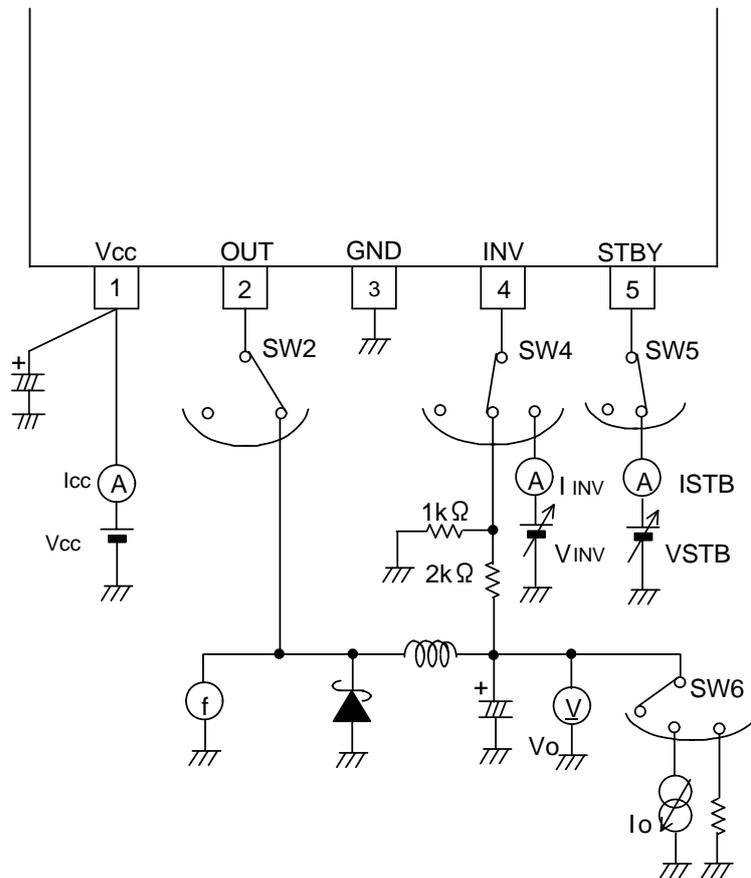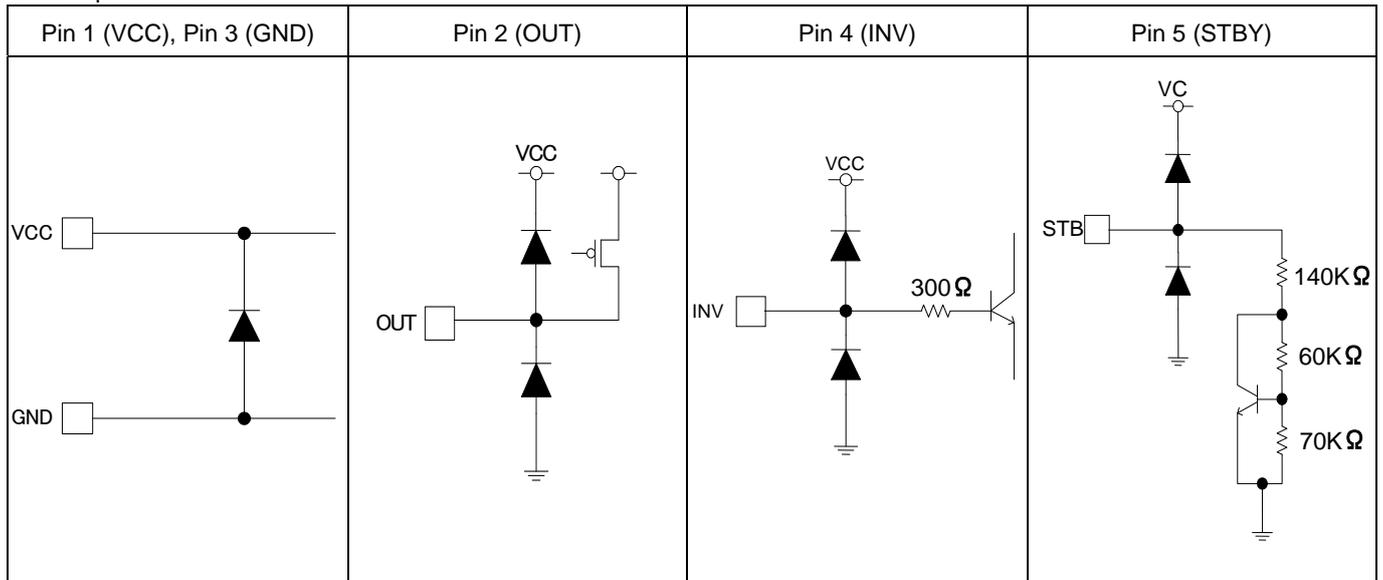| Pin 1 (VCC), Pin 3 (GND)	Pin 2 (OUT)	Pin 4 (INV)	Pin 5 (STBY)

Fig.33Input Output Equivalent Circuit

●Notes for use

1. Absolute Maximum Ratings
    Use of the IC in excess of absolute maximum ratings such as the applied voltage or operating temperature range may result in IC deterioration or damage. Assumptions should not be made regarding the state of the IC (short mode or open mode) when such damage is suffered. A physical safety measure such as a fuse should be implemented when use of the IC in a special mode where the absolute maximum ratings may be exceeded is anticipated.

2. GND voltage
    Ensure a minimum GND pin potential in all operating conditions. In addition, ensure that no pins other than the GND pin carry a voltage lower than or equal to the GND pin, including during actual transient phenomena.

3. Thermal design
    Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

4. Inter-pin shorts and mounting errors
    Use caution when orienting and positioning the IC for mounting on printed circuit boards. Improper mounting may result in damage to the IC. Shorts between output pins or between output pins and the power supply and GND pin caused by the presence of a foreign object may result in damage to the IC.

5. Operation in strong electromagnetic field
    Operation in a strong electromagnetic field may cause malfunction.

6. Thermal shutdown circuit (TSD circuit)
    This IC incorporates a built-in thermal shutdown circuit (TSD circuit). The TSD circuit is designed only to shut the IC off to prevent runaway thermal operation. Do not continue to use the IC after operating this circuit or use the IC in an environment where the operation of the thermal shutdown circuit is assumed.

7. Testing on application boards
    When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Ground the IC during assembly steps as an antistatic measure, and use similar caution when transporting or storing the IC. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process.

8. IC pin input
This IC is a monolithic IC which (as below) has P+ substrate and betweenthe various pin. A P-N junction is formed from this P layer of each pin. For example the relation between each potential is as follows. (When GND > PinB and GND > PinA, the P-N junction operates as a parasitic diode.) Parasitic diodes can occur inevitably in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits as well as operation faults and physical damage. Accordingly, you must not use methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND(P substrate)voltage to an input pin.
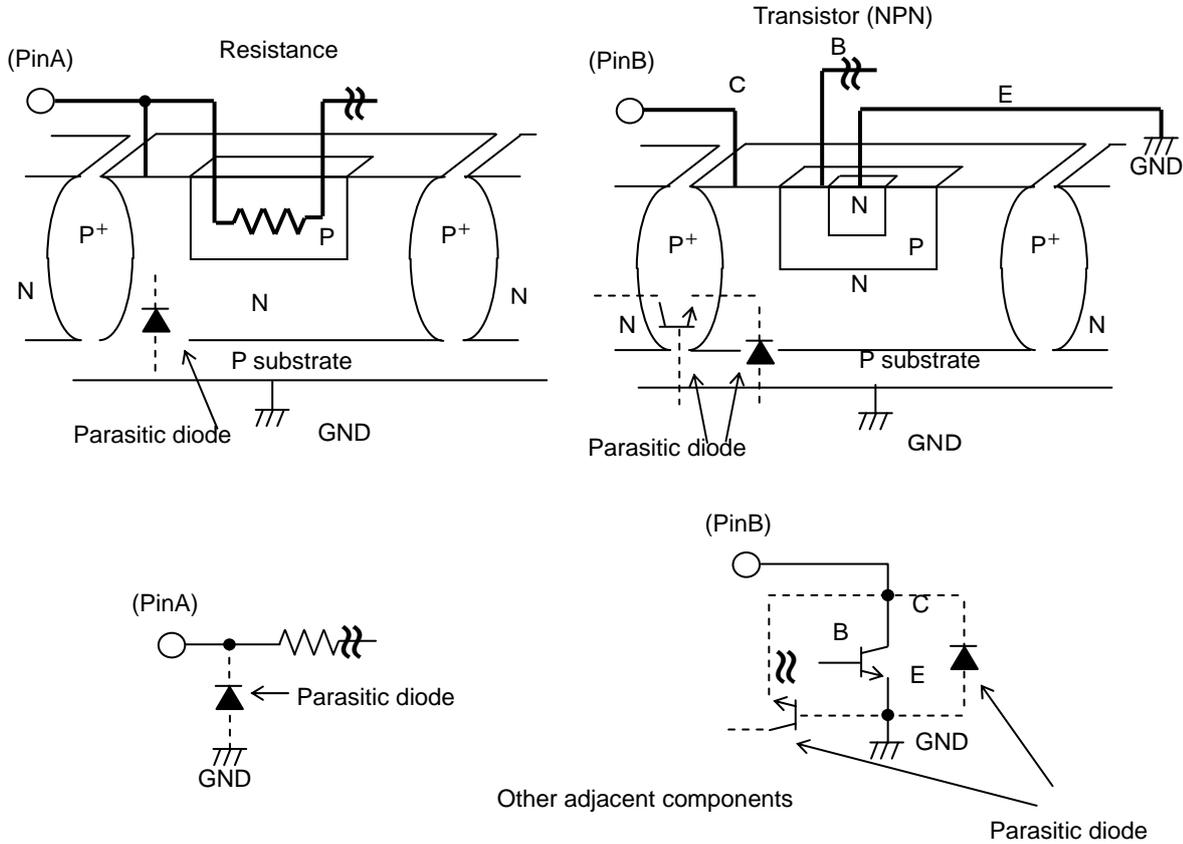
Fig.34   Simplified structure of a Bipolar IC

9. Common impedance
Power supply and ground wiring should reflect consideration of the need to lower common impedance and minimize ripple as much as possible (by making wiring as short and thick as possible or rejecting ripple by incorporating inductance and capacitance).

10. Pin short and mistake fitting
Do not short-circuit between OUT pin and VCC pin, OUT pin and GND pin,
or VCC pin and GND pin. When soldering the IC on circuit board,
please be unusually cautious about theorientation and the position of the IC.
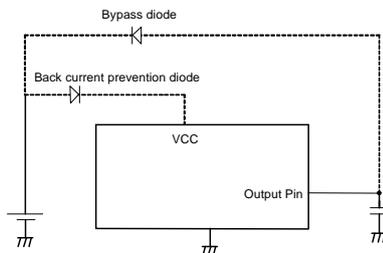
Fig.35

11. Application circuit

Although we can recommend the application circuits contained herein with a relatively high degree of confidence, we ask that you verify all characteristics and specifications of the circuit as well as performance under actual conditions. Please note that we cannot be held responsible for problems that may arise due to patent infringements or noncompliance with any and all applicable laws and regulations.

12. Operation

The IC will turn ON when the voltage at the STBY pin is greater than 2.0V and will switch OFF if under 0.3V. Therefore, do not input voltages between 0.3V and 2.0V. Malfunctions and/or physical damage may occur.

●Power Dissipation

TO252-S

(1) No heat sink
(2) 2layer PCB
     (Copper laminate area 15 mm×15mm)
(3) 2layer PCB
     (Copper laminate area 70 mm×70mm)
(4) 4layer PCB
     (Copper laminate area 70 mm×70mm)

Fig.36

TO220

(1) No heat sink
(2) Aluminum heat sink
     50×50×2 (mm^3)
(3) Aluminum heat sink
     100×100×2 (mm^3)
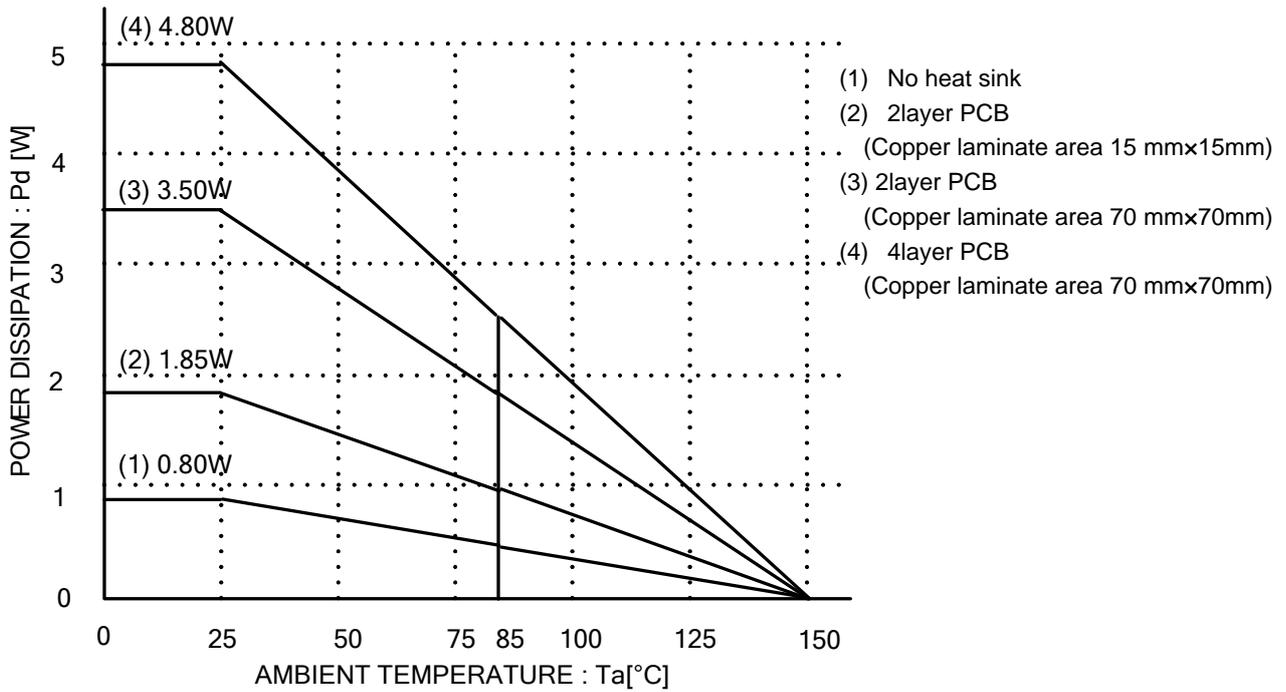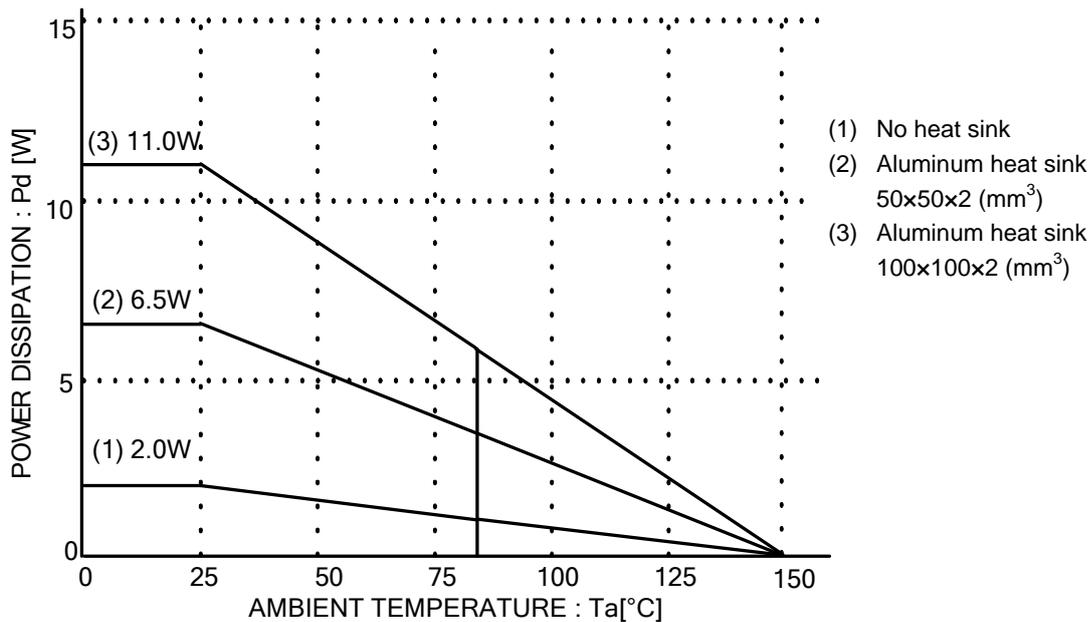
Fig.37

●Ordering part number

| B | D | | 9 | 7 | 0 | 1 | | F | P | - | E | 2 |

Part No.

Part No.
9701=36V/1.5A
9702=36V/1.5A
9703=36V/3.0A

Package
FP : TO252-5
CP-V5 : TO220CP-V5
T/T-V5 : TO220FP-5(V5)

Packaging and forming specification
E2: Embossed tape and reel
None:Tray,Tube

●Package specifications

TO252-5

(Unit : mm)

<Tape and Reel information>
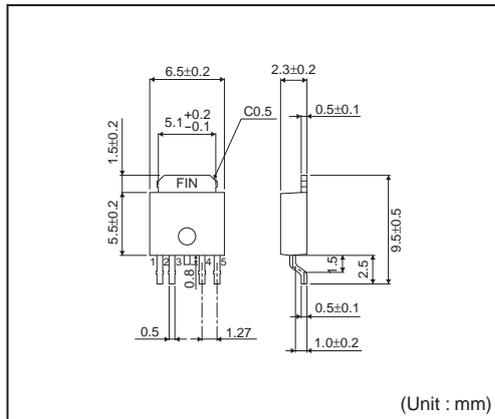
Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the lower left when you hold reel on the left hand and you pull out the tape on the right hand)

1pin   Direction of feed

Reel   ＊Order quantity needs to be multiple of the minimum quantity.

TO220FP-5

(Unit : mm)

<Tape and Reel information>

Container	Tube
Quantity	500pcs
Direction of feed	Direction of products is fixed in a container tube

＊Order quantity needs to be multiple of the minimum quantity.

TO220FP-5(V5)

(Unit : mm)

<Tape and Reel information>

Container	Tube
Quantity	500pcs
Direction of feed	Direction of products is fixed in a container tube

＊Order quantity needs to be multiple of the minimum quantity.

TO220CP-V5

(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the lower left when you hold reel on the left hand and you pull out the tape on the right hand)

Reel　　1pin　　Direction of feed

＊Order quantity needs to be multiple of the minimum quantity.

Notice

Precaution on using ROHM Products

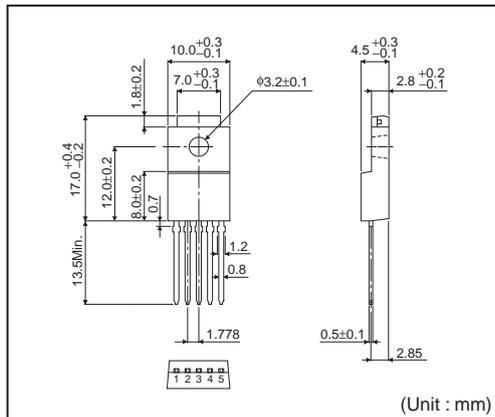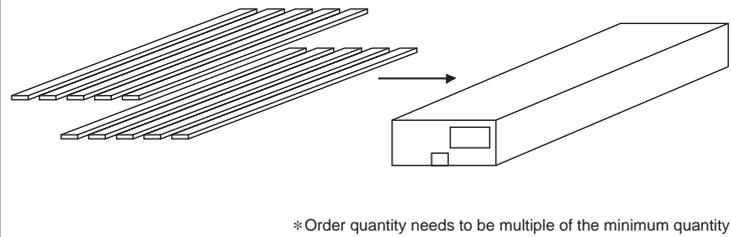1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment [Note 1], transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
    [a] Installation of protection circuits or other protective devices to improve system safety
    [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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    [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
    [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
    [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
    [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
    [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
    [f] Sealing or coating our Products with resin or other coating materials
    [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
    [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
    [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
    [b] the temperature or humidity exceeds those recommended by ROHM
    [c] the Products are exposed to direct sunshine or condensation
    [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

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