

Large Current External FET Controller Type Switching Regulators



Single-output Step-up, Negative Voltage, Step-down Switching Regulators (Controller type)

BD9300F/BD9300FV

● Description

The BD9300F/FV 1-channel DC/DC Step-up, step-down, and inverting converter controller.

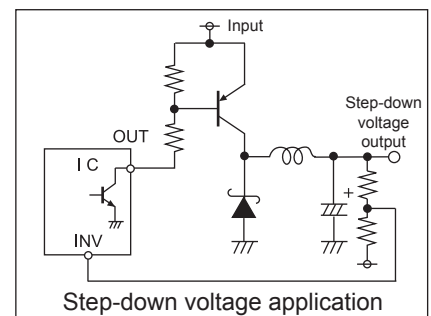
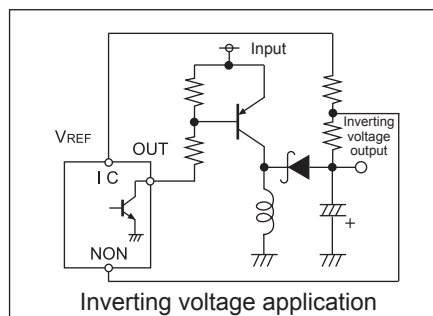
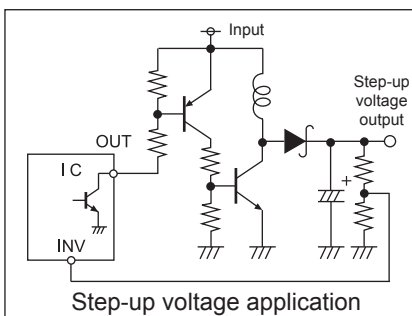
This IC has a wide input voltage range of 3.6 to 35 V, providing for a variety of applications. The pin assignment is similar to that of the BA9700, facilitating a space-saving application.

● Features

- 1) 1-channel PWM control DC/DC converter controller
- 2) High voltage input of 3.6 to 35 V
- 3) Reference voltage accuracy of $\pm 1\%$
- 4) Oscillation frequency variable in the range of 20 to 800 kHz
- 5) Built-in UVLO (Under Voltage Lock Out) circuit and SCP (Short Circuit Prevention) circuit
- 6) Current in standby mode: 0 μA (typ.)
- 7) Switching external synchronization available (Slave operation)
- 8) SSOP-B14 Package (for BD9300FV) or SOP14 Package (for BD9300F)

● Applications

- TV, power supply for liquid crystal display TV, and backlight
- DSC, DVD, printer, DVD/DVD recorder, and other consumer products



● Absolute maximum ratings(Ta=25°C)

Item	Symbol	Rating	Unit
Power supply voltage	Vcc	36	V
Power dissipation	Pd	400 *	mW
Operating temperature	Topr	-40 to +85	°C
Storage temperature	Tstg	-55 to +125	°C
Output current	Io	100 **	mA
Output voltage	Vo	36	V
Maximum junction temperature	Tjmax	125	°C

* Reduce by 4 mW/°C over 25°C, when mounted on a glass epoxy PCB of 70mmX70mmX1.6mm)

** Should not exceed Pd-value.

● Recommended operating range (Ta=25°C)

Item	Symbol	Limits			Unit
		Min	Typ	Max	
Power supply voltage	Vcc	3.6	12	35	V
Output sink current	Io	-	-	30	mA
Output voltage	Vo	-	-	35	V
Timing capacitance	CT	33	-	1000	pF
Timing resistance	RT	5	-	100	kΩ
Oscillation frequency	Fosc	20	-	800	kHz

● Electrical characteristics (Unless otherwise specified, Ta=25°C, Vcc=12V, CT=200pF, RT=20kΩ)

Item	Symbol	Limits			Unit	Conditions
		Min	Typ	Max		
[Reference voltage block]						
Reference voltage	VREF	2.475	2.500	2.525	V	IREF=1mA
Input stability	VDLI	-	1.5	20	mV	Vcc=3.6 to 35V IREF=1mA
Load stability	VULD	-	0.5	20	mV	IREF=0 ~ 1mA
1/2 reference voltage	1/2VREF	1.212	1.25	1.288	V	
[Triangular wave oscillator block]						
Oscillation frequency	FOSC	165	220	275	kHz	
Charge mode threshold voltage	VOSC+	-	1.95	-	V	
Discharge mode threshold voltage	VOSC-	-	1.45	-	V	
Frequency variation	FDVO	-	1	-	%	Vcc=3.6 to 35V
[Protection circuit block]						
Threshold voltage	VIT	1.5	1.8	2.1	V	
Charge current	Iscp	-	7	11	μA	
[Rest period adjustment circuit block]						
Upper limit threshold voltage	VtH	2.05	-	-	V	Duty Cycle=0%
Lower limit threshold voltage	VtL	-	-	1.35	V	Duty Cycle=100%
Input bias current	Ibd	-	0.1	1	μA	DTC=1.5V
Latch mode charge current	Idtc	200	500	-	μA	DTC=0V
[Under voltage lock out block]						
Threshold voltage	VUT	-	2.8	-	V	

○ Not designed to be radiation-resistant.

● Electrical characteristics (Unless otherwise specified, $T_a=25^\circ\text{C}$, $V_{CC}=12\text{ V}$, $C_T=200\text{pF}$, $R_T=20\text{ k}\Omega$)

Item	Symbol	Limits			Unit	Conditions
		Min	Typ	Max		
[Error amplifier block]						
Input bias current	I_{IB}	–	0.1	1	μA	
Open loop gain	A_V	–	85	–	dB	Null AMP
Maximum output voltage	V_{OH}	2.3	2.5	–	V	
Minimum output voltage	V_{OL}	–	0.7	0.9	V	
Output sink current	I_{OI}	0.1	1	–	mA	$V_{FB}=1.25\text{V}$
Output source current	I_{OO}	40	70	–	μA	$V_{FB}=1.25\text{V}$
[Output block]						
Saturation voltage	V_{SAT}	–	1.0	1.4	V	$I_o=30\text{mA}$
Leak current	I_{LEAK}	–	–	10	μA	$OUT=35\text{V}$
[Control block]						
CTL ON voltage	V_{ON}	2	–	–	V	
CTL OFF voltage	V_{OFF}	–	–	0.7	V	
CTL sink current	I_{CTL}	–	57	90	μA	$V_{CTL}=5\text{V}$
[Whole device]						
Standby current	I_{STB}	–	0	10	μA	$V_{CTL}=0\text{V}$
Average supply current	I_{CC}	–	1.2	2.4	mA	$R_T=V_{REF}$

○ Not designed to be radiation-resistant.

● Measurement circuit diagram

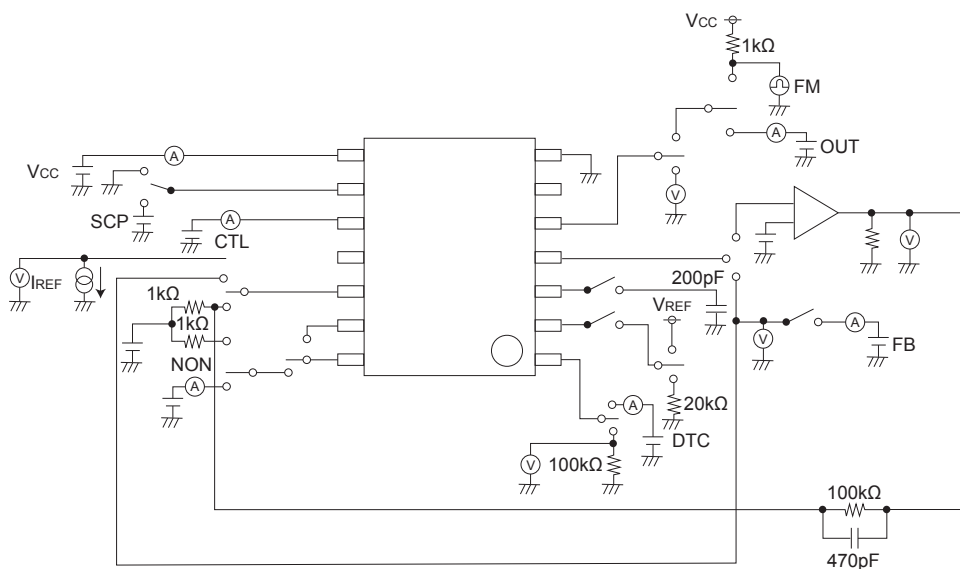


Fig. 1 Typical measurement circuit

● Reference characteristics data (Unless otherwise specified, $T_a=25^\circ\text{C}$)

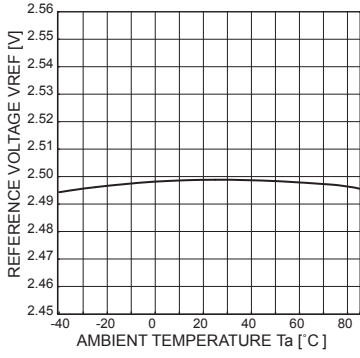


Fig.2 Reference voltage vs. Ambient temperature

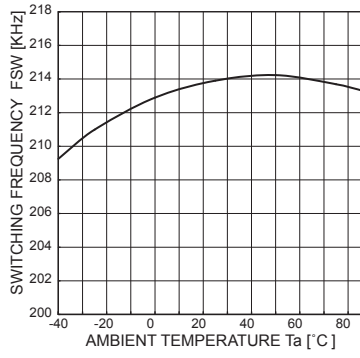


Fig.3 Switching frequency vs. Ambient temperature

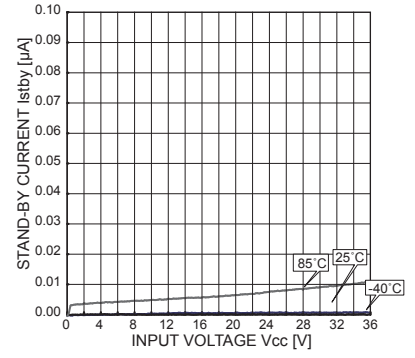


Fig.4 Standby current

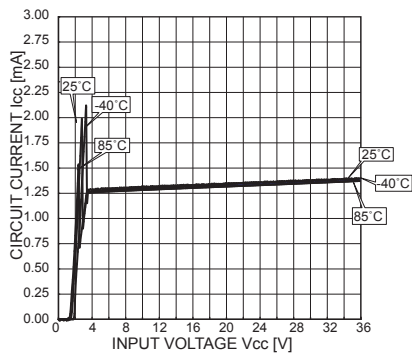


Fig.5 Circuit current

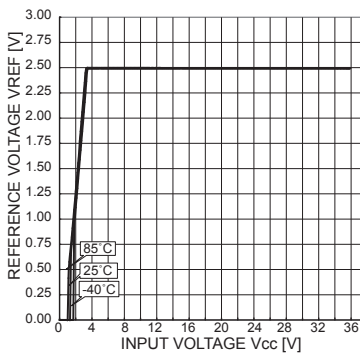


Fig.6 Reference voltage

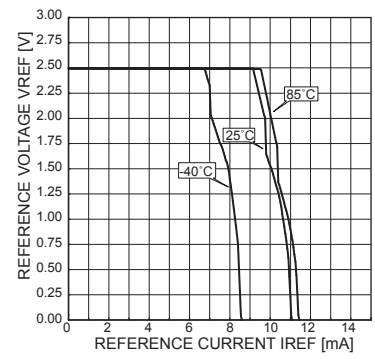


Fig.7 Reference voltage vs. Output current

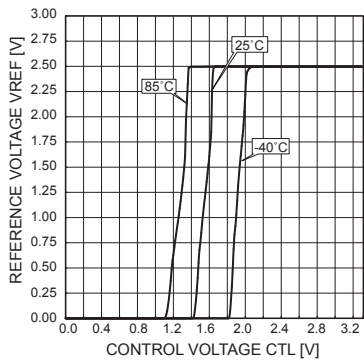


Fig.8 Control threshold voltage

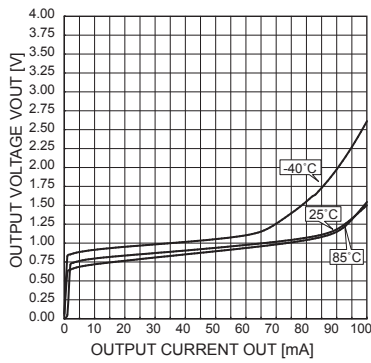


Fig.9 Output current capacitance

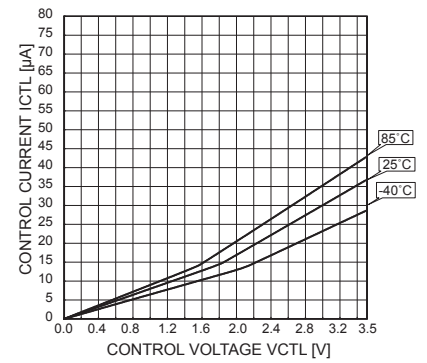
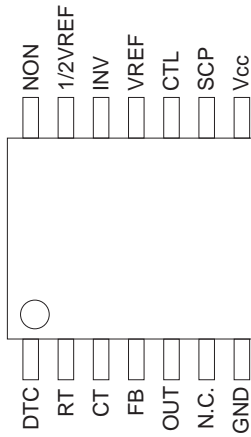


Fig.10 Control sink current

● Pin assignment



● Block diagram

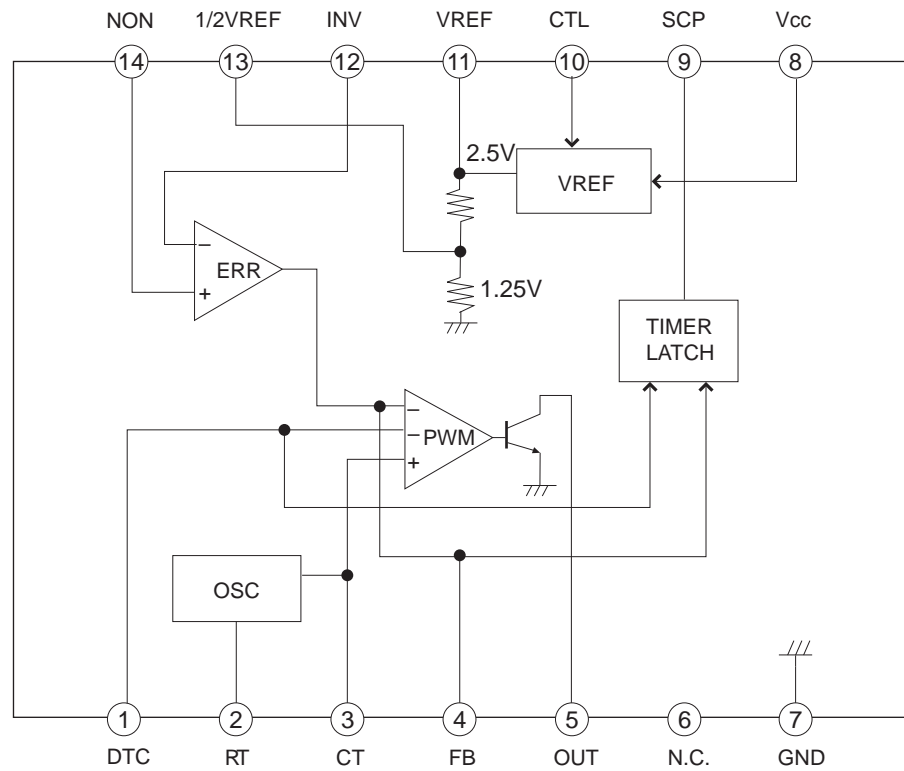


Fig. 11 Pin assignment / Block diagram

● Pin assignment and function

Pin No.	Pin name	Function
1	DTC	Rest period setting voltage input
2	RT	External timing resistance
3	CT	External timing capacitance
4	FB	Error amplifier output
5	OUT	PWM output (open collector)
6	N.C.	–
7	GND	Ground
8	Vcc	Power supply
9	SCP	External timer latch setting capacitance (Ground if not used)
10	CTL	Control input
11	VREF	Reference voltage output
12	INV	Inverting input for error amplifier
13	1/2VREF	1/2 reference voltage output
14	NON	Non-inverting input for error amplifier

● Description of operations

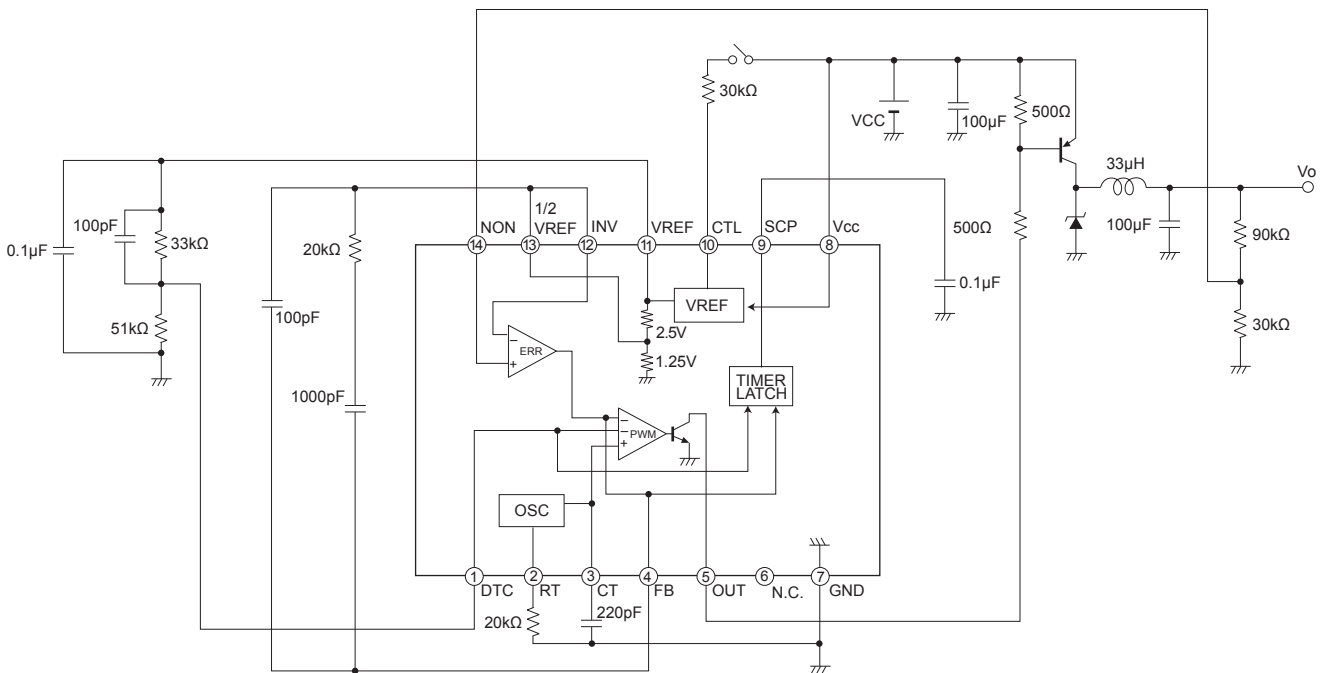


Fig. 12 Typical application circuit

VREF block

The VREF block is a block to output a reference voltage of 2.5 V (TYP), which is used as the operating power supply for all the Internal. The CTL pin is used to turn ON/OFF the reference voltage. Furthermore, this reference voltage has a current capacitance of 1 mA (MIN) or more, from which a high-accuracy reference voltage can be generated through dividing resistance.

ERRAMP block

The ERRAMP block is an error amplifier to amplify potential between the NON and the INV pins and then output a voltage. The FB pin output voltage determines the output pulse Duty. When the FB voltage reaches 1.95 V (TYP) or more, switching will be OFF (Duty=0%). When the FB voltage reaches 1.45 V (TYP) or less, the output NPN Tr will be FULL ON (Duty=100%).

OSC block

The OSC block is a block to determine the switching frequency through the RT and the CT pins. RT and CT voltages determine the triangular waveform.

TIMER LATCH block

The TIMER LATCH block is an output short circuit protection circuit to detect output short circuit when the output voltage from the FB pin of the error amplifier reaches 1 V (TYP) or less. When the FB voltage reaches 1 V (TYP) or less, the TIMER will starts operating to charge the SCP pin at a current capacitance of 7 μA (TYP). When the SCP voltage reaches 1.8 V (TYP), the LATCH will be activated to shut down the circuit.

PWM/Driver block

The PWM/Driver block is a PWM comparator to determine Duty value differences between output from the error amplifier and the oscillator triangular wave. The DTC voltage determines the maximum duty ratio. When the DTC voltage reaches 1.95 V (TYP), the switching OFF is activated. FULL ON will be activated when the DTC voltage reaches 1.45 V (TYP). The DTC voltage setting should be made through dividing resistance with the VREF block.

● Timing chart

· Basic operation

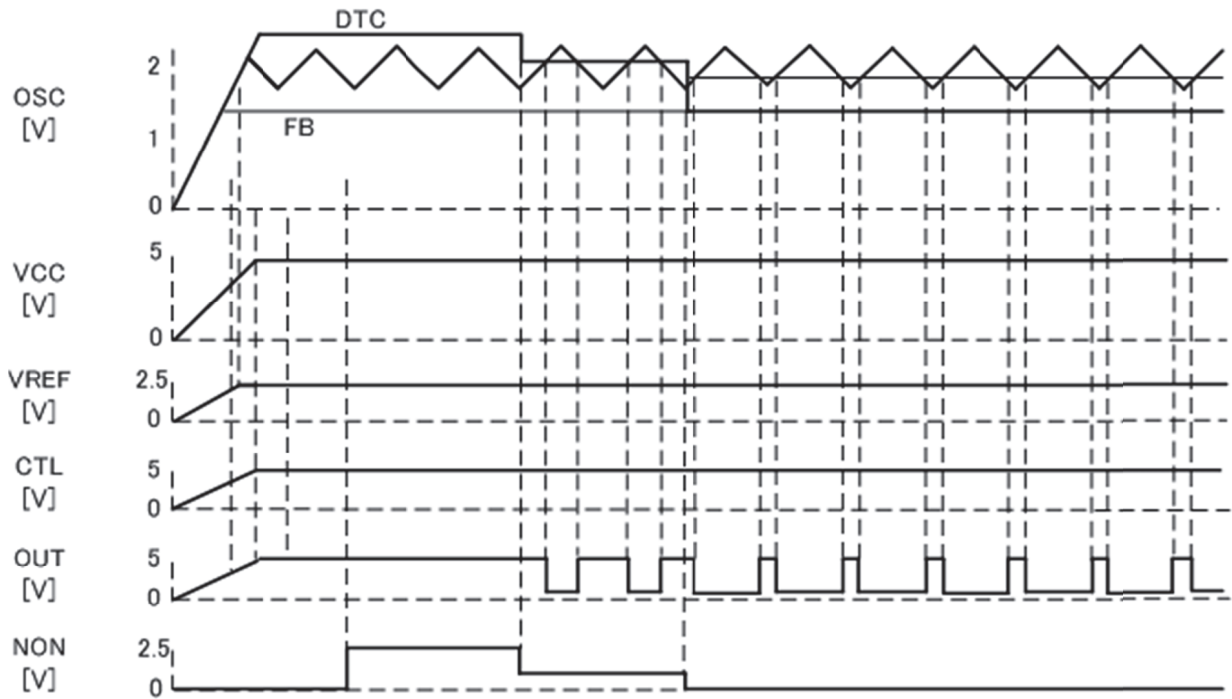


Fig. 13 Basic operation

· When the short circuit protection is activated

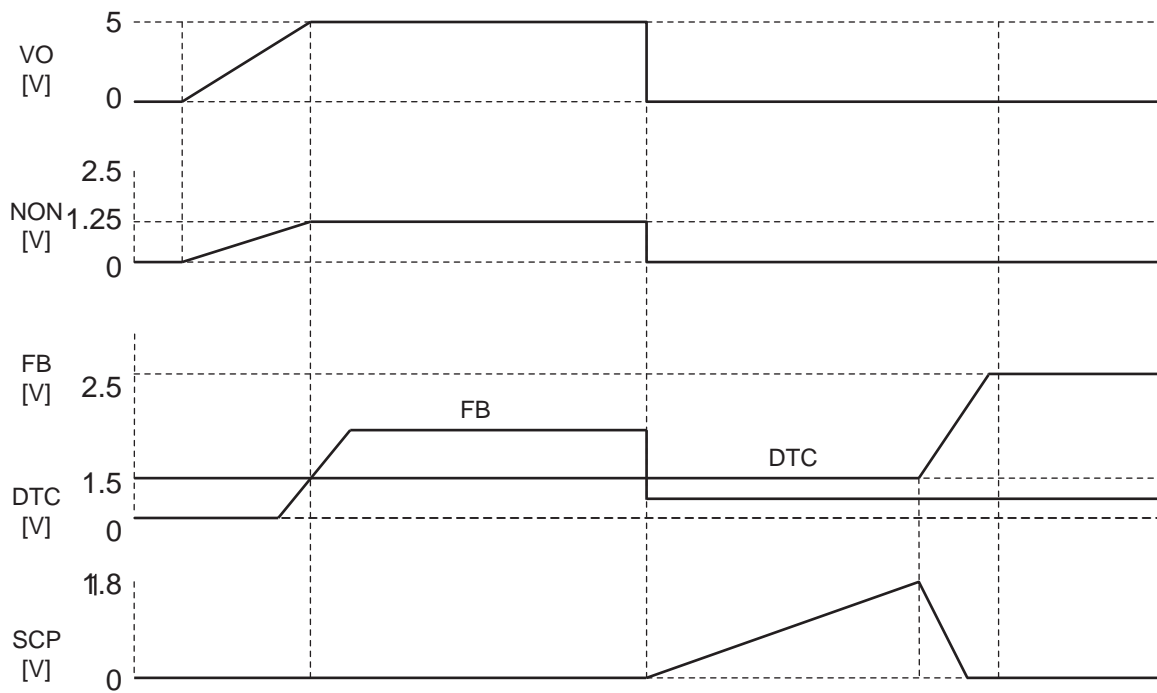


Fig. 14 Timing when the short circuit protection is activated

● External component setting procedure

(1) Design of feedback resistance constant

Set step-down, step-up, and inverting feedback resistance as shown below. Set resistance in the range of 1 kΩ to 330 kΩ. Setting the resistance to 1 kΩ or less will result in degraded power efficiency, while setting it to 330 kΩ or more will increase the offset voltage due to the input bias current of 0.1μA (TYP) of the error amplifier.

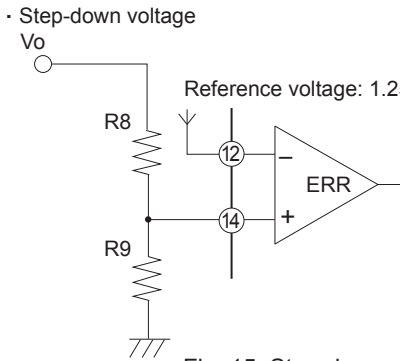


Fig. 15 Step-down voltage

$$V_o = \frac{R8+R9}{R9} \times 1.25 \text{ [V]}$$

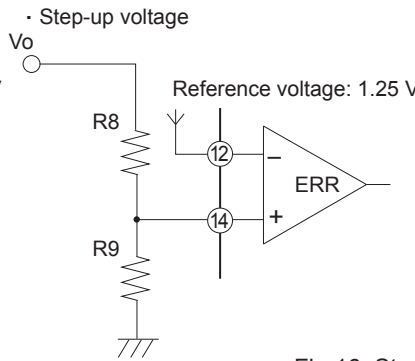


Fig.16 Step-up voltage

$$V_o = \frac{R8+R9}{R9} \times 1.25 \text{ [V]}$$

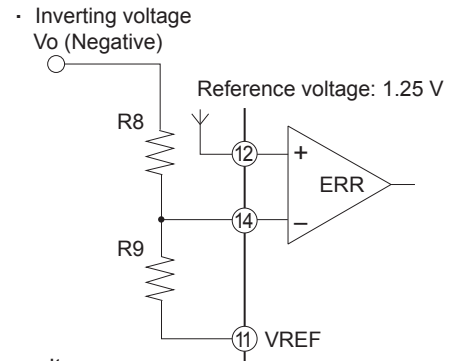


Fig. 17 Inverting voltage

$$V_o = 1.25 \left(1 - \frac{R8}{R9} \right) \text{ [V]}$$

(2) Setting of oscillation frequency

Connecting a resistor and capacitor to the RT pin (pin 2) and the CT pin (pin 3) will set the triangular wave oscillation frequency. The RT determines the charge/discharge current to the capacitor. Referring to Fig. 18, set RT resistor and the CT capacitor. Recommended setting ranges are 5 to 100 kΩ for the CT resistor, 33 to 1000 pF for the CT capacitor, and 20 kHz to 800 kHz for the oscillation frequency. Any setting outside of these ranges may turn OFF switching, thus impairing the operation guarantee.

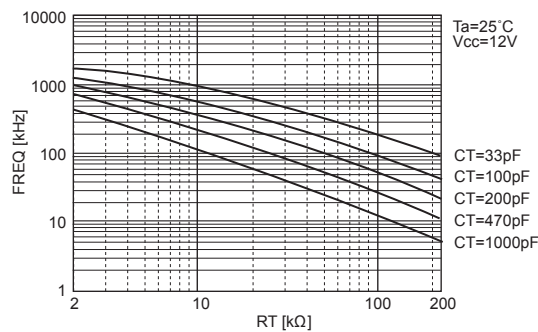


Fig. 18 RT/CT vs. Frequency

(3) Setting of DTC voltage

Applying the VDTC voltage to the DTC pin (pin 1) will fix the maximum duty ratio. This will serve to prevent the power transistor (FET) from being FULL ON. Fig. 19 shows the relationship between the DTC voltage and the maximum duty ratio. Referring to this Figure, set the DTC voltage. Next, generate the VDTC by dividing the VREF voltage with resistance and then input the VDTC in the DTC pin.

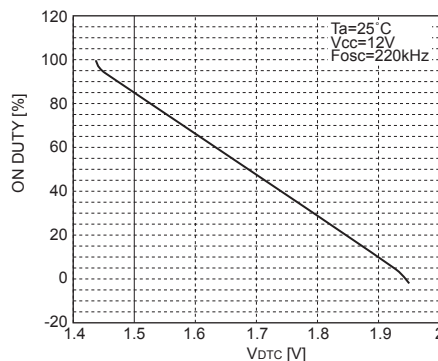


Fig. 19 DTC voltage vs. Maximum duty

Furthermore, the maximum duty ratio should be designed so as not to become a maximum duty for the normal use. The following section shows ranges for the normal use.

• Step-down voltage

$$ON Duty MAX = \frac{VOMAX}{VCCMIN}$$

• Step-up voltage

$$ON Duty MAX = \frac{VOMAX - VOMIN}{VOMAX}$$

• Inverting voltage

$$ON Duty MAX = \frac{VOMAX}{VOMAX - VCCMIN}$$

(4) Setting of soft start time

Adding a capacitor to the DTC resistance divider will enable the soft start function activation.

The soft start function will be required to prevent an excessive increase in the coil current and overshoot of the output voltage, while in startup operation. Fig. 20 shows the relationship between the capacitor and the soft start time. Referring to this Figure, set the capacitor. It is recommended to set the capacitance value in the range of 0.01 to 10 μF . Setting the capacitance value to 0.01 μF or less, may cause overshoot to the output voltage, while setting it to 10 μF or more may cause an inverse current in the internal parasitic diode when the power supply is grounded, thus resulting in damage to the internal element.

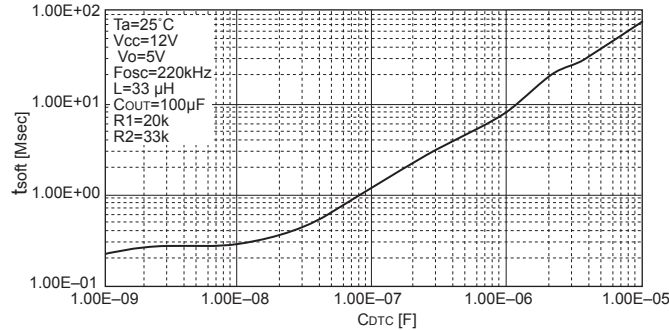


Fig. 20 Soft start capacitance vs. Delay time

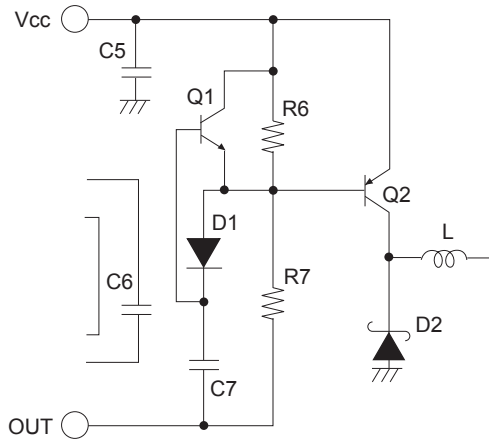


Fig. 21 ON/OFF peak circuit

Since the PNP Tr is generally slow in switching, in terms of the sat characteristics, the ON/OFF peak circuit is used as an acceleration circuit. The D1 and the C7 generate an ON peak current, while the Q1 and the C7 forms an OFF peak circuit. Set pull-up resistance to 510 Ω as a guide at VCC=12 V. It is recommended to set this resistance in the range of 100 k Ω to 10 k Ω . In order to make adjustment of the R6 and R7, however, pay attention of the points listed in table below.

NO.	Item	To reduce R6	To reduce R7
1	Efficiency	Degraded	Degraded
2	Tr Turn ON / Turn OFF	Faster Turn OFF	Faster Turn OFF
3	Switching frequency	Increasable	Increasable
4	Load current capacitance	Degraded	Degraded

Take 1000 pF as a guide for the C7 setting. If the ON/OFF peak currents are inadequate, increase the C7 capacitance value. It is recommended to set capacitance values in the range of 100 pF to 10000 pF. Setting the capacitance value to 10000 pF or more may increase the peak current and degrade the power efficiency.

(6) Phase compensation

Phase compensation setting procedure

The phase compensation setting procedure varies with the selection of output capacitors used for DC/DC converter application. In this connection, the following section describes the procedure by classifying into the two types. Furthermore, the application stability conditions are described in the Description section.

1. Application stability conditions
2. For output capacitors having high ESR, such as electrolytic capacitor
3. For output capacitors having low ESR, such as ceramic capacitor or OS-CON

1. Application stability conditions

The following section shows the stability conditions of negative feedback system.

- DSC, DVD, printer, DVD/DVD recorder, and other consumer products At a 1 (0-dB) gain, the phase delay is 150° or less (i.e., the phase margin is 30° or more).

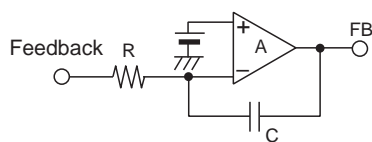
Furthermore, since the DC/DC converter application is sampled according to the switching frequency, GBW of the overall system should be set to 1/10 or less of the switching frequency. The following section summarizes the targeted characteristics of this application.

- DSC, DVD, printer, DVD/DVD recorder, and other consumer products At a 1 (0-dB) gain, the phase delay is 150° or less (i.e., the phase margin is 30° or more).
- DSC, DVD, printer, DVD/DVD recorder, and other consumer products The GBW (i.e., frequency at 0-dB gain) for this occasion is 1/10 or less of the switching frequency.

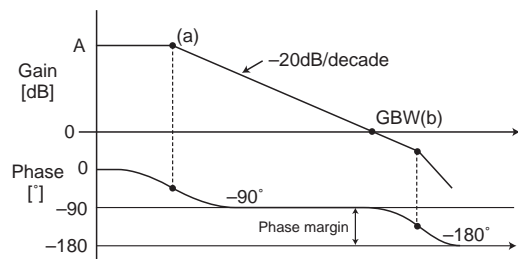
In other words, the responsiveness is determined with restrictions on the GBW. Consequently, in order to upgrade the responsiveness, higher switching frequency should be provided.

In order to ensure the stability through the phase compensation, a secondary phase delay (-180°) resulting from LC resonance should be canceled with a secondary phase lead (i.e., through inserting two phase leads). Furthermore, the GBW (i.e., frequency at 1-dB gain) is determined according to phase compensation capacitance to be provided for the error amplifier. Consequently, in order to reduce the GBW, increase the capacitance value.

(1) Typical (sun) integrator (Low pass filter)



(2) Open loop characteristics of (mon) integrator



(a) point $f_a = \frac{1}{2\pi R C A}$ [Hz]

(b) point $f_b = GBW = \frac{1}{2\pi R C}$ [Hz]

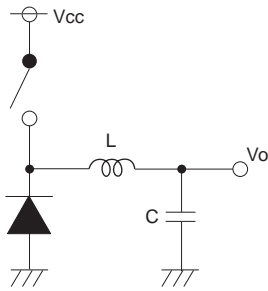
Fig. 22 Typical integrator characteristics

Since the error amplifier is provided with (sun) or (mon) phase compensation, the low pass filter is applied. In the case of the DC/DC converter application, the R becomes a parallel resistance of the feedback resistance.

2. For output capacitors having high ESR, such as aluminum electrolytic capacitor

For output capacitors having high ESR (i.e., several ohms), the phase compensation setting procedure becomes comparatively simple. Since the DC/DC converter application has a LC resonant circuit attached to the output, a -180° phase-delay occurs in that area. If ESR component is present there, however, a $+90^\circ$ phase-lead occurs to shift the phase delay to -90° . Since the phase delay is desired to set within 150° , this is a very effective method but has a demerit to increase the ripple component of the output voltage.

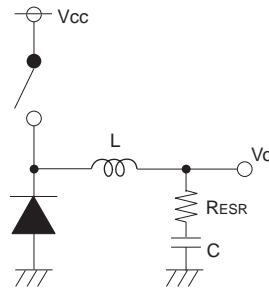
(3) LC resonant circuit



$$f_z = \frac{1}{2\pi\sqrt{LC}} \text{ [Hz]}$$

At this resonance point, a -180° phase-delay occurs.

(4) With ESR provided



$$f_z = \frac{1}{2\pi\sqrt{LC}} \text{ [Hz]} : \text{Resonance point}$$

$$f_{ESR} = \frac{1}{2\pi \text{RESR}C} \text{ [Hz]} : \text{Phase lead}$$

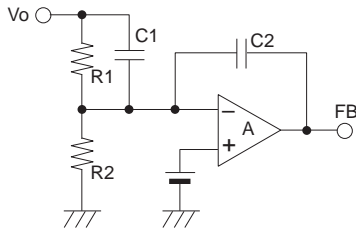
A -90° phase-delay occurs.

* Same for the phase compensation of inverting and step-up voltages

Fig. 23 DC/DC converter output application

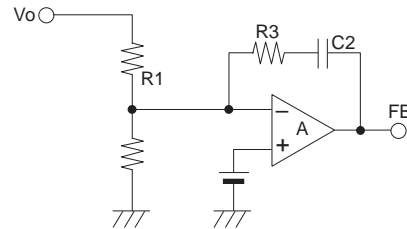
According to changes in phase characteristics due to the ESR, only one phase lead should be inserted. For this phase lead, select either of the methods shown below:

(5) Insert feedback resistance in the C.



$$\text{Phase lead: } f_z = \frac{1}{2\pi C_1 R_1} \text{ [Hz]}$$

(6) Insert the R3 in integrator.



$$\text{Phase lead: } f_z = \frac{1}{2\pi C_2 R_3} \text{ [Hz]}$$

Fig. 24 Typical phase compensation circuit

To cancel the LC resonance, phase lead frequency should be set close to the LC resonant frequency.

3. For output capacitors having low ESR, such as a ceramic capacitor or OS-CON

In order to use capacitors having low ESR (i.e., several tens of mW), two phase-leads should be inserted so that a -180° phase-delay, due to LC resonance, will be compensated. The following section shows a typical phase compensation procedure.

· Phase compensation with secondary phase lead

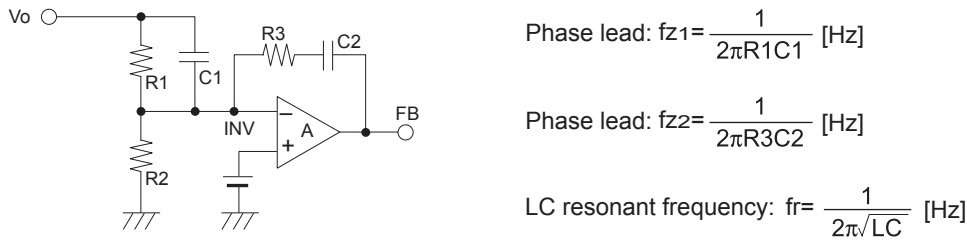


Fig. 25 Typical circuit after secondary compensation circuit

For the settings of phase lead frequency, insert both of the phase leads close to the LC resonant frequency.

Phase compensation on the BD9300F/FV

For BD9300F/FV, since the error amplifier input is inverted to the normal input, the phase compensation procedure is slightly different. (The BD9300F/FV returns feedback to the NON pin.)

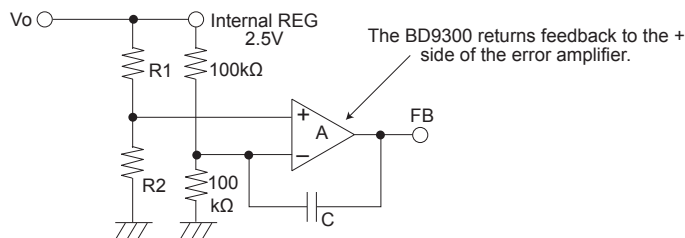


Fig. 26 Typical circuit after phase compensation on BD9300F/FV

The BD9300F/FV feeds back on the + side input and returns the phase compensation on the - side input. Consequently, resistance of the resistance divider being used to determine the reference voltage has influence on the frequency characteristics. (The BD9300F/FV has a 1/2 VREF pin to divide resistance by 100 kΩ.)

The following section shows the phase characteristics.

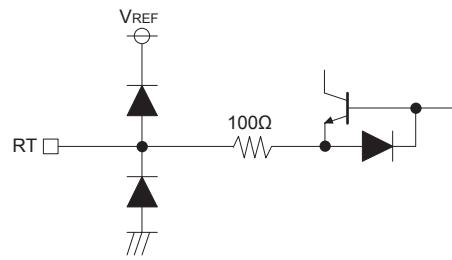
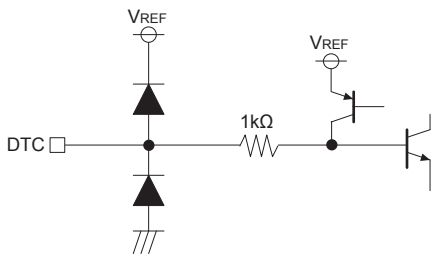
$$\text{Primary phase delay: } fp = \frac{1}{2\pi C \frac{100k\Omega}{2} (1+A)} \text{ [Hz], where A is approximately 80 dB.}$$

$$\text{Phase lead: } fz = \frac{1}{2\pi C \frac{100k\Omega}{2}} \text{ [Hz]}$$

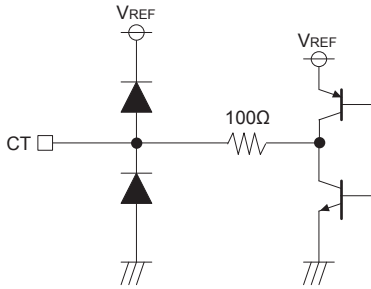
As a result, inserting a phase compensation capacitor will cause phase lead component. If any further phase lead is required, add a capacitor in parallel with the R1.

● Equivalent circuit

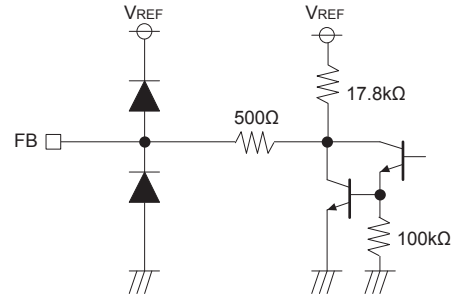
(1) DTC



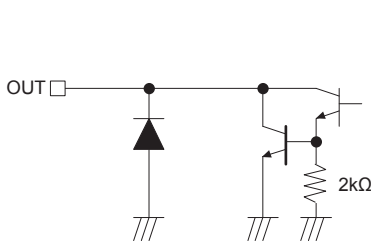
(3) CT



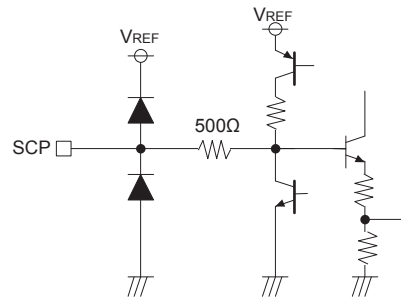
(4) FB



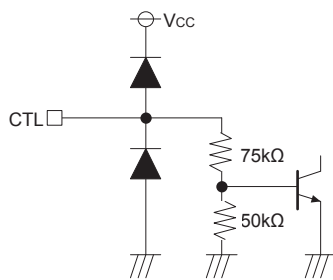
(5) OUT



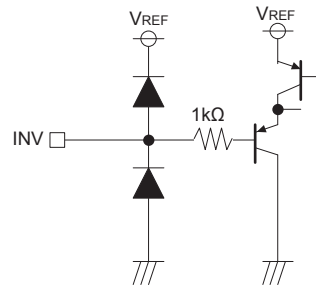
(9) SCP



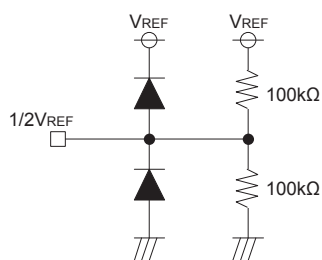
(10) CTL



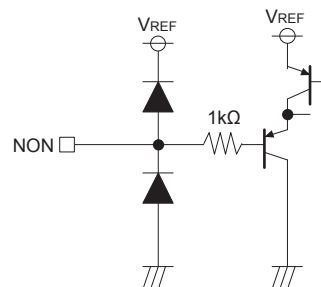
(12) INV



(13) 1/2VREF



(14) NON



● Cautions on use

1) Absolute maximum ratings

An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.

2) GND potential

Ground-GND potential should maintain at the minimum ground voltage level. Furthermore, no terminals should be lower than the GND potential voltage including an electric transients.

3) Thermal design

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

4) Inter-pin shorts and mounting errors

Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if positive and ground power supply terminals are reversed. The IC may also be damaged if pins are shorted together or are shorted to other circuit's power lines.

5) Operation in strong electromagnetic field

Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.

6) 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. Always turn the IC's power supply off before connecting it to, or removing it from a jig or fixture, during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting and storing the IC.

7) IC pin input

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements to keep them isolated. PñN junctions are formed at the intersection of these P layers with the N layers of other elements, creating a parasitic diode or transistor. For example, the relation between each potential is as follows:

○ When $GND > Pin A$ and $GND > Pin B$, the PñN junction operates as a parasitic diode.

○ When $Pin B > GND > Pin A$, the PñN junction operates as a parasitic transistor^f.

Parasitic diodes can occur inevitably in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND (P substrate) voltage to an input pin, should not be used.

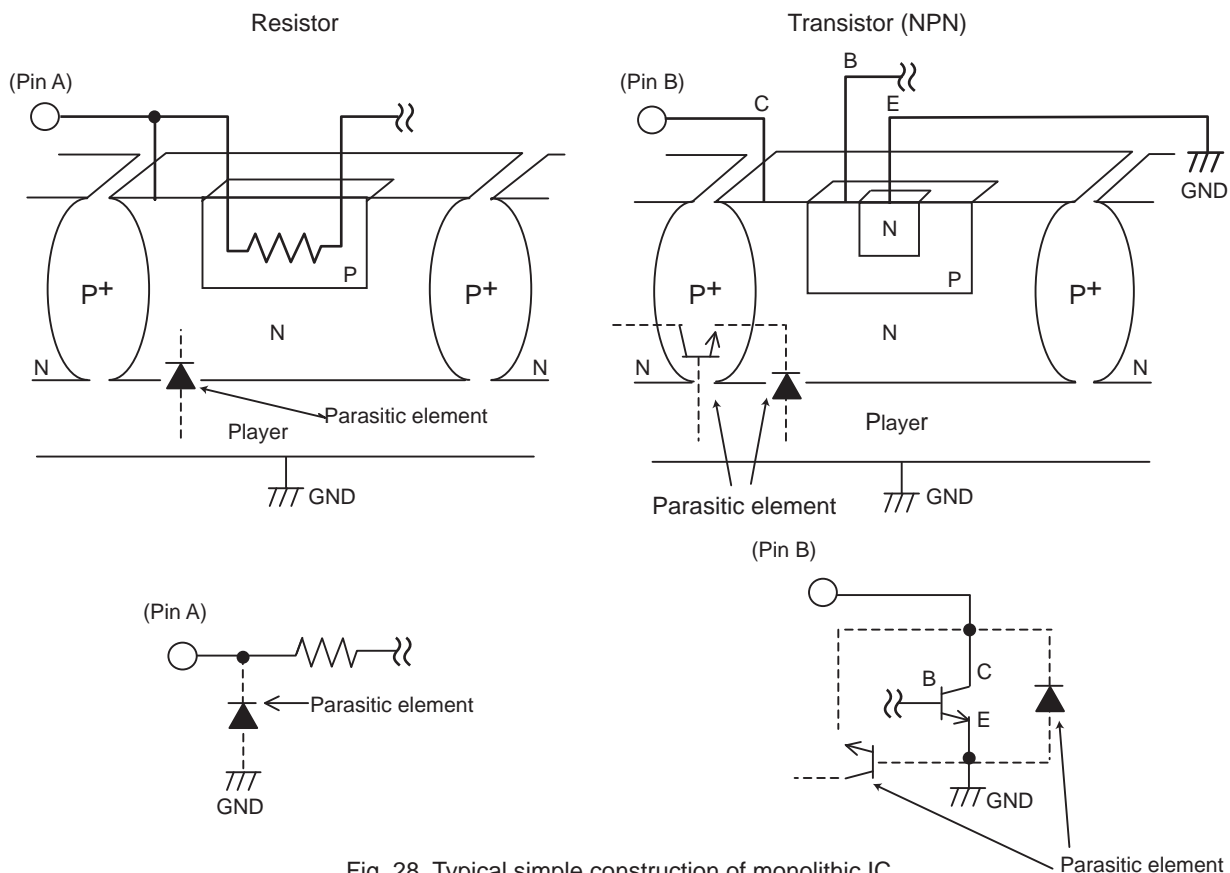


Fig. 28 Typical simple construction of monolithic IC

8) Ground wiring pattern

The power supply and ground lines must be as short and thick as possible to reduce line impedance. Fluctuating voltage on the power ground line may damage the device.

● Derating curve

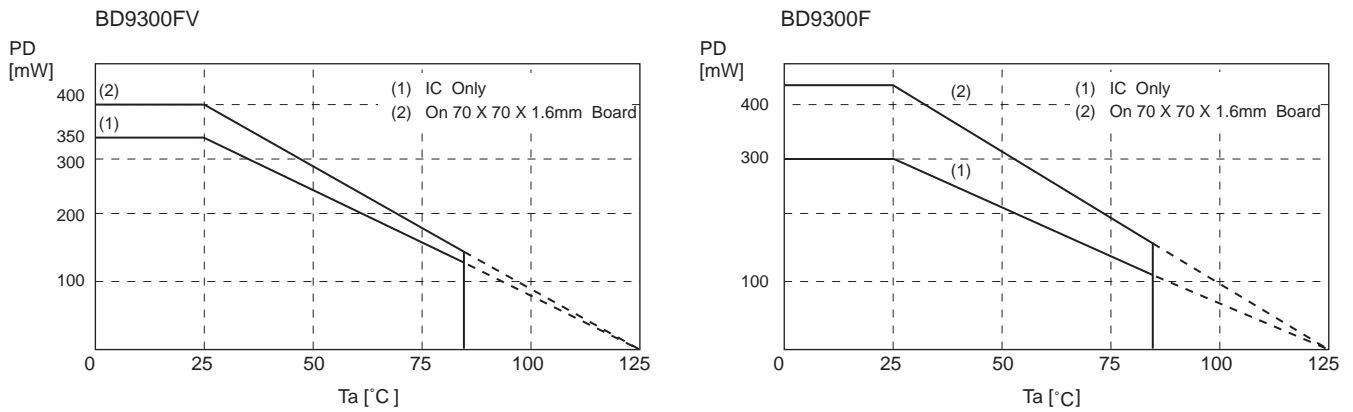
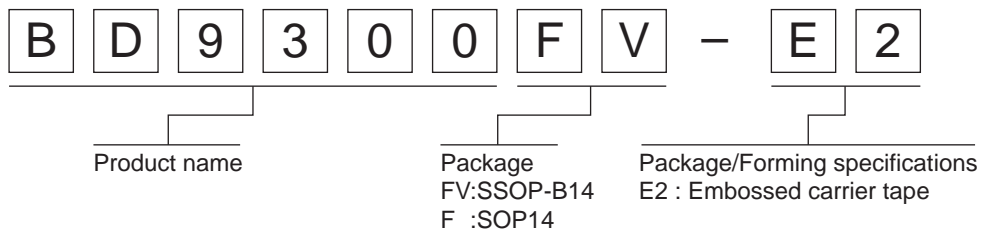


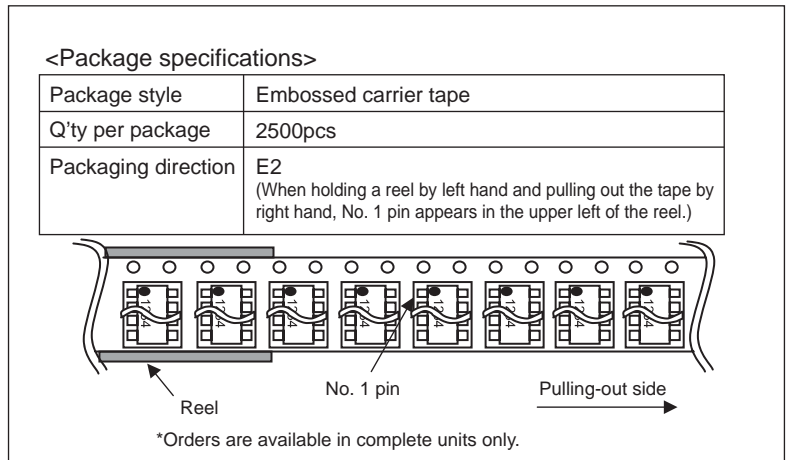
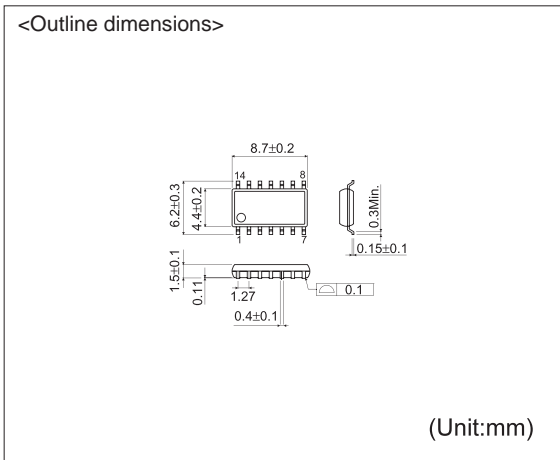
Fig. 29 Thermal derating characteristics

● Selection of order type

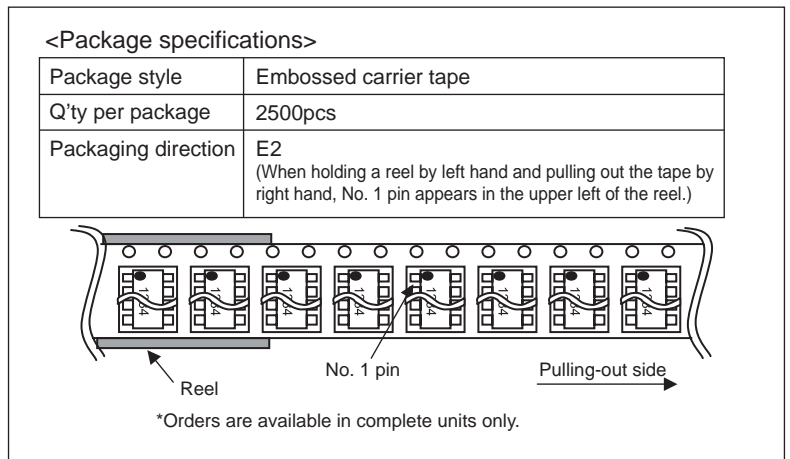
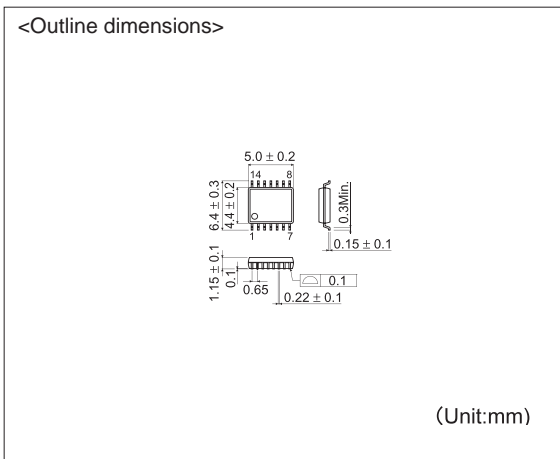


● Package specifications

SOP14



SSOP-B14



- The contents described herein are correct as of September, 2008
- The contents described herein are subject to change without notice. For updates of the latest information, please contact and confirm with ROHM CO.,LTD.
- Any part of this application note must not be duplicated or copied without our permission.
- Application circuit diagrams and circuit constants contained herein are shown as examples of standard use and operation. Please pay careful attention to the peripheral conditions when designing circuits and deciding upon circuit constants in the set.
- Any data, including, but not limited to application circuit diagrams and information, described herein are intended only as illustrations of such devices and not as the specifications for such devices. ROHM CO.,LTD. disclaims any warranty that any use of such devices shall be free from infringement of any third party's intellectual property rights or other proprietary rights, and further, assumes no liability of whatsoever nature in the event of any such infringement, or arising from or connected with or related to the use of such devices.
- Upon the sale of any such devices, other than for buyer's right to use such devices itself, resell or otherwise dispose of the same, implied right or license to practice or commercially exploit any intellectual property rights or other proprietary rights owned or controlled by ROHM CO., LTD. is granted to any such buyer.
- The products described herein utilize silicon as the main material.
- The products described herein are not designed to be X ray proof.

The products listed in this catalog are designed to be used with ordinary electronic equipment or devices (such as audio visual equipment, office-automation equipment, communications devices, electrical appliances and electronic toys). Should you intend to use these products with equipment or devices which require an extremely high level of reliability and the malfunction of which would directly endanger human life (such as medical instruments, transportation equipment, aerospace machinery, nuclear-reactor controllers, fuel controllers and other safety devices), please be sure to consult with our sales representative in advance.

Contact us for further information about the products.

San Diego	TEL: +1-858-625-3630	FAX: +1-858-625-3670	Tianjin	TEL: +86-22-23029181	FAX: +86-22-23029183
Atlanta	TEL: +1-770-754-5972	FAX: +1-770-754-0691	Shanghai	TEL: +86-21-6279-2727	FAX: +86-21-6247-2066
Boston	TEL: +1-978-371-0382	FAX: +1-928-438-7164	Hangzhou	TEL: +86-571-87658072	FAX: +86-571-87658071
Chicago	TEL: +1-847-368-1006	FAX: +1-847-368-1008	Nanjing	TEL: +86-25-8689-0015	FAX: +86-25-8689-0393
Dallas	TEL: +1-469-287-5366	FAX: +1-469-362-7973	Ningbo	TEL: +86-574-87654201	FAX: +86-574-87654208
Denver	TEL: +1-303-708-0908	FAX: +1-303-708-0858	Qingdao	TEL: +86-532-5779-312	FAX: +86-532-5779-653
Detroit	TEL: +1-248-348-9920	FAX: +1-248-348-9942	Suzhou	TEL: +86-512-6807-1300	FAX: +86-512-6807-2300
Nashville	TEL: +1-615-620-6700	FAX: +1-615-620-6702	Wuxi	TEL: +86-510-82702693	FAX: +86-510-82702992
Mexico	TEL: +52-33-3123-2001	FAX: +52-33-3123-2002	Shenzhen	TEL: +86-755-8307-3008	FAX: +86-755-8307-3003
Düsseldorf	TEL: +49-2154-9210	FAX: +49-2154-921400	Dongguan	TEL: +86-769-8393-3320	FAX: +86-769-8398-4140
Munich	TEL: +49-8999-216168	FAX: +49-8999-216176	Fuzhou	TEL: +86-591-8801-8698	FAX: +86-591-8801-8690
Stuttgart	TEL: +49-711-7272-370	FAX: +49-711-7272-3720	Guangzhou	TEL: +86-20-3878-8100	FAX: +86-20-3825-5965
France	TEL: +33-1-5697-3060	FAX: +33-1-5697-3080	Huizhou	TEL: +86-752-205-1054	FAX: +86-752-205-1059
United Kingdom	TEL: +44-1-908-306700	FAX: +44-1-908-235788	Xiamen	TEL: +86-592-238-5705	FAX: +86-592-239-8380
Denmark	TEL: +45-3694-4739	FAX: +45-3694-4789	Zhuhai	TEL: +86-756-3232-480	FAX: +86-756-3232-460
Espoo	TEL: +358-9725-54491	FAX: +358-9-7255-4499	Hong Kong	TEL: +852-2-740-6262	FAX: +852-2-375-8971
Salo	TEL: +358-2-7332234	FAX: +358-2-7332237	Taipei	TEL: +886-2-2500-6956	FAX: +886-2-2503-2869
Oulu	TEL: +358-9-5372930	FAX: +358-8-5372931	Kaohsiung	TEL: +886-7-237-0881	FAX: +886-7-238-7332
Barcelona	TEL: +34-9375-24320	FAX: +34-9375-24410	Singapore	TEL: +65-6332-2322	FAX: +65-6332-5662
Hungary	TEL: +36-1-4719338	FAX: +36-1-4719339	Philippines	TEL: +63-2-807-6872	FAX: +63-2-809-1422
Poland	TEL: +48-22-5757213	FAX: +48-22-5757001	Thailand	TEL: +66-2-254-4890	FAX: +66-2-256-6334
Russia	TEL: +7-495-739-41-74	FAX: +7-495-739-41-74	Kuala Lumpur	TEL: +60-3-7958-8355	FAX: +60-3-7958-8377
Seoul	TEL: +82-2-8182-700	FAX: +82-2-8182-715	Penang	TEL: +60-4-2286453	FAX: +60-4-2286452
Masan	TEL: +82-55-240-6234	FAX: +82-55-240-6236	Kyoto	TEL: +81-75-365-1218	FAX: +81-75-365-1228
Dalian	TEL: +86-411-8230-8549	FAX: +86-411-8230-8537	Yokohama	TEL: +81-45-476-2290	FAX: +81-45-476-2295
Beijing	TEL: +86-10-8525-2483	FAX: +86-10-8525-2489			

Excellence in Electronics

ROHM

ROHM CO., LTD.

21 Saiin Mizosaki-cho, Ukyo-ku, Kyoto
615-8585, Japan
TEL: +81-75-311-2121 FAX: +81-75-315-0172
URL <http://www.rohm.com>

Published by
KTC LSI Development Headquarters
LSI Business Promotion Group

Notice

Precaution on using ROHM Products

- 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
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

- 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:
 - Installation of protection circuits or other protective devices to improve system safety
 - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc. prior to use, must be necessary:
 - Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
 - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
 - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
 - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
 - Sealing or coating our Products with resin or other coating materials
 - 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
 - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- 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.
- De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- 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

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, 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

A two-dimensional barcode 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 concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.
2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).
3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.
2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.
3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.
4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

General Precaution

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.
2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.
3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.