

Ultra high efficiency Non-Isolated Type DC-DC converter

Bellnix® **BST-30A Series**

BST-30A series is ultra small size, low profile, ultra high efficiency, low noise and non-isolated type DC-DC converter developed for Distributed Power Architecture (DPA). The output voltage is adjustable in a wide range of 1.0V to 3.3V. Furthermore, a tracking function is built-in as a standard and it is easy to compose sequence circuits for applications required for power supply sequences of FPGA etc.

<Features>

- Low Profile, Ultra Small Size (W=38.0 L=13.8 H=10.0mm)
- Adjustable Output Voltage
- Input/ Output Non-Isolated Type
- Ultra High Efficiency 93%
- Wide Operating Temp. Range -40°C to 85°C
- SMD type
- Long life, High performance and Low Price
- Wide Input Voltage Range
- Built-in Over-Current Protection
- Tracking Function
- Remote ON/OFF Control
- High Reliability with the Latest SMD Structure
- No Electrolytic Capacitor



<Model, Rating and Specification> Table1

Models	Input Rated Voltage V	Input V Vdc	Output V Vdc	Output Adjustable range V	Output I A	Efficiency % (typ.) *2	Package
BST05-3.3S30PCM	5.0	4.75 - 5.5	3.3	1.0-3.3	0-30 *1	93.0	SMD
BST12-3.3S30PCM	12.0	8.0 - 14.0	(1.0-3.3)	1.0-3.3		92.0	SMD

*1: Derating is necessary by the output voltage.
 *2: The value of efficiency is the one of the rated input-output.

<Outline>

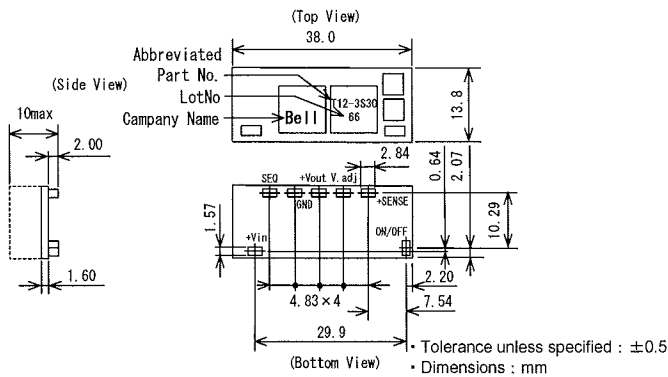


Fig.1 Outline

<Recommended Pad Layout>

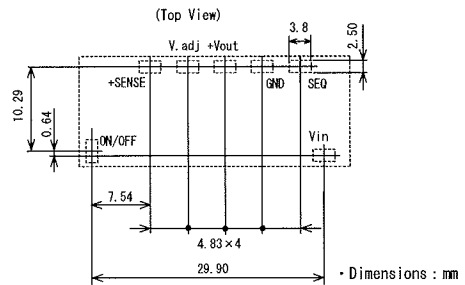


Fig.2 Recommended Pad Layout

Table.2

Pin	Symbol	Function
1	ON/OFF	Remote ON/OFF Control
2	+Vin	Positive Input pin
3	SEQ	Tracking Function pin
4	GND	Input/Output Ground pin
5	+Vout	Positive Output pin
6	V.adj	Output Voltage Adjust pin
7	+SENSE	Positive Output Sensing pin

Pin no. is not shown for the unit.
 Pin substances: Copper
 Plating: Tin plating after nickel plating.

<Absolute Maximum Rating>

Table.3

Item	Symbol(Unit)	BST05-3.3S30PCM		BST12-3.3S30PCM	
		min	max	min	max
Input Voltage	+Vin(V)	0	+5.8	0	+15
Tracking Terminal Voltage	SEQ (V)	0	Vin max	0	Vin max
Operating Temperature Range	Ta (°C)	-40	+85	-40	+85
Storage Temperature Range	Tstg (°C)	-40	+85	-40	+85

In case of no description in article of "condition", the meaning is typical value(Ta=25±5°C), Input-Output range.

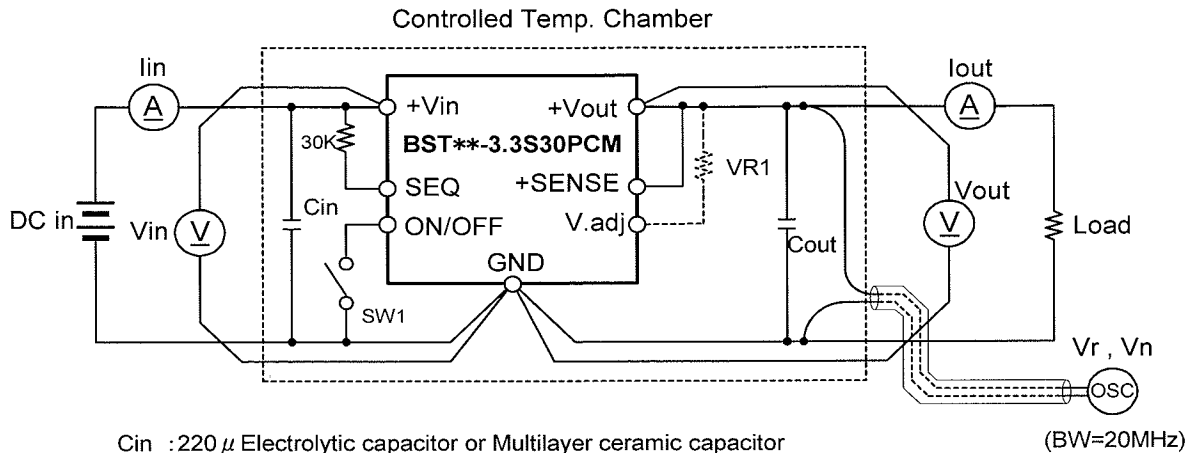
Table.4

<Specification/Standard>

Item	Specification/Standard		Condition
	BST05-3.3S30PCM	BST12-3.3S30PCM	
Input Characteristics			
Input Voltage Range	4.75 to 5.5V(rating+5V)	8.0 to 14V(rating+12V)	
Input Current	21A typ	7.6A typ	At rated Input/Output
	110mA typ	190mA typ	At non-load, At Rated Input/Output
	8.5mA typ	7mA typ	When Output is OFF(+Vin to SEQ 30kΩ)
Output Characteristics			
Output Voltage Setting Accuracy	3.3±5%	3.3±5%	
Output Current	0 to 30A	0 to 25A	At Vo=(1.8) to 3.3V
	0 to 30A	0 to 30A	At Vo=1.0 to 1.8V
Line Regulation	0.5%typ, 1.5%max	0.5%typ, 1.5%max	For Input Voltage Range
Load Regulation	0.5%typ, 1.5%max	0.5%typ, 1.5%max	For Load 0 to 30A
Temperature Regulation	±0.01%/°Ctyp	±0.01%/°Ctyp	For -40 to +30°C
Output Ripple/Noise	30mVp-p typ	50mVp-p typ	Measured At BW=20MHz
	100mVp-p max	100mVp-p max	AT Measuring Condition of Fig.3
Adjustable Output Range	1.0 to 3.3V	1.0 to 3.3V	Adjustable by external resistor Set at 3.3V at Shipping
Other Characteristics			
Frequency	300kHz × 2phase	300kHz × 2phase	
Efficiency	93%typ	92%typ	At Rated Input/Output
Additional Function			
Over-Current Protection	Operate at over 105% of rating	Operate at over 105% of rating	
Over-Voltage Protection	None	None	
Remote ON/OFF Control	Attached	Attached	
Tracking Function	Attached	Attached	
General Condition			
Operating Temp. Range	-40 to +85°C		Refer to article of thermal Derating
Storage Temp. Range	-40 to +85°C		
Operating Humidity Range	20 to 95%RH		
Storage Humidity Range	20 to 95%RH		
Cooling Condition	Output Voltage : 1.0to3.3V Natural Convection:20A max Air Flow:30A max	Output Voltage : 1.0to1.8V Natural Convection:17A max Air Flow:30A max	Refer to article of< thermal Derating> Temp. derating required from +30°C <Condition> 90X160mm(copper leaf thickness 35um) FR-4 t=1.6
		Output Voltage : (1.8)to3.3V Natural Convection:13A max Air Flow:25A max	
Outline/Weight			
Outline	38.0 × 13.8 × 10.0max		Refer to article of<Outline>
Weight	9.0g typ		

Note : Unless otherwise specified, Ta=25±5°C, rating Input/Output.

<Test Circuit>



Cin : 220 μ Electrolytic capacitor or Multilayer ceramic capacitor
 Cout: 10 μ F Tantalum capacitor//1 μ F Multilayer ceramic capacitor

VR1 : Vout Down Resistor

Fig.3 Test Circuit

<Block Diagram>

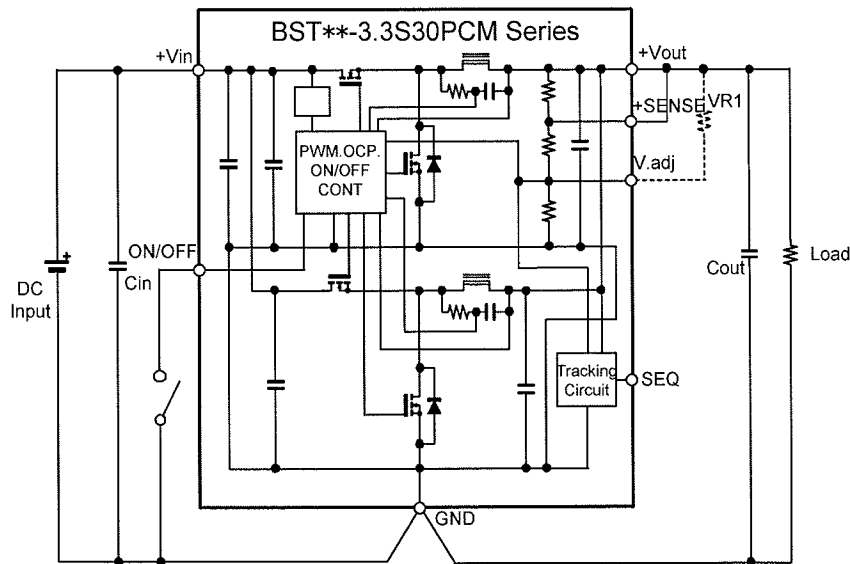
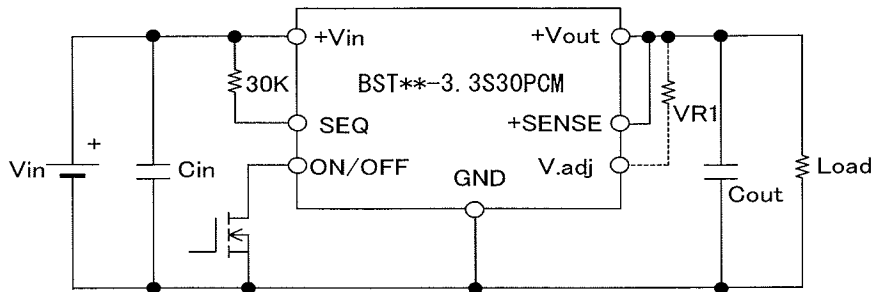


Fig.4 Block Diagram

<Standard Connection>



Cin: 220 μ F Electrolytic capacitor or multilayer ceramic capacitor
 Cout: 10 μ F Tantalum capacitor / 1 μ F multilayer ceramic capacitor
 VR1: Adjustable output voltage resistor

Fig.5 Standard Connection circuit

- Note1. Be sure to add the input capacitor(Cin) and output capacitor(Cout) shown in connection circuit diagram.
- Note2. Keep ON/OFF pin open when the ON/OFF control is not being used.
- Note3. Keep the V.adj pin open when output voltage is not being adjusted.
- Note4. Connect the resistor of 30K Ω between +Vin- and SEQ when tracking is not being performed.
- Note5. Be sure to short between +Vout- and +SENSE when sensing is not being performed.

<Output Voltage Adjustment Function>

Variable can have an output voltage (1.0V to 3.3V) by connecting external resistance VR1 between the +Vout - V.adj terminals. Refer to the following computed-type for the computation of the external resistance VR1.

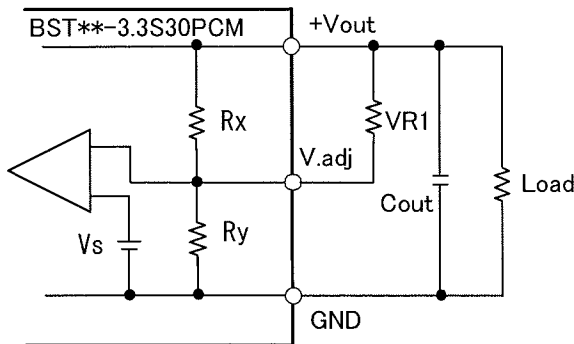


Fig.6 Circuit Diagram of Adjustable Output Circuit

$$VR1 = \frac{R_x \times R_y (V_o - V_s)}{V_s \times R_x - R_y (V_o - V_s)}$$

Vs	0.7V
Rx	30.51k Ω
Ry	8.2k Ω
Vo	Desired Output Voltage 1.0-(3.3)

*Same for BST05 and BST12 Series

ex.

Vout(V)	VR1(k Ω)
1.0	3.972
1.8	22.307
2.5	68.262
3.3	open

- Note1 : Do the confirmation of the output voltage and the adjustment of the resistance value after you calculate external resistance.
- Note2 : Set it up by more than the resistance two serial connection when you can't set it up by one external resistance.
- Note3 : Open a V.adj terminal when you don't have an output voltage variable and use in 3.3V.

<Remote on/off Function>

The output of the converter is controlled by open-circuiting or short-circuiting between ON/OFF - GND pins.

- 1) When ON/OFF is not controlled,
An ON/OFF pin is to open.
- 2) When ON/OFF is controlled
 - Output On mode : Between ON/OFF - GND pins **Open** (ON/OFF Pin Open Voltage 5.5Vmax)
 - Output voltage Off mode : Between ON/OFF - GND pins **Short** (0 to 0.4Vmax, 1mAmax)

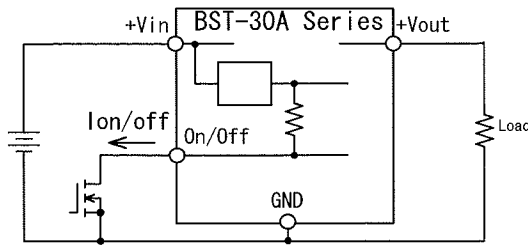
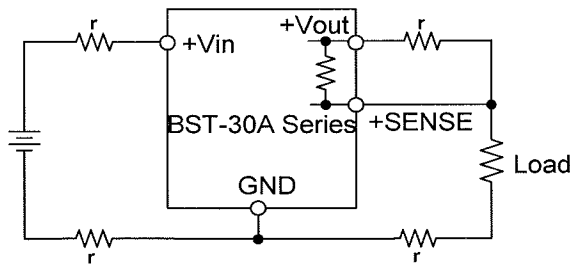


Fig.7 ON/OFF Inner Circuit

<Remote Sensing>

This product has a remote sensing terminal, and it is given The consideration to have stable output at the using point, being influenced by voltage drop due to the wiring. Since the ground of input/ output for this product is a common type of non-isolated type, only +output is able to sense. Remote sense line is a part of the field back loop, and since only a small amount of current is flowing in, particular attention shall be paid for drawing layouts and patterns.



r:Line Impeadance

Fig. 8 Circuit Diagram of sensing

<Output Voltage Tracking>

For BST-30A series, output voltage tracking operation during power-up and power-down of the converter is possible by using the SEQ pin. The following three types of tracking method are possible.

- 1 Sequential Operating
- 2 Ratio-metric Tracking
- 3 Simultaneous Tracking

Tracking operation impresses the control voltage from modules or external voltage to the SEQ pin and makes the control voltage track the output voltage. This simplifies the task at power-up and power-down. Also by connecting DC-DC converters together, a composition to track their output voltage will be made.

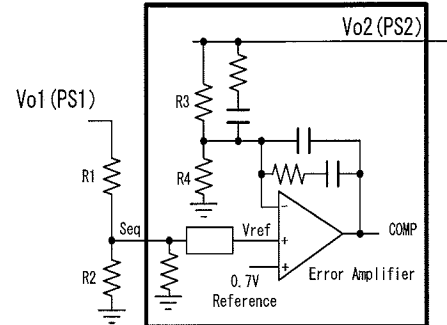


Fig. 9 Tracking Diagram

1.Sequential Operating

Sequential operation is shown in figure 10. By composing a circuit of PWRGD signal from PS1(3.3V)with components such as resistance-capacitor etc. inside the dotted line, the control voltage will be input to SEQ pin of PS2(1.8V). Figure 11-1 and 11-2 show the wave form at operation. Figure 11-1(Power-Up)shows a wave form of ; power-up the PS1(3.3V) first, and once the PS1(3.3V) reaches a stable voltage, PWRGD signal of PS1 will be output. Then time constant will be generated by the time constant circuit composed of components such as R-C etc. inside the dotted line, and will be input to SEQ pin of PS2(1.8V) and control the PS2(1.8V). Figure 11-2 (Power-Down) shows the wave form of PS1 (3.3V) output voltage using the off signal which has been output at approximately 90% or below the rated voltage and when off-controlling the PS2(1.8V).

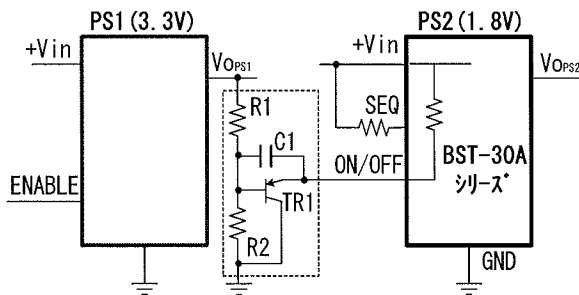


Fig.10 Example for Sequential operation connection

Note:

- Time constant circuit (C-R) inside the dotted line of figure 10 is a block diagram. In practise use, compose a circuit which suits the practical usage.
- The output ripple noise may increase by connecting a capacitor between SEQ - GND pins. Be sure not to connect any capacitor to the SEQ pin directly.

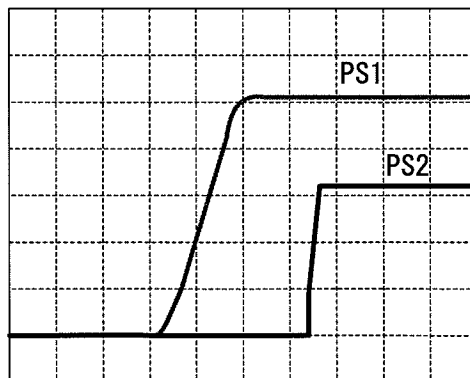


Fig 11-1 Sequential operation (Power-Up)

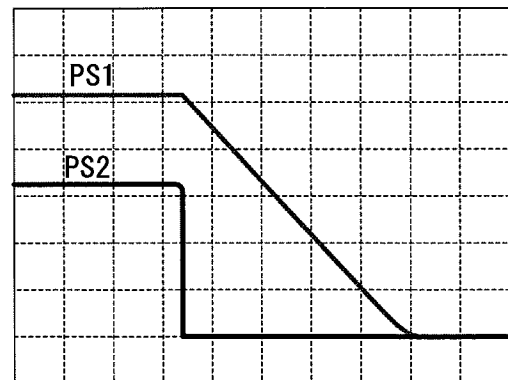


Fig 11-2 Sequential operation (Power-Down)

2. Ratio-Metric tracking operation

To practise Ratio-Metric Tracking Operation as Fig 13-1,13-2,14-1,14-2, connect external resistor Rseq between +Vout (Vo1) - SEQ pins. Please follow below procedure to calculate Rseq.

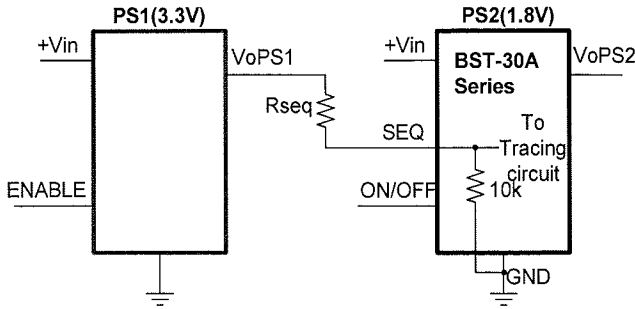


Fig.12 Ratio-Metric connection method

Ratio-Metric tracking Case 1

For case1, PS1 rises first at power up and falls later at power down. Following is how to calculate the value of PS1.

First, calculate the voltage difference when the output voltage of PS1(Vo1)and PS2(Vo2) are stable. $\Delta V=Vo_1-Vo_2$ (Refer to Figure 13-1, 13-2)

$$R_{seq} = \frac{(Vo_2 + \Delta V) - V_{ref}}{V_{ref}} \times 10k\Omega \quad \text{Equation 1}$$

Note 1: $V_{ref}=0.25 \times Vo_2$, refer to table 9.
 Note 2: ΔV =voltage difference between Vo_1 and Vo_2

Example) PS1 : $Vo_1=3.3V$, PS2 : calculate the R1 at $Vo_2=1.8V$
 $\Delta V=3.3-1.8=1.5V$ $V_{ref}=0.25 \times 1.8V=0.45V$

$$R_{seq} = \frac{(1.8+1.5)-0.825}{0.45} \times 10k\Omega = 63.3k\Omega$$

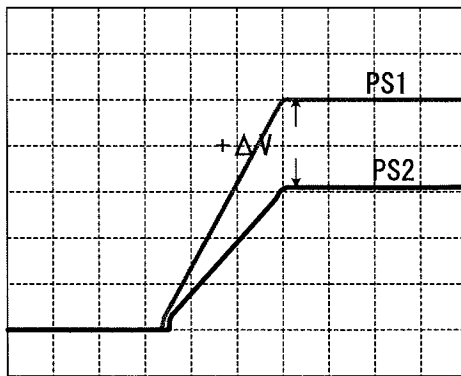


Fig.13-1 Ratio-Metric tracking Case1 (Power-up)

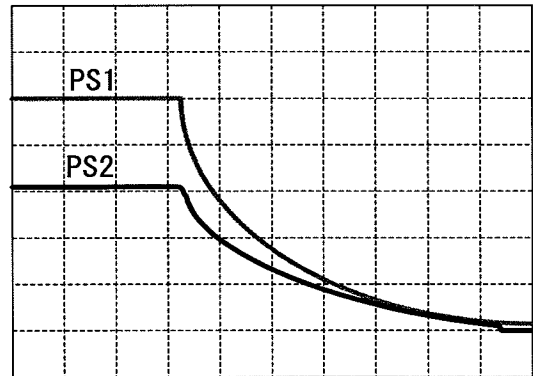


Fig.13-2 Ratio-Metric tracking Case 1 (Power-down)

Ratio-metric Tracking Case2

For case 2, PS2 rises first at power up and falls later at power down. Calculate Rseq by equation 2.

First, calculate the voltage difference $\Delta V = V_{o1} - V_{o2}$ of PS2(V_{o1}) and PS2(V_{o2}) when the output voltage of PS2 is stable. (Refer to figure 20,21)

$$R_{seq} = \frac{(V_{o2} - \Delta V) - V_{ref}}{V_{ref}} \times 10k\Omega$$

Equation 2

Note 1: $V_{ref} = 0.25 \times V_{o2}$, refer to table 9

Note 2: ΔV = Voltage difference of V_{o1} and V_{o2} when PS2(V_{o2}) reaches the rating voltage.

Example) PS1 : $V_{o1} = 3.3V$, PS2 : Calculate the Rseq at $V_{o2} = 1.8V$

$V_{ref} = 0.25 \times V_{o2} = 0.25 \times 1.8V = 0.45V$

Voltage difference of PS2 (V_{o2}) at rated voltage and PS1 (V_{o1}) will be set at $\Delta V = 1.0V$.

$$R_{seq} = \frac{(1.8 - 0.8) - 0.45}{0.45} \times 10k\Omega = 12.2k\Omega$$

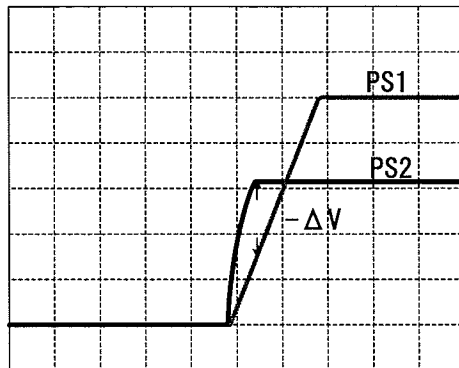


Fig. 14-1 Ratio-Metric tracking Case2 (Power-up)

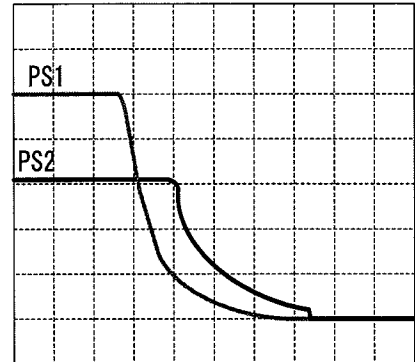


Fig. 14-2 Ratio-Metric tracking Case 2 (Power-down)

Typical example of output voltage $V_{o2}(PS2)$ vs. V_{ref}

Table 5

$V_{o2}(PS2)$	$V_{ref} (=0.25 \times V_{o2})$
1.0	0.25
1.2	0.3
1.5	0.375
1.8	0.45
2.5	0.625
3.3	0.825

Ultra high efficiency Non-Isolated Type DC-DC converter

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BST-30A Series

3. Simultaneous Tracking Operation

Similarly to ratio-metric tracking, simultaneous tracking operation is implemented by using a voltage divider around SEQ pin. For simultaneous tracking operation, there is no voltage difference between PS1 (Vo1) and PS2 (Vo2), and is used at power-up and power-down. The simultaneous tracking operation can be accomplished by putting Rseq equal to 30kΩ through PS1 (Vo1) to SEQ pin of PS2 (Vo2)

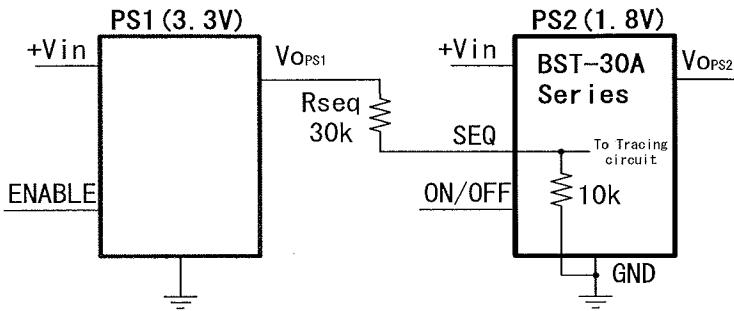


Fig.15 Simultaneous tracking connection method

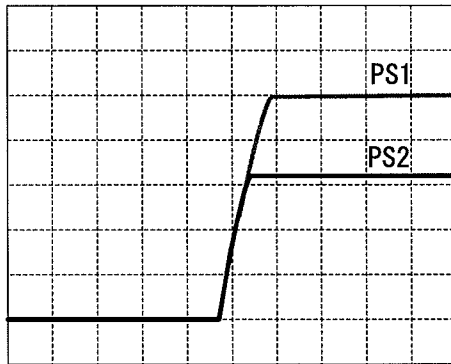


Fig.16-1 Simultaneous tracking (Power-up)

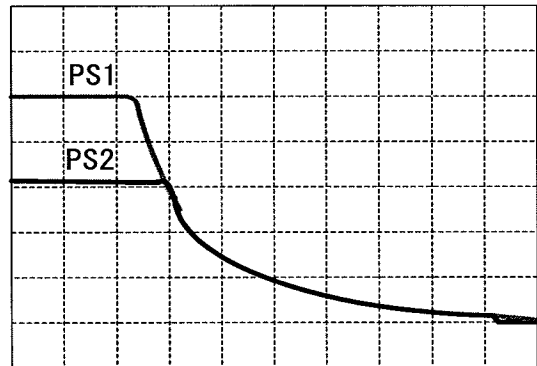


Fig.16-2 Simultaneous Tracking (Power-down)

4. Precautions for using the tracking function

- 1) The initial condition for tracking operation is to set the ON/OFF control pin of PS2 "On", and then apply voltage to the input pin of PS1 and PS2.
- 2) For the SEQ pin voltage, it is required to keep it 0V as it is for 8msec. or more after the input voltage reaches V_{in-min} voltage.
- 3) This short period is to initialize the soft-start. Until PS2 completes the soft-start operation, it will not track the voltage of PS1.
When the soft-start operation completes, PS2 can start tracking the SEQ pin voltage.
- 4) At power-down due to input interception, proper tracking operation is not possible when the input voltage of both convertres becomes minimum or below. So it is a good way to use the On/Off of PS1 to implement power tracking at power-down.
- 5) SEQ pin voltage must not exceed the adsolute maximum voltage.
- 6) When not using the tracking operation, connect from SEQ pin to +Vin with a 30k Ω resistance.
- 7) When the SEQ pin voltage is short, the output setting voltage will fall. So be careful that the SEQ pin voltage does not go short.

<Overcurrent Protection Circuit>

- This converter has Over-current Protection Circuit built-in and will protect against output over-current.
- Once the over-current condition is solved, the converter will go back to normal constant voltage operation.
- Long-time over-current or short circuit condition will cause damage to the converter. Please avoid it.

Overcurrent Protection circuit of this converter is hiccup mode.

When adding a capacitor of large capacity to output. The output may not start up normally.

Pay attention to this matter.

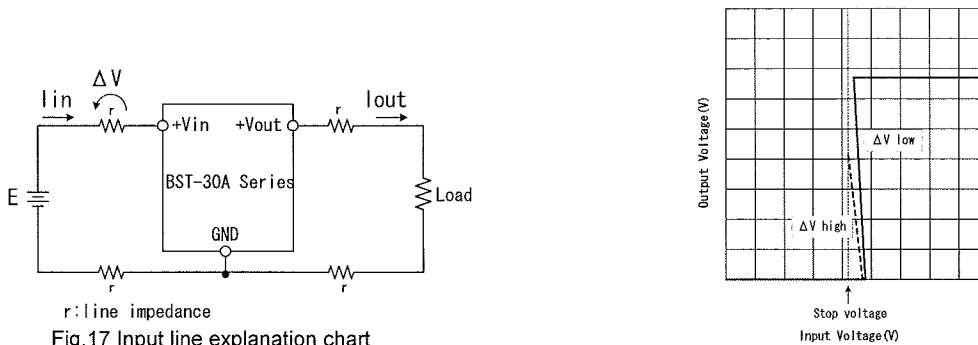
<Input Line Impedance>

This product is a converter of the large current type. Please note that input voltage will be exceeded the absolute maximum rate when input line's resistor is too high. Relative possible event is noted as below .

Keep the impedance of input line in low level using thick & short wire between the supply source and converter input pin for the countermeasure.

1) Start-up

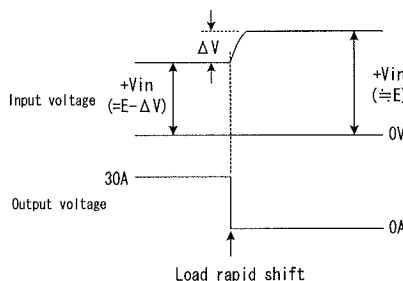
At start-up, high power current will flow to the input side when the load is high. Voltage drop will occur at the input line for this input current. In case of high voltage drop, input pin voltage of the converter will fall, and when falling below the stop voltage, the converter will stop.



2) Rapid shift of loading

Input voltage will rise when the load is changed in rapid shift from heavy loading to light loading.

The reason for this event is the input current will fall in rapid shift and then the voltage drop of input line will also fall down, and a nearly same voltage as the supply source voltage will impress directly to the input pin of converter.



3) Over-current in operation

The input voltage will rise in case of the over-current protection circuit operates for the heavy loading status by any cause.

Because in over current condition, input current will fall and then the voltage drop of input line will fall down, a nearly same voltage as supply source voltage will impress directly to the input pin of the converter.

4) ON/OFF control in use (At output ON=> OFF)

Input voltage will rise when switching ON to OFF using ON/OFF control with in heavy loading condition.

In this case, voltage drop of input line will fall down because only standby current will flow to input when output is OFF.

As the result, a nearly same voltage as supply source voltage will impress directly to the input pin of the converter.

Ultra high efficiency Non-Isolated Type DC-DC converter

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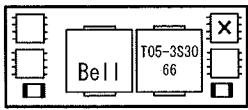
<Thermal Derating>

This converter operates in a wide temperature range, however when the ambient temperature is high, cooling by proper heat radiation is required. The thermal derating shown below is a support for proper use of converter and thermal designing. For certain cooling, it is required to check your own equipment's temperature under both maximum ambient temperature and cooling ventilated condition with the converter mounted inside the device/system. When checking with your own equipment, the hot spot temperature (marked "X" in the drawing below) shall not exceed 105°C.

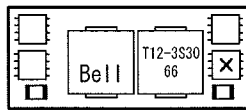
<Heat radiation pattern condition>

- Board material FR-4 $t=1.6$ (Both sided board)
- Board size 90×160mm (Copper leaf thickness 35μm)

<Points at measuring>



BST05-3.3S30PCM



BST12-3.3S30PCM

BST05-3.3S30PCM Derating Curve

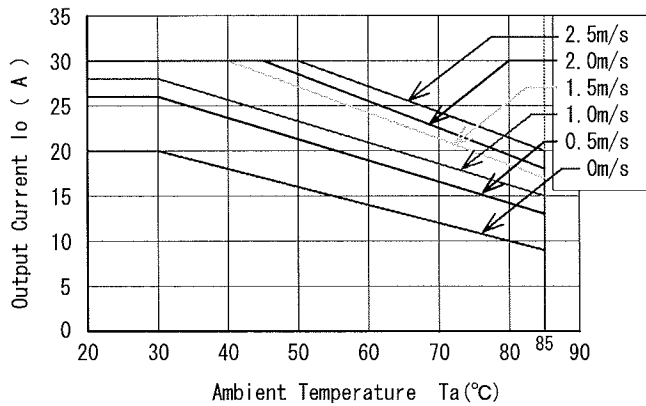


Fig.18-1 Thermal derating curve ($V_{in}=5V, V_o=1.0-3.3V$)

BST12-3.3S30PCM Derating Curve

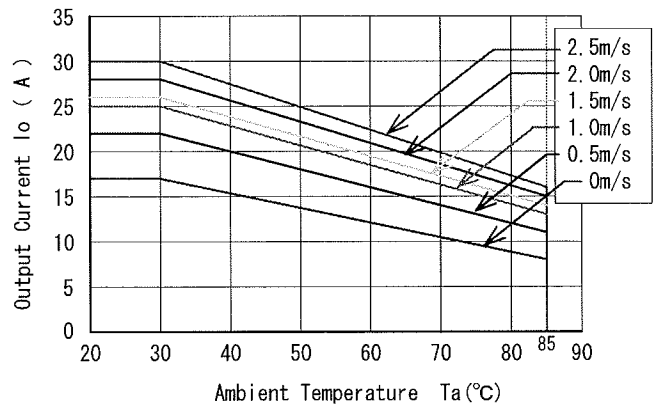


Fig.18-2 Thermal derating Curve ($V_{in}=12V, V_o=1.0-1.8V$)

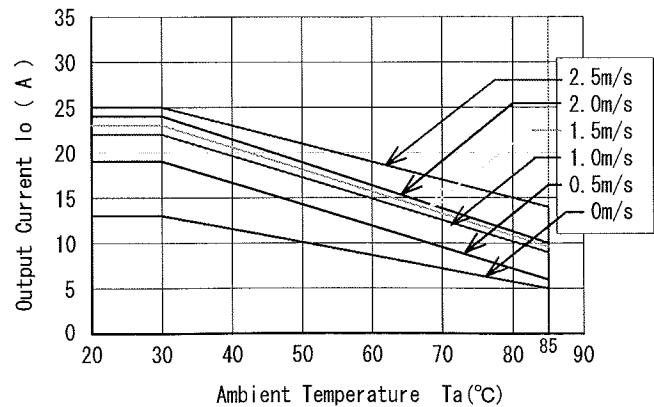


Fig.18-3 Thermal Derating Curve ($V_{in}=12V, V_o= [1.8] -3.3V$)

<Soldering Conditions>

- This converter is for reflow soldering. Do not vibrate at reflow.
- Soldering by hand and flow soldering are not possible for this converter.
- Before reflow soldering the converters which have been left in the opened dry package, be sure to pre-bake the converters.
- Re-baking is also required before reflow soldering if it has been in dry-pack for more than 1 year or kept in 30°C/60%RH for more than 168hours with the dry-package opened.

Infrared radiation and air reflow soldering condition

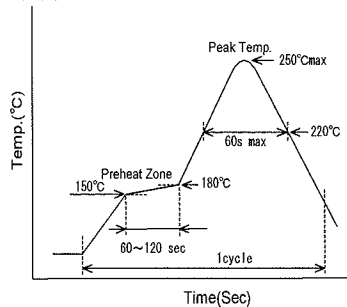


Fig.19 Temperature Profile

<Storage conditions and humidity countermeasure before mounting>

Storage conditions before being mounted should be ambient temperature 30°C and ambient humidity 60%RH or below. Also, keep these products in place where the unit will not be influenced by direct sunshine or poisonous gas(chloric, sulfur etc.).For dampproof package articles, be sure not to open except under the managed conditions.

<Vibration and Shock>

Vibration	5-10Hz	All amplitude 10mm(1 hour in each of 3 orthogonal axes)
	10-55Hz	Acceleration 2G (1hour in each of 3 orthogonal axes)
Shock	Acceleration	20G(3 directions, 3 times each)
	Shocking Time	11±5ms

<Note>

1.Fuse

This converter does not have a built-in fuse. For safety and system protection, be sure to put a fuse to the input line of the +Vin side.

2.To prevent reverse connection of input power supply

For this converter, if the input voltage is connected in reverse by mistake, it will be damaged. If there is a possibility of reverse add a protection circuit as shown in figure 20. Be sure that the power supply on the supplying side has the capacity to fuse the fuse.

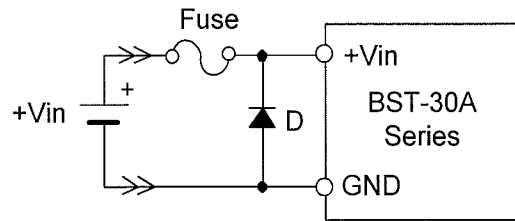


Fig.20. To prevent reverse input voltage protection (ex.)

3.Overvoltage Protection

This converter does not have a built-in over-voltage protection. If the switching element in this converter is damaged in short mode, DC input will go out as it is. However, to avoid damage at over-voltage mode, be sure to add an input intercepting circuit as shown in figure 21.

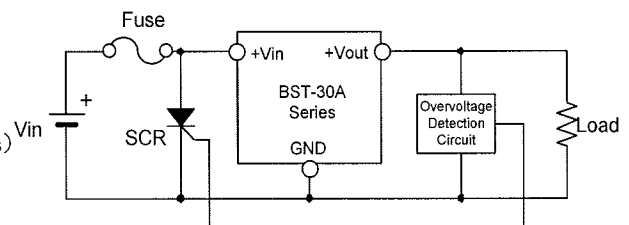


Fig.21 Overvoltage Protection Circuit (ex.)

<Precautions>

- This product intends to be used for general electronic equipments (Clerical work machines, Telecommunications equipments, and Measurement equipments). Therefore, do not use for medical equipments, nuclear power equipments, and trains, etc. the malfunction and damage of which may influence directly to human life and property. Please confirm when using it in the case except general electronic equipment.
- For this product, parallel/series operation is not possible.
- For mounting this product, please do not use connector or socket. The performance may not be fulfilled by the effect of contacting resistor. Mount to print board by soldering because constant taking out and putting in converter during turning on electricity will cause damage of the converter.
- This product has a built-in over current and short protection circuit, but long time short circuit will cause failure, so please avoid it.
- The product may be damaged if it is used under nonstandard electric and environmental conditions such as temperature.
So please be sure to keep the standards.
- There is a possibility of damage by static. When the worker has electrified static, please earth discharge and working on an earthed worktable will be recommended.
- Do not store in a place where corrosive gas may be generated or at a dusty place.
- This product does not have a built in fuse. When it is abnormal, please connect the fuse with + input line as a protection for excessive current flowing into the input. Please make sure that the power supply has the capacity that the fuse can be cut.
- This product does not have a built in over voltage protection. When over voltage is abnormally generated in the module, there is such a mode that the input voltage appears to the output straight, which may cause smoke and ignition. Please make sure to add the over-voltage protection circuit to prevent it.
- No test certificate is attached to this product.