

BUD series is a non-isolated DC/DC converter that features wide input / output, buck-boost,  $\pm$ output, small size (10×11×6mm). It is ideal for supplying power to analog circuits from unstable bus voltages for batteries, unstable power supplies and so on.



### ■ Features

- Wide input / output
- Buck-boost type
- $\pm$  Output
- Ultra small size: SMD package
- High efficiency
- Max 1.8W output (Input / output voltage derating required)
- Over-power protection
- UVLO function
- Remote ON/OFF control
- Equipped with skip mode at light load
- Non-isolated type
- Operating temp.  $T_a = -40^\circ\text{C}$  to  $+85^\circ\text{C}$
- RoHS compliance
- Output voltage setting is determined by the single resistor

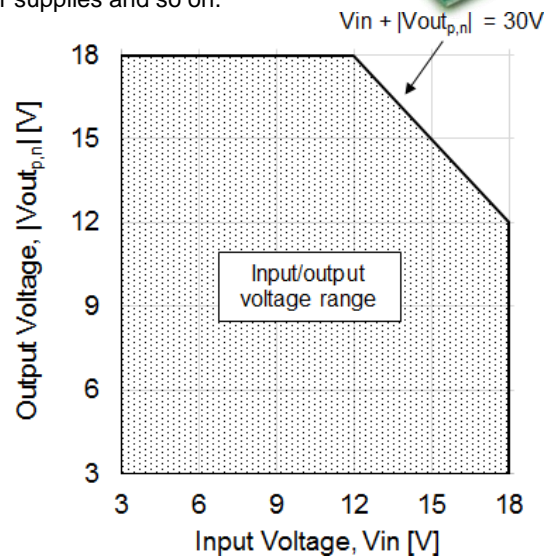


Figure 1 Input/ output voltage range

### ■ Model & rating

Table 1

Models BUD Series	Input V V <sub>dc</sub>	Output V V <sub>dc</sub>	Output P W	Line Reg. % (max.)	Load Reg. % (max.)	Ripple noise mV <sub>pp</sub> (typ.)	Efficiency % (typ.)
<b>BUD12-12W042</b>	12 (3 to 18)	$\pm 12$ ( $\pm 3$ to 18)	1 ( $\pm 0.5W$ each)	1.0	1.0	10	87.5 ( $P_o=0.8W \times 2$ )

Note 1: In the measurement circuit in section 4-3.

Note 2: Unless otherwise specified the product is measured at input voltage 12V, output voltage  $\pm 12V$ , output power  $0.5W \times 2$ , and ambient temperature  $25^\circ\text{C} \pm 5^\circ\text{C}$ .

Note 3: Ripple noise is measured at  $BW=20\text{MHz}$ .

Note 4: The usable input / output voltage range is within the range shown in Fig. 1.

Note 5: The output voltage settings for positive and negative outputs are equal ( $V_{out_p} = |V_{out_n}|$ ).

Note 6: Maximum output power of 1.8W ( $\pm 0.9W$  each) can be output depending on input/ output conditions. For details, refer to section 4-4.

### ■ Specification

Table 2

Input/ output voltage range	Refer to Figure 1.
Rated input voltage	12V
Rated output voltage	$\pm 12V$
Rated output power	$0.5W \times 2$
Output voltage accuracy	$\pm 5\%$ max.
Line regulation	Refer to Table 1 (To the regulation of the input voltage range in Table 1)
Load regulation	Refer to Table 1 (To the regulation of $P_{out_{p,n}} = 0.05$ to $0.5W$ )
Mutual regulation	100mV typ, 200mV max ( $10\% \leq P_{out_{p,n}} \leq 100\%$ )
Ripple noise	Refer to Table 1 (Measurement frequency bandwidth 20MHz)
Efficiency	Refer to Table 1
Standby current	0.1 $\mu\text{A}$ typ., 1.1 $\mu\text{A}$ max. (Input voltage 4.2V)
Over-current protection	Operates at 105% or more of the rated output power, automatic restoration.
UVLO	Available
Remote On/ Off	Available
Operating temperature range	$-40^\circ\text{C}$ to $+85^\circ\text{C}$
Storage temperature range	$-40^\circ\text{C}$ to $+85^\circ\text{C}$
Operating humidity	20 to 95%R.H. (Max. wet bulb temperature $69^\circ\text{C}$ with non-condensing)
Storage condition	Until being mounted, keep below $30^\circ\text{C}/60\%$ R.H.
Cooling condition	Natural air cooling
Mass	0.7g
Outer dimension	$W=10$ $L=11$ $H=6$ (mm) (For details refer to section 6-1)

\* The above specifications are provided with rated value, unless otherwise specified.

\* The contents provided in this data sheet may be changed at any time without prior notice.

## 1. Scope

These specifications shall apply to the non-isolated DC/DC converter BUD12-12W042 series.

## 2. Model/ Rating

Model name	Rated input voltage	Rated output	Shape	Remarks
BUD12-12W042	DC 12V	DC $\pm$ 12V, 0.5W $\times$ 2	SMD	

## 3. Environmental conditions

## 3-1. Temperature range

In operation -40°C to +85°C (Refer to section 5 for details)

In storage -40°C to +85°C

## 3-2. Humidity range

In operation 20 to 95%RH (However, max. wet bulb temperature 69°C, no condensation)

In storage Same as above

Note) Refer to section 10-2 for details of storage before mounting.

## 4. Specifications &amp; standards

This product is RoHS compliance.

## 4-1. Recommended operating conditions

Item	Mark	min.	max.	Unit	Conditions
Input (VIN pin) voltage	V <sub>in</sub>	3	18	V	
Output (+VOUT, -VOUT pin) voltage*1	V <sub>outp,n</sub>	3	18 or 30 - V <sub>in</sub>	V	The smaller one as the max value.
Output power*2,*3	P <sub>outp,n</sub>	0	0.5	W	

\*1 The absolute values of the output voltage settings for positive and negative outputs are equal (V<sub>outp</sub> = |V<sub>outn</sub>|).

\*2 The power described is for one side. Depending on the input /output voltage, it can output  $\pm$ 0.9W each, up to 1.8W in total. For details refer to section 4-4.

\*3 P<sub>outp</sub> = V<sub>outp</sub>  $\times$  I<sub>outp</sub>, P<sub>outn</sub> = V<sub>outn</sub>  $\times$  I<sub>outn</sub>

## 4-2. Electrical characteristics

Electrical characteristics \*1, \*2

Item	Mark	min.	typ.	max.	Unit	Conditions
<b>Input characteristics</b>						
UVLO operation voltage	Vuv		2.2	2.5	V	When Vin drops
Standby current*4,*6	Ioff		0.1	1.1	uA	Vin = 4.2V, Von/off = 0V
			13.5		uA	Vin = 18V, Von/off = 0V
<b>Output characteristics</b>						
Output voltage accuracy*7		-5		+5	%Vout	$3V \leq  Vout_{p,n}  \leq 18V$ Poutp= Poutn = 0.5W
Static line regulation			0.5	1.0	%Vout	Vin = 3V to 18V $3V \leq  Vout_{p,n}  \leq 18V$ (fixed value) Poutp,n =100% (fixed value)
Static load regulation*3*8			0.5	1.0	%Vout	$3V \leq Vin \leq 18V$ (fixed value) $3V \leq  Vout_{p,n}  \leq 18V$ (fixed value) Poutp,n = 0.05W to 100%
Static mutual load regulation*3			100	200	mV	$3V \leq Vin \leq 18V$ (fixed value) $3V \leq  Vout_{p,n}  \leq 18V$ (fixed value) $10\% \leq Pout_{p,n} \leq 100\%$
			300	500	mV	$3V \leq Vin \leq 18V$ (fixed value) $3V \leq  Vout_{p,n}  \leq 18V$ (fixed value) $0\% \leq Pout_{p,n} \leq 100\%$
Output ripple noise	$\Delta V_{pp}$		10	20	mVpp	Vin = 12V Vout = $\pm 12V$ Poutp= Poutn = 0.5W
Over-power protection*3	Pop	105			%	
<b>ON/OFF control</b>						
ON/OFF pin ON voltage	VH	1.2			V	
ON/OFF pin OFF voltage	VL			0.4	V	
Shutdown time	Toff	2.5			ms	Von/off = Low(OFF) to High(ON) interval must be Toff or more.
ON/OFF pin input impedance	Rin	400	800	1600	k $\Omega$	

Item	Mark	min.	typ.	max.	Unit	Conditions
<b>Other functions, characteristics</b>						
Efficiency <sup>*3</sup>	$\eta$		87.5		%	$P_{out_{p,n}} = 100\%$
Switching frequency	fsw	1.0	1.2	1.5	MHz	Fixed switching frequency $3V \leq V_{in} \leq 18V$ $3V \leq  V_{out_{p,n}}  \leq 18V$
Turn-on delay <sup>*6 *9</sup>	td			7	ms	$3V \leq V_{in} \leq 18V$ $3V \leq  V_{out_{p,n}}  \leq 18V$
Temperature drift			0.008		%Vout /°C	
Output load capacity	Cout <sub>p</sub> , Cout <sub>n</sub>			3000	uF	
Skip mode operating range <sup>*5, *6</sup>	Pskip <sub>p</sub> , Pskip <sub>n</sub>		75		mW	$V_{in} = 18V$ $V_{out_{p,n}} = \pm 12V$
			$4.6 \times V_{in} - 8$		mW	$3V \leq V_{in} \leq 18V$ $3V \leq  V_{out_{p,n}}  \leq 18V$
Mass	m		0.7		g	

\*1 With measurement circuit of 4-3.

\*2 Unless otherwise specified, the following measurement conditions will apply. Rated input, rated output, balance load ( $I_{out_p} = |I_{out_n}|$ ),  $V_{in} + |V_{out_{p,n}}| \leq 30V$ , ambient temperature  $25^\circ C \pm 5^\circ C$ .

\*3 Maximum output power  $P_{out_{p,n}}(\max)$  shown in section 4-4 is 100%.

\*4 Only the sink current of the VIN pin is measured.

\*5 Fixed switching frequency for  $P_{out_p} \geq P_{skip_p}$  and  $P_{out_n} \geq P_{skip_n}$ .

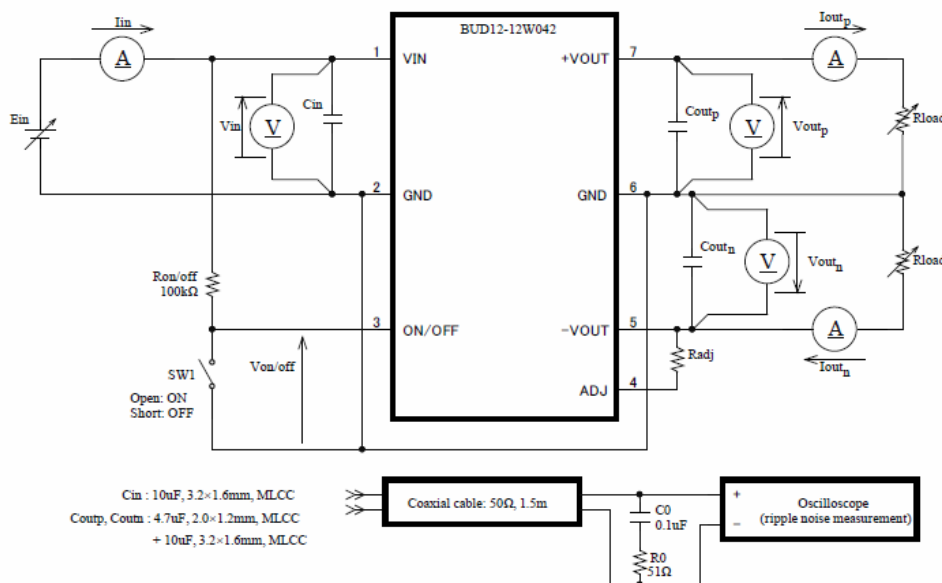
\*6 This is a design value and not all inspected.

\*7 When the output voltage setting accuracy is  $\pm 1\%$  with respect to the R<sub>adj</sub> calculated value (Section 7-2-Formula (1)).

\*8 If the load is less than 0.05W each, the regulation rate may increase depending on the conditions.

\*9 Turn-on time varies depending on load characteristics and additional capacity.

#### 4-3. Measurement circuit



Measurement circuit

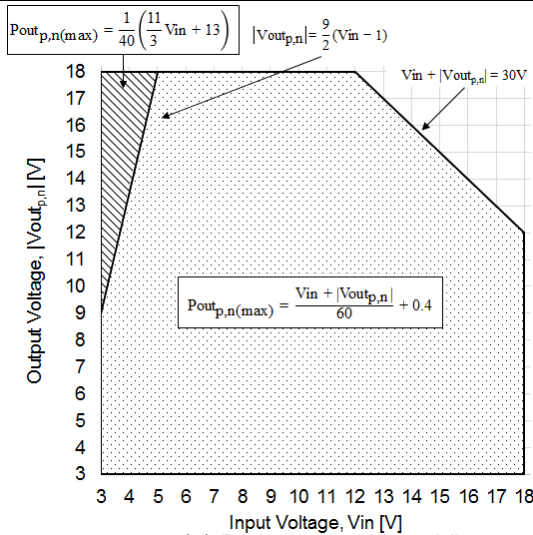
4-4. Maximum output power

The input and output voltage conditions allow the maximum output power  $P_{outp(max)}$  and  $P_{outn(max)}$  to be output up to 0.9W each, for a total of 1.8W.

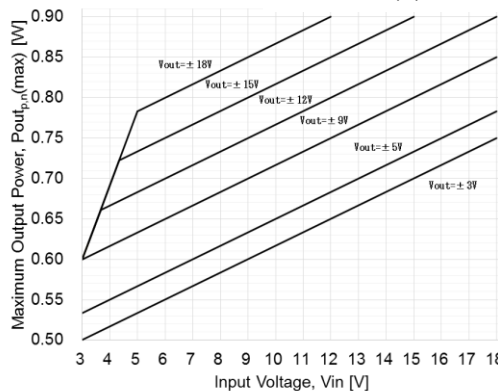
The maximum output power  $P_{outp,n(max)}$  due to the input and output voltage is specified by the figure below, and the main maximum output power and current values are shown in the table below.

Maximum output power, output current

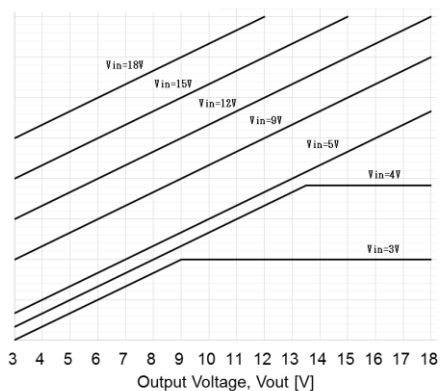
Vin [V]	Voutp,n [V]	Poutp,n(max) [W]	Pout(total) [W]	Ioutp,n(max) [A]	Vin [V]	Voutp,n [V]	Poutp,n(max) [W]	Pout(total) [W]	Ioutp,n(max) [A]
3	±3	0.50	1.00	±0.167	3	±12	0.60	1.20	±0.050
5	±3	0.53	1.07	±0.178	5	±12	0.68	1.37	±0.057
12	±3	0.65	1.30	±0.217	12	±12	0.80	1.60	±0.067
15	±3	0.70	1.40	±0.233	15	±12	0.85	1.70	±0.071
18	±3	0.75	1.50	±0.250	18	±12	0.90	1.80	±0.075
3	±5	0.53	1.07	±0.107	3	±15	0.60	1.20	±0.040
5	±5	0.57	1.13	±0.113	5	±15	0.73	1.47	±0.049
12	±5	0.68	1.37	±0.137	12	±15	0.85	1.70	±0.057
15	±5	0.73	1.47	±0.147	15	±15	0.90	1.80	±0.060
18	±5	0.78	1.56	±0.156	3	±18	0.60	1.20	±0.033
-	-	-	-	-	5	±18	0.78	1.56	±0.043
-	-	-	-	-	12	±18	0.90	1.80	±0.050



(a)  $P_{outp,n(max)}$  -  $V_{out}$ ,  $V_{in}$



(b)  $P_{outp,n(max)}$  -  $V_{in}$



(c)  $P_{outp,n(max)}$  -  $V_{out}$

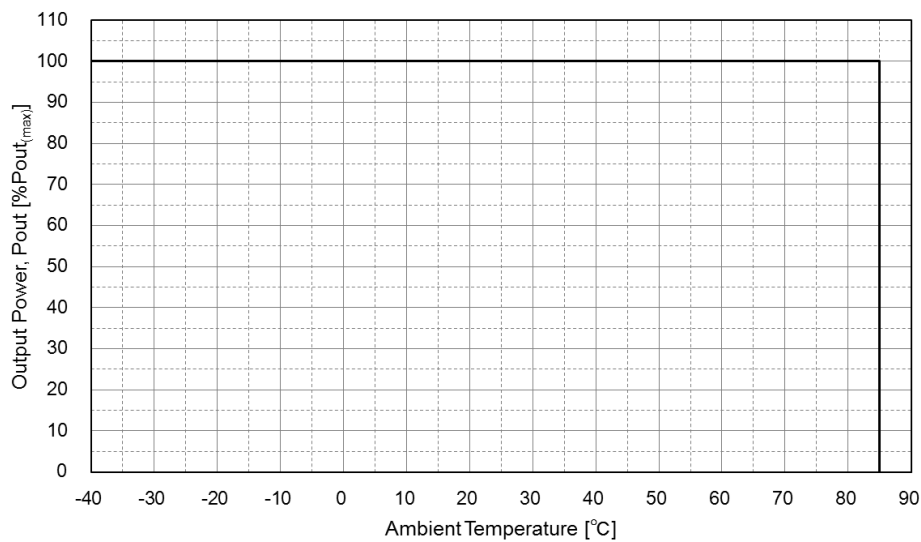
Maximum output power

## 5. Temperature derating

Install this product in a good place for convection. Also, be sure to mount it on the board before use. This product is designed to radiate heat using the mounted board. Make the line connecting to the converter wide. Especially, the heat radiation from the GND terminal is large, so make the GND line wide.

The derating curve below is the data when mounted on a double-sided board with a copper foil thickness of 35 $\mu$ m, a copper foil area of 60 x 60 mm (both sides), and a board thickness of 1.6 mm. Please use it for reference as the heat radiation characteristics will change depending on the wiring.

The temperature characteristics of this converter are greatly affected by the mounted board and ambient conditions. Therefore, eventually be sure to mount the converter in the device that will be actually installed in and when operating at the maximum ambient temperature of the equipment to be used, make sure that the surface temperature of the temperature measurement parts shown below does not exceed 112.5°C.

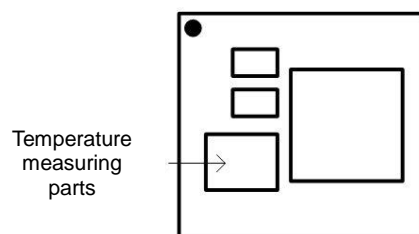


Temperature derating curve

Note 1:  $3V \leq V_{in} \leq 18V, 3V \leq |V_{out,n}| \leq 18V$

Note 2: 60mm×60mm, copper foil thickness of 35 $\mu$ m, two-layer (double-sided) board

Note 3: Maximum output power  $P_{out,p,n(max)}$  shown in section 4-4 is 100%.

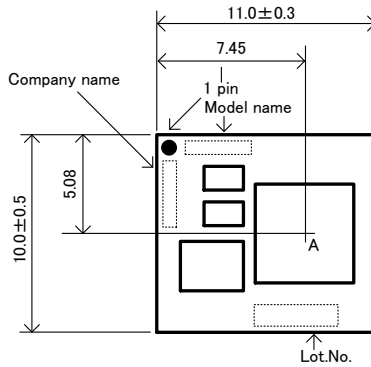


Top View

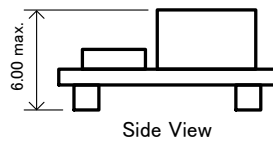
Temperature measuring parts

6. Dimensions and pin description

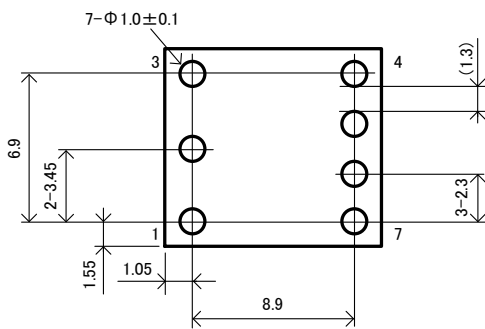
6-1. Shape and dimensions (SMD type)



Top View



Side View



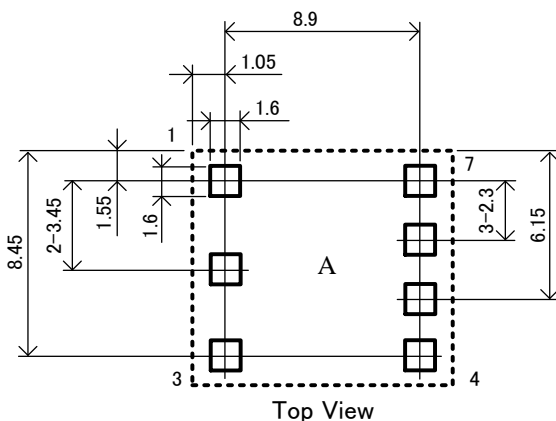
Bottom View

Shape, dimensions (SMD type)

Note 1: When mounting with an automatic machine, please pick up at point A.

Unit: mm  
Dimensional tolerance:  $\pm 0.2$ mm  
Pin flatness:  $0.127$ mm

6-2. Recommended footprint



Top View

Recommended footprint

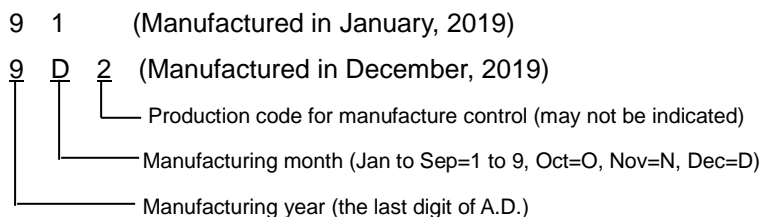
Note 1: Dimensions are recommended values. Please consider the design criterion of the customer when designing.

Unit: mm

## 6-3. Pin description

Pin	Name	Function
1	VIN	Power input pin. Connect to a power supply voltage of +3 to 18V.
2, 6	GND	Ground pin
3	ON/OFF	Remote ON/OFF signal input pin. High voltage input turns the output on, and low voltage input turns the output off. Please refer to section 7-3 for the control method.
4	ADJ	Output voltage setting pin. Connect an output voltage setting resistor between the ADJ pin and -VOUT pin. Refer to section 7-2 for the selection method of the output voltage setting resistor.
5	-VOUT	(-) Output pin
7	+VOUT	(+) Output pin

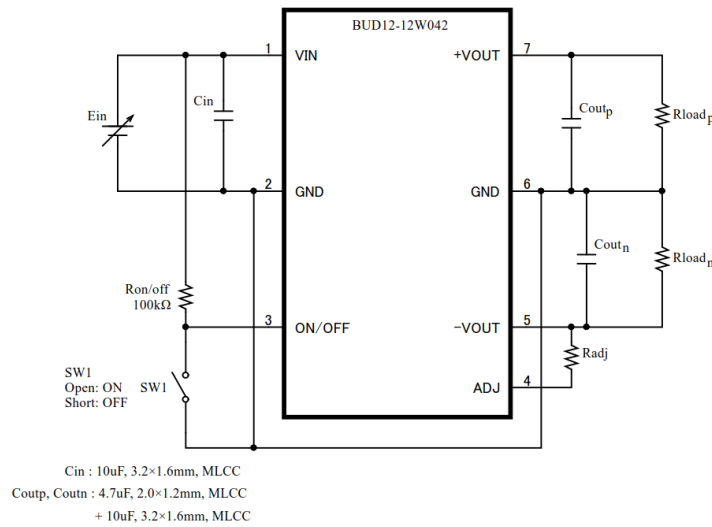
## 6-4. Lot. No.



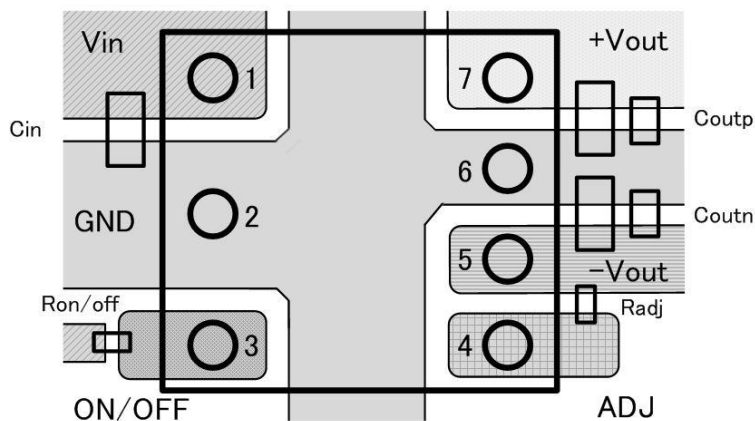


## 7. How to use

## 7-1. Standard connection diagram and recommended layout



Standard connection diagram



Recommended layout

Note 1: Radj is the output voltage setting resistor. Be sure to connect a resistor with a value according to the output voltage setting (Section 7-2), and do not leave it OPEN.

Note 2: Connect the input and output capacitors Cin, Coutp, Coutn as close as possible to the converter pin.

Note 3: The recommended layout diagram shows only the mounting surface. Design the pattern in consideration of the input and output conditions and the ambient temperature to be used.

Note 4: If the output load is less than 0.05W on one side, the regulation rate may increase depending on the conditions.

7-2. Output voltage adjustment method

The output voltage can be adjusted by connecting a resistor between the ADJ pin and the -VOUT pin. Connect a resistor Radj of the value according to the following equation.

$$R_{adj} = \frac{1.039 - 1.217 \times |V_{out_{p,n}}|}{2.589 \times |V_{out_{p,n}}| - 60.17} \times 10^6 - 33000 \text{ } [\Omega] \tag{1}$$

However,  $3V \leq |V_{out_{p,n}}| \leq 18V$  and  $V_{in} + |V_{out_{p,n}}| \leq 30V$ . Refer to the table below for main setting examples.

Note 1: Be sure not to leave Radj OPEN. Overvoltage ( $\pm 23.3V$  typ. at OPEN) may be output, which may lead to damage the converter.

Typical example

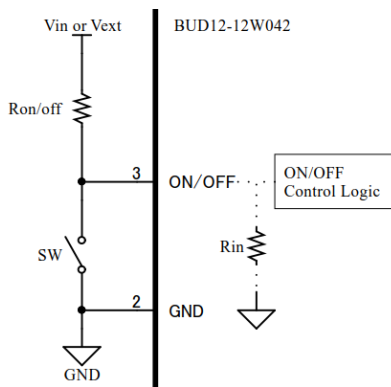
Vout <sub>p,n</sub>   Settings [V]	Radj [kΩ]
3.3	24.7(≈ 22 + 2.7)
5	73.8(≈ 27 + 47)
12	433(≈ 330 + 47 + 56)
15	774(≈ 680 + 47 + 47)

7-3. ON/ OFF control

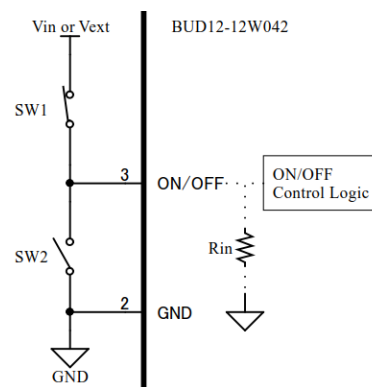
By setting the voltage between the ON/OFF pins Von/off to High or Low, the output settings can be controlled without switching the input on or off physically. For ON/OFF pin threshold voltage VH, VL and input resistor, refer to section 4-2.

ON/OFF control can be performed with the circuit shown below.

ON/OFF pin voltage Von/off [V]	Output setting
High (Von/off > VH)	ON
Low (Von/off < VL)	OFF



ON/OFF control circuit example (pull-down configuration)



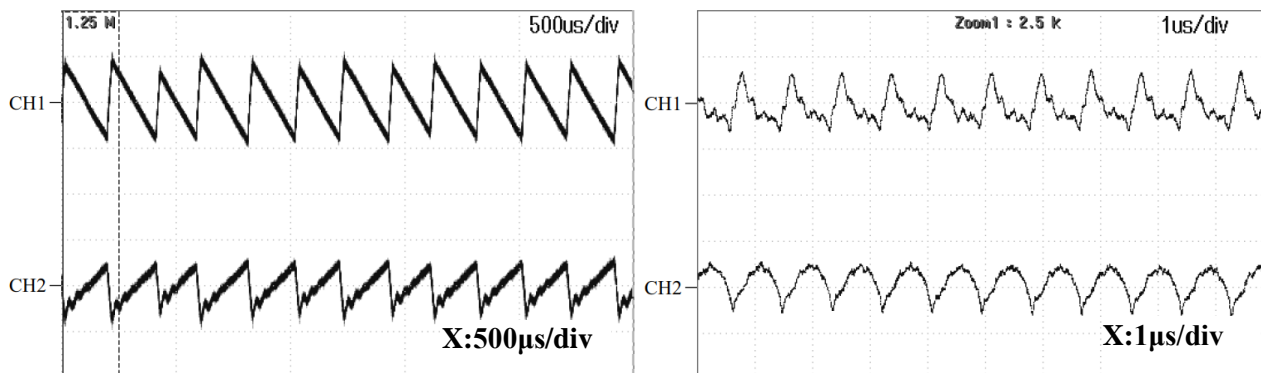
ON/OFF control circuit example (push-pull configuration)

Note 1 Be careful not to cause chattering between the ON/OFF and GND pins, and make sure that there is an interval of Toff (section 4-2) or more from OFF to ON.

## 7-4. Skip mode

In the range where the output current is small, the mode is skip mode (intermittent switching operation, shown below), and the loss at light load is suppressed.

Output ripple increases in the skip mode.



(a)  $V_{in} = 18V$ ,  $V_{outp,n} = \pm 12V$ ,  $P_{outp,n} = 0W$   
At skip mode

(b)  $V_{in} = 12V$ ,  $V_{outp,n} = \pm 12V$ ,  $P_{outp,n} = 0.5W$   
At fixed switching frequency

CH1:  $V_{outp}$  (5mV/div), CH2:  $V_{outn}$  (5mV/div)  
Output ripple noise waveform

## 7-5. Thermal shutdown

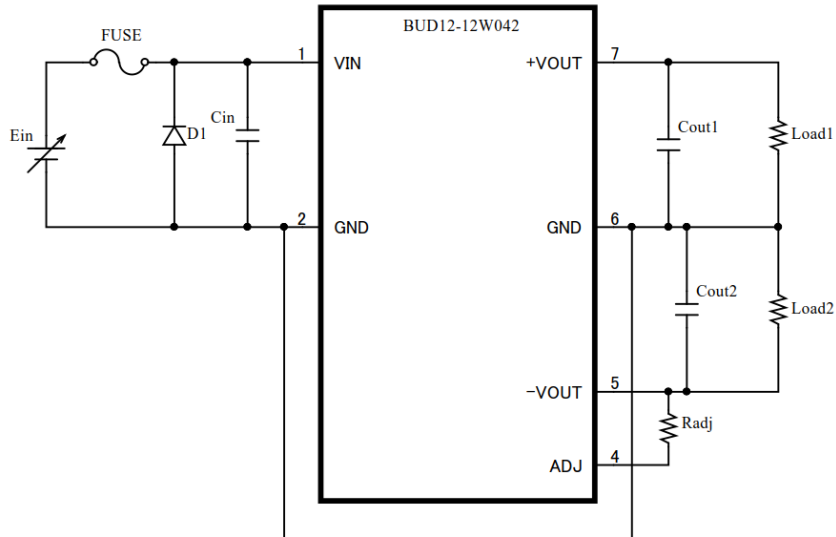
When the detected temperature of this product is 160°C typ. or more, the thermal shutdown operates and the switching operation stops.

## 7-6. Over-power protection

It limits the output power when the converter is overpowered (Section 4-2 –Pop) and automatically recovers when the overpowered state is removed. Avoid maintaining overpowered conditions for extended periods of time.

## 8. Reverse polarity protection at the input (Example)

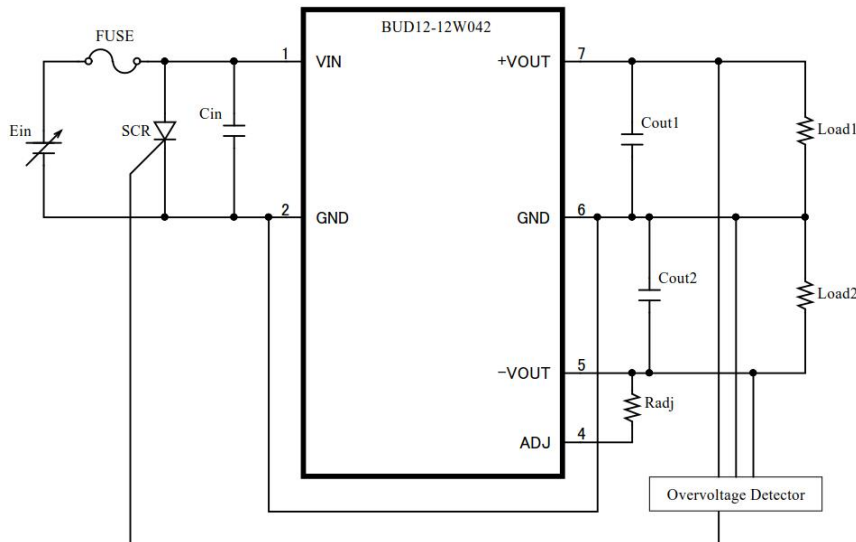
Inadvertently, reversing the polarity of the input connected to the product can lead to product damage. If there is a possibility that the polarity reversal may occur, add a protection circuit to the product. The figure below is an example of a protection circuit using a fuse and diode



Reverse polarity protection circuit

## 9. Over-voltage protection (Example)

This product does not have a built-in over-voltage protection function. If the output voltage setting resistor Radj becomes OPEN, please add the input blocking circuit as shown in the figure below in case the internal element of the product is damaged in short mode.



Over-voltage protection circuit (Example)

Note1: If the converter is damaged in over-voltage mode, ON/OFF control will not operate.

Note2: If the power source of the converter has an ON/OFF function, over-current protection function, etc., this can be used.

Note3: Allow enough capacity in the DC power supply for the fuse to blow.

**10. Mounting requirements**

The following conditions will apply to soldering temperature, time and storage before mounting.

This converter cannot be implemented in a flow.

**10-1. Reflow method**

Pre-heat temperature: 150 to 180°C, 120sec max. (See the figure below)

Peak temperature: 250°C max.

220°C or more 60sec max.

The number or times of reflow: Once

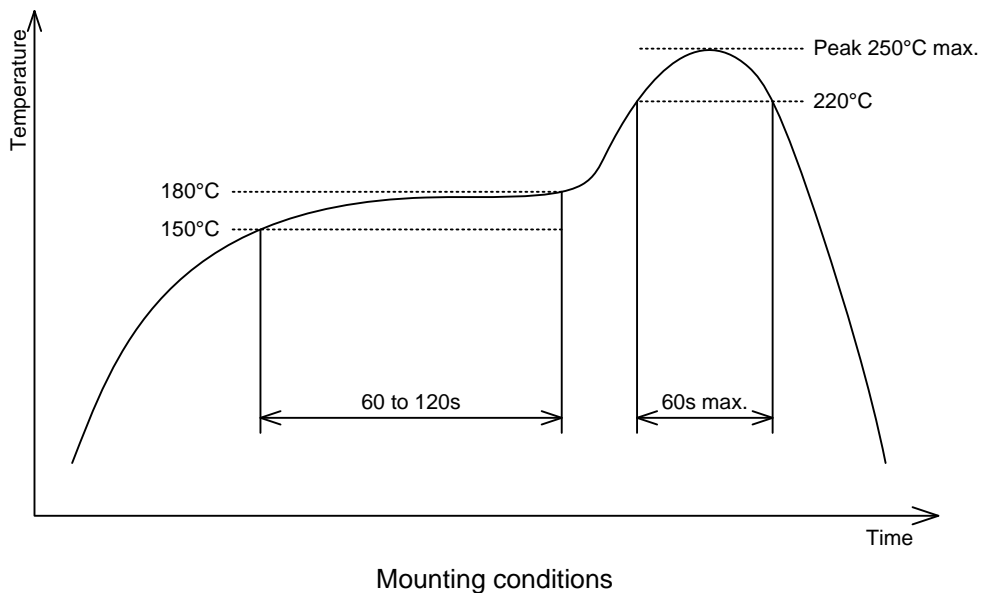
Note1: Refrain from giving vibrations during reflow, for it may cause converter components to move.

Note2: After mounting the converter onto the board, reflow cannot be made again by turning over the mounted boards.

**10-2. Storage before mounting**

Humidity control level for this product is MSL2. For storage before mounting, please keep it at 30°C/60% R.H. or less.

After mounting, it depends on the storage conditions.

**11. Vibration and shock testing**

Vibration: 5 to 10Hz, total amplitude 10mm, 10 to 55Hz acceleration 2G (1 hour each in 3 directions)

Shock: Acceleration 20G (3 times each in three directions)

Shock time 11 $\pm$ 5ms

## 12. Cleaning

This product is not for immersible cleaning. No-clean flux is recommended for this product.

## 13. Precautions for use

To ensure user's safety, check specifications before using the product and always observe the following precautions for use.

- The product is intended for use in general electronics equipment (office equipment, communication equipment, measurement equipment). Do not use the product for medical equipment, nuclear equipment, trains, etc., whereby human life or property may be directly affected by a damaged product. Consult with us for any use other than for such general electronics equipment.
- The product is not suitable for series operation.
- Do not use connectors and sockets for mounting the product. Contact resistance may have an adverse effect on the performance. Use soldering method for mounting on a printed circuit board.
- The product has a built-in overcurrent protection circuit but avoid a prolonged short circuit state which may lead to failure.
- The product may be damaged if used under nonstandard electrical conditions or nonstandard environmental conditions including temperature. Ensure use within the standards.
- Avoid storing or using the product in a place that generates corrosive gas or dust.
- The product may be damaged by static electricity. Make sure that the workplace is guarded against static buildup and static electricity on operators by use of proper grounding.
- A fuse mechanism is not built in the product. Connect a fuse to the + input line to guard against excessive input current under abnormal circumstances. Allow enough capacity in the power supply for a fuse to blow.
- This product does not have built-in overvoltage protection. If the converter is damaged for any reason, there is a mode in which the input voltage appears directly at the output, causing smoke and ignition. In order to prevent these, add an overvoltage protection circuit.
- The product does not come with a test report.
- Specifications may be changed without prior notice for product improvement.

## 14. Warranty

The warranty term of the product is one year after shipment. Should the product become defective within the warranty period due to our design or workmanship, the product will be repaired free of charge or replaced.

However, this warranty does not cover products which have been subjected to unauthorized inner modifications, etc.

The scope of our warranty is limited to that of the product concerned.

## 15. Other matters

If any doubt arises regarding this specification, it will be decided after consultation between the two parties.