RBBA3000-50
HIGH CURRENT, NON-ISOLATED DC/DC CONVERTER

The RBBA3000-50 is a high-current (50A) intelligent buck–boost converter based on an internal digital signal processor.

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DESCRIPTION

The RBBA3000-50 is a high-current (50A) intelligent buck–boost converter, utilizing an internal digital signal processor (DSP). The dedicated DSP controller enables additional features, making this product highly suitable for a variety of practical power supply applications, including purely analog systems. In addition to its fast response to transient loads, the DSP core supports a comprehensive set of output protections, including short circuit, adjustable output current limit, over-voltage fault protection, and over-temperature protection.

The input voltage range spans from 9V to 60VDC, with a 100ms surge withstand capability up to 80VDC. This wide input range makes the RBBA3000-50 ideal for battery-powered systems, including those using lead-acid or lithium-ion battery packs, where the charger supply voltage may surge if the battery load is disconnected suddenly. The converter also features an under-voltage lock-out (UVLO), which disables the converter if the input voltage drops below 6V (typ.).

A growing trend is moving away from AC uninterruptible power supplies (UPS) and toward DC-backed systems for ensuring functionality during power outages. Using an AC supply to charge a battery or supercapacitor energy storage device, and then using that stored energy to provide AC power during an emergency, is highly inefficient for maintaining continuity. The power losses in both the DC charging circuit and the AC inverter are significant, which limits most UPS systems to providing only a few minutes of backup power. This is typically enough for computers to shut down, but it is often insufficient for mechanical systems like robotics or assembly machines to complete tasks or safely return to a resting position. By contrast, using a high-current 48VDC system allows direct battery backup, providing enough power for even heavy industrial assembly plants to reset safely. The RBBA3000-50 is perfect for such applications, as it can deliver a stable 48V output from an input voltage that is equal to, higher, or lower than 48VDC.

The converter is housed in a standard half-brick case, with an aluminum baseplate that ensures efficient thermal bonding with a heatsink. With appropriate cooling, the RBBA3000-50 can operate at full load across the full industrial temperature range of -40°C to +85°C. The datasheet includes calculation examples to help determine the necessary power derating based on heatsink size or application altitude. Additionally, four threaded inserts are provided to securely mount the converter to both the PCB and the heatsink.

All power supplies must comply with strict limits for radiated and conducted EMI (electromagnetic interference). The RBBA3000-50 datasheet provides guidance on the necessary external EMC filtering to meet the EN55032 Class A standard.

SET OUTPUT VOLTAGE

The RBBA3000-50 defaults to an output voltage of approximately 1.3V if the output voltage trim resistor or trim voltage is not connected. This safety feature ensures that the converter's high output current capability does not damage the user's application during testing or in the event of a board fault.

There are two methods for setting the output voltage: using an external resistor or applying an external trim voltage. The trim pin is continuously monitored by the internal DSP core, allowing dynamic output voltage adjustment. This capability enables the supply voltage to the application to be modified based on load or standby status, reducing overall power consumption.

Set Output Voltage Using a Fixed Resistor

The calculation is as follows:

$$R_{Trim} = \frac{714900}{Vout_{set} + 3.459} - 10870$$

R_{Trim} = Trim Resistor Value [Ω]
$Vout_{set}$ = Trimmed Output Voltage [V]

For example, the following commonly used output voltage trim resistors could be used.

TRIMMED OUTPUT	TRIM RESISTOR (E96) [kΩ]
12	35.7
15	28.0
24	15.0
36	7.15
48	3.01
60	0.392

Table 1: Required Output / Trim Resistor

Based on the table above, a 50kΩ potentiometer could be used to manually adjust the output voltage over the range of 12V to 60V.

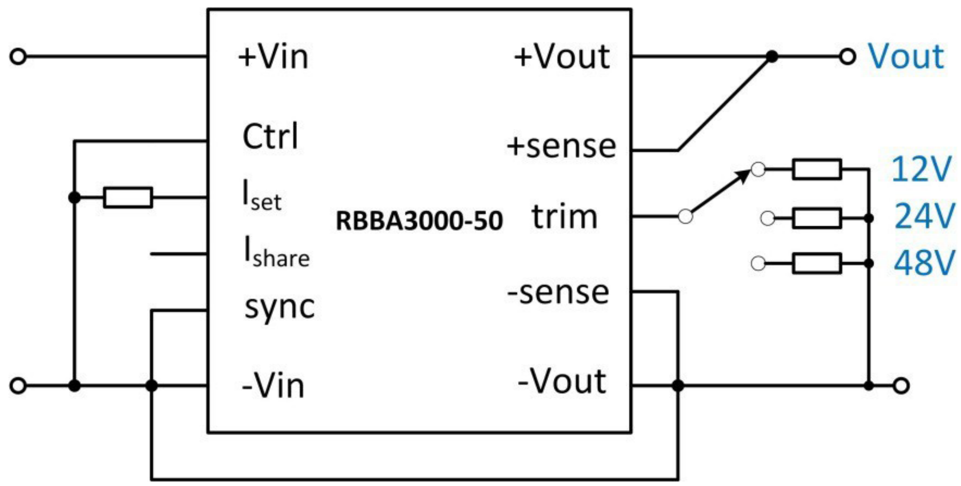

Figure 1: V_{out} set

Set Output Voltage Using an External Voltage

The output Voltage of the RBBA3000-50 can also be set using an external voltage. The calculation is as follows:

$$V_{setU} = 2.366 - 2.316 \cdot \frac{Vout_{set}}{60}$$

V_{setU} = External Voltage [V]
$Vout_{set}$ = Required Output Voltage [V]

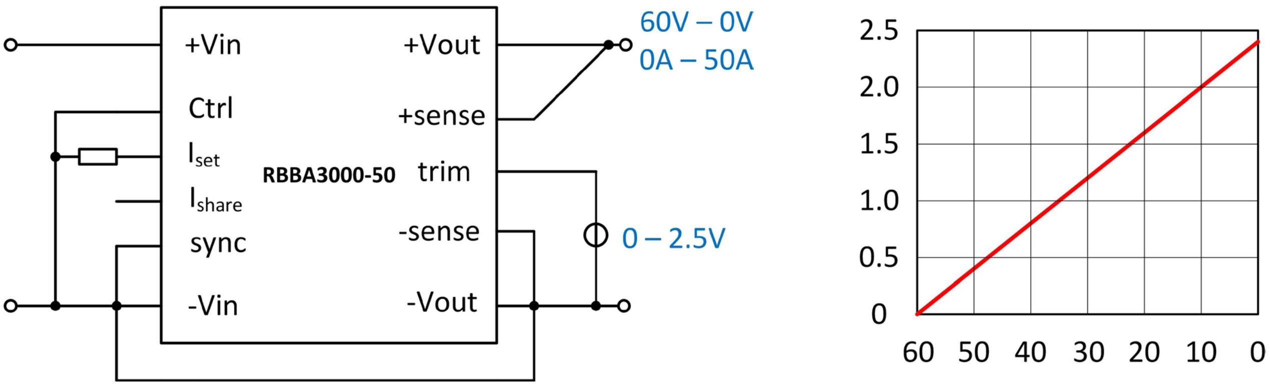

Figure 2: Vout ext. Voltage control

An internal voltage reference will pull the trim pin to 2.5V if it is left floating. For stability, the output voltage responds to changes in the V_{setU} voltage with a slope of approximately 100mV/ms. While dynamic voltage adjustment is possible to accommodate varying operating conditions, the response time is not fast enough to support functions like dynamic signal envelope voltage tracking.

However, if the application enters standby mode and the output voltage is reduced (e.g., from 24V to 12V to halve power consumption), the standby and wake-up times will be very quick.

OUTPUT CURRENT LIMITING (MAX OUTPUT CURRENT)

The RBBA3000-50 has a default output current limit of 55A if the I_{set} pin (pin #4) is not connected. Therefore, if no output current limiting is required, the I_{set} pin can be left floating.

There are two methods for setting the output current limit (maximum output current): using an external fixed or variable resistor, or applying an externally set voltage. The I_{set} pin is continuously monitored by the internal DSP core, enabling dynamic output current limiting. This feature allows, for example, increasing the current limit to accommodate high start-up inrush currents, and then reducing it to protect the application from overload conditions. The current limiting function operates in hiccup mode, meaning if the output is overloaded or short-circuited, the output will be turned off temporarily, and the converter will attempt to restart.

Set Output Current Limit Using a Fixed Resistor

The calculation is as follows:

$$R_{Iset} = \frac{25 \cdot Iout_{set}}{165 - 2.5 \cdot Iout_{set}}$$

R_{Iset} = Current limit set resistor (Ω)
$Iout_{set}$ = Required output current limit (A)

For example, the following commonly used output current limit trim resistors could be used.

REQUIRED LIMIT [A]	ISET RESISTOR (E96) [kΩ]
10	1.78
20	4.32
30	8.25
40	15.4
50	31.6
55	floating

Table 2: Required Current Limit / Iset Resistors

Based on the table above, a 33kΩ potentiometer in series with a 2R resistor could be used to manually adjust the output current limit over the range of 48A to 10A.

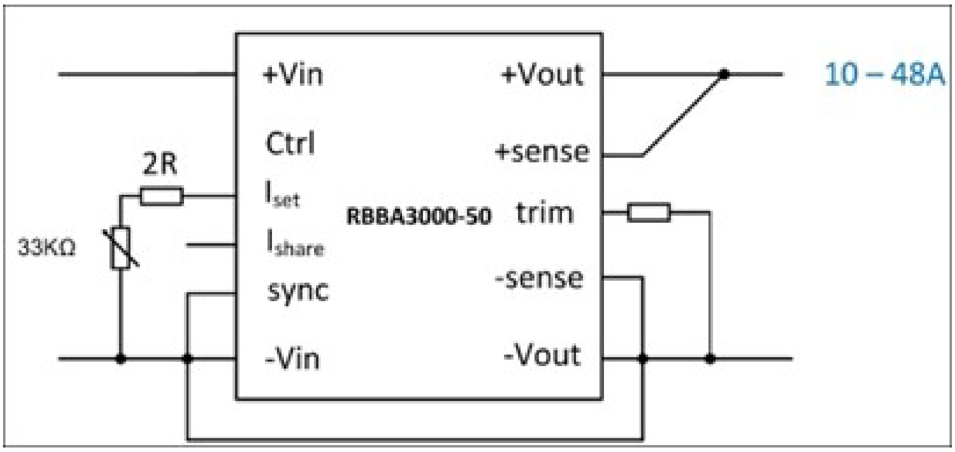

Figure 3: RBBA3000-50 output current limit setting via R_{Iset}.

Set Output Current Limit Using an External Voltage

The output current limit of the RBBA3000-50 can also be set using an external voltage.

The calculation is as follows:

$$V_{setI} = 2.5 \cdot \frac{Iout_{set}}{50}$$

V_{setI} = External voltage (V)
$I_{out,set}$ = Required output current limit (A)

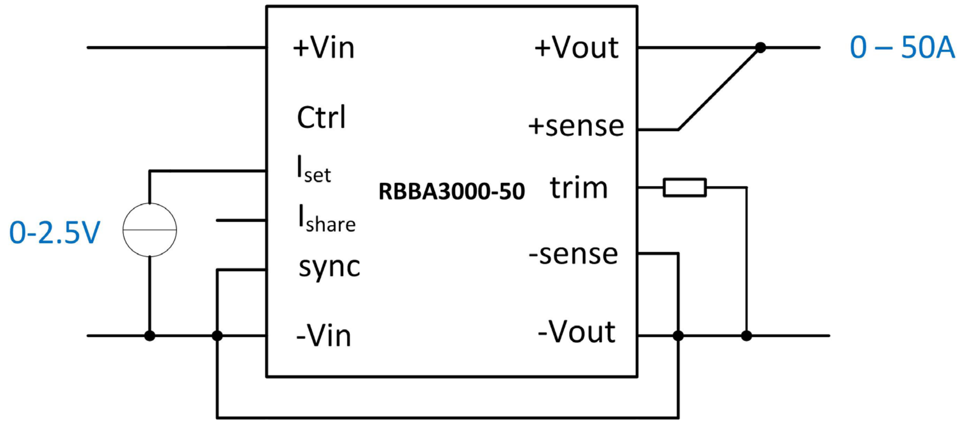

Figure 4: RBBA3000-50 output current limit setting via V_{setI}.

CURRENT LIMIT [A]	V_{SETI} [V]
5	0.25
10	0.5
20	1.0
30	1.5
40	2.0
50	2.5
55	floating

Table 3: Current Limit / V_{setI}

This feature allows DAC control of the output current limit setting for dynamic current limiting.

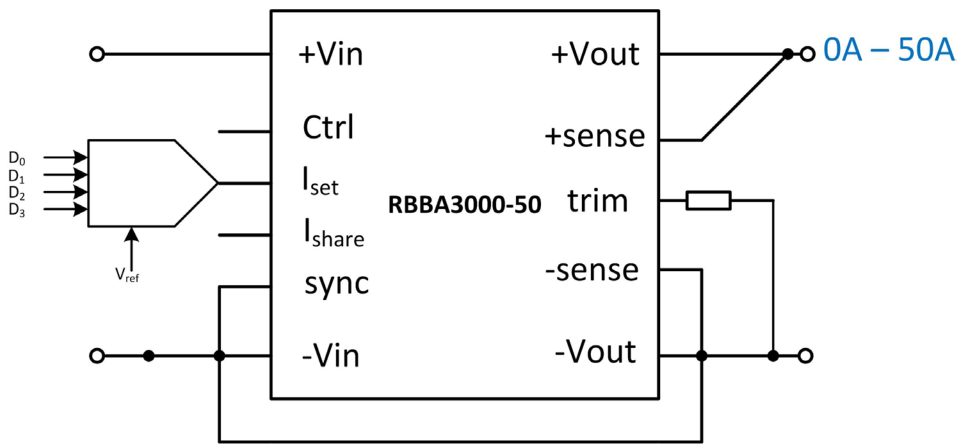

Figure 5: $Iout_{set}$ DAC control

An internal voltage reference will pull up the I_{set} pin to 3.3V ($Iout_{set}$ = 55A) if the pin is left disconnected. Therefore, if no output current limiting is required, leave the I_{set} pin floating.

For an application example of how to use this feature to make a power-limited (constant-voltage) converter, see the next section.

CURRENT SHARE / CURRENT MONITOR

Current Monitor

The RBBA3000-50 has a dual-function current share/current monitor pin.

For single converter applications, the pin can be used to monitor the output load. In this case, the voltage generated by the converter will correspond to the output current with a linear relationship.

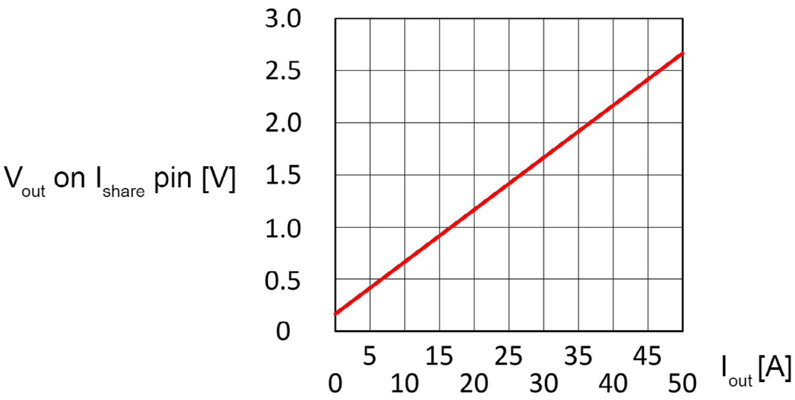

Figure 6: I_{mon}

This function eliminates the need for an external shunt resistor to monitor the high-side current, thereby removing the drawbacks of power loss through the shunt and its temperature variation. Additionally, it eliminates the need for a high-current precision shunt resistor, amplifier, and current mirror, reducing associated costs.

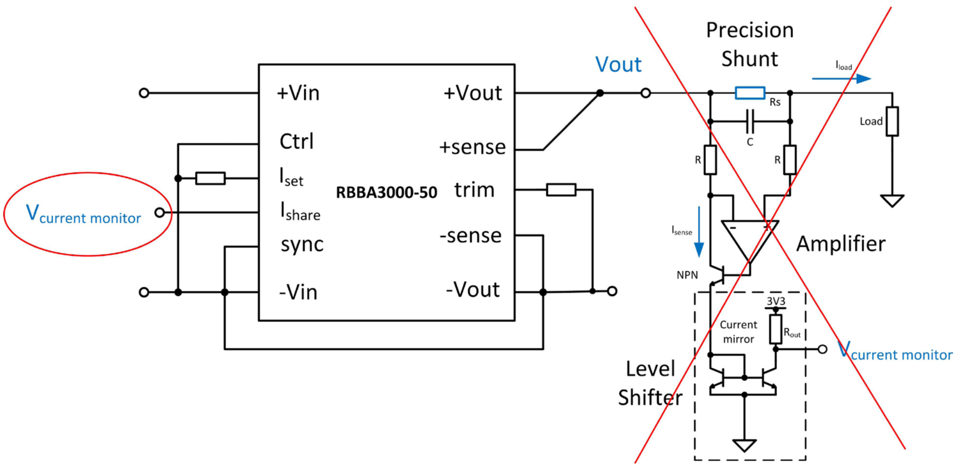

Figure 7: Current monitor cct

The I_{share} output can also be connected to an ADC to interface the RBBA3000-50 with a microcontroller, enabling continuous load monitoring.

The following example shows a simple load "traffic light" circuit that indicates the load on the output. This basic indicator can notify the operator about the current drain on the primary side battery or warn that the converter may enter thermal protection if the output loading remains consistently high.

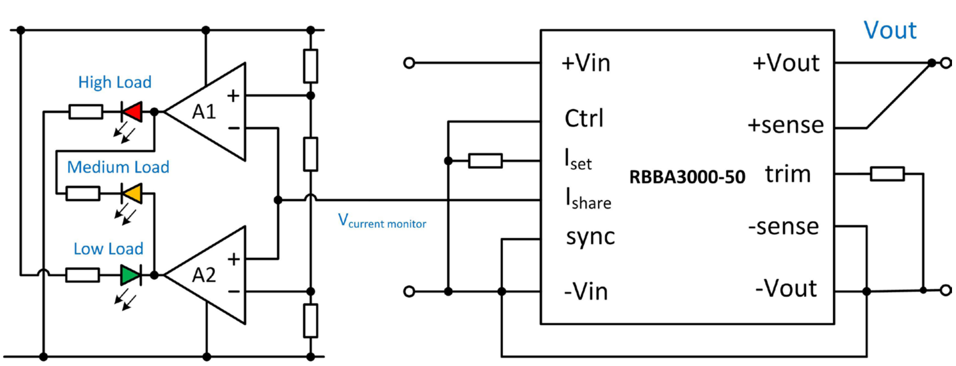

Figure 8: Current monitor ample

To use the current monitoring signal and create a current-limited power supply, a feedback circuit is required.

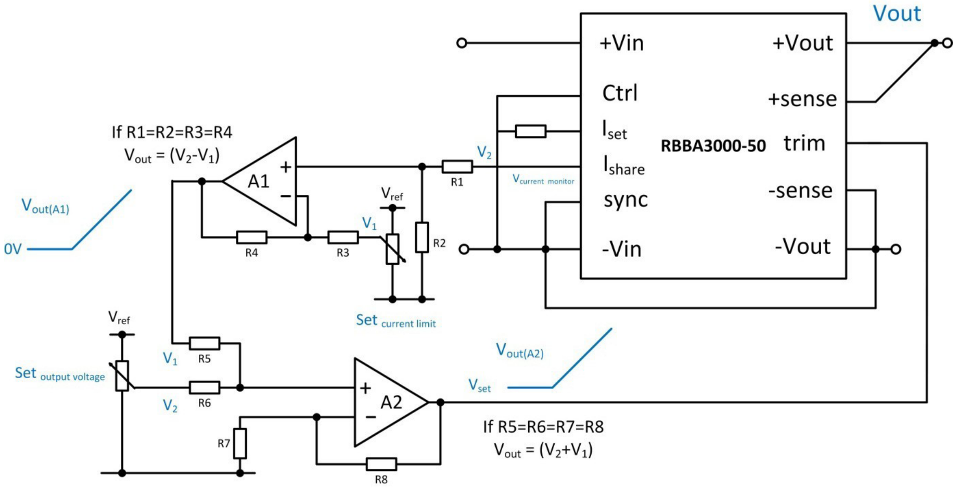

Figure 9: Current monitor with two operational amplifiers

This application example uses two operational amplifiers. Op-Amp A1 subtracts the set current limit input (0–2.5V) from the I_{share} output voltage. For instance, if the current limit is set to 20A by trimming the set current limit voltage to 1.20V, the output of A1 will be zero below 20A and will increase linearly with the load current at a rate of 50mV/A.

Op-Amp A2 then adds the output of A1 to a pre-set voltage from the set output voltage input. For example, if the output voltage is set to 1.44V by trimming the set output voltage to 1.4V, and if the output current exceeds 20A, the output of A2 will increase, reducing the output voltage and, consequently, the output current for a fixed load.

This configuration allows the RBBA3000-50 to effectively limit the power when the load current exceeds 20A.

Current Share

The second function of the I_{share} pin is to enable load sharing between two converters, allowing for a total output current of 70A, or between three converters in parallel to support a 100A load. To use this function, simply connect the Ishare pins of the converters.

Both converters must be set to the same output voltage, share the same source, have the +sense pins connected together at the summing point, and feature a symmetrical layout to ensure equal track resistances and accurate current sharing.

No OR-ing diodes are required.

Application example 36V/70A power supply

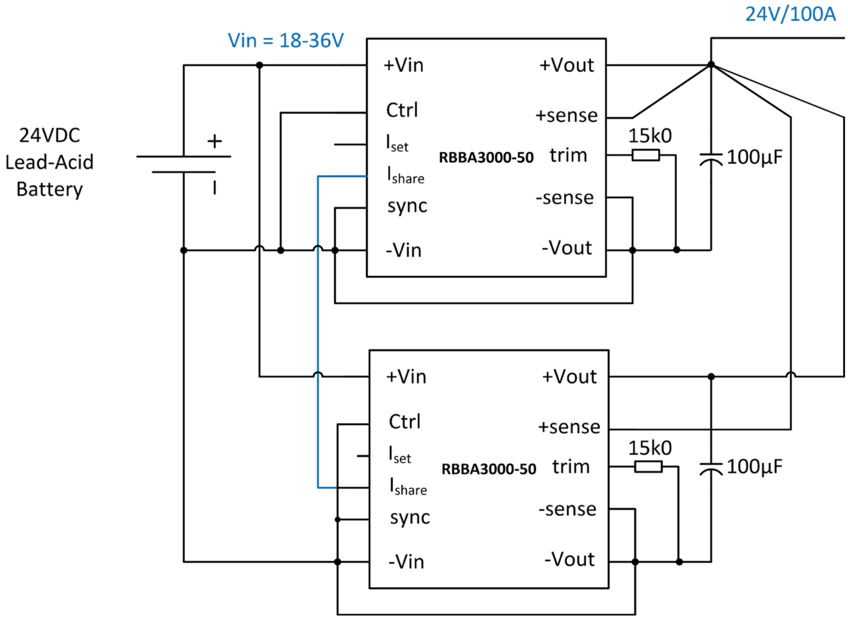

Figure 10: RBBA stabilized 24V

The design rules for parallel operation are as follows:

1. Keep all high-current tracks the same length and the same impedance.
2. Paralleled devices have to have the same baseplate temperature (e.g. all mounted on the same heatsink).
3. Use the same supply voltage with a rise time of greater than 1V/ms to avoid start-up issues due to any slight differences between the UVLO levels in the two converters.
4. Add at least 100µF output capacitance per converter.
5. Start-up current should not exceed 50A, so either use a soft-start load or load sequencing.
6. Two modules = 70A max. and three modules = 100A max.

PROTECTIONS

The RBBA3000-50 has a comprehensive set of protection features.

Under-Voltage Lockout

The converter will not start up until the input voltage exceeds 8V±1V and will shut down if the voltage drops below 6V±1V. This ensures protection against excessive input current conditions.

Short-Circuit Protection

If the converter's output is short-circuited, it will shut down and enter hiccup mode, automatically restarting once the short is cleared. There is no time limit on the duration of the short circuit.

Over-Current Protection

If the output current exceeds 110% of the maximum output current (i.e., 55A) or the limit set on the Iset pin, the output will shut down and the converter will enter hiccup mode, automatically restarting once the over-current condition is resolved.

Over-Voltage Protection

The DSP core continuously monitors the output voltage. If it exceeds the maximum limit (see table below), the converter will shut down and latch off. The converter can only be restarted once the power is turned off and reapplied.

VOUT_SET	OVP TRIGGERING POINT
0-3.5VDC	5V
3.5-47.5VDC	143%
>47.5VDC	68V typ.

Table 4: OVP Limits

Input Over-Current Protection

The DSP core continuously monitors the input current. If it exceeds the maximum limit of 55A, the converter will shut down and latch off. The converter can only be restarted once the power is turned off and reapplied.

Over-Temperature Protection

The baseplate temperature is continuously monitored by the DSP core. If the temperature exceeds 110°C, the converter will shut down and automatically restart once the temperature drops below approximately 90°C.

Soldering Information

The RBBA3000-50 can be lead-free wave soldered using single-wave or double-wave solder baths, following the typical thermal profile outlined below:

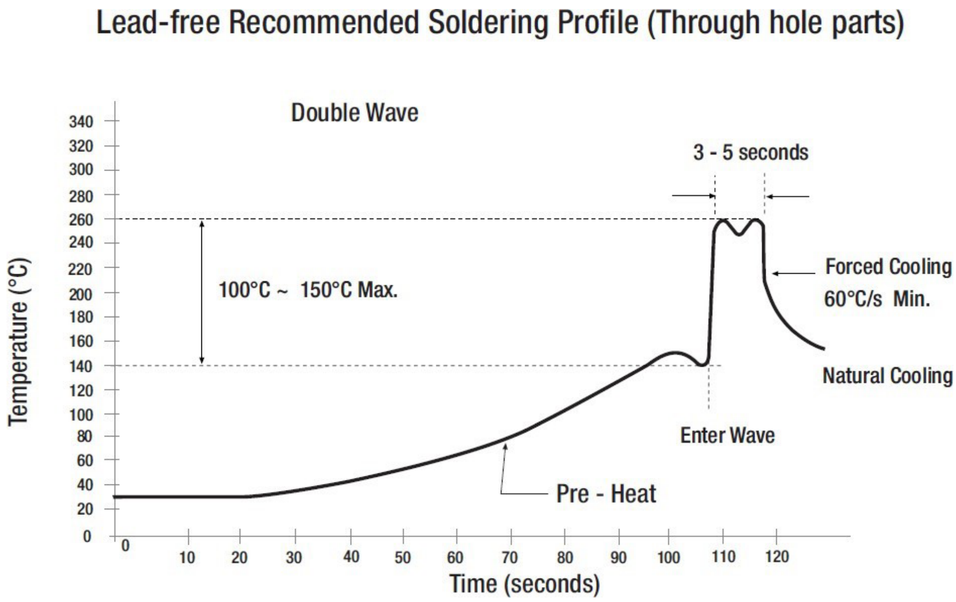

Figure 11: Lead-Free Soldering Profilel

The preheat rate should not exceed 3°C/s, and the natural cooling rate should not exceed 6°C/s. The baseplate temperature should not exceed 200°C.

The RBBA3000-50 is not suitable for use with reflow soldering ovens (e.g., pin-in-paste techniques).

For hand soldering, use a soldering iron with a temperature set between 385°C and 420°C. The contact time between the soldering iron tip and the pins should not exceed 6 seconds.

MECHANICAL INFORMATION

The RBBA3000-50 uses an industry-standard quarter-brick case (60.60 x 63.2 x 13.0mm) fitted with four M3 threaded inserts.

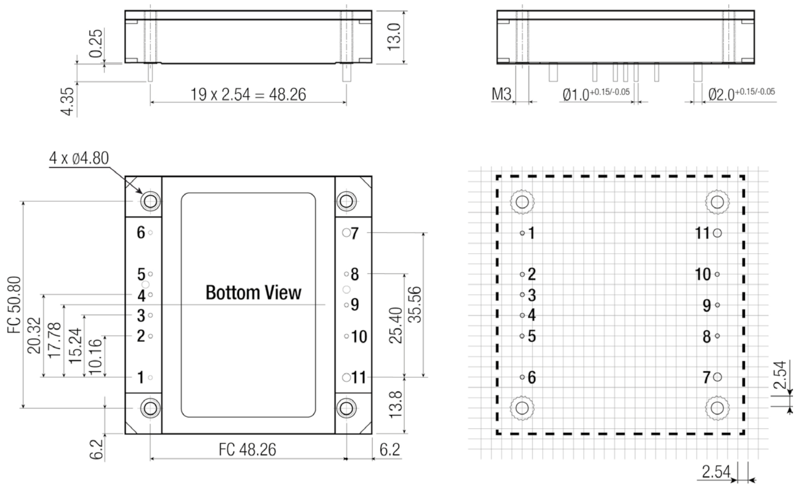

Figure 12: Dimension Drawing

Pins 1, 2, 3, 4, 5, 6, 8, 9, and 10: Ø1.00mm, copper, matte Tin plated, Ni under-plated
Pins 7 and 11: Ø2.00mm, copper, matte Tin plated, Ni under-plated

Mounting Suggestion

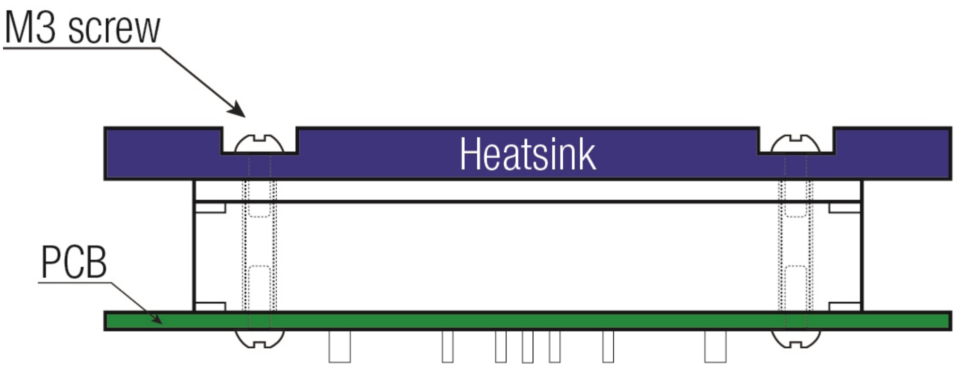

Figure 13: Mounting Suggestion

Fixing screws: M3 x 6 (+ thickness of PCB or heatsink)

FURTHER APPLICATION EXAMPLES

Application Example: 12V-to-24V boost converter

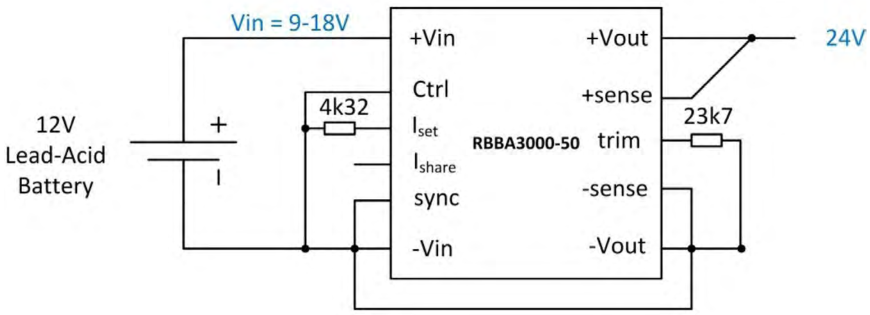

Figure 14: 12V-to-24V boost converter

Application Example: 48V-to-12V buck converter with output load monitoring

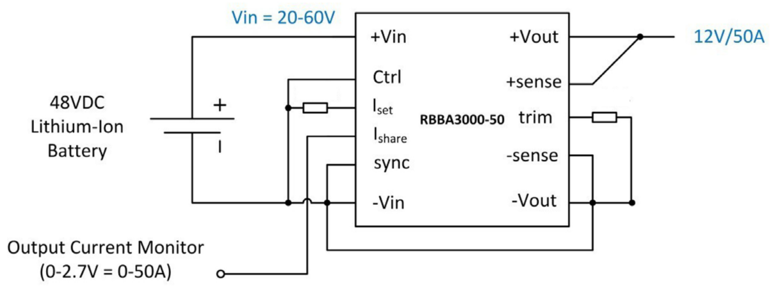

Figure 15: 48V-to-12V buck converter with output load monitoring

Application Example: 36V/70A stabilizer (Buck/Boost) with active current limit

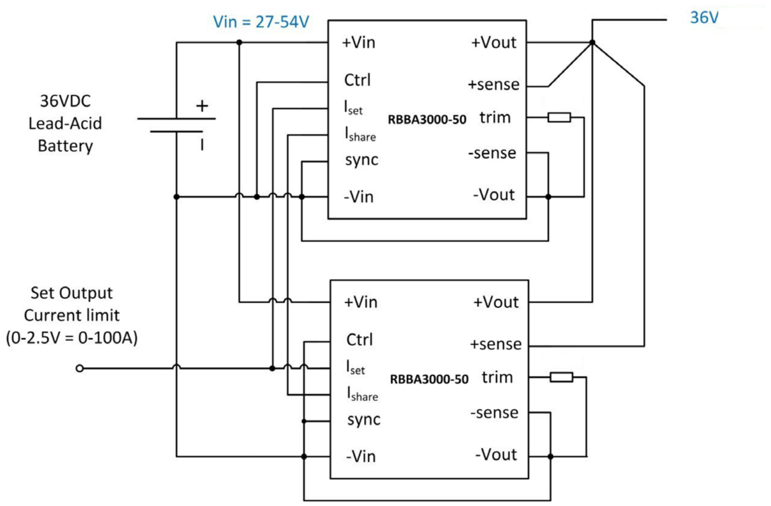

Figure 16: 36V/70A stabilizer (Buck/Boost)

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