



CHB150W8 Series Application Note V15

ISOLATED DC-DC CONVERTER CHB150W8 SERIES APPLICATION NOTE



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1. Introduction

The CHB150W8 series of DC-DC converters offers 150 watts of output power @ single output voltages of 12, 15, 24, 28, 48VDC with industry standard half-brick. It has a wide (8:1) input voltage range of 9 to 75VDC (36VDC nominal) and 1500VDC isolation.

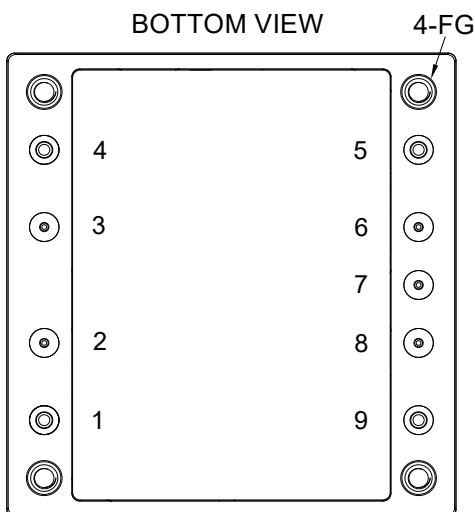
High efficiency up to 90%, allowing case operating temperature range of -40°C to 100°C. An optional heat sink is available to extend the full power range of the unit.

The standard control functions include remote **on/off** (positive or negative) and +10%, -10% adjustable output voltage.

Fully protected against input UVLO (under voltage lock out), output over-current, output over-voltage, over-temperature and continuous short circuit conditions.

CHB150W8 series can be used in the field of telecommunications, data communications, wireless communications, servers etc.

2. Pin Function Description



No	Label	Function	Description	Reference
1	+Vin	+V Input	Positive Supply Input	Section 7.1
2	Remote	On/Off	External Remote On/Off Control	Section 6.5
3	Case	Case	Connected to Base Plate	
4	-Vin	-V Input	Negative Supply Input	Section 7.1
5	-Vo	-V Output	Negative Power Output	Section 7.2/7.3
6	-Sen	-Sense	Negative Output Remote Sense	Section 6.6
7	Trim	Trim	External Output Voltage Adjustment	Section 6.7
8	+Sen	+Sense	Positive Output Remote Sense	Section 6.6
9	+Vo	+V Output	Positive Power Output	Section 7.2/7.3
--	--	Mounting Insert	Mounting Insert (FG)	Section 9.5/10.2

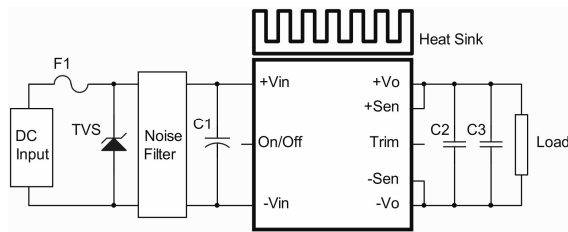
Note: Base plate can be connected to FG through M3 threaded mounting insert. Recommended torque 3Kgf-cm.



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3. Connection for Standard Use

The connection for standard use is shown below. An external input capacitor (C1) 330uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 10uF solid tantalum and 1uF ceramic capacitor for other models and 48Vout with 10uF aluminum and 1.0uF ceramic. The output terminal of 24, 28, 48Vout models required a minimum capacitor 100uF to maintain specified regulation.



Symbol	Component	Reference
F1, TVS	Input fuse, TVS	Section 10.1
C1	External capacitor on input side	Note Section 7.1
C2, C3	External capacitor on the output side	Section 7.2/7.3
Noise Filter	External input noise filter	Section 10.2
Remote On/Off	External Remote On/Off control	Section 6.5
Trim	External output voltage adjustment	Section 6.7
Heat Sink	External heat sink	Section 9.2/9.3/9.4/9.5
+Sense/-Sense	--	Section 6.6

Note:

If the impedance of input line is high, C1 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20°C.

4. Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown below. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test. We can calculate:

- Efficiency
- Load regulation and line regulation

The value of efficiency is defined as:

$$\eta = \frac{V_o \times I_o}{V_{in} \times I_{in}} \times 100\%$$

Where:

V_o is output voltage,
 I_o is output current,
 V_{in} is input voltage,
 I_{in} is input current

The value of load regulation is defined as:

$$\text{Load reg.} = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where:

V_{FL} is the output voltage at full load
 V_{NL} is the output voltage at no load

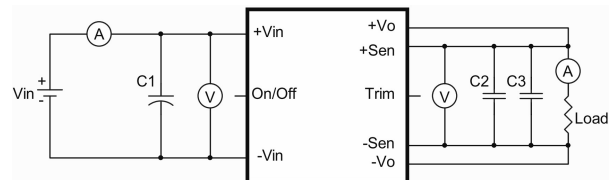
The value of line regulation is defined as:

$$\text{Line reg.} = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where:

V_{HL} is the output voltage of maximum input voltage at full load.

V_{LL} is the output voltage of minimum input voltage at full load.



CHB150W8 Series Test Setup

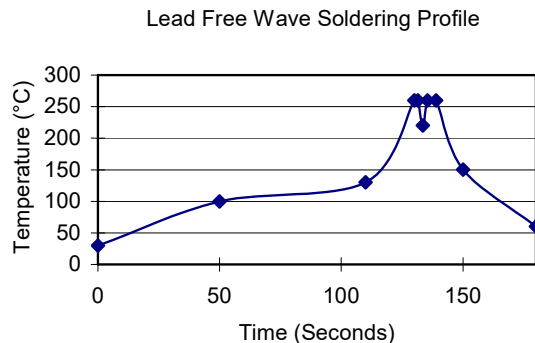
C1: 330uF ESR<0.7Ω

C2: 1uF/1210 ceramic capacitor

C3: 10uF tantalum (for 48Vout with 10uF Aluminum solid capacitor)

Note:

The output terminal of 24, 28, 48Vout models required a minimum capacitor 100uF to maintain specified regulation.





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6.3 Output Over Voltage Protection

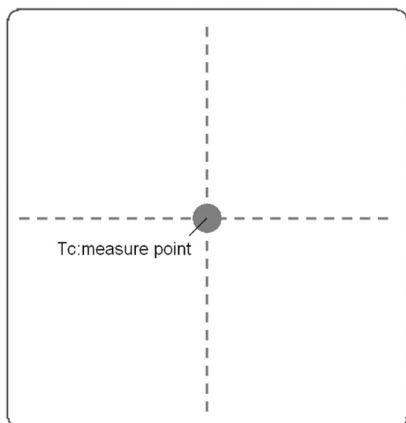
The converter is protected against output over voltage conditions. When the output voltage is higher than the specified range, the module enters a hiccup mode of operation. The operation is identical with over current protection.

Note:

Please note that device inside the power supply might fail when voltage more than rate output voltage is applied to output pin. This could happen when the customer tests the over voltage protection of unit. OVP can be tested by using the TRIM UP function. Consult us for more information.

6.4 Over Temperature Protection

These modules have an over temperature protection circuit to safeguard against thermal damage. Shutdown occurs with the maximum case reference temperature is exceeded. The module will restart when the case temperature falls below over temperature recovery threshold. Please measure case temperature of the center part of aluminum base plate.

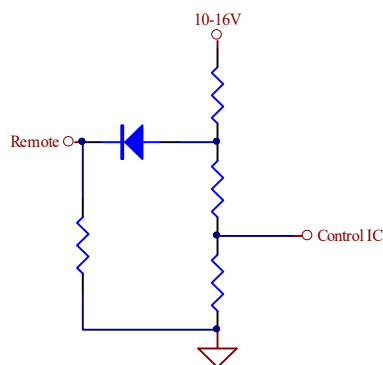


6.5 Remote On/Off

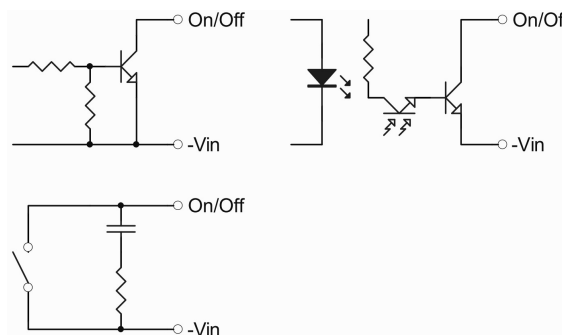
The On/Off input pin permits the user to turn the power module on or off via a system signal. Two remote **on/off** options are available. Positive logic turns the module on during a logic high voltage on the **on/off** pin, and off during a logic low. Negative logic remote **on/off** turns the module off during a logic high and on during a logic low. The **on/off** pin is internally pulled up through a resistor. A properly de-bounced mechanical switch, open collector transistor, or FET can be used to drive the input of the **on/off** pin. If not using the remote **on/off** feature: For positive logic, leave the **on/off** pin open. For negative logic, short the **on/off** pin to -Vin.

Logic State (Pin 2)	Negative Logic	Positive Logic
Logic Low	Module on	Module off
Logic High	Module off	Module on

The converter remote **on/off** circuit built-in on input side. The ground pin of input side remote **on/off** circuit is -Vin pin. Inside connection sees below.



Connection examples see below



Remote On/Off Connection Example



CHB150W8 Series

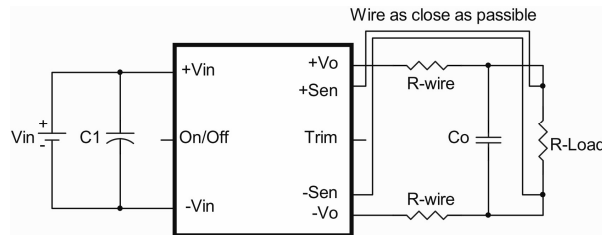
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6.6 Output Remote Sensing

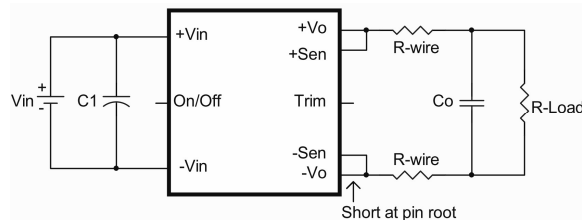
The CHB150W8 series converter has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the CHB150W8 series in order to compensate for voltage drops in distribution and maintain a regulated voltage at the point of load. The remote-sense voltage range is:

$$[(+V_{out}) - (-V_{out})] - [(+Sense) - (-Sense)] \leq 10\% \text{ of } V_{o_nominal}$$

When remote sense is in use, the sense should be connected by twisted-pair wire or shield wire. If the sensing patterns short, heavy current flows and the pattern may be damaged. Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 400mm. This is shown in the schematic below.



If the remote sense feature is not to be used, the sense pins should be connected locally. The **+sense** pin should be connected to the **+V_{out}** pin at the module and the **-sense** pin should be connected to the **-V_{out}** pin at the module. Wire between +Sense and +V_{out} and between -Sense and -V_{out} as short as possible. Loop wiring should be avoided. The converter might become unstable by noise coming from poor wiring. This is shown in the schematic below.

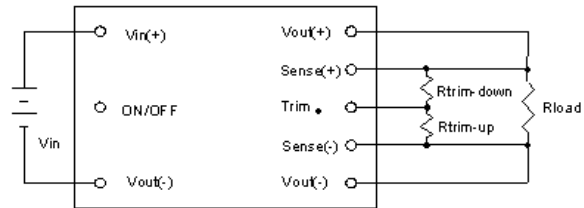


Note:

Although the output voltage can be varied (increased or decreased) by both remote sense and trim, the maximum variation for the output voltage is the larger of the two values not the sum of the values. The output power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. Using remote sense and trim can cause the output voltage to increase and consequently increase the power output of the module if output current remains unchanged. Always ensure that the output power of the module remains at or below the maximum rated power. Also be aware that if V_{o_set} is below nominal value, P_{out_max} will also decrease accordingly because I_{o_max} is an absolute limit. Thus, $P_{out_max} = V_{o_set} \times I_{o_max}$ is also an absolute limit.

6.7 Output Voltage Adjustment

Output may be externally trimmed (-10% to +10%) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.



Output Voltage Trim Circuit Configuration

The Trim pin should be left open if trimming is not being used. Connecting an external resistor (R_{trim_down}) between the Trim pin and the $V_{out}(+)$ (or $Sense(+)$) pin decreases the output voltage. The following equation determines the required external resistor value to obtain a down percentage output voltage change of $\Delta\%$

$V_{out}=12V, 15V$

$$R_{trim_down} = 20 * \frac{(V_{o_set} - \Delta\% * V_{o_set} - 1.24)}{\Delta\% * V_{o_set}} - 100K\Omega$$

$V_{out}=24V$

$$R_{trim_down} = 20 * \frac{(V_{o_set} - \Delta\% * V_{o_set} - 2.5)}{\Delta\% * V_{o_set}} - 100K\Omega$$

$V_{out}=28V$

$$R_{trim_down} = 23.7 * \frac{(V_{o_set} - \Delta\% * V_{o_set} - 2.5)}{\Delta\% * V_{o_set}} - 150K\Omega$$

$V_{out}=48V$

$$R_{trim_down} = 36 * \frac{(V_{o_set} - \Delta\% * V_{o_set} - 2.5)}{\Delta\% * V_{o_set}} - 200K\Omega$$



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Where

$$V_{out} = V_{o,set}, \Delta\% = \left(\frac{V_{o,set} - V_{desired}}{V_{o,set}} \right) \times 100$$

For example, to trim-down the output voltage of 12V module(CHB150W8-36S12) by 5% to 11.4V, $R_{trim-down}$ is calculated as follow:

$$\Delta\% = 5\%$$

$$R_{trim_down} = 20 * \frac{(12 - 5\% * 12 - 1.24)}{5\% * 12} - 100K\Omega$$

$$R_{trim_down} = 238.7K\Omega$$

Connecting an external resistor ($R_{trim-up}$) between the Trim pin and the V_{out} (-) (or Sense (-)) pin increases the output voltage. The following equations determine the required external resistor value to obtain a up percentage output voltage change of $\Delta\%$.

$V_{out}=12V, 15V$

$$R_{trim_up} = 20 * \frac{(1.24 - \frac{0.46 * 100}{100 + 4.3})}{\Delta\% * V_{o,set}} - \frac{4.3 * 100}{100 + 4.3} K\Omega$$

$V_{out}=24V$

$$R_{trim_up} = 20 * \frac{(2.5 - \frac{0.46 * 100}{100 + 5.6})}{\Delta\% * V_{o,set}} - \frac{5.6 * 100}{100 + 5.6} K\Omega$$

$V_{out}=28V$

$$R_{trim_up} = 23.7 * \frac{(2.5 - \frac{0.46 * 150}{150 + 5.6})}{\Delta\% * V_{o,set}} - \frac{5.6 * 150}{150 + 5.6} K\Omega$$

$V_{out}=48V$

$$R_{trim_up} = 36 * \frac{(2.5 - \frac{0.46 * 200}{200 + 5.1})}{\Delta\% * V_{o,set}} - \frac{5.1 * 200}{200 + 5.1} K\Omega$$

Where

$$V_{out} = V_{o,set}, \Delta\% = \left(\frac{V_{desired} - V_{o,set}}{V_{o,set}} \right) \times 100$$

For example, to trim-up the output voltage of 12V module(CHB150W8-36S12) by 5% to 12.6V, $R_{trim-up}$ is calculated as follow:

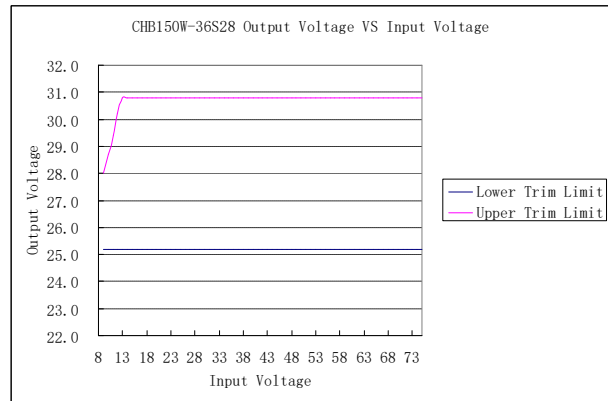
$$\Delta\% = 5\%$$

$$R_{trim_up} = 20 * \frac{(1.24 - \frac{0.46 * 100}{100 + 4.3})}{5\% * 12} - \frac{4.3 * 100}{100 + 4.3} K\Omega$$

$$R_{trim_up} = 22.5K\Omega$$

Note:

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote sense and trim, the output voltage of the module can be increased and consequently increase the power output of the module if output current remains unchanged. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power (Maximum rated power= $V_{o,set} \times I_{o,max}$). The output voltage on 12V&15V&24V&48V models is adjustable within the range of +10% to -10%. For 28V models, see input & output trim curves for trim up and trim down is -10%.



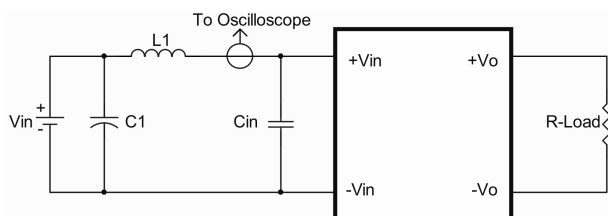


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7. Input / Output Considerations

7.1 Input Capacitance at the Power Module

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (C_{in}) should be placed close to the converter input pins to de-couple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown as below represents typical measurement methods for reflected ripple current. C_1 and L_1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L_1).

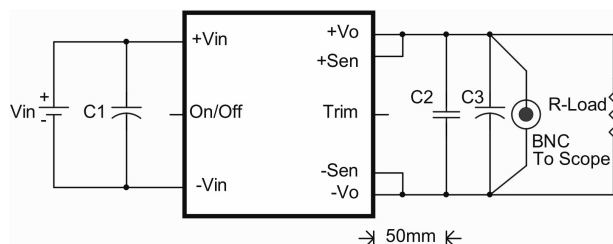


L_1 : 10uH

C_1 : None

C_{in} : 330uF ESR<0.7ohm

7.2 Output Ripple and Noise



C_1 : None

C_2 : 1uF/1210 ceramic capacitor

C_3 : 10uF solid tantalum capacitor

48Vout 10uF aluminum solid capacitor

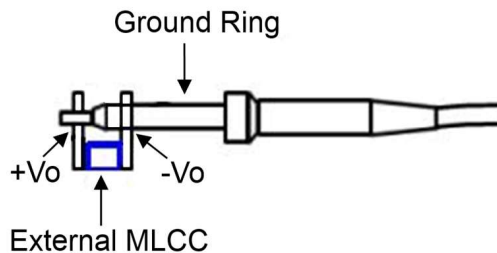
Cout: The output terminal of 24, 28, 48Vout models required a minimum capacitor 100uF to maintain specified regulation

Output ripple and noise measured with 10uF solid tantalum capacitors (for 48Vout with 10uF Aluminum) and 1uF ceramic capacitors across output. A 20 MHz bandwidth oscilloscope is normally used for the measurement.

The conventional ground clip on an oscilloscope probe should never be used in this kind of measurement. This clip, when placed in a field of radiated high frequency energy, acts as an antenna or inductive pickup loop, creating an extraneous voltage that is not part of the output noise of the converter.



Another method is shown in below, in case of coaxial-cable/BNC is not available. The noise pickup is eliminated by pressing scope probe ground ring directly against the -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.



7.3 Output Capacitance

The CHB150W8 series converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitors should be located close to the point of load (<100mm). PCB design emphasizes low resistance and inductance tracks in consideration of high current applications. Output capacitors with their associated ESR values have an impact on loop stability and bandwidth. Cincon's converters are designed to work with load capacitance to see specifications.

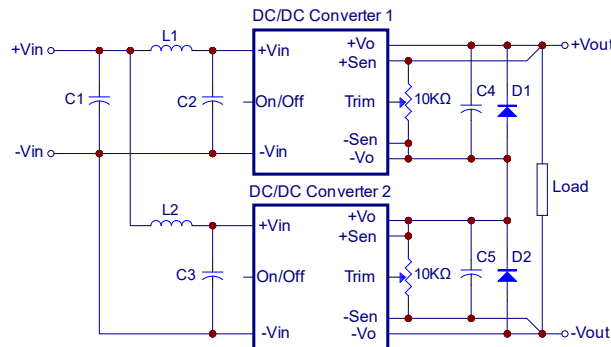


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8. Series and Parallel Operation

8.1 Series Operation

Series operation is possible by connecting the outputs two or more units. Connection is shown in below. The output current in series connection should be lower than the lowest rate current in each power module.



Simple Series Operation Connect Circuit

L1, L2: 1.0uH

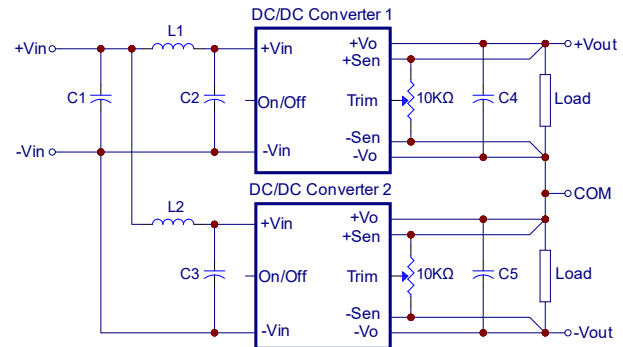
C1, C2, C3: 330uF ESR<0.7Ω

C4, C5: The output terminal of 24, 28, 48Vout models required a minimum capacitor 100uF to maintain specified regulation

Note:

1. If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20°C.
2. Recommend Schottky diode (D1, D2) be connected across the output of each series connected converter, so that if one converter shuts down for any reason, then the output stage won't be thermally overstressed. Without this external diode, the output stage of the shut-down converter could carry the load current provided by the other series converters, with its MOSFETs conducting through the body diodes. The MOSFETs could then be overstressed and fail. The external diode should be capable of handling the full load current for as long as the application is expected to run with any unit shut down.

Series for \pm output operation is possible by connecting the outputs two units, as shown in the schematic below.



Simple \pm Output Operation Connect Circuit

L1, L2: 1.0uH

C1, C2, C3: 330uF ESR<0.7Ω @100KHz

C4, C5: The output terminal of 24, 28, 48Vout models required a minimum capacitor 100uF to maintain specified regulation

Note:

If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20°C.

8.2 Parallel Operation

The CHB150W8 series parallel operation is not possible.



Parallel for redundancy operation is possible by connecting the units as shown in the schematic below. The current of each converter become unbalance by a slight difference of the output voltage. Make sure that the output voltage of units of equal value and the output current from each power supply does not exceed the rate current. Suggest use an external potentiometer to adjust output voltage from each power supply.



C4, C5: The output terminal of 24, 28, 48Vout models required a minimum capacitor 100uF to maintain specified regulation

If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20°C.



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9. Thermal Design

9.1 Operating Temperature Range

The CHB150W8 series converters can be operated within a wide case temperature range of -40°C to 100°C. Consideration must be given to the derating curves when ascertaining maximum power that can be drawn from the converter. The maximum power drawn from open half brick models is influenced by usual factors, such as:

- Input voltage range
- Output load current
- Forced air or natural convection
- Heat sink optional

9.2 Convection Requirements for Cooling

To predict the approximate cooling needed for the half brick module, refer to the power derating curves in **section 9.4**. These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be monitored to ensure it does not exceed 100°C as measured at the center of the top of the case (thus verifying proper cooling).

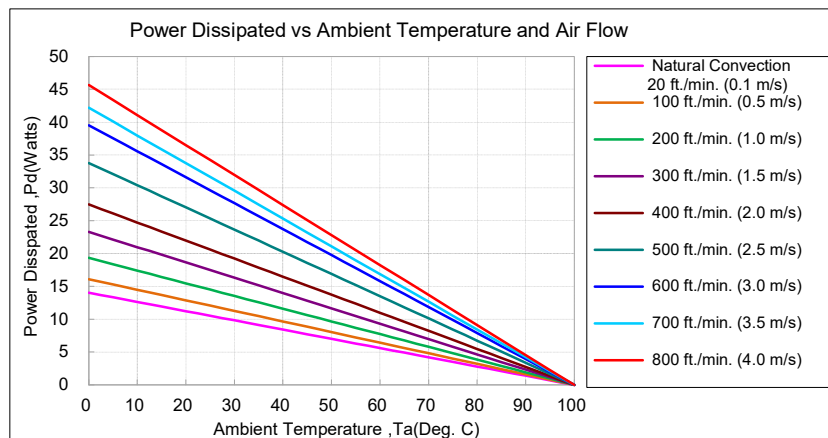
9.3 Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. The example is presented in **section 9.4**. The power output of the module should not be allowed to exceed rated power ($V_{o_set} \times I_{o_max.}$).

9.4 Power Derating

The operating case temperature range of CHB150W8 series is -40°C to +100°C. When operating the CHB150W8 series, proper de-rating or cooling is needed. The maximum case temperature under any operating condition should not exceed 100°C.

The following curve is the de-rating curve of CHB150W8 series without heat sink.



AIR FLOW RATE	TYPICAL Rca
Natural Convection	
20ft./min. (0.1m/s)	7.12 °C/W
100 ft./min. (0.5m/s)	6.21 °C/W
200 ft./min. (1.0m/s)	5.17 °C/W
300 ft./min. (1.5m/s)	4.29 °C/W
400 ft./min. (2.0m/s)	3.64 °C/W
500 ft./min. (2.5m/s)	2.96 °C/W
600 ft./min. (3.0m/s)	2.53 °C/W
700 ft./min. (3.5m/s)	2.37 °C/W
800 ft./min. (4.0m/s)	2.19 °C/W



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Example:

What is the minimum airflow necessary for a CHB150W8-36S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 40°C?

Solution:

Given: $V_{in}=36V_{dc}$, $V_o=12V_{dc}$, $I_o=12.5A$

Determine Power dissipation (P_d): $P_d=P_i-P_o=P_o(1-\eta)/\eta$, $P_d=12 \times 12.5 \times (1-0.895)/0.895=17.60\text{Watts}$

Determine airflow: Given: $P_d=17.60W$ and $T_a=40^\circ C$

Check Power Derating curve: Minimum airflow=500 ft./min.

Verify:

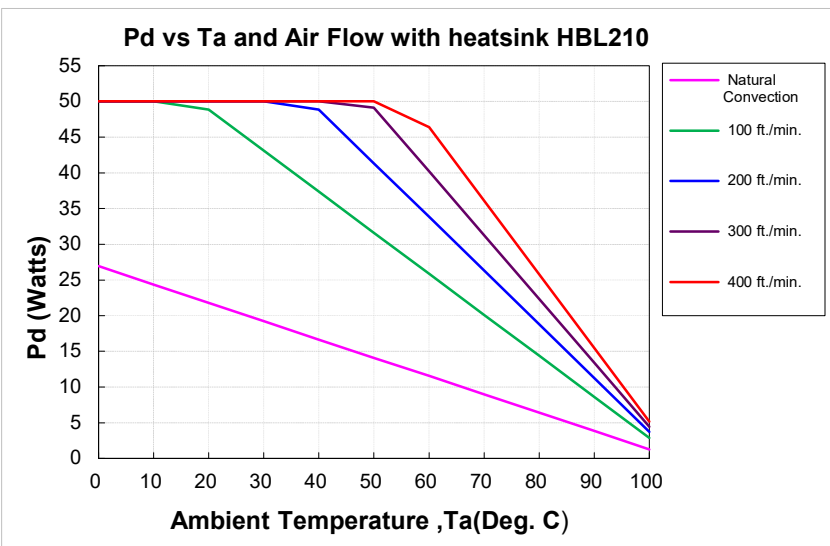
Maximum temperature rise is $\Delta T=P_d \times R_{ca}=17.60 \times 2.96=52.1^\circ C$

Maximum case temperature is $T_c=T_a+\Delta T=92.1^\circ C < 100^\circ C$

Where:

The R_{ca} is thermal resistance from case to ambient environment.

T_a is ambient temperature and T_c is case temperature.



AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	3.9 °C/W
100 ft./min. (0.5m/s)	1.74 °C/W
200 ft./min. (1.0m/s)	1.33 °C/W
300 ft./min. (1.5m/s)	1.12 °C/W
400 ft./min. (2.0m/s)	0.97 °C/W

Example with heat sink HBL210 (M-C308):

What is the minimum airflow necessary for a CHB150W8-36S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 40°C?

Solution:

Given: $V_{in}=36V_{dc}$, $V_o=12V_{dc}$, $I_o=12.5A$

Determine Power dissipation (P_d): $P_d=P_i-P_o=P_o(1-\eta)/\eta$, $P_d=12 \times 12.5 \times (1-0.895)/0.895=17.60\text{Watts}$

Determine airflow: Given: $P_d=17.60W$ and $T_a=40^\circ C$

Check above Power de-rating curve: Minimum airflow=100 ft./min

Verify:

Maximum temperature rise is $\Delta T=P_d \times R_{ca}=17.60 \times 1.74=30.6^\circ C$

Maximum case temperature is $T_c=T_a+\Delta T=70.6^\circ C < 100^\circ C$

Where:

The R_{ca} is thermal resistance from case to ambient environment.

T_a is ambient temperature and T_c is case temperature.



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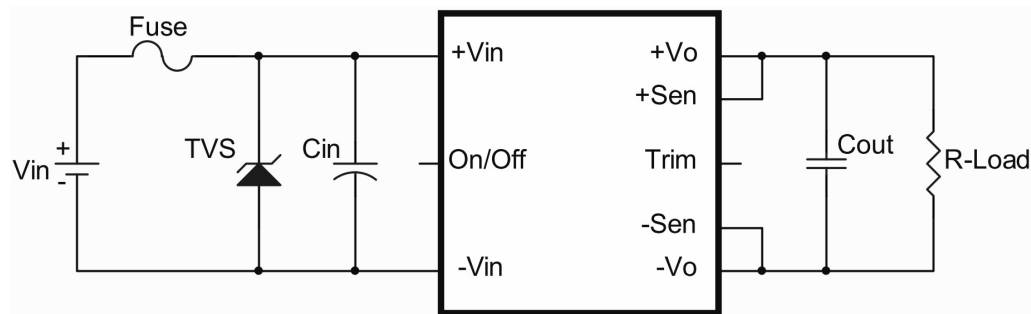
9.5 Half Brick Heat Sinks

Heat sinks assembly [refer to Datasheet-Thermal](#)

10. Safety & EMC

10.1 Input Fusing and Safety Considerations

The CHB150W8 series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 30A fast acting fuse for all models. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage (as shown).



The external input capacitor (C_{in}) and transient voltage suppressor diode (TVS) are required if CHB150W8 series has to meet EN 61000-4-4, EN 61000-4-5.

The C_{in} recommended a 220 μ F/100V (NICHICON PW series) aluminum capacitor. And the TVS recommended a SMDJ78A transient voltage suppressor.

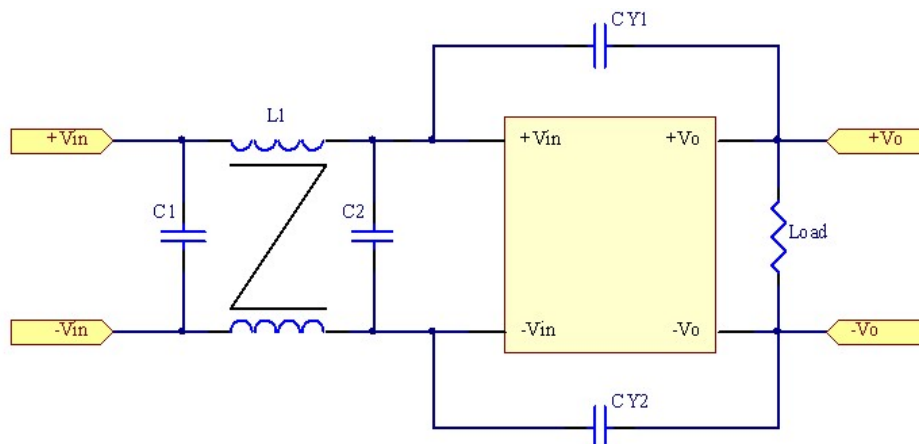
The output terminal of 24, 28, 48Vout models required a minimum capacitor 100 μ F to maintain specified regulation

10.2 EMC Considerations

EMI Test standard: EN 55032 Class A Conducted Emission

Test Condition: Input Voltage: Nominal, Output Load: Full Load

(1) EMI and conducted noise meet EN 55032 Class A:



Connection circuit for conducted EMI Class A testing



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Model No.	C1	C2	CY1	CY2	L1
CHB150W8-36S12	220uF/100V	220uF/100V	1500pF	1500pF	0.2mH
CHB150W8-36S15	220uF/100V	220uF/100V	1500pF	1500pF	0.2mH
CHB150W8-36S24	220uF/100V	220uF/100V	1500pF	1500pF	0.2mH
CHB150W8-36S28	220uF/100V	220uF/100V	1500pF	1500pF	0.2mH
CHB150W8-36S48	220uF/100V	220uF/100V	1500pF	1500pF	0.2mH

Note:

C1, C2 NICHICON PW series aluminum capacitors

CY1, CY2 is ceramic capacitors

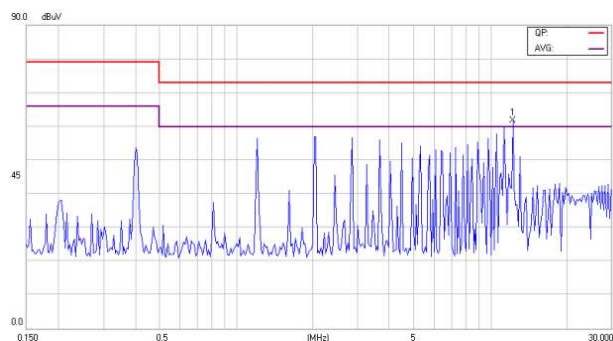
L1 Core use SM CM20*12*10 Winding 5turns (double wire)



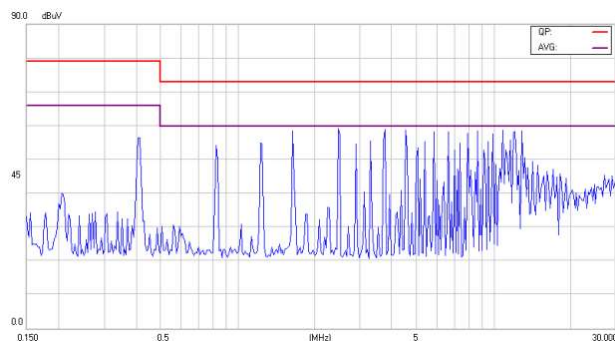
CHB150W8 Series Application Note V15

Conducted A:

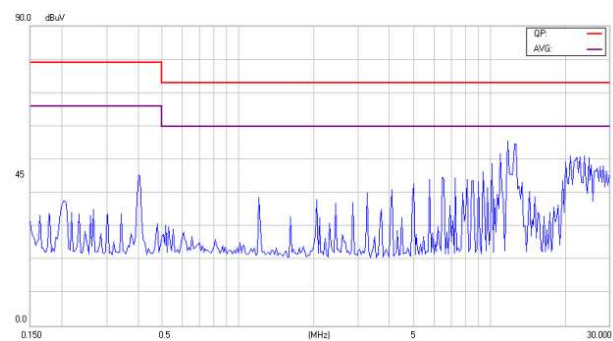
CHB150W8-36S12



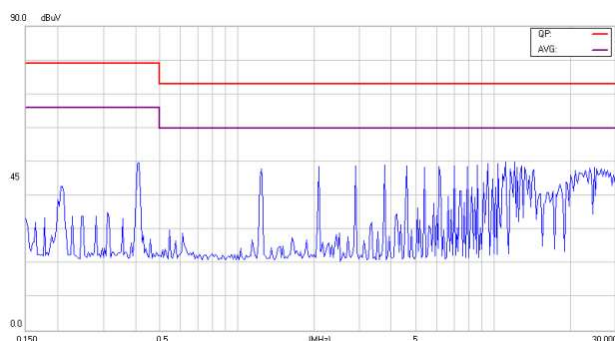
CHB150W8-36S15



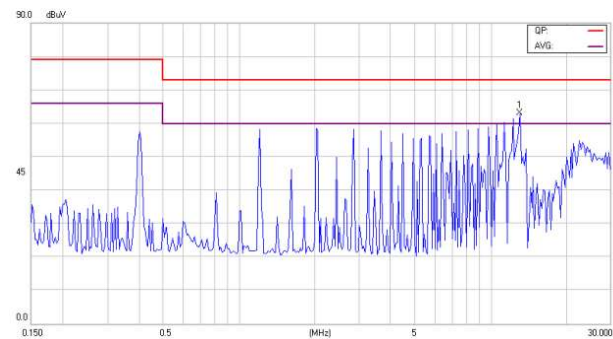
CHB150W8-36S24



CHB150W8-36S28



CHB150W8-36S48



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