



CHB500W-24SXX Series Application Note V10

ISOLATED DC-DC CONVERTER CHB500W-24SXX SERIES APPLICATION NOTE



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CHB500W-24SXX Series

Application Note V10

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1. Introduction

The CHB500W-24SXX series of DC-DC converters offers 500 watts of output power @ single output voltages of 12, 24, 28, 48, 54VDC with industry standard half-brick. It has a 4:1 input voltage range of 9 to 40VDC (24VDC nominal) and 3000VDC Basic isolation.

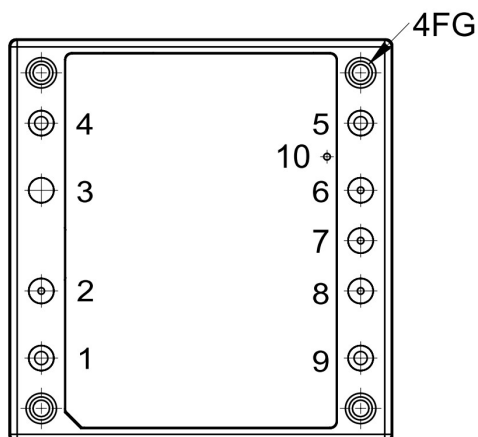
Compliant with EN 55032/EN 55035. High efficiency up to 91.5%, allowing case operating temperature range of -40°C to 105°C. An optional heat sink is available to extend the full power range of the unit.

The standard control functions include remote **on/off** (positive or negative) and +15% to -20% (except for 54Vout +10% to -20%) 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.

CHB500W-24SXX series is designed primarily for common applications of 12V, 24V nominal voltage and also suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. Pin Function Description



| No | Label | Function | Description | Reference |
|----|--------|------------------|------------------------------------|-------------------------|
| 1 | +Vin | +V Input | Positive Supply Input | Section 7.1/7.2 |
| 2 | ON/OFF | On/Off | External Remote On/Off Control | Section 6.5 |
| 3 | NP | No Pin | | |
| 4 | -Vin | -V Input | Negative Supply Input | Section 7.1/7.2 |
| 5 | -Vo | -V Output | Negative Power Output | Section 7.3/7.4 |
| 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 7.3/7.4 |
| 10 | PC | Parallel Control | Singal Wire Parallel Control | Section 8.2 |
| | -- | Mounting Insert | Mounting Insert (FG) | Section 9.5/10.2 |

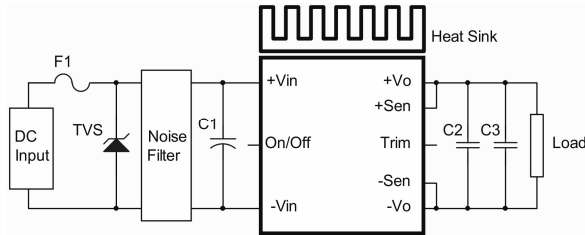
Note: Base plate can be connected to FG through M3 threaded mounting insert. Recommended torque 4~8Kgf-cm.



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3. Connection for Standard Use

The connection for standard use is shown below. An external input capacitor (C1) 2200uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 10uF polymer tantalum and 1uF ceramic capacitors for all models.



| Symbol | Component | Reference |
|---------------|---------------------------------------|-------------------------|
| F1, TVS | Input fuse, TVS | Section 10.1 |
| C1 | External capacitor on the input side | Note Section 7.2 |
| C2, C3 | External capacitor on the output side | Section 7.3/7.4 |
| 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 capacitors 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:

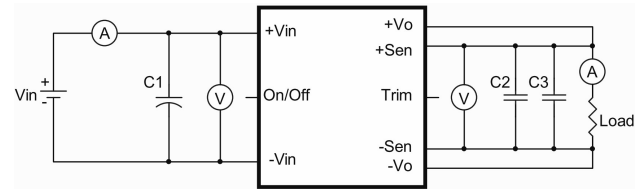
V_{FL} is the output voltage at full load
 V_{NL} is the output voltage at no load

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 80% full load.



CHB500W-24SXX Series Test Setup

C1: 2200uF/63V ESR<0.056Ω

C2: 1uF/1210 ceramic capacitor

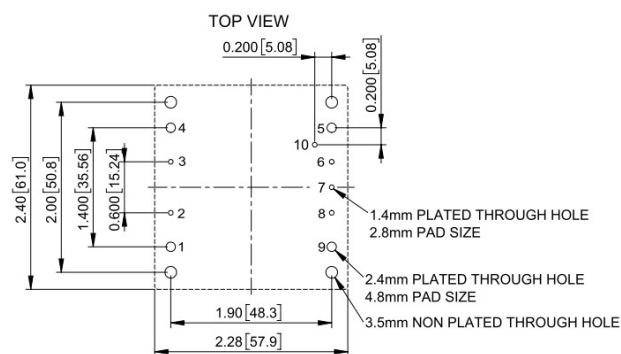
C3: 10uF polymer tantalum capacitor (ESR ≤ 0.05Ω)



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5. Recommend Layout, PCB Footprint and Soldering Information

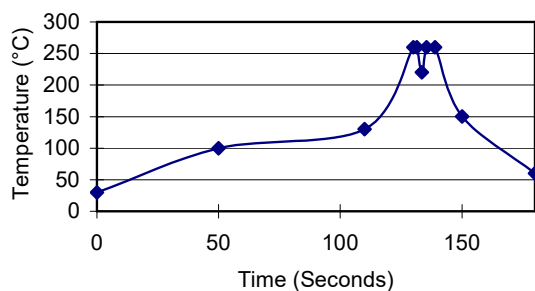
The system designer or end user must ensure that metal and other components in the vicinity of the converter meet the spacing requirements for which the system is approved. Low resistance and inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds.



Clean the soldered side of the module with a brush, prevent liquid from getting into the module. Do not clean by soaking the module into liquid. Do not allow solvent to come in contact with product labels or resin case as this may changed the color of the resin case or cause deletion of the letters printed on the product label. After cleaning, dry the modules well.

The suggested soldering iron is 450°C for up to 5 seconds (less than 50W). Furthermore, the recommended soldering profile is shown below, and PCB layout is referring to **Section 10.2**.

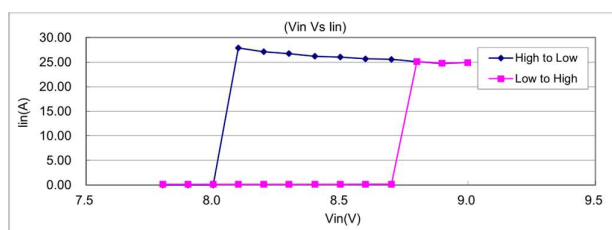
Lead Free Wave Soldering Profile



6. Features and Functions

6.1 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the CHB500W-24SXX series unit. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.



Note:

If need to configure UVLO turn off threshold to 8Vdc, please make sure the output power is no more than 80% full load, even though the 9V operating is short duration.

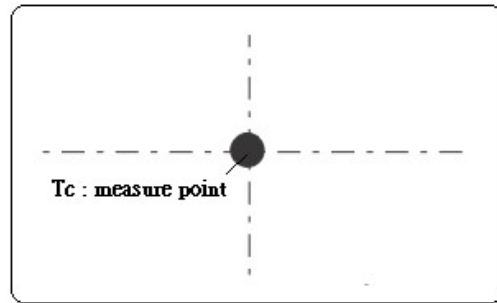
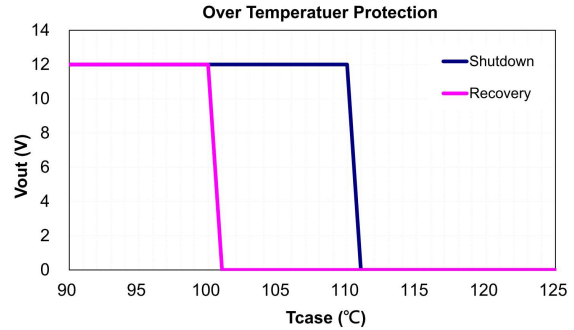
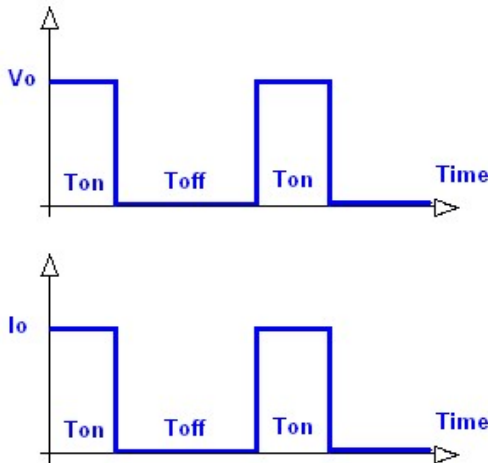
And the module operating between input 9Vdc to 12Vdc, please make sure the output power is no more than 80% full load.



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6.2 Over Current/Short Circuit Protection

All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into hiccup mode protection.



6.3 Output Over Voltage Protection

The output over voltage protection consists of circuitry that internally limits the output voltage. If more accurate output over voltage protection is required, then an external circuit can be used via the remote **on/off** pin.

Note:

Please note that device inside the power supply might fail when voltage more than rated 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 CHB500W-24SXX series allows the user to switch the module on and off electronically with the remote **on/off** feature. All models are available in "positive logic" and "negative logic" (optional) versions. The converter turns on if the remote **on/off** pin is high (>3.5Vdc to 65Vdc or open circuit). Setting the pin low (0 to <1.2Vdc) will turn the converter off. The signal level of the remote **on/off** input is defined with respect to ground.

If not using the remote **on/off** pin, leave the pin open (converter will be on).

Models with part number suffix "N" are the "negative logic" remote **on/off** version. The unit turns off if the remote **on/off** pin is high (>3.5Vdc to 65Vdc or open circuit). The converter turns on if the **on/off** pin input is low (0 to <1.2Vdc). Note that the converter is off by default.

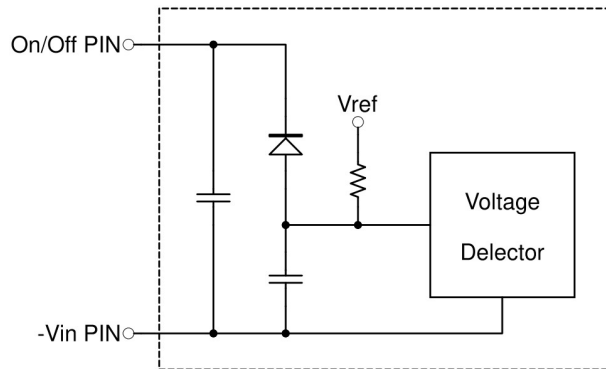
| Logic State (Pin 2) | Negative Logic | Positive Logic |
|---------------------|----------------|----------------|
| Logic Low | Module on | Module off |
| Logic High | Module off | Module on |



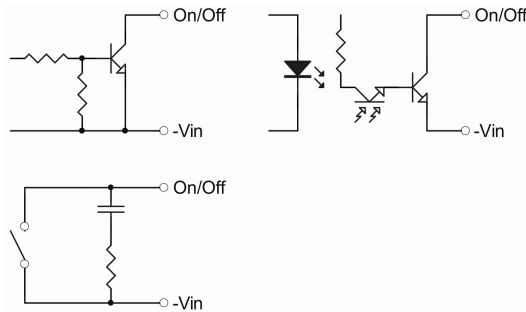
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The converter remote **on/off** circuit built-in on input side. The ground pin of input side remote **on/off** circuit is -Vin pin. Inside connection sees below.



Connection examples see below.



Remote On/Off Connection Example

6.6 Output Remote Sensing

The CHB500W-24SXX 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 CHB500W-24SXX 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:

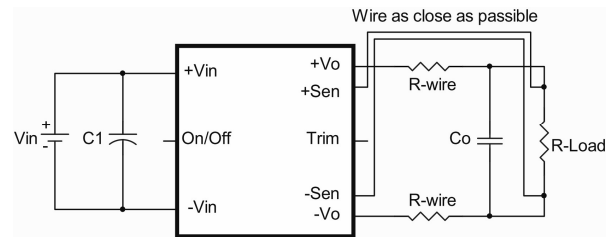
For Vo=54V

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

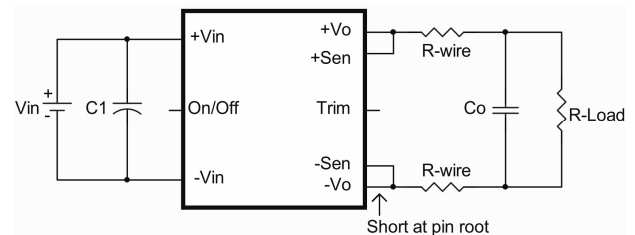
For Others

$$[(+V_{out}) - (-V_{out})] - [(+Sense) - (-Sense)] \leq 15\% \text{ of } V_{o_nominal}$$

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 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 +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module. Wire between +Sense and +Vout and between -Sense and -Vout 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.

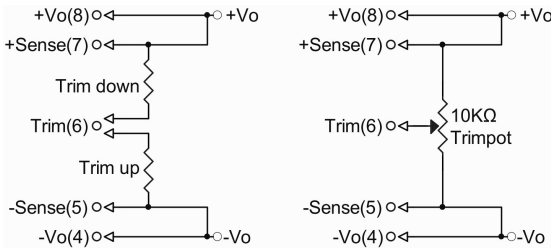


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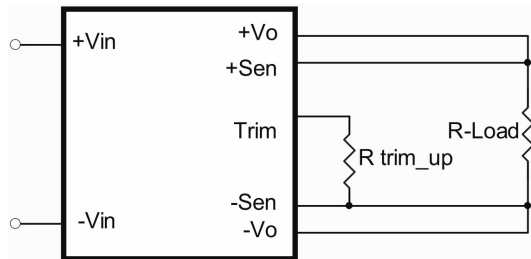
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6.7 Output Voltage Adjustment

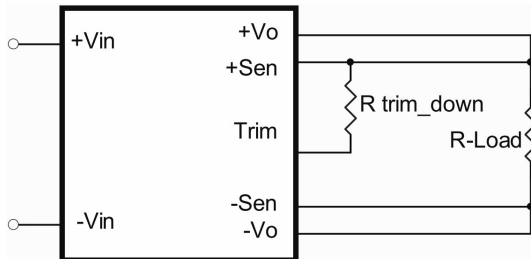
Output may be externally trimmed (+15% to -20%, except 54Vout is +10% to -20%) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.



In order to trim the voltage up or down, one needs to connect the trim resistor either between the trim pin and -Sense for trim-up or between trim pin and +Sense for trim-down. The output voltage trim range is +15% to -20%, except 54Vout, it is +10% to -20%. This is shown:



Trim-up Voltage Setup



Trim-down Voltage Setup

The value of R_{trim_up} defined as:

$$R_{trim_up} = \left[\frac{V_r \times R1 \times (R2 + R3)}{R2 \times (V_o - V_{o,nom})} \right] - R_t \text{ (K}\Omega\text{)}$$

Where:

R_{trim_up} is the external resistor in K Ω

$V_{o,nom}$ is the nominal output voltage

V_o is the desired output voltage

$R1$, $R2$, $R3$, R_t and V_r are internal to the unit and are defined in Table 1

Table 1 – Trim up and Trim down Resistor Values

| Model Number | Output Voltage (V) | R1 (K Ω) | R2 (K Ω) | R3 (K Ω) | Rt (K Ω) | Vr (V) |
|---------------|--------------------|------------------|------------------|------------------|------------------|--------|
| CHB500W-24S12 | 12.0 | 6.8 | 2.37 | 2.2 | 10 | 2.5 |
| CHB500W-24S24 | 24.0 | 15 | 2.43 | 5.9 | 20 | 2.5 |
| CHB500W-24S28 | 28.0 | 15.4 | 2.49 | 10 | 23.2 | 2.5 |
| CHB500W-24S48 | 48.0 | 28.7 | 2.4 | 15 | 43.2 | 2.5 |
| CHB500W-24S54 | 54.0 | 36 | 2.43 | 14 | 51 | 2.5 |

For example, to trim-up the output voltage of 12V module (CHB500W-24S12) by 15% to 13.8V, R_{trim_up} is calculated as follows:

$R1=6.8K\Omega$, $R2=2.37K\Omega$, $R3=2.2K\Omega$, $R_t=10K\Omega$, $V_r=2.5V$, $V_o=13.8V$, $V_{o,nom}=12V$

$$R_{trim_up} =$$

$$\left[\frac{2.5 \times 6.8 \times (2.37 + 2.2)}{2.37 \times (13.8 - 12)} \right] - 10 = 8.2 \text{ (K}\Omega\text{)}$$

The typical value of R_{trim_up}

| Trim up (%) | 12V | 24V | 28V | 48V | 54V |
|-------------|------------------------------|--------|--------|--------|--------|
| | R_{trim_up} (K Ω) | | | | |
| 1% | 263.17 | 515.62 | 666.51 | 1040.5 | 1075 |
| 2% | 126.59 | 247.81 | 321.65 | 498.72 | 512.44 |
| 3% | 81.06 | 158.54 | 206.70 | 318.04 | 324.63 |
| 4% | 58.29 | 113.91 | 149.23 | 227.73 | 230.72 |
| 5% | 44.63 | 87.12 | 114.74 | 173.54 | 174.38 |
| 6% | 35.53 | 69.27 | 91.75 | 137.42 | 136.81 |
| 7% | 29.02 | 56.52 | 75.33 | 111.62 | 109.98 |
| 8% | 24.15 | 46.95 | 63.01 | 92.27 | 89.86 |
| 9% | 20.35 | 39.51 | 53.43 | 77.21 | 74.21 |
| 10% | 17.32 | 33.56 | 45.77 | 65.17 | 61.69 |
| 11% | 14.83 | 28.69 | 39.50 | 55.32 | |
| 12% | 12.76 | 24.64 | 34.28 | 47.11 | |
| 13% | 11.01 | 21.20 | 29.85 | 40.16 | |
| 14% | 9.51 | 18.26 | 26.06 | 34.21 | |
| 15% | 8.21 | 15.71 | 22.78 | 29.05 | |

CHB500W-24SXX series has Trim up Derating by Input Voltage is required shown below.



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The value of R_{trim_down} defined as:

$$R_{trim_down} = R1 \times \left[\frac{V_r \times R1}{R2 \times (V_{o,nom} - V_o)} - 1 \right] - R_t (K\Omega)$$

Where:

R_{trim_down} is the external resistor in K Ω
 $V_{o,nom}$ is the nominal output voltage
 V_o is the desired output voltage
 $R1, R2, R3, R_t$ and V_r are internal to the unit and are defined in Table 1

For example: to trim-down the output voltage of 12V module (CHB500W-24S12) by 20% to 9.6V, R_{trim_down} is calculated as follows:

$R1=6.8K\Omega, R2=2.37K\Omega, R3=2.2K\Omega, R_t=10K\Omega, V_r=2.5V, V_o=9.6V, V_{o,nom}=12V$

$$R_{trim_down} = 6.8 \times \left[\frac{2.5 \times 6.8}{2.37 \times (12 - 9.6)} - 1 \right] - 10 = 3.52 (K\Omega)$$

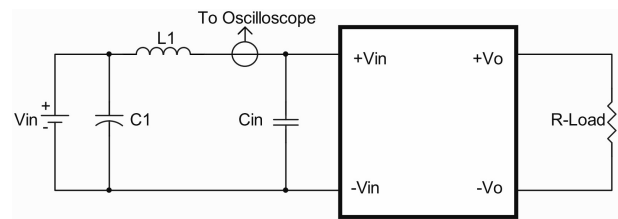
The typical value of R_{trim_down}

| Trim down (%) | 12V | 24V | 28V | 48V | 54V |
|---------------|----------------------------|--------|--------|--------|--------|
| | $R_{trim_down} (K\Omega)$ | | | | |
| 1% | 389.67 | 929.51 | 811.80 | 1715.6 | 2382.1 |
| 2% | 186.43 | 447.25 | 386.60 | 821.86 | 1147.5 |
| 3% | 118.69 | 286.50 | 244.87 | 523.94 | 736.05 |
| 4% | 84.82 | 206.13 | 174.00 | 374.98 | 530.28 |
| 5% | 64.49 | 157.90 | 131.48 | 285.60 | 406.83 |
| 6% | 50.94 | 125.75 | 103.13 | 226.02 | 324.52 |
| 7% | 41.27 | 102.79 | 82.89 | 183.46 | 265.73 |
| 8% | 34.01 | 85.56 | 67.70 | 151.54 | 221.64 |
| 9% | 28.36 | 72.17 | 55.89 | 126.71 | 187.35 |
| 10% | 23.85 | 61.45 | 46.44 | 106.85 | 159.91 |
| 11% | 20.15 | 52.68 | 38.71 | 90.60 | 137.47 |
| 12% | 17.07 | 45.38 | 32.27 | 77.06 | 118.76 |
| 13% | 14.47 | 39.19 | 26.82 | 65.60 | 102.93 |
| 14% | 12.23 | 33.89 | 22.14 | 55.78 | 89.37 |
| 15% | 10.30 | 29.30 | 18.09 | 47.27 | 77.61 |
| 16% | 8.60 | 25.28 | 14.55 | 39.82 | 67.32 |
| 17% | 7.11 | 21.74 | 11.42 | 33.25 | 58.24 |
| 18% | 5.78 | 18.58 | 8.64 | 27.41 | 50.17 |
| 19% | 4.59 | 15.76 | 6.16 | 22.18 | 42.95 |
| 20% | 3.52 | 13.23 | 3.92 | 17.48 | 36.46 |

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. $C1$ and $L1$ simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance ($L1$).

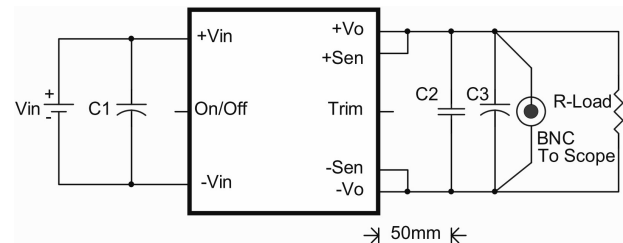


$L1: 3\mu H$

$C1: 1000\mu F/100V$ (KMG) aluminum capacitor and $470\mu F/63V$ polymer capacitor connect in parallel

$C_{in}: 1000\mu F/100V$ (KMG) aluminum capacitor and $470\mu F/63V$ polymer capacitor connect in parallel

7.2 Output Ripple and Noise



$C1: 2200\mu F/63V$ ESR<0.056 Ω

$C2: 1\mu F/1210$ ceramic capacitor

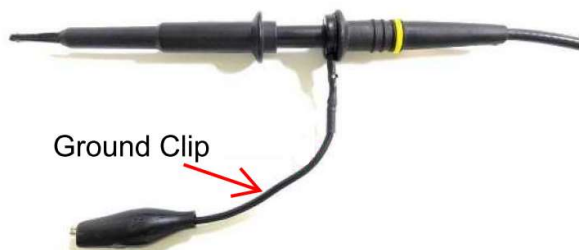
$C3: 10\mu F$ polymer tantalum capacitor (ESR $\leq 0.05\Omega$)

Output ripple and noise measured with $10\mu F$ polymer tantalum capacitor and $1\mu F$ ceramic capacitors across output. A 20 MHz bandwidth oscilloscope is normally used for the measurement.

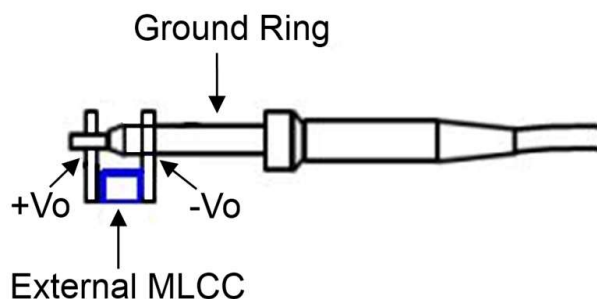
The conventional ground clip on an oscilloscope probe should never be used in this kind of measurement. This clip, when placed in a field of radiated high frequency energy, acts as an antenna or inductive pickup loop, creating an extraneous voltage that is not part of the output noise of the converter.



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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.



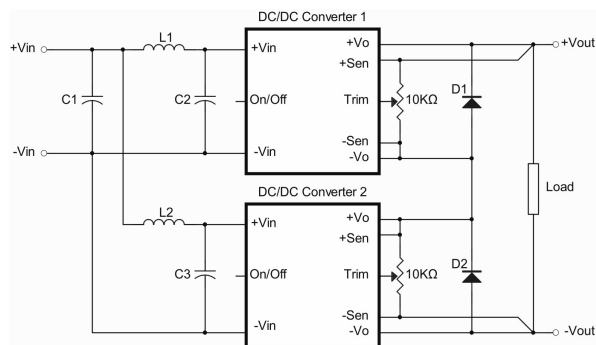
7.3 Output Capacitance

The CHB500W-24SXX 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.

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: 2200uF/63V ESR<0.056Ω

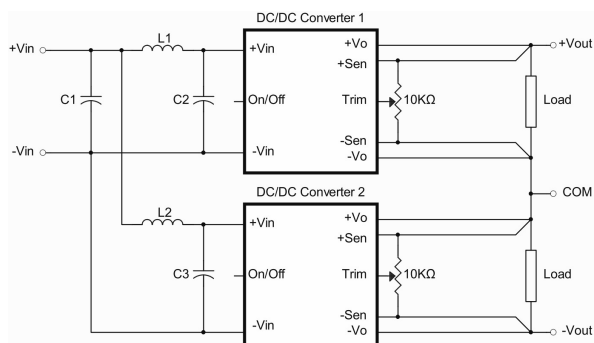
Note:

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.



CHB500W-24SXX Series Application Note V10

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: 2200uF/63V ESR<0.05Ω

Note:

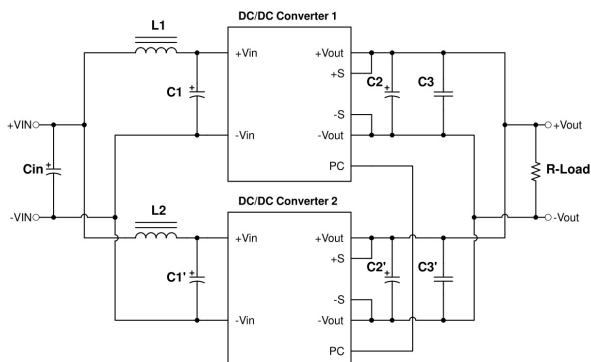
If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20°C.

8.2 Parallel Operation

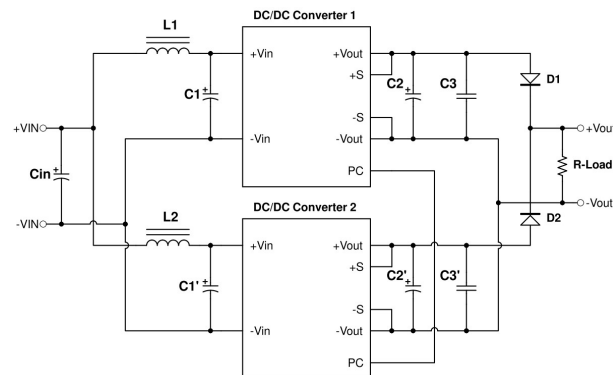
The CHB500W-24SXX-PC series are also designed for parallel operation. When paralleled, the load current can be equally shared between the modules by connecting the PC pins together.

There are two different parallel operations for CHB500W-24SXX-PC series, one is parallel operation when load can't be supplied by only one power unit; the other is the N+1 redundant operation which is high reliable for load of N units by using N+1 units.

(a) parallel operation



(b) N+1 redundant connection



L1, L2: 1.0uH

Cin, C1, C1': 2200uF/63V ESR<0.056Ω

C2, C2': 1000uF/63V

C3, C3': 1uF MLCC

Note:

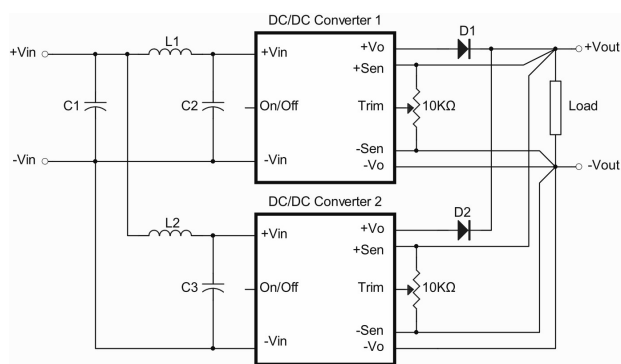
If the impedance of input line is high, Cin, C1 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20°C.



CHB500W-24SXX Series Application Note V10

8.3 Redundant Operation

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 rated current. Suggest use an external potentiometer to adjust output voltage from each power supply.



Simple Redundant Operation Connect Circuit

L1, L2: 1.0uH

C1, C2, C3: 2200uF/63V ESR<0.056Ω

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.



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9. Thermal Design

9.1 Operating Temperature Range

The CHB500W-24SXX series converters can be operated within a wide case temperature range of -40°C to 105°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 quarter 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 quarter 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 105°C as measured at the center of the top of the case (thus verifying proper cooling).

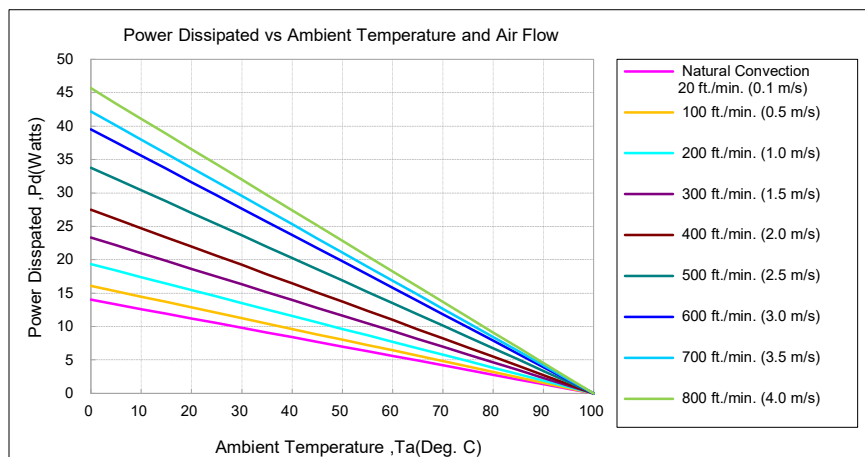
9.3 Thermal Considerations

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 CHB500W-24SXX series is -40°C to +105°C. When operating the CHB500W-24SXX series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 105°C.

The following curve is the de-rating curve of CHB500W-24SXX series without heat sink.



| AIR FLOW RATE | TYPICAL R_{ca} |
|---|------------------|
| 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 |



CHB500W-24SXX Series

Application Note V10

Example:

What is the minimum airflow necessary for a CHB500W-24S24 operating at nominal line voltage, an 70% load output current of 14.6A, and a maximum ambient temperature of 25°C?

Solution:

Given: $V_{in}=24V_{dc}$, $V_o=24V_{dc}$, $I_o=14.6A$

Determine power dissipation (P_d): $P_d = P_i - P_o = P_o(1-\eta)/\eta$, $P_d=24 \times 14.6 \times (1-0.91)/0.91=34.65Watts$

Determine airflow: Given: $P_d=34.65W$ and $T_a=25^\circ C$

Check power derating curve: Minimum airflow=800 ft./min.

Verify:

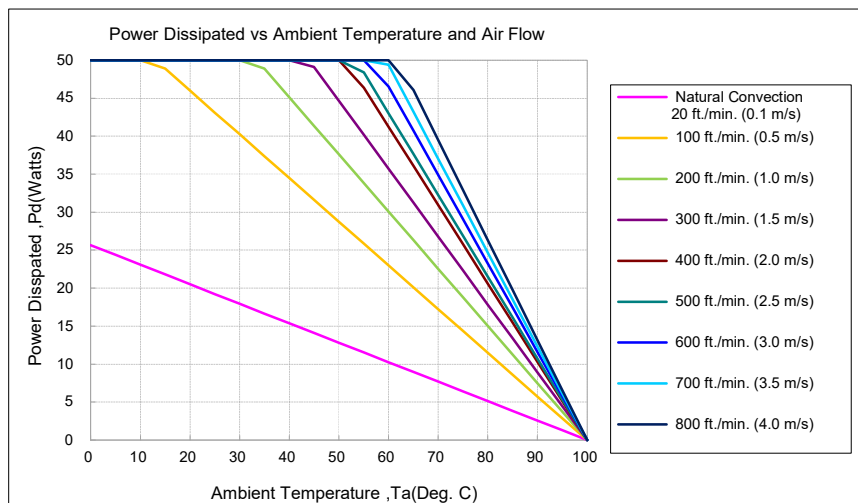
Maximum temperature rise is $\Delta T = P_d \times R_{ca} = 34.65 \times 2.19 = 75.88^\circ C$

Maximum case temperature is $T_c = T_a + \Delta T = 100.9^\circ C < 105^\circ C$

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 |
| 500 ft./min. (2.5m/s) | 0.92 °C/W |
| 600 ft./min. (3.0m/s) | 0.86 °C/W |
| 700 ft./min. (3.5m/s) | 0.81 °C/W |
| 800 ft./min. (4.0m/s) | 0.76 °C/W |

Example with heatsink HBL210 (M-C308):

What is the minimum airflow necessary for a CHB500W-24S24 operating at nominal line voltage, an output current of 21A, and a maximum ambient temperature of 50°C?

Solution:

Given: $V_{in}=24V_{dc}$, $V_o=24V_{dc}$, $I_o=21A$

Determine power dissipation (P_d): $P_d = P_i - P_o = P_o(1-\eta)/\eta$, $P_d=24 \times 21 \times (1-0.91)/0.91=49.85Watts$

Determine airflow: Given: $P_d=49.85W$ and $T_a=50^\circ C$

Check above power de-rating curve: Minimum airflow= 400 ft./min.

Verify:

Maximum temperature rise is $\Delta T = P_d \times R_{ca} = 49.85 \times 0.97 = 48.35^\circ C$

Maximum case temperature is $T_c = T_a + \Delta T = 98.35^\circ C < 105^\circ C$

Where:

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

T_a is ambient temperature and T_c is case temperature



CHB500W-24SXX Series Application Note V10

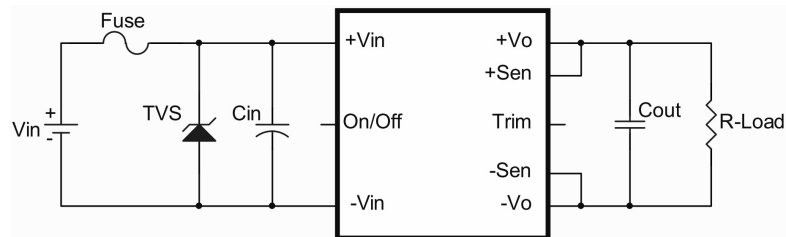
9.5 Half Brick Heat Sinks:

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

10. Safety & EMC

10.1 Input Fusing and Safety Considerations

The CHB500W-24SXX series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 80A time delay 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 (Cin) and transient voltage suppressor diode (TVS) are required if CHB500W-24SXX series has to meet EN 61000-4-4, EN 61000-4-5.

The Cin recommended a 3300uF/50V (Chemi-Con KMG series) aluminum capacitor. And the TVS recommended a SMDJ40A transient voltage suppressor.

10.2 EMC Considerations

EMI Test standard: EN 55032 Class A Conducted & Radiated Emission

Test Condition: Input Voltage: 24Vdc, Output Load: Full Load

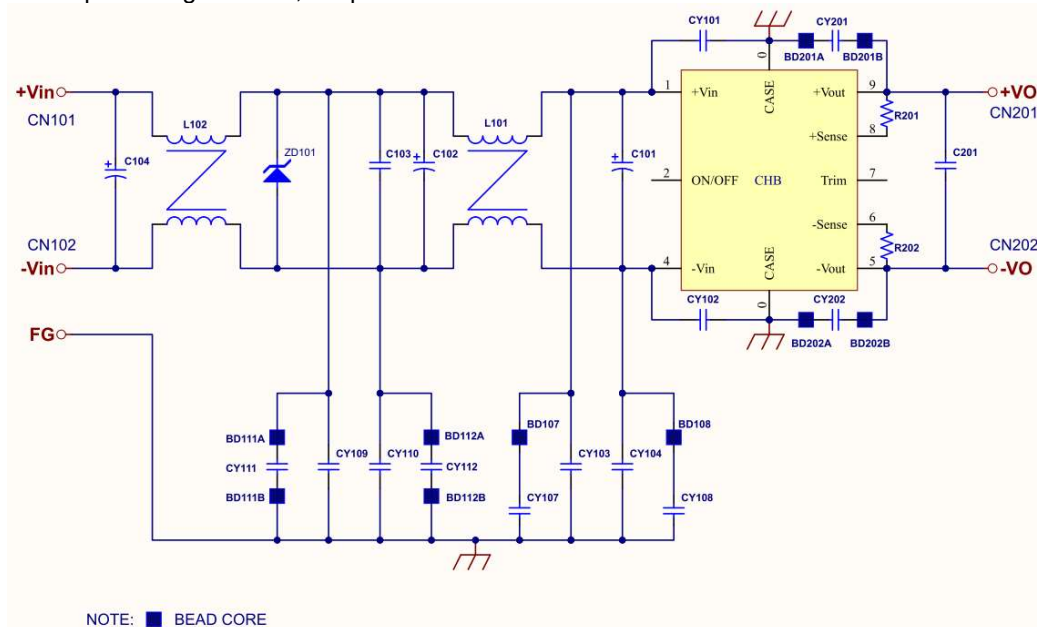


Figure1 Connection Circuit



CHB500W-24SXX Series Application Note V10

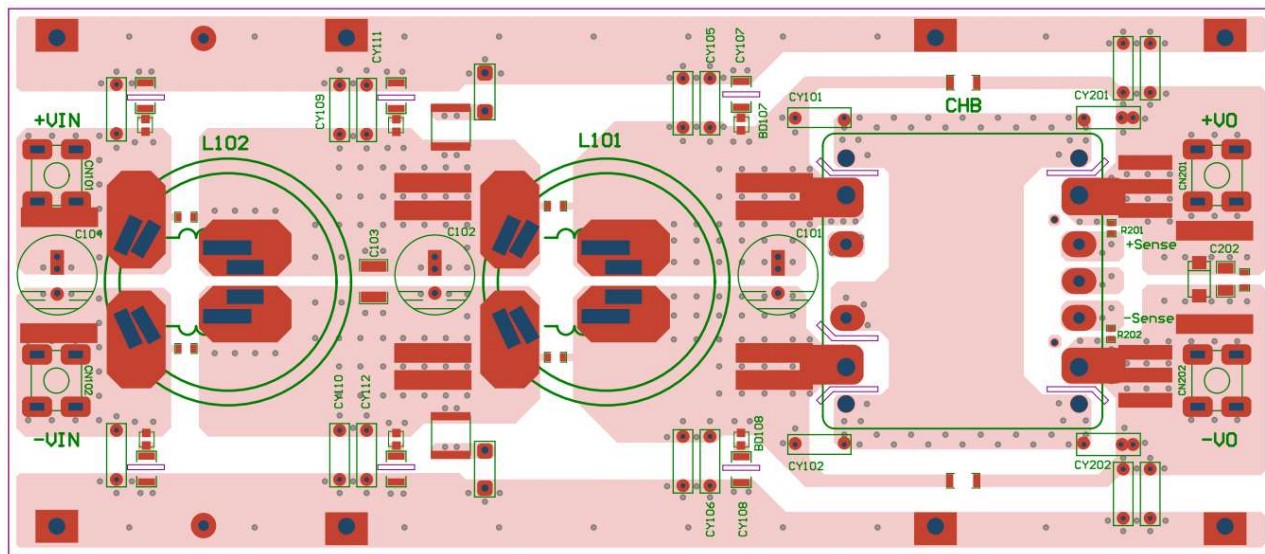


Figure2 PCB Layout Top View

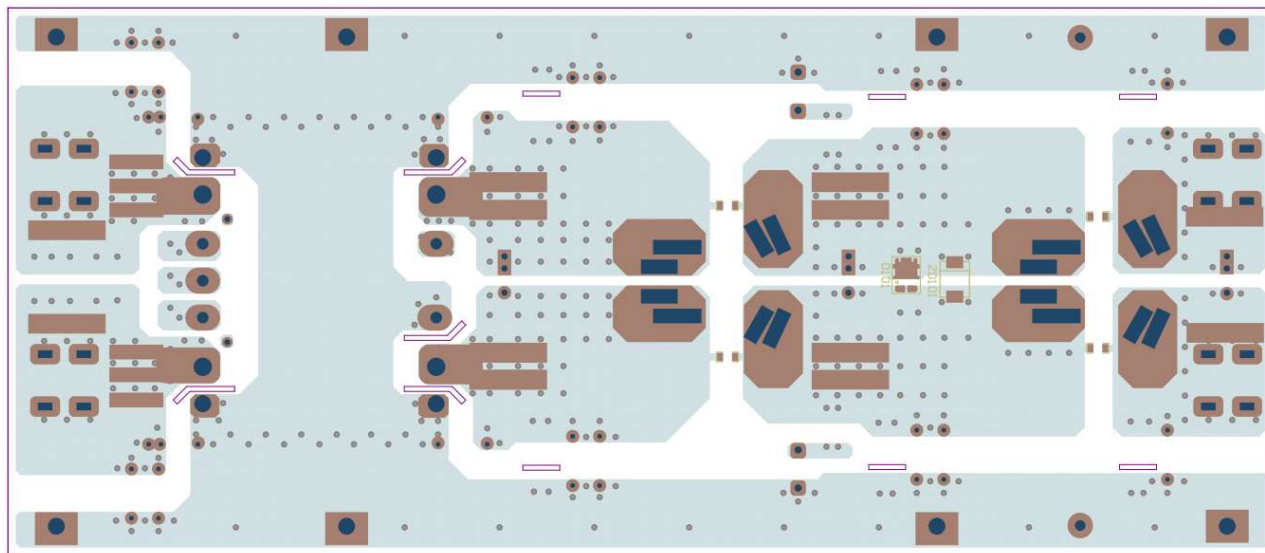


Figure3 PCB Layout Bottom View



CHB500W-24SXX Series Application Note V10

Components value:

| | Model Number | | | | |
|----------------------------------|---------------------|-------|-------------|-------------|-------|
| Model Name | 24S12 | 24S24 | 24S28 | 24S48 | 24S54 |
| C101, C102, C104 | 820uF/50V | | | | |
| C103 | 10uF/50V | | | | |
| C202 | 1uF/250V | | | | |
| CY111, CY112 | 2200pF/400V | | | 4700pF/250V | |
| CY101, C102, CY109, CY110 | 4700pF/250V | | | | |
| CY105, CY106 | NC | | 2200pF/400V | | |
| CY201, CY202 | 10000pF 250V | | | | |
| BD111A, BD111B BD112A, BD112B | BRH3.5*3.2*1.mm | | | NC | |
| BD107, BD108 | BPH 4030225-400T-G | | | | |
| BD201A, BD201B BD202A, BD202B | SN030 T28*1.7*1.2mm | | | | |
| CY107, CY108 | 2200pF/250VAC | | | | |
| R201, R202 | 0R 1% | | | | |
| ZD101 | SMDJ40A | | | | |
| L101, L102 | 1.58mH | | | | |
| CN202, CN203, CN204, CN205 | P-831N | | | | |

Note:

C101, C102, C104: NIPPON CHEMI-CON KY series aluminum capacitor or equivalent

C103: 2220 X7R ceramic

C202: 1812 X7R ceramic

CY101, CY102, CY105, CY106, CY109, CY110, CY111, CY112: TDK Y1 DIP capacitor or equivalent

CY201, CY202: TDK Y2 DIP capacitor or equivalent

CY107, CY108: Y2 CAP. SMD 2211 X7R.

BD111A, BD111B, BD112A, BD112B: BRH3.5*3.2*1.2mm CHILISIN

BD107, BD108: SMD bead core TAI-TECH or equivalent.

BD201A, BD201B, BD202A, BD202B: SN030 T2.8*1.7*1.2 SM

R201, R202: Chip resistor 0805.

ZD101: TVS SMD DO-214AB LITTLEFUSE.

L101, L102: T60405-R6123-X263 VAC or HF322010-371B204-PF SUNLEI or MP5093015-220204BFA-L4.5 GLOBAL MAGIC or equivalent.

CN202, CN203, CN204, CN205: P-831N DINKLE



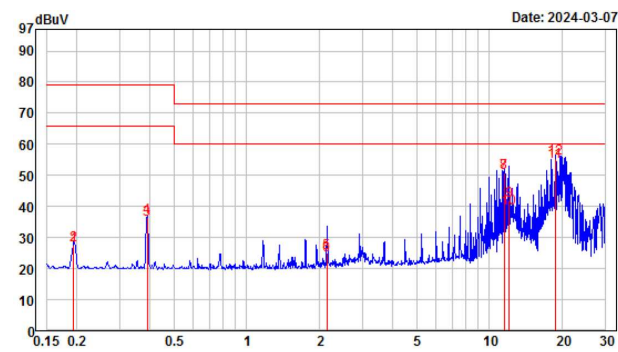
CHB500W-24SXX Series

Application Note V10

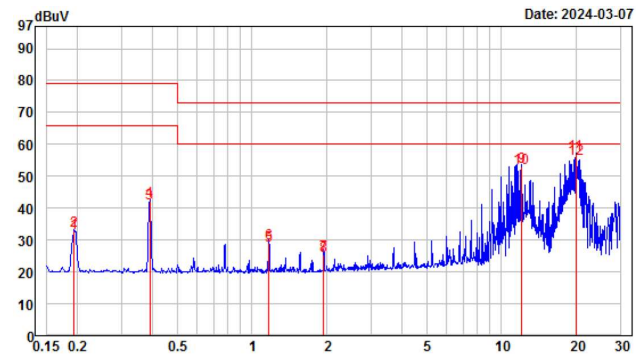
Conducted Emission:

CHB500W-24S12

Line

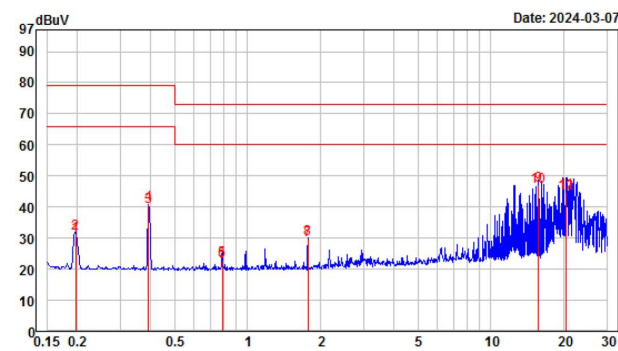


Neutral

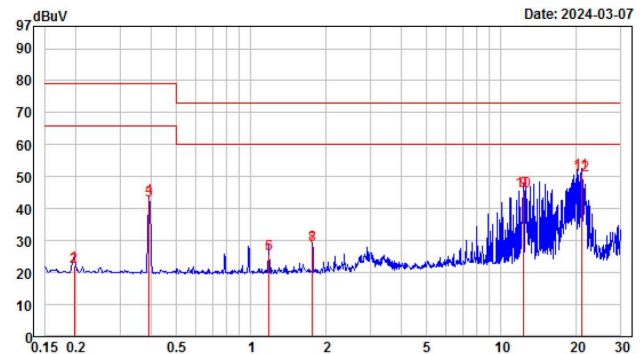


CHB500W-24S24

Line

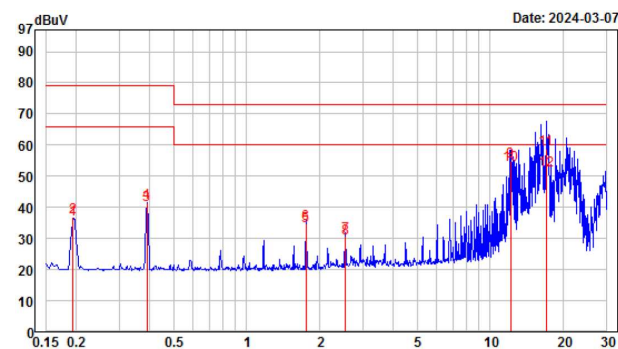


Neutral

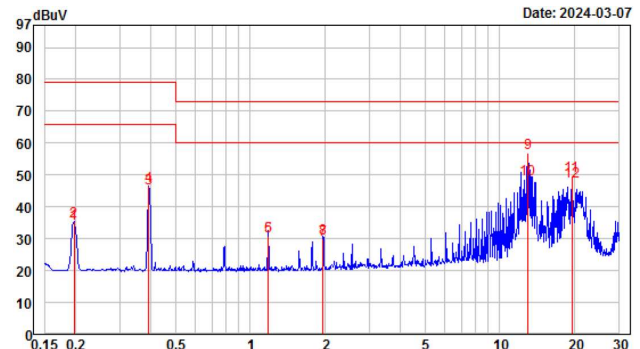


CHB500W-24S28

Line



Neutral



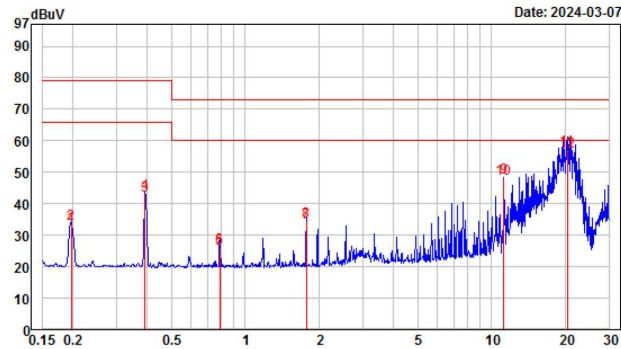


CHB500W-24SXX Series

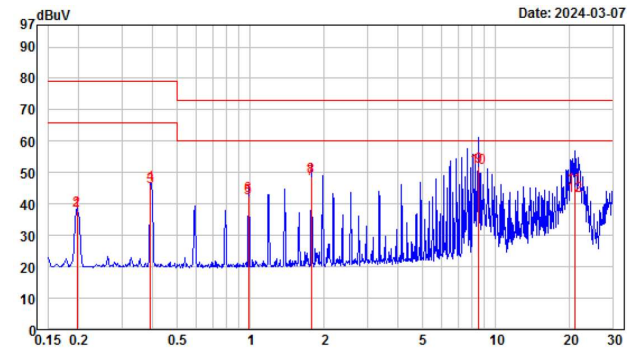
Application Note V10

CHB500W-24S48

Line

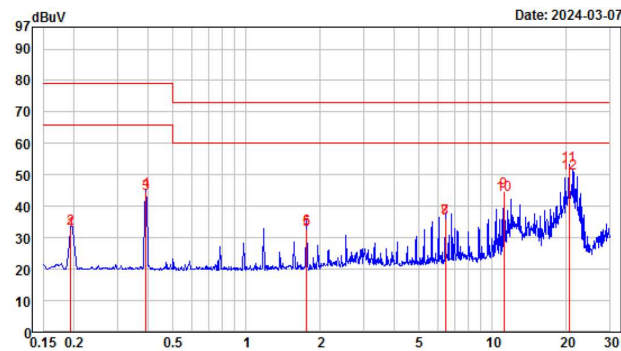


Neutral

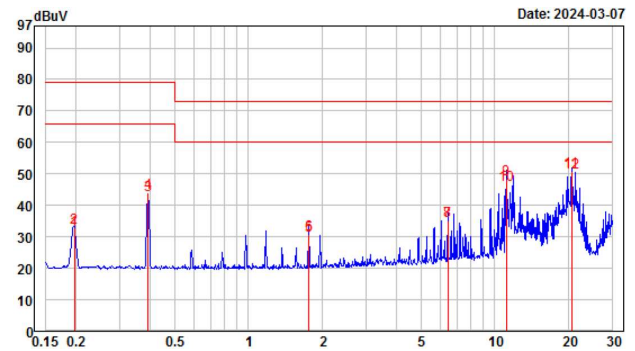


CHB500W-24S54

Line



Neutral





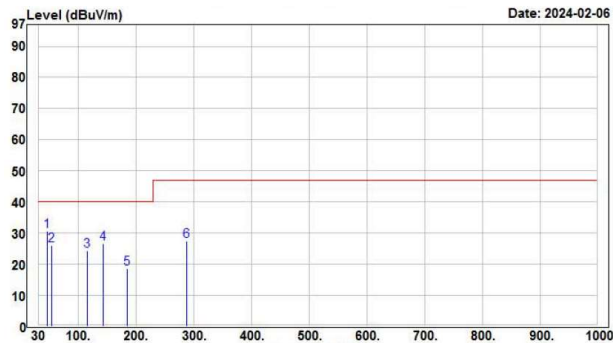
CHB500W-24SXX Series

Application Note V10

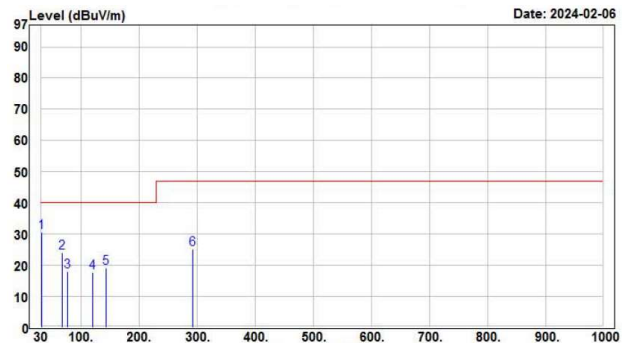
Radiated Emission:

CHB500W-24S12

Vertical

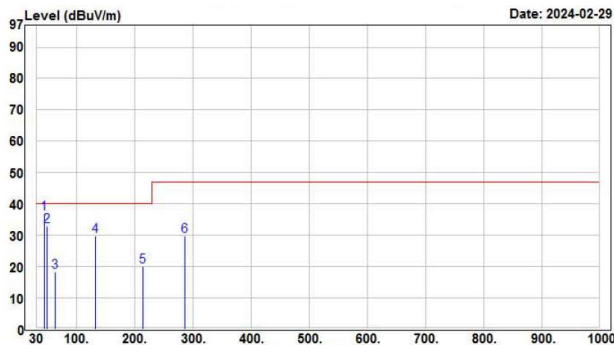


Horizontal

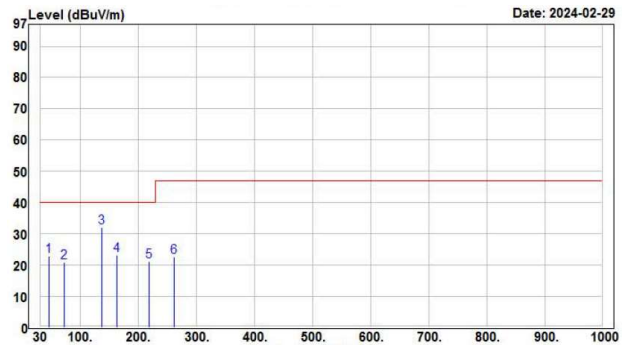


CHB500W-24S24

Vertical

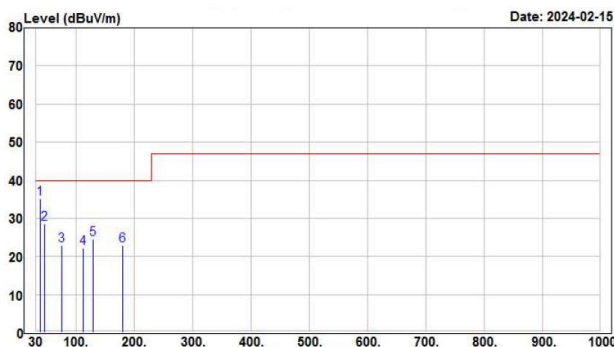


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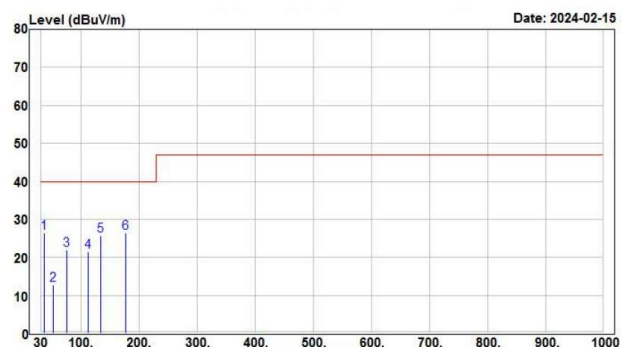


CHB500W-24S28

Vertical



Horizontal



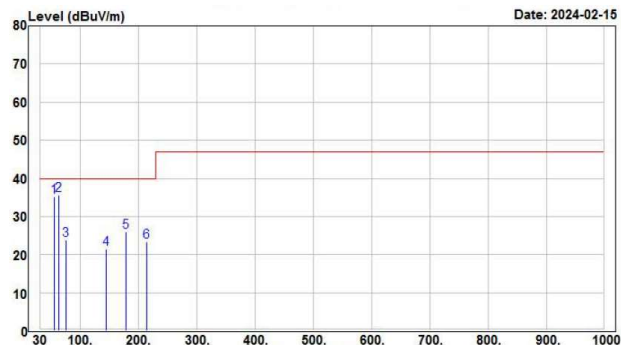


CHB500W-24SXX Series

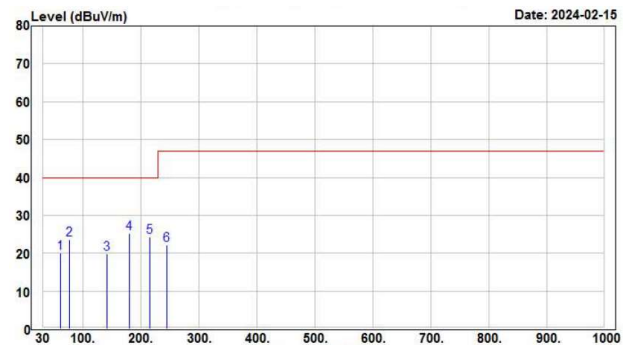
Application Note V10

CHB500W-24S48

Vertical

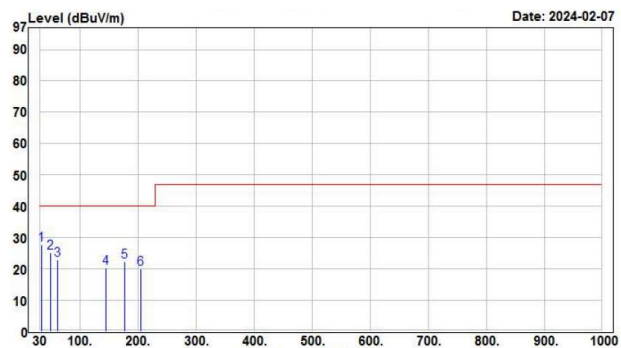


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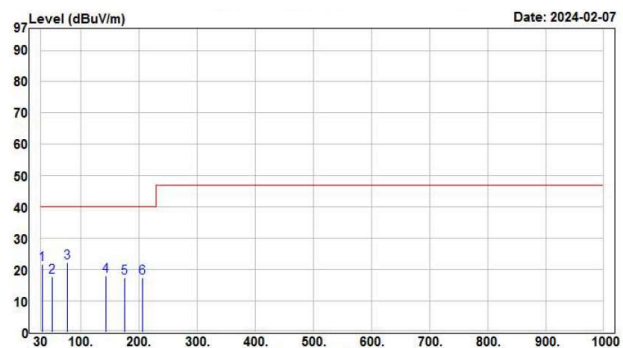


CHB500W-24S54

Vertical



Horizontal



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