POWERBOX Industrial Line
PHB300W Series
300W Single Output
DC/DC Converter
Manual V12

Table of Contents

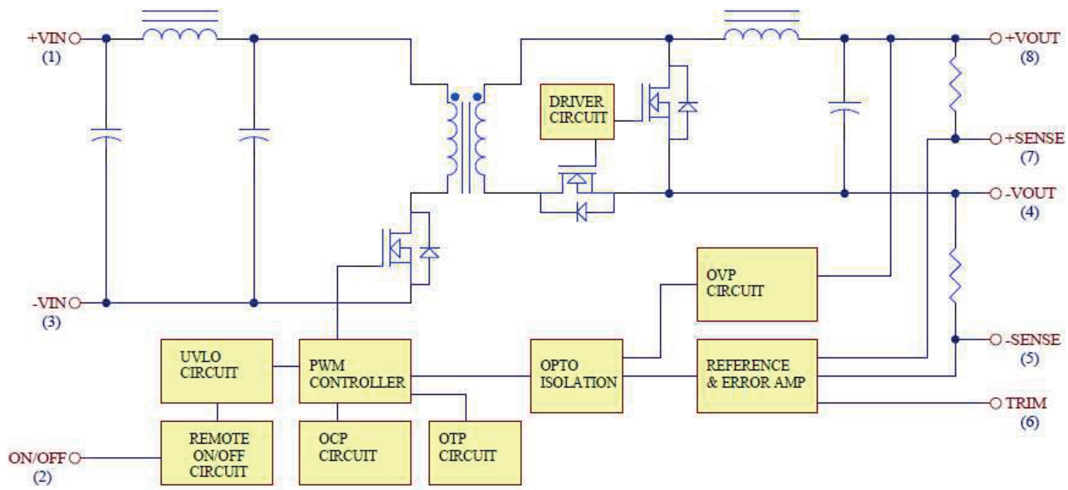
1. Introduction

This specification describes the features and functions of PHB300W series of isolated DC/DC converters. These are highly efficient, reliable and compact, high power density, single output DC/DC converters. The modules can be used in the field of telecommunications, data communications, wireless communications, servers etc. The PHB300W series can deliver up to 60A output current and provide a precisely regulated output voltage over a wide range of 9-36VDC and 18-75VDC. The modules can achieve high efficiency up to 92%. The module offers direct cooling of dissipative components for excellent thermal performance. Standard features include remote on/off(positive or negative), remote sense, output voltage adjustment, over voltage, over current and over temperature protection.

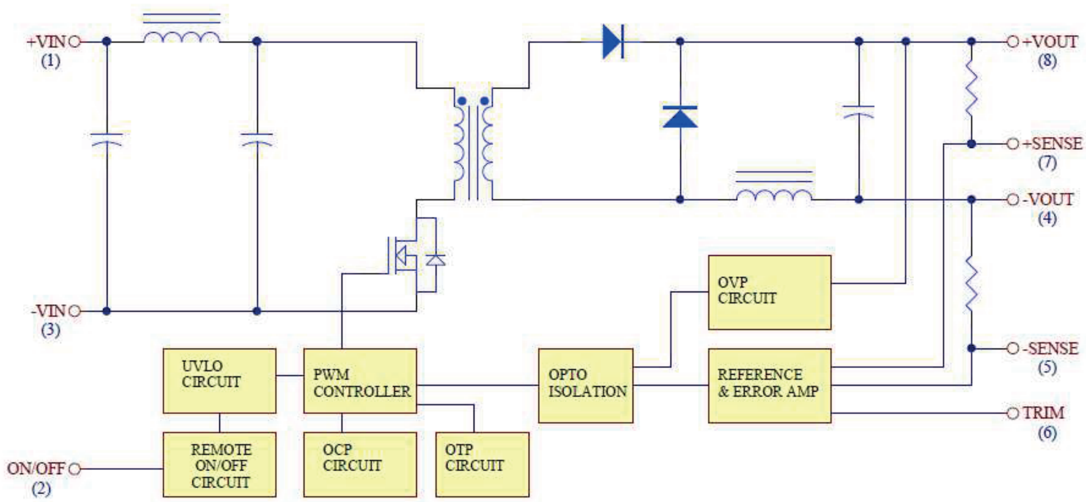
2. DC/DC Converter Features

- 300W Isolated output
- Efficiency to 92%
- Fixed switching frequency
- Input under voltage protection
- Over temperature protection
- Over voltage/current protection
- Remote On/Off
- Industry standard half-brick package
- Fully isolated to 1500VDC
- UL60950-1 2nd approval

3. Electrical Block Diagram



Electrical Block Diagram for 5Vout, 12Vout and 15Vout



Electrical Block Diagram for other modules

4. Technical Specifications

(All specifications are typical at nominal input, full load at 25°C unless otherwise noted.)

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only, functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect the device reliability.

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Input voltage						
Continuous		24SXX	-0.3		36	VDC
		48SXX	-0.3		75	VDC
Transient	100ms	24SXX			50	VDC
		48SXX			100	VDC
Operating case temperature			-40		100	°C
Storage temperature			-55		105	°C
Isolation voltage, 1 minute	Input/output, input/case,output/case		1500			VDC

Input Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Operating input voltage		24SXX	9	24	36	VDC
		48SXX	18	48	75	VDC
Input Under Voltage Lockout						
Turn-on voltage threshold		24SXX	8	8.8	9	VDC
		48SXX	16	17	18	VDC
Turn-off voltage threshold		24SXX	7	8.0	8.5	VDC
		48SXX	15	16	17	VDC
Lockout hysteresis voltage		24SXX		0.8		VDC
		48SXX		1		VDC
Maximum input current	100% Load, Vin=9V for 24SXX	24SXX			40	A
	100% Load, Vin =18V for 48SXX	48SXX			19	A
No-load input current		24S05		200		mA
		24S12		200		mA
		24S15		250		mA
		24S24		80		mA
		24S28		80		mA
		24S48		100		mA
		48S05		100		mA
		48S12		100		mA
		48S15		130		mA
		48S24		60		mA
		48S28		60		mA
		48S48		80		mA
Inrush current (I^2t)		All			1	A^2s
Recommended input fuse		24SXX		45		A
		48SXX		30		A
Input capacitance (external)		24SXX	1000			uF
		48SXX	220			uF

Output Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Output voltage set point	Vin=Nominal Vin, Io = Io_max, Tc=25°C	Vo=5.0 V	4.925	5	5.075	VDC
		Vo=12 V	11.82	12	12.18	VDC
		Vo=15 V	14.775	15	15.225	VDC
		Vo=24 V	23.64	24	24.36	VDC
		Vo=28 V	27.58	28	28.42	VDC
		Vo=48 V	47.28	48	48.72	VDC
Output voltage regulation						
Load regulation	Io=Io_min to Io_max	All			±0.2	%
Line regulation	Vin=low line to high line	All			±0.2	%
Temperature coefficient	TC=-40°C to 100°C	All			±0.03	%/°C
Output voltage ripple and noise						
Peak-to-Peak	5Hz to 20MHz bandwidth,	Vo=5.0V			100	mV
	full load, 10uF tantalum	Vo=12V			120	mV
	(for 24S05 with 330uF	Vo=15V			200	mV
	tantalum, 24S12 with 100uF	Vo=24V & 28V			280	mV
	tantalum and 48Vout with	Vo=48 V			480	mV
RMS	10uF aluminum) and 1.0uF	Vo= 5.0V			40	mV
	ceramic capacitors across	Vo=15V			60	mV
	output	Vo=12V			80	mV
		Vo=24V & 28V			100	mV
		Vo=48V			200	mV
Operating output current range		Vo=5.0 V	0		60	A
		Vo=12 V	0		25	A
		Vo=15 V	0		20	
		Vo=24 V	0		12.5	A
		Vo=28 V	0		10.7	A
		Vo=48 V	0		6.25	A
Output peak power	3 Seconds with maximum duty cycle of 10%, average output power not to exceed 300W	All			350	Watt
Output DC current limit inception	Output voltage=90% ,nom output voltage	All	120	125	160	%
Output capacitance	Full load (resistive)	24S05	470		10000	uF
		24S12	330		10000	uF
		24S15	0		10000	uF
		24S24	220		4700	uF
		24S28	220		4700	uF
		24S48	220		2200	uF
		48S05	0		10000	uF
		48S12	0		10000	uF
		48S15	0		10000	uF
		48S24	0		4700	uF
		48S28	0		4700	uF
		48S48	220		2200	uF

Dynamic Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Output voltage current transient						
Step change in output current	di/dt=0.1A/us, load change from 75% to 100% to 75% of Io,max	All			±5	%
Setting time (within 1% Vout nominal)	di/dt=0.1A/us	All			500	us
Turn-on delay and rise time						
Turn-on delay time, from On/Off control	Von/off to 90%Vo_set	All		40	75	ms
Turn-on delay time, from input	Vin_min to 90%Vo_set	All		120	250	ms
Output voltage rise time	10%Vo_set to 90%Vo_set	All		25	50	ms

Efficiency

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Efficiency	Vin=1/2Nominal Vin, 100% Load	24S05		88		%
		24S12		91		%
		24S15		91		%
		24S24		88		%
		24S28		88.5		%
		24S48		88		%
		48S05		89		%
		48S12		92		%
		48S15		92		%
		48S24		90		%
		48S28		91		%
		48S48		90		%
	Vin=Nominal Vin, 100% Load	24S05		88.5		%
		24S12		91		%
		24S15		91		%
		24S24		88		%
		24S28		88.5		%
		24S48		88		%
		48S05		90		%
		48S12		92		%
		48S15		92		%
		48S24		90		%
		48S28		89.5		%
		48S48		89		%

Isolation Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Isolation voltage	Input to output, in to case, output to case, 1 minute	All			1500	VDC
Isolation resistance		All	10			MΩ
Isolation capacitance	Input to output	All		2000		pF

Feature Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Switching frequency		All		220		KHz
ON/OFF control, positive remote On/Off logic						
Logic low (module off)		All			1.2	V
Logic high (module on)		All	3.5 or open circuit		75	V
ON/OFF control, negative remote On/Off logic						
Logic high (module off)		All	3.5 or Open Circuit		75	V
Logic high (module on)		All			1.2	V
On/off current (for both remote on/off logic)	Ion/off at Von/off=0.0V	All			1	mA
Leakage current (for both remote on/off logic	Logic high, Von/off=15V	All			1	mA
Off converter input current	Shutdown input idle current	All		7	10	mA
Output voltage trim range	Vin=18-23V Iout=max rated current	48S28	-10		0	%
	Vin=23-75V, Pout=max rated power Iout=max rated current	48S28	-10		+10	%
	Pout=max rated power	Others	-10		+10	%
Output over voltage protection		All	115	125	140	%
Over-temperature shutdown		All		110		°C

General Specifications

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
MTBF	Io=100% of Io_max: Ta=25°C per MIL-HDBK-217F	All		600		Khours
Weight		All		114		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The PHB300W series converters can be operated within a wide case temperature range of -40°C to 100°C. Consideration must be given to the de-rating curves when ascertaining maximum power that can be drawn from the converter. The maximum power drawn from half brick models is influenced by usual factors, such as:

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

5.2 Output Voltage Adjustment

Section 6.8 describes in detail how to trim the outputvoltage with respect to its set point. The output voltage on 5V&12V&15V&24V&28V&48V models is adjustable within the range of +10% to – 10%.For 48S28 models, see input& output trim curves.

5.3 Over Current Protection

The converter is protected against over current or short circuit conditions. At the instance of current-limit inception, the module enters a hiccup mode of operation, whereby it shuts down and automatically attempts to restart. While the fault condition exists, the module will remain in this hiccup mode, and can remain in this mode until the fault is cleared. The unit operates normally once the output current is reduced back into its specified range.

5.4 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.

5.5 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(-).

5.6 UVLO&OVLO (Under/Over Voltage Lock Out)

Input under voltage lockout is standard with this converter. At input voltages below the input under voltage lockout limit, the module operation is disabled.

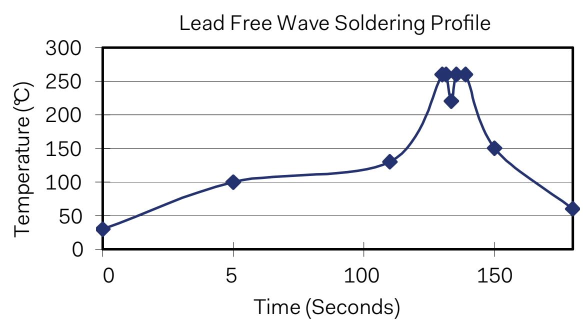
5.7 Over Temperature Protection

These modules have an over temperature protection circuit to safeguard against thermal damage. When the case temperature rises above over temperature shutdown threshold, the converter will shut down to protect it from overheating. The module will automatically restart after it cools down.

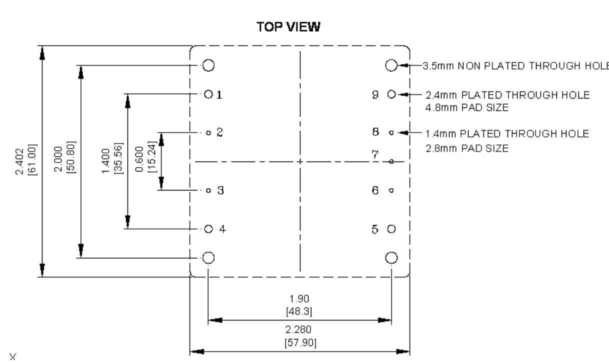
6. Applications

6.1 Recommended 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. The recommended soldering profile and PCB layout are shown below.



Note:
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4°C/Sec (From 50°C to 100°C)
3. Soaking temperature: 0.5°C/Sec (From 100°C to 130°C), 60±20 seconds
4. Peak temperature: 260°C, above 250°C 3~6 Seconds
5. Ramp up rate during cooling: -10.0°C/Sec (From 260°C to 150°C)



6.2 Convection Requirements for Cooling

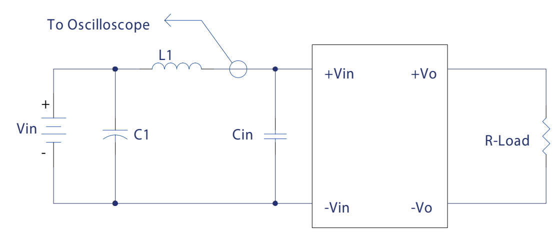
To predict the approximate cooling needed for the half brick module, refer to the power de-rating curves in section 6.5. These de-rating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be monitored to ensure it does not exceed 100°C as being measured at the center of the top of the case (thus verifying proper cooling).

6.3 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 test data is presented in section 6.5. The power output of the module should not be allowed to exceed rated power (Vo_set x Io_max).

6.4 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 (Cin) 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).



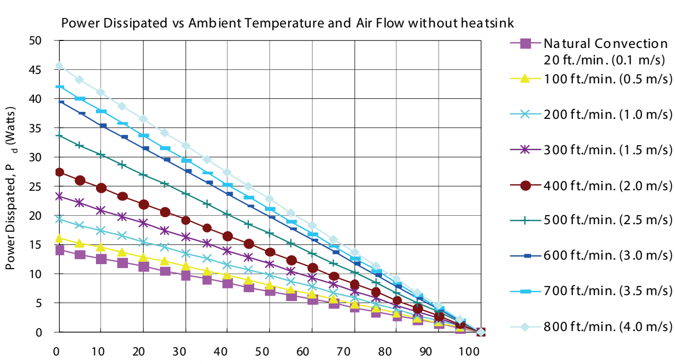
L1: 12uH
C1: NC
Cin: 1000uF for 24Vin, 220uF for 48Vin models
ESR<0.7ohm @100KHz
Input Reflected-Ripple Test Setup

6.5 Power De-rating

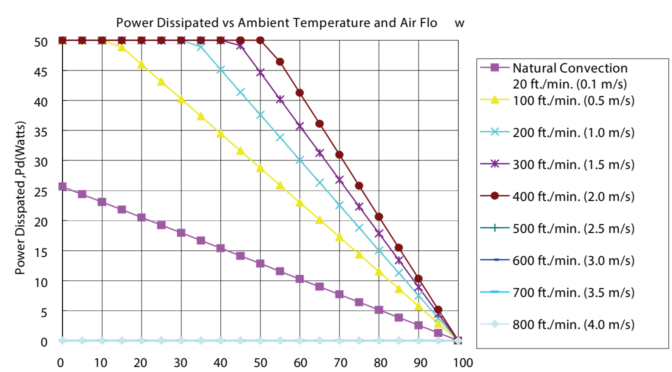
The operating case temperature range of PHB300W series is -40°C to +100°C. When operating the PHB300W series, proper de-rating or cooling is needed. The maximum case temperature under any operating condition should not be exceeded 100°C. The following curve is the de-rating curve of PHB300W series without heat sink.

Example (without heatsink)
What is the minimum airflow necessary for a PHB300W-48S05 operating at nominal line voltage, an output current of 60A, and a maximum ambient temperature of 20°C?
Solution:
Given: V_{in}=48Vdc Vo=5Vdc Io=60A
Determine power dissipation (Pd):
Pd =Pi-Po=Po(1-η)/η
Pd =5V×60A×(1-0.90)/0.90=33.4Watts
Determine airflow:
Given: Pd =33.4W and Ta=20°C
Check above power de-rating curve:
Minimum airflow= 800 ft./min.
Verifying:
The maximum temperature rise:
ΔT = Pd × Rca=33.4W×2.19=73.1°C
The maximum case temperature:
Tc=Ta+ΔT=93.1°C <100°C
Where:
The R_{ca} is thermal resistance from case to ambient environment.
The T_a is ambient temperature and the Tc is case temperature.

Example (with heatsink M-C308):
What is the minimum airflow necessary for a PHB300W-48S05 operating at nominal line voltage, an output current of 60A, and a maximum ambient temperature of 40°C?
Solution:
Given: Vin=48Vdc, Vo=5Vdc, Io=60A
Determine Power dissipation (Pd):
Pd=Pi-Po=Po(1-η)/ η
Pd=5Vx60Ax(1-0.90)/0.90=33.4Watts
Determine airflow:
Given: P_d=33.4W and Ta=40°C
Check above Power de-rating curve:
Minimum airflow= 100 ft./min.
Verifying:
The maximum temperature rise ΔT = Pd × Rca=33.4×1.74=58.1°C
The maximum case temperature Tc=Ta+ΔT=98.1°C <100°C
Where:
The R_{ca} is thermal resistance from case to ambient environment.
The T_a is ambient temperature and the T_c is case temperature.

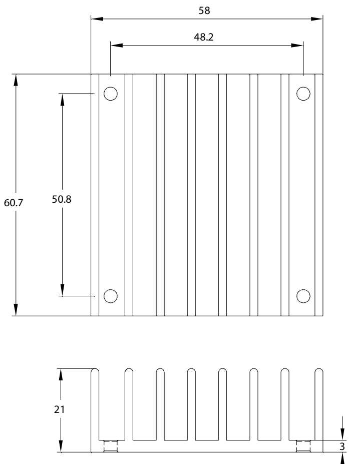


AIR FLOW RATE	TYPICAL Rca
Natural Convection 20ft./min. (0.1m/s)	7.12°C/W
100 ft./min. (0.5m/s)	6.21°C/W
200 ft./min. (1.0m/s)	5.17°C/W
300 ft./min. (1.5m/s)	4.29°C/W
400 ft./min. (2.0m/s)	3.64°C/W
500 ft./min. (2.5m/s)	2.96°C/W
600 ft./min. (3.0m/s)	2.53°C/W
700 ft./min. (3.5m/s)	2.37°C/W
800 ft./min.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

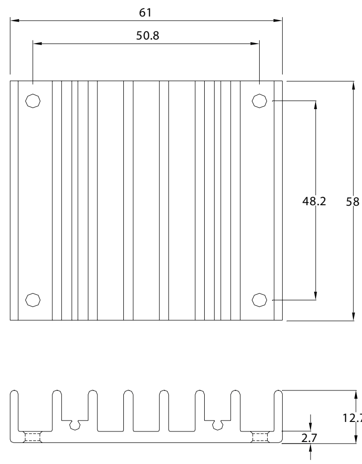


AIR FLOW RATE	TYPICAL Rca
Natural Convection 20ft./min. (0.1m/s)	3.9°C/W
100 ft./min. (0.5m/s)	1.74°C/W
200 ft./min. (1.0m/s)	1.33°C/W
300 ft./min. (1.5m/s)	1.12°C/W
400 ft./min. (2.0m/s)	0.97°C/W

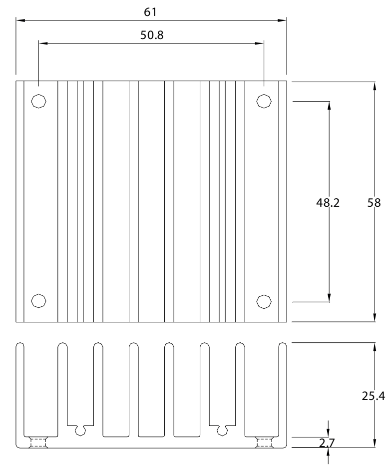
6.6 Half Brick Heat Sinks



M-C308



M-C091



M-C092

M-C308 (G6620400201)
Longitudinal Heat Sink

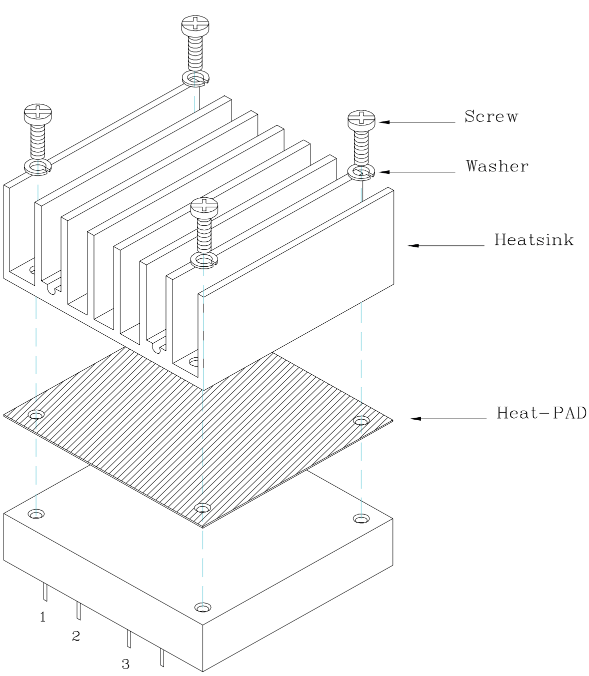
Rca:
3.90°C/W (typ.), natural convection
1.74°C/W (typ.), at 100LFM
1.33°C/W (typ.), at 200LFM
1.12°C/W (typ.), at 300LFM
0.97°C/W (typ.), at 400LFM

M-C091 (G6610120402)
Transverse Heat Sink

Rca:
4.70°C/W (typ.), natural convection
2.89°C/W (typ.), at 100LFM
2.30°C/W (typ.), at 200LFM
1.88°C/W (typ.), at 300LFM
1.59°C/W (typ.), at 400LFM

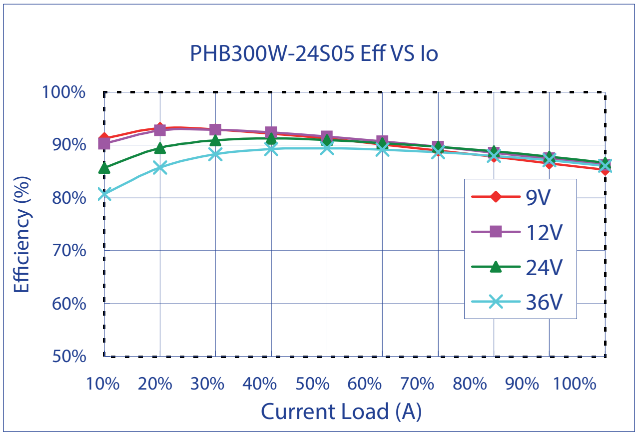
M-C092 (G6610130402)
Transverse Heat Sink

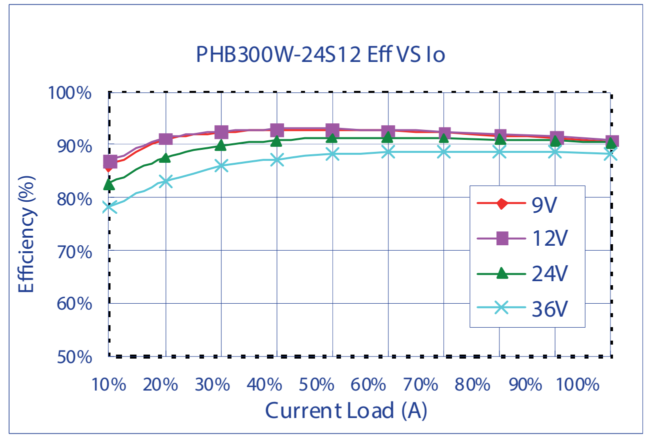
Rca:
3.00°C/W (typ.), natural convection
1.44°C/W (typ.), at 100LFM
1.17°C/W (typ.), at 200LFM
1.04°C/W (typ.), at 300LFM
0.95°C/W (typ.), at 400LFM

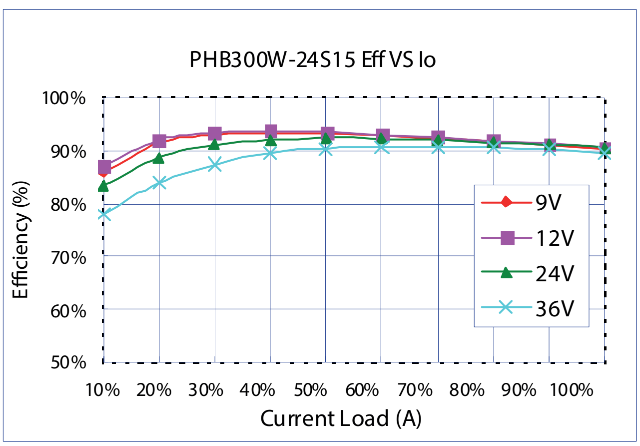


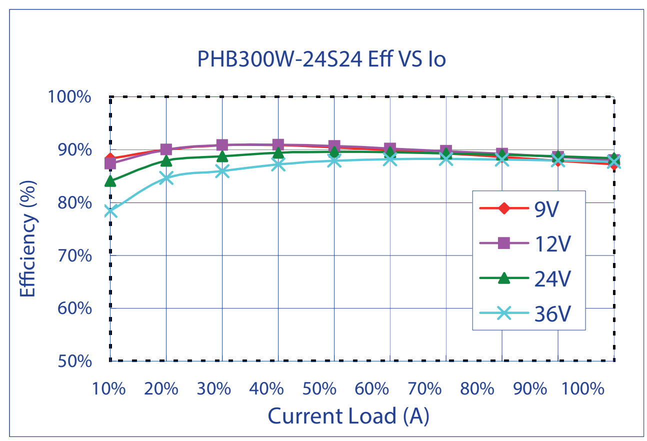
THERMAL PAD: SZ 56.9*60*0.25 mm (G6135041091)
SCREW: SMP+SW M3*8L
(G75A1300322)

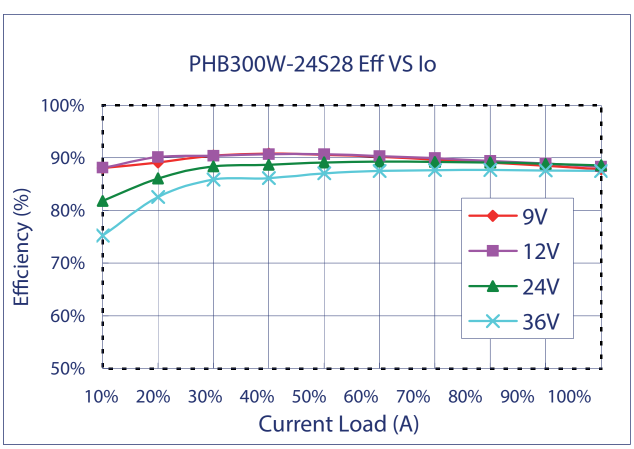
6.7 Efficiency VS. Load

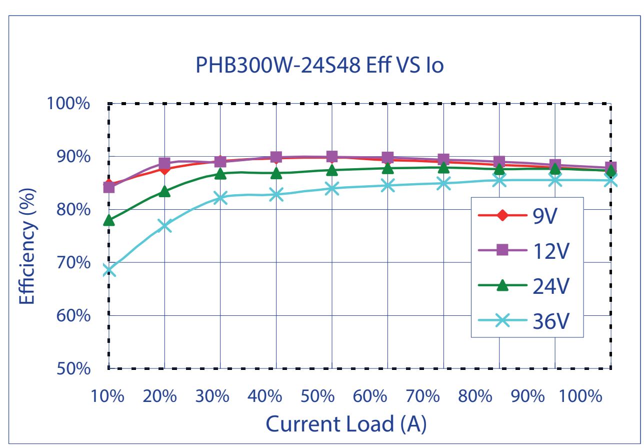


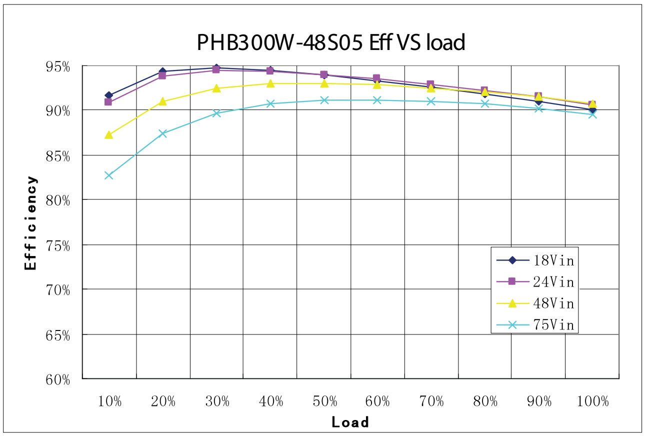


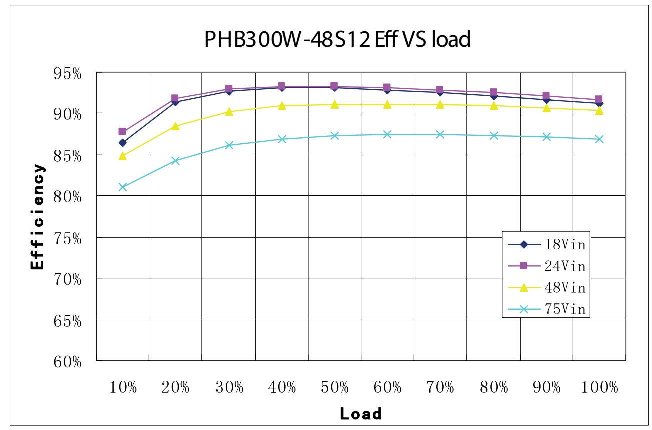


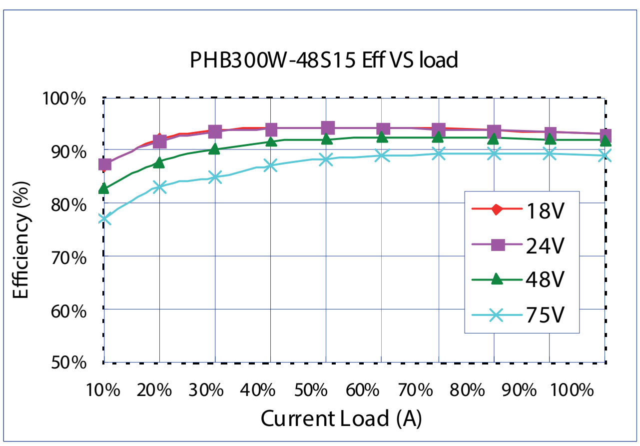


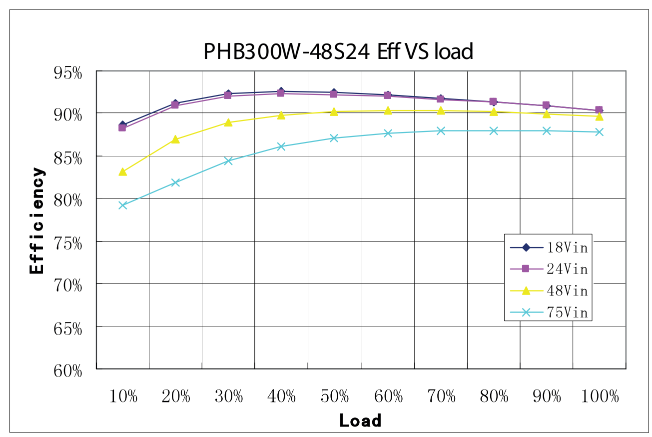


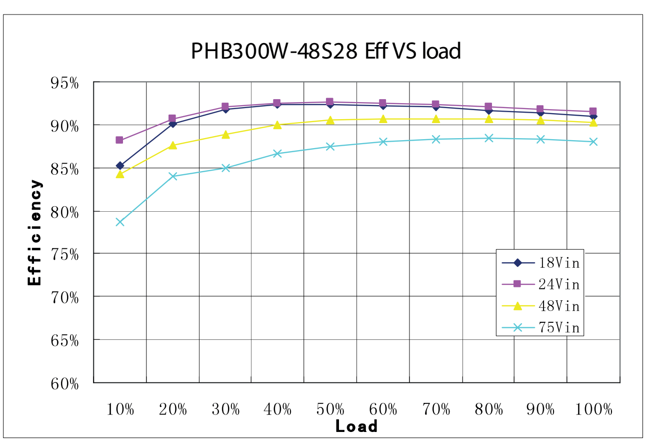


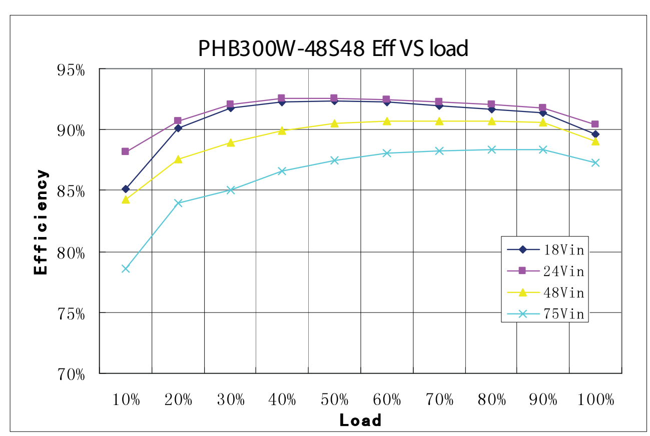

PHB300W-48S05 Eff VS load
Efficiency
95%
90%
85%
80%
75%
70%
65%
60%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Load
18Vin
24Vin
48Vin
75Vin


PHB300W-48S12 Eff VS load
Efficiency
95%
90%
85%
80%
75%
70%
65%
60%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Load
18Vin
24Vin
48Vin
75Vin

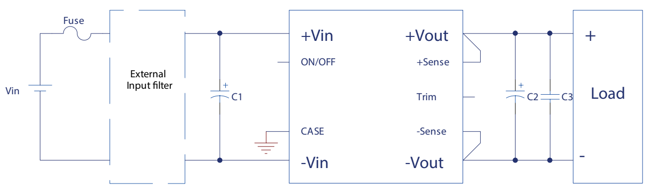

PHB300W-48S15 Eff VS load
Efficiency (%)
100%
90%
80%
70%
60%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (A)
18V
24V
48V
75V


PHB300W-48S24 Eff VS load
Efficiency
95%
90%
85%
80%
75%
70%
65%
60%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Load
18Vin
24Vin
48Vin
75Vin

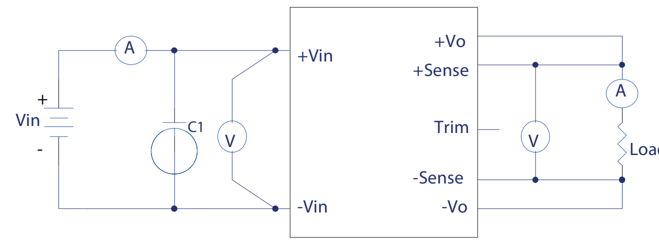

PHB300W-48S28 Eff VS load
Efficiency
95%
90%
85%
80%
75%
70%
65%
60%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Load
18Vin
24Vin
48Vin
75Vin


PHB300W-48S48 Eff VS load
Efficiency
95%
90%
85%
80%
75%
70%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Load
18Vin
24Vin
48Vin
75Vin

6.8 Test Set-Up



Typical electrical connection (Positive logic)



PHB300W Series Test Setup

For typical electrical connection, please refer to the connection above.

1. Put input capacitor C1, more than 1000uF for 24Vin, 220uF for 48Vin, If the ambient temperature is less than -20°C, use 3 pieces of the recommended capacitor above. If the impedance of input line is high, input capacitor must be more than above.
2. Put output capacitor, C2 and C3 according to minimum and maximum capacitor recommendation on page 4. If the ambient temperature is less than -20°C, use at least 3 pieces of the recommended minimum capacitors.
3. Use external fuse for each unit. The basic test setup 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:

$$\eta = \frac{Vo \times Io}{Vin \times Iin} \times 100\%$$

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:

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

Where:

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

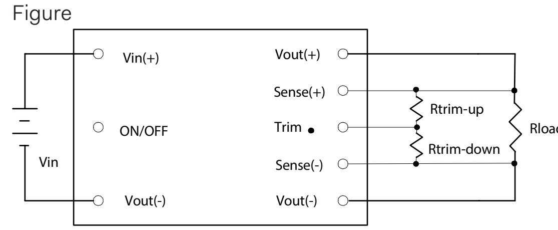
The value of line regulation is defined as:

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

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.

6.9 Output Voltage Adjustment

The Trim input permits the user to adjust the output voltage up or down 10%. This is accomplished by connecting an external resistor between the Trim pin and either the Vout (+) pin or the Vout(-) pin (COM pin), see Figure



Output voltage trim circuit configuration

The Trim pin should be left open if trimming is not being used. Connecting an external resistor (Rtrim-down) between the Trim pin and the Vout(-) (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 Δ%

$$R_{trim-down} = \left[\frac{511}{\Delta\%}\right] - 10.22)k\Omega$$

Where

$$\Delta\% = \left(\frac{V_{o,set} - V_{desired}}{V_{o,set}}\right) x100$$

For example, to trim-down the output voltage of 12V module (PHB300W-48S12) by 5% to 11.4V, Rtrim-down is calculated as follow: Δ%=5

$$R_{trim\text{-}down} = (\frac{511}{5} - 10.22)k\Omega$$

$$R_{trim\text{-}down} = 91.98k\Omega$$

Connecting an external resistor (Rtrim-up) between theTrim pin and the Vout (+) (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 Δ%

$$R_{trim\text{-}up} = \left[\frac{5.11V_{out}(100 + \Delta\%)}{1.24 \text{ x } \Delta\%} - \frac{511}{\Delta\%} - 10.22\right]k\Omega$$

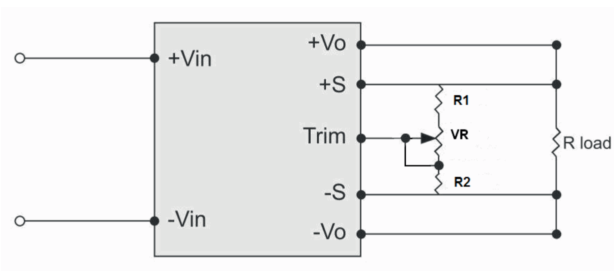
Where

$$\Delta\% = \left(\frac{V_{o,set} - V_{desired}}{V_{o,set}}\right) x100$$

For example, to trim-up the output voltage of 12V module (PHB300W-48S12) by 5% to 12.6V, Rtrim-up is calculated as follow: Δ%=5

$$R_{trim\text{-}up} = \left(\frac{5.11 \text{ x } 12 \text{ x } 100 + 5)}{1.24 \text{ x } 5} - \frac{511}{5} - 10.22\right) k\Omega$$

$$R_{trim\text{-}up} = 924\, k\Omega$$



Output voltage trim circuit configuration with VR

Recommended resistor values:

Vout (V)	R1 (KΩ)	R2 (KΩ)	VR (KΩ)
5	13	5.6	10
12	33	4.7	20
15	36	3.9	20
24	47.5	3	20
28	51	2.7	20
48	56	1.65	20

$$R1 + VR \geq \frac{37.089 \times R2 \times Vo - 40.88 \times R2}{40.88 - R2} (K\Omega) \cdots\cdots (1)$$

$$R1 \leq \frac{45.331 \times R2 \times Vo - 61.32 \times R2}{61.32 + R2} (K\Omega) \cdots\cdots (2)$$

Ex: PHB300W-48S24
IF R2=3KΩ

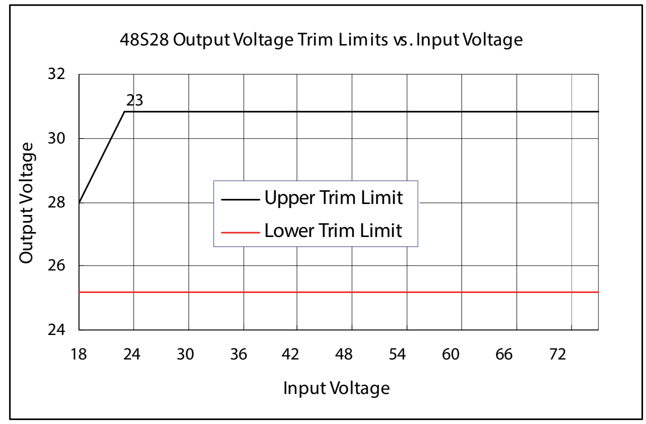
$$R1 + VR \geq \frac{37.089 \times 3 \times 24 - 40.88 \times 3}{40.88 - 3} = 67.259 K\Omega$$

$$R1 \leq \frac{45.331 \times 3 \times 24 - 61.32 \times 3}{61.32 + 3} = 47.884 K\Omega$$

$$VR \geq 67.258 - 47.884 = 19.375 K\Omega$$

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 = Vo,set x Io,max)

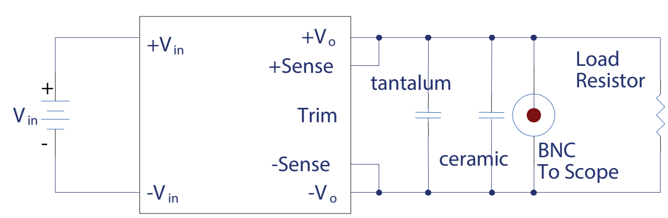
The output voltage on 5V&12V&15V& 24V&28V&48V model is adjustable within the range of +10% to −10%. For 48S28 model see input & output trim curves for trim up and trim down is -10%.



6.10 Output Remote Sensing

The PHB300W 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 PHB300W 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:
[(+Vout) - (-Vout)] – [(+Sense) – (-Sense)] ≤ 10% of Vo_nominal
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.

6.11 Output Ripple and Noise



Output ripple and noise is measured with 10uF solid tantalum (for 24S05 with 330uF tantalum, 24S12 with 100uF tantalum and 48Vout with 10uF aluminum) and 1uF ceramic capacitors across the output.

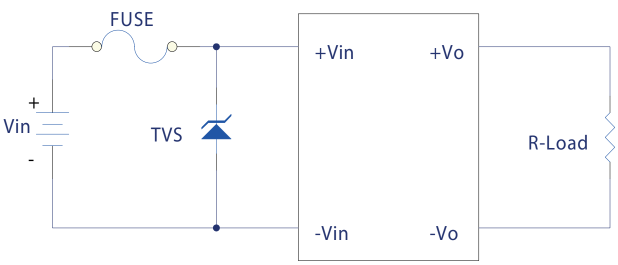
6.12 Output Capacitance

For good transient response, low ESR output capacitors should be located close to the point of load. 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. Must increased three or four times the minimum output capacitance when operating below - 20°C and the absolute maximum value of PHB300W series' output capacitance, please refer to Page 4 Maximum Output Capacitance. For values larger than this please contact local Powerbox representative.

7. Safety & EMC

7.1 Input Fusing and Safety Considerations

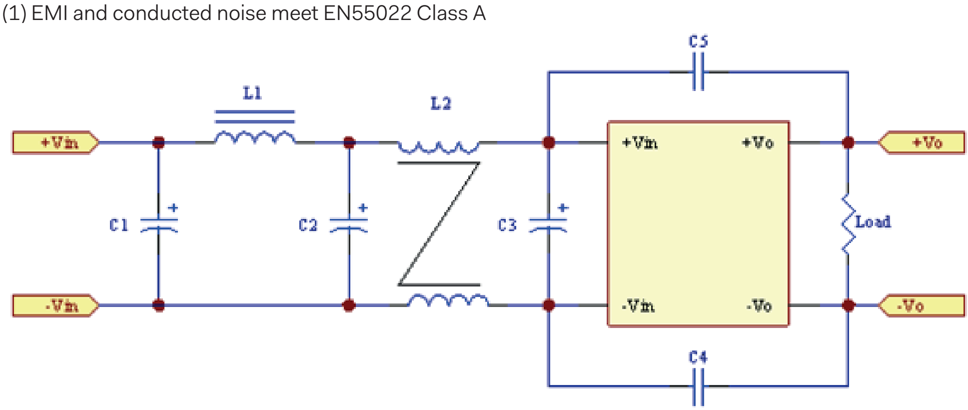
The PHB300W series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage (as shown).



7.2 EMC Considerations

Suggested Circuits for Conducted EMI CLASS A

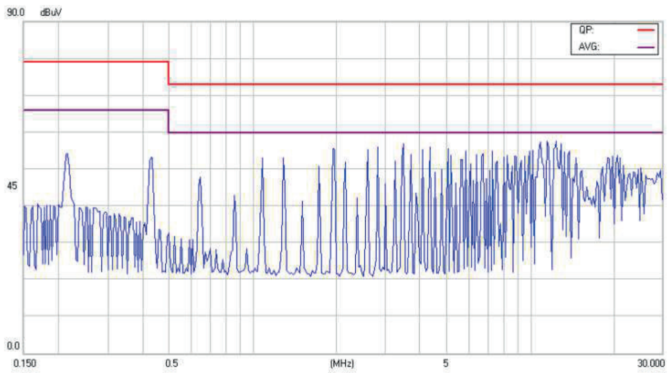
(1) EMI and conducted noise meet EN55022 Class A



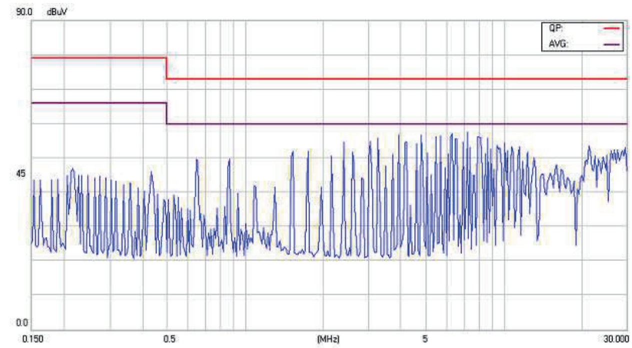
Class A

Model No.	**C1**	**C2**	**C3**	**C4**	**C5**	**L1**	**L2**
PHB300W-24S12	100uF/50V KY	220uF/100V PW	220uF/100V PW	1000pF/3KV	NC	1.0uH	0.2mH
PHB300W-24S24	220uF/100V KY	220uF/100V KY	220uF/100V KY	4700pF/2KV	NC	1.0uH	0.2mH
PHB300W-48S05	NC	220uF/100V KY	220uF/100V KY	NC	NC	1.0uH	0.2mH
PHB300W-48S28	NC	220uF/100V KY	220uF/100V KY	NC	NC	Short	0.2mH
PHB300W-48S48	NC	220uF/100V KY	220uF/100V KY	1000pF/2KV	1000pF/2KV	1.0uH	0.2mH

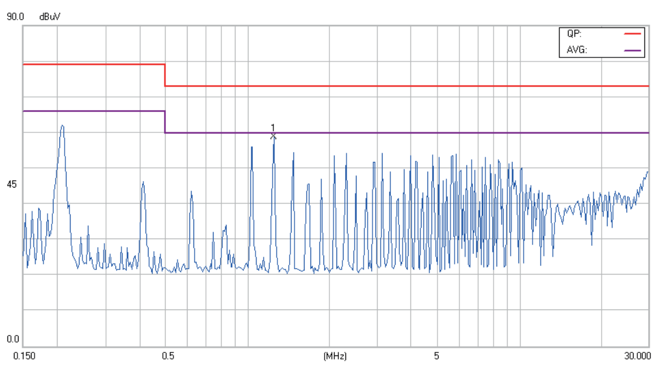
Note:
C1, C2, C3 is NIPPON-CHEMICON KY series or NICHICON PW series aluminum capacitor, C4, C5 are ceramic capacitors.
L1: UPIA1207-1R0M 3L, L2: Core: SM CM20*12*10, 5turns double wire



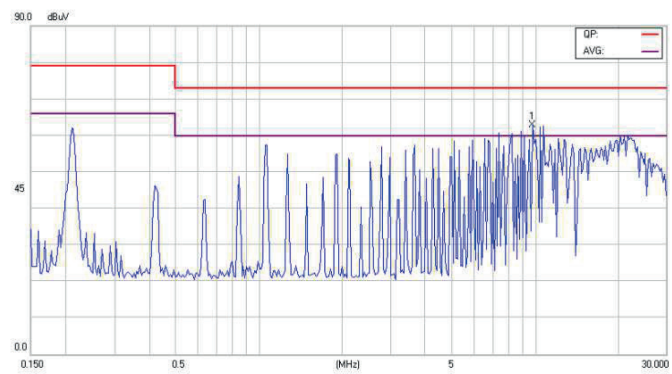
PHB300W-24S12 Class A Conducted Emissions
Test Condition: nominal input voltage, output at full load



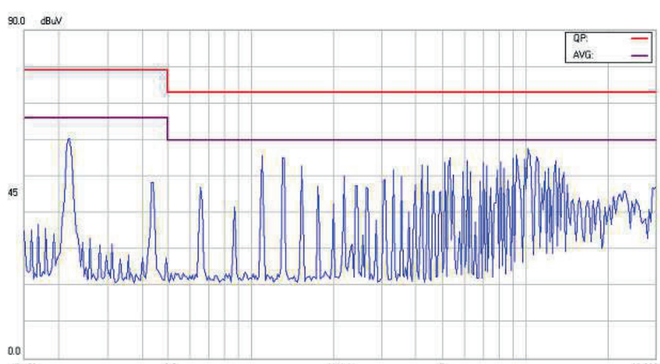
PHB300W-24S24 Class A Conducted Emissions
Test Condition: nominal input voltage, output at full load



PHB300W-48S05 Class A Conducted Emissions
Test Condition: nominal input voltage, output at full load



PHB300W-48S28 Class A Conducted Emissions
Test Condition: nominal input voltage, output at full load



PHB300W-48S48 Class A Conducted Emissions
Test Condition: nominal input voltage, output at full load

8. Part Number

Format: PHB300W – 48 X OO L-Y

Parameter Symbol	Series PHB300W	Nominal Input Voltage II	Number of Outputs X	Output Voltage OO	Remote ON/OFF Logic L	Option Y
Value	PHB300W	24: 24 Volts 48: 48 Volts	S: Single	05: 05 Volts 12: 12 Volts 15: 15 Volts 24: 24 Volts 28: 28 Volts 48: 48 Volts	None: Positive N: Negative	C Clear Mounting Insert (3.2mm DIA)

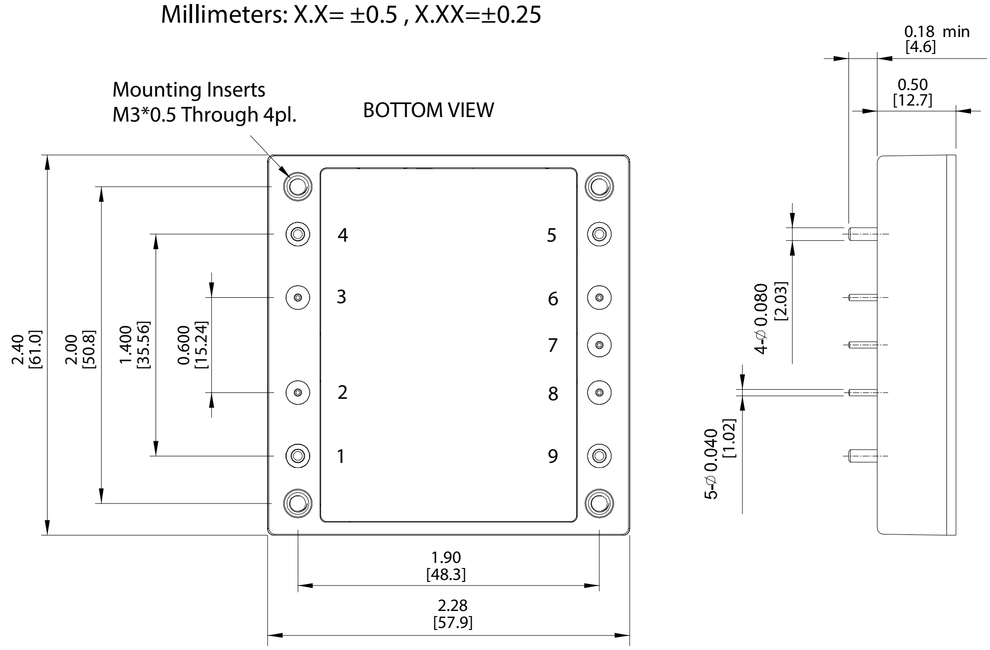
9. Mechanical Specifications

9.1 Mechanical Outline Diagrams

All Dimensions In Inches(mm)

Tolerances Inches: X.XX= ±0.02 , X.XXX= ±0.010

Millimeters: X.X= ±0.5 , X.XX=±0.25



Pin	Function
1	+V Input
2	ON/OFF
3	CASE
4	-V Input
5	-V Output
6	-Sense
7	Trim
8	+Sense
9	+V Output

NOTE: 1. Suffix "-C" to the Model Number with Clear Mounting Insert (3.2mm DIA)