POWERBOX Industrial Line
PHB50W Series
25-50W 4:1 Single Output
DC/DC Converter
Manual V18

Table of Contents

1. Introduction

The PHB50W series offers 50 watts of output power with high power density in an industry standard half-brick package. The PHB50W series has wide (4:1) input voltage ranges of 9-36 and 18-75VDC and provides a precisely regulated output. This series has features such as high efficiency, 1500VDC isolation and a case operating temperature range of –40°C to 100°C. The modules are fully protected against input UVLO (under voltage lock out), output short circuit, output over voltage and over temperature conditions. Furthermore, the standard control functions include remote on/off and output voltage trimming. All models are highly suited to telecommunications, distributed power architectures, battery operated equipment, industrial, and mobile equipment applications.

2. DC/DC Converter Features

- 33-50W isolated output
- 4:1 wide input range
- Efficiency (at full load) up to 87%
- Regulated output
- Fixed switching frequency
- Input under voltage lockout protection
- Over current protection
- Remote ON/OFF
- Continuous short circuit protection
- Industry standard half-brick package
- Fully isolated to 1500VDC

3. Electrical Block Diagram

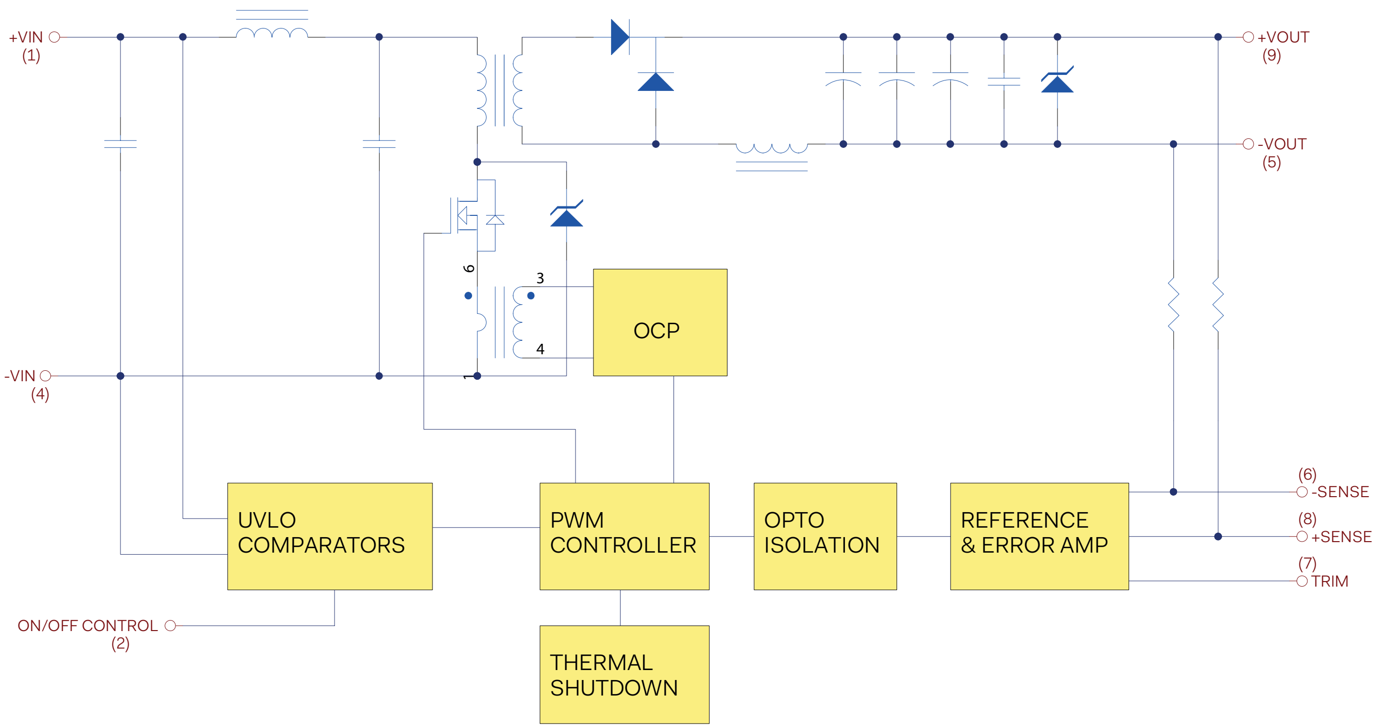


Figure 1 Electrical Block Diagram of PHB50W Series Module

4. Technical Specifications

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

Absolute Maximum Ratings

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Input voltage						
Continuous		24SXX	-0.7		36	VDC
		48SXX	-0.7		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		VDC
		48SXX		17		VDC
Turn-off voltage threshold		24SXX		8.0		VDC
		48SXX		16		VDC
Lockout hysteresis voltage		24SXX		0.8		VDC
		48SXX		1		VDC
Maximum input current	100% Load, Vin=9V for 24SXX	24SXX		7.1		A
	100% Load, Vin =18V for 48SXX	48SXX		3.4		A
No-load input current		24SXX		50		mA
		48SXX		50		mA
Inrush current (I^2t)					TBD	A^2s
Input reflected ripple current	P-P thru 12uH inductor, 5Hz to 20Mhz	24SXX		TBD		mA
		48SXX		TBD		mA

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=3.3 VDC	3.267	3.3	3.333	VDC
		Vo=5.0 VDC	4.95	5	5.05	VDC
		Vo=12 VDC	11.88	12	12.12	VDC
		Vo=15 VDC	14.85	15	15.15	VDC
		Vo=24 VDC	23.76	24	24.24	VDC
		Vo=28 VDC	27.72	28	28.28	
		Vo=48 VDC	47.52	48	48.48	VDC
Output voltage regulation						
Load regulation	Io=Io_min to Io_max (for 48Vout: Require a 47uF aluminum capacitor connected between +Vout and –Vout)	All			±0.2	%
Line regulation	Vin=low line to high line (for 48Vout: Require a 47uF aluminum capacitor connected between +Vout and –Vout)	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, full load, 10uF tantalum and 1.0uF ceramic capacitors	Vo= 3.3V & 5.0V			100	mV
		Vo=12V & 15V			150	mV
		Vo=24V			240	mV
		Vo=28V			280	mV
	Full load 1.0uF ceramic capacitors	Vo=48V			480	mV
RMS	5Hz to 20MHz bandwidth, full load, 10uF solid tantalum and 1.0uF ceramic capacitors	Vo= 3.3V & 5.0V			40	mV
		Vo=12V & 15V			60	mV
		Vo=24V & 28V			100	mV
	Full load 1.0uF ceramic capacitor	Vo=48V			200	mV
Operating output current range		Vo=3.3 VDC	0		10	A
		Vo=5.0 VDC	0		10	A
		Vo=12 VDC	0		4.16	A
		Vo=15 VDC	0		3.33	
		Vo=24 VDC	0		2.08	A
		Vo=28 VDC	0		1.78	A
		Vo=48 VDC	0		1.04	A
Output DC current limit inception	Output voltage=90% ,nom output voltage	All	110		160	%
Maximum output capacitance	Full load (resistive)	XXS33	0		10000	uF
		XXS05	0		10000	uF
		XXS12	0		4160	uF
		XXS15	0		3330	uF
		XXS24	0		2080	uF
		XXS28	0		1780	uF
		XXS48	0		1040	uF

Dynamic Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Output voltage current transient						
Step change in output current	75% to 100% 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 10%Vo_set	All		5		ms
Turn-on delay time, from input	Vin_min to 10%Vo_set	All		40		ms
Output voltage rise time	10%Vo_set to 90%Vo_set	All		1		ms

Efficiency

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
100% load		24S33		79		%
		24S05		81		%
		24S12		83		%
		24S15		85		%
		24S24		84		%
		24S28		83		%
		24S48		83		%
		48S33		81		%
		48S05		83		%
		48S12		85		%
		48S15		87		%
		48S24		86		%
		48S28		85		%
		48S48		84		%

Isolation Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Isolation voltage, 1 minute	input/output, input/case, output/case				1500	VDC
Isolation resistance			10			MΩ
Isolation capacitance	Input to output			1000		pF

Feature Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Switching frequency				300		KHz
ON/OFF control, positive remote On/Off logic						
Logic low (module off)	Von/off at Ion/off=1.0mA				0.8	V
Logic high (module on)	Von/off at Ion/off=0.0uA		3.5 or open circuit		75	V
ON/OFF control, negative remote On/Off logic						
Logic high (module off)	Von/off at Ion/off=0.0uA		3.5 or Open Circuit		75	V
Logic high (module on)	Von/off at Ion/off=1.0mA				0.8	V
Off converter input current	Shutdown input idle current				10	mA
Output voltage trim range	Pout=max rated power		-10		+10	%
Output over voltage protection	With TVS clamp		115	125	140	%
Over-temperature shutdown	Shutdown Case Temperature			100		°C
	Restart threshold Case Temperature			70		°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			1		Mhours
Weight				94		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The PHB50W 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 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 output voltage with respect to its set point. The output voltage on all models is adjustable within the range of +10% to –10%.

5.3 Over Current 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 output voltage of converter will be going down into current limit and power fold- back protection.

5.4 Output Over Voltage Protection

The output terminals connect a TVS (Transient Voltage Suppressor) diode. The TVS is used by the function of output over voltage protection to avoid the output voltage increase too high in abnormal condition. If more accurate output over voltage protection is required then an external circuit can be used via the remote on/off pin.

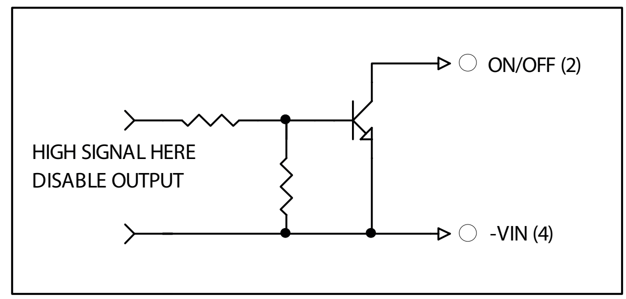
5.5 Remote On/Off

The PHB50W 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 or open circuit). Setting the pin low (<0.8Vdc) 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 or open circuit). The converter turns on if the On/Off pin input is low (<0.8Vdc). Note that the converter is off by default

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

Input under voltage lockout is standard on the PHB50W 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.

5.7 Over Temperature Protection

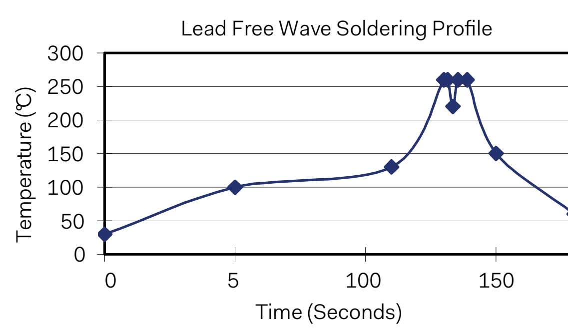


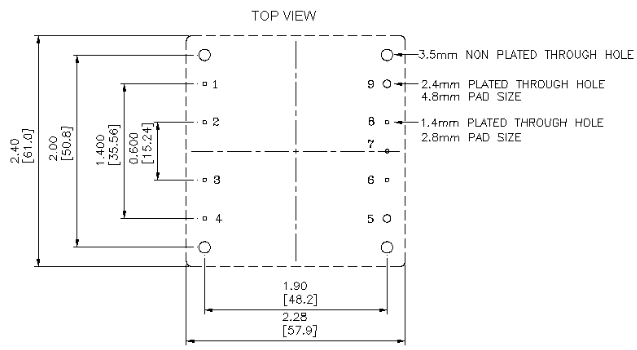
These modules have an over temperature protection circuit to safeguard against thermal damage. The module shuts down and latches off when the maximum case reference temperature is exceeded. The module will restart when the case temperature falls below restart threshold.

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.





6.2 Convection Requirements for Cooling

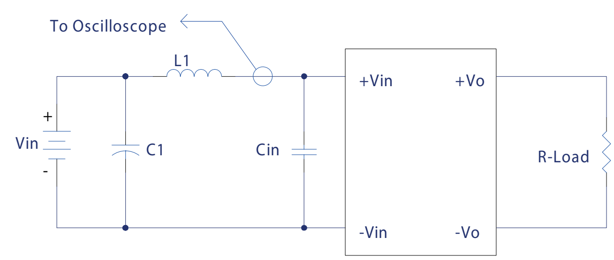
To predict the approximate cooling needed for the half brick module, refer to the power derating curves in section 6.4. These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled 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).

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 example is presented in section 6.4. 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: 220uF ESR<0.1ohm @100KHz
Cin: 100uF ESR<0.1ohm @100KHz
Input Reflected-Ripple Test Setup

6.5 Power De-rating

The operating case temperature range of PHB50W series is -40°C to +100°C. When operating the PHB50W series, proper de-rating or cooling is needed. The maximum case temperature under any operating condition should not be exceeded 100°C.

Example

What is the minimum airflow necessary for a PHB50W-24S12 operating at nominal line voltage, an output current of 16A, and a maximum ambient temperature of 50°C?

Solution:

Given: V_{in}=24Vdc Vo=12Vdc Io=16A

Determine power dissipation (Pd):

Pd =Pi-Po=Po(1-η)/η

Pd =12×4.16×(1-0.83)/0.83=10.22Watts

Determine airflow:

Given: Pd =10.22W and Ta=50°C

Check above power de-rating curve:

Minimum airflow= 300 ft./min.

Verifying:

The maximum temperature rise:

ΔT = Pd × Rca=10.22W×4.29=43.84°C

The maximum case temperature:

Tc=Ta+ΔT=93.84°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-C092):

What is the minimum airflow necessary for a PHB50W-48S05 operating at nominal line voltage, an output current of 15A, and a maximum ambient temperature of 60°C?

Solution:

Given: Vin=24Vdc, Vo=5Vdc, Io=10A

Determine Power dissipation (Pd):

Pd=Pi-Po=Po(1-h)/ h

Pd=5x10x(1-0.81)/0.81=11.73Watts

Determine airflow:

Given: Pd=11.73W and Ta=60°C

Check above Power de-rating curve:

Pd<20W, Natural Convection

Verifying:

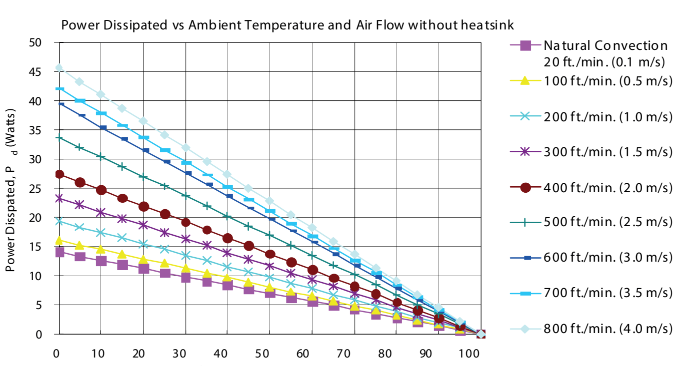
The maximum temperature rise DT = Pd × Rca=11.73×3=35.19°C

The maximum case temperature Tc=Ta+DT=95.19°C <100°C

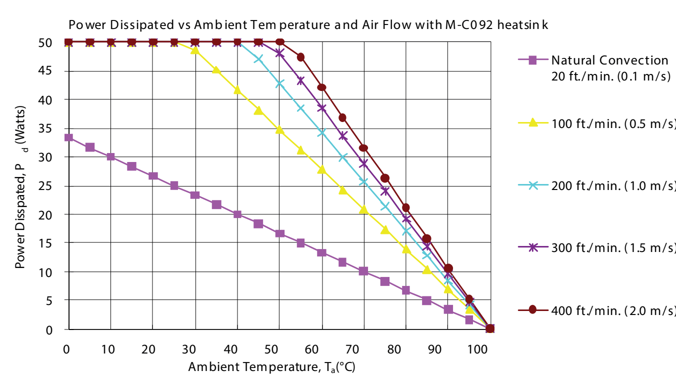
Where:

The Rca is thermal resistance from case to ambient environment.

The Ta is ambient temperature and the Tc is case temperature.

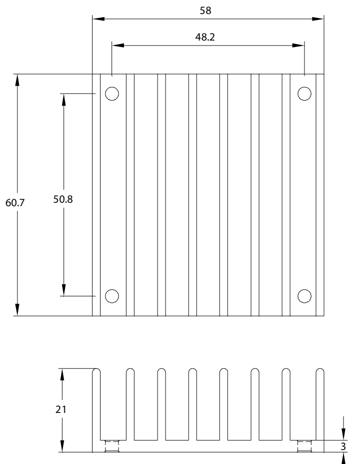


AIR FLOW RATE	TYPICAL Rca
Natural Convection 20ft./min. (0.1m/s)	7.12°C/W
100 ft./min. (0.5m/s)	6.21°C/W
200 ft./min. (1.0m/s)	5.17°C/W
300 ft./min. (1.5m/s)	4.29°C/W
400 ft./min. (2.0m/s)	3.64°C/W
500 ft./min. (2.5m/s)	2.96°C/W
600 ft./min. (3.0m/s)	2.53°C/W
700 ft./min. (3.5m/s)	2.37°C/W
800 ft./min.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

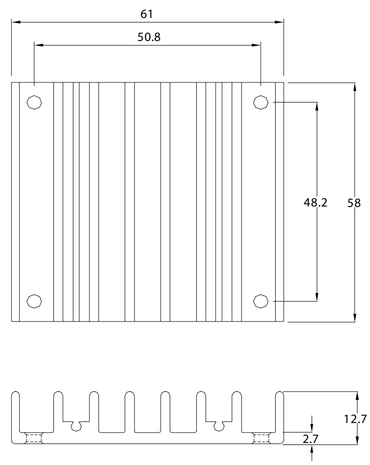


AIR FLOW RATE	TYPICAL Rca
Natural Convection 20ft./min. (0.1m/s)	3°C/W
100 ft./min. (0.5m/s)	1.44°C/W
200 ft./min. (1.0m/s)	1.17°C/W
300 ft./min. (1.5m/s)	1.04°C/W
400 ft./min. (2.0m/s)	0.95°C/W

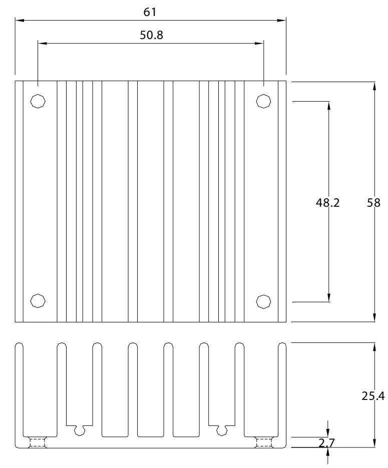
6.6 Half Brick Heat Sinks



M-C308



M-C091

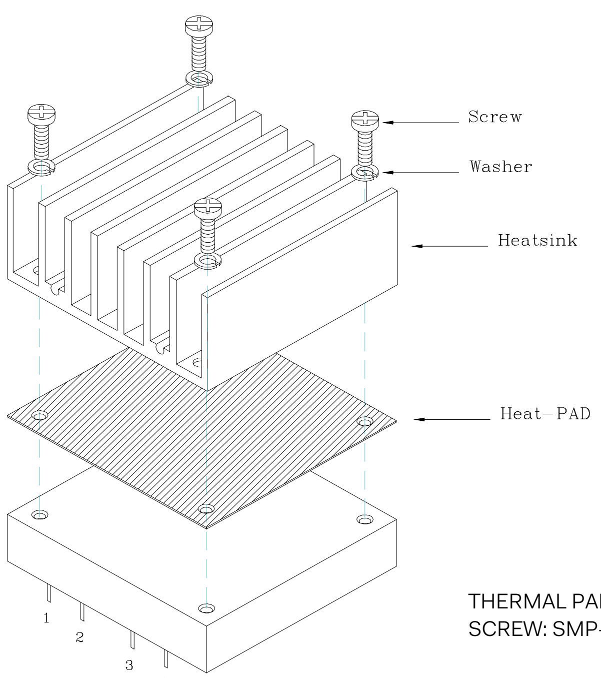


M-C092

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

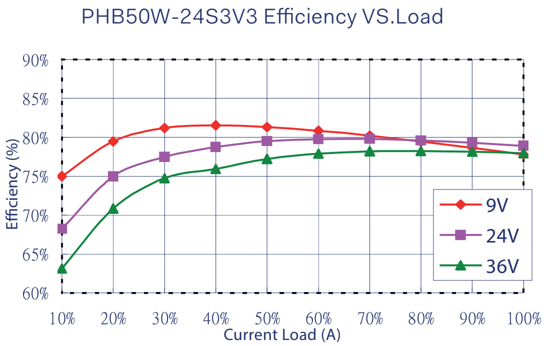
M-C091 (G6610120402)
Transverse Heat Sink
Rca:
4.70°C/W (typ.), natural convection
2.89°C/W (typ.), at 100LFM
2.30°C/W (typ.), at 200LFM
1.88°C/W (typ.), at 300LFM
1.59°C/W (typ.), at 400LFM

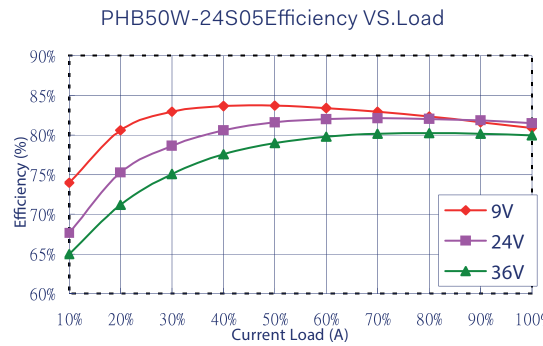
M-C092 (G6610130402)
Transverse Heat Sink
Rca:
3.00°C/W (typ.), natural convection
1.44°C/W (typ.), at 100LFM
1.17°C/W (typ.), at 200LFM
1.04°C/W (typ.), at 300LFM
0.95°C/W (typ.), at 400LFM

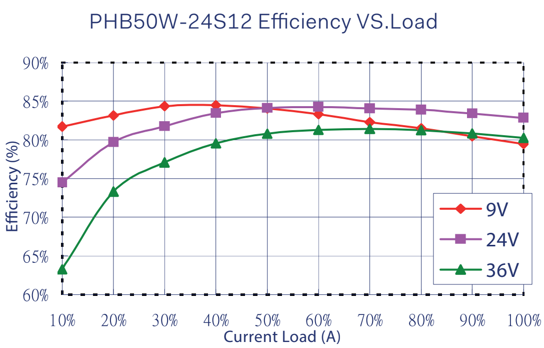


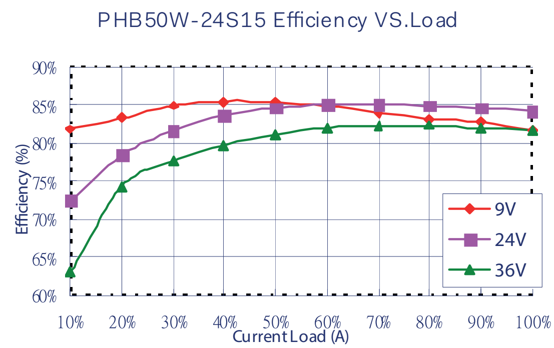
THERMAL PAD: SZ 56.9*60*0.25 mm (G6135041091)
SCREW: SMP+SW M3*8L (G75A1300322)

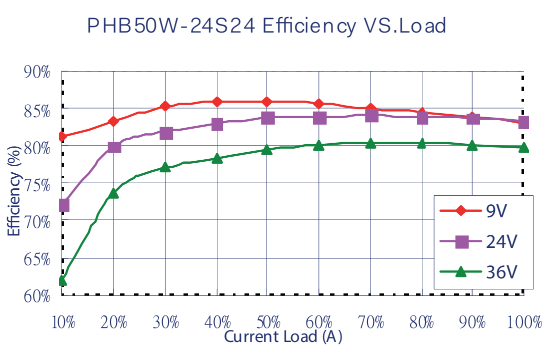
6.7 Efficiency VS. Load

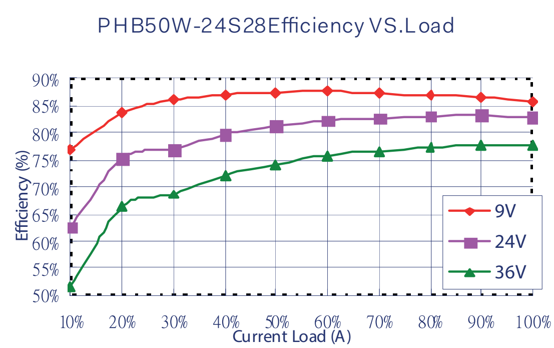




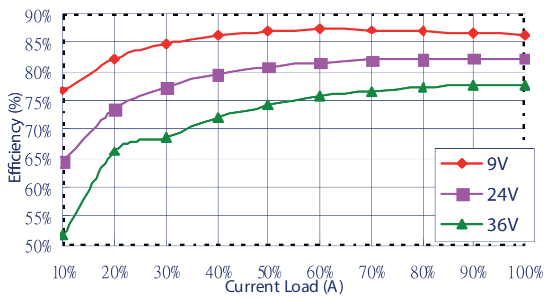




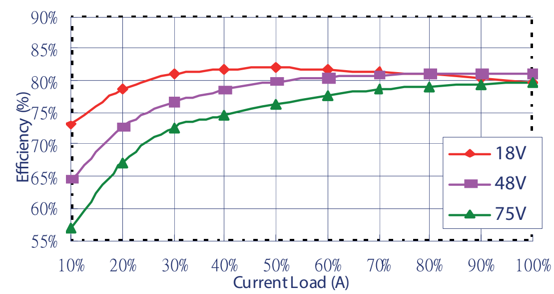




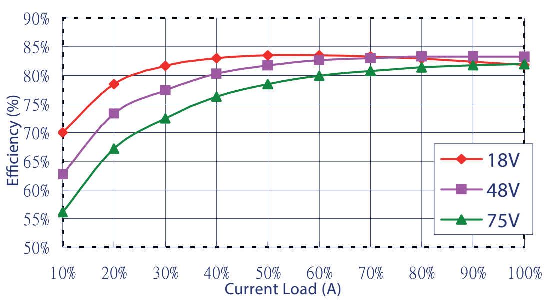
PHB50W-24S48Efficiency VS.Load



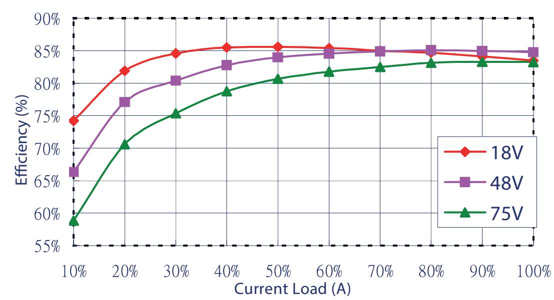
PHB50W-48S3V3 Efficiency VS.Load



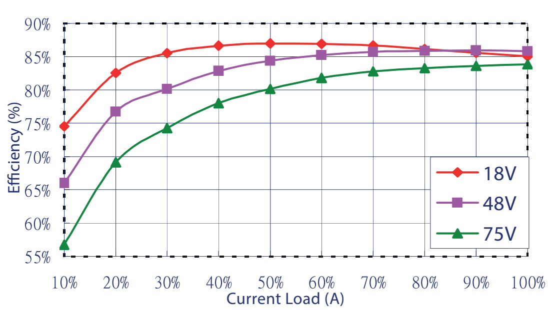
PHB50W-48S05 Efficiency VS.Load



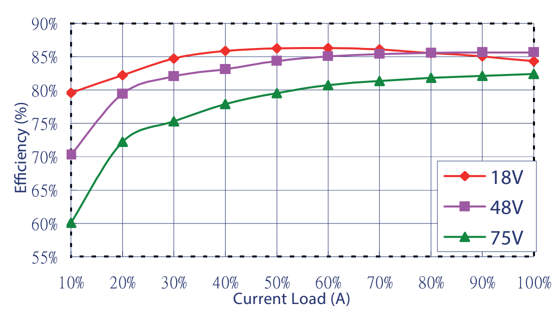
PHB50W-48S12 Efficiency VS.Load



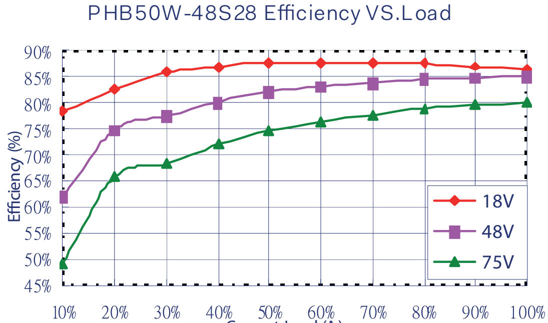
PHB50W-48S15 Efficiency VS.Load



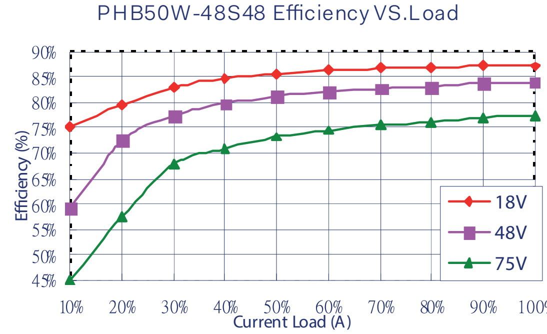
PHB50W-48S24 Efficiency VS.Load



PHB50W-48S28 Efficiency VS.Load



PHB50W-48S48 Efficiency VS.Load



6.8 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:

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

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:

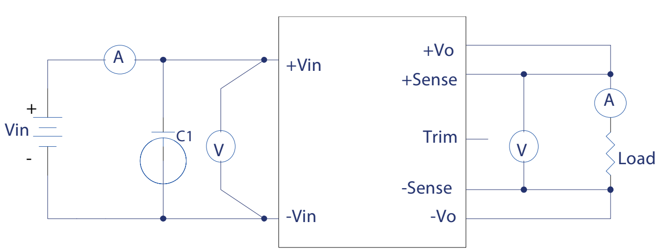
$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

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:

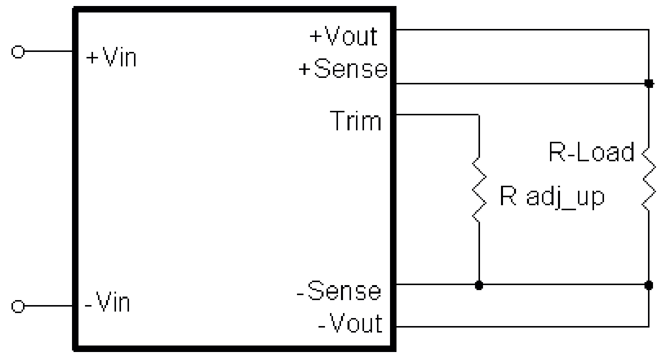
$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

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.

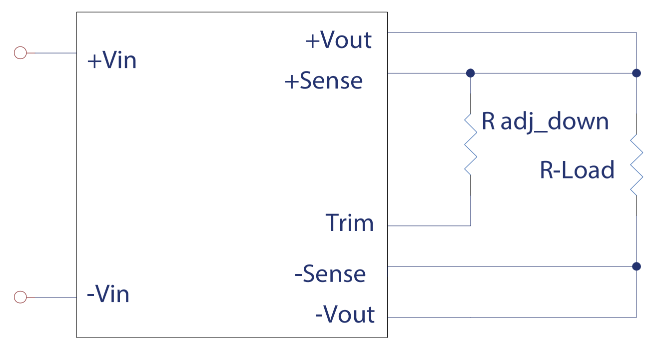


6.9 Output Voltage Adjustment

In order to trim the voltage up or down, one needs to connect the trim resistor either between the trim pin and -Vo for trim-up or between trim pin and +Vo for trim-down. The output voltage trim range is ±10%. This is shown:



Trim-up Voltage Setup



Trim-down Voltage Setup

Vout (V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	Vr (V)	Vf (V)
3.3V	3	12	18	1.24	0.46
5V	2.32	8.2	NC	2.5	0
12V	9.1	51	18	2.5	0.46
15V	12	82	18	2.5	0.46
24V	20	100	20	2.5	0.46
28V	23.7	150	16	2.5	0.46
48V	36	270	14	2.5	0.46

Table of trim resistor values

The value of Radj_up defined as:

$$R_{adj\_up} = \left(\frac{R_1\left(V_r - V_f\left(\frac{R_2}{R_2 + R_3}\right)\right)}{Vo - V_{o\_nom}}\right) - \frac{R_2 R_3}{R_2 + R_3} \quad (K\Omega)$$

Where:
Radj_up is the external resistor in KΩ. Vo_nom is the nominal output voltage. Vo is the desired output voltage.
R1, R2, R3 and Vr are internal components and are defined in the table of trim resistor values

For example, to trim-up the output voltage of 5V module (PHB50W-48S05) by 8% to 5.4V, Radj_up is calculated as follows:

Vo – Vo_nom = 5.4 – 5.0 = 0.4V
R1 = 2.32 KΩ, R2 = 8.2 KΩ,
Vr= 2.5 V , Vf=0 V

$$R_{adj\_up} = \frac{5.8}{0.4} - 8.2 = 6.3\ (K\Omega)$$

The value of Radj-down defined as:

$$R_{adj\_down} = \frac{R_1 \times (V_o - V_r)}{V_{o\_nom} - V_o} - R_2 \quad (K\Omega)$$

Where:
Radj_down is the external resistor in KΩ.
Vo_nom is the nominal output voltage.
Vo is the desired output voltage.
R1, R2, R3 and Vr are internal components

For example: to trim-down the output voltage of 12V module (PHB50W-48S05) by 8% to 4.6V, Radj_down is calculated as follows:

Vo_nom – Vo = 5.0 – 4.6 = 0.4 V
R1 = 2.32 KΩ, R2 = 8.2 KΩ, Vr = 2.5 V

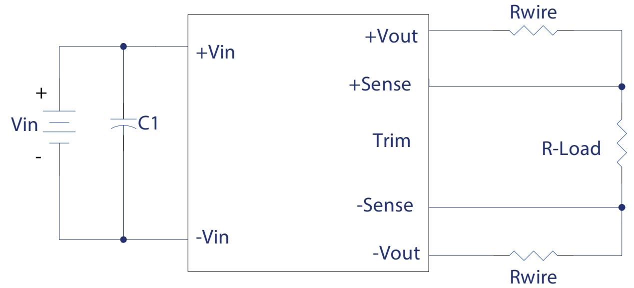
$$R_{adj\_down} = \frac{2.32 \times 4.6\ - 2.5}{0.4} - 8.2 = 3.98\ \ (K\Omega)$$

6.10 Output Remote Sensing

The PHB50W 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 PHB50W 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)] $\leq$ 10% of Vo_nominal

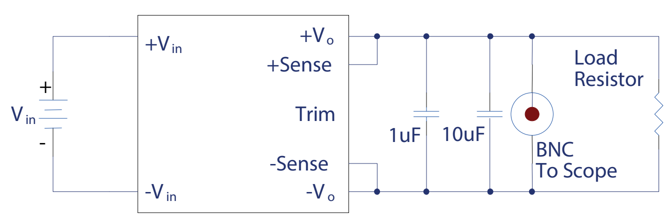
If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module.

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 Vo.set is below nominal value, Pout.max will also decrease accordingly because Io.max is an absolute limit. Thus, Pout.max = Vo.set x Io.max is also an absolute limit.

6.11 Output Ripple and Noise



Output ripple and noise is measured with 1.0uF ceramic and 10uF solid tantalum capacitors across the output (48V: 1uF ceramic capacitors only).

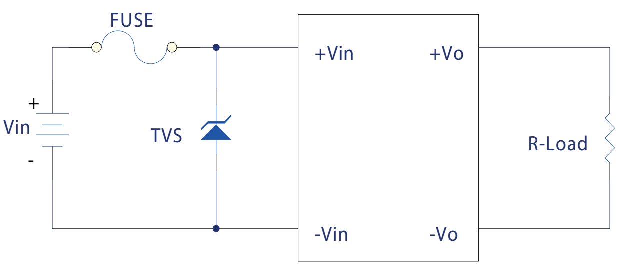
6.12 Output Capacitance

The PHB50W 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. 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. Powerbox converters are designed to work with load capacitance to see technical specifications

7. Safety & EMC

7.1 Input Fusing and Safety Consideration

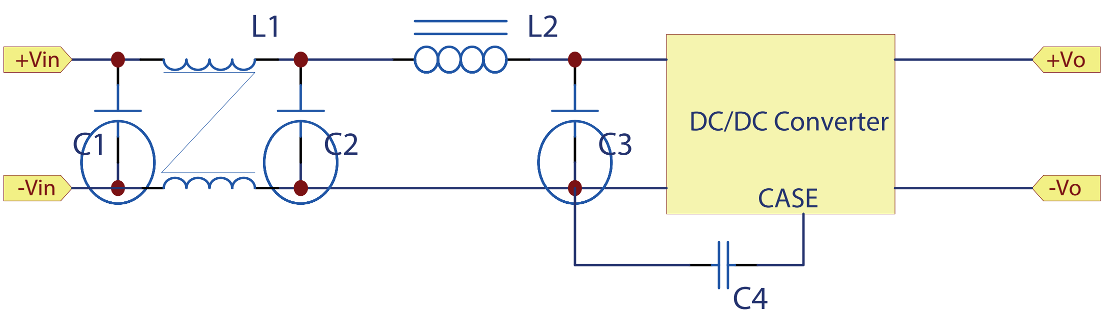
The PHB50W series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 15A time delay fuse for 24Vin models, and 8A for 48Vin models. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage (as shown).



7.2 EMC Considerations

Suggested Circuits for Conducted EMI CLASS A & Class B

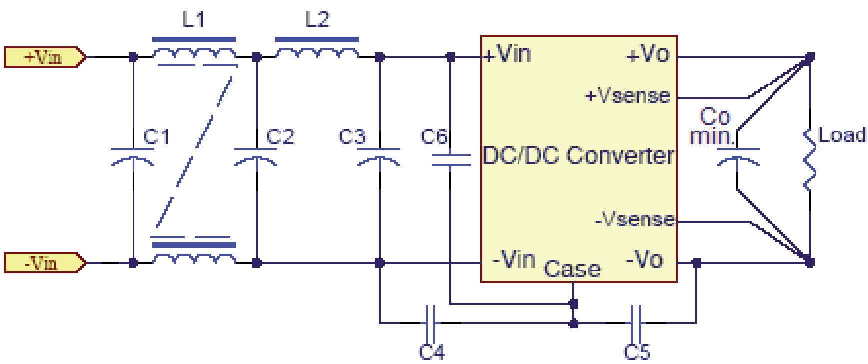
(1) EMI and conducted noise meet EN55022 Class A specifications:



Model No.	C1	C2	C3	C4	L1	L2
PHB50W-24S33	NC	100uF/50V	100uF/50V	2200pF/2KV	Short	3.5uH
PHB50W-24S05	NC	100uF/50V	100uF/50V	2200pF/2KV	Short	3.5uH
PHB50W-24S12	NC	100uF/50V	100uF/50V	2200pF/2KV	Short	3.5uH
PHB50W-24S15	NC	100uF/50V	100uF/50V	2200pF/2KV	Short	3.5uH
PHB50W-24S24	10uF/50V	100uF/50V	100uF/50V	NC	1.5mH	3.4uH
PHB50W-24S28	NC	100uF/50V	100uF/50V	2200pF/2KV	Short	3.4uH
PHB50W-48S33	NC	47uF/100V	47uF/100V	2200pF/2KV	Short	3.4uH
PHB50W-48S05	NC	47uF/100V	47uF/100V	2200pF/2KV	Short	3.4uH
PHB50W-48S12	NC	47uF/100V	47uF/100V	2200pF/2KV	Short	3.4uH
PHB50W-48S15	NC	47uF/100V	47uF/100V	2200pF/2KV	Short	3.4uH
PHB50W-48S28	NC	100uF/100V	100uF/100V	2200pF/2KV	Short	3.4uH
PHB50W-48S24	NC	47uF/100V	47uF/100V	2200pF/2KV	Short	3.4uH

Note: 47uF/100V NIPPON CHEMI-CON KMF series aluminum capacitors, 10uF/50V, C4 is ceramic capacitors.
100uF/50V, 100uF/100V NIPPON CHEMI-CON KY series aluminum capacitors.

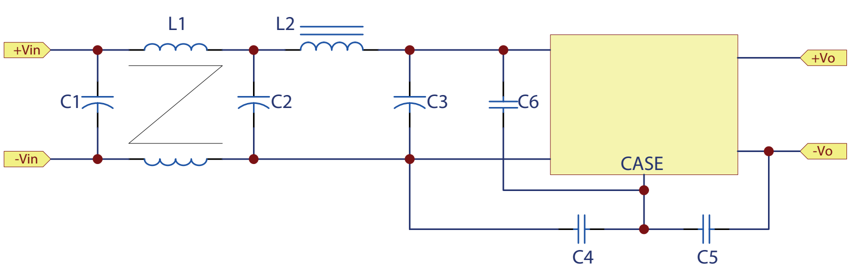
(2) EMI and conducted noise meet EN55022 Class A specifications:



Model No.	C1	C2	C3	C4	C5	C6	L1	L2
PHB50W-24S48	NC	100uF/50V	100uF/50V	NC	NC	NC	Short	3.5uH
PHB50W-48S48	NC	47uF/100V	47uF/100V	2200pF/2KV	NC	NC	Short	3.5uH

Note: C2, C3 NIPPON CHEMI-CON KMF series, C4 is ceramic capacitors, Co min. for Vo: 48V.

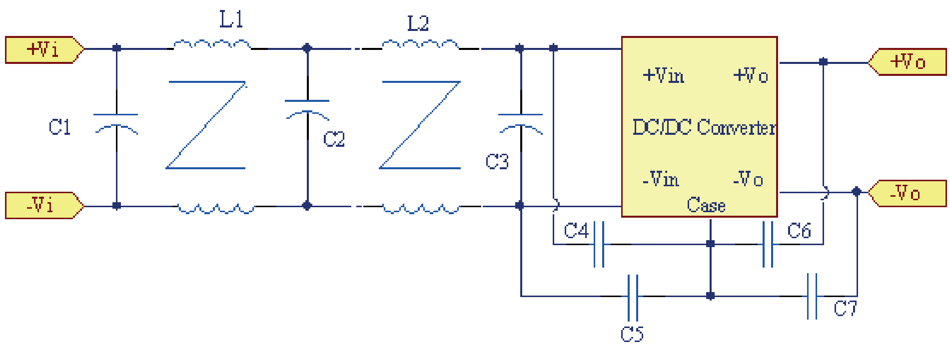
(3) EMI and conducted noise meet EN55022 Class B specifications:



Model No.	C1	C2	C3	C4	C5	C6	L1	L2
PHB50W-24S33	100uF/50V	100uF/50V	100uF/50V	3300pF/2KV	NC	NC	0.65mH	1.5uH
PHB50W-24S05	100uF/50V	100uF/50V	100uF/50V	2200pF/2KV	NC	NC	0.65mH	1.5uH
PHB50W-24S12	100uF/50V	100uF/50V	100uF/50V	3300pF/2KV	NC	NC	0.65mH	1.5uH
PHB50W-24S15	100uF/50V	100uF/50V	100uF/50V	2200pF/2KV	NC	NC	0.65mH	1.5uH
PHB50W-24S24	10uF/50V	100uF/50V	100uF/50V	2200pF/2KV	3300pF/2KV	1000pF/2KV	1.5mH	3.4uH
PHB50W-48S33	47uF/100V	47uF/100V	47uF/100V	3300pF/2KV	3300pF/2KV	1000pF/2KV	1.5mH	3.4uH
PHB50W-48S05	47uF/100V	47uF/100V	47uF/100V	3300pF/2KV	3300pF/2KV	1000pF/2KV	1.5mH	3.4uH
PHB50W-48S12	47uF/100V	47uF/100V	47uF/100V	3300pF/2KV	3300pF/2KV	1000pF/2KV	1.5mH	3.4uH
PHB50W-48S15	47uF/100V	47uF/100V	47uF/100V	3300pF/2KV	3300pF/2KV	1000pF/2KV	1.5mH	3.4uH
PHB50W-48S24	47uF/100V	47uF/100V	47uF/100V	3300pF/2KV	3300pF/2KV	1000pF/2KV	1.5mH	3.4uH

Note: 100uF/50V, 47uF/100V NIPPON CHEMI-CON KMF series aluminum capacitors, 10uF/50V, C4, C5, C6 is ceramic capacitors.

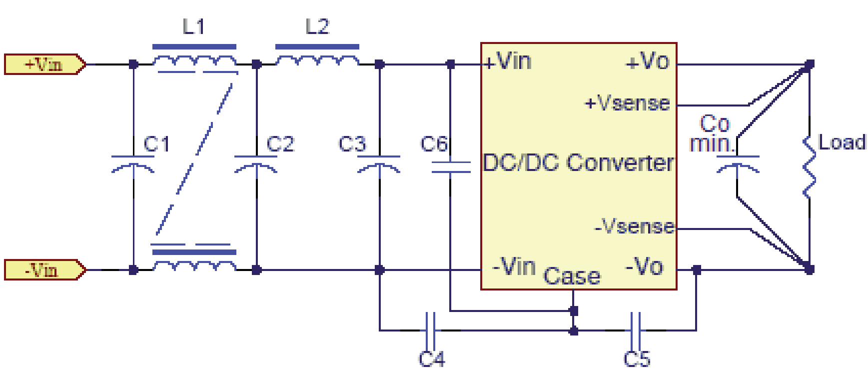
(4) EMI and conducted noise meet EN55022 Class B specifications:



Model No.	C1	C2	C3	C4	C5	C6	C7	L1	L2
PHB50W-24S28	100uF/50V	100uF/50V	NC	NC	1000pF/2KV	NC	NC	0.12mH	0.34mH
PHB50W-48S28	100uF/100V	100uF/100V	NC	NC	1000pF/2KV	NC	NC	0.12mH	0.34mH

Note: C1, C2 NIPPON CHEMI-CON KY series, C5 is ceramic capacitors

(5) EMI and conducted noise meet EN55022 Class B specifications:



Model No.	C1	C2	C3	C4	C5	C6	L1	L2
PHB50W-24S48	10uF/50V	100uF/50V	100uF/50V	4700pF/2KV	2200pF/2KV	1000pF/2KV	1.5mH	3.4uH
PHB50W-48S48	47uF/100V	47uF/100V	47uF/100V	4700pF/2KV	2200pF/2KV	1000pF/2KV	1.5mH	3.4uH

Note: 100uF/50V, 47uF/100VNIPPON CHEMI-CON KMF series, 10uF/50V, C5, C6 is ceramic capacitors, Co min. for Vo: 48V.

8. Part Number

Format: PHB50W – II X OO L-Y

Parameter Symbol	Series PHB50W	Nominal Input Voltage II	Number of Outputs X	Output Voltage OO	Remote ON/OFF Logic L	Option Y
Value	PHB50W	24: 24 Volts 48: 48 Volts	S: Single	33: 3.3 Volts 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

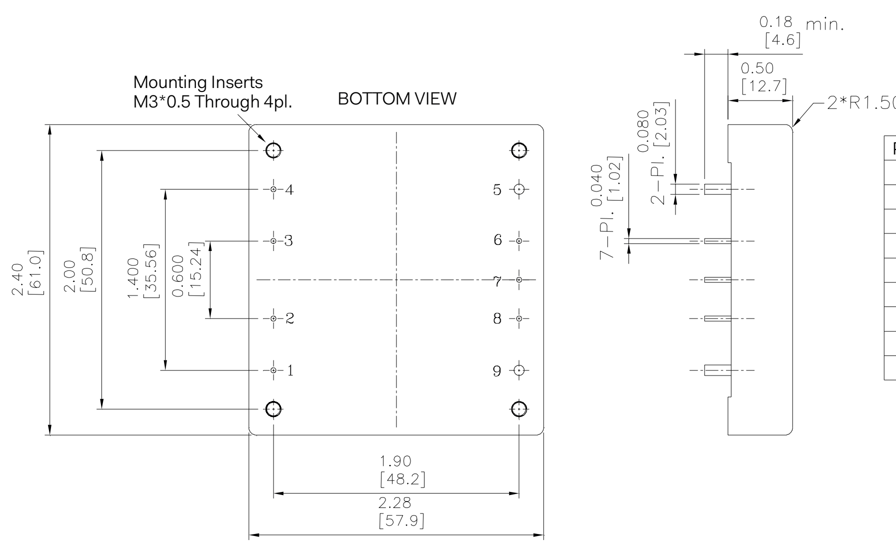
9.1 Mechanical Outline Diagrams

CASE HB

All Dimensions In Inches(mm)

Tolerances Inches: X.XX= ±0.02 , X.XXX= ±0.0 10

Millimeters: X.X= ±0.5 , X.XX=±0.25



Pin	Function
1	+Vin
2	ON/OFF
3	CASE
4	-Vin
5	-Vout
6	-Sense
7	Trim
8	+Sense
9	+Vout