# PDXX SERIES


## 3-5W,AC-DC CONVERTER

PD---- are high efficiency green power modules with least packaging provided by PowerPax. The features of these are wide input voltage, DC and AC all in one, high efficiency, high reliability, low loss, safety isolation etc. They are widely used in industrial, office, civil and medical equipments. EMC and safety standards meet international standards IEC61000 EN60950/UL60601 and IEC60950, and Multi-certificate is in processing.

### PRODUCT FEATURES

1. Universal Input :85 ~ 264VAC,50/60Hz
2. AC and DC all in one (input from the same terminal)
3. Low Ripple and Noise
4. Over output voltage protection , short circuit protection and Over temperature
5. High efficiency, High power density
6. Low loss, green power
7. Multiple models available
8. industrial, medical level specifications
9. 3 years warranty

### MODEL SELECTION

PD05-20B24

- Output Voltage
- Output Style
- Input Voltage
- Isolation Voltage
- Rated Power
- Package Style
- Product Series

### PRODUCT PROGRAM

| Approval | Model | Package | Power | Output (Vo1/Io1) | Output (Iomax/T) | Ripple and Noise (TYP) | Efficiency (%)(TYP) |
|---|---|---|---|---|---|---|---|
| UL/CE60950 | PD03-10B03 | 37.0X23.0X15.0mm | 2.3W | 3.3V/700mA | 900mA/60S | 30mV | 63 |
| | PD03-10B05 | | 3W | 5v/600mA | 750mA/60S | | 72 |
| | PD03-10B09 | | | 9V/330mA | 450mA/60S | | 74 |
| | PD03-10B12 | | | 12V/250mA | 330mA/60S | | 76 |
| | PD03-10B15 | | | 15V/200mA | 250mA/60S | | 76 |
| | PD03-10B24 | | | 24V/125mA | 160mA/60S | | 78 |
| UL/CE60601 | PD05-20B03 | 50.8X25.4X15.16mm | 4.2W | 3.3V/1250mA | 1400mA/60S | 30mV | 66 |
| | PD05-20B05 | | 5W | 5v/1000mA | 1300mA/60S | | 72 |
| | PD05-20B09 | | | 9V/550mA | 700mA/60S | | 74 |
| | PD05-20B12 | | | 12V/420mA | 550mA/60S | | 76 |
| | PD05-20B15 | | | 15V/333mA | 450mA/60S | | 76 |
| | PD05-20B24 | | 5.5W | 24V/230mA | 300mA/60S | | 78 |

Note:
1. Ripple and Noise were measured by the method of anear measure(The details see the anear measure);
2. Unless otherwise specified, all specifications above are measured at rated input voltage and rated output load, TA=25$^{o}$C, humidity < 75%;
3. All specifications stated in this datasheet are subject to the above listed models only. For specifications of non-standard models, please contact our technical Support team.
4. Product can not be continuously over current, or it will cause permanent damage to the device.

### INTPUT SPECIFICATIONS

| | | |
|---|---|---|
| Input Voltage Range | | 85~264VAC, 110~370VDC |
| Input Frequency | | 47~440Hz |
| Input Current | PD03 models<br>PD05 models | 110VAC 230VAC<br>65mA, typ 30mA, typ<br>110mA,typ 70mA, typ |
| Inrush Current | PD03 models<br>PD05 models | 110VAC 230VAC<br>10A, typ 20A, typ<br>10A,typ 20A, typ |
| External input fuse(recommended) | PD03 models<br>PD05 models | 0.5A/250V Slow blow<br>1A/250V Slow blow |

## OUTPUT SPECIFICATIONS

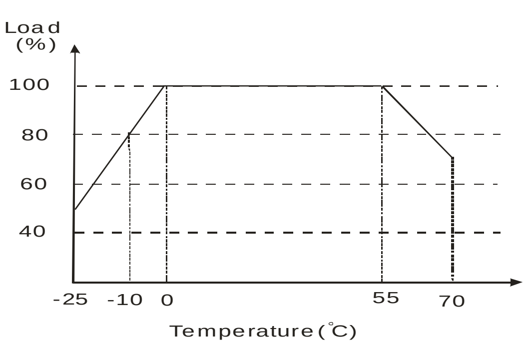
| | | |
|---|---|---|
| Voltage set accuracy | | ±2%(±3% when 3.3V output ) (typ) |
| Input variation | | ±0.5% (typ) |
| Load variation (10% to 100%) | | ±1% (typ) |
| Ripple& noise(p-p) | 20MHz Bandwidth | 30mV(typ) |
| Short circuit protection | | Continuous, and auto resume |
| Over temperature protection | | 150°C(max) |
| Over output voltage protection | PD03 models<br>PD05 models | chip lock up<br>diode clamp and chip lock up |

## COMMON SPECIFICATIONS

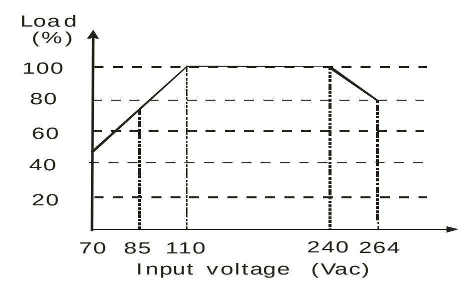
| | | |
|---|---|---|
| Temperature ranges | Operating<br>Power derating (above 55°C):<br>Storage:<br>Case temperature: | -25°C ~ +70°C<br>2% / °C<br>-40°C ~ +105°C<br>+95°C max |
| Hold-up time | (Vin=230VAC) | 50ms(typ) |
| Humidity | | 95%(max) |
| Temperature coefficient | | 0.02%/°C |
| Switching frequency | | 100kHz(typ) |
| Efficiency | | 76% typ |
| I/O-isolation voltage | PD03 models<br>PD05 models | 3000VAC/1Min<br>4000VAC/1Min |
| Leakage current | | None |
| EMI/RFI conducted | PD03 models<br>PD05 models | EN55022, level A<br>EN55011, level A |
| EMC compliance | Electrostatic discharge ESD<br>RF field susceptibility<br>Electrical fast transients/bursts on mainsline<br>PD03 models<br>PD05 models<br>Surge* PD03 models<br>PD05 models | IEC/EN 61000-4-2 level 4 8kV/15kV<br>IEC/EN 61000-4-3<br><br>IEC/EN 61000-4-4 level 3 2kV<br>IEC/EN 61000-4-4 level 4 4kV<br>IEC/EN 61000-4-5 level 3 1kV/2kV<br>IEC/EN 61000-4-5 level 4 2kV/4kV |
| Safety standards | PD03 models<br>PD05 models | IEC60950,EN60950,UL60950<br>IEC60601,EN60601 |
| Safety approvals | PD03 models<br>PD05 models | EN60950,UL60950<br>EN60601-1 |
| Safety Class | | CLASS 2 |
| Case material | | UL94V-0 |
| Install | | PCB |
| MTBF | | >200,000h @25°C |

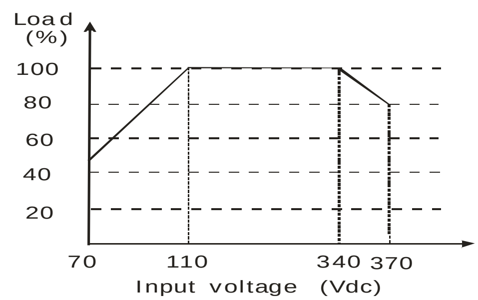
Note: External input pressure sensitive resistor is required to PD03 models at inrush experiment, refer to typical application figure.

## TEMPERATURE VS LOAD

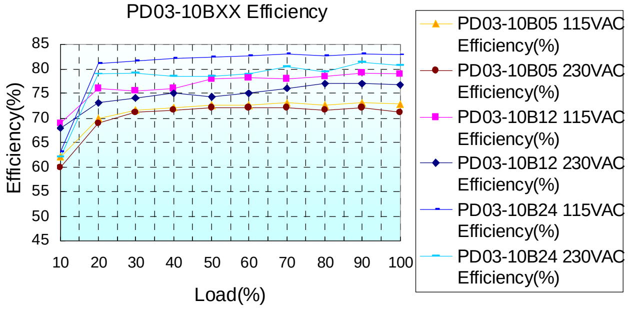


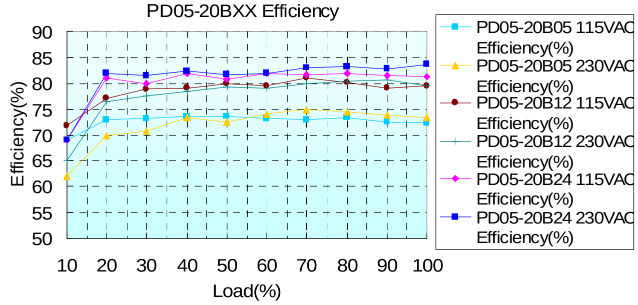

## INPUT VOLTAGE VS LOAD



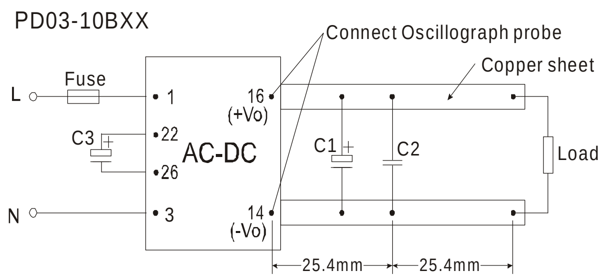



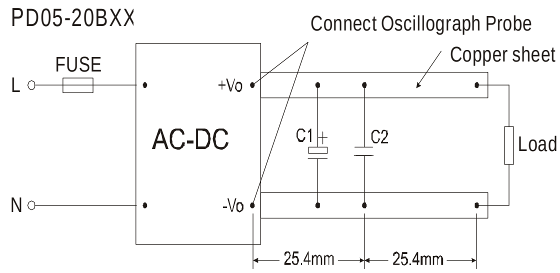
## TYPICAL EFFICIENCY CURVE




## ANEAR MEASURE




## TYPICAL APPLICATIONS

PD03-10B**

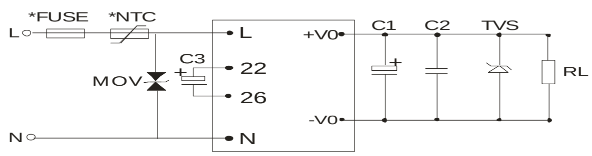



Figure1

PD05-20B**

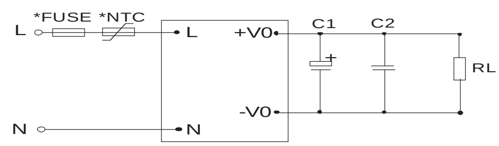



Figure 2

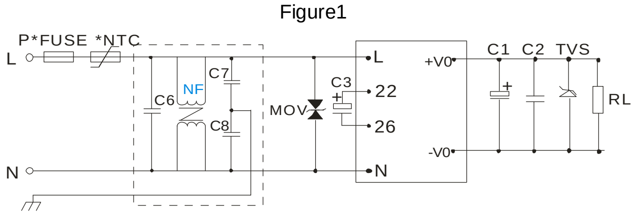



Figure3 LD03 EMC Application Figure

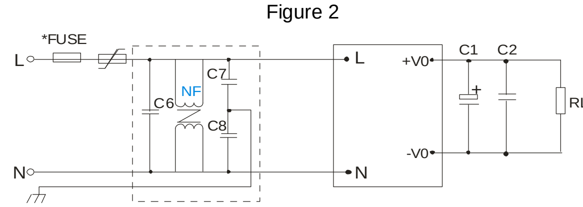



Figure4 LD05 EMC Application Figure

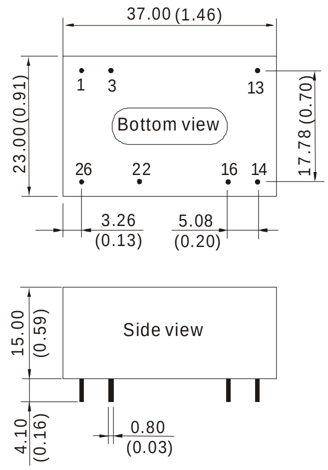
| EXTERNAL CAPACITORS TYPICAL VALUE(Unit: mF) | | | | | | | |
|---|---|---|---|---|---|---|---|
| model | C1 | C2 | C3 | TVS | model | C1 | C2 |
| PD03-10B03 | 150 | 0.1 | 4.7/400V | P4KE6.8A | PD05-20B03 | 47 | 0.1 |
| PD03-10B05 | 150 | 0.1 | 4.7/400V | P4KE6.8A | PD05-20B05 | 47 | 0.1 |
| PD03-10B09 | 120 | 0.1 | 4.7/400V | P4KE12A | PD05-20B09 | 33 | 0.1 |
| PD03-10B12 | 120 | 0.1 | 4.7/400V | P4KE20A | PD05-20B12 | 33 | 0.1 |
| PD03-10B15 | 120 | 0.1 | 4.7/400V | P4KE20A | PD05-20B15 | 33 | 0.1 |
| PD03-10B24 | 68 | 0.1 | 4.7/400V | P4KE30A | PD05-20B24 | 10 | 0.1 |

Note：

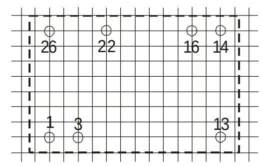
1. Output filtering capacitors C1, C3 is electrolytic capacitors, It is recommended to use high frequency and low impedance electrolytic capacitors. For capacitance and current of capacitor please refer to manufacture's datasheet. Voltage derating of capacitor should be 80% or above. C2 is ceramic capacitor, it is used to filter high frequency noise. TVS is a recommended component to protect post-circuits (when converter fails).
2. MOV is required to LD03 models，model: 471KD05, it is used to protect the device under surge.
3. It is recommended to connect FUSE, the parameter for PD03 models is 0.5A/250V slow blow, for PD05 models is1A/250V slow blow. External input NTC is recommended to use 5D-14 or 10Ω/2W wire-round resistor.
4. If EMC performance is required, recommended to add "EMC filter" at the input end(see figure 3,4)
   C6:X capacitor, recommended parameter 0.1uF/275V;
   C7,C8:Y capacitor, recommended parameter 220pF/2000V;
   NF: common model choke, recommended inductance is about 10mH-30mH.
5. PD03 models: Terminals 22 and 26 are internal rectification and filtering terminals. To protect the models further, it is recommended to connect an electrolytic capacitor C3 (it is recommended to be 4.7uF/400V). If operation voltage of the module is between 160~264VAC, C3 can be removed.

# PD03-10BXX

*First Angle Projection*




RECOMMENDED FOOTPRINT
*Top view,grid:2.54mm(0.1inch),*
*diameter:1.20mm(0.047inch)*




Note:
Unit:mm(inch)
Pin diameter:0.80±0.05mm
Pin tolerances:±0.25mm
General tolerances:±0.50mm
Weight: 25g

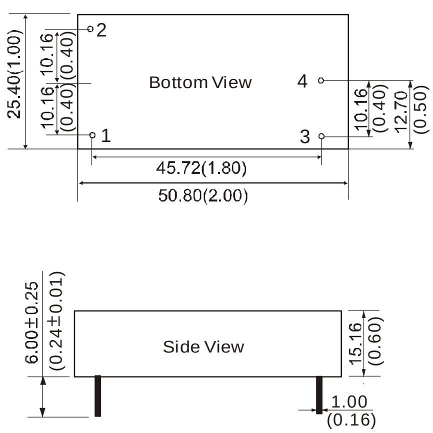
FOOTPRINT DETAILS

| PIN | FUNCTION |
|---|---|
| 1 | L |
| 3 | N |
| 13 | NC |
| 14 | -Vo |
| 16 | +Vo |
| 22 | +Vin(DC) |
| 26 | -Vin(DC) |

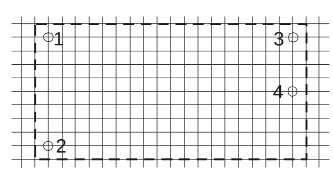
NC:No connection

# PD05-20BXX

*First Angle Projection*




RECOMMENDED FOOTPRINT
*Top view,grid:2.54mm(0.1inch),*
*diameter:1.60mm(0.063inch)*




Note:
Unit:mm(inch)
Pin diameter:1.00±0.10mm
General tolerances:±0.50mm
Weight: 35g

FOOTPRINT DETAILS

| Pin | Function |
|---|---|
| 1 | N |
| 2 | L |
| 3 | +Vo |
| 4 | -Vo |

# AC-DC Converter Application Guidelines

## 1. Foreword

The following guidelines should be carefully read prior to converter use. Improper use may result in the risk of electric shock, damaging the converter, or fire.

### 1. 1 Risk of Injury

A. To avoid the risk of burns, do not touch the heat sink or the converter's case.
B. Do not touch the input terminals or open the case and touch internal components, which cold result in electric shock or burns.
C. When the converter is in operation, keep hands and face at a distance to avoid potential injury during improper operation.

### 1. 2 Installation Advice

A. Please make sure the input terminals and signal terminals are properly connected in accordance with the stated datasheet requirements.
B. To ensure safe operation and meet safety standard requirements, install a ***slow blow*** fuse at input of the converter.
C. Installation and use of AC/DC converters should be handled by a qualified professional.
D. AC/DC converters are used in the primary transmission stage of a design and thus, should be installed in compliance with certain safety standards.
E. Please ensure that the input and output of the converter are incorporated into the design out of the reach of the end user. The end product manufacturer should also ensure that the converter is protected from being shorted by any service engineer or any metal filings.
F. The application circuits and parameters shown are for reference only. All parameters and circuits are to be verified before completing the circuit design.
G. These guidelines are subject to change without notice; please check our website for updates.

## 2. General AC-DC Converter Applications

### 2.1 Basic Application Circuit

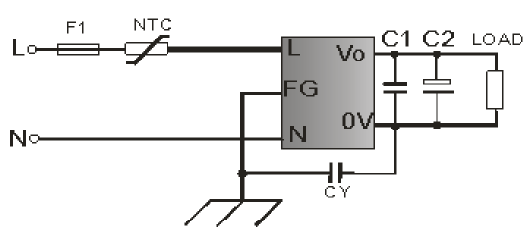



Figure 1.General AC-DC converter applications circuit

In Figure 1, F1 refers to the input fuse. Proper fuse selection should be a safety agency approved, slow blow fuse. Selection of the proper fuse rating is necessary to ensure power converter and system protection (potential failure if the rating is too high) and prevent false fuse blowing (which could happen if the rating is too low). Below is the formula to calculate the proper rating:

$$\mathbf{I} = \mathbf{3} \times \mathbf{V_o1} \times \mathbf{I_o1} / \boldsymbol{\eta} / \mathbf{Vin(min.)}$$

$\mathbf{V_o1}$ = output voltage

$\mathbf{I_o1}$ = output current;

$\boldsymbol{\eta}$ = the converter's efficiency;

**Vin(min)** = the minimum input voltage

Futher circuit notations:

- **NTC** is a thermistor.
- **CY** and CX are safety capacitors.
- **C1** is a high frequency ceramic capacitor or polyester capacitor, 0.1μF/50V.
- **C2** is output filtering high frequency aluminum electrolytic capacitor. Select a 220μF rating if the output current is greater than 5A, or a 100μF rating if the output current is less than 5A. The insulation voltage should be derated to less than 80% of rated value.

For dual or triple output converters, the circuit of input side remains the same and the outputs should be considered independently in component selection (see Figure 3).

The application circuit shown in Figure 1 is typical application circuit, whereby all PowerPax products will meet EMI Class B, and Class 3 lightening strike and surge testing (see component datasheets for more details). To comply with more stringent EMC testing, additional filtering should be incorporated. See Figure 2 for a suggested filtering circuit.

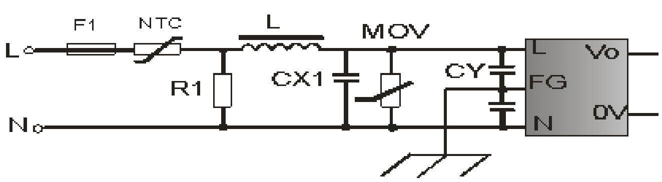



Figure 2. Input filter circuit

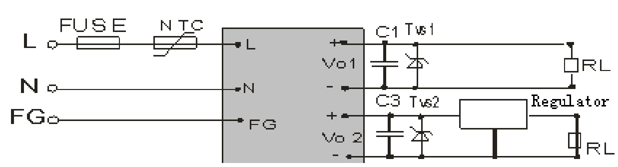



Figure 3. Typical application circuit

For multi-output converters, the main output is typically a fully regulated output. If the end application requires critical regulation on the auxiliary output(s), a linear regulator or other regular should be added after the converter. (Note: Some PowerPax converters have built in linear regulators; please contact our Technical Department for details).

## 3. AC-DC Converter Safety Related Design Notes

### 3.1 Marking Requirements

Wherever, there are fuses, protective grounds, or switches, clear symbols should be indicated according safety standards. Touchable dangerous high voltage and energy sources should be marked with "**Caution!"** indications.

### 3.2 Input Cable Requirements:

Input cables of L, N and E should be brown, blue and yellow/green cables, respectively. Ensure that the ground cable (yellow & green cable) of Type I devices (those that rely on basic insulation and protection ground to avoid electric shock) are securely connected to the ground, and the earth resistance is lower than 0.1Ω

### 3.3 Clearance and Creepage

For Type I devices, ensure:

- L and N are in front of the fuse.
- The clearance distance between the input and the metal case is above 2mm and creepage is above 2.5mm.

For Type II devices (those that rely on strengthened insulation or double insulation to avoid electric shock) ensure:

- L and N are in front of the fuse
- The clearance distance between the input and the metal case is above 2mm and creepage is above 2.5mm.
- The clearance between the input and the metal case or SELV is above 4mm, and creepage of that is above 5mm.

### 3.4 Input energy

If the input capacitor is large, a discharge resistor may be added to ensure that, after disconnect, the voltage held between Input L, N, and the protective ground will be discharged to 37% of its maximum value or below. In Figure 2, R1 is the discharge resistor.

## 4. Heat Dissipation in AC/DC Converter Module Applications

Trends toward higher density in AC/DC module designs make heat dissipation an important concern. The effect of heat on the electrolytic capacitor is of particular concern, as the life of such capacitors can be drastically reduced when operated in a constant high temperature environment, leading to a higher potential for failure. Proper handling of heat will increase the life of the converter and surrounding components, thus lowering risk of failures. Some suggestions for handling dissipated heat are summarized, below:

**(1) Ambient Air Cooling**

For miniature and high power density converters, free air cooling is recommended, mainly due to cost and space concerns.

- Heat dissipates to the ambient air through the converter case or exposed surfaces. Heat may also dissipate to ambient air if there is a gap between the converter and the PCB.
- Heat dissipates from the converter case and exposed surfaces to PCB by radiation.
- Heat conducts through terminals (pins) to PCB.

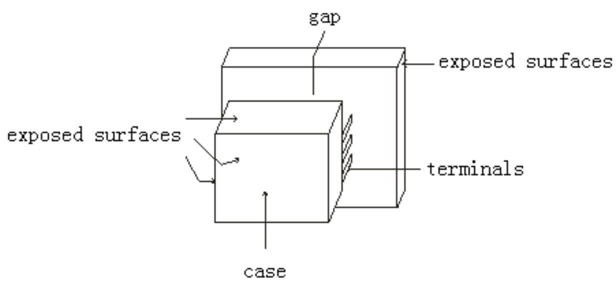



Figure 4. converter assembled on PCB

In such applications, please pay particular attention to:

A. Air Flow - Because the heat dissipation is mainly through convection and radiation, the converter needs an environment with good air flow. It may be helpful to design heat dissipation venting holes throughout the end product, near the converter's location. For best convection cooling, ensure that air flow is not blocked by large components

B. Layout of Heat Generating Components - In most applications, the AC/DC converter is usually not the only heat generating component. It is recommended to keep a good distance between each heat generating component to minimize heat dissipating clusters.

C. PCB Design - The PCB, which the power converter is assembled on, is not only a base to mount the converter, but also acts as a heat sink for it, therefore heat dissipation should be considered in PCB layout. We recommend extended the area of the main copper loop and decrease the component density on the PCB to improve the ambient environment.

**(2) Heat Sinks**

When free air convection is not sufficient enough, we recommend the use of a heat sink for further cooling. As the converters are filled with heat conductive silicon or epoxy, the heat distribution in converter is even and it radiates from the converter to the air. The efficiency of this convection is dependent on the size of the surface area of the converter. The use of heat sinks is a practical method to add surface area and improve the convection. There are many kinds of heat sinks available in the market. PowerPax recommends considering the following factors in selecting a heat sink:

- The heat sink should be made of a good heat conducting material, such as aluminum and copper.
- The larger the surface area, the better the radiation. Therefore, heat sinks usually have a ridged surface or special coatings to make a larger surface area.
- Use the longest and thickest possible heat sink for best convection.

Heat sinks are best attached to the converter's surface, where the difference in temperature between the surface and the ambient is largest. The use of heat conductive material between the heat sink and the converter's surface to make a better contact and to improve heat conductance is suggested. To avoid case distortion, please do not affix the heat sink too firmly to the converter case.

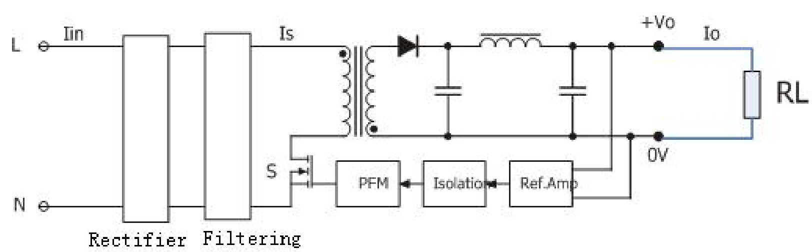
**(3) Forced Air Cooling**

In some systems, where a heat sink does not effectively reduce the ambient temperature, a fan is used to improve the heat radiation. Fans can lower the surface temperature of the converter, but large fans also occupy extra space in the system. It is important to select a suitable fan size, where the speed of the fan will determines how effective it is. The faster the speed, the better the effect on reducing radiated heat. As high speed will also cause increased noise, there is a need to balance the choice between the how effective the fan is against how much audible noise it generates.

A long, rectangular shaped AC/DC converter should use a horizontal fan, and channeled heat sinks should use vertical fans, in order to encourage air flow through the channels.

## 5. Input Under Voltage Impact

### 5.1 Block Diagram of AC/DC Converter

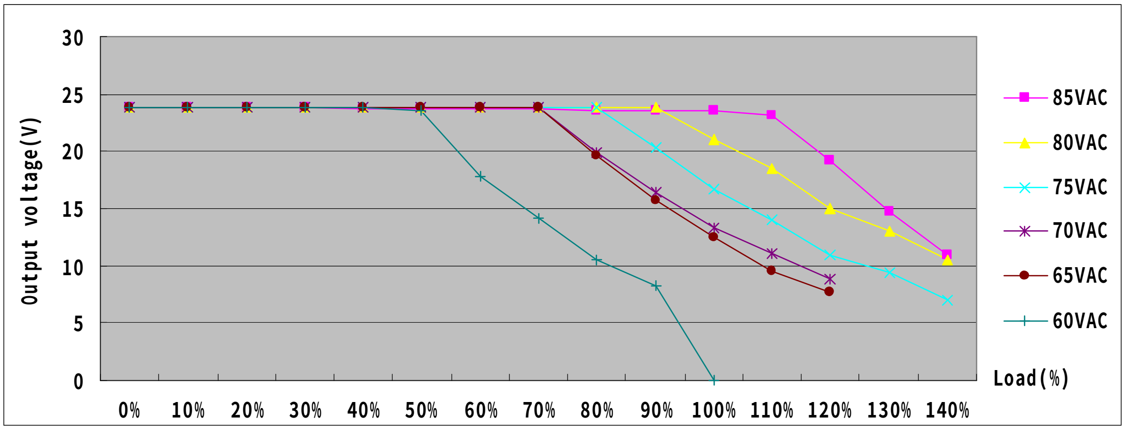



### 5.2 Impact to Converter Reliability

The input voltage range of PowerPax AC/DC converters is 85~264VAC or 120~370VDC. When the converter is operated within the rated input voltage range, the output current can be used up to the maximum rated specification. The total output power is $I_o$ x $V_o$.

If the converter is operated with an input voltage that is under the rated voltage, offering the same output power of $I_o$ x $V_o$ , causes the current (Is) at the transistor (S) to be increased. Long term operation under this condition will damage the transistor (S).

## 5.3 Input Voltage vs Load Capability (PD03-00B24)




| Load | 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | 110% | 120% | 130% | 140% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 85VAC | 23.85 | 23.82 | 23.79 | 23.77 | 23.74 | 23.71 | 23.68 | 23.65 | 23.61 | 23.58 | 23.57 | 23.19 | 19.2 | 14.7 | 11 |
| 80VAC | 23.83 | 23.82 | 23.82 | 23.83 | 23.82 | 23.82 | 23.81 | 23.81 | 23.81 | 23.8 | 21 | 18.5 | 15 | 13 | 10.5 |
| 75VAC | 23.83 | 23.83 | 23.83 | 23.83 | 23.82 | 23.82 | 23.82 | 23.81 | 23.77 | 20.29 | 16.65 | 14.02 | 10.98 | 9.39 | 7.04 |
| 70VAC | 23.83 | 23.83 | 23.83 | 23.83 | 23.82 | 23.82 | 23.81 | 23.79 | 19.96 | 16.44 | 13.32 | 11.14 | 8.79 | | |
| 65VAC | 23.83 | 23.83 | 23.83 | 23.83 | 23.82 | 23.82 | 23.82 | 23.8 | 19.6 | 15.67 | 12.46 | 9.57 | 7.65 | | |
| 60VAC | 23.83 | 23.83 | 23.83 | 23.83 | 23.82 | 23.51 | 17.86 | 14.13 | 10.52 | 8.28 | 0 | | | | |