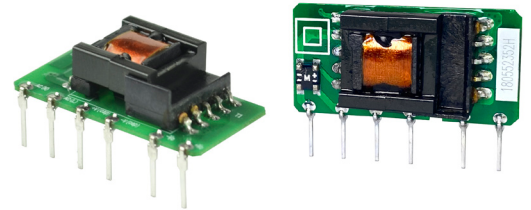


**SERIES:** PBO-3 | **DESCRIPTION:** AC-DC POWER SUPPLY

**FEATURES**

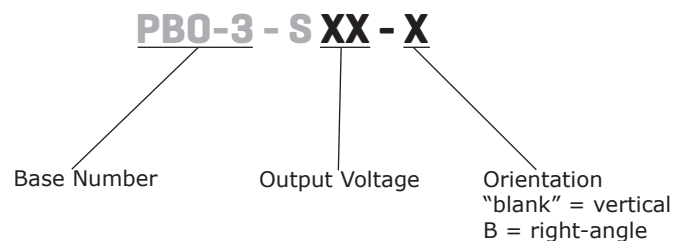
- up to 3 W continuous power
- ultra-compact SIP package
- available in straight-pin and bent-pin configurations
- wide input voltage range
- over current and short circuit protections
- 3,000 Vac isolation
- IEC, EN, UL 62368 safety approvals
- efficiency up to 77%



| MODEL                     | output voltage<br>(Vdc) | output current |             | output power<br>max<br>(W) | ripple and noise <sup>1</sup><br>max<br>(mVp-p) | efficiency <sup>2</sup><br>typ<br>(%) |
|---------------------------|-------------------------|----------------|-------------|----------------------------|---|---------------------------------------|
|                           |                         | min<br>(mA)    | max<br>(mA) |                            |   |                                       |
| PBO-3-S3.3 <sup>4,5</sup> | 3.3                     | 60             | 600         | 1.98                       | 150   | 65                                    |
| PBO-3-S5 <sup>4,5</sup>   | 5                       | 60             | 600         | 3                          | 150   | 70                                    |
| PBO-3-S9 <sup>4</sup>     | 9                       | 33.3           | 333         | 3                          | 150   | 73                                    |
| PBO-3-S12 <sup>4,5</sup>  | 12                      | 25             | 250         | 3                          | 150   | 74                                    |
| PBO-3-S15 <sup>5</sup>    | 15                      | 20             | 200         | 3                          | 150   | 75                                    |
| PBO-3-S24 <sup>4,5</sup>  | 24                      | 12.5           | 125         | 3                          | 150   | 77                                    |

- Notes:
1. At full load, nominal input, 20 MHz bandwidth oscilloscope, with a 1  $\mu$ F ceramic and 10  $\mu$ F electrolytic capacitor on the output.
  2. At 230 Vac input.
  3. All specifications are measured at  $T_a=25^\circ\text{C}$ , humidity <75%, 115 or 230 Vac input voltage, and rated output load unless otherwise specified.
  4. Discontinued model - vertical pin version.
  5. Discontinued model - right-angle pin version.

**PART NUMBER KEY**



## INPUT

| parameter                 | conditions/description | min | typ | max  | units |
|---------------------------|------------------------|-----|-----|------|-------|
| voltage                   |                        | 85  |     | 305  | Vac   |
|                           |                        | 70  |     | 430  | Vdc   |
| frequency                 |                        | 47  |     | 63   | Hz    |
| current                   | at 115 Vac             |     |     | 0.12 | A     |
|                           | at 277 Vac             |     |     | 0.06 | A     |
| inrush current            | at 115 Vac             |     | 13  |      | A     |
|                           | at 277 Vac             |     | 23  |      | A     |
| no load power consumption | at 230 Vac             |     |     | 0.25 | W     |

## OUTPUT

| parameter                  | conditions/description                    | min | typ          | max | units  |
|----------------------------|---|-----|--------------|-----|--------|
| capacitive load            | 3.3 Vdc output models                     |     |              | 820 | μF     |
|                            | 5 Vdc output models                       |     |              | 680 | μF     |
|                            | 9/12 Vdc output models                    |     |              | 470 | μF     |
|                            | 15 Vdc output models                      |     |              | 330 | μF     |
|                            | 24 Vdc output models                      |     |              | 100 | μF     |
| initial set point accuracy | 3.3 Vdc output models                     |     |              | ±6  | %      |
|                            | all other models                          |     |              | ±5  | %      |
| line regulation            | at full load                              |     |              |     |        |
|                            | 3.3 Vdc output models<br>all other models |     | ±2.5<br>±1.5 |     | %<br>% |
| load regulation            | from 10~100% load                         |     |              |     |        |
|                            | 24 Vdc output models<br>all other models  |     | ±6<br>±3     |     | %<br>% |
| switching frequency        |   |     |              | 65  | kHz    |
| temperature coefficient    |   |     | ±0.15        |     | %/°C   |

## PROTECTIONS

| parameter                | conditions/description    | min | typ | max | units |
|--------------------------|---------------------------|-----|-----|-----|-------|
| over current protection  | auto recovery             | 110 |     | 500 | %     |
| short circuit protection | continuous, auto recovery |     |     |     |       |

## SAFETY & COMPLIANCE

| parameter           | conditions/description  | min   | typ | max | units |
|---------------------|---|-------|-----|-----|-------|
| isolation voltage   | input to output for 1 minute  | 3,000 |     |     | Vac   |
| safety approvals    | certified to 62368: IEC, EN, UL   |       |     |     |       |
| safety class        | class II  |       |     |     |       |
| conducted emissions | CISPR22/EN55022 Class A, (recommended circuit 1,2,6)  |       |     |     |       |
|                     | CISPR22/EN55022 Class B, (recommended circuit 3,4,5)  |       |     |     |       |
| radiated emissions  | CISPR22/EN55022 Class A, (recommended circuit 1,2,6)  |       |     |     |       |
|                     | CISPR22/EN55022 Class B, (recommended circuit 3,4,5)  |       |     |     |       |
| ESD                 | IEC/EN61000-4-2, contact ±4 kV, perf. Criteria B  |       |     |     |       |
| radiated immunity   | IEC/EN61000-4-3, 10V/m, perf. Criteria A  |       |     |     |       |
| EFT/burst           | IEC/EN61000-4-4, ±2 kV (recommended circuit 1,2,3), perf. Criteria B                                |       |     |     |       |
|                     | IEC/EN61000-4-4, ±4 kV (recommended circuit 4,5,6), perf. Criteria B                                |       |     |     |       |
| surge               | IEC/EN61000-4-5, line to line ±1 kV (recommended circuit 1,2), perf. Criteria B                     |       |     |     |       |
|                     | IEC/EN61000-4-5, line to line ±2 kV (recommended circuit 6), perf. Criteria B                       |       |     |     |       |
|                     | IEC/EN61000-4-5, line to line ±1 kV/line to ground ±2 kV (recommended circuit 3) perf. Criteria B   |       |     |     |       |
|                     | IEC/EN61000-4-5, line to line ±2 kV/line to ground ±4 kV (recommended circuit 4,5) perf. Criteria B |       |     |     |       |
| conducted immunity  | IEC/EN61000-4-6 Class A, 10 Vr.m.s, perf. Criteria A  |       |     |     |       |

## SAFETY & COMPLIANCE (CONTINUED)

| parameter                    | conditions/description                     | min     | typ | max | units |
|------------------------------|--|---------|-----|-----|-------|
| voltage dips & interruptions | IEC/EN61000-4-11, 0%-70%, perf. Criteria B |         |     |     |       |
| MTBF                         | as per MIL-HDBK-217F at 25 °C              | 300,000 |     |     | hours |
| RoHS                         | 2011/65/EU                                 |         |     |     |       |

Notes: 1. The power supply is considered a component which will be installed into final equipment. The final equipment still must be tested to meet the necessary EMC directives.

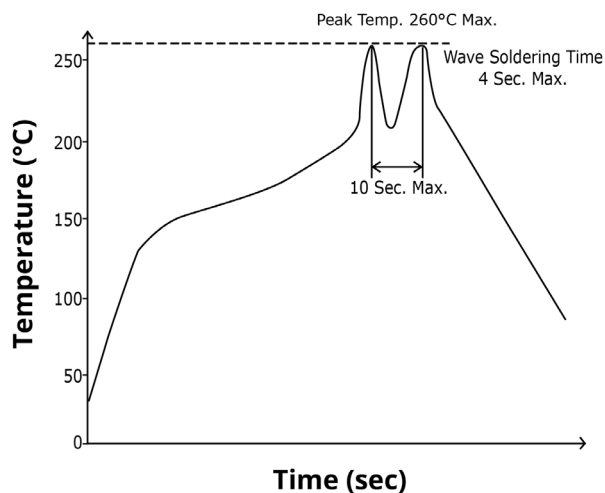
## ENVIRONMENTAL

| parameter             | conditions/description | min | typ | max | units |
|-----------------------|------------------------|-----|-----|-----|-------|
| operating temperature | see derating curves    | -40 |     | 85  | °C    |
| storage temperature   |                        | -40 |     | 105 | °C    |
| storage humidity      | non-condensing         |     |     | 85  | %     |

## SOLDERABILITY

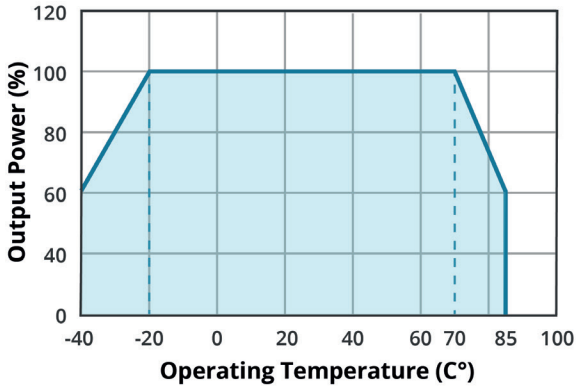
| parameter      | conditions/description | min | typ | max | units |
|----------------|------------------------|-----|-----|-----|-------|
| hand soldering | for 3~5 seconds        | 350 | 360 | 370 | °C    |
| wave soldering | for 5~10 seconds       | 255 | 260 | 265 | °C    |

### WAVE SOLDERING PROFILE

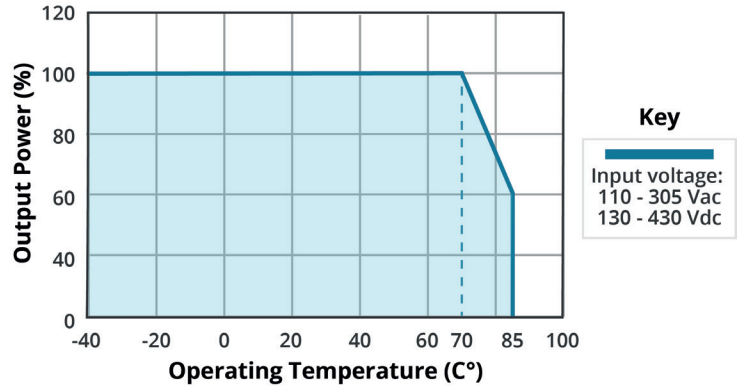


## DERATING CURVES

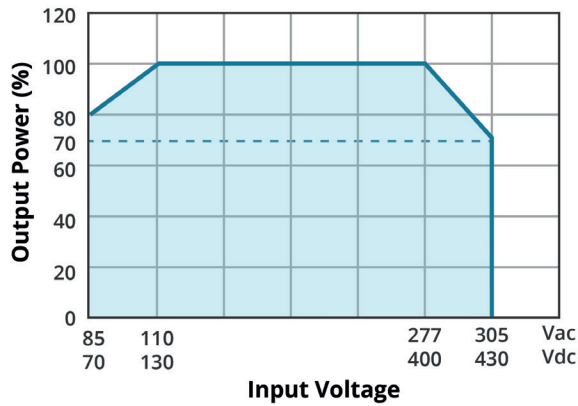
**TEMPERATURE DERATING CURVE**



**TEMPERATURE DERATING CURVE**

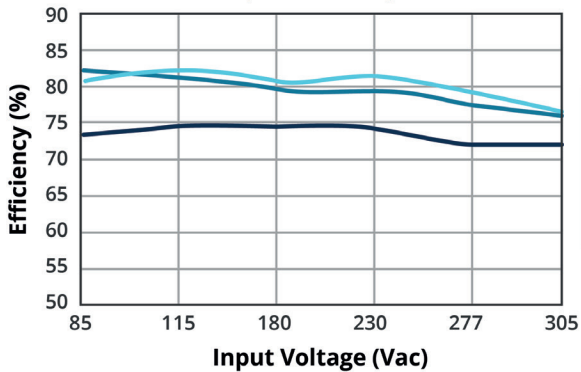


**INPUT VOLTAGE DERATING CURVE (25°C)**

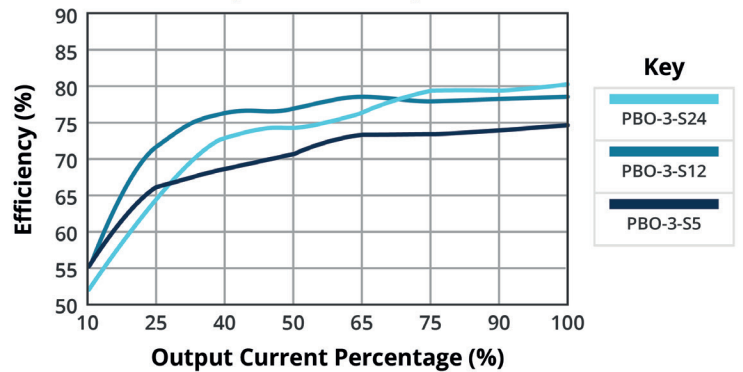


## EFFICIENCY CURVES

**EFFICIENCY VS INPUT VOLTAGE (FULL LOAD)**



**EFFICIENCY VS OUTPUT LOAD (VIN = 230 VAC)**



## MECHANICAL

| parameter  | conditions/description  | min | typ | max | units    |
|------------|---|-----|-----|-----|----------|
| dimensions | vertical models: 35.00 x 11.00 x 18.00 (1.38 x 0.43 x 0.71 inches)<br>right-angle models: 35.00 x 18.00 x 11.00 (1.38 x 0.71 x 0.43 inches) |     |     |     | mm<br>mm |
| weight     |   |     | 6   |     | g        |

## MECHANICAL DRAWING

### Vertical Orientation

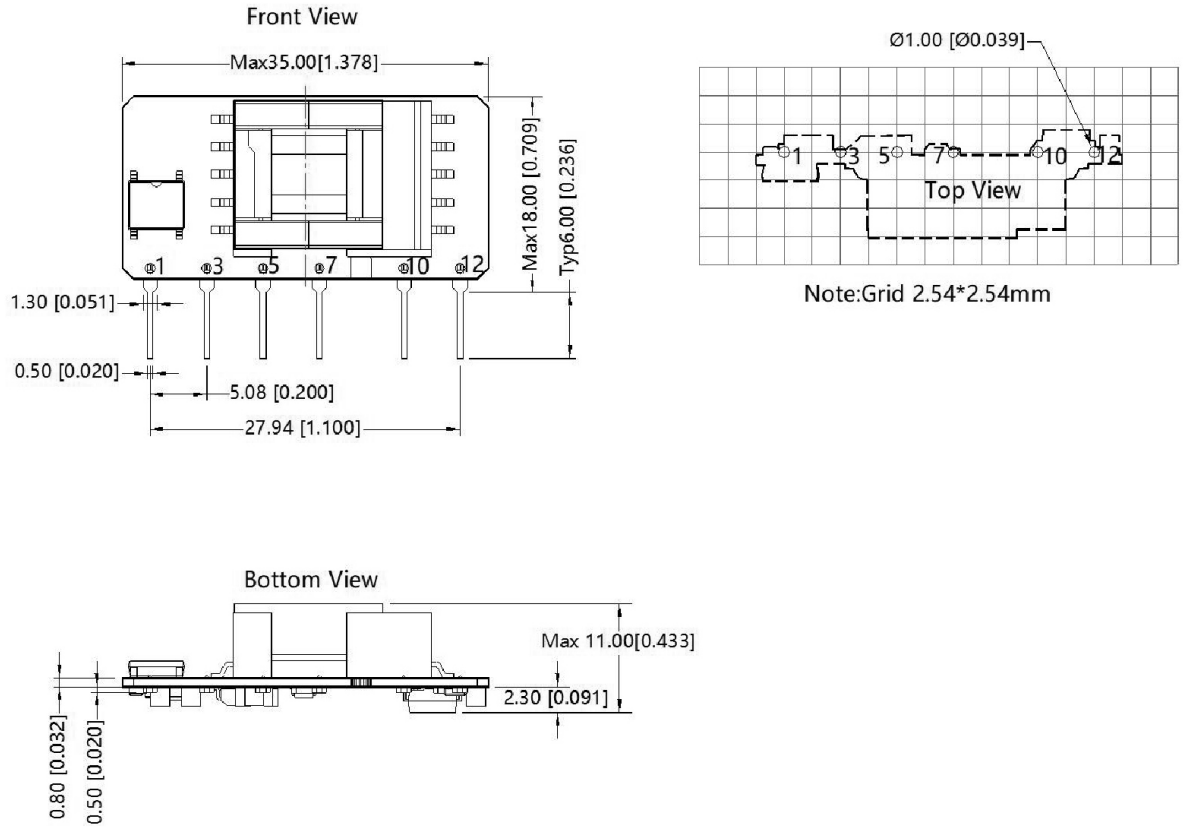
units: mm[inch]

pin section tolerance:  $\pm 0.10[\pm 0.004]$

tolerance:  $\pm 0.50[\pm 0.020]$

| PIN CONNECTIONS |          |
|-----------------|----------|
| PIN             | Function |
| 1               | AC (N)   |
| 3               | AC (L)   |
| 5               | +V(CAP)  |
| 7               | -V(CAP)  |
| 10              | -Vo      |
| 12              | +Vo      |

Note: 1. It is required to add C1 between pins 5 & 7 (see application circuits).



## MECHANICAL DRAWING (CONTINUED)

### Right-angle Orientation

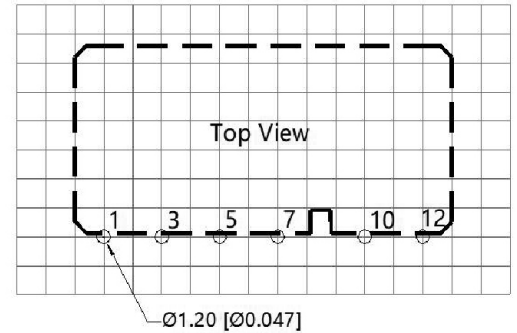
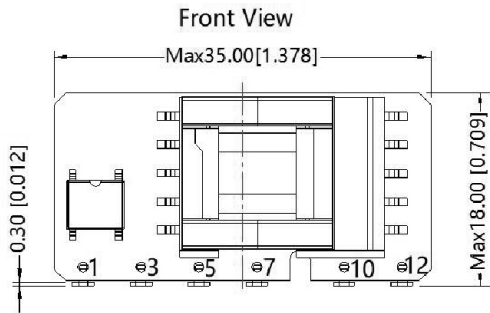
units: mm[inch]

pin section tolerance:  $\pm 0.10[\pm 0.004]$

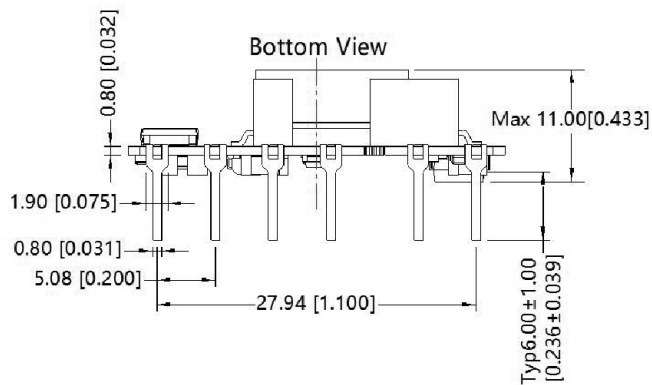
tolerance:  $\pm 0.50[\pm 0.020]$

| PIN CONNECTIONS |          |
|-----------------|----------|
| PIN             | Function |
| 1               | AC (N)   |
| 3               | AC (L)   |
| 5               | +V(CAP)  |
| 7               | -V(CAP)  |
| 10              | -Vo      |
| 12              | +Vo      |

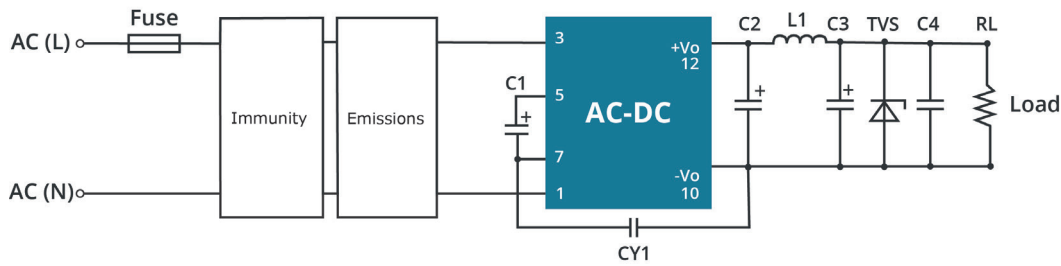
Note: 1. It is required to add C1 between pins 5 & 7 (see application circuits).



Note: Grid 2.54\*2.54mm



## APPLICATION DESIGN REFERENCE



| PBO-3 series additional circuits design reference |          |   |         |
|---|----------|---|---------|
| Immunity design circuits for reference            |          | Emissions design circuits for reference |         |
| Class III   | Class IV | Class A                                 | Class B |
|   |          |   |         |

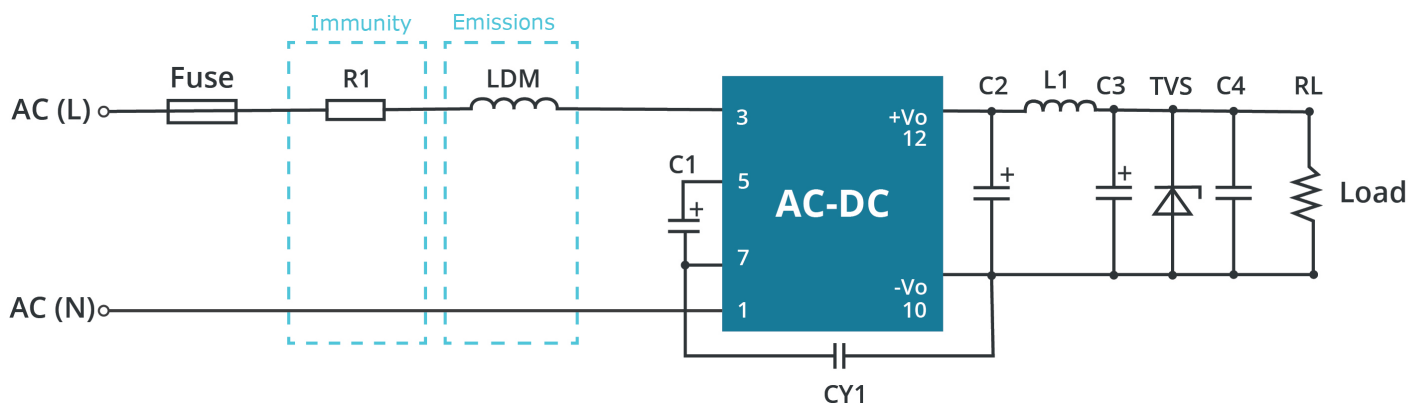
| PBO-3 Series additional component selection guide |                 |  |                                   |                  |               |           |                |
|---|-----------------|--|-----------------------------------|------------------|---------------|-----------|----------------|
| Part no.  | FUSE (required) | C1 (required)                                    | C2 (required)                     | L1 (required)    | C3 (required) | C4        | CY1 (required) |
| PBO-3-S3.3  | 1A/300V         | 10μF/450V (-20°C~85°C)<br>22μF/450V (-40°C~85°C) | 270μF/16V (solid-state capacitor) | 4.7μH (max 60mΩ) | 120μF/25V     | 0.1μF/50V | 1.0nF/400 Vac  |
| PBO-3-S5  |                 |  |                                   |                  | 68μF/35V      |           |                |
| PBO-3-S9  |                 |  |                                   |                  | 47μF/35V      |           |                |
| PBO-3-S12   |                 |  |                                   |                  | 220μF/35V     |           |                |
| PBO-3-S15   |                 |  |                                   |                  |               |           |                |
| PBO-3-S24   |                 |  |                                   |                  |               |           |                |

Note: 1. C1: Input capacitors, C2: output storage capacitors, must be connected externally.  
 2. It is recommended using an electrolytic capacitor with high frequency and low ESR rating for C3. Combined with C2, L1, they form a pi-type filter circuit. Choose a capacitor voltage rating with at least 20% margin, in other words not exceeding 80%. C4 is a ceramic capacitor, used for filtering high frequency noise. A suppressor diode (TVS) is a recommended to protect the application in case of a converter failure and specification should be 1.2 times of the output voltage.

| PBO-3 Series Environmental and EMC selection guide |                               |   |                     |                         |           |           |
|--|-------------------------------|---|---------------------|-------------------------|-----------|-----------|
| Recommended circuit                                | Application environmental     | Typical industry  | Input voltage range | Environment temperature | Emissions | Immunity  |
| 1/2  | Basic application             | None  | 85 ~ 305 Vac        | -40° ~ 88°C             | Class A   | Class III |
| 3  | Indoor civil environment      | Smart home / Home appliances (2Y)   |                     | -25° ~ 55°C             | Class B   | Class III |
|  | Indoor general environment    | Intelligent building / Intelligent agriculture                                    |                     | -25° ~ 55°C             | Class B   | Class IV  |
| 4/5  | Indoor industrial environment | Manufacturing workshop  |                     | -25° ~ 55°C             | Class B   | Class IV  |
| 6  | Outdoor general environment   | ITS / Video monitoring / Charging point / Communication / Security and protection |                     | -40° ~ 85°C             | Class A   | Class IV  |

## EMC RECOMMENDED CIRCUIT

**Circuit 1**

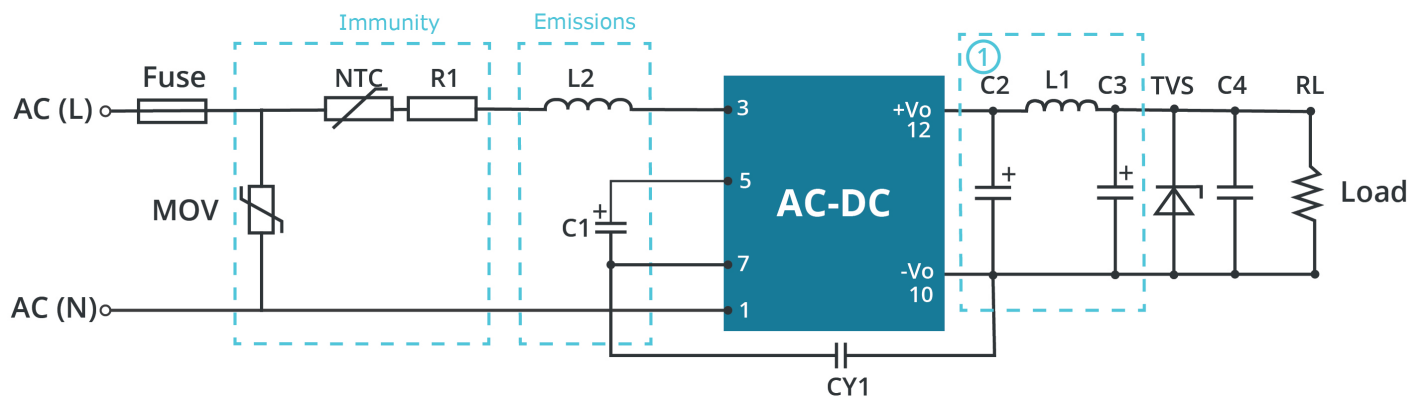


**Table 1**

| Application enviromental | Ambient temperature range | Immunity Class | Emissions Class |
|--------------------------|---------------------------|----------------|-----------------|
| Basic application        | -40°C ~ 85°C              | Class III      | Class A         |

| Component       | Recommended value  |
|-----------------|--------------------|
| R1              | 12Ω/3W             |
| LDM             | 4.7mH              |
| FUSE (required) | 1A/300V, slow-blow |

**Circuit 2**



**Table 2**

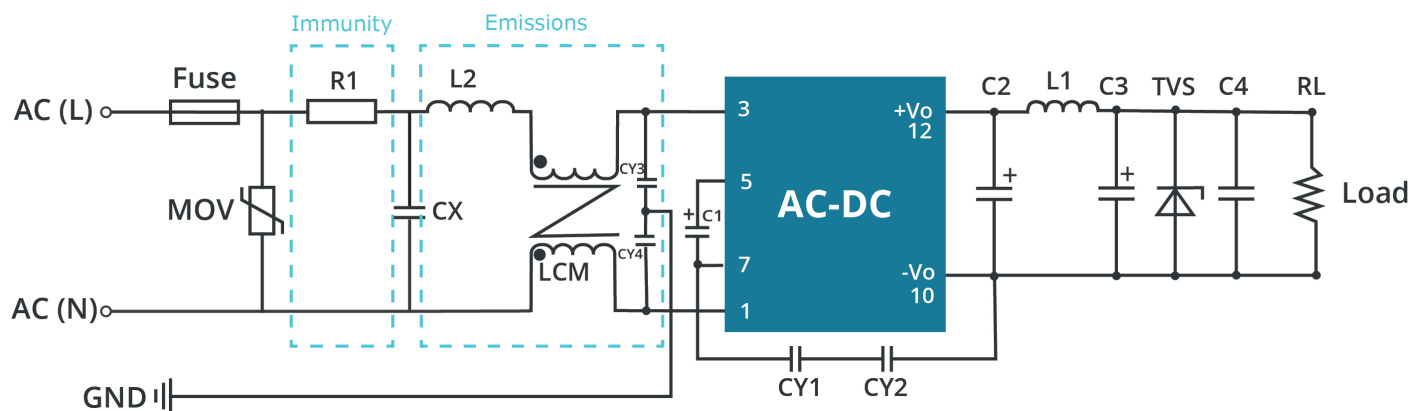
| Application enviromental | Ambient temperature range | Immunity Class | Emissions Class |
|--------------------------|---------------------------|----------------|-----------------|
| Basi application         | -40°C ~ 85°C              | Class III      | Class A         |

| Component       | Recommended value  |
|-----------------|--------------------|
| R1              | 12Ω/2W             |
| L2              | 4.7mH              |
| NTC             | 13D-5              |
| MOV             | S14K350            |
| FUSE (required) | 1A/300V, slow-blow |



## EMC RECOMMENDED CIRCUIT (CONTINUED)

**Circuit 3**



**Table 3**

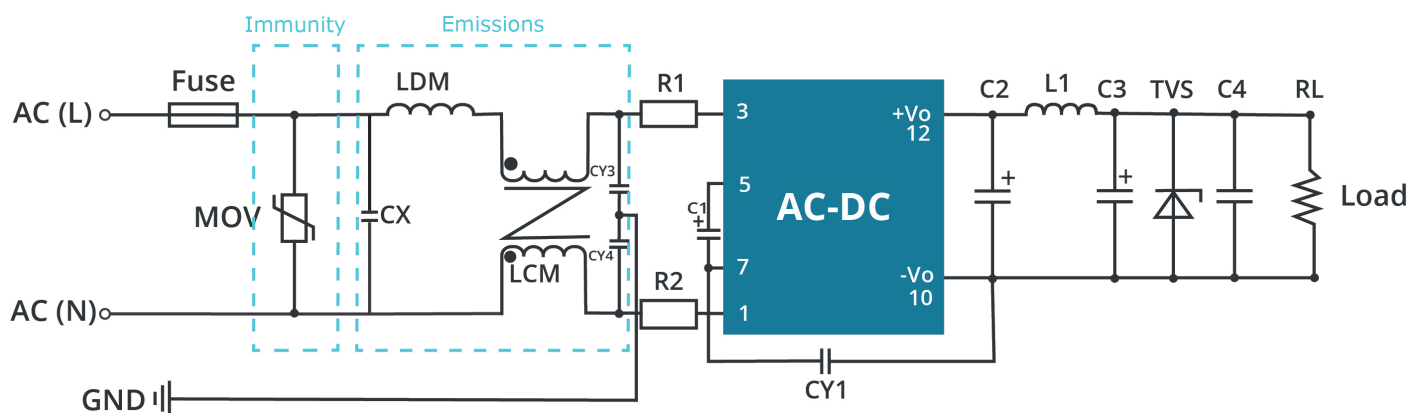
| Application enviromental | Ambient temperature range | Immunity Class | Emissions Class |
|--------------------------|---------------------------|----------------|-----------------|
| Indoor civil / general   | -40°C ~ 55°C              | Class III      | Class B         |

| Component       | Recommended value  |
|-----------------|--------------------|
| R1              | 12Ω/3W             |
| CY1 (CY2)       | 1.0nF/400Vac       |
| LCM             | 3.5mH              |
| LDM             | 0.33mH             |
| CX              | 0.1μF/310Vac       |
| CY3, CY4        | 0.56nF/400Vac      |
| FUSE (required) | 1A/300V, slow-blow |

Note: In the home appliance application environment, the two Y capacitors of the primary and secondary need to be externally connected (CY1/CY2, value at 2.2nF/400Vac) which can meet the EN60335 certification. In other industries, only one Y capacitor is required.

## EMC RECOMMENDED CIRCUIT (CONTINUED)

**Circuit 4**



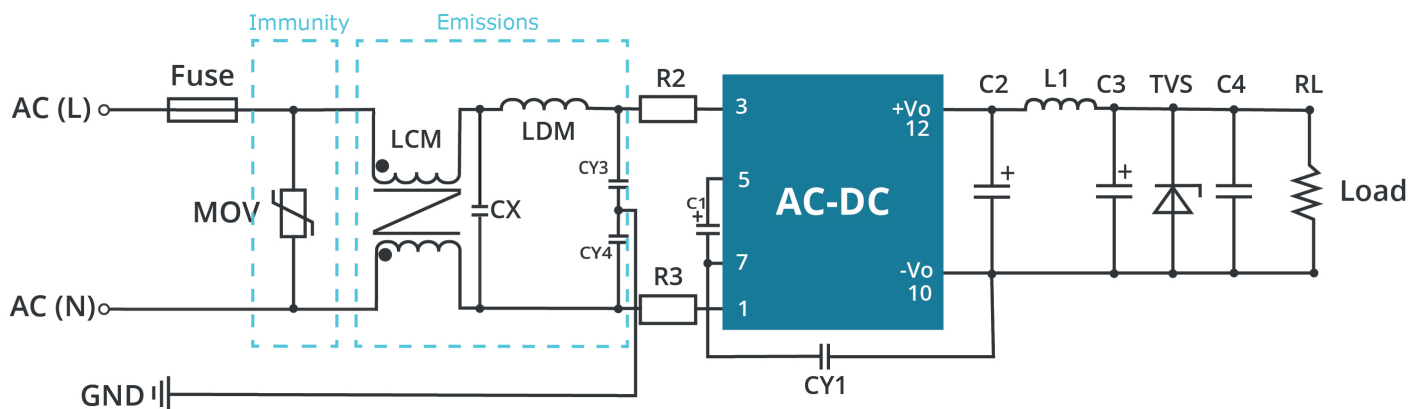
**Table 4**

| Application enviromental | Ambient temperature range | Immunity Class | Emissions Class |
|--------------------------|---------------------------|----------------|-----------------|
| Indoor industrial        | -25°C ~ 55°C              | Class IV       | Class B         |

| Component       | Recommended value  |
|-----------------|--------------------|
| MOV             | S14K350            |
| C1              | 450V/22uF          |
| CY1             | 2.2nF/400Vac       |
| CX              | 0.1μF/310Vac       |
| LCM             | 3.5mH              |
| LDM             | 0.33mH             |
| R1, R2          | 12Ω/2W             |
| CY3, CY4        | 0.56nF/400Vac      |
| FUSE (required) | 2A/300V, slow-blow |

## EMC RECOMMENDED CIRCUIT (CONTINUED)

**Circuit 5**



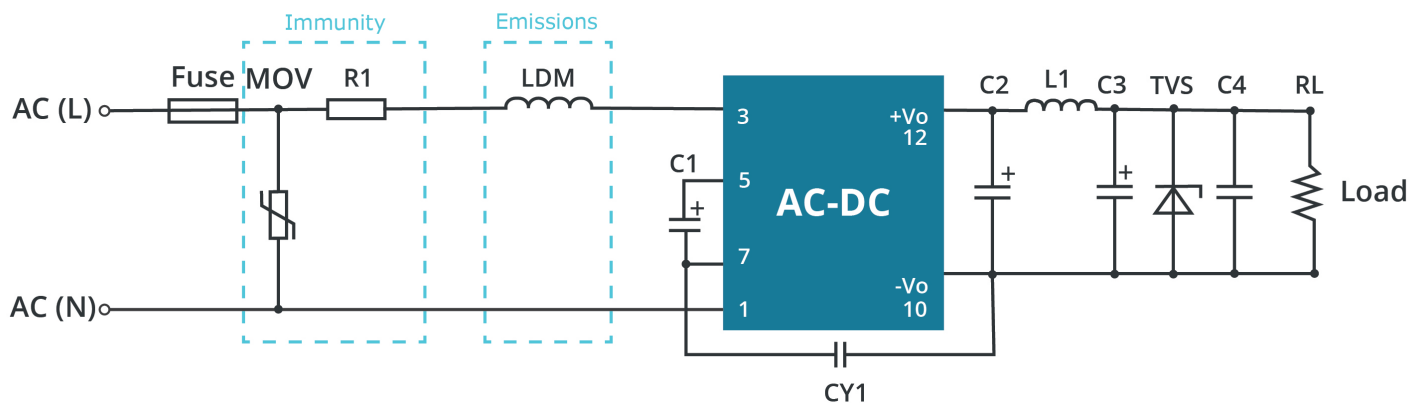
**Table 5**

| Application enviromental | Ambient temperature range | Immunity Class | Emissions Class |
|--------------------------|---------------------------|----------------|-----------------|
| Indoor industrial        | -25°C ~ 55°C              | Class IV       | Class B         |

| Component       | Recommended value  |
|-----------------|--------------------|
| MOV             | S14K350            |
| C1              | 450V/22uF          |
| CY1             | 2.2nF/400Vac       |
| CY3/CY4         | 0.56µF/400Vac      |
| CX              | 0.1µF/310Vac       |
| LCM             | 3.5mH              |
| LDM             | 0.33mH             |
| R2/R3           | 12Ω/2W             |
| FUSE (required) | 2A/300V, slow-blow |

## EMC RECOMMENDED CIRCUIT (CONTINUED)

**Circuit 6**



**Table 6**

| Application enviromental   | Ambient temperature range | Immunity Class | Emissions Class |
|----------------------------|---------------------------|----------------|-----------------|
| Outdoor general enviroment | -40°C ~ 85°C              | Class IV       | Class A         |

| Component       | Recommended value  |
|-----------------|--------------------|
| MOV             | S14K350            |
| C1              | 450V/22uF          |
| LDM             | 4.7mH              |
| R1              | 12Ω/3W             |
| FUSE (required) | 2A/300V, slow-blow |

## REVISION HISTORY

| rev. | description  | date       |
|------|--|------------|
| 1.0  | initial release  | 10/18/2016 |
| 1.01 | internal IC changed  | 05/11/2017 |
| 1.02 | updated efficiency curves  | 02/05/2018 |
| 1.03 | datasheet update,<br>safety approvals updated to match 62368 certification,<br>PCN-656-95022R-01   | 10/12/2020 |
| 1.04 | product image updated  | 09/16/2021 |
| 1.05 | derating curves updated  | 01/18/2022 |
| 1.06 | product image updated  | 03/10/2022 |
| 1.07 | UKCA mark added  | 05/25/2022 |
| 1.08 | discontinued models PBO-3-S3.3, PBO-3-S3.3-B, PBO-3-S5,<br>PBO-3-S5-B, PBO-3-S9, PBO-3-S12, PBO-3-S12-B, PBO-3-S15,<br>PBO-3-S15-B, PBO-3-S24, PBO-3-S24-B | 09/13/2022 |

The revision history provided is for informational purposes only and is believed to be accurate.



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