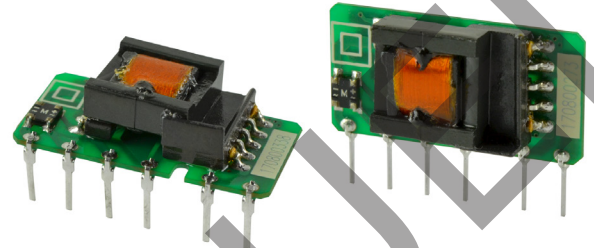


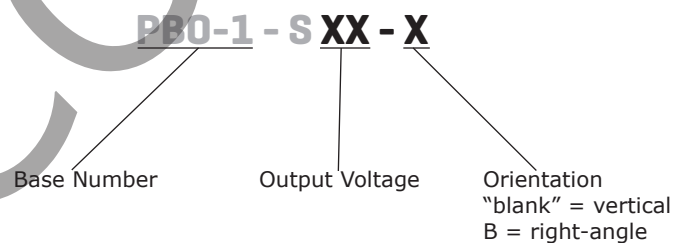
**SERIES: PBO-1 | DESCRIPTION: AC-DC POWER SUPPLY**
**FEATURES**

- up to 1 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



| MODEL     | output<br>voltage<br>(Vdc) | output<br>current |             | output<br>power<br>max<br>(W) | ripple<br>and noise <sup>1</sup><br>max<br>(mVp-p) | efficiency <sup>2</sup><br>typ<br>(%) |
|-----------|----------------------------|-------------------|-------------|-------------------------------|----------------------------------------------------|---------------------------------------|
|           |                            | min<br>(mA)       | max<br>(mA) |                               |                                                    |                                       |
| PBO-1-S5  | 5                          | 10                | 200         | 1                             | 120                                                | 66                                    |
| PBO-1-S9  | 9                          | 5.55              | 111         | 1                             | 120                                                | 67                                    |
| PBO-1-S12 | 12                         | 4.15              | 83          | 1                             | 120                                                | 70                                    |
| PBO-1-S15 | 15                         | 3.35              | 67          | 1                             | 120                                                | 69                                    |
| PBO-1-S24 | 24                         | 2.1               | 42          | 1                             | 120                                                | 68                                    |

Notes: 1. At full load, nominal input, 20 MHz bandwidth oscilloscope, see Application Circuit.  
 2. At 230 Vac input.  
 3. All specifications are measured at Ta=25°C, humidity <75%, 115 or 230 Vac input voltage, and rated output load unless otherwise specified.

**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             |     | 9   |      | A     |
|                           | at 277 Vac             |     | 15  |      | A     |
| no load power consumption | 24 Vdc output models   |     |     | 0.3  | W     |
|                           | all other models       |     |     | 0.25 | W     |

## OUTPUT

| parameter                  | conditions/description | min | typ   | max | units |
|----------------------------|------------------------|-----|-------|-----|-------|
| capacitive load            | 5 Vdc output models    |     |       | 220 | μF    |
|                            | all other models       |     |       | 100 | μF    |
| initial set point accuracy | 5 Vdc output models    |     |       | ±8  | %     |
|                            | all other models       |     |       | ±5  | %     |
| line regulation            | at full load           |     | ±1.5  |     | %     |
| load regulation            | from 5~100% load       |     | ±6    |     | %     |
|                            | 24 Vdc output models   |     | ±3    |     | %     |
| all other models           |                        |     |       |     |       |
|                            |                        |     |       |     |       |
| hold-up time               | at 230 Vac             | 150 | 180   |     | ms    |
| switching frequency        |                        |     |       | 100 | 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<br>certified to 60950: UL/cUL                                            |       |     |     |       |
| safety class        | Class II                                                                                            |       |     |     |       |
| conducted emissions | CISPR32/EN55032, Class A (recommended circuit 1,2,6)                                                |       |     |     |       |
|                     | CISPR32/EN55032, Class B (recommended circuit 3,4,5)                                                |       |     |     |       |
| radiated emissions  | CISPR32/EN55032, Class A (recommended circuit 1,2,6)                                                |       |     |     |       |
|                     | CISPR32/EN55032, 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, Class B (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   |       |     |     |       |
| conducted immunity  | IEC/EN61000-4-5, line to line ±2 kV/line to ground ±4 kV (recommended circuit 4,5) perf. Criteria B |       |     |     |       |
|                     | 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               | 200,000 |     |     | hours |
| RoHS                         | 2011/65/EU                                 |         |     |     |       |

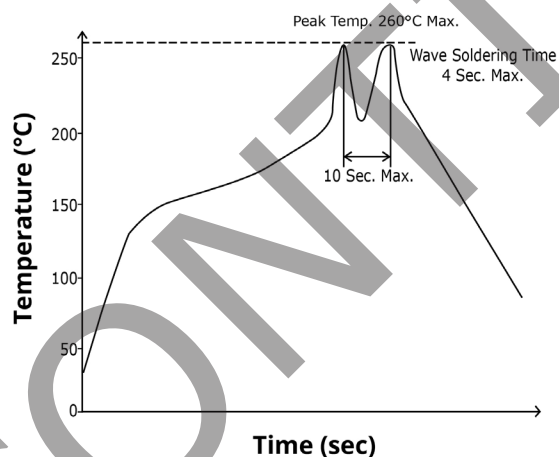
Notes: 1. The power supply is considered a component which will be installed into final equipment. The final equipment still must be tested to meet the necessary EMC directives.

**ENVIRONMENTAL**

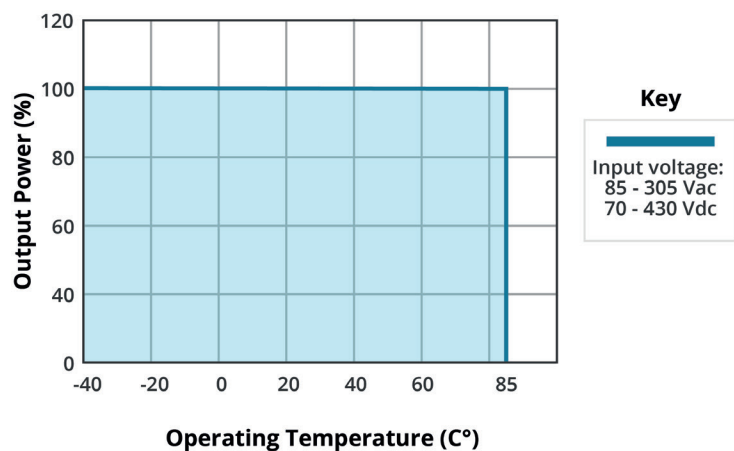
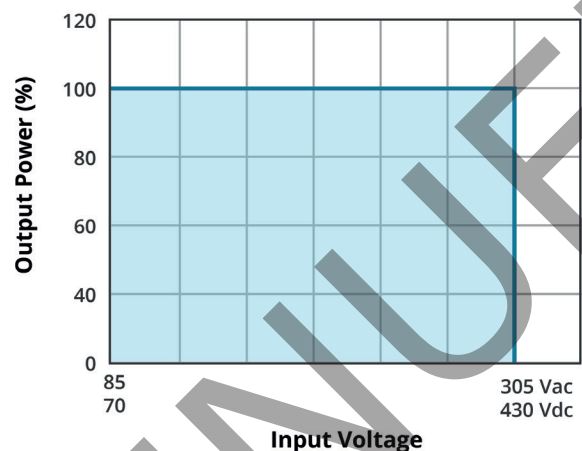
| parameter             | conditions/description | min | typ | max | units |
|-----------------------|------------------------|-----|-----|-----|-------|
| operating temperature | see derating curves    | -40 |     | 85  | °C    |
| storage temperature   |                        | -40 |     | 105 | °C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

**SOLDERABILITY**

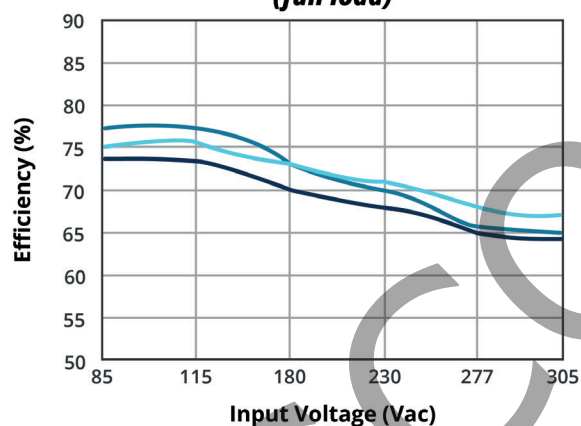
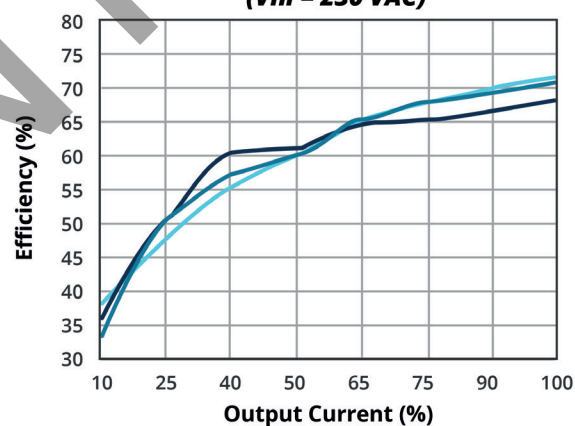
| parameter      | conditions/description | min | typ | max | units |
|----------------|------------------------|-----|-----|-----|-------|
| hand soldering | for 3~5 seconds        | 350 | 360 | 370 | °C    |
| wave soldering | for 5~10 seconds       | 255 | 260 | 265 | °C    |

**WAVE SOLDERING PROFILE**

## DERATING CURVES

**TEMPERATURE DERATING CURVE****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)    |     |     |     | mm    |
|            | right-angle models: 35.00 x 18.00 x 11.00 (1.38 x 0.71 x 0.43 inches) |     |     |     | mm    |
| weight     |                                                                       |     | 6   |     | g     |

## MECHANICAL DRAWING

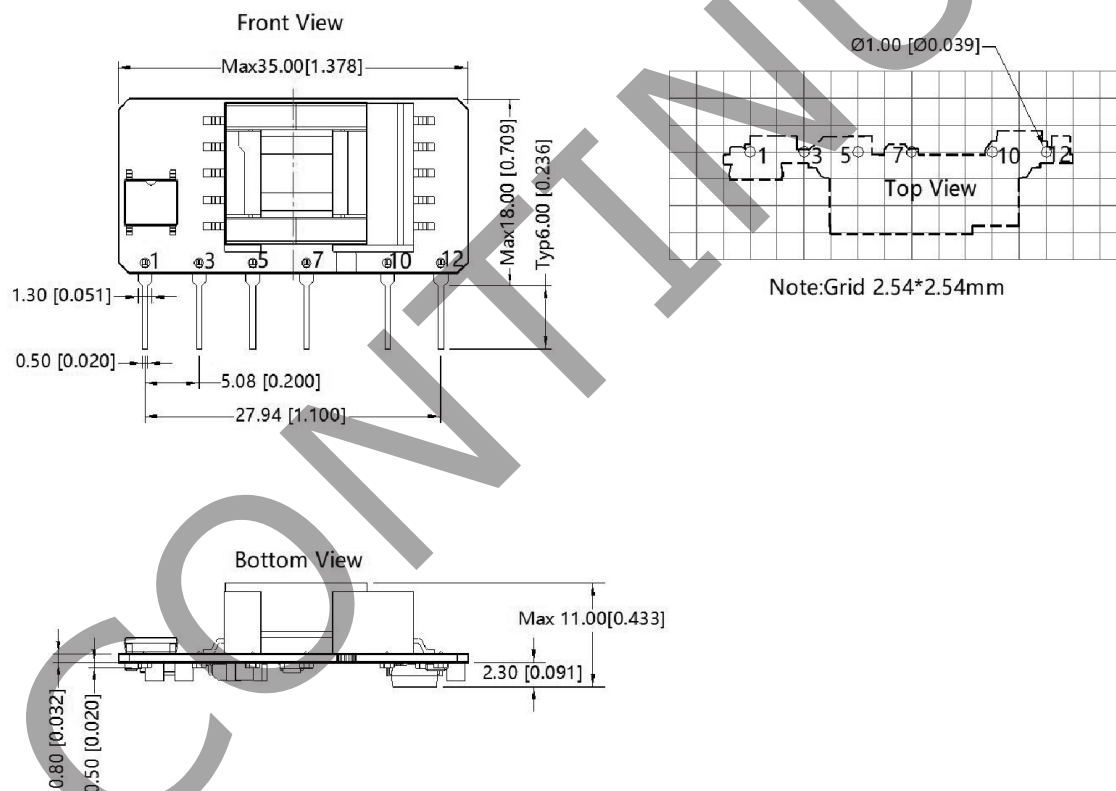
### Vertical Orientation

units: mm[inch]

tolerance:  $\pm 0.50[\pm 0.020]$ pin section tolerance:  $\pm 0.10[\pm 0.004]$ 

| 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)

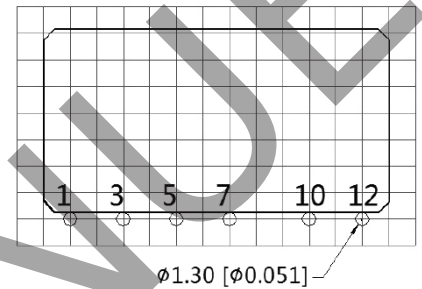
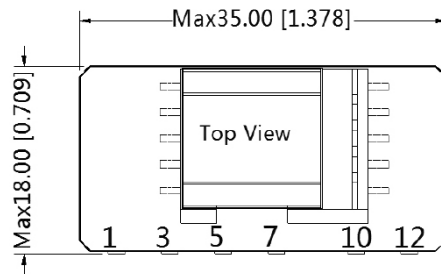
### Right-angle Orientation

units: mm[inch]

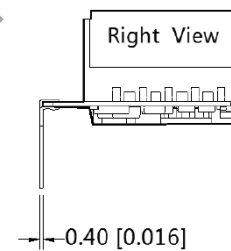
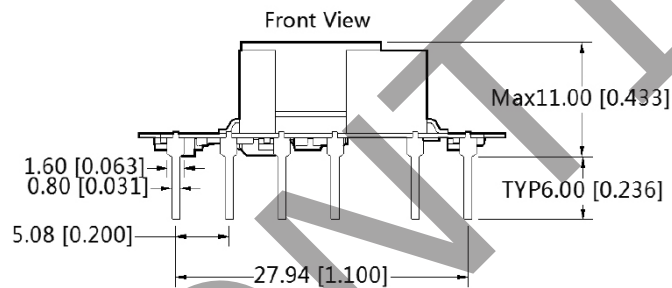
tolerance:  $\pm 0.50$  [ $\pm 0.020$ ]pin section tolerance:  $\pm 0.10$  [ $\pm 0.004$ ]

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

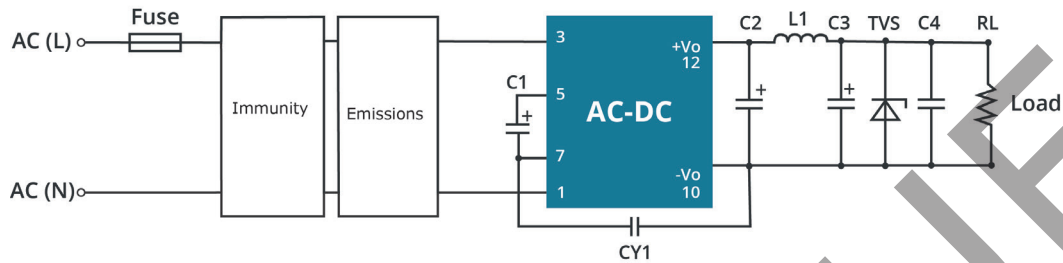
Note: 1. It is required to add C1 between pins 5 & 7 (see application circuits).



Note: Grid 2.54\*2.54mm



## APPLICATION DESIGN REFERENCE



PBO-1 series additional circuits design reference

| Immunity design circuits for reference |          | Emissions design circuits for reference |         |
|----------------------------------------|----------|-----------------------------------------|---------|
| Class III                              | Class IV | Class A                                 | Class B |
|                                        |          |                                         |         |

PBO-1 Series additional component selection guide

| Part no.  | FUSE<br>(required) | C1<br>(required)                                        | C2<br>(required)                     | L1<br>(required)    | C3<br>(required) | C4        | CY1<br>(required) | TVS      |
|-----------|--------------------|---------------------------------------------------------|--------------------------------------|---------------------|------------------|-----------|-------------------|----------|
| PBO-1-S5  | 1A/300V            | 4.7μF/450V<br>(-20°C~85°C)<br>10μF/450V<br>(-40°C~85°C) | 270μF/16V<br>(solid-state capacitor) | 2.2μH<br>(max 60mΩ) | 68μF/35V         | 0.1μF/50V | 1.0nF/400 Vac     | SMBJ7.0A |
| PBO-1-S9  |                    |                                                         | 100μF/16V<br>(solid-state capacitor) |                     |                  |           |                   | SMBJ12A  |
| PBO-1-S12 |                    |                                                         | 100μF/16V<br>(solid-state capacitor) |                     |                  |           |                   | SMBJ20A  |
| PBO-1-S15 |                    |                                                         | 100μF/35V                            |                     |                  |           |                   | SMBJ20A  |
| PBO-1-S24 |                    |                                                         | 100μF/35V                            |                     |                  |           |                   | SMBJ30A  |

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-1 Series Enviromental and EMC selection guide

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

## EMC RECOMMENDED CIRCUIT

Circuit 1

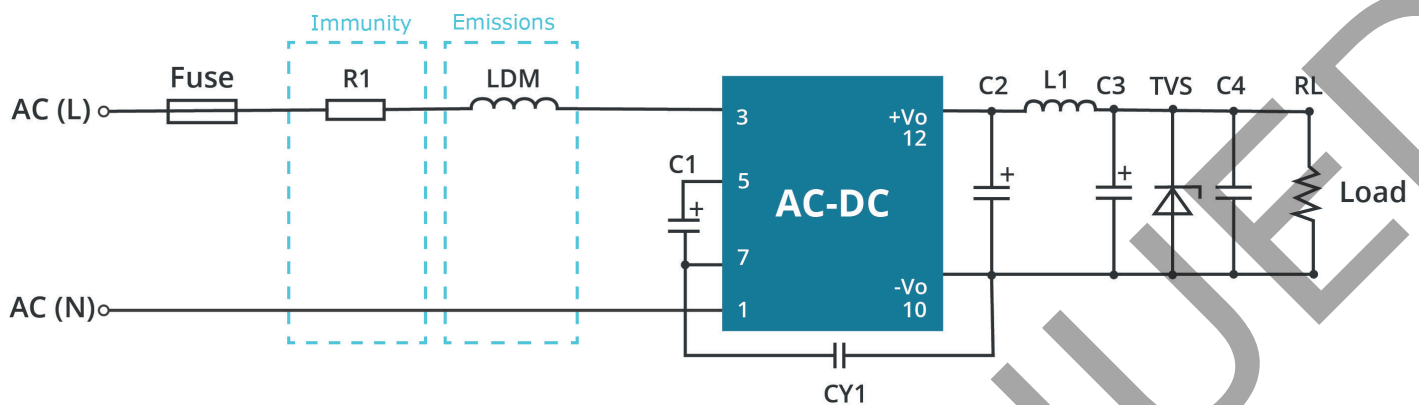


Table 1

| 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

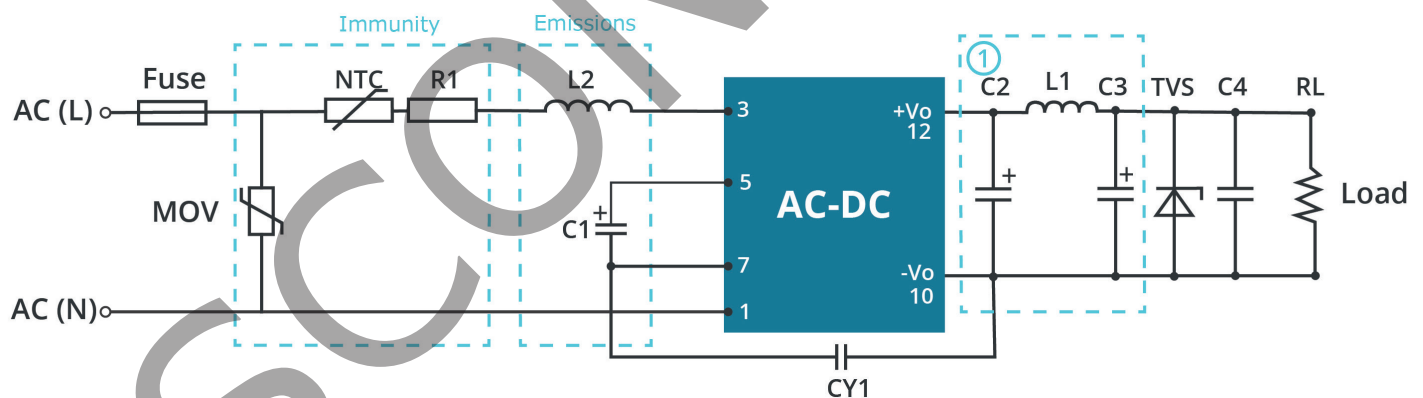
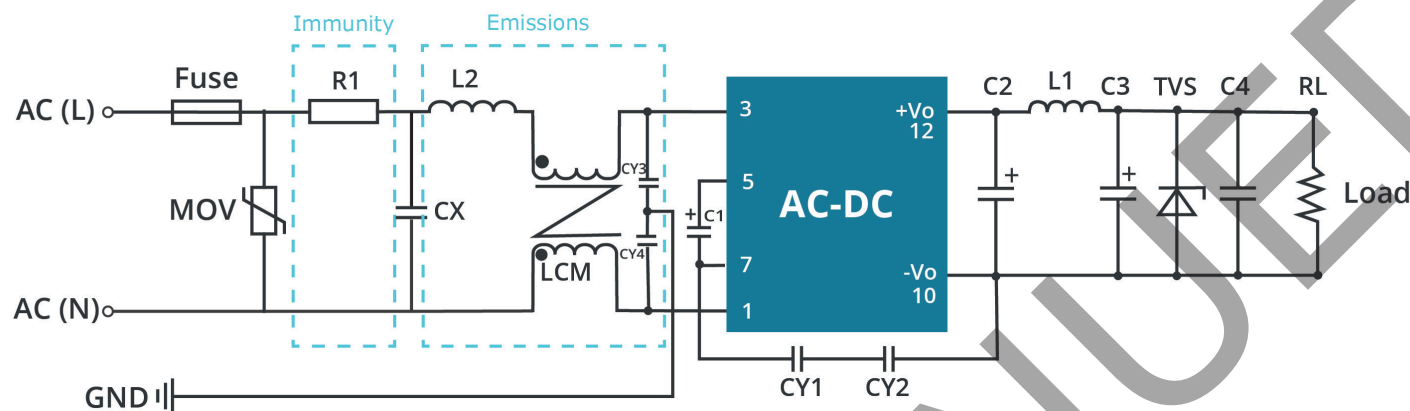


Table 2

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

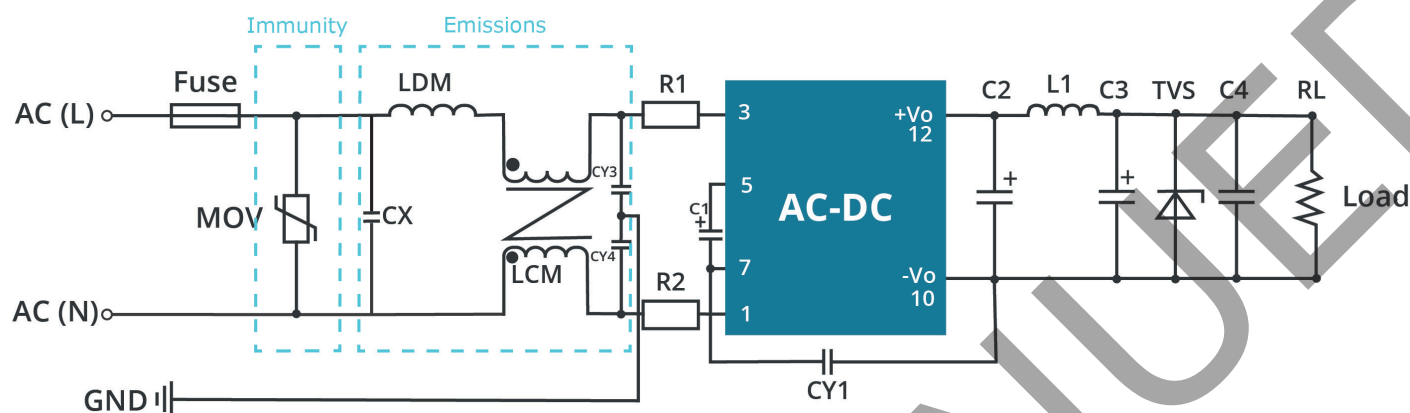
| Component       | Recommended value  |
|-----------------|--------------------|
| R1              | 12Ω/2W             |
| L2              | 4.7mH              |
| NTC             | 13D-5              |
| MOV             | S14K350            |
| FUSE (required) | 1A/300V, slow-blow |

**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         |

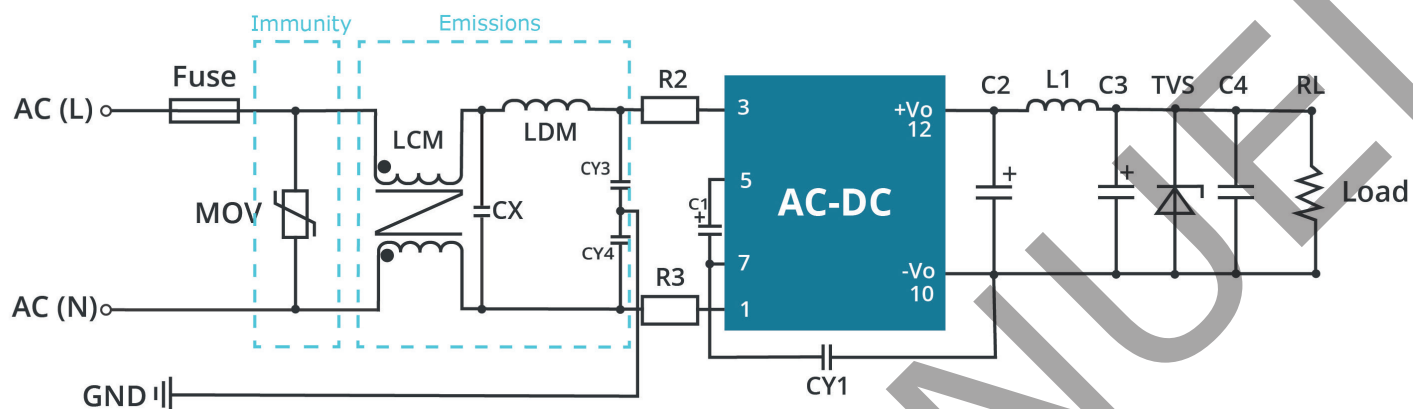
| Component       | Recommended value  |
|-----------------|--------------------|
| R1              | 12Ω/3W             |
| CY1 (CY2)       | 1.0nF/400Vac       |
| LCM             | 3.5mH              |
| LDM             | 0.33mH             |
| CX              | 0.1μF/310Vac       |
| CY3, CY4   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

Note: In the home appliance application enviroment, 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**

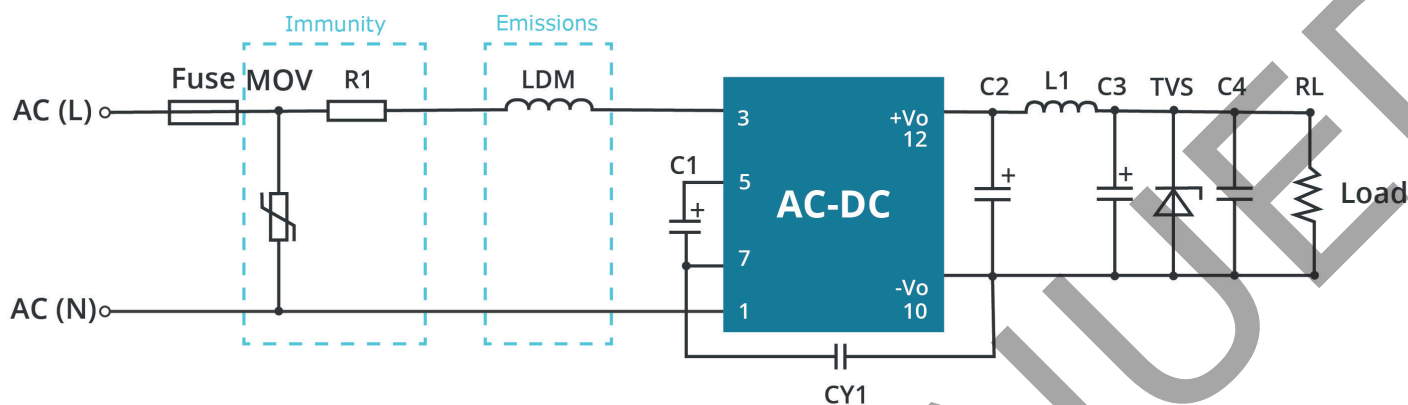
| Application enviromental | Ambient temperature range | Immunity Class | Emissions Class |
|--------------------------|---------------------------|----------------|-----------------|
| Indoor industrial        | -25°C ~ 55°C              | Class IV       | Class B         |

| 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                                                                                  | 12/08/2017 |
| 1.02 | datasheet update,<br>safety approvals updated to match 62368 certification,<br>PCN-656-95022R-01 | 10/12/2020 |
| 1.03 | clarified safety certifications                                                                  | 11/24/2020 |
| 1.04 | derating and efficiency curves updated                                                           | 01/18/2022 |
| 1.05 | UKCA mark added                                                                                  | 05/25/2022 |

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



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