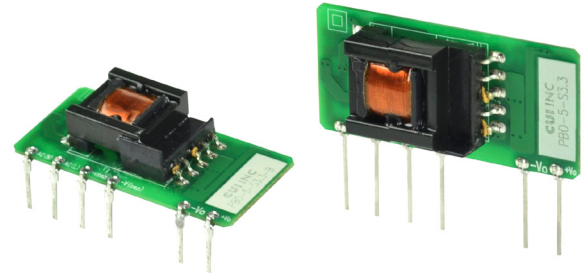




## SERIES: PBO-5 | DESCRIPTION: AC-DC POWER SUPPLY

### FEATURES

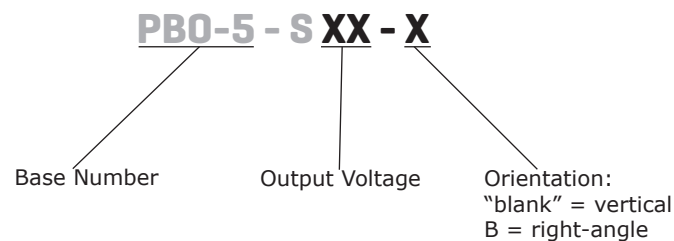
- up to 5 W continuous power
- ultra-compact SIP package
- wide input voltage range
- over current and short circuit protections
- 4,000 Vac isolation
- UL 62368, CE safety approvals
- efficiency up to 79%



| 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-5-S3.3 | 3.3                        | 0                 | 1000        | 3.3                           | 150                                                | 67                                    |
| PBO-5-S5   | 5                          | 0                 | 1000        | 5                             | 150                                                | 74                                    |
| PBO-5-S9   | 9                          | 0                 | 560         | 5                             | 150                                                | 75                                    |
| PBO-5-S12  | 12                         | 0                 | 420         | 5                             | 150                                                | 76                                    |
| PBO-5-S15  | 15                         | 0                 | 340         | 5                             | 150                                                | 77                                    |
| PBO-5-S24  | 24                         | 0                 | 210         | 5                             | 150                                                | 79                                    |

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 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<br>100 |         | 264<br>400 | Vac<br>Vdc |
| frequency                 |                          | 47        |         | 63         | Hz         |
| current                   | at 115 Vac<br>at 230 Vac |           |         | 0.2<br>0.1 | A<br>A     |
| inrush current            | at 115 Vac<br>at 230 Vac |           | 5<br>10 |            | A<br>A     |
| leakage current           | CY0 is 1 nF/400 Vac      |           |         | 0.25       | mA         |
| no load power consumption |                          |           |         | 0.5        | W          |

## OUTPUT

| parameter                  | conditions/description                    | min | typ      | max      | units    |
|----------------------------|-------------------------------------------|-----|----------|----------|----------|
| capacitive load            | 3.3 Vdc output models                     |     |          | 2,200    | μF       |
|                            | 5 Vdc output models                       |     |          | 1,500    | μF       |
|                            | 9 Vdc output models                       |     |          | 680      | μF       |
|                            | 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<br>all other models |     |          | ±3<br>±2 | %<br>%   |
| line regulation            | at full load                              |     | ±0.5     |          | %        |
| load regulation            | from 10~100% load                         |     |          | ±1.5     | %        |
| hold-up time               | at 115 Vac<br>at 230 Vac                  |     | 15<br>75 |          | ms<br>ms |
| switching frequency        |                                           |     | 100      |          | kHz      |
| temperature coefficient    |                                           |     | ±0.02    |          | %/°C     |

## PROTECTIONS

| parameter                | conditions/description    | min | typ | max | units |
|--------------------------|---------------------------|-----|-----|-----|-------|
| over voltage protection  | output voltage clamp      |     |     |     |       |
|                          | 3.3 & 5 Vdc output models |     |     | 7.5 | Vdc   |
|                          | 9 Vdc output models       |     |     | 15  | Vdc   |
|                          | 12 & 15 Vdc output models |     |     | 20  | Vdc   |
|                          | 24 Vdc output models      |     |     | 30  | Vdc   |
| over current protection  | auto recovery             | 150 |     |     | %     |
| short circuit protection | continuous, auto recovery |     |     |     |       |

## SAFETY & COMPLIANCE

| parameter           | conditions/description                                                   | min   | typ | max | units |
|---------------------|--------------------------------------------------------------------------|-------|-----|-----|-------|
| isolation voltage   | input to output at 5 mA for 1 minute                                     | 4,000 |     |     | Vac   |
| safety approvals    | UL 62368, EN 62368                                                       |       |     |     |       |
| safety class        | class II                                                                 |       |     |     |       |
| conducted emissions | CISPR32/EN55032 Class A, (external circuit required, see figure 1)       |       |     |     |       |
|                     | CISPR32/EN55032 Class B, (external circuit required, see figure 2)       |       |     |     |       |
| radiated emissions  | CISPR32/EN55032 Class B, (external circuit required, see figure 1)       |       |     |     |       |
| ESD                 | IEC/EN61000-4-2 Class B, ±6 kV                                           |       |     |     |       |
| radiated immunity   | IEC/EN61000-4-3 Class A, 10V/m                                           |       |     |     |       |
| EFT/burst           | IEC/EN61000-4-4 Class B, ±2 kV (external circuit required, see figure 1) |       |     |     |       |
|                     | IEC/EN61000-4-4 Class B, ±4 kV (external circuit required, see figure 2) |       |     |     |       |

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.

## SAFETY & COMPLIANCE (CONTINUED)

| parameter                    | conditions/description                                                        | min     | typ | max | units |
|------------------------------|-------------------------------------------------------------------------------|---------|-----|-----|-------|
| surge                        | IEC/EN61000-4-5 Class B, $\pm 1$ kV (external circuit required, see figure 1) |         |     |     |       |
|                              | IEC/EN61000-4-5 Class B, $\pm 1$ kV/ $\pm 2$ kV                               |         |     |     |       |
| conducted immunity           | IEC/EN61000-4-6 Class A, 10 Vr.m.s (external circuit required, see figure 2)  |         |     |     |       |
| voltage dips & interruptions | IEC/EN61000-4-11 Class B, 0%-70%                                              |         |     |     |       |
| MTBF                         | as per MIL-HDBK-217F at 25 °C                                                 | 300,000 |     |     | hours |
| RoHS                         | 2011/65/EU                                                                    |         |     |     |       |

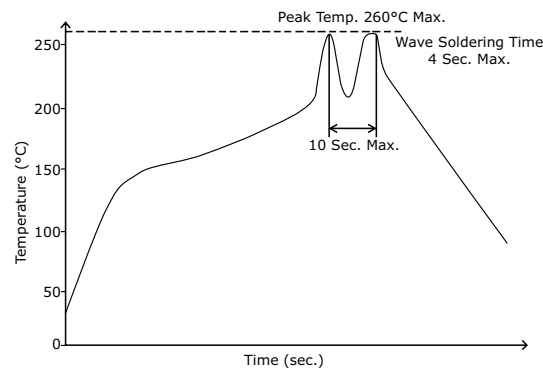
Notes: 1. The power supply is considered a component which will be installed into final equipment. The final equipment still must be tested to meet the necessary EMC directives.

## ENVIRONMENTAL

| parameter             | conditions/description | min | typ | max | units |
|-----------------------|------------------------|-----|-----|-----|-------|
| operating temperature | see derating curves    | -25 |     | 85  | °C    |
| storage temperature   |                        | -40 |     | 105 | °C    |
| storage humidity      | non-condensing         |     |     | 85  | %     |

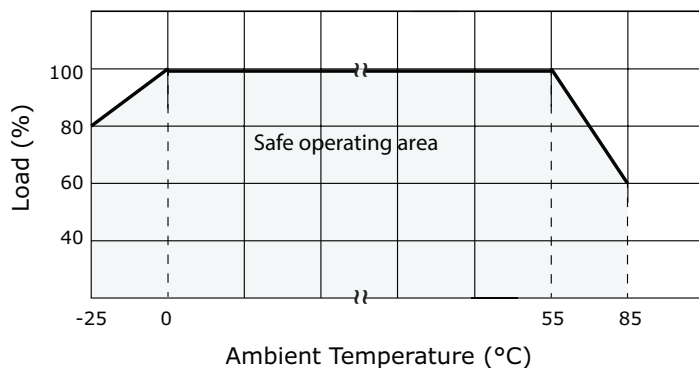
## SOLDERABILITY

| 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    |

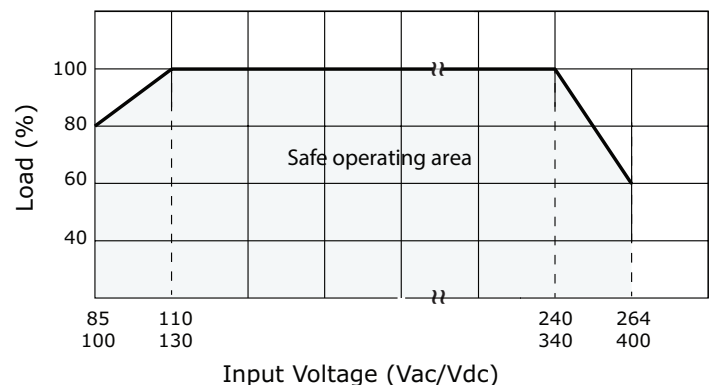


## DERATING CURVES

load vs. ambient temperature  
(at 85~264 Vac / 100~400 Vdc input voltage)

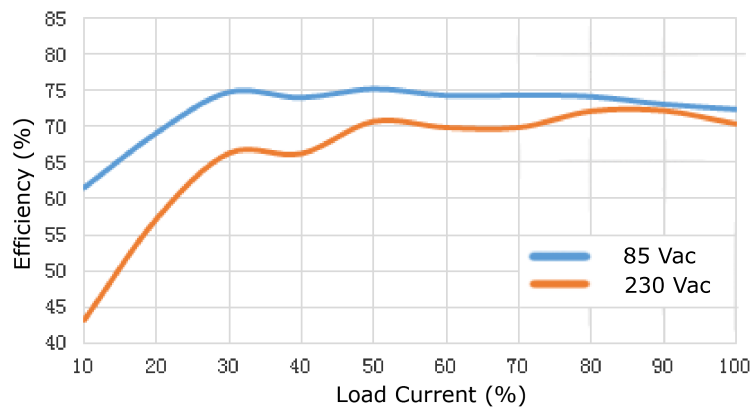


load vs. input voltage  
(at 25°C)

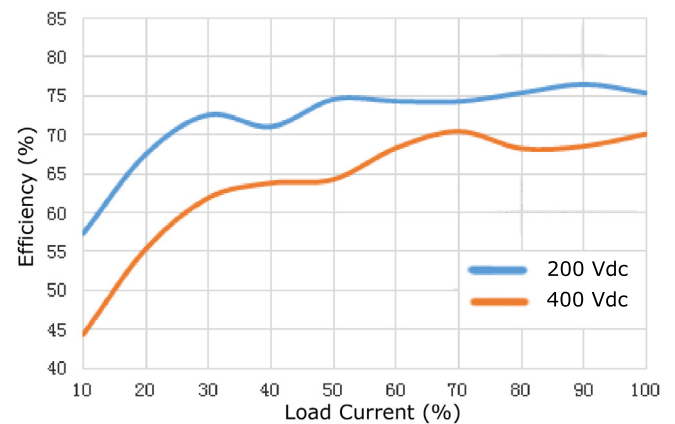


## EFFICIENCY CURVES

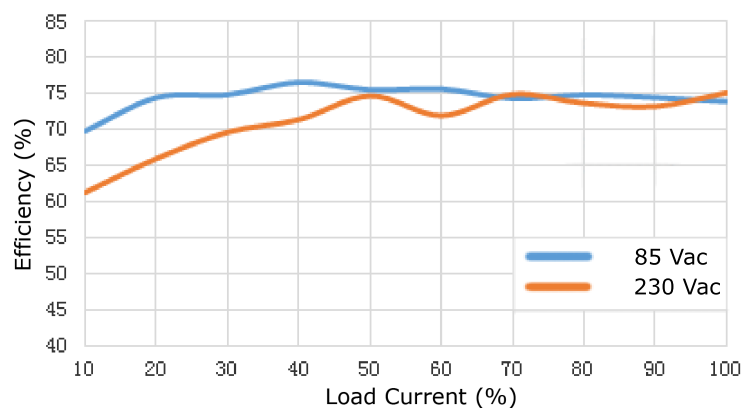
PBO-5-S3.3 AC Input Efficiency Curve  
(Efficiency vs. Load Current)



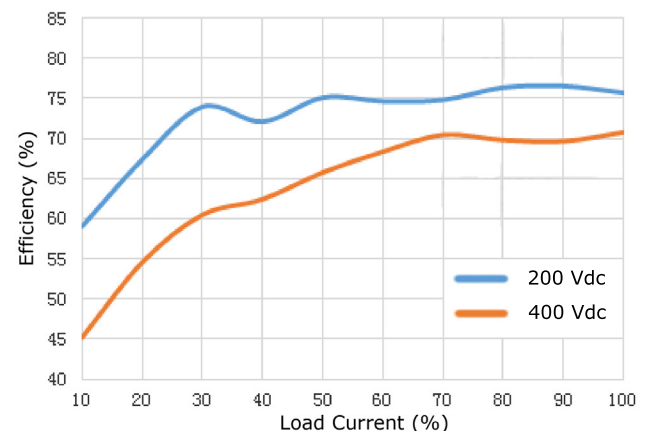
PBO-5-S3.3 DC Input Efficiency Curve  
(Efficiency vs. Load Current)



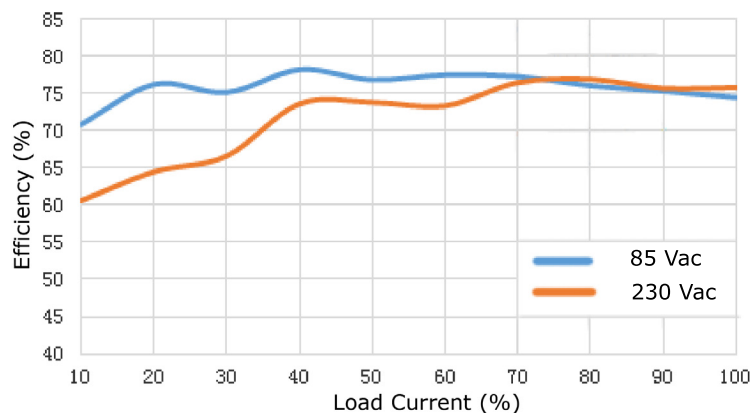
PBO-5-S5 AC Input Efficiency Curve  
(Efficiency vs. Load Current)



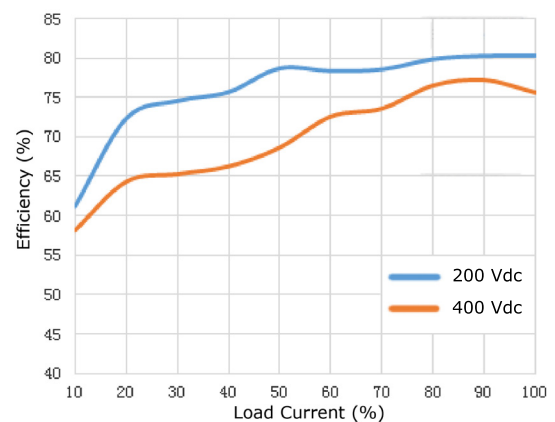
PBO-5-S5 DC Input Efficiency Curve  
(Efficiency vs. Load Current)



PBO-5-S9 AC Input Efficiency Curve  
(Efficiency vs. Load Current)

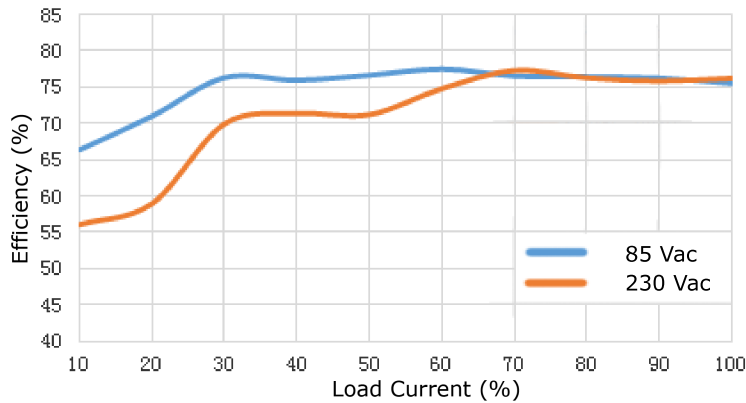


PBO-5-S9 DC Input Efficiency Curve  
(Efficiency vs. Load Current)

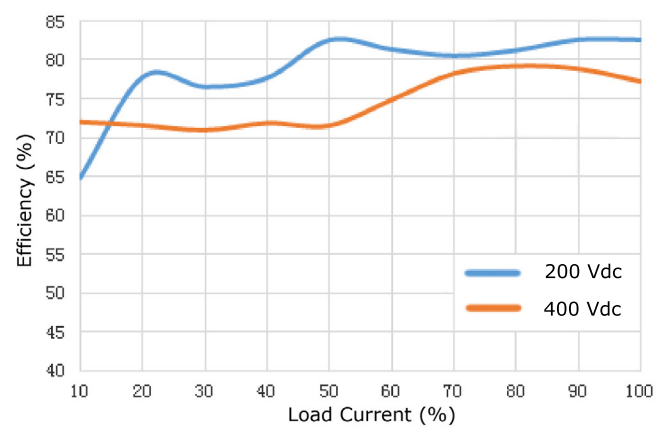


## EFFICIENCY CURVES (CONTINUED)

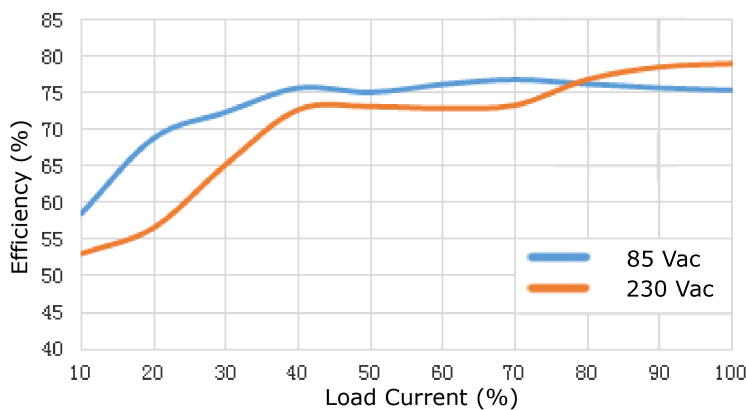
PBO-5-S12 AC Input Efficiency Curve  
(Efficiency vs. Load Current)



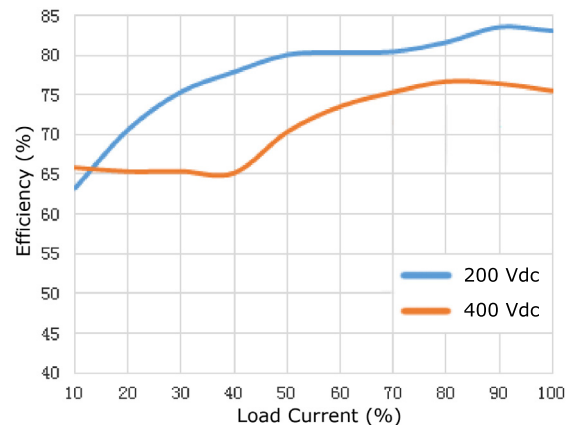
PBO-5-S12 DC Input Efficiency Curve  
(Efficiency vs. Load Current)



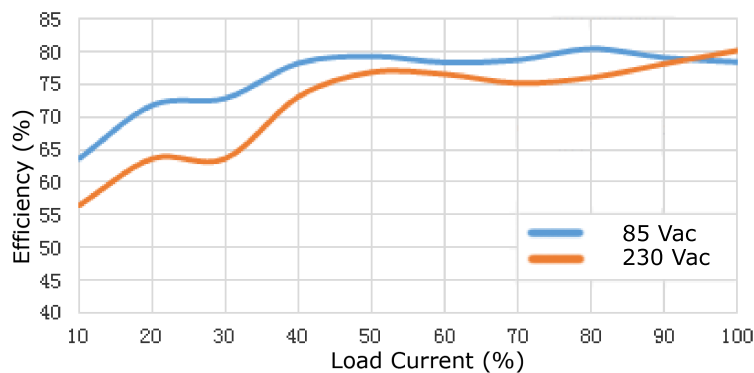
PBO-5-S15 AC Input Efficiency Curve  
(Efficiency vs. Load Current)



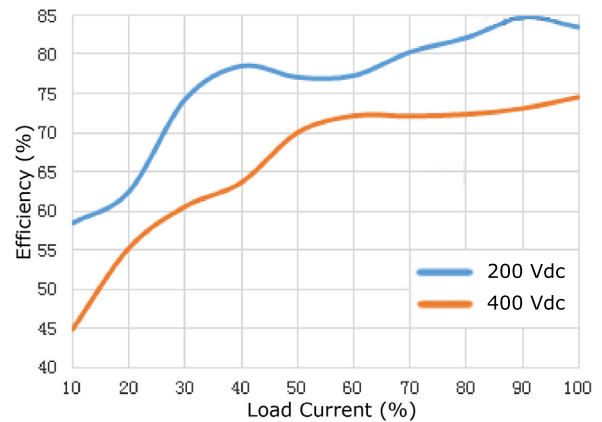
PBO-5-S15 DC Input Efficiency Curve  
(Efficiency vs. Load Current)



PBO-5-S24 AC Input Efficiency Curve  
(Efficiency vs. Load Current)



PBO-5-S24 DC Input Efficiency Curve  
(Efficiency vs. Load Current)



## MECHANICAL

| parameter  | conditions/description                                                   | min | typ | max | units |
|------------|--------------------------------------------------------------------------|-----|-----|-----|-------|
| dimensions | vertical models: 40.00 x 12.80 x 18.50 (1.575 x 0.504 x 0.729 inches)    |     |     |     | mm    |
|            | right-angle models: 40.00 x 20.00 x 12.80 (1.575 x 0.787 x 0.504 inches) |     |     |     | mm    |
| weight     |                                                                          |     | 7   |     | g     |

## MECHANICAL DRAWING

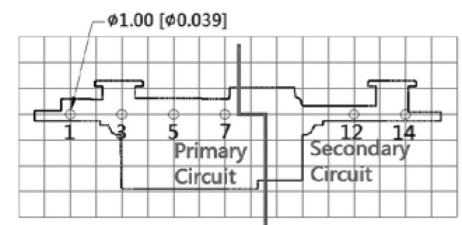
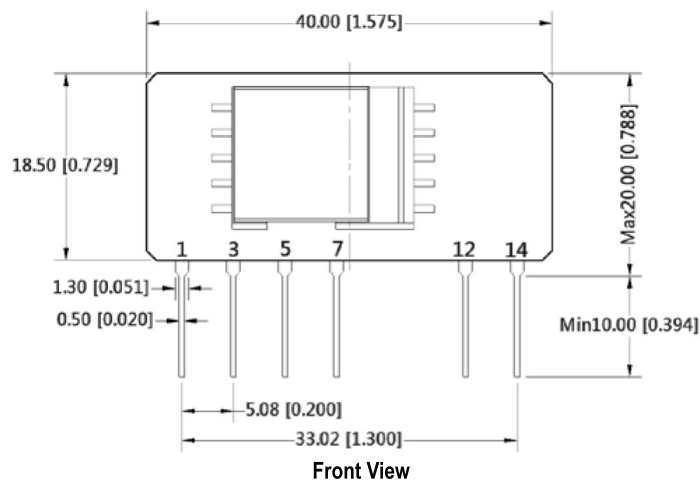
### Vertical Orientation

units: mm[inch]

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

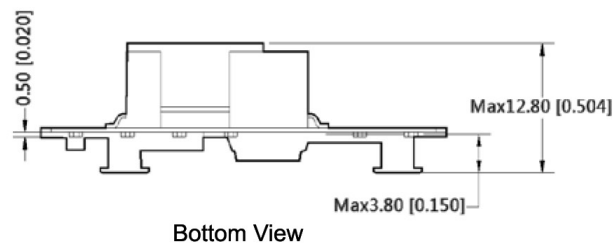
| PIN CONNECTIONS |          |
|-----------------|----------|
| PIN             | Function |
| 1               | AC (N)   |
| 3               | AC (L)   |
| 5               | +V(CAP)  |
| 7               | -V(CAP)  |
| 12              | -Vo      |
| 14              | +Vo      |

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



Note: Grid 2.54\*2.54mm

Top View  
PCB Layout



Bottom View

## MECHANICAL DRAWING (CONTINUED)

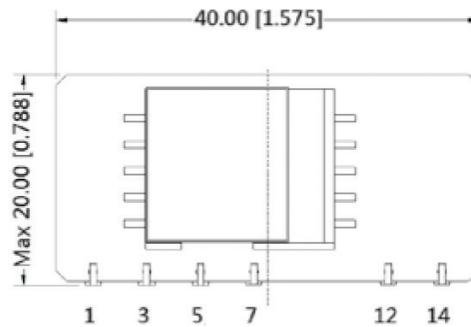
### Right-angle Orientation

units: mm[inch]

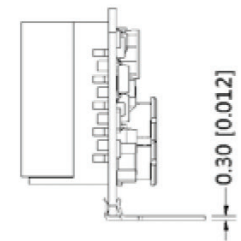
tolerance:  $\pm 0.50[\pm 0.020]$ pin section tolerance:  $\pm 0.10[\pm 0.004]$ 

| PIN CONNECTIONS |          |
|-----------------|----------|
| PIN             | Function |
| 1               | AC (N)   |
| 3               | AC (L)   |
| 5               | +V(CAP)  |
| 7               | -V(CAP)  |
| 12              | -Vo      |
| 14              | +Vo      |

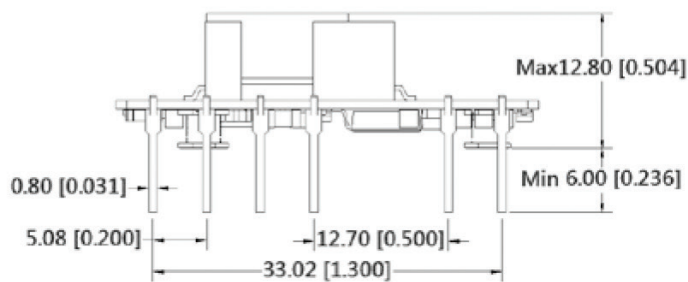
Note: 1. It is required to add C1 between pins 5 & 7 (see application circuits).



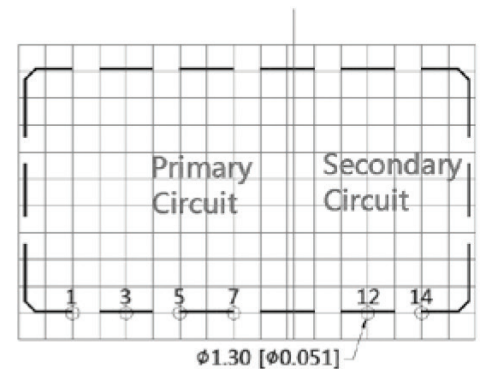
Top View



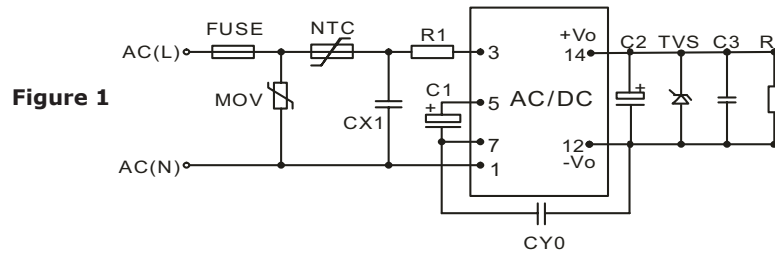
Right View



Front View

Top View  
PCB Layout

## APPLICATION CIRCUIT

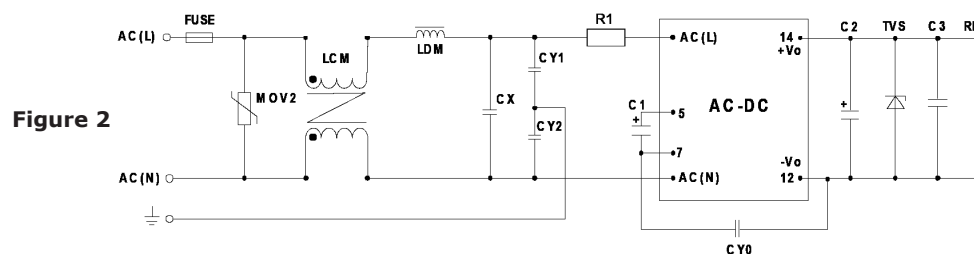


**Table 1**

| Recommended External Circuit Components |                   |         |       |              |        |                 |            |                 |          |           |
|-----------------------------------------|-------------------|---------|-------|--------------|--------|-----------------|------------|-----------------|----------|-----------|
| Vo (Vdc)                                | FUSE <sup>1</sup> | MOV     | NTC   | CX1          | R1     | C1 <sup>1</sup> | CY0        | C2 <sup>1</sup> | TVS      | C3        |
| 3.3                                     | 1A/250V           | S14K350 | 13D-5 | 0.1μF/275Vac | 12Ω/2W | 10μF/400V       | 1nF/400Vac | 220μF/35V       | SMBJ7.0A | 100nF/50V |
| 5                                       | 1A/250V           | S14K350 | 13D-5 | 0.1μF/275Vac | 12Ω/2W | 10μF/400V       | 1nF/400Vac | 220μF/35V       | SMBJ7.0A | 100nF/50V |
| 9                                       | 1A/250V           | S14K350 | 13D-5 | 0.1μF/275Vac | 12Ω/2W | 10μF/400V       | 1nF/400Vac | 220μF/35V       | SMBJ12A  | 100nF/50V |
| 12                                      | 1A/250V           | S14K350 | 13D-5 | 0.1μF/275Vac | 12Ω/2W | 10μF/400V       | 1nF/400Vac | 150μF/35V       | SMBJ20A  | 100nF/50V |
| 15                                      | 1A/250V           | S14K350 | 13D-5 | 0.1μF/275Vac | 12Ω/2W | 10μF/400V       | 1nF/400Vac | 150μF/35V       | SMBJ20A  | 100nF/50V |
| 24                                      | 1A/250V           | S14K350 | 13D-5 | 0.1μF/275Vac | 12Ω/2W | 10μF/400V       | 1nF/400Vac | 100μF/35V       | SMBJ30A  | 100nF/50V |

Note: 1. Required components.

## EMC RECOMMENDED CIRCUIT



**Table 2**

| Recommended External Circuit Components |                      |
|-----------------------------------------|----------------------|
| FUSE                                    | 1A/250V, slow fusing |
| MOV2                                    | S14K320              |
| LCM                                     | 3.5mH                |
| LDM                                     | 330μH                |
| CX                                      | 0.1μF/275 Vac        |
| CY1, CY2                                | 1nF/400 Vac          |
| R1                                      | 12Ω/2W               |
| C1                                      | 10μF/400V            |
| CY0                                     | 1nF/400Vac           |

Note: Also refer to Table 1.

- Notes:
- C1 is required for both AC and DC inputs. For input voltages greater than 370 Vdc, the recommended value is 10 μF / 450 V.
  - C2 is recommended to be a high frequency and low impedance capacitor. For capacitance and rated ripple current of capacitors, refer to the datasheets provided by the manufacturers. Voltage derating of capacitors should be 80% or above.
  - C3 is a ceramic capacitor used to filter high frequency noise.
  - TVS is a recommended post-component to protect post-circuits (if converter fails).
  - It is required to have a distance  $\geq 6.4$  mm for safety between external components in primary and secondary circuit.

## REVISION HISTORY

| rev. | description                                                                                                 | date       |
|------|-------------------------------------------------------------------------------------------------------------|------------|
| 1.0  | initial release                                                                                             | 10/18/2016 |
| 1.01 | added right-angle pin versions, updated to 62368 safety approvals, reduced component height to 12.80 mm max | 04/19/2018 |

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



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