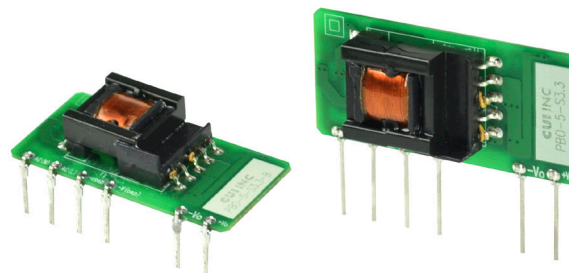




SERIES: PBO-5 | **DESCRIPTION:** AC-DC POWER SUPPLY

FEATURES

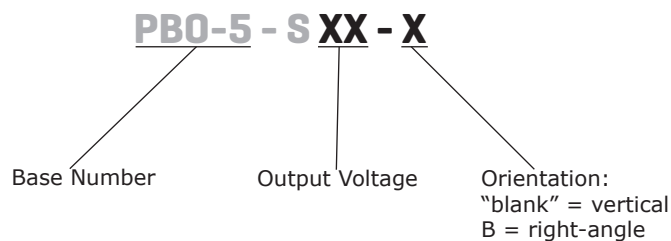
- up to 5 W continuous power
- ultra-compact SIP package
- wide input voltage range
- over current and short circuit protections
- 4,000 Vac isolation
- UL 62368, CE safety approvals
- efficiency up to 79%



| MODEL | output voltage (Vdc) | output current | | output power max (W) | ripple and noise ¹ max (mVp-p) | efficiency ² typ (%) |
|------------|-------------------------|----------------|-------------|----------------------------|---|---------------------------------------|
| | | min (mA) | max (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 µF ceramic and 10 µF 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 | | 264 | Vac |
| | | 100 | | 400 | Vdc |
| frequency | | 47 | | 63 | Hz |
| current | at 115 Vac | | | 0.2 | A |
| | at 230 Vac | | | 0.1 | A |
| inrush current | at 115 Vac | | 5 | | A |
| | at 230 Vac | | 10 | | 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 | | | ±3 | % |
| | all other models | | | ±2 | % |
| line regulation | at full load | | ±0.5 | | % |
| load regulation | from 10~100% load | | | ±1.5 | % |
| hold-up time | at 115 Vac | | 15 | | ms |
| | at 230 Vac | | 75 | | 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, ±1 kV (external circuit required, see figure 1) | | | | |
| | IEC/EN61000-4-5 Class B, ±1 kV/±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 | | | | |

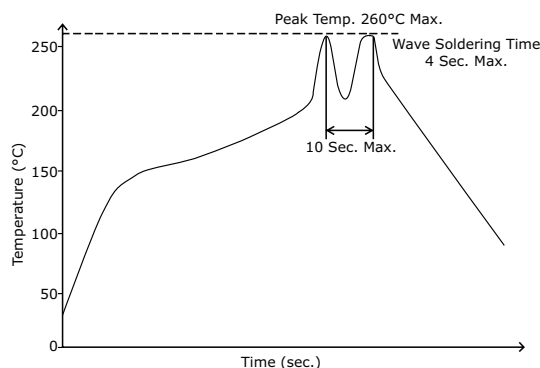
Notes: 1. The power supply is considered a component which will be installed into final equipment. The final equipment still must be tested to meet the necessary EMC directives.

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 | % |

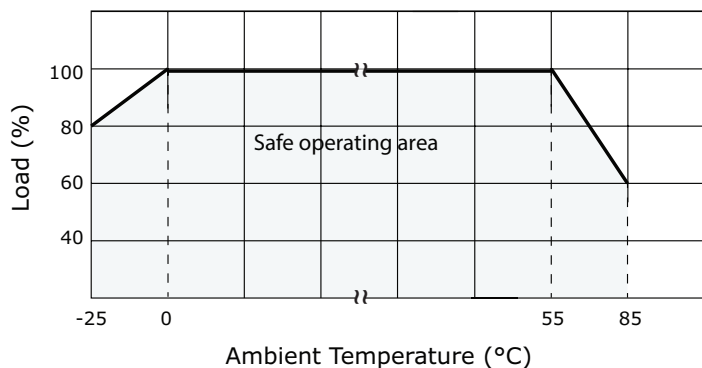
SOLDERABILITY

| 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 |

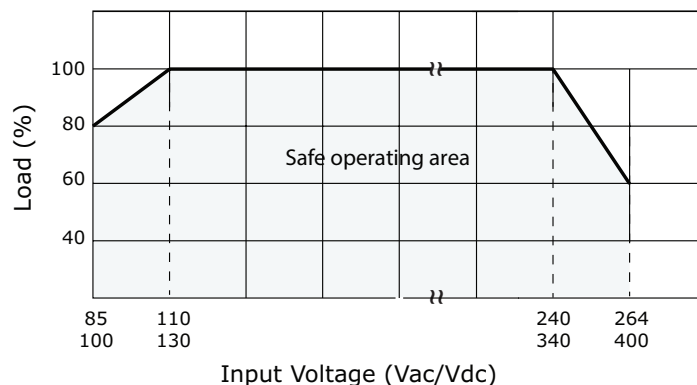


DERATING CURVES

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

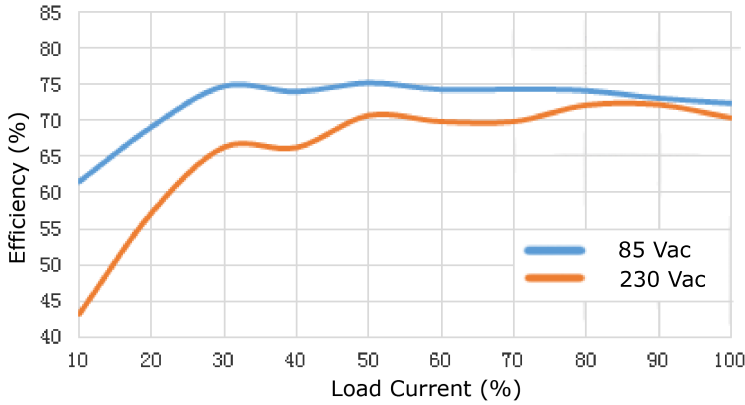


load vs. input voltage
(at 25°C)

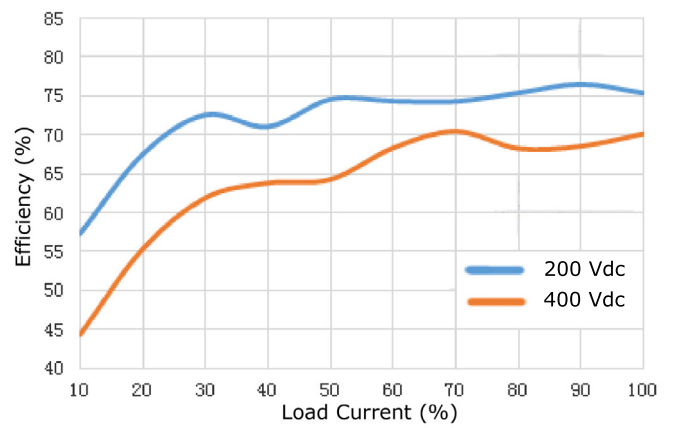


EFFICIENCY CURVES

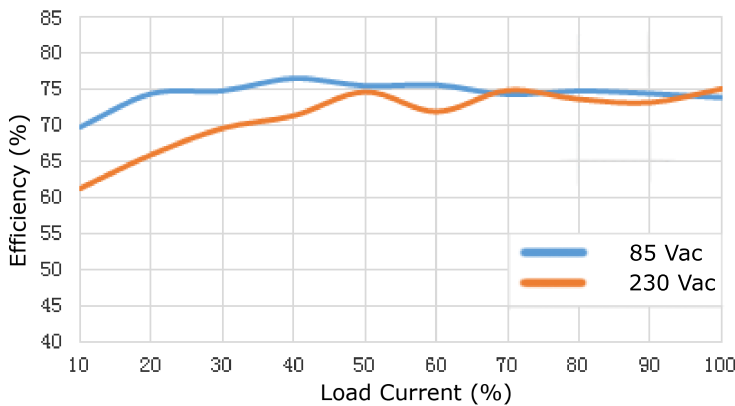
PBO-5-S3.3 AC Input Efficiency Curve
(Efficiency vs. Load Current)



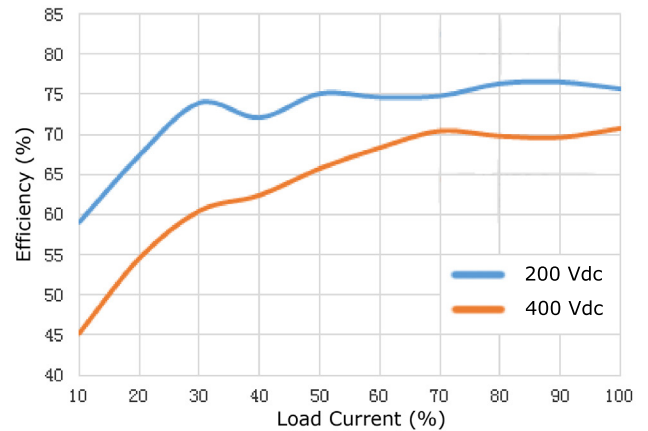
PBO-5-S3.3 DC Input Efficiency Curve
(Efficiency vs. Load Current)



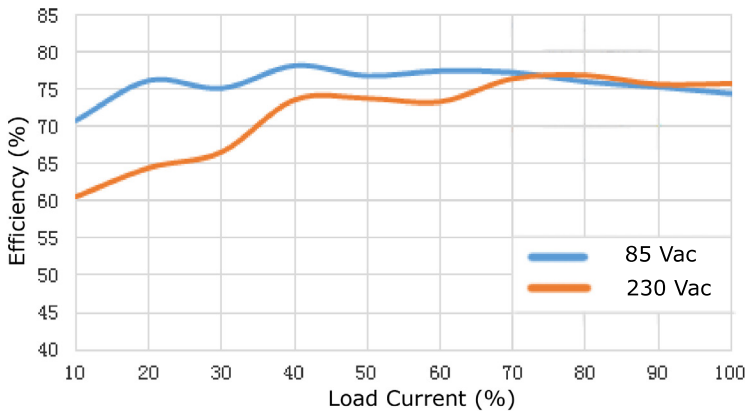
PBO-5-S5 AC Input Efficiency Curve
(Efficiency vs. Load Current)



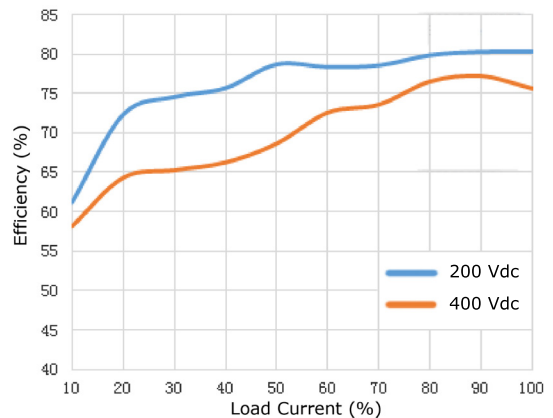
PBO-5-S5 DC Input Efficiency Curve
(Efficiency vs. Load Current)



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

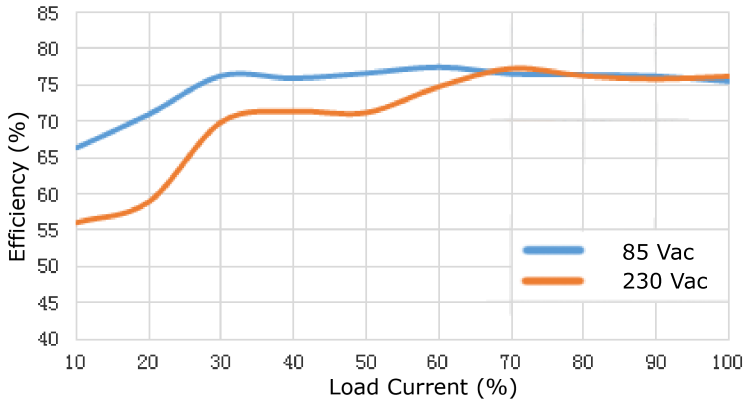


PBO-5-S9 DC Input Efficiency Curve
(Efficiency vs. Load Current)

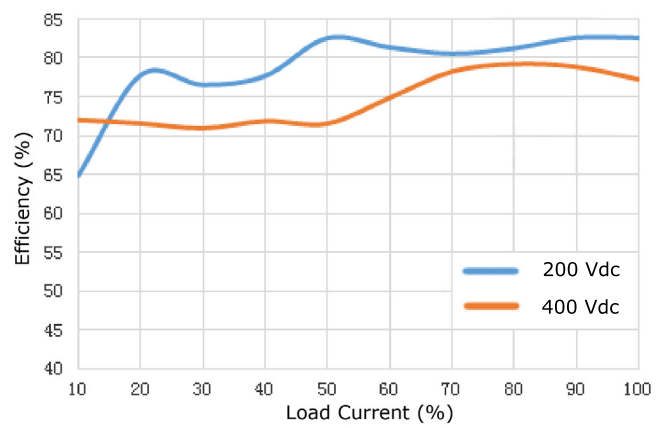


EFFICIENCY CURVES (CONTINUED)

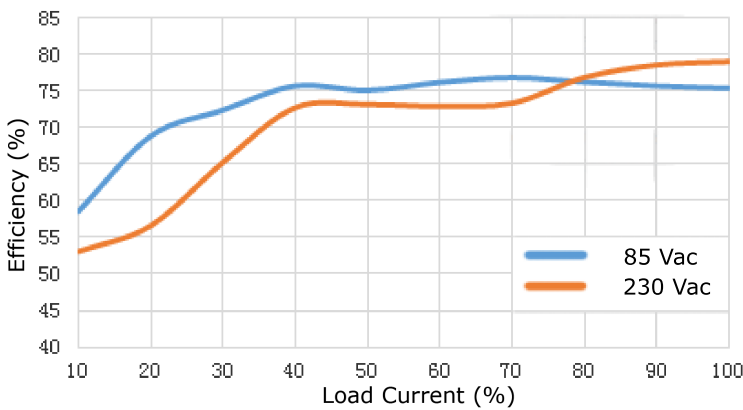
PBO-5-S12 AC Input Efficiency Curve
(Efficiency vs. Load Current)



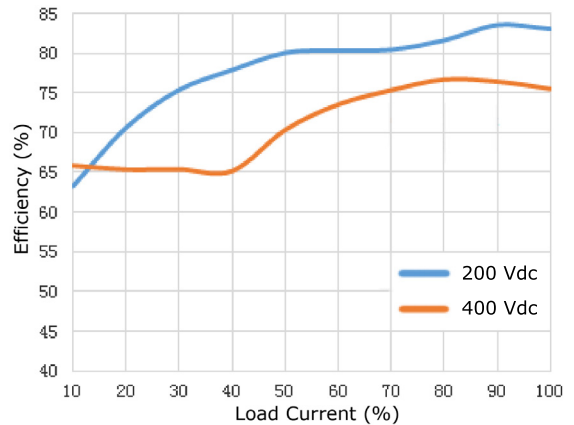
PBO-5-S12 DC Input Efficiency Curve
(Efficiency vs. Load Current)



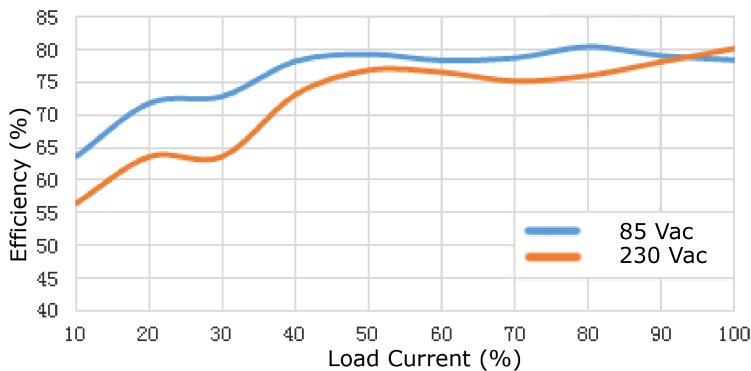
PBO-5-S15 AC Input Efficiency Curve
(Efficiency vs. Load Current)



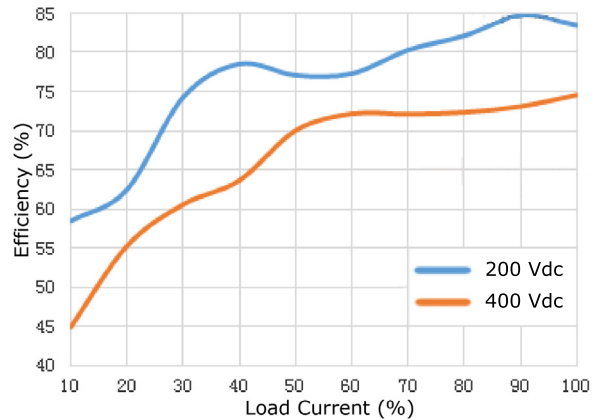
PBO-5-S15 DC Input Efficiency Curve
(Efficiency vs. Load Current)



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) right-angle models: 40.00 x 20.00 x 12.80 (1.575 x 0.787 x 0.504 inches) | | | | mm mm |
| weight | | | 7 | | g |

MECHANICAL DRAWING

Vertical Orientation

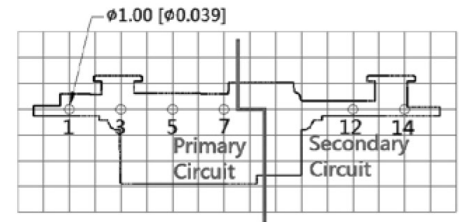
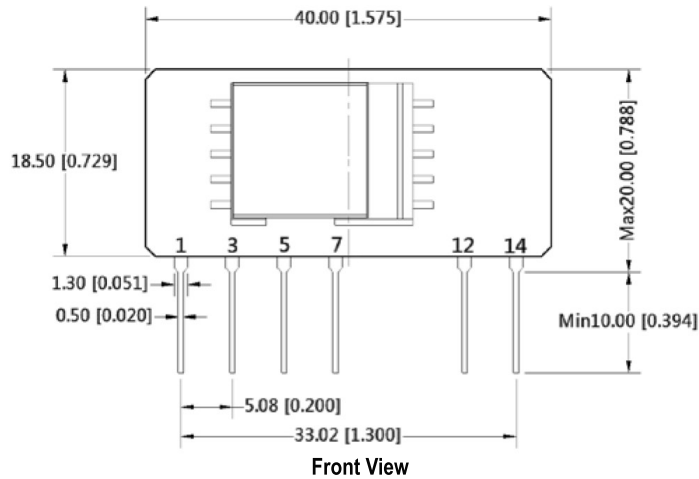
units: mm[inch]

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

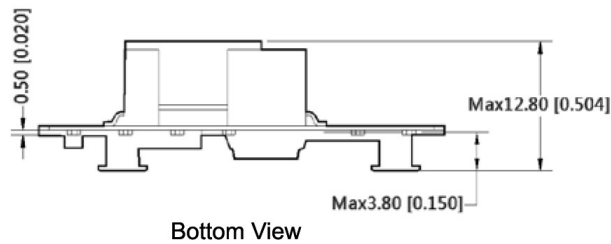
pin section tolerance: $\pm 0.10[\pm 0.004]$

| 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



MECHANICAL DRAWING (CONTINUED)

Right-angle Orientation

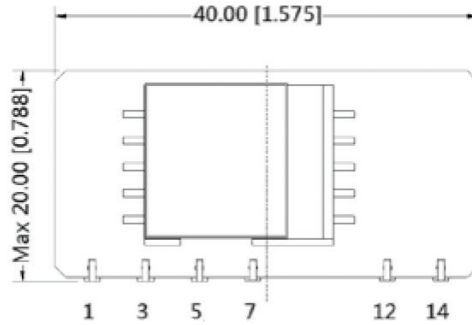
units: mm[inch]

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

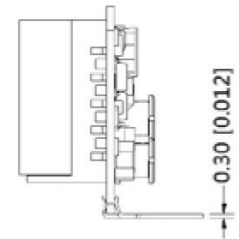
pin section tolerance: $\pm 0.10[\pm 0.004]$

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

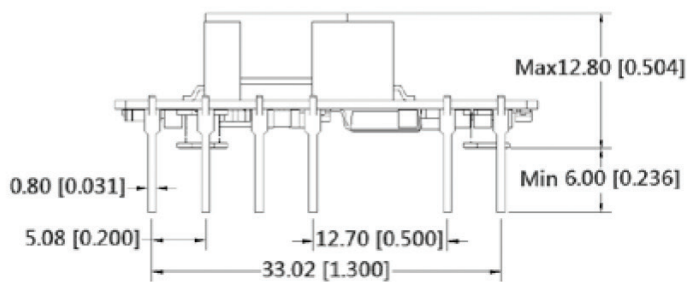
Note: 1. It is required to add C1 between pins 5 & 7 (see application circuits).



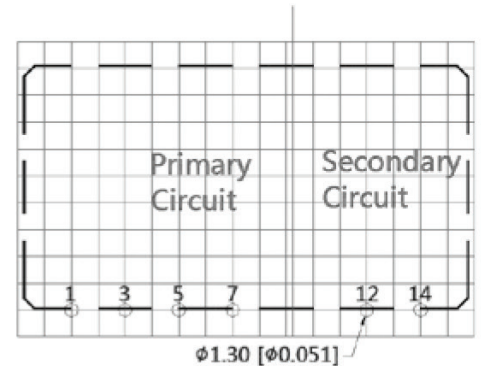
Top View



Right View



Front View



Top View
PCB Layout

APPLICATION CIRCUIT

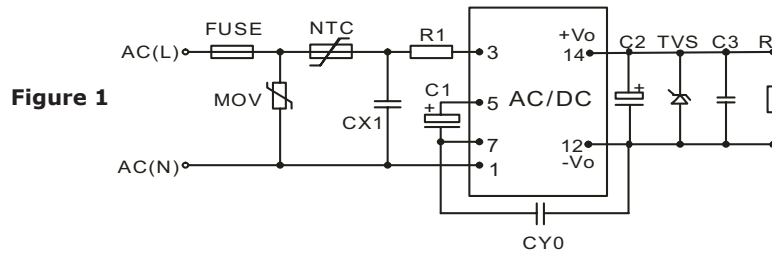


Table 1

| Recommended External Circuit Components | | | | | | | | | | |
|---|-------------------|---------|-------|--------------|--------|-----------------|------------|-----------------|----------|-----------|
| Vo (Vdc) | FUSE ¹ | MOV | NTC | CX1 | R1 | C1 ¹ | CY0 | C2 ¹ | 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

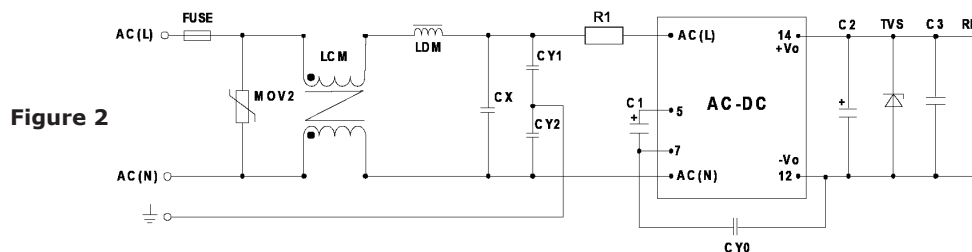


Table 2

| 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 ≥ 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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