# MBC250 Series
# Medical Power Supplies
# 12 VDC, 24 VDC, 48 VDC

The MBC250 series of AC-DC power supplies are designed to suit medical and many other applications. This family meets the international information technology and medical safety standards. The high efficiency design has minimal power loss in end equipment, resulting in higher reliability, ease of thermal management.

## Features

- Designed for Medical equipment (meet MOOP and MOPP)
- High efficiency up to 90% at 230 VAC full load
- Universal AC input voltage range: 90-264 VAC
- Active power factor correction
- Over temperature, output over voltage, over current and short circuit protection
- Input over voltage, under voltage protection
- Low conducted and radiated EMI (EN 55011 class A 6db margin)
- Safety approval to UL 60601-1 3rd,CSA60601-1 3rd and IEC60950-1 3rd
- High power density design: 11.2 W/in$^3$
- Compact size: 3.0 (W) x 1.5 (H) x 5.0 (L) inch
- ROHS compliant

## Applications

- Medical
- Telecom
- Datacom
- Industrial equipment

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# MBC250-10XXG

## 1 Ordering Information

| MODELS | OUTPUT VOLTAGE (VDC) | MAX LOAD CONVECTION | MAX LOAD 200 LFM | MINIMUM LOAD | RIPPLE & NOISE | TOTAL REGULATION |
|---|---|---|---|---|---|---|
| MBC250-1012G | 12 V | 10 A | 19 A | 0 A | 1% | ± 3% |
| MBC250-1024G | 24 V | 5 A | 10.5 A | 0 A | 1% | ± 3% |
| MBC250-1048G | 48 V | 2 A | 5.25 A | 0 A | 1% | ± 3% |
| MBC250-1024S302G[1)] | 26.7 V | 4.5 A | 9.43 A | 0 A | 1% | ± 3% |

[1)] MBC250-1024S302G is an extended model for MBC250-1024G.

## 2 Overview

The MBC250-10XXG is a high efficiency and high power density AC to DC power supply. It uses single phase transition mode PFC converter and well proven two-FET forward converter with output diode rectifiers, providing increased system reliability and high efficiency. With around 200 LFM (1 m/s) system air cooling, MBC250-1012G can delivery up to 228W continuous output power and 252W for MBC250-1024G and MBC250-1048G.

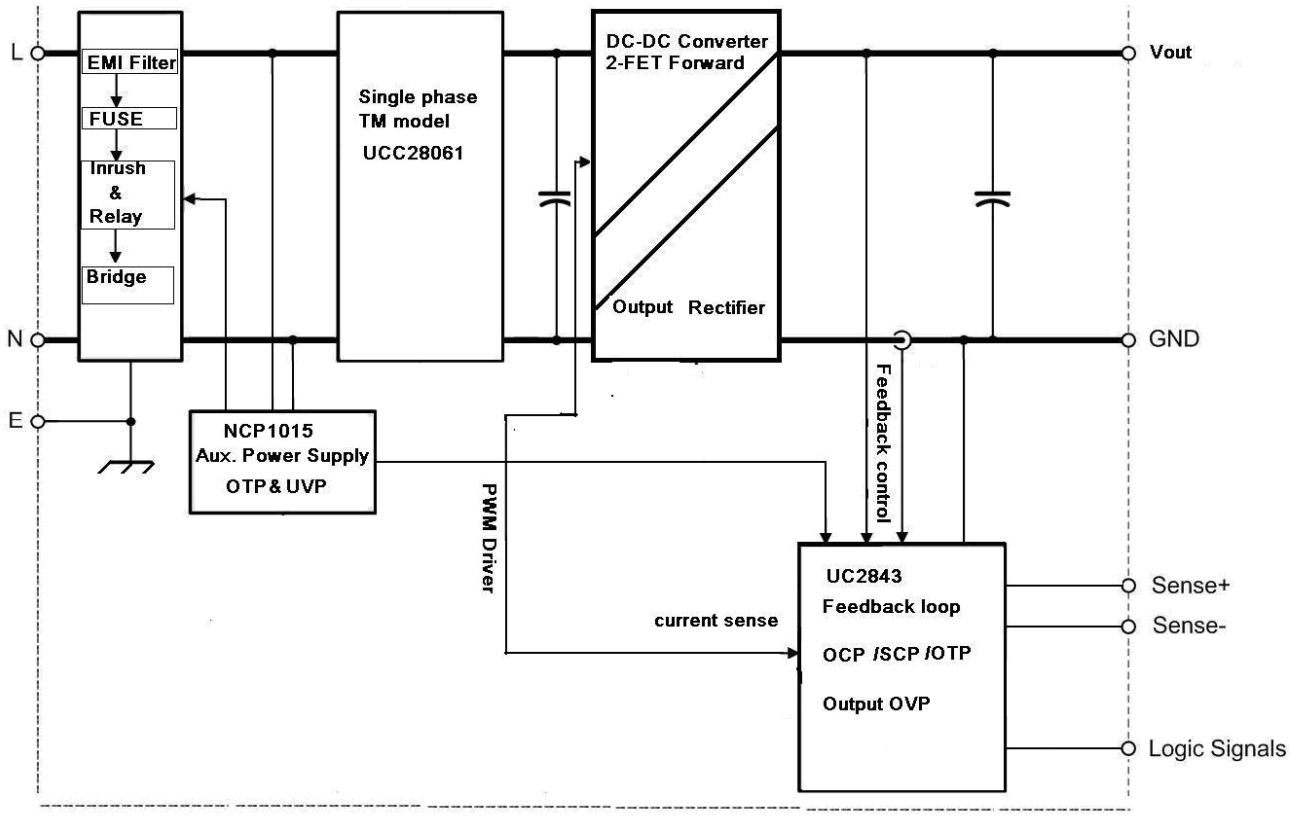


*Figure 1: MBC250-10XXG block diagram*

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## 3 Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings may cause performance degradation, adversely affect long-term reliability, and cause permanent damage to the supply.

| PARAMETER | | DESCRIPTION / CONDITION | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{i\,maxc}$ | Max continuous input | Continuous | | | 264 | VAC |

## 4 Environmental and Mechanical

| PARAMETER | | DESCRIPTION / CONDITION | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $V_{i\,min}$ to $V_{i\,max}$, $I_{1\,nom}$, | -10 | | +50 | °C |
| $T_{Aext}$ | Extended temp range | Derated output | +50 | | +70 | °C |
| $T_S$ | Storage temperature | Non-operational | -40 | | +85 | °C |
| | Dimensions | Width | | 76.2 | | mm |
| | | Height | | 38.1 | | mm |
| | | Depth | | 127.0 | | mm |
| $M$ | Weight | | | 0.5 | | kg |

## 5 Input Specifications

General Condition: $T_A$ = -10… 50 °C unless otherwise noted.

Active fan air cooling required: 200 LFM (1 m/s).

| PARAMETER | | DESCRIPTION / CONDITION | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{i\,nom}$ | Nominal input voltage | | 100 | | 240 | VAC |
| $V_i$ | Input voltage ranges | Normal operating ($V_{i\,min}$ to $V_{i\,max}$) | 90 | | 264 | VAC |
| $I_{i\,max}$ | Max input current | | | | 3.5 | $A_{rms}$ |
| $I_{i\,p}$ | Inrush current limitation | $V_{i\,nom}$=115 VAC, $T$= 25°C (see Figure 2)<br>$V_{i\,nom}$=230 VAC, $T$= 25°C (see Figure 3) | | | 30<br>60 | $A_p$ |
| $F_i$ | Input frequency | | 47 | 50/60 | 63 | Hz |
| PF | Power factor | $V_{i\,nom=}$=264 VAC, > 0.5 $I_{o\,nom}$ | 0.9 | | | W/VA |
| $V_{i\,on}$ | Turn-on input voltage[1)] | Ramping up | 82 | | 89 | VAC |
| $V_{i\,off}$ | Turn-off input voltage[1)] | Ramping down | 78 | | 85 | VAC |
| η | Efficiency | $V_{i\,nom}$=230 VAC, 0.5·$I_{o\,nom}$, $V_{o\,nom}$, $T_A$ = 25 °C<br>$V_{i\,nom}$=230 VAC, 1.0·$I_{o\,nom}$, $V_{o\,nom}$, $T_A$ = 25 °C | 88[2)]<br>90 | | | % |
| $T_{hold}$ | Hold-up Time | After last AC zero point, $V_o$ within regulation, $V_i$ = 115 VAC, $P_{o\,nom}$ | 12 | 18 | | mS |
| $Li$ | Earth leakage current | 264 VAC at 60 Hz | | | 300 | uA |

[1)] The power supply is provided with a minimum hysteresis of 2 V during turn-on and turn-off within the ranges.

[2)] For MBC250-1012G/1048G half load minimum efficiency is 87.5%.

### 5.1 Input Fuse

Double fusing with 5 A slow-blow type (5 × 20 mm), in series with Live and neutral line inside of the power supply protects against severe defects. The fuses and a VDR form together with the input filter an effective protection against high input transients.

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### 5.2 Inrush Current

The AC-DC power supply exhibits an X-capacitance of only 2.0 µF, resulting in a low and short peak current, when the supply is connected to the mains. The internal bulk capacitor will be charged through a power resistor which will limit the inrush current (see Figure 2 and 3).

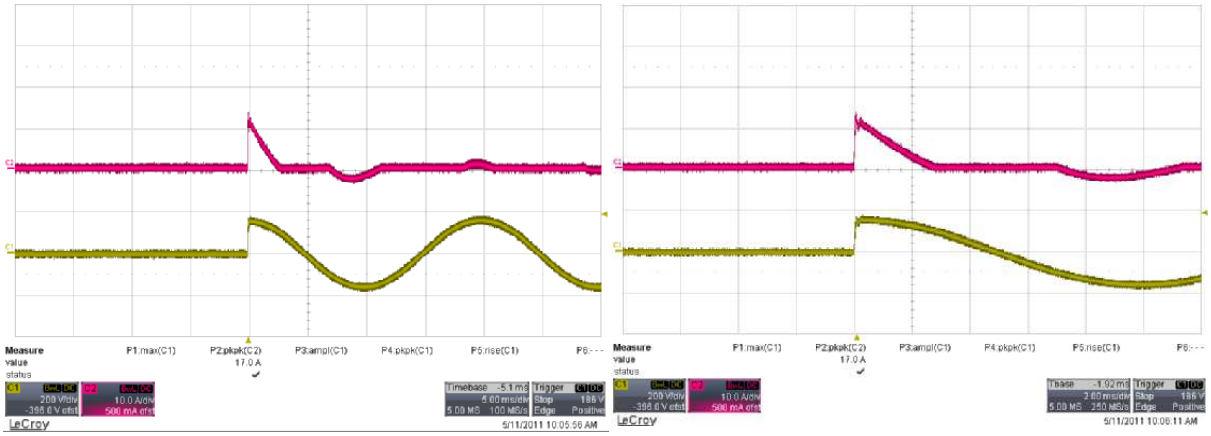


*Figure 2: Inrush current, $V_{in}$ = 115 VAC, Phase=90°, CH1: $V_{in}$ (200 V/div), CH2: $I_{in}$ (10 A/div)*
*Test data: the inrush current is 13 A at 115 VAC input*

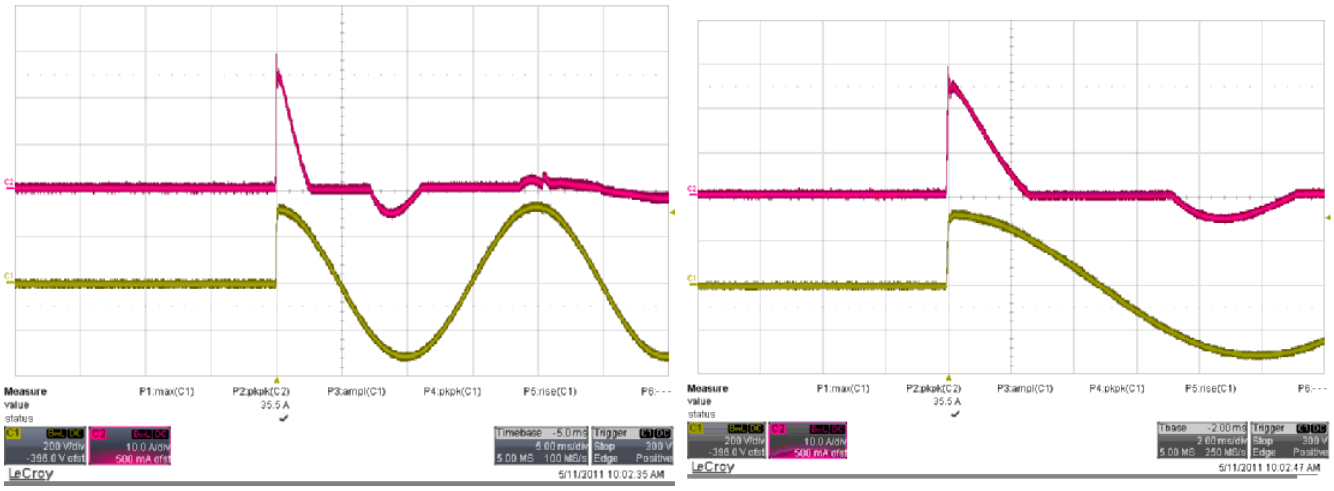


*Figure 3: Inrush current, $V_{in}$ = 230 VAC, Phase=90°, CH1: $V_{in}$ (200 V/div), CH2: $I_{in}$ (10 A/div)*
*Test data: the inrush current is 30 A at 230 VAC input*

### 5.3 Input Under-voltage

If the sinusoidal input voltage stays below the input under voltage lockout threshold $V_{on}$, the supply will be inhibited. Once the input voltage returns within the normal operating range, the supply will return to normal operation again.

### 5.4 Power Factor Correction

Power factor correction (PFC) is achieved by controlling the input current waveform synchronously with the input voltage. A specified PFC controller is implemented in single phase transition mode topology giving outstanding PFC results over a wide input voltage and load ranges. The input current will follow the shape of the input voltage.


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### 5.5 Efficiency

The high efficiency (see Figure 4, 5 and 6) is achieved by using state-of-the-art silicon power devices in conjunction with transition mode PFC topology minimizing switching losses. Synchronous rectifiers on the output reduce the losses in the high current output path for MBC250-1012G.

Schottky diode and ultra-fast diode are used as rectifiers for MBC250-1024G and MBC250-1048G separately due to the high output voltage level.

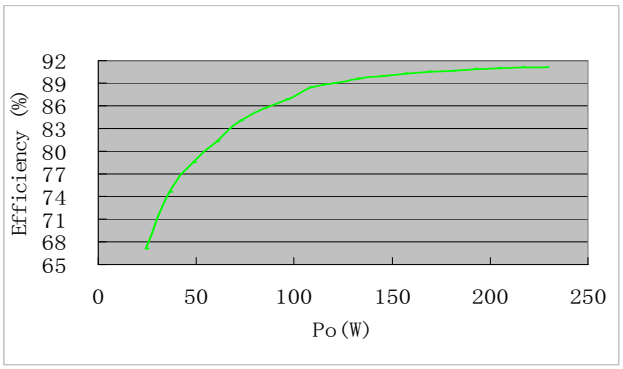


*Figure 4: Efficiency vs. Output Power at 230 VAC, MBC250-1012G*

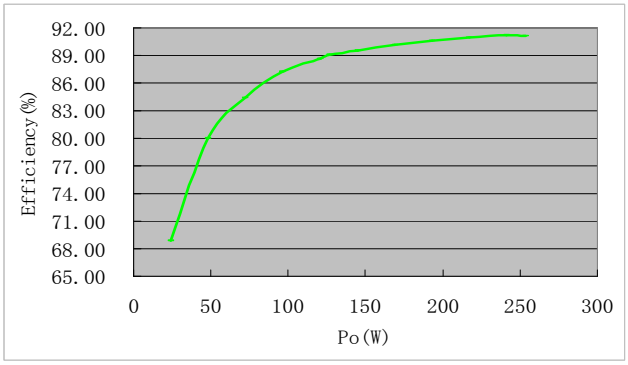


*Figure 5: Efficiency vs. Output Power at 230 VAC, MBC250-1024G*

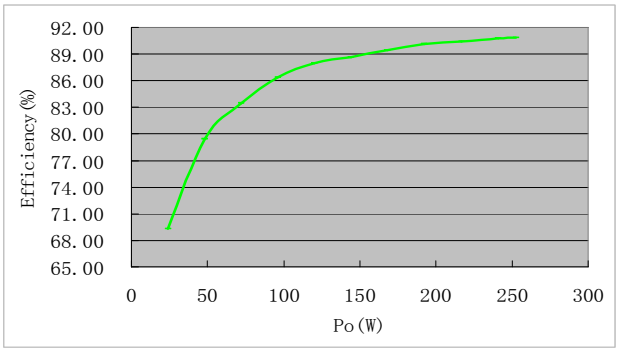


*Figure 6: Efficiency vs. Output Power at 230 VAC, MBC250-1048G*



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## 6 Output Specifications

General Condition: $T_A$ = -10 … +50 °C unless otherwise noted. Active fan air cooling required: 200 LFM (1 m/s).

| PARAMETER | | DESCRIPTION / CONDITION | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **Main Output $V_o$** | | | | | | | |
| $V_o$ | Nominal output voltage | 0.5 ·$I_O$, $T_{amb}$ = 25 °C | MBC250-1012G | | 12.0 | | VDC |
| | | | MBC250-1024G | | 24.0[1] | | VDC |
| | | | MBC250-1048G | | 48.0 | | VDC |
| $V_{o\ set}$ | Output set point accuracy | 0.5 ·$I_O$, $T_{amb}$ = 25 °C | MBC250-1012G | -50 | | 50 | mV |
| | | | MBC250-1024G | -75 | | 75 | mV |
| | | | MBC250-1048G | -150 | | 150 | mV |
| $P_{o\ nom}$ | Nominal output power | | MBC250-1012G | 0 | | 228 | W |
| | | | MBC250-1024G | 0 | | 252 | W |
| | | | MBC250-1048G | 0 | | 252 | W |
| $I_{o\ nom}$ | Nominal output current | | MBC250-1012G | 0 | | 19 | A |
| | | | MBC250-1024G | 0 | | 10.5[2] | A |
| | | | MBC250-1048G | 0 | | 5.25 | A |
| $V_{o\ p\text{-}p}$ | Output ripple voltage | $V_{o\ nom}$, $I_{o\ nom}$, 20 MHz BW | MBC250-1012G | | 60 | 120 | mVpp |
| | | | MBC250-1024G | | 80 | 240[3] | mVpp |
| | | | MBC250-1048G | | 150 | 480 | mVpp |
| $dV_{o\ Load}$ | Load regulation | $V_i$ = $V_{i\ nom}$, 0 - 100 % $I_{o\ nom}$ | MBC250-1012G | -360 | 50 | 360 | mV |
| | | | MBC250-1024G | -720[4] | 80 | 720[4] | mV |
| | | | MBC250-1048G | -1440 | 130 | 1440 | mV |
| $dV_{o\ Line}$ | Line regulation | $V_i$ =$V_{i\ min}$...$V_{i\ max}$ | MBC250-1012G | -120 | 80 | 120 | mV |
| | | | MBC250-1024G | -120 | 80 | 120 | mV |
| | | | MBC250-1048G | -120 | 80 | 120 | mV |
| $dV_{dyn}$ | Dynamic load regulation | $\Delta I_o$ = 50% $I_{o\ nom}$, $I_o$ = 50 … 100% $I_{o\ nom}$, $dI_o/dt$ =1 A/µs, recovery within 5% of $V_{o\ nom}$ | MBC250-1012G | -0.6 | 0.25 | 0.6 | V |
| | | | MBC250-1024G | -1.2 | 0.45 | 1.2 | V |
| | | | MBC250-1048G | -2.4 | 0.7 | 2.4 | V |
| $t_{rec}$ | Recovery time | | | | | 2 | mS |
| $t_{delay}$ | Turn-on Delay | Time required for output within regulation after intial application of AC input @90 VAC | | 0.3 | 1 | 2 | Sec |
| $t_{rise}$ | Turn on Rise time | $V_O$ = 10…90% $V_{O\ nom}$ | | | 10 | 20 | mS |
| $C_{Load}$ | Capacitive loading | $T_{amb}$ = 25 °C | MBC250-1012G | | | 4200 | µF |
| | | | MBC250-1024G | | | 2300 | µF |
| | | | MBC250-1048G | | | 1150 | µF |

[1] The nominal output voltage is 26.7 VDC for MBC250-1024S302G.

[2] The rated output current is 9.43 A for MBC250-1024S302G.

[3] The output ripple voltage is 267 mVpp for MBC250-1024S302G.

[4] The load regulation is ±800 mV for MBC250-1024S302G.

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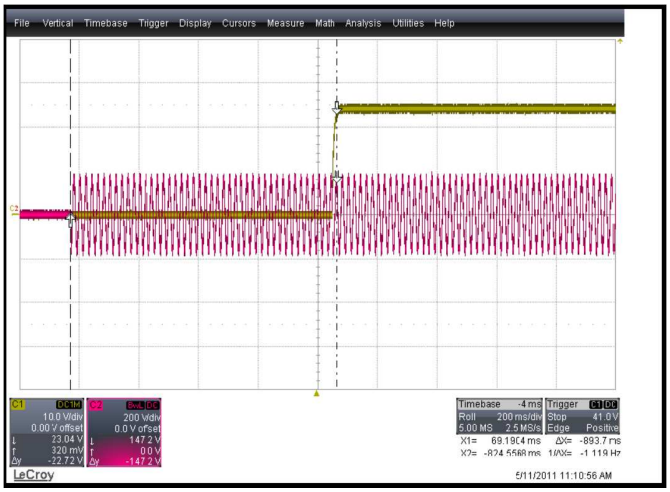
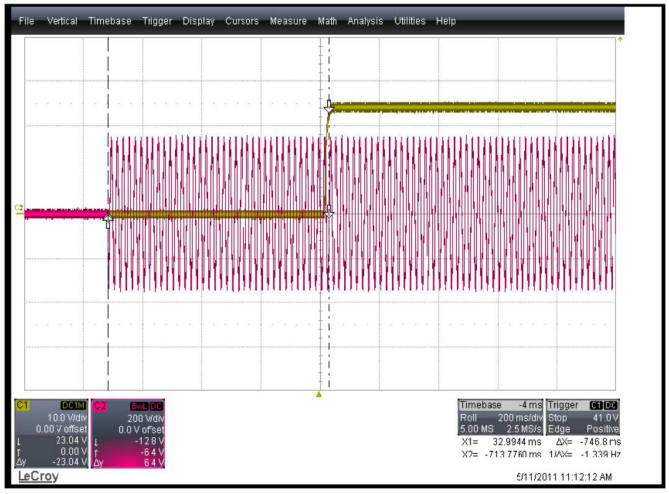
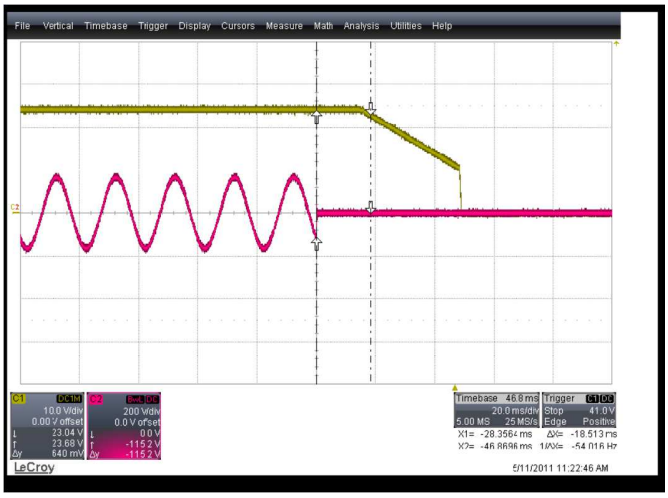


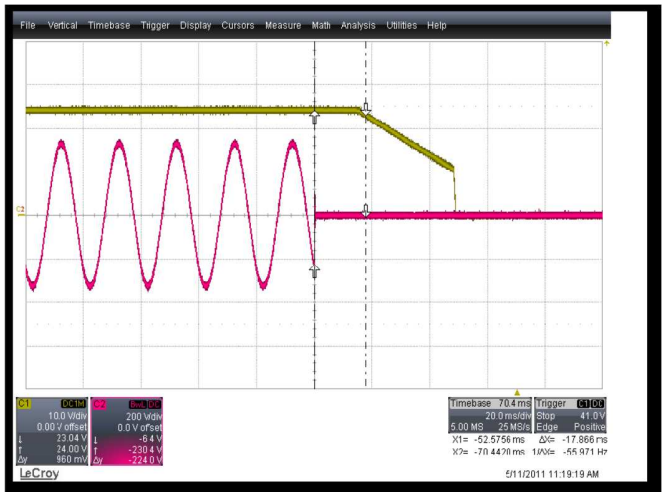

*CH1:Vo (10 V/div)* *CH2:Vin (200 V/div)*
*Figure 5: Turn on AC line 115 VAC, full load (200 mS/div)*




*CH1:Vo (10 V/div)* *CH2:Vin (200 V/div)*
*Figure 6: Turn on AC line 230 VAC, full load (200 mS/div)*




*CH1:Vo (10 V/div)* *CH2:Vin (200 V/div)*
*Figure 7: Turn off AC line at 115 VAC, full load (20 mS/div)*




*CH1:Vo (10 V/div)* *CH2:Vin (200 V/div)*
*Figure 8: Turn off AC line at 230 VAC, full load (20 mS/div)*

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*CH1:Vo (10 V/div)  CH2:Vin (200 V/div)*
*Figure 9: AC drop out 12 mS at 115 VAC (50 mS/div)*

*CH1:Vo (10 V/div)  CH2:Vin (200 V/div)*
*Figure 10: AC drop out 12 mS at 230 VAC (50 mS/div)*

*CH1:Vo (10 V/div)  CH2:Vin (200 V/div)*
*Figure 11: AC drop out 50 mS@115 VAC (50 mS/div), Vo restart*

*CH1:Vo (10 V/div)  CH2:Vin (200 V/div)*
*Figure 12: AC drop out 50 mS@230 VAC (50 mS/div), Vo restart*

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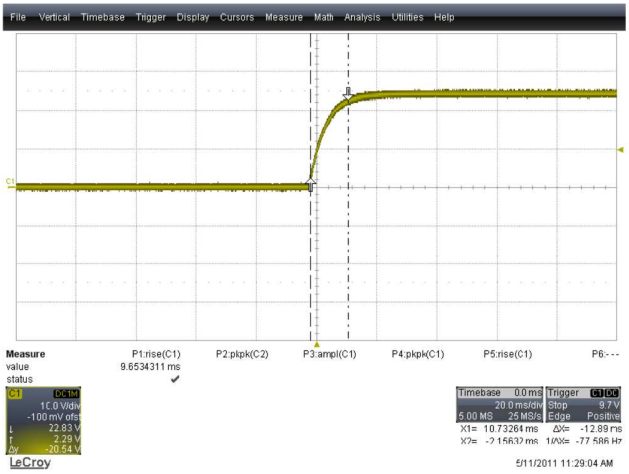
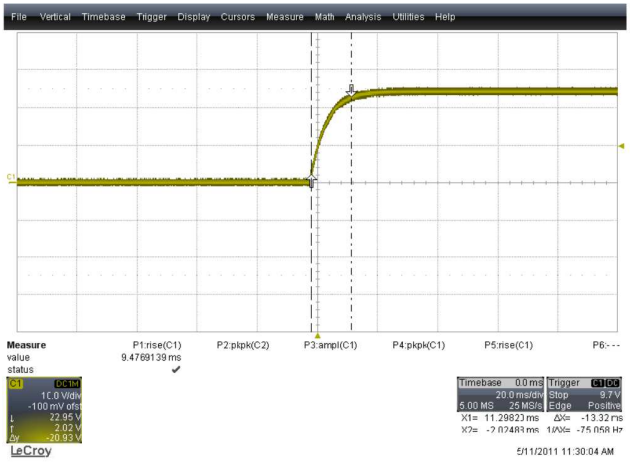


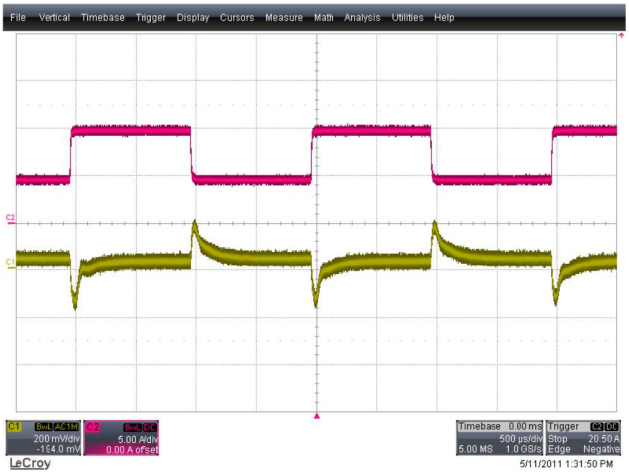

*CH1:Vo (10 V/div)*

*Figure 13: Vo rise time at 115 VAC (20 mS/div)*



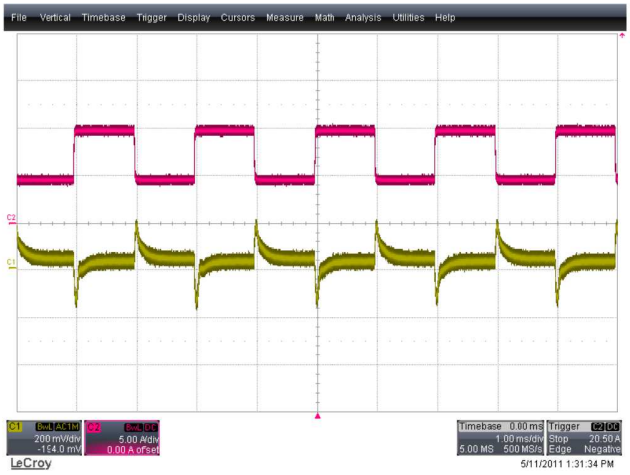

*CH1:Vo (10 V/div)*

*Figure 14: Vo rise time at 230 VAC (20 mS/div)*




*CH1: Vo (200 mV/div) CH2: I1 (5 A/div)*

*Figure 15: Load transient VO, 5.25 A <-> 10.5 A (0.5 mS/div), 2 A/µs*




*CH1: Vo (200 mV/div) CH2: I1 (5 A/div)*

*Figure 16: Load transient V0, 5.25 A <-> 10.5 A (1 mS/div), 2 A/µs*

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## 7 Protection

| PARAMETER | | DESCRIPTION / CONDITION | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $F$ | Input fuses (L and N) | Not user accessible, time lag characteristic | | | 5.0 | | A |
| Vo ov | OV threshold | | MBC250-1012G | 14.0 | | 16.0 | VDC |
| | | | MBC250-1024G | 28.0[1] | | 32.0[1] | VDC |
| | | | MBC250-1048G | 53 | | 57 | VDC |
| $I_{o\ lim}$ | Current limit | $V_i$ > 90 VAC, $T_a$ < 50 °C | MBC250-1012G | 21 | 22.5 | 25 | A |
| | | | MBC250-1024G | 11.5[2] | 12.6 | 13.7[2] | A |
| | | | MBC250-1048G | 5.8 | 6.4 | 6.8 | A |
| $T_{SD}$ | Over temperature on heat sinks | Automatic shut-down | | 91 | 96 | 101 | °C |

[1] The voltage range of Over Voltage Protection for MBC250-1024S302G is 29.0~34.0 VDC.
[2] The current range of Over Current Protection for MBC250-1024S302G is 10.3~12.3 A.

### 7.1 Overvoltage Protection

The AC-DC power supply provides a fixed threshold overvoltage (OV) protection implemented with a HW comparator. Once an OV condition has been triggered, the supply will shut down and latch the fault condition. The latch can be unlocked by disconnecting the supply from the AC mains only.

### 7.2 Current Limitation

The main output current limitation will decrease linearly to 50% from 50 °C to 70 °C (ambient temperature at inlet, Fig. 17).

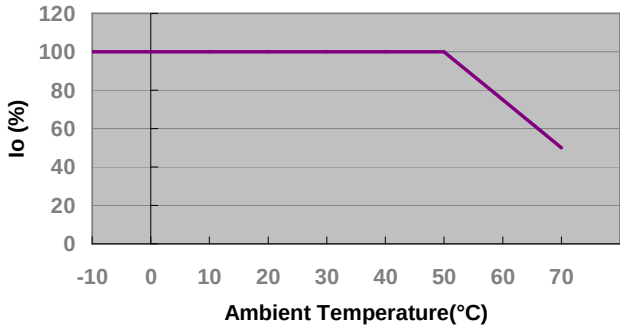


*Figure 17: Output Current Limitation Curve*

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## 8 Power Good Signal

The Out-OK output gives a status indication of the converter and the output voltages. It can be used for control functions such as data protection, central system monitoring or as a part of a self-testing system. Connect the Out-OK (Power Good) as shown in Figure 18, VOK <1.0 V indicates that the output voltage(s) of the converter are within the range.

The Out-OK is an active low signal, i.e. Power Good will pull low internally when output is within regulation. Out-OK is high impedance internally when there is error condition such as output voltage out of range due to overload or an external overvoltage. This signal is electrically isolated from the output.

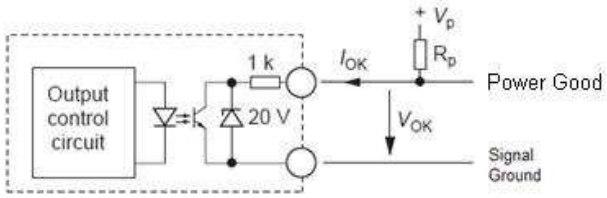


*Figure 18: Power Good signal*

Power Good Signal Description:

1. O/P V OK – Signal Low, Opto conducting, (max sink current 0.5mA)
2. O/P V Bad – Signal High, Opto opening, (max leakage current 25µA)

## 9 Electromagnetic Compatibility

### 9.1 Immunity

Note: Most of the immunity requirements are derived from EN 61000-6-1:2007.

| TEST | STANDARD / DESCRIPTION | CRITERIA |
|---|---|---|
| ESD Contact Discharge | EN 61000-4-2, Level 2 | A |
| RF Susceptibility | EN 61000-4-3, Level 3 | A |
| Fast Transient/Burst | EN 61000-4-4, Level 3 | B |
| Surge | EN 61000-4-5, Class 3 | B |
| RF Conducted Immunity | EN 61000-4-6, Class 3 | A |
| Magnetic Fields | EN 61000-4-8 | A |
| Voltage Dips and Interruptions | EN 61000-4-11 | C |

### 9.2 Emission

| TEST | STANDARD / DESCRIPTION | CRITERIA |
|---|---|---|
| Conducted Emission | EN55011: 0.15 … 30 MHz, QP and AVG, single unit | Class A 6 dB Margin |
| Radiated Emission | EN55011 : 30 MHz … 1 GHz, QP, single unit | Class A 6 dB Margin |
| Harmonic Emissions | IEC61000-3-2, Vin = 100 VAC/ 60 Hz, 100% Load | Class A |
| | IEC61000-3-2, Vin = 240 VAC/ 50 Hz, 100% Load | Class A |
| Voltage Fluctuation and Flicker | EN61000-3-3 | PASS |
| Rules for Unintentional Radiations | FCC Part 15, Sub Part-B | PASS |



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## 10 Safety/Approvals

Maximum electric strength testing is performed in the factory according to IEC 60950-1, Input-to-output electric strength tests should not be repeated in the field. Power-One will not honor any warranty claims resulting from electric strength field tests.

| PARAMETER | | DESCRIPTION / CONDITION | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| | Agency Approvals | UL60601-1 3rd<br>CSA60601-1 3rd<br>IEC 60950-1 3rd | | Approved by independent body (see CE Declaration) | | |
| | Insulation Safety Rating | Input / Case | | Basic | | |
| | | Input / Output | | Reinforced | | |
| | | Output / Case | | Basic | | |
| dc | Creepage / clearance | Primary (L/N) to protective earth (PE) | | According to safety standard | | mm |
| | | Primary to secondary | | | | mm |
| | Electrical strength test | Input to case | | 2.3 | | KVDC |
| | | Input to output | | 4.0 | | KVAC |
| | | Output and Signals to case | | 1.5 | | kVAC |

## 11 Mechanical

### 11.1 Dimensions

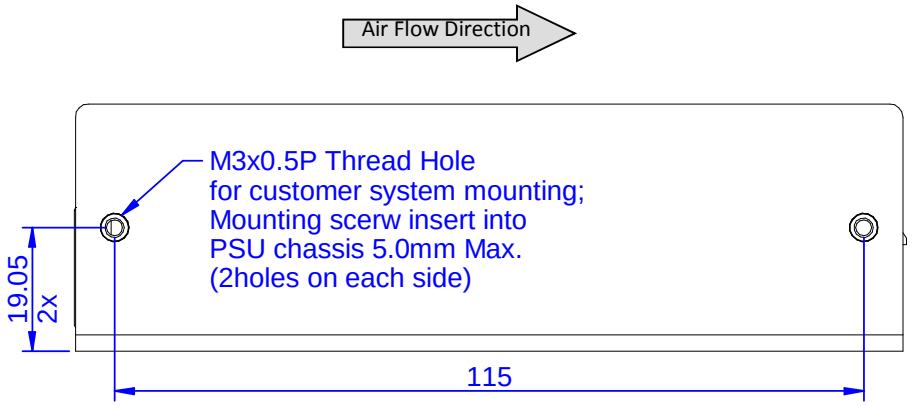


*Figure 19: Side view 1*



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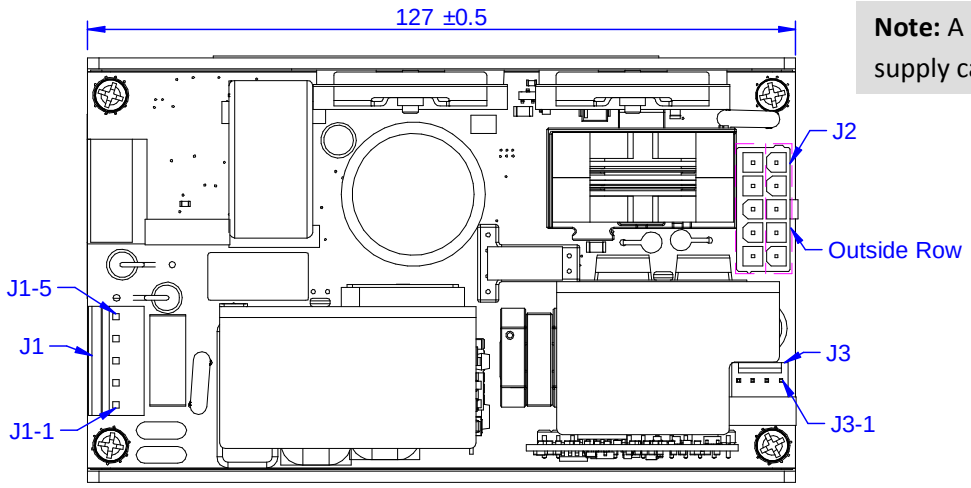


**Note:** A 3D step file of the power supply casing is available on

*Figure 20: Top view*

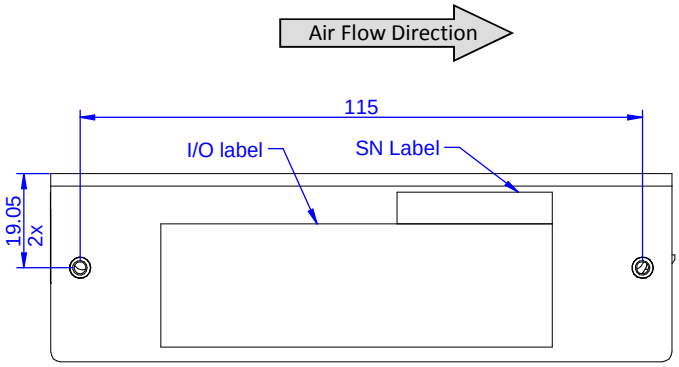


*Figure 21: Side view 2*

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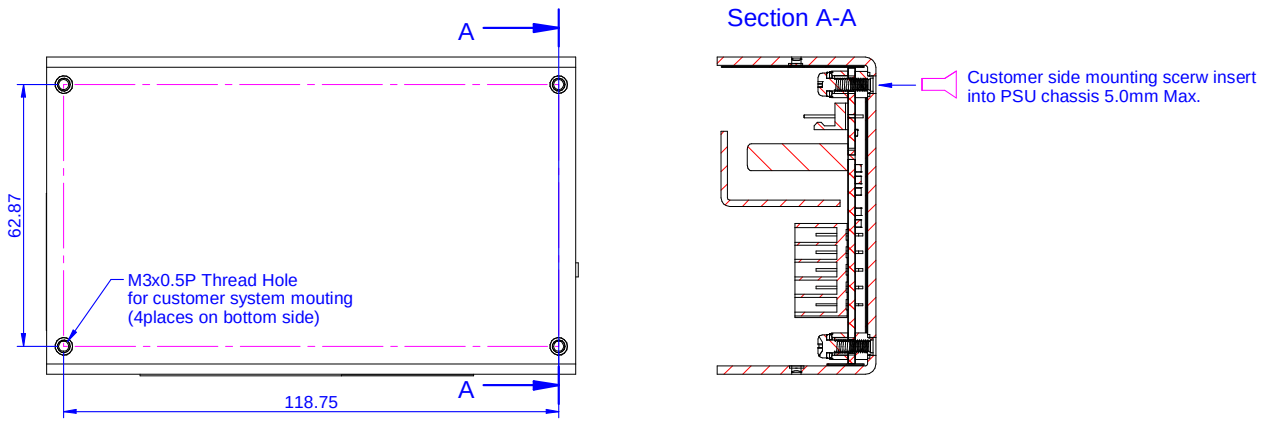


*Figure 22: Bottom view 2*

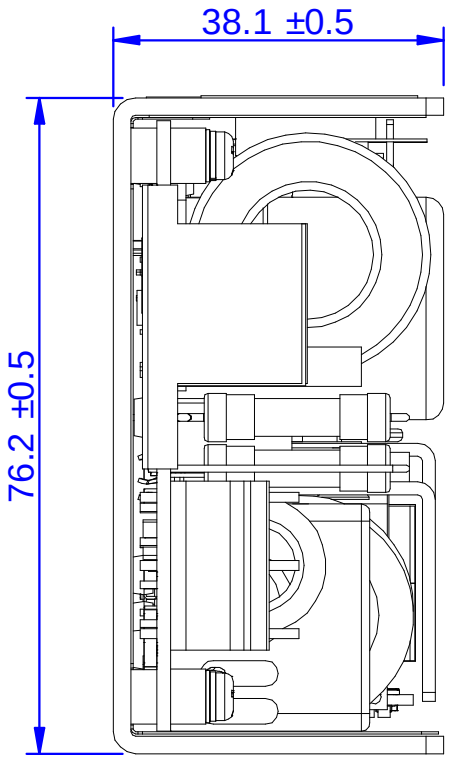


*Figure 23: Front view*

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### 11.2 Connections

## Connector Pin Assignment:

J1

| PIN | CONNECTION |
|---|---|
| 1 | Earth |
| 2 | Not fitted |
| 3 | Neutral |
| 4 | Note fitted |
| 5 | Line |

J2

| PIN | CONNECTION |
|---|---|
| Inside Row (Pin 1-5) | -Vo |
| Outside Row (Pin 6-10) | +Vo |

J3

| PIN | CONNECTION |
|---|---|
| 1 | Vo Sense - |
| 2 | Vo Sense + |
| 3 | Power Good |
| 4 | Power Good Return |

## Mating parts( Molex or equivalent):

| CONNECTOR | HOUSING | CRIMP TERMINAL | WIRE GAUGE |
|---|---|---|---|
| J1 | 09-50-3051 | 08-50-0105 | AWG # 18 |
| J2 | 39-01-2105 | 44476-3112 | AWG # 16 |
| J3 | 22-01-3047 | 08-50-0113 | AWG # 22-30 |



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