



# MBS601 Series

## 600 W AC-DC Power Supplies

### Sealed IP66/67/68

The MBS601 Series of AC-DC power supplies provides up to 600 W of regulated output power through a wide input voltage range 85 – 264 VAC in a single output of 24 VDC or 48 VDC.

The MBS601 Series comes in a 4.92 x 9.86 x 2.36 inch form factor with a full set of protection features.

The MBS601 Series is available in an aluminium extruded chassis having fins for an optimal heat dispersion via natural convection. The input / output connections are fixed to the chassis through water tight glands, which combined with the sealed enclosure, give the power supply an IP66/67/68 ingress protection grade.

The -SL option offers a 5 V<sub>DC</sub> stand-by output and a set of control signals: +/- remote sense, remote On/Off (-PS\_Inhibit), power good (PS\_Ok), I-share (ISHARE1+V\_SLOGIC).

The MBS601 Series complies with the latest edition of the IEC/EN 60601-1 safety standards for medical equipment requiring 2x MoPP protection grade and displays the CE Mark for the European Low Voltage Directive (LVD).



### Key Features & Benefits

- Sealed enclosure, IP66/67/68 Ingress Protection grade
- High efficiency up to 94% (50% to 100% load)
- Low stand-by power consumption (< 0.35 W)
- Universal input voltage range 85 – 264 VAC
- Input inrush current limiting <30 A
- 800 W peak power (up to 10 s)
- Single 24, 48 VDC voltages
- Active PFC, EN61000-3-2 compliant (Class C, >25% load)
- Low earth / touch leakage current
- Over temperature, OV, OC and SC protections.
- Stand by +5 V, 1.5 A output.
- Remote On / Off signal
- Overall dimensions 125.0 x 250.5 x 60.0 mm (4.92 x 9.86 x 2.36 in)
- Medical safety approval to IEC 60601-1 3rd edition, 2xMoPP protection grade BF appliances compatible IEC 60601-1-2 4th edition EMC compliant

### Applications

- Clinical Analysers
- Dental units / chairs
- MRI / Full Body TC Systems
- Medical Diagnostic & Imaging Systems

## 1. MODEL SELECTION

| MODEL NUMBER   | PACKAGE & COOLING   | INPUT VOLTAGE RANGE [VAC] | NOM. OUTPUT VOLTAGE [VDC] | MAX. OUTPUT POWER [W] | MAX. OUTPUT CURRENT [A] | DIMENSIONS                                       |
|----------------|---|---------------------------|---------------------------|-----------------------|-------------------------|--|
| MBS601-1T24    | Sealed Chassis<br>Natural Convection                      | 85 - 305                  | 24                        | 600                   | 25                      | 125.0 x 250.5 x 60.0 mm<br>4.92 x 9.86 x 2.36 in |
| MBS601-1T24-SL | Sealed Chassis<br>Natural Convection<br>+ Control Signals | 85 - 305                  | 24                        | 600                   | 25                      |  |
| MBS601-1T48    | Sealed Chassis<br>Natural Convection                      | 85 - 305                  | 48                        | 600                   | 12.5                    |  |
| MBS601-1T48-SL | Sealed Chassis<br>Natural Convection<br>+ Control Signals | 85 - 305                  | 48                        | 600                   | 12.5                    |  |

## 2. INPUT SPECIFICATIONS

| PARAMETER                                    | DESCRIPTION / CONDITION  | MIN                 | NOM     | MAX  | UNIT             |   |
|--|--|---------------------|---------|------|------------------|---|
| AC Input Voltage                             | MoPP grade   | 85                  | 100-240 | 264  | V <sub>RMS</sub> |   |
|  | MoOP grade   | 85                  | 100-277 | 305  |                  |   |
|  | PS starts and operates at 85 V <sub>AC</sub> at all load conditions  |                     |         |      |                  |   |
| DC Input Voltage                             | Built in fuses has been safety certified up to 250 V <sub>DC</sub> .<br>Operating the MBS601 above that limit up to 300 V <sub>DC</sub> does require an external fuse protection.  | 170                 | -       | 300  | V <sub>DC</sub>  |   |
| Input Frequency                              | 440 Hz with reduced PFC and output power rating.<br>Consult factory for details.   | 47                  | 50/60   | 63   | Hz               |   |
| Input Current                                | RMS at 180 V <sub>AC</sub> , maximum load, 50 / 60 Hz  | -                   | -       | 4.0  | A                |   |
|  | RMS at 85 V <sub>AC</sub> , maximum load, 50 / 60 Hz   | -                   | -       | 8.5  |                  |   |
| Inrush Current                               | Cold start, 25 °C ambient, full load   | 115 V <sub>AC</sub> | -       | -    | 20               | A |
|  |  | 230 V <sub>AC</sub> | -       | -    | 30               |   |
| Fusing                                       | High breaking, 10 A, 250 V on each AC lines.   | -                   | -       | 10   | A                |   |
| Efficiency                                   | At 115 V <sub>AC</sub>   | 20% rated load      | 89      | -    | -                | % |
|  |  | 50% rated load      | 93      | -    | -                |   |
|  |  | 100% rated load     | 92      | -    | -                |   |
|  | At 230 / 264 V <sub>AC</sub>   | 20% rated load      | 90      | -    | -                |   |
|  |  | 50% rated load      | 94      | -    | -                |   |
|  |  | 100% rated load     | 94      | -    | -                |   |
| Input Power Consumption                      | Power on, 115 V <sub>AC</sub> , no load  | -                   | -       | 5    | W                |   |
|  | Power on, 230 V <sub>AC</sub> , no load  | -                   | -       | 4    |                  |   |
|  | Stand by, 115, 230 V <sub>AC</sub> , no load   | -                   | -       | 0.35 |                  |   |
| Power Factor                                 | From 50 to 100% of rated load, 230, 115 V <sub>AC</sub> , 50 / 60 Hz input voltages.   | 0.90                | -       | -    | -                |   |
| THDi   | From 50 to 100% rated load, 115, 230, 264 V <sub>AC</sub> 50 / 60 Hz.  | -                   | -       | 20   | %                |   |
| Harmonic Current<br>Fluctuations and Flicker | Complies with EN 61000-3-2 at 230 V <sub>AC</sub> , 50/60 Hz, Class A, D.<br>Complies with EN 61000-3-2 Class C at 230 V <sub>AC</sub> , 50/60 Hz, >150 W load.<br>Complies with EN 61000-3-3 at nominal voltages and full load. |                     |         |      |                  |   |
| Earth Leakage Current                        | Normal conditions  |                     |         |      |                  |   |
|  | 115 V <sub>RMS</sub> , 60 Hz   | -                   | 170     | -    | μA               |   |
|  | 230 V <sub>RMS</sub> , 50 Hz   | -                   | 290     | -    |                  |   |
| 264 V <sub>RMS</sub> , 60 Hz (worst case)    | -  | -                   | 460     |      |                  |   |

## 3. OUTPUT SPECIFICATIONS

| PARAMETER  | DESCRIPTION / CONDITION  | MIN  | NOM      | MAX                 | UNIT                    |    |
|--|--|--|----------|---------------------|-------------------------|----|
| V1 Output Voltages   | ±0.5% set point accuracy<br>RS+ closed on +V1, RS- closed on V1 RTN, at 20% load (option SL).  | -  | 24<br>48 | -                   | V                       |    |
| V1 Output Power Rating *   | Convection cooling (Refer to the de-rating curves below)<br>Peak (less than 10 s, after P_OK high)   |  |          | 600<br>800          | W                       |    |
| V1 Output Current *  | V1: 24 V <sub>DC</sub><br>V1: 48 V <sub>DC</sub>   |  |          | 25.0<br>12.5        | A                       |    |
| V1 Voltage Adjustment Range                                      | Manually by push up and down buttons   | -  | ±5       | -                   | %V1                     |    |
| V1 Line Regulation   | V <sub>AC</sub> : 85 – 264 V <sub>RMS</sub>  | -  | -        | ±0.1                | %V1                     |    |
| V1 Load-Line-Cross Regulation                                    | V <sub>AC</sub> : 85 – 264 V <sub>RMS</sub> ; I <sub>1</sub> : 0 – 100%  | -  | -        | ±2                  | %V1                     |    |
| V1 Ripple and Noise  | Rated load, Peak-to-peak, 20 MHz BW.<br>(100 nF ceramic, 10 µF tantalum at load)   | -  | -        | 1                   | %V1                     |    |
| Transient Response:<br>V1, 5V <sub>SB</sub><br>Voltage Deviation | 25% load changes at 1 A/µs<br>24 V at 1000 µF load / I <sub>OUT</sub> > 2.5 A<br>48 V at 560 µF load / I <sub>OUT</sub> > 1.25 A<br>5 V <sub>SB</sub> at 560 µF load / I <sub>OUT</sub> > 0.1 A                  | -  | -        | ±5                  | %V1<br>%V <sub>SB</sub> |    |
| V1 Start-up Rise Time  | 85 < V <sub>IN</sub> < 264, any load conditions.   | 10   | -        | 100                 | ms                      |    |
| V1 Hold-up Time  | At nominal V <sub>IN</sub> , full load   | 16   | -        | -                   | ms                      |    |
| V1 Current Sharing Accuracy                                      | Two units in parallel at I <sub>1</sub> rated load.<br>VS-Logic and I-Share signals connected together.<br>RS+, RS- signals connected together and to the load   | 45.5   | -        | 54.5                | %I <sub>1</sub>         |    |
| Start-up Delay   | V1 in regulation after de-asserting PS_Inhibit<br>V1 in regulation after AC is applied (worst case: 85 V <sub>AC</sub> )<br>5V <sub>SB</sub> in regulation after AC is applied (worst case: 85 V <sub>AC</sub> ) | -  | -        | 450<br>2050<br>1500 | ms                      |    |
| Turn-on Overshoot  |  | -  | -        | 10<br>10            | %V1<br>%V <sub>SB</sub> |    |
| Minimum Load   | V1, 5V <sub>SB</sub>   | 0  | -        | -                   | A                       |    |
| Maximum Load Capacitance   |  | V1: 24 V <sub>DC</sub><br>V1: 48 V <sub>DC</sub> | -        | -                   | 16000<br>8000           | µF |
| 5 V <sub>SB</sub> Output Voltage                                 | ±3% set point accuracy, 20% load.  | -  | 5        | -                   | V                       |    |
| 5 V <sub>SB</sub> Output Current                                 |  | -  | -        | 1.5                 | A                       |    |
| 5 V <sub>SB</sub> Load-Line-Cross Regulation                     | V <sub>AC</sub> : 85 – 264 V <sub>RMS</sub> ; I <sub>SB</sub> : 0 – 100%   | -  | -        | ±5                  | %V <sub>SB</sub>        |    |

\* Rated currents and combined power are referred to 55 °C ambient and V<sub>AC</sub> ≥ 180 V<sub>RMS</sub>.

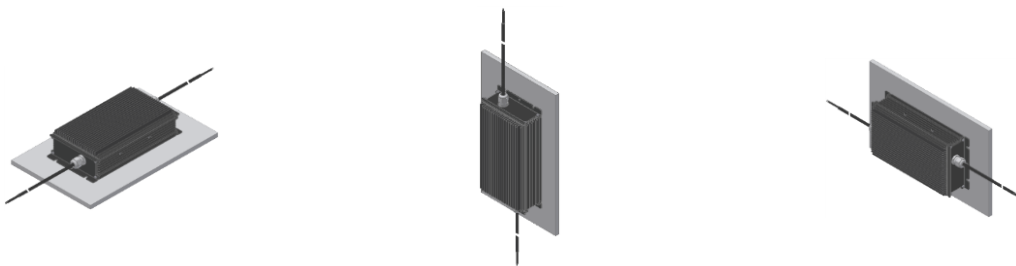


Figure 1. Mounting Orientation

3.1 OUTPUT POWER DE-RATING CURVES

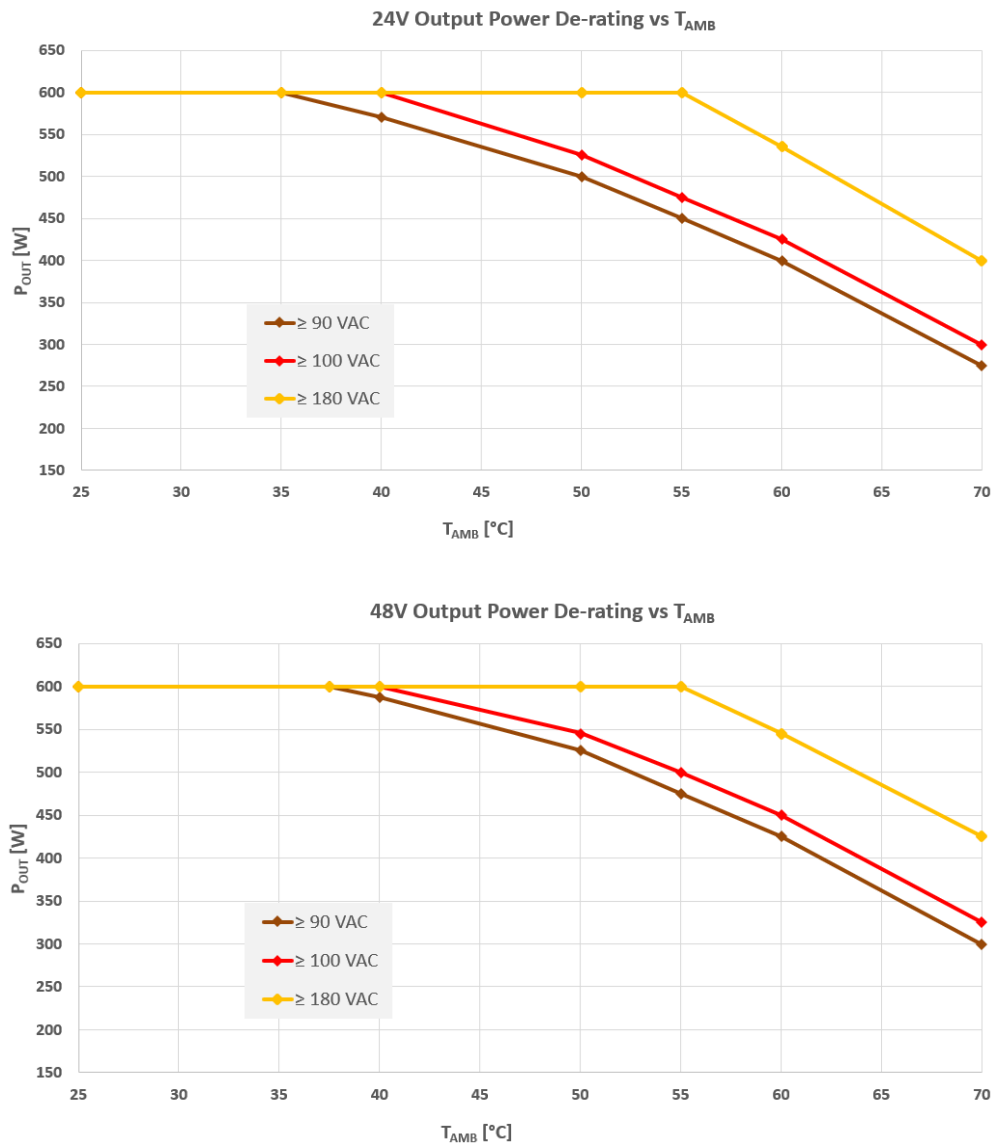


Figure 2. Power Derating Curves of MBS601 Series V1 P<sub>OUT</sub> to T<sub>AMB</sub>

Note: The de-rating curves are effective regardless mounting orientation

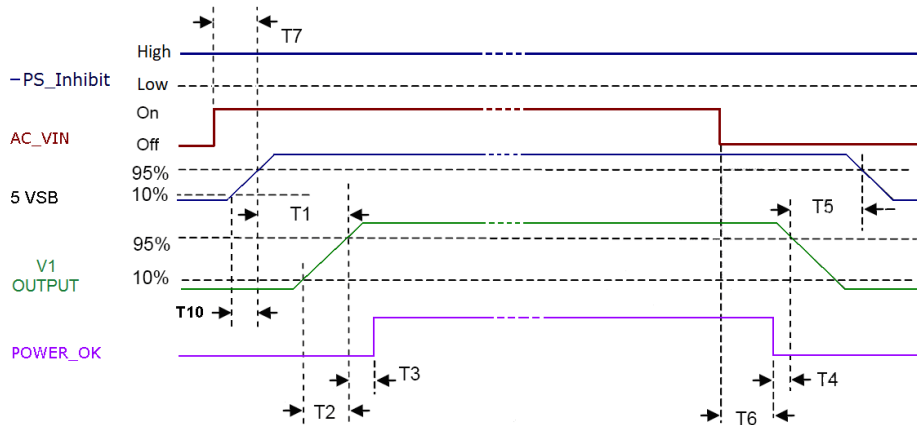
## 4. SIGNALS, CONTROLS & TIMING SPECIFICATIONS

Base signals and controls are accessible from signal connector P204.

| SIGNAL                  | DESCRIPTION / CONDITION   | MIN | NOM | MAX  | UNIT |
|-------------------------|---|-----|-----|------|------|
| -PS_Inhibit             | Active low. Input low voltage                                   | 0   | -   | 1.5  | V    |
|                         | Input high voltage ( $I_{IN}= 300 \mu A$ )                      | 3.5 | -   | 5.5  | V    |
|                         | V1 disabled when -PS_Inhibit is pulled low                      |     |     |      |      |
|                         | 5V <sub>SB</sub> not affected by -PS_Inhibit                    |     |     |      |      |
| P_OK*                   | V1 enabled when -PS_Inhibit is floating or high                 |     |     |      |      |
|                         | Logic level low (<10 mA sinking)                                | -   | -   | 0.7  | V    |
|                         | Logic level high (100 $\mu A$ sourcing)                         | 2.4 | -   | 5.5  | V    |
|                         | Low to high time after V1 in regulation                         | 40  | -   | 350  | ms   |
| 5V <sub>SB</sub> Output | Power down warning time   | 1   | -   | -    | ms   |
|                         | Active and in regulation after a $85 < V_{AC} < 264$ is applied | -   | -   | 1500 | ms   |
|                         | 5V <sub>SB</sub> not affected by PS_Inhibit                     |     |     |      |      |

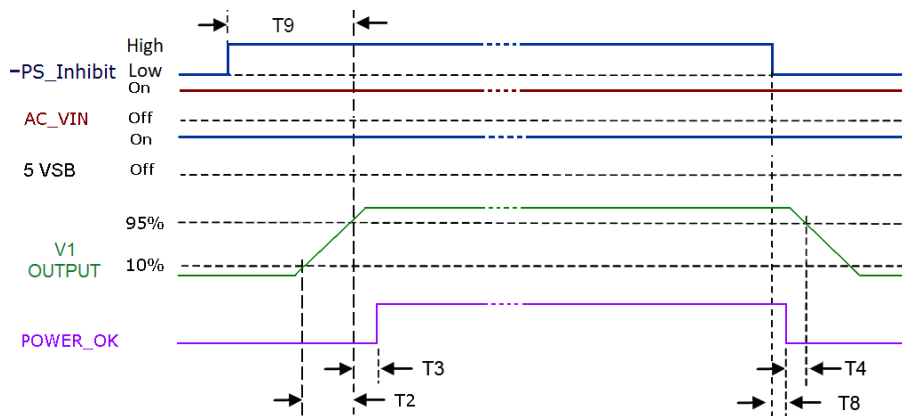
\* When V1 is On, a P\_OK low may indicates V1 under voltage condition. When two MBS601 operate in parallel, P\_OK low in one unit indicates that it is not sharing the expected amount of current (current sharing fault). A 10 k $\Omega$  internal pull up to 5V<sub>SB</sub> is used; do not add any other external pull up.

### AC/DC INPUT OFF-TO-ON AND ON-TO-OFF TIMINGS



|                                       |                             |
|---------------------------------------|-----------------------------|
| 5V <sub>SB</sub> On – V1 On           | 250 ms ≤ T1 ≤ 550 ms        |
| V1 rise time                          | 10 ms ≤ T2 ≤ 100 ms         |
| 5V <sub>SB</sub> rise time            | 3 ms ≤ T10 ≤ 40 ms          |
| V1 On – POWER_OK delay                | 200 ms ≤ T3 ≤ 350 ms        |
| Power down warning                    | T4 ≥ 1 ms                   |
| V1 Off – 5V <sub>SB</sub> Off         | T5 ≥ 0.5 s (V1 load > 25 W) |
| AC Off – POWER_OK low                 | T6 ≥ 15 ms                  |
| AC_On – 5V <sub>SB</sub> turn on time | T7 ≤ 1.5 s                  |

### PS\_INHIBIT OFF-TO-ON AND ON-TO-OFF TIMINGS



|                                  |  |
|----------------------------------|--|
| V1 rise time                     | $10 \text{ ms} \leq T2 \leq 100 \text{ ms}$  |
| V1 On – POWER_OK delay           | $200 \text{ ms} \leq T3 \leq 350 \text{ ms}$ |
| Power down warning               | $T4 \geq 1 \text{ ms}$                       |
| PS_Inhibit – POWER_OK low timing | $T8 \leq 2 \text{ ms}$                       |
| PS_Inhibit – V1 On delay         | $T9 \leq 450 \text{ ms}$                     |

## 5. PROTECTION SPECIFICATIONS

| PARAMETER                            | DESCRIPTION / CONDITION  | MIN  | NOM | MAX | UNIT                |
|--------------------------------------|--|------|-----|-----|---------------------|
| Input Under Voltage                  | Auto-recovering  | 58   | 75  | 82  | V <sub>AC</sub>     |
| Input Fuse                           | High breaking, 10 A, 250 V on L and L1.                            | -    | -   | 10  | A                   |
| Over Current                         | At nominal input voltages  |      |     |     |                     |
|                                      | V1: Hiccup mode, auto-recovering (>10 s)                           | 108  | -   | 132 | %I <sub>Rated</sub> |
|                                      | V1: Hiccup mode, auto-recovering (<10 s)                           | 135  | -   | 163 | %I <sub>Rated</sub> |
| Short Circuit                        | 5 V <sub>SB</sub> : Hiccup mode, auto-recovering:                  | 1.6  | -   | 3.6 | A                   |
|                                      | At nominal input voltages  |      |     |     |                     |
|                                      | V1: Hiccup mode, auto-recovering.                                  | -    | -   | -   |                     |
| Over Voltage                         | 5V <sub>SB</sub> : Hiccup mode, auto-recovering.                   |      |     |     |                     |
|                                      | V1, Power shut down, latch off.                                    | 120  | -   | 145 | %V <sub>NOM</sub>   |
| Over Temperature (on primary stage)  | 12V <sub>SB</sub> , Hiccup mode, auto-recovering.                  | -    | -   | 150 |                     |
|                                      | Shut down, latch off.  | -    | -   | -   | °C                  |
| Over Temperature (on secondary side) | Hiccup mode, auto-recovering.                                      | -    | -   | -   | °C                  |
| Isolation: Primary-to-Secondary      | Reinforced (2x MoPP)   | 5660 | -   | -   | V <sub>DC</sub>     |
|                                      |  | 4000 | -   | -   | V <sub>AC</sub>     |
| Isolation: Input-to-Earth            | Basic (1x MoPP)  | 2121 | -   | -   | V <sub>DC</sub>     |
|                                      | Production tested at 2121 V <sub>DC</sub>                          | 1500 | -   | -   | V <sub>AC</sub>     |
| Isolation: V1-to-5V <sub>SB</sub>    | Basic  | 100  | -   | -   | V <sub>AC</sub>     |
| Isolation: Output-to-Earth           | Basic (1x MoPP)  | 1500 | -   | -   | V <sub>AC</sub>     |
| Equipment Protection Class           | Class I, compatible with BF (Body Floating) ME (Medical Equipment) |      |     |     |                     |

## 6. ENVIRONMENTAL SPECIFICATIONS

| PARAMETER                                 | DESCRIPTION / CONDITION  | MIN    | NOM | MAX          | UNIT   |
|---|--|--------|-----|--------------|--------|
| Operating Temperature Range               | No de-rating up to 55°C, at $\geq 180 V_{AC}$  | -30    | -   | 55           | °C     |
| Operating Temperature Range with Derating | See derating curves and conditions in the Output Specifications section  | -      | -   | 70           | °C     |
| Storage Temperature                       | As per IEC/EN 60721-3-1 Class 1K4  | -40    | -   | 85           | °C     |
| Transportation Temperature                | As per IEC/EN 60721-3-2 Class 2K4  |        |     |              |        |
| Humidity                                  | RH, Non-condensing Operating.<br>Non-operating   | -      | -   | 90<br>95     | %<br>% |
| Operating Altitude                        | Medical grade MoPP (100-240 $V_{AC}$ , 50/60 Hz)<br>Medical grade MoOP (100-277 $V_{AC}$ , 50/60 Hz)<br><b>EN 60068-2-27</b>   | -      | -   | 4000<br>5000 | m      |
| Shock                                     | Operating: Half sine, 30 g, 18 ms, 3 axes, 6x each (3 positive and 3 negative).<br>Non-Operating: Half sine, 50 g, 11 ms, 3 axes, 6x each (3 positive and 3 negative).   |        |     |              |        |
| Vibration                                 | <b>EN 60068-2-64</b><br>Operating: Sine, 10 – 500 Hz, 1 g, 3 axes, 1 oct/min., 60 min.<br>Random, 5 – 500 Hz, 0.02 $g^2/Hz$ , 1 $g_{RMS}$ , 3 axes, 30 min.<br>Non-Operating: 5 – 500 Hz, 2.46 $g_{RMS}$ (0.0122 $g^2/Hz$ ), 3 axes, 30 min. |        |     |              |        |
| MTBF                                      | Full Load, 40 °C ambient<br>80% Duty cycle, Telcordia SR-332 Issue 2   | 200000 | -   | -            | Hours  |
| Useful Life                               | Nominal $V_{IN}$ , 80% load, 40 °C ambient (IPC9592)   | -      | 10  | -            | Years  |

## 7. ELECTROMAGNETIC COMPATIBILITY (EMC) – EMISSIONS

| PARAMETER                          | DESCRIPTION / CONDITION   | STANDARD  | PERFORMANCE CLASS |
|------------------------------------|---|---|-------------------|
| Conducted                          | 115, 230, 277 $V_{RMS}$ , Maximum load  | EN 55011 (ISM)<br>EN 60601-1-2 (Medical)<br>FCC Part 15 | B                 |
| Radiated                           | The “SL” variant compliance to the Class B is conditioned by the use of a common ground plane between the power supply and its load | EN 55011 (ISM)<br>EN 60601-1-2 (Medical)<br>FCC Part 15 | B                 |
| Line Voltage Fluctuation & Flicker | At 20%, 50% and 100% maximum load<br>Nominal input voltages   | EN 61000-3-3  |                   |
| Harmonic Current Emission          | 230 VAC input voltage, 50 / 60 Hz<br>230 VAC 50 / 60 Hz, >150 W load  | EN 61000-3-2<br>EN 61000-3-2                            | A, D<br>C         |

## 8. ELECTROMAGNETIC COMPATIBILITY (EMC) – IMMUNITY

| PARAMETER               | DESCRIPTION / CONDITION  | STANDARD                          | TEST LEVEL    | CRITERIA |                     |
|-------------------------|--|-----------------------------------|---------------|----------|---------------------|
|                         | Reference standard for the medical version                         | EN 60601-1-2                      |               |          |                     |
| ESD                     | 15 kV air discharge, 8 kV contact, at any point of the system.     | EN 61000-4-2                      | 4             | A        |                     |
| Radiated Field          | 10 V/m, 20-2700 MHz, 1 KHz, 80% AM.                                | EN 61000-4-3                      | 3             | A        |                     |
| Electric Fast Transient | $\pm 2$ kV on AC power port for 1 minute                           | EN 61000-4-4                      | 3             | A        |                     |
| Surge                   | $\pm 2$ kV line to line; $\pm 4$ kV line to earth on AC power port | EN 61000-4-5                      | 4             | A        |                     |
| Conducted RF Immunity   | 10 $V_{RMS}$ , 0.15-80 MHz, 1 kHz, 80% AM                          | EN 61000-4-6                      | 3             | A        |                     |
| Dips and Interruptions  | 200 – 277 $V_{AC}$ :   | Drop-out to 0% for 10 ms          | EN61000-4-11  | A        |                     |
|                         |  | Dip to 40% for 5 cycles (100 ms)  | EN61000-4-11  | A        |                     |
|                         |  | Dip to 70% for 25 cycles (500 ms) | EN61000-4-11  | A        |                     |
|                         |  | Drop-out to 0% for 5 s            | EN61000-4-11  | B        |                     |
|                         | 100 – 127 $V_{AC}$ :   | Drop-out to 0% for 10 ms          | EN 61000-4-11 |          | A                   |
|                         |  | Dip to 40% for 5 cycles (100 ms)  | EN 61000-4-11 |          | A (derate to 150 W) |
|                         |  | Dip to 70% for 25 cycles (500 ms) | EN 61000-4-11 |          | A (derate to 400 W) |
|                         |  | Drop-out to 0% for 5 s            | EN 61000-4-11 |          | B                   |



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## 9. SAFETY AGENCIES APPROVALS

| CERTIFICATION BODY            | SAFETY STANDARDS   | CATEGORY |
|-------------------------------|--|----------|
| CSA / UL                      | CSA C22.2 No.60601-1, ANSI/AAMI ES60601-1 3rd edition + A1<br>Including Risk Management Assessment   | Medical  |
| IEC IECCE<br>CB Certification | IEC/EN 60601-1 3rd edition+A1<br>Including Risk Management Assessment  | Medical  |
| CE                            | Directive 93/42/CEE: Safety Requirement of the Medical Device<br>Directive 2014/30/EU: Electromagnetic Compatibility (EMC)<br>Directive 2011/65/EU: RoHS 2 | Medical  |
|                               | Designed to meet IEC/EN/UL/CSA 61010-1 2 <sup>nd</sup> edition   |          |

## 10. MECHANICAL SPECIFICATIONS

| PARAMETER          | DESCRIPTION / CONDITION                          |
|--------------------|--|
| Weight             | 2770 g (6.11 lb)<br>2850 g (6.28 lb) – SL models |
| Overall Dimensions | 125.0 x 250.5 x 60.0 mm (4.92 x 9.86 x 2.36 in)  |

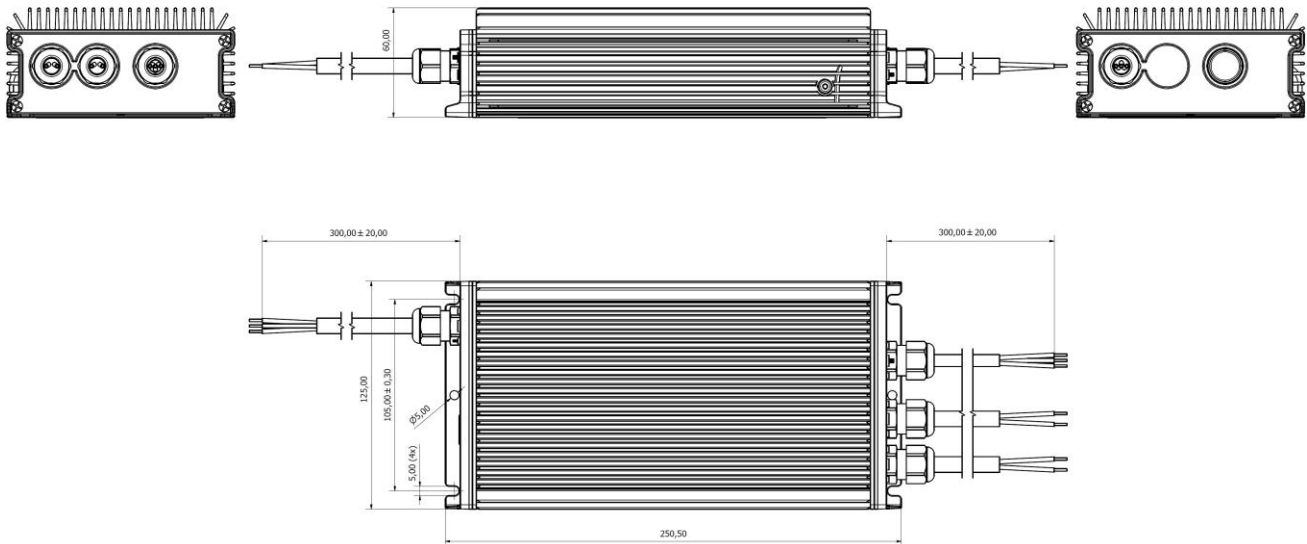
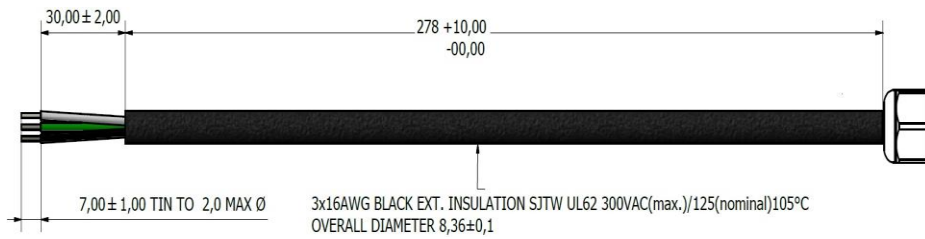


Figure 3. Mechanical drawing



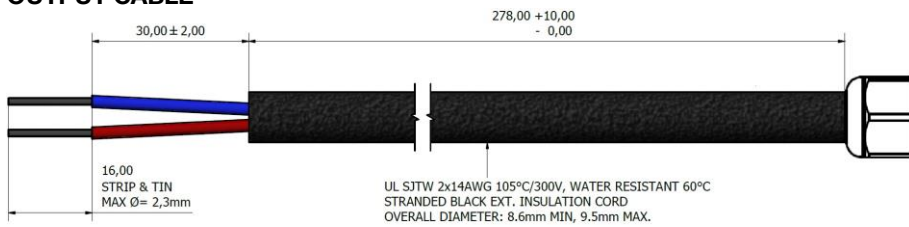
## 11. CONNECTIONS

### INPUT CABLE

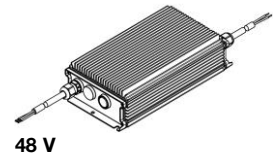
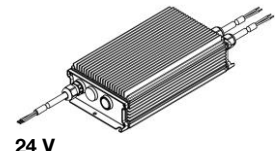


| WIRE COLOR | FUNCTION |
|------------|----------|
| BLACK      | Line     |
| GREEN      | PG       |
| WHITE      | Neutral  |

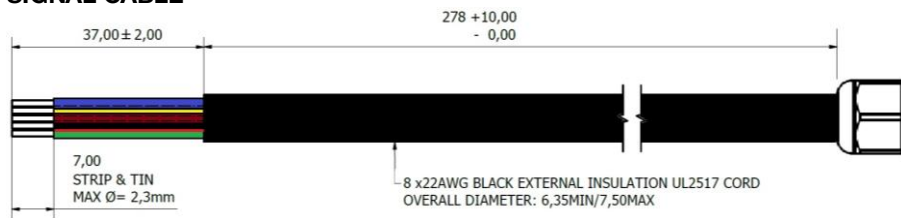
### OUTPUT CABLE



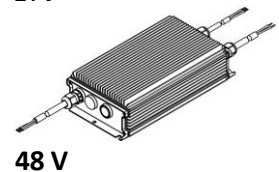
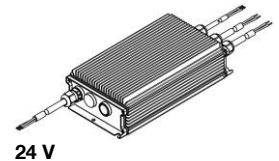
| WIRE COLOR | FUNCTION |
|------------|----------|
| RED        | +V1      |
| BLUE       | V1 RTN   |



### SIGNAL CABLE



| WIRE COLOR | FUNCTION    |
|------------|-------------|
| BLACK      | RTN         |
| RED        | +5 VSB      |
| BROWN      | RS-         |
| GREEN      | P_OK        |
| YELLOW     | - PSINHIBIT |
| GREY       | VS_LOGIC    |
| BLUE       | I SHARE 1   |
| WHITE      | RS+         |



For more information on these products consult: [tech.support@psbel.com](mailto:tech.support@psbel.com)

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