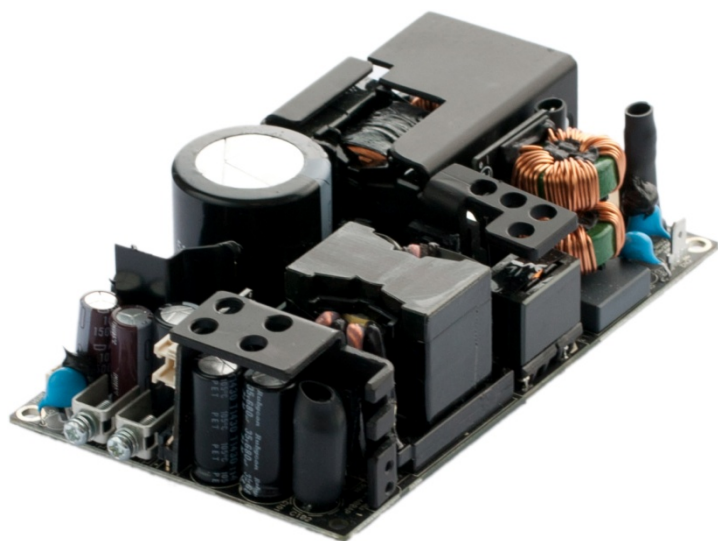


# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24



## MDS-400APB24

### Highlights & Features

- Safety Approvals to IEC 60601-1 3.1rd ed. & IEC 60950-1
- Compliant with IEC 60601-1-2 4th Ed. Requirements
- Up to 200W convection, 400W force air
- IT & Medical Safety Approvals

### Safety Standards



**Model Number:** MDS-400APB24  
**Unit Weight:** 405 g  
**Dimensions (W x L x H):** 76.5 x 127.3 x 36.1 mm  
 3 x 5 x 1.4 inch

### General Description

The MDS-400APB24 of internal open frame power supplies come with universal AC input range from 90Vac to 264Vac. Other features include low leakage, Type BF Patient Access Leakage Currents, and electric shock protection compliance with 2 x MOPP requirements. The MDS series is certified for EMC standards according to EN 55011 for industrial, scientific and medical (ISM) radio-frequency equipment; and, EN 55032 for Industrial Technology Equipment (ITE) radio-frequency equipment. In addition, only recognized Japanese capacitors are used to ensure long product life.

The MDS-400A series comes with both medical and ITE safety approvals, including UL/CE/CCC (5000meters), and CB certification. Designs are compliant with RoHS Directive 2011/65/EU for environmental protection.

### Model Information

#### Medical AC-DC Open Frame

| Model Number | Main Output Voltage | Main Output Current | Standby Output Voltage | Standby Output Current | Fan Output Voltage | Fan Output Current      | Total Max Output Power |
|--------------|---------------------|---------------------|------------------------|------------------------|--------------------|-------------------------|------------------------|
| MDS-400APB24 | 24Vdc               | 0-16.66A            | 5Vdc                   | 0-2A                   | 12Vdc              | 0.05-0.6A <sup>1)</sup> | 400W <sup>2)</sup>     |

1) Fan output will be presenting when 24V main output is available

2) With 10CFM force air

### Model Numbering

|                            |                                                  |                      |                               |                                    |                              |                                   |
|----------------------------|--------------------------------------------------|----------------------|-------------------------------|------------------------------------|------------------------------|-----------------------------------|
| MDS                        | 400                                              | A                    | P                             | B                                  | 24                           |                                   |
| Delta Medical Power Supply | Max wattage in the product series.<br>400 → 400W | Family Code<br>A ~ Z | Product Type<br>P: Open Frame | Input Type Code<br>B: 3pin Class I | Output Voltage<br>24 for 24V | Revision code,<br>Refer to page.7 |

# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

### Specifications

#### Input Ratings / Characteristics

|                                                                           |                                                                                    |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Nominal Input Voltage                                                     | 100-240Vac                                                                         |
| Input Voltage Range                                                       | 90-264Vac                                                                          |
| Nominal Input Frequency                                                   | 50-60Hz                                                                            |
| Input Frequency Range                                                     | 47-63Hz                                                                            |
| Input Current (max)                                                       | 5.5A                                                                               |
| Input Surge Voltage (max)                                                 | 300Vac for 100ms                                                                   |
| Full load Efficiency (typ.)                                               | 92% @ 115Vac/60Hz<br>93% @ 230Vac/50Hz, Reference Fig.1                            |
| Standby Power (max)                                                       | 0.5W (only standby working with Inhibit signal high)<br>@ 115Vac/60Hz, 230Vac/50Hz |
| Inrush Current (max)                                                      | 40A@230Vac, cold start                                                             |
| Input-PE(protective earth) leakage current(max)                           | 0.1mA @ NC, 0.3mA @ SFC1)                                                          |
| Output-PE(protective earth) leakage current for Type BF application (max) | 0.1mA @ NC, 0.5mA @ SFC 1)                                                         |
| Power Factor (min)                                                        | 0.95 @ 115V/50Hz, 230V/50Hz, full load                                             |

1) NC: normal condition, SFC: single fault condition

#### Leakage Current

| Input-PE Leakage Current                          | 100Vac/60Hz(Typ) | 264Vac/60Hz(Typ) | Delta Limit | IEC60601-1 Limit |
|---------------------------------------------------|------------------|------------------|-------------|------------------|
| Normal Condition                                  | 18.3uA           | 44.6uA           | 100uA max   | 5000uA max       |
| Single Fault Condition                            | 33.7uA           | 91.9uA           | 300uA max   | 10000uA max      |
| Output-PE Leakage Current for Type BF application |                  |                  |             |                  |
| Normal Condition                                  | 29.4uA           | 87.3uA           | 100uA max   | 100uA max        |
| Single Fault Condition                            | 43.5uA           | 130.5uA          | 500uA max   | 500uA max        |

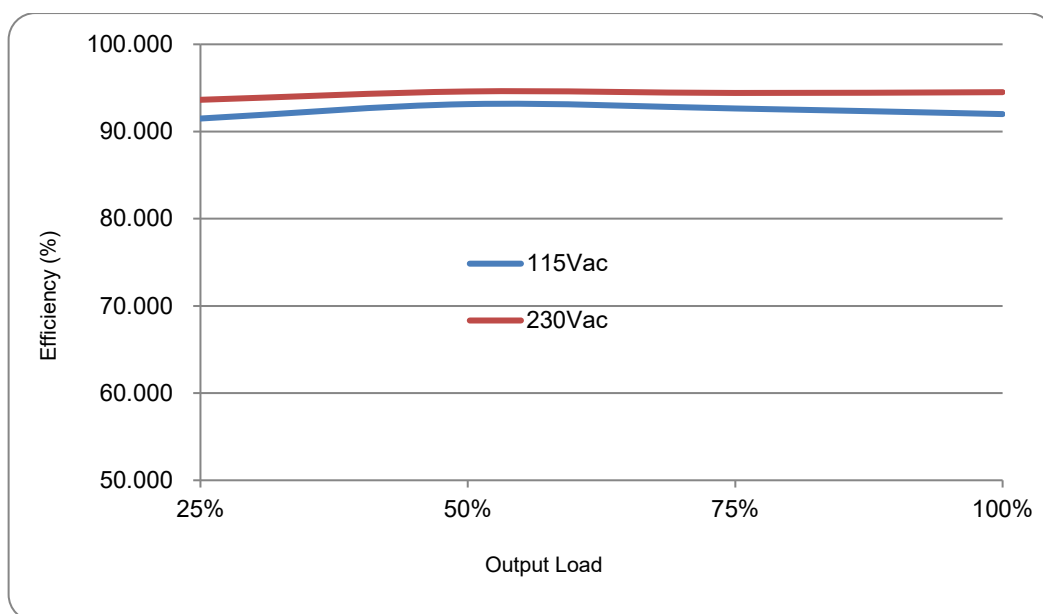


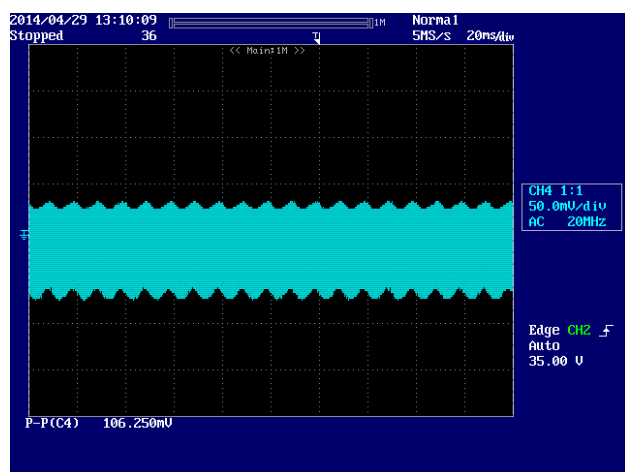
Fig.1 Efficiency versus output load

# Medical AC-DC Open Frame Power Supply

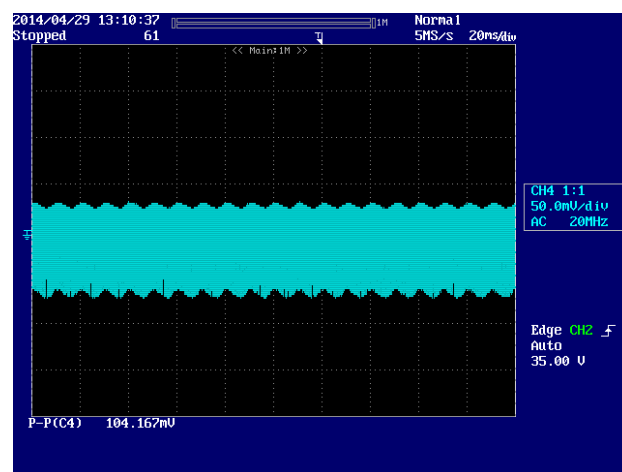
## 24V/400W 3"x5" High Density MDS-400APB24

### Output Ratings / Characteristics

|                                                       |                                                                                                                                                       |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nominal Output Voltage (Vrated)                       | 24V                                                                                                                                                   |
| Output Voltage Tolerance                              | ±3%                                                                                                                                                   |
| Output Power                                          | 400W max with 10CFM air cooling                                                                                                                       |
| Line Regulation (max)                                 | ±0.5%                                                                                                                                                 |
| Load Regulation (max)                                 | ±1%                                                                                                                                                   |
| Ripple & Noise (typ.)                                 | 1%pk-pkVrated@ Full load, Reference Fig. 2                                                                                                            |
| Start-up Time(max)                                    | 2000ms@115Vac                                                                                                                                         |
| Hold-up Time (min)                                    | 10ms@115Vac, with 400W load                                                                                                                           |
| Dynamic Response (Overshoot & Undershoot O/P Voltage) | ±5% @50-100% load                                                                                                                                     |
| Capacitive load (max)                                 | 1500uF                                                                                                                                                |
| Rise time (max)                                       | 100ms                                                                                                                                                 |
| Remote Sense                                          | Compensate up to 500mV lead drop with remote sense<br>Short and reverse connection protected. PSU can work normally with remote sense pins left open. |



(a) 115V (measured value=106mV)



(b) 230V (measured value=104mV)

Fig.2 Ripple & Noise example, 20MHz BW

### Output Ratings / Characteristics—Standby Output

|                                                   |                             |
|---------------------------------------------------|-----------------------------|
| Nominal Output Voltage of standby output (Vrated) | 5V                          |
| Total Regulation of standby output                | ± 3%                        |
| Ripple & Noise of standby output                  | 100mV max (Refer to Fig. 3) |

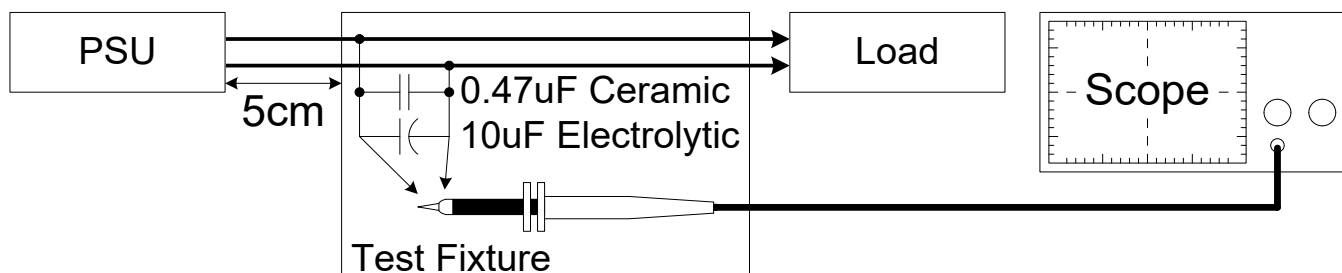


Fig.3 Ripple & Noise measurement circuit

# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

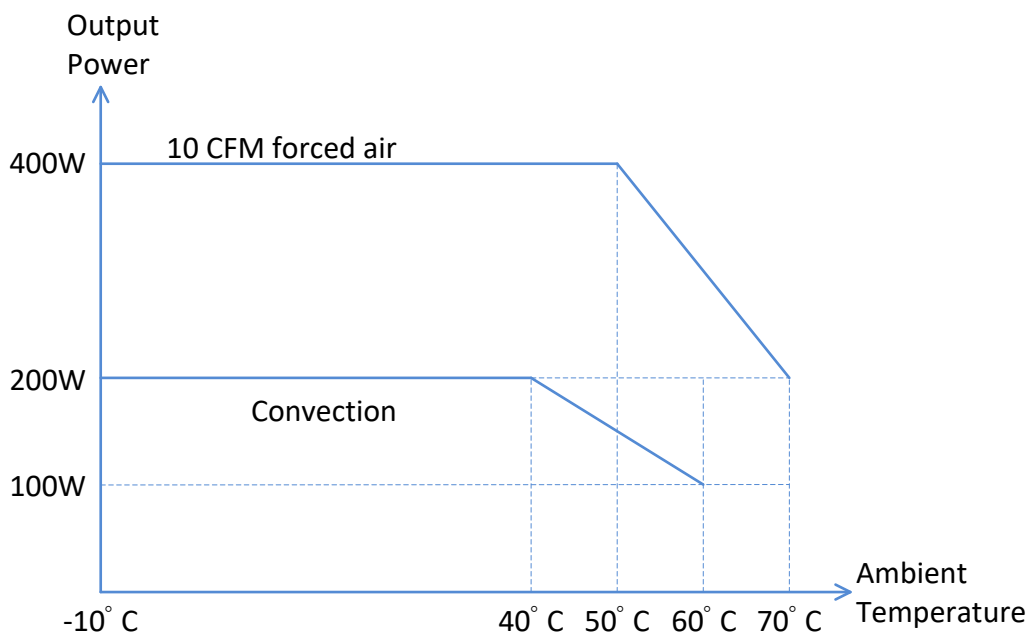
### Mechanical

|                             |                                         |
|-----------------------------|-----------------------------------------|
| Case Cover                  | NA                                      |
| Dimensions (W x L x H typ.) | 76.5 x 127.3 x 36.1mm (3 x 5 x 1.4inch) |
| Unit Weight                 | 405g                                    |
| Indicator                   | NA                                      |
| Cooling System              | NA                                      |

### Environment

|                             |           |                                                                                                                                                                                                                   |
|-----------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Surrounding Air Temperature | Operating | Absolute Max<br>-10°C to +70°C, supported power linearly de-rate from 50°C to 50% rated up to 70°C for forced air.<br>Convection power de-rate from 200W @ 40°C to 100W @ 60°C<br>Note: see power de-rating curve |
|                             | Storage   | -40°C to +85°C                                                                                                                                                                                                    |
| Operating Humidity          |           | 5-95% RH (Non-Condensing)                                                                                                                                                                                         |
| Operating Altitude          |           | 5,000 meters (16,400 feet or 50kPa)                                                                                                                                                                               |
| Non-operating Altitude      |           | 5,000 meters (16,400 feet or 50kPa)                                                                                                                                                                               |
| Shock Test (Non-Operating)  |           | 50G, 11ms, 3 shocks for each direction                                                                                                                                                                            |
| Vibration (Operating)       |           | 5-500Hz, 5Grms, 15 minute for each three axis                                                                                                                                                                     |

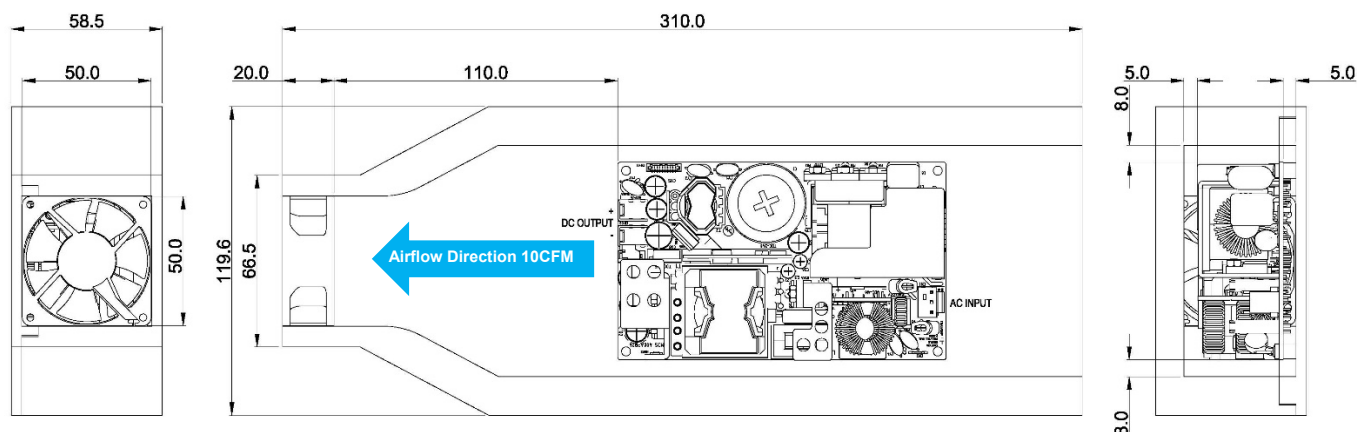
### Power De-rating curve



# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

Thermal Fixture Setup. With Fan P/N: DELTA AFB0512HHD



### Protections

|                              |                                                                                                 |
|------------------------------|-------------------------------------------------------------------------------------------------|
| Overvoltage (max)            | 135% of rated voltage, Latch Mode                                                               |
| Overload / Overcurrent (max) | Main output 160% of rated current<br>Standby 3A max<br>Hiccup Mode(Non-Latching, Auto-Recovery) |
| Over Temperature             | Latch Mode                                                                                      |
| Short Circuit                | Hiccup Mode,(Non-Latching, Auto-Recovery)                                                       |

### Reliability

|                                                                  |                                     |
|------------------------------------------------------------------|-------------------------------------|
| MTBF(Minimum) at 115Vac, 400W, 35°C, 10CFM Air Flow Convection A | 500 kHrs based on Telecordia SR-332 |
| Operating life at 115Vac, 400W, ambient 25 °C, 10CFM Air Flow    | 26,280Hrs                           |

### Safety Standards / Directives

|                    |                                                                                                                                                           |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Medical Safety     | IEC60601-12 <sup>nd</sup> and 3 <sup>rd</sup> , and 3 <sup>rd</sup> +A1 edition CB report<br>TUV EN60601-1:2006<br>UL60601-1+CAN/CSA 60601-1: (Ed.3.2005) |
| ITE Safety         | IEC60950-1 CB report<br>TUV60950-1<br>UL60950-1+CAN/CSA60950-1<br>GB4943.1-2011, GB9254-2008, GB17625.1-2003                                              |
| CE                 | MDD Directive 93/42/EEC                                                                                                                                   |
| Environmental      | RoHS Directive 2011/65/EU Compliant                                                                                                                       |
| Galvanic Isolation | Input to/Output (2XMOPP) 4000 Vac<br>Input to/Ground(1XMOPP) 1500Vac <sup>1)</sup><br>Output to/Ground(1XMOPP) 1500Vac ( Type BF application rated)       |

1) PSU can support PoE applications with Primary to FG 2500Vac test.

# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

### EMC (Compliant with IEC 60601-1-2 4th Ed. Requirements)

|                                   |               |                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EMC / Emissions                   |               | EN55011 & compliant with EN55032, FCC Title 47:Class B                                                                                                                                                                                                                                                                                              |
| Harmonic Current Emissions        | IEC61000-3-2  | Meet Class D limit                                                                                                                                                                                                                                                                                                                                  |
| Immunity to                       |               |                                                                                                                                                                                                                                                                                                                                                     |
| Voltage Flicker                   | IEC61000-3-3  |                                                                                                                                                                                                                                                                                                                                                     |
| Electrostatic Discharge           | IEC61000-4-2  | Level 4 Criteria A <sup>1)</sup><br>Air Discharge: 15kV<br>Contact Discharge: 8kV                                                                                                                                                                                                                                                                   |
| Radiated Field                    | IEC61000-4-3  | Criteria A <sup>1)</sup><br>80MHz-2700MHz, 10V/m AM modulation<br>385MHz-5785MHz, 28V/m Pulse mode and other modulation                                                                                                                                                                                                                             |
| Electrical Fast Transient / Burst | IEC61000-4-4  | Level 3 Criteria A <sup>1)</sup> :2kV                                                                                                                                                                                                                                                                                                               |
| Surge                             | IEC61000-4-5  | Level 3 Criteria A <sup>1)</sup><br>Common Mode <sup>3)</sup> : 2kV<br>Differential Mode <sup>4)</sup> : 1kV                                                                                                                                                                                                                                        |
| Conducted                         | IEC61000-4-6  | Level 2 Criteria A <sup>1)</sup><br>150kHz-80MHz, 3Vrms, 6Vrms at ISM bands and Amateur radio bands                                                                                                                                                                                                                                                 |
| Power Frequency Magnetic Fields   | IEC61000-4-8  | Criteria A <sup>1)</sup><br>Magnetic field strength 30A/m                                                                                                                                                                                                                                                                                           |
| Voltage Dips                      | IEC61000-4-11 | Criteria A <sup>1)</sup><br>0% U <sub>T</sub> , 0.5 cycle (10ms)<br>, 0°/45°/90°/135°/180°/225°/270°/315°/360°<br><br>Criteria B <sup>2)</sup><br>0% U <sub>T</sub> , 1 cycle (20ms), 0°<br><br>Criteria B <sup>2)</sup><br>70% U <sub>T</sub> , 25 cycle (500ms), 0°<br><br>Criteria B <sup>2)</sup><br>0% U <sub>T</sub> , 250 cycle (5000ms), 0° |

1) Criteria A: Normal performance within the specification limits

2) Criteria B: Output out of regulation, or shuts down during test. Automatically restore to normal operation after test.

3) Asymmetrical: Common mode (Line to earth)

4) Symmetrical: Differential mode (Line to line)

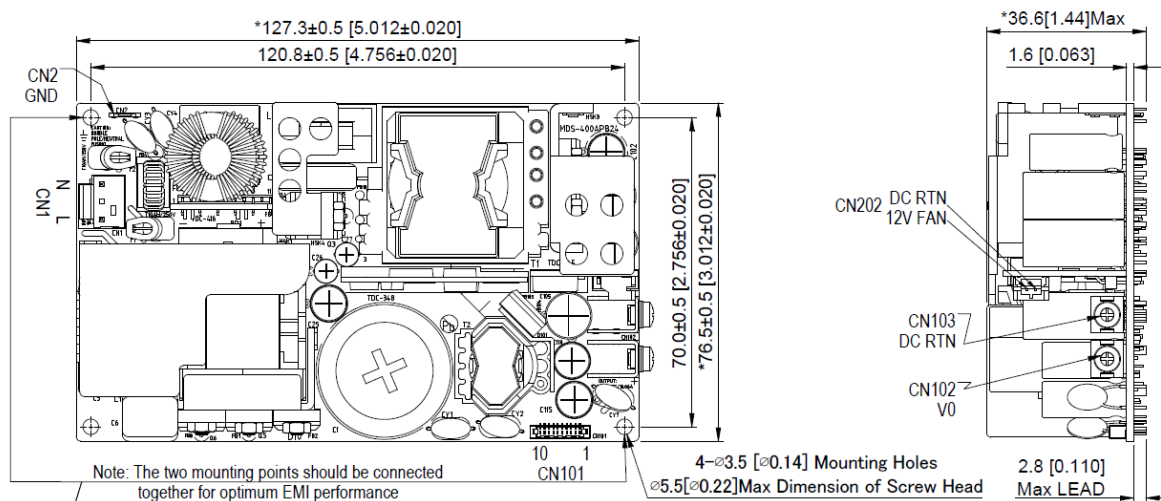
# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

### Dimensions

W x L x H: 76.5 x 127.3 x 36.1 mm

Mechanical drawing (3Pin input type)



### Notes

—Dimensions are in mm(inches)

- CN1 mates with Molex housing 26-03-4030 and Molex series 6838 crimp terminals. Input Line can also be connected to Input Neutral, and Input Neutral can be connected to Input Line.
- CN102 & CN103(Output Connector) : Cross recessed pan head screws M3X0.5x10, with spring washers and flat washers, force required to tighten the screws is 7~8kgf.cm(6.1~7.0inch-lb)
- CN2 : PINGOOD JP-13T or equivalent mates with KST:FDNYD1-187 or other applicable connectors.
- CN202 mates with JST housing PHR-2 and JST SPH-002T-P0.5S terminals.
- CN101 mates with Molex housing 1041421000 and Molex series 104539-8002 crimp terminals.

| Control and STANDBY connector CN101 |                                 |
|-------------------------------------|---------------------------------|
| Pin 1                               | Remote sense +                  |
| Pin 2                               | Remote sense -                  |
| Pin 3                               | Power Good +                    |
| Pin 4                               | Power Good -(DC RTN)            |
| Pin 5                               | Remote ON_OFF/INHIBIT +         |
| Pin 6                               | Remote ON_OFF/INHIBIT -(DC RTN) |
| Pin 7                               | 5V Standby                      |
| Pin 8                               | DC RTN                          |
| Pin 9                               | 5V Standby                      |
| Pin 10                              | DC RTN                          |

Two mounting points in mechanical drawing need to be connected to system earth case together, Protective bonding conductor from the end product protective earth terminal (if any) can be tied to CN2 for open frame model.

### MDS-400APB24 □□

|    |                                                                                                                                                                                                                                                                                                                                                                       |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AA | Delta Standard                                                                                                                                                                                                                                                                                                                                                        |
| AB | A mating connector with Molex housing 1041421000 and Molex terminals 1045398002, with jumper wire between pins 5 and 6, will be inserted into CN101. This will allow the power supply to turn on, without user intervention, upon the application of input AC voltage Due to presence of mating connector, external connections cannot be made to pins 1-10 of CN101. |

# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

### Functions

#### Start-up Time

The time required for the output voltage to reach 90% of its set value, after the input voltage is applied.

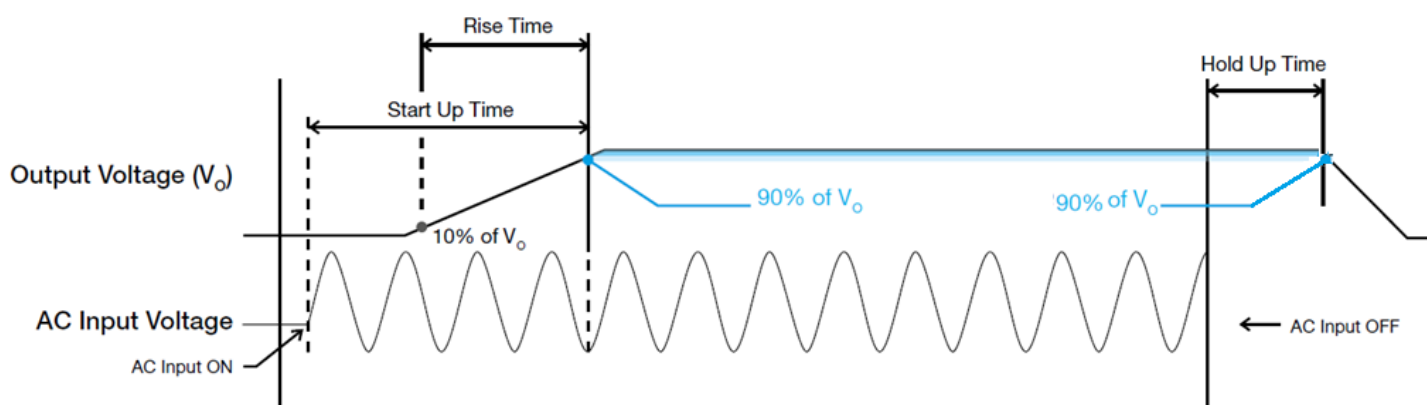
#### Rise Time

The time required for the output voltage to change from 10% to 90% of its set value.

#### Hold-up Time

Hold up time is the time when the AC input collapses and output voltage retains regulation for a certain period of time. The time required for the output to reach 90% of its set value, after the input voltage is removed.

#### ■ Graph illustrating the Start-up Time, Rise Time, and Hold-up Time



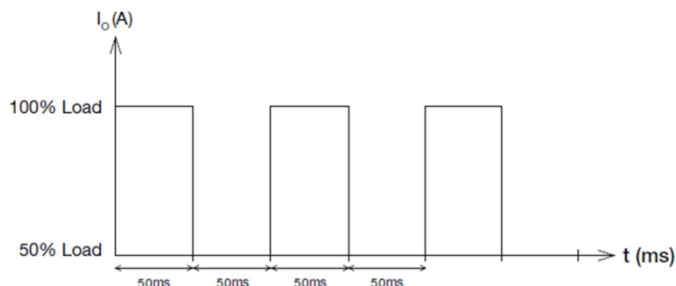
# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

### Dynamic Response

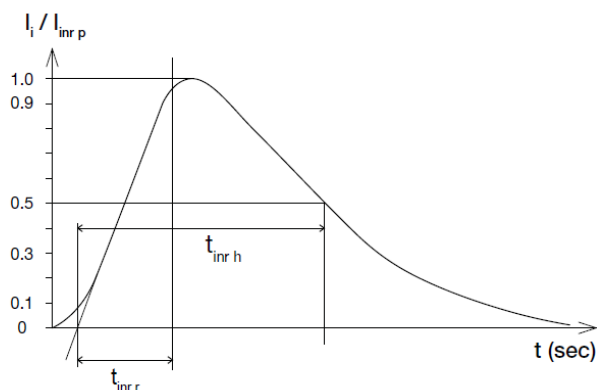
The power supply output voltage will remain within  $\pm 5\%$  of its steady state value, when subjected to a dynamic load 50 to 100% of its rated current.

■ 50 to 100% Load



### Inrush Current

Inrush current is the peak, instantaneous, input current measured and, occurs when the input voltage is first applied. For AC input voltages, the maximum peak value of inrush current will occur during the first half cycle of the applied AC voltage. This peak value decreases exponentially during subsequent cycles of AC voltage.

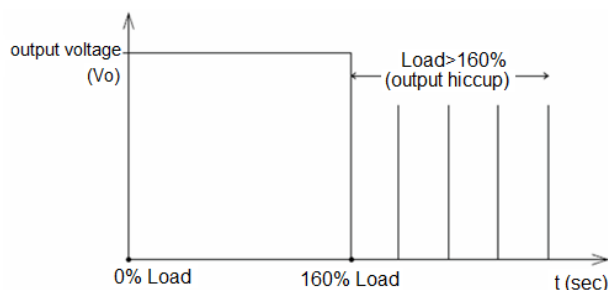


### Overvoltage Protection

The power supply's overvoltage circuit will be activated when its internal feedback circuit fails. The output voltage shall not exceed its specifications defined on Page 4 under "Protections". Power supply will latch off, and require removal/re-application of input AC voltage in order to restart.

### Short Circuit Protection

The power supply's output OLP/OCP function also provides protection against short circuits. When a short circuit is applied, the output current will operate in "Hiccup mode", as shown in the illustration in the OLP/OCP section on this page. The power supply will return to normal operation after the short circuit is removed.



### Overload & Overcurrent Protections

The power supply's Overload (OLP) and Overcurrent (OCP) Protections will be activated before output current under 160% of  $I_o$  (Max load). Upon such occurrence,  $V_o$  will start to drop. Once the power supply has reached its maximum power limit, the protection will be activated and the power supply will go into "Hiccup mode" (Auto-Recovery). The power supply will recover once the fault condition causing the OLP and OCP is removed and  $I_o$  is back within the specified limit.

Additionally, if the  $I_{out}$  is <160% but >100% for a prolong period of time (depending on the load), the Over Temperature Protection (OTP) will be activated due to high temperature on critical components. The power supply will then go into latchmode.

### Over Temperature Protection

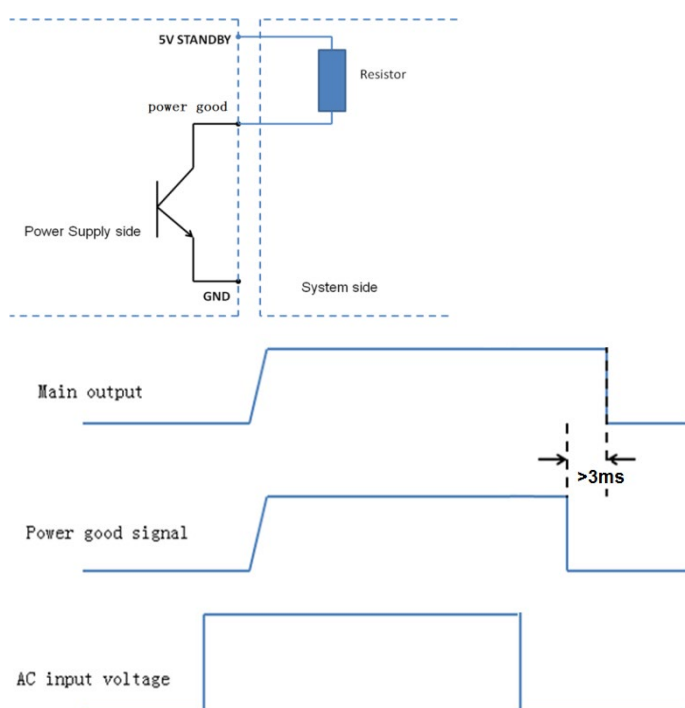
As mentioned above, the power supply also has Over Temperature Protection (OTP). This is activated when the overload condition persists for an extended duration and the output current is below the overload trigger point but >100% load. In the event of a higher operating temperature condition at 100% load, the power supply will run into OTP when the surrounding air temperature is higher than the operating temperature. When activated, the output voltage will go into latch mode until the input voltage is removed; then, reapplied, and the surrounding air temperature drops to its normal operating temperature.

# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

### Power Good

Power Good+ pin is an open collector transistor (40V/600mA rating). A resistor (suggested value 10Kohm, 1/8W) can be added between 5V STANDBY pin (or, other available pull-up voltage that is no greater than 30V) and the Power Good+ pin (refer to figure below). Value of pull-up resistor may have to be adjusted, depending on voltage used, and other end-use conditions of the Power Good+ pin connection to the product. When AC input is on, Power Good+ pin will be high. When AC input is off, Power Good+ pin will be low. There will be a minimum of 3 milliseconds between the time the power good goes to low level, and the time when the output reaches 90% of its rated value.



### Remote On\_Off/ INHIBIT

Remote ON\_OFF/ INHIBIT can be used to enable or disable only the main output. When the main output is disabled, the +5V Standby output will continue to operate. This signal can be pulled down to a low level of 0.3 volts, or shorted to DC-Return, in order for the main output to be enabled; and, floated (no connection to the signal), or pulled up to a value greater than or equal to 3 volts, in order to disable the main output.

### Remote Sense

Remote sense feature can be used to compensate for the extra voltage drop on output wires that are connected from the main output terminals, to the load. With wires connected from the remote sense pins, at the same locations as the wires from the main output, the remote sense function can compensate up to 500mV voltage drop. The power supply will not be damaged if the remote sense pins are shorted, or if a reverse/inverted polarity connection is made to the load.

# Medical AC-DC Open Frame Power Supply

## 24V/400W 3"x5" High Density MDS-400APB24

### Certificate



All Delta Medical Power products conform to the European directive 2011/65/EU. RoHS is the abbreviation for "Restriction of the use of certain hazardous substances"



Delta has been certified as meeting the requirement of ISO 13485: 2003 and EN ISO 13485:2012 for the design and manufacture of switching power supply and adaptor for medical device.



In addition to a UL Total Certification Program (TCP) approved client laboratory for IEC60950 and IEC60065. Delta also has participated UL Client Test Data Program (CDTP) for IEC 60601

### Attention

Delta provides all information in the datasheets on an "AS IS" basis and does not offer any kind of warranty through the information for using the product. In the event of any discrepancy between the information in the catalog and datasheets, the datasheets shall prevail (please refer to [www.DeltaPSU.com](http://www.DeltaPSU.com) for the latest datasheets information). Delta shall have no liability of indemnification for any claim or action arising from any error for the provided information in the datasheets. Customer shall take its responsibility for evaluation of using the product before placing an order with Delta.

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