N2Power™
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Product Specification

ML100 (Medical) Series

100 Watt Power Supplies

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1. Introduction

1.1 Introduction

This specification defines the ML100 series of 100W Open-Frame, U-Frame, Enclosed and DIN Rail, single-phase (3-wire) universal input switching mode power supplies. It includes information regarding the mechanical details, cooling requirements, connector configurations, electrical and signal specifications, and environmental ranges for storage and operation of the power supplies. These supplies achieve very high packaging densities and low air cooling requirements by virtue of their very high efficiency design.

N2Power Model numbers for this series of power supplies begin with:

- MLO for Open-Frame models
- MLU for U-Frame models
- MLE for Enclosed models
- MLD for DIN Rail models

However, except where it is necessary to distinguish them, the series is referred to as ML100 throughout this Specification.

Figure 1-1 ML100 Open-Frame, U-Frame, Enclosed and DIN Rail Power Supplies

1.2 Agency Compliance

Safety	**Complies with Standard**	**Remarks**
United States	ANSI/AAMI ES60601-1:2005	Leakage Current – see Table 2-2
	UL 60601-1	Hi-pot – Input to Output = 4000Vac
Canada	CAN/CSA-C22.2 No. 601.1	
	CAN/CSA-C22.2 No. 60601-1 (2008)	
EU Council	EN 60601-1: 2006	Low Voltage Directive
International	IEC 60601-1: 2005 3rd Edition	

EMC	**Complies with Standard**	**Remarks**
Emission	EN 55011: 2009/A1: 2010	Conducted Emission Class B
	CISPR 11: 2009/A1: 2010	Radiated Emission Class B
	EN 60601-1-2: 2007	
	IEC 61000-3-2: 2006+A2: 2009	Harmonic Current Emissions
	IEC 61000-3-3:2008	Voltage Fluctuations & Flicker
Immunity	EN 60601-1-2: 2007	
	EN 61000-4-2	Electrostatic Discharge
	EN 61000-4-3	Radiated Susceptibility
	EN 61000-4-4	Fast Transient/Burst Immunity
	EN 61000-4-5	Power Mains Surge Immunity
	EN 61000-4-6	Conducted Susceptibility
	EN 61000-4-8	Power Frequency Magnetic Field
	EN 61000-4-11	Voltage Dips, Short Interruptions

Reduction of Hazardous Substances (RoHS)	**Complies with Standard**	**Remarks**
EU Council	2011/65/EU RoHS 2 Directive	RoHS 2 Directive

Marks of Conformance		
United States & Canada	c US E469416	(Underwriters Laboratories File E469416)
	2xMOPP	
TUV		
EU Council	CE	
RoHS	RoHS Compliant	

Table 1-1 Agency Compliance

2. AC Input

2.1 Input Line Requirements

The following table defines the voltage and frequency requirements for the AC line inputs to the ML100 Series which is capable of supplying full rated power in continuous operation throughout the specified ranges of voltages and frequencies. The power supply will automatically recover from AC power loss and is capable of starting under maximum load at the minimum AC input voltage described below.

Parameter	Minimum	Nominal	Maximum
RMS Input Voltage	90 VAC	100–240 VAC	264 VAC
RMS Input Current			1.15A/115VAC 0.55A/230VAC
Input Frequency	47 Hz	50/60 Hz	63 Hz

Table 2-1 ML100 Series AC Input Parameters

2.2 Input Over-Current Protection

The ML100 Series incorporates a primary AC line fuse for input over-current protection to prevent damage to the power supply and meet product safety requirements as outlined in Section 1.2.

2.3 Inrush Current Limiting

The cold start inrush current for the ML100 Series is 30A at 115VAC and 60A at 230VAC.

Repetitive ON/OFF cycling of the AC input voltage shall not damage the power supply or cause the input fuse to fail.

2.4 Low Input Voltage

The application of an input voltage below the minimums specified in Table 2-1 shall not cause damage to the power supply.

2.5 Leakage Current

There are 2 types of leakage current applicable to medical power suppliers:

Earth leakage current: current flowing from the mains part through or across the insulation into the protective earth conductor.

Touch Current (Enclosure Leakage Current): leakage current flowing from the enclosure or from parts thereof, excluding patient connections, accessible to any operator or patient in normal use, through an external path other than the protective earth conductor, to earth or to another part of the enclosure.

Note: The meaning of this term is the same as that of “enclosure leakage current” in the first and second editions of this standard. The term has been changed to align with IEC 60950-1 and to reflect the fact that the measurement now applies also to parts that are normally protectively earthed.

Model Name	Class I or Class II	Leakage Current Measurement
ML100-*XX*	Class I	Earth Leakage: 23µA (N.C.)
		Earth Leakage: 34µA (S.F.C.)
		Touch Leakage: 65µA (N.C.)
		Touch Leakage: 92µA (S.F.C.)

Table 2-2 Leakage Current

3. DC Outputs

3.1 Output Voltage Regulation

The DC output voltages shall remain within the Minimum and Maximum limits of Table 3-1 when measured at the power supply connector under all specified line, load and environmental conditions contained herein.

Model	Output	Rated Voltage	Regulation	Minimum (VDC)	Nominal (VDC)	Maximum (VDC)
ML100-12	V1	12	±1%	11.880	12.00	12.120
ML100-15	V1	15	±1%	14.850	15.00	15.150
ML100-18	V1	18	±1%	17.820	18.00	18.180
ML100-24	V1	24	±1%	23.760	24.00	24.240
ML100-28	V1	28	±1%	27.720	28.00	28.280
ML100-36	V1	36	±1%	35.640	36.00	36.360
ML100-48	V1	48	±1%	47.520	48.00	48.480

Table 3-1 ML100 Output Voltage Specifications

3.2 No Load Operation

The power supply will operate under a no load condition and will not result in damage. The power supply will remain stable and operate normally after application of loads.

CAUTION

Remove AC power prior to installing or removing secondary loads.

3.3 Output Current/Power

The maximum available output power is always a function of the cooling airflow and temperature. The total output is reduced with unrestricted natural convection cooling and an ambient temperature of 50°C or less.

3.3.1 Output Loading

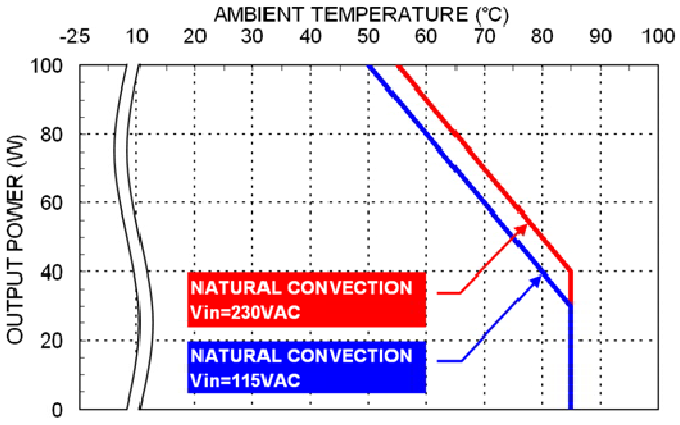
The output currents listed below require natural convection cooling at no more than 50°C.

Model	Rated V1 Output	Maximum Convection Load
ML100-12	12V	8.34A
ML100-15	15V	6.67A
ML100-18	18V	5.56A
ML100-24	24V	4.17A
ML100-28	28V	3.58A
ML100-36	36V	2.78A
ML100-48	48V	2.09A

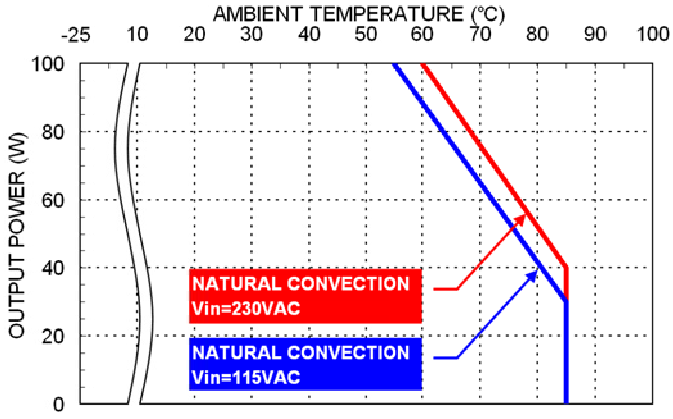
Table 3-2 Min/Max Load Currents

3.3.2 High Temperature Derating

The ML100 Series can be operated at elevated temperatures by derating the total maximum output power (or current) by 2.34%/°C from 50°C to 80°C (see Figure 3-1).



Derating Curve vs. Ambient Temperature
MLO100 and MLU100



Derating Curve vs. Ambient Temperature
MLE100 and MLD100

Figure 3-1 Derating Curves: ML100 Series

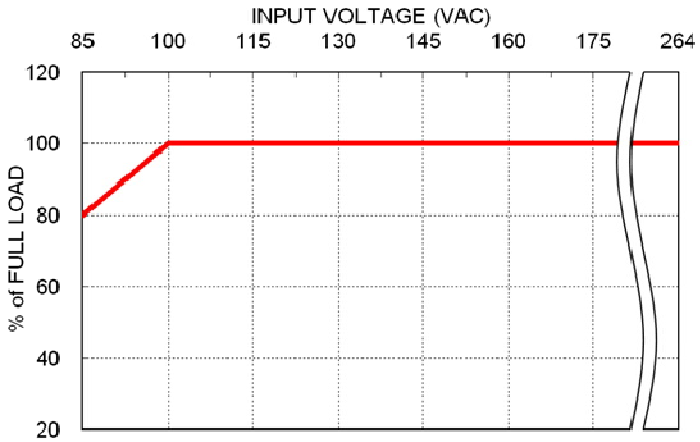


Figure 3-2 Load vs. Input Voltage: ML100 Series

3.4 Output Ripple/Noise

Output ripple voltage and noise are measured at 20MHz of bandwidth by using a 12" twisted pair wire terminated with a 0.1µf & 47µf in parallel. The ripple noise is measured from the output pin connectors (V+ and V-).

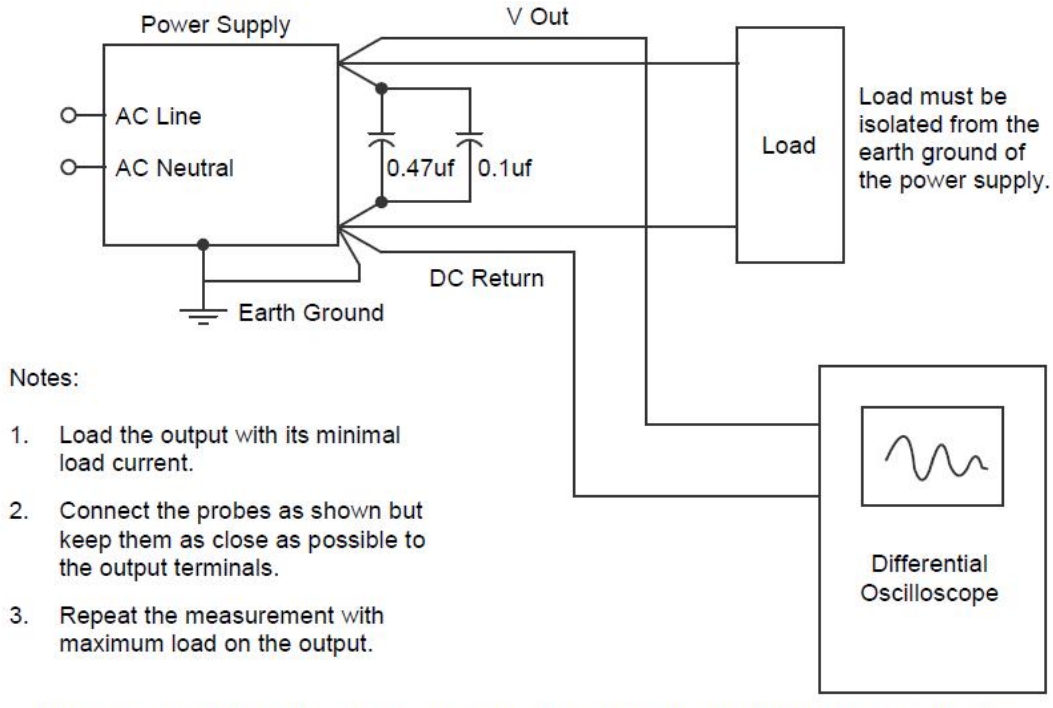
3.4.1 Ripple/Noise Limits

The ripple voltage of the outputs is measured at the pins of the mating connector. Ripple and noise shall not exceed the limits specified in Table 3-3 under any condition of line voltage and frequency specified in Section 2.1 and DC loading specified in Section 3.3.1.

Model	Output	Voltage	Maximum Ripple + Noise (peak-to-peak)
ML100-12	V1	12V	120mV
ML100-15	V1	15V	150mV
ML100-18	V1	18V	160mV
ML100-24	V1	24V	160mV
ML100-28	V1	28V	180mV
ML100-36	V1	36V	190mV
ML100-48	V1	48V	340mV

Table 3-3 Ripple Voltage

3.4.2 Ripple/Noise Test Setup



Note: The ML100-12 and -15 are measured with 10uf. The ML100-24, -28 and -36 are measured with 1uf. The ML100-48 is measured with 0.1uf. Do not parallel with 0.47uf.

Figure 3-3 Ripple Noise Measurement Setup

3.4.3 Over Voltage Protection

No single fault is able to cause a sustained over voltage condition on any output. When an over-voltage condition occurs, the power supply will shut down and will not restart until AC power is turned off and back on. The ML100 Series will shut down under the following over voltage conditions:

Model	Minimum	Nominal	Maximum
ML100-12	13.80V	15.00V	16.20V
ML100-15	17.25V	18.75V	20.25V
ML100-18	20.70V	22.50V	24.30V
ML100-24	27.60V	30.00V	32.40V
ML100-28	32.20V	35.00V	37.80V
ML100-36	41.40V	45.00V	48.60V
ML100-48	55.20V	60.00V	64.80V

Table 3-4 Over-Voltage Protection Limits

3.4.4 Short Circuit Protection

A short circuit is defined as an impedance of less than 0.1 ohms placed between DC RETURN and any output. A short circuit will cause no damage to the power supply and will cause it to shutdown. The power supply will periodically attempt a restart until the short circuit condition is removed. After successfully restarting, the power supply will operate normally.

3.5 Local and Remote Sensing

Remote sensing is provided to compensate for voltage drops in the V1 (+ Output) and DC RETURN connections to the load. The 0V Sense input must always be connected to the DC Return terminal of the load, which will reduce the voltage drop in the external return wiring.

If the V1 Sense input is left open, the V1 output may not meet its load regulation specification. The V1 output will meet its load regulation specification when the V1 Sense pin is connected to one of the V1 output pins. Connecting the V1 Sense pin to the V1 output at the load will reduce the voltage drop in the external V1 wiring.

3.6 Output Rise Time

All output voltages shall rise from 10% to 90% of nominal output voltage (as specified in Table 3-1) within 15ms to 150ms. The output voltages waveform must be a monotonic ramp from 10% to 90% of final setpoint within the regulation band under any loading conditions as specified in Section 6.

For the purposes of this specification, a monotonic ramp is defined as always having a positive slope of from zero to 10*Vout volts/millisecond. During any 5-millisecond portion of the ramp, its slope must be greater than 5% of its rated voltage per millisecond.

3.7 Overshoot At Turn On/Turn Off

The output voltage overshoot upon the application or removal of the input mains voltage is less than 5% for all ML100 models above the nominal voltage. No opposite polarity voltage is present on any output during turn on or turn off.

4. General Specifications

4.1 Environmental

The ML100 Series meets or exceeds the following environmental specifications:

Parameter	Conditions	Specification	Remarks
Temperature	Operating	-25°C to 85°C	
	Non-Operating	-40°C to 85°C	
Relative Humidity	Operating	90% Maximum	Non-Condensing
	Non-Operating	95% Maximum	Non-Condensing
Altitude	Operating	16,404 feet MSL Max.	5,000 meters
Shock	No damage	50G half-sine, 11mS	18 shocks (3 shocks for each + axis) + X, + Y, + Z axes
Vibration	No damage	2.0G RMS Maximum	10-500Hz, 10-min. each axis. Certified IEC60068-2-6-2007; IEC60068-2-64-2008

Table 4-1 Environmental Specifications

4.2 Mean Time Between Failures

The calculated MTBF of the ML100 is 790,000 hours, which is equal to or greater than the specified hours of continuous operation at maximum output loading and worst-case input line voltage with convection cooling at 25°C. N2Power does not warrant the MTBF to be representative of any particular unit. The MTBF of the power supply is calculated with an 80% confidence level in accordance with (MIL-HDBK-217F). Actual failure rates vary from unit to unit.

4.3 Labeling/Marking

The power supply is marked and labeled with the N2Power logo and part number, model number, input and output specifications, production code, appropriate safety agency logos and CE mark.

A typical label is pictured below.

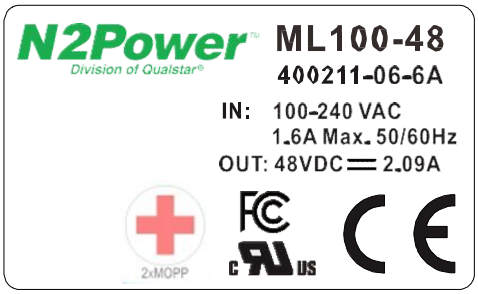


Figure 4-1 Sample ML100 Label

4.4 Net Weight

The ML100 Series models weigh 5.50 ounces (156 grams)

4.5 Mounting

The ML100 Series units are mounted with screws at the mounting holes at the corners. The diameter of the mounting holes is 3.2 mm (0.125 in.)

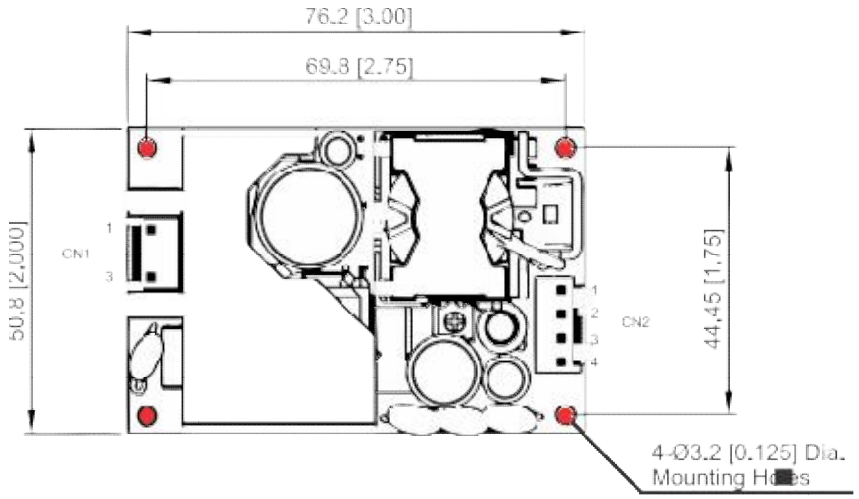


Figure 4-2 ML100 Mounting Hole Locations

4.6 Mating Connectors

The user must furnish all mating connectors. The mating connectors must meet the requirements of all applicable safety agencies (UL and/or TUV).

Model	Designator	Connector	Mating Housing	Terminal
ML100	CN1 (AC Input)	JST B3P-VH or equivalent	JST VHR-3N or equivalent	JST SVH-21T-P1.1 or equivalent
	CN2 (DC Output)	JST B4P-VH or equivalent	JST VHR-4N or equivalent	JST SVH-21T-P1.1 or equivalent

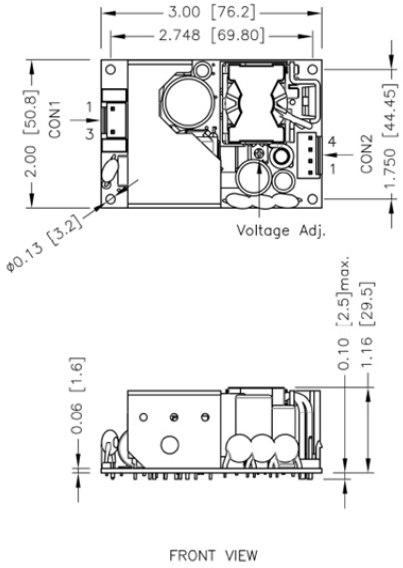
Table 4-2 ML100 Mating Connectors

4.7 Output Grounding

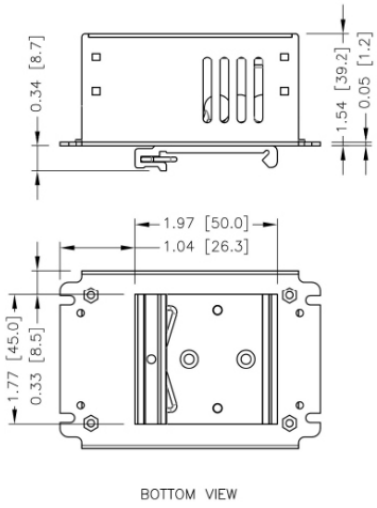
The DC RETURN signal may be connected to the power supply chassis ground (safety earth) at the plated through mounting hole(s) shown in red in Figure 4-2.

4.8 Physical Dimensions

Open-Frame Type



DIN Rail Type



Connector Pin Assignments

CON1 – Input Connector	
Pin 1	Line
Pin 3	Neutral

CON2 – Output Connector	
Pin 1, 2	- V_{out}
Pin 3, 4	+V_{out}

Notes

1. All dimensions are in inches [mm]
2. Tolerance: x.xx±0.02 (x.x±0.5) x.xxx±0.01 (x.xx±0.25)
3. M3x0.5 screw locked torque MAX 5Kgf.cm/0.49N.m
4. Any one of the four screw holes of the Open Frame chassis can be used as a PG connection point for CLASS I application.

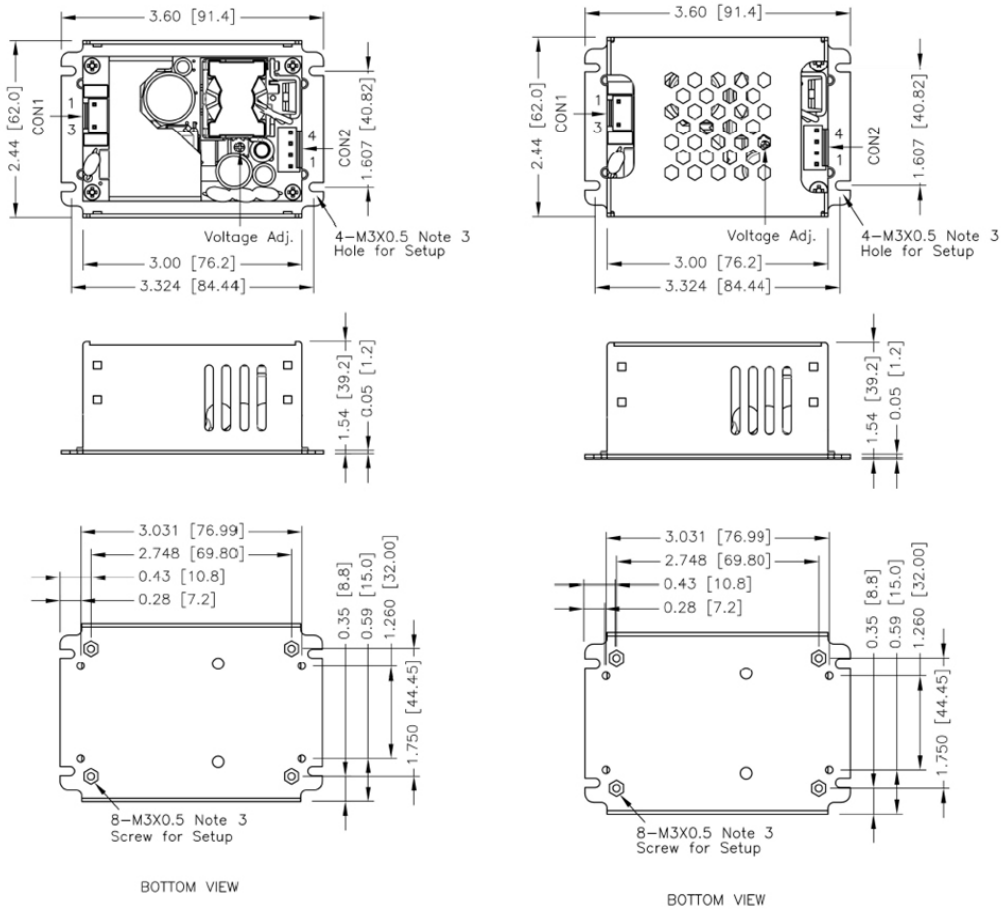


Figure 4-3 Mechanical Drawings (All Models)

5. Efficiency

The efficiencies for ML100 medical power supplies are listed below. They were measured at full load, 25°C at 230VAC.

Output	Load	AC	Efficiency
12V	8.34A	230VAC	91%
15V	6.67A	230VAC	92%
18V	5.56A	230VAC	92%
24V	4.17A	230VAC	92%
28V	3.58A	230VAC	92%
36V	2.78A	230VAC	91%
48V	2.09A	230VAC	91%

Table 5-1 ML100 Series Output Currents at Rated Efficiency

6. Signals

6.1 Power Good Signal/PS_OK Signal/

6.1.1 Power Good (PG)

The Power Good (PG) Signal provides a low logic level to indicate that sufficient time has expired for the DC outputs to be within their regulation limits and that sufficient mains energy is stored by the power supply to ensure continuous power operation within specification for the duration of the hold-up time.

6.1.2 PS_OK

The PS_OK signal is the logical complement of the Power Good signal and both signals are driven by open-collector transistors. The Power-On Delay time for the ML100 is <1000ms and the Rise Time is 10ms to 30ms for either 115VAC or 230VAC at full load.

6.2 Voltage Hold-Up Time

The power supply will maintain output regulation despite a loss of input power, when operating at full load, for 16ms at 115VAC or 30ms at 230VAC.

7. Ordering Information

The following table provides the N2Power part numbers that should appear on your purchase order and will appear on any N2Power correspondence:

MODEL	PART NUMBER	OUTPUT VOLTAGE
MLO100-12	400211-01-7	12
MLU100-12	400212-01-5	
MLE100-12	400213-01-3	
MLD100-12	400214-01-1	
MLO100-12B	400211-08-2	
MLU100-12B	400212-07-2	
MLE100-12B	400213-07-0	
MLD100-12B	400214-07-8	
MLO100-15	400211-02-5	15
MLU100-15	400212-02-3	
MLE100-15	400213-02-1	
MLD100-15	400214-02-9	
MLO100-15B	400211-09-0	
MLU100-15B	400212-08-0	
MLE100-15B	400213-08-8	
MLD100-15B	400214-08-6	
MLO100-18	400211-07-4	18
MLU100-18	400212-13-2	
MLE100-18	400213-13-2	
MLD100-18	400214-13-2	
MLO100-18B	400211-14-0	
MLU100-18B	400212-14-0	
MLE100-18B	400213-14-0	
MLD100-18B	400214-14-0	
MLO100-24	400211-03-3	24
MLU100-24	400212-03-1	
MLE100-24	400213-03-9	
MLD100-24	400214-03-7	
MLO100-24B	400211-10-8	
MLU100-24B	400212-09-8	
MLE100-24B	400213-09-6	
MLD100-24B	400214-09-4	

MODEL	PART NUMBER	OUTPUT VOLTAGE
MLO100-28	400211-04-1	28
MLU100-28	400212-04-9	
MLE100-28	400213-04-7	
MLD100-28	400214-04-5	
MLO100-28B	400211-11-6	
MLU100-28B	400212-10-6	
MLE100-28B	400213-10-4	
MLD100-28B	400214-10-2	
MLO100-36	400211-05-8	36
MLU100-36	400212-05-6	
MLE100-36	400213-05-4	
MLD100-36	400214-05-2	
MLO100-36B	400211-12-4	
MLU100-36B	400212-11-4	
MLE100-36B	400213-11-2	
MLD100-36B	400214-11-0	
MLO100-48	400211-06-6	48
MLU100-48	400212-06-4	
MLE100-48	400213-06-2	
MLD100-48	400214-06-0	
MLO100-48B	400211-13-2	
MLU100-48B	400212-12-2	
MLE100-48B	400213-12-0	
MLD100-48B	400214-12-8	

MLO models are Open Frame, MLU models are U-Frame, MLE models are Enclosed and MLD models are DIN Rail.

Model No. suffix: B = Class II protection;
Blank = Class I protection

Table 7-1 ML100 Series Part Numbers

All ML Series power supplies are RoHS compliant For warranty information refer to www.n2power.com . Direct all questions, orders or requests for quotation as follows:

N2Power Order Desk:	orders@n2power.com	805-583-7744 x112
Fax:		805-978-5212
Sales:	sales@n2power.com	805-583-7744 x122
Technical Support	techsupport@n2power.com	805-583-7744 x119
Address	1267 Flynn Road	Camarillo, CA 93012