N2Power™
A subsidiary of Qualstar Corporation

Product Specification

ML40 series

40W AC-DC

Medical Power Supplies

Document No. 702601 Rev. 08-16-21

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1. Introduction

1.1 Introduction

This specification defines the ML40 series of universal input, single output 40W switch mode power supplies. It includes information regarding the mechanical details, electrical and environmental ranges for storage and operation of the power supply. These power supplies achieve very high packaging densities. All of the ML40 family models are listed in Table 3-1.

All models of the ML40 series can be used as standalone power supplies and have different chassis options – ML**O**40 for **O**pen frame, ML**U**40 for **U** Chassis, ML**E**40 for **E**nclosure and ML**D**40 for **D**in rail.

MLO40

MLU40

MLE40

MLD40

Figure 1-1 ML40 Series

1.2 Agency Compliance

All of the ML40 models comply with the following international agency standards:

Safety	**Complies with Standard**	**Remarks**
United States	ANSI/AAMI ES60601-1	Leakage Current – see Table 2-2
	UL60950-1	Hi-pot – Input to Output = 4000Vac
	UL62368-1	
Canada	CAN/CSA-C22.2 No. 601.1	
	CAN/CSA-C22.2 No. 60601-1	
	CAN/CSA-C22.2 No. 60950-1	
	CAN/CSA C22.2 No.62368-1	
EU Council	EN 60601-1	Low Voltage Directive
	EN60950-1	
	EN62368-1	
International	IEC 60601-1	
	IEC60950-1	
	IEC62368-1	
EMC	**Complies with Standard**	**Remarks**
Emission	EN55032	
	FCC Part 15 Subpart B	Class B
	EN 55011	Class B
	EN 60601-1-2	
	IEC 61000-3-2	Harmonic Current Emissions
	IEC 61000-3-3	Voltage Fluctuations & Flicker
Immunity	EN 60601-1-2:	
	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	2002/95/EC	RoHS Directive
	2011/65/EU	RoHS 2 Directive
	2015/863/EU	Amending Annex II to Directive 2011/65/EU
Marks of Conformance		
United States & Canada	c US E469416	(Underwriters Laboratories File E469416)
	2xMOPP	
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 ML40 models which are 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	85VAC	100–240VAC	264VAC
RMS Input Current	-	-	1.05A / 100VAC 0.55A / 240VAC
Input Frequency	47Hz	50/60Hz	63Hz

Table 2-1 ML40 Series Input Parameters

2.2 Input Over Current Protection

The ML40 series incorporate 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 (25°C) inrush current at 90° input phase angle (i.e. AC switch is closed at the peak of the AC sine wave input) is limited to less than 60 Amps peak for 230 VAC.

Repetitive ON-OFF cycling of the AC input voltage should not damage the power supply or cause the input fuse to open.

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.

Table 2-2 Leakage Current

Model Name	Class I or Class II	Leakage Current Measurement
ML40-*XX*	Class I	Earth Leakage: < 0.5mA (N.C)
		Earth Leakage: < 0.6mA (S.F.C.)
		Touch Leakage: < 100µA (N.C.)
		Touch Leakage: < 150µA (S.F.C.)

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	Rated Voltage (VDC)	Load Regulation	Output voltage accuracy range		
			Minimum (VDC)	Nominal (VDC)	Maximum (VDC)
		±0.7%	4.95	5	5.05
ML#40-05	5	±0.5%	7.42	7.5	7.58
ML#40-7P5	7.5	±0.5%	8.91	9	9.09
ML#40-09	9	±0.5%	11.88	12	12.12
ML#40-12	12	±0.5%	14.85	15	15.15
ML#40-15	15	±0.5%	17.82	18	18.18
ML#40-18	18	±0.5%	23.76	24	24.24
ML#40-24	24	±0.5%	27.72	28	28.28
ML#40-28	28	±0.5%	35.64	36	36.36
ML#40-36	36	±0.5%	47.52	48	48.48
ML#40-48	48	±0.5%	52.47	53	53.53
ML#40-53	53				

Table 3-1 Output Voltage Specifications

Note: "#" denotes the type of chassis, which can be
O =Open frame, U=U Chassis, E=Enclosure, D=Din Rail

3.2 No Load Operation

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

3.3 Output Current/Power

The maximum available output power is always a function of the input voltage and ambient temperature. The maximum output currents of all models of ML40 are listed in Table 3-2. Refer to Section 3.3.1 and 3.4.1 for input voltage range and ambient temperature at which ML40 can deliver these maximum output powers.

Model	Voltage VDC	Current (Max) A
ML#40-05	+5	8
ML#40-7P5	+7.5	5.34
ML#40-09	+9	4.45
ML#40-12	+12	3.34
ML#40-15	+15	2.67
ML#40-18	+18	2.23
ML#40-24	+24	1.67
ML#40-28	+28	1.43
ML#40-36	+36	1.12
ML#40-48	+48	0.84
ML#40-53	+53	0.77

Table 3-2 Max Load Currents

3.3.1 Input Voltage Derating

The ML40 series can be operated at the minimum input voltage of 85VAC with the total maximum output power of 40W.

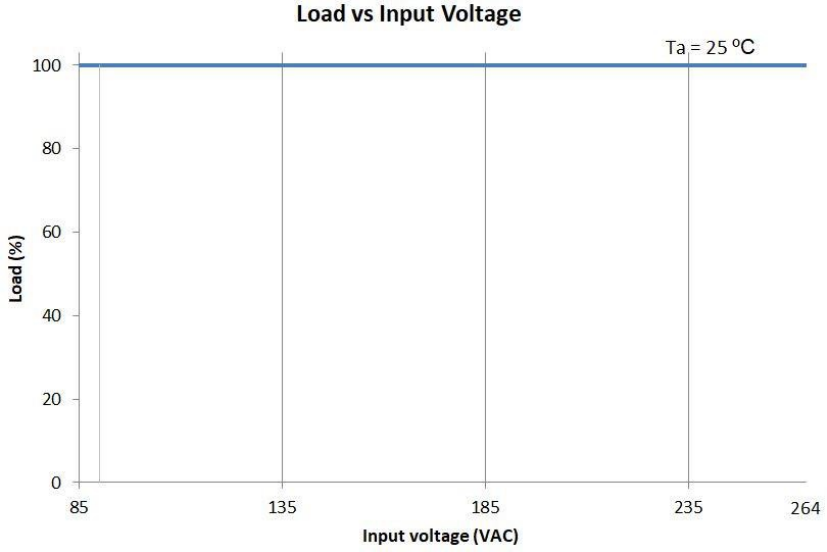

Figure 3-1 Load vs. Input Voltage

3.4 Cooling

ML40 can deliver maximum output power with unrestricted convection cooling. "Unrestricted" means there are no nearby obstructions that would impede the convection cooling process.

3.4.1 High Temperature Derating

The ML40 series can be operated at elevated temperatures by derating the total maximum output power (or current). Refer to below graphs to get the maximum output power at a specific ambient temperature.

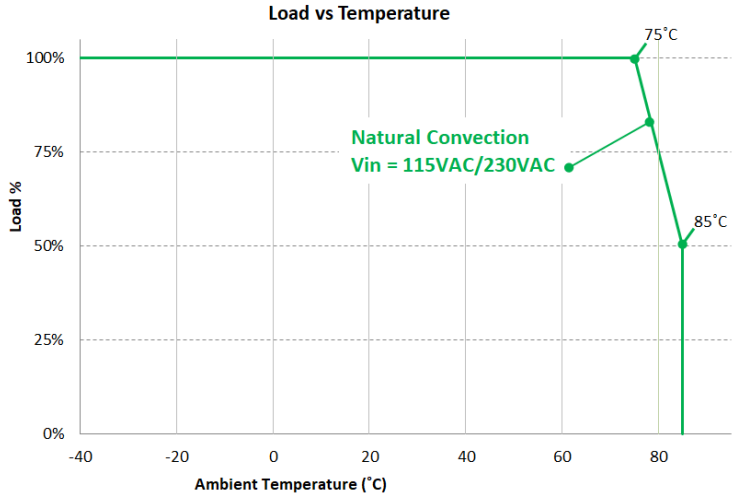

Figure 3-2 Temperature Derating Curve for ML#40-XX where XX refers to 5, 7P5, 9 and 28

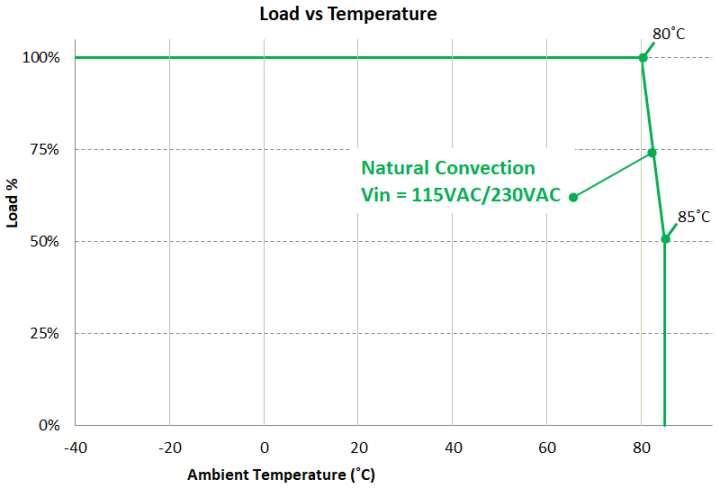

Figure 3-3 Temperature Derating Curve for ML#40-XX where XX refers to 12, 15, 24, 36, 48 and 53

3.5 Output Ripple/Noise

Output ripple voltage and noise are measured at 20MHz of bandwidth by using a 12" twisted pair-wire terminated with a ceramic capacitor (MLCC) in parallel. The capacitance values of this MLCC are 10µF for 5V, 7.5V, 9V, 12V, 15V output models, 1µF for 24V, 28V, 36V output models or 0.1µF for 48V and 53V output models. The ripple noise is measured from the output pin connectors.

3.5.1 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 3-2.

Model	Output Voltage	Maximum Ripple+Noise (peak-to-peak)
ML#40-05	5 V	75 mV
ML#40-7P5	7.5 V	75 mV
ML#40-09	9 V	75 mV
ML#40-12	12 V	75 mV
ML#40-15	15 V	75 mV
ML#40-18	18 V	75 mV
ML#40-24	24 V	75 mV
ML#40-28	28 V	75 mV
ML#40-36	36 V	75 mV
ML#40-48	48 V	150 mV
ML#40-53	53 V	150 mV

Table 3-3 Ripple Voltage of ML40

3.5.2 Ripple/Noise Test Setup

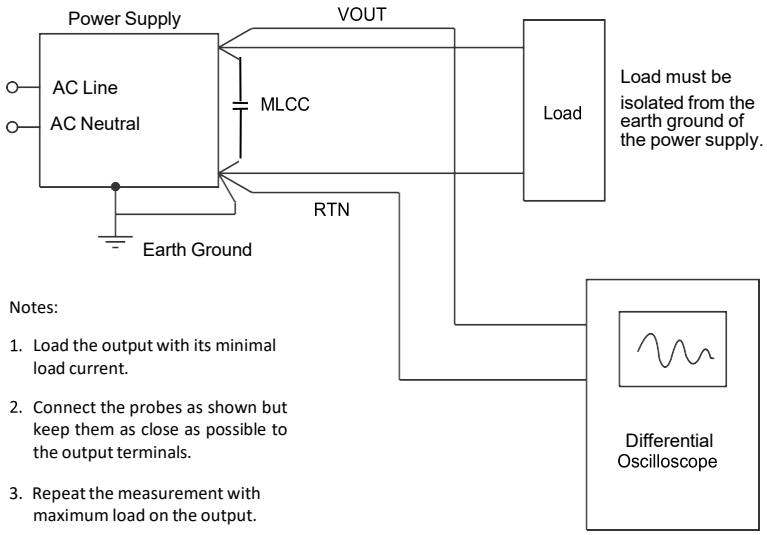

Figure 3-4 Ripple Noise Measurement Setup

3.6 Output Protection

There are output protection schemes designed to protect the load and the ML40 series from component failures and extraordinary circumstances.

3.6.1 Over Voltage Protection (OVP)

No single fault is able to cause a sustained over voltage condition on the output. When an over-voltage condition occurs at output, the power supply will shut down. Following an OVP event, the ML40 will not restart until AC power is turned off and back on.

Model	Output (VDC)	OVP Voltage		
		Minimum (VDC)	Nominal (VDC)	Maximum (VDC)
All	5 V	6.3	6.6	7.0
	7.5 V	9.4	9.9	10.5
	9 V	11.3	11.9	12.6
	12 V	15.0	15.9	16.8
	15 V	18.8	19.9	21.0
	18 V	22.5	23.8	25.2
	24 V	30.0	31.8	33.6
	28 V	35.0	37.1	39.2
	36 V	45.0	47.7	50.4
	48 V	60.0	63.6	67.2
	53 V	66.3	70.2	74.2

Table 3-4 Over Voltage Protection Limits

3.6.2 Over Current Protection (OCP)

An excessive load will cause the output to shut down. The maximum output power before the power supply shuts down is about 145% (typical) of the rated output power. The power supply will periodically attempt to restart until the over-current condition is removed.

3.6.3 Short Circuit Protection

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

3.7 Output Rise Time

Output voltage shall rise from 10% to 90% of nominal output voltage within 20ms. The output voltage waveform must be a monotonic ramp from 10% to 90% of final set point within the regulation band under any loading conditions specified in the respective load current tables in Table 3-2.

For the purposes of this specification, a monotonic ramp is defined as always having a positive slope 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.

3.8 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 ML40 models above the nominal voltage. No opposite polarity voltage will be present on any output during turn on or turn off.

3.9 Voltage Trim

A potentiometer (Figure 3-5) is provided to allow the user to adjust the output voltage up or down by up to 10%. The ability of the output to maintain its specified regulation accuracy under severe load or line conditions could be diminished by trimming the output to a higher than nominal voltage. The load current and power should not exceed the maximum limits described in Section 3.3.

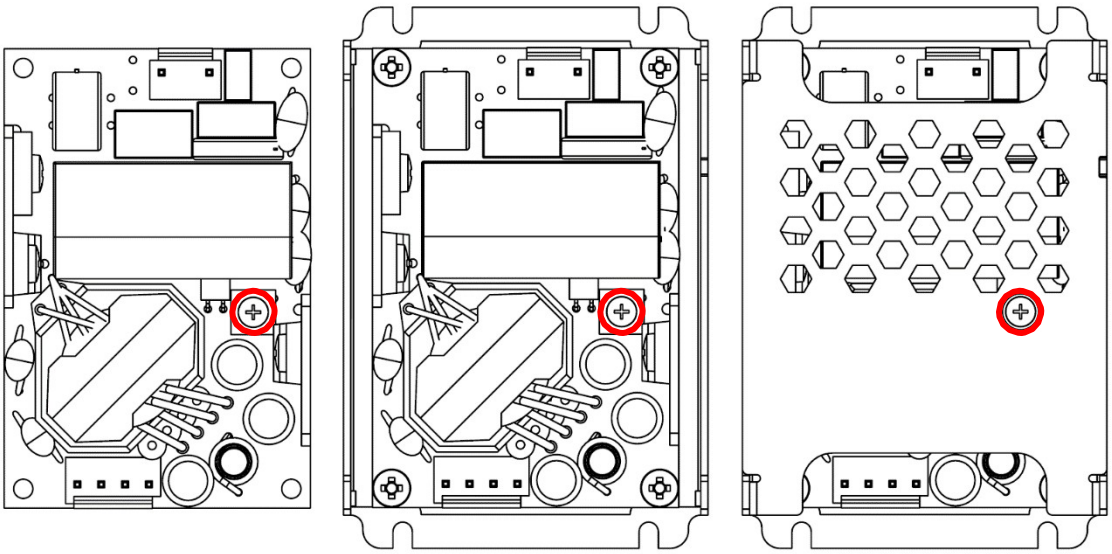

Figure 3-5 Potentiometer to adjust output voltage

4. General Specifications

4.1 Environmental

The ML40 series meets or exceeds the following environmental specifications:

Parameter	Conditions	Specification	Remarks
	Operating	-40°C to 85°C*	
	Non-Operating	-40°C to 85°C*	
Relative Humidity	Operating	5-95% Maximum	Non-Condensing
	Non-Operating	95% Maximum	Non-Condensing
Altitude	Operating	16404 feet MSL Max.	5,000 meters
Vibration	No damage	2.0 G RMS Maximum	10-500Hz, 10-min/1cycle, 60 min each along x, y, z
		2.0 G RMS Maximum	axis. Mounting: Compliance to IEC60068-2-6

Table 4-1 Environmental Specifications

Note on (*): Refer to **Figure 3-2** for derating at different temperatures.

4.2 Mean Time between Failures

The calculated MTBF of all models is equal to or greater than 3,010,000 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 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.

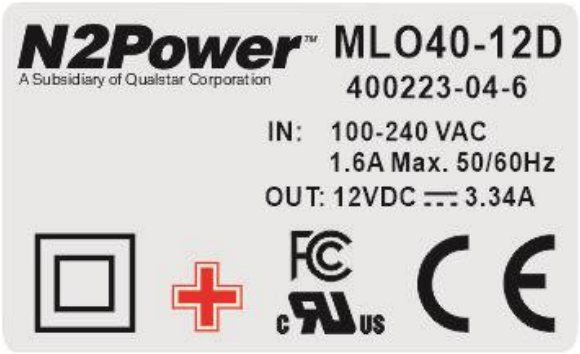

Figure 4-1 Sample XL40 series Label

4.4 Net Weight

Model	Pound	Ounces	Kilograms
MLO40	0.25	4.02	0.11
MLU40	0.34	5.43	0.15
MLE40	0.37	5.96	0.17
MLD40	0.42	6.70	0.19

Table 4-2 Net Weights

4.5 Mounting and Physical Dimensions

All ML40 models are provided with four mounting holes of the following size.

Model	Millimeter (mm)	Inch (in)
ML#40	3.2	0.126

Table 4-3 Mounting Screw Sizes

See mechanical drawings for mounting hole locations and the dimensions of the power supplies. All the units are in "mm [in]" format with the tolerance of x.xx±0.5 [x.xxx±0.02].

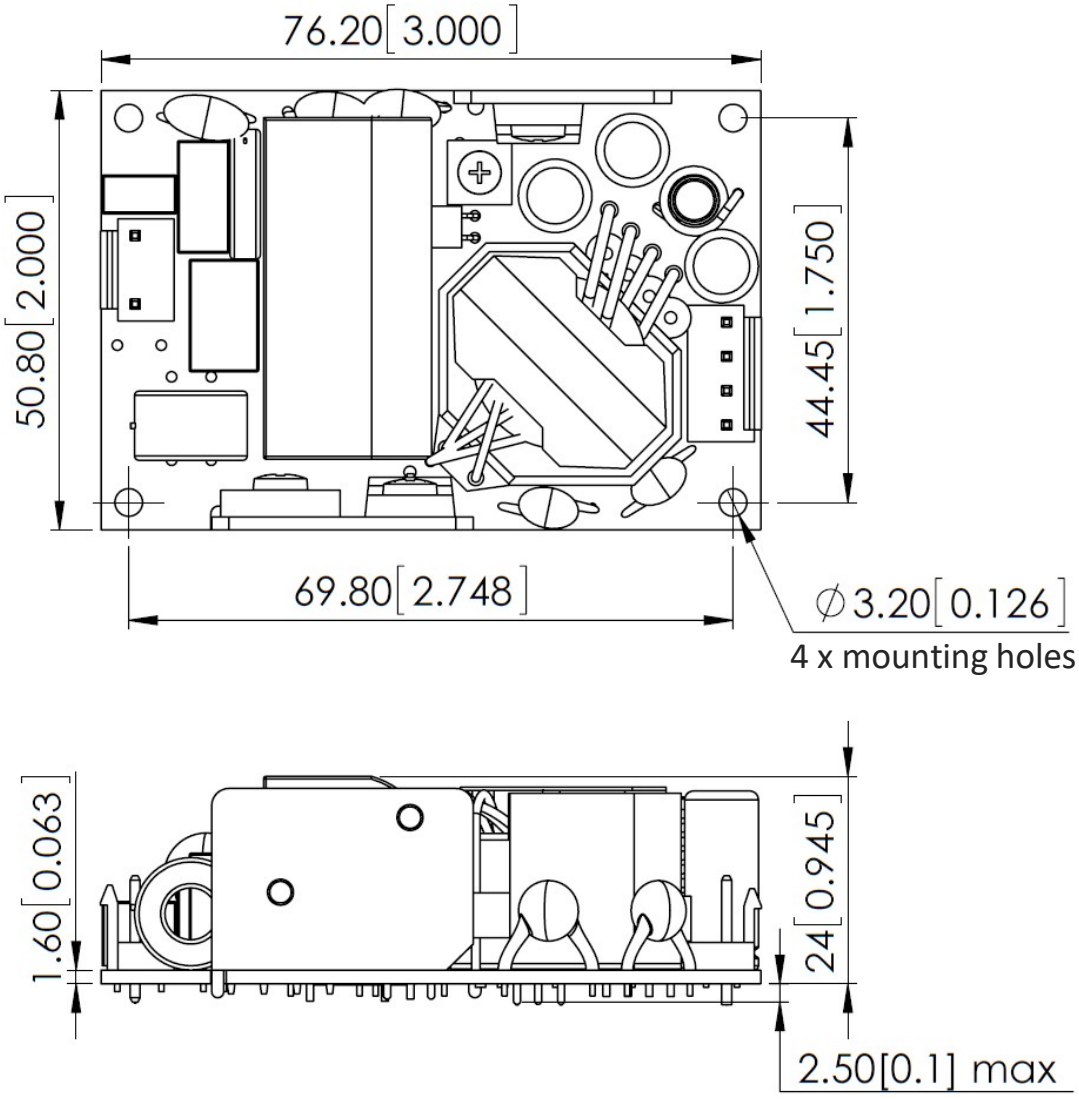

Figure 4-2 MLO40 models: Mounting Hole Locations and Dimensions

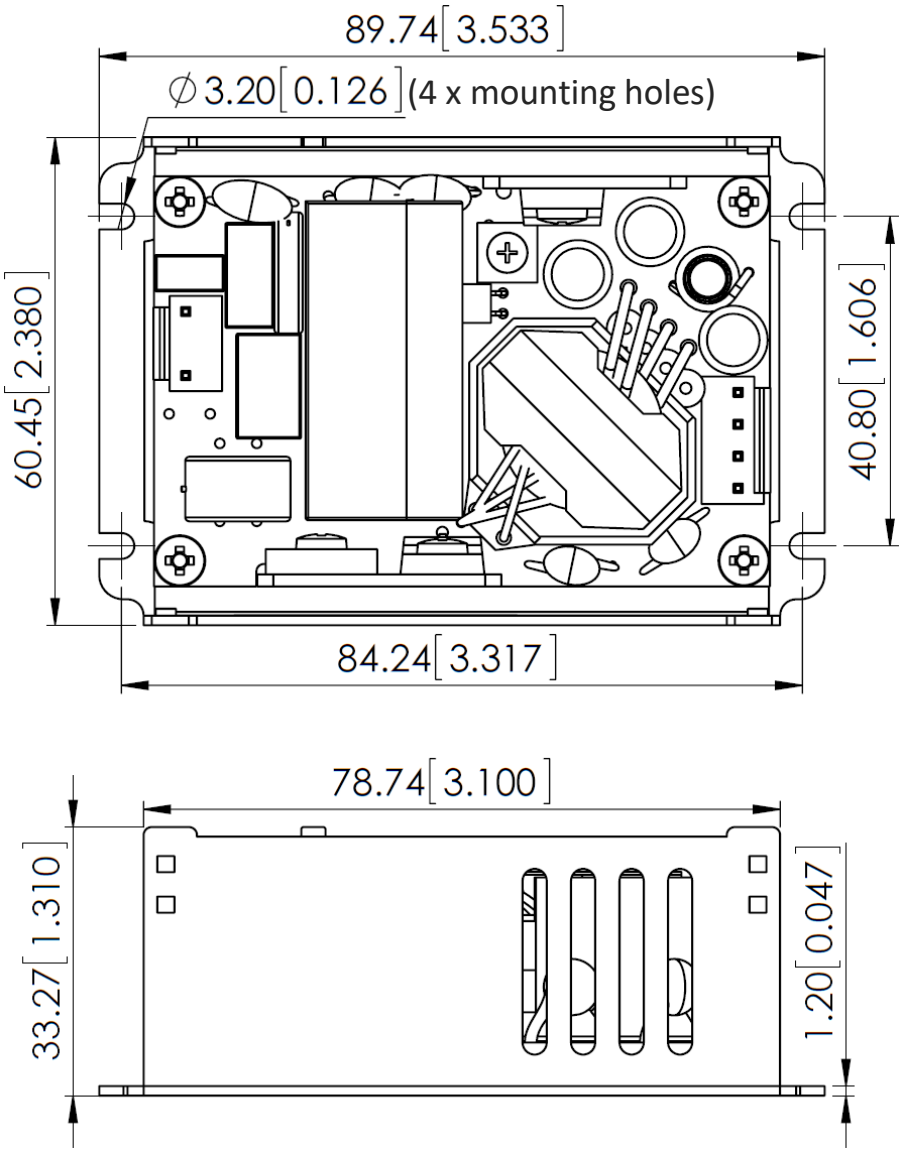

Figure 4-3 MLU40 models: Mounting Hole Locations and Dimensions

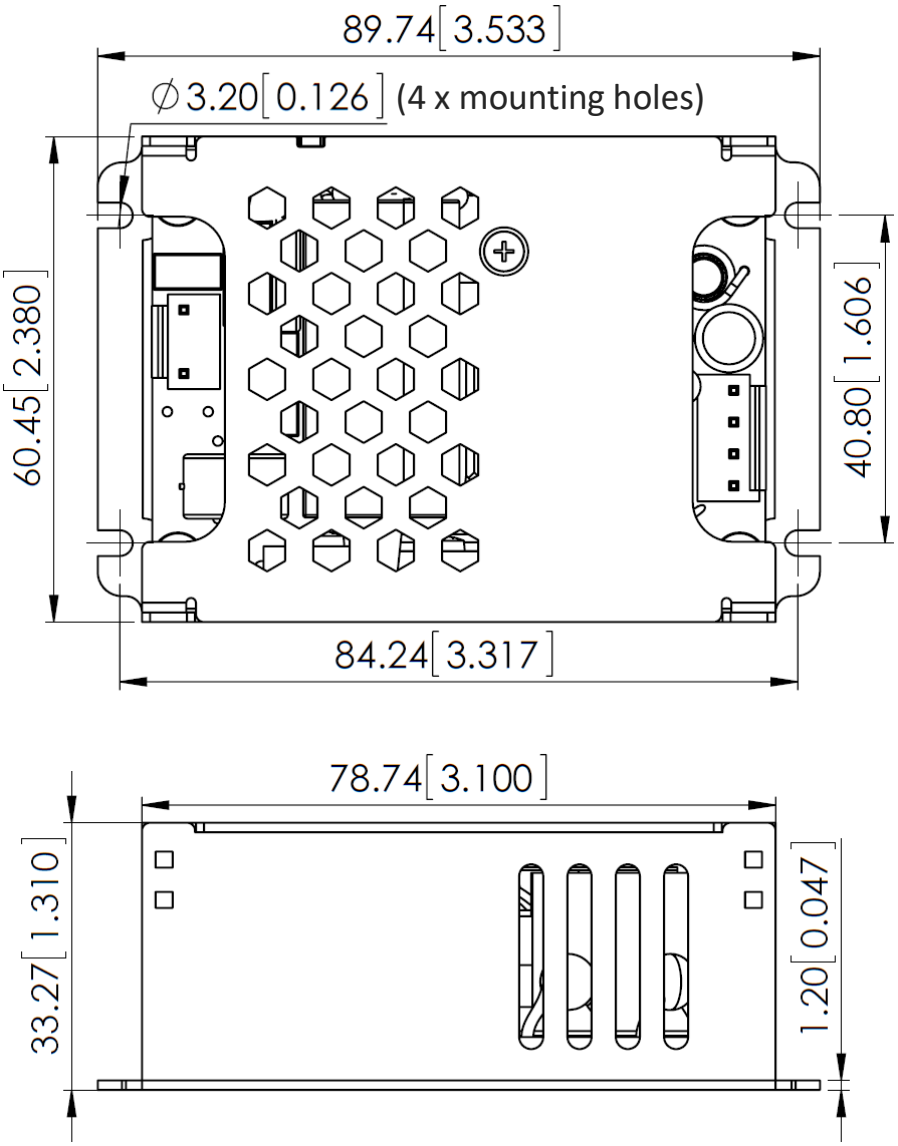

Figure 4-4 MLE40 models: Mounting Hole Locations and Dimensions

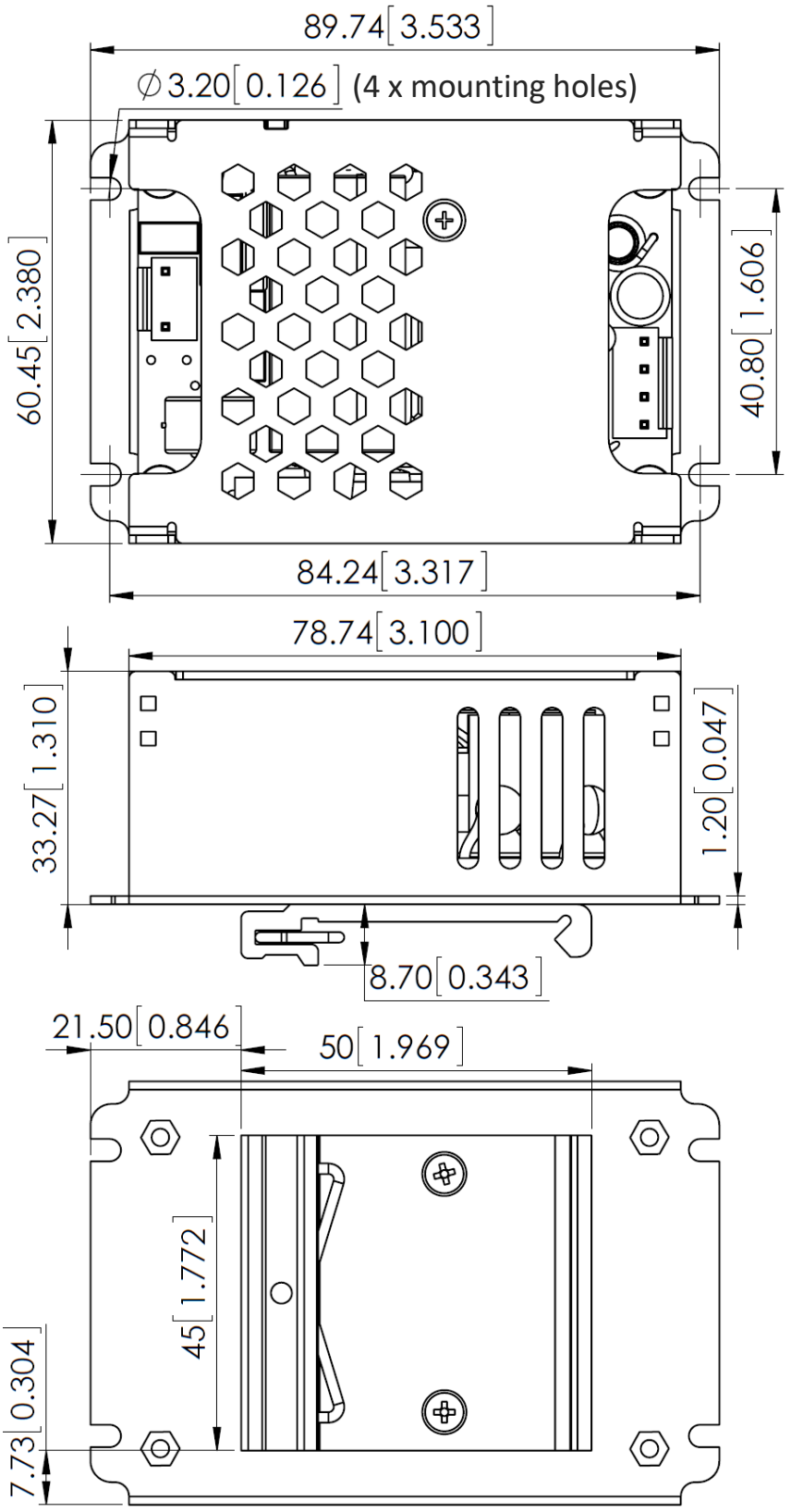

Figure 4-5 MLD40 models: Mounting Hole Locations and Dimensions

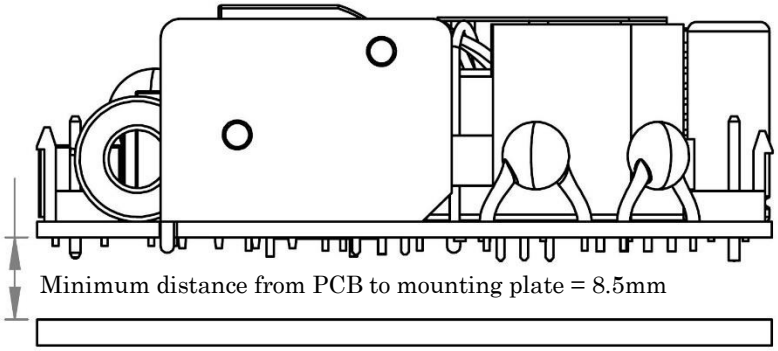

Figure 4-6 ML40 minimum distance requirement from mounting plate

When ML40 models are mounted on the FG mounting plate, the distance from the mounting plate to the PCB must be at least 8.5mm.

A standoff less than 8.5mm high is acceptable when a thin insulator, 0.4mm thick (polyester, fish paper or equivalent UL rated 94V-2 minimum) is placed between the power supply and the mounting chassis (refer to applicable UL standard for clearance requirements).

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	Mating Housing	Terminal
Mains input Options		JST Type	AC INPUT	VHR-3N	SVH-21T-P1.1
			+/-VOUT (DC Output)	VHR-4N	SVH-21T-P1.1
		Molex Type	AC INPUT	09-50-8031	SD-2478
			+/-VOUT (DC Output)	09-50-8061	SD-2478
		Terminal Block	AC INPUT	Screw locked torque- max 2Kgf.cm/0.2N.m	Wire dimension range 26 ~ 16AWG
			+/-VOUT (DC Output)		

Table 4-4 Mating connectors

4.7 Output Grounding

For CLASS I protection type power supplies (without suffix "C" at model names), the RTN signal may be connected to the power supply chassis ground (safety earth) screw terminals on the power supplies as shown in Figure 4-7.

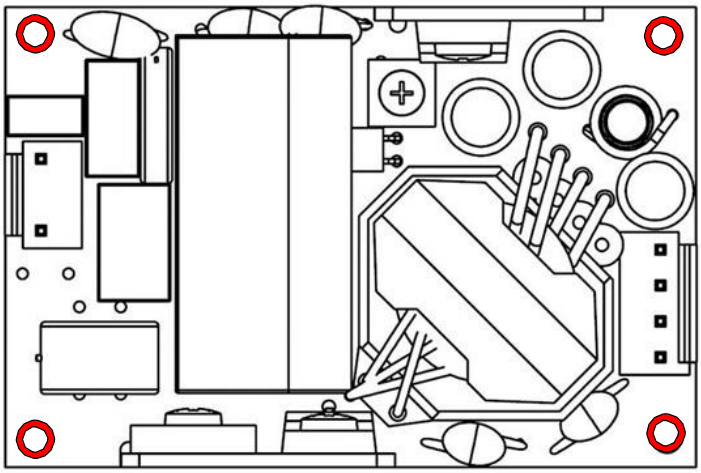

Figure 4-7 Safety ground connection points

4.8 Pin Definitions

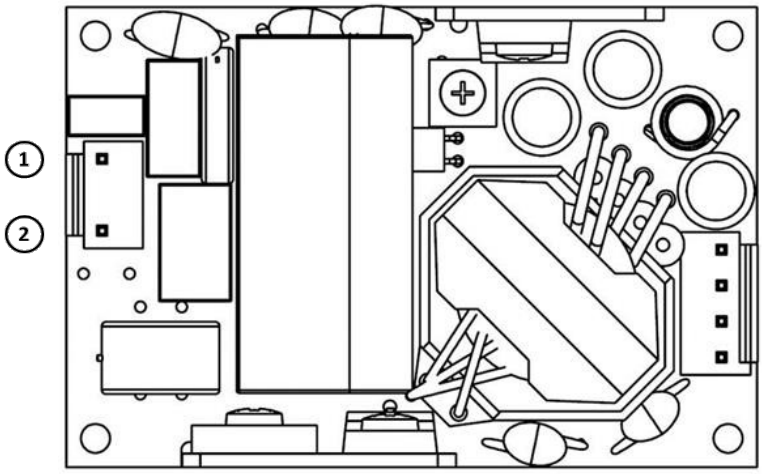

Figure 4-8 Pin Definitions

Model	Connector	Pin No.	Assignment
All	AC Input Terminal	1	AC NEUTRAL
		2	AC LINE
	Output Connector	3, 4	VOUT
		5, 6	RTN (VOUT Return)

Table 4-5 Pin Definitions

5. Efficiency

The efficiencies for the ML40 power supply models are listed below. They were measured at full load, 25 ˚C at 230AC.

Model	Output Voltage	Total Load	Efficiency
ML#40-05	5 V	40 W	90 %
ML#40-7P5	7.5 V	40 W	90 %
ML#40-09	9 V	40 W	91 %
ML#40-12	12 V	40 W	92.5 %
ML#40-15	15 V	40 W	93.5 %
ML#40-18	18 V	40 W	93%
ML#40-24	24 V	40 W	93.5 %
ML#40-28	28 V	40 W	93.5 %
ML#40-36	36 V	40 W	92.5 %
ML#40-48	48 V	40 W	93 %
ML#40-53	53 V	40 W	92.5 %

Table 5-1 Efficiency

6. Timing and Control

6.1 Power Supply Timing

The maximum duration for the output to rise up to regulated output voltage (99% of nominal voltage) from the start of AC input voltage is 1 second.

6.2 Voltage Hold-Up Time

The power supply will maintain output regulation per Table 3-1 despite a loss of input power at 115VAC/60Hz and 230VAC/50Hz at maximum rated continuous output for a minimum of 25ms.

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	Output Voltage	N2Power Part Number
MLO40-05C	5 V	400223-14-5
MLU40-05C		400225-14-0
MLE40-05C		400226-14-8
MLD40-05C		400224-14-3
MLO40-05D		400223-01-2
MLU40-05D		400225-01-7
MLE40-05D		400226-01-5
MLD40-05D		400224-01-0
MLO40-7P5C	7.5 V	400223-15-2
MLU40-7P5C		400225-15-7
MLE40-7P5C		400226-15-5
MLD40-7P5C		400224-15-0
MLO40-7P5D		400223-02-0
MLU40-7P5D		400225-02-5
MLE40-7P5D		400226-02-3
MLD40-7P5D		400224-02-8
MLO40-09C	9 V	400223-16-0
MLU40-09C		400225-16-5
MLE40-09C		400226-16-3
MLD40-09C		400224-16-8
MLO40-09D		400223-03-8
MLU40-09D		400225-03-3
MLE40-09D		400226-03-1
MLD40-09D		400224-03-6
MLO40-12C	12 V	400223-17-8
MLU40-12C		400225-17-3
MLE40-12C		400226-17-1
MLD40-12C		400224-17-6
MLO40-12D		400223-04-6
MLU40-12D		400225-04-1
MLE40-12D		400226-04-9
MLD40-12D		400224-04-4

Model	Output Voltage	N2Power Part Number
MLO40-121C	12 V	400223-18-6
MLU40-121C		400225-18-1
MLE40-121C		400226-18-9
MLD40-121C		400224-18-4
MLO40-121D		400223-05-3
MLU40-121D		400225-05-8
MLE40-121D		400226-05-6
MLD40-121D		400224-05-1
MLO40-15C	15 V	400223-19-4
MLU40-15C		400225-19-9
MLE40-15C		400226-19-7
MLD40-15C		400224-19-2
MLO40-15D		400223-06-1
MLU40-15D		400225-06-6
MLE40-15D		400226-06-4
MLD40-15D		400224-06-9
MLO40-151C	15 V	400223-20-2
MLU40-151C		400225-20-7
MLE40-151C		400226-20-5
MLD40-151C		400224-20-0
MLO40-151D		400223-07-9
MLU40-151D		400225-07-4
MLE40-151D		400226-07-2
MLD40-151D		400224-07-7
MLO40-18C	18 V	400223-21-0
MLU40-18C		400225-21-5
MLE40-18C		400226-21-3
MLD40-18C		400224-21-8
MLO40-18D		400223-08-7
MLU40-18D		400225-08-2
MLE40-18D		400226-08-0
MLD40-18D		400224-08-5

Model	Output Voltage	N2Power Part Number
MLO40-24C	24 V	400223-22-8
MLU40-24C		400225-22-3
MLE40-24C		400226-22-1
MLD40-24C		400224-22-6
MLO40-24D		400223-09-5
MLU40-24D		400225-09-0
MLE40-24D		400226-09-8
MLD40-24D		400224-09-3
MLO40-28C	28 V	400223-23-6
MLU40-28C		400225-23-1
MLE40-28C		400226-23-9
MLD40-28C		400225-23-1
MLO40-28D		400223-10-3
MLU40-28D		400225-10-8
MLE40-28D		400226-10-6
MLD40-28D		400224-10-1
MLO40-36C	36 V	400223-24-4
MLU40-36C		400225-24-9
MLE40-36C		400226-24-7
MLD40-36C		400224-24-2
MLO40-36D		400223-11-1
MLU40-36D		400225-11-6
MLE40-36D		400226-11-4
MLD40-36D		400224-11-9
MLO40-48C	48 V	400223-25-1
MLU40-48C		400225-25-6
MLE40-48C		400226-25-4
MLD40-48C		400224-25-9
MLO40-48D		400223-12-9
MLU40-48D		400225-12-4
MLE40-48D		400226-12-2
MLD40-48D		400224-12-7
MLO40-53C	53 V	400223-26-9
MLU40-53C		400225-26-4
MLE40-53C		400226-26-2
MLD40-53C		400224-26-7
MLO40-53D		400223-13-7
MLU40-53D		400225-13-2
MLE40-53D		400226-13-0
MLD40-53D		400224-13-5

Table 7-1 ML40 Part Numbers

The model names in the above table are for CLASS II D protection type. ML40s for CLASS I C protection are also available.

All ML40 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 (Attention N2Power):		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	