

# Technical Specification

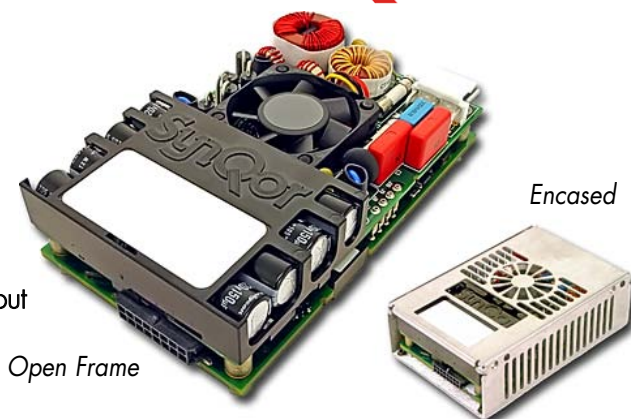
## AQ0400MU48E

### MEDICAL GRADE AC/DC POWER SUPPLY WITH PFC

<b>85-264 V<sub>RMS</sub></b> Input Voltage	<b>48V Semi-Regulated</b> Output Voltage	<b>400W Continuous</b> Output Power	<b>500W Transient</b> Output Power	<b>91% @ 400W</b> Efficiency
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#### FEATURES

- High efficiency (91% at 400 W)
- Universal input voltage range
- Semi-regulated output for bus stability
- Parallel operation supported
- 5V "Always On" standby power output
- Integral fan cooling with speed control
- Active PFC; EN61000-3-2 compliant
- Low leakage; EN60601-1 compliant
- Low noise; EN55011 / EN55022 Class B compliant
- Over-current, over-voltage, and over-temp protection
- DC Power Good / AC Power Good signals, Remote enable input
- Fan status output / Fan enable input
- Small size: 3" x 5" x 1.45" (open frame)
- RoHS 6/6 compliant



#### AQ0400MU48E ELECTRICAL CHARACTERISTICS

All specifications typical with TA=25 °C unless otherwise specified.

##### INPUT SPECIFICATIONS

AC input voltage	Universal range	85-264 V <sub>RMS</sub>
Input frequency		47-63 Hz
Input current	115 V <sub>RMS</sub> @ 400 W	4 A <sub>RMS</sub>
	230 V <sub>RMS</sub> @ 400 W	2 A <sub>RMS</sub>
Power factor		>0.98
Input surge current	264 V <sub>RMS</sub> (cold start)	40 A max.
Internal input fuses	Both AC lines	6.3 A

##### ISOLATION SPECIFICATIONS

Isolation voltage	Input to output	4000 V <sub>RMS</sub>
	Input to ground	1500 V <sub>RMS</sub>
	Output to ground (BF and CF models)	1500 V <sub>RMS</sub>
	Output to ground (BFD and CFD models)	5000 V <sub>PULSE</sub>
Insulation resistance	Output to ground	10 MΩ min.
Leakage currents		See Note 2

##### EMC CHARACTERISTICS

Conducted emissions	EN55011 and EN55022, FCC part 15	Level B
Line frequency harmonics	EN61000-3-2	Class A
Voltage fluctuations	EN61000-3-3	Clause 5b
ESD air	EN61000-4-2	Level 3
ESD contact	EN61000-4-2	Level 3
Radiated immunity	EN61000-4-3	Level 3
Fast transients	EN61000-4-4	Level 3
Line surge immunity	EN61000-4-5	Level 3
Conducted immunity	EN61000-4-6	Level 3
Power freq. mag. field	EN61000-4-8	3 A/m
Voltage dip immunity	EN61000-4-11	Perf Criteria A, A, B <5% U <sub>I</sub> ; 10 ms, 70% U <sub>I</sub> ; 500 ms, 40% U <sub>I</sub> ; 100 ms

##### SAFETY AGENCY CERTIFICATIONS

- UL60601-1 and UL60950
- IEC/EN 60601-1 and IEC/EN 60950
- CE Marked
- cUL CSA Standards
- Meets NFPA 99 2005 300 μA earth leakage

##### OUTPUT SPECIFICATIONS

Output power (continuous)	85-132/170-264 V <sub>RMS</sub>	400 W
	132-170 V <sub>RMS</sub>	See Figure 4
Nominal DC output voltage	At 250 W	50 V
Total regulation	Over line, load and temperature	±6.0%
Output ripple	Switching frequency (20 MHz BW)	200 mVpp
	Twice line frequency	1.8 V <sub>RMS</sub>
Output current	Continuous	8.5 A max.
	5 s transient	11 A max.
Turn-on delay		2 s max.
Transient response	load steps from 50-75%	3% typ / 6% max. dev.
	At 0.2 A/μs	100 ms recovery
Overvoltage protection	Cyclic restart	110-120%
Short circuit protection	Cyclic operation	115% rated load
Maximum load capacitance		1,000 μF
Auxiliary output	Always on (see Note 1)	5 V @ 50 mA
Thermal protection	Automatic recovery	+125 °C (PCB Temp)
REMOTE_ENABLE	Input Low Voltage	0.45 V (max)
	Input High Voltage	4.15 V (min)

##### GENERAL SPECIFICATIONS

Efficiency	115 Vac @ 400 W	89.5% typ.
	230 Vac @ 400 W	91.0% typ.
Hold-up time	Until Vout drops 20%	20 ms @ 400 W
Fundamental ripple freq.	Input	500 kHz
	Output	250 kHz
Audible noise	Fan speed varies with temp.	39 dBA @ 1 m max.
Weight (Open frame \ Encased)		342.5 \ 445.9 g (12.08 \ 15.7 oz)
MTBF	Telcordia SR-332	343.6 kHours
	Demonstrated	TBD kHours

##### ENVIRONMENTAL CHARACTERISTICS

Thermal performance	Operating ambient (see Figure 2)	0 °C to +70 °C
	Non-operating ambient	-40 °C to +85 °C
Relative humidity	Non-condensing	5-95% RH
Altitude	Operating	10,000 ft max.
	Non-operating	30,000 ft max.
Random vibration	5-500 Hz	0.03 g <sup>2</sup> /Hz
Shock	Halfsine, 10 ms, 3 axes	20 g peak

### NOTES:

1. Derate 1mA/°C above 50 °C ambient temperature.
2. Leakage currents:

AC Leakage Current from Input to Earth	AC Line Connection	Normal Condition	Open Neutral Fault
ACuQor Typical at 110% nominal input voltage 60 Hz	240V L-N, 1 phase	125 µA	250 µA
	208V L-L, 120V L-N, 1 of 3 phases	62 µA	124 µA
	240V L-N-L, 120V L-N, split phase	62 µA	124 µA

AC Leakage Current from Output to Earth	Model	Normal Condition	Open Earth Fault	AC Backdrive Fault
ACuQor Typical at 264 Vac 60 Hz input	AQ..BF..	2 µA	36 µA	125 µA
	AQ..CF..	2 µA	6 µA	18 µA

For convenience, the following tables show limits allowed by various standards:

AC Leakage Current from Input to Earth	Standard	Normal Condition	Open Neutral Fault
Maximum Allowed per Standard	IEC60601-1	500 µA	1000 µA
	NFPA 99 2005	300 µA	—
	IEC60905	3500 µA	—

AC Leakage Current from Output to Earth	Contact Type	Normal Condition	Open Earth Fault	AC Backdrive Fault
Maximum Allowed per IEC60601-1	BF	100 µA	500 µA	5000 µA
	CF	10 µA	50 µA	50 µA

## EFFICIENCY, DERATING, AND V<sub>OUT</sub> DROOP CURVES

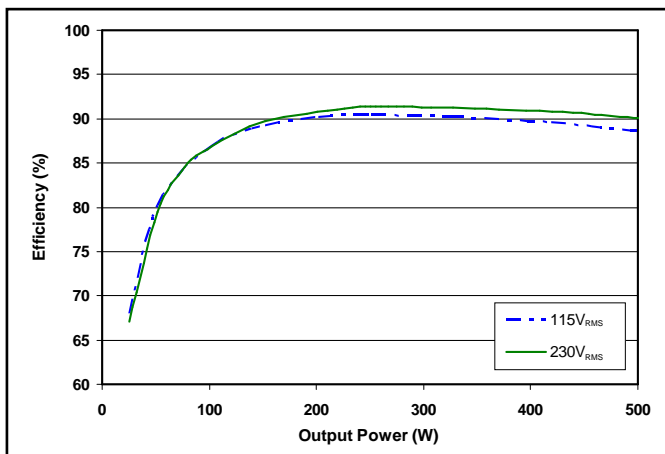


Figure 1: Efficiency curves.

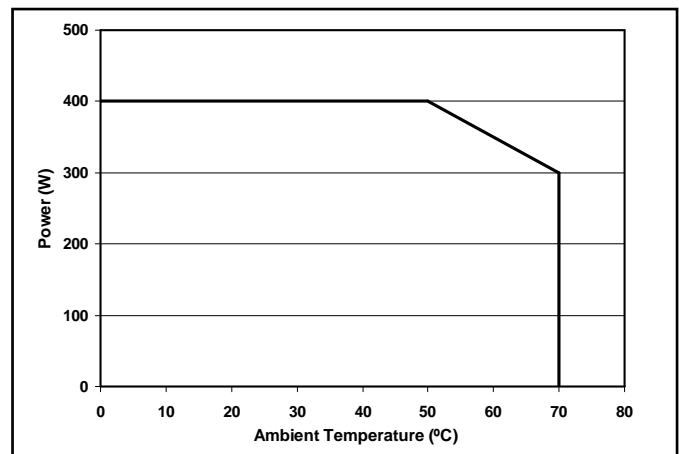


Figure 2: Continuous power derating curve in natural convection.

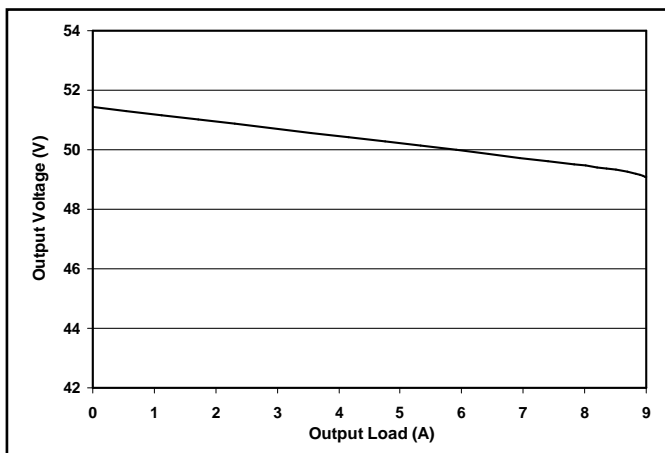


Figure 3: Output voltage droop characteristics.

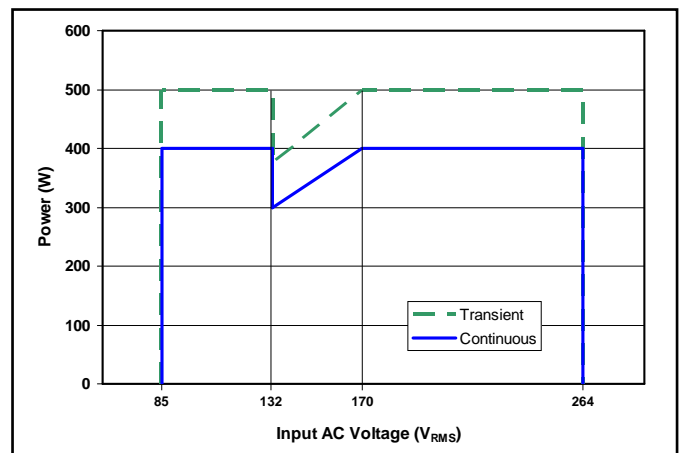
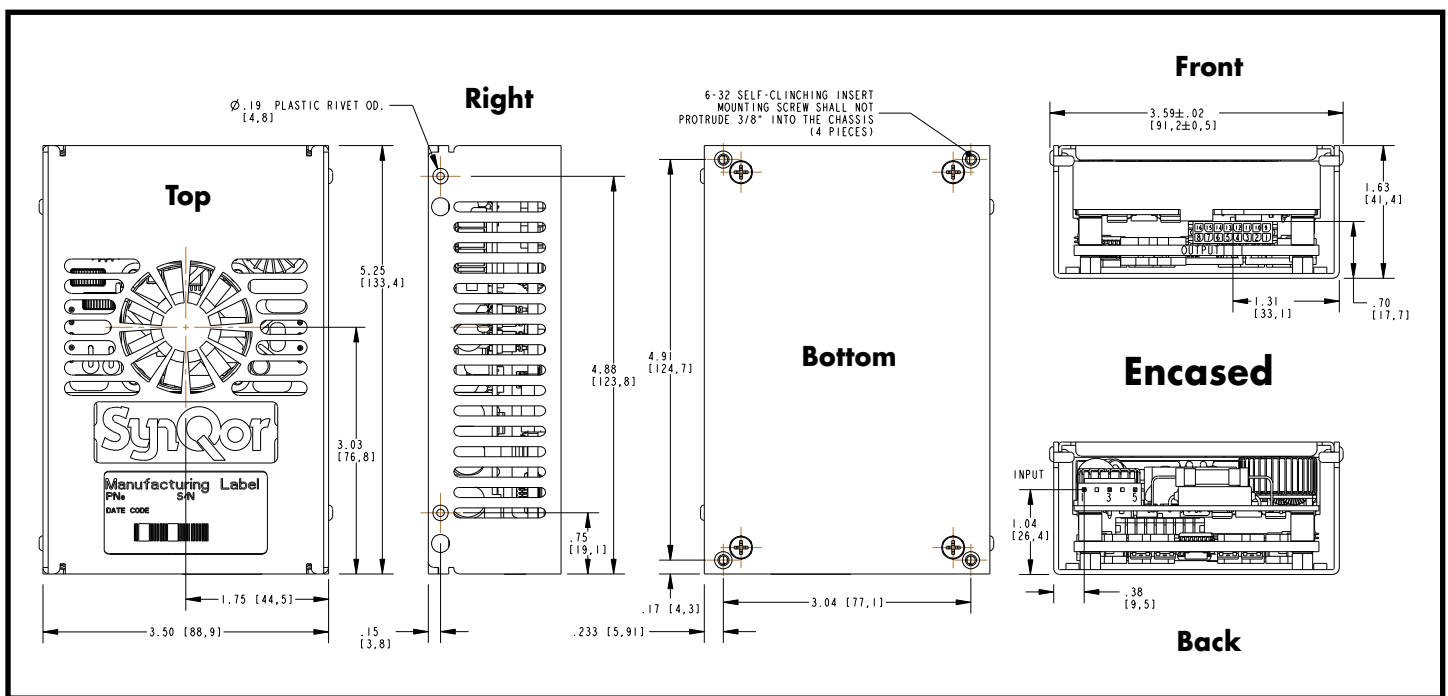
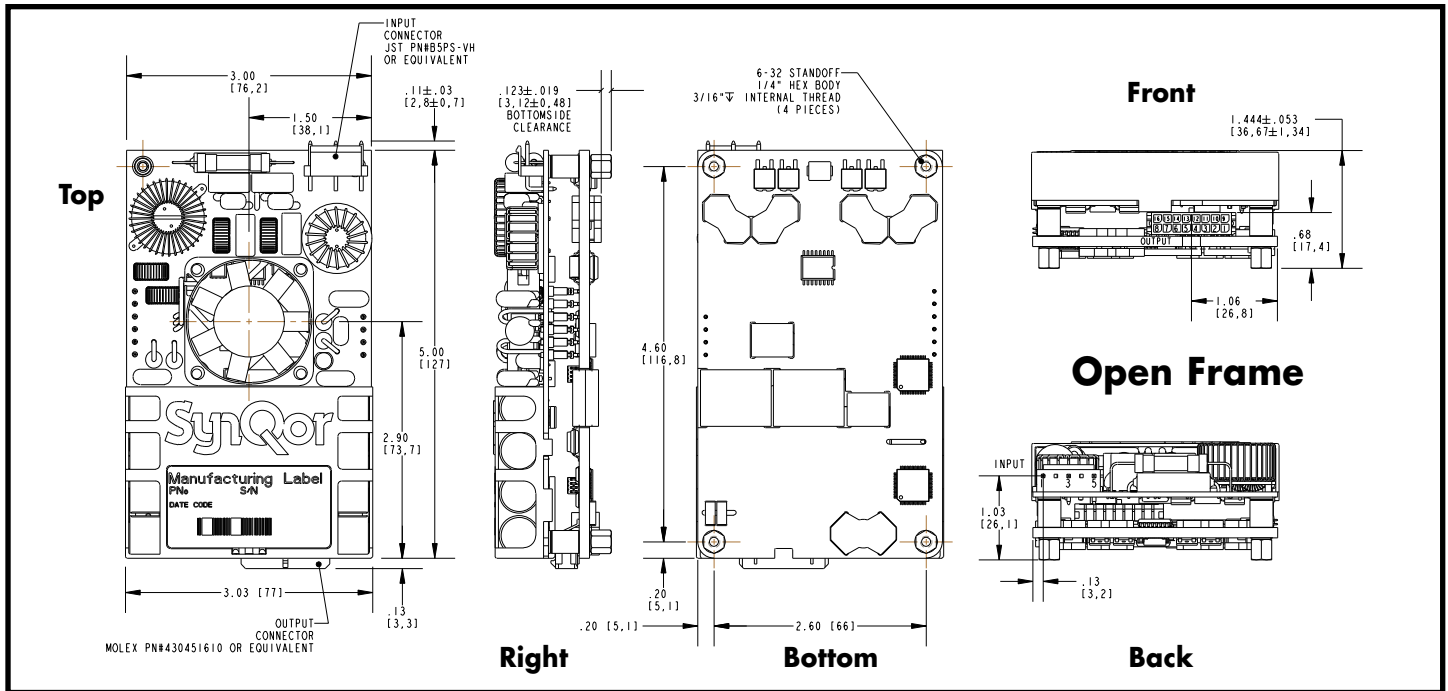


Figure 4: Rated output power vs Input AC Voltage.

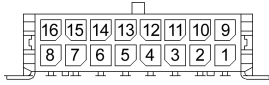
### MECHANICAL DRAWINGS



### NOTES

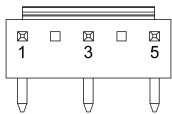
- 1) Recommended screw tightening torque of 6 in.lbs
  - 2) Undimensioned components are shown for visual reference only
  - 3) All dimensions in inches [mm]
- Tolerances: x.xx in ± 0.02  
 x.xxx in ± 0.010

### CONNECTOR DETAILS



#### INDIVIDUAL OUTPUT CONNECTOR PINOUT

Pin 1	FAN_GOOD	Open collector with internal 5V pullup. See Figure A. Pulsed low on fan failure, 100ms, 50% duty. Short to V <sub>OUT(-)</sub> to disable fan.
Pin 2	AC_POWER_GOOD	Open collector with internal 5V pullup. See Figure B. Pulled low on AC power dropout.
Pin 3	DC_POWER_GOOD	Open collector with internal 5V pullup. See Figure B. Pulled low during startup ramp and prior to temperature shutdown.
Pin 4	5V_STANDBY	5V @ 50mA available whenever AC power is applied.
Pin 5	V <sub>OUT(+)</sub>	Positive Output Voltage.
Pin 6	V <sub>OUT(+)</sub>	Positive Output Voltage.
Pin 7	V <sub>OUT(+)</sub>	Positive Output Voltage.
Pin 8	V <sub>OUT(+)</sub>	Positive Output Voltage.
Pin 9	Reserved	Reserved for future use.
Pin 10	Reserved	Reserved for future use.
Pin 11	REMOTE_ENABLE	Logic input. See Figure C. Pull high to enable main output.
Pin 12	V <sub>OUT(-)</sub>	Negative Output Voltage.
Pin 13	V <sub>OUT(-)</sub>	Negative Output Voltage.
Pin 14	V <sub>OUT(-)</sub>	Negative Output Voltage.
Pin 15	V <sub>OUT(-)</sub>	Negative Output Voltage.
Pin 16	V <sub>OUT(-)</sub>	Negative Output Voltage.



#### INDIVIDUAL INPUT CONNECTOR PINOUT

Pin 1	Ground
Pin 3	AC Neutral
Pin 5	AC Line

#### MATING CONNECTORS

Connector	Type	Pins
OUTPUT	Molex 430251600	Molex 430300008
INPUT	JST VHR-5N	JST SVH-41T-P1.1

### PARALLEL OPERATION

For proper operation, externally connect all pins of like function together, in parallel, between connectors. Being wired in parallel, the REMOTE\_ENABLE inputs will operate simultaneously. The FAN\_GOOD, AC\_POWER\_GOOD, and DC\_POWER\_GOOD signals will generate wired-OR outputs. The 5V\_STANDBY outputs wired in parallel are rated for the same power as a single 5V\_STANDBY output, since the linear regulators do not support current sharing. The VOUT(+) outputs support current sharing and have negative current (back-drive) protection.

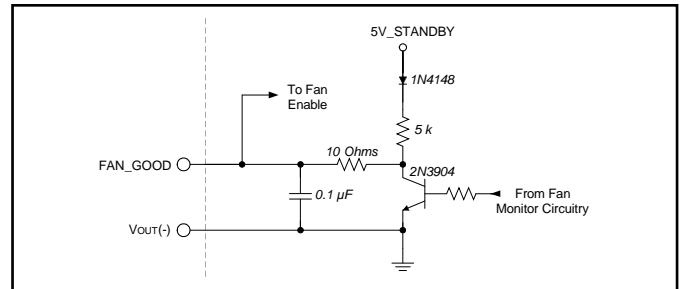


Figure A: Fan status output / Fan enable input interface circuitry.

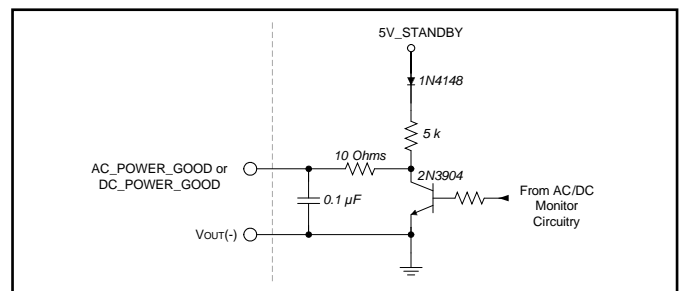


Figure B: Power good interface circuitry.

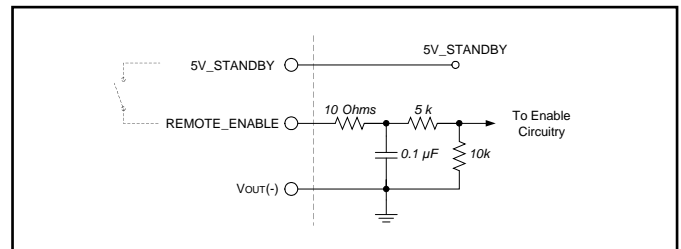


Figure C: Remote enable interface circuitry.

## INSTALLATION INSTRUCTIONS

**General:** ACuQor AC/DC power supplies are intended for use as components in medical and industrial equipment. ACuQor units must be properly installed within end use equipment before they can be safely applied as described in this document. The suitability of the ACuQor/equipment combination must be verified through end product investigation.

**Mounting:** Refer to the [Mechanical Drawings](#) section. ACuQor units are provided with threaded stainless-steel stand-offs or inserts for mounting. This mounting hardware is internally connected to the input connector protective-earth terminal for functional-earth EMC control. Any orientation (vertical, horizontal, etc.) may be used. Adequate air space should be provided over the fan intake (top) and exhaust (sides) to allow for exchange of cooling air. ACuQor is designed for a pollution degree 2 environment. The suitability of the enclosed and open-frame ACuQor mechanical assemblies must be verified through end product investigation.

**Open-Frame Models:** A minimum of 5 mm electrical clearance is required from the connector ends, the top and sides of open-frame models. A minimum 5 mil polyester Mylar film sheet (or equivalent rugged insulation) attached to the mounting surface is required to allow some deflection and to meet defibrillation proof insulation requirements.

**Encased models:** A minimum of 5 mm electrical clearance should be allowed from the connector ends of encased models.

**Input:** Refer to the [Connector Details](#) section for input connector wiring. ACuQor products require a single phase AC power source of 100-240V 50/60Hz nominal. Refer to nameplate label for input current ratings. A protective-earth connection is also required. Minimum wire size of 18 AWG (1mm<sup>2</sup>) is recommended. Both sides of the AC line are internally fused with Littelfuse 6.3A 250V 21606.3XEP fuses. These fuses are not user replaceable.

**Output:** Refer to the [Connector Details](#) section for output connector wiring and signal I/O functionality. Refer to nameplate label for output current ratings. Main DC output (Vout+, Vout-) pins should use 20 AWG (0.5mm<sup>2</sup>) wire size. Individual main output pins should not be loaded to more than 5A. For currents greater than 5A, multiple main output pins/wires must be used in parallel. All signal I/O pins are referenced to Vout-.

**EMC:** ACuQor products have been tested to the EMC specifications listed in the [Electrical Characteristics](#) section. However, end use equipment must be tested to verify EMC compliance.

**Patient Contact:** ACuQor models include versions designed for BF and CF patient contact application per IEC60601-1. Note that equipment and wiring may add to system leakage currents so that the end product must be tested for compliance. Refer to the [Electrical Characteristics](#) section for typical ACuQor input and output leakage currents. In addition, ACuQor defibrillation rated models comply with the minimum output-protective earth creepage/clearance requirement and defibrillator pulse test of IEC60601-1.

**Hipot Testing:** ACuQor products are rated for Hipot testing levels of 1500 Vac input to protective-earth, 1500 Vac output to protective-earth, and 4000 Vac input to output. When performing the 4000 Vac input to output test, the test voltage must be balanced evenly 2000 Vac input and output to protective-earth. Two oppositely phased test voltage sources or a single test voltage source with external balancing impedances (capacitors) may be used to prevent overstressing input or output to protective-earth insulation per IEC60601-1 2005 sub clause 8.8.1 and IEC60601-1 1990 sub clause 20.4g.



# Technical Specification

**AC Input: 85-264 V<sub>RMS</sub>**  
**DC Output: 48 V semi-regulated**  
**Power: 400 W**  
**Grade: Medical**

## PART NUMBERING SYSTEM

The part numbering system for SynQor's ACuQor AC/DC power supplies follows the format shown in the table below. All *Options* are not available for every *Output Power* model, please contact SynQor for availability.

Family	Output Power	Grade	Range	Output Voltage	Package	Thermal Design	Options
<b>AQ</b>  ACuQor series of AC/DC semi-regulated output power supplies	<b>0300:</b> 300 W <b>0400:</b> 400 W <b>0800:</b> 800 W <b>1200:</b> 1200 W	<b>M:</b> medical <b>I:</b> industrial	<b>U:</b> universal (85-264 V <sub>RMS</sub> )	<b>24:</b> 24 V <b>36:</b> 36 V <b>48:</b> 48 V	<b>E:</b> single; flat <b>R:</b> double; flat <b>S:</b> double; stacked <b>T:</b> triple; flat <b>U:</b> triple; stacked	<b>A:</b> open frame <b>C:</b> encased <b>Q:</b> QorCool enhanced	<b>Medical Grade:</b> <b>BF:</b> BF isolation rating <b>BFD:</b> BF isolation rating; defibrillator proof <b>CF:</b> CF isolation rating <b>CFD:</b> CF isolation rating; defibrillator proof

**Example: AQ0300MU24EABFD**

## ACCESSORIES

SynQor offers a series of assemblies that can be ordered according to the table below. Mechanical drawings for these accessories are available for download in pdf format from the SynQor [website](#).

Part number	Description
AQ-CBL-INPUT1C	Input mating cable with pre-stripped wire ends (36" long).
AQ-CBL-OUT1C	Output mating cable with pre-stripped wire ends (18" long).
AQ-CBL-OUT2C	Output mating cable with connectors on both ends (18" long).
AQ-INSUL1M	Single module bottom-side Mylar insulator for open frame mounting.
AQ-EVAL-PRL3	Evaluation board for up to three paralleled modules.

## APPLICATION NOTES

A variety of application notes and technical white papers can be downloaded in pdf format from the SynQor [website](#).

## PATENTS (additional patent applications may be filed)

SynQor holds the following patents, one or more of which might apply to this product:

5,999,417	6,222,742	6,545,890	6,577,109
6,594,159	6,731,520	6,894,468	6,896,526
6,927,987	7,050,309	7,072,190	7,085,146

## Contact SynQor for further information:

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### Warranty

SynQor offers a two (2) year limited warranty. Complete warranty information is listed on our [website](#) or is available upon request from SynQor.

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