



## MILITARY-GRADE INVERTER

<b>160 - 330 Vdc Input</b>	<b>Single-Phase 4000 W / 5000 VA Output</b>	<b>Surge-Rated for 5250 W / 6500 VA Transient (10 s)</b>	<b>115 Vrms, 230 Vrms 50 Hz, 60 Hz, or 400 Hz Output Options</b>	<b>91% Full Load Efficiency</b>
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*Sealed Construction, Ultra Low Weight, Compact Size*



DESIGNED & MANUFACTURED IN USA

**N+M REDUNDANCY**  
(optional)

SynQor's Military Field-Grade Inverter units are designed for the extreme environmental and demanding electrical conditions of Military/Aerospace applications. SynQor's MINV incorporates field proven high efficiency designs and rugged packaging technologies. The MINV will accept a 270 Vdc source as defined by MIL-STD-704 and changes it to a well-conditioned Single-Phase AC output using a two-stage DC link isolated topology. It is designed to comply with a wide range of military standards in addition to MIL-STD-704. Options include a selection of output voltage amplitudes, frequencies and an electronic breaker on the AC output to permit fault-tolerant parallel operation for higher power and/or N+M redundant systems.

### Combine Units for Higher Power, Voltage, 3-Phase AC Output, and/or Redundancy

#### Features

- Sealed, weather-proof, shock-proof construction
- Two-stage, DC link isolated topology
- 4000 W (5000 VA) output power; 10 s transient to 5250 W (6500 VA)
- Full power operation: -40 °C to +55 °C
- 160 - 330 Vdc Input voltage as defined by MIL-STD-704
- Reverse Polarity Protected to -650 Vdc
- Pure sinusoidal AC output voltage
- Handles 0.0–1.0 power factor loads and non-linear loads
- Up to 32 units can be combined for higher power, higher voltage, or a 3-Phase AC output
- Capable of N+M redundancy with optional "AC Output Electronic Breaker" (R option) and the appropriate configuration cable
- User I/O and Configuration signal ports
- Battle Mode for over-temperature events
- 1U high rack mount unit (17.00"W x 22.42"D x 1.73"H)
- Low weight: 33 lbs.

#### Specification Compliance

MINV 270 units are designed to meet:

- MIL-STD-704 - Aircraft Electric Power Characteristics
- MIL-STD-810G - Environmental Engineering Considerations
- MIL-STD-461F - Electromagnetic Interface

#### In-Line Manufacturing Process

- AS9100 and ISO 9001 certified facility
- Full component traceability

#### Options

- 115 Vrms or 230 Vrms AC output
- 50 Hz, 60 Hz, or 400 Hz AC output (software selectable)
- Shipboard version with floating output neutral wire
- N+1 Redundancy

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# Technical Specification

## DC INPUT CHARACTERISTICS

Voltage - Steady State	160 - 330 Vdc
Voltage - 100ms Transient	150 - 350 Vdc
Input Current - Typical	16.6 A (4000 W, 270 V)
Input Current - Maximum	30 A (4000 W, 150 V)
Internal Fuse Rating	40 A Fast Blow
Reverse Polarity Protection	-650 Vdc

## AC OUTPUT CHARACTERISTICS

Continuous Output Power	4000 W (5000 VA)
Transient Output Power (15 seconds)	5250 W (6500 VA)
AC Output Waveform	Pure Sinusoidal
Voltage Line-Neutral	115 Vrms $\pm$ 3%
	230 Vrms $\pm$ 3%
Frequency (software selectable)	60 Hz $\pm$ 0.5%
	50 Hz $\pm$ 0.5%
	400 Hz $\pm$ 0.5%
Output Voltage Total Harmonic Distortion	<2%
Load Power Factor	0-1.0 (leading or lagging)
Efficiency	90% (4000 W load)
	88% (2000 W load)

## Single-Phase Output

Steady State Load Current	43.5 Arms (115 Vrms)
	21.7 Arms (230 Vrms)
Transient Load Current (15 seconds)	56.5 Arms (115 Vrms)
	28.3 Arms (230 Vrms)
Peak Load Current (Min. Shutdown Threshold)	104 Apk (115 Vrms)
	52 Apk (230 Vrms)

Specifications subject to change without notice.

## ENVIRONMENTAL CHARACTERISTICS MIL-STD-810G

### Temperature Methods 501.5, 502.5

Operating Ambient Temperature	
Full Rated Power	-40 °C to +55 °C
Reduced Power	+55 °C to +70 °C
Storage Temperature	-40 °C to +70 °C

### Altitude Method 500.5

Operating	0 - 18,000 ft
Non-operating	0 - 40,000 ft

### Environmental Tests

Shock/Drop	Method 516.6, Procedures 1, 4, 6
Temperature Shock	Method 503.5, Procedure 1
Vibration	Method 514.6, CAT 5, 7, 8, 9, 24
Fungus	Method 508.6
Salt Fog	Method 509.5
Sand and Dust	Method 510.5, Procedures 1, 2
Rain	Method 506.5 Procedure 1
Humidity	Method 507.5 Procedure 2
Mechanical Vibrations of Shipboard Equipment	Method 528 Procedure 1

## RELIABILITY CHARACTERISTICS MIL-HDBK-217F

MTBF: 450 kHrs	MIL-217F Ground Benign, Ta=25 °C
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## INTERFACE STD FOR AIRCRAFT SYSTEMS MIL-STD-704

270 Volts DC System
115 V 1-Phase Output Power per Table I, Table II, Table III (Order F / R Option to Float Output)

## ELECTROMAGNETIC CAPABILITY MIL-STD-461F

CE101-2	30 Hz - 10 kHz
CE102	10 kHz - 10 MHz
CS101	30 Hz - 150 kHz
CS106	Pulse Transients
CS114 (Curve #5)	10 kHz - 200 MHz
CS115	Impulse Excitation
CS116	10 kHz - 100 MHz
RE101 (Navy Limit)	30 Hz - 100 kHz
RE102 (Navy Topside Limit)	10 kHz - 1 GHz

## MECHANICAL CHARACTERISTICS

Chassis Size	17.00" W x 22.42" D x 1.73" H (1U)
Case Material	Aluminum
Weight	33 lbs.

### DC Input Connector

DC Input Connector	CA3102E20-19PXB34
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### AC Output Connectors

115V Single Phase	CB2-20-19SXS34-FM
230V Single Phase	CB2-20-19SXS34-FM

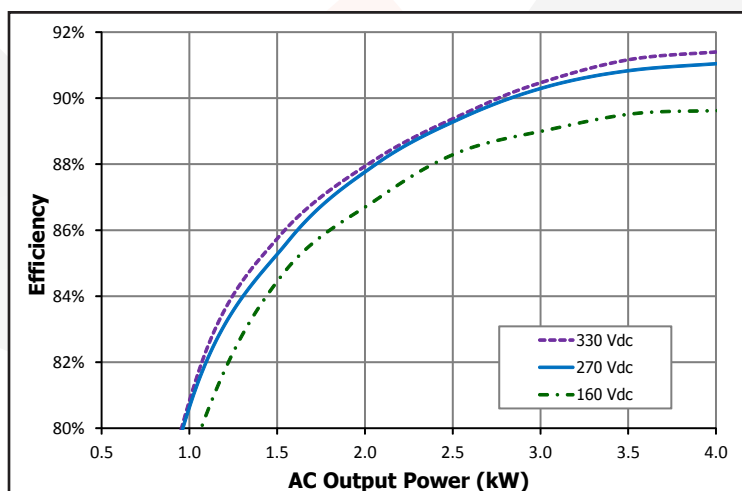
### I/O Ports

Configuration I/O Port	HD DB15 Male
User I/O Port	HD DB15 Female
Ethernet Port	Amphenol RJF22N00, Code B

### Cooling Exhaust Fans

Sound Pressure Level (SPL)	64 dB(A)
Air Flow	0.92(m³/min) 32.5 CFM

Two fans in system; above specs are for each fan separately.





## Technical Specification

### High Density DB15 Female (15 Pin Connector)

Signal	PIN	Function
TX	2	RS232 DCE Device Transmit
RX	3	RS232 DCE Device Receive
GND	4, 5	Ground reference for all digital inputs and outputs
BATTLE_MODE	6	TTL-Input*, pull "low" to engage Battle Mode to disable internal over temperature protection, has internal pull-up to +5 V
INPUT_GOOD	7	Open collector* output where "low" indicates DC Input voltage is within range
+5 V	8	Vout with minimal current drive usable as a pull-up voltage for open collector output signals. Load must be < 35 mA
REMOTE_START	12	Drive this line to +5 V with $\geq 5$ mA to enable MINV output
SHUTDOWN	13	Drive this line to +5 V with $\geq 5$ mA to disable MINV output
OUT_OK	14	Open collector* output where "low" indicates AC Output voltage is within range
OVER_TEMP	15	Open collector* output where "low" indicates that the MINV is at or above its maximum temperature

\*With an internal 50 k Pull-up Resistor to 5 V and ESD Protection Diodes



#### Safety & Qualifications - Pending

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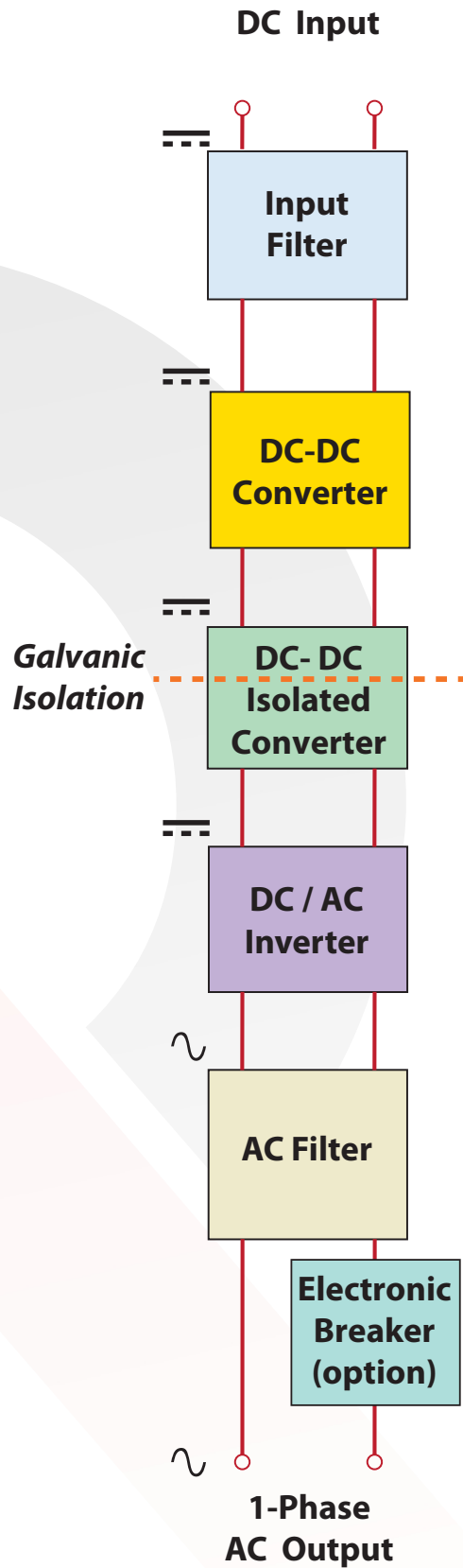
CAN/CSA C22.22 No.62368-1

EN 62368-1

IEC-62368



## Block Diagram





## Application Section

### **“R” and “F” Options: Paralleling With and Without Redundancy**

#### **“F” Option: Expanded Paralleling**

With the “F” option, up to 32 MINV units can be placed in parallel. AC output current sharing among the paralleled units is accomplished with a high speed digital configuration cable. The units will share the total load current to within  $\pm 2\%$ , and for a split-phase or 3-phase system the AC voltages and AC currents will have phase balance within  $\pm 2$  degrees.

While up to 32 “F” option units can be placed in parallel, there is no guarantee of redundancy. A failure of any one unit with the “F” option could cause the AC output bus to collapse.

#### **“R” Option: AC Output Electronic Breaker**

In addition to paralleling up to 32 units, the “R” option also adds an electronic breaker to the AC output of the MINV to permit fault-tolerant, glitch-free parallel operation. With this option, when several MINV units are connected in parallel at their AC outputs and one unit has an internal fault that might otherwise have pulled down the AC output bus, the electronic breaker will disconnect the failed unit so that the remaining paralleled units can continue to power the bus. This allows the system to be “fault-tolerant”. The disconnect occurs very quickly so that the AC output voltage will remain within its specified parameters as long as the remaining paralleled units can deliver the total load power. This allows the system to continue running “glitch-free”.

The electronic breaker is a single-pole breaker present in the hot-side AC output wire only. The neutral AC output wire is left floating from the MINV chassis to facilitate the paralleling of units into various configurations.

#### **“R” Option: N+M Redundancy**

The “R” option makes it possible to set up N+1, or more generally N+M, redundant systems with a total of up to 32 MINV units. In such a system the failure of one unit (or M units) will not cause the overall system to fail. A failed unit can then be replaced to return the redundancy level to its original design. The replacement unit can be inserted into a live, operating system with proper precautions, but for safety reasons it is recommended that the system be turned off first.

#### **Output Power Cable Connection**

MINV systems are formed by first connecting the neutral wires of all the individual units together. For single phase systems, the hot wires are also connected together to form a single bank of MINV units. Split-phase systems are formed by connecting the hot output wires into two banks. One bank will have its output voltage phase-shifted  $180^\circ$  from the other. The phase-shift is determined by the configuration cable. Similarly, 3-phase systems are formed by grouping the hot output wires into three banks, each bank having its output voltage phase-shifted by  $120^\circ$ . Again, the phase shift is determined by the configuration cable. Since 3-phase systems are formed by connecting the neutral wires together and phase shifting the hot wires, the AC outputs must be wye-connected to form 3-phase systems. Delta connection of MINV units is not supported. However, once a 3-phase system is formed, loads may be connected as wye or delta.

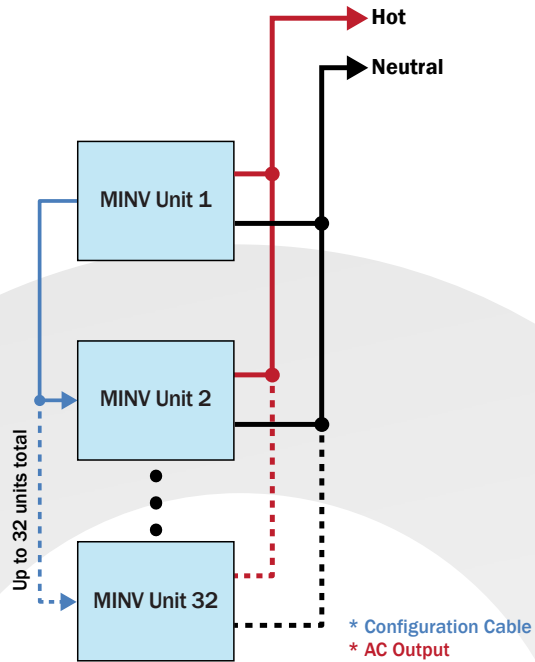
The diagrams on the following page give examples of how multiple MINV units with the “F” or “R” option can be connected to create higher output power single-phase, split-phase, and 3-phase AC systems. Systems with the “R” option will have N+M redundancy as long as N units are sufficient for the maximum load power per phase. Note, again, that the maximum total number of units that can be arranged in any of these configurations is 32.

#### **Configuration Cables**

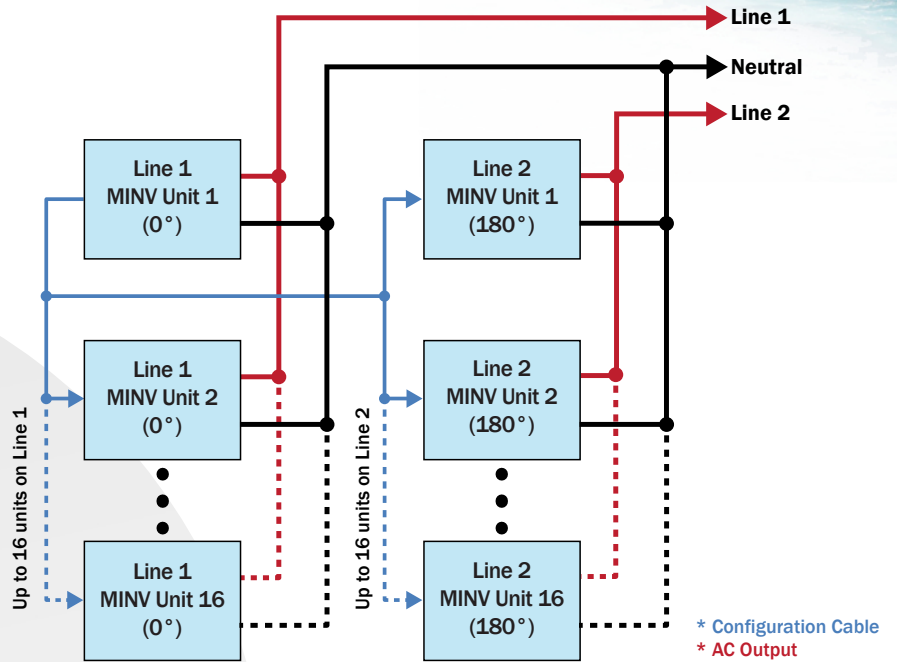
Any system of “F” or “R” option MINV units requires a specific configuration cable that defines the arrangement of MINV units in the system. The configuration cable determines the phase shift for split-phase and 3-phase systems. The cable also provides high speed digital communication for current sharing on each phase.

Configuration cables for two parallel units and three parallel units in a single-phase system, two unit split-phase systems, and three unit three phase systems are available as standard products. Please contact the factory to purchase configuration cables for systems larger than three MINV units.

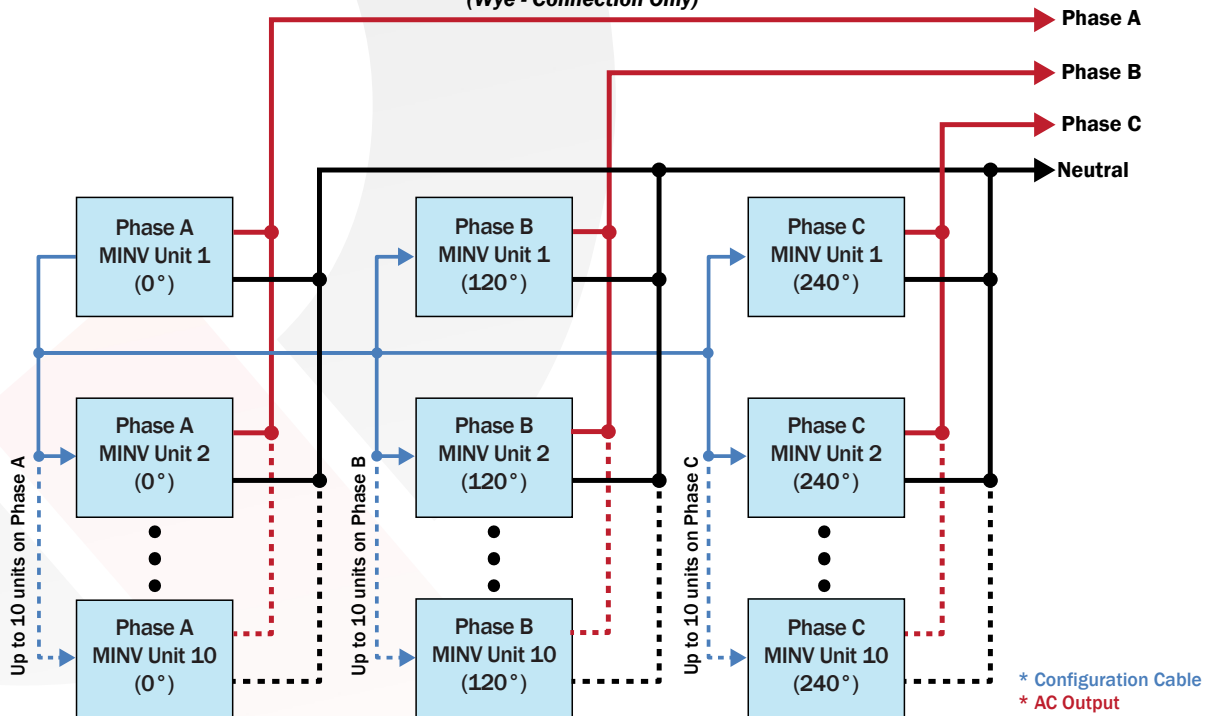
### Single Phase Output System



### Split Phase Output System



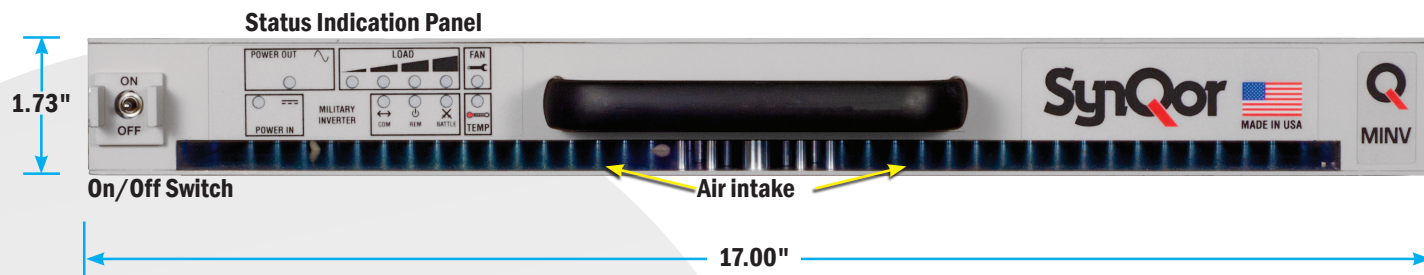
### 3-Phase Output System (Wye - Connection Only)



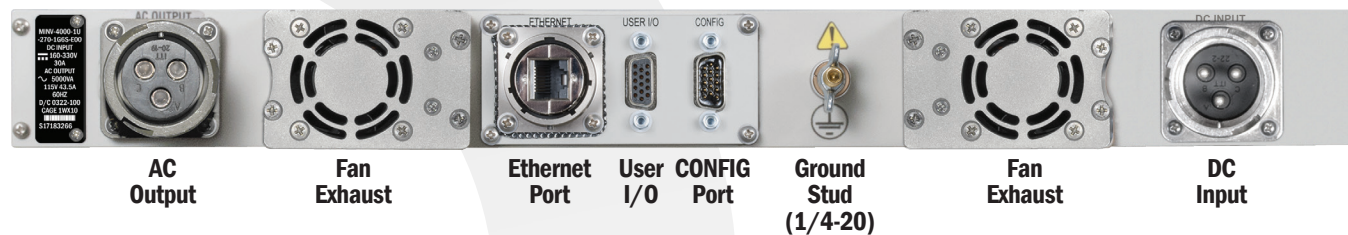
\*Contact factory for system specific configuration cables.



## MINV-4000-1U-270

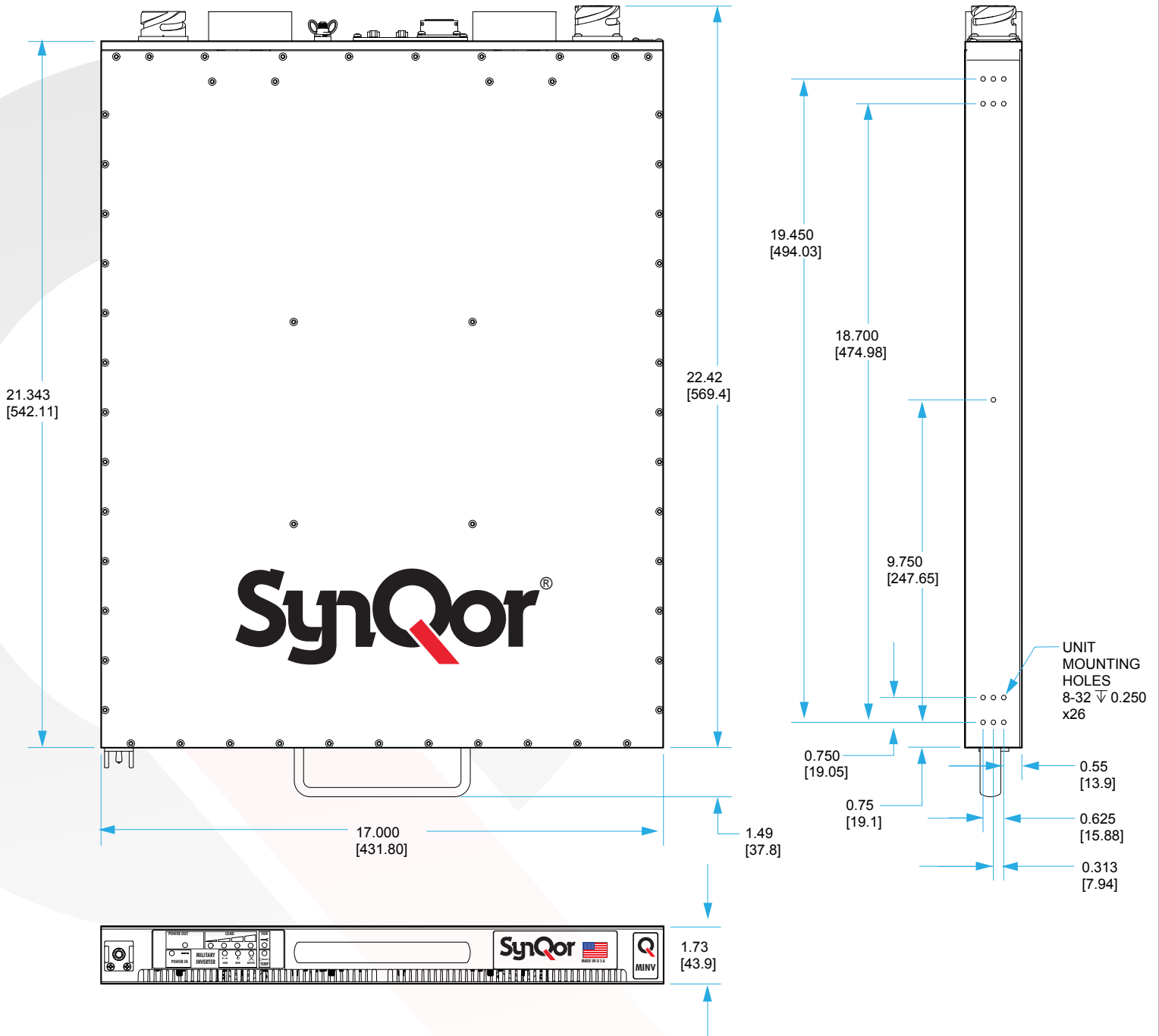


## MINV-4000-1U-270 Rear Panel





# Mechanical Diagram 1U





## Accessory Options

Rail Kits	
Slide Rail Kit <sup>2</sup>	<b>SYN-9002</b>
Fixed Bracket Kit <sup>3</sup>	<b>SYN-9031</b>
Power Cables (10' long)	
DC Input (Hardwire)	<b>SYN-9655</b>
AC Output (Hardwire)	<b>SYN-9140</b>
Rackmount Transit Cases	
Transit Case, 3U, Gray, with Casters <sup>3</sup>	<b>SYN-9410</b>
Transit Case, 3U, Gray, No Casters <sup>3</sup>	<b>SYN-9412</b>
Fan Replacement Kit	
Counter-Rotating Replaceable Fan Modules (Pack of 2)	<b>SYN-9452</b>

### Notes:

- 1: Other Options also available, check the website or contact [power@synqor.com](mailto:power@synqor.com) for further information.
- 2: Slide Rail Kit (SYN-9002) is not recommended for transit and ruggedized use.
- 3: Fixed Bracket Kit (SYN-9031) with Transit Case (SYN-9410 or SYN-9412) is required for transit and ruggedized use (qualified to pass MIL-STD-810G Loose Cargo and Transit Drop requirements).

User Communications (I/O) Cables	
HD DB15M to DB9F (RS232, 10')	<b>SYN-9301</b>
HD DB15M to DB15M (RS232 and Digital I/O, 10')	<b>SYN-9305</b>
Mil-Circular to RJ45 (Ethernet, 10')	<b>SYN-9321</b>
Configuration Cables	
HD DB15F to DB15F (2 Units Parallel, 3')	<b>SYN-9341</b>
HD DB15F to DB15F (3 Units Parallel, 6')	<b>SYN-9343</b>
HD DB15F to DB15F (4 Units Parallel 9')	<b>SYN-9344</b>
HD DB15F to DB15F (5 Units Parallel 15')	<b>SYN-9345</b>
HD DB15F to DB15F (2 Units Series, 3')	<b>SYN-9613</b>
HD DB15F to DB15F (3 Units 3 Phase, 6')	<b>SYN-9617</b>



Optional  
Rackmount Transit Case





Base Models			
Model Number	Power	Height (W x D x H)	Weight
MINV-4000-1U-270	4000 W 5000 VA	1U (17.00" x 22.42" x 1.73")	33 lbs.

Base Models	Options					Options	
	AC Output Voltage	AC Output Neutral Wire	AC Output Set Point Freq	Output Config	Additional Options	AC Output Voltage	
MINV-4000-1U-270-	1 2	G F R	5 6 4	S	-E 00	AC Output Neutral Wire	G Grounded F Floating* R AC Output Electronic Breaker*
						AC Output Set Point Freq	5 50 Hz 6 60 Hz 4 400 Hz
						Output Config	S One Single-Phase Output
						Additional Options	-E 00 Ethernet/SNMP with Config Loading

Not all combinations make valid part numbers, please contact SynQor for availability.  
See the Product Summary web page for more options.

**\*Notes:**

Order "F: Floating" option when configuring the AC output for multi-unit combinations of up to 32 units.

Order "R: AC Output Electronic Breaker" option for fault-tolerant, glitch-free parallel systems of up to 32 units with N+M redundancy.  
The AC output neutral wire will not be connected to the chassis for either the F option or R option.

**Example:**

**MINV-4000-1U-270-1G6S-E00**

**Contact SynQor for further information and to order:**

Phone: 978-849-0600 Fax: 978-849-0602

E-mail: [power@synqor.com](mailto:power@synqor.com) Web: [www.synqor.com](http://www.synqor.com)

Address: 155 Swanson Road, Boxborough, MA 01719 USA

**WARRANTY**

SynQor offers a one (1) year limited warranty. Complete warranty information is listed on our website or is available upon request from SynQor.

**PATENTS**

SynQor holds numerous U.S. patents, one or more of which apply to most of its power conversion products. Any that apply to the product(s) listed in this document are identified by markings on the product(s) or on internal components of the product(s) in accordance with U.S. patent laws. SynQor's patents include the following:

7,765,687 7,787,261  
8,149,597 8,644,027