

# SynQor®

**MINV** MILITARY  
FIELD-GRADE  
**MINV-4000-1U-28**

## MILITARY FIELD-GRADE INVERTER

|  |  |   |   |                                     |
|--|--|---|---|-------------------------------------|
| <b>4000 W /<br/>5000 VA<br/>Output Power</b> | <b>28 V<br/>Nominal<br/>DC Input Voltage</b> | <b>20 V - 33 V<br/>DC Input<br/>Voltage</b> | <b>115 Vrms or 230 Vrms<br/>50 Hz, 60 Hz, or 400 Hz<br/>AC Output Voltage Options</b> | <b>89%<br/>Full Load Efficiency</b> |
|--|--|---|---|-------------------------------------|

*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. This MINV will accept a DC input voltage while delivering a well-conditioned AC output to the load. It is designed and manufactured in SynQor's USA facilities to comply with a wide range of military standards. 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
- 4000 W (5000 VA) output power
- Full power operation: -40 °C to +55 °C
- 28 V nominal DC input
- 20 V - 33 V input range
- 18 V - 40 V transient input range
- Pure sinusoidal AC output voltage (115 Vrms, 60 Hz)
- Handles 0.0—1.0 power factor loads and non-linear loads
- Low-power sleep state draws < 500 uA from source
- Up to 32 units can be combined for higher power, voltage or a 3-Phase AC output
- Up to 32 units can be combined to form a higher power fault-tolerant, glitch-free system, perhaps with N+M redundancy, by ordering with the "AC Output Electronic Breaker" 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 22.43 "D x 1.73 "H)
- Low weight: 32 lbs.

### Specification Compliance

MINV-4000 units are designed to meet:

- MIL-STD-1399-300B - Interface Std for Shipboard Systems
- MIL-STD-810G - Environmental Engineering Considerations
- MIL-STD-461F - Electromagnetic Interference
- MIL-STD-704F - Aircraft Electrical Power Characteristics
- MIL-STD-1275D - Vehicle Elec. Power Characteristics

### Options

- 115 Vrms or 230 Vrms AC output
- 50 Hz, 60 Hz, or 400 Hz AC output
- Shipboard version with floating neutral wire

### Contents

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# Technical Specification

## DC INPUT CHARACTERISTICS

|                                  |                          |
|----------------------------------|--------------------------|
| Steady State Operating Voltage   | 20 - 33 V                |
| Continuous Maximum Input Current | 240 A (full load, 20 V)  |
| Transient Operating Voltage      | 18 - 40 V (500ms @ 18 V) |
| Transient Maximum Input Current  | 275 A                    |

## AC OUTPUT CHARACTERISTICS

|                               |                            |
|-------------------------------|----------------------------|
| Total Output Power Continuous | 4000 W (5000 VA)           |
| AC Output Waveform            | Pure Sinusoidal            |
| Voltage Line-Neutral          | 115 Vrms ± 3%              |
|                               | 230 Vrms ± 3%              |
| Frequency                     | 60 Hz ± 0.5%               |
|                               | 50 Hz ± 0.5%               |
|                               | 400 Hz ± 0.5%              |
| Load Power Factor             | 0-1.0 (leading or lagging) |
| Total Harmonic Distortion     | 2% (3000 W resistive load) |

## Single-Phase Output

|                           |                      |
|---------------------------|----------------------|
| Steady State Load Current | 43.5 Arms (115 Vrms) |
|                           | 21.7 Arms (230 Vrms) |
| Peak Load Current         | 78 Apk (115 Vrms)    |
|                           | 39 Apk (230 Vrms)    |

Specifications subject to change without notice.

\* Regarding MIL-STD-461 CE-101, the 50 uH series inductance of a standard LISN adversely affects the input ripple of the MINV. Such a large series source inductance (50 uH in each power lead) is not generally encountered in a 28 V DC source of such high power rating. Therefore, testing for CE-101 (DC input) was conducted with 3 different configurations: two using 50 uH LISNs and a 54 mF capacitor connected across the input to the MINV, and one using 5 uH LISNs for which no additional capacitor was added. These configurations all passed CE-101 for all frequencies.

## ENVIRONMENTAL CHARACTERISTICS MIL-STD-810G

### Temperature Methods 501.5, 502.5

|                            |                 |
|----------------------------|-----------------|
| Operating Temperature      |                 |
| Full Rated Power           | -40 °C — +55 °C |
| Reduced Power per Figure B | -40 °C — +70 °C |
| Storage Temperature        | -40 °C — +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 | 468 kHrs | MIL-217F Ground Benign, Ta=25 °C |
|------|----------|----------------------------------|

## ELECTROMAGNETIC CAPABILITY MIL-STD-461F

|        |                  |
|--------|------------------|
| CE101* | 30 Hz - 10 kHz   |
| CE102  | 10 kHz - 10 MHz  |
| CS101  | 30 Hz - 150 kHz  |
| CS106  | 10 kHz - 40 GHz  |
| CS114  | 10 kHz - 200 MHz |
| CS116  | 10 kHz - 100 MHz |
| RE101  | 30 Hz - 100 kHz  |
| RE102  | 10 kHz - 18 GHz  |
| RS101  | 30 Hz - 100 kHz  |
| RS103  | 2 MHz - 40 GHz   |

## MECHANICAL CHARACTERISTICS

### 1U Standard Chassis

|                          |                                   |
|--------------------------|-----------------------------------|
| Chassis Size (W x D x H) | 17.00 "W x 22.43 "D x 1.73 "(1U)H |
| Case Material            | Aluminum                          |
| Total Weight             | 32 lbs.                           |

### DC Input Connectors

|                        |                 |
|------------------------|-----------------|
| DC (-) Input Connector | CGE2E18H5ZWB-16 |
| DC (+) Input Connector | CGE2E18H5ZNB-16 |

### AC Output Connectors

|                    |              |
|--------------------|--------------|
| 115 V Single Phase | CB2-20-19SXS |
| 230 V Single Phase | CB2-20-19SXS |

### I/O Ports

|                        |                           |
|------------------------|---------------------------|
| User I/O Ports         | HD DB15 Female            |
| Configuration I/O Port | HD DB15 Male              |
| 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.  |
| DCIN_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          |
| BLACKOUT_MODE | 9    | TTL-Input*, pull "low" to engage Blackout Mode to disable front-panel LEDs and audible alarms, has internal pull-up to +5 V. |
| REMOTE_START  | 12   | Drive this line "high" with $\geq 5$ mA to enable MINV outputs   |
| SHUTDOWN      | 13   | Drive this line "high" with $\geq 5$ mA to disable MINV outputs  |
| 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)

CAN/CSA C22.2 No.60950-1

UL 60950-1

EN 60950-1

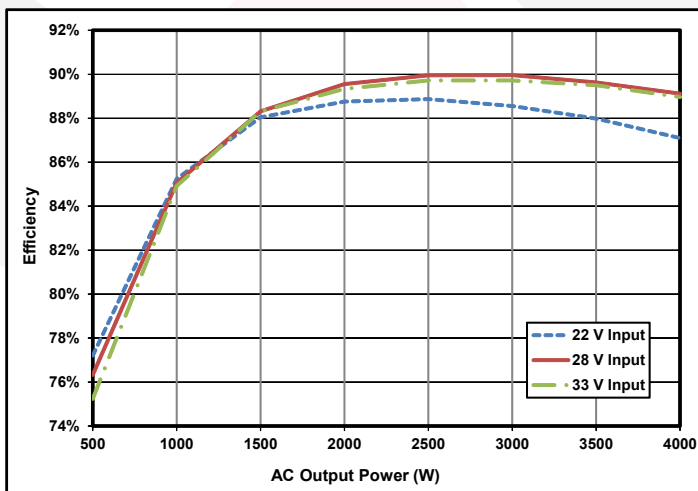


Figure A: Typical efficiency curves for All Output Configurations

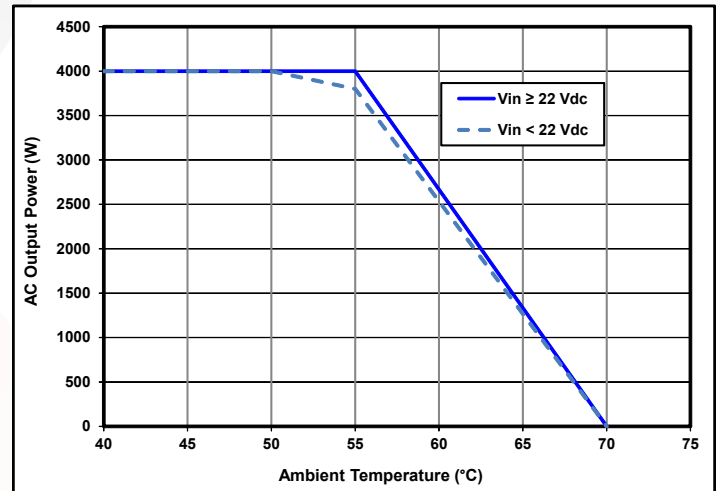
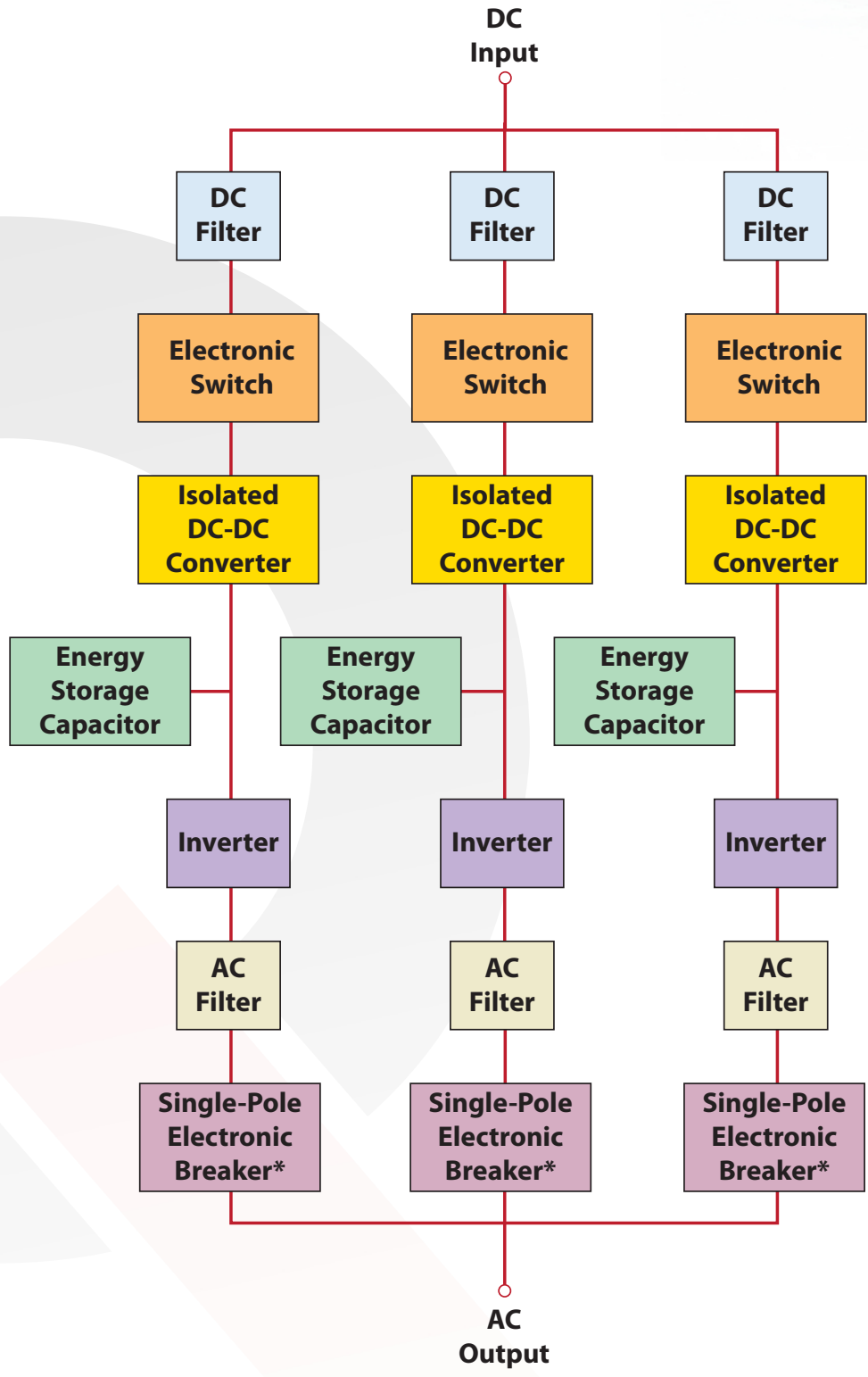


Figure B: Thermal Derating Curve (output power vs. ambient temperature)





Block Diagram



\* Single-Pole Electronic Breaker installed on all AC output filter modules when ordering "R" option



## 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.

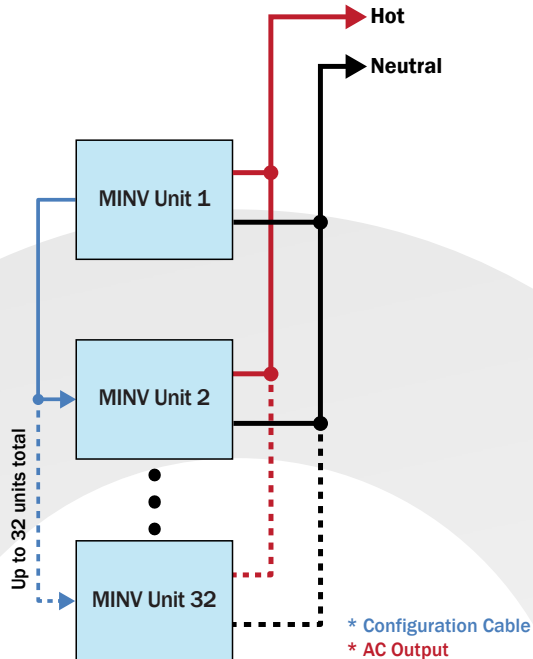
The diagrams on the following page give examples of how multiple MINV units with the “F” or “R” option can be connected to create higher output power single-phase, split-phase, and 3-phase AC systems. Systems with the “R” option will have N+M redundancy as long as N units are sufficient for the maximum 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**

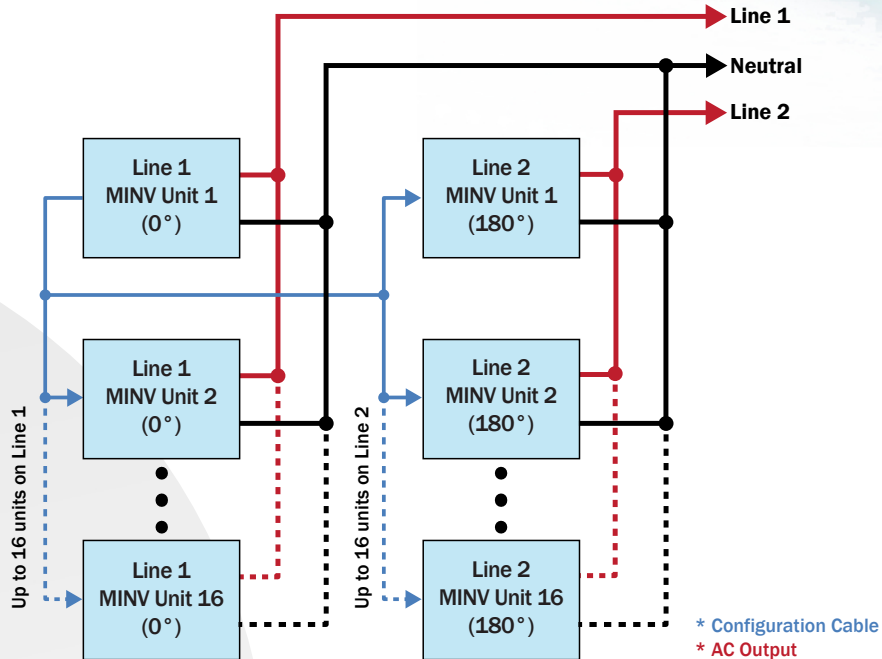
Any system of “F” or “R” option MINV units requires a specific configuration cable that defines the arrangement of MINV units in the system. The configuration cable determines the phase shift for split-phase and 3-phase systems. The cable also provides high speed digital communication for current sharing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

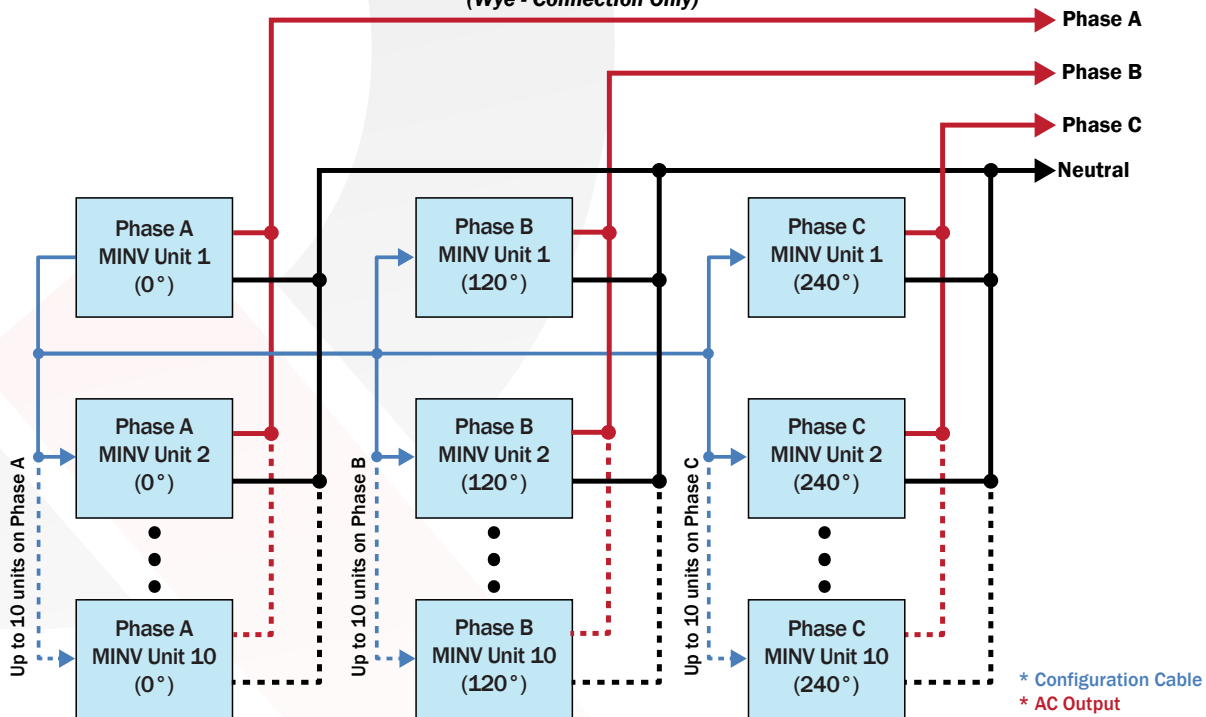
### Single Phase Output System



### Split Phase Output System



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

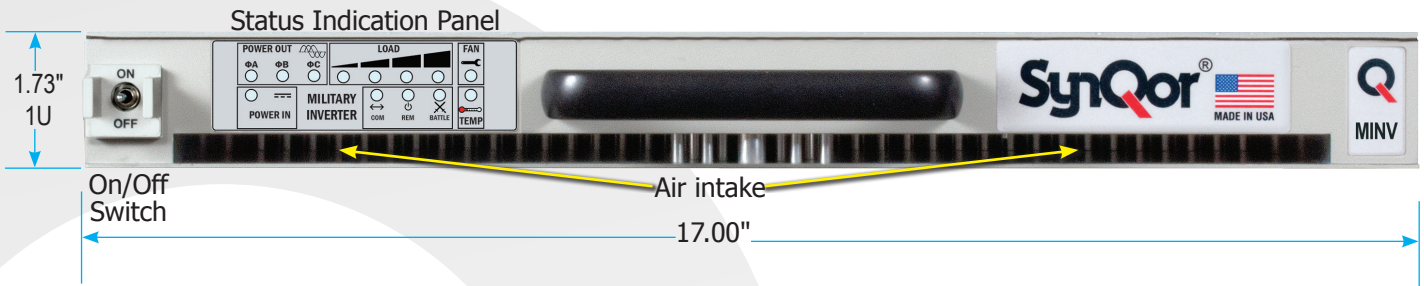




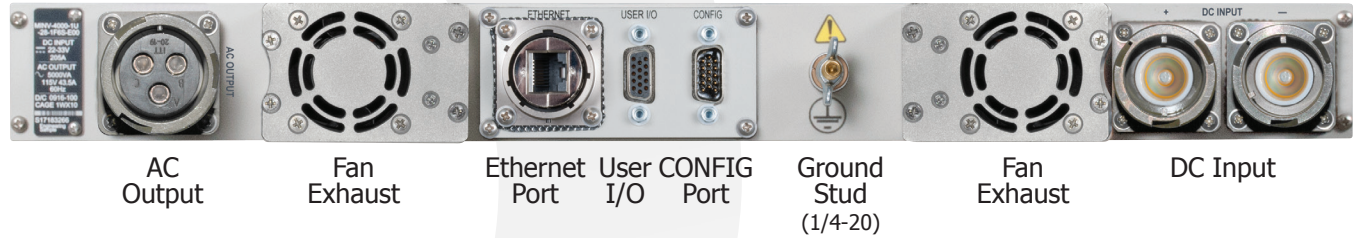


Mechanical Features

MINV-4000-1U-28

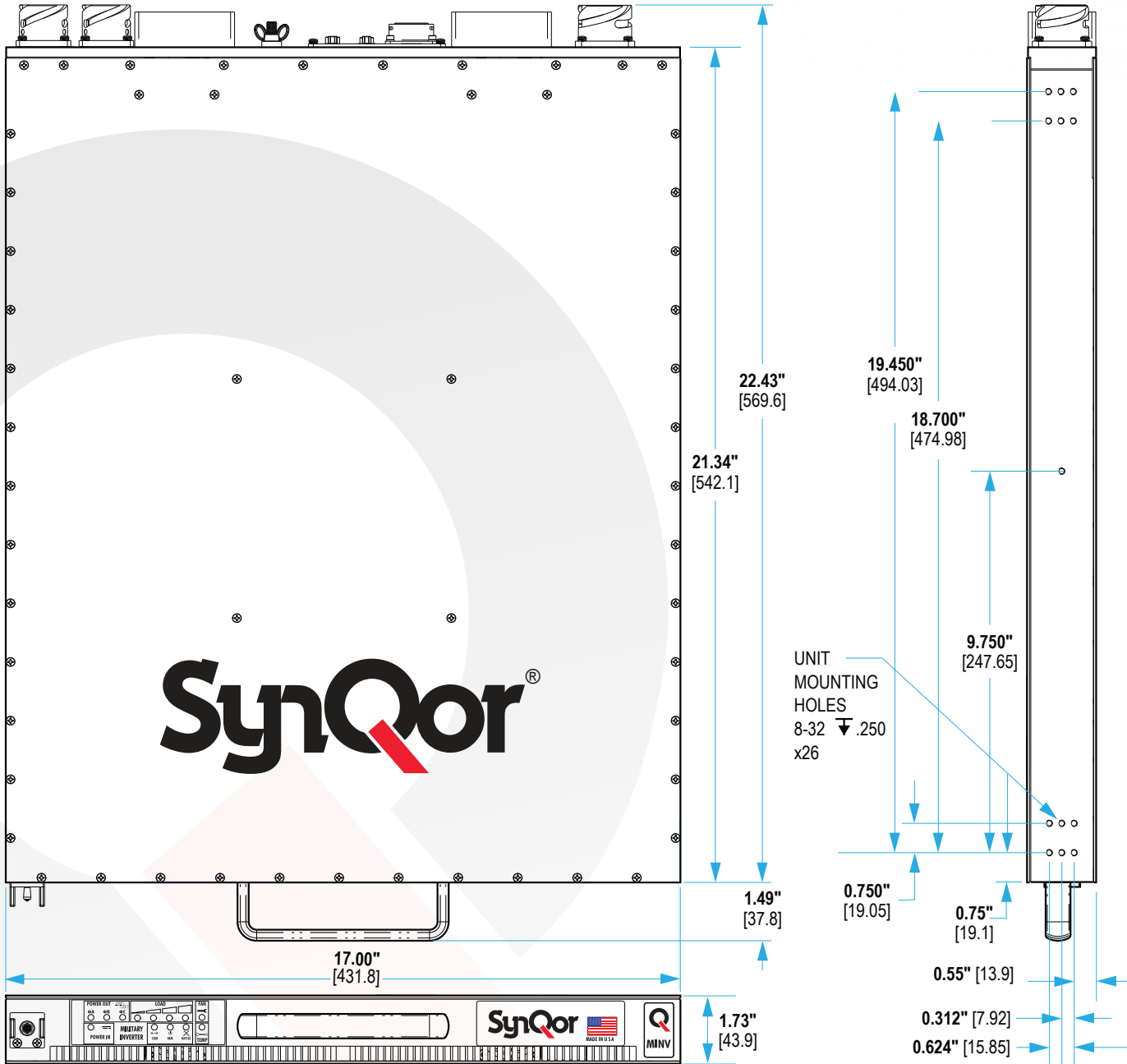


MINV-4000-1U-28





# 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)                           |                   |
| AC Output (Hardwire)                              | <b>SYN-9630</b>   |
| DC Input Negative (Hardwire)                      | <b>SYN-9652</b>   |
| DC Input Positive (Hardwire)                      | <b>SYN-9651</b>   |
| Power Cables (3' long)                            |                   |
| DC Output (MPS), DC Input (MINV), 3', Negative    | <b>SYN-9180</b>   |
| DC Output (MPS), DC Input (MINV), 3', Positive    | <b>SYN-9181</b>   |
| Power Cables (2' long)                            |                   |
| DC Output (MPS), DC Input (MINV), 2', Negative    | <b>SYN-9180-2</b> |
| DC Output (MPS), DC Input (MINV), 2', Positive    | <b>SYN-9181-2</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 Module           | <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).



Optional  
Rackmount Transit Case

| 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, Expanded Paralleling, 3') | <b>SYN-9341</b> |
| HD DB15F to DB15F (3 Units Parallel, Expanded Paralleling, 6') | <b>SYN-9343</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> |



\* Contact factory for system specific configuration cables.



## Ordering Information

| Base Models  |                |                          |                              |         |
|--------------|----------------|--------------------------|------------------------------|---------|
| Model Number | Power          | Nominal DC Input Voltage | Height (W x D x H)           | Weight  |
| MINV-4000-1U | 4000 W 5000 VA | 28 V                     | 1U (17.00" x 22.43" x 1.73") | 32 lbs. |

| Base Models   | Options          |                   |                        |                          |               |                    | Options                  |  |
|---------------|------------------|-------------------|------------------------|--------------------------|---------------|--------------------|--------------------------|--|
|               | DC Input Voltage | AC Output Voltage | AC Output Neutral Wire | AC Output Set Point Freq | Output Config | Additional Options | DC Input Voltage         | Options  |
| MINV-4000-1U- | 28               | 1<br>2            | G<br>F<br>R            | 5<br>6<br>4              | S             | -E<br>00<br>CE     | 28                       | 20 - 33 V  |
|               |                  |                   |                        |                          |               |                    | AC Output Voltage        | 1 115 Vrms<br>2 230 Vrms   |
|               |                  |                   |                        |                          |               |                    | AC Output Neutral Wire   | G Grounded<br>F Floating*<br>R AC Output Electronic Breaker*                     |
|               |                  |                   |                        |                          |               |                    | AC Output Set Point Freq | 5 50 Hz<br>6 60 Hz<br>4 400 Hz   |
|               |                  |                   |                        |                          |               |                    | Output Config            | S Single-Phase Output  |
|               |                  |                   |                        |                          |               |                    | Additional Options       | -E Ethernet/SNMP with Configuration Loading<br>00 No CE Marking<br>CE CE Marking |

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.

**Examples:**

MINV-4000-1U-28-1G6S-E00

MINV-4000-1U-28-2G5S-ECE (230 V output with CE marking)

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

**Phone:** 978-849-0600  
**Toll Free:** 888-567-9596  
**Fax:** 978-849-0602  
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**Address:** 155 Swanson Road  
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 USA

**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:

6,896,526 6,927,987 7,050,309 7,085,146  
 7,765,687 7,787,261 8,149,597 8,644,027

**WARRANTY**

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