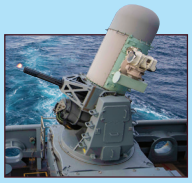
MPPS MILITARY FIELD-GRADE

3-PHASE AC TO DC POWER SUPPLY



Operator's Guide

MPPS-4000-270 Series

3Φ to DC

MPPS-4000-270

N+M REDUNDANCY

Made in USA

SynQor®

Advancing The Power Curve®

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Table of Contents

Section IV Multiple Unit Configuration

Section V Control Interface Details

Section VI Maintenance

Section VII Trouble-Shooting Guide

Hazardous Voltages

The ***INPUT AND OUTPUT POWER*** connectors and cables of the SynQor MPPS may have voltages that are unsafe. ***INJURY OR DEATH ON CONTACT*** may result. Appropriate safety precautions should be taken. All connections should be made in accordance with ***LOCAL ELECTRICAL CODES.***

- The ***CHASSIS*** should be connected to earth or system ground with Ground Stud on the rear panel, see mechanical diagrams.
- For the ***AC INPUT*** cable and connector:
  - Do not assume that a hazardous voltage is not present at the terminals of the AC input connector, even if the MPPS appears to be "OFF".
  - Do not make contact with the terminals of the AC input connector.
  - Always connect the cable to the MPPS before it is connected to the source of AC power.
  - Always disconnect the AC input cable from the source of AC power before disconnecting it from the MPPS.
  - If the AC input cable is connected to the source of AC power and not connected to the MPPS, do not contact the exposed terminals of the AC input cable.
  - If custom built cables are used to power the MPPS unit, verify that the custom input cabling has a reliable ground connection and that the ground connection has not been accidentally swapped with a line connection. Connecting the ground wire to a live line could possibly put hazardous voltages across the chassis.
  - Connections between the AC input cable and the source of AC power should not be accessible.
- For the ***DC OUTPUT*** cable and connector:
  - Do not assume that a hazardous voltage is not present at the terminals of the DC OUTPUT connector, even if the MPPS appears to be "OFF".
  - Do not make contact with the terminals of the DC OUTPUT connector.
  - Connect the DC OUTPUT cable to the MPPS before the MPPS is turned on.
  - If connection of the load to the DC OUTPUT cable has exposed conductors, make this connection before connecting the DC OUTPUT cable to the MPPS.
  - Connections between the DC OUTPUT cable and the AC load should not be accessible.

Hazardous Energies

The ***INPUT AND OUTPUT POWER*** connectors and cables of the SynQor MPPS may be a source of high levels of energy. Do not inappropriately make electrical contact between any terminal of a connector and another, or between any wire of a cable and another, or between any terminal or wire and the MPPS Unit's chassis or ground. ***DAMAGING ELECTRICAL ARCS*** may result. Care should be taken to avoid accidental electrical contacts of this sort. The CHASSIS should be connected to earth or system ground through the Ground Stud on the rear panel, see mechanical diagrams.

Protection from the Environment

The SynQor MPPS is a ruggedly built product having its electronics contained in a sealed chamber. It is capable of withstanding harsh levels of mechanical acceleration, shock and vibration, temperature and pressure variations, and exposure to water, salt, sand and dust within the levels specified in the data sheet. ***THESE LEVELS SHOULD NOT BE EXCEEDED.***

Do not obstruct the air intake in the front of the MPPS or the fan exhausts in the rear panel of the MPPS while the MPPS is operating.

User Serviceable Parts

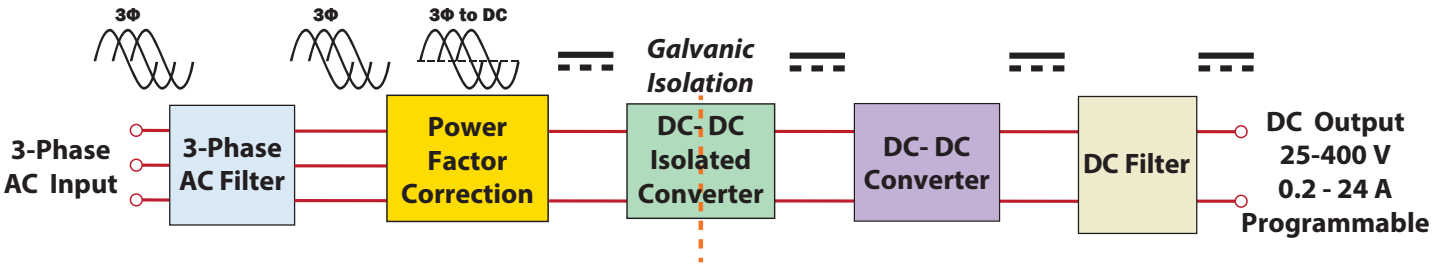
MPPS-4000-270 fans are user replaceable with kits available from SynQor. Please contact the SynQor factory for obtaining fan replacement kits and instructions (Counter-Rotating Replaceable Fan Module , two piece kit, SYN-9452). The SynQor MPPS has no other user serviceable parts inside. ***DO NOT REMOVE*** the cover of the MPPS or any of its connectors. Other than fan assembly replacement, only factory trained personnel should perform unit repairs.

Product Description

SynQor's Military 3-Phase AC to DC Power Units are designed for the extreme environmental and demanding electrical conditions of Military/Aerospace applications. SynQor's MPPS-4000-270 units incorporate field proven high efficiency designs and rugged packaging technologies. The MPPS-4000-270 will accept an AC 3-Phase Input with a voltage and frequency range of 360-528 Vrms (line to line) and 47-65 Hz. The unit will deliver a tightly regulated, programmable DC output to the load. The output voltage can be programmed 25-400 V, and the output current can be programmed 0.2 – 24 A. The output is surge-rated to 4500 W transient durations up to 15 seconds. All MPPS units are designed and manufactured in SynQor's USA facilities to comply with a significant set of military standards. A communication/control port is available to permit monitoring and control through a host computer system. Front panel LEDs provide information on the status of the MPPS. The electronic circuitry within the MPPS-4000 Series products is designed, qualified and screened according to SynQor's MIL-COTS Standards. It complies with the requirements of MIL-STD-1399-300B and MIL-STD-461F. The MPPS-4000 Series products are designed and manufactured to withstand the harshest environments and use encountered in military applications. The electronic circuitry is contained in a sealed chamber constructed from a die-cast aluminum chassis that is weather-proof and shock-proof. Redundant, water-proof fans on the rear panel draw cooling air over the heatsink fins below the sealed chamber. Military-grade circular connectors are used, and optional attached connector covers are available for when the cables are not attached. The MPPS-4000 products comply with a wide range of testing according to MIL-STD-810G. The SynQor MPPS-4000 Series products are designed and manufactured in the U.S.A.

Product Topology

The SynQor MPPS-4000-270 Series products use an isolated topology that provides protection to the load from spikes, noise, surges, brownouts, blackouts, etc. in the input power source. They also provide smoothing of load transients and nonlinear load profiles so that the input power source is not subjected to these disturbances. EMI filters are present at all MPPS external inputs and outputs.



Power flows in the MPPS unit from the AC INPUT through an AC 3-Phase EMI Line Filter, to a 3-Phase AC-DC converter with Power Factor Correction (PFC). DC power is then passed through an isolated DC-DC converter to create a galvanic isolation layer between the AC input and the DC mid-bus. Bulk energy storage capacitors connected to the mid-bus smooth imbalances in the power flow. The DC OUTPUT is then created by a DC-DC converter that draws power from the isolated DC mid-bus. The DC-DC provides a tightly regulated output that is user programmable from 25 – 400 Vdc. The DC-DC converter also provides a user programmable current limit from 0.2 – 24 A. An output EMI Filter eliminates switching frequency noise from the DC-DC converter. An ideal diode after the output filter prevents circulating currents when multiple units are paralleled. The ideal diode also provides N+M redundancy for paralleled units. There is a communication/control port that provides a digital interface to a host computer, which allows the user to program the output voltage and output current limit. A host computer also allows the user enable/disable the unit, monitor input and output power, and monitor system health and status.

Part Numbering Scheme and Options

This table shows the part numbering scheme for the full line of SynQor MPPS products:

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

Base Models	Options					
	Line to Line Input Voltage	Number of Input Phases	Input Freq Range	Output Voltage	Output Config	Additional Options
MPPS-4000-1U-	**4**	**T**	**L**	**270**	**S**	**-E 00**

Example:

MPPS-4000-1U-4TL270S-E00

Options		
Line to Line Input Voltage	**4**	360-528 V
Number of Input Phases	**T**	3-Phase
Input Freq Range	**L**	47-65 Hz
270	**270**	Nominal Output Voltage
Output Config	**S**	DC Programmable, 25 - 400 Vdc 0.2 - 24 A
Additional Options	**-E00**	Ethernet/SNMP with Config Loading

The MPPS-4000-270 Series of products provide up to 4000 W (4500 W transient) of DC output power.

Standard Features include:

- Three phase 360 – 528 Vac line-to-line input voltage
- 47 – 65 Hz input frequency
- 25 – 400 Vdc output.
- 0.2 – 24 A current limit.
- 270 Vdc @ 16.6 A factory default
- RS-232 serial port and logic-level I/O communication.
- An Ethernet port provides web and SNMP interfaces.

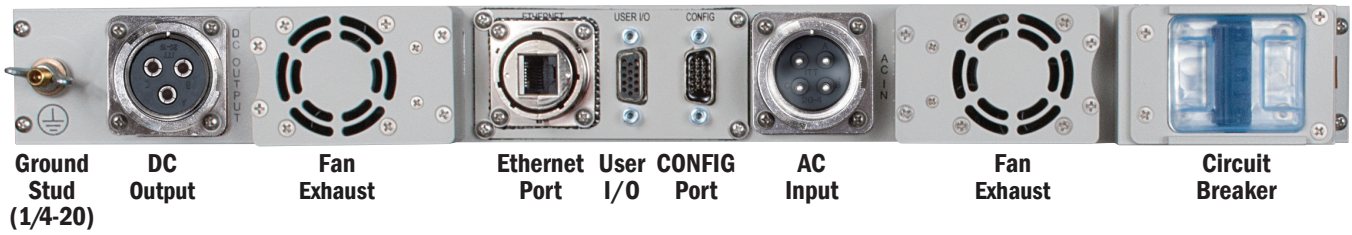
Product Specifications

The next pages show the electrical and mechanical specifications of the MPPS-4000-270 Series of products. Data sheets showing these specifications and other information can be found at the web site

https://www.synqor.com/product-guide/military/system/rack-mount/ac-dc-power-supply.

MPPS-4000-270-1U UNIT Front

MPPS-4000-270-1U UNIT Rear



Transit Case Option

Technical Specifications

AC INPUT OPERATING CHARACTERISTICS	
Voltage	3-Phase, 360-528 Vrms L-L
Frequency	47-65 Hz
Input Current Total Harmonic Distortion	<3% (4000 W load)
Input Power Factor (Distortion Component)	>0.99 (4000 W load)
Input Current Balance (Highest - Lowest)	<2%
Max. Input Current Per Phase @ 360 Vrms L-L	8.5 Arms (4500 W load)
Integrated AC Input Circuit Breaker Rating	12 Arms

DC OUTPUT CHARACTERISTICS	
Continuous Output Power	4000 W
Transient Output Power (15 seconds)	4500 W
Voltage Range	25 - 400 V
Voltage Setpoint (Default)	270 V
Voltage Accuracy	± 3%
Voltage Setpoint Resolution	1 V
Voltage Regulation (Over Load & Temperature)	± 5%
Current Limit Range (User Adjustable)	0 - 24 A
Current Limit Resolution	0.2 A
Short Circuit Protection Trip Current	80 A
Maximum Output Capacitance	18 mF

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

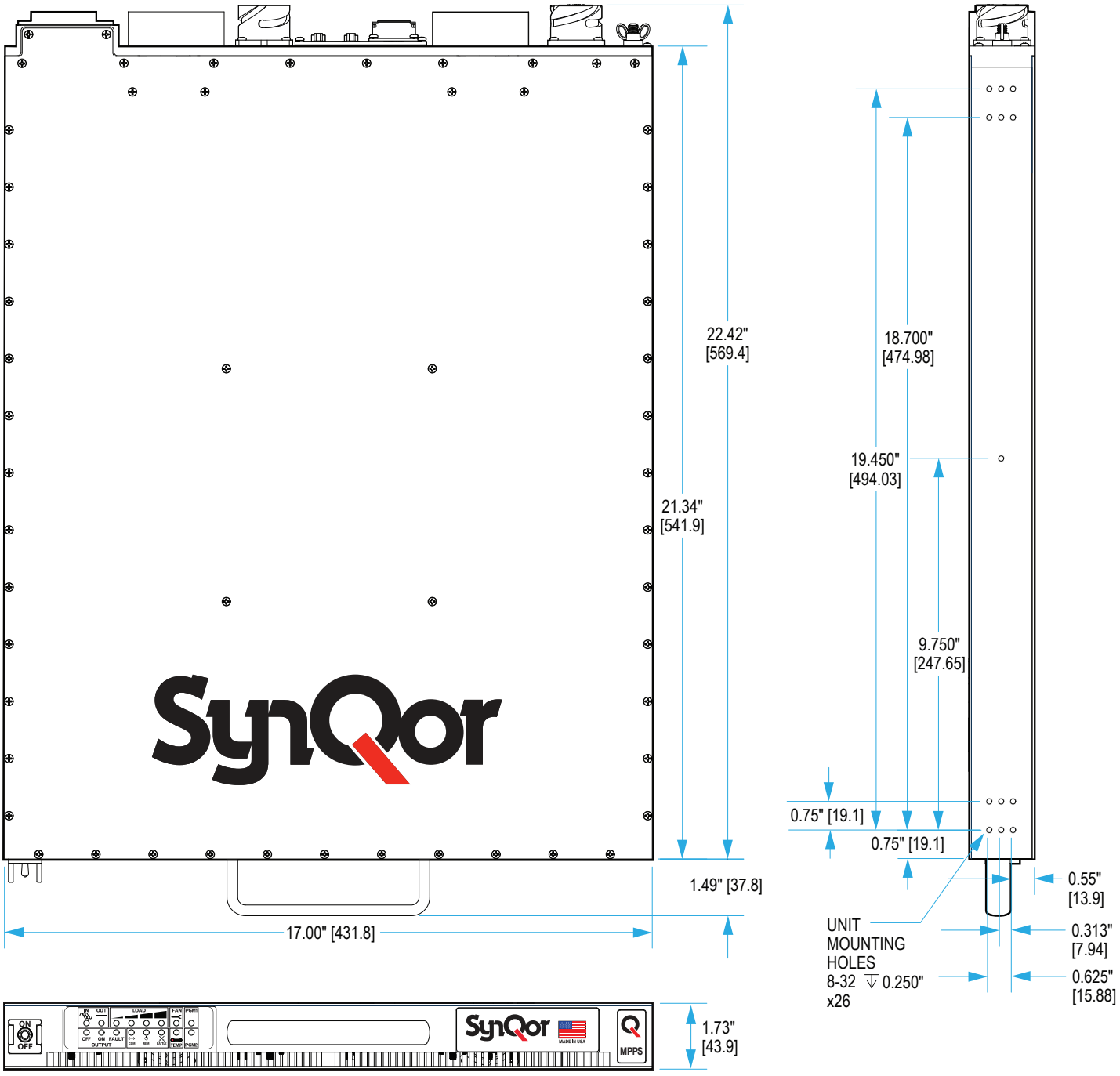
RELIABILITY CHARACTERISTICS MIL-HDBK-217F	
MTBF: 450 kHrs	MIL-217F Ground Benign, Ta=25 °C

INTERFACE STD FOR SHIPBOARD SYSTEMS MIL-STD-1399B
Type I 440 V 3-Phase Input Power

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.
AC Input Connectors	
AC Input Connector	CB2-20-4PHA34-FM
DC Output Connectors	
DC Output Connector	CB2-20-19SXSA34-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(m^3/min) 32.5 CFM
Two fans in system; above specs are for each fan separately.	

1U Mechanical Diagram



Efficiency

Figure 1 shows the typical efficiency with which the MPPS-4000-270 series unit delivers power to its DC OUTPUT load from 60 Hz:

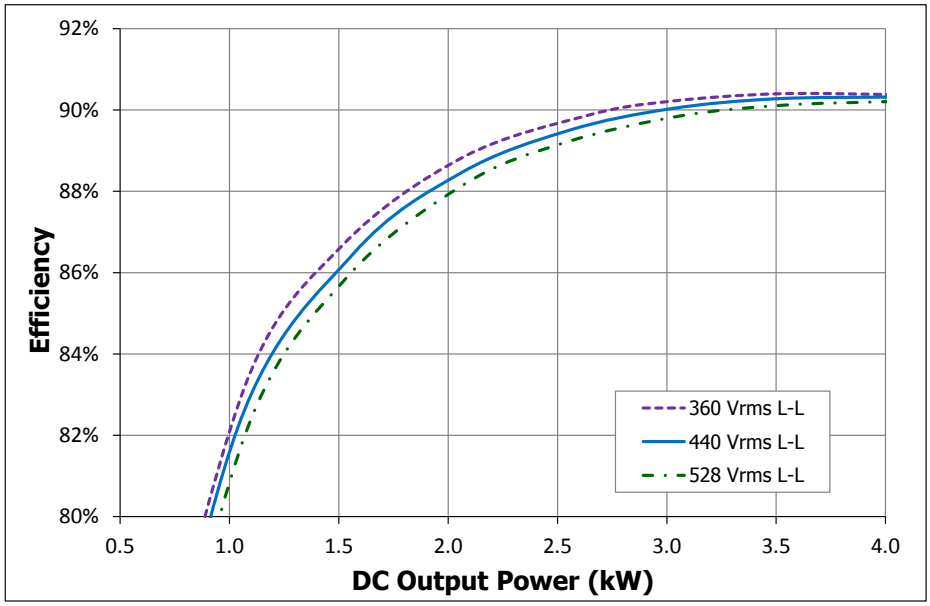


Figure 1

Total Output Power

The total MPPS output power for the MPPS-4000-270 series is rated at 4000 W for 15 seconds. These ratings apply at an ambient temperature as high as 55 °C (131 °F).

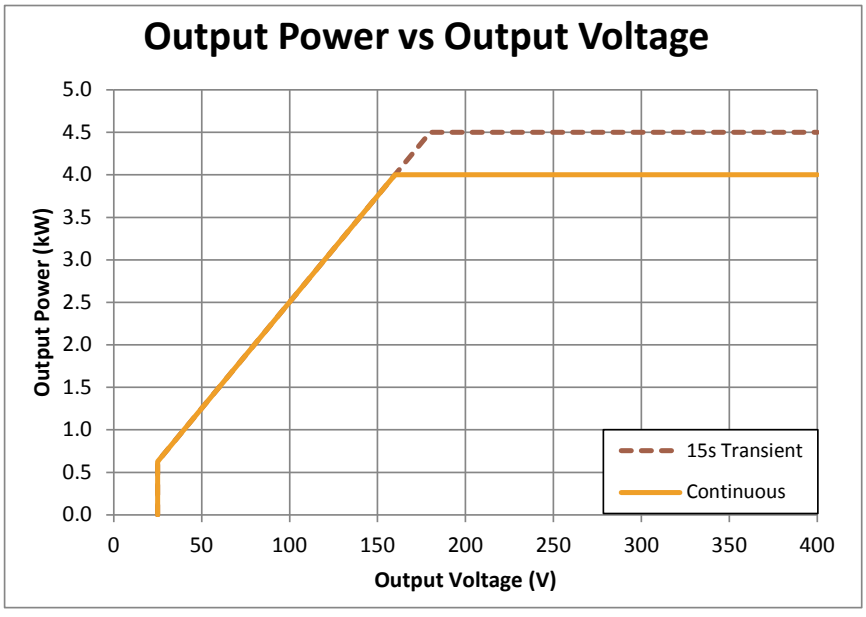


Figure 2

Temperature Derating

The maximum steady-state MPPS output power as a function of ambient air temperature and AC input voltage is shown below in Figure 3. (See Section IV).

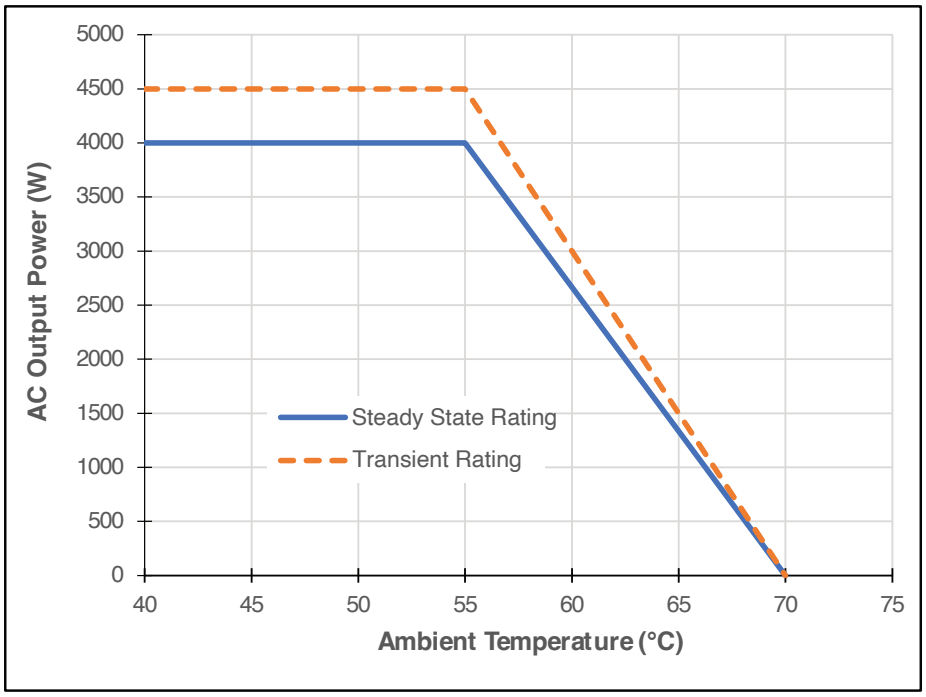


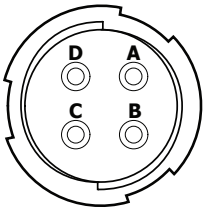
Figure 3: Output Power vs. Ambient Temperature

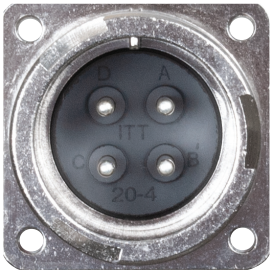
Power Cable Wiring Diagram

Looking at the rear panel, the MPPS connector terminals have the following functions and locations:

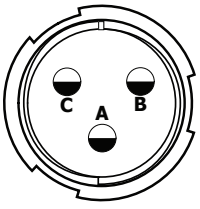
AC INPUT	
Pin	Function
A	Line A (360-528)
B	Line B (360-528)
C	Line C (360-528)
D	Ground

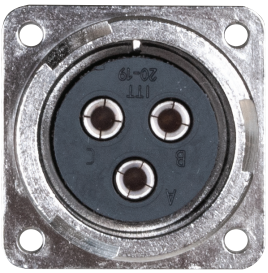
Warning: Pin D should never be connected to a line Voltage





DC OUTPUT	
Pin	Function
A	Vout+
B	Vout_RTN
C	Ground





Set-Up

The recommended procedure for setting up the MPPS is the following:

- Make sure the AC BREAKER on the rear panel of the MPPS is in the “OFF” position.
- The AC breaker on the rear panel is classified as a supplementary protector and is not designed for branch circuit protection. A suitable circuit breaker should be added externally for the AC input if branch circuit protection is required.
- Connect the ground wire to the ground stud on the rear panel of the MPPS.
- Connect the DC OUTPUT cables, first to the MPPS and then to the load.
- Connect the USER I/O cables.
- Check that pin D in the input connector is not connected to a line voltage. On input cables provided by SynQor, pin D (input AC ground) is connected to the green color wire.
- Connect the INPUT cables, first to the MPPS and then to the AC source.
- Turn on the source (if it has an up-stream breaker).
- Move the AC BREAKER on the rear panel of the MPPS to the ON position.

Start-Up

- VERIFY that all connections to the MPPS are correct.
- If the AC source is present and within specifications, a POWER IN LEDs on the front panel will light up green.
- Momentarily push the “ON/OFF” switch on the front panel of the MPPS upward. The switch can then be released and it will return to its normal (neutral) position.
- The MPPS will immediately enable its outputs (assuming there is no fault condition). The color of the POWER OUT LED(s) on the front panel will change to green. The LOAD LEDs on the front panel will indicate the amount of power being delivered to the load.

Shut-Down

- Shut down the equipment connected to the MPPS.
- Push the “ON/OFF” switch on the front panel of the MPPS downward and hold it in this position for 1 second (or more). The switch can then be released to return to its normal position.
- The MPPS will disable its outputs.

Power Cable Connections

For safety reasons, the input and output power cables should be connected to the MPPS before the source of AC power is turned on, and before the MPPS is turned on (see **Section I: Warnings** and the **SET-UP** section above). Similarly, one should first turn "OFF" the MPPS and the source of input power before any power cables are disconnected from the MPPS .

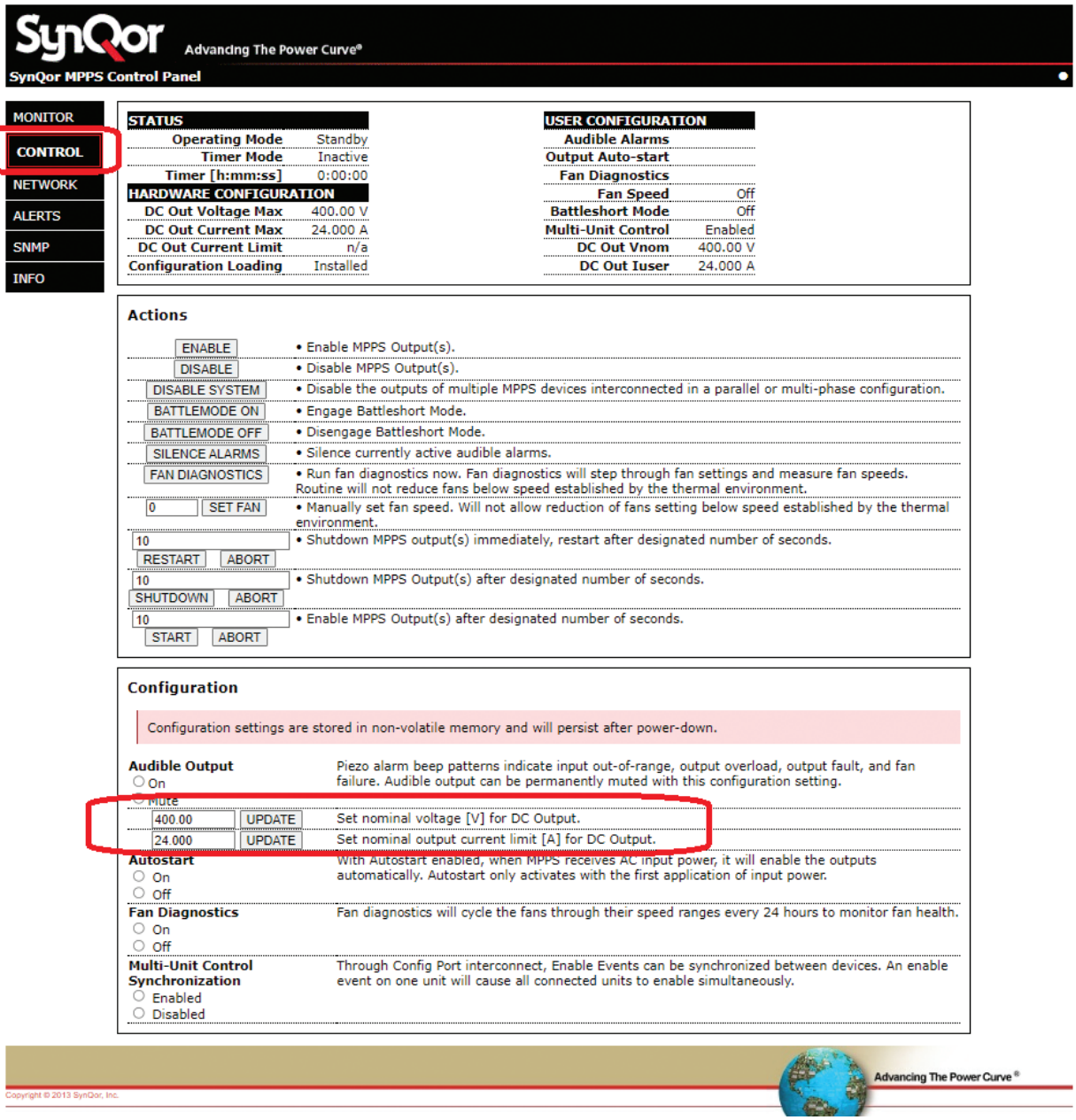
> ***ALSO NOTE*** *that when the MPPS is turned "ON" and delivering power to a load, and then another piece of equipment is connected to the same output, it is possible that this connection will momentarily disrupt the quality of the MPPS's output voltage. It is possible that this new load will momentarily draw a large surge of current as it starts up. If this happens, the output of the MPPS could reach its maximum current limit, and the MPPS will reduce its output voltage to keep the current from getting any larger. This reduction in voltage will be corrected once the new load reaches its normal mode of operation, but in the meantime the reduction of the MPPS's output voltage might cause one or more of the other loads to malfunction. Whether or not this will be a problem depends on the characteristics of the various loads.*

Programming The Output

The output voltage and current limit can be programmed by the user through either the web page or by the RS-232 interface. The output voltage can be programmed from 25 – 400 Vdc. The output current limit can be programmed from 0.2 – 24 A.

Updating the output voltage from low to high may also cause the output current limit to be updated since the MPPS cannot deliver more than 4500 W. For example, the MPPS can deliver 4500 W when set to 200 V, 22.5 A. If the output voltage is set to 400 V, the MPPS will automatically scale back the current to 11.25 A so as not to exceed 4500 W.

To set the voltage through the web page, navigate to the control page. Under "Configuration", enter the desired output voltage in volts and the desired current limit in amps. Click update to apply the changes. These values are stored in non-volatile memory, and do not need to be reentered after the MPPS-4000-270 is power cycled.



Setting the output voltage and output current using the web interface

To set the voltage through the RS-232 interface, configure the RS-232 terminal with 115.2 k baud, 8 data bits, no parity, and one stop bit. Using a third party terminal application such as HyperTerminal, send the following commands:

SET ILIM x [mA]
SET VNOM x [V]

Example: Set Vout to 200 V, ILim to 15 A.

SynQor>SET VNOM 200
Flash Updated.

SynQor>SET ILIM 15000
Flash Updated.

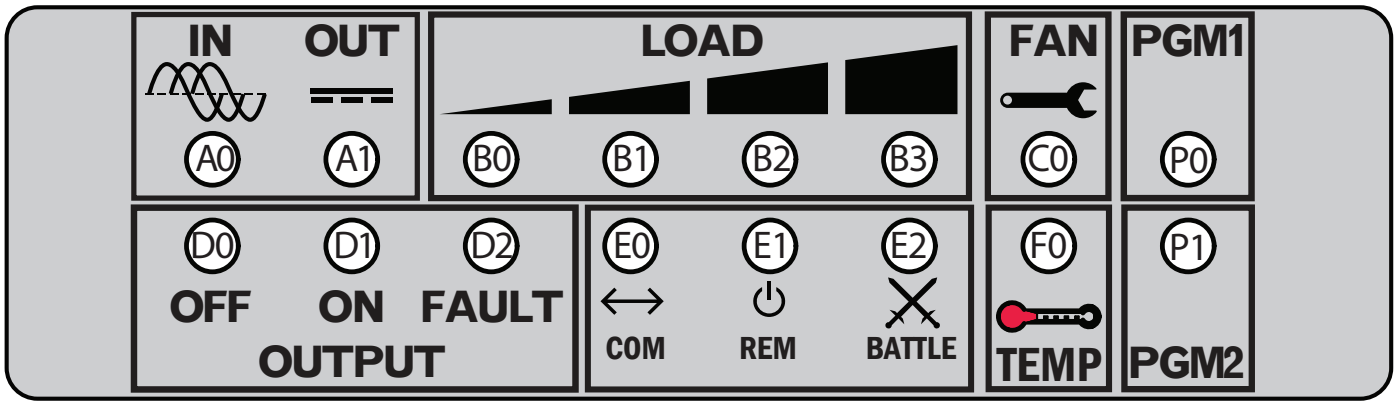
Note that after each command the system will return “Flash Updated”. This indicates that the values have been stored in non-volatile memory, and do not need to be reentered when the MPPS-4000 is power cycled.

Front Panel Indicators

To indicate the status of the MPS or MPPS there are 16 LEDs on the front panel. These indicators are described in this section.

LEDs

Each Unit has 16 LEDs, as shown below, that indicate the status of the operation of the Unit:



- **Power-In Indicator (LED in position A0)**

The LED A0 indicates the status of input phases A, B and C:

LED Appearance	Description	Indication
	**Green**	*Input is Ready to Provide Load Power*
	**Red**	*Input has Dropped Out of Range*
	**Off**	*Unit input power is "OFF" or on Initial Startup Input not in Range*

- **Power-Out Indicator (LED in position A1)**

The LED in position A1 indicates the status of the DC OUTPUT, according to the table below:

LED Appearance	Description	Indication
	**Green**	*Unit is "On" and the Output Voltage is Within Range*
	**Amber**	*Unit is "On" but the Output Voltage is Out of Range*
	**Red**	*Unit is "Off" and the Output Voltage is Within Range*
	**Off**	*Unit is "Off"*

- **Load Power Indicators (LEDs in positions B0 – B3)**

The LEDs in positions B0 through B3 indicate the total output power of the Unit according to the table:

LED Appearance	Description	Indication
	*B0 Dimmed Green; B1, B2, B3 "Off"*	*Total Load Power <25%*
	*B0 Green; B1 Dimmed Green; B2 - B3 "Off"*	*Total Load Power <50%*
	*B0, B1 Green; B2 Dimmed Green; B3 "Off"*	*Total Load Power <75%*
	B0, B1, B2 Green; B3 Dimmed Green	*Total Load Power <100%*
	*B0, B1, B2 Green; B3 Blinking Red*	*Total Load Power ≥100%*

- **Fan service Required Indicator (LED in position C0)**

The LED in position C0 indicates weather the two cooling fans in the rear panel of the MPPS are OK or if their performance is degraded. Led colors for the fan status are define in the table below:

LED Appearance	Description	Indication
	**Green**	*Both Fans are "OK"*
	**Amber**	*One or Both Fans Have Recently Had Degraded Performance and Diagnostic Tests are Being Performed*
	**Red**	*One or Both Fans Presently Have Degraded Performance*

- **Output State Indicators (LEDs in positions D0, D1 and D2)**

The LED in position D0 indicates that output is “OFF”. LED in position D1 indicates that the unit is in the “ON” state. LED D2 indicates that presently a fault condition exists in the MPPS’s input or output. The LED colors for each LED in this section is defined according to the table below:

LED Appearance	Description	Indication
	**Amber**	*D0 Power is Currently not being Delivered to the Load*
	**Green**	*D1 Power is being Delivered to the Load within the Specified Parameters*
	**Red**	*D2 A fault condition exists on the Input or Output of the Device*

- **Control Status (LED in positions E0, E1, E2)**

The LED in position E0, E1 or E2 indicates whether RS-232 or Ethernet Port, Remote Enable/Shutdown or Battle Short are active:

LED Appearance	Description	Indication
	**Green**	*E0: RS-232 active or Ethernet Port Active, E1: Remote Enable Active*
	**Blinking Red**	*E2: Battle Short Mode Active, Temperature Shutdowns Removed*
	**Red**	*E1: Remote Shutdown Active*

- **Cooling System Indicator (LED in position F0)**

  The LED in position F0 indicates the temperature and status of the cooling system for the Unit according to the table below:

LED Appearance	Description	Indication
	**Green**	*Moderate Temperature (Fans Off or Running at 30%)*
	**Blinking Green**	*Warm Temperature (Fans Running at 60%)*
	**Amber**	*Elevated Temperature (Fans Running at 90%)*
	**Red**	*Maximum Temperature (Fans Running at 100%)*
	**Blinking Red**	*Over Temperature Warning*

- **Reserved (LEDs in position P0 & P1)**

  This section of the LEDs in the panel have been reserved for future use.

Audible alarm

For critical situations, a pattern of audible tones will be repeated every 5 seconds, according to the table below. This audible alarm can be **silenced** by holding the "ON/OFF" switch on the front panel in the "UP" position while the MPPS is operating and its output is running, or in the "DOWN" position while in Standby Mode, until a chirp is heard. A new alarm condition will cause the audible alarm to be reactivated. Contact Factory for instructions on how to permanently silence the alarm.

Number of Tones in Pattern	Indication
One	*Input Voltage is Lower than Minimum Operating Level*
Two	*Load Power is greater than or Approaching 100% Rated Power*
Three	*DC output voltage is low. MPPS is likely in current limit. MPPS may need to be power cycled to clear this condition.*
Four	*One or Both Fans have Presently a Degraded Performance*

Operating Environment

The SynQor MPPS-4000-270 Series is designed for the extreme environmental conditions of military and aerospace applications. All the electronic circuitry is contained in a sealed, weather-proof, shock-proof chamber constructed of die-cast aluminum. Only the redundant, water-proof cooling fans are exposed to the environment. The Unit will shut down if it is too hot and Battle Mode is not active.

The MPPS (with cables connected or connector covers installed) has been qualified to the following requirements of MIL-STD-810G:

MIL-STD-810G Test Method	Name	Procedure	Details
500.5	Low Pressure	I, II and III	▪ 15,000 ft. operating ▪ 40,000 ft. storage
501.5	High Temperature	I and II	▪ +55 °C operating ▪ +65 °C storage
502.5	Low Temperature	I and II	▪ -20 °C operating ▪ -20 °C storage
503.5	Temperature Shock	I	▪ 10 cycles; >10 °C/minute
506.5	Rain	I	▪ 4” rain/hour ▪ 40 mph wind velocity
507.5	Humidity	NA	▪ >95%
508.6	Fungus	NA	▪ 28 day test
509.5	Salt Fog	NA	▪ 5% salt solution ▪ 2 cycles (24 hr. wet/24 hr. dry)
510.5	Sand and Dust	I and II	▪ 20 mph blowing dust ▪ 40 mph blowing sand
514.6	Vibration	Category 5	▪ 5 Hz (300 RPM) ▪ Loose Cargo
514.6	Vibration	Category 7	▪ General Exposure
514.6	Vibration	Category 8	▪ C-130 Aircraft level
514.6	Vibration	Category 9	▪ General Exposure
514.6	Vibration	Category 24	▪ PSD = 0.04 g^2/Hz; 20-2000 Hz ▪ Operating
516.6	Shock	I, IV and VI	▪ 20 g/20 ms; 40 g/11 ms; 75 g/6 ms ▪ 48 inch drop in transit case ▪ 30 degree tilt and drop
528	Mechanical Vibrations of Shipboard Equipment	I	▪ Operating

General Considerations

The The MPPS-4000-270 supports up to 32 units in parallel for:

- Higher output power
- N+M Redundancy and/or increased MTBF

Paralleling is achieved using CONFIGURATION CABLES. N+M redundancy is achieved with an ideal diode internal to the MPPS.

MPPS Configuration Cables

CONFIGURATION CABLES provide digital communication between MPPS units and are required for current sharing. The configuration cable plugs into the CONFIG port located on the MPPS back panel.

All ends of a CONFIGURATION CABLE must be connected to a MPPS unit to ensure signal integrity. If an end of the CONFIGURATION CABLE cannot be connected for some reason, an IP67 sealed cap should be installed with a 2.0 K terminator between pins 14 and 15.

The table below lists part numbers for CONFIGURATION CABLES of up to 5 units in parallel. Contact the factory for parallel systems with more than 5 units in parallel.

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

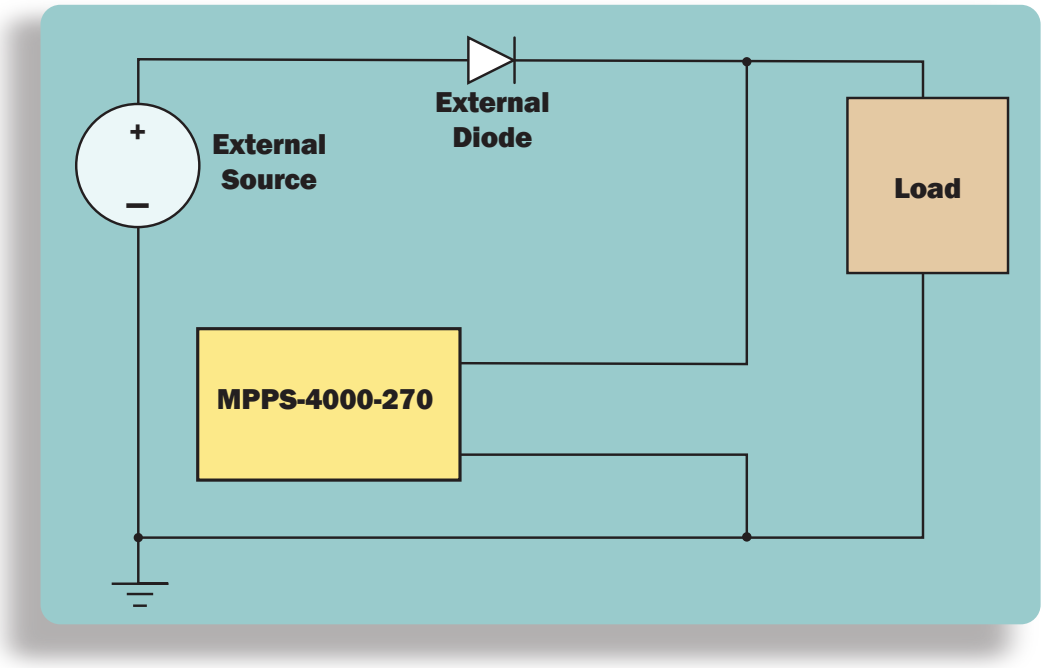
N+M Redundancy – Ideal Diode

The ideal diode on the DC OUTPUT provides N+M redundancy when multiple units are placed in parallel. An N+M redundant system consists of N units to supply the maximum load, and M additional units to provide redundancy. Typically, one additional unit is used for redundancy giving "N+1 redundancy".

During normal operation, all N+M units will power the load. Should one unit fail, the remaining units will increase their output current to continue to power the load. The failed unit can be removed and replaced to restore the redundancy level of the system to its original design. The replacement unit can be inserted into a live, operating system, but for safety reasons it is recommended that all units in the system be disabled first.

In addition to N+M redundancy, the ideal diode prevents power from flowing into the unit during normal operation. This ensures that power cannot circulate between multiple units when the outputs are in parallel. The digital communications ensures the load is shared evenly.

The ideal diode also allows the MPPS to work in simple "diode ORing" parallel schemes with External sources. This allows the MPPS to operate as a second possible source to a high voltage DC bus. In this configuration the source with the highest output voltage will deliver the full load, assuming the External Source has a diode on its output. The External Source cannot exceed the maximum output voltage of the MPPS. Connecting the MPPS to a supply that exceeds its maximum rating will cause permanent damage to the MPPS.



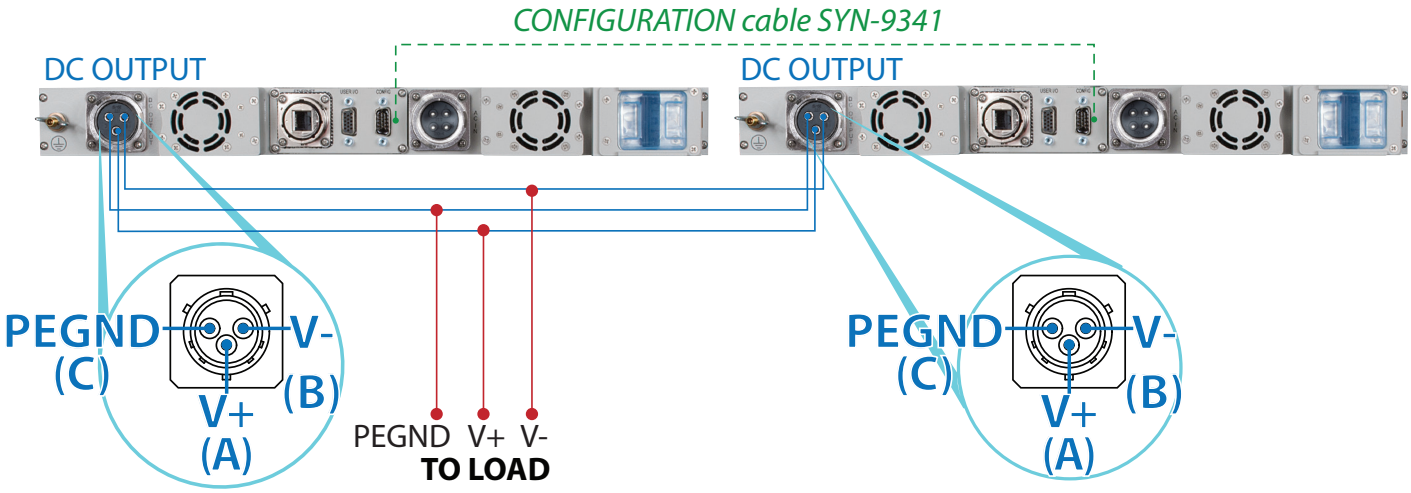
MPPS diode ORing with 3rd party auxiliary supply

Parallel Connection of the DC Outputs

MPPS units can be connected in parallel for increased power and/or redundancy.

Two MPPS units with DC OUTPUTs Paralleled

The following diagram shows how to connect two MPPS units in parallel. The wiring diagram explains how the DC OUTPUT cables and the CONFIGURATION cable needs to be connected:

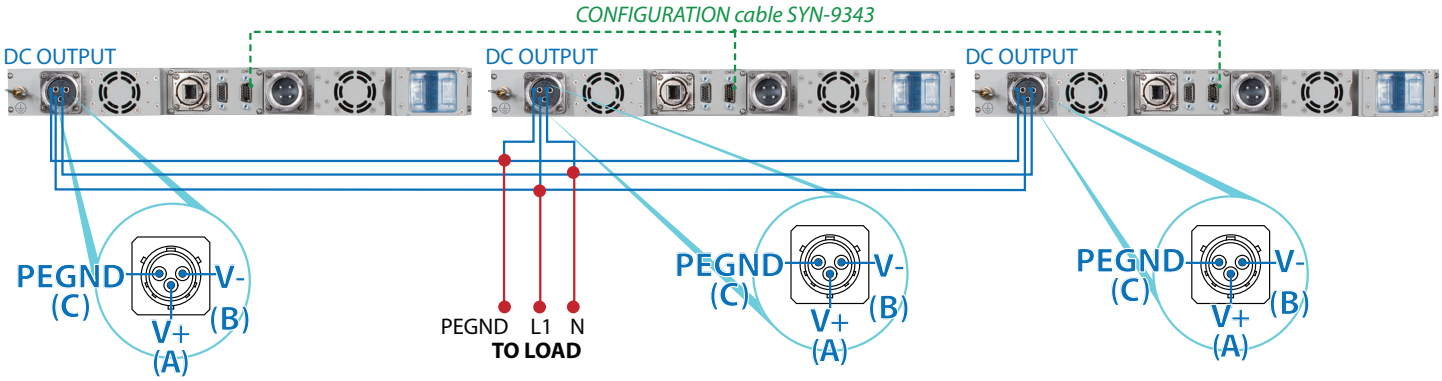


The cable sizes for the blue and red cable sections show above are as follows:

Blue Cable Section Minimum Wire Size	Red Cable Section Minimum Wire Size
#10AWG (6 mm^2)	#6AWG (16 mm^2)

Three MPPS units with DC OUTPUTs Paralleled

The following diagram shows how to connect two MPPS units in parallel. The wiring diagram explains how the DC OUTPUT cables and the CONFIGURATION cable need to be connected:



If the user is providing its own DC OUTPUT cable, the size of the blue and red cable sections shown above, should follow the guidelines shown in the table below depending on DC OUTPUT voltage of the MPPS units.

Blue Cable Section Minimum Wire Size	Red Cable Section Minimum Wire Size
#10AWG (6 mm²)	#4AWG (26 mm²)

Multi-Unit DC OUTPUT On/Off Control

In multi-unit operation, a single front panel "ON" switch actuation, "REMOTE-ON" rear panel signal input, or *OUTPUT ENABLE* serial command will cause all MPPS devices to enable their outputs. Any "OFF" front panel switch actuation, "REMOTE-OFF", or *OUTPUT DISABLE* serial command will only disable that specific MPPS. Sending the *SYSTEM DISABLE* serial command to any MPPS unit a multi-unit configuration will cause a coordinated shutdown of all DC OUTPUTs. If any single MPPS no longer has a valid input power source (e.g., no AC input), it will shut down while the DC OUTPUTs of the remaining systems stay active.

DC OUTPUT Grounding

The DC OUTPUT of the MPPS is floating with respect to chassis ground. For convenience, a chassis ground wire is included on the output connector should the load need to be grounded. Either Vout- or Vout+ can be connected to chassis ground.

Internal protection devices clamp the output to within ±1000 V of chassis ground. For margin, the output must not be grounded to another source that sees more than ±300 V with respect to chassis ground. As an example, Vout- should not be tied to the AC line of a grounded AC system.

Connecting AC INPUTs

Whether there are two, three or more MPPS units in the multiple-unit configuration, there are several ways that the 3-Phase AC INPUTS can be connected to power sources:

- All units could be connected to the same 3-Phase AC source/panel.
- Units could be connected to different 3-Phase AC sources/panels.

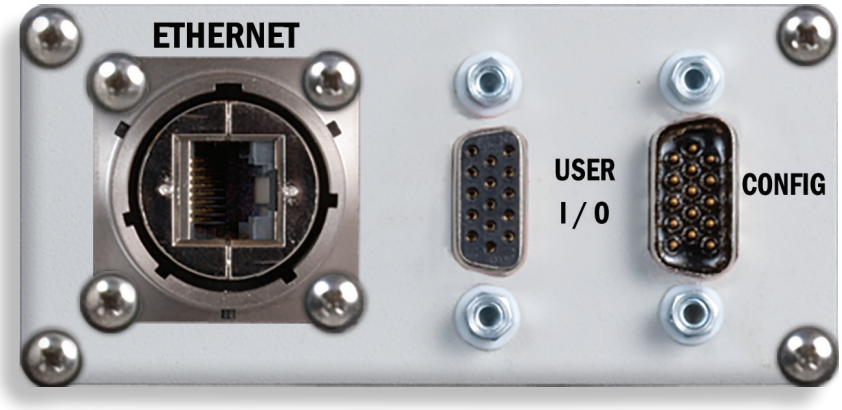
The only requirement is that the MPPS units have input voltages and frequencies that fall within the specified ranges of the 3-Phase AC INPUTS of the individual MPPS units.

Wiring Caution

WARNING: *LETHAL HIGH VOLTAGES MAY BE PRESENT ON MPPS AC INPUT AND OUTPUT CONNECTIONS. ALL AC INPUT AND OUTPUT CABLE CONNECTORS MUST BE INSTALLED PRIOR OPERATION. DISCONNECTED CABLE CONNECTORS MAY HAVE VOLTAGES PRESENT FROM ANOTHER UNITS IN A GROUP AND COULD POTENTIALLY BE HARMFUL.*

Control Cable Connections

There are two high-density (three-row) DB15 connectors located on the rear panel of the MPPS:

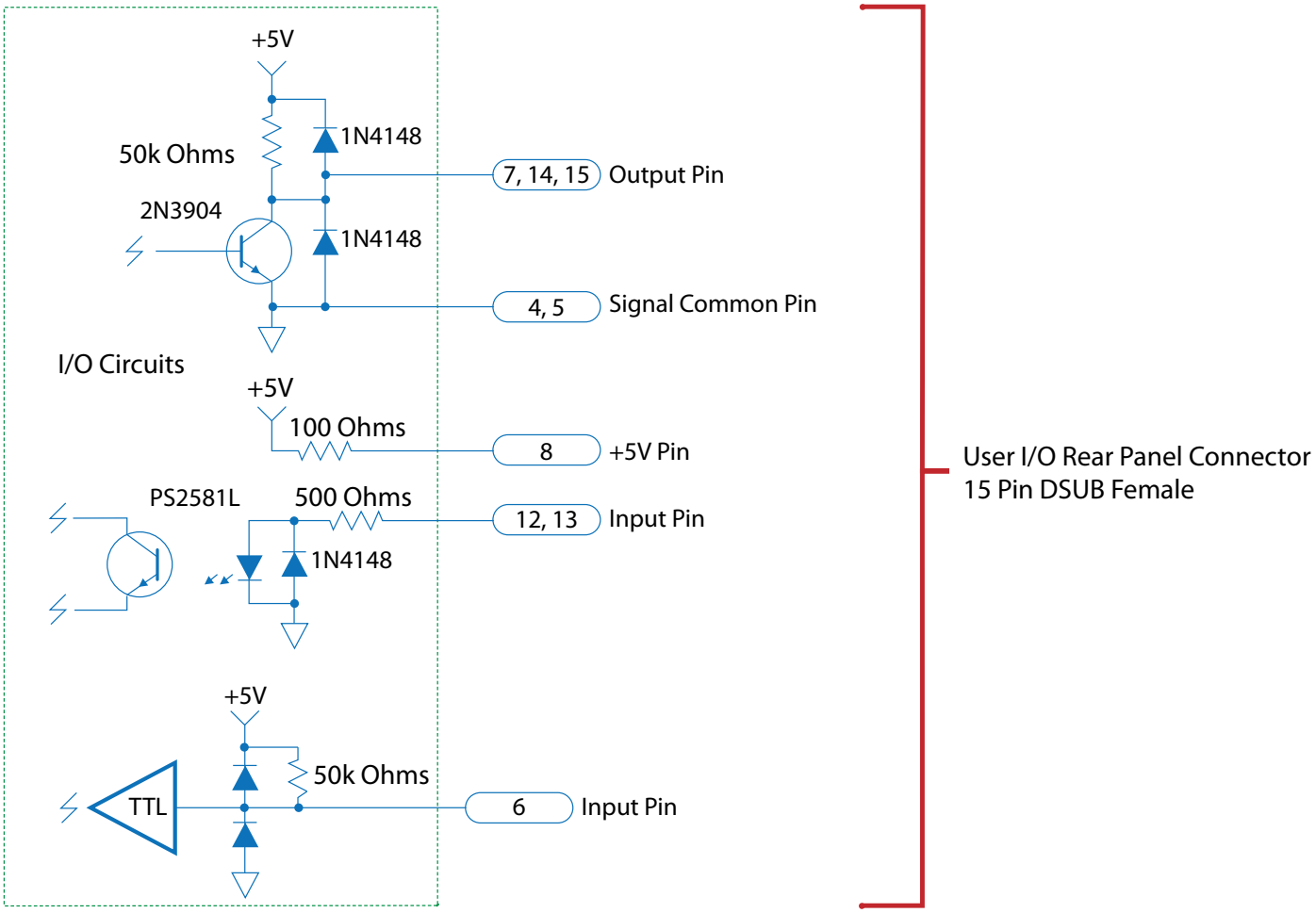


The User I/O female DB15 connector on the left is for an optional connection to a host/system computer so that it can control the MPPS and receive information regarding the status of the MPPS.

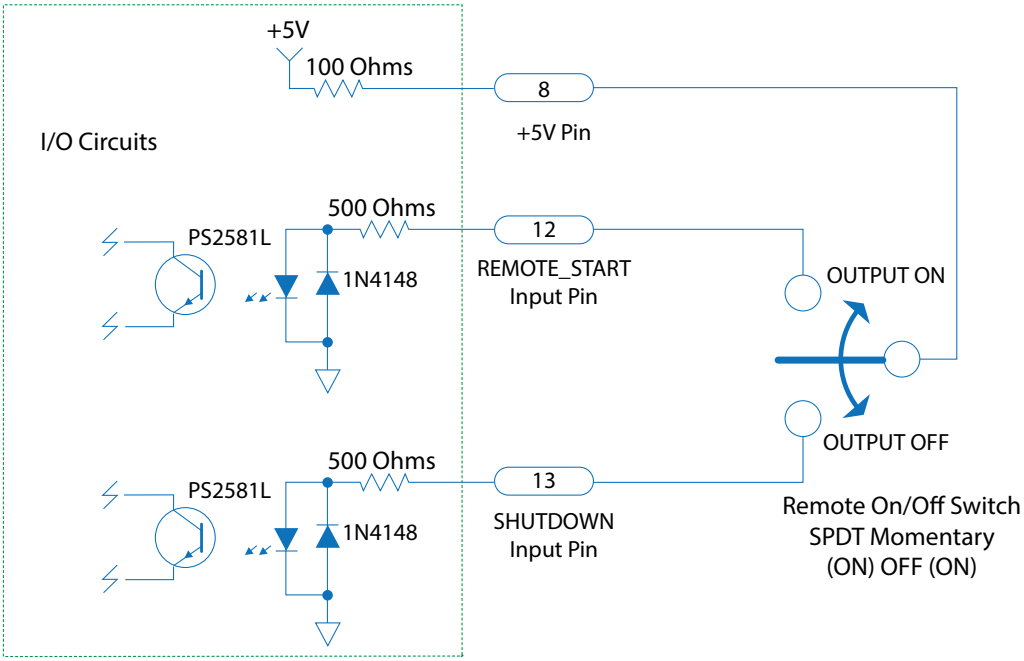
The Configuration male DB15 connector on the right provides for synchronized startup and shutdown operation of multiple interconnected units, using the SYN-9341, SYN-9343, SYN-9344 or SYN-9345 cables. See the “Possible configurations of the DC OUTPUTs” on page 22 for supported configurations details.

The designation/location of the pins for the User I/O female high-density DB15 connector are shown below:

Internal User I/O Circuits



Remote On/Off Switch Connections



Note: A 2PDT or 3PDT switch may be substituted for single control of 2 or 3 MPPS machines, respectively.

Digital Input/Output Control Signals

There are 3 input and 4 output digital signals available on the User I/O female high-density DB15 connector. The pin assignments and functions of these digital I/O signals are as follows:

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
ACIN_GOOD	7	Open collector* output where "low" indicates AC 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 ≥ 5 mA to enable MPPS output
SHUTDOWN	13	Drive this line to +5 V with ≥ 5 mA to disable MPPS output
OUT_OK	14	Open collector* output where "low" indicates DC Output voltage is within range
OVER_TEMP	15	Open collector* output where "low" indicates that the MPPS is at or above its maximum temperature

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

Battle Mode disables internal over-temperature shutdown limits in the MPPS hardware. Battle Mode is indicated with a flashing red light in panel position E2. This mode can be commanded by pulling low on to I/O Port Pin 6, or via serial command "BS ON".

Ethernet Interface

The Ethernet interface provides a web page based user interface for monitoring and control of the MPPS. The Ethernet interface also provides a RFC-1628 compliant remote SNMP monitoring interface for the unit.

The Ethernet interface supports 10BASE-T and 100BASE-T standards. It utilizes a standard RJ-45 connector, also allowing a metallic sealable circular military outer housing. The interface supports auto-negotiation, polarity correction, and Auto-MDIX (detection and use of straight through or cross-over cables).

IP address assignment can be configured to be acquired by the unit automatically via DHCP or set up through a static address entry via the web interface. The Ethernet interface also provides a local DHCP server that allows direct MPPS to host computer connections.

For a detailed description of the Ethernet port and SNMP implementation see the SynQor website at: **www.synqor.com/MPS-ESNMP**

RS-232 Serial Interface

The female high-density DB15 User I/O connector also provides for an RS-232 interface between the MPPS and the host/system computer. The interface has a 115.2 kbaud with eight data bits, no parity bit and one stop bit. The pin assignments and functions for this RS-232 interface are as follows:

Signal	Pin Number	Function
GND	4 and 5	Ground reference for RX and TX signals
RX	3	RS-232 DCE/MPPS Device Receive signal
TX	2	RS-232 DCE/MPPS Device Transmit signal

The RS-232 port provides read back of Unit's state, as well as the configuration and control of the MPPS's operation. The port can be used from a standard terminal interface, or from a custom computer application. For MPPS Units, this port can be used to program the output voltage characteristics.

Readback information that is available:

- DC OUTPUT Voltage
- DC OUTPUT Power
- Battle Mode
- On/Off Synchronization
- Internal Temperatures
- External Switch Input Status
- DC OUTPUT Current
- Total Output Power
- Fan diagnostics
- Output enable / disable
- AC Input Frequency
- Fan RPM

Parameters that are controllable through the interface:

- Output voltage (25 – 400 V)
- On/Off Synchronization
- Alarm enable / disable
- Output enable / disable
- Current limit (0.2 – 24 A)
- Battle Mode
- Fan Diagnostics

For a detailed description of the terminal interface see the SynQor website.
https://www.synqor.com/document-viewer?document=MPS_User_Commands.pdf

Fans

The fans on the rear panel have sealed bearings that do not require any regular maintenance. Fan assemblies are user replaceable with kits available from SynQor. Please contact the SynQor factory for obtaining fan replacement kits.

Cleaning

The MPPS Unit has a sealed chamber for its electronics that is weather-proof. Only the fans on the rear panel are exposed to the environment, and these fans are also weather-proof. The Unit can therefore be cleaned without concern of getting liquids inside the chamber. **NOTE**, *however, that if the cables have been removed from the unit then the unit connectors should have their covers installed to protect the connector from damage, contamination or corrosion. If connectors are not protected, then care should be taken to prevent physical or liquid damage to the connector terminals.* **ALSO NOTE,** *care should be taken to not get excess liquid on the AC BREAKER switch in the back panel.*

Cleaning should be done either with soap and water or with an Isopropyl alcohol and water mixture. A soft cloth should be used.

Do not immerse the Unit in water to clean it.

Rust corrosion in connectors could be an issue.

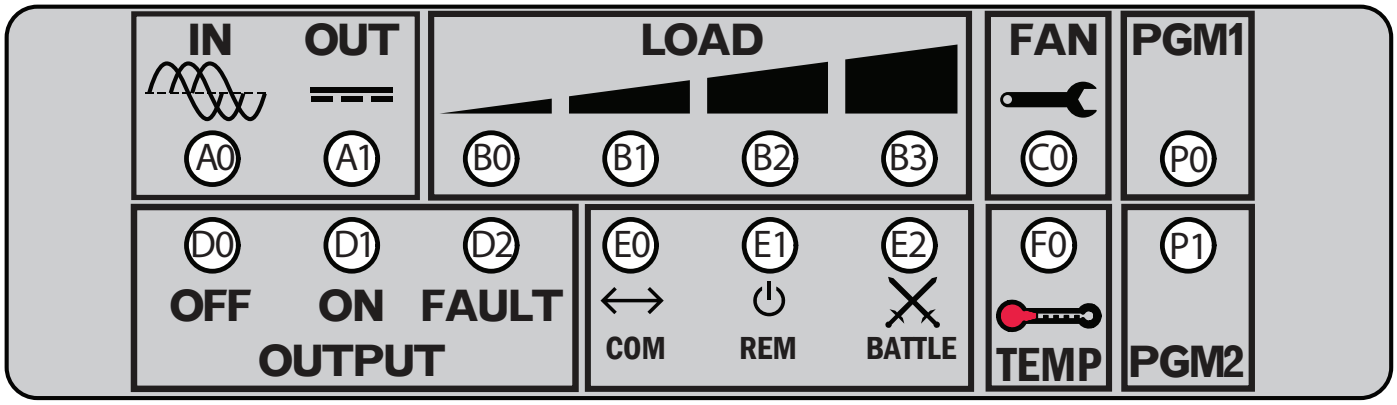
Fault Conditions

The SynQor MPPS has no user-serviceable parts within it other than the cooling fans. If the unit has an internal malfunction only factory trained personnel should attempt to repair it.

There are, however, several external conditions that could cause the MPPS to not operate as desired. These external conditions can likely be corrected by the user.

The 16 LEDs on the front panel are the best and first place to look to determine what might be wrong with the Unit. The table on the next several pages is therefore organized by what these LEDs indicate, and for each indication there is a listing of what might possibly be wrong.

The front panel LED array is shown below. The designations of the 16 LEDs in this array are used in the following table.



LED	Indication	Possible Problem(s)
A0: **AC INPUT Power LED**	LED is OFF	•The AC INPUT power source is not turned “ON”. •The AC INPUT cable is not connected or it is wired wrong. •The AC Breaker on the rear panel is “OFF”. •The MPPS Unit is “OFF” and needs to be turned “ON”.
	LED is Red	•The AC INPUT voltage has dropped out of Range.
	LED is OFF	•Unit has no input power or on Initial Startup Input not in Range”. •The AC Breaker on the rear panel is “OFF”.
A1: **DC OUTPUT Power LED**	LED is OFF	•The Unit is “OFF” and needs to be turned “ON”.
	LED is AMBER	•The DC OUTPUT load is higher than 4000 W by enough to trigger the power limit circuitry. •The DC OUTPUT is shorted within the cable or a load. •Some other source of power is connected to the DC OUTPUT.
	LED is RED	•The Unit has been turned “OFF”, but due to a malfunction within the Unit it is still running and providing an DC OUTPUT voltage. •Some other source of voltage is connected to the DC OUTPUT and is powering it when the Unit is disabled.

LED	Indication	Possible Problem(s)
B0 – B3: LOAD POWER LEDs	B3 is BLINKING RED	•Total load power is greater than or approaching 4000 W. The Unit may still be delivering its specified output voltage because the load power is not high enough to trigger the power limit circuitry.
	B0 – B3 are all OFF	•No power is being delivered to the load. •The Unit is "OFF" and needs to be turned "ON". •The loads or output cables are not connected. •The loads are all turned "OFF". •The loads are simply not drawing any appreciable power at the time.
C0: Fan Service Required LED	LED is AMBER	•One or both fans have recently had degraded performance but seem to be OK now. The Unit is running a diagnostic test.
	LED is RED	•One or both fans presently have degraded performance, even if they are running, and service is recommended at the earliest convenient time. •Ensure that the fan blades are not obstructed from turning.
F0: Cooling System LED	LED is BLINKING GREEN	•Indicates that the fans are running at 60% of their rated speed. There is no problem.
	LED is AMBER	•Indicates that the fans are running at 90% of their rated speed. There is no problem, but the Unit is operating at a high ambient temperature and a high load combination.
	LED is RED	•Fans are running at 100% of rated speed to keep the Unit cool. The maximum recommended temperature may be exceeded, but the fans are keeping things cool enough to avoid triggering the over-temperature shut-down circuitry.
	LED is BLINKING RED	•The maximum recommended temperature may be exceeded and the system is approaching over-temperature protection. The load and / or ambient temperature should be reduced if possible.
All LEDs:	All LEDs are OFF	•The AC INPUT power is not turned "ON". •The AC Breaker on the rear panel is "OFF".
Audible Alarm: (pattern repeats every 5 seconds)	One tone	•The AC INPUT voltage is lower than the minimum operating level. •Raise the AC INPUT voltage above the minimum level or verify the wiring is appropriate for the input current so as not to cause an excessive voltage drop.
	Two tones	•The total Unit load power is above 4000 W. •Loads should be reduced if the condition persists.
	Three tones	•The DC OUTPUT has experienced either a short circuit or a load having a start-up surge current characteristic that the MPPS could not start. The DC OUTPUT has therefore turned "OFF". •To reset, the Unit OUTPUT must be turned "OFF" and then "ON".
	Four tones	•One or more fans have encountered a fault or degraded performance. •The Unit may still operate with degraded fan performance, but should be serviced soon. Ensure the fan blades are not obstructed.

Two other conditions should be mentioned:

- **The fans are "OFF" when the MPPS Unit is running**

  It is normal for the fans to be "OFF", even if the Unit is running and delivering power to the load, as long as the temperature of the Unit is low enough. If the Fan Service Required LED (F0) is green, both of the fans are OK, even if they are not running.

- **The MPPS Unit does not turn "OFF" when the "ON/OFF" switch is pushed down**

  When the "ON/OFF" switch on the front panel is pushed down, the Unit does not respond to this signal for approximately 1 second. This is done to ensure that the Unit is not accidently turned "OFF". If the user does not hold the "ON/OFF" switch in the "OFF" position for a full second before releasing it, the Unit will not turn "OFF".

Other possible situations that are the result of external issues that a user could likely correct are related to:

- **Loads that draw a large surge of current at start-up**

  Several problems could arise with such a load:

  Some DC loads draw a very large amount of current when an input voltage is first applied to them. This may also happen when the Unit is first turned "ON" if the load is already connected to the Unit. Or it may happen when the load itself is turned "ON" and/or connected to the DC OUTPUT of a Unit that is already running. Common examples of such loads are motors and incandescent lights, but some electronic equipment can also display this characteristic.

Several problems could arise with such a load:

- **Loads that draw a large surge of current at start-up:**

  If there is more than one load connected to the DC OUTPUT that displays this start-up surge characteristic, and the MPPS is not capable of starting all the loads at once, it may be possible to switch on the loads in a specific sequence, one by one allowing for a complete successful system power-up. For instance, if the MPPS cannot start up a load consisting of lights and an induction motor that has a startup current 5 times larger than the operating current, it may be possible to start the induction motor first. Once the motor has reached its normal operating speed and current, then the lights can be turned "ON" without triggering the MPPSs current limit protection.

- **A newly started load disturbs the existing Unit loads.**

  A common problem can occur when the MPPS is running and powering one or more loads connected to its DC OUTPUT, and then an additional load is turned "ON". If this newly started load draws a large surge current at start-up, it can cause the current limit of the MPPS's DC OUTPUT to be triggered, which in turn causes the output voltage to drop. The drop could cause the existing loads to be disturbed. Furthermore, if the voltage drops is far enough below the rated limit, the MPPS will turn "OFF" its DC OUTPUT and initiate a new start-up sequence. This latter action could cause an interruption of existing running loads. If this disruption in the loads is a problem, then the solution is to make sure that loads with large startup surges are started first, and then proceed to start the rest of the loads.

- **Input Cable wire resistance is too high:**

  The resistance of the input power cable is to high due to an excessive cable length combined with an inappropriate cable size, loose panel/breaker terminals, connector contamination or corrosion. The accumulated resistance in the cable, drops the input voltage into the MPPS below the rated limit during normal load condition. The phenomenon that may be displayed is as follows:

  In standby mode, the MPPS draws very little power/current from the AC INPUT. The voltage drop across the AC INPUT cable from the source to the MPPS is therefore negligible at this point. The MPPS sees that the voltage at the AC INPUT is within the specified range, and enables the output; the load begins to draw power which in turn requires the MPPS to draw current via the AC Input cables and terminals. As the input current rises, a large voltage drop appears across the input cable and terminals. If the voltage into the MPPS drops below the minimum rated value, the MPPS may determine that the AC INPUT is out of range and proceed to shut down. After this occurs, no current is being drawn through the input cables and terminals once again, the MPPS detects that the AC INPUT voltage is back to normal, and begins the startup sequence once again after a 1 second delay. The cycle will continue to repeat over and over, until voltage drop in the input circuit is corrected. The following are possible solutions to this problem: 1) make sure that the cable diameter for the required length is sufficient to deliver the full amperage to the MPPS unit, 2) tighten the distribution panel/breaker terminals or 3) clean any contamination or corrosion buildup on all terminals and connectors.

Notes

MPPS Military Field-Grade

3-Phase AC to DC Power Supply

Operator's Guide

MPPS-4000-270 Series

Made in USA

006-0007309 03/19/2024 Rev A

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