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**VANGUARD™ (RVN SERIES)
RECTIFIERS AND SHELVES
OPERATING MANUAL**

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UNIPOWER Telecom, Division of UNIPOWER Corporation

NORTH AMERICA • 3900 Coral Ridge Drive, Coral Springs, Florida 33065, USA • Tel: +1 954-346-2442 • Fax: +1 954-340-7901 • sales@unipower-corp.com
EUROPE • Parkland Business Centre, Chartwell Road, Lancing BN15 8UE, ENGLAND • Tel: +44(0)1903 768200 • Fax: +44(0)1903 764540 • info@unipower-europe.com

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VANGUARD™ (RVN SERIES) RECTIFIERS AND SHELVES OPERATING MANUAL

1.0 INTRODUCTION

This operating manual should be read through carefully before installing and operating the Vanguard rectifier.

The Vanguard™ (RVN Series) rectifier modules and shelves operate as a complete hot-swap power system for charging a 48V or 24V lead-acid battery or directly powering a load. See Figure 1. Each rectifier module produces up to 20 amperes at 54.4VDC (48V version) or 40 amperes at 27.2VDC (24V version). The 48V version is factory set to 54.4VDC output and the 24V version is factory set to 27.2VDC. Three rectifiers in a 19-inch shelf produce up to 60A at 54.4VDC or 120A at 27.2VDC; four rectifiers in a 23-inch shelf produce up to 80A at 54.4VDC or 160A at 27.2VDC. The rectifiers have single-wire active load sharing for automatic paralleling, and output ORing diodes which permit hot-swap addition or replacement of modules while the power system is operating. A shelf with rectifier modules can also be operated as an N+1 redundant power system with hot-swap, no-downtime replacement of a faulty module.

These power systems operate with a wide 103 to 265VAC input range at 47 to 63Hz and a separate AC input connection to each rectifier module. The modules have input power factor correction and Class B EMI input filters. The output voltage is tightly regulated and precisely adjustable over a wide range of 40 to 58VDC or 20 to 29VDC by means of a front panel, 12-turn potentiometer. Each module also has a remote analog input which can be used to adjust the output voltage over the same range. Using an external power controller in conjunction with this input permits automatic battery voltage control of equalize and float voltages together with temperature-compensated charging. The rectifiers can operate into a zero-voltage (dead) battery or short circuit without harm to the system. The output overload characteristic is a constant power output above 48V or 24V (depending on model) and a constant current output below these voltages. The output is floating with respect to frame or AC grounds.

A 25-pin interface subminiature D connector on the backplane of the shelf furnishes control and monitoring inputs and outputs. An enable input turns the entire shelf output off or on. Remote sensing connections provide precise regulation at the battery or point of load. Other control signals are AC good, DC good and thermal alarm logic outputs; analog voltage current monitor outputs; and analog voltage remote adjust inputs - - all for each individual rectifier module.

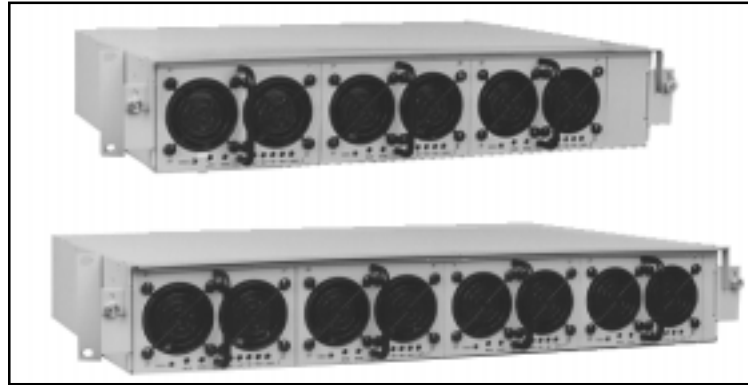


Figure 1. Vanguard Rectifier Modules and Shelves.

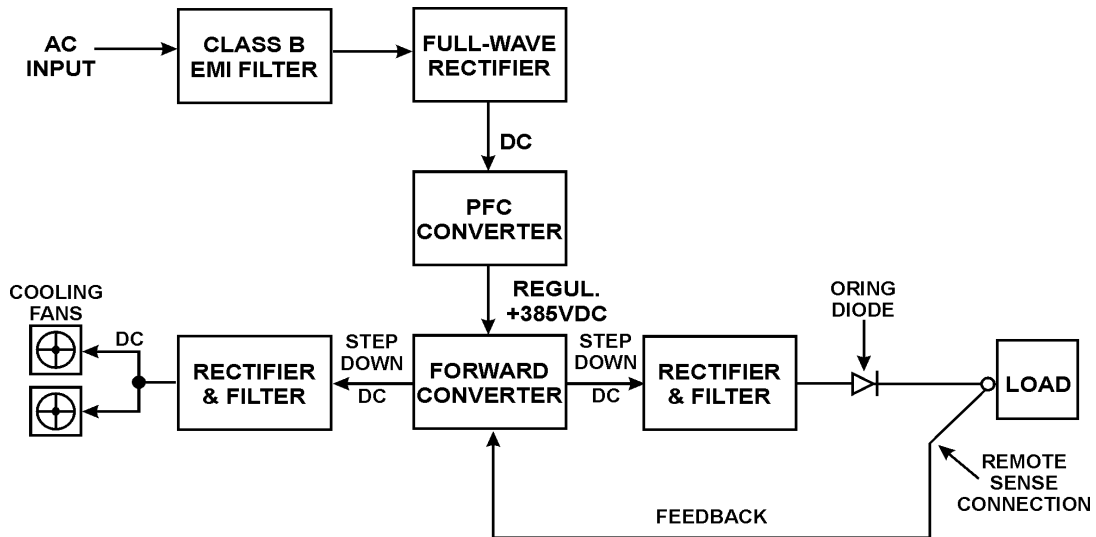


Figure 2. Vanguard Rectifier Block Diagram.

Front-panel green LEDs indicate AC power good, DC power good and output current for each rectifier module. The output current is displayed by a five-segment LED showing 20% of full load current per segment. The rectifier modules and shelves are safety agency certified and CE marked.

2.0 IMPORTANT FEATURES

The following is a summary of the important features of the Vanguard rectifier modules and shelves:

- ◆ Charges Batteries or Powers Loads Directly
- ◆ Constant Output Voltage
- ◆ Front Panel Output Adjustment
- ◆ Remote Analog Output Adjustment
- ◆ Wide Range Output Voltage Adjustment
- ◆ Output Overload Protected
- ◆ 48VDC and 24VDC Versions
- ◆ Low Profile: 2 Mounting Positions (3.5 inches or 89mm) Height
- ◆ 19 or 23-Inch Shelves
- ◆ Shelf Capacity Up to 4 Rectifier Modules
- ◆ High Power Density: 6.1 Watts/Cubic Inch
- ◆ Light Weight: 7.15 lbs. per Rectifier Module
- ◆ 87% Efficiency
- ◆ 0.99 Power Factor
- ◆ Class B EMI Input Filter
- ◆ Wide Range Input: 103-265 VAC at 47-63Hz
- ◆ Battery Temp. Compensated Charge Regulation*
- ◆ Remote Sensing
- ◆ Active, Single-Wire Load Sharing
- ◆ Integral ORing Diodes
- ◆ Hot-Swappable Rectifier Modules
- ◆ Redundant or Non-Redundant Operation
- ◆ LED Operating Indicators
- ◆ Control and Monitoring Interface Signals

* With external power controller

3.0 PRODUCT LINE

3.1 Rectifier Modules

MODEL	NOMINAL OUTPUT	FACTORY SET OUTPUT	MAX. OUTPUT CURRENT
RVN48/20	48VDC	54.4V	20A
RVN24/40	24VDC	27.2V	40A

3.2 Shelves

MODEL	NOM. VOLTS	WIDTH	HEIGHT	NUMBER OF MODULES	MAX. OUTPUT CURRENT
RVN2U-19	48	19" (483MM)	3.5" (89MM)	3	60A
RVN2U-23	48	23" (584MM)	3.5" (89MM)	4	80A
RVN2U-19	24	19" (483MM)	3.5" (89MM)	3	120A
RVN2U-23	24	23" (584MM)	3.5" (89MM)	4	160A

3.3 AC Input Options

CODE	OPTION
C	IEC AC Input Connectors
D	AC Input Conduit Connections

NOTE: Add Option Code Letter as suffix to the shelf model number.

4.0 SAFETY WARNINGS

- 4.1 These rectifier modules and shelves have hazardous external and internal voltages. They should be handled, tested and installed only by qualified technical persons who are trained in the use of power systems and are well aware of the hazards involved.
- 4.2 The input terminals are at hazardous voltage potentials. Do not touch this area when power is applied.
- 4.3 When operating this rectifier system, the frame ground terminal must be connected to safety ground by means of a three-wire AC power line to minimize electrical shock hazard and to ensure low EMI (electromagnetic interference).
- 4.4 The internal voltages are at hazardous potentials. The rectifier module covers should not be removed. There are no user-serviceable components in these units. Removing the covers of the rectifier modules will void the warranty.

5.0 WARRANTY

All products of UNIPOWER Telecom, a division of UNIPOWER Corporation, are warranted for two (2) years from date of shipment against defects in material and workmanship. This warranty does not extend to products which have been opened, altered or repaired by persons other than persons authorized by the manufacturer or to products which become defective due to acts of God, negligence or the failure of customer to fully follow instructions with respect to installation,

application or maintenance. This warranty is extended directly by the manufacturer to the buyer and is the sole warranty applicable. EXCEPT FOR THE FOREGOING EXPRESS WARRANTY, THE MANUFACTURER MAKES NO WARRANTY, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. As the sole and exclusive remedy under this warranty, the manufacturer, at its option, may repair or replace the non-conforming product or issue credit, provided the manufacturer's inspection establishes the existence of a defect. To exercise this remedy, the buyer must contact the manufacturer's Customer Service Department to obtain a Return Material Authorization number and shipping instructions. Products returned without prior authorization will be returned to buyer. All products returned for repair must be shipped freight prepaid to UNIPOWER. If the buyer fails to fully comply with the foregoing, the buyer agrees that no other remedy (including, but not limited to, incidental or consequential damages for lost profits, lost sales, injury to person or property or any other incidental or consequential losses) shall be available to the buyer.

6.0 UNPACKING AND INSPECTION

- 6.1 This Vanguard Series Rectifier System was carefully tested, inspected and packaged for shipment from our factory. Upon receipt of the unit it should be carefully unpacked and inspected for any damage in shipment.
- 6.2 If there is evidence of damage, do not attempt to test the unit. The freight carrier should be notified immediately and a claim for the cost of the rectifier system should be filed with the carrier for direct reimbursement. Be sure to include the model and serial number of the damaged unit in all correspondence with the freight carrier. Also save the shipping carton and packing material as evidence of damage for the freight carrier's inspection.
- 6.3 UNIPOWER Telecom will cooperate fully in case of any shipping damage investigation.
- 6.4 Always save the packing materials for later use in shipping the unit. Never ship the rectifier system without proper packing.

7.0 DESCRIPTION OF OPERATION

- 7.1 **Block Diagram.** A diagram of a Vanguard Rectifier Module is shown in Figure 2. The AC input first goes through a Class B EMI filter then to a full-wave rectifier and high-frequency (50kHz) power factor correction (PFC) converter. The output of the PFC converter is a regulated DC voltage at approximately +385V. This voltage is converted down to either 48VDC or 24VDC nominal, depending on the model. This is done by a forward converter operating at 80 kHz. The output of this converter goes through a rectifier, filter and ORing diode to the module output. Feedback from the

remote sense terminals back to the forward converter pulse-width modulator regulates the output voltage and keeps it constant.

- 7.2 Power Factor Correction.** This high-frequency converter circuit achieves a power factor of 0.99 by forcing the AC input current into a sinusoidal waveform, in phase with the input voltage. The input current is a smooth sine wave of much lower amplitude than the normal series of high-amplitude, input current pulses that are present in a unit without power factor correction. The result is lower RMS input current for a given output power level.
- 7.3 Cooling Fans.** Another output from the forward converter is rectified, filtered and used to power the two DC ball bearing cooling fans on the rectifier module.
- 7.4 Interface Signals.** The rectifier incorporates a number of interface control and supervisory signals which operate off internal circuits and are brought to the outside. These include remote enable, which enables or inhibits the entire shelf, and a current share connection which permits operating the shelf in parallel with other shelves for increased power. Other signals brought out of the shelf for each rectifier module include thermal alarm, current monitor, AC good, DC good and a remote adjust which permits adjustment of each rectifier output voltage by means of an external analog control voltage.

8.0 FRONT PANEL DESCRIPTION

The front panel of a Vanguard rectifier module is shown in Figure 3. From left to right are: output voltage adjustment potentiometer (12-turn), AC Good LED (green), DC Good LED (green) and the 5-LED (green) output current monitor which indicates 20% of full load current per LED. There are two 60 mm cooling fans and a vertical handle between them.

9.0 RECTIFIER MODULE SPECIFICATIONS

Specifications for a Single Rectifier Module. Typical at 115/230VAC Line, Full Load and 25°C Unless Otherwise Noted.

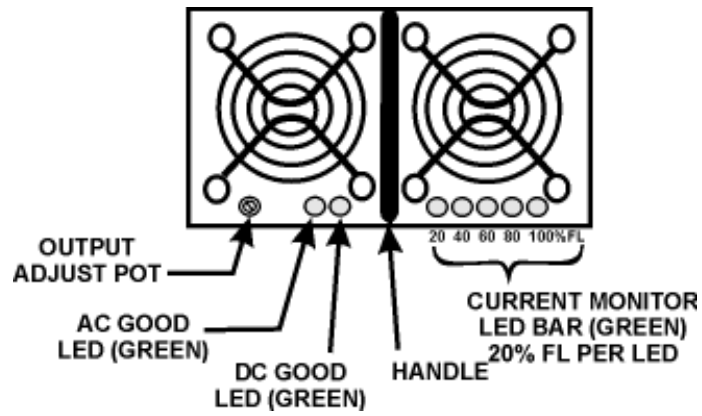


Figure 3. Front Panel of Vanguard Rectifier Module

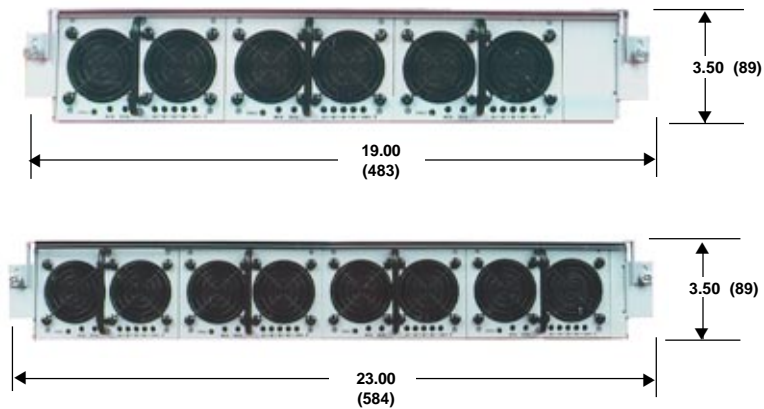
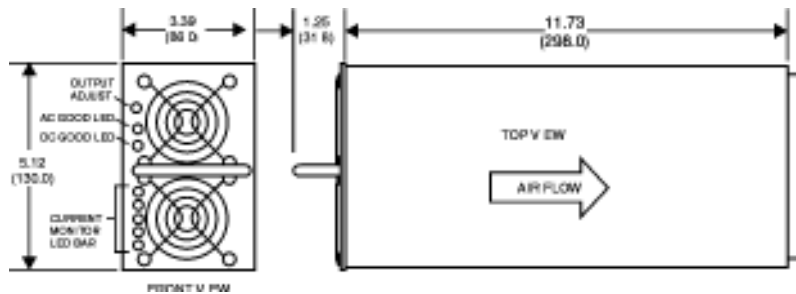


Figure 4. Vanguard Series Mechanical Dimensions

INPUT

Voltage Range	103-265VAC
Power Factor	0.99
Total Harmonic Distortion, Max.	5%
Frequency	47-63Hz
Inrush Current Limiting	50A Peak
Input Current, Full Load	10.5A@120VAC
.....	5.5A@230VAC
EMI Filter, Conducted	FCC20780 pt. 15J Curve B
.....	EN55022 Curve B
Fast Transients, Line-Line	EN61000-4-4, Level 3
Surges, Line-Line	EN61000-4-5, Level 2
Line-Ground	EN61000-4-5, Level 3

OUTPUT

Current & Voltage ¹	20A@54.4VDC
.....	40A@27.2VDC
Voltage Adjustment Range, 48V Nominal	40.0-58.0VDC
24V Nominal	20.0-29.0VDC
Line & Load Regulation, Max.	0.5%
Holdup Time	20msec.
Overvoltage Protection, 48V Out	59V
24V Out	29V
Filtering: Wideband Noise, 20MHz BW	
48V Out, P-P	500mV
24V Out, P-P	250mV
Voice Band Noise	<32dBnC
Current Limit	105% Rated Current
Efficiency	87%

SAFETY STANDARDS UL1950, CSA22.2-950, EN60-950

STATUS INDICATORS

AC Good	Green LED and Logic LO Output
DC Good	Green LED and Logic LO Output
Output Current	5-Seg. Green LED Bar Graph
.....	Proportional Analog Output Voltage
Thermal Alarm	Logic HI Output

ENVIRONMENTAL

Operating Temp. Range	0°C to +70°C
Output Current Derating	2.5%/°C, 50°C to 70°C
Storage Temp. Range	-40°C to + 85°C
Humidity	0% to 95%, Non-Condensing
MTBF	>250,000 Hours
Cooling	Internal DC Ball Bearing Fans

PHYSICAL SPECIFICATIONS

Case Material	Aluminum
Finish	Powder Coat Gray
Dimensions, Inches (mm)	
Rectifier Module	3.39 H x 5.12 W x 11.73 D (86 x 130 x 298)
19" Shelf	3.50 H x 19.00 W x 15.94 D (89 x 483 x 405)
23" Shelf	3.50 H x 23.00 W x 15.94 D (89 x 584 x 405)
Weight	
Rectifier Module	7.15 lbs (3.24 kg.)
19" Shelf	18.05 lbs (8.19 kg.)
23" Shelf	22.00 lbs. (9.98 kg.)

NOTE: 1. Voltage set at factory.

10.0 DESCRIPTION OF RECTIFIER MODULE FEATURES & OPTIONS

FEATURE / OPTION	DESCRIPTION
Power Factor Correction	The input current is a sine wave in-phase with the input voltage to give a power factor of 0.99. Input current total harmonic distortion is less than 5%.
Wide Range AC Input	The AC input range is continuous from 103 to 265VAC, 47-63Hz, for wide range operation.
EMI Input Filter	This filter suppresses conducted noise from the rectifier back onto the AC line. The filter meets FCC20780 part 15J Curve B and EN55022 Curve B.
Inrush Current Limiting	When the rectifier is turned on, the initial input current is limited to a peak value of 50 amperes.
Wide Range Output Voltage Adjustment	For a 48V unit the adjustment range is 40V to 58V. Factory voltage setting is 54.4VDC. For a 24V model the adjustment range is 20V to 29V. Factory voltage setting is 27.2VDC. The adjustment is made from the front panel by means of a 12-turn potentiometer or from the input to the remote adjust terminal.
Remote Output Adjust	This input is used to remotely adjust each rectifier output voltage. An analog voltage from 0 to +2V controls approximately 40-60V output for a 48V rectifier or 20-30V output for a 24V rectifier. This input can be controlled externally by a power control system to precisely control battery charging. The analog inputs can also be connected together so that the external control voltage adjusts all the module outputs simultaneously.

FEATURE / OPTION	DESCRIPTION
Thermal Protection	If either the PFC converter stage or the output power converter overheats, the rectifier module will automatically shut down and give an output alarm logic HI. The DC Good LED also turns off. After about 10 minutes the rectifier module will cool and automatically start up again.
Current Sharing	The Vanguard rectifier modules are automatically connected to current share with each other when they are inserted into the shelf. A single-wire connection provides this. The modules current share with an accuracy of 10% of their full load output current for total loads of 50% to 100%. The shelf current share pin can be used to current share with another shelf of the same output voltage.
ORing Diodes	This diode in series with each module output protects the parallel-connected modules. If the output of one module fails to a short or to a lower than normal output voltage, the other modules are not affected. Also when hot-swapping modules, the diode prevents a glitch in the output voltage while the output is still rising on the inserted module.
Overvoltage Protection	The output is protected from overvoltage due to fault conditions in the module. Overvoltage protection is set at approximately 59V for the 48V version and 29V for the 24V version. The result is a latched shutdown of the rectifier module. It is reset by cycling the AC input off for 20 seconds, and then on.
No Load Operation	The module output can be operated down to zero load while maintaining output regulation.
Hot Plug Connectors	The hot plug connectors used in both the modules and shelves are high-reliability connectors specifically designed for hot swap applications. They have staged pin lengths for safety and optimum operation. The ground (common) pin makes first contact and an interlock pin makes last contact, turning the rectifier module on (provided the shelf is “enabled”).
Hot Swap Operation	Hot swap operation means that the rectifier modules can be removed and replaced while the shelf is powering the load. If the shelf is operated in an N+1 redundant mode, hot-swap replacement will not affect the output voltage.
Output Protection	Output current limiting protects the output of each rectifier module from damage due to a dead battery or other short circuit condition. This protection is continuous, without damage, and recovery is automatic when the overload is removed. The current limit characteristic is essentially a constant power limit above 48V or 24V (depending on model) and a constant current limit below these values. Current limiting begins at about 105% of rated output current.

FEATURE / OPTION	DESCRIPTION
LED Indicators	The AC Good indicator is a green LED, showing that input AC is present and that the PFC converter and internal control supply are operating. The DC Good indicator is a green LED showing that the output voltage is present and within operating range. The output current monitor consists of five green LEDs in a row. Each LED, from left to right indicates 20% of full load current (4A for 48V model and 8A for 24V model).
AC Input Options	There are two input options: IEC320 connectors of which each shelf has one per rectifier module; or terminal blocks, one per module, for conduit connections. These options are chosen at the time of ordering.
Control and Monitoring Signals	For detailed description of Enable, Thermal Alarm, Current Monitor, Current Share, Remote Sense, Remote Adjust, AC Good and DC Good signals see Section 16, Description of Control and Supervisory Signals.

11.0 MECHANICAL SPECIFICATIONS

The mechanical dimensions of the Vanguard Series rectifier modules and shelves are shown in Fig. 4. Both 19-inch and 23-inch shelves are shown.

12.0 SAFETY AND INDUSTRY STANDARDS

12.1 The Vanguard rectifiers and shelves meet the following safety certifications:

STANDARD	AGENCY
UL1950	UL
CSA22.2-950	CUL
EN60-950	DEMKO

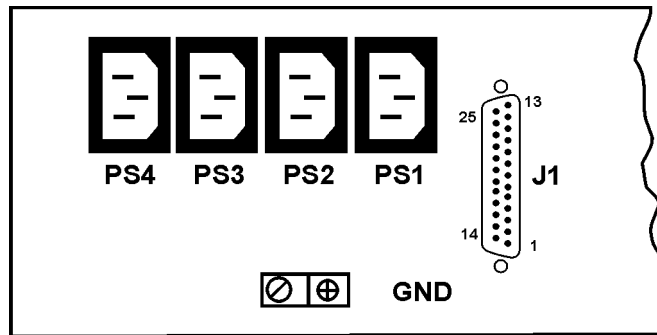
12.2 The Vanguard rectifier and shelves are CE marked to indicate conformance to the European Union's Low Voltage Directive.

12.3 Input conducted EMI meets FCC20780 part 15J Curve B and EN55022 Curve B.

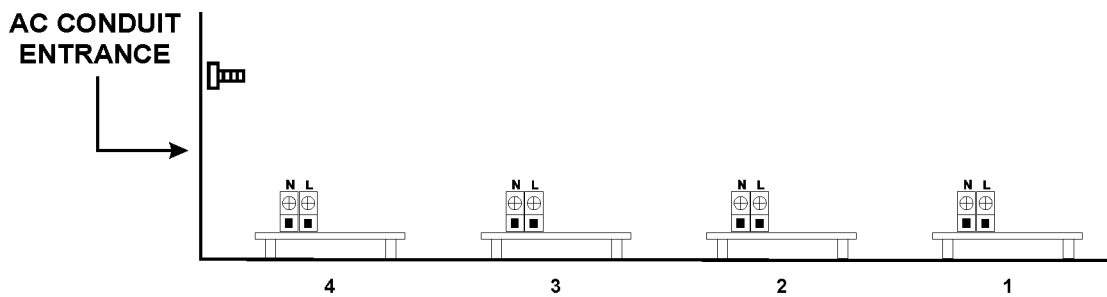
12.4 Input fast transient specifications meet EN61000-4-4 Level3; input surges, line-to-line, meet EN61000-4-5 Level 2; and input surges, line-to-ground, meet EN61000-4-5 Level 3.

13.0 OPERATING INFORMATION

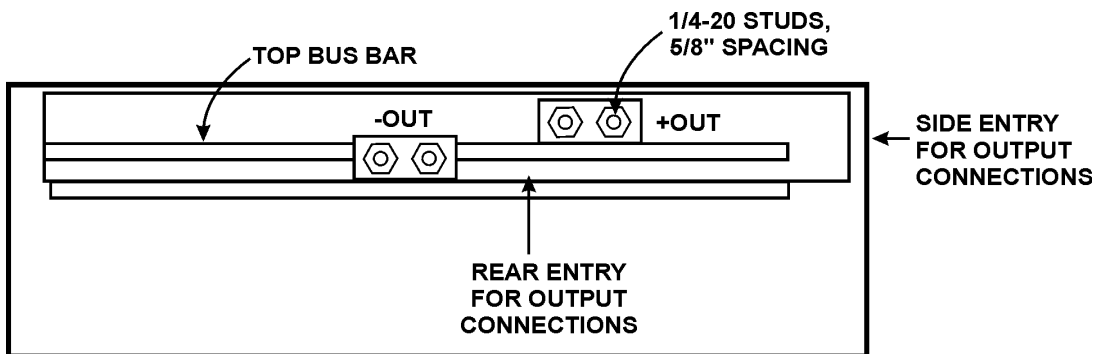
- 13.1 Input Voltage.** The Vanguard Series rectifiers operate off worldwide AC input voltages within the range of 103 to 265 VAC at 47 to 63 Hz. There are two AC input options chosen at the time of ordering: standard IEC320 connectors or conduit-cable type connections to terminal blocks. In both cases there is a separate connection for each rectifier module at the rear of the shelf. For complete details see Section 17.2 and Figure 5 (a) and (b).
- 13.2 Output Connection.** The 24V or 48V output is provided on two copper bus bars. Each bus bar has a bracket with two 1/4-20 studs with nuts. Connection should be made by means of two-hole barrel lugs. For complete details see Section 17.3 and Figure 5(c). Both positive and negative outputs are floating with a minimum 100V isolation from the chassis.
- 13.3 Output Voltage.** The output voltage of each rectifier module is factory set to 54.4V for the 48V rectifier and 27.2V for the 24V rectifier. At these voltages, a minimum current of 20A or 40A is produced, respectively. If a different output voltage is required it should be accurately set for each module by means of the front panel, high resolution, 12-turn output adjustment potentiometer. The output voltage can also be adjusted by means of the remote adjust input connected to an external voltage source. In both cases the adjustment range is 40-58V or 20-29V.
- 13.4 Output Power.** Maximum output power is 20A at 54.4 VDC or 40A at 27.2 VDC, both giving a total maximum output of 1,088 volt-amperes. The maximum output power of a module may be drawn at up to 50°C ambient temperature. Above 50°C the output current must be derated by 2.5%/°C. See Fig. 6. The maximum operating temperature is 70°C, at which the output current must be derated by 50%.
- 13.5 Output Overload Protection.** Each rectifier module output is protected from damage due to overload, a dead battery or another short circuit condition. This protection is continuous and without damage; recovery is automatic when the load is removed. The current limit characteristic is shown in Fig. 7. and is essentially a constant power limit above 48V or 24V (depending on model) and a constant current limit below these voltages. At 54.4V limiting takes place at approximately 21A; at 27.2V it takes place at approximately 42A. These currents are 5% above the rated output currents at the given voltages.



(a) Rear View of IEC 320 AC Input Connections



(b) Rear View of Conduit AC Input Connections



(c) Rear View of DC Output Connections

Figure 5. Rear Shelf Input & Output Connections

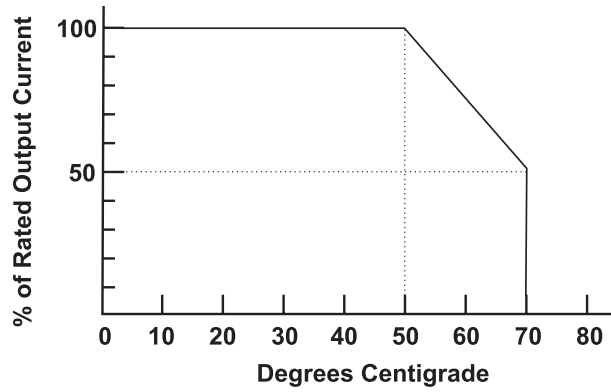
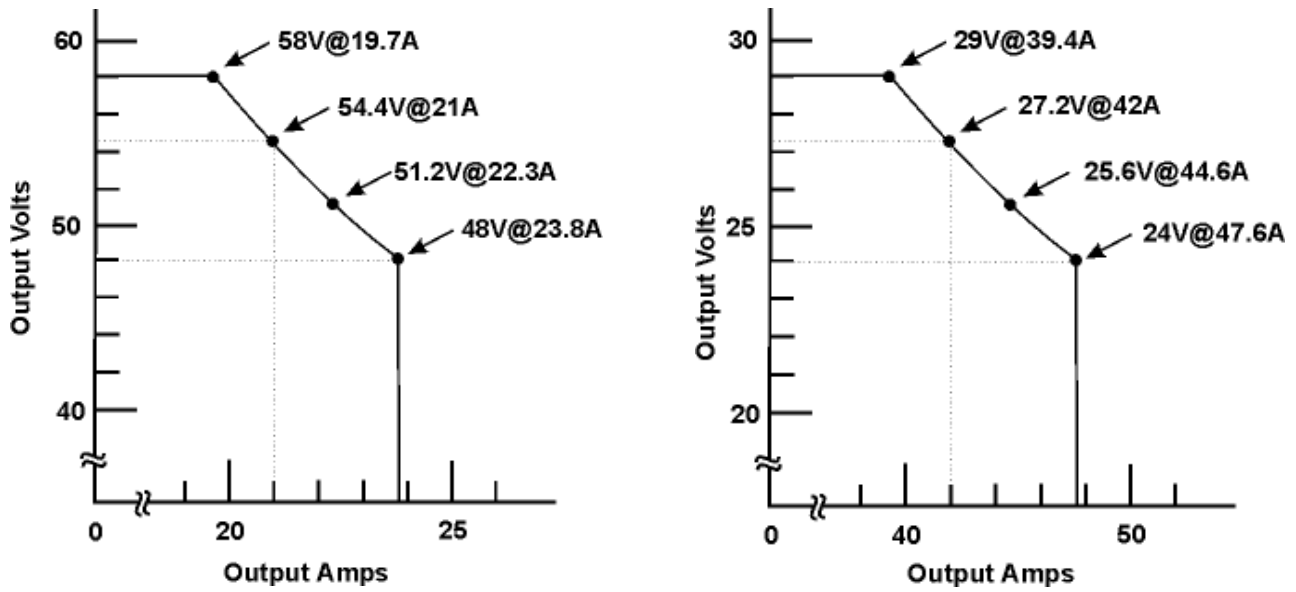


Figure 6. Rated Output Current vs. Ambient Temperature



(a) 48V Rectifier

(b) 24V Rectifier

Figure 7. Typical Rectifier Current Limit Characteristics

- 13.6 Remote Sensing.** Remote sensing connections are made to pins 11 (+Sense) and 23 (-Sense) of the rectifier shelf J1 connector. Remote sensing is used to regulate the output voltage at the point of load, i.e., a battery or other load, by compensating for the voltage drop in the wires to the load. The +Sense lead must be connected to the + side of the load and the -Sense to the - side of the load. The sense leads should be a color-coded, twisted pair of AWG no. 22 or 24 copper wire. See Fig. 8.

Remote sensing can compensate for a total voltage drop of 1.0V, or 0.5V per load wire. The sense leads should not exceed 10 feet (3 meters) in length. If remote sensing is not required, the sense leads may be left open; there is an internal 10-ohm resistor connected from each output to its remote sense lead.

Be careful not to reverse the sense lead connections, as this will blow the 10-ohm resistors.

- 13.7 Control Supervisory Signals.** All control and supervisory signals are accessible at J1, a 25-pin subminiature D connector on the back of the rectifier shelf. See Section 16 for a complete description of these input and output signals.
- 13.8 Alarm Signals.** Among the control and supervisory signals are three sets of logic alarms: thermal alarm, AC good and DC good. All are opto-isolated, floating, open collector, TTL-compatible signals referenced to Signal Common, J1 Pin 22. There are three logic alarms for each rectifier module. The first alarm is **Thermal Alarm**. When a rectifier module internally overheats, this logic signal goes HI 100 msec. before the rectifier automatically shuts down. After about 10 minutes the module will cool down and automatically start up again. The next alarm is **AC Good**. A logic HI indicates that there is no AC input or that the PFC converter stage has failed. The third alarm is **DC Good**. A logic HI indicates a DC output failure or a cooling fan failure.

14.0 PARALLEL OPERATION

The rectifier modules in the shelf are all connected in the parallel, current sharing mode by means of a single-wire current share connection among them. A shelf can be operated in either an N+1 redundant mode or non-redundant mode.

- 14.1 Redundant Operation.** From Table 14-1, the 19-inch shelf can be operated in a 2+1 redundant mode and the 23-inch shelf can be operated in a 3+1 redundant mode. This means, in the former case for example, that the full load current must be carried by two rectifier modules. While operating

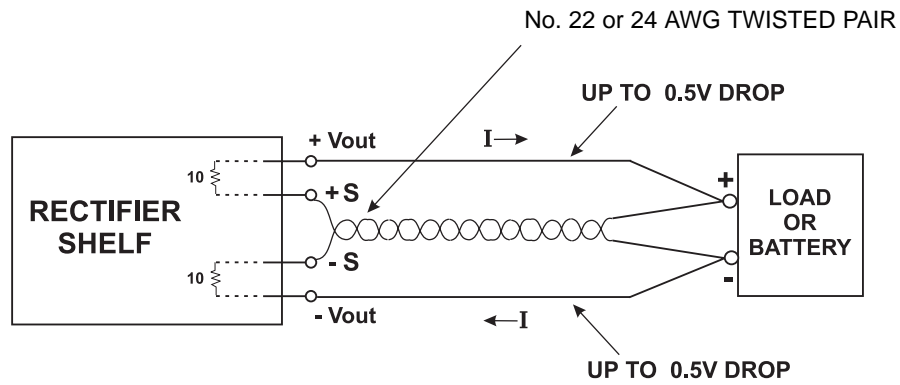


Figure 8. Remote Sensing Connection

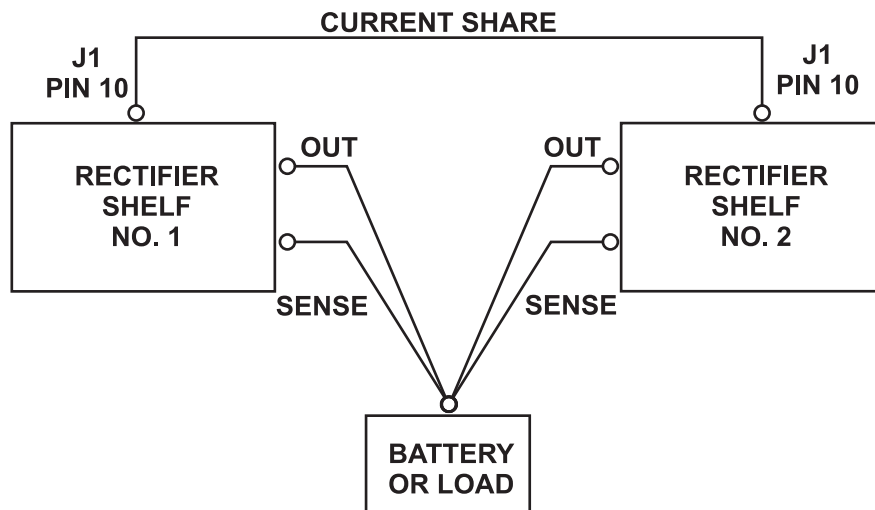


Figure 9. Parallel Connection Vanguard Shelves.

normally, the current is shared approximately equally among the three modules. If one module fails, however, the output current is then maintained by the two operating modules. The failed unit can be replaced without affecting the output current to the load. N+1 redundancy with quick replacement of a failed module results in virtually infinite MTBF.

Table 14-1 Redundant and Non-Redundant Operation

MODE	SHELF WIDTH	NUMBER OF MODULES	NOM. VOLTS	AMPS MAX.
Redundant, 2+1	19-inch	3	48	40
Non-Redundant	19-inch	3	48	60
Redundant, 3+1	23-inch	4	48	60
Non-Redundant	23-inch	4	48	80
Redundant, 2+1	19-inch	3	24	80
Non-Redundant	19-inch	3	24	120
Redundant, 3+1	23-inch	4	24	120
Non-Redundant	23-inch	4	24	160

14.2 Non-Redundant Operation. Higher output current can be achieved by operating the shelf in a non-redundant mode as seen in Table 14-1. However, in this case if a rectifier module fails, the load will lose power since only part of the required current can be supplied by the remaining modules, and they will go into current limit. The failed rectifier module, however, can be quickly replaced to restore the load current.

14.3 Multiple Parallel Shelf Operation. Multiple shelves can also be operated in parallel by interconnecting their current share terminals (J1 Pin 10). The total power can be expanded by several times. In this case N+1 redundant operation is achieved by reserving one module of the total for redundancy. For example, if two full 19-inch shelves are employed with a total of six rectifier modules, then for 5+1 redundancy the full load must be able to be carried by the output of five modules. In such applications each set of remote sense wires must be separately connected to the battery or point of load. See Figure 9 for a simplified illustration of two rectifier shelves connected in parallel.

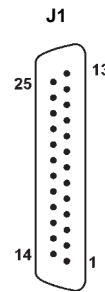
15.0 CONTROL & SUPERVISORY SIGNAL CONNECTIONS

15.1 Connections for control and supervisory signals are made at the shelf rear to connector J1, a standard 25-pin subminiature D connector (Positronics No. SD25F0S500X with FC752OD pins). The mating connector is Positronics SD25M000OZ with MC752OD pins.

15.2 The pin connections to J1 are shown in the table. Note that five of the pins (asterisked) are for connection to the fourth rectifier module in a 23-inch wide shelf.

J1 SIGNAL CONNECTOR

PIN	FUNCTION	PIN	FUNCTION
1	Remote Enable	14	AC Good-1
2	Thermal Alarm-1	15	DC Good-1
3	Current Monitor-1	16	AC Good-2
4	Thermal Alarm-2	17	DC Good-2
5	Current Monitor-2	18	AC Good-3
6	Thermal Alarm-3	19	DC Good-3
7	Current Monitor-3	20	AC Good-4*
8	Thermal Alarm-4*	21	DC Good-4*
9	Current Monitor-4*	22	Signal Common
10	Current Share	23	-Sense
11	+ Sense	24	Remote Adjust-1
12	Remote Adjust-2	25	Remote Adjust-3
13	Remote Adjust-4*		



Standard subminiature
D Connector
(Positronics
SD25F0S500X
with FC752OD pins)

* These pins are used only on the 23-inch shelf. On the 19-inch shelf they are No Connection.

16.0 DESCRIPTION OF CONTROL AND SUPERVISORY SIGNALS

SIGNAL	PIN	DESCRIPTION
Remote Enable	1	This is an opto-isolated input. A TTL LO (sinking 5mA) or short to Pin 22 enables (turns on) all rectifier modules in the shelf. This input is referenced to Signal Common, Pin 22.
Thermal Alarm - 1	2	These are opto-isolated, floating, open collector outputs for the designated rectifier modules. A TTL LO (sinks 10mA) is normal. A TTL HI indicates thermal shutdown and occurs 100 msec. before the rectifier shuts down. These outputs are referenced to Signal Common, Pin 22.
Thermal Alarm - 2	4	
Thermal Alarm - 3	6	
Thermal Alarm - 4	8	
Current Monitor - 1	3	These are analog output voltages which are proportional to the output currents of the designated rectifier modules over the full load range. The scale is linear, 0 to +5V, with full scale representing 25A for a 48V rectifier module and 50A for a 24V module. These outputs are referenced to -Sense, Pin 23.
Current Monitor - 2	5	
Current Monitor - 3	7	
Current Monitor - 4	9	

SIGNAL	PIN	DESCRIPTION
Current Share	10	This is an analog control signal made up of the current share signals of all rectifier modules connected together. This pin is used to connect to Pin 10 of another identical rectifier shelf to share output currents. Output currents between shelves are shared within an accuracy of 10% of full load current over a 50% to 100% load range. This signal is referenced to -Sense, Pin 23.
+ Sense - Sense	11 23	These remote sense leads should be connected as a twisted pair to the respective + and - load points to provide regulation at the point of load. Removal of the sense leads transfers regulation control to the output terminals of the rectifier shelf via internal 10-ohm sense resistors.
Remote Adjust - 1 Remote Adjust - 2 Remote Adjust - 3 Remote Adjust - 4	24 12 25 13	These are analog voltage inputs to the designated rectifier modules by which the output voltage is adjusted. A zero to + 2V input represents approximately 40 to 60V output for a 48V rectifier module or 20 to 30V for a 24V module. This input should be driven from a source impedance less than 100 ohms and is referenced to -Sense, Pin 23. If the input control voltage is above 2.5V or the pin is left open, the output voltage reverts to the value determined by the front panel potentiometer setting.
AC Good - 1 AC Good - 2 AC Good - 3 AC Good - 4	14 16 18 20	These are opto-isolated, floating, open collector outputs for the designated rectifier modules. A TTL LO (sinks 10mA) indicates the AC input is present and the PFC converter stage has output. A TTL HI indicates AC input or PFC converter failure. This signal is referenced to Signal Common, Pin 22.
DC Good - 1 DC Good - 2 DC Good - 3 DC Good - 4	15 17 19 21	These are opto-isolated, floating, open collector outputs for the designated rectifier modules. A TTL LO (sinks 10mA) indicates that the unit is operating properly with output voltage in its controllable range. A TTL HI indicates the output is outside the 40-60V range for a 48V rectifier or outside the 20-30V range for a 24V rectifier, the unit has failed or is in current limit, or there is a cooling fan failure. This signal is referenced to Signal Common, Pin 22.
Signal Common	22	This is the reference common for the opto-isolated floating outputs. This common floats with the external logic common.

17.0 INSTALLATION

- 17.1 Mounting.** The Vanguard Series rectifier shelves are mounted in a rack by means of mounting brackets on each side of the shelves. One set of standard brackets is supplied with each shelf. There are four different bracket positions on the side of the shelf, from front position to 6 inches from the front. When mounting, the shelf should be first be securely mounted to the rack, then the rectifier modules inserted into the shelf. The rectifier modules should be secured by tightening the thumbnuts which hold the retaining bracket in place.
- 17.2 AC Input Connections.** There are two AC input options for the rectifier shelves. See Figure 5(a) and (b). The first option uses IEC320 connectors for standard IEC power cords. As shown there are three or four separate connectors on the back of the shelf, one for each rectifier module, depending on whether the shelf is for a 19- or 23-inch rack. At full power for 120VAC input, each module draws about 10.5 amperes and must be connected to its own 15-ampere AC circuit.
- The second input option is for a conduit type connection where the AC line for each rectifier module is connected to a two-terminal barrier strip. There is one terminal block for each module. Safety ground connections must be made to the chassis ground terminal as shown in the diagram.
- 17.3 DC Output Connections.** The DC output connections are shown in Figure 5(c). The positive and negative output connections are made to the copper bus bars as shown. The upper bar is positive and the lower one negative. Each bar has a bracket with two $\frac{1}{4}$ - 20 studs with nuts. Connection to the bus bars should be made by means to two-hole barrel lugs. The output wires should be sized in accordance with the load current and length of conductor. Table 17-1 shows minimum permissible copper wire size up to 50°C ambient temperature.
- 17.4 Contact Resistance.** The two-hole barrel lugs should be clean, and a tight, firm connection should be made to the output terminals to minimize contact resistance.
- 17.5 Control and Supervisory Signal Connections.** These connections are made to J1, a subminiature D 25-pin connector (Positronics No. SD25F0S500X) by means of the mating connector. Details for these connections are given in Section 15.

- 17.6 Cooling.** Each rectifier module is cooled by two 60 mm, internal DC ball bearing fans. For proper cooling the area in front of the fans and around the air exits should be kept clear for unimpeded air flow.

Table 17-1 Minimum Output Copper Wire Sizes

SHELF NOM. VOLTAGE	NO. OF MODULES	MAX. OUTPUT CURRENT	MINIMUM WIRE SIZE	WIRE CIRCULAR MILS	VOLTAGE DROP* PER LOOP FOOT
48V	1	20	# 12 AWG	6,530	77.2mV
	2	40	# 8 AWG	16,510	62.2mV
	3	60	# 6 AWG	26,250	58.9mV
	4	80	# 4 AWG	41,740	49.3mV
24V	1	40	# 8 AWG	16,510	62.2mV
	2	80	# 4 AWG	41,740	49.3mV
	3	120	# 2 AWG	66,360	46.6mV
	4	160	# 1/0 AWG	105,600	39.0mV

* Loop foot is a one-foot distance from rectifier output to load. Voltage drop is the total drop for both wires.

18.0 MAINTENANCE

No routine maintenance is required on the Vanguard Series except for periodic cleaning of dust and dirt around the fans and the ventilation holes. A small vacuum nozzle should be used for this.

19.0 RECTIFIER AND SHELF SETUP AND TESTING

- 19.1** The rectifier modules and shelf can be initially tested mounted in a rack or on a test bench. The rectifier system is initially tested one rectifier module at a time in the shelf.
- 19.2** Connect a three-wire AC power line to the PS-1 (rectifier module no. 1) IEC320 connector on the back of the shelf. Alternatively, a conduit AC line can be connected to the module no. 1 input terminal block. Be sure to connect the AC safety ground wire to the shelf ground terminal. Do not plug the AC line into the power socket yet.
- 19.3** Connect a resistive power load across the DC output terminals. This load can be a DC electronic load that is set to the resistive mode or a high-power resistor that has the proper power capacity and cooling. For this test the load should be between 10% and 50% of the full load rating of the rectifier. For the 48V rectifier the resistor should be between 5 and 27 ohms; for the 24V

rectifier it should be between 1.4 and 7 ohms.

- 19.4** Connect a color-coded, twisted pair (no. 22 or 24 AWG) from the remote sense pins to the load. The +Sense lead (J1 Pin 11) **must go** to the positive side of the load and the - Sense lead (J1 Pin 23) must go to the negative side of the load. **Connect a wire from Remote Enable (J1 Pin 1) to Signal Common (Pin 22). This connection must be made for the module to operate.**
- 19.5** Insert one of the rectifier modules into slot 1 of the shelf (leftmost slot.) Plug the AC power in and measure the voltage across the load at the remote sense points with a digital voltmeter. The voltage should be approximately 54.4V for a 48V rectifier or 27.2V for a 24V rectifier. If a different output voltage is desired, it should be set by means of the voltage adjustment potentiometer on the front panel.
- 19.6 Checking the Front Panel LEDs.** The AC Good and DC Good LEDs should both be green. The current monitor LED bar should be green in proportion to the output load current (20% of full load per LED).
- 19.7 Checking the Current Monitor Output.** Measure the voltage at the Current Monitor output (J1 Pin 3 to - Sense Pin 23) with a digital voltmeter. The output voltage should be approximately +0.2V per ampere of load current for a 48V module and approximately +0.1V per ampere for a 24V module.
- 19.8 Checking the Remote Enable Input.** Next, disconnect the Remote Enable wire going from J1 Pin 1 to Pin 22. The rectifier output should turn off, giving zero volts across the load. The DC Good LED should go off.
- 19.9 Checking the AC Good and DC Good Outputs.** Connect the - lead of an external 5V power supply to Signal Common (J1 Pin 22). Connect one end of a 2K resistor to the + lead of the 5V supply and the other end to the AC Good output (J1 Pin 14). Connect one end of another 2K resistor to the + lead of the 5V supply and the other end to the DC Good output (J1 Pin 15). See Figure 10. Reconnect the Remote Enable wire. Measure the output voltage at both J1 Pins 14 and 15 with respect to Signal Common (Pin 22) with a digital voltmeter. Both voltages should be less than 0.5VDC, indicating a TTL LO.
- 19.10 Checking the Remote Adjust Input.** Connect a 200-ohm resistor and 200-ohm potentiometer to an external 5V power supply as shown in Figure 11. Connect the wiper arm of the pot to the Remote Adjust input, Pin 24. With

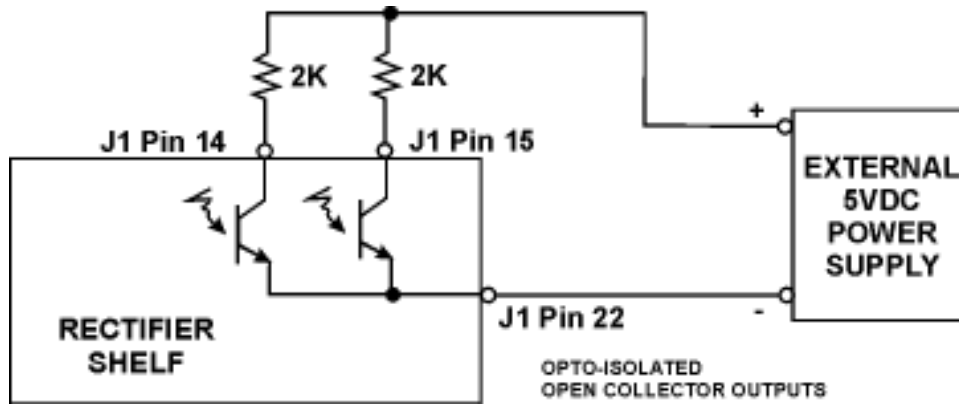


Figure 10. Checking AC Good and DC Good Outputs

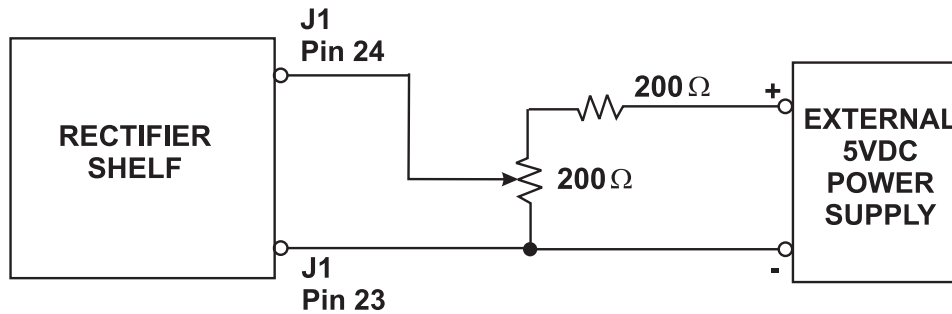


Figure 11. Checking Remote Adjust Input

the voltage at the wiper arm set to zero, check the output voltage of the rectifier module with a digital voltmeter. For a 48V unit it should be approximately 40V and for a 24V unit it should be approximately 20V. Next, adjust the wiper arm to +2V and check the output voltage of the rectifier module. For a 48V unit it should be approximately 58V and for a 24V unit it should be approximately 29V. Unplug the external 5V supply and unplug the AC input to the rectifier shelf.

19.11 Checking the Other Rectifier Modules. Each rectifier module should be tested in the above manner to verify its operation. Go back to Section 19.5 and proceed through the tests one by one until all rectifier modules have been verified.

19.12 Checking the Complete Rectifier Shelf. Confirm that the output voltages of the individual rectifier modules are all accurately set to 54.4 or 27.2 (for 48V or 24V rectifier modules respectively) or to another required voltage. The voltages between modules should be set to within 50mV of each other for best performance of the current sharing circuitry. Insert all rectifier modules into the shelf. Connect a power load -- high-power resistor or electronic load in resistive mode -- in accordance with the table, to the output of the shelf. Connect the + and - Sense leads to + and - sides of the load, respectively, as in Section 19.4.

Table 19-1 Rectifier Shelf Loads For Test

SHELF	NO. RECT. MODULES	OUTPUT VOLTAGE	LOAD CURRENT	LOAD RESISTOR
19"	3	54.4	30-40A	1.36 - 1.81Ω
19"	3	27.2	60-80A	0.34 - 0.45Ω
23"	4	54.4	50-60A	0.91 - 1.09Ω
23"	4	27.2	100-120A	0.23 - 0.27Ω

Note that on the back of the shelf each rectifier module has its own AC power connection. For this test each rectifier should be connected to a separate 15A AC circuit. Plug the rectifier shelf into the AC power source.

Check the load voltage with a digital voltmeter. It should be very close to 54.4 or 27.2VDC, depending on the model tested. The AC Good and DC Good LEDs should both be green on each rectifier module. Two or three current monitor LEDs should be on for each module, depending on the value of the load current.

Next, check the Current Monitor output voltage of each rectifier module. The modules should be sharing the load current approximately equally. Measure the voltage from pins 3, 5, 7 and 9 to the -Sense Pin 23. The voltages should all be within 10% of each other. Pin 9 is measured only for the four-module shelf.

While the shelf is operating, pull Module no. 1 out while monitoring the output voltage with a digital voltmeter. It should remain the same. Insert the module back into the shelf. Repeat this for each of the other modules. This test determines that hot-swapping is functioning properly in the N+1 redundant mode.

With all the modules inserted into the shelf, check the Enable input for the entire shelf. Disconnect the Remote Enable wire going from J1 Pin 1 to Pin 22. The shelf output should turn off and the output voltage go to zero. Reconnect the Remote Enable wire.

This completes the shelf setup and testing.

20.0 TROUBLE SHOOTING GUIDE

20.1 If you encounter difficulties in getting the rectifier modules or shelf to operate properly, go through the following troubleshooting guide.

20.2 Table 20-1. Vanguard Rectifier Troubleshooting

SYMPTOM	POSSIBLE CAUSE	ACTION TO TAKE
No output, AC Good and DC Good LEDs off.	No input power.	Check connection to AC source. Check AC source circuit breakers.
No output, DC Good LED off, AC Good LED on.	Remote Enable in OFF mode.	Make sure J1 Pin 1 (Remote Enable) is connected to Pin 22, Signal Common.
No output, DC Good LED off, AC Good LED on, LED Bar Graph on	Shorted output.	Check for short and remove.
No output, DC Good LED off, AC Good LED on.	Overvoltage protection (OVP) has latched.	Reset output by cycling the AC input OFF for 20 seconds, and then back ON.

Table 20-1. (Continued)

SYMPTOM	POSSIBLE CAUSE	ACTION TO TAKE
No output, DC Good LED off, AC Good LED on.	Overtemperature protection is activated on one or more rectifier modules.	Check the open collector Thermal Alarm output of each module for a logic HI or open, indicating activated thermal protection. Allow module to cool down for about 10 minutes. It will then start up automatically. Check to see if the cooling fans are operating.
No output, DC Good LED off, AC Good LED on, LED Bar Graph on.	Output load is too great for the number of rectifier modules.	Reduce load to proper level.

20.3 If none of the above actions solves the problem, call UNIPOWER Telecom 954-346-2442 Ext. 400 for help and try to resolve the problem over the telephone.