PRICE: $25.00

OPERATING MANUAL
VANGUARD™ TVN SERIES
BULK POWER FRONT END

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Manual No. TVN-900-2
8/29/01 TVN-Man

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ILLUSTRATIONS

OPERATING MANUAL
VANGUARD™ TVN SERIES BULK POWER FRONT END

1.0 INTRODUCTION

This operating manual should be read through carefully before installing and operating the Vanguard™ TVN Series hot-swap, bulk power front end.

The TVN Series hot-swap modules and rack mount form a bulk power front end with high-power outputs at 24 or 48VDC. See Figure 1. Each module has a 1000-watt output: 24V at 42A or 48V at 21A. Three modules in a rack produce 24V at 126A or 48V at 63A. Using the three modules in a 2+1 redundant configuration produces 24V at 84A or 48V at 42A (2000 watts). The modules have single-wire active load sharing for automatic paralleling of outputs, and output ORing diodes permit hot-swap addition or replacement of modules while the system is operating.

The TVN Series operates worldwide with a 85-264VAC input range at 47-63Hz. Each module has input power factor correction and a Class B EMI filter. The output voltage is tightly regulated. There is a green AC power good LED and green DC power good LED on the front panel. Each module is self-cooled by two 60mm internal fans.

The TVN Series rack has two copper bus bars for the output and two small connectors at the back of each module for the control functions: AC power good, DC power good, current share, enable, thermal alarm, current monitor, high and low margin, OVP reset, module present, remote adjust and remote sense. There is also a 5V 100mA auxiliary output for powering external control circuits.

The hot-swap modules and racks are safety agency certified and CE marked.

2.0 FEATURES

The following is a summary of the important features of the TVN Series modules:

- For Distributed Power Systems
- Tightly Regulated Output Voltage
- 1000-Watt Modules
- Output Overload Protected
- 24 and 48VDC Versions

Figure 1. TVN Series Bulk Power Front End.

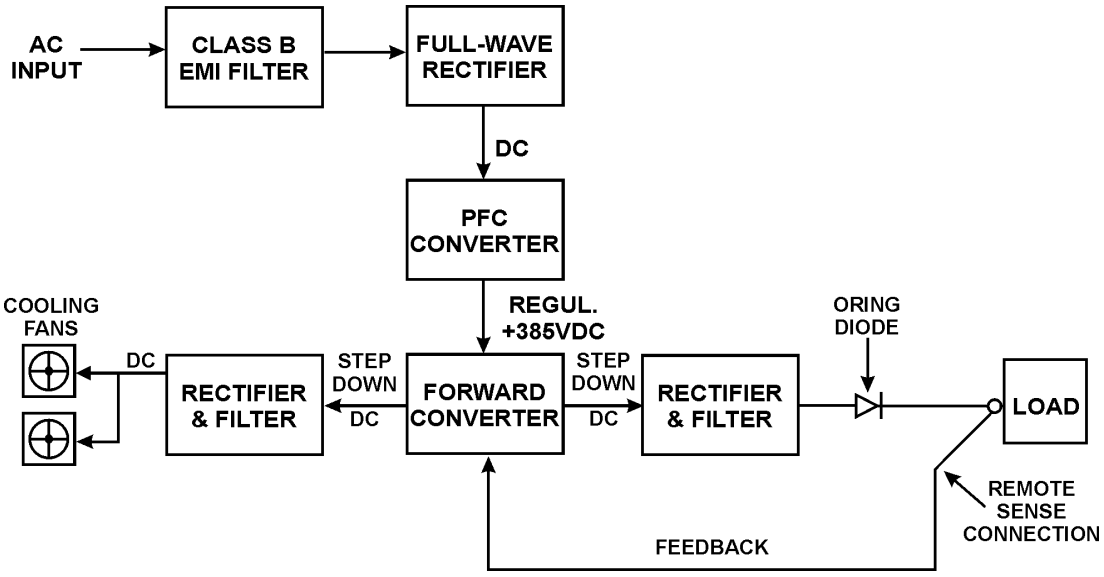


Figure 2. TVN Series Module Block Diagram.

- Low Profile: 2U(3.43 inches or 87mm) Height
- 2U or 3U 19 -Inch Racks
- Rack Capacity: Up to 5 Modules
- High Power Density: 5.6 Watts/Cubic Inch
- 85% Efficiency
- 0.98 Power Factor
- Class B EMI Input Filter
- Worldwide Input: 85-264 VAC at 47-63Hz
- Up to 5000W Redundant or 4000W Non-Redundant
- Remote Sensing
- Active, Single-Wire Load Sharing
- Integral ORing Diodes
- Hot-Swappable Modules
- Front Panel Switch Option
- LED Operating Indicators
- Control and Monitoring Interface Signals

3.0 PRODUCT LINE

3.1 Hot-Swap Modules

MODEL	MAX. WATTS	OUTPUT VOLTAGE	MAX. OUTPUT CURRENT
TVN5000	1000	24	42A
TVN7000	1000	48	21A

3.2 Racks

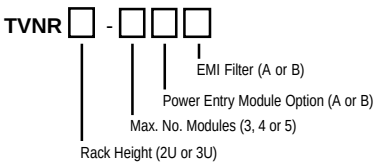
MODEL	WIDTH	HEIGHT	MAX. NO. OF MODULES
TVNR2U	19" (483MM)	3.43" (87MM)	3
TVNR3U	19" (483MM)	5.21" (132MM)	5

3.3 System Rack Options

RACK MODEL SELECTION GUIDE

RACK HEIGHT	MAX. NO. MODULES	CODE	POWER ENTRY MODULE	EMI FILTER
2U	3	A	Standard: Single terminal block, rear AC entry.	A = Class A B = Class B
		B	Optional: Three IEC line cord connectors for rear AC entry. Three ON/OFF switches on front panel of Power Entry Module.	
3U	4	A	Standard: Single terminal block, rear AC entry. 220/230VAC only.	B = Class B
		B	Optional: Dual IEC line cord connectors for rear AC entry. Two ON/OFF switches on front panel of Power Entry Module. 220/230VAC only.	
3U	5	A	Standard: No Power Entry Module. Single terminal block, rear AC entry. 220/230VAC only.	A = Class A (only)

Rack Designation



4.0 SAFETY WARNINGS

4.1 These hot-swap modules and racks 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 power 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 module covers should not be removed. There are no user-serviceable components in these units. Removing the covers of the modules will void the warranty.

5.0 WARRANTY

All products 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 TVN Series Power 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 Corporation 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 TVN Series 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 24 or 48VDC 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, switching at 50kHz, achieves a power factor of 0.98 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 DC ball bearing cooling fans in the module.

7.4 **Interface Signals.** The module 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 module, and a current share connection which permits operating the rack in parallel with other racks for increased power. Other signals brought out of the rack mount for each module are AC good, DC good, thermal alarm, current monitor, high and low margin, OVP reset, module present and a 5VDC auxiliary output.

8.0 FRONT PANEL DESCRIPTION

The front panel of a TVN Series module is shown in Figure 3. On the left side of the panel are the output adjustment potentiometer, AC Good LED (green) and DC Good LED (green). On the right side is a five-LED output-current bar graph. There are two cooling fans and a handle in between them.

9.0 TVN MODULE SPECIFICATIONS

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

OUTPUT SPECIFICATIONS

Total Output Power, Max.	1000 watts
Output Voltage Adj. Range, 24V	20-29VDC
48V	40-58VDC
Total Regulation[1].	<±1.0%
Ripple & Noise (Pk-Pk)[2].	<1%
Hold-Up Time [3].	>20mS
Dynamic Response[4].	1mS
Temperature Coefficient.	±0.02%/°C
Minimum Load.	0A
Overload Protection.	Constant Power Limiting
Overvoltage Protection	Selective Latched Shutdown
Remote Sense	Up to 0.5V Per Wire

INPUT SPECIFICATIONS

Input Voltage Range	85-264VAC Single Phase
Power Factor	0.99
Input Frequency	47-63Hz
Inrush Limiting	50A Peak
Input Current, Full Load	9.8A, 120VAC
	5.1A, 230VAC
Input EMI Filter, Conducted	EN55022 Curve B
	FCC20780 pt. 15J Curve B

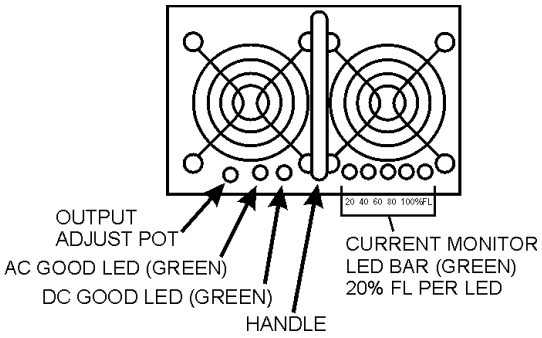


Figure 3. Front Panel of TVN Series Module

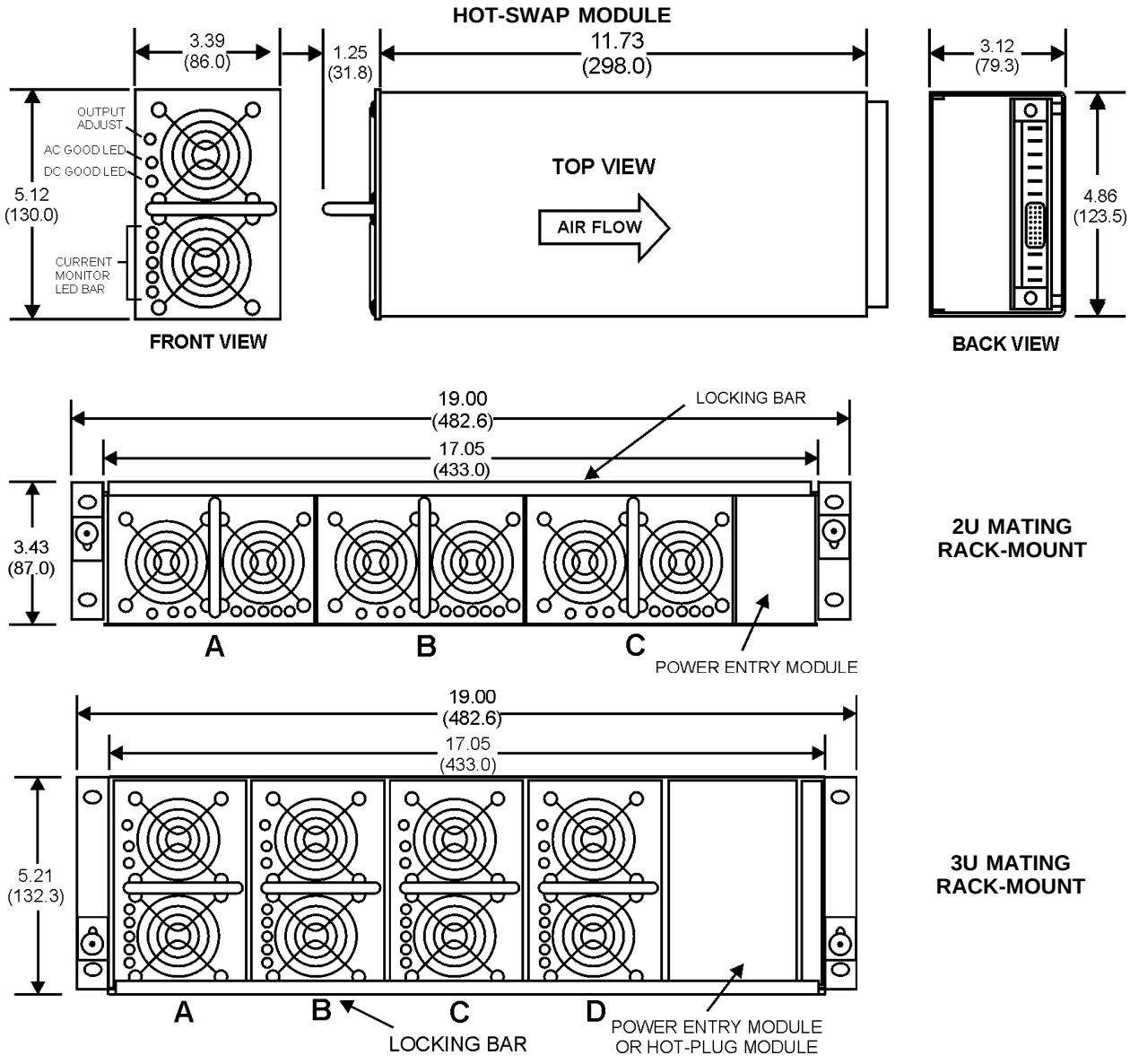


Figure 4. TVN Series Mechanical Dimensions

Harmonic Distortion	EN61000-3-2
Input Immunity, Conducted	
Fast Transients, Line-Line	±2kV (EN61000-4-4 Level 3)
Surges, Line-Line	±1kV (EN61000-4-5 Level 2)
Surges, Line-Ground	±2kV (EN61000-4-5 Level 3)
Input Protection	Internal Fuse, 20A

GENERAL SPECIFICATIONS

Efficiency	>85% at Full Load
Switching Frequency	80kHz Nominal
Overtemperature Protection	Power Shutdown
Isolation, class I [5].	>3000VAC Input - Output
	>1500VAC Input - Ground
	>50VDC Output - Ground
Safety Standards	EN60-950, UL1950, CSA22.2-950

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature	0°C to 70°C Ambient
Derating	2.5% / °C, 50°C to 70°C
Storage Temperature	-40°C to +85°C
Cooling	Integral Ball Bearing Fans

PHYSICAL SPECIFICATIONS

Case Material	Aluminum
Dimensions, Inches (mm)	
Hot-Plug Module	3.1 H x 4.9 W x 11.7 D
	(79 x 124 x 298)
3-Module Rack	3.4 H x 17.1 W x 14.7D
	(87 x 434 x 374)
5-Module Rack	5.2 H x 17.1 W x 14.7 D
	(132 x 434 x 374)
Weight, Module	7.15lbs. (3.24 kg.)

NOTES:
1. At remote sense point over full line range and 0-100% load change.
2. 20MHz bandwidth. Measured with 0.1µF ceramic and 10µF tantalum capacitors in parallel across the output.
3. 1000W output power at nominal AC line.
4. <5% deviation recovering to within 1% for 50% load change.
5. Using single wire current share with remote sense connected.
6. Input - output isolation figure is for isolation components only.
   100% production Hipot tested.

10.0 DESCRIPTION OF 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 0.98. Input current total harmonic distortion meets EN61000-3-2.
Wide Range AC Input	The AC input range is continuous from 85 to 264VAC, 47-63Hz, for worldwide operation.
EMI Input Filter	This filter suppresses conducted noise from the module back onto the AC line. The filter meets FCC20780 part 15J Curve B and EN55022 Curve B.
Inrush Current Limiting	When the module is turned on, the initial input current is limited to a peak value of 50 amperes.
Thermal Protection	If the PFC converter or the output power converter overheats, the TVN module will automatically shut down and give a thermal alarm TTL HI. The DC Good LED also turns off. After about 10 minutes the module will cool and automatically start up again.
Current Sharing	The TVN modules are automatically connected to current share with each other when they are inserted into the rack. 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 rack current share pin can be used to current share with another rack 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 29V for the 24V version and 59V for the 48V version. The result is a latched shutdown of the module. It is reset by cycling the AC input off for about 20 seconds and then back on, or by holding the OVP Reset LO.
No Load Operation	The module output can be operated down to zero load while maintaining output regulation.
AC Input Options	There are two input versions: A two-position terminal block for conduit connection (standard) or IEC320 connectors (option B).

FEATURE / OPTION	DESCRIPTION
Hot-Swap Connectors	The hot-swap connectors used in both the modules and racks 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 module on (provided the rack is "enabled").
Hot Swap Operation	Hot swap operation means that the modules can be removed and replaced while the rack is powering the load. If the rack 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 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. Current limiting begins at about 105% of rated output current.
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).
Control and Monitoring Signals	For detailed description of Remote Enable, Current Share, Thermal Alarm, Current Monitor, High & Low Margin, OVP Reset, Module Present, Remote Adjust, Remote Sense, AC Good and DC Good signals see Section 17, Description of Control and Supervisory Signals.

11.0 MECHANICAL SPECIFICATIONS

The mechanical dimensions of the TVN Series modules and rack are shown in Figure 4.

12.0 SAFETY AND INDUSTRY STANDARDS

12.1 The Vanguard TVN modules and racks meet the following safety certifications:

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

12.2 The TVN modules and racks 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.

12.1 Input fast transient specifications meet EN61000-4-4 Level 3; 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 TVN Series modules operate off worldwide AC input voltages within the range of 85 to 264 VAC at 47 to 63 Hz. There are two AC input versions of the racks to chose from. The standard model has a two-position terminal block for a conduit cable connection. An optional version, Option B, has IEC320 connectors. For complete details see Section 18.2 and Figure 5.

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 18.3 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 module is factory set to 24 or 48 volts, ±1%.

13.4 Output Power. Maximum output current is 42A at 24 VDC or 21A at 48 VDC, giving a maximum output power of 1000 watts. The maximum output power of a module may be drawn up to 50°C ambient temperature. Above 50°C the output current must be derated by 2.5%/°C. See Figure 6. The maximum operating temperature is 70°C, at which the output current must be derated by 50%.

13.5 Output Overload Protection. Each module output is protected from damage due to overload or other short circuit condition. This protection is continuous and without damage; recovery is automatic when the overload or short is removed.

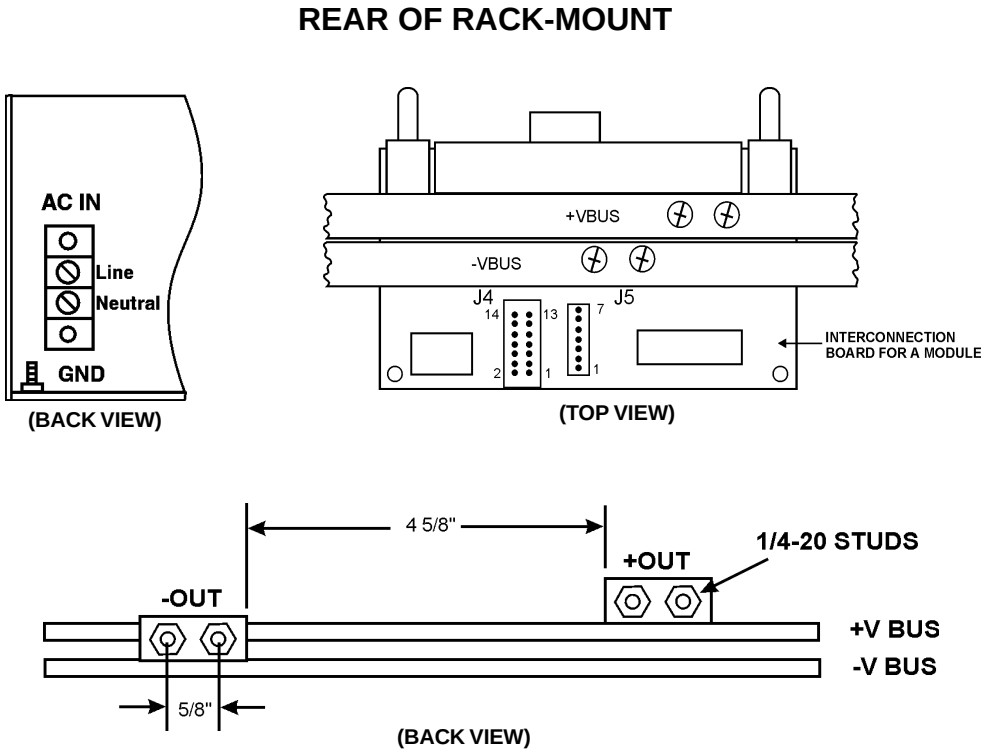


Figure 5. Rear Rack Input & Output Connections

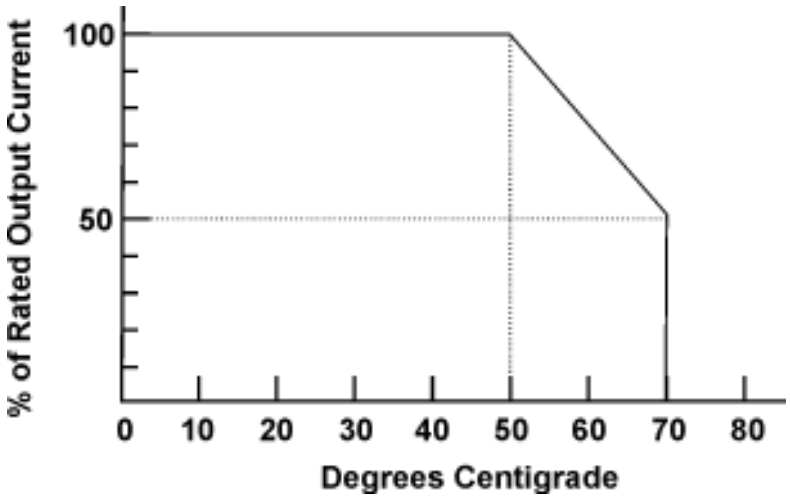


Figure 6. Rated Output Current vs. Ambient Temperature

13.6 Remote Sensing. Remote sensing connections are made to pins 1 (+Sense) and 2 (-Sense) of the rack J5 connector for each module. Remote sensing is used to regulate the output voltage at the point of 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 Figure 7.

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 for local sensing at the output terminals. Be careful not to reverse the sense lead connections.

13.7 Control & Supervisory Signals. Control and supervisory signals for each module are accessible at J4, a 14-pin connector, and J5, a 7-pin connector, on the back of the rack. See Section 17 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 5V Aux. Return, J4 Pin 12. There are three logic alarms for each module. The first alarm is **Thermal Alarm**. When a module internally overheats, this logic signal goes HI 100msec. before the module 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 cooling fan failure.

14.0 PARALLEL OPERATION

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

14.1 Redundant Operation. From Table 14-1, the 19-inch rack mount can be operated in a 2+1 redundant mode. This means that the full load current is carried by two modules. While operating 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 mod-

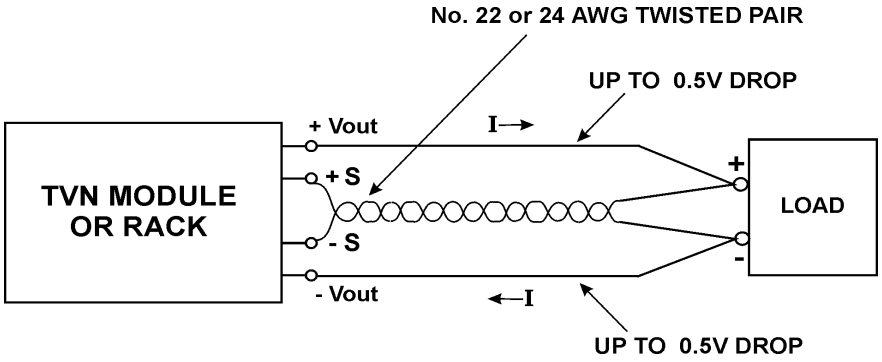


Figure 7. Remote Sensing Connection

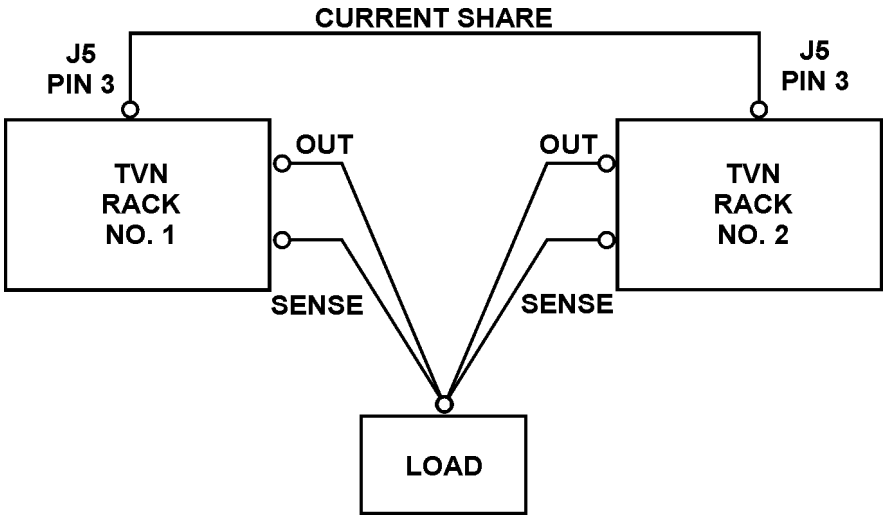


Figure 8. Parallel Connection of TVN Racks.

ules. 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	NUMBER OF MODULES	NOM. VOLTS	AMPS MAX.	TOTAL WATTS
Redundant, 2+1	3	24	84	2000
Non-Redundant	3	24	126	3000
Redundant, 2+1	3	48	42	2000
Non-Redundant	3	48	63	3000
Redundant, 3+1	4	24	126	3000
Non-Redundant	4	24	168	4000
Redundant, 3+1	4	48	63	3000
Non-Redundant	4	48	84	4000
Redundant, 4+1	5	24	168	4000
Non-Redundant	5	24	210	5000
Redundant, 4+1	5	48	84	4000
Non-Redundant	5	48	105	5000

14.2 Non-Redundant Operation. Higher output current can be achieved by operating the rack in a non-redundant mode as seen in Table 14-1. However, in this case if a 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 module, however, can be quickly replaced to restore the load current.

14.3 Multiple Parallel Rack Operation. Multiple racks can also be operated in parallel by interconnecting their current share terminals (J5 Pin 3). 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 three-module 19-inch racks are employed with a total of six modules, then 5+1 redundancy is achieved and 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 point of load. See Figure 8 for a simplified illustration of two TVN racks connected in parallel.

15.0 RACK CONTROL & SUPERVISORY SIGNAL CONNECTIONS

15.1 Connections for control and supervisory signals are made at the back of the rack to connectors J4 and J5. J4 is a Molex No. 15-47-8143; J5 is a Molex No. 70543-0006. Mating connectors are Molex Nos. 70450 and 70400 respectively.

15.2 The pin connections to J4 and J5 are shown in the table. See Figure 5.

RACK-MOUNT INTERFACE
CONTROL & SUPERVISORY SIGNALS

J4				J5	
PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	NC	8	Margin - Low	1	+ Sense
2	Output - ve	9	Remote Enable	2	- Sense
3	DC Good	10	OVP Reset	3	Current Share
4	Thermal Alarm	11	+5V Aux.	4	Remote Adjust
5	Current Monitor	12	5V Aux. Return	5	+V Bus
6	AC Good	13	Module Present	6	-V Bus
7	Margin - High	14	NC	7	- Sense

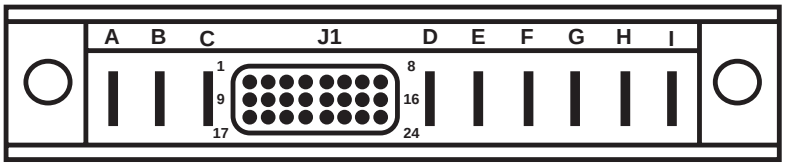
16.0 TVN MODULE CONNECTIONS

If the TVN module or modules are used separately from the rack or in a user configured rack, connections should be made to the high-reliability hot-swap connector on the back of the module with the functions as shown in Figure 9.

17.0 DESCRIPTION OF CONTROL AND SUPERVISORY SIGNALS (RACK)

SIGNAL	J4 PIN	DESCRIPTION
N.C. N.C.	1 2	No Connection.
DC Good	3	An opto-isolated, open-collector output for each module. A TTL LO (sinks 10mA) indicates that the module is operating properly with the output voltage in its controllable range. A TTL HI indicates the output voltage is outside the 40-60V range for a 48V module or outside the 20-30V range for a 24V module, the module has failed, is in current limit or there is a cooling failure. This signal is referenced to the 5V Auxiliary Return, Pin 12.
Thermal Alarm	4	An opto-isolated, open-collector output for each module. A TTL LO (sinks 10mA) indicates normal operation. A TTL HI indicates thermal shutdown and occurs 100msec. before the module shuts down. This signal is referenced to the 5V Auxiliary Return, Pin 12.
Current Monitor	5	An analog output voltage proportional to the output current of each module. The scale is linear, 0 to +5V, with full scale representing 50A for a 24V module and 25A for a 48V module. This signal is referenced to -Sense, J5 Pin 2 or 7.
AC Good	6	An opto-isolated, open-collector output for each module. 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 the 5V Auxiliary Return, Pin 12.
Margin-High	7	A TTL LO at this input causes the module output voltage to rise by approximately 10%, provided this remains within the controllable range of the output. A TTL HI or open gives the normal output voltage. This signal is referenced to -Sense, J5 Pin 2 or 7.

TVN MODULE CONNECTOR



MODULE J1 POWER CONNECTIONS

TERMINAL	FUNCTION	TERMINAL	FUNCTION
A	AC Neutral	E	- V Output
B	AC Line	G	+ V Output
C	Frame Ground	H	+ V Output
D	-V Output	F & I	No Present

NOTE: J1 connector is an ELCON FLATPAQ™ No. 279-0320-00100
Mating receptacle is No. 279-0320-00200

MODULE
J1 CONTROL & SUPERVISORY SIGNALS

PIN	FUNCTION	PIN	FUNCTION
1	Interlock	9	DC Good
2	Remote Adjust	10	Thermal Alarm
3	Margin - High	12	Current Monitor
4	Margin - Low	16	- Sense
5	Enable	17	AC Good
6	OVP Reset	20/21	5V Aux. Return
7	+ Current Share	22/23	+5V Aux.
8	- Current Share	24	+ Sense

Figure 9. TVN Series Hot-Swap Module Connections

SIGNAL	J4 PIN	DESCRIPTION
Margin-Low	8	Same operation as Margin-High, except TTL LO causes the output voltage to drop by approximately 10%.
Remote Enable	9	An opto-isolated input. A TTL LO (sinking 5mA) enables the given module. This signal is referenced to the 5V Auxiliary Return, J4 Pin 12.
OVP Reset	10	A TTL LO at this input resets the overvoltage protection latching circuit (also the sense resistor failure latching). This signal is referenced to -Sense, J5 Pin 2 or 7.
+5V Aux. Output	11	This is a floating +5V 100mA output for powering external control circuits. It is used internally to power the external side of the four opto-isolated interfaces with which it shares a common return. It has a ±5% voltage tolerance and is isolated to 100VDC from all other output connections.
5V Aux. Return	12	This is the return for the above +5V supply and is in common with the opto-isolated returns Remote Enable, AC Good, DC Good and Thermal Alarm.
Module Present	13	A ground (TTL LO) at this output means the given module is installed. An open means there is no module present. This signal is referenced to -Sense, J5 Pin 2 or 7.
SIGNAL	**J5 PIN**	**DESCRIPTION**
+Sense -Sense	1 2	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 tranfers regulation control to the output bus bars of the rack via internal 10-ohm sense resistors. The sense leads of all three modules are internally connected together by means of a ribbon cable.
Current Share	3	This is an analog control signal made up of the current share signals of all the rack modules connected together by a ribbon cable. This pin can be used to connect to J5 Pin 3 of another Vanguard™ rack to share output currents. Output currents between identical racks are shared with an accuracy of 10% of full load current over a 50% to 100% load range. This signal is referenced to -Sense, J5 Pin 2 or 7.
Remote Adjust	4	An analog voltage input to this pin adjusts the individual module output voltage. A zero to +2V input represents approximately 20 to 30V output for a 24V module or 40 to 60V output for a 48V module. This input should be driven from a source impedance less than 100 ohms and is referenced to -Sense, J5 Pin 2 or 7. 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.

SIGNAL	J5 PIN	DESCRIPTION
+V Bus -V Bus	5 6	These two pins are connections to the + and - output bus bars. They are at the average voltage for the three module outputs.
- Series	7	This is another -Sense terminal identical to J5 Pin 2.

Comments on Control and Supervisory Signal Connections. All connections to J4, plus J5 Pin 4, are individual signals for each individual module. There is no common connection for these signals between the modules. The J5 connections, except for Pin 4, are connected in common for all three modules by means of a ribbon cable.

18.0 INSTALLATION

18.1 Mounting. See Figure 4. The TVN Series chassis is mounted in a rack by means of mounting brackets on each side of the chassis. When mounting, the chassis should first be securely mounted to the rack, then the modules should be inserted into the chassis. The modules are secured by positioning the locking bar and tightening the nuts on each end.

18.2 AC Input Connections. There are two AC input versions of the TVN racks. See Figure 5. The standard version is for a conduit cable connection to a two-terminal barrier strip. Ground connection is made to the chassis by means of the no. 8-32 stud shown in the diagram. The optional version (Option B) uses IEC320 connectors for power cords.

18.3 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 ¼ -20 studs with nuts. Connection to the bus bars should be made by means of two-hole crimp-type lugs. The output wires should be sized in accordance with the load current and length of conductor.

18.4 Contact Resistance. The connecting wires or lugs should be clean, and a tight, firm connection should be made to the output bus bars to minimize contact resistance.

18.5 Control and Supervisory Signal Connections. These connections are made to the J4 and J5 connectors by means of mating connectors. Details for these connections are given in Sections 15.1 and 15.2.

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

19.0 MAINTENANCE

No routine maintenance is required on the TVN 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.

20.0 TVN MODULES AND RACK SETUP AND TESTING

20.1 The TVN modules and rack can be initially tested mounted in a rack or on a test bench. The power system is initially tested one module at a time in the rack.

20.2 Connect an AC conduit cable to the proper terminals on the input terminal block and the safety ground wire to the 8-32 ground stud. Or, for the optional version of the rack, connect three-wire power cords to the IEC320 connectors on the back of the rack. Do not plug the AC lines into the power socket yet.

20.3 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 about 25% and 50% of the full load rating of the module. For the 24V module the resistor should be between 1.1 and 2.3 ohms and for the 48V module it should be between 4.6 and 9.1 ohms.

20.4 Connect a color-coded, twisted pair (no. 22 or 24 AWG) from the remote sense pins to the load. The +Sense lead (J5 Pin 1) **must go** to the positive side of the load and the - Sense lead (J5 Pin 2) **must go** to the negative side of the load. **The Remote Enable input (J4 Pin 9) must be shorted to the 5V Auxiliary Return, J4 Pin 12, for the module to operate**.

20.5 Insert one of the TVN modules into position A of the rack (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 at the rated output voltage of the module, i.e., 24 or 48V, ±1%. If a different output voltage is desired, it should be set by means of the voltage adjust-

ment potentiometer on the front panel.

20.6 Checking the Front Panel LEDs. The AC Good and DC Good LEDs should both be green. The LED current monitor bar should have one or two LEDs on, depending on output current (20% of full load per LED).

20.7 Checking the Current Monitor Output. Measure the voltage at the Current Monitor output (J4 Pin 5 to -Sense, J5 Pin 2 or 7) 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 of load current for a 24V module.

20.8 Checking the Remote Enable Input. Next, disconnect the Remote Enable wire from J4 Pin 9 to Pin 12. The module output should turn off, giving zero volts across the load. The DC Good LED should go off.

20.9 Checking the AC Good and DC Good Outputs. Connect the -lead of an external 5V power supply to 5V Aux. Return (J4 Pin 12). Connect one end of a 2K resistor to the +lead of the 5V supply and the other end to the AC Good output (J4 Pin 6). Connect one end of another 2K resistor to the +lead of the 5V supply and the other end to the DC Good output (J4 Pin 3). See Figure 10. Reconnect the Remote Enable wire. Measure the output voltage at both J4 Pins 3 and 6 with respect to the 5V Aux. Return (J4 Pin 12) with a digital voltmeter. Both voltages should be less than 0.5VDC, indicating a TTL LO.

20.10 Checking the Remote Adjust Input. If the remote adjust function is to be used, do the following test. 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, J5 Pin 4 and the -5V from the supply to -Sense J5 Pin 2 or 7. With the voltage at the wiper arm set to zero, check the output voltage of the 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 module. For a 48V unit it should be approximately 58V and for a 24V unit it should be approximately 29V.

Disconnect the Remote Enable wire from J4 Pin 9 to Pin 12. Measure the output voltage at both J4 Pins 3 and 6 with respect to the 5V Aux. Return, J4 Pin 12, with a digital voltmeter. Pin 3 should be at a TTL HI, or about +5V. Pin 6 should be at a TTL LO, or less than +0.5V. Reconnect the Remote Enable wire. Disconnect the external 5V supply and unplug the

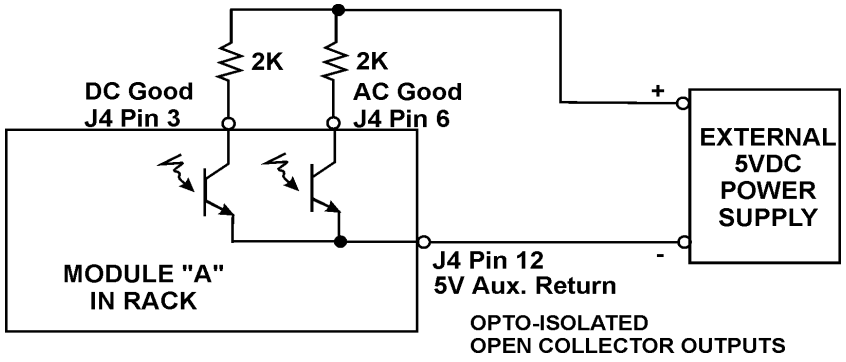


Figure 10. Checking AC Good and DC Good Outputs

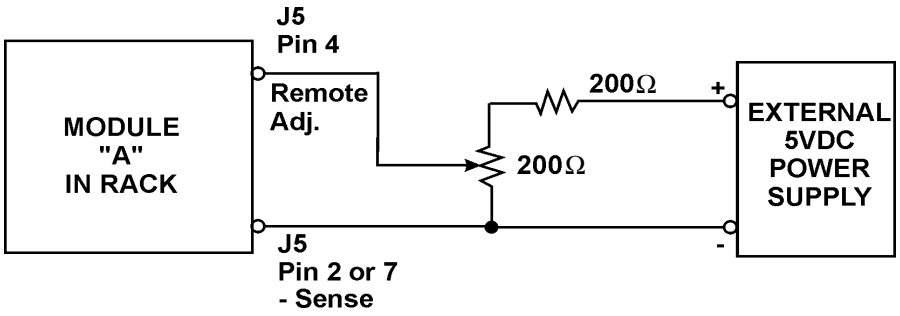


Figure 11. Checking Remote Adjust Input

AC input to the TVN rack.

20.11 Checking the Other TVN Modules. Each module should be tested in the above manner to verify its operation. Go back to Section 20.5 and proceed through the tests one by one until all modules have been verified.

20.12 Checking the Complete TVN Rack. Confirm that the output voltages of the individual modules are all accurately set to 24 or 48V or to another required voltage. The voltage between modules should be set within ±1% of each other for best performance of the current sharing circuitry. Insert all modules into the rack. Connect a power load -- high-power resistor or electronic load in resistive mode -- in accordance with Table 20-1 to the output of the rack. Connect the + and - Sense leads to + and - sides of the load, respectively, as in Section 20.4. Connect all Remote Enable wires from each J4 Pin 9 to each J4 Pin 12. Plug the rack into the AC power source.

Table 20-1 TVN Rack Loads For Test

RACK	NO. OF MODULES	OUTPUT VOLTAGE	APPROX. LOAD CURRENT	APPROX. LOAD RESISTOR
2U	3	24	63A	0.38Ω
2U	3	48	32A	1.50Ω
3U	4	24	105A	0.23Ω
3U	4	48	53A	0.91Ω
3U	5	24	147A	0.16Ω
3U	5	48	74A	0.65Ω

Check the load voltage with a digital voltmeter. It should be very close to 24 or 48VDC (±1%), or other set voltage, depending on the model tested. The AC Good and DC Good LEDs should both be green on each 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 each voltage from J4 pin 5 to the -Sense, J5 Pin 2 or 7. The voltages should all be within 10% of each other.

While the rack is operating, pull Module A out while monitoring the output voltage with a digital voltmeter. It should remain the same. Insert the module back into the rack. 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 rack, check the Remote Enable inputs for the entire rack. Disconnect the Remote Enable wires from each J4, Pin 9 to each J4 Pin 12. The rack output should turn off and the output voltage should go to zero.

Reconnect the Remote Enable wires. This completes the rack setup and testing.

21.0 TROUBLESHOOTING GUIDE

21.1 If you encounter difficulties in getting the modules or complete rack to operate properly, go through the following troubleshooting guide.

21.2 Table 21-1. TVN Module and Rack 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 J4 Pin 9 (Remote Enable) for each module is shorted to J4 Pin 12 (5V Aux. Return).
No output, DC Good LED off, AC Good LED 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 10 seconds and then back ON or by applying a short or TTL LO to J4 Pin 10 (referenced to -Sense, J5 Pin 2 or 7).
No output, DC Good LED off, AC Good LED on.	Overtemperature protection is activated on one or more modules.	Allow modules to cool down for about 10 minutes. They will then start up automatically. Check to see if the cooling fans are operating.
No output, DC Good LED off, AC Good LED on.	Output load is too great for the number of modules.	Reduce load to proper level.

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