



**OPERATING MANUAL
TWRI SERIES RF/WIRELESS
FRONT-ENDS AND SHELVES**

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OPERATING MANUAL

TWRI SERIES RF/WIRELESS FRONT-ENDS AND SHELVES

1.0 INTRODUCTION

This operating manual should be read through carefully before installing and operating TWRI Series front-ends.

The TWRI Series front-end modules and shelves operate as a complete hot-swap power system for directly powering an RF Amplifier load. There are five different modules providing 2250 watts of output power at 28V, 29V, 30V, 31V or 32V respectively. Three modules in the 19-inch shelf produce up to 6750 watts while four modules in the 23-inch shelf produce up to 9000 watts. The modules 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 from a 170 to 264VAC input range at 47 to 63Hz with a separate AC input connection to each module. The modules have input power factor correction and Class B EMI input filters. The output voltage is tightly regulated and precisely adjustable 26.5 to 33.5V 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. The output overload characteristic is a constant current output at 105% of rated output current. The output is floating with respect to frame or AC grounds. Multiple shelves can be connected in parallel for higher overall power requirements.

A 25-pin interface subminiature D connector on the backplane of the shelf provides control and monitoring inputs and outputs. An inhibit input turns the entire shelf output off or on. Remote sensing connections provide precise regulation at the 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 module.

Front-panel green LEDs indicate AC power good and DC power good for each module. The rectifier modules and shelves are safety agency certified and CE marked.

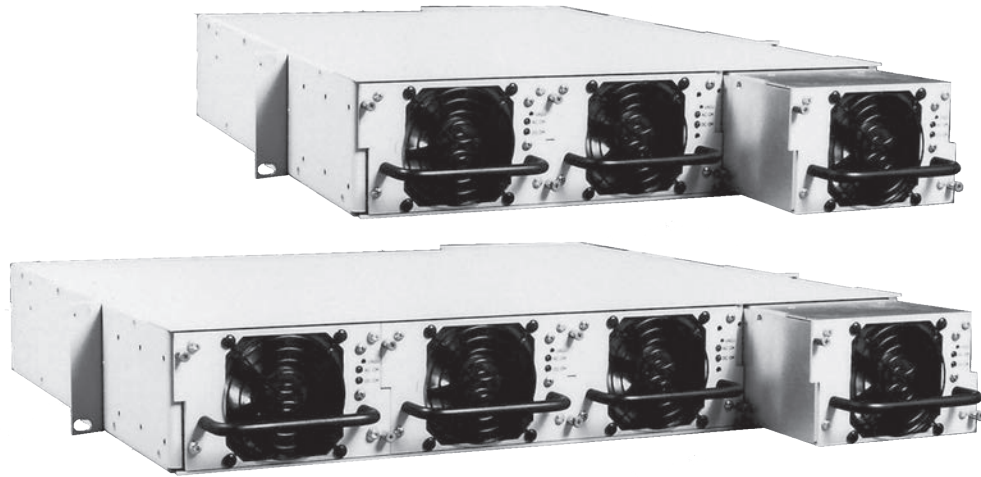


Figure 1. TWRI Modules with 19" & 23" Shelves

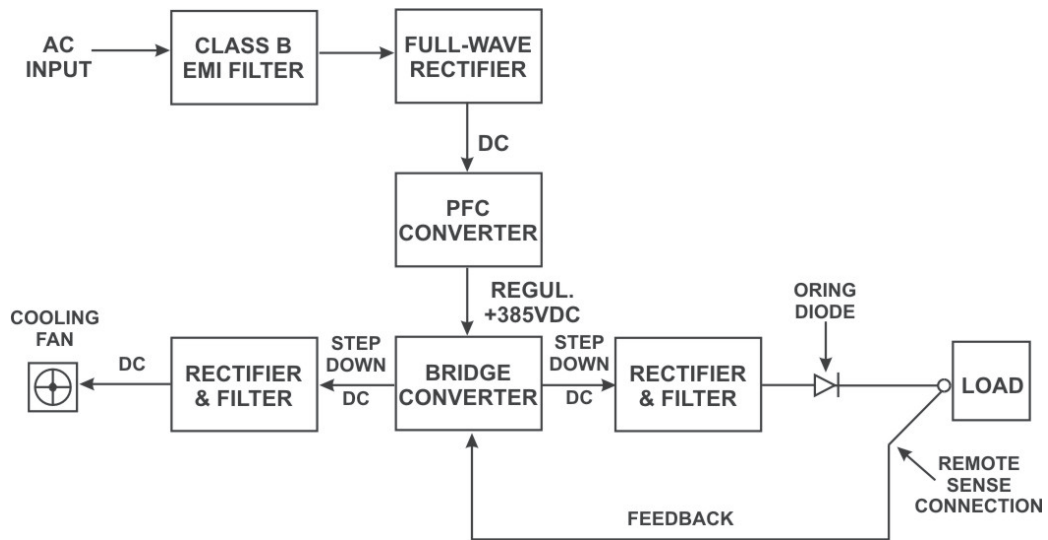


Figure 2. Block Diagram

2.0 FEATURES

The following is a summary of the important features of the TWRI Series modules and shelves:

- ◆ 85% Efficiency
- ◆ Power Factor Correction to EN61000-3-2
- ◆ 10.6W/In³ Power Density
- ◆ Hot-Swap, N+1 Redundant Operation
- ◆ 2U 19-inch or 23-inch Rack Mounting
- ◆ 26.5-33.5V Output Adjustment Range
- ◆ 28 to 32VDC Rated Output
- ◆ 2250W Module Output Power
- ◆ Up to 9000W Total Power, Non-Redundant
- ◆ Up to 6750W Total Power, 3+1 Redundant
- ◆ Integral ORing Diodes
- ◆ Output Current Limiting
- ◆ Inrush Current Limiting
- ◆ Remote Output Adjustment

3.0 PRODUCT LINE

3.1 Ranger Rectifier Modules

MAX. POWER	OUTPUT VOLTAGE ^{1,2}	OUTPUT CURRENT	MODEL NO.
2250W	28V	80.4A	TWRI6000
2250W	29V	77.6A	TWRI6001
2250W	30V	75.0A	TWRI6002
2250W	31V	72.6A	TWRI6003
2250W	32V	70.3A	TWRI6004

Notes:

1. These are standard, factory-set output voltages. Consult factory for alternate settings.
2. The output voltage adjustment range for all models is 26.5V to 33.5V.

3.2 Shelves

MAX. POWER	DESCRIPTION	MAX. CURRENT	MODEL NO.
6750W	19" Rack-Mount 3-Bay 3 x Terminal Block AC Input	245A	RRS2U-19
9000W	23" Rack-Mount 4-Bay 4 x Terminal Block AC Input	325A	RRS2U-23

4.0 SAFETY WARNINGS

- 4.1 These 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 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

TRWI Series is warranted for three (3) 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 TWRI Series power system was carefully tested, inspected and packaged for shipment from our factory. The modules and shelves are shipped separately. 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 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 simplified diagram of a TWRI 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 (70kHz) 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 28VDC, 29VDC, 30VDC, 31VDC or 32VDC nominal, depending on the model. This is done by a bridge-configured converter operating at 70 kHz. The output of this converter goes through a rectifier, filter and ORing diode to the module output. Feedback from the remote sense terminals goes back to the converter's pulse-width modulator which regulates the output voltage and keeps it constant.
- 7.2 Power Factor Correction.** This high-frequency converter circuit 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 Fan.** Another output from the bridge converter is rectified, filtered and used to power the DC ball bearing cooling fan on 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 inhibit, 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, AC good, DC good, current monitor 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 TWRI module is shown in Figure 3. From top to bottom are: output voltage adjustment potentiometer (12-turn), AC Good LED (green) and DC Good LED (green). A single 80 mm fan cools the module.

9.0 MODULE SPECIFICATIONS

Specifications for a single module, typical at 120 or 230VAC Line, Full Load and 25°C unless Otherwise Noted.

INPUT

Voltage Range	170-264VAC
Power Factor	>0.98
Harmonic Distortion	EN61000-3-2
Frequency	47-63Hz
Input Current @ 230VAC	11.8A
Inrush Current Limiting, Max.	25A Peak
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
Input Protection	Internal Fuse, 20A

OUTPUT

Current & Voltage	See Model Table
Output Power	2250W
Voltage Adjustment Range	26.5-33.5V
Line & Load Regulation, Max.	1%
Filtering: Wideband Noise, 20MHz BW ¹	250mV pk-pk
Dynamic Response ²	1mS
Temperature Coefficient	0.05%/°C
Holdup Time	20msec.
Overload Protection	Constant Current Limiting
Overvoltage Protection	Latch Off
Active Current Share ³	10% Differential From Rated Current
Remote Sense	Up to 0.5V per Wire

SAFETY STANDARDS	UL60950-1 2 nd Ed.
	CSA22.2 No. 60950-1 2 nd Ed.
	EN60950-1 2 nd Ed.

STATUS INDICATORS

AC GOOD	Green LED
DC GOOD	Green LED

ALARM SIGNALS (Logic LO, TTL compatible)

ACOK	AC present, 5V standby operating
DCOK	DC output within -10% of nominal
Thermal Alarm	Indicates Thermal Shutdown

GENERAL ENVIRONMENTAL

Switching Frequency	70kHz nominal
Efficiency	85%
Operating Temp. Range	0°C to +70°C
	-40°C start-up, reduced performance
Output Current Derating	2.5%/°C, 50°C to 70°C
Storage Temp. Range	-40°C to +85°C
Environment	Pollution Degree 2
Humidity	0% to 95%, Non-Condensing
ESD	Bellcore GR-1089-Core and EN61000-4-2
MTBF, 35°C (Bellcore)	200,000 Hours
Cooling	Integral Ball Bearing Fan

PHYSICAL SPECIFICATIONS

Case Material	Aluminum
Case Dimensions, Inches (mm)	3.3 H x 4.9 W x 13.1 D (83.8 x 124.5 x 332.7)
Weight	10.15 lbs. (4.6 kg.)

Notes:

1. 20MHz bandwidth. Measure with 0.1µF ceramic and 10µF tantalum capacitors in parallel across the output.
2. <5% deviation, recovering to within 1% for 50% load change.
3. Using single wire current share with remote sense connected.

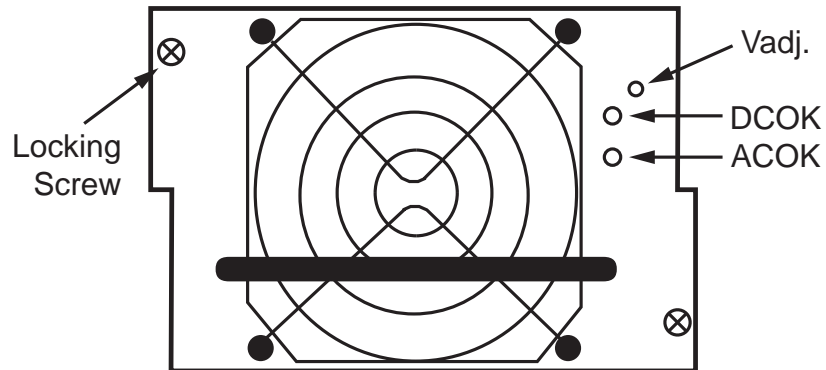


Figure 3. Front Panel of Ranger Rectifier Module

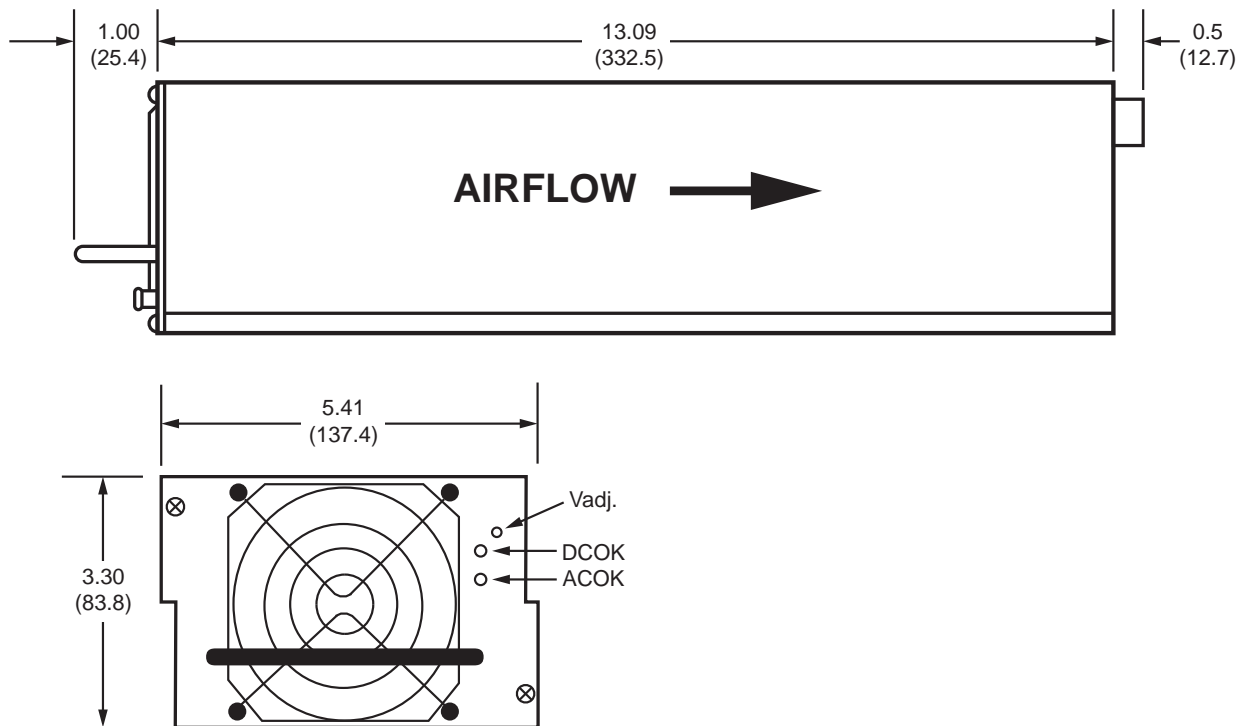
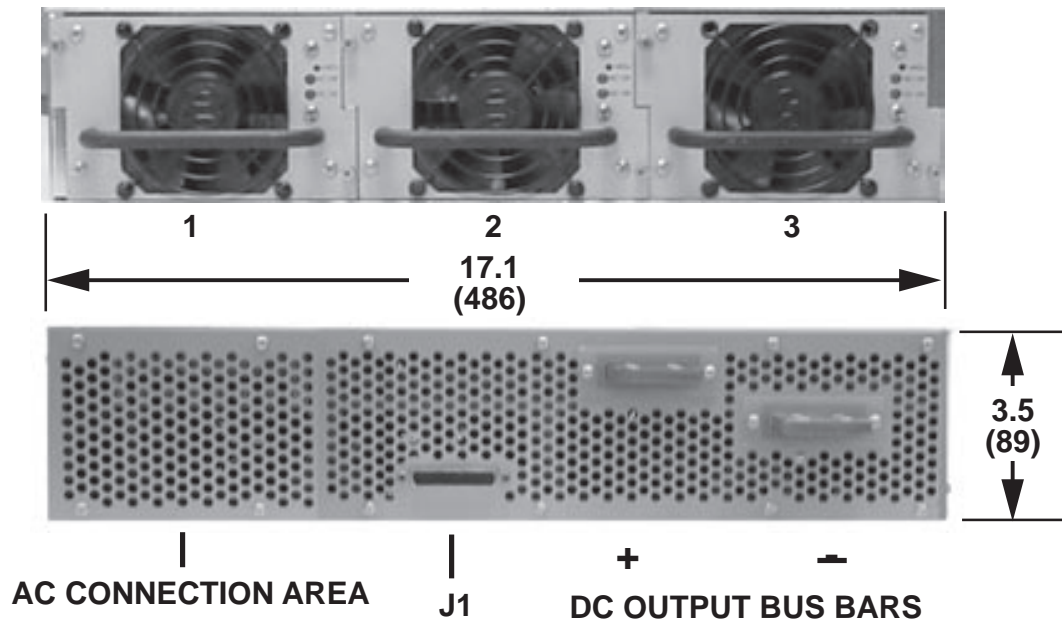


Figure 4. Module Dimensions

ALL DIMENSIONS IN INCHES (mm).

RRS2U-19 - 3-BAY



RRS2U-23 - 4-BAY

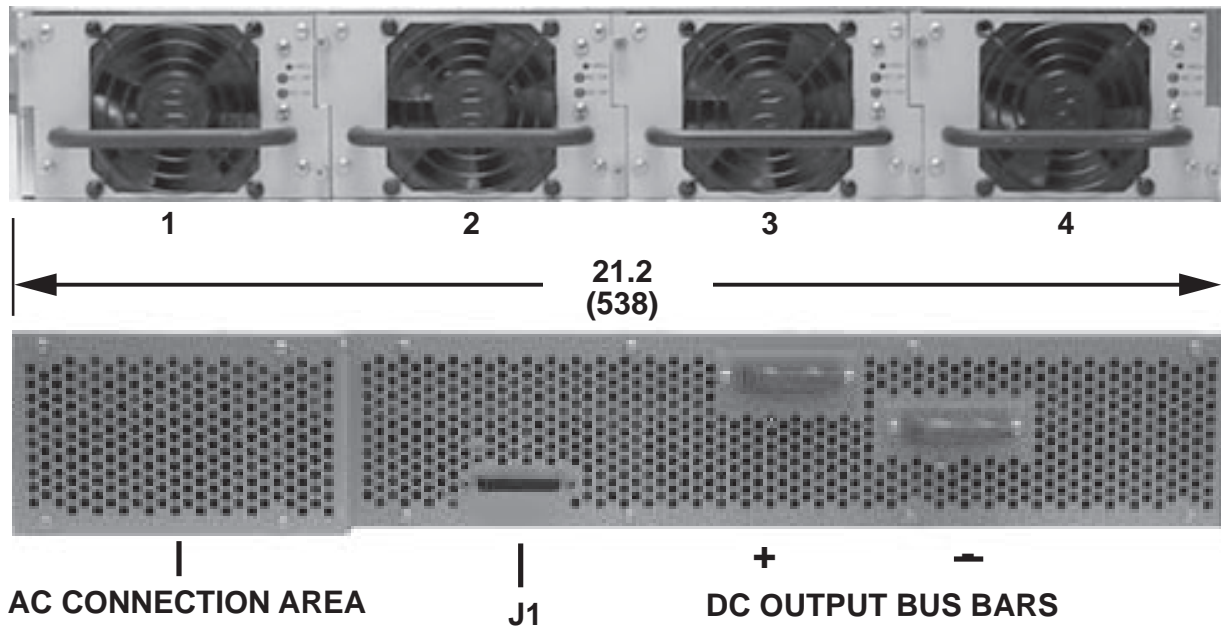


Figure 5. Shelf Dimensions

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 is less than 5%.
Wide Range AC Input	The AC input range is continuous from 170 to 264VAC, 47-63Hz.
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 25 amperes.
Output Voltage Adjustment Range	For all models the adjustment range is 26.5V to 33.5V. 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 +5V controls approximately 26.5V to 33.5V. 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.
Thermal Protection	If the module overheats internally, it will automatically shut down and give an output alarm logic LO. The DC Good LED also turns off.
Current Sharing	The 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 37V. The result is a latched shutdown of the 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.

FEATURE/OPTION	DESCRIPTION
Hot Swap Operation	Hot swap operation means that the 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 module from damage due to a short circuit or other overload condition. This protection is continuous, without damage, and recovery is automatic when the overload is removed. The current limit characteristic is essentially a constant current. 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.
Control and Monitoring Signals	For detailed description of Inhibit, Thermal Alarm, Current Share, Remote Sense, Remote Adjust, AC Good and DC Good, and Current Monitor signals see Section 17, Description of Self Control and Supervisory Signals.

11.0 MECHANICAL SPECIFICATIONS

The mechanical dimensions of the TWRI Series modules and shelves are shown in Figures 4 and 5 respectively.

12.0 SAFETY AND INDUSTRY STANDARDS

12.1 TWRI series modules and shelves meet the following safety requirements:

STANDARD

UL60950-1, 2nd Edition

CSA22.2 No. 60950-1, 2nd Edition

EN60950-1, 2nd Edition

12.2 TWRI series modules 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.

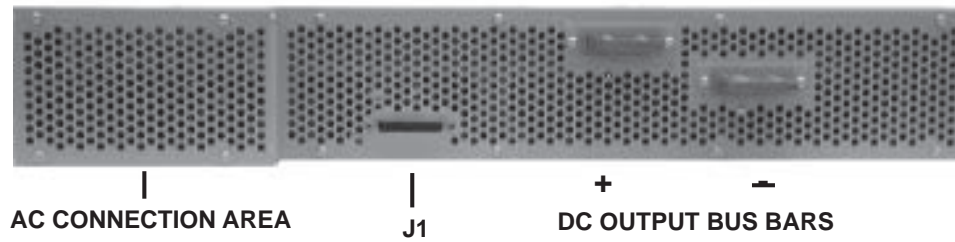
12.4 Input fast transient specifications meet EN61000-4-4 Level 3; input surges, line-to-line, meet EN61000-4-5 Level 2; and input surges, line-to-ground, meet EN61000-4-5 Level 3.

13.0 OPERATING INFORMATION

13.1 **Input Voltage.** TWRI Series modules operate from AC input voltages within the range of 170 to 264 VAC at 47 to 63 Hz. There is a separate input connection for each module to a terminal block at the rear of the shelf. For complete details see Section 18.2 and Figure 6 (a & b).

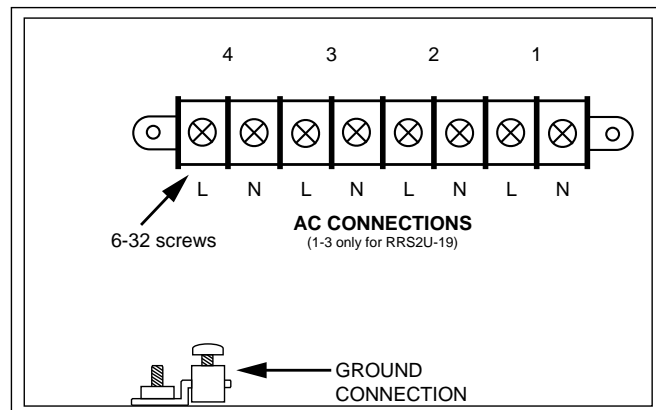
13.2 **Output Connection.** The output is provided on two ¼-inch thick copper bus bars. Each bus bar has four ¼-inch holes for bolting the output connections. For complete details see Section 18.3 and Figure 6 (c). Both positive and negative outputs are floating and isolated from the chassis.

13.3 **Output Voltage.** The output voltage of each module is factory set to 28V, 29V, 30V, 31V or 32V depending on model. 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 these cases the adjustment range is 26.5V to 33.5V.

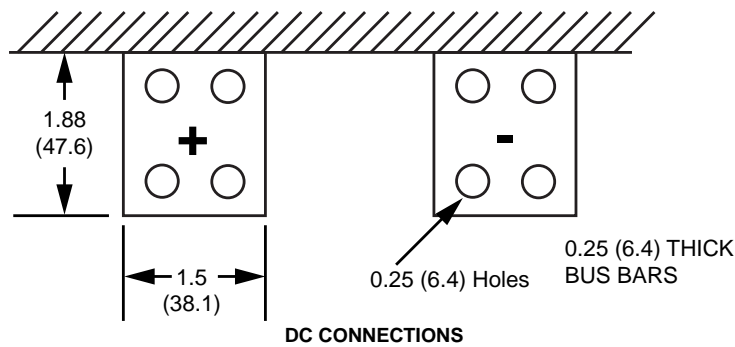


Remove four screws to expose AC connection area.

(a) Rear Connections to Ranger Shelf



(b) Uncovered AC Input Connection Area



(c) Top View of DC Output Bus Bars

Figure 6. AC Input and DC Output Connections

13.4 Output Power. Maximum output power is 2250 watts for each module. 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 Figure 7. The maximum operating temperature is 70°C, at which the output current must be derated by 50%.

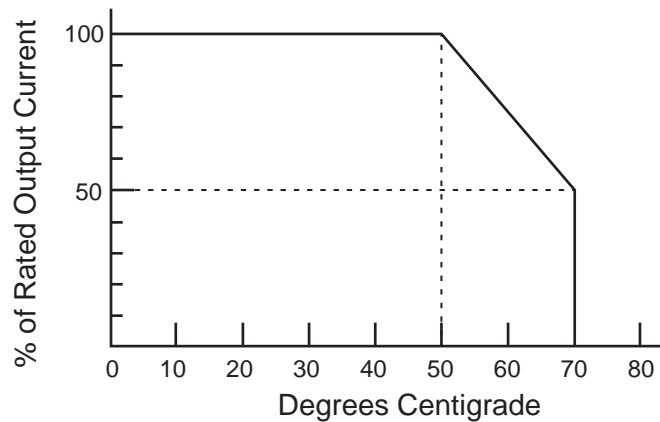


Figure 7. Rated Output Current vs. Ambient Temperature

13.5 Output Overload Protection. Each module output is protected from damage due to overload or short circuit conditions. This protection is continuous and without damage; recovery is automatic when the load is removed. The current limit characteristic is a constant current. Current limiting takes place at approximately 105% of the rated output current.

13.6 Remote Sensing. Remote sensing connections are made to pins 11 (+Sense) and 23 (-Sense) of the shelf J1 connector. 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 8 below.

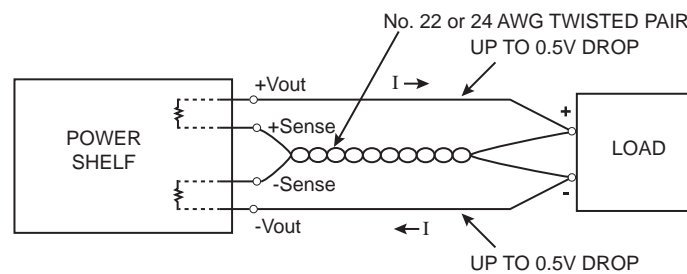


Figure 8. Remote Sensing Connection

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 and Supervisory Signals. All control and supervisory signals are accessible at J1, a 25-pin sub-miniature D connector on the back of the shelf. 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 TTL-compatible signals referenced to -Sense, J1 Pin 23. There are three logic alarms for each module. The first alarm is **Thermal Alarm**. When a module internally overheats, this logic signal goes LO 100 msec. before the automatically shuts down. 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.

14.0 PARALLEL OPERATION

The 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 model RRS2U-19 can be operated in a 2+1 redundant mode and the 23-inch shelf model RRS2U-23 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 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 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	NUMBER OF MODULES	NOM. VOLTS	WATTS MAX.
Redundant, 2+1 Non-Redundant	RRS2U-19	3	28-32	4500 6750
Redundant, 3+1 Non-Redundant	RRS2U-23	4	28.32	6750 9000

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 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 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 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 shelves connected in parallel.

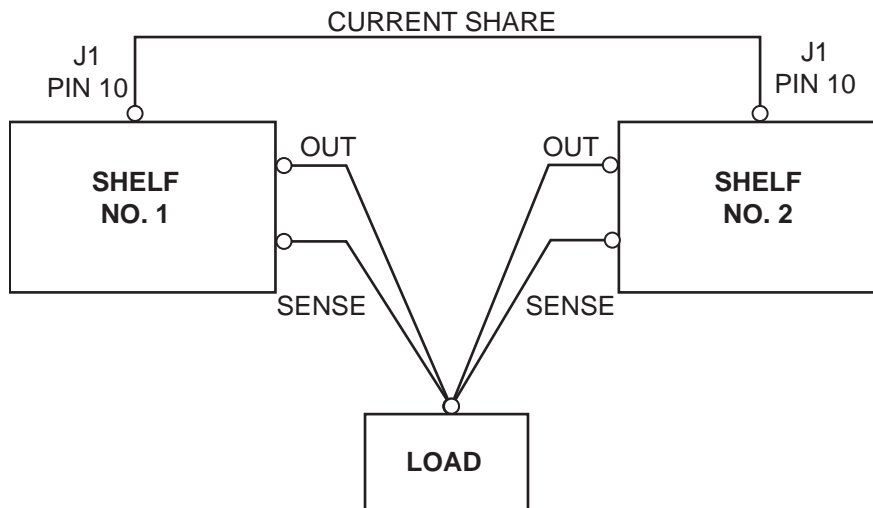


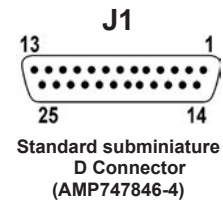
Figure 9. Parallel Connection of Power Shelves.

15.0 SHELF 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 (AMP747846-4). The mating connector is AMP747912-2.
- 15.2** The pin connections to J1 are shown in the table. Note that four of the pins (asterisked) are for connection to the fourth rectifier module in a 23-inch wide shelf.

PIN	FUNCTION	PIN	FUNCTION
1	Inhibit	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	N.C.
10	Current Share	23	-Sense
11	+Sense	24	Remote Adjust - 1
12	Remote Adjust - 2	25	Remote Adjust - 3
13	Remote Adjust - 4*		

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



MATING CONNECTOR KIT

Mating Connector: AMP747912-2
Order Kit No: 775-1441-0000

16.0 MODULE CONNECTIONS

If the module or modules are used separately from the shelf or in a user-configured shelf, connections should be made to the hot-swap connector on the back of the module with the functions shown in Figure 10. The Enable/Interlock (pin 15) must be connected to -Sense (pin 13 or 16) for the module to operate.

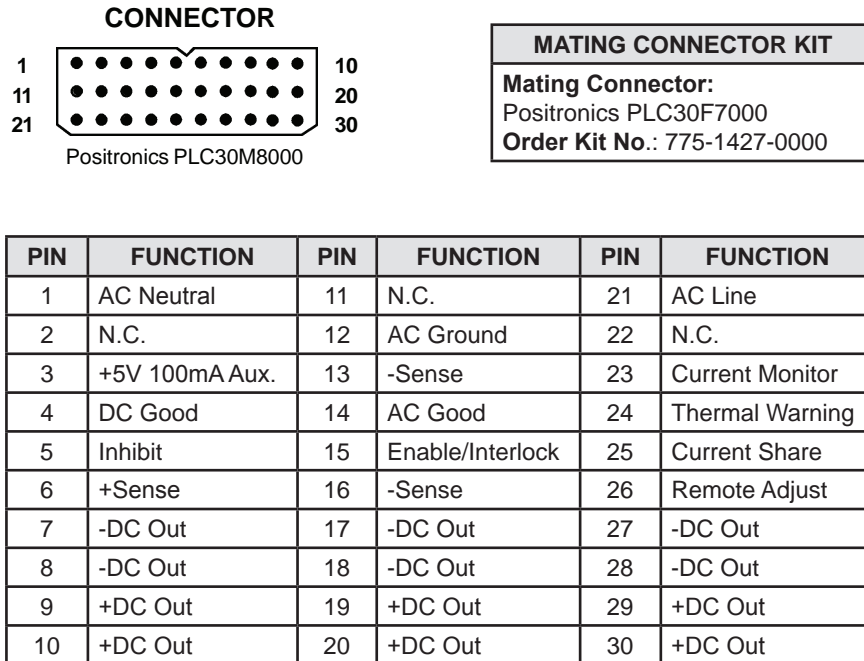


Figure 10. Module Pin Connections.

17.0 DESCRIPTION OF SHELF CONTROL AND SUPERVISORY SIGNALS

SIGNAL	PIN	DESCRIPTION
Inhibit	1	A logic LO (sinking 5mA) or short to Pin 23 inhibits (turns off) all rectifier modules in the shelf. This input is referenced to -Sense, Pin 23.
Thermal Alarm - 1	2	A logic HI is normal. A logic LO (sinks 2mA) indicates thermal shutdown and occurs 100 msec. before the rectifier shuts down. These outputs are referenced to -Sense, Pin 23.
Thermal Alarm - 2	4	
Thermal Alarm - 3	6	
Thermal Alarm - 4	8	
Current Monitor - 1	3	This output gives an analog voltage proportional to the module output current. The range is approximately 0V to +5V, corresponding to zero to rated output current. This output is referenced to -Sense, Pin 23.
Current Monitor - 2	5	
Current Monitor - 3	7	
Current Monitor - 4	9	
Current Share	10	This is an analog control signal made up of the current share signals of all modules connected together. This pin is used to connect to Pin 10 of another identical 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	11	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 in the modules.
- Sense	23	
Remote Adjust - 1	24	These are analog voltage inputs to the designated modules by which the output voltage is adjusted. A zero to + 5V input represents approximately 26.5V to 33.5V. This input should be driven from a source impedance less than 100 ohms and is referenced to -Sense, Pin 23.
Remote Adjust - 2	12	
Remote Adjust - 3	25	
Remote Adjust - 4	13	
AC Good - 1	14	A logic LO (sinks 2mA) indicates the AC input is present and the PFC converter stage has output. A logic HI indicates AC input or PFC converter failure. This signal is referenced to -Sense, Pin 23.
AC Good - 2	16	
AC Good - 3	18	
AC Good - 4	20	
DC Good - 1	15	A logic LO (sinks 2mA) indicates that the unit is operating properly with output voltage in its controllable range. A logic HI indicates the output is outside the 26.5V to 33.5V range, the unit has failed or is in current limit. This signal is referenced to -Sense, Pin 23.
DC Good - 2	17	
DC Good - 3	19	
DC Good - 4	21	

18.0 INSTALLATION

18.1 Mounting - TWRI Series 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 seven different bracket positions on the side of the shelf, from front position to 6 inches from the front. When mounting, the shelf should first be securely mounted to the rack, then the modules inserted into the shelf. The modules should be secured by tightening the two captive panel screws on each module.

18.2 AC Input Connections - The AC input connections to the shelf are shown in Figure 6 (b). As shown, there are separate connections for each module on the eight-terminal strip. All connections must be AC three-wire with the safety ground wires going to the ground connection terminal at the bottom of the chassis. The connections are labeled by module number.

18.3 DC Output Connections - The DC output connections are shown in Figure 6 (a) & (c). The positive and negative output connections are made to the copper bus bars as shown. The upper left bar is positive and the lower right one negative. Each bus bar has four ¼-inch holes. Connection to the bus bars should be made by means of four bolts with nuts. The output wires or bus bars should be sized in accordance with the load current and length of conductor. The table below shows minimum permissible copper wire sizes up to 50°C ambient temperature.

NO. OF MODULES	MAX. OUTPUT CURRENT	MINIMUM WIRE SIZE
1	80.4A	# 4 AWG
2	160.8A	# 2/0 AWG
3	241.2A	# 4/0 AWG
4	321.6A	2 x # 2/0 AWG

18.4 Contact Resistance - Connection to the bus bars should be clean and tight to minimize contact resistance.

18.5 Control and Supervisory Signal Connections - These connections are made to J1, a sub-miniature D 25-pin connector (AMP747846-4) by means of the mating connector. Details for these connections are given in Section 15.

18.6 Cooling - Each rectifier module is cooled by an 80 mm, DC ball bearing fan. 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 TWRI 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 SETUP AND TESTING

- 20.1** The modules and shelf can be initially tested mounted in a rack or on a test bench. The system is initially tested one module at a time in the shelf.
- 20.2** Connect a three-wire AC power line to module no. 1 on the back of the shelf. Be sure to connect the AC safety ground wire to the shelf ground terminal. Do not plug the AC line into the 230VAC source 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 10% and 50% of the full load rating of the module.
- 20.4** Connect a color-coded, twisted wire 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.
- 20.5** Insert one of the modules into slot 1 of the shelf (leftmost slot). Plug the AC power line into a 230VAC source and measure the voltage across the load at the remote sense points with a digital voltmeter. The voltage should be approximately the specified voltage for that module. If a different output voltage is desired, it should be set by means of the voltage adjustment potentiometer on the front panel.
- 20.6** **Checking the Front Panel LEDs** - The AC Good and DC Good LEDs should both be green.
- 20.7** **Checking the Inhibit Input** - Next, connect the Inhibit input (J1 Pin 1) to Pin 23. The rectifier output should turn off, giving zero volts across the load. The DC Good LED should go off.

20.8 Checking the AC Good and DC Good Outputs - Disconnect the Inhibit wire. Measure the output voltage at both J1 Pins 14 and 15 with respect to -Sense (Pin 23) with a digital voltmeter. Both voltages should be less than 0.5VDC, indicating a logic LO.

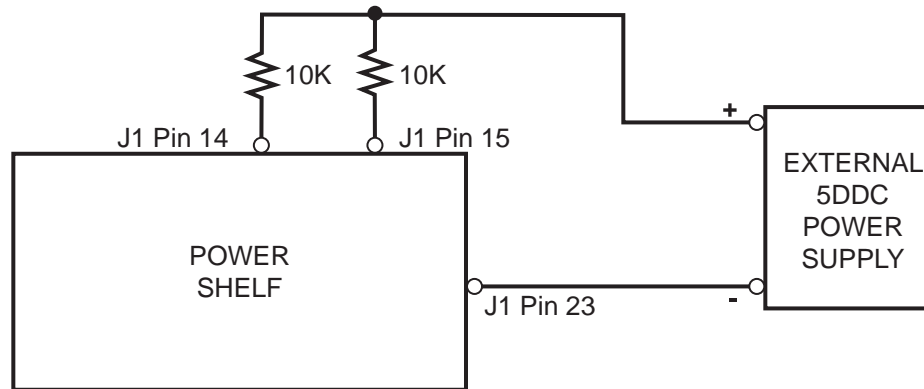


Figure 11. Checking AC Good and DC Good Outputs

20.9 Checking the Remote Adjust Input - Connect a variable external power supply as shown in Figure 10. With the output voltage set to zero, check the output voltage of the module with a digital voltmeter. It should be approximately 26.5V. Next, adjust the supply output to +5V and check the output voltage of the module. It should be approximately 33.5V. Unplug the external 5V supply and unplug the AC input to the shelf.

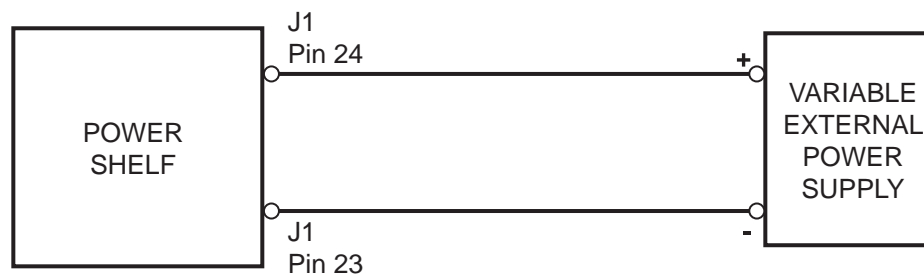


Figure 12. Checking Remote Adjust Input

20.10 Checking the Other Rectifier 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. Disconnect the AC input power.

20.11 Checking the Complete power shelf - Confirm that the output voltages of the individual modules are all accurately set to their specified output voltage 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 modules into the shelf. Connect the system load to the output of the shelf. Connect the + and - Sense leads to + and - sides of the load, respectively, as in Section 20.4.

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

Check the load voltage with a digital voltmeter. It should be very close to the specified output voltage, depending on the model tested. The AC Good and DC Good LEDs should both be green on each module.

This completes the shelf setup and testing. Disconnect the AC input power.

21.0 TROUBLESHOOTING GUIDE

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

21.2 Table 21-1. Ranger 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.	Inhibit in OFF mode.	Make sure J1 Pin 1 (Inhibit) open and not connected to Pin 23 (-Sense) or output ground.
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 20 seconds, and then back ON.
No output, DC Good LED off, AC Good LED on.	Overtemperature protection is activated on one or more modules.	Check the Thermal Alarm output of each module for a logic LO, indicating activated thermal protection. Allow module to cool down for about 10 minutes. 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 Please note that there are no user serviceable parts inside either the modules or the shelves and that opening either will void the warranty.

If you are still unable to resolve any problem call your nearest UNIPOWER sales office for support:

US +1 954 346 2442
 UK +44 (0)1903 768200

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TWRI SERIES

RF/WIRELESS POWER SUPPLY

Hot-Swap 2U, Up to 9,000 Watts

DESCRIPTION

UNIPOWER's TWRI Series are 2U high hot-swappable power supplies designed specifically for RF/Wireless applications such as transmitter power amplifiers. There are 5 different models with different output voltages at a power level of 2250W. The modules have automatic load sharing and output ORing diodes so they can be hot-swapped while the system is operating. Module output voltage can be controlled by 0V to +5V analog input.

Green LEDs indicate AC and DC power good. The power supplies also have control and monitoring features and a +5V standby output. Operating temperature range is -20°C to +70°C.

Companion 19-inch and 23-inch shelves hold up to three or four modules which can also be operated in a N+1 redundant mode.

FEATURES

- ◆ 85% Efficiency
- ◆ Power Factor Correction to EN61000-3-2
- ◆ 10.6W/In³ Power Density
- ◆ Hot-Swap, N+1 Redundant Operation
- ◆ 2U 19-inch or 23-inch Rack Mounting
- ◆ 26.5-33.5V Output Adjustment Range
- ◆ 28 to 32VDC Rated Output
- ◆ 2250W Module Output Power
- ◆ Up to 9000W Total Power, Non-Redundant
- ◆ Up to 6750W Total Power, 3+1 Redundant
- ◆ Integral ORing Diodes
- ◆ Output Current Limiting
- ◆ Inrush Current Limiting
- ◆ Remote Output Adjustment

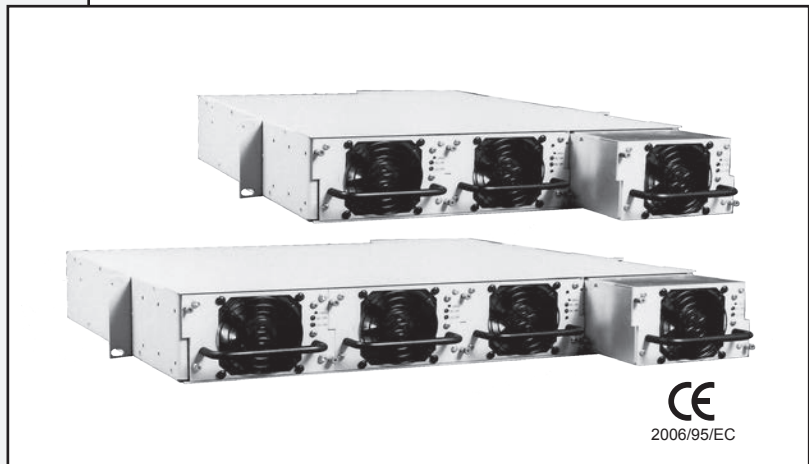
TWO YEAR WARRANTY

SAFETY STANDARDS

UL60950-1 2nd Edition
CSA22.2, No. 60950-1 2nd Edition
EN60950-1 2nd Edition

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FRONT-END / RECTIFIER MODULES

MAX. POWER	OUTPUT VOLTAGE ^{1,2}	OUTPUT CURRENT	MODEL NO.
2250W	28V	80.4A	TWRI6000
2250W	29V	77.6A	TWRI6001
2250W	30V	75.0A	TWRI6002
2250W	31V	72.6A	TWRI6003
2250W	32V	70.3A	TWRI6004

Notes:

1. These are standard, factory-set output voltages. Consult factory for alternate settings.
2. The output voltage adjustment range for all models is 26.5V to 33.5V.

POWER SHELF ORDERING GUIDE

MAX. POWER	DESCRIPTION	MAX. CURRENT	MODEL NO.
6750W	19" Rack-Mount 3-Bay 3 x Terminal Block AC Input	245A	RRS2U-19
9000W	23" Rack-Mount 4-Bay 4 x Terminal Block AC Input	325A	RRS2U-23

ACCESSORIES

DESCRIPTION	PART NUMBER
Connector Kit - Module	775-1427-0000
Connector Kit - Shelf	775-1441-0000
Blanking Panel - Shelf	256-1652-0000

MODULE SPECIFICATIONS

Typical at Nominal Line, Full Load and 25°C Unless Otherwise Noted.

INPUT

Voltage Range	170-264VAC
Power Factor	>0.98
Harmonic Distortion	EN61000-3-2
Frequency	47-63Hz
Input Current @ 230VAC	11.8A
Inrush Current Limiting, Max.	25A Peak
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
Input Protection	Internal Fuse, 20A

OUTPUT

Current & Voltage	See Model Table
Output Power	2250W
Voltage Adjustment Range	26.5-33.5V
Line & Load Regulation, Max.	1%
Filtering: Wideband Noise, 20MHz BW ¹	250mV pk-pk
Dynamic Response ²	1mS
Temperature Coefficient	0.05%/°C
Holdup Time	20msec.
Overload Protection	Constant Current Limiting
Overvoltage Protection	Latch Off
Active Current Share ³	10% Differential From Rated Current
Remote Sense	Up to 0.5V per Wire

SAFETY STANDARDS UL60950-1 2nd Ed., CSA22.2 No. 60950-1 2nd Ed., EN60950-1 2nd Ed.

STATUS INDICATORS

AC GOOD	Green LED
DC GOOD	Green LED

ALARM SIGNALS (Logic LO, TTL compatible)

ACOK	AC present, 5V standby operating
DCOK	DC output within -10% of nominal
Thermal Alarm	Indicates Thermal Shutdown

GENERAL ENVIRONMENTAL

Switching Frequency	70kHz nominal
Efficiency	85%
Operating Temp. Range	0°C to +70°C -40°C start-up, reduced performance
Output Current Derating	2.5%/°C, 50°C to 70°C
Storage Temp. Range	-40°C to +85°C
Environment	Pollution Degree 2
Humidity	0% to 95%, Non-Condensing
ESD	Bellcore GR-1089-Core and EN61000-4-2
MTBF, 35°C (Bellcore)	200,000 Hours
Cooling	Integral Ball Bearing Fan

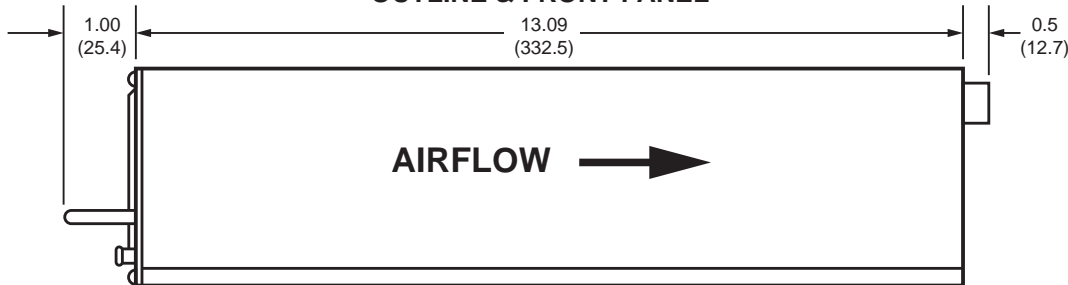
PHYSICAL SPECIFICATIONS

Case Material	Aluminum
Case Dimensions, Inches (mm)	3.3 H x 4.9 W x 13.1 D (83.8 x 124.5 x 332.7)
Weight	10.15 lbs. (4.6 kg.)

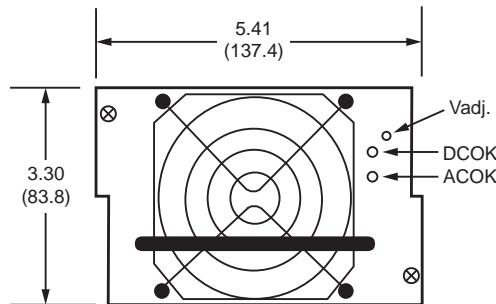
Notes:

- 20MHz bandwidth. Measure with 0.1µF ceramic and 10µF tantalum capacitors in parallel across the output.
- <5% deviation, recovering to within 1% for 50% load change.
- Using single wire current share with remote sense connected.

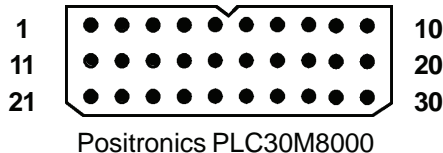
OUTLINE & FRONT PANEL



ALL DIMENSIONS IN INCHES (mm).



CONNECTOR



PIN CONNECTIONS

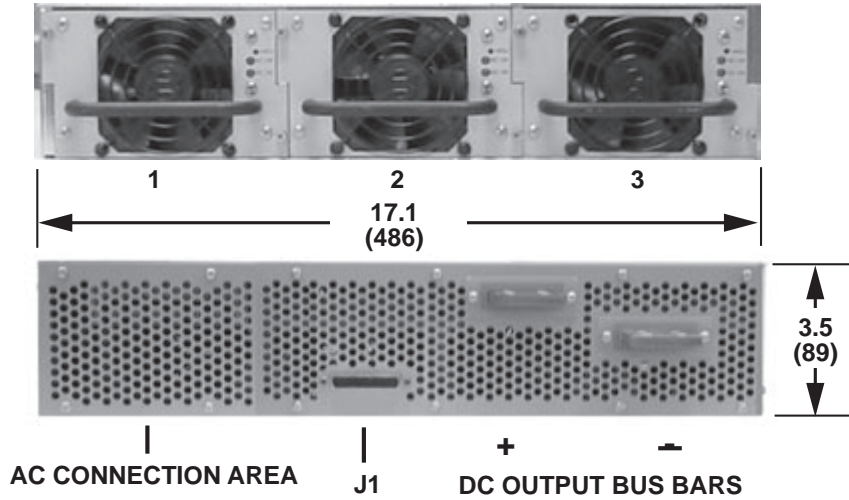
PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	AC Neutral	11	N.C.	21	AC Line
2	N.C.	12	AC Ground	22	N.C.
3	+5V Standby	13	- Sense	23	N.C.
4	DC OK	14	AC OK	24	Thermal Alarm
5	Inhibit	15	Enable / Interlock	25	Current Share
6	+ Sense	16	- Sense	26	Remote Adjust
7	- DC Out	17	- DC Out	27	- DC Out
8	- DC Out	18	- DC Out	28	- DC Out
9	+ DC Out	19	+ DC Out	29	+ DC Out
10	+ DC Out	20	+ DC Out	30	+ DC Out

NOTES:

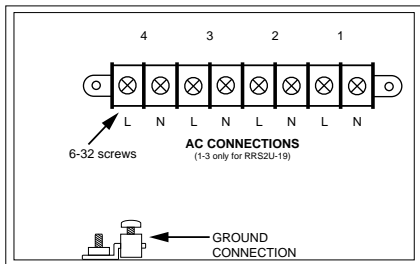
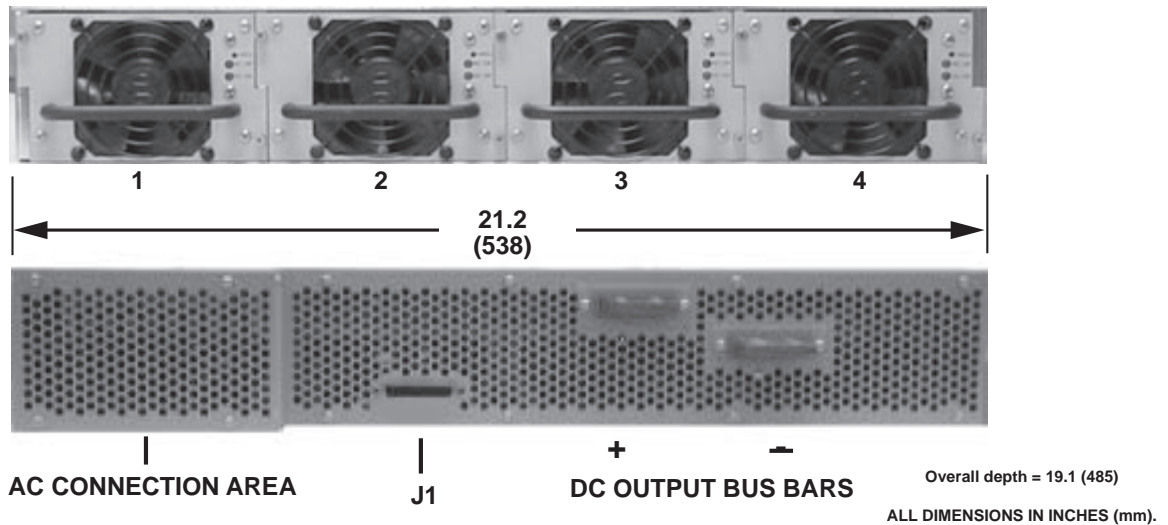
- For proper operation all +DC Out pins must be connected together and all -DC Out pins must be connected together.
- The +5V standby return is to -Sense (pin 16).
- All signals are referenced to -Sense (pin 16).

SPECIFICATIONS, RACKS/SHELVES

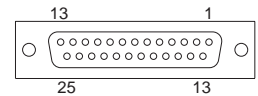
RRS2U-19 - 3-BAY



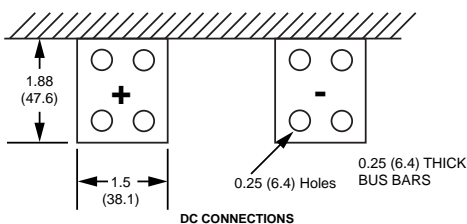
RRS2U-23 - 4-BAY



SIGNAL CONNECTOR - J1 ²			
PIN	FUNCTION	PIN	FUNCTION
1	Inhibit	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 ¹
8	Thermal Alarm - 4 ¹	21	DC Good - 4 ¹
9	Current Monitor - 4 ¹	22	N.C.
10	Current Share	23	Sense -Ve
11	Sense +Ve	24	Remote Adjust - 1
12	Remote Adjust - 2	25	Remote Adjust - 3
13	Remote Adjust - 4 ¹		



25-way D-type Socket



- NOTES:
 1. These pins are N.C. on RRS2U-19.
 2. All signals are referenced to Sense -Ve.