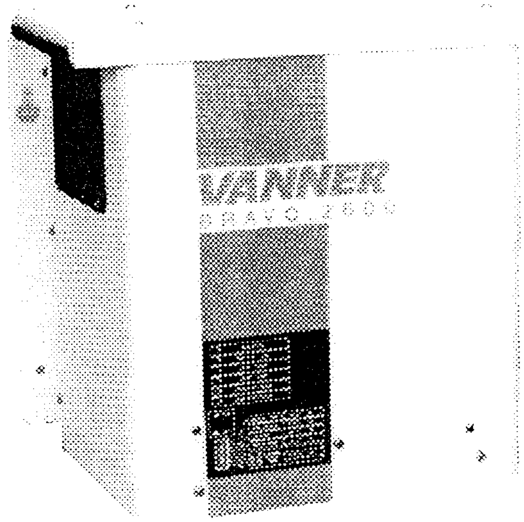
VANNER POWER GROUP

OWNER'S MANUAL



Bravo 2600—AC Power Inverter/Charger System

OM/D96397 Rev. A

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N **Note**
Important Information

W **Warning**
Failure to observe Warning could cause damage to equipment or harn personnel

Section 1: Introduction

Thank you for purchasing a Vanner inverter system. We are confident that you will be satisfied with its performance and its many features. With proper installation and care, you can look forward to years of service from this high performance product.

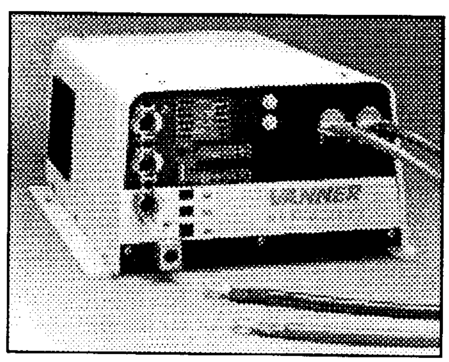
This document will describe the operation, technical specifications and installation procedures of the various models and accessories offered in this inverter product line. We suggest that you familiarize yourself with the model numbers of the inverter and optional accessories you have purchased before proceeding with this manual. If you require additional information please contact your dealer, or contact us directly at the location shown on this inside cover of this manual.

Section 2: System Operation

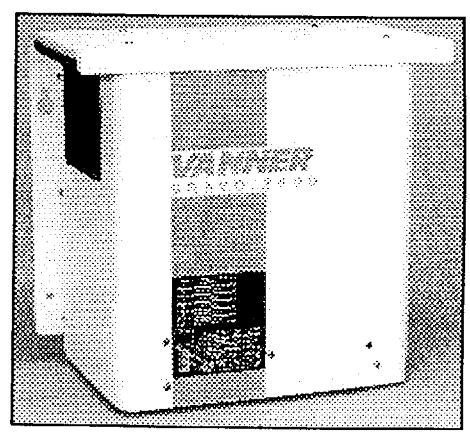
2A) Product Variations

We have designed the Bravo 2600 inverter product line to meet the requirements of a variety of applications. In order to meet these requirements, we offer different models based upon the following variations:

- Inverter-only or Inverter with Battery Charger and AC Transfer Switch
- 12 Volt or 24 Volt DC Input
- 120 Volt/60 Hz or 230 Volt/50 Hz Output Power
- Wall Mount or Shelf Mount Enclosure



Bravo Model BRC12-2600SH
(Shelf Mount Enclosure)



Bravo Model BRC12-2600WH
with "Drip Shield/Handle" option
(Wall Mount Enclosure)

FIGURE 1—Bravo 2600 Inverter/Charger Illustration

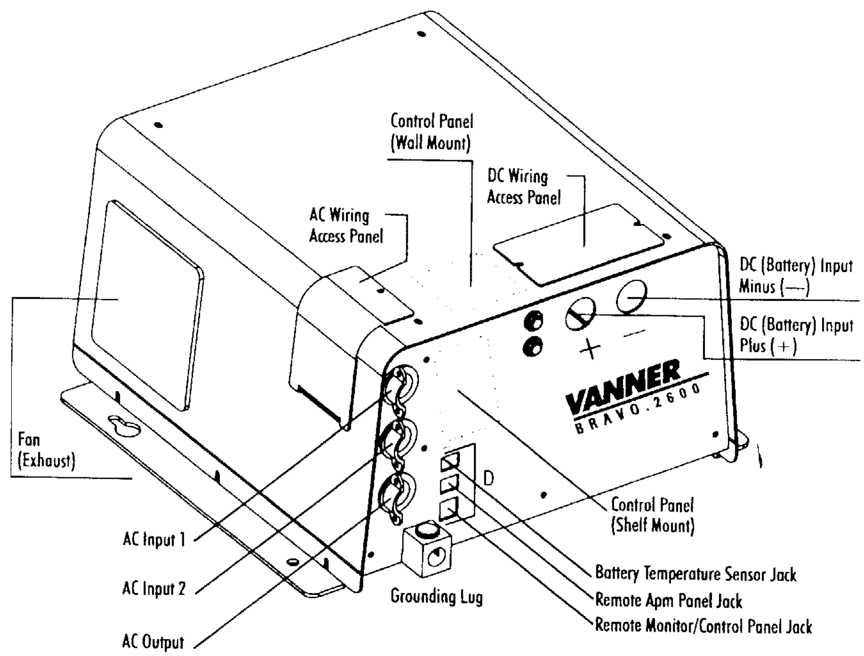


TABLE 1—Bravo 2600 Product Models

MODEL #	DC INPUT VOLTAGE	AC OUTPUT VOLTAGE	AC OUTPUT FREQUENCY	MOUNTING TYPE	BATTERY CHARGER OUTPUT AMPS
BR12-2600SH	12.0 Vdc	120 Volts ±5%	60Hz ±0.1%	Shelf	N/A
BRC12-2600SH	12.0 Vdc	120 Volts ±5%	60Hz ±0.1%	Shelf	120 Amps
BRC12-2600WH	12.0 Vdc	120 Volts ±5%	60Hz ±0.1%	Wall	120 Amps
BRC24-2600SH	24.0 Vdc	120 Volts ±5%	60Hz ±0.1%	Shelf	60 Amps
BRC24-2600WH	24.0 Vdc	120 Volts ±5%	60Hz ±0.1%	Wall	60 Amps
BRC12-2600WH/EX	12.0 Vdc	230 Volts ±5%	50Hz ±0.1%	Wall	120 Amps
BRC24-2600WH/EX	24.0 Vdc	230 Volts ±5%	50Hz ±0.1%	Wall	60 Amps

TABLE 2—Bravo 2600 Accessories

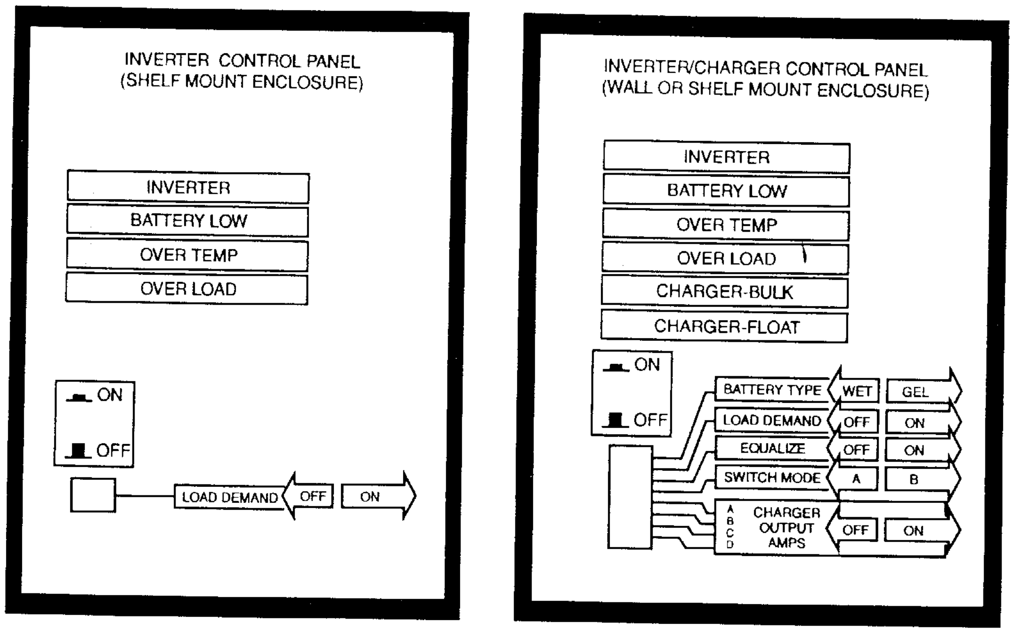
MODEL #	DESCRIPTION
D06789	Bravo 2600 Inverter/Charger Remote Panel with 20' Cable
D06790	Bravo 2600 Inverter Remote Panel with 20' Cable
D06791	Bravo 2600 Automatic Power Management (APM) Panel with 20' Cable
D07213	Bravo 2600 Drip Shield/Handle

2B) Control Panel

General Description

The Control Panel contains LED (light emitting diode) indicators and switches that you will need to use when installing and operating your inverter system.

FIGURE 2—Control Panel



WARNING

To ensure compete isolation from external power, use a remote disconnect switch in the DC and AC input circuits.

System On/Off Switch

The On/Off Switch allows you to control the operation of the inverter and battery charger. Please note that this switch does not disconnect power from the inverter system. It sends a signal to the system's electronics to control the inverter and battery charger. You have two choices of how this On/Off Switch operates, and it depends on the position of the Programming Switch *Mode A or B* located on the Control Panel.

Mode A Position: The On/Off Switch controls only the inverter; the battery charger remains on and will operate when shore/utility power is present.

Mode B Position: The On/Off Switch controls both the inverter and the battery charger. In the Off position, the battery charger will remain off regardless of the presence of shore/utility power, however, the AC transfer switch will operate.

NOTE
Place the On/Off Switch to the Off position when changing Switch/ Mode positions.

In the On position, with shore/utility power present, the battery charger will automatically charge and/or maintain the charge on your battery while passing the shore/ utility power through the AC transfer switch to power the AC loads connected to the system. When shore/utility power is removed the AC transfer switch quickly connects the AC loads to the inverter, which will obtain its power from the battery to power the loads.

Programming Switch

The Programming Switch is a dip type switch with eight individual slide switches. By placing the switch in the left or right position you select the desired function. Note: on inverter-only models (models without battery charger) only the Load Demand switch is used.

Programming Switch Positions:

Batt. Type : Left position = Flooded (wet) lead acid battery type; Right position = Gel lead acid battery type.

Load Demand: Left position = Load Demand disabled/Off; Right position = Load Demand Enabled/Automatic.

Equalize : To initiate the Equalize battery charging model, move the switch from the Left position to the Right position, then return it to the Left position.

Switch Mode: Left position = Mode A (On/Off Switch only controls the inverter) Right position = Mode B (On/Off Switch controls both the inverter and battery charger).

NOTE
Some inverters (early versions) had only the amp values shown and no "A,B,C,D" legends. These were incorrectly marked and should reference the amp settings in the above table.

Load Demand

The inverter also has an energy-saving feature called "load demand." With this feature, the inverter output is pulsed, significantly reducing the current draw from the battery until a demand is made on its output. Continuous output of 120 VAC resumes when an AC load greater than 5 watts is applied. Load demand can be disabled with the Setup switch on the front panel.

Protective Interlocks

Battery Low: The inverter continually monitors the DC input voltage to ensure that the battery contains sufficient charge to supply power to the inverter. In the event that the battery voltage drops to 10.5 (21) volts, an indication of a low charge in the battery, the inverter will shut off, and the *Low Battery* indicator will blink. The *Low Battery* indicator will illuminate steady when the battery voltage drops near the shutoff voltage to provide an "earlywarning" prior to shutting down.

Over Temperature: The inverter will shut off if internal temperature sensors detect a high temperature condition that would damage the inverter.

Over Load: If a short circuit or a very large load is applied to the inverter's output the inverter will shut down and the *Over Load* indicator will illuminate.

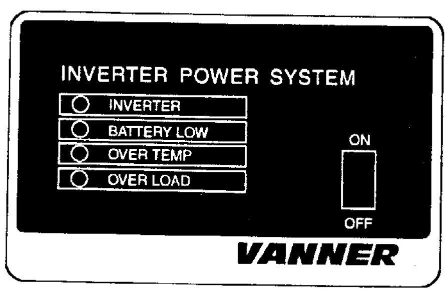
Battery Charger Output Amps

Four switches are provided to set the battery charger output current in the bulk (constant current) mode. By setting certain switches in the Right (On) position, you can adjust the output current. Starting with the top switch, each switch is twice the value in amps, of the previous switch.

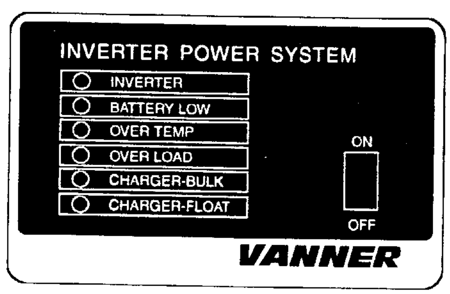
12 Volt System		24 Volt System	
Switch	Value	Switch	Value
A	8 amps	A	4 amps
B	16 amps	B	8 amps
C	32 amps	C	16 amps
D	64 amps	D	32 amps

LED Indicators

A set of LED (Light Emitting Diode) indicators are provided to display the status of the inverter system. Six LEDs are provided on inverter/charger models and four are provided on inverter-only models. Table 3—LED Status Indicators describes the LEDs and their functions.



Remote Panel
D06790 for Inverter-only Models



Remote Panel
D06789 for Inverter/Charger Models

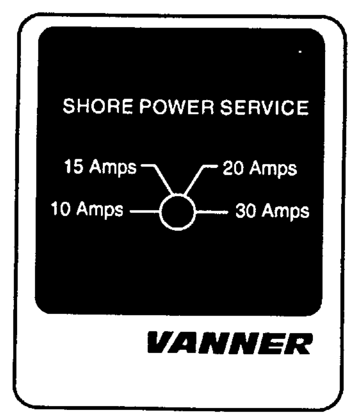
Remote Panels

Remote Monitor/Control Panel

The optional Remote Monitor/Control Panel allows the inverter to be monitored from a remote location (within 20'). The panel contains status LED indicators that match the LED indicators on the inverter's control panel. It also contains an On/Off switch. Two remote panels are available—one for inverter-only and one for inverter/charger systems. A 20 foot. cable is supplied with each remote panel.

Remote Automatic Power Management (APM) Panel

The optional remote APM Panel is used to select the size of the AC shore/utility power service that is available. This panel is usually installed near the shore power hookup. The panel's switch setting should match the circuit breaker size of the shore/utility power service (10, 15, 20, or 30 amps). A 20ft. cable is supplied with the panel.



APM Panel
D06791

TABLE 3—LED Status Indicators

INVERTER	LIGHT ACTION	DESCRIPTION
	Steady Green Light	Inverter is On.
	Slow Blinking Green Light	Inverter is in "Sleep Mode." Shore Power is supplying AC power to loads.
	Fast Blinking Green Light	Inverter is in "Sleep Mode." Shore Power is Off.
	(Sleep Mode—Requires a minimum 5 watt load to activate inverter ac output.)	
BATTERY LOW	**LIGHT ACTION**	**DESCRIPTION**
	Solid Red	Low Battery warning light. Inverter is On.
	Blinking Red	Battery has decayed to 10.5 or 21.0 volts DC causing inverter shutdown. Battery must be recharged. Then, Inverter On/Off switch must be reset to activate.
OVERTEMP	**LIGHT ACTION**	**DESCRIPTION**
	Solid Red	Inverter has shutdown due to over temperature. Shutdown may be caused by high ambient temperature or restricted cooling air flow to inverter. Shutdown sensor will auto reset when temperature has cooled.
OVERLOAD	**LIGHT ACTION**	**DESCRIPTION**
	Blinking Red	The inverter is On and warning of pending overload shutdown. Reduce the AC load quickly other inverter will shut off due to the overload condition.
	Solid Red	The inverter is Off. Shutdown was caused by overload, the inverter On/Off switch must be reset to activate.
CHARGER BULK	**LIGHT ACTION**	**DESCRIPTION**
	Blinking Yellow	Charger is On. Battery is low and being charged at full current output or at a limited rate as selected on the charger output switch. Current output will remain at a constant level until battery voltage reaches bulk voltage setpoint. Then, charger remains in Absorption stage (constant voltage-reducing current for a timed period before reducing to float stage.
	Solid Yellow	Equalize switch has been turned On. Charger voltage is at a maximum and will remain for approximately two hours.
CHARGER FLOAT	**LIGHT ACTION**	**DESCRIPTION**
	Solid Green	Charger is On. Battery is close to full charge. Charger output voltage is reduced to a preset maintenance level and current is limited to a rate selected on the charger output switch.

2C) Wiring Panel

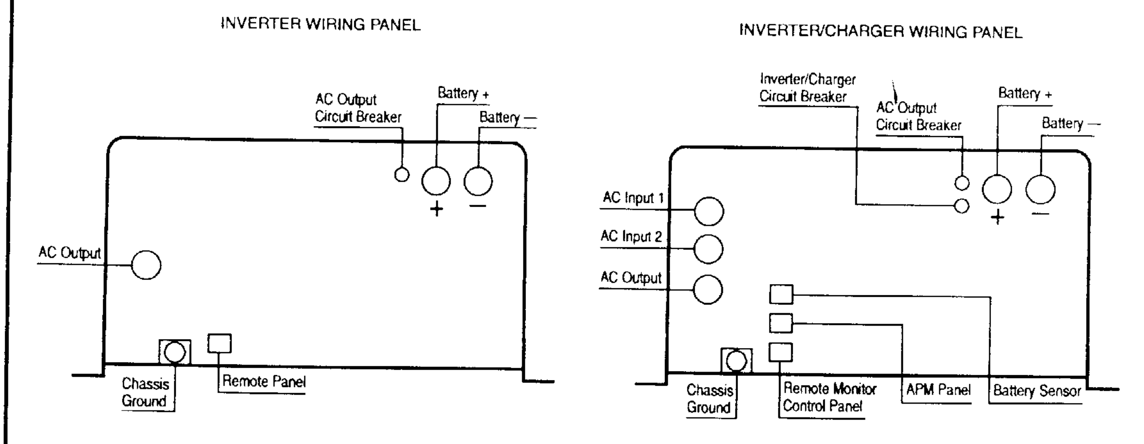
General Description

The wiring Panel where all field wiring is connected to the inverter. For wall mounted enclosures this panel is located on the inverter's bottom surface. For surface mounted enclosures the wiring panel is on the front, perpendicular to the mounting surface.

AC Output

This circuit breaker provides over-current protection in the AC output circuit.

FIGURE 3—Wiring Panel



INV/CHGR

This circuit breaker provides over current protection in the AC Input 1 circuit.

DC (Battery) Input

A DC wiring enclosure is located behind the wiring panel and contains terminals to connect the two cables from the battery. Cable clamps are provided to secure the cables after they are terminated in the wiring enclosure. A removable cover allows access to the wiring enclosure.

AC Input & Output

An AC wiring box is located behind the wiring panel to connect the field wires to the wires that are provided inside the wiring box. Two cable clamps are provided for the AC input, and one for the AC output.

Battery Sensor

This four-wire RJ11 modular jack is provided for the optional Battery Temperature Sensor.

APM Switch

This four-wire RJ11 modular jack is provided for the optional Automatic Power Management remote panel.

Remote Panel

This eight-wire RJ11 modular jack is provided for the optional Monitor/Control remote panel.

2D) Theory of Operation

Inverter Overview

In general, an inverter converts DC electrical power into AC power. This power can be used to operate various AC driven appliances.

The most common battery systems are 12 or 24 volt. Some systems, however, operate on higher voltages such as 32, 36, 48, or 120 volts. The most common inverter AC output power is 120 volts at a frequency of 60 Hz, although some inverters are designed to produce 240 volts, or both 120 and 240 volts at 60 Hz. Because some countries use power of different voltage and frequency (e.g. 230 volts at 50 Hz), inverters are available to conform to these requirements.

Inverters use electronic circuits to switch DC input power at the required frequency, such as 60 Hz. This "switched" DC resembles AC power, and is then stepped up in voltage through a transformer. The result is a modified sine wave AC output of the required voltage and frequency that can power AC-driven equipment.

Inverter Types

The three available inverter types are distinguished by the type of AC output wave form they produce. This wave form affects the AC loads they operate. This section provides an overview of these inverter types, including the advantages and disadvantages associated with using each type.

Sine Wave Inverter
Sine wave inverters produce an AC output wave form like power produced by the electric utility companies and rotating generators. The sine wave inverter's wave form is characterized by the highest peak voltage and smooth voltage transitions (no steps or square wave components). Such inverters are the most costly of the three inverter types because they contain additional electronics to produce the required wave form.

Modified Sine Wave Inverter
Modified sine wave inverters are sometimes called "quasi sine wave inverters" or "modified square wave inverters."

Modified sine wave inverters generally cost more than square wave inverters because they contain additional electronic circuitry to produce True RMS regulated AC output. Modified sine wave inverters have higher AC peak voltages than square wave inverters, and automatically control the width of the AC output wave form to regulate the output voltage (pulse-width modulation). The shape of the modified sine wave inverter's wave form includes a square wave component.

Although this wave form has a higher peak voltage than do square wave inverters, its peak voltage is not as high as a pure sine wave. Therefore, AC loads containing power supplies might not always operate properly on the modified sine wave inverter.

Square Wave Inverter
The square wave inverter is a low cost device that produces a pure square wave AC power output. This AC power can be an accurate 60 Hz frequency if it is crystal controlled. It does not have the necessary peak voltage to properly operate many AC appliances that contain electronic power supplies (e.g. computers, TVs, and VCRs). The square wave is appropriate when operating AC loads such as resistive heating devices or lighting loads.

2E) Inverter Sizing

Power Output Rating

Power output is an important consideration when selecting an inverter. Power is defined as the rate that a device produces (or uses) electrical energy. This rate is measured in watts or kilowatts (one kilowatt equals 1,000 watts), or sometimes in volt-amps. Volt-amps are obtained by multiplying volts times amps produced or used by a device.

The VA (volt-ampere) rating is always equal to, or greater than the power rating of the device. The difference between the power rating and the VA rating is called the "power factor" (PF), for example: Power Rating = VA x PF. The inverter will protect itself based on the output current, and therefore must be sized to handle the VA rating of the load.

To properly determine an inverter size (in watts) for your application, decide which AC loads you plan to operate. Inverter size is the sum of the wattages of the AC loads that you wish to run at the same time, plus a safety factor of 10 to 20 percent.

Continuous Power: Continuous power is defined as the AC power in watts (or voltamps) an inverter can produce on a continuous basis. The ambient temperature can affect the continuous rating of the inverter, and is normally specified at 25° C for high quality inverters.

Surge Power: Inverter power can also be rated in terms of surge power. Surge power is the short term duration of AC power that the inverter can produce. It is often specified as the watts (or voltamps) that can operate a resistive load for two or three seconds. Sometimes this is specified in AC amps because the inverter may allow its output voltage to drop (which would reduce is wattage). Like continuous power, the surge rating is also affected by ambient temperature.

NOTE
For a 24 volt DC inverter, the input is ½ amp input for every 10 watts AC output.

DC Power Consumption

An inverter consumes DC power, and produces AC power to operate attached loads. In general, we can see a direct relationship between DC input power and AC output power. This allows us to establish the following rule:

For every 10 watts of AC output power, an inverter requires one amp of DC input power on a 12 volt input inverter.

Example: An inverter powering a 1,000 watt AC load requires 100 amps DC at 12 volts (1000 watts/10 = 100 amps).

Using our rule, we can determine the requirements for an electrical system needed to power our inverter (typically, an alternator and battery combination, or a photovoltaic panel and battery combination).

Problem Loads

Although modified sine wave inverters will operate most AC loads, some loads may exhibit problems because the wave form is different than the pure sine wave of utility power. This is due to the square wave components and that the peak voltage is not quite as high as a pure sine wave. Loads that may exhibit problems include motor speed controls found on ceiling fans and air conditioner fans, light dimmer controls, clocks, microwave ovens (cooking time may vary and the clock may be erratic), video monitors and TVs (may have lines in the picture), AM radios (may create a noise), laser printers, copying machines, fluorescent lights, and power supplies in some electronic devices. Rechargeable battery devices may also overheat and be damaged by the inverter. If you wish to operate a rechargeable battery device on the inverter you should first power it up and closely observe it for a period of time to ensure that it does not run too hot.

2F) Battery Charger Option

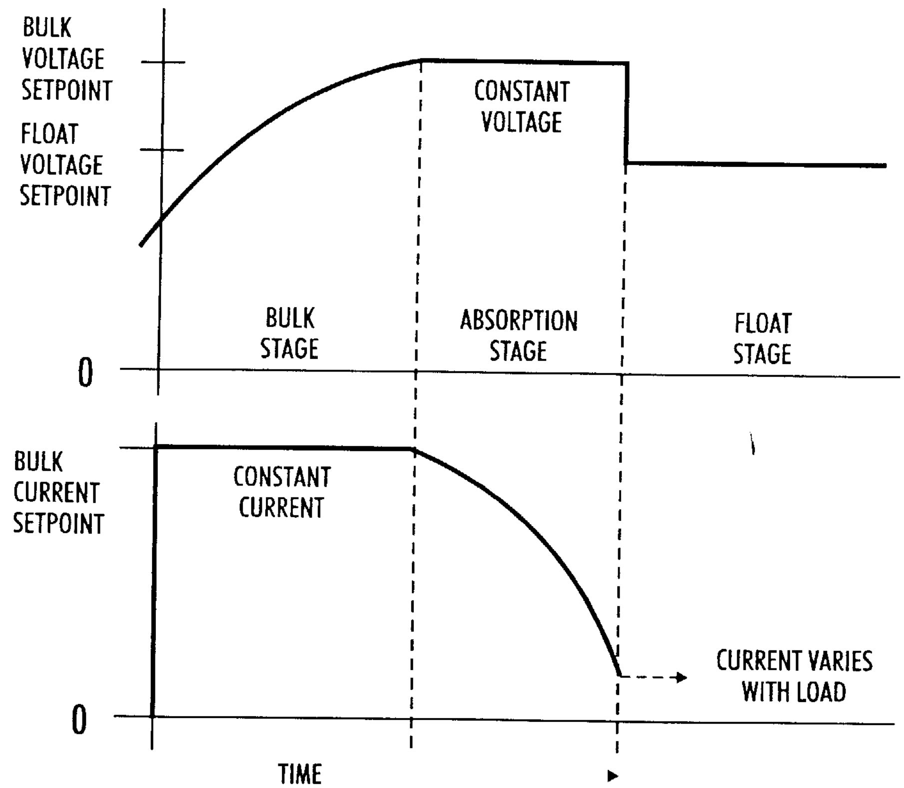
The Bravo 2600 Battery Charger's advanced design incorporates an automatic, multistage charger. This design enables the unit to automatically charge batteries, maintaining the battery's integrity and reducing the likelihood of premature failure. The battery charger is designed to be used with lead-acid type batteries including sealed and gel types, but *not* for nickel-cadmium (Ni-Cad) or nickel-iron types.

The three stages of charging are the BULK, the ABSORPTION, and the FLOAT. Figure 4 shows how the battery voltage and the charger output current to the battery are related over the entire charge cycle.

Bulk Charge

The Bulk Charge mode provides a fixed current for rapid charging of the battery system. The output current is adjustable in 8-Amp steps (4-Amp steps on 24-Volt systems), up to the maximum rating, to match the charging requirements of the battery. The battery voltage rises until it reaches the charger's bulk voltage value, 14.2 VDC for flooded batteries, or 14.1 VDC for gel batteries (on 24-Volt systems 28.4 and 28.2 respectively). At this point, the battery is approximately 80-percent charged.

FIGURE 4—Battery Charging Graph



Absorption Charge

During Absorption Charge mode, the charger's output voltage remains fixed at the bulk charge value, and the output current decreases as the battery reaches full charge. After about one hour, the charger advances to Stage 3 Float mode.

Float/Maintenance Mode

When the charger enters Float mode, its voltage is reduced to the float voltage value 13.2 VDC for flooded batteries, or 13.6 VDC for gel batteries (on 24-Volt systems 26.4 and 27.2 VDC respectively). This setting is sufficient to keep the battery charged, but not so high as to boil or overcharge the batteries.

Equalization Charge

WARNING

This manually initiated mode provides an equalization cycle to boil the battery system for a fixed time. This removes the sulfate buildup on the battery plates, and is to be used *only* on flooded lead acid batteries. The Equalization Charge mode is started by cycling the front panel Equalize switch to the "on" position and then the "off" position. The charge then increases its output voltage to 14.2 VDC (28.4 VDC on 24-Volt systems) for approximately two hours. The inverter then returns to Float mode.

WARNING

Guidelines For Battery Charging

Warning

The following information on battery charger setup adjustments should be used as guidelines only. We strongly recommend that you contact the manufacturer of your batteries to obtain the specific setup values for the type and model you are using. This is due to the fact that battery charging parameters such as bulk, float and equalize voltages vary from one manufacturer to another, and that gel cell batteries have different parameters than wet lead acid batteries. An improperly adjusted battery charger may cause damage to your batteries!

The maximum charging current for a battery is usually equal to 20% of the battery's C rate for lead acid batteries, and 50% of the battery's C rate for gel cell batteries. The C rate is numerically equal to the amp-hour capacity for the battery. For example, a 280 amp-hour battery has a C rate of 280 amps, and the maximum charge rate would be 56 amps DC. (Note that this is <u>not</u> the same as the battery's Cold Cranking Amp rating.) You should also take into consideration that if two batteries are connected in parallel their amp-hours add but if batteries are connected in series their amp-hours remain the same.

2G) Automatic AC Power Transfer

General Description

The Automatic AC Power Transfer consists of the AC Transfer Switch and the Automatic Power Management (APM) functions. Its purpose is to control the AC power switching between the AC inputs, the inverter and the AC output. Automatic AC Power Transfer is provided only on models that include the battery charger option.

Two 30 amp AC inputs are provided, which allow flexibility in adapting to different sizes and configurations of available AC input power, e.g., generator, shore/utility power.

Automatic Power Management (APM) monitors the AC input and proportionally controls the battery charger power usage in order to keep the AC input under a preset current level (30 amps default, or the amps value of the APM remote switch — 10, 15, 20 or 30 amps). The APM remote switch allows you to set the system to match the size of the shore/utility AC supply, minimizing the chance of tripping the shore power's circuit breaker if the inverter system's combined AC output loads and battery charger's AC requirements exceed the available shore power supply.

AC Transfer Switch

The AC Transfer Switch consists of a set of electromechanical relays that automatically switches AC power from the sources (DC to AC inverter or AC inputs) to the AC output. When AC input power is available from a generator or the utility supply, it is routed to the AC output to power AC loads that may be connected. It is also routed to the internal battery charger, enabling it to charge the battery. In the event of a loss of AC input power the AC transfer switch quickly switches the system's AC output to the inverter, which will then provide the AC power. There will be a short power interruption to the AC output when the relays transfer. This time is about 30 milliseconds (0.03 seconds). The inverter will draw power from the battery in this mode. When AC power is restored it must be present for 10 seconds before the AC transfer switch switches the AC output from the inverter to the AC input. This delay allows for the AC input to stabilize before switching the AC power.

The system contains two AC inputs, each rated for 30 amps AC at 120 VAC. The purpose of these separate AC inputs is to connect to separate 30 amp AC supply circuit breakers (assuming that a full 60 amps is available). This allows one AC input to power the battery charger and the other to supply the AC output loads through the AC transfer switch. However, some installations do not have this large of an AC supply, or in the case of a mobile home or boat, the supply may vary in size depending on the supply size (marina or campground). In order to accommodate these installations we have designed the AC transfer switch to be able to A) use the two separate AC inputs (AC Input 1 & AC Input 2) as described above, or 2) to use AC input 1 to power both the battery charger and the AC output. In the latter, a total of 30 amps must supply the battery charger and the connected AC loads, so care must be taken not to overload the system, e.g., the battery charger trying to run at full capacity and large AC loads operating from the same AC source.

Figure 5 shows the system configuration details. When AC Input 1 and AC Input 2 are connected to separate 30 amp supplies, SW1 is in position B. This allows AC input 2 to supply power to the AC output through SW2's position B. AC Input 1 supplies power to the battery charger. When AC input power is removed, SW2 switches the AC output to the inverter through position A. In this mode the inverter will obtain power from the battery and supply power to the AC output.

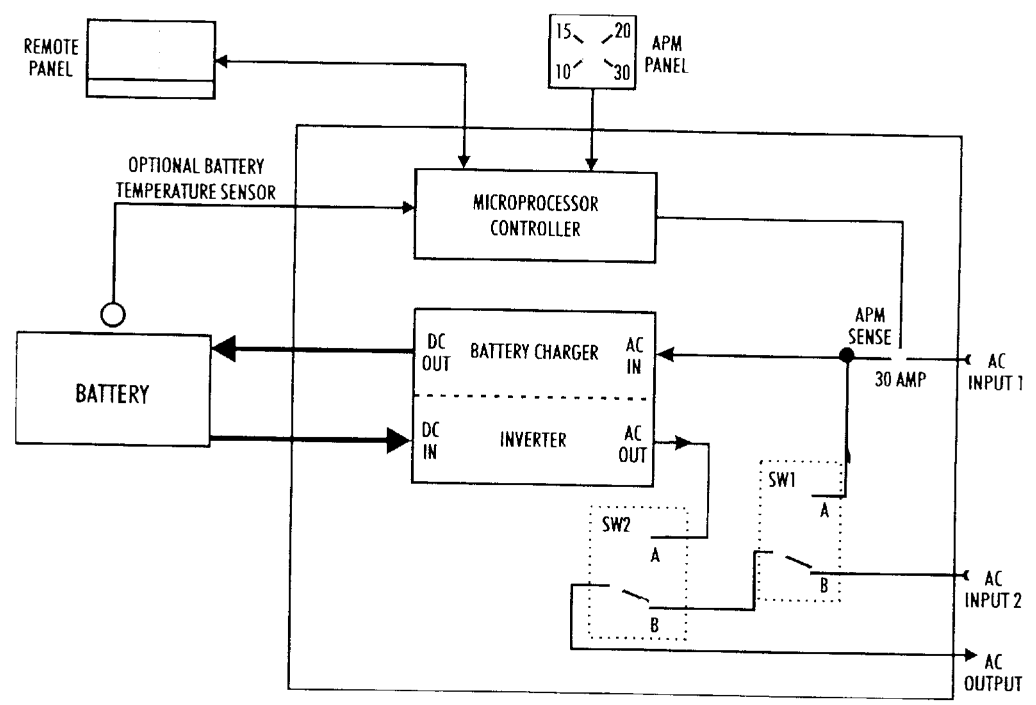
For those installations that need to use the two AC inputs (60 amp supply) on some occasions but have limited shore power (30 amps or less) under different circumstances, AC Input 1 and AC Input 2 should be wired to separate 30 amp supply circuit breakers. When a 60 amp supply is available both circuit breakers should be turned on. If the system is connected to a limited supply, the circuit breaker to AC Input 2 should be turned off. With AC Input 1 powered and AC Input 2 not powered, the transfer relays will route AC Input 1 power to the battery charger, and to the AC output through SW1 position A and SW2 position B.

For safety purposes, the inverter output neutral is connected to the inverter chassis ground when operating in the inverter mode. This is a requirement of the National Electrical Code for all systems of this type. When power is supplied from the AC Input the AC transfer system breaks the neutral to ground connection and the neutral to ground connection is then supplied by the AC source system, e.g., shore or generator power. This transfer system presents no problems for a properly installed land or marine system. The installer should verify that all AC circuits connected to the unit output are an insulated neutral type as required by the National Electrical Code (NEC) article 551.

Automatic Power Management (APM)

APM is a feature that proportionally controls the battery charger's output current, and therefore its AC input current draw. With a 30 amp input supply to AC Input 1 the battery charger will operate at its full capacity, with its output DC current being a function of the Bulk Mode output amps program switch setting. If the APM remote panel is installed, its switch can be set to the size of the AC input supply (10, 15, 20

FIGURE 5—AC Power Transfer Switch



or 30 amps). This setting will cause the battery charger to limit its input power to conform to the AC input current setpoint. As the APM sensor is located at the AC Input 1 before the connection to SW1 (see Figure 5), APM will proportionally control the battery charger to limit the AC power as a function of both the battery charger power draw and the AC loads that get power from AC Input 1 through SW1 position A. In other words, when AC Input 2 is not being used, APM reduces the power consumption of the battery charger based upon the setting of the APM switch. For example, if the APM switch is set at 20 amps and the AC output loads connected were drawing 15 amps, the battery charger would be limited to draw only 5 amps AC. Note also that if the APM switch is set to 20 amps and the AC load is 21 amps then the battery charger gets zero AC amps for charging.

N

NOTE

For those installations that will only have a 30 amp AC supply, the supply should be connected to AC Input 1. No connection to AC Input 2 is required.

APM also monitors the incoming AC voltage and current to be sure the voltage is within limits (100 to 132 VAC on 60 Hz models and 190 - 260 VAC on 50 Hz models). If the AC voltage is outside of these limits, the charger will cease operation until the voltage returns to within the limits.

SECTION 3: INSTALLATION

3A) Unpacking the Inverter

Inspect the shipping container and equipment for loose or damaged parts. If any damage is found, immediately notify the freight carrier.

3B) Inverter Installation Considerations

The wiring of your inverter installation should conform to the National Electric Code (NEC) and any other state or local codes in effect at the time of installation. These codes have been written for your protection and their requirements should be followed.

WARNING
This equipment employs components that spark. To prevent fire or explosion, DO NOT install in compartments containing batteries or flammable materials.

Mounting

Locate a secure, dry, flat horizontal or vertical surface large enough to mount the inverter. The location should be as close to the battery as possible without being in the same compartment and should provide adequate ventilation to maintain room temperature while the inverter is operating. The location must allow unobstructed cooling air flow at sides and bottom of the unit, and the location must be free from road spray, dripping water or other moisture contamination. A recommended minimum clearance of 4 inches (102 mm) should be maintained on all sides of the unit.

Wiring Procedures

WARNING
A poorly made high current electrical connection may result in risk of fire and personal injury.

A) The DC cables should be as short as possible. It is more electrically efficient to run the lower current AC wiring longer distances.

B) Route the DC positive and negative cables as close together as possible, and use cable ties to keep them together. This reduces some electromagnetic radiation that could interfere with some sensitive electronics.

C) On vehicle installations do not use the vehicle chassis as the DC negative conductor. Use a cable the same size as the DC positive to go directly from the inverter to the battery negative or engine block where battery negative connects.

D) Route the AC and DC power wiring separately, and with as much physical separation as possible, from low voltage wiring such as audio and video signal wires.

E) DC power input cables which pass through steel or other ferrous metal walls need to pass through the same hole. If two holes are required, cut a slot connecting the two holes to prevent a transformer effect.

DC Input Wiring

The DC input terminals are located in the field wiring compartment located at the front right of the unit. The connections are pressure terminals that require a stripped cable and are tightened by an Allen screw. The positive and negative cables enter the compartment through separate strain reliefs located at the right front of the unit.

NOTE
The USCG, CFR Title 33, Subpart 183 requires conductors to be the stranded type having moisture resistance and flame retardant insulation.

Table 4 shows the recommended minimum cable size which should be used. Wire sizing charts published in the NEC may allow a greater ampacity than we recommend. We have sized the cable for a maximum voltage drop to maintain better performance of your inverter installation. For best performance, wire the DC negative directly back to the battery, and do not use the vehicle chassis as the DC negative conductor.

The wiring of your inverter installation should conform to the National Electric Code (NEC), United States Coast Guard (USCG), Code of Federal Regulations (CFR) Title 33, Subparts 183, and any other state or local codes in effect at the time of installation. Article 551 of the NEC requires any DC cable from a battery, which measures longer than 18 inches along its length, be protected by a fuse. For marine installations, the USCG regulations found in CFR Title 33, Subparts 183.460 requires each ungrounded output conductor from a storage battery, other than to the engine cranking motor, to have a manually reset trip-free circuit breaker or fuse within 18 inches of the battery as measured along the conductor.

WARNING
The inverter's AC output wiring must be designed to prevent AC power from an external source (shore power or a generator) back into the inverter's AC output. AC feedback can cause damage to the inverter.

AC Wiring

TABLE 4—DC Cable Size Chart

DC Cable Length		
Size	Maximum Length	
	12 Volt	24 Volt
0 AWG	NA	12 ft.
00 AWG	NA	15 ft.
000 AWG	10 ft.	20 ft.
0000 AWG	14 ft.	20 ft.
250 mcm AWG	16 ft.	20 ft.

The AC connections are located in the field wiring compartment at the front left of the unit. Three sets (one set on inverter-only models) of wire pigtails are provided and require either a butt splice or wire nuts for connection. Each set consists of a black hot, white neutral and green ground wires, approximately eight inches long. The wire sets are marked AC Output, AC Input 1 and AC Input 2. The field wires are brought in through the three cable clamps and terminated to the three sets of wires inside the wiring compartment.

WARNING
Failure to connect the chassis bonding lug to the chassis of the vehicle, the boat's grounding system, or to earth ground may result in a lethal shock hazard.

Some installations require the installation of Ground Fault Circuit Interrupter (GFCI)

TABLE 5—DC Fuse Size Chart

System	Fuse	Fuse Holder
12 Volt	Bussman ANN400 Vanner p/n 04523	Bussman 4164 Vanner p/n 03637
24 Volt	Bussman ANN200 Vanner p/n 04522	Bussman 4164 Vanner p/n 03637

type circuit breakers in the AC distribution system. Because the output waveform of the inverter is not the same as that supplied by a generator or the utility, some GFCI devices do not function properly. The following list of GFCI circuit breakers have been tested and function properly with this inverter system.

TABLE 6—Ground Fault Current Interrupter (GFCI) Recommendations

Ground Wiring

Manufacturer	Manufacturer Part Number
GE	THQL-1115GF
Leviton	6490-I
Hubbel	GF5252
Pass & Seymour	1591R, 2091S

There is a terminal on the wiring panel of your inverter which is marked "CHASSIS BONDING LUG". This is a compression type terminal requiring only an Allen Wrench to make the connection. This terminal has been provided for safety to prevent possible shock hazards. You must connect a #6 AWG minimum size wire to this terminal and then to chassis of the vehicle, the boat's grounding system, or to earth ground.

Inverter Installation Procedure

Step 1: Turn the inverter OFF and disconnect power to the wiring harness. Make sure the power to the inverter is disconnected. Verify that the inverter is turned OFF (the ON-OFF/RESET Inverter switch is in the OFF-RESET position).

Step 2: Select a location for the unit. An ideal installation location has the following characteristics:

- Close to the battery (usually within six feet).
- Protected from the weather.
- Well ventilated.

Step 3: Route DC input cables. Route the negative and positive DC input cables from the inverter to the battery. If required, protect cables where they contact hard, sharp edges.

Step 4: Install the in-line fuse. Install an in line fuse in the red, positive DC input cable between the battery and inverter, within 18 in. of the battery or DC wiring bus system. (See DC Fuse Size Table 5).

Step 5: Connect Bonding Lug. Use a AWG No.8 or larger copper conductor to connect the chassis bonding lug to the vehicle chassis and/or earth ground.

Step 6: Connect the inverter to the battery.

A) Remove the cover plate on the DC cable compartment exposing the positive and negative Allen head terminal lugs.

B) Remove the two Allen screws from the terminal lugs.

C) Strip the two (positive and negative) DC cable ends 3/4 in.

D) Insert the black, negative (-) cable end through the strain relief and into the negative terminal lug. Ensure that all cable strands are completely in the lug.

E) Insert the Allen screw into the negative terminal block and tighten to 275 pound-inches.

F) Insert the red, positive (+) cable end through the strain relief and into the positive terminal lug. Ensure that all cable strands are completely in the lug.

G) Insert the Allen screw into the positive terminal block and tighten to 275 pound-inches. Note it is recommended to retighten allen screws in 30 days to insure firm contact.

H) Tighten the two cable clamps.

I) Inspect the DC cable compartment to ensure that no foreign particles are present.

J) Replace the cover plate over the DC cable compartment.

WARNING
The AC Output from the inverter must be wired to a Ground Fault Circuit Interrupter (GFCI) to ensure a safe installation. See Table 6 for recommended GFCI breakers.

Step 7: Connect the AC output. Remove the cover of the AC wiring compartment. Identify the three wires (black, white, and green) labeled AC Output. Insert the three conductor field wiring cables through the strain relief into the AC wiring compartment, and tighten the strain relief with a screwdriver. Connect the three field wires to the three AC output wires inside the AC wiring compartment using suitable wire terminators such as crimped butt splices or wire nuts. Replace the cover to the AC wiring compartment when all AC connections are complete.

Step 8: Connect AC Inputs (Inverters equipped with Battery Charger option). Remove the cover of the AC wiring compartment. Identify the two sets of three wires (black, white, and green) labeled AC Input 1" and AC Input 2". Two cable clamps are provided to route the three conductor field cables into the AC wiring compartment. Install the two field cables and connect them to the six wires for AC input 1 and AC input 2 using suitable wire termination, such as crimped butt splices or wire nuts. Tighten the strain reliefs with a screwdriver and replace the AC wiring compartment cover.

AC input 1 and AC input 2 should be connected to two separate AC circuit breakers in the main AC input distribution panel (from shore/utility power or generator) if a 60 amp supply will be used. If a single 30 amp supply will only be used it is only necessary to connect this supply to AC Input 1 (no connect to AC Input 2). See *Section 2G—Theory of Operation, AC Power Transfer Switch*, for more details.

Step 9: Verify Installation. Verify all connections are tight and secure for maximum performance.

3C) Remote Panels

Remote Monitor/Control Panels

Unpacking the Remote Monitor/Control Panel

Inspect the shipping container and equipment for loose, damaged, or missing parts. The remote panel includes a 20-ft. interconnecting cable. If any damage is found, immediately notify the freight carrier.

Installing the Remote Monitor/Control Panel

Step 1: Locate a suitable place to install the remote panel such as a flat surface near the power control/distribution panel or drivers compartment. The mounting surface should have sufficient space to accommodate the remote panel's depth and cable routing.

Step 2: Route the 20-ft. interface cable from the remote panel mounting area to the inverter.

Step 3: Plug the interface cable into the inverter's wiring panel (RJ-11 telephone-type jack labeled "Remote"). Plug the other end of the cable into the rear of the remote panel.

Step 4: Mount the remote panel using four #8 screws.

Automatic Power Management (APM) Panel

Unpacking the Automatic Power Management (APM) Panel

Inspect the shipping container and equipment for loose or damaged parts. If any damage is found, immediately notify the freight carrier.

Installing the Automatic Power Management (APM) Panel

Step 1: Locate a suitable place to install the APM panel. This may be near the remote monitor/control panel or near the shore power connector.

Step 2: Route the 20ft. interface cable from the remote panel mounting area to the inverter.

Step 3: Plug the interface cable into the inverter's wiring panel (RJ-11 telephone-type jack labeled "APM Panel"). Plug the other end of the cable into the rear of the remote panel.

Step 4: Mount the remote panel using four No. 8 screws.

3D) System Start-up and Testing

NOTE

Steps shown with * are for models with the battery charger option.

Step 1: Completely install the unit following the instructions provided in *Section 4—System Design Considerations and Section 3—Inverter Installation.*

Step 2: Place the System On/Off switch on the inverter and remote LED panel in the OFF position.

Step 3: Verify that the external GFCI breaker is reset and connect an AC load, such as a 100-Watt test light.

* Step 4: Determine the desired mode (A or B) for the system On/Off switch and move the Setup switch to that position. Bravo systems equipped with the battery charger option provide two modes of operation from the front panel On/Off switch. The operating modes (mode A or mode B) are selected during installation by the front panel Setup switch.

Mode A: In this mode, the System On/Off switch controls only the inverter. The battery charger and the AC Transfer switch remain operational, (i.e., when AC input shore/utility power is present the battery charger operates regardless of the System On/Off switch position.

Mode B: In this mode, the System On/Off switch controls both the inverter and battery charger. When off, the transfer relay switches; however, the relay is DC and uses battery power.

* Step 5: Place the Wet/Gel Setup switch to the correct position for the installed battery type.

* Step 6: Place the Equalizer Setup switch to the OFF position.

* Step 7: Determine the correct charger output amps and place the Setup switch positions to match this value.

NOTE
Early Bravo 2600 versions displayed incorrect charge output amp values on the front panel.

The correct values for 12 VDC input models (model numbers beginning with "BRC12") are:

Incorrect Value	Correct Value
10 Amps	8 Amps
20 Amps	16 Amps
40 Amps	32 Amps
80 Amps	64 Amps

The correct values for 24 VDC input models (model numbers beginning with "BRC24") are:

Incorrect Value	Correct Value
5 Amps	4 Amps
10 Amps	8 Amps
20 Amps	16 Amps
40 Amps	32 Amps

On the later Bravo 2600 versions the Charger Output Setup switch on the front panel is labeled as follows:

For 12-Volt models, the output amps corresponding to the switch positions are:

A .... 8 Amps
B .... 16 Amps
C .... 32 Amps
D .... 64 Amps

For 24-Volt models, the output amps corresponding to the switch positions are:

A .... 4 Amps
B .... 8 Amps
C .... 16 Amps
D .... 32 Amps

Determine the combined value of switches that match the desired charger output amps and place these switches to the ON (right) position. For example, on a 12-Volt system, for a charger output of approximately 80 Amps, the 64-Amps and 16-Amp switch positions would be ON and the 8-Amp and 32-Amp switch positions would be OFF.

Step 8: Place the Load Demand Setup switch in the ON position to test this function. It can be changed later if this feature is not used.

Step 9: Turn on the battery DC power to the inverter.

*Step 10: Turn on the AC shore/power (or generator) through the AC breakers to power AC inputs (1 and 2) to the system.

Step 11: Place the System On/Off switch on the Remote LED panel to the ON position (depressed position).

Step 12: Place the System On/Off switch on the Inverter panel to the ON position (depressed position).

Step 13: The inverter control panel LED indication displays Charge Bulk or Charge Float mode. (If the battery is fully charged, it will advance from Bulk mode to Float mode after a time delay).

Step 14: The AC output 100 watt test light should be on, indicating the presence of shore power and correct operation of the AC Transfer switch.

*Step 15: Place the system On/Off switch to the OFF position. If the Mode A/B switch is in the A position, the AC output test light will remain on and the Bulk or Float light will remain on. Return the system On/Off switch to the ON position. If the Mode A/B switch is in the B position when placing the system On/Off switch in the OFF position, the AC output test light remains on and the Bulk and Float LED indicators turns off. Return the system On/Off switch to the ON position.

*Step 16: Disconnect the AC shore power input. The AC output test light blinks, indicating the operation of the Transfer switch connection to AC output to the inverter output.

Step 17: The Inverter LED on the inverter control panel has a solid light indicating correct inverter operation. At this point, apply AC loads up to 2600 Watts to verify full-power operation.

Step 18: Disconnect all AC loads. The Inverter LED blinks, indicating that the inverter is in the Load Demand mode (the energy-saving, standby mode).

Step 19: Apply an AC load greater than 5 Watts, for example, a 100-Watt test light. The AC output should turn on and the inverter LED should stop blinking and become solid.

*Step 20: Apply shore power. After a five second delay the AC output test light should blink as the load transfers from inverter power to shore power. The Inverter LED turns off and the Charger Bulk or Charger Float LED turns on.

- Step 21: Test the battery charger operation by first discharging the battery. Discharge the battery by placing the AC load on the system and operating the inverter, (remove shore power input). When the battery charge level is low, the Battery Low LED turns on and the inverter turns off. Apply shore power and observe the battery charger operation. The system begins with the Charger-Bulk LED flashing, indicating Step 1: bulk charge operation. This supplies a constant current battery charger output. Connect an ammeter to the DC cables between the inverter and the battery to monitor the current (DC amp), and a volt meter to the battery to monitor the battery voltage.

  After some time, the battery voltage rises to the bulk voltage (14.2 VDC for wet batteries or 14.1 VDC for gel batteries) indicating the charger is in Step 2: Absorption mode. The battery voltage remains constant (bulk voltage value), and the charger output current tapers off. After approximately one hour, the charge advances to Step 3: Float mode. The Charger Float LED turns on and the battery voltage drops to the float voltage value (13.2 VDC for wet batteries or 13.6 VDC for gel batteries). The charger remains in this status until shore power is removed.

SECTION 4: SYSTEM DESIGN CONSIDERATIONS

4A) Inverter System Design Considerations

To get the best performance from your inverter, it must be installed properly and have an ample DC supply. We will not be able to cover all the possible situations encountered when installing a power inverter, but we will cover the basic information required to properly size your vehicle alternator and inverter battery, as well as give some examples of AC power distribution systems which are commonly used. Keep in mind that if information in this manual directly conflicts with instructions from a specific battery or other equipment manufacturer, you should follow that manufacturer's recommendations.

Inverter DC Input Current Requirements

A DC to AC inverter converts DC power into AC power. For the purposes of this discussion, power (watts) is equal to the supply voltage (volts) multiplied by the current draw (amps) from the supply for both AC and DC circuits. For example, 2400 watts = 12 volts DC x 200 amps, and 2400 watts = 120 volts AC x 20 amps. From these two examples of 2400 watts at 12 volts and 2400 watts at 120 volts, it is easy to see that since there is a 1 to 10 voltage conversion (12 to 120), there is a 10 to 1 amp conversion (200 to 20). A more accurate relationship between the input power and output power is:

(DC Input Power) x (Efficiency) = (AC Output Power)

This formal relationship has lead to the following rule of thumb for estimating the DC input amps for an inverter:

For 12 volt DC inverters: output watts ÷ 10 = DC input current

For 24 volt DC inverters: output watts ÷ 20 = DC input current

This rule of thumb can be used to estimate the minimum alternator size required for your application and is also used later in calculating the minimum size battery required when operating from battery only. The following examples should help to clarify the use of this rule of thumb.

NOTE

If the appliance is rated in amperes (amps) instead of watts, multiply the amps by 120 to get watts.

Example A: What is the DC current draw of a 12 volt DC input inverter when it is operating a vacuum cleaner with a name plate rating of 6 amps at 120 volts AC?

The appliance rating is given in amperes, so we must first calculate the power it consumes. Then the rule of thumb can be used to find the DC input current of the inverter.

Output power = 120 volts x 6 amps = 720 watts, and DC input current = 720 ÷ 10 = 72 amps DC.

Example B: What is the DC current draw of a 24 volt DC input inverter when it is operating a toaster with a name plate rating of 1050 watts at 120 volts AC?

Since the appliance is rated in watts, the rule of thumb can be applied directly:

DC input current = 1050 ÷ 20 = 52.5 amps DC.

This information on estimating the DC input current requirement for an inverter will allow you to size an alternator or charging system to supply an inverter for continuous operation. This rule of thumb will be used later in the discussions on battery sizing.

4B) Battery Types and Ratings

The batteries in general use for automotive, solar, and marine use are lead-acid storage batteries. They can be separated into two categories according to their use: engine cranking batteries and deep cycle batteries. The engine cranking battery is specifically designed to supply hundreds of amps for a short period of time to start an engine. Cranking an engine usually uses a small portion of the battery's total capacity and once the engine is running, the battery is quickly recharged by the engine's alternator. The deep cycle battery is specifically designed to deliver current for extended periods of time and can be almost totally discharged before recharging.

The "deep cycle" lead-acid battery is designed to withstand the deep discharge/recharge cycling that is typical of most inverter installations. These batteries are available in the "maintenance free" style where the electrolyte does not need to be checked or replenished and they also are available in the gelled electrolyte style or "Gel Cells". Deep cycle batteries are generally advertised for use in recreational vehicles or boats and are sometimes referred to as RV or marine batteries.

Battery Council International (BCI) is a voluntary industry organization which has helped to standardize battery ratings. Ratings in use at this date are: Cold Cranking Amperes (CCA), Marine Cranking Amperes (MCA), Reserve Capacity (RC) and Ampere-Hour (A-H). The first two of these ratings are used for sizing an engine cranking battery and have no bearing on a battery's cycling ability. Reserve Capacity is a rating given to cranking batteries to give a person some idea of how long the battery may last if the vehicle charging system were to break down and needed to continue driving the vehicle (to the nearest freeway off ramp or service station). This brings us to the oldest and probably least understood battery capacity rating, the ampere-hour. The ampere-hour is defined as follows:

Ampere-Hour (A-H):
A unit of measure for a battery's electrical storage capacity, obtained by multiplying the discharge current in amperes by the time in hours of discharge. The rating is usually for a discharge period of 20 hours and an end voltage of 10.5 volts. Example: A battery which delivers 5 amperes for 20 hours has a capacity of 100 A-H. 5 amperes x 20 hours = 100 Amp-Hr.)

The reason the A-H rating is misunderstood is simple. A battery that has a rating of 100 A-H cannot always deliver 100 A-H. The underlaying reason is the efficiency with which the battery converts its chemical energy into electric energy. The A-H capacity of a battery is affected in the following ways:

Discharge rate:
A battery becomes less efficient as the discharge current increases. For example, a typical 100 A-H battery is specified to be able to deliver 5 amps for a period of 20 hours. If the discharge current were increased to 25 amps, the capacity will be reduced to approximately 75 A-H (25 amps x 3 hours = 75 A-H).
Operating temperature:
A battery becomes less efficient at lower temperatures. Most battery manufacturers specify the battery A-H capacity at 80°F. At a temperature of 32°F, the same battery will have only about 65% of its rated capacity even though it may be fully charged. At a temperature of 0°F, a battery's capacity will be reduced to about 40% of its rated capacity.

Battery age:
As a battery is used, some of the active material on the battery plates will deteriorate and become useless. As the battery gets older, there will be less and less useful material left on the plates and the operating time will become noticeably shorter. A battery will age faster (loose active material from its plates faster) if it is deeply discharged regularly, if it is left in a discharged state for extended periods of time, or if it is repeatedly overcharged.

4C) Sizing the Inverter Battery

Sizing a battery system for an inverter application can be a very tedious task if all the different variables, such as discharge rate, depth of discharge, and operating life time are included in the calculations. To simplify these calculations and get a reasonably correct battery size, we will assume: 1) A 50% depth of discharge for the purpose of obtaining a reasonable life time for a reasonable battery system cost, 2) there is no

charge current into the battery system, 3) the batteries are in a fully charged state at the beginning of the discharge cycle, and 4) the DC current draw from the battery does not exceed 1/3 the C rate for any length of time.
Follow the steps listed below to find the A-H capacity required for your application.

Step 1: Make a list of each appliance, its power requirement in watts, and the amount of time in hours it will be operating between charging cycles.

Step 2: Calculate the watt-hours required for each appliance by multiplying the power requirement by the operating time of that appliance.

Step 3: Calculate the total watt-hours needed by adding together the watt-hours of each appliance.

Step 4: Find the amp-hours consumed by dividing the total watt-hours found in step 3 by 10 for 12 volt DC systems or by 20 for 24 volt DC systems.

Step 5: Multiply the amp-hours consumed by 2 (for 50% depth of discharge) to get the battery amp-hour capacity desired.

Example 1: **Follow Steps 1 through 3 (above)**

Appliance	Power Rating	Operating Time	Watt-Hours Consumed
TV, VCR, Stereo	225 watts	2.5 hours	563 watt-hours
Small Refrigerator	300	3.8	1,140
Microwave	800	0.3	240
TOTALS			1,943 watt-hours

Step 6: Amp-hours consumed = 1943 watt-hours ÷ 10 = 194.3 amp-hours for 12 a volt system.

Step 7: The minimum battery size for this application is 2 x 194.3 = 388.6 amp-hours.

4D) DC Charging Systems

The DC charging system is a very important part of your inverter installation. The system consists of the primary charger (engine alternator or photovoltaic array), a secondary charger, if used, the battery, and other equipment which may be used such as battery isolator diodes. The complexity of the system depends on the way the inverter is used. In some cases, such as utility or service vehicles, the system may be as simple as the engine alternator and the cranking battery which also powers the inverter. In most cases, additional equipment is needed to provide additional DC power and/or protection. These systems can be grouped into two categories, the single battery and the dual battery systems.

In the single battery system, there is one battery which is shared for starting the engine and operating the inverter. This is a common practice in a service vehicle where the engine runs all the time and allows the alternator to provide continuous charging for the battery. In this case, the inverter can be connected directly to the engine cranking battery. Great care should be used when operating this type of system. If the engine were to be shut off and the inverter operated, it would not take a very long time for the inverter to discharge the cranking battery and disable the vehicle! The most important detail of this system is the alternator output rating. The continuous output of the alternator needs to be at least as much as the total DC current draw on the system. The total DC current draw must include the inverter, warning lights, radios, engine controls, and any other device connected to the DC system.

The dual battery system uses two separate batteries, one for starting the engine and operating the vehicle's systems, and one for operating the inverter. The two batteries are usually referred to as the "cranking battery" and the "house battery" respectively. The two separate batteries are usually charged from the same source, the engine alternator, but are separated by a device called a battery isolator. The battery isolator allows DC current to flow from the alternator into each battery, but blocks current from flowing from one battery to the other. This is a must to protect the cranking battery in recreation vehicles, boats and other vehicles where the inverter needs to be operated when the engine (therefore the alternator) is not running.

Up to this point we have spoken of the battery as if it were a single battery. In some cases this may be true, but in general, the battery may be made up of several individual batteries electrically connected together to form a "Bank" of batteries. Batteries can be connected in series, parallel, or a combination of series and parallel as long as all of the batteries in the bank are of equal ratings, are from the same manufacturer, and are the same age. Old and new batteries should never be mixed in the same battery bank. A series connection is where two or more batteries are connected positive (+) to negative (-) and the total voltage of the battery bank is the sum of the voltage of each battery in the bank. For example, most large custom coaches require a 24 volt battery to crank the large diesel engine. The 24 volts is usually provided by connecting two 12 volt batteries in series, and sometimes by connecting four 6 volt batteries in series. *The ratings of the series connected battery bank remain the same as the individual battery's rating.* If the battery bank is made up of two 8D size batteries in series, each with a CCA of 1050 amps, 425 minutes RC, and amp-hour capacity of 200 A-H, then these individual battery ratings are also the ratings of the entire 24 volt battery bank.

Parallel connected batteries are batteries of the same voltage and rating which are connected positive to positive and negative to negative. They form a battery bank that has the same voltage as each individual battery. *The ratings of a parallel connected battery bank, in general, are the sum of the individual batteries.* For instance, if two 8D batteries are connected in parallel, and each battery has the ratings given in the paragraph above, then the ratings for the battery bank become 2100 CCA, 900 minutes RC, and approximately 400 amp-hours.

4E) Inverter Applications

There are many different ways that an inverter can be installed and is probably only limited by ones imagination and wiring codes. There are only a few types which we will convey to you that use good engineering practices and will cover most needs in a recreational or service vehicle.

Inverter Only Installation

The term "inverter only" means that the inverter is the only source of AC power on board the vehicle. This type of installation is typical of a service vehicle which needs AC power to run power tools and other equipment during the work day and does not require the inverter to operate when the vehicle engine (and therefore the battery charging system) is not running. The AC power distribution system usually consists of an AC circuit breaker and one or more receptacles.

Inverter With Multiple AC Power Sources

In an installation where there are multiple AC sources, the system needs to be designed so that one and only one AC source can be connected to the distribution wiring at any one time. This is to prevent the selected power source from back feeding one of the other power sources. It may be accomplished by using a manual transfer switch, or an elaborate automated system which chooses and switches to the best available AC source. A very simple manual transfer system may consist of a cable which is plugged into the desired AC source. Please note that in all cases where a transfer switch is used, it must switch both the AC "HOT" and "Neutral". This will prevent many problems, especially when a Ground Fault Circuit Interrupter (GFCI) is used. Also note that the AC distribution panel must have an insulated neutral bus. The insulated neutral is a requirement of the Nation Electrical Code (NEC) Article 551-54(c).

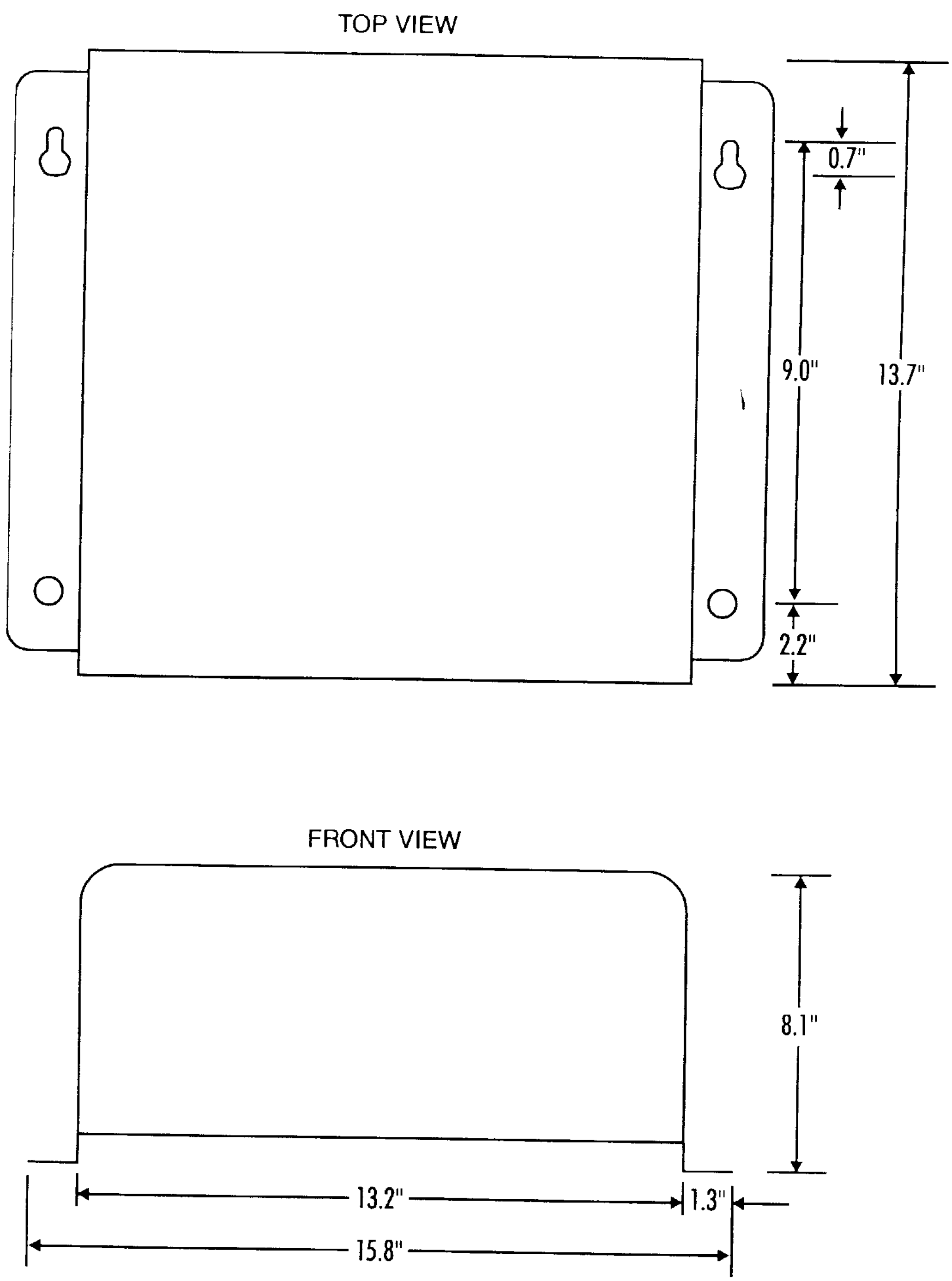
Section 5: Bravo 2600 Specifications

BRAVO	INVERTERS & INVERTER/CHARGERS						
INVERTER MODEL #	BR12-2600SH	BRC12-2600SH	BRC24-2600SH	BRC12-2600WH	BRC24-2600WH	BRC12-2600WH/EX	BRC24-2600WH/EX
AC Output Power							
Continuous	2600 Watts			2600 Watts		2600 Watts	
Surge (3 sec.)	7800 Watts			7800 Watts		7800 Watts	
Output Voltage	120 Volts ±5%			120 Volts ±5%		230 Volts ±5%	
Frequency	60 ±0.1Hz			60 ±0.1Hz		50 ±0.1 Hz	
Output Waveform	Modified Sine Wave			Modified Sine Wave		Modified Sine Wave	
DC Input Voltage							
Nominal	12.0 VDC	12.0 VDC	24.0 VDC	12.0 VDC	24.0 VDC	12.0 VDC	24.0 VDC
Minimum	10.5 VDC	10.5 VDC	21.0 VDC	10.5 VDC	21.0 VDC	10.5 VDC	21.0 VDC
Maximum	16.0 VDC	16.0 VDC	32.0 VDC	16.0 VDC	32.0 VDC	16.0 VDC	32.0 VDC
DC Current Draw							
OFF	0.08 Amps Typ.		0.08 Typ.	0.08 Amps Typ.	0.08 Typ.	0.08 Amps Typ.	0.08 Typ.
Load Demand (waiting)	0.17 Amps Typ.		0.17 Typ.	0.17 Amps Typ.	0.17 Typ.		
Full ON No Load	2.1 Amps Typ.		0.7 Typ.	2.1 Amps Typ.	0.7 Typ.		
Full ON With Load	Approx. Load Wattage ÷ 10 or Load Amps x 12		Approx. Load Wattage ÷ 20 or Load Amps x 12	Approx. Load Wattage ÷ 10 or Load Amps x 12	Approx. Load Wattage ÷ 20 or Load Amps x 6	Approx. Load Wattage ÷ 10 or Load Amps x 24	Approx. Load Wattage ÷ 20 or Load Amps x 12
Charger							
DC Output*	N/A	120 Amp	60 Amp	120 Amp	60 Amp	120 Amp	60 Amp
AC Input Voltage	N/A	120 Volt Nominal		120 Volts Nominal		230 Volts Nominal	
AC Input Current	N/A	0-26.5 Amps		0-26.5 Amps		0-13.5 Amps	
System							
Ambient Temp.	-20° to +105° F (-29° to +40° C)						
Cooling Air	Thermostatically controlled fan cooled						
Enclosure	White painted aluminum with non-corrosive hardware						
Weight	60 lbs						
Dimensions	8.3" H x 15.7" W x 14.5" D						
Mounting Type	Shelf	Shelf	Shelf	Wall	Wall	Wall	Wall
AC Output & Input	Hardwired	Hardwired	Hardwired	Hardwired	Hardwired	Hardwired	Hardwired
AC Input/Power Transfer Time	N/A	Hardwired 30ms	Hardwired 30ms	Hardwired 30ms	Hardwired 30ms	Hardwired 30ms	Hardwired 30ms

* The battery charger's output is adjustable in 8 Amp increments (4 amps on 24Vdc models) through a setup switch.

BATTERY TYPE:	12 Volt Battery		24 Volt Battery	
	Gel	Flooded	Gel	Flooded
Bulk Voltage	14.1 VDC	14.2 VDC	28.2 VDC	28.4 VDC
Float Voltage	13.6 VDC	13.2 VDC	27.2 VDC	26.4 VDC
Notes: A Gel/Flooded battery type selection setup switch is located on the front panel				

FIGURE 6—Dimensional Drawings



SECTION 6: MAINTENANCE & TROUBLESHOOTING

6A) Preventative Maintenance

There are no user serviceable components inside these inverters. For service refer to Vanner Power Group or other qualified service personnel.

6B) Maintenance Items

For continued reliability and safety, a monthly maintenance program should be implemented to include the following:

1. Check to insure that all external wiring is secure and corrosion free.
2. Check air ventilation openings for dust and other obstructions.
3. Examine receptacle, indicators and switches for cracks and breaks.
4. Check to ensure that the two DC battery cable terminals are tight. (275 lb inches).

6C) Troubleshooting Procedures

The following are the most common questions heard by Vanner service professionals. If your situation does not apply to the following categories, please contact your local Vanner Power Group Service Center.

Vanner Power Group Customer Service: 1-800-AC-POWER

SYMPTOM ON lamp does not light steadily after pushing in the ON-OFF/ RESET Inverter Switch.

SOLUTION Lamp flashes when utility power is present.
Lamp flashes in Load Demand Waiting mode.
Check battery connections if utility power is OFF.
Check DC fuses if utility power is OFF.

SYMPTOM ON lamp fully illuminates. AC load does not run.

SOLUTION Check and reset circuit breaker.
Verify AC load and cord are in proper condition.

SYMPTOM BATTERY LOW lamp illuminates when AC load is applied.

SOLUTION Check battery connections.
Check battery condition.
Recharge battery if voltage is less than 10.5 VDC.
Check the vehicle's alternator charging system for proper operation.

SYMPTOM OVERTEMP lamp illuminates.

SOLUTION Something has caused the unit to overheat. Check for obstruction of air flow to the cooling fan or from ventilation holes. Verify AC load is within unit's rated capacity.

SYMPTOM OVERLOAD lamp illuminates with AC load applied.

SOLUTION Verify AC load is within unit's rated capacity.

SYMPTOM DC fuse blows when connecting DC input cables.

SOLUTION Check for reverse polarity: red cable to battery positive (+), black cable to battery negative (-). The unit may be damaged and require repair service.

SYMPTOM LEDs are dimly lit even when the unit is off.

SOLUTION This is normal. The microprocessor is constantly scanning the LEDs and some LEDs are connected to pins of the microprocessor that are used for other parts of the circuit such as the On/Off Reset switch.

Section 7: GFCI Test Record

For maximum protection against electrical shock hazard, operate the Test Switch on the Ground Fault Circuit Interrupter at least once a month.

NOTE
Photocopy this page and place it in your maintenance notebook.

ENTER YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
19___												

LIMITED WARRANTY

Vanner Inc. doing business as The Vanner Power Group, referred to herein as Vanner, warrants that this product is free from defects in materials and workmanship for a period of one (1) year from date of installation or one and one half (1½) years from date of manufacture from Vanner's factory, whichever is less if and only if the following requirements are complied with:

1. The product is installed and checked out properly according to all guidelines, instructions, and checkout procedures set forth in the product's Installation and Operating Manual.
2. The installer records all checkout data required and completes, signs, and returns the warranty registration card to Vanner within ten (10) days after installation.

Vanner does not warrant its products against any and all defects when: Defect is a result of material or workmanship not provided by Vanner; normal wear and tear, or defects caused by misuse or use in contrary to instructions supplied; neglect, accident, reversed polarity, unauthorized repairs and/or replacements.

All warranties of merchantability and fitness for a particular purpose: written or oral, expressed or implied, shall extend only for a period of one (1) year from date of installation or one and one half (1½) years from date of shipment from Vanner's factory, whichever is first. There are no other warranties which extend beyond those described on the face of this warranty. Some states do not allow limitation on how long an implied warranty lasts, so the above limitations may not apply to you.

Vanner does not undertake responsibility to any purchaser of its product for any undertaking, representation, or warranty made by any dealers or distributors selling it's products beyond those herein expressed, unless expressed in writing by an officer of Vanner.

Vanner does not assume responsibility for incidental or consequential damages, including but not limited to, responsibility for loss of use of this product, removal or replacement labor, loss of time, inconvenience, expense for telephone calls, shipping expense, loss or damage to property, or loss of revenue. Some states do not allow the exclusion or limitation of incidental or consequential damages, so these limitations may not apply to you.

Vanner reserves the right to repair, replace, or allow credit for any material returned under this warranty. Any damage caused by the customer will be charged or deducted from the allowance.

All warranty work will be performed at Vanner's factory, or authorized repair facility utilizing a valid Warranty Authorization Number (WAN) prior to repair. Products shall be delivered to Vanner's facility, freight prepaid and fully insured. Products repaired under warranty, or replacement parts or products will be returned to originating US or Canadian location prepaid through the same transportation means and level of service as received, unless directed otherwise.