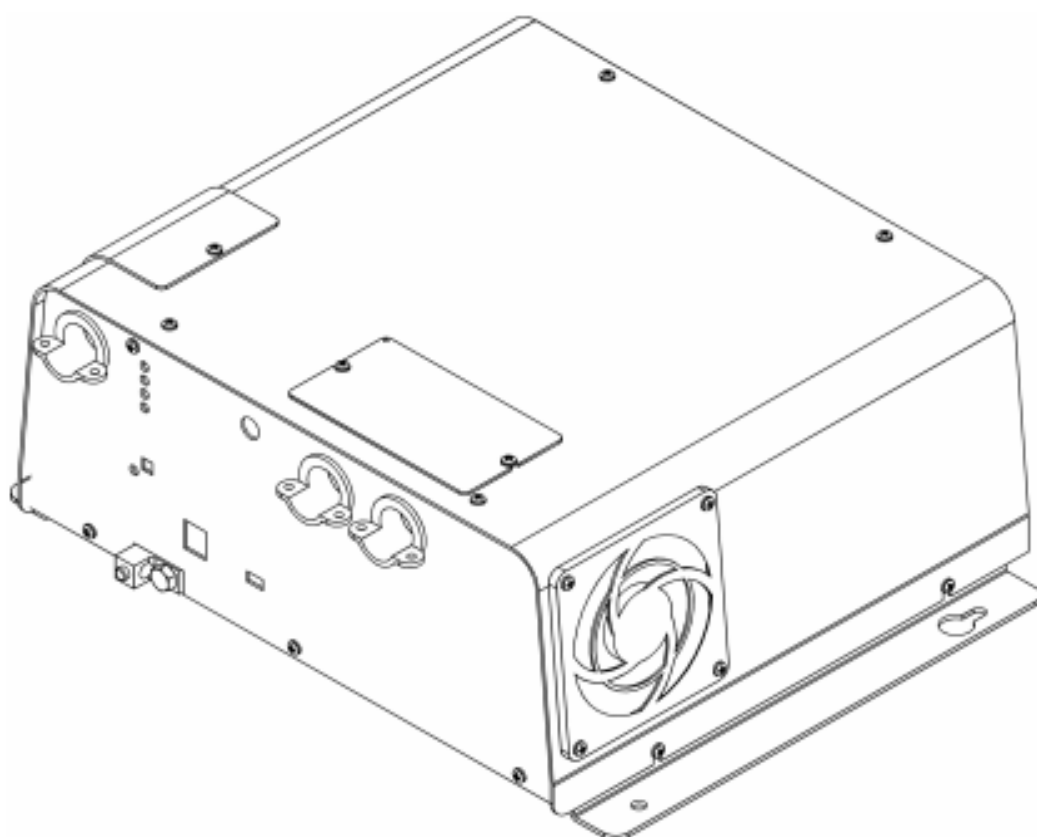


BRAVO 1800



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1-800- AC POWER

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Icon Legend



Note

Important
Information



Warning

Failure to observe
Warning could
cause damage to
equipment and
harm 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 1800 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
- Hardwired AC output or CFGI Duplex Receptacle

FIGURE 1—Bravo 1800 Inverter/Charger Illustration



*Bravo Model BRC12-1800511
(Shelf Mount Enclosure)*



*Bravo Model BRC12-1800WH
with "Drip Shield/Handle" option
(Wall Mount Enclosure)*

TABLE 1—Bravo 1800 Product Models

MODEL #	DC INPUT VOLTAGE	AC OUTPUT VOLTAGE	AC OUTPUT FREQUENCY	MOUNTING TYPE	BATTERY CHARGER OUTPUT AMPS
BR12-1800SH	12.0 Vdc	120 Volts \pm 5%	60Hz \pm 0.1%	Shelf	N/A
BR12-1800SG	12.0 Vdc	120 Volts \pm 5%	60Hz \pm 0.1%	Shelf	N/A
BRC12-1800SH	12.0 Vdc	120 Volts \pm 5%	60Hz \pm 0.1%	Shelf	80 Amps
BRC12-1800WH	12.0 Vdc	120 Volts \pm 5%	60Hz \pm 0.1%	Wall	80 Amps
BRC24-1800WH	24.0 Vdc	120 Volts \pm 5%	60Hz \pm 0.1%	Wall	40 Amps
BRC12-1800WH/EX	12.0 Vdc	230 Volts \pm 5%	50Hz \pm 0.1%	Wall	80 Amps
BRC24-1800WH/EX	24.0 Vdc	230 Volts \pm 5%	50Hz \pm 0.1%	Wall	40 Amps

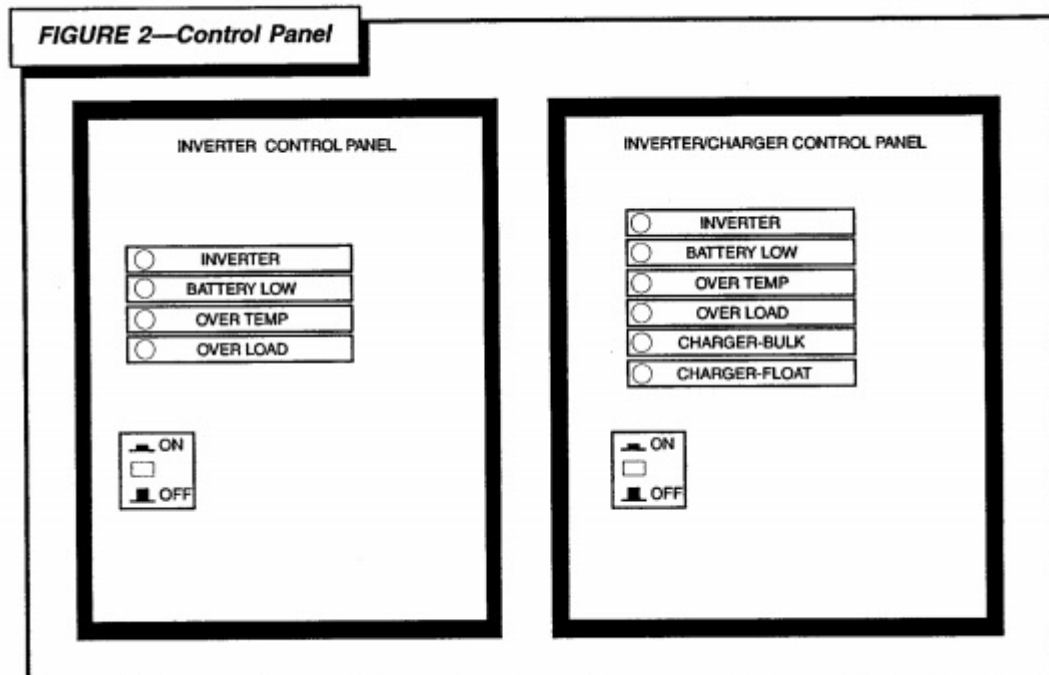
TABLE 2—Bravo 1800 Accessories

MODEL #	DESCRIPTION
D05039	Bravo 1800 Inverter/Charger Remote Panel with 20' Cable
D07065	Bravo 1800 Drip Shield/Handle
03637	Fuse Holder
04522	ANN-200, 200 Amp Fuse
03640	ANN-125, 125 Amp Fuse

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.



**WARNING**

To ensure complete 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.

Note—The ON/OFF switch only controls the inverter portion of the system. On Inverter/Charger system the battery charger portion of the system is always on when AC input power is present.

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 containing three individual slide switches. By placing the switch in the upper or lower 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 :	Lower position = Flooded (wet) lead acid battery type. Upper position = Gel lead acid battery type.
Load Demand:	Lower position = Load Demand disabled/Off. Upper position = Load Demand Enabled/Automatic.
Charger Output:	Lower position = High output (80 amp on 12 Vdc models or 40amps on 24 Vdc models). Upper position = Low output (40 amps on 12 Vdc models and 20 amps on 24 Vdc models).

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 <i>Low Battery</i> indicator will blink. The <i>Low Battery</i> indicator will illuminate steady when the battery voltage drops near the shut-off voltage to provide an "early warning" 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 <i>Over Load</i> indicator will illuminate.

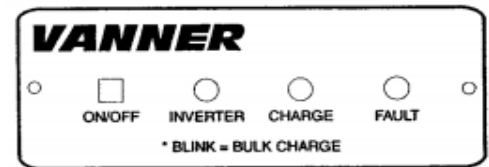
LED Indicators

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 Monitor Control Panel

The optional Remote Monitor/Control Panel allows the inverter to be monitored from a remote location (within 20'). The panel contains three status LED indicators. A 20 foot cable is supplied with each remote panel.

Remote Panel –P/N DO5039

**Table 3-LED Status Indicators**

Inverter	Light Action	Description
	Steady Green Light	Inverter is On
	Slow Blinking Green Light	Inverter circuit is Off. Shore power is supplying AC power to loads. The Inverter will restart when shore Power input is removed.
	Fast Blinking Green Light	Inverter is in "sleep mode". Shore Power is Off.
	Green Light Off	Inverter is Off. If one of the two charger lights is On or blinking, then Shore Power is on and supplying AC to the load.
(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 unit has cooled.
Overload	Light Action	Description
	Blinking Red	The inverter is On and warning of pending overload shutdown. Reduce the AC load quickly or inverter will shut off due to the overload condition.
	Solid Red	The inverter is Off. Shutdown was caused by overload. Remove the load and cycle the inverter On/Off switch to reset to the inverter.
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).
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.

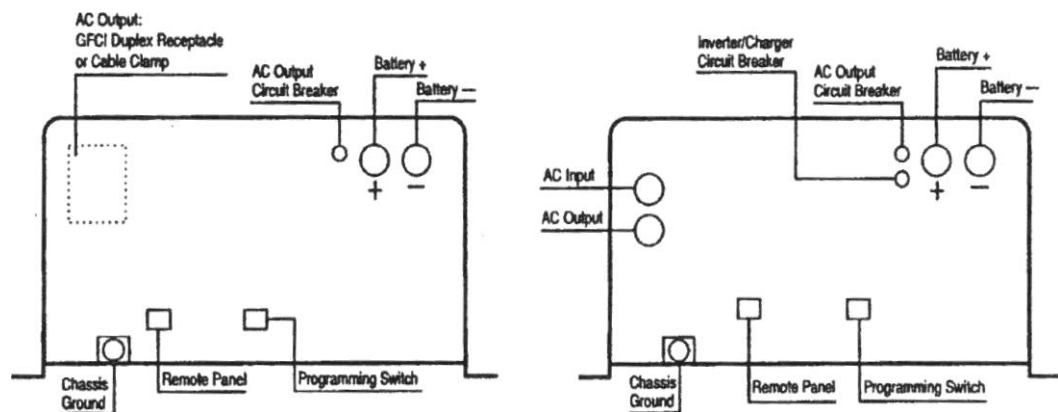
AC Output

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

FIGURE 3—Wiring Panel

INVERTER WIRING PANEL

INVERTER/CHARGER WIRING PANEL



INV/CHINV/CHGR

This circuit breaker provides over current protection in the AC Input circuit to the charger and the AC output of the inverter, depending on which mode the unit is in.

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 dams 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. One cable clamp is provided for the AC input, and one cable clamp (or GFCI receptacle) for the AC output.

There is no AC input cable damp on non-charger models having GFCI receptacles.

Remote Panel

This six-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 its wattage). Like continuous power, the surge rating is also affected by ambient temperature.

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

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

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 1800 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-add 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 two steps (80 or 40 amps on 12-Volt systems and 40 or 20 amps on 24-volt systems), 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). This ends the Bulk Charge stage. At this point, the battery is approximately 80-percent charged.

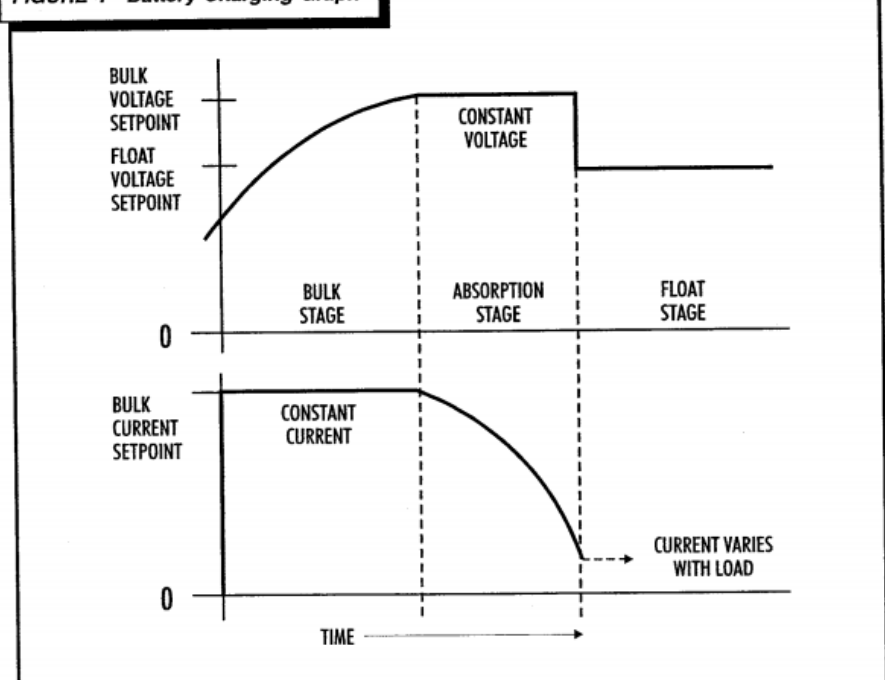
Absorption Charge

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. The charger will remain in Float until the battery will accept the selected charger output amps.

FIGURE 4—Battery Charging Graph



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!

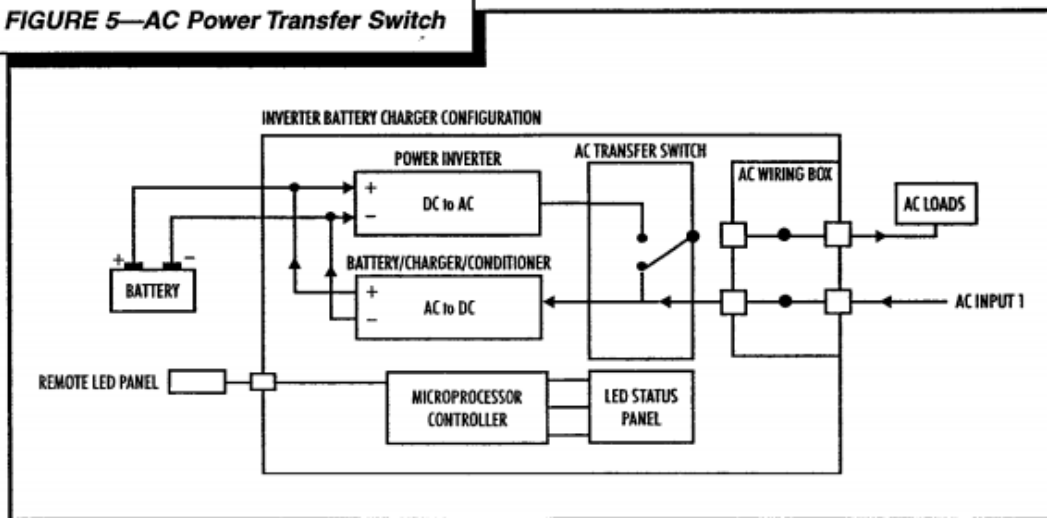
The maximum charging current for a battery is usually equal to 20% of the battery's C rate for lead acid batteries, and 50% of the battery's C rate for gel cell batteries. The C rate is numerically equal to the amp-hour capacity for the battery. For example, a 280 amp-hour battery has a C rate of 280 amps, and the maximum charge rate would be 56 amps DC. (Note that this is not 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**AC Transfer Switch**

The AC Transfer Switch consists of a set of electromechanical relays that automatically switches AC power from the sources (inverter AC or input AC) 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 5 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.

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.

The Battery Charger 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. If the inverter On/Off switch is on then the AC load will switch back to inverter power and run off of the DC.

FIGURE 5—AC Power Transfer Switch

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



Warning

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

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.

Mounting

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. Air is pulled in through the mounting surface and the bottom of the unit and is blown out on the right side. The unit must be mounted to a solid surface, no course surfaces.

Wiring Procedures

- The DC cables should be as short as possible. It is more electrically efficient to run the lower current AC wiring longer distances.
- 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 other sensitive electronics.
- 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.
- 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.

E. 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.

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. This is acceptable since the inverter chassis is aluminum and not a ferrous metal.

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 minimum 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.

N

NOTE

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

TABLE 4—DC Cable Size Chart

DC Cable Length		
Size	Maximum Length	
	12 Volt	24 Volt
2 AWG	NA	12 ft.
1 AWG	NA	15 ft.
0 AWG	8 ft.	20 ft.
00 AWG	13 ft.	20 ft.
000 AWG	16 ft.	20 ft.

AC Wiring—Hardwired Models

The AC connections are located in the field wiring compartment at the front left of the unit. Two 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 and AC Input. The field wires are brought in through the two cable dams and terminated to the two sets of wires inside the wiring compartment.

TABLE 5—DC Fuse Size Chart

System	Fuse	Fuse Holder
12 Volt	Bussman ANN200 Vanner p/n 04522	Bussman 4164 Vanner p/n 03637
24 Volt	Bussman ANN125 Vanner p/n 03640	Bussman 4164 Vanner p/n 03637



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.

**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.

AC Wiring—Model BR12-1800SG

This inverter-only model is provided with a GFCI duplex receptacle for its AC output.

Ground Fault Current Interrupter Protection

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

****Note:** If GFCI trips and the inverter is in load demand mode the GFCI may not reset until you toggle inverter off and back on and then you will have 5 seconds to reset GFCI before unit goes back into load demand again or you can disable load demand via dipswitch, if available.

TABLE 6—Ground Fault Current interrupter (GFCI)

Manufacturer	Manufacturer Part Number
GE	THQL-1115GF
Leviton	6490-I
Hubbell	GF5252, **
Pass & Seymour	1591R, 2091S
Bydon	BYB-E15

Recommendations**Ground Wiring**

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 #8 AWG minimum size wire to this terminal and then to chassis of the vehicle, the boat's grounding system, or to earth ground.

**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 receptacles.

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.
- 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.
- Note: on model BRI2-1800SG the AC output is provided through a GFCI duplex receptacle.
- Step 8:** Connect AC Input (Inverters equipped with Battery Charger option). Remove the cover of the AC wiring compartment. Identify the set of three wires (black, white, and green) labeled AC Input. A cable clamp is provided to route the three conductor field cables into the AC wiring compartment. Install the field cable and connect it to the three wires for AC input using suitable wire termination, such as crimped butt splices or wire nuts. Tighten the strain relief with a screwdriver and replace the AC wiring compartment cover.
- Step 9:** Verify Installation. Verify all connections are tight and secure for maximum performance.

3C) Remote Panels

Remote Monitor/Control Panel

Unpacking the Remote Monitor/Control Panel

Inspect the shipping container and equipment for loose, damaged, or missing parts. The remote panel includes a 20 foot 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 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 two #8 screws.

3D) System Start-up and Testing

- 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 receptacle is reset and connect an AC load, such as a 100-Watt test light.
- Step 4** Place the Wet/Gel Setup switch to the correct position for the installed battery type.
- Step 5** Determine the correct Charger Output amps and place the Setup switch positions to match this value.

Charger Output Amps:

Switch Position	12 VDC	24 VDC
UP	40 Amps	20 Amps
DOWN	80 Amps	40 Amps

- Step 6** 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 7** Turn on the battery DC power to the inverter.
- Step 8:** Turn on the AC shore/power (or generator) through the AC breakers.
- Step 9:** Place the System On/Off switch on the Remote LED panel to the ON position (depressed position).
- Step 10:** Place the System On/Off switch on the Inverter panel to the ON position (depressed position).
- Step 11:** The inverter control panel LED indication displays Charge Bulk or Charge Float
- Step 12:** 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 13:** Place the system On/Off switch to the OFF 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.
- *Step 14:** 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. The Bulk or Float light will turn off.
- Step 15:** The inverter LED on the inverter control panel has a solid light indicating correct inverter operation. At this point, apply AC loads up to 1800 watts to verify full-power operation.
- Step 16:** Disconnect all AC loads. The inverter LED blinks, indicating that the inverter is in the Load Demand mode (the energy saving, standby mode)
- Step 17:** 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 18:** Apply shore power. After a five second delay the AC output test light should quickly blink once, indicating the transfer of the load from



NOTE

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



WARNING

Consult the battery manufacturer to determine the correct charging amp setting. This will typically be 10-20% of the battery "C" rating.

inverter to shore power. The inverter LED should change from solid to blinking and become solid.

- *Step 19:** 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:

$$(\text{DC Input Power}) \times (\text{Efficiency}) = (\text{AC Output Power})$$

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

$$\text{For 12 volt DC inverters: output watts} \div 10 = \text{DC input current}$$

For 24 volt DC inverters: output watts $\div 20$ = 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. For 230 Volt 50Hz models multiply the amps by 230 to get the 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?

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 (AH):

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 AmpHr.)

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 underlying 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 r. 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 (lose 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.
- 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.

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

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

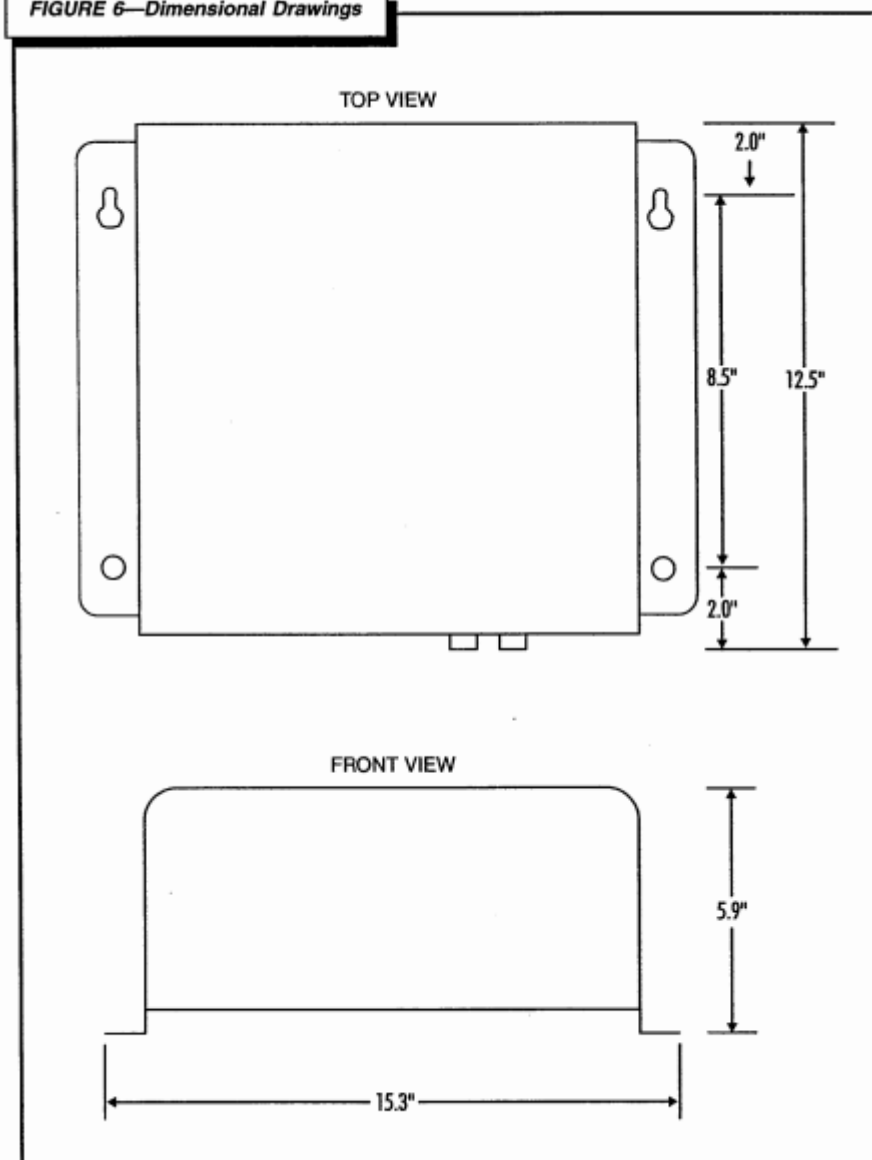
In an installation where there are multiple AC sources, the system needs to be designed so that one and only one AC source can be connected to the distribution wiring at any one time. This is to prevent the selected power source from back feeding one of the other power sources. It may be accomplished 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 1800 Specifications

BRAVO							
INVERTERS			INVERTER CHARGERS				
INVERT MODEL #	BR12-1800SH	BR12-1800SG	BRC12-1800SH	BRC12-1800WH	BRC24-1800WH	BRC12-800WH/EX	BRC24-1800WH/EX
AC Output Power							
Continuous	1800 WATTS		1800 WATTS			1800 WATTS	
Surge (3 sec.)	30 AMPS AT 100 VOLTS		30 AMPS AT 100 VOLTS			30 AMPS AT 100 VOLTS	
Output Voltage	120 VOLTS ±5%		120 VOLTS ±5%			130 VOLTS ±5%	
Frequency	60±0.1 HZ		60±0.1 HZ			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	12.0 VDC	12.0 VDC	24.0 VDC	12.0 VDC	24.0 VDC
Minimum	10.5 VDC	10.5 VDC	10.5 VDC	10.5 VDC	21.0 VDC	10.5 VDC	21.0 VDC
Maximum	16.0 VDC	16.0 VDC	16.0 VDC	16.0 VDC	32.0 VDC	16.0 VDC	32.0 VDC
DC Current Draw							
OFF	0.023 AMPS TYP.		0.023 AMPS TYP.	0.023 AMPS TYP.	0.023 AMPS TYP.	0.023 AMPS TYP.	0.023 AMPS TYP.
Load Demand (waiting)	0.11 AMPS TYP.		0.11 AMPS TYP.	0.11 AMPS TYP.	0.11 AMPS TYP.	0.11 AMPS TYP.	0.11 AMPS TYP.
Full ON No Load	1.2 AMPS TYP.		1.2 AMPS TYP	1.2 AMPS TYP	0.7 AMPS TYP	1.2 AMPS TYP	0.7 AMPS 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 12	Approx. Load Wattage ÷10 or load amps x 12	Approx. Load Wattage ÷20 or load amps x 12
Charger							
DC Output*	N/A		80/40 AMP	80/40 AMP	40/20 AMP	80/40 AMP	40/20 AMP
AC Input Voltage	N/A		120 VOLT NOMINAL			230 VOLTS NOMINAL	
AC Input Current	N/A		0-20 AMPS			0-10 AMPS	
System							
Ambient Temp.	- 20 ° TO +105° f (-29° TO +40° C)						
Cooling Air	THERMOSTATICALLY CONTROLLED FAN COOLED						
Enclosure	WHITE PAINTED ALUMINIUM WITH NON-CORROSIVE HARDWARE						
Weight	38 LBS		45 LBS				
Dimensions	6.2"H X 15.3"W X 12.3"D						
Mounting Type	Shelf	Shelf	Shelf	Wall	Wall	Wall	Wall
AC Output & Input	Hardwired	GFCI RECEPTACLE	Hardwired	Hardwired	Hardwired	Hardwired	Hardwired
AC Input/Power Transfer Time	N/A	N/A	HARWIRED 30MS	HARWIRED 30MS	HARWIRED 30MS	HARWIRED 30MS	HARWIRED 30MS

* The battery charger's output is adjustable through the high/low 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 Inc. 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 Inc. Service Center.

Vanner Inc. Customer Service: 1.800.ACPOWER

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.

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

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Section 8: Limited Warranty

NORTH AMERICAN LIMITED WARRANTY

Vanner Inc., referred to herein as Vanner, warrants that this product is free from defects in materials and workmanship for a period of two (2) years from date of installation or two and one half (2 1/2) years from date of manufacture, 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 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.
3. The product was purchased after January 1, 2000.

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 two (2) years from date of installation or two and one half (2 1/2) years from date of manufacture, whichever is first. There are no other warranties that 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 its 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 North American location prepaid via same transportation means and level of service as received, unless directed otherwise. Prepaid freight policy does not apply to locations outside North America.