4-3 Inverter

4-3 Inverter

The 450 LXi is equipped with a Vanner Power Group IQ Series AC Power Inverter. This is a very important system within the coach. This system can pull power out of 12-volt batteries and convert it to 120 VAC to run appliances. It can also can pull 120 VAC power and convert it to 12 volt as needed to change the house batteries when connected to 120 VAC shore power or generator. Lights on the motor home use 12 volt and appliance use 120. This is useful when you are some place that does not have plug-ins or you cannot run generator for some reason. For example, maybe the park you are in has rules that state no running generator after a certain time; this is where your inverter would come in handy.

4-3.1 Inverter Overview

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 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 square wave components). Such inverters are the most costly of the three inverter types because they contain extra electronics to produce the required wave form.

Modified Sine Wave Inverters

These are sometimes called "quasi sine wave inverters" or "modified square waves inverters." Modified sine wave inverters produce an AC output wave different from the power produced by the electric utility companies and rotating generators. 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 Inverters

These are low cost devices that produce a 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 peak voltage necessary 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, lighting loads or universal motor loads.

4-3.2 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 pick 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 desire 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.

4-3.3 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 AH 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 = 75 A-H).

Operating Temperature:
A battery becomes less efficient at lower temperatures. Most battery manufacturers specify the battery A-H capacity at 80ØF. At a temperature of 32ØF, the same battery will have only about 65% of its rated capacity even though it may be fully charged. At a temperature of 0ØF, 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.

4-3.4 DC Power Consumption

An inverter takes in 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).

4-3.5 Standard Features

4-3.5.1 Standard Features Furnished on All Models of the IQ Series

1. 120 volt AC 60 Hz Quasi-sine wave output
2. Output short circuit/overload protection through electronic sensing
3. Output circuit breakers
4. Automatic shutoff for Low Battery
5. Automatic shutoff for Overload
6. Automatic momentary shutoff/restart for over temperature
7. All controls and AC connections accessible at the front of the inverter
8. AC input/output terminal strip
9. Load demand including Automatic Throttle Control (1 amp ground signal)
10. Load demand enable/disable switch
11. Built-in GFCI duplex receptacle protected by a 15 amp circuit breaker.
12. Jack to accept optional Remote Switch or Remote Operating Panel

4-3.5.2 Additional Standard Features furnished only with IQ Models - (Inverter only)

- Three output circuits with 15 amp, 20 amp and 30 amp output circuit breakers

4-3.5.3 Additional Standard Features furnished only with IQC Models - (Inverter/Charger)

1. Three Stage Battery Charger
2. Manually initiated Equalize Charging Cycle
3. Adjustable charge rate
4. Charging voltage settings for gel or wet batteries
5. No minimum battery voltage required for charging (will charge a Dead Battery)
6. Jack for optional Battery Temperature Compensation Sensor
7. Automatic Power Management (charger input power control)
8. Jack for optional Automatic Power Management Panel
9. Automatic Transfer Switch with 5 second acceptable time delay
10. Accepts one or two AC input circuits up to 30 amps each
11. Automatic acceptance of second AC input circuit
12. Inverter Disable switch to allow pass through and battery charging only.
13. Charger Disable switch to allow pass through only
14. Pass through capability while battery is disconnected
15. AC input voltage tolerance selector switch (90vac or 77 vac switchover)

NOTE: The Battery Charger, Automatic Transfer Switch and Automatic Power Management are operational only when AC input power (shore power) is present.

4-3.6 Specifications

Specifications	Model Number			
	IQ12-2600	IQ24-2600	IQ12-3600	IQ24-3600
	IQC12-2600	IQC24-2600	IQC12-3600	IQC24-3600
AC Output Power				
Continuous Surge (3 sec) amps	2600 Watts 65 Amps	2600 Watts 65 Amps	3600 Watts 80 Amps	3600 Watts 80 Amps
Output Voltage - All Models Output Frequency - All Models Output Waveform - All Models	120 Volts +/-5% 60 Hz +/- 0.1 Hz Modified Sine Wave			
DC Input Voltage Range	10.5 - 16.0 VDC	21.0 - 32.0 VDC	10.5 - 16.0 VDC	21.0 - 32.0 VDC
DC Input Current Draw at no load				
Inverter Off	60 ma	60 ma	60 ma	60 ma
Inverter ON in Load Demand Mode	160 ma	160 ma	160 ma	160 ma
Inverter ON - Load Demand OFF	1.8 amps		1.8 amps	
AC Output Wiring Method				
All IQ Models (inverter only) All circuits are breaker protected	1 GFCI Duplex Receptacle 1 - 15 amp output terminal 1 - 20 amp output terminal 1 - 30 amp output terminal			
All IQC Models (inverter/charger)	1 GFCI Duplex Receptacle			
All circuits are breaker protected	1 - 30 amp output terminal			
AC Input Wiring Method				
All IQC Models (inverter/charger)	1 - 30 amp input terminal for charging and feed through			
All circuits are breaker protected	1 - 30 amp input terminal for optional feed through only			
Battery Charger (IQC Models)				
Charging Output Current	120 amps	60 amps	120 amps	60 amps
AC Input Current	Proportional to 30 amps 120 VAC input @ 120 amps 12 volt input			
WET Bulk Charge Voltage	14.4 vdc	28.8 vdc	14.4 vdc	28.8 vdc
WET Float Charge Voltage	13.2 vdc	26.4 vdc	13.2 vdc	26.4 vdc
GEL Bulk Charge Voltage	14.1 vdc	28.2 vdc	14.1 vdc	28.2 vdc
GEL Float Charge Voltage	13.6 vdc	27.2 vdc	13.6 vdc	27.2 vdc
AC Input Voltage Tolerance for Transfer Switch				
Low Input Voltage Switchover Value	90 VAC or 77VAC (Selectable)			
AC Input Voltage	120 VAC + 12 volts / -30 or -43 volts (selectable)			
AC Input Frequency	60 Hz +/- 5 Hz			
Transfer Switch Transfer Time	30 ms			
System				
Ambient Temperature Cooling Air Enclosure Dimensions All Models	Continuous output at -40 to +105 degrees F (-40 t +40 degrees C) Thermostatically controlled exhaust fan White painted aluminum with noncorrosive hadware 8.4"H x 17.5"W x 14.0"D			
Unit Weight	60 lbs.	60 lbs.	75 lbs.	75 lbs.

4-3.7 Definitions

4-3.7.1 Quasi Sine Wave

Quasi Sine Wave Inverters are sometimes called "modified sine wave inverters" or "modified square wave inverters". Quasi sine wave inverters produce an AC output wave different from the power produced by the electric utility companies and rotating generators. 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 quasi sine wave inverters.

4-3.7.2 Load Demand Feature and Load Demand Mode

The Load Demand Feature is an energy conserving feature which allows the inverter to enter the "Load Demand Mode" whenever the inverter is ON and the AC load has been less than 5 watts for approximately 5 seconds. While in the "Load Demand Mode" the inverter does not produce 120 volts AC but instead produces pulses of reduced AC voltage which the inverter uses to look for a load. When an AC load greater than 5 watts is sensed, the inverter will turn fully ON to produce 120 Volts AC. The "Load Demand Mode" is often also described as "stand-by mode" or "sleep mode". While in the "Load Demand Mode" the inverter consumes approximately 140 milliamps of 12 volt DC power.

The Load Demand Feature can be turned OFF by setting Selector Switch 2 to the OFF position. This will cause the inverter to remain fully ON, producing 120 Volts AC, whenever the inverter switch is ON and regardless of AC load. It is desirable to do this when the device being powered draws less than 5 watts. An example of such a device is a plastic pipe fusion machine which draws less than 5 watts during the "coupling cooling time". With the Load Demand Feature turned OFF and operating no AC load the inverter consumes approximately 1.8 amps of 12 volt DC power.

4-3.7.3 Automatic Transfer Switch

The Transfer Switch is a standard feature provided on all IQC models. The Transfer Switch automatically allows input power, from an external AC power source such as shore power or a generator, to pass through the inverter output circuit and be used to operate inverter loads.

4-3.7.4 Automatic Power Management

The optional Automatic Power Management (APM) Panel, part number D07934, may be used with IQC Models only. The APM Panel allows the operator to set the maximum AC amps (10 amps, 15 amps, 20 amps or 30 amps) the battery charger may draw from shore power input AC1. The APM Panel is useful in preventing nuisance tripping of the shore power circuit breaker in motor home or similar applications, where the size of the shore power circuit breaker varies from campground to campground and occasionally be rated less than 30 amps. If the AMP Panel is not used the default setting is 30 amps.

4-3.7.5 Inverter Mode and Charger Mode

The following applies only to IQC Models. IQ Models do not have charger mode.

The IQC is in "Inverter Mode" when it is functioning as an inverter. The unit is in "Charger Mode" when it is functioning as a battery charger.

For all IQC models, the factor that determines whether the unit is in "Inverter Mode" or "Battery Charger Mode" is the presence or absence of "in-tolerance" AC input power. Whenever "in-tolerance" AC input power becomes available the IQC automatically switches from inverter mode to charger mode.

4-3.8 Important Safety Instructions

This section contains important safety and operating instructions for the Vanner Power Group "IQ Series" Power Inverter and Inverter/Charger System as prescribed by Underwriters Laboratory (UL). The IQ Series Inverter and Inverter/Charger Family is listed as compliant with UL 458 (only if the UL/CUL symbol is on the front of the unit), Power Converters/ Inverters and Power Converter/Inverter Systems for Land Vehicles (12 and 24 volt models only), and UL 1741 Power Conditioning Units for use in Residential Photovoltaic Power Systems. The Vanner Power Group "IQ Series" also listed to the Canadian National Standard CSA - C22.2 No. 107.1 - 1951.

SAVE THESE INSTRUCTIONS

▲**WARNING:** This equipment employs components that tend to produce arcs and sparks. To prevent fire or explosion, DO NOT install in confined areas or compartments that contain batteries or flammable materials.

▲**WARNING:** Risk of electrical shock. Use only the ground fault circuit interrupter (GFCI) receptacle(s) or circuit breaker(s) specified in the installation and operation instructions supplied with this inverter. Other types may fail to operate properly when connected to this equipment.

!!CAUTION: Read this entire inverter section before powering up.

!!CAUTION: DO NOT cover or obstruct ventilation openings. DO NOT mount in zero-clearance compartments. Overheating may result.

NOTICE: The output of this device is not sinusoidal. The IQ SERIES inverter has a total harmonic distortion of 34.6 percent and maximum single harmonic of 24 percent.

4-3.9 General Precautions

1. Do not expose the Vanner IQ series Inverter to direct water spray or snow.
2. To reduce the risk of a fire hazard, do not cover or obstruct the ventilation openings.
3. Do not install this unit in a zero clearance compartment the result may be overheating or diminished performance.
4. To avoid the risk of fire, electric shock, or injury to persons, do not use attachments not recommended or sold by the Vanner Power Group.
5. Vanner recommends that all DC and AC electrical wiring be performed by a certified electrician or technician to ensure compliance with all proper national and local wiring regulations.
6. To avoid a risk of fire and/or electric shock, always verify wiring connections are in good electrical condition. All external conductors must use proper wire size to avoid dangerous overheating or diminished performance.
7. If the Vanner inverter system has been dropped or damaged in any way, do not operate until its operation has been verified to be safe by a qualified technician.
8. To reduce the risk of electric shock always disconnect the AC and DC connections to the Vanner Inverter system before attempting any maintenance. Simply turning the unit off does not prevent electric shock.
9. The Vanner "IQ Series" inverter system must be properly grounded in accordance with local and national codes and ordinances before operation. For most installations the negative (ground) conductor should be bonded to the grounding system at one and only one point in the system.
10. Do not disassemble the IQ Series Inverter/Charger; see the service section of this manual for instructions on obtaining service for the IQ Series Inverter/Charger. Attempting to service the unit yourself may result in a risk of electrical shock or fire.

4-3.10 Explosive

1. This equipment contains components, which tend to produce arcs or sparks. To prevent fire or explosion do not install in compartments containing batteries or flammable materials or in locations, which require ignition, protected equipment. This includes any space containing gasoline-powered machinery, fuel tanks, or joints, fittings, or other connection between components of the fuel system.
2. Working in the vicinity of a lead-acid battery is dangerous. Batteries generate explosive gases during normal battery operation. To reduce the risk of battery explosion, follow these instructions and those published by the battery manufacturer and the manufacturer of the equipment in which the battery is installed.

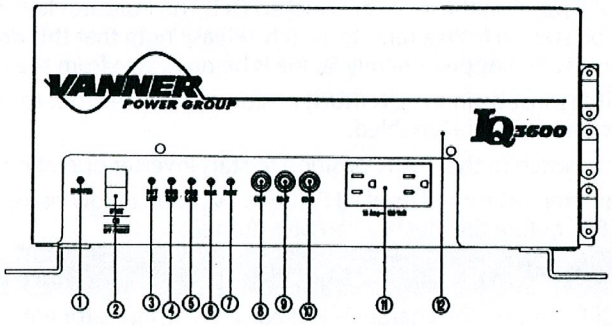
4-3.11 Precautions When Working with Batteries

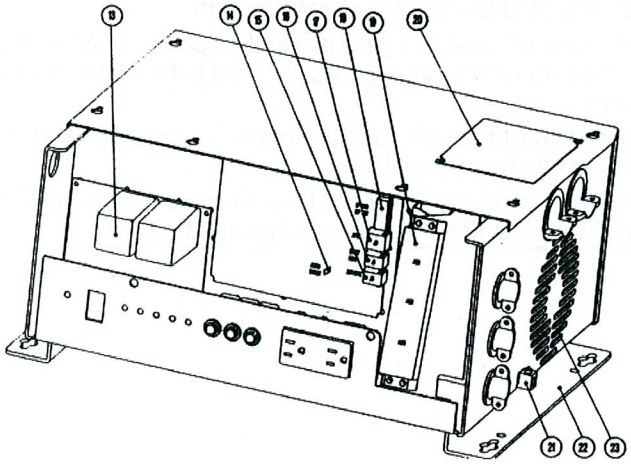
1. Always have someone within range of your voice to come to your aid when you work near a lead-acid battery.
2. Have access to plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
3. Always wear complete eye protection and clothing protection. Avoid touching eyes while working near batteries.
4. If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cold water for at least 20 minutes and get medical attention immediately.
5. NEVER smoke or allow a spark or flame in the vicinity of batteries. Gases produced by batteries are explosive.
6. Be careful when working with metal tools around batteries. Potential for spark exists or short-circuit of the battery or other electrical part that may cause an explosion.
7. Never charge a frozen battery. Attempt to warm battery above 32 degrees F before charging.

4-3.12 Component Identification and Description of Operation

1. The following numbered paragraphs directly correspond with the

FIGURE 1 - IQ SERIES ILLUSTRATION





Pictured: Model IQC Inverter/Charger with front cover removed

4-3.12.1 (1) Inverter Indicator Light

All Models	
Light Action	**Description**
Green Light is OFF	Inverter circuit is OFF
Solid Green	Inverter is ON (producing AC power)
Fast Blinking Light (2 blinks per second)	Inverter is in Load Demand Mode
IQC Models (Inverter Charger) in Charger Mode (shore power is ON)	
Slow Blinking Light (1 blink per second)	Inverter is standing by while shore power is supplying AC power to loads.

4-3.12.2 (2) ON/OFF Switch

All Models	
The ON/OFF switch is a three-position rocker switch whose function is similar to the ignition switch on a vehicle. The low position is OFF/RESET. The middle position is ON (RUN). The high position is START, which is a momentary position.	
IQ Models and IQC Models in Inverter Mode (shore power is OFF)	
Light Action	**Description**
OFF:	In the OFF position the inverter is locked OFF. The indicator lights do not function and the inverter cannot be started from a remote switch. (Please note that this ***does not disconnect power*** from the inverter system.) Approximately 50 ma is being drawn from the battery.
ON (RUN):	The switch must be in the ON (RUN) position for the inverter to be operational and for remote switch capability to be enabled.
START:	Press the switch to the START position to start inverter operation.
RESET:	If the inverter has turned itself OFF due to overload or low battery, the switch must be moved to OFF/RESET before the inverter can be restarted.
IQC Models (Inverter/Charger) in Charger Model (shore power is ON)	
OFF:	In the OFF position the charger is locked OFF. The indicator lights do not function and the charger cannot be started from a remote switch. (Please note that this ***does not disconnect power*** from the inverter system.) No power is being drawn from the battery.
ON (RUN):	Power on AC1 input is being monitored for proper voltage and frequency but power on AC1 will not be accepted for charging or pass through.
START:	If both input AC1 and AC2 have power then power on AC2 will pass through. No power is drawn from the battery. The battery does not need to be connected for the power on AC2 to pass through. The switch must be in the ON(RUN) position for the charger to be operational and for remote switch capability to be enabled. Press the switch to the START position to initiate acceptance of AC1 input for charger/transfer switch function and to start charger operation.

4-3.12.3 (3) BATTERY/LOW Indicator Light

All Models	
Light Action	**Description**
Solid Red	Inverter is On and battery voltage has decayed to 11 or 22 volts DC warning imminent inverter shutdown unless battery voltage is increased by charging.
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.

4-3.12.4 (4) OVER TEMPERATURE Indicator Light

All Models	
Light Action	**Description**
Solid Red	Inverter or Charger has shutdown due to over temperature. Shutdown may be caused by high ambient temperature or restricted cooling air flow to the inverter. Shutdown sensor will automatically reset when the unit has cooled.

4-3.12.5 (5) OVERLOAD Indicator Light

All Models	
Light Action	**Description**
Solid Red	The inverter is ON and the inverter's AC output circuitry is sensing an overload condition. If the AC load is not reduced the inverter will shut itself OFF.
Blinking Red	The inverter is Off. An overload has occurred and the inverter has shut off to protect itself. Once shut off, the inverter On/Off switch must be cycled to reset the unit.

4-3.12.6 (6) BULK CHARGE Indicator Light

All Models	
The light is present on all models but is functional only on IQC Models. (See *"Battery Charger Theory of Operation"* for charger information details.	
Light Action	**Description**
Blinking Yellow:	The unit is in Charger Mode (shore power is ON) and the charger is in either the BULK STAGE or ABSORPTION STAGE of the battery charging cycle.
Solid Yellow:	The unit is in Charger Mode (shore power is ON) and the charger is in the EQUALIZATION CYCLE.

4-3.12.7 (7) FLOAT CHARGE Indicator Light

The light is present on all models but is functional only on IQC Models. (See *"Battery Charger Theory of Operation"* for charger performance details.)

All Models	
Light Action	**Description**
Solid Green	Description
Blinking Green	The unit is in Charger Mode (shore power is ON) and the charger is in the FLOAT STAGE of the battery charging cycle. Both the Battery Charger and Inverter functions have been turned OFF by turning Program Switches 5 and 4 to the left position. Shore power is ON. (See *PROGRAM SWITCH* description.)

4-3.12.8-10 (8-10) AC CIRCUIT BREAKERS

IQC Models (Inverter Only)			
(8)	CB1	20 amp	Protects output circuit AC1.
(9)	CB2	15 amp	Protects output circuit AC2 and built-in GFCI receptacle.
(10)	CB3	30 amp	Protects output circuit AC3.
IQC Models (Inverter/Charger)			
(8)	CB1	30 amp	Protects input circuit AC1.
(9)	CB2	15 amp	Protects built-in GFCI receptacle.
(10)	CB3	30 amp	Protects output circuit AC3.

4-5.12.11 (11) AC OUTPUT RECEPTACLE

All Models

GFCI convenience receptacle, 120vac 1800 watt maximum output, protected by 15 amp circuit breaker CB2. (The GFCI is a 20 amp T-Slot receptacle but is protected by a 15 amp breaker in order to meet Canada's CSA requirements. If CB2 is changed to a 20 amp breaker the unit no longer meets CSA.)

4-5.12.12 (12) FRONT COVER

All Models

The Front Cover must be removed to access the AC Wiring Terminal Strip, the Program Switches and remote control connections located on the control circuit board. BE SURE THE INVERTER IS TURNED OFF AND ALL EXTERNAL SOURCES OF POWER ARE TURNED OFF BEFORE REMOVING THE FRONT COVER to access the AC Wiring Terminal Strip.

4-5.12.13 (13) AUTOMATIC POWER TRANSFER SWITCH

IQC Models Only

The Automatic Power Transfer Switch is furnished only on IQC Models and consists of a circuit board containing two relays. (IQ Models do not have the transfer switch but instead have a terminal strip in this location.) See Automatic Power Transfer Switch Theory of Operation for performance details.

4-5.12.14 (14) AUTOMATIC THROTTLE CONTROL TERMINAL J31

All Models

Terminal J31 is provided to be used on utility vehicles where the inverter needs to operate continuous heavy AC loads and the vehicle is equipped with an Automatic Throttle. Use J31 to turn ON the Auto Throttle to ensure that the vehicle alternator is producing maximum output whenever the inverter is powering a load.

J31 is controlled by the Load Demand circuit therefore Programming Switch 2 must be in the ON position when Terminal J31 is used.

J31 is a ¼" spade terminal located in the lower right midsection of the control circuit board. The terminal is designed to provide ground control for a Bosch relay. Vanner part number 05235 or equal. Install a 1 amp fuse in line near the inverter.

4-5.12.15 (15) REMOTE CONTROL JACK J9

All Models

Jack J9 is an 8 wire modular jack for use with optional Remote Control Switch, Remote Control Adapter or Remote Operating Panel.

4-5.12.16 (16) BATTERY TEMPERATURE COMPENSATION CONTROL JACK J1

(Jack J1 is present on all models but is functional on IQC Models only.)

IQC Models

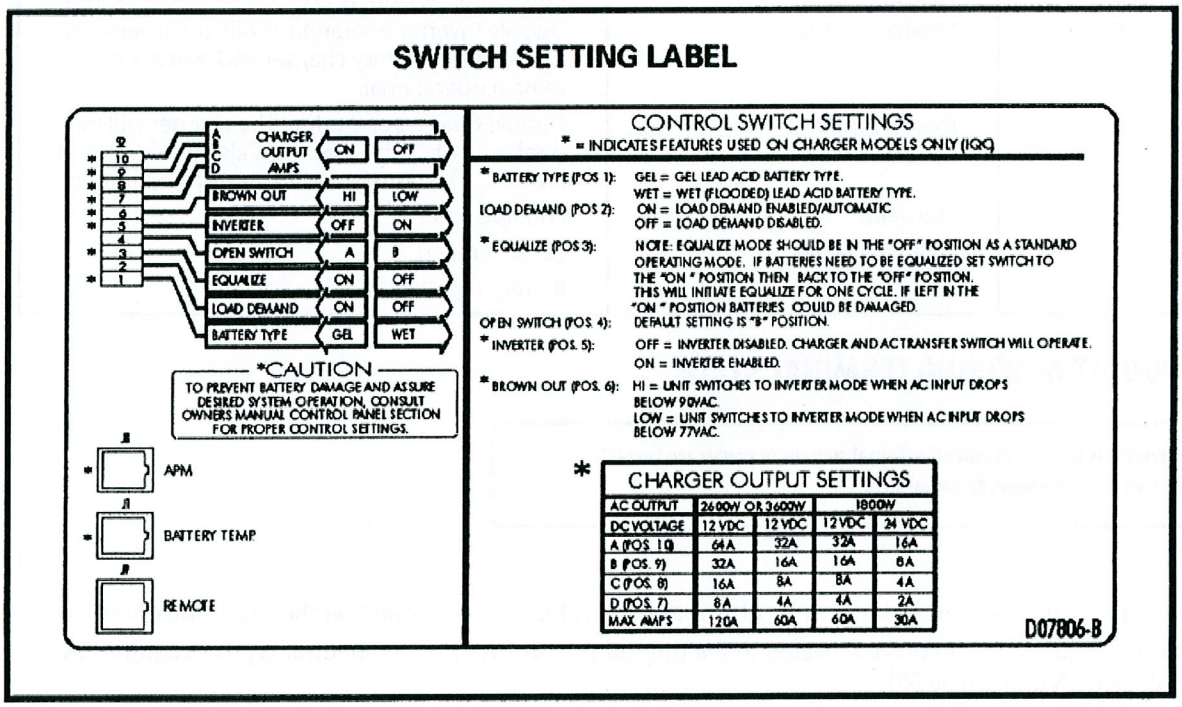
Jack J1 is a 4 wire modular jack for use with optional Battery Temperature Compensation Control, Vanner part no. D00000, to reduce charging voltage at higher battery temperatures.

4-5.12.17 (17) AUTOMATIC POWER MANAGEMENT (APM) Panel JACK J8

(Jack J8 is present on all models but is functional on IQC Models only.)

IQC Models

Jack J8 is a 4 wire modular jack for use with optional Automatic Power Management (APM) Panel, Vanner part No. D07934. The optional APM Panel allows the 30 amp (default) APM Current Setting to be adjusted to match the circuit breaker at the shore power source (10 amps, 15 amps, 20 amps, or 30 amps). See Theory of Operation for performance details.



4-3.12.18 (18) PROGRAMMING CONTROL SWITCHES

Located on the top right corner of the control circuit board is a 10 position DIP switch containing the 10 individually numbered slide-type Programming Switches in one housing. All switch functions are described below and on the label inside the front cover.

IQ Models (Inverter only)

Only Switch 2 of the Programming Switch is functional on IQ Models and is used to enable or disable the Load Demand Feature.

IQC Models (Inverter/Charger)

All positions of the Programming Switch are functional on IQC Models.

Item	Switch No.	Left / Right Position	Function
4-3.12.10	10	Add 64 (32) amps / 0	12Volt (24V) Bulk charge rate
4-3.12.9	9	Add 32 (16) amps / 0	12Volt (24V) Bulk charge rate
4-3.12.8	8	Add 16 (8) amps / 0	12Volt (24V) Bulk charge rate
4-3.12.7	7	Add 8 (4) amps 0	12Volt (24V) Bulk charge rate
4-3.12.6	6	90 VAC / 77 VAC	Low AC Input Voltage switchover tolerance value.
4-3.12.5	5	Disable/Enable	Disable Inverter operation. While the inverter is disabled the battery charger and transfer switch remain operational.
4-3.12.4	4	Disable/Enable	Disable Charger operation. The charger will be disabled only if the inverter is also disabled at dip switch 5. The transfer switch remains operation.
4-3.12.3	3	Start/Off	Equalize Start
4-3.12.2	2	Enable/Disable	Load Demand
4-3.12.1	1	Gel/Wet	Battery Type

4-3.12.19 (19) 120 VOLT AC WIRING TERMINAL STRIP

!!CAUTION: Be sure the inverter is turned off and all external sources of power are turned off before accessing the AC Input/Output wiring terminal strip.

General

AC Output and input wires will enter through the three (3) strain relief cable clamps located on the right side of the unit.

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.

Vanner has designed the AC terminal block to accommodate spade or ring wire terminals and wire size up to 10 gauge. Refer to local codes for correct AC wire size appropriate for your inverter system and loads.

Ground Fault Circuit Interruption

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.

Approved Ground Fault Current Interrupters (GFCI Recommendations)

Manufacturer	Manufacturer Part Number
Pass & Seymour	2091-S, 2091-SI, 1591-R, 1591-SI
Hubbell	GF53521A
Bryant	GFR53FTI
Goldstar	GSM15SB
Square D	Q0230GFI
General Electric	THQL-1115GF
Electric Center (Siemens)	ECB120GF
Westinghouse	GFCB130
Murray (Siemens)	MP120GF

IQ Models (Inverter Only)	
General	AC1, AC2 and AC3 are all output circuits
AC1	AC output circuit protected by 20 amp circuit breaker CB1.
AC2	AC output circuit protected by 15 amp circuit breaker CB2. (The built-I GFCI receptacle receives its power from AC2.)
AC3	AC Output circuit protected by 30 amp circuit breaker CB3.

IQC Models (Inverter/Charger)	
General	AC1 and AC2 are input circuits. AC3 is the only output circuit.
	The purpose of having two separate 30 amp AC inputs is to allow full 30 amp AC feed through capability while also allowing full battery charging capability. (The charger can draw 27.5 amps when set to the maximum charge settings.)
	When the external source has less than 60 amps of input power available be careful that the battery charging power requirement combined with the AC loads do not overload the AC source. See Automatic Power Management (APM) Panel p/n D06791 to control the amount of input power used by the battery charger.
AC1	Primary AC input circuit protected by 30 amp circuit breaker CB1. Input voltage and frequency are monitored for proper tolerance at all times on AC1. Input power supplied to AC1 is used for battery charging and, when power is not applied to AC2, for pass through to AC3.
AC2	Optional AC input circuit used only for passthrough. Input power supplied to AC2 will pass through only while input power is supplied to AC1. When input power is supplied to both AC1 and AC2 then AC1 is used only for battery charging and AC2 is used only for pass through.
AC3	The pass through circuit automatically switches away from AC1 when input power is applied to AC2. The pass through circuit automatically switches back to AC1 when input power is removed from AC2.
	AC output circuit protected by 30 amp circuit breaker CB3. (The built-in GFCI receptacle receives its power from AC3 via CB2.)

NOTICE:

When the inverter/charger is connected to an external power source, the internal circuit breakers (CB1, CB2 and CB3) are considered supplemental and do not qualify as "branch rated" circuit breakers. External AC circuits carrying power to and from the unit must conform to National Electric Code and any other applicable codes.

The Automatic Power Transfer Switch switches both hot and neutral. For safety purposes the inverter output neutral (terminal #8) is connected to the inverter chassis ground only when the unit is in inverter mode. This is a requirement of the National Electric Code for all systems of this type that neutral should be connected to ground only at the source of AC power, which is the inverter when in inverter mode. When an external AC input (shore power, generator) is available, the IQC Transfer Switch system breaks the connection between neutral and inverter chassis ground. The neutral-to-ground connection for pass through power is then provided by the AC input source.

4-3.12.20 (20) DC INPUT WIRING COMPARTMENT

All Models

The DC wiring enclosure is located on the top right side of the inverter and contains 5/16" diameter studs to permit connection of two cables from the battery.

BE AWARE that, as a large number of capacitors become charged upon completion of the DC circuit, THERE WILL BE A LARGE SPARK when the last battery connection is made. The spark is normal and will occur every time the batteries are connected.

4-3.12.21 (21) GROUND WIRING LUG

All Models

This is a compression type terminal requiring only a flat blade screwdriver to make the connection. This terminal has been provided for safety to prevent possible shock hazards. Connect a #8 AWG minimum size wire to this terminal and then to the vehicle chassis ground or earth ground.

4-3.12.22 (22) MOUNTING BRACKETS

All Models

The IQ Series utilizes detachable mounting brackets which offer a variety of mounting configurations.

▲WARNING: Do not remove the plastic mounting feet. All units require ¾" space minimum under the unit to allow air flow for proper cooling.

4-3.12.23 (23) COOLING FAN

All Models

The cooling fan exhausts air out through the cooling fan opening. Cool air is drawn from the bottom and left sides of the unit. Obstruction of the intake or exhaust air flow will create overheating problems which will diminish the performance of the unit.

4-3.13 Procedure to Check Battery Charger Operation

Due to the amount of time to perform this procedure, verifying the battery charger function, it may be postponed to a convenient time.

To test the battery charger operations, first discharge the battery by placing a large AC load (approx. 50% of the units rated capacity) on the system and operating the inverter with shore power off. The AC load will discharge the battery over a time relative to the amount battery capacity, size of load, and ambient temperature.

When the battery charge level is low, the Battery Low LED turns on and will stay on until the battery voltage has dropped to the Battery Low shutdown stage the inverter shuts off and the LED begins to blink. The Battery voltage has decayed to 10.5 Vdc (or 21.0 Vdc for 24 volt models). Now, apply shore power and observe the battery charger operation. The system begins with the Charger-Bulk Light blinking, indicating bulk charge operation. This supplies a constant current charge output. Connect an ammeter to the DC cables between the inverter and the battery to monitor the current (DC amps), and a volt meter to the battery to monitor the battery voltage rising.

After some time, the battery voltage rises to the Absorption voltage (14.4 VDC for wet batteries or 14.1 VDC for gel batteries). The Charger-Bulk light continues to flash, indicating the charger is in Bulk or Absorption mode. The battery voltage remains constant (Absorption voltage value), and the charger output current tapers off. After approximately twenty minutes, the charge advances to Float mode. The Charger Float LED turns ON an the battery voltage drops to the float voltage value (13.2 VDC for wet batteries or 13.6 VDC for gel batteries). The charger will remain in this stage until shore power is removed or until the battery will again accept the bulk charge amperage.

4-3.14 Theory of Operation

4-3.14.1 Battery Charger Operation

The IQ Series' Battery Charger incorporates an automatic, three-stage charger. This design enables the unit to automatically charge batteries, maintaining the battery's integrity and reducing the likelihood of premature failure. This 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.

There are three automatic charge stages; Bulk, Absorption, and Float.

Bulk Charge Stage

The Bulk Charge Stage (fixed current) provides a fixed charging current for rapid charging of the battery bank. The charger output current is adjustable in 8-Amp steps (4-Amp steps on 24-Volt systems), up to the maximum charger rating, to match the charging requirements of the battery. The Bulk Stage is initiated when the battery will accept the charging amps selected. As the battery accepts charge the battery voltage will rise to the charger's Bulk Voltage value, 14.4 VDC for flooded batteries, or 14.1 VDC for gel batteries (on 24-Volt systems 28.8 and 28.2 respectively). When battery voltage reaches the Bulk Voltage Value the Bulk Charging Stage is complete. At this point, the battery is approximately 80-percent charged.

Absorption Charge Stage

During Absorption Charge Stage (fixed voltage), the charger's output voltage remains fixed at the Bulk Charge value and the output current will decrease as the battery becomes fully charged. The Absorption Stage ends after twenty minutes and the charger advances to the Float Stage.

Float/Maintenance Charge Stage

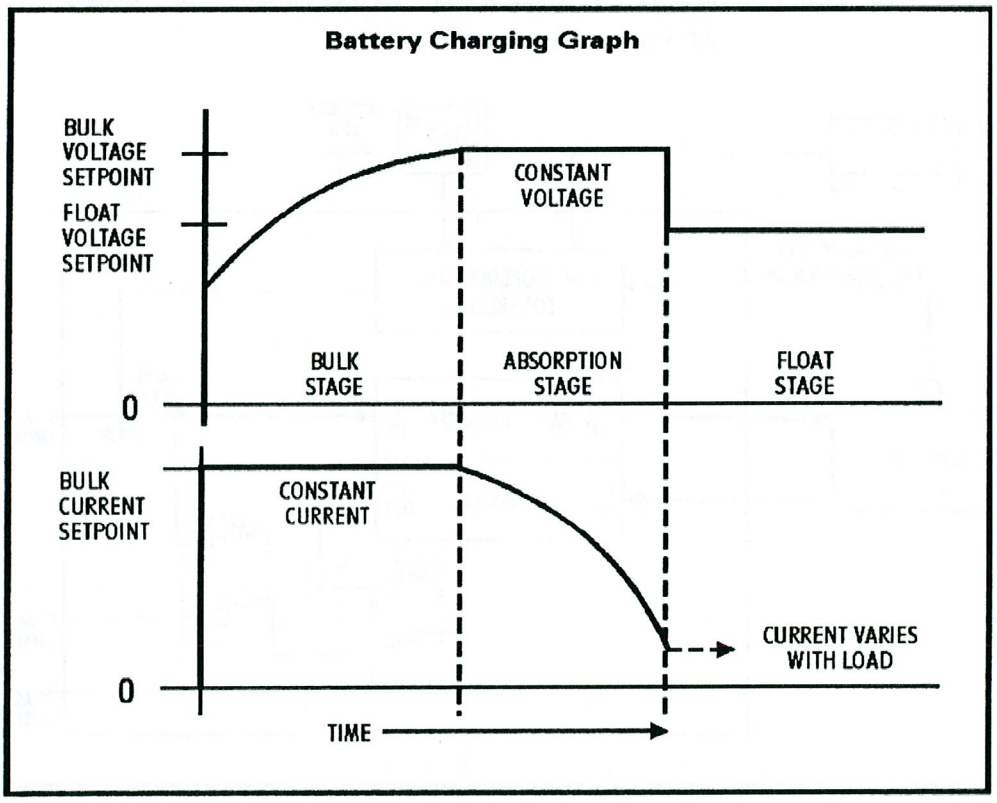
When the charger enters Float Stage, its output voltage is reduced to the float voltage value 13.2 VDC for flooded batteries, or 13.6 VDC for gel batteries (on 24-Volt systems 26.4 and 27.2 VDC respectively). This setting is sufficient to keep the battery charged, but not so high as to boil or over-charge the batteries. The charger will remain in Float Stage until the battery will accept the Bulk Charge Output Amps selected.

Equalization Cycle

This manually initiated cycle provides a 1 hour equalization charge at the Bulk Voltage level to boil the battery. This removes the sulfate build-up on the battery plates, and is used only on flooded lead acid batteries.

▲**WARNING:** Do not use with sealed or lead calcium maintenance free batteries.

The Equalization Charge Cycle is initiated by switching Program Switch 3 from OFF to the ON position. The Equalize Cycle is automatically terminated after 1 hour. The Equalize Cycle will be manually terminated by turning the Program Switch 3 to the OFF position or by turning the Main ON/OFF Switch OFF or by turning shore power OFF.



4-3.14.2 Automatic Power Transfer Switch Theory of Operation

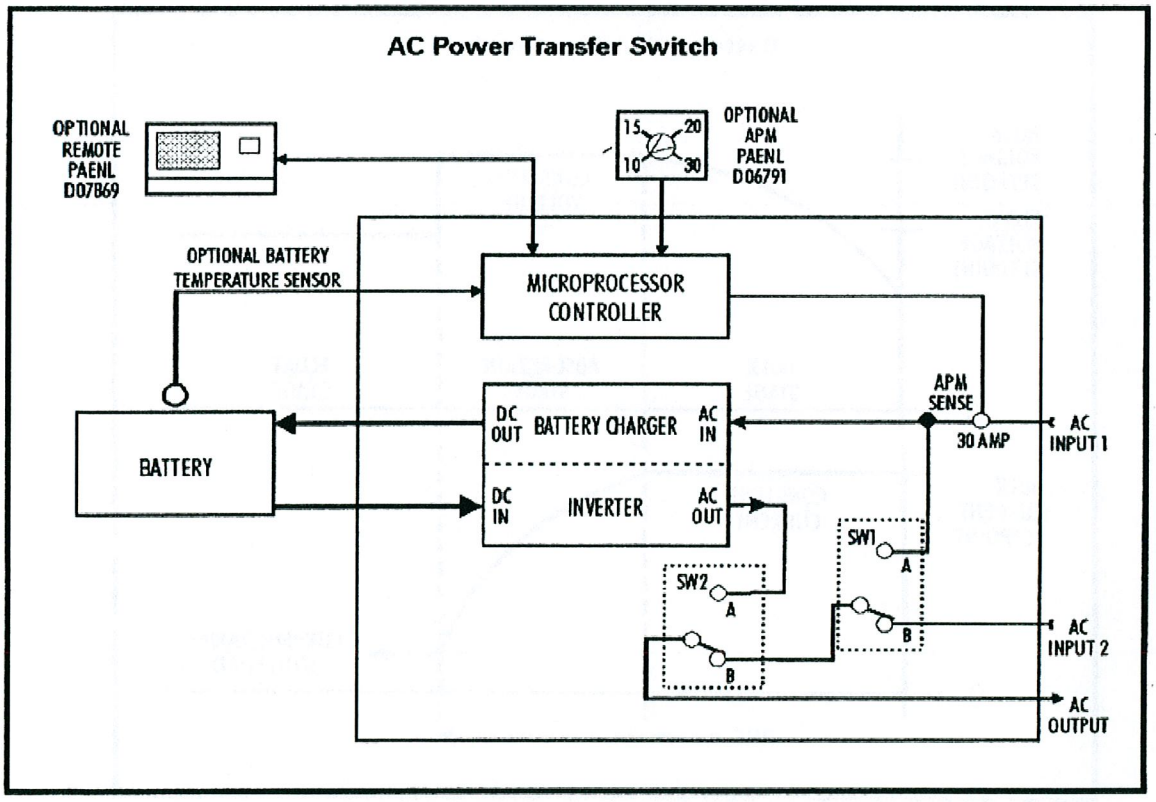
The function of the Automatic Transfer Switch is to automatically accept AC input power from shore or generator, and use this power to operate inverter loads and to provide power for battery charging. Upon loss of AC input power, the transfer switch automatically switches the AC loads back to inverter power. Transfer time is approximately 30 milliseconds (0.030 seconds). The 0.030 second transfer time allows all but the most sensitive loads to transfer from inverter power to shore power and back to inverter power without interruption.

AC input voltage and frequency are monitored for proper tolerance at all times on AC1. When the AC input is within tolerance for approximately 5 seconds, the power is passed through to AC3 output circuit and the IQC automatically switches from inverter mode to battery charger mode. The IQC automatically switches back to inverter mode when input power is disconnected or when input power is no longer within tolerance. See IQ Series Specifications page for AC input voltage and frequency tolerances. The 5 second delay occurs only if the inverter is fully ON when input power becomes available. There is no 5 second time delay if the inverter is in the "Load Demand Mode" when input power becomes available.

Switch 6 on the Programming Switch allows the user to select either 90 AC input volts or 77 AC input volts to be the Low AC Input Voltage switchover tolerance value. Set switch 6 to match the quality of AC being supplied. HI (90 VAC) is generally used on more stable AC power (Residential or Industrial Supplies). LOW (77VAC) is used with less stable AC power (motor generator, solar, rural supplies).

For all IQC models, the factor that determines whether the unit is in "inverter mode" or "battery charger mode" is the presence or absence of "in-tolerance" input power. Whenever "in-tolerance" input power becomes available the IQC automatically switches from inverter mode to charger mode.

The transfer switch switches both hot and neutral. For safety purposes the inverter output neutral (terminal #8) is connected to the inverter chassis ground only when the unit is in inverter mode. This is a requirement of the National Electric Code for all systems of this type that neutral should be connected to ground only at the source of AC power, which is the inverter when in inverter mode. When an external AC input (shore power, generator) is available, the IQC Transfer Switch system breaks the connection between neutral and inverter chassis ground. The neutral-to-ground connection for pass through power is then provided by the AC input source.



4-3.14.3 Automatic Power Management (APM) Theory of Operation

Automatic Power Management (APM) Feature

When the IQC is connected to shore power and operating large AC loads it is possible that the AC loads combined with battery charging requirements may exceed 30 amps. To prevent nuisance tripping of the shore circuit breaker the Automatic Power Management circuit constantly monitors the AC current entering input AC1. (Input AC1 is used to power the battery charger and to power AC loads connected to the IQC output circuit when input AC2 is not used.) If the AC input current exceeds 30 amps the APM circuit automatically reduces power to the battery charger until either the AC1 input current is less than 30 amps or until the battery charger power is zero. The APM circuit will override the Program Switch Bulk Charge Output Amps Setting and proportionally reduce the battery charger output as necessary.

The optional APM Panel (Vanner part no. D07934) allows the operator to select the maximum AC amps the battery charger may draw from shore power input AC1. The APM Panel allows the Automatic Power Management Feature to be adjusted to match the size of the shore power circuit breaker, 10 amps, 15 amps, 20 amps or 30 (default) amps. In motor home or similar applications, where the shore power source varies from campground to campground, the APM Panel is useful in preventing nuisance tripping of the circuit breaker at the shore power source. This panel is usually installed near the shore power hookup.

Example 1: Input AC2 is not receiving power, the APM Panel switch is set at 15 amps and the AC output load is drawing 10 amps. Under these conditions the APM will allow the battery charger to draw up to 5 AC amps. If the AC output load is increased and exceeds the APM setting then the battery charger will be reduced to zero AC amps.

Example 2: Input AC2 is receiving power and the APM Panel switch is set at 15 amps. Under these conditions the battery charger will be allowed to draw up to 15 AC amps regardless of AC output load.

4-3.14.4 Automatic Throttle Control Terminal J31 Theory of Operation

Terminal J31 is provided on all models and is to be used on utility vehicles where the inverter needs to operate continuous heavy AC loads and the vehicle is equipped with an Automatic Throttle. Use J31 to turn ON the Auto Throttle to ensure that the vehicle alternator is producing maximum output whenever the inverter is powering a load.

J31 is controlled by the Load Demand circuit therefore Programming Switch 2 must be in the ON position when Terminal J31 is used.

J31 is a ¼" spade terminal located in the lower right midsection of the control circuit board. The terminal is designed to provide ground control for a Bosch relay, Vanner part number 05235 or equal. Install a 1 amp fuse in line near the inverter.

4-3.15 Preventative Maintenance

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

4-3.15.1 Maintenance Items

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

1. Check to ensure that all DC and AC wiring connections are secure and corrosion free.
2. Check for ventilation openings for dust and other obstructions
3. Examine receptacle, indicators and switches for cracks and breaks.
4. Examine for any surfaces that are discolored or deformed due to excessive heat.

4-3.16 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 or the Vanner Power Group Customer Service Department: 1-800-AC-POWER (1-800-227-6937). Please have your model and serial number available when consulting customer service.

ALWAYS CHECK THE FOLLOWING FIRST:

DC Fuse condition

AC output and input breakers AC1, AC2, and AC3

Check all GFCI breakers as equipped throughout AC system

Unit On/Off and Remote On/Off switch positions

Plug-in and operate an AC load from the convenience receptacle located on inverter from panel.

Check battery connections for tightness or corrosion

Check battery voltage at battery and inverter.

SYMPTOM	ON LED does not light steadily after pushing in the ON-OFF/RESET Inverter Switch. Lamp flashes in Load Demand Waiting mode.
SOLUTION	For IQC Models - Check battery connections if utility power is OFF. Check DC fuses if utility power is OFF. Lamp flashes when utility power is present.
SYMPTOM	Inverter LED does not illuminate
SOLUTION	Reset On/Off switch on unit and remote Disconnect remote switch and attempt starting with unit On/Off switch Check DC fuse condition
SYMPTOM	ON lamp fully illuminates. AC load does not run.
SOLUTION	Check and reset AC circuit breakers. Check and reset any GFCI breakers in AC circuit. Verify AC load and wiring 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 charging system for proper operation (vehicle alternator, PV array, generator).
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	Excessive audible buzzing during inverter operation but inverter operates loads.
SOLUTION	Check mounting bracket bolt tightness Remount inverter with rubber insulator washers
SYMPTOM	AC loads do not seem to be fully energized when operating from inverter power
SOLUTION	Check AC output voltage at convenience receptacle. Check for overheated DC or AC wiring
SYMPTOM	Unit does not operate and a "burn wire" smell emits from inverter
SOLUTION	Disconnect AC loads and battery immediately Unit may require service

4-3.17 GFCI Test Record

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

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

Use this chart to keep a record of this procedure.