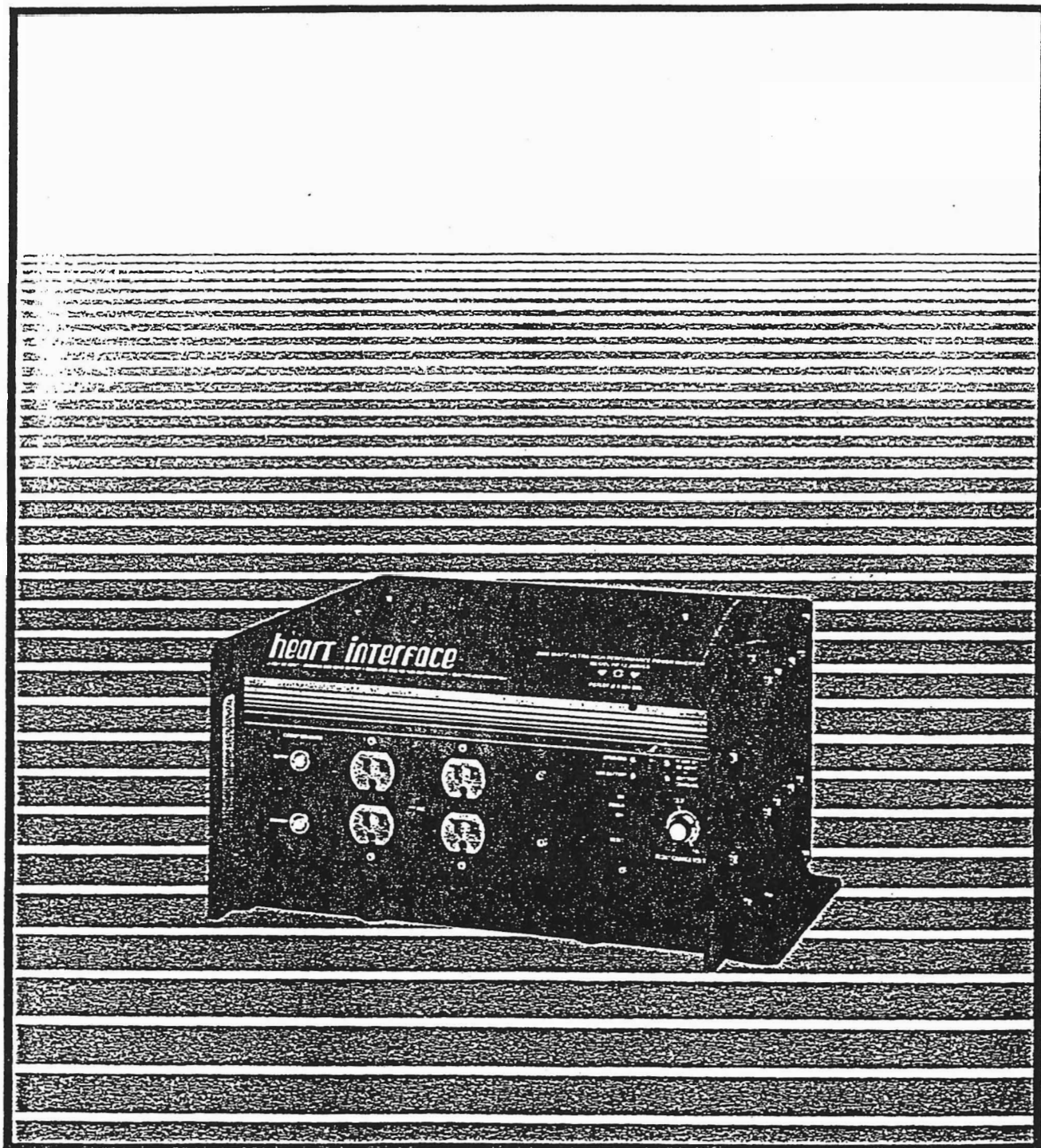


# Owners Manual

Models HF24-2500X

HF24-2500SX



**heart**  
INTERFACE

## INTRODUCTION

Your Heart Interface HF24-2500 series power inverter is a member of the most advanced line of mobile AC power systems available. When used with a properly sized battery bank this unit will supply AC power for loads up to 2500 watts and provide ample surge power for starting inductive loads.

This Heart is used in a wide range of applications, including remote homes, RVs, sail and power boats, and a host of industrial standby power installations. Its versatility is due to a unique combination of high power and precise regulation.

## QUICK HOOK-UP AND TESTING

If you would like to quickly hook up your Heart and check its performance before you tackle your installation please follow these guidelines.

Unpack and inspect the Heart. Check to see that the power switch is in the off position.

Use a volt meter to check the voltage of your battery bank. You must supply 24 volts DC nominal battery voltage to the Heart. Because battery voltage is critical to the performance of your Heart it is recommended that you own a simple volt meter. The Heart will accept battery voltage between 21.6 and 29.0 volts DC.

IT IS EXTREMELY IMPORTANT TO OBSERVE CORRECT POLARITY WHEN HOOKING UP THE HEART. REVERSE POLARITY CONNECTION, EVEN FOR AN INSTANT, WILL RESULT IN DAMAGE TO THE HEART.

Connect the black cable protruding from the back of the Heart to the negative terminal of the battery. Because you can draw 100 amps and more through these cables it is important, even for a quick test, to make a solid connection.

Connect the red cable from the Heart to the positive battery terminal. Current may flow momentarily when this connection is made. This is not cause for alarm, but take care not to make this connection in the presence of flammable fumes.

Once the unit is connected to the battery you may turn the power switch on.

Immediately upon turn-on the indicator LED lights on the front of the unit will flash. The overload light will flash green and then go out first, the low battery light will stay on slightly longer. These lights will be illuminated only for a brief moment. During normal operation both LED indicator lights will remain off.

You may now operate any appliance that is rated within the capacity of the Heart.

#### MEASURING THE OUTPUT VOLTAGE WITH A METER

You may measure the output voltage of the Heart with your volt meter, however, it is possible that you will not measure the 117-119 AC volts RMS that the unit provides. This is due to the output wave shape of the Heart, which can only be accurately measured with a true RMS volt meter, a rather specialized instrument. Do not be concerned about measuring output voltage that varies with load and battery voltage, this is normal and should be expected unless you have a true RMS volt meter. When measured with a standard volt meter you can expect readings somewhere between 90 and 140 volts, and since different meters contain different measuring circuits it is impossible to predict the exact reading you may get.

If you measure the output voltage with nothing plugged into the front of the Heart you will get a very low reading, usually between 20 and 30 volts AC. This is the no-load or idle state of the unit and is perfectly normal. True RMS voltage in idle is about 55 volts AC.

A good way to confirm that your voltage regulation circuit in the Heart is working is to observe the brightness of an incandescent light bulb. If the brightness appears about the same as the light plugged into utility power or a generator, then you know the voltage regulation is correct. A relatively small change in voltage will produce a noticeable change in light output.

#### INSTALLATION

##### MOUNTING:

The Heart is provided with mounting flanges to allow you to secure the unit down. This will certainly be desirable in a mobile installation, though not necessary if the unit will be used in a stationary application.

The Heart may be mounted in any position. You can bolt it to a horizontal or vertical surface, or on an angle. It is important that the Heart be secured to a flat surface that will allow air to flow under the unit. Also provide for some air flow around the unit. This will insure adequate cooling when operating high powered loads.

When bolting to either a shelf or wall or bulkhead use 1/4 inch stainless steel bolts with lockwashers. Tighten to 20-25 ft./lbs. of torque. You will notice that this squashes the rubber feet somewhat, this is intentional.

While designed to be quite rugged, it is best to provide protection for the Heart from the elements. Do not allow water to splash on the unit and avoid temperature extremes. The Heart will work best in an ambient air temperature between 30 and 120 degrees F.

Do not mount the Heart in the battery box. While charging, batteries give off a flammable mixture of hydrogen and oxygen. If the Heart and the batteries are mounted together in an air tight box a potential fire hazard is created.

Carefully consider the location of the Heart. It is best to locate the unit as close as practical to the batteries so as to keep the cables short. It is better to run longer AC wires than longer DC cables.

#### BATTERY CABLES:

The Heart is supplied with battery cables protruding from the back. Red is positive and black is negative.

If possible, you may simply connect these cables directly to the battery bank, being careful to observe correct polarity.

If the battery bank is too far away from the Heart for the cables to reach, then you must obtain cables the appropriate length and bolt them to the cables from the Heart. Use only insulated, stranded, copper cable for your battery cables. Solid copper bus bars can also be used to connect the Heart battery cables to the battery terminals.

Keep in mind that there will be a drop in voltage across the battery cables, the longer the cable the greater this voltage drop will be. This voltage drop represents a waste of your battery capacity and reduces the performance of your inverter. To measure this voltage drop use your volt meter to measure the battery voltage at the battery terminals and then at the junction between the Heart cables and your extension cables. Do this while operating a load of about 2500 watts. If this voltage drop is in excess of 1 volt DC then you should consider either shorter or larger gauge cable.

If your overall length is less than 10 feet then use at least 0 (1/0) gauge cable. For overall runs up to 20 feet use at least 00 (2/0) gauge cable. Do not use battery cables longer than 20 feet unless absolutely necessary. If you must use cables longer than 20 feet, use either 000 (3/0) or 0000 (4/0) cable. It does not hurt to oversize the cables beyond these recommendations.

It is helpful to identify the positive cable by either using red insulated cable or by putting red tape at both ends. This will help to prevent accidental mispolarity. These battery cable extensions must be made with copper ring terminals on both ends.

These may be professionally crimped or soldered onto the cable. If you make the cables yourself be sure to solder the terminals to the cable.

Remember that the Heart is capable of drawing over 100 amps across these cables. This represents a considerable amount of current and for this reason proper cable size and terminal connections are of the utmost importance, both for performance and safety. Do not attempt to undersize the battery cables or make use of improper connections.

Once you have obtained the appropriate extension cables you are ready to connect them to the Heart cables. This is done by bolting the terminals together. Make sure the connection is tight and then insulate the connection with either electrical tape or heat shrink insulation. Connect both the positive and the negative extension cables to the cables coming from the Heart, making sure that there is a red identifying mark on the positive cable.

An alternate method of connecting the battery cables together is the use of quick-disconnect fittings. These are available for the different size cables and provide a convenient way to disconnect the Heart from the battery bank. To make use of these connectors you must cut the terminals off of the Heart battery cables and attach the quick-disconnect fittings.

#### OVER-CURRENT PROTECTION FOR THE BATTERY CABLES:

In some installations it may be desirable to use a fuse or circuit breaker to provide over-current protection for the DC input to the Heart. This can prevent disaster if somehow a short circuit is developed across the battery cables.

You must use at least a 200 amp fuse or circuit breaker to allow for the surge capability of the Heart. The fuse or circuit breaker should be installed in the positive battery cable within 18 inches of the battery bank.

#### BATTERY INTERCONNECTIONS:

It is very important that the battery bank be hooked up correctly to provide the 24 volt configuration necessary to operate the Heart. You may use a pair of 12 volt batteries or four 6 volt batteries to form a basic 24 volt battery bank. To accomplish this you connect the positive terminal of one battery to the negative terminal of another. When using 12 volt batteries connect 2 of them together in this fashion, when using 6 volt batteries connect 4 of them together, positive to negative. This is known as series connection. When batteries are connected in

series the voltage of the battery bank is equal to the sum of the voltage of each battery. The amp-hour capacity of the battery bank is equal to the amp-hour capacity of one individual battery.

You may increase the amp-hour capacity of the battery bank by creating more than one 24 volt battery bank and hooking these banks up in parallel. To connect the battery banks in parallel you connect the positive posts of each 24 volt bank together and the negative posts together. This will result in a 24 volt battery bank with increased amp-hour capacity. When batteries are connected in parallel the voltage of the battery bank is equal to the voltage of one battery. The amp-hour capacity is the sum of the capacities of each individual battery.

Use at least 0 (1/0) gauge copper cable fitted with the proper terminals for your battery interconnections. Make sure that all connections are clean and tight.

#### BATTERY CONNECTIONS:

Once you have made your battery extension cables and interconnected your battery bank you are ready to permanently hook up the Heart. Use your volt meter to confirm the voltage and polarity of your battery bank.

First connect the negative battery cable to the negative post on the battery bank. Make sure the post and the terminal are clean and bolt them together tightly.

Now connect the positive battery cable to the positive post of the battery bank.

Current will flow momentarily when the positive connection is made. This is the result of a capacitor charging inside the unit and should be of no concern, but do not make this connection in the presence of any flammable gas, such as that from charging batteries.

Make sure the positive terminal and post are clean and bolt them together tightly.

#### GROUND CONNECTION:

On the back of the Heart you will find a stud labeled CHASSIS GROUND. This stud is for the purpose of connecting the chassis of the Heart to ground. You will also find an identical stud labeled EQUIPMENT GROUND. This stud is for the purpose of connecting any equipment to the grounding system. The CHASSIS GROUND and EQUIPMENT GROUND are electrically bonded together.

To properly ground the Heart use a green insulated 8 gauge wire with appropriate terminals on each end.

Remove the nut from the chassis ground stud using a 3/8 inch wrench. Place one end of your green wire over the stud and replace the nut. Tighten snugly, but take care not to overtighten. Overtightening can spin the stud in the chassis, and compromise the ground connection.

The green wire will be connected to ground, which will vary depending on the installation. In a stationary installation connect the wire to an earth ground. This will be either a water pipe or a copper rod pounded into the ground or an existing ground rod. In a vehicle connect the wire to the vehicle chassis. Make sure the connection is electrically sound. In a boat you will connect to the existing grounding system.

The ground lugs in the output sockets of the Heart are connected to the chassis ground. This means that when you plug an appliance with a standard 3 wire grounded plug into the Heart, the ground from the appliance is connected through the Heart to ground.

The neutral wire of the AC output is not attached to ground in the unit. In many installations this neutral will be attached to ground in the breaker panel. The decision to ground the AC neutral is left to the user.

The battery cables from the Heart are not connected internally to the chassis. You may ground either the positive or the negative battery or you may leave the battery bank ungrounded. It is most common for the negative battery to be attached to ground. Like the grounding of the AC neutral, this decision is left to the user.

It is very important for safe operation that grounding be carefully done. Please do not operate the Heart without the protection afforded by proper grounding of the chassis.

#### AC OUTPUT CONNECTION:

You may simply plug your appliances directly into the Heart or you may wire from the Heart to a breaker panel for distribution of power through your existing wiring.

To connect directly to a breaker panel you must start with a 3 terminal AC plug that will fit the sockets on the front of the Heart. Connect 3 wires to this plug and run them to the breaker panel. Refer to local electrical codes to determine the appropriate wire size, keeping in mind the 20 amp output of the Heart. Use at least 12 gauge wire for the AC connection. Refer to the output socket wiring diagram in the Installation Guide to determine which wire is hot, neutral, and ground coming from the plug.

Some models are equipped with a cable hardwire protruding from the back of the unit. In this case there will be three wires, black is hot, white is neutral, and green is ground. These are provided with heat-shrink insulation on each wire. THESE WIRES WILL CARRY DANGEROUS VOLTAGE, USE CAUTION WHEN HANDLING.

The cable hardwire models are fitted with a 1/2 inch conduit connection on the back.

#### SPLIT PHASE OUTPUT CONNECTION (240 VOLTS):

Split phase models are designated by the suffix P and provide 4 wire output, 2 legs of 120 volts and 1 leg of 240 volts.

Red and black are the hot wires, you can draw 10 amps at 240 volts across them. White is neutral, you may draw 10 amps at 120 volts between red and white and between black and white. The green wire is the ground. A 1/2 inch conduit connection is used, with the intention of running these wires through 1/2 inch conduit.

240 VOLT ELECTRICITY IS POTENTIALLY DANGEROUS, INSTALLATION SHOULD BE CARRIED OUT ONLY BY A QUALIFIED INSTALLER.

#### TRANSFER SWITCHING:

When installing the Heart in a system that also uses a generator or utility power you must make use of transfer switching, using either a switch or a manual method.

#### WARNING!

DO NOT CONNECT THE HEART AND ANOTHER AC SOURCE (GENERATOR OR UTILITY POWER) TO THE BREAKER PANEL AT THE SAME TIME. THIS IS KNOWN AS BACKFEEDING AND MAY DAMAGE THE HEART.

A transfer switch is a device that allows you to connect 2 or more AC sources into the same system without allowing both to be on line at the same time. A transfer switch can be manual, a good example of which is a marine rotary selector switch such as found on many boats. Transfer switches are also available which sense voltage and switch automatically, these are common on RVs. The other acceptable method is to run a plug from the breaker panel and manually plug it into the desired AC source.

Regardless of what method of transfer switching you decide on, never allow two AC sources to feed the same line at the same time. Even if the Heart is switched off during a backfeed, it is possible it may be damaged.



If your Heart contains the built-in battery charger there is a transfer switch contained in the unit. Refer to the STANDBY OPTION section of this manual for details.

## OPERATION

It is recommended that all loads be turned off or disconnected before turning on the Heart. This is especially important for any high powered loads, and is less important for small loads.

To operate simply move the power switch to the on position.

Both LED indicator lights will flash momentarily. The overload LED will flash green and go out first. The low battery light will flash red and go out after the overload light.

The unit is now running and ready to supply AC power to your loads.

## WHAT TO EXPECT:

There are virtually no limitations to what will operate on your Heart, within the 2500 watt rating. You may operate fluorescent and incandescent lights, refrigerators and freezers, computers, televisions, well pumps, etc. The list is virtually endless.

Electrical appliances fall into 2 broad groups, resistive and inductive. Resistive loads are simple ones in which the electricity creates heat and no motion. Typical resistive loads that you may operate include incandescent lights or electric heaters. It is easy to figure what resistive loads will operate on the Heart, so long as the load is 2500 watts or less there will be no problem.

Inductive loads are generally those in which the electricity goes through a coil of wire. These loads usually contain motors, such as fans and refrigerators; or transformers, which are found in most electronics such as TVs, computers and fluorescent lights. Inductive loads require a larger amount of power to get them started than to run them, sometimes up to 6 times as much power. This inductive surge must be taken in to account when figuring what will operate on the Heart. The Heart will provide surge power up to 3 times its rated output to allow inductive loads to start. A good rule of thumb is to figure that your HF24-2500 will operate a 3/4 horsepower inductive motor. Capacitor-start motors require the minimum surge to get started and are therefore recommended when possible.

#### THE LOAD DEMAND CIRCUIT:

Your Heart features a unique load demand circuit that allows it to be left on and to draw very little power if it is not actually operating any loads.

This circuit is automatic and virtually instantaneous. While in idle or no-load the unit draws less than 100 milliamps (1/10 amp) from the battery bank and is putting out about 50 volts RMS. This will typically be measured as 20-30 volts on an averaging volt meter.

The load demand circuit is set to detect a 15 watt load. If you attempt to operate an appliance which draws less than 15 watts you will have to run an additional load simultaneously to insure that the Heart will come out of idle.

Occasionally a small inductive load that draws around 15 watts will fail to bring the unit out of idle. An example might be an electric shaver. If this happens you must simply operate a resistive load in conjunction with the shaver. A 15 watt light bulb will be enough to force the unit out of idle if you are running a very small inductive load.

The load demand circuit may be disabled if desired. In this case the Heart will not go into idle and will always be ready to operate even the smallest load. Please contact the factory or your dealer for instructions on making this adjustment.

#### THE PROTECTION CIRCUITS:

The Heart has 3 levels of protection against overloads and a circuit which protects against excessively high or low battery voltage..

#### OVERLOAD PROTECTION:

There is a very fast overload protection circuit in the Heart to protect against short circuits. This is activated if there is a short circuit in your wiring or if you attempt to start a large induction motor in excess of the surge rating of the Heart. The overload protection circuit is indicated by the overload LED on the front of the unit. This LED will light green if an overload condition occurs.

The overload circuit will quickly shut down the output of the Heart when activated. If the short circuit or inductive overload is removed within 10 seconds, the unit will automatically reset and continue normal operation.

If the overload condition persists for more than 10 seconds the unit will completely turn itself off, leaving the green overload LED shining. If this situation occurs you must discover and eliminate the cause of the overload. Once the overload is removed, you may restart the Heart by turning the power switch off, pausing a moment, and then switching it back on.

#### CIRCUIT BREAKER PROTECTION:

The 20 amp circuit breaker on the front of the Heart is a relatively slow breaker which will allow the unit to provide ample surge power and to operate loads between 2500 and 7500 watts for a limited time.

For example, if you attempt to operate a 22 amp AC appliance it will run fine for several minutes. The circuit breaker will eventually trip, protecting the Heart from extended operation over its rated output.

When the breaker trips it will pop out, extending about 1/4 inch. To reset simply push the breaker back in firmly and the unit will restart.

#### PROTECTION FROM OVERHEATING:

Because the Heart is not quite 100% efficient, there will be heat built up in the unit during the operation of loads which are close to the rated output. If a 2500 watt load is run long enough the thermal protection in the Heart will come into play. Under normal circumstances you can run the unit at 2500 watts of resistive load for about 2 hours.

Wound into the center of the transformer is a thermal sensor that will shut down the Heart if internal temperatures approach the maximum rating of the components. If this happens the overload LED will come on, glowing red.

When this occurs you must give the unit time to cool down before re-starting. When the unit gets cool enough to start back up, the overload LED will turn green. After the overload LED turns green you may re-start the unit by turning the power switch to the off position, pausing for a moment, then turning it on again.

#### HIGH AND LOW BATTERY VOLTAGE PROTECTION:

The Heart will accept battery voltage ranging from 20.0 to 30.0 volts. If the voltage of the battery bank falls outside of this range the low battery LED will come on, glowing red. The low battery light will glow for a few moments while the unit

continues to operate. If the high or low battery voltage persists the unit will shut itself down, the low battery LED will extinguish and the overload light will be left on, glowing green.

The low battery cut out is designed to prevent the battery bank from discharging totally and thereby incurring permanent damage. There is a time delay built into this circuit which allows the battery voltage to momentarily drop below 20.0 volts. This will allow the voltage to dip substantially while starting an induction motor.

The high battery cut out is designed to protect the Heart from excessive input voltage. When this circuit is activated the low battery LED comes on red, just as in the case of the low battery cutout. Once the unit shuts down, the green overload light is left on.

If the low battery LED comes on you should measure the battery voltage to determine if it is high or low. If it is high you are probably overcharging the battery and should check both the charging system and the water level in the battery. If the battery voltage is low then it is time to recharge.

When checking for low battery voltage bear in mind that this low voltage will rebound when the load is removed. If the low battery protection circuitry shuts the unit down it is quite likely that the battery voltage will measure higher than the 20 volt cutoff point. Put a load on the battery bank and recheck the voltage.

#### MAINTENANCE

The Heart is a solid-state electronic device that requires no maintenance. It is recommended that you clean the unit periodically with a damp cloth.

Keep the Heart dry at all times. If water gets inside the unit immediately disconnect from the batteries and dry it out. Make sure it is completely dry before attempting to use the unit.

While the Heart does not require any maintenance, it is very important to perform regular maintenance on the battery bank. This includes checking the electrolyte level and filling with distilled water as necessary, and cleaning all battery connections. Keeping the tops of the batteries clean will help reduce their tendency to self discharge.

#### THE "S" OPTION - AUTOMATIC BATTERY CHARGING

The "S" version of this unit is designated the HF24-2500SX and includes a built-in 40 amp DC battery charger and 20 amp AC transfer switch. This battery charger is quite powerful and very

sophisticated in its regulation, providing a charge curve according to the recommendations of deep-cycle battery manufacturers. Unlike most battery chargers, the Heart combines the ability to rapidly recharge in a constant current mode, with a precise float capability, maintaining the battery bank indefinitely in a constant voltage mode. Float voltage and bulk charge cut-off voltage are adjustable by the knob on the front panel.

#### HOW THE CHARGER WORKS:

When 120 volts is applied to the line cord of the Heart Interface the inverter operation is immediately ceased, the internal relay sends the incoming AC to the charger circuitry, current is reversed through the transformer, and the unit starts to charge the battery bank. The switching time between inverter and charger modes is about 1/2 second, which means a computer plugged into the unit will crash when the transfer is made. The HF24-2500SX was never intended to operate as an uninterruptible power supply for computers.

The battery charger in the HF24-2500SX is a unique design that makes use of both constant current and constant voltage modes to provide rapid and complete recharging and precise floating of the battery bank.

The idea behind charging deep-cycle batteries is to pump current into them until the voltage reaches the gassing point. It is not until this point that the battery bank has reached full charge. The voltage at which this occurs is about 28.4 volts for new batteries at 77 degrees F. It is important to reduce the charge rate at the end of this bulk charge phase so as to prevent overcharging. Once the battery bank has reached the gassing point and the current has ramped down the bank can be considered completely charged. At this point if the charger is to remain on the voltage must be reduced or the batteries will lose excessive water. Proper float voltage is about 26.4 volts for new batteries at 77 degrees F. Older batteries and colder temperatures may require a slightly higher bulk charge and float voltage.

The Heart battery charger is fully regulated, which means that the unit is constantly sensing battery voltage and adjusting its output in response to this. When a battery bank is discharged its voltage is low and the Heart will put out full current. If the voltage comes up very fast, as may be the case in small battery banks, the Heart will reduce its output. This prevents overcharging small banks.

The FLOAT VOLTAGE CONTROL allows the user to adjust not only the float voltage, but also the point at which bulk charging stops and floating is initiated. This float voltage control does not affect the output current of the charger, so turning it up does

not result in faster charging. The only time that turning the float voltage control up will increase the output of the charger is towards the end of the charging cycle when the output is being ramped down because the battery is nearing full charge.

The battery charger will bulk charge the battery bank up to about 2 volts higher than the setting of the float voltage control. It will do this at a constant current until it reaches the end of the charge cycle, when the current will gradually ramp down. This ramping down of the charger current can be followed by watching the BATTERY CHARGING LED. During this ramping down phase the battery bank is accepting its final charge, which needs to be completed at a reduced rate to prevent over charging.

Once the battery voltage reaches 2 volts above the float voltage control setting and the current has ramped down to about 10 amps DC, the charger goes from bulk charge mode to float mode. In the float mode the battery bank is held at the precise voltage that is set by the float voltage control.

Once in the float mode you can draw up to 20 amps DC from the battery bank and the Heart will remain in the float mode. If more than 20 amps is drawn from the battery bank the Heart will interpret this as a discharged battery and the bulk charge mode will take over. In this case it will raise the battery voltage to the gassing point and water loss may occur from the battery bank. If you will be drawing more than 20 amps from the battery bank while the charger is on, it is important to turn the float voltage control all the way down. This keeps the battery bank voltage below the gassing point.

#### HOW TO USE THE CHARGER:

Each standby unit is supplied with a standard 3 wire AC line cord protruding from the center of the back, this is used to plug in the charger. In the simplest scenario this is plugged into a 120 volt AC socket at which point the Heart will recharge the battery bank. The battery charger may be turned off and on with the power switch. This switch must be in the on position for the battery charger to operate.

At the moment when the AC line cord is plugged in you will hear the internal transfer switch emit a distinct click. At this point the incoming AC voltage is directed through the transfer switch to the outlets on the front panel and to the hardwire connection if present. Inverter operation stops at this point and the red AC INPUT LED is illuminated.

It takes a few moments for the battery charger to come on after the unit is plugged in. Charge rate is indicated by the 3 color BATTERY CHARGING LED as described below.

OFF - 0-10 amps  
GREEN - 10-20 amps  
YELLOW - 20-30 amps  
RED - 30-40 amps

If the battery bank is low and in need of recharging, the BATTERY CHARGING LED will start out in the red color and the unit will deliver 40 amps. Into very small battery banks this output may be somewhat reduced to prevent overcharging. As the battery bank approaches full charge the charging rate will taper off, and the LED will change from red to green, then from green to yellow, and then off all together. When the LED is off it indicates that the battery bank is fully charged and the unit is in the float mode.

#### THE FLOAT VOLTAGE CONTROL:

In the lower right hand corner of the HF24-2500SX you will find a knob labeled FLOAT VOLTAGE CONTROL, this controls not only the float voltage, but also the finish voltage in the bulk charge mode. Calibration on this knob is from 24 to 28 volts DC. This knob is adjusted to the desired float voltage based on temperature and battery age, type, and condition. Consult your battery manufacturer for their recommendations.

The bulk charge finish voltage will be 2 volts higher than the setting of the float voltage control. By adjusting the float voltage you are also adjusting this finish voltage. Remember that this control does not adjust charger output current.

#### THE INTERNAL TRANSFER SWITCH:

There is a 20 amp relay inside the Heart that feeds incoming AC power to the battery charger and also acts as the internal transfer switch. This relay routes the incoming power to the output of the Heart whenever the unit is plugged into a 120 volt AC source.

All of the power that is routed through the Heart to the output goes through the 20 amp circuit breaker on the front panel. Therefore, regardless of the power capability of the external 120 volt source, you are limited to drawing 20 amps from the Heart.

In an installation where it will be necessary to draw more than 20 amps from the system when plugged into an alternate power source you must make use of an external transfer switch. (See the Installation Guide for more detailed information on transfer switching.)

#### USING THE BATTERY CHARGER WITH AN AC GENERATOR:

You may power the battery charger in the Heart Interface with either utility power or an engine driven AC generator. When using a generator there is one necessary precaution you must take when making the installation.

When a generator is started the voltage gradually builds up from zero to 120 volts as the engine comes up to speed. During this period of voltage instability, if the Heart is hooked up to the generator, there may be a chattering of the internal transfer switch. This will be quite audible and if allowed to persist will burn out the points in the internal transfer switch.

To avoid this damaging situation you must not connect the Heart battery charger to the generator until the engine has come up to speed and the voltage has stabilized. This can be done manually or by use of a transfer switch with a built-in time delay.

A popular solution for this is a transfer switch offered through Heart Interface and our dealers. Designated the HTS-30, this is a 30 amp double-pole double-throw relay with a built-in 45 second time delay. The HTS-50 is a similar switch with two double -pole double-throw relays, it is used for 240 volt applications, or the relays can be paralleled for 50 amp switching, or it can be used to switch between a generator and the Heart to a breaker panel and to provide a time delay for the input to the generator. Consult the Installation Guide for details on installing these transfer switches.

You may safely operate the battery charger with any size generator, but when operating with a small generator you may not get the full 40 amps output current. This is because the battery charger requires full peak AC voltage to provide 40 amps and when a generator is loaded heavily the peak AC voltage goes down. It requires about a 6 kilowatt generator to get 40 amps from the battery charger.

#### EQUALIZING THE BATTERY BANK:

Most liquid electrolyte deep-cycle battery manufacturers recommend an occasional equalizing charge, which is simply a controlled overcharge. Your Heart is capable of equalizing most battery banks.

To apply an equalizing charge simply crank the float voltage control all the way up. At this setting of 28 volts the charger will attempt to drive the battery bank to 30 volts. It is possible that the bank may never actually reach 30 volts, but you will get vigorous gassing which is characteristic of an equalizing charge.



Do not allow this condition to persist for more than a few hours. Vent the battery bank to prevent to build up of fumes and keep an eye on electrolyte level. Do not let the batteries get hot. After the equalizing charge is applied check the electrolyte level in each cell and replenish as necessary with distilled water.

The goals of an equalizing charge are to bring each cell up to the same potential, to knock as much sulfate off the plates as possible, and to mix up the electrolyte, which tends to stratify. Equalizing is not absolutely necessary but may help to extend battery life. Do not equalize a battery bank that is unsupervised. Do not equalize a gell-cell type battery.

## BATTERIES

The performance of your Heart Interface will be highly dependent on the battery bank that you use. The following information will help you to understand how to size and maintain your battery bank.

### BATTERY SIZING:

The size of your battery bank will depend entirely on the loads that you operate and the time between recharges.

We recommend that you use true deep-cycle batteries with your Heart Interface. Golf cart batteries are a good choice. RV or marine deep-cycle batteries are acceptable, but do not have the life expectancy of the golf cart battery. Do not use automotive starting batteries as they will die after only a very few deep discharge cycles. Even the 8D type diesel starting batteries will not hold up under deep discharging. There is no substitute for a true heavy-duty deep-cycle battery.

Gaining increasing popularity is the gell-cell type battery. Several features make these gell-cells attractive, including no maintenance, no chance of spills, and some types are capable of accepting a very high charge current for rapid recharging. In addition the internal resistance of these batteries is lower than that of conventional lead-acid batteries. This means that the battery voltage stays higher under load, which adds a measure of performance to the Heart.

Deep-cycle battery capacity is expressed in amp-hours, usually this number will refer to a 20 hour discharge cycle. For example, a 100 amp-hour battery will deliver 5 amps for 20 hours. If the discharge rate is greater than 5 amps the overall amp-hours available will be reduced. Drawing 20 amps, a 100 amp-hour battery will deliver only about 80 amp-hours. Drawing 100 amps the battery will deliver about 45 amp-hours.

Deep-cycle batteries can be discharged 80% without permanent damage. This means that a 100 amp-hour battery has 80 amps of useful capacity. The number of discharge cycles in the life of a battery is directly dependent on how deeply they are discharged. If you only draw 50% of the battery capacity each time before you recharge, your battery bank will last much longer than a bank of batteries which is discharged 80% each time.

To size your battery bank you need to determine approximately how many amp-hours you will consume between charging cycles. Start by looking on each of your appliances for the number of watts that it consumes. Then figure out how many hours the appliance will run between charging cycles. For example, a small refrigerator consumes 240 watts. It will operate for about 10 hours per day. This means it will consume about 2400 watt-hours per day. Ohm's law tells us that watts equals volts times amps. Therefore, if we divide the watt-hours by our 24 volt battery voltage we get 100 amp-hours. Figure in about 10% extra for inefficiency, so that this refrigerator will draw about 110 amp-hours per day from your battery bank.

A minimum of a 140 amp-hour battery bank will be necessary to power the above refrigerator for one day, assuming that we discharge the battery bank to 80%. A larger bank will allow for less deep discharging and longer battery life.

WATTS = VOLTS x AMPS

WATT-HOURS = WATTS CONSUMED BY APPLIANCE x HOURS OF USE

AMP-HOURS = WATT-HOURS - VOLTS

#### USING BATTERIES:

Your Heart Interface operates on a 24 volt battery bank. The actual voltage of this bank may get as low as 21.6 volts or as high as 29.0 volts. Within this range the output voltage of the Heart will remain constant at 119-121 volts RMS.

Battery bank output voltage will drop under load. The larger the battery bank the smaller the voltage drop will be. For this reason it is advantageous to have as large of a battery bank as practical, especially if you will be starting inductive loads such as refrigeration motors or well pumps. In most cases, inductive loads will start easier if the battery voltage is relatively high.

As you use your Heart you will find it useful to monitor the state of charge of your battery bank. This will let you know when it is time to recharge without letting the low battery cutout circuit shut the unit down unexpectedly.

The state of charge of a battery can be measured by two instruments, a hydrometer or a volt meter. Hydrometers measure the specific gravity of the electrolyte in the battery. This

gives you a very accurate measurement of the state of charge but has two significant disadvantages. For one, the temperature of the electrolyte will affect the reading that you get. Unless you measure the electrolyte temperature and make appropriate adjustments you will not get accurate state of charge readings from your hydrometer. The other disadvantage to taking hydrometer readings is that the process tends to be messy. Not only do you risk getting battery acid on your clothes but you also risk contaminating the battery electrolyte with dirt. Contamination in the battery can seriously impair the performance and longevity.

We recommend that you measure the state of charge of your battery bank with a digital volt meter capable of reading to at least tenths and preferably hundredths of a volt.

The voltage measurement must be taken with the batteries at rest, having been neither charged nor discharged for several hours. A fully charged 24 volt battery bank will read about 25.4-25.8 volts at 80 degrees F. (30 degrees C.) The voltage of a deep-cycle battery bank that is discharged to the 50% level will be about 24.4 volts. A battery bank that is 80% discharged will read about 21.0 volts. These voltage measurements are only slightly affected by temperature.

The ambient air temperature will have an affect on battery performance. Expect reduced performance from very cold batteries. The rated specifications of a battery are true at about 77 degrees F. At 30 degrees F. the capacity of a battery is reduced by about 30%. At 0 degrees F. the battery capacity is reduced to about 50% of its potential.

#### BATTERY CHARGING:

You may charge your battery bank from several different charging sources including engine alternators, photovoltaic solar panels, hydro or wind systems, and standard AC operated battery chargers. It is not uncommon for more than one of these sources to charge the batteries at the same time. You may operate the Heart at all times, whether charging simultaneously or not.

You must use a battery bank with the Heart. It will not operate on the charging system alone.

#### PRODUCT DESCRIPTION

The Heart Interface is made up of a pulse width modulation control circuitry that drives two banks of Field Effect Transistors (FETs) and a large transformer.

DC power enters the Heart through the battery cables and is connected directly to each bank of FETs. DC is also fed to the Main Circuit Board. The FET banks act as high current switches, one bank switches on to create the positive half of the output and the other bank switches the negative half. Heart Interface uses the latest in ruggedized FETs, which have a very low resistance when they are on. This allows for high surge capability and efficiency.

The transformer in the Heart is hand-wound, dipped in lacquer, and baked in our factory. The wire used is a special flat section material made to our specifications. This transformer is exceptionally low in resistance and very efficient.

The layout inside the unit places the transformer in the center of the chassis. Sixteen FETs are soldered in parallel on a circuit board which is then fitted with extruded heat sinks, this is the power module and there are two in each unit. The heat sinks are mounted on the sides of the chassis with silicon insulating pads, in this way the entire heavy gauge chassis is used as a heat sink for the power modules.

The control circuit board is mounted to the front panel. The switch and LED indicator lights are mounted onto the main control board. The control board sends a signal to the power modules turning the FETs off and on. Circuitry on the control board insures that the frequency is kept stable at 60 Hz and, by constantly monitoring the output, the voltage is regulated at 120 volts RMS. Also contained on the main circuit board are the protection circuits and, in a standby unit, the battery charger control circuit.

The HF24-2500SX model includes a 40 amp battery charger. To achieve this the flow of current is reversed through the transformer and the current rectified by the diodes built into the FETs.

The standby model has a relay inside which is bolted to the lid inside the unit. When the Heart is plugged into either utility power or a generator this relay closes. This routes the incoming AC power directly to the output sockets and also to the battery charger circuitry.

#### REMOTE CONTROL OPERATING PANEL

A flush mount remote control panel with a 20 foot wiring harness is available for the HF24-2500, please specify X or SX model. This plugs into the 9 pin connector on the front panel of the Heart.

To operate the unit with the remote control you must leave the power switch on the Heart itself in the OFF position.

## TROUBLESHOOTING

Most problems will fall into one of three categories. If a problem occurs please refer to the following guidelines.

### LOAD BEHAVING ABNORMALLY:

Most loads will run on the Heart just like they do on utility power. Occasionally certain inductive loads will emit a slightly louder hum than normal. This is due to the Heart output wave shape. If the problem is unacceptable there are sine wave filters available. Contact your dealer for more information.

If a small load will not start and run it may be related to the load demand circuit. Turn on an incandescent light bulb of at least 15 watts and try the load again.

Digital clocks will ordinarily keep good time on the Heart but occasionally we encounter one that runs 2 or 3 times faster than normal. This problem is due to the modified sine wave output.

It is possible that the start-up of a large inductive load such as a well pump will interfere with the operation of sensitive electronics such as computers. What may happen is that while the Heart is surging to start the big motor, the computer will crash. If you will be starting a motor which requires the full current that the Heart is capable of delivering, such as a 3/4 horsepower induction motor, do not operate sensitive electronics at the same time.

Microwave ovens depend on high peak AC voltage to cook at full speed. The peak AC voltage output of the Heart is dependent on the input battery voltage. The higher the battery voltage the faster the microwave will cook. Do not be surprised if your microwave oven takes 15% to 25% longer to cook when operated with the Heart. Cooking speed will be increased by raising the battery voltage.

### MOTORS NOT STARTING:

Because of the large surge required to get them started, it is sometimes difficult to predict exactly which induction motors are within the capacity of the Heart. We have found that 3/4 horsepower capacitor-start motors will reliably work on the Heart, even in very deep well pump applications.

If a problem is encountered getting a motor started the first thing to do is confirm that your battery voltage is adequate. This must be done while the motor is attempting to start. Use a volt meter and watch the momentary voltage drop while you start

the motor. If the voltage is dropping below 22.0 volts this may be why the motor will not start. Check all the battery connections and the state of charge of the battery bank.

If the connections appear solid and the battery bank is fully charged, but the voltage drops below 22 volts, you may want to consider a larger battery bank.

If the voltage does not drop below 22 volts, but the motor will not start, the addition of a capacitor across the motor may help. Use a motor-run capacitor of about 3 uf.

#### WELL PUMPS:

The Heart Interface HF24-2500 is used in water pumping installations all over the world. It is designed to perform in the place of utility or generator power in standard deep well pump installations.

Many deep well pumps will operate on 240 volts, for this application the Heart is available with the split-phase output. A step-up transformer may be used on the output of a 120 volt HF24-2500 to feed a 240 volt well pump.

It is very important that the AC voltage drop along the wires to the pump be kept minimal, use adequate wiring. In general it is best to size the pump as small as possible and do not exceed 3/4 horsepower.

If the pump will operate continuously, or for hours on end, you must fan cool the Heart.

#### AIR CONDITIONERS:

The HF24-2500 can be used to power one 13,500 Btu roof air conditioner such as those found on RVs. The best candidates for this application are bus conversions with existing 24 volt DC electrical systems.

A large battery bank will allow operation of the air conditioner for a limited time while parked, but the system is most effectively used when driving down the road, the alternator providing the 70-80 amps DC required to operate the air conditioner.

Extended operation of the air conditioner will create heat inside the Heart. Because efficiency drops off slightly at very high power the unit will run cooler if all other loads are turned off. Fan cooling is recommended.

#### NO OUTPUT FROM THE HEART:

If you are unable to get any output voltage from the Heart the first thing you need to check is the battery voltage. Confirm that neither dead batteries nor bad connections are the source of the problem.

If the Heart does not hum at all, puts out no power, and displays the green overload LED continuously, you should contact your dealer or Heart Interface.

#### WARRANTY INFORMATION

Your Heart Interface is under limited warranty for a period of one year from the date of purchase. Terms of the warranty are spelled out on the warranty registration card. Please fill this card out completely and return it to Heart Interface in order to validate your warranty.

Heart Interface will pay shipping one way if your unit requires service within the warranty period. After this time the customer is responsible for all shipping costs. Please keep the original box and hard foam packing material in case you need to ship the Heart for any reason. Please ship the unit freight prepaid and it will be returned freight prepaid to you. If you ship the unit freight collect it will be returned freight collect.

The HF24-2500 is too heavy to be shipped via UPS. It must be shipped either via motor freight or air freight.

If you think that your Heart requires servicing please contact the factory. You will be asked during the call to provide the serial number of your unit, please have it ready. Depending on your location, you will get the unit to a factory authorized service center or to the factory itself.

Please be prepared to show proof of purchase date on any warranty claim.