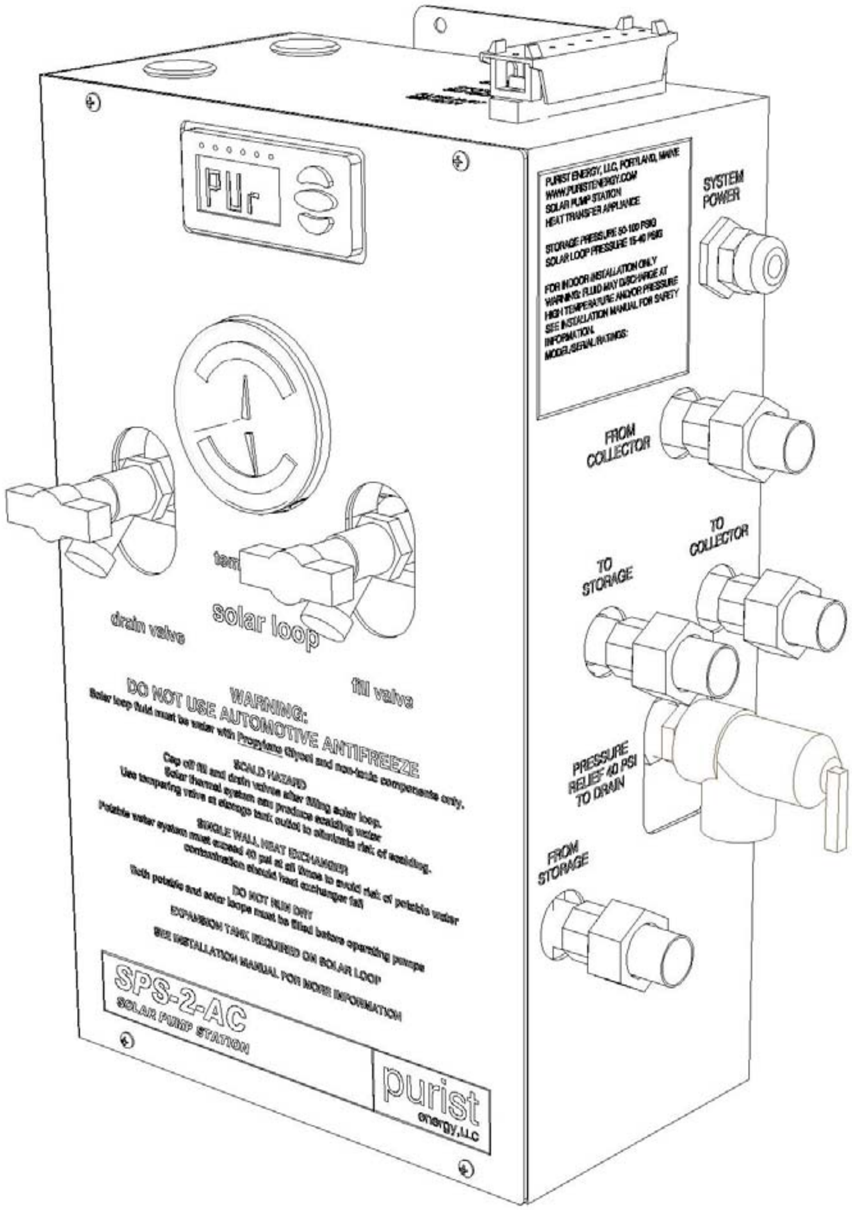
purist
energy,LLC

# SPS-2-AC
# Solar Pump Station
# Installation Manual




Manufactured by:
Purist Energy, LLC
www.puristenergy.com

Technical help:
tech@puristenergy.com

REV 2.2

# Installation record

| | |
|---|---|
| Company Name: | |
| Installer Name: | |
| License Number: | |
| Phone Number: | |
| Email Address: | |

| Date | Solar Loop Pressure | Solar Loop pH | Service Notes |
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# USING THIS MANUAL

**This manual contains text boxes to warn of potentially hazardous or damaging situations.**

**The following descriptions define the meaning of each text box:**

**⚠ WARNING**

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

**⚠ CAUTION**

CAUTION with the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

**CAUTION**

CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

# CONTENTS

# 1. General Information

## 1.1. How It Operates

The SPS-2-AC Solar Pump Station is a prepackaged solar hot water appliance that includes most components required for a solar hot water installation in a single appliance.

The SPS-2-AC forms the basis for a Closed Filled Loop system. It circulates a heat transfer fluid to the collectors and back to a heat exchanger, where the heat is transferred to the stored potable (drinkable) water for use. The solar loop is completely filled with fluid, and since it is exposed to outdoor temperatures, requires a non-freezing mixture of water and Propylene Glycol (not automotive antifreeze) in areas prone to freezing.

In a closed filled loop system, there are two "loops", or piping circuits. The "solar loop" travels to the solar collector and back, and the "potable loop" draws water from the storage tank and returns it warmer. The two loops are separate and do not mix, but both connect to the heat exchanger where heat is transferred from the solar to the potable loop.

For the solar loop, the unit contains the heat exchanger, a circulator pump, pressure/temperature gauge, pressure relief valve, fill and drain valves, and a check valve. In addition to the collectors, a fluid expansion tank and air vent is required to be installed external to the SPS-2-AC on the solar loop.

For the potable loop, the unit contains the heat exchanger and a circulator pump.

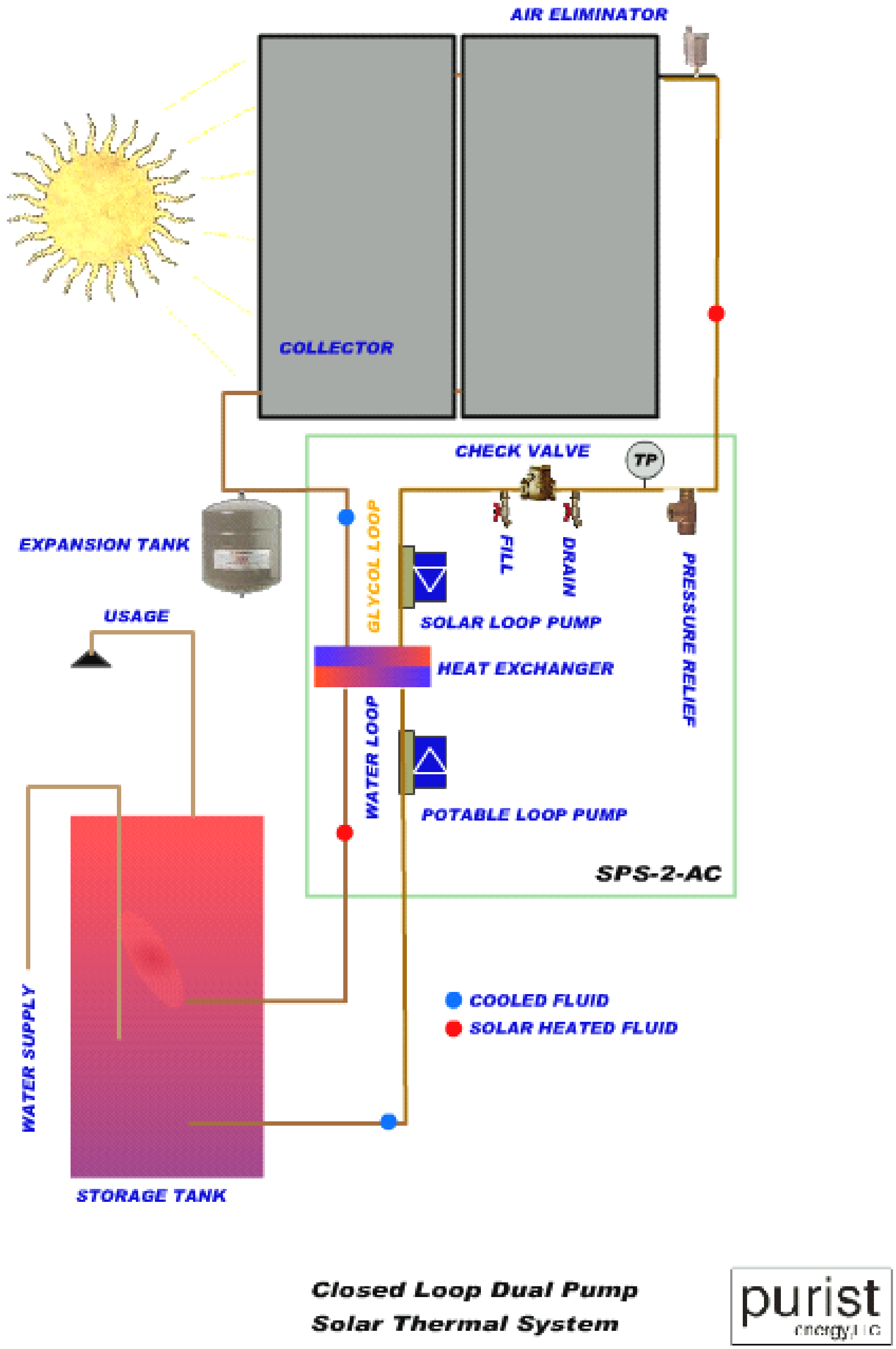
The SPS-2-AC also contains controls for powering the pumps when the water is heated by the collector, monitoring for faults, and eliminating excess heat from the system if necessary.

## 1.2. System Component Overview

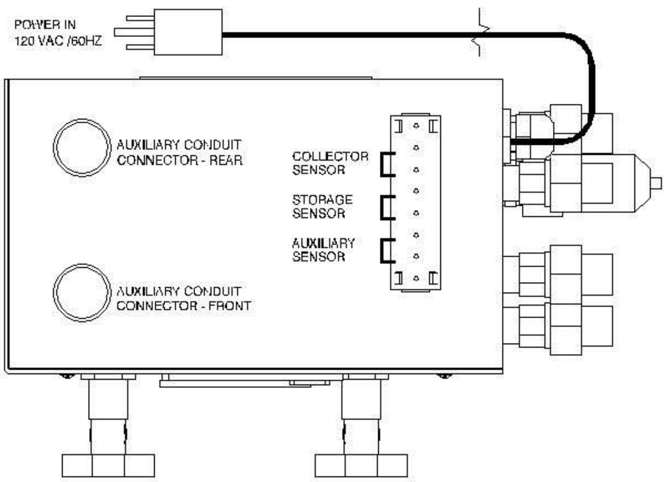
A solar hot water system with the SPS includes the following major components

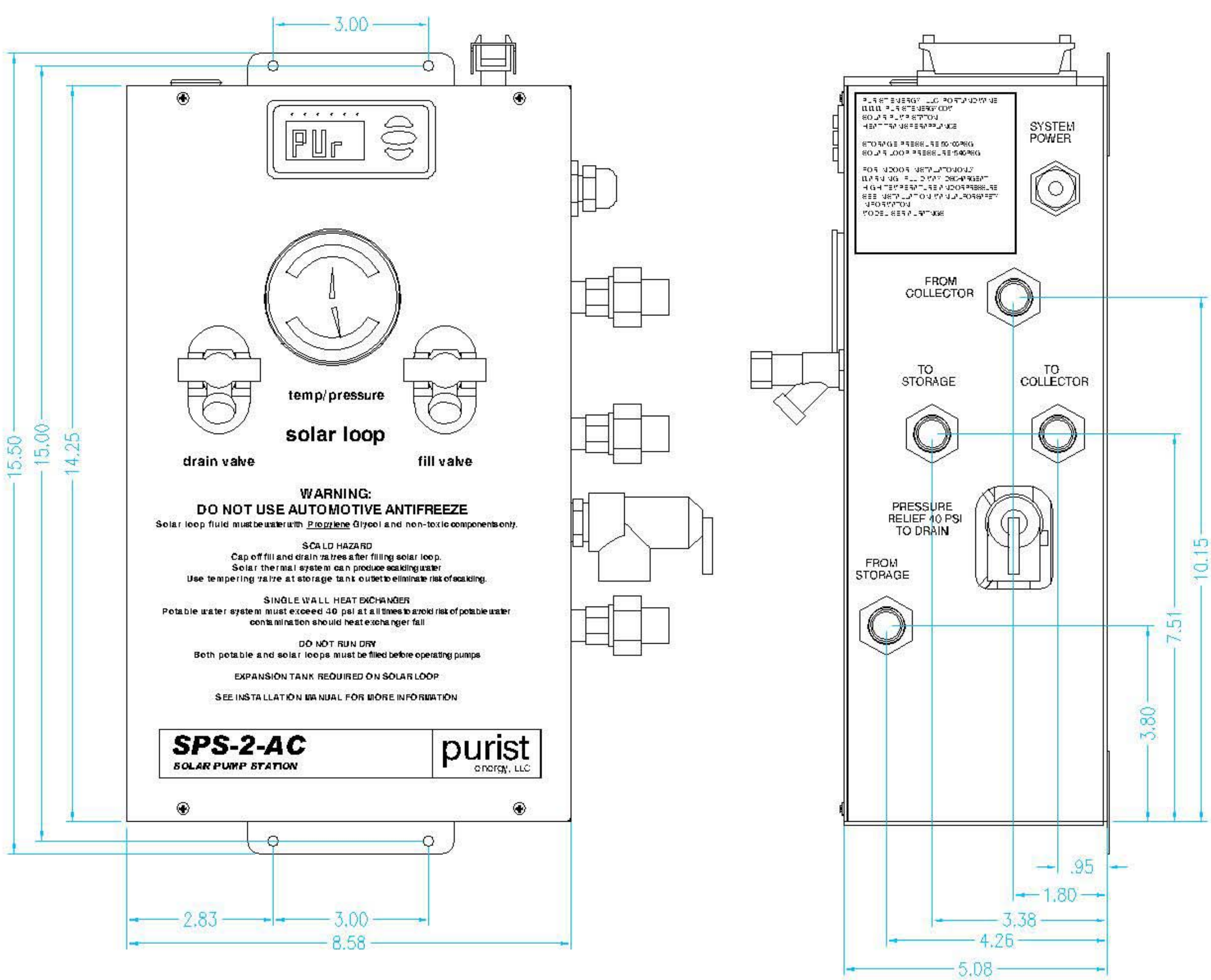
- Storage tank. A storage tank is required to gather the solar energy collected for usage. Storage tank size is based upon usage.
- Solar Collector(s). These are mounted in the sun to collect the available solar energy to be transferred to the potable water. Collector(s) size is based upon storage tank size. Multiple collectors are often connected together to provide appropriate energy input.
- SPS-2-AC Solar Pump Station. The Pump Station includes pumps and other components for the potable and the solar loop.
- Piping. Piping is required between the collector(s) and the SPS-2-AC, and between the SPS-2-AC and the storage tank. Size and material is addressed later in this manual.
- Expansion tank. An expansion tank is required on the solar loop piping between the SPS-2-AC and the collector(s).
- Air vent / Eliminator. An air vent is required on the solar loop piping at the highest point to eliminate air from the closed loop.

### 1.3. System Diagram:

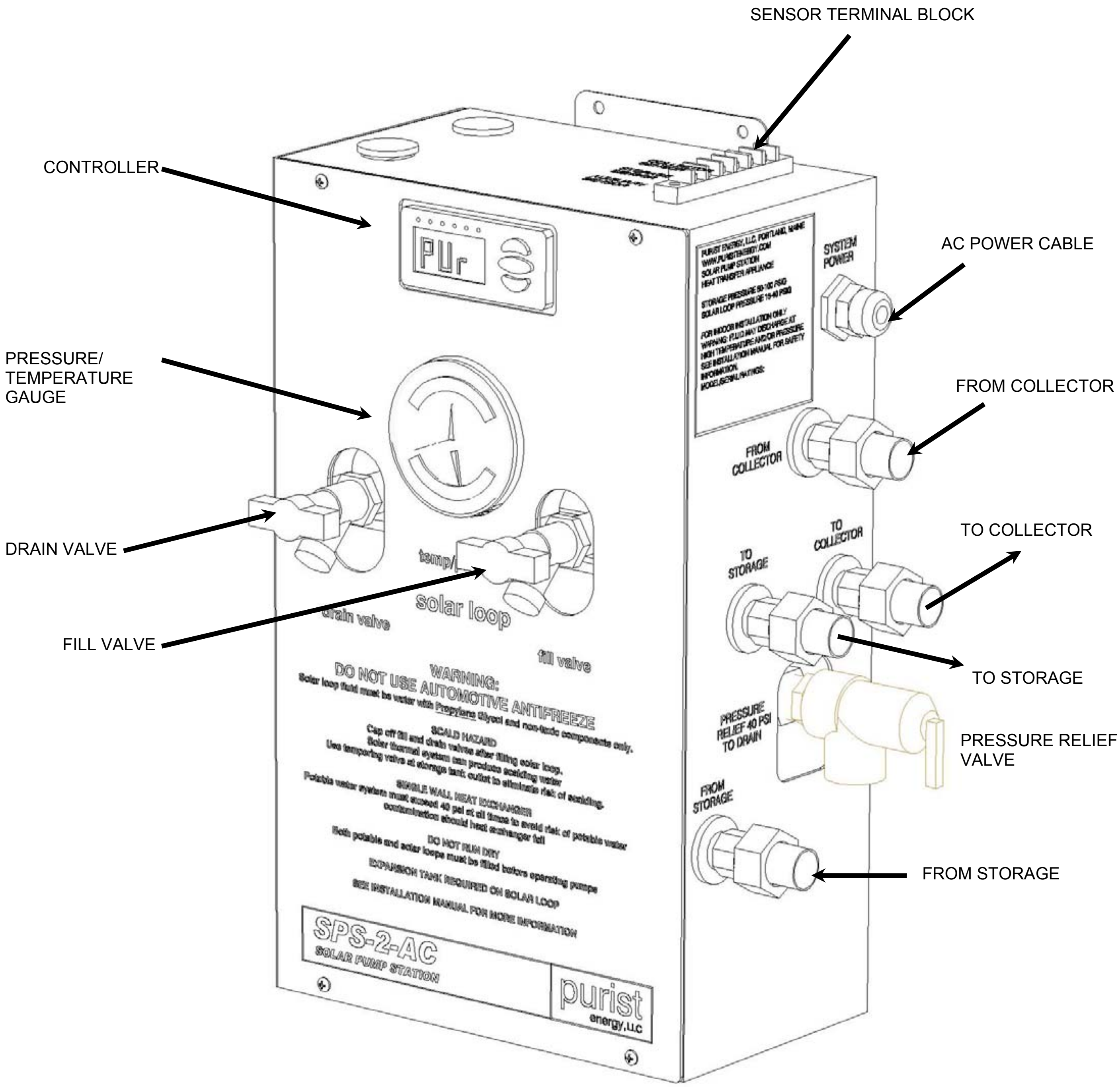


## 1.4. Dimensions



## 1.5. Connections and Components



# 2. Installation Requirements

## 2.1. Solar Collector elevation limitation:

The solar loop on the SPS-2-AC has a pressure relief valve set to 40 PSI to eliminate or significantly reduce the possibility of contamination of the potable water from the solar loop. This pressure relief valve also limits the maximum elevation of the solar panels above the SPS unit. Since water has weight in the fluid lines, higher collectors increase the pressure at the bottom of the loop.

It is therefore necessary that the solar collector(s) be less than 75 feet above the SPS system.

## 2.2. Storage Sizing guidelines:

A solar thermal system should be sized to provide 100% of domestic hot water during the summer months, and less during the winter depending on location. In this way, it will not be necessary to dump a significant amount of excess heat in the summer.

Storage tank size and collector(s) size are the two basic figures to be determined in sizing a solar hot water system. Tank size is based upon both usage and the ability to "ride through" periods of low sun. Typical hot water usage for a household has been proven to be as follows:

- 20 Gallons of hot water for each of the first two people
- 15 gallons for each additional person.
- Size up to the next standard sized tank.

For example, a family of four might require 20 x 2 = 40 plus 15 x 2 =30, or 70 gallons of hot water. A standard tank to fit this application might be 75 or 80 gallons.

A family of two would only require about 40-50 gallons of hot water storage.

An increase in storage for a given usage will provide better performance during periods of low sun, but will also require an increase in collector area to provide fully heated water.

An energy efficient home with low flow sinks and showerheads, energy efficient appliances and other measures will reduce the hot water requirements.

## 2.3. Collector Sizing Guidelines

The SPS-2-AC appliance is designed to be used with any of several types of collectors, including the most popular types, flat plate collectors and evacuated tube collectors.

Collector manufacturers can provide accurate data for collector sizing. The following guidelines are for rough estimates only. Collector site, angle, shadows and other factors can affect these figures significantly.

### 2.3.1. Evacuated Tube Collector sizing (Assuming 52mmx1800mm glass/glass tubes):

Cold Climates – 0.6 tubes per gallon storage

Mild Climates – 0.5 tubes per gallon storage

Warm Climates – 0.4 tubes per gallon storage

### 2.3.2. Flat Plate Collector sizing (Assuming single layer glazing):

Cold Climates – 0.8 – 1.0 ft2 per gallon storage

Mild Climates – 0.7 - 0.8 ft2 per gallon storage

Warm Climates – 0.6- 0.7 ft2 per gallon storage

## 2.4. Storage Tank Guidelines

The SPS-2-AC will work with any conventional water heater as a solar storage tank. It is preferred to have a dedicated tank for solar storage, which will then act as a preheat tank for a second water heater or boiler. The second water heater may be electric, gas or other fuel, and may be conventional or instantaneous type. If instantaneous, then it must have modulating burners which vary heat input based upon the incoming water temperature.

THE SPS-2-AC IS CURRENTLY TESTED FOR USE WITH UP TO 180 GALLONS OF STORAGE. Please consult with the factory before attempting to use this product with more hot water storage.

## 2.5. Expansion tank

An expansion tank is required on the solar loop to provide expansion for both fluid volume changes due to heating, and volume changes should the solar fluid boil out of the collector during power outages or other failures.

The expansion tank size required is dependent upon several factors;

• Collector volume (in case of fluid boiling during over-temperature stagnation).

The expansion tank must be able to accept at least the total volume of the collectors. This is usually the largest requirement for expansion tank volume.

• Piping System Volume (Fluid itself will expand 5-10% when heated)

The expansion tank must be able to accept 10% of the total solar loop volume.

Whichever of the above is greater should provide the basis for selection of an expansion tank. In cases where the result is close, select the next larger tank as a safety factor.

It is important to note that the expansion tank be sized based upon its acceptance volume and not its overall volume. The pre-charged diaphragm in the tank takes up some of the volume even when at the pre-charge pressure. The following lists standard expansion tank sizes and their acceptance volumes:

| SIZE | ACCEPTANCE |
|---|---|
| 2.1 | 1.4 |
| 4.7 | 3.0 |
| 6.6 | 4.3 |

The bladder in the expansion tank should face down to allow air to escape during system charging.

The expansion tank should be charged with an air pump to no more than 35 psi (The system pressure relief will vent at 45 psi.). Ideal pressure is determined by the following, where CE is the collector elevation above tank in feet:

CE/2.3 + 5 psi.

For example, for a 30 foot elevation (3-story building), the charge pressure should be 30/2.3 + 5 = 18 psi.

## 2.6. Closed loop vent

An automatic or manual air vent is required at the highest point in the system (above the highest point in the collector piping to allow air to escape from the top of the closed loop and allow the loop to fill completely.

It is possible on a sloped roof to mount the air vent in the attic space. This makes it easier to shut off and replace, and can help the aesthetics of the installation outdoors.

It is recommended that the air vent be fitted with an isolation valve, as they are prone to failure after several years. A high quality air vent with all-metal construction is recommended.

## 2.7. Anti-scald valve

An anti-scald must be installed on the potable tank outlet to fixtures to prevent the possibility of scalding water.

**⚠ CAUTION**

SCALD HAZARD

Solar thermal system can produce scalding water. Use tempering valve at storage tank outlet to eliminate risk of scalding.

## 2.8. Excess heat dump device

A device to relieve the system of excess heat is required to prevent the potable water tank from overheating. Though the system will shut off the pumps at the over-temperature setpoint, this can cause damage to the solar fluid. The SPS-2-AC has output AUX2 on the back of the controller for powering the heat dump device if this is required. The supply is 120 VAC, 1A. Conduit connections are located on top of the box to accept standard Class2 AC control transformers to step down to other AC voltages. The heat relieving device can be one of several types, below are examples:

- Solenoid to drain. This is the simplest method, requiring a small 120 VAC solenoid valve that opens and dump hot water from the tank to a drain when thermostat temperature is reached. This will allow low temperature water to enter and cool the system.
- Circulator Pump + finned tube radiator. A 120 VAC circulator pump connected to a circulation loop containing a finned tube radiator or buried coil of tubing can be used to dump excess heat from the system. The loop can be connected to the solar loop circuit to take advantage of the existing closed loop controls (fill/drain valves, expansion tank, etc.)
- Thermostatic valve on solar loop. A thermostatic valve is similar to a thermostat in an automobile, and opens at a set temperature. A three way thermostatic valve can be used to open a bypass at a set temperature. This method does not require the use of the controller thermostat circuit.

AUX2 must be programmed to operate as required.

## 2.9. Temperature Sensors

Temperature sensors are placed in or on the piping close to the collector outlet and at the bottom and top of the storage tank, with wires to the terminal block on the SPS-2-AC.

Temperature sensors are 10K-Ohm thermistors.

## 3. Electrical Connections

> **⚠ CAUTION**
>
> Follow the electrical code requirements of the local authority having jurisdiction. In the absence of such requirements, follow the latest edition of the National Electrical Code ANSI/NFPA 70 in the U.S. or the latest edition of CSA C22.1 Canadian Electrical Code, Part 1, in Canada.

> **⚠ CAUTION**
>
> When servicing or replacing parts within the SPS, label all wires prior to disconnection to facilitate an easy and error free reconnection. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

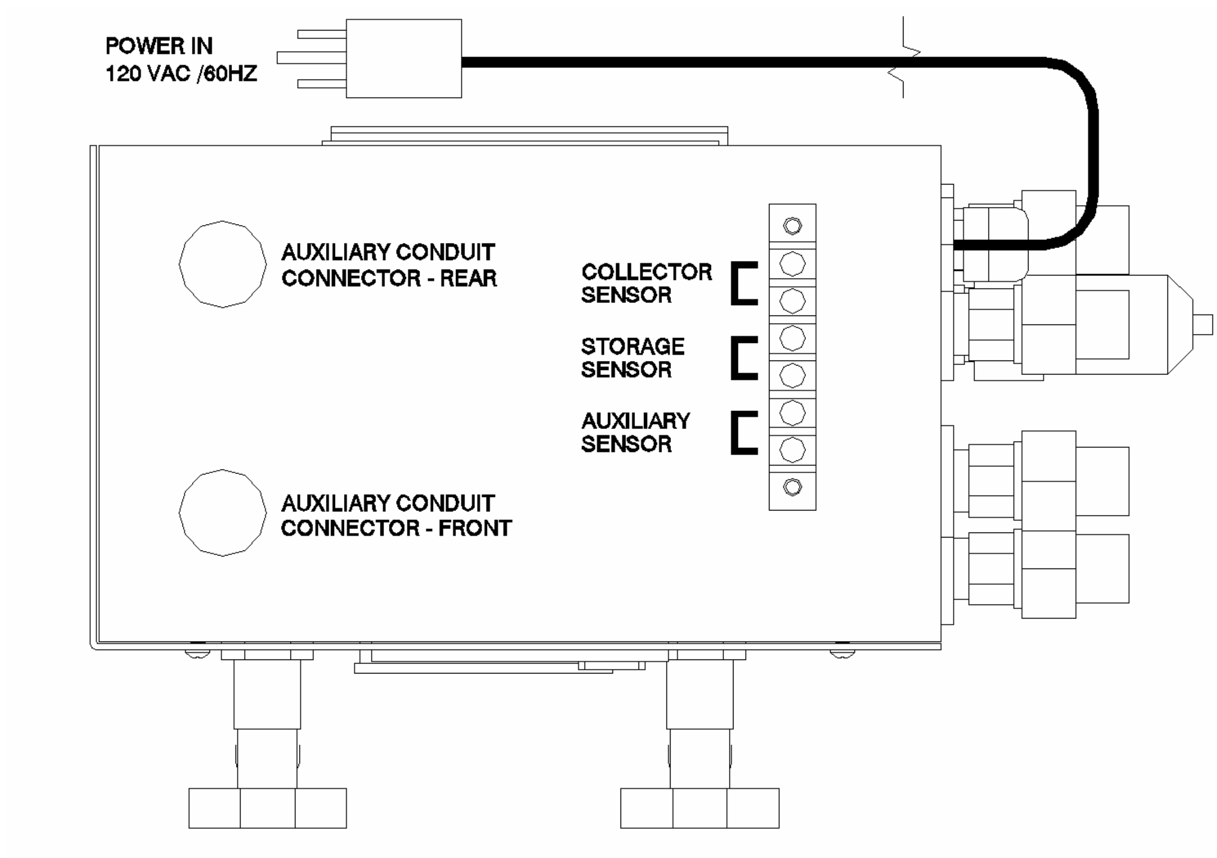



**Figure 1: Electrical Connection Locations**

### 3.1. AC Power

AC Power is provided by a standard 120 VAC grounded plug on an 8 ft cable. A receptacle should be provided for this connection. Do not use an extension cord.

If local codes or the installation require fixed wiring to the AC supply, the strain relief may be removed and replaced with a ½” conduit hub connector.

### 3.2. T1 Collector Sensor

The collector sensor is to be 10K-Ohm thermistor type.

It is to be installed in or on the hot water line at the outlet of the collector, as close to the collector as possible, or in a sensor port it if available. The sensor should be well insulated and protected to obtain the most accurate reading possible.

The collector sensor cable should be rated for the highest stagnation temperatures of the collector. Note that evacuated tube collectors can reach temperatures above 200C on stagnation.

The supplied collector sensor is provided with a 6 ft cable, but will require extension wire to connect to the SPS-2-AC terminals. Extension wire should be 18 AWG, two conductor cable with a PVC jacket. Belden 8760 is recommended for indoor use or Belden 8428 for use outdoors.

The storage sensor should be connected to the terminals marked “Collector Sensor”. Polarity does not matter.

### 3.3. T2 Storage Bottom Sensor

The storage sensor is to be 10K-Ohm thermistor type.

The storage sensor is to be connected to the storage tank at a point near the bottom of the tank. A typical location is connected to the lower heater element, which is not connected on solar storage tanks. The sensor should be well insulated and protected to obtain the most accurate reading possible.

Storage sensor is provided with a 6 ft cable, and can often be directly connected to the SPS-2-AC.

The storage sensor should be connected to the terminals marked “Storage Sensor”. Polarity does not matter.

### 3.4. T3 Auxiliary Sensor – (Storage TOP)

The Auxiliary sensor is to be 10K-Ohm thermistor type.

The Auxiliary sensor is to be connected to the storage tank at a point near the TOP of the tank. A typical location is connected to the upper heater element, which is typically not connected on solar storage tanks. The sensor should be well insulated and protected to obtain the most accurate reading possible.

The auxiliary sensor is used to control the auxiliary outputs of the controller.

### 3.5. Auxiliary Outputs

In addition to the 120VAC Pump output, the system is provided with 2 additional outputs for control of devices to add or extract heat from the storage tank.

#### 3.5.1. AUX1 – Tank Auxiliary Heating Thermostat

AUX1 can be used to control an auxiliary heat source, such as the electric heating element of the storage tank, based upon the temperature at T3, and the setpoint SP2. In this way it functions as a thermostat for heating the storage tank.

AUX1 is linked to an events schedule, which can be programmed for daily, weekly, or weekday schedules if desired. If it is desired for AUX1 to be on at all times that T3 is above SP1, the scheduler should be adjusted for continuous operation. See the Controller Programming section for more details.

The AUX1 output is sourcing 120 VAC from the AUX1 terminal. Connect to the load and connect the neutral lead from the load to the 120 VAC power supply Neutral leg.

### 3.5.2. AUX2 - Tank Auxiliary Heating / Cooling Thermostat

AUX2 can be used in one of several modes, depending upon system configuration.

AUX2 can be used to control an auxiliary heat source, such as the electric heating element of a tank. In this way it is described at a “thermostat for heating”.

AUX2 can also be used to control an auxiliary device for taking heat out of the tank, such as a radiant heat zone valve, pump, or solenoid valve. In this way it is described at a “thermostat for cooling”.

Modes available for AUX2 include the following:

- Mode 0 – Thermostat for cooling the storage tank. AUX2 output will energize when T3 > SP1
- Mode 1 - Thermostat for heating the storage tank. AUX2 output will energize when T3 < SP1
- Mode 2 - Thermostat for cooling the storage tank (as Mode 0), during an active event in the event schedule.
- Mode 3 - Thermostat for heating the storage tank (as Mode 1), during an active event in the event schedule
- Mode 4 - Cyclic timer with initial state on
- Mode 5 - Cyclic timer with initial state on during an active event in the event schedule

The AUX2 output is sourcing 120 VAC from the AUX2 terminal. Connect to the load and connect the neutral lead from the load to the 120 VAC power supply Neutral leg.

# 4. Potable Loop Piping

## 4.1. Connections

Connections are ½" copper unions with sweat connections. Remove the fittings from the SPS-2-AC before soldering.

## 4.2. Piping Materials

Recommended tubing is 3/8" flexible copper refrigeration type tubing for most applications (note that flexible tubing does not follow "standard" sizes used with rigid copper.) Use ½"=3/8" reducing bushings to adapt the 3/8" tubing to the ½" fittings.

## 4.3. Piping Arrangements

There are several acceptable methods to hook up potable water piping to a water storage tank:

### 4.3.1. Lower Element Port in/out

This method requires modification to the lower heating element, or replacement using a special element adapter.

Standard parts are available for many conventional water heaters. Contact Purist Energy for details.

### 4.3.2. Drain valve cold inlet in/out

This method involves changing the drain valve to an assembly that includes potable outlet to SPS, potable return from SPS with and injector tube, and replaces the drain valve. The injector tube should inject solar heated water as high as possible into the tank to prevent mixing the tank.

### 4.3.3. Drain valve cold inlet / Modified cold water dip tube solar return.

This method involves changing the cold water feed location to the storage tank. The cold water inlet to the tank is fed to the drain port, refitting the drain valve to the piping with a tee. The potable outlet to the SPS-2-AC is fed from this same cold water supply, ensuring that the SPS-2-AC gets the coldest water available. The potable return (solar heated potable water) is piped to the tank's standard cold water inlet dip tube, which should be cut to 1/3 of its original length. This will return the solar heated potable water to the upper portion of the tank.

### 4.3.4. Using a specially ported storage tank.

Special tanks with additional ports for the external heat exchanger are available, such as the AOSmith ProMax Solar®, Rheem Solaraide® and Vaughn Hotstow®.

Keep in mind that the storage tank required does NOT require an internal heat exchanger. Some solar storage tanks are available with internal heat exchangers. The SPS-1 series product line is designed for use with these tanks.

### 4.4. System flush

The piping should be flushed with TSP or other cleanser to remove flux residue and clean the piping.

### 4.5. Air elimination

Before starting the pumps, it is important to get the air out of the potable loop. This is easily possible when the potable system has been pressurized by simply cracking the upper union fitting until a small amount of water comes out.

# 5. Solar Loop Piping

## 5.1. Pump head basics

The SPS-2-AC solar loop pump provides pressure in the solar loop to push the fluid through the collector, lines, heat exchanger and fittings. This pressure is called "head" and is the driving force for flow in the loop. Opposing the pump head are frictional losses in the loop. These include the friction caused by the pipe itself as well as the restrictions of the fittings and heat exchanger. Variations in the solar loop piping therefore cause what is known as "head loss". The pump head must overcome the head losses to produce adequate flow. The head pressure developed by the solar loop pump in the SPS-2-AC can be graphed in a pump curve.

Larger diameter tubing produces a smaller amount of head loss, but obviously costs more. For economy, it is typical to use the smallest size tubing that will provide adequate flow.

It is also wise to design the piping run of the solar loop to be as short as possible, both to save tubing cost and to reduce head loss. Shorter tube runs produce less head loss.

Below is a pump curve for the solar loop pump of the SPS-2-AC:

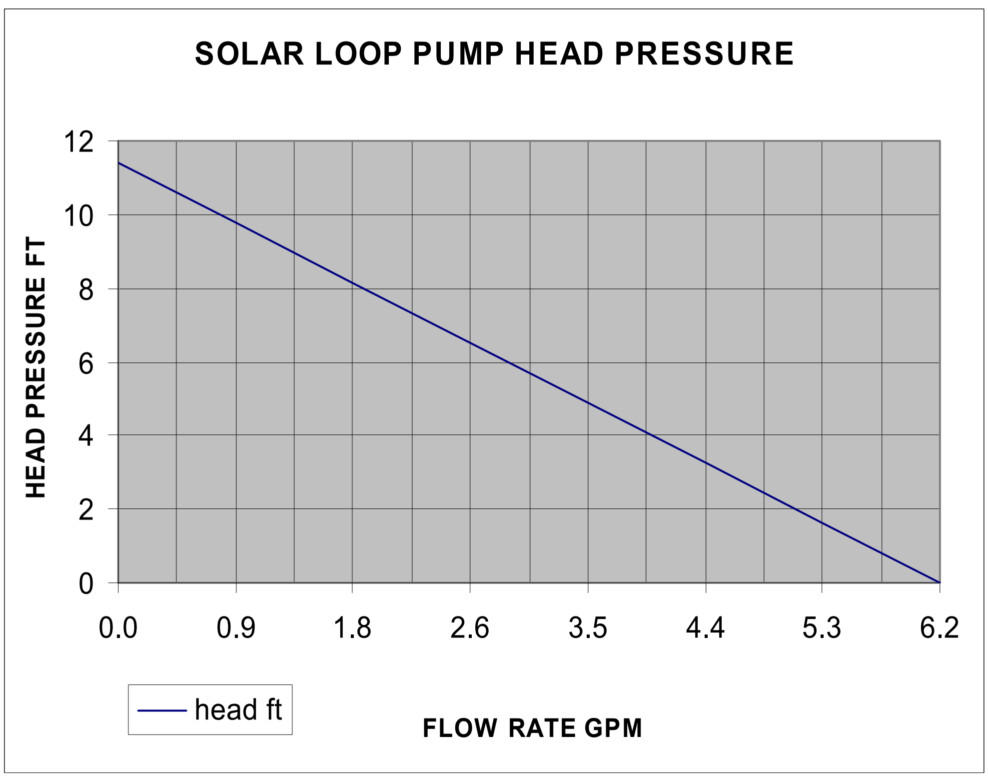



**Figure 2: Solar Loop Pump Head Pressure**

If we assume that the heat exchanger, fittings and collector(s) produce about 1 ft H2O head loss, we can determine the required tube size for the solar loop.

### 5.2. Solar Loop line sizing

The first step in determining line size for the solar loop piping is to determine the required flow rate for the collectors. This is available from collector manufacturer and is typically about 1 GPM per collector.

Using the combined flow rate of all collector(s), refer to Figure 2: Solar Loop Pump Head Pressure to determine the head pressure available at this flow rate. Subtract 1 ft H2O to allow for heat exchanger, fittings, collector(s) head loss, and a correction factor for glycol (Head drop tables are based upon water).

You will now have an available head pressure and flow rate.

You can determine the solar loop line length by measuring the distance from SPS-2-AC to the collectors. A fairly accurate estimate is all that is required.

Using these values, refer to Figure 4: Head Loss Chart - 1/2" ID Tube, and Figure 5: Head Loss Chart - 3/4" ID Tube to determine the minimum tube size required at the required flow rate.

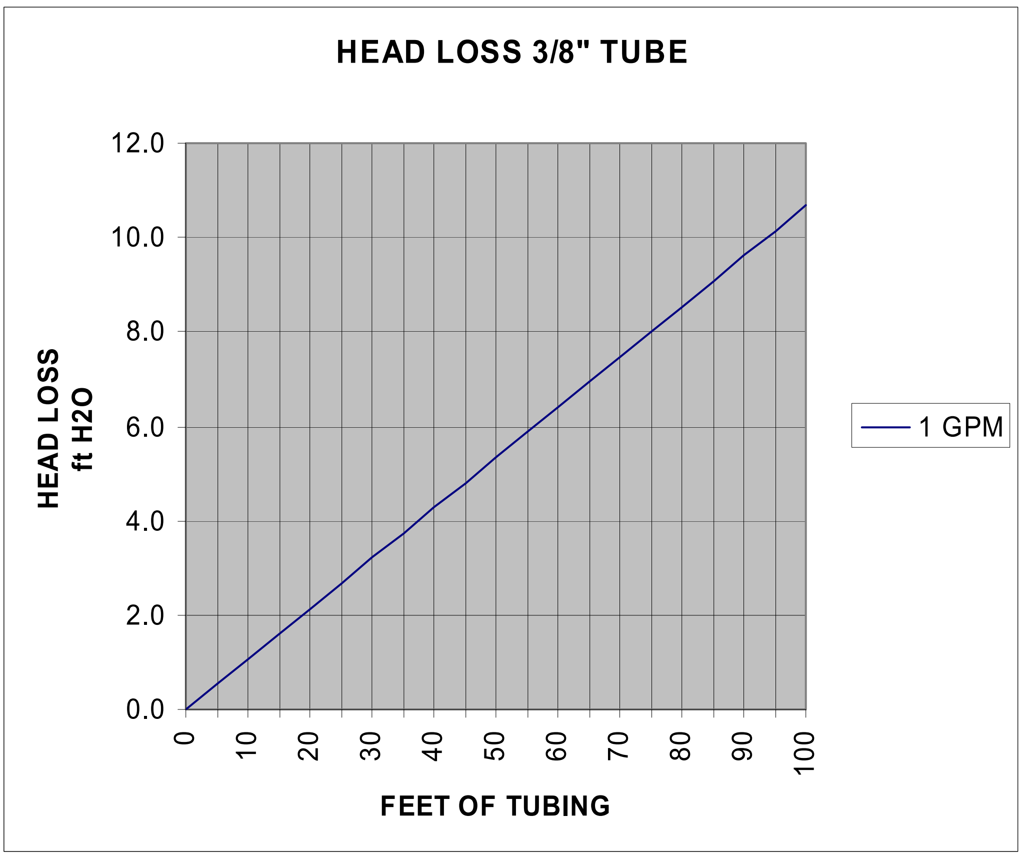



**Figure 3: Head Loss Chart, 3/8" ID Tube (1/2" OD)**

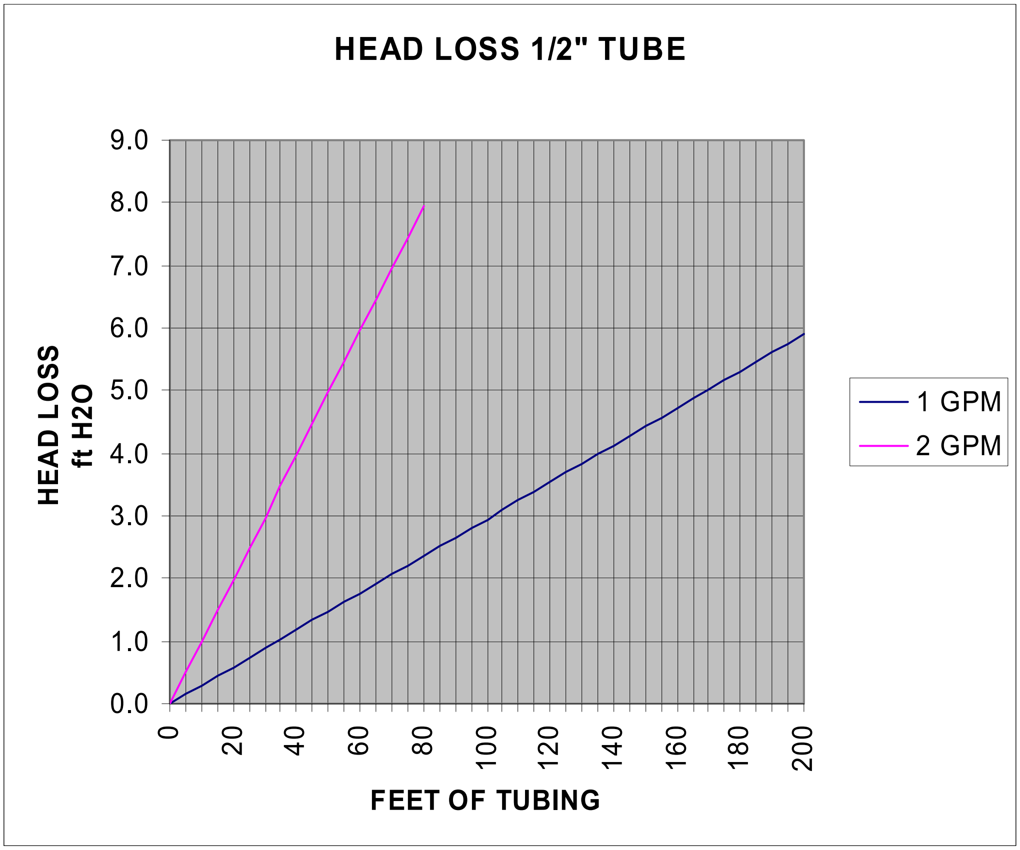



**Figure 4: Head Loss Chart - 1/2" ID Tube (5/8" OD)**

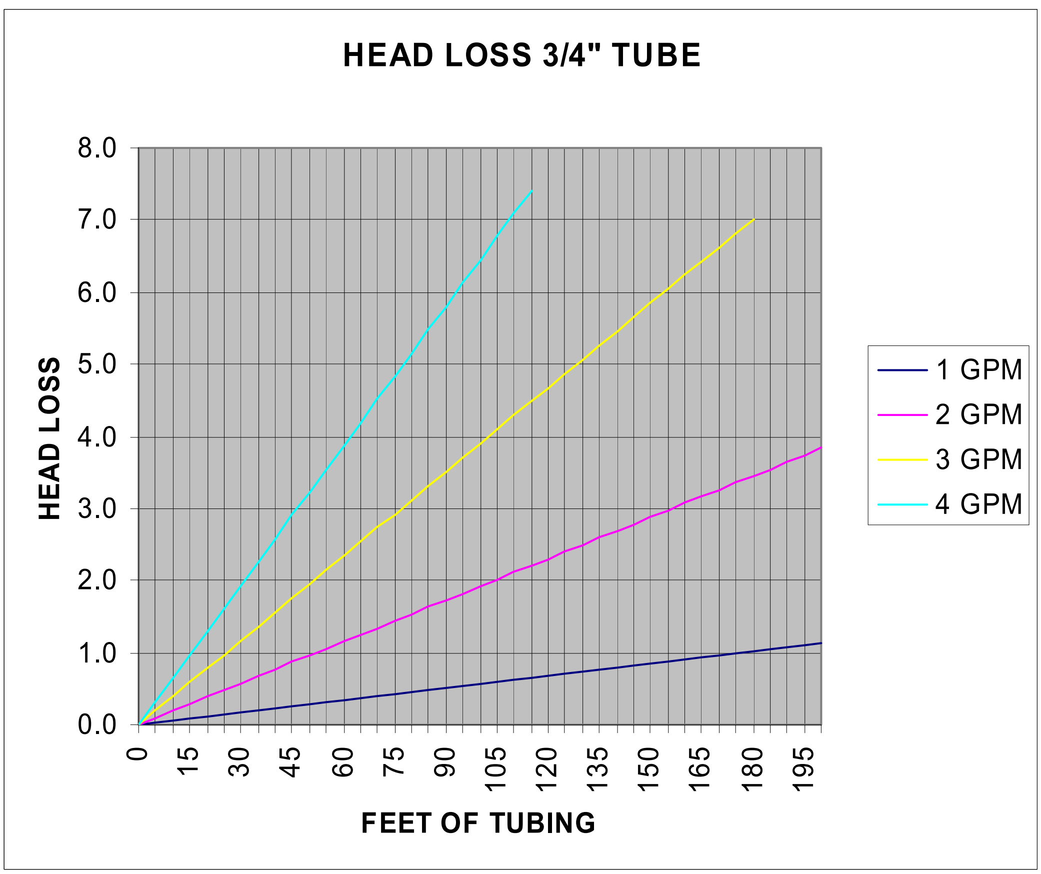



**Figure 5: Head Loss Chart - 3/4" ID Tube (7/8" OD)**

### 5.2.1. EXAMPLE 1:

- (1) 30 tube evacuated tube collector.
- Recommended flow rate of .026 GPM per tube, or .78 GPM total.
- 100 foot total loop length

Refer to Figure 2: Solar Loop Pump Head Pressure. It can be seen that with .78 GPM flow, there is about 10ft H2O head available from the SPS-2-AC pump. We then subtract 1 ft of head for fittings and heat exchanger losses and assume 9 ft H2O is available for line losses.

Now looking at ½ tube on Figure 4: Head Loss Chart - 1/2" ID Tube , we see that ½" tube will allow 1 GPM flow rate to a length of over 200 ft, with a head loss of 6ft H2O. ½" tubing is a good choice for the application, but lets see if it can be done with 3/8".

Now looking at 3/8" tube on Figure 3: Head Loss Chart, 3/8" ID Tube , we see that 3/8" tube will allow 1 GPM flow rate to a length of about 85 ft, with a head loss of our maximum 9ft H2O. Since the head loss at 100 ft length is above 10 ft H2O, the pumps could not push the fluid through the solar loop. If the solar loop line length was shorter than 85 ft, 3/8" tube would become an option.

### 5.2.2. EXAMPLE 2:

- (2) 3' x 8' flat plate collectors
- Recommended flow rate of 1 GPM per collector
- 80 foot total loop length

Refer to Figure 2: Solar Loop Pump Head Pressure. It can be seen that with 2 GPM flow, there is about 8ft H2O head available from the SPS-2-AC pump. We then subtract 1 ft of head for fittings and heat exchanger losses and assume 7 ft H2O is available for line losses.

Now looking at ½ tube on Figure 4: Head Loss Chart - 1/2" ID Tube , we see that ½" tube will provide the 2 GPM flow rate up to a length of about 70ft (from Figure 2).

## 5.3. Expansion tank / fittings

The expansion tank shall be rated for hot water service (240°F) and may be fit in the solar loop line wherever it is convenient on the line to the collectors from the SPS-2-AC. This is recommended to reduce the temperatures at the tank and prolong its life. Follow the manufacturers guidelines for orientation, typically the fitting should be located on the top to allow air to escape easily.

Install the expansion tank with Teflon® pipe dope.

## 5.4. Air eliminator / fittings

The air eliminator should be placed at the highest elevation in the system. Often it is possible to locate the air vent inside an attic.

The air vent should be used with a baseboard tee with an internal scoop, to assist in air elimination.

Install the air vent with Teflon® pipe dope.

### 5.5. Connections

Connections are ½” copper unions with sweat connections. Remove the fittings from the SPS-2-AC before soldering.

### 5.6. Piping to and from Collector(s)

Follow line sizing guidelines in the beginning of this section.

Run lines through insulated space whenever possible.

Slope lines towards SPS unit to assist in charging and servicing system. Avoid upward bends that create air pockets that can be difficult to remove during charging..

Recommended tubing is flexible copper refrigeration type tubing (note that flexible tubing does not follow “standard” sizes used with rigid copper.)

Rigid ½” copper has an (OD) of 5/8”. Rigid ¾” has an outer diameter of 7/8”

### 5.7. Pressure test

Pressurize the system with a garden hose and tap water by flushing into fill valve and out drain valve to remove most air from system, then shutting off fill AND drain valve and pressurizing slowly to 40 psi. DO NOT EXCEED 45 PSI on the solar loop or the pressure relief valve will vent.

### 5.8. System flush

The piping should be flushed with TSP or other cleanser to remove flux residue and clean the piping.

It is possible to flush through the system with a garden hose and bucket to remove most particulate.

### 5.9. Insulation

Solar loop should be insulated to the greatest extent possible using materials that can withstand the highest temperatures produced by the selected collector(s).

Typically, open cell foam is not acceptable for these lines, and closed cell products such as Armaflex® or Armaflex HT® are better selections.

### 5.10. Pressure relief drain

The pressure relief valve should be piped to within 6” of the floor, or according to local codes. Only a small amount of fluid will be contained in the solar loop.

# 6. System controller functions

## 6.1. Overview

The SPS-2-AC controller performs several basic functions in a solar hot water system. Its primary function is that of a differential temperature controller. This means that it looks at the storage bottom temperature T2 and the collector temperature T1, and if T1 is greater than T2 by the programmed differential ON temperature DT, it turns on pumps to start flowing the solar loop and transferring solar heat to the storage tank. The pump will then turn off at the lower differential OFF setpoint.

The controller also can be used to control two additional devices either add heat or relieve excess heat if the tank upper sensor T3 reaches [SP1] (AUX1) or [SP2] (AUX2) "thermostat" setpoints. AUX1 can only be used to add heat to the tank.

If the temperature continues to rise above the maximum safe temperature of the tank setpoint [HT2], the system switches the pumps off and the HT2 error will be displayed.

All setpoints are provided with hysteresis settings to prevent short cycling of the pumps or devices.

## 6.2. Controller Indicators and Buttons

Refer to Figure 6: Controller Faceplate

| | |
|---|---|
| **PUMP indicator** | Illuminates when the pump power is on. |
| **AUX1 indicator** | Illuminates when AUX1 is activated |
| **AUX2 indicator** | Illuminates when AUX2 is activated |
| **SET button** | Used for menu navigation |
| **UP arrow button** | Used for menu navigation |
| **DOWN arrow Button** | Used for menu navigation |


**Figure 6: Controller Faceplate**

## 6.3. Controller Basic Functions

The controller includes two menus, basic and advanced. Access to basic menu involves pressing buttons on the faceplate for various time periods. The advanced menu is accessible by pressing buttons and entering a pass code.

The basic menu allows reading the current temperatures, min/max temperatures, and clock time. It also provides access to common setpoints SP1, SP2 and Ht2 as well as selection of pump mode and AUX1 manual mode.

The following chart describes the button presses required to access:

| PRESS | QUICK | 2 SECOND | 10 SECOND |
|---|---|---|---|
| UP | SCROLL MIN/MAX TEMPS<br>t-1 t-2 t-3 diF<br>RE-PRESS AND HOLD<br>TO RESET MIN/MAX | | AUX1 MANUAL ON FOR TIME<br>A1t |
| SET | CLOCK<br>HR/MIN/DAY# | ADJUST<br>SP1 SP2 Ht2 | |
| DOWN | DISPLAY CURRENT TEMP<br>t-1 t-2 t-3 diF<br>REPRESS TO TOGGLE | | ADJUST<br>PUMP MODE<br>OFF On Aun AuA |

### 6.3.1. View Current Temperatures

By pressing the DOWN button quickly (and repressing until desired sensor is reached), you can view the current temperatures for each sensor, as well as the current temperature differential.

Note this is differential is NOT the differential temperature setpoint diF – it is displaying the actual current value of T1-T2.

### 6.3.2. View Min/Max Temperatures

By pressing the UP button quickly, you can view the maximum and minimum temperatures (since last reset) for each sensor, as well as the minimum and maximum temperature differential. The controller will scroll through t-1 t-2 t-3 diF, showing the minimum, then maximum temperatures. If the UP key is re-pressed, the values are reset and the message rSt will be shown on the display.

### 6.3.3. Clock Display

To see the current clock time and date, press SET quickly

The current hour (24 hour clock) will be displayed, followed by the minutes, and then the day of the week. For ease of understanding the menus, Day 1 should be set to Sunday, and day 7 to Saturday.

### 6.3.4. Adjusting Basic Setpoints:

The following settings can be adjusted at the basic menu level by pressing the SET button for 2 seconds. Each Setpoint name will be displayed, followed by the current setpoint. Use the up and down buttons to adjust the setpoints as required, and press SET to store the value.

| Variable | Description | Values | Default Celsius | Default Fahrenheit |
|---|---|---|---|---|
| SP1 | AUX1 Setpoint. AUX1 output will energize if S3 < SP1 | A1L - A1H (See advanced menu.) | 70 | 160 |
| SP2 | AUX2 Setpoint. AUX2 output will energize if S3 < or > SP2 | A2L - A2H (See advanced menu.) | 70 | 160 |
| Ht2 | Overheat temperature for sensor T2. To shut down pumps when tank is too hot. | 0-210 | 80 | 180 |

### 6.3.5. Manual Activation of AUX1:

AUX1 output can be manually overridden to ON for the time specified in function A1t. Note that AUX1 will not turn on if A1t is set to zero.

Since AUX1 can only be used to add heat to the tank, this function would be useful to enable an auxiliary heating supply or heating element for a short period (max 5 minutes).

### 6.3.6. Pump Modes

The following chart describes the basic pump modes available to adjust:

| Pump Mode | Description |
|---|---|
| OFF | Circulation pumps always OFF |
| On | Circulation pumps always ON<br>CAUTION – PUMP DAMAGE WILL OCCUR IF PUMPS ARE NOT FILLED WITH FLUID.<br>IT REQUIRES AT LEAST 15 SECONDS TO CHANGE MODE! |
| Aun | Circulation pumps operating in automatic mode WITHOUT sensor 3 temperature validation. In this mode the circulation pump will be activated only by the differential of temperature (T1-T2). |
| AuA | Circulation pumps operating in automatic mode WITH sensor 3 temperature validation. In this mode the circulation pump will be activated by the differential temperature (T1-T2) as well as when the temperature at T1 is hotter than at T3. |

### 6.4. Controller Advanced Functions Sub-Menu 123

the advanced menus, press UP and DOWN arrow buttons simultaneously for two seconds until SEL appears (presses must be very closely timed), then release them.

When Cod appears, press SET button, and enter the menu code 123 using the arrow buttons. When the code is in the display, press SET the pass code will be confirmed. Use the UP and DOWN arrow buttons to access the other functions in the Sub-menu and proceed in the same manner to adjust them.

To leave each menu and return to normal operations, press SET button for a several seconds until --- appears.

Several function submenus are available after the menu code 123 has been accepted. Toggle between them and press SET to modify parameters in those menus.

See the following sections for more details:

| Menu | Menu Description | Section |
|---|---|---|
| Cod | Access Code Entry | above |
| FUn | Advanced Configuration Functions | 6.4.1 |
| MOd | Events Planner Operating Mode | 6.4.2 |
| Pro | Programming of the Events Schedule | 6.4.3 |
| CLo | Adjustment of the clock and the day of the week | 6.4.4 |

### 6.4.1. FUn Advanced Configuration Functions

When the FUn menu is selected, the following variable can be adjusted:

| Function | Description | Default Celsius | Default Fahrenheit |
|---|---|---|---|
| Ind | Indicator displayed sensor temperature (T1, T2, T3). This establishes the default temperature reading on the display | 3 | 3 |
| dOn | Differential setpoint for turning on the pump (T1-T2) | 8 | 14 |
| dOF | Differential setpoint for turning off the pump (T1-T2)<br>Value must be less than dOn | 4 | 7 |
| dEL | Minimum time for the pump off, in seconds.<br>Prevents short cycling of pump. | 0 | 0 |
| ICE | Temperature of T1 to turn the pump on.<br>Can be used for freeze / slush protection. | 3 | 38 |
| Ht1 | Overheat temperature for T1 to turn the pump off<br>Can be used for protection of PEX solar loop piping (Note: Use of PEX piping and this function is not recommended) | 99.9 | 212 |
| HY1 | Overheated hysteresis for T1 to turn the pump back on.<br>Prevents short cycling of pump. | 1 | 1 |
| Ht2 | Overheat temperature for T2 to turn the pump off | 99.9 | 212 |
| HY2 | Overheated hysteresis for T2 to turn the pump back on.<br>Prevents short cycling of pump. | 1 | 1 |
| A1Y | AUX1 Hysteresis. Prevents short cycling of AUX1. | 1 | 1 |
| A1L | AUX1 Minimum setpoint.<br>Sets basic menu limits. | -50 | -58 |
| A1H | AUX1 Maximum setpoint. Sets basic menu limits. | 105 | 221 |
| A1t | AUX1 Time, in minutes, for manual activation of AUX1 when basic menu manual mode is set. Set to 0 to disable manual override of AUX1. This could be used to run an electric element for a short period to add heat when using a single tank. | 0 | 0 |
| A2m | AUX2 Mode of Operation<br>• Mode 0 – Thermostat for cooling the storage tank.AUX2 output will energize when T3 > SP1<br>• Mode 1 - Thermostat for heating the storage tank. AUX2 output will energize when T3 < SP1<br>• Mode 2 - Thermostat for cooling the storage tank (as Mode 0), linked to the event schedule.<br>• Mode 3 - Thermostat for heating the storage tank (as Mode 1), linked to the event schedule<br>• Mode 4 - Cyclic timer with initial state on<br>• Mode 5 - Cyclic timer with initial state on, linked to the event schedule | 0 | 0 |

| Func-tion | Description | Default Celsius | Default Fahrenheit |
|---|---|---|---|
| A2y | Hysteresis of the AUX2 operation. Prevents short cycling of AUX2. | 1 | 1 |
| A2L | Minimum setpoint of the AUX2 operation.<br>Sets basic menu limits. | -50 | -58 |
| A2H | Maximum setpoint of the AUX2 operation.<br>Sets basic menu limits. | 105 | 221 |
| tOn | Cyclical timer time on, in minutes | 1 | 1 |
| tOF | Cyclical timer time off, in minutes | 1 | 1 |
| AMd | Auxiliary Mode<br>Method for connecting the AUX outputs to the events agenda.<br>AUX1 is only enabled with an event active.<br>AUX2 can be linked or separated from the events sched-ule with A2M<br>• Mode 0<br>o AUX1 active with events 1,2,3,4<br>o AUX2 active with events 1,2,3,4<br>• Mode 1<br>o AUX1 active with event 1<br>o AUX2 active with events 2,3,4<br>• Mode 2<br>o AUX1 active with events 1,2<br>o AUX2 active with events 3,4<br>• Mode 3<br>o AUX1 active with events 1,2,3<br>o AUX2 active with event 4 | 0 | 0 |
| OF1 | Indication offset for the temperature of the T1, for calibration. | 0 | 0 |
| OF2 | Indication offset for the temperature of the T2, for calibration. | 0 | 0 |
| OF3 | Indication offset for the temperature of the T3, for calibration. | 0 | 0 |
| Adr | Address of the controller on the RS485 network, 1 to 247 | 1 | 1 |

### 6.4.2. MOd - Events Schedule Operating Modes

When the MOd menu is selected, the following variables can be adjusted. These define the time basis for events programming.

For ease of understanding the menus, note that day 1 is Sunday, and day 7 is Saturday. Days 2 through 6 are Monday through Friday.

| Function | Description |
|---|---|
| 1b1 | In this mode, the controller can configure up to 4 events for each individual day of the week. |
| 2t6 | In this mode, the controller can configure up to 4 events for weekdays (days 2 though 6) and 4 different events for Saturday and Sunday (day 7 and 1). |
| 1t7 | In this mode, the controller can configure up to 4 events to be used for all days of the week. |

### 6.4.3. Pro - Programming the events schedule.

The events schedule can be used to *restrict the operation* of the AUX1 or AUX2 outputs to specific time periods.

For each defined time period, the ON/OFF times are set for the configured AUX outputs established with Function Menu function AMd.

**AUX1 will only function during active events schedule time periods**. If it is desired to have AUX1 active any time T3>SP1, then a continuous event should be set to enable the output at all times.

**AUX2 will only function during active time periods if variable A2M is set to Mode 2, 3 or 5.**

**A2M modes 0, 1 and 4 disable the events schedule for AUX2 and allow it to operate any time that T3>SP2.**

Once the Events Schedule Operating Mode [section 6.4.2] has been selected, the Programming mode will adapt to the selected mode, and provide options for each available time period.

The time periods available for each Mode option are defined below:

| Mode | Time Periods |
|---|---|
| 1b1 | P1 = Day 1 Sunday<br>P2 = Day 2 Monday<br>P3 = Day 3 Tuesday<br>P4 = Day 4 Wednesday<br>P5 = Day 5 Thursday<br>P6 = Day 6 Friday<br>P7 = Day 7 Saturday |
| 2t6 | P26 = Day 2 though 6, Monday through Friday<br>P7 = Day 7 Saturday<br>P1 = Day 1 Sunday |
| 1t7 | P17= All days of the week, Day 1-7 are programmed the same. |

Up to 4 event times can be programmed for each Time Period. The start and end times of each event are configured using the following parameters:

| Function | Description |
|---|---|

| | |
|---|---|
| On1 | Start (ON) time for Event 1 |
| OF1 | End (OFF) time for Event 1 |
| On2 | Start (ON) time for Event 2 |
| OF2 | End (OFF) time for Event 2 |
| On3 | Start (ON) time for Event 3 |
| OF3 | End (OFF) time for Event 3 |
| On4 | Start (ON) time for Event 4 |
| OF4 | End (OFF) time for Event 4 |

It should be clear that if the event mOd is 1b1, then there are 8 x 7 times that can be set to activate 4 event on and off times for 7 separate days.

If all events are not required, they can be disabled by increasing the OF time until it reads OFF_

If it is desired to have the event continue though midnight to the next day, increase the OF time until it reads Cro. Also, configure the event for the next time period to begin at 00hr and 00min.

### 6.4.4. CLo - Adjusting the Clock and day of the week

After entering the CLo menu item, press the SET key and the settings will appear in the following order: Current Hour, Minutes, Day of the Week. Adjust as required using up and down arrows and press SET when complete. For ease of understanding the menus, Day 1 should be set to Sunday, and day 7 to Saturday.

## 6.5. Temperature Units Sub-Menu 231

To enter the Temperature Units submenu to select Celsius or Fahrenheit units, follow the directions in section 6.4, but select code 231.

Select the units desired (Celsius or Fahrenheit), and press SET.

## 6.6. Controller troubleshooting

Controller errors are displayed on the screen as error codes.

The following are failure / warning codes and their causes:

| Function | Description |
|---|---|
| Er1 | T1 sensor (collectors) disconnected or out of range |
| Er2 | T2 sensor (tank bottom) disconnected or out of range |
| Er3 | T3 sensor (tank top) disconnected or out of range |
| ICE | Temperature for sensor 1 is freezing |
| Ht1 | Temperature for sensor 1 is overheated |
| Ht2 | Temperature for sensor 2 is overheated |
| PPP | Configuration parameters not programmed or out of range |
| On | Circulation pump in manual ON mode |
| OFF | Circulation pump in manual OFF mode |

# 7. System Startup and Operation

This section pertains to startup of the system after all lines have been installed and tested, and the system is properly installed electrically as well.

**ENSURE THAT THE POTABLE LOOP IS FILLED BEFORE PROCEEDING**

Before starting the pumps, it is important to get the air out of the potable loop. This is easily possible when the potable system has been pressurized by simply cracking the upper union fitting until a small amount of water comes out. It is then typically safe to run the potable pump, but listen to the pumps for changes in sound. If it goes from low pitch to high pitch and stays there, it may be a good idea to crack the union fitting again momentarily to ensure the pump is filled.

**CAUTION**

DO NOT RUN DRY

Both potable and solar loops must be filled before operating pumps

## 7.1. Solar Loop Fluid

Solar loops fluid shall be distilled water with non-toxic propylene glycol freeze protection additives only. Refer to the manufacturers guidelines for diluting the glycol mixture to provide adequate freeze protection for your area.

Note that the minimum dilution will provide higher efficiency, as water has a higher capacity to transfer heat than propylene glycol.

**⚠ CAUTION**

DO NOT USE AUTOMOTIVE ANTIFREEZE Solar loop fluid must be water with Propylene Glycol and non-toxic components only

## 7.2. Using a compression sprayer as a charge pump

A compression sprayer, sold at hardware stores for spraying herbicides and pesticides, can be used as a charge pump with minor modifications. Simply cut off the end of the spray hose just before the spray nozzle and fit it with a barb fitting to female hose bib adapter. The barb fitting should be pressed into the end of the spray hose and a clamp should be applied. The female hose bib will then attach to the “fill” valve on the SPS-2-AC.

Assembled charge kits are available from Purist Energy.

## 7.3. Charging

The basic method of charging requires the air vent to be open and the drain valve closed. Hook up charge pump to the fill valve and pump the system full of fluid. When system pressure is up to 35 psi, as read on the SPS-2-AC pressure gauge, close the fill valve leave the pump attached.

At this point both pumps should be filled with water – either potable or solar, and it is safe to start the pumps manually to eliminate more air from the solar loop.

Press the manual ON on the controller button and you should hear the pumps start.

Run the pump as you observe the pressure gauge. If it drops below 35 psi, open the fill valve slightly with the pressurized charge pump on. Repressurize the system to 35 psi. If air is eliminated from the top of the loop, it will drop the pressure and will require more fluid to maintain pressure.

Repeat the pressurizing every 10 minutes for one hour and the line should be charged properly.

After several hours of operation the system should be rechecked for pressure.

**⚠ CAUTION**

SCALD HAZARD Cap off fill and drain valves after filling solar loop. Solar thermal system can produce scalding water. Use tempering valve at storage tank outlet to eliminate risk of scalding.

# 8. Monitoring performance

## 8.1. Operation Check

When the system has been installed, charged and brought into operation, it is simple to check functionality on a day with solar energy available. Feel the supply and return tubes to the collector and you should notice an increase in temperature on the return from the collector(s). If you do not, check the solar loop pressure and make sure it is still filled with fluid and at sufficient pressure to reach the top.

# 9. System Maintenance

## 9.1. Solar loop fluid check

Propylene Glycol solar loop fluid will degrade with years of heating, and will degrade faster with overheating. Excessive temperatures (above 250°F) will cause propylene glycol solutions to degrade. These temperatures can occur during power outages on sunny days, or if heat dumping mechanism cannot eliminate excess heat at a sufficient rate.

Solar Loop Fluid should be checked at least once per year using Litmus paper. pH should stay above 8.0 (slightly alkaline). If pH drops below this value it is advisable to replace the fluid and flush the system with water in through the fill valve and out the drain valve with a garden hose. The system then should be drained, flushed, and fluid replaced as described in section 7 System Startup and Operation.

## 9.2. Potable loop heat exchanger fouling

Areas with high mineral content (hard) water will require a heat exchanger flush periodically depending upon the extent of the mineral concentration. If the water is known to have high mineral content, the potable loops should be flushed with vinegar or other solution for this purpose. To reduce the occurrence, a hard water electromagnetic water conditioner may be installed no the potable loop piping between the tank and SPS unit.

### 9.3. Expansion Tank check

Expansion tanks usually have a lifetime of approximately 15 years. The expansion tank should be checked yearly for proper pressure and condition.

### 9.4. Air vent check

Automatic air vents should be provided with isolation valves for ease of replacement. The air vent should be checked during system fluid check.

## 10. Electrical Diagram

Figure 7: SPS-2-AC Electrical Schematic is provided for reference. Please contact Purist Energy or your or an authorized service representative should any problems arise with system operation.

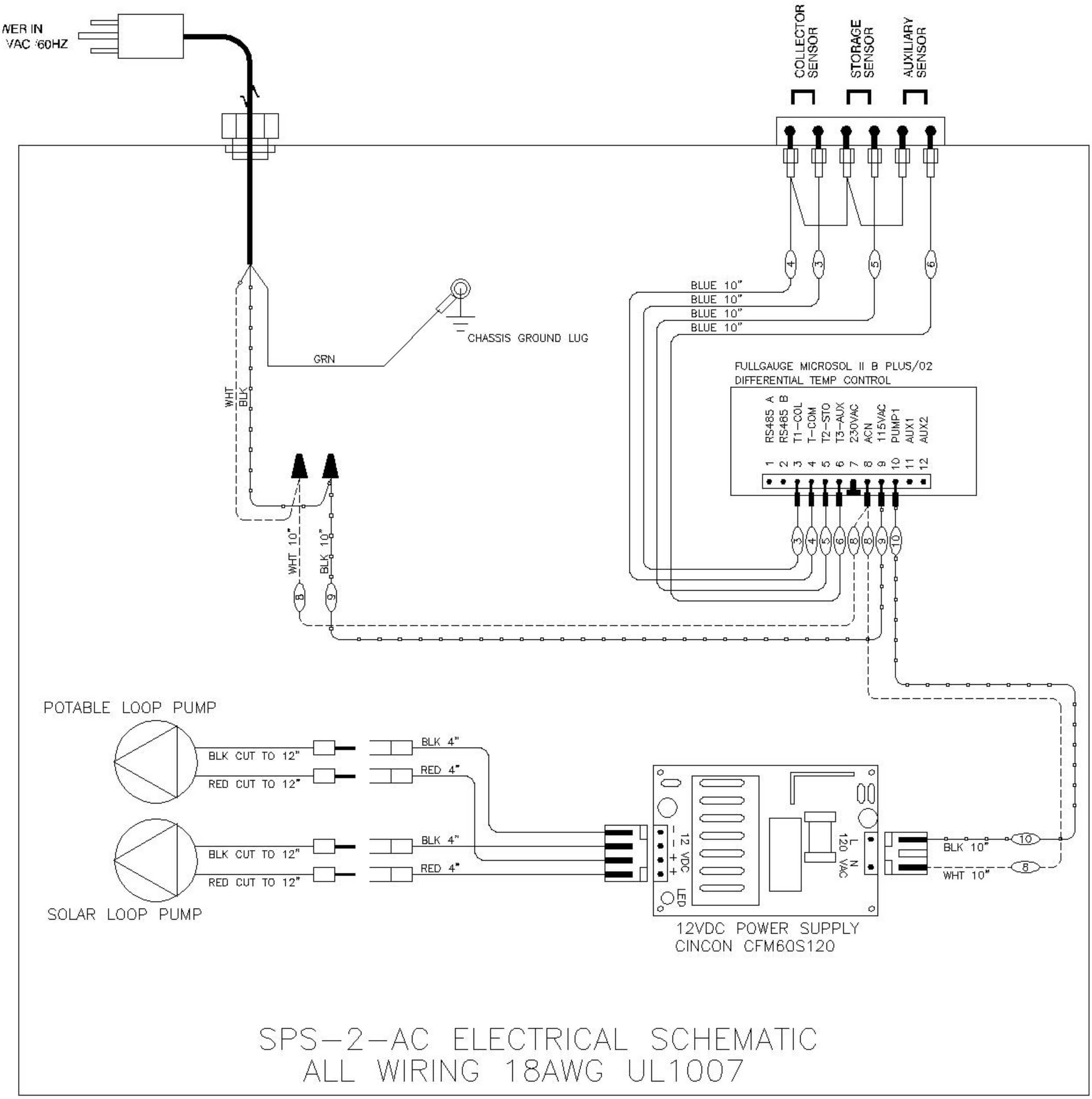



**Figure 7: SPS-2-AC Electrical Schematic**

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