

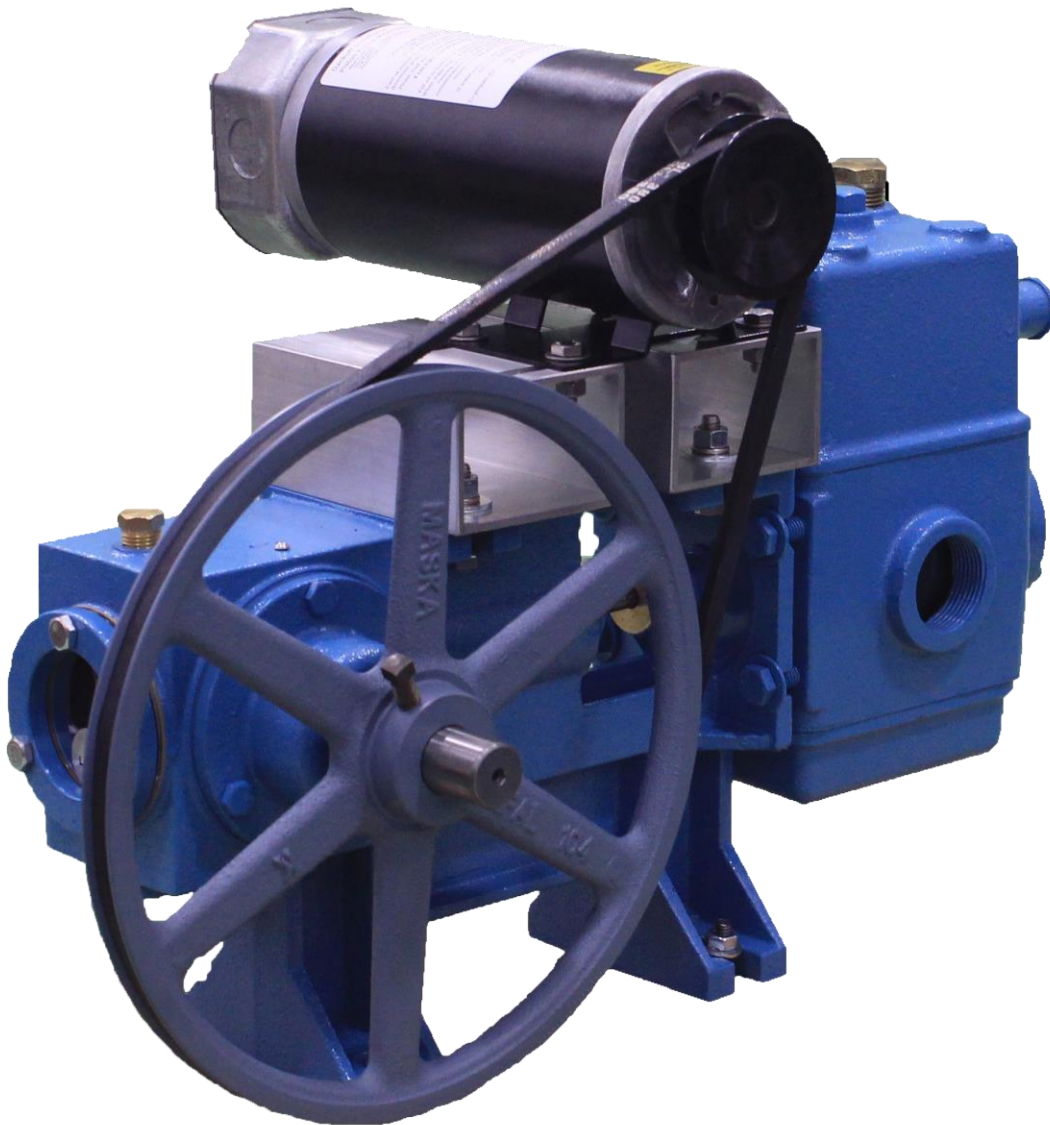


Solar ForceTM

*Piston
Pump*

Installation & Service Manual

Please record the MODEL # _____ - _____ Serial # _____



The above displayed SolarForce 3010 model is shown without the belt guard, for illustration purposes. Do not run the SolarForce without the supplied belt guard.

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1. WARNINGS

Please review the following warnings. These are listed for both personal safety and the safety of the products. Disregarding or ignoring these warnings can result in **SERIOUS INJURY** and/or **VOID THE WARRANTY**. If this system is being installed without a licensed pump installer, an electrician or knowledge of electrical circuits is **HIGHLY** recommended. If any questions or concerns regarding these warnings should arise, please contact your local Dankoff Solar Dealer or Dankoff Solar Technical Support at 1(505) 395-2491. Dankoff Solar Pumps and/or its parent company, Solar Power & Pump Company, LLC, is **NOT LIABLE** for any **DAMAGE** or **INJURY**.

- The system should be installed and serviced by qualified personnel only. All local, state, and federal electrical codes should be observed. Make **ABSOLUTELY CERTAIN** all power sources are disconnected prior to wiring.
- Extreme heat can damage the pump. Protect the pump from sunlight or other heat sources.
- Install proper system grounding for safety and lightning protection. Proper grounding can significantly reduce the chance of extreme damage. See *Section 4.4 Grounding and Lightning Protection*.
- Under-sizing the wires or failing to install a fuse or circuit breaker can cause a **FIRE HAZARD AND CAUSE DAMAGE TO THE MOTOR**. Follow all guidelines laid out in *Section 4*.
- Do not touch solar panel or pump wires together to test for a spark.
- Do not run the pump dry.
- Do not run the pump without the supplied belt guard.

2. INSTALLATION REQUIREMENTS

NON-SUBMERSIBLE PUMPS

Do not submerge pump or motor in water. Do not allow water to drip on the motor. Protect the pump and motor from sunshine. If the pump is installed outdoors, supply weather protection, such as a sheet-metal shield, shed or well house.

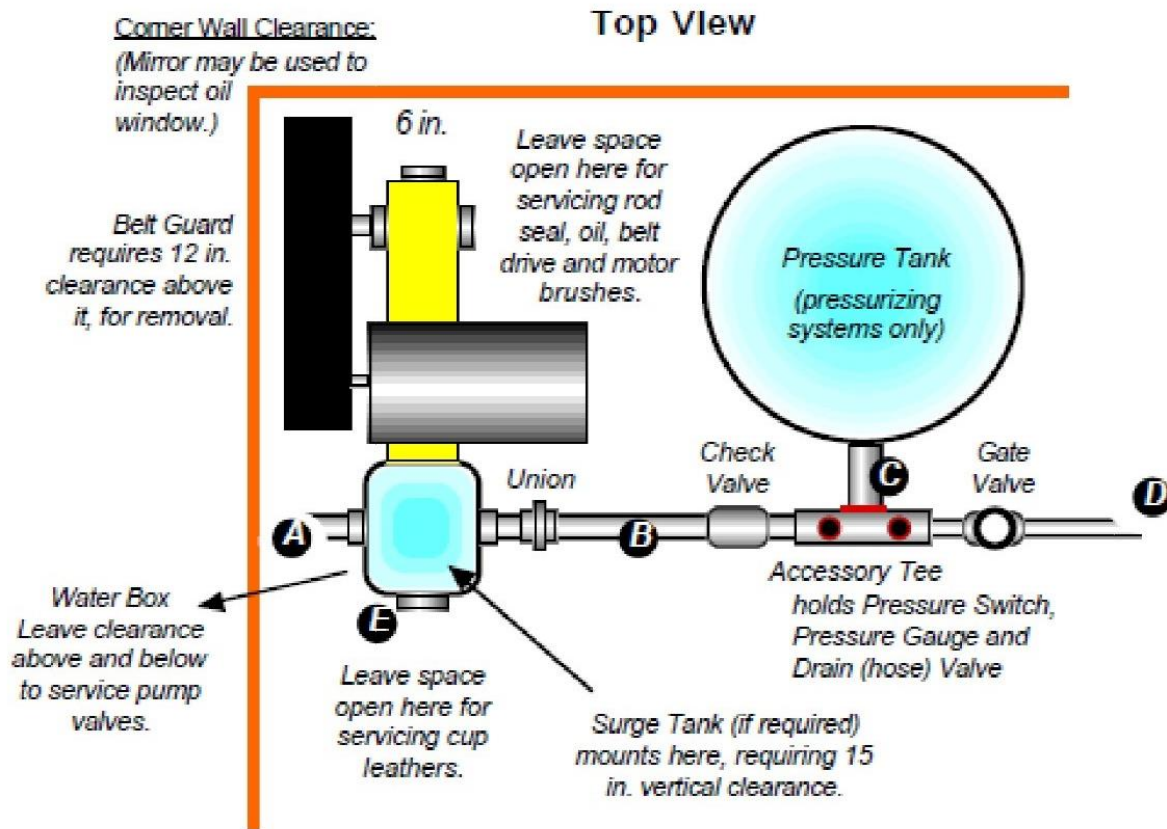
LOCATING AND MOUNTING THE PUMP

If the pump is to be located higher than the water source, mount the pump as low as possible. Minimize suction lift, for greatest reliability.

Allow easy access to the round plate on the front of the water box. The plate will need to be removed to replace piston seals (leathers) occasionally. If the water source is dirty, more maintenance is required, leave plenty of work space.

See *Figure 2-1: Solar Force Piston Pump System Layout* for necessary clearance requirements. Observe the shown minimum clearance for better access during inspections and maintenance.

Figure 2-1: Solar Force Piston Pump System Layout



Bolt the pump directly to a strong, firm surface. Do not mount on rubber pads. Expect traces of water and oil leakage at the rod packing. Pipe from Pressure Relief Valve (not shown) must lead to safe drainage. Avoid humps in

the intake line, to eliminate air pockets.

The pump and the belt guard must be screwed or bolted down to a base of wood, concrete or steel. Be sure that the mounting structure will be able to support the weight of the pump and plumbing and is sturdy enough to prevent vibration from shaking the pump loose. The mounting structure should be able to support the pump, in damp conditions, for many years. Level the mounting base, to ensure proper oil distribution.

Place the belt guard over the belt drive assembly and position it so that the pulleys turn freely, then screw it down to the mounting surface.

WARNING:

DO NOT OPERATE PUMP WITHOUT BELT GUARD IN PLACE.

Catching a finger, loose clothing or hair in the mechanism can lead to serious injury.

Expect some water leakage from the rod packing. Traces of oil may also leak from the crankcase, around the shaft and window. Mount the pump so that oil cannot leak into the water supply and place rags under the pump to absorb oil and water that may drip.

Shelter the pump from rain, dirt and hot sun, as well as from children and wildlife. Leave air space around the motor for cooling. If the pump is insulated for freeze protection, do not insulate the motor.

SURGE TANK

A piston pump produces a pulsating flow. It stops and starts with every cycle. A surge tank smooths the pulsating flow. This greatly increases the efficiency of the system.

The tank provided contains an air bladder inside, much like a balloon, with a tire-type air fitting on top. The air bladder acts like a cushion, or spring.

DO NOT add air to the bladder. Adding air causes water to hammer against the bladder, producing pump vibration and rough operation.

ADDING CRANKCASE OIL

Do not run the pump until 8 ounces (240 cc) of SAE 30-weight (ISO 100) oil has been added to the crankcase (food grade SAE 30-weight is supplied with the pump). When changing or adding oil, use quality SAE 30-Weight. To add oil, either remove the brass plug above the clear sight-window, or remove the sight-window. Bring the oil level up to the bottom edge of the window. Filling higher will cause oil leaks.

INTAKE PLUMBING

The pump has a *maximum suction lift of 20 feet*. Do not restrict the intake with undersized pipe or suction lift beyond specified limits. Doing so will cause "cavitation" (formation of vapor bubbles). A slapping sound is evidence of cavitation, which will cause excessive wear and loss of performance. Place the pump as near as possible to the water supply.

Model 3040: The intake pipe must be no smaller than 1 1/4 inch size (the size of the intake port on the pump). If the intake pipe is over 25 feet long, use 1 1/2 inch pipe.

Models 3010 & 3020: Intake pipe of 1 inch minimum, 1 1/4 if over 25 feet long.

Do not use flexible hose that crushes or kinks easily. Do not allow intake to draw sediment from the bottom of water source. Avoid humps in the intake pipe that can cause air pockets and obstruct the flow of water. A gradual incline is best.

If the pump is placed higher than the water source, a foot valve is required.

Shutoff Valve - If the pump is placed lower than the water source, install a shutoff valve to stop water flow when performing maintenance on the pump.

Screening Debris - If the water source contains sand, consider the addition of a sand screen. If the water contains larger debris, use a foot valve with a large intake screen to filter out large particles and sticks that can catch in the foot valve. Add an in-line screen or disc filter near the pump water intake to catch debris where it may be cleaned out easily.

OUTLET PLUMBING

A check valve must be installed at the pump outlet. This increases system efficiency and ease of maintenance, and will prevent continuous leakage at the rod packing. Use a spring-loaded check valve with a rubber seat.

If the outlet pipe is long, increase the size to larger than 1 inch to reduce friction loss. Consult a pipe sizing/friction loss chart for correct pipe diameter.

ELECTRICAL WIRING

Low Voltage Direct Current motors require larger wire than conventional 115/220 VAC motors. Consult the wire size chart, or ask your dealer for wire size recommendations. Undersized wire will reduce pump speed, and can cause a fire hazard. Always follow the National Electrical Code®. If you are not experienced with electrical installations, hire a qualified electrician. Use *Figure 2-2: Wire Sizing Chart* to determine the minimum size wire needed for installation.

Figure 2-2: Wire Sizing Chart

Length (feet)	Current (amps)									
	5	10	15	20	25	30	40	50	60	70
15	16	12	10	10	8	8	6	6	4	4
20	14	12	10	8	8	6	6	4	4	4
25	14	10	8	8	6	6	4	4	2	2
30	12	10	8	6	6	4	4	2	2	2
40	12	8	6	6	4	4	2	2	1	1/0
50	10	8	6	4	4	2	2	1	1/0	1/0
60	10	6	6	4	2	2	1	1/0	2/0	2/0
70	10	6	4	2	2	2	1/0	2/0	2/0	3/0
80	8	6	4	2	2	1	1/0	2/0	3/0	3/0
90	8	4	4	2	1	1/0	2/0	3/0	3/0	4/0

American Wire Gauge (AWG)

Motor Wiring: Red = Positive, Black = Negative.

Direction of Rotation: Clockwise.

If the motor turns counterclockwise, reverse the wiring.

Example 1: The motor is rated at 10 Amps maximum current draw and the solar panels are 30 feet away. The correct wire size is 10 gauge (10 AWG).

Example 2: The motor is rated at 7 Amps maximum current draw and the batteries are 50 feet away.

The correct wire size is 8 gauge (8 AWG). Always use the next higher rating on the chart if there is not an exact match for the motors amperage rating.

PROTECTION FROM ELECTRICAL OVERLOAD

A mechanical or hydraulic fault in the system can cause motor overload. If protection is not provided, this can cause damage to the motor or other parts of the power system, and cause a fire hazard. A circuit breaker or fuse will disconnect the circuit and prevent damage.

***Failure to install a proper fuse or circuit breaker
will void your warranty.***

On a non-battery solar-direct system with a current booster controller (LCB), install the breaker or fuse in the circuit between the current booster and the pump, not between the array and the booster. Place the fuse or breaker close to the controller, not at the motor.

A circuit breaker is preferred over a fuse. Most AC breakers cannot be used for DC circuits. Square-D® QO or QB-Series breakers are commonly available at electric supply stores and are UL-listed for low voltage DC up to 48V. MidNight Solar Inc.® produces an extensive line of circuit breakers and enclosures and are available directly from retailers online.

If installing a fuse, use either a plastic plug type automotive fuse (24V, 30 Amp Max.) or a cartridge type time-delay fuse in a disconnect enclosure. Do not use the small glass type of fuse. Keep spare fuses nearby. Never substitute a larger amperage fuse if there is a problem.

Amp Rating of fuse or circuit breaker - Find the “Amp Rating” of the motor, then multiply that value by 1.35 (taken to the next standard value).

Example 1: The “Amp Rating” of the motor is 10 amps. $10 \times 1.35 = 13.5$. The next standard size fuse/breaker is 15 amps. Use a 15 amp fuse/breaker in this circuit.

Example 2: The “Amp Rating” of the motor is 2.7 amps. $2.7 \times 1.35 = 3.6$. The next standard size fuse/breaker is 5 amps. Use a 5 amp fuse/breaker in this circuit.

GROUND AND LIGHTNING PROTECTION

Proper grounding will greatly reduce risk of lightning damage to the motor.

A proper ground system consists of a minimum of one 8 ft. copper-plated ground rod driven into the ground, preferably in a moist spot close to the PV array. If available, a steel well casing is an excellent grounding point; drill and tap a bolt hole to make good electrical contact with it.

In a dry, lightning-prone location, use more than one ground rod at least 10 ft. apart. Bury bare copper wire between them. Use minimum #8 ground wire (larger for distances exceeding 20 ft.).

In a rocky location, where ground rods can't be driven, bury 150 feet (total) of bare copper wire, radiating out in two or more directions from the PV array. Try to contact moist earth as much as possible. Use only copper or bronze electrical connectors designed for grounding application, and ensure all connections are well secured.

Connect the ground system to the frame of the PV array with 8 AWG copper wire. Also ground metallic support structures and electrical enclosures.

3. SOLAR ARRAY WIRING (FOR PV-DIRECT SYSTEMS)

Warning – The photovoltaic array generates hazardous voltages. All wiring **MUST** be done by qualified personnel, in compliance with local, state, and national electrical codes.

To prevent shock hazard while working on array wiring, leave one wire disconnected between two modules to break the circuit, or cover array to shade it.

Attention – Wiring the panels in the wrong configuration (series or parallel) can damage the controller and/or pump. Be certain of the wiring configuration (See Figure 5-1: Solar Panel Wiring Diagram for examples) prior to connecting the array. Additionally, it is recommended to cover or shade the panels when connecting them to the controller or pump. This prevents electrical discharge from damaging the equipment. Any damage caused by disregarding these warnings will NOT be covered under the warranty.

If the system uses only a single panel, simply connect the positive (+) and negative (-) wires from the panels to the pump or controller; however, if more power or voltage is needed to meet the pump requirements, multiple panels will have to be wired in either series, parallel, or series/parallel. Examples are provided below to better explain the differences between these configurations.

For these examples, ratings from a common panel will be used:

195W (24V) Panel Rating – VMP: 38.16 VDC; VOC: 45.36 VDC; I: 5.10 amps

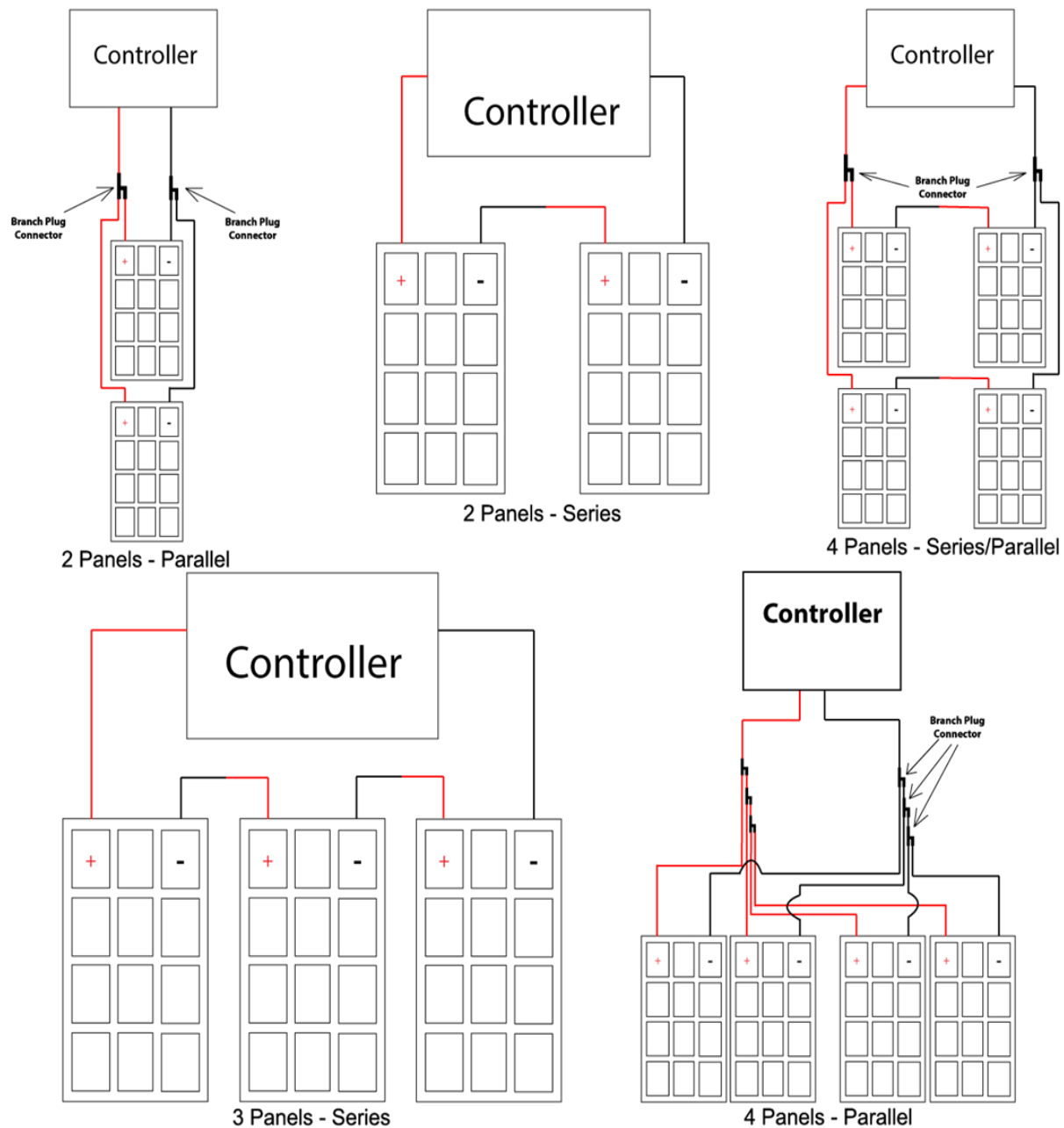
Parallel – Solar panels that are wired in parallel combine their wattage and their amperage, while the voltage remains the same. In the first example (2 Panels – Parallel) on Figure 5-1, the positive (+) ends of each panel are connected via a branch connector. The same is done for the negative (-) ends of each panel. Because this is wired in a parallel configuration, the voltage remains constant at 38 VDC (VMP or average up to 45.36 VDC open circuit), the watts are doubled to 390W (195W x 2), and a current of 10.20 amps (5.10 amps x 2) is present. Adding extra panels in parallel increase the amperage available (for higher pumping pressure) to the pump and increased hours of pumping time when compared to a single panel system.

Series – Solar panels that are wired in series combine their wattage and voltage, while the amperage remains constant. This is displayed in the second example (2 Panels – Series) on Figure 5-1. The positive (+) end of the first panel connects to the pump or controller, while the negative (-) connects to the positive (+) of the second panel. The second panel's negative (-) connects to the pump or controller, completing the circuit. Since this array is wired in series, the voltage doubles to 76 VDC (VMP or average up to 90.72 VDC open circuit), the watts double to 390W (195W x 2), and the current remains the same at 5.10 amps. The most common need for this configuration is to power a higher voltage motor.

Series/Parallel – The third example (4 Panels – Series/Parallel) on Figure 5-1 shows two parallel strings of two panels in series. Each string of two panels in series produces 76 VDC (VMP or average up to 90.72 VDC open circuit), 390W, and 5.10 amps. The two strings connected in series/ parallel produces 76 VDC (VMP or average up to 90.72 VDC open circuit), 780W, and 10.20 amps. This configuration is reserved for higher voltage pumps that require more current than a single string of solar panels wired in series can provide.

Solar Panels can be wired in a number of variations to produce the desired Watt/Voltage/Amperage configuration. Below are examples of the most common 2-4 panel wiring configurations, including panel arrays configured in series, parallel, and a combination of the two.

Figure 3-1: Solar Panel Wiring Diagram



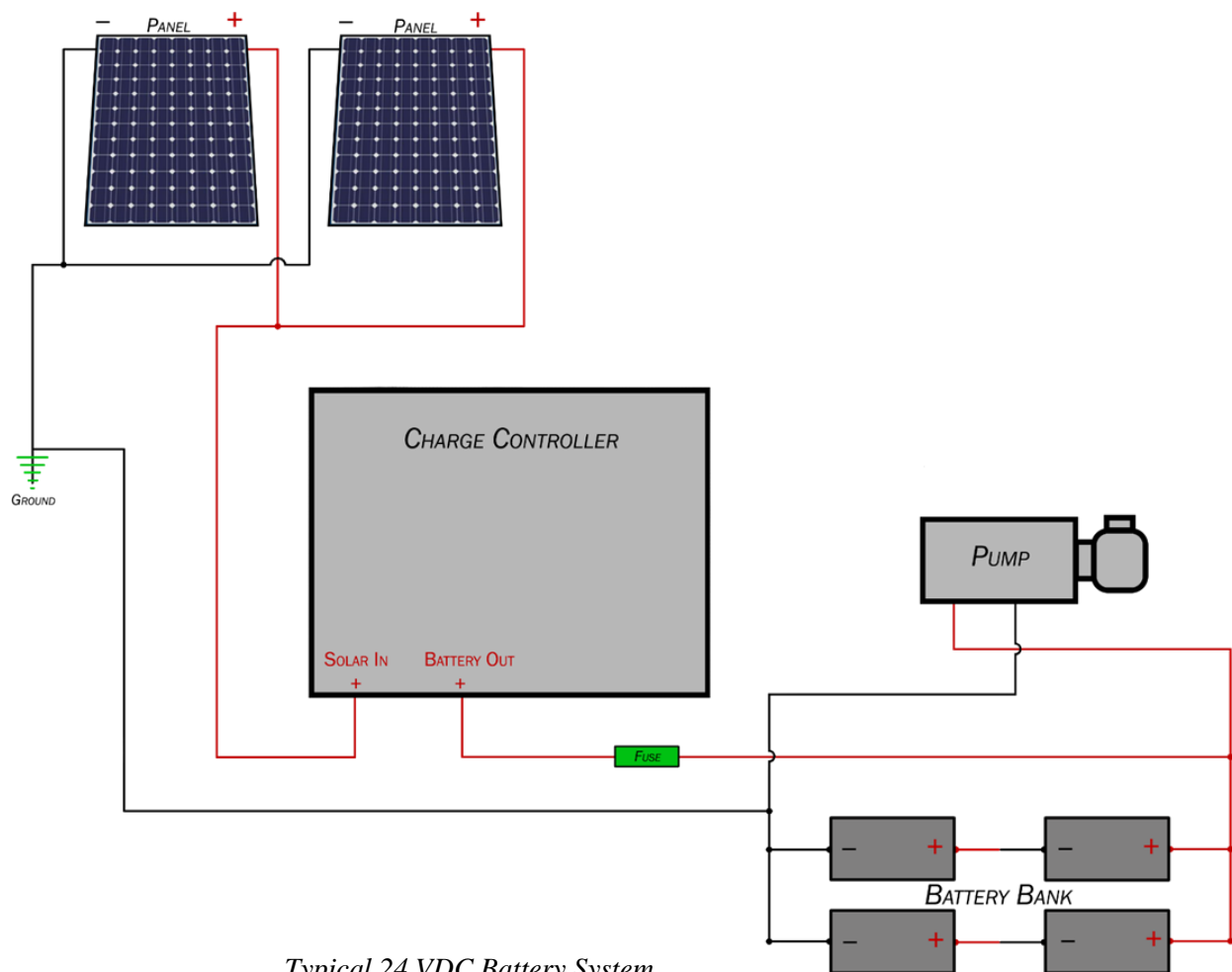
4. BATTERY SYSTEMS

Battery System – The battery system voltage is determined by the motor voltage. A 12 volt motor requires a 12 volt battery bank; a 24 volt motor, a 24 volt battery bank, etc. A battery's size (capacity in Amps) is measured in Amp Hours, the higher the Amp Hour Rating, the more amperage is available between charges.

The run time of the pump (when no sunlight is available) is directly proportional to the size of the battery or battery bank. Adding more batteries to the battery bank, or increasing the size of the

batteries in the battery bank, increases the overall amperage available and increases run time. The charge time of the battery bank is determined by the amperage available from the solar array. Large solar arrays with high current output will charge a battery bank to full charge at a much faster rate than small (or single panel) arrays.

Figure 4-1: Battery Charge Controller Wiring Diagram



The solar array must be sized large enough that, with the pump running at full capacity, the battery bank will still charge simultaneously.

The solar array must have a DC voltage output higher than the peak charge voltage of the battery bank (A typical 12 volt battery is fully charged when its voltage reaches 14.1 VDC). Solar panels may be connect in series, parallel and series/parallel (see page 14) to increase voltage and amperage output.

The DC output from the solar array goes directly to a Charge Controller. The charge controller is an electronic device that regulates the correct voltage to the battery bank to ensure proper charging. It is sized to the array by voltage (12, 24 or 48 VDC are common), and amperage requirements. Charge controllers rated from 2 to 25 Amps DC output are common and large battery banks often have controllers capable of 60 Amp outputs or higher. The higher the current capability of the charge controller, the faster the recharge time of the battery bank.

Batteries may be connected in series and parallel (like solar panels) to achieve the desired voltage and amperage requirements of the pump.

A 12 VDC motor will typically use two or more 12 VDC batteries connected in parallel (positive to positive, negative to negative) to power the pump.

A 24 VDC motor (Figure 7-1) will typically use two 12 VDC batteries connected in series (positive to negative) to attain the required voltage. Two more batteries connected in series can be added in parallel to increase the battery banks storage capacity, and the pumps run time.

WHEN DESIGNING A BATTERY SYSTEM, ALL BATTERIES MUST BE OF THE SAME SIZE (AMP HOUR RATING) AND VOLTAGE.

Example 1: Correct – Four 6 VDC, 120 AH batteries in series to produce 24 VDC.

Example 2: Correct – Two 12 VDC, 92 AH batteries in series to produce 24 VDC.

Example 3: Incorrect – One 12 VDC, 92 AH battery and two 6 VDC 120 AH batteries in series to produce 24 VDC.

5. PUMP OPERATION

PRIMING - IF PUMP INTAKE IS HIGHER THAN THE WATER SOURCE

Remove the plug next to the surge tank and add water. Turn the belt pulley by hand and continue adding water until the water box is full. Water will seep through the outlet valves when they are not under pressure, and fill the cylinder. Reinstall the plug.

If any point on the intake line is higher than the top of the pump's water box, install a pipe tee and plug at that point. Prime the pump at the tee. Ensure to displace any air that may be trapped in the high point on the intake line.

STARTUP PROCEDURE & SERVICING THE LEATHER CUP SEALS

If the pump fails to transfer water after priming, it may be because the leather seals are dry; allow the seals some time to soak up water and expand. If it still doesn't pump, the leathers will need to be stretched by hand.

The leathers are part of the Piston Cup Assembly and are located in the Water Box (the water box is end of the pump with the water inlet and outlet). The leathers are connected to the piston head (in the crankcase) via the Piston Rod.

Loosen the Packing Nut and remove the three 11mm bolts from the Water Box Head Cover (on the end of the pump), then carefully remove the Cover. Do not damage the gasket. Using a $\frac{3}{4}$ " deep socket, unscrew the leathers (from the Piston Rod) by turning CCW.

If the piston rod unscrews from the Piston Head, remove both the Piston Rod and leathers using a pair of pliers to gently push the Piston Rod out of the Water Box (ensure the Packing Box Nut is loosened).

Stretch the leathers with your fingers, then replace the assembly in the cylinder, turning CW to reattach to the Piston Rod or Piston Head (if the rod was removed).

Caution:
Do not overtighten the Piston Cup Assembly.

Use the provided aluminum cylinder as a guide when re-installing the Piston Cup Assembly.

If pump output is only 1/2 capacity and pulsating, one leather is not sealing. The leather should usually seat itself in a short time. If not, remove the Piston Cup and stretch the leathers again.

Run-in: The pump may draw higher current than specified when new. This is normal and will correct itself as the pump wears in.

ADJUSTING THE PACKING NUT

The Piston Rod enters the Water Box through a packing seal. Water will leak around this seal when the pump is first started. Using the supplied wrench, tighten the Packing Nut until the pump slows substantially and the leaking stops. This will compress the packing. Loosen the nut slightly until the pump runs faster and is slowed only slightly by the packing pressure. If adjusted correctly, there should be little or no accumulation of water.

PRESSURE RELIEF VALVE

A Pressure Relief Valve is an important safety device that is installed on the front of the Water Box, above the round plate. In the event of blockage at the outlet, the valve will open and prevent damage to the pump. Fit a pipe or hose to the valve to drain water safely away should the valve open.

The valve is factory pre-set for 100 PSI (180 feet / 55 m). Water will start bypassing the valve at approximately 80 PSI. A pressure adjustment screw is located under the knurled cover with the pressure rating stamp (typically 100 PSI). If total lift is greater than 80 PSI, remove the cover and turn the adjustment screw clockwise until water leakage stops (no further). Never allow pump pressure to exceed 100 PSI.

6. MAINTENANCE

1. Tighten the Packing Nut around the Piston Rod when required to keep water leakage to a minimum. Tighten it lightly, while the pump is running. Do not overtighten it. Slight leakage is normal.
2. Check belt tension periodically. The belt should deflect no more than approximately 1/4" (6mm). Adjust the tension by loosening the motor bolts and sliding the motor.
3. The Pump Leathers are critical to proper operation of the pump. When worn, the pump will turn faster, draw less current, and pump less water. Replacement leathers are available from Dankoff or your dealer. Never use rubber seals. They cause excessive friction and may cause sand particles to scratch the cylinder wall. When replacing the leathers, use the supplied aluminum cylinder as an insertion guide. See "Starting the Pump & Servicing the Leathers".
4. Check the oil level at regular intervals. Stop the pump and allow a minute for the oil to settle. If the oil develops an opaque light-brown (milky) color, it is contaminated with water and must be changed immediately. Wipe out the crank case to remove water, and leave it open to dry out before refilling. Keep oil filled to the bottom of the inspection window.

5. Change the oil every 2 to 5 years. Pumps under constant use will require more frequent oil changes. Use 8 oz. (240 cc) of SAE 30-weight (ISO 100) oil.
6. Check the Rod Wiper (the rubber disk on the Piston Rod, diagram part #57). The Wiper prevents water from leaking down the Piston Rod and into the crank case. It must fit tightly on the Piston Rod and move with the rod. Use silicone sealant or a rubber adhesive to secure the Wiper to the rod if it is loose.
7. Check the Motor Brushes. Motor Brushes are small blocks of carbon-graphite that make electrical contact to the commutator of the motor. When worn out completely, the electrical circuit is broken and the motor will stop.

The brushes are located under the two curved plates on the rear of the motor. The brushes are held in with clips and are removed by hand. New brushes measure 1 1/4 " (3 cm) long. The brushes should be replaced when worn approximately half-way. Typically, Brushes should last 5-10 years. Checking the brushes every year provides indication of the expected wear and helps predict life expectancy.

STORING AND RESTARTING YOUR PUMP

Drain the pump when not in use for periods of 2 months or more. This allows the leathers to dry and prevents mold and mildew and also prevents heavy accumulation of rust. Remove one of the plugs under the Water Box. Remove the round cover plate on the front of the water box, and remove the piston assembly using a 3/4" socket wrench. Replace the cover plate loosely to keep insects and rodents out.

To restart the pump see "Startup Procedure."

LONG-TERM CARE

Crankcase Oil: If the pump operates all-day, change the oil during the first year.

Cup Leathers: Leathers may last for 5-10 years, however, leather saturated with abrasive material acts like sandpaper. Changing the leathers periodically will protect the cylinder from abrasive wear when pumping water with high particle content.

Even clear water may contain occasional particles of sand, or traces of clay. Inspect the cylinder by removing the round plate from the Water Box and turning the pulley to draw the piston inward. The cylinder wall should feel smooth to the touch. Replace the cup leathers at more frequent intervals if the cylinder becomes abraded or scratched.

Valves: The rubber Valve Discs will wear quicker in dirty water, but typically last 5000-10,000 hours. Replace the Valve Discs and Valve Springs when cracked or when excessive wear is evident.

Tools: Inspection and maintenance:

- *Wrenches:*
 - *Packing Nut Wrench (Included with Pump) or 1-1/8"*
 - *Standard 7/16", 1/2", 9/16" Box-End Wrenches*
 - *Socket Wrench with 3/4" deep socket (or shallow socket with short extension)*
- *Pliers:*
 - *Common Slip-Joint Pliers*
- *Screwdrivers (for motor brush covers):*
 - *Phillips Head (1/2 HP Model Pumps)*
 - *Flat Head (1/4 HP Model Pumps)*
- *Pipe Wrenches:*
 - *As Needed*

KEEP THESE INSTRUCTIONS IN A DRY, SAFE PLACE

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