**SD 6-35 PUMP**
- Maximum Pump Voltage: 30 Volts
- Maximum Total Dynamic Head: 35 Meters (115 Feet)
- Flow at Full Depth: 6.0 lpm (1.6 gpm)

**SD 3-70 PUMP**
- Maximum Pump Voltage: 30 Volts
- Maximum Total Dynamic Head: 70 Meters (230 Feet)
- Flow at Full Depth: 3.0 lpm (0.8 gpm)

**SD 12-30 PUMP**
- Maximum Pump Voltage: 30 Volts
- Maximum Total Dynamic Head: 30 Meters (100 Feet)
- Flow at Full Depth: 12.0 lpm (3.15 gpm)

**CC 2000 CONTROLLER**
- Maximum Solar/Input Voltage: 300 Volts
- Maximum Output Current: 14 Amps
- Maximum Output Power: 2000 Watts

**SS 100 WATER SENSOR**
- Corrosion Proof
- Accurate sensing with Kyocera Controllers

**CD 300 CONTROLLER**
- Maximum Solar/Input Voltage: 50 Volts
- Maximum Output Current: 10 Amps
- Maximum Output Power: 300 Watts
Greetings

Thank you for your interest in Kyocera solar electric water pumping systems and products. Water pumping and solar power are natural partners that create economic solutions for any remote water delivery application.

Kyocera Solar, Inc., with more than 18 years experience and thousands of pumps and controllers in service around the globe, is the premier solar pumping system manufacturer. Kyocera manufactures a full range of solar powered pumps and systems that are changing the way water is delivered to livestock and people when utility service is expensive, unreliable or non-existent.

At Kyocera, we take pride in being able to provide the highest quality pumping systems at the most affordable prices. This is possible because our technical breakthroughs have increased pump efficiency to record levels, decreasing the power (wattage of solar modules) necessary to deliver the required water, thereby lowering your total system cost.

Kyocera Solar supports a worldwide network of authorized dealers and distributors of solar pumping products. The company chooses the members of this network in order to achieve full customer satisfaction. These water delivery professionals can provide excellent site evaluation, system sizing and specification, installation and post-sales service.

Kyocera Solar, Inc. and its distributor network strive for superior customer service before and after the sale. Kyocera understands that trouble-free water delivery, especially in remote locations, is critical to the well being of all living things. Our job is to meet that critical need.

Introducing Kyocera Solar, Inc.

As a world leading supplier of high technology ceramic applications, Kyocera has stepped into the forefront in development of photovoltaic modules, which convert sunlight energy directly into electricity.

Kyocera began research into photovoltaics in 1973, and has installed thousands of systems worldwide since 1978. Its years of experience and state-of-the-art technology have produced quality modules in a range of sizes, power and voltages to meet the various energy needs of the growing photovoltaic market.

Kyocera is one of the world’s largest vertically-integrated producers and suppliers of solar energy products. Our solar division U.S. headquarters are located in Scottsdale, Arizona, with regional sales affiliates in Brazil and Australia. Kyocera Solar, Inc. (KSI), our North American solar products subsidiary, services thousands of customers in both the developed and developing worlds.

Around the globe, people are enjoying better lifestyles because of solar electric systems provided by KSI. These systems make it possible for families to light their homes, utilize a telephone or experience a broadcast program for the first time. With thousands of successful installations worldwide, KSI continues to be the leader in the solar electric industry.
Kyocera Solar, Inc. Capabilities

Kyocera is the leading manufacturer of solar electric modules with primary production facilities located in Kyoto, Japan. In total, Kyocera Group produces more than 60 megawatts per year of highly efficient, multi-crystalline solar electric modules.

KSI operates a training facility at its headquarters in Scottsdale, AZ. Our instructors and industry experts present the most complete and up-to-date courses available. These sessions can train operators in proper system performance and troubleshooting.

KSI services a domestic and international network of more than 1,500 experienced authorized distributors and dealers.

KSI is capable of providing complete satisfaction to customers with solutions for global power needs. Our capability extends from manufacturing capacity, system design, and integration to training and customer services.

KSI provides service to our customers at every level of the sale, from system design, training, integration and installation.

KSI provides its customers with a wide range of engineering services from conceptual design and feasibility studies through detailed product documentation and power system specifications.

KSI stocks the largest inventory of solar electric products in the industry, including thousands of photovoltaic modules. Dedicated shipping personnel closely coordinate orders and can provide on-the-spot shipping information.

KSI services a diverse array of customers ranging from small domestic businesses to international companies, governments and institutions. These customers need fully integrated power systems. At KSI headquarters, teams of solar engineers and technicians assemble and integrate thousands of complete solar electric systems for immediate on-site deployment.
KSI serves the widely varying needs of customers for distributed solar electricity through two major market channels. Industrial customers, such as original equipment manufacturers, government organizations, utilities, corporate clients, and institutions, are serviced directly with fully integrated systems packages. KSI also services a global network of more than 1,500 authorized distributors and dealers with components, packaged systems, engineering, technical support, project management, sales aids, and training.

From large multi-kilowatt power plants to the smallest trickle charger, Kyocera solar products are backed by experience and technology you can rely on for all of your photovoltaic applications.
Solar Water Pumping Basics

Where do solar pumping systems work?

Solar pumping systems work anywhere the sun shines. The majority of the continental U.S. enjoys plenty of sun to operate a pumping system economically.

The intensity of light varies greatly throughout the day. Morning and afternoon sunlight is less intense because it is entering the earth’s atmosphere at a high angle and passing through a greater cross section of atmosphere, which reflects and absorbs a portion of the light.

We measure sun intensity in equivalent full sun hours. One hour of full sun is roughly equivalent to the sunlight on a clear summer day at noon.

The sunlight or insolation levels also vary seasonally. Fortunately, most needs for water correspond with the sunniest seasons of the year – spring, summer and fall.

Small to medium solar electric pumping systems are easily portable. By mounting the solar system on an axle or trailer, a system can be moved from well to well. This increases the economic return of a system by increasing the seasons of use. It may also correspond with the rotation of grazing areas.

How does the sun power a pump?

The photovoltaic effect produces a flow of electrons. Electrons are excited by particles of light and find the attached electrical circuit the easiest path to travel from one side of the solar cell to the other. Envision a piece of metal such as the side panel of a car. As it sits in the sun, the metal warms. This warming is caused by the exciting of electrons, bouncing back and forth, creating friction, and therefore, heat. The solar cell merely takes a percentage of these electrons and directs them to flow in a path. This flow of electrons is, by definition, electricity.

Photovoltaics or solar electric cells convert sunlight directly into electricity. This electricity is collected by the wiring in the module, then supplied to the DC pump controller and motor, which, in turn, pumps water whenever the sun shines. At night, or in heavy cloud conditions, electrical production and pumping ceases.

Economics of Solar Water Pumping

The economy and reliability of solar electric power make it an excellent choice for remote water pumping. Cattle ranchers in the Western U.S., Canada, Mexico, and Australia are enthusiastic solar pump users. Their water sources are spread over many miles of rangeland where power lines are few and refueling and maintenance costs are substantial.

If your water source is 1/3 mile or more from the powerline, solar is a favorable economic choice. This fact is reinforced by a number of Rural Electric Co-Operatives across the U.S. These Co-Ops actively advocate the use of solar pumps, as the cost to extend new lines is subsidized by other rate payers.

A solar pump minimizes future costs and uncertainties. The fuel is free. Moving parts are reduced to as few as one. A few spare parts can assure you many years of reliable water supply at near-zero operating costs.

Solar power and water pumping are a natural. Generally, water is needed most when the sun shines its brightest. Solar modules generate maximum power in full sun conditions when we typically need larger quantities of water. Because of this “sun synchronous” matching, solar is an economical choice over windmills and engine driven generators for most locations where utility power is non-existent. Owners of solar water pumping systems enjoy a reliable power system that requires no fuel and very little attention.
Fixed vs. Tracking Mount Structure

Fixed Mount structures are less expensive and tolerate higher wind loading. By fixing the modules due south, less water is pumped than a tracking system which orients the modules towards the sun as it arcs across the southern sky.

Tracking mount structures keep the modules at a 90 degree angle to the sun all day long. This provides more power to the pump over a longer period of the day, which produces 20 to 40 percent more water daily in the summertime.

Mounting Structures and Array Placement

Solar modules should be located in a sunny spot where no shading occurs. Even shadows from a tree limb, tall grass, or fence rails can substantially reduce power output.

For these reasons we typically mount the solar modules on a pole or ground mount above any obstacles. Remember the solar array can be placed some distance from the water source if shading is a problem. Wire size can be increased to compensate for longer cable runs and the associated voltage drop.

Water Storage – Efficient and Effective

Storing water in a good sized cistern or stock tank has many advantages. It is less expensive and more efficient than storing energy in batteries, giving your system a flywheel effect over cloudy days and letting the pump work at a slower continuous pace over the day. As a rule of thumb, the tank should be able to store 3 or 5 days worth of water. Generally speaking, animals, plants and humans use less water on cloudy days.

Conversely, the sunniest days are when we consume the most water and when the solar modules are providing the pump with the most power.

Solar Trackers and Water Pumping – A Perfect Match

Trackers offer a great advantage when pumping water. Our passive single axis trackers are known for their excellent reliability and service life. They take no power from the system as they operate from the heat of the sun striking the frame members, causing freon to move from one cylinder to another. Our trackers come with a 10 year warranty and are highly recommended in all but the windiest locations. High winds can pull the array off the correct sun angle and will negatively affect power production if winds are consistent.

Windmills: Yesterday’s Answer to Remote Water Delivery

There are still thousands of windmill water pumping units standing in the western U.S. Regrettably, many are inoperable. These pumps were very valuable for remote (off grid) sites, with the proper minimum wind conditions, when manpower was plentiful and cheap. Windmills, though potentially long lasting, need dedicated maintenance. The downhole leathers require inspection and high winds can cause mechanical damage to the blades. Parts for these mills are expensive and sometimes hard to find.

Solar water pumping systems have many advantages over windmill water pumpers. Though the initial cost of solar powered systems can be similar to that of a windmill (however, in many cases far less) the life time costs are much lower. Windmills must be used where there is a steady, constant wind for maximum results while solar pumps operate anywhere the sun shines. Solar pumping systems can be installed in less than a day by an individual or small crew and can be portable, while windmills (because of the need to erect a tower) can take a larger crew a much longer time to install. Windmills are secured to the ground and are stationary. Solar powered water pumping systems are the modern day upgraded version of the windmill which uses natural resources to deliver water in off grid locations.

Why we don’t Recommend Batteries in Water Pumping Systems

While batteries may seem like a good idea, they have a number of disadvantages in pumping systems. They reduce the efficiency of the overall system. The solar modules operating voltage is dictated by the battery bank and is reduced substantially from levels which are achieved by operating the pump directly. Batteries also require additional maintenance and under and over-charge protection circuitry which adds to the cost and complexity of a given system. For these reasons, only about five percent of solar pumping systems employ a battery bank.
Gas Fired Generators vs. Solar Energy

Generators are commonly used to provide power beyond the powerline. We have several economic studies concerning the economics of solar versus generators as a power choice. These studies consider all costs involved: modules, mounting structure, pumps, miscellaneous components, installation, operation, maintenance, yearly inspection, component replacement and salvage value. With this we can determine a life cycle cost and a present value. One such comparison was done by the Bureau of Land Management at Battle Mountain, Nevada specifically comparing solar water pumping systems. For one 3.8 gpm system with a 275 foot design head, the PV system cost only 64% as much over 20 years as the generator system did over only 10 years. This remote solar site is also used only 14% as many labor hours.

In 1989, Sandia National Laboratories noted that photovoltaic pumping systems in remote locations would often be cost effective compared to generators, even with 5 times the initial capital cost. Low end generators, which are initially inexpensive, require consistent maintenance and have a design life of approximately 1,500 hours. Small to medium sized solar pumping systems often initially cost less than a durable slow speed engine driven generator. Most larger pump systems initially cost more than generator systems, but tend to be far more economical in the end.

Solar Powered vs. Gas-Fired Generators and Windmills

<table>
<thead>
<tr>
<th>SYSTEM TYPE</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Electric Power System</td>
<td>Low Maintenance, Clean, No fuel needed, Easy to install, Reliable long life, Unattended operation, Low recurrent costs, System is modular and can be matched closely to need</td>
<td>Relatively high initial cost, Lower output in cloudy weather</td>
</tr>
<tr>
<td>Diesel (or Gas) Power Systems</td>
<td>Moderate capital costs, Can be portable, Extensive experience available, Easy to install</td>
<td>Needs maintenance and replacement, Maintenance often inadequate, reducing life, Fuel often expensive and supply intermittent, Noise, dirt and fume problem, Site visits necessary</td>
</tr>
<tr>
<td>Windmill</td>
<td>Potentially long-lasting, Works well in windy site</td>
<td>High maintenance, Costly repair, Difficult to find parts, Seasonal disadvantages, Need special tools for installation, Labor intensive, No wind, no power, no water</td>
</tr>
</tbody>
</table>
**Designing a Solar Pumping System**

There are many aspects of designing a solar pumping system. This guide provides the information to correctly select a pump, controller, sensors, solar array, wiring, and pipe. The process is broken down into the following steps:

**STEP 1 - Determining your basic amount of water required per day.**

**STEP 2 - Calculating the TOTAL DYNAMIC HEAD.**

**STEP 3 - Determining the solar resource for your location.**

**STEP 4 - Selecting the pump, controller, and solar array.**

**STEP 5 - Selecting the correct solar array mounting method.**

**STEP 6 - Selecting the right size pump cable and pipe.**

**STEP 7 - Using water level sensors and pump controls.**

**IMPORTANT NOTE:** SD series pumps and SC series pumps use a different process for some steps in the design, especially pump selection. Look for “SD ONLY” or “SC ONLY” in the text.

**STEP 1 - Daily Water Requirement and Storage**

The size and cost of your system will depend on the amount of water required per day. AC pumping systems connected to a utility power grid are generally designed to run on demand with a specified flow rate. Unlike grid-tied systems, solar pumping systems are designed to provide a certain quantity of water per day. Water is pumped during sunlight hours and stored in a tank. The daily requirement is simply a total of all water required during a 24 hour period. This quantity is expressed in LITERS PER DAY or GALLONS PER DAY.

Tanks are used to store water for use during the night or periods of cloudy weather. Tanks are usually large enough to hold 3 to 5 days of daily water output.

If your application requires large amounts of water on a periodic basis, like watering a crop once a week, divide the weekly requirement by 7 to arrive at an average daily requirement. A system such as this should have a tank large enough to hold at least 1.5 times the weekly requirement.

Information about water needs is available from many sources. Government agencies can provide information for household and agricultural applications. Some guidelines for water uses and daily quantities are shown below. These are general guidelines only; actual values depend on many factors.

**TABLE 1 – TYPICAL WATER REQUIREMENTS**

<table>
<thead>
<tr>
<th>USE</th>
<th>USAGE LITERS PER DAY</th>
<th>USAGE GALLONS PER DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>EACH PERSON, FOR ALL PURPOSES</td>
<td>284</td>
<td>75</td>
</tr>
<tr>
<td>EACH MILKING COW</td>
<td>133</td>
<td>35</td>
</tr>
<tr>
<td>EACH COW/CALF PAIR</td>
<td>38 – 114</td>
<td>10 – 30</td>
</tr>
<tr>
<td>EACH HORSE, DRY COW, OR BEEF ANIMAL</td>
<td>38 – 76</td>
<td>10 – 20</td>
</tr>
<tr>
<td>EACH SHEEP</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>EACH HOG</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>100 CHICKENS</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

**STEP 2 - Calculating TOTAL DYNAMIC HEAD**

Total Dynamic Head, or TDH, is a very important factor in system design. TDH is the effective pressure the pump must operate against. TDH is expressed in METERS or FEET. TDH is the sum of 3 factors:

1. **TOTAL VERTICAL LIFT**

   TOTAL VERTICAL LIFT is the sum of the STANDING WATER LEVEL, DRAWDOWN, and ELEVATION. The STANDING WATER LEVEL (SWL), measured in meters or feet, is the distance from the top of the well to the surface of the water in the well when no water is being pumped (see **FIGURE 1** on page 12). The STANDING WATER LEVEL water is also called the “static” (at rest) water level. The DRAWDOWN, measured in meters or feet, is the distance the standing water level lowers when water is pumped from the well. Depending on the well, the DRAWDOWN may be 1 to 20 meters (3 to 50 feet) or more. Slow flowing wells will have the greatest DRAWDOWN. The STANDING WATER LEVEL and DRAWDOWN can also be provided by the well drilling company or by testing the well. The DRAWDOWN is related to the flow rate of the pumping system; the greater the flow rate, the greater the DRAWDOWN.
NOTE: The sum of the STANDING WATER LEVEL and the DRAWDOWN is called the PUMPING LEVEL. ELEVATION to point of use, measured in meters or feet, is the vertical distance from the top of well to the point of use, such as the top of a storage tank.

2. FRICTION LOSS
The FRICTION LOSS, measured in equivalent meters or feet, is the pressure required to overcome friction in the pipes from the pump to the point of use. The friction is based on: rate of flow, the length, diameter, and type of pipe, and also the number and type of pipe fittings used. The greater the flow, the greater the FRICTION LOSS. Tables are used to calculate friction loss.

3. TANK PRESSURE
TANK PRESSURE, expressed in equivalent meters or feet of head, is the operating pressure of the storage tank. Solar pumping systems have very large tanks because no water is pumped at night or in very cloudy weather, pressurized tanks are rarely used in solar pumping systems. However, systems with battery power can be used to pump to pressurized tanks. For typical, non-pressurized systems, TANK PRESSURE equals zero.

TOTAL DYNAMIC HEAD = TOTAL VERTICAL LIFT + FRICTION LOSS + TANK PRESSURE

TOTAL VERTICAL LIFT
To calculate TOTAL DYNAMIC HEAD it is best to make a sketch like FIGURE 1 on next page.

Calculate the TOTAL VERTICAL LIFT by adding the STANDING WATER LEVEL, the DRAWDOWN and the ELEVATION.

FRICTION LOSS
In most cases, calculating FRICTION LOSS can be simplified. If the system storage tank is located close to the well head, 10 meters (30 feet) or less, and the recommended pipe size is used, a simple rule can be used. Friction loss, in equivalent head, can be estimated at 5% of the TOTAL VERTICAL LIFT. This will allow for a few straight runs of pipe and a few fittings.

In cases where the tank is located far from the well, more than 10 meters (30 feet), more accurate calculations must be used for FRICTION LOSS. FRICTION LOSS is based on the size and length of the pipe, the number and type of fittings, and the FLOW RATE. Solar pumping systems, unless connected to a battery, pump only when the sun is shining on the solar array. Cloudy weather will also affect the flow rate. The flow rate varies over the course of the day with the peak flow occurring at midday. Because our system design is not complete (a pump and array have not been selected yet), the TOTAL DAILY OUTPUT can only be estimated. To estimate the flow rate, make a guess for the TOTAL DAILY OUTPUT and use the following equations:

US:
GPM (gallons per minute) = GPD (gallons per day) / 360

Metric:
LPM (liters per minute) = LPD (liters per day) / 360

Example:
DAILY REQUIREMENT = 3600 liters per day
FLOW RATE = 3600 / 360 = 10 liters per minute

Calculate the friction loss by adding the length of all piping in the system. Use TABLE 2 or 3 to express the friction loss from fittings in equivalent length of pipe. Add the total of fitting losses to pipe losses. Using the total equivalent length of pipe, and the flow rate, find the head loss in meters per meter of pipe, or feet per foot of pipe, from TABLE 4 or 5. Multiply this number by the total equivalent length of pipe. This number is the FRICTION LOSS in meters or feet of head.

When the system design is complete, use the actual DAILY OUTPUT of the chosen pump and array, recalculate the FLOW RATE, and review the FRICTION LOSS calculations. If necessary, recalculate the FRICTION LOSS and the TOTAL DYNAMIC HEAD and double-check your pump and array choice.

TANK PRESSURE
Tank pressure is specified from other system needs. When a pressurized tank is used, convert the cutoff pressure to meters or feet of head. If the water is allowed to flow free into an open or vented tank, the TANK PRESSURE is zero, use a value of zero when calculating TOTAL DYNAMIC HEAD. To convert pressure to equivalent head, use the following formulas:

US:
HEAD (in feet) = PRESSURE (psi) x 2.31

Metric:
HEAD (in meters) = PRESSURE (kPa) x 0.102

Example:
FIGURE 1 is a good example of how a system should be sketched to calculate TOTAL DYNAMIC HEAD. The worksheet on the following page can be used for the calculation. Practice the calculation using FIGURE 1). The TOTAL DYNAMIC HEAD for this system equals 92.852 feet.
WORKSHEET 1 - TOTAL DYNAMIC HEAD

CALCULATING TOTAL VERTICAL LIFT:

Standing water level
Drawdown
Elevation
TOTAL VERTICAL LIFT (add lines 1 – 3)

CALCULATING FRICTION LOSS:

Simplified method, tank close to well (see text):
FRICITION LOSS (multiply line 4 by 0.05)

Calculated method, tank far from well (see text):

Total length of all pipes; add the length of all pipes.
Equivalent length of fittings; add the equivalent length of all fittings (from TABLE 2 or 3).
Total equivalent length of pipe (add lines 6 & 7)
TOTAL DAILY OUTPUT (estimated or actual)
Flow rate (divide line 9 by 360)
Friction loss per length (from TABLE 4 or 5; use next largest flow rate and actual pipe size)
Friction loss (multiply line 8 & 11)

CALCULATING TOTAL DYNAMIC HEAD:

TOTAL VERTICAL LIFT (enter line 4)
TOTAL FRICTION LOSS (enter line 5 or 12, see text)
TANK PRESSURE (in meters or feet of head)
TOTAL DYNAMIC HEAD (add lines 13 – 15)

TABLE 2 - (METRIC) FRICTION LOSS FOR FITTINGS IN EQUIVALENT METERS OF PIPE

<table>
<thead>
<tr>
<th>TYPE OF FITTING AND APPLICATION</th>
<th>NOMINAL SIZE OF PIPE FITTING (NPT)</th>
<th>1/2&quot;</th>
<th>3/4&quot;</th>
<th>1&quot;</th>
<th>1 1/4&quot;</th>
<th>1 1/2&quot;</th>
<th>2&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSERT COUPLING</td>
<td>EQUIVALENT LENGTH OF PIPE (IN METERS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threaded Adapter (Plastic to Thread)</td>
<td>0.9 0.9 0.9 0.9 0.9 0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90° Standard Elbow</td>
<td>0.6 0.6 0.9 1.2 1.2 1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Tee (Straight Flow)</td>
<td>0.3 0.6 0.6 0.9 0.9 1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Tee (90° Flow)</td>
<td>1.2 1.5 1.8 2.1 2.4 3.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate Valve</td>
<td>0.3 0.3 0.3 0.3 0.6 0.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swing Check Valve</td>
<td>1.5 2.1 2.7 3.7 4.0 5.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 3 - (US) FRICTION LOSS FOR FITTINGS IN EQUIVALENT FEET OF PIPE

<table>
<thead>
<tr>
<th>TYPE OF FITTING AND APPLICATION</th>
<th>NOMINAL SIZE OF PIPE FITTING (NPT)</th>
<th>EQUIVALENT LENGTH OF PIPE (IN FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/2&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>INSERT COUPLING</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>THREADED ADAPTER (PLASTIC TO THREAD)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>90° STANDARD ELBOW</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>STANDARD TEE (STRAIGHT FLOW)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>STANDARD TEE (90° FLOW)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>GATE VALVE</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SWING CHECK VALVE</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

### TABLE 4 - (Metric) FRICTION LOSS FOR SCH 40 PCV PIPE IN EQUIVALENT METERS

<table>
<thead>
<tr>
<th>FLOW IN LITERS PER MINUTE</th>
<th>NOMINAL PIPE SIZE LOSS IN METERS OF HEAD PER ONE METER OF PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15.8 mm 1/2&quot;</td>
</tr>
<tr>
<td>5</td>
<td>0.0058</td>
</tr>
<tr>
<td>10</td>
<td>0.0068</td>
</tr>
<tr>
<td>15</td>
<td>0.0076</td>
</tr>
<tr>
<td>20</td>
<td>0.021</td>
</tr>
<tr>
<td>25</td>
<td>0.028</td>
</tr>
<tr>
<td>30</td>
<td>0.035</td>
</tr>
<tr>
<td>35</td>
<td>0.042</td>
</tr>
<tr>
<td>40</td>
<td>0.053</td>
</tr>
<tr>
<td>45</td>
<td>0.064</td>
</tr>
<tr>
<td>50</td>
<td>0.074</td>
</tr>
<tr>
<td>60</td>
<td>0.080</td>
</tr>
<tr>
<td>70</td>
<td>0.086</td>
</tr>
</tbody>
</table>

### TABLE 5 - (US) FRICTION LOSS FOR SCH 40 PCV PIPE IN EQUIVALENT FEET

<table>
<thead>
<tr>
<th>FLOW IN GALLONS PER MINUTE</th>
<th>NOMINAL PIPE SIZE LOSS IN FEET OF HEAD PER ONE FOOT OF PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>2</td>
<td>0.041</td>
</tr>
<tr>
<td>3</td>
<td>0.087</td>
</tr>
<tr>
<td>4</td>
<td>0.148</td>
</tr>
<tr>
<td>5</td>
<td>0.225</td>
</tr>
<tr>
<td>6</td>
<td>0.321</td>
</tr>
<tr>
<td>7</td>
<td>0.415</td>
</tr>
<tr>
<td>8</td>
<td>0.530</td>
</tr>
<tr>
<td>9</td>
<td>0.640</td>
</tr>
<tr>
<td>10</td>
<td>0.746</td>
</tr>
<tr>
<td>12</td>
<td>0.286</td>
</tr>
<tr>
<td>14</td>
<td>0.380</td>
</tr>
<tr>
<td>16</td>
<td>0.483</td>
</tr>
<tr>
<td>20</td>
<td>0.605</td>
</tr>
<tr>
<td>25</td>
<td>0.746</td>
</tr>
<tr>
<td>30</td>
<td>0.877</td>
</tr>
<tr>
<td>35</td>
<td>1.018</td>
</tr>
<tr>
<td>40</td>
<td>1.160</td>
</tr>
<tr>
<td>45</td>
<td>1.302</td>
</tr>
<tr>
<td>50</td>
<td>1.543</td>
</tr>
<tr>
<td>60</td>
<td>1.784</td>
</tr>
<tr>
<td>70</td>
<td>2.025</td>
</tr>
</tbody>
</table>
STEP 3 - Determining Your Solar Resource

The daily output of a solar pumping system varies with the amount of direct sunlight striking the surface of the solar modules. The more sunlight, the more water pumped. The amount of sunlight varies with weather, time of year, and location. You must know the amount of sunlight in your area before a proper system design can be completed. Also patterns of water usage vary. Some users require more water in summer while other users require the same amount of water in winter or summer. This manual contains "solar maps" that will aid you in determining your solar resource. These maps will provide you with a number called Sun Hours On Tilt, or S.H.O.T., and a color that represents the amount of solar resource for your location and application.

The first step is to determine the pattern of water usage. If the application requires a minimum amount of water each day, the system should be designed to provide this amount of water with the least amount of sunlight. This generally occurs in winter. Solar maps, on the following pages, are provided for both December and June. Users requiring the same amount of water each day should use the December map in the northern hemisphere and the June map in the Southern hemisphere. Systems designed with these maps will provide the required water in winter when the least amount of sunlight or energy is available. They will also provide more water in summer.

If the application requires more water in the summer the system should be designed using the June map in the northern hemisphere and the December map in southern hemisphere. These systems will produce less water in winter, and in some cases may not provide any water in the winter. These maps also assume that the solar array is fully exposed to sunlight during the entire day and is not shaded by trees or hills.

The angle the solar array is tilted toward the sun affects the energy produced. In order to produce the most energy the solar array must be pointed directly at the sun with the rays of sunlight falling perpendicular to the surface of the solar array. The S.H.O.T. maps provide the optimal angle the array should be tilted for maximum energy output during that season. In fact, these maps are only accurate when the array is mounted at the angle specified on the map. If the angle is changed, the water produced will decrease.

Users in tropical areas, between -23° and +23° of latitude, should examine both maps to determine the solar resource. Also the array tilt angle in these areas is a concern. Solar arrays in the tropics should not be mounted flat or at angles less than 15° despite the fact the sun may be directly overhead. Arrays mounted at low angles become covered with dirt and debris and lose energy output. Mounting at angles 15° or greater insures that rain and gravity will help keep the modules clean.

The solar array surface in the northern hemisphere should be pointed true south. Arrays in the southern hemisphere should be pointed true north. Arrays near the equator can be aimed north or south.

SUN HOURS ON TILT & TILT ANGLE

To determine the solar resource, follow these steps:

1. Decide whether to design the system for winter or summer.
2. Find your location on the maps, be sure to use the correct map for summer or winter. Remember the seasons are dependent on the hemisphere.
3. Read the color from the installation site on the map and use the legend to determine the S.H.O.T. value (kiloWatthours per meter squared per day on a tilted flat plate collector). This value is also known as "Sun Hours On Tilt". This value will be used to select the correct pump and array.
4. Use the scale on the right side of the maps to determine the optimum tilt angle for the solar array. "FS" means facing south and "FN" means facing north. See FIGURE 2 - ARRAY TILT ANGLE in STEP 5 - ARRAY MOUNTING to see how this angle is measured on the solar array.
Canada and USA
Sun Hours On Tilt (S.H.O.T.)
Maps

December

Latitude

Optimum Tilt Angle

Longtitude

Sun Hours On Tilt (kWh/m²/day on tilted array)

<table>
<thead>
<tr>
<th>Optimum Tilt Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>15° FS</td>
</tr>
<tr>
<td>20° FS</td>
</tr>
<tr>
<td>25° FS</td>
</tr>
<tr>
<td>30° FS</td>
</tr>
<tr>
<td>35° FS</td>
</tr>
<tr>
<td>40° FS</td>
</tr>
<tr>
<td>45° FS</td>
</tr>
<tr>
<td>50° FS</td>
</tr>
<tr>
<td>55° FS</td>
</tr>
<tr>
<td>60° FS</td>
</tr>
<tr>
<td>65° FS</td>
</tr>
<tr>
<td>70° FS</td>
</tr>
<tr>
<td>75° FS</td>
</tr>
<tr>
<td>80° FS</td>
</tr>
<tr>
<td>85° FS</td>
</tr>
</tbody>
</table>

June

Latitude

Optimum Tilt Angle

Longtitude

Sun Hours On Tilt (kWh/m²/day on tilted array)

<table>
<thead>
<tr>
<th>Optimum Tilt Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 2</td>
</tr>
<tr>
<td>2 to 3</td>
</tr>
<tr>
<td>3 to 4</td>
</tr>
<tr>
<td>4 to 5</td>
</tr>
<tr>
<td>5 to 6</td>
</tr>
<tr>
<td>6 to 7</td>
</tr>
<tr>
<td>7 to 8</td>
</tr>
<tr>
<td>8 to 10</td>
</tr>
<tr>
<td>10 to 14</td>
</tr>
</tbody>
</table>
Mexico, Central America and Caribbean Nations
Sun Hours On Tilt (S.H.O.T.) Maps
South America Sun Hours On Tilt (S.H.O.T.) Maps

### Sun Hours On Tilt (kWh/m²/day on tilted array)
- **None**
- 0 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- 8 to 10
- 10 to 14

### Optimum Tilt Angle

#### December
- 10° N: 15° FS
- 0°: 15° FS/N
- 10° S: 15° FN
- 20° S: 15° FN
- 30° S: 25° FN
- 40° S: 35° FN
- 50° S: 45° FN
- 60° W to 80° W: 55° FN

#### June
- 10° N: 15° FS
- 0°: 15° FS/N
- 10° S: 15° FN
- 20° S: 15° FN
- 30° S: 25° FN
- 40° S: 35° FN
- 50° S: 45° FN
- 60° W to 80° W: 55° FN

#### Latitude and Longitude
- **Latitude:** 10° N to 50° S
- **Longitude:** 80° W to 40° W
Australasia
Sun Hours On Tilt (S.H.O.T.)
Maps

December

Latitude

Optimum Tilt Angle

90° E 100° E 110° E 120° E 130° E 140° E 150° E 160° E 170° E

Longitude

June

Latitude

Optimum Tilt Angle

90° E 100° E 110° E 120° E 130° E 140° E 150° E 160° E 170° E

Longitude
Asia
Sun Hours On Tilt (S.H.O.T.)
Maps

December

Latitude

Longtitude

Optimum
Tilt Angle

70° N
60° N
50° N
40° N
30° N
20° N
10° N
0°
10° S
20° E 40° E 60° E 80° E 100° E 120° E 140° E 160° E 180° E

June

Latitude

Longtitude

Optimum
Tilt Angle

70° N
60° N
50° N
40° N
30° N
20° N
10° N
0°
10° S
20° E 40° E 60° E 80° E 100° E 120° E 140° E 160° E 180° E
Europe
Sun Hours On Tilt (S.H.O.T.)
Maps

### December

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Optimum Tilt Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>70° N</td>
<td>85° FS</td>
</tr>
<tr>
<td>65° N</td>
<td>80° FS</td>
</tr>
<tr>
<td>60° N</td>
<td>75° FS</td>
</tr>
<tr>
<td>55° N</td>
<td>70° FS</td>
</tr>
<tr>
<td>50° N</td>
<td>65° FS</td>
</tr>
<tr>
<td>45° N</td>
<td>60° FS</td>
</tr>
<tr>
<td>40° N</td>
<td>55° FS</td>
</tr>
<tr>
<td>35° N</td>
<td>50° FS</td>
</tr>
</tbody>
</table>

### June

<table>
<thead>
<tr>
<th>Sun Hours On Tilt (kWh/m²/day on tilted array)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 to 14</td>
</tr>
<tr>
<td>8 to 10</td>
</tr>
<tr>
<td>7 to 8</td>
</tr>
<tr>
<td>6 to 7</td>
</tr>
<tr>
<td>5 to 6</td>
</tr>
<tr>
<td>4 to 5</td>
</tr>
<tr>
<td>3 to 4</td>
</tr>
<tr>
<td>2 to 3</td>
</tr>
<tr>
<td>0 to 2</td>
</tr>
<tr>
<td>None</td>
</tr>
</tbody>
</table>
STEP 4 - Selecting the pump, array and controller

Selecting the right components is crucial to performance of your system. Component selection requires three pieces of information; the DAILY WATER REQUIREMENT, the TOTAL DYNAMIC HEAD, and the SUN HOURS ON TILT. Follow the steps below to choose the correct pump, array, and controller for your application.

CHOOSING PUMP TYPE – SD OR SC?

SD series pumps are low volume pumps that allow for a simple low cost system. These pumps are typically used for single family water supply and livestock watering. SC series pumps offer much higher volumes of water, and will pump from greater depth, but require larger, more costly, solar arrays. These pumps are usually used for village water supply and moderate agricultural needs.

If you are unsure about which type of pump to use, consider using an SD series first. This will be the lowest cost option. If the SD series does not provide enough water, select an SC series system.

Both SD and SC series pumps will deliver more water per day when the solar modules are placed on a TRACKER. TRACKERS boost water output in the morning and afternoon and extend the daily run time by gathering more sunlight. Trackers will boost output 30-40% in summer and about 5-15% in winter. Keep this in mind when sizing your system. Trackers have certain drawbacks and cannot be used in all situations. Read “STEP 5 – ARRAY MOUNTING” before making a final decision about a TRACKER.

SELECTING THE RIGHT CONTROLLER

After you have chosen a pump and array, selecting the right controller is simple:

- All SC series pumps use the CC 2000 controller.
- All SD series pumps use the CD 300 controller.

Both controllers increase the daily output of the system and provide many convenient features for controlling and monitoring of the pumping system.

SELECTING THE PUMP AND ARRAY – SD ONLY

SD series pumps are small diaphragm pumps that provide for a low cost solar pumping system. They can operate with as little as 50 Watts of power, depending on TOTAL DYNAMIC HEAD and DAILY WATER REQUIREMENT. SD series use a rubber diaphragm for pumping. The diaphragm does not tolerate water with a high sand content. The sand will cause premature diaphragm failure. Certain sands, such as shale or silica, are worse than others. SD series pumps should be used with a SAND SHROUD if there is any possibility of sand in the well. SAND SHROUDS fit over the pump to prevent sand from reaching the pump intake. SAND SHROUDS increase the diameter of the pump and require a larger well casing. SD series pumps also require yearly maintenance to replace the diaphragm and cam assembly.

Failure to service the pump will lead to diaphragm failure and major damage to the pump motor and electrical parts. This may void warranties. There are 3 pumps in the SD series. See TABLE 6 below for basic performance and well diameter requirements.

**TABLE 6 - SD SERIES PERFORMANCE**

<table>
<thead>
<tr>
<th>PUMP MODEL</th>
<th>MAXIMUM TOTAL DYNAMIC HEAD</th>
<th>TYPICAL DAILY OUTPUT*</th>
<th>MINIMUM WELL DIAMETER / NO SAND SHROUD</th>
<th>MINIMUM WELL DIAMETER WITH SAND SHROUD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD 12-30</td>
<td>30 meters (98 feet)</td>
<td>2700 - 5000 liters (710 - 1320 gallons)</td>
<td>12.7 cm (5 inches)</td>
<td>15.2 cm (6 inches)</td>
</tr>
<tr>
<td>SD 6-35</td>
<td>35 meters (115 feet)</td>
<td>2200 - 3000 liters (580 - 790 gallons)</td>
<td>10.2 cm (4 inches)</td>
<td>12.7 cm (5 inches)</td>
</tr>
<tr>
<td>SD 3-70</td>
<td>70 meters (230 feet)</td>
<td>700 - 1400 liters (185 - 370 gallons)</td>
<td>10.2 cm (4 inches)</td>
<td>12.7 cm (5 inches)</td>
</tr>
</tbody>
</table>

*These ranges are based on 5-6 Sun Hours On Tilt, normal array sizes without trackers, and TDH from 50 – 100% of maximum. System output will vary with local conditions.

If the minimum well diameter, and maximum TOTAL DYNAMIC HEAD are suitable for your system, and the daily output is close to your needs, consider an SD series pump. This will be the lowest cost solution. Remember, an SD pump requires yearly maintenance for proper operation. Use the following section, “SELECTING THE PUMP AND ARRAY – SD ONLY”, to select the correct array and predict performance of your system.

Select an SD pump using TABLE 6. The TOTAL DYNAMIC HEAD of the well must be less than or equal to the MAXIMUM TOTAL DYNAMIC HEAD of the selected pump. The diameter of the well must be greater than or equal to the MINIMUM WELL DIAMETER for the selected pump.

In general, your selection is easy. The SD 12-30 provides more water at less depth. The SD 3-70 provides less water at greater depth. The SD 6-35 is used when the well diameter is small and the SD 12-30 will not fit. Be sure to remember the sand shroud when considering well and pump diameters.

To determine array size and solar modules required, use the performance graphs on the following pages. The first page of graphs is an example. A complete example is shown on the next page.
EXAMPLE

System Conditions

Desired TOTAL DAILY OUTPUT: 7000 liters per day (1847 gallons per day)
TOTAL DYNAMIC HEAD: 10 meters (33 feet)
Location Provides: 6-7 Sun Hours On Tilt
Well Diameter: 15.2 cm (6 inches)
Water Condition: sandy

1. Select a pump that will provide the most water at the TOTAL DYNAMIC HEAD. The SD 12-30 will provide the most water.
2. Consider the sand shroud. This pump will require a sand shroud because the well is sandy.
3. Consider the diameters. The SD 12-30 with a sand shroud requires a well with a minimum diameter of 15.2 cm. The SD 12-30, with a sand shroud, will fit in this application.
4. Using the SD 12-30 PERFORMANCE GRAPH (marked "EXAMPLE"), locate the desired liters per day (TOTAL DAILY OUTPUT) on the lower left side of the graph, point A.
5. The system TDH equals 10 meters. Draw a line to the right until it crosses the "10 meter TOTAL DYNAMIC HEAD" line, point B.
6. The system SUN HOURS ON TILT equals 6-7. From point B, draw a vertical line upward until it crosses the "6-7 SUN HOURS ON TILT" line, point C.
7. Draw a horizontal line through point C. Point D shows the required array wattage and point E shows the quantity and model of Kyocera modules that will provide required amount of water. This system will provide the desired amount of water with two KC80 solar modules. If point E does not directly intersect an array configuration, the next largest array should be selected.

IMPORTANT NOTES:

1. The array wattage listed on the graph is the total of the nameplate wattage ratings of the solar modules at STC (STANDARD TEST CONDITIONS). The performance charts are corrected for operation in a hot climate, such as Phoenix, Arizona. In cooler climates actual performance will be better.
2. Under no circumstances should more than 2 modules be placed in any series string. The MAXIMUM INPUT VOLTAGE for the CD 300 Pump Controller is 50 Volts. Under certain conditions, a solar module can produce almost 25 Volts.

NOTE: The pump performance shown on the following charts represents actual system output in real applications. The performance has been de-rated for dirt and temperature losses on the solar modules, power losses in wiring, and other system losses. Other manufacturers may not take these factors into consideration when advertising their pumps or systems. This makes comparison to other pumps difficult. These charts are provided so that you can design a system that performs up to the expectations of the customer. In most cases, the actual system will perform better than the charts suggest.
NOTE:
1. SD series systems require a CD 300 Pump Controller to provide the performance as shown.
2. Single, 12 Volt module systems require CD 300 Pump Controller to operate at full power.
3. Systems using 2 solar modules should be wired with the solar modules in series.
4. Systems using 4 modules or more should be wired series/parallel. Modules should be connected first in strings of 2 modules in series. These strings should then be paralleled to achieve the required power.
NOTE:
1. SD series systems require a CD 300 Pump Controller to provide the performance as shown.
2. Single, 12 Volt module systems require CD 300 Pump Controller to operate at full power.
3. Systems using 2 solar modules should be wired with the solar modules in series.
4. Systems using 4 modules or more should be wired series/parallel. Modules should be connected first in strings of 2 modules in series. These strings should then be paralleled to achieve the required power.
NOTE:
1. SD series systems require a CD 300 Pump Controller to provide the performance as shown.
2. Single, 12 Volt module systems require CD 300 Pump Controller to operate at full power.
3. Systems using 2 solar modules should be wired with the solar modules in series.
4. Systems using 4 modules or more should be wired series/parallel. Modules should be connected first in strings of 2 modules in series. These strings should then be paralleled to achieve the required power.
NOTE:
1. SD series systems require a CD 300 Pump Controller to provide the performance as shown.
2. Single, 12 Volt module systems require CD 300 Pump Controller to operate at full power.
3. Systems using 2 solar modules should be wired with the solar modules in series.
4. Systems using 4 modules or more should be wired series/parallel. Modules should be connected first in strings of 2 modules in series. These strings should then be paralleled to achieve the required power.
SELECTING THE PUMP AND ARRAY – SC ONLY

SC series pumps are high volume centrifugal pumps. Centrifugal pumps are designed to operate at a specific depth. Proper pump selection is important. The wrong pump will not deliver the full potential provided by the solar resource. The solar array powering the pump is also important for proper system performance. An under sized array will limit daily output. An over-sized array will increase the cost of the system.

All SC series pumps require a MINIMUM WELL DIAMETER of 10.2 cm (4 inches). SC series pumps are tolerant of reasonable amounts of sand in the water and do not generally require SAND SHROUDS.

Selecting the right pump is simple; follow the steps below:

1. Find the pump performance chart with the correct SUN HOURS ON TILT for your location.
2. On this chart, mark the TOTAL DYNAMIC HEAD on the horizontal scales on the chart. Draw a vertical line. The charts are labeled in both meters and feet.
3. Now mark the chart with daily water requirement. Draw a horizontal line. The charts are labeled with liters per day and gallons per day.
4. Where these lines cross will show both the correct pump model and the array size required. If your cross lies above the highest trace on the chart, the SC series pumps will not provide enough water. You may reconsider the amount of water required per day.

The charts provided are for fixed arrays set at the recommended tilt angle. Trackers can be used to increase output. Kyocera Solar offers 5 arrays for use with SC series solar pumping systems:

- 16 KC120 modules wired 8 in series by 2 in parallel for SC1000 series applications.
- 16 KC80 modules wired 8 in series by 2 in parallel for SC1000 series applications.
- 8 KC120 modules, these can be wired 8 in series for SC1000 applications, or 4 in series by 2 in parallel for SC500 applications.
- In general, an SC1000 pump with 8 KC120’s will slightly outperform an SC500 pump with 8 KC120’s.
- 8 KC80 modules wired 4 in series by 2 in parallel for SC500 applications.
- 4 KC120 modules wired 4 in series for SC500 applications.

EXAMPLE

**System Conditions**

<table>
<thead>
<tr>
<th>Desired TOTAL DAILY OUTPUT:</th>
<th>7900 liters per day (2087 gallons per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL DYNAMIC HEAD:</td>
<td>70 meters (230 feet)</td>
</tr>
<tr>
<td>Location Provides:</td>
<td>4-5 Sun Hours On Tilt</td>
</tr>
</tbody>
</table>

1. Locate the chart labeled "4-5 Sun Hours On Tilt".
2. Find the TOTAL DAILY OUTPUT on right or left side of the chart, point A, and draw a horizontal line from this point.
3. Find the TOTAL DYNAMIC HEAD on the top or bottom of the chart, point B, and draw a vertical line.
4. Where the lines cross, point C, falls in the pumping zone for the SC 1000 25-85. This will be the best pump for this application.
5. Point C lies in the band that requires 16 KC120 modules for operation. Follow the vertical line up from point C to point D.
   Read the value, the system will actually produce 10,000 liters per day.

NOTE: The pump performance shown on the following charts represents actual system output in real applications. The performance has been de-rated for dirt and temperature losses on the solar modules, power losses in wiring, and other system losses. Other manufactures may not take these factors into consideration when advertising their pumps or systems. This makes comparison to other pumps difficult. These charts are provided so that you can design a system that performs up to the expectations of the customer. In most cases, the actual system will perform better than the charts suggest.
Designing A Solar Water Pumping System 29

Solar Water Pumping Applications Guide

TOTAL DYNAMIC HEAD (METERS)

TOTAL DYNAMIC HEAD (FEET)

SC SERIES PERFORMANCE 4.5 Sun Hours On Tilt
**STEP 5 - Array mounting**

Array mounting has a large effect on system performance. There are two common methods for array mounting for solar pumping systems; **TRACKING** and **FIXED**.

**TRACKING**

Tracking arrays provide additional water output and can reduce overall system cost, especially for large systems.

- In summer months, trackers provide 30-40% more water than shown on the charts.
- In winter months, trackers provide 5-15% more water than shown on the charts.
- Trackers allow a reduction in array size.

However, trackers do have certain drawbacks.

- Trackers are difficult and expensive to ship.
- Trackers for large systems are heavy structures that require several workers to lift into position.
- Trackers require a large metal pole for mounting.
- In areas with regular cloud cover, trackers can get "lost" and not point at the sun.
- In areas with high winds, trackers can be damaged or blown in wrong direction.

In general, trackers are the preferred method for array mounting in the SC series systems. The SC pump is centrifugal and requires the additional RPM early in the morning and late in the day to move water. SC series systems that cannot use trackers must instead use larger arrays to produce equivalent output.

**FIXED**

Fixed mounting must be used where trackers are not practical. Also, in small systems, the additional cost of the tracker does not offset the reduction in solar module cost. SD series pumps are generally connected to fixed arrays.

**MOUNTING ANGLE**

Whether using a fixed or tracking array, mounting angle is important for maximum water production. The general principle is simple; the array should be angled directly at the sun at solar noon. The rays of sunlight should be perpendicular to the surface of the array. **FIGURE 2** shows how the tilt angle is measured.

The position of the sun changes with the seasons of the year. The tilt angle of the array cannot be perfect for all seasons. Some users are able to change the angle of their array a few times during the year to increase water output. At any time of the year, output can be maximized by adjusting the array to directly face the sun at solar noon. The Sun Hours On Tilt maps, on pages 17 through 23, provide the optimum angle for the season. Here are some simple rules for tilt angle based on the latitude of the location:

- Arrays mounted at \([\text{latitude} + 15\,\text{degrees}]\) will maximize output in the winter. Output during the peak of winter will be diminished by about 13%.
- Arrays mounted at \([\text{latitude} – 15\,\text{degrees}]\) will maximize output in the summer. Output during the peak of summer will be diminished by about 13%.
- Arrays mounted at \([\text{latitude}]\) will usually maximize yearly output. Output during the peak of summer and winter will be diminished by about 4%.
- Arrays should never be mounted horizontally. A minimum angle of 10 degrees is recommended to prevent dirt build up on the solar modules. Wet and humid locations should use a minimum of 15 degrees to prevent the growth of mold and fungus.

**STEP 6 - Pump cable and pipe**

**CABLE**

Properly selecting and installing wire is essential for pump performance. Solar electricity is very valuable and waste should be avoided. Solar pump installations generally use larger wire than AC systems to avoid power loss. Use the following tables to determine what size of wire to use. The deeper the well, the larger the wire.

For all SD and SC applications, pump cable should be 3 conductor, jacketed cable approved for submersible pumps. Conductors should be stranded for low resistance; solid conductors are not suitable. The preferred colors for the conductors are RED, BLACK, and GREEN. Other colors can be used as long as close attention is paid to polarity. Kyocera Solar offers the perfect cable for solar pumping applications.

**WIRE SIZE FOR SD SERIES PUMPS – 5% LOSS**

<table>
<thead>
<tr>
<th>PUMP MODEL</th>
<th>LENGTH OF PUMP CABLE</th>
<th>MINIMUM WIRE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD 12-30</td>
<td>0 to 26 meters</td>
<td>4 mm²</td>
</tr>
<tr>
<td></td>
<td>26 to 43 meters</td>
<td>6 mm²</td>
</tr>
<tr>
<td></td>
<td>0 to 85 feet</td>
<td>12 AWG</td>
</tr>
<tr>
<td></td>
<td>85 to 140 feet</td>
<td>10 AWG</td>
</tr>
<tr>
<td>SD 6-35</td>
<td>0 to 43 meters</td>
<td>4 mm²</td>
</tr>
<tr>
<td></td>
<td>0 to 140 feet</td>
<td>12 AWG</td>
</tr>
<tr>
<td>SD 3-70</td>
<td>0 to 43 meters</td>
<td>4 mm²</td>
</tr>
<tr>
<td></td>
<td>140 feet and over</td>
<td>10 AWG</td>
</tr>
<tr>
<td></td>
<td>43 meters and over</td>
<td></td>
</tr>
</tbody>
</table>
**WIRE SIZE FOR SC 500 PUMPS – 3% LOSS**

<table>
<thead>
<tr>
<th>LENGTH OF PUMP CABLE</th>
<th>MINIMUM WIRE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 18 meters</td>
<td>0 to 60 feet</td>
</tr>
<tr>
<td>18 to 29 meters</td>
<td>60 to 95 feet</td>
</tr>
<tr>
<td>29 to 46 meters</td>
<td>95 to 150 feet</td>
</tr>
<tr>
<td>46 meters and over</td>
<td>150 feet and over</td>
</tr>
</tbody>
</table>

**WIRE SIZE FOR SC 1000 PUMPS – 3% LOSS**

<table>
<thead>
<tr>
<th>LENGTH OF PUMP CABLE</th>
<th>MINIMUM WIRE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 34 meters</td>
<td>0 to 110 feet</td>
</tr>
<tr>
<td>34 to 55 meters</td>
<td>110 to 180 feet</td>
</tr>
<tr>
<td>55 to 88 meters</td>
<td>180 to 285 feet</td>
</tr>
<tr>
<td>88 meters and over</td>
<td>285 and over</td>
</tr>
</tbody>
</table>

A high quality, waterproof connection between the pump wires and supply cable is very important. Use the splice kit supplied with the pump and follow the instructions supplied with the kit. Do not attempt to use electrical tape for a splice. Whenever cutting the cable for replacement or pump service, always use a new splice kit, Kyocera part number 85902.

**PIPE**

Size and type of pipe are important for proper system performance. Larger pipe sizes can be used to reduce friction loss on long horizontal runs. Larger sizes should be avoided in vertical runs because sand in the water may settle and cause blockage. Smaller sizes should not be used because friction losses will increase. Plastic pipe is preferred for all pumps because the smooth surface of the pipe reduces friction loss. SD series pumps must be used with plastic pipe; the plastic pipe provides a cushioning effect and protects the pump diaphragm from damage. Proper pipe size and type for each pump is listed in the table below:

**PIPE SIZE and TYPE**

<table>
<thead>
<tr>
<th>PUMP MODEL</th>
<th>PIPE SIZE</th>
<th>PIPE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD 12-30</td>
<td>3/4” (19 mm)</td>
<td>POLYETHYLENE</td>
</tr>
<tr>
<td>SD 6-30</td>
<td>1/2” (12.7 mm)</td>
<td>DO NOT USE STEEL PIPE</td>
</tr>
<tr>
<td>SD 3-70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC500 15-60</td>
<td>1-1/4” (35.1 mm)</td>
<td>THREADED PVC</td>
</tr>
<tr>
<td>SC500 25-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC500 35-35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC500 40-25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC1000 15-105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC1000 25-85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC1000 35-70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC1000 45-60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC1000 60-45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC1000 105-30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**STEP 7 - Water level sensors and pump controls**

Both SD and SC series require water for lubrication and cooling. Brief periods, a minute or two, of dry running can be tolerated. Periods longer than that will damage or destroy the pump. In wells where there is possibility of water being pumped dry, an SS100 water level sensor should be used to protect the pump against dry run conditions.

The SS 100 is designed to work exclusively with Kyocera Solar’s CD 300 and CC 2000 pump controllers. The SS 100 water level sensor uses proprietary technology to provide a corrosion proof solution for well water level sensing. The SS 100 is constructed entirely of plastics and glass. There are no metals and no electrical currents to cause corrosion. The SS 100 water level sensor is intended primarily for use in wells to provide pump shutoff when a well runs dry or is overdrawn.

The SS 100 can also be used in storage tanks to provide pump shutoff when a tank becomes full. Although standard float switches provide a more economical solution, there are circumstances where the slender profile or ease of installation may make the SS 100 the best choice.

The SS 100 is supplied with 45 meters (150 feet) of polyethylene jacketed cable attached. The cable is long enough to suit most installations. For installations requiring more than 45 meters length; extensions and splice kits are available. The cable is durable, waterproof and can be buried directly in the earth to simplify installation.

Both the CD 300 and CC 2000 pump controllers provide both WELL and TANK inputs for use with the SS 100. In addition, inputs are provided so pumps can be controlled by mechanical switches.
SC Series Submersible Water Pumps

- **Water Delivery up to 43 gpm/162 lpm, Pumping Range 0-550 feet / 0-167 meters**
- **Brushless, Permanent Magnet Motor with Multi-Stage Centrifugal Pump End**
- **Corrosion-Resistant, Permanently Lubricated and Maintenance Free**

The Kyocera SC Series of submersible solar pumps are high quality, maintenance-free, DC powered pumps designed specifically for water delivery in remote locations.

They operate on 140 to 1000 watts of direct current at 30 to 120 volts. The power may be supplied from a variety of independent sources including solar modules and/or batteries.

The motors are state of the art, brushless DC, permanent magnet type constructed from marine grade bronze and 304 stainless steel. Designed with a pump motor face, they bolt directly to standard 4.0 inch diameter submersible pump ends. Internal pressure equalization allows motor submergence to any depth without damage to seals.

The pump ends are multi-stage centrifugal. They are manufactured by Goulds Pumps, Inc., constructed from 304 stainless steel and plastics. The impellers and diffusers are constructed from a rugged thermoplastic and are extremely resistant to mineral and algae deposits. Field replacement of the pump end is easily accomplished without the use of specialized tools.

The SC series pumps can be installed below the water level in a well, lake, river or cistern. They can be used to fill open tanks or used to pressurize water systems with heads up to 550 feet (167 meters). They are designed for use in **stand alone** water delivery systems. They are pollution-free, corrosion resistant, permanently lubricated and quiet. There is no better way to provide water for livestock, remote homes, campsites, small farms or any other need beyond the commercial power grid.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Model Number</th>
<th>Optimal Flow</th>
<th>Optimal Head</th>
<th>Power</th>
<th>Diameter</th>
<th>Total Length</th>
<th>Total Weight</th>
<th>Pump Outlet Connection Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>85750</td>
<td>SC 500 15-60</td>
<td>3.70 (14)</td>
<td>203.4 (62)</td>
<td>550</td>
<td>3.75 (9.53)</td>
<td>26.4 (67.1)</td>
<td>26.0 (11.8)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85751</td>
<td>SC 500 25-40</td>
<td>6.08 (23)</td>
<td>137.8 (42)</td>
<td>550</td>
<td>3.75 (9.53)</td>
<td>25.2 (64.0)</td>
<td>25.0 (11.4)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85752</td>
<td>SC 500 35-35</td>
<td>9.25 (35)</td>
<td>108.3 (33)</td>
<td>550</td>
<td>3.75 (9.53)</td>
<td>22.9 (58.2)</td>
<td>25.0 (11.4)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85753</td>
<td>SC 500 40-25</td>
<td>11.1 (42)</td>
<td>88.6 (27)</td>
<td>550</td>
<td>3.75 (9.53)</td>
<td>21.5 (54.6)</td>
<td>24.0 (10.9)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85754</td>
<td>SC 1000 15-105</td>
<td>4.49 (17)</td>
<td>374.0 (114)</td>
<td>1050</td>
<td>3.75 (9.53)</td>
<td>33.4 (84.7)</td>
<td>33.0 (14.8)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85755</td>
<td>SC 1000 25-85</td>
<td>6.34 (24)</td>
<td>315.0 (96)</td>
<td>1050</td>
<td>3.75 (9.53)</td>
<td>31.7 (80.4)</td>
<td>32.0 (14.3)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85756</td>
<td>SC 1000 35-70</td>
<td>8.98 (34)</td>
<td>236.2 (72)</td>
<td>1050</td>
<td>3.75 (9.53)</td>
<td>27.8 (70.5)</td>
<td>31.0 (13.9)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85757</td>
<td>SC 1000 45-60</td>
<td>11.62 (44)</td>
<td>193.6 (59)</td>
<td>1050</td>
<td>3.75 (9.53)</td>
<td>26.4 (70.0)</td>
<td>29.0 (13.0)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85758</td>
<td>SC 1000 60-45</td>
<td>16.11 (61)</td>
<td>147.6 (45)</td>
<td>1050</td>
<td>3.75 (9.53)</td>
<td>26.4 (70.0)</td>
<td>29.0 (13.0)</td>
<td>1-1/4&quot; NPT</td>
</tr>
<tr>
<td>85759</td>
<td>SC 1000 105-30</td>
<td>22.45 (106)</td>
<td>98.4 (30)</td>
<td>1050</td>
<td>3.75 (9.53)</td>
<td>27.6 (70.1)</td>
<td>31.0 (13.9)</td>
<td>2&quot; NPT</td>
</tr>
</tbody>
</table>
**SD Series Submersible Water Pumps**

- **Water Delivery up to 4.36 gpm / 16.5 lpm, Pumping Range 0-230 feet / 0-70 meters**
- **Highest Quality Submersible Pump in its Class**
- **Field Serviceable with Simple Hand Tools**

The Kyocera SD Series of submersible solar pumps are highly efficient, low voltage, DC powered, diaphragm type positive displacement pumps designed specifically for water delivery in remote locations.

They operate on 12 to 30 volts of direct current that may be supplied from a variety of independent power sources including solar panels and/or batteries. Power requirements can be as little as 35 watts. Constructed of marine grade bronze and 304 stainless steel, these pumps are the highest quality submersible pumps in their class.

Kyocera’s SD series pumps can be installed below water level in a pond, river or cistern, or installed by hand into a ground water well. They can be used to fill an open tank or in a pressurized water delivery system.

Simplicity is the key feature of the SD series pumps. They are easy to install, require very little maintenance and are completely field serviceable.

The SD series pumps are designed for use in **stand alone** water delivery systems. They are pollution-free, corrosion-resistant and quiet. It is the ideal way to provide water for livestock, remote homes, campsites, small farms or any other need beyond the commercial power grid.

**Model SD 3-70 .................................................. P/N 85221**

**Model SD 6-35 .................................................. P/N 85222**

Suitable for installation in 4.0 inch (100.0 mm) minimum inside diameter wells. The addition of a sand shroud requires installation in 5.0 inch (127.0 mm) minimum inside diameter wells. Flow rates up to 2.4 GPM (9.0 LPM) and heads up to 230 feet (70.0 meters).

*Dimensions (Outside Diameter, Length, Weight):*
3.8 in. (96.0 mm), 10.75 in. (273.0 mm), 21.0 lbs. (9.5 kg)

**Model SD 12-30 .................................................. P/N 85220**

Suitable for installation in 5.0 inch (127.0 mm) minimum inside diameter wells. The addition of a sand shroud requires installation in 6.0 inch (152.0 mm) minimum inside diameter wells. Flow rates up to 4.5 GPM (17.0 LPM) and heads up to 100 feet (30.0 meters).

*Dimensions (Outside Diameter, Length, Weight):*
4.62 in. (117.35 mm), 10.75 in. (273.0 mm), 23.4 lbs. (10.6 kg)
The CC 2000 pump controller is designed to connect solar modules to Kyocera Solar’s SC series submersible motors and centrifugal pumps. The controller provides current boosting combined with true Maximum Power Point Tracking (MPPT) of the solar modules. The pump controller’s microprocessor constantly monitors the incoming solar power and boosts current to operate the solar modules at their peak power point and maximize pump output. The controller is entirely self-configuring and requires no setup or adjustment by the user to ensure proper operation.

The CC 2000 controller will accommodate two to twelve solar modules in series. Any combination of modules can be used as long as the total Open Circuit Voltage (VOC) does not exceed 300 Volts. Strings of modules can be wired in parallel to maximize daily water production.

In addition to solar modules, the controller will also operate from 24 to 144 Volt battery banks for use in a broad range of applications. The CC 2000 controller is only intended for use with Kyocera Solar’s SC series of motors.

The controller’s unique design simplifies control and troubleshooting of pumping systems. Inputs are provided for remote switches and Kyocera Solar’s unique water level sensor. Indicators provide convenient information about voltages, switch and sensor status, and overload conditions.

Kyocera Solar’s newly designed pump controller is user friendly. It is designed to provide maximum power under varying conditions and requires no programming by the user. We are proud to introduce the Kyocera Solar line of pump controllers and are confident you will be satisfied.

**Model CC 2000**

---

**Description**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Ambient Temperature</td>
<td>50°C</td>
</tr>
<tr>
<td>Minimum Ambient Temperature</td>
<td>-20°C</td>
</tr>
<tr>
<td>Maximum Solar/Input Voltage (total VOC @ -20°C)</td>
<td>300 Volts</td>
</tr>
<tr>
<td>Max. Output Current - Current Boost Mode (input voltage greater than output voltage)</td>
<td>14 Amps</td>
</tr>
<tr>
<td>Max. Output Power - Current Boost Mode (input voltage greater than output voltage)</td>
<td>2000 Watts</td>
</tr>
<tr>
<td>Input Current Limiting</td>
<td>15 Amps</td>
</tr>
<tr>
<td>High Temperature Protection (shutdown temperature at heatsink)</td>
<td>85°C</td>
</tr>
<tr>
<td>Solar and Pump Wire Sizes</td>
<td>0.5 - 16 mm² (6 - 20 AWG)</td>
</tr>
<tr>
<td>Sensor and Remote Switch Wire Sizes</td>
<td>0.2 - 2.5 mm² (14 - 24 AWG)</td>
</tr>
</tbody>
</table>
The CD 300 pump controller is designed to connect solar modules to Kyocera Solar’s SD series submersible diaphragm pumps. The controller provides current or voltage boosting combined with true Maximum Power Point Tracking (MPPT) of the solar modules. The pump controller’s microprocessor, using true MPPT, constantly monitors the incoming solar power and boosts current or voltage to operate the solar modules at their peak power point and maximize pump output. The controller is entirely self configuring and requires no setup or adjustment by the user to ensure proper operation.

The CD 300 controller will accommodate one or two 36-cell modules in series. Other combinations of modules can be used as long as the total Open Circuit Voltage (VOC) does not exceed 50 Volts. Modules can be wired in parallel to maximize daily water production. Highest efficiencies (94-98%) will be attained when the solar modules are wired in series for operation between 30-42 Volts. However, single modules, such as a KC120, can also be used, maintaining controller efficiencies over 92%.

In addition to solar modules, the controller will also operate the pump using 12 or 24 Volt battery banks as a power source. The CD 300 controller will also work with any permanent magnet positive displacement pump rated for 30 Volts with 10 Amps maximum current draw.

The controller’s unique design simplifies control and troubleshooting of pumping. Inputs are provided for remote switches and Kyocera Solar’s unique water level sensor. Indicators provide convenient information about voltages, switch and sensor status, and overload conditions.

Kyocera Solar’s newly designed pump controller is user friendly. It is designed to provide maximum power under varying conditions and requires no programming by the user. We are proud to introduce the Kyocera Solar line of pump controllers and are confident you will be satisfied.

Model CD 300 ................................................................................................................. P/N 85223
Kyocera Solar Modules

- High efficiency multicrystal modules
- Consistent, reliable time proven products
- Cell efficiency over 14%
- UL listed (KC modules only)
- 6 inch cell modules
- Low iron, tempered glass, EVA encapsulant and anodized aluminum frame construction
- 25 year output warranty on KC Series modules
- 10 year output warranty on KS Series modules

<table>
<thead>
<tr>
<th>Model</th>
<th>KC120</th>
<th>KC80</th>
<th>KC70</th>
<th>KC60</th>
<th>KC50</th>
<th>KC40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Power (Watts)</td>
<td>120.0</td>
<td>80.0</td>
<td>70.0</td>
<td>60.0</td>
<td>50.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Current at Max. Power (Amps)</td>
<td>7.1</td>
<td>4.73</td>
<td>4.14</td>
<td>3.55</td>
<td>3.00</td>
<td>2.34</td>
</tr>
<tr>
<td>Voltage at Max. Power (Volts)</td>
<td>16.9</td>
<td>16.9</td>
<td>16.9</td>
<td>16.9</td>
<td>16.7</td>
<td>16.9</td>
</tr>
<tr>
<td>Short Circuit Current (Amps)</td>
<td>7.45</td>
<td>4.97</td>
<td>4.35</td>
<td>3.73</td>
<td>3.1</td>
<td>2.48</td>
</tr>
<tr>
<td>Open Circuit Current (Volts)</td>
<td>21.5</td>
<td>21.5</td>
<td>21.5</td>
<td>21.5</td>
<td>21.5</td>
<td>21.5</td>
</tr>
<tr>
<td>Length (Inches)</td>
<td>56.0</td>
<td>38.4</td>
<td>34.1</td>
<td>29.6</td>
<td>25.2</td>
<td>20.7</td>
</tr>
<tr>
<td>Width (Inches)</td>
<td>25.7</td>
<td>25.7</td>
<td>25.7</td>
<td>25.7</td>
<td>25.7</td>
<td>25.7</td>
</tr>
<tr>
<td>Depth (Inches)</td>
<td>2.0</td>
<td>2.0</td>
<td>2.2</td>
<td>2.0</td>
<td>2.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Shipping Weight (Lbs.)</td>
<td>30.0</td>
<td>25.0</td>
<td>19.0</td>
<td>20.0</td>
<td>16.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Part Number (P/N)</td>
<td>15484</td>
<td>15483</td>
<td>15474</td>
<td>15482</td>
<td>15473</td>
<td>15472</td>
</tr>
</tbody>
</table>

All Specification at 25°C. Wattage rating are + or – 5%.

Interconnects

- An important part of system wiring is proper module connection that exhibits the highest degree of reliability and performance in severe climates
- All are pre-assembled, featuring tin-plated copper fork terminals for #10 stud, crimped and soldered to #10 AWG stranded copper wire with adhesive "melt-wall" shrink tubing heat sealed over the crimp connection

All cables are UL type TC, 600V, 90°C with black PVC sunlight resistant jacket and include corrosion resistant, non-metallic, liquid-tight cable strain relief connectors KC Series are PG 13. Overall lengths pre-sized for best appearance. Two-wire cable assemblies are red and black conductors, used for 12V system parallel connections and series/parallel connections on 24V or 48V systems. Three-wire assemblies are red/black/blue conductors, typically used for a 24V series/parallel connection of last module in a 4-panel assembly. Single conductor cables are type XLP, typically used for series connections on pole mounted arrays. Model numbers are indicated as AWG – conductor and length (in inches).

10-2 x 30  ................................................................. P/N 43605
30.0 in. / 0.44 lbs. (76.0 cm / 0.2 kg)
Trackers

- The Zomeworks universal passive Track Rack can increase solar array power output by 25% or more.
- The adjustable single-axis passive solar tracker follows the sun by heated liquid flowing between east and west sealed canisters.

UTR020 - 2.5 in. pipe ......................................................... P/N 20370
For two modules: KC60, KC80, KC120
Rack size: 67.0 in. x 36.0 in. x 6.0 in. (170.0 cm x 91.0 cm x 15.2 cm)
Two boxes: 45.0 lbs. and 50.0 lbs. (20.5 kg and 22.7 kg)

UTR040 - 3.0 in. pipe ......................................................... P/N 20371
For four modules: KC60, KC80, KC120
Rack size: 107.0 in. X 99.0 in. (271.8cm X 251.5 cm X15.2 cm)
Two boxes: 25.0 lbs. and 140.0 lbs. (11.4 kg and 63.6 kg)

UTR070 - 6.0 in. pipe ......................................................... P/N 20373
For eight modules: KC60, KC80, KC120, PV120
Rack size: 119.0 in. X 115.0 in. X 6 in.
Two boxes: 85 lbs. And 255.0 lbs. (38.6 kg and 141.0 kg)

Racks

- Mounts are steel construction for pole gimbal and strong-back tubing.
- Solar module attachment rails are aluminum angle.

PTK120-04 ................................................................. P/N 21961
Four modules, fits 4 in. pipe
Three boxes total 95.0 lbs. (43.2 kg)

PTK120-08 ................................................................. P/N 21964
Eight modules, fits 6 in. pipe
Three boxes total 170.0 lbs. (77.3 kg)

SD 6-35/3-70 Drop Kit

- 1/2" Polyethylene tube
- Pump cable - red, black and green color code
- Safety rope
- 1/2" NPT fitting kit (hose barb, hose clamp, 90° elbow)

50’ Tube, 75’ 12-2 Cable .................................................. P/N 85254
100’ Tube, 125’ 12-2 Cable ............................................. P/N 85258
150’ Tube, 175’ 10-2 Cable ............................................. P/N 85262
200’ Tube, 225’ 10-2 Cable ............................................. P/N 85266
250’ Tube, 275’ 10-2 Cable ............................................. P/N 85268
SD 12-30 Drop Kit

- 3/4” Polyethylene tube
- Pump cable – red, black and green color code
- Safety rope
- 3/4” NPT fitting kit (hose barb, hose clamp, 90° elbow)

50’ Tube, 75’ 12-2 Cable ................................................................. P/N 85272
100’ Tube, 125’ 10-2 Cable ............................................................... P/N 85276

SD 12-30 Sand Shroud

- Eliminates destructive sand intrusion
- Easy installation including retrofit
- Constructed of rugged PVC and Polyethylene
- Reusable nylon coated stainless steel ties included
- Dimensions: 5.6” OD x 30.0” (requires 6” well)
- Compatible with Kyocera SD 12-30 pump only

SD 12-30 Sand Shroud ................................................................. P/N 85225

SD 6-35/3-70 Sand Shroud

- Eliminates destructive sand intrusion
- Easy installation including retrofit
- Constructed of rugged PVC and Polyethylene
- Reusable nylon coated stainless steel ties included
- Dimensions: 4.5” OD x 30.0” (requires 5” well)
- Compatible with Kyocera SD 6-35 and SD 3-70 pumps only

SD 6-35/3-70 Sand Shroud ................................................................. P/N 85226

SS-100 Water Sensor

- Non-corrosive sensor: Glass and plastic construction
- Compatible with CD 300 and CC 2000 controllers only
- One sensor required per well or tank application
- Sensor provided with 150’ of attached cable

SS-100 Water Sensor ................................................................. P/N 85230

SS-100 Water Sensor Splice Kit

- Used for splicing SS-100 water sensor cable (P/N 43397)
- Required in wells deeper than 150’
- 18 AWG - 22 AWG (0.50 mm² - 0.75 mm²)
- Includes butt splices and adhesive lined shrink tube

SS-100 Water Sensor Splice Kit ................................................................. P/N 85235
SS-100 Water Sensor Cable

- Used with SS-100 water sensor in wells deeper than 150'
- SS-100 splice kit required (P/N 85235)
- #20 AWG - 2 conductor with polypropylene insulation
- Sold in 50’ increments

SS-100 Water Sensor Cable ................................................................. P/N 43397

SD Series Splice Kit

- Used for splicing pump cable
- #10 AWG - 12 AWG (4.0 mm² - 6.0 mm²)
- Includes butt splices and adhesive lined shrink tube

SD Series Splice Kit ................................................................. P/N 85946

SC Series Splice Kit

- Used for splicing pump cable
- #6 AWG - 12 AWG (4.0 mm² - 16.0 mm²)
- Includes butt splices and adhesive lined shrink tube

SC Series Splice Kit ................................................................. P/N 85902

Submersible Pump Cable

- Red, black and green color code - Ideal for DC pumps
- Sold in 50’ increments

#12 AWG (4 mm²) ................................................................. P/N 43403
#10 AWG (6 mm²) ................................................................. P/N 43433
#8 AWG (10 mm²) ................................................................. P/N 43423
#6 AWG (16 mm²) ................................................................. P/N 43453

Safety Disconnect Kit

- Provides one step disconnect for system
- Outdoor Nema 3R enclosure (2 pole fusible - 30 amp)
- Includes ground block and two 15 amp fuses
- Pole mount using pole clamp kit (P/N 79902) and mounting bracket kit (P/N 79903)
- Enclosure Dimensions: 7.3” x 10.0” x 5.0” (18.5 cm x 25.4 cm x 12.7 cm)

Safety Disconnect Kit ................................................................. P/N 85965
Mounting Bracket Kit

- Mounts safety disconnect (P/N 85965) to pole
- Used with pole clamp kit (P/N 79902)
- Corrosion resistant stainless steel construction
- Two per kit (necessary hardware included)

Mounting Bracket Kit ................................................................. P/N 79903

Pole Clamp Kit

- Mounts CD 300 or CC 2000 controller directly to pole
- Used with mounting bracket kit (P/N 79903) to pole mount safety disconnect kit (P/N 85965)
- Accommodates 2” to 7” diameter pole
- Corrosion resistant stainless steel construction
- Two per kit

Pole Clamp Kit ................................................................. P/N 79902

Ground Rod Kit

- Grounds pump, array, controller and mounting rack
- 5/8” diameter copper clad steel rod
- Includes 10 feet of #6 AWG (16 mm²) bare wire, copper ground clamp and lug

Ground Rod Kit ................................................................. P/N 42800

Lightning Arrestor

- Helps prevent damage from lightning
- Silicon oxide varistor, potted PVC case
- 18” #12 AWG (4 mm²) THHN leads
- Fast response
- Mounts in 1/2” conduit knockout

Lightning Arrestor ................................................................. P/N 36978
**SYSTEM DESIGN CHECKLIST**

This checklist is for your convenience. Not all of the materials listed here are provided by Kyocera Solar. Not all of the Kyocera products shown here are in this catalog. Contact your dealer for additional assistance with these parts.

<table>
<thead>
<tr>
<th>✔</th>
<th>ITEM</th>
<th>SUPPLIED BY KYOCERA</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>SOLAR MODULES</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>MODULE BOLT KITS</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>MODULE INTERCONNECTS</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>ARRAY OUTPUT CABLE</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>ARRAY GROUNDING KIT</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>TRACKER OR FIXED RACK</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>POLE</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>CONCRETE</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

**SOLAR ARRAY**

- Solar Modules
- Module Bolt Kits
- Module Interconnects
- Array Output Cable
- Array Grounding Kit
- Tracker or Fixed Rack
- Pole
- Concrete

**CONTROLLER, DISCONNECTS AND SENSORS**

- Pump Controller
- Mounting Clamps
- Disconnect Switch
- Mounting Bracket Kit
- Water Sensor
- Water Sensor Cable
- Water Sensor Cable Splice Kit
- Ground Rod Kit
- Lightning Arrester
- Fuses (disconnects come with 1 set)

**PUMPS, CABLE AND PIPE**

- SD or SC Series Pump
- Sand Shroud (SD only)
- Pump Cable
- Cable Splice Kit (comes with pump)
- Pipe & Cable Kits (SD Only)
- Pipe & Couplings (SC systems)

**OTHER**

- Electrical Tape
- Wire Ties
- Teflon Tape or Pipe Dope
- Float Switches
- Safety Rope
- Torque Arrester
- Well Seal or Pitless Adapter
KSI Customer Service Return Policy
September, 2001
1-800-223-9907

All authorized Kyocera Solar, Inc. dealers are required to process warranty claims. The dealer must obtain a Return Authorization (RA) number in order to return goods to Kyocera Solar, Inc. Only refused or undeliverable orders may be returned without an RA number.

**Authorized returns will be accepted without a stocking or handling fee under the following conditions:**

1. The goods are returned in original condition and packaging within 30 days.
2. The goods were received damaged, failed, or inoperable.
3. The goods were returned due to failure within the manufacturer’s warranty period.
4. The goods were returned due to customer order error within 30 days.
5. The goods were returned due to salesperson error.
6. The goods were shipped in error.

**Authorized returns will be accepted with a minimum stocking or handling fee under the following conditions:**

1. The goods were returned within 30 days, but not in original packaging. (Minimum 10% handling fee or cost of re-packaging, whichever is greater).
2. The goods were returned after 30 days. (15% handling fee).
3. Custom or special order products may be charged a higher handling fee.

**Authorized returns for non-warranty items will be accepted for repair under the following conditions:**

1. The goods were authorized for return to be repaired.
2. The customer must approve the cost amount of repairs.
3. The goods will not be returned until payment in full has been received.
4. If the customer declines the repairs, the parts will be returned.

**Refused or non-deliverable goods will be handled in the following manner:**

1. In the case of orders refused without prior notification, the receiving party will be charged freight plus 10% handling.
2. In the case of undeliverable goods, the customer will pay freight.

**General conditions and terms:**

2. All returns require a RA except as listed above.
3. The customer is responsible for freight to Kyocera. Except in special circumstances listed above, freight back to the consumer or dealer will be the responsibility of Kyocera Solar, Inc.
4. All questions or concerns must be directed to Kyocera Solar, Inc. Customer Service.
Warranty Terms and Conditions
September, 2001

Warranty Performance
Every product offered is fully guaranteed by the manufacturer. The complete warranty detail of each product is available upon request. The manufacturer’s warranty sets the terms and conditions for repair or replacement of non-conforming material. Kyocera Solar, Inc. offers no coverage beyond the manufacturer’s explicit warranty. Kyocera Solar, Inc. is not responsible for any incidental or consequential damage to persons, property, or other loss or injury resulting from a defect or improper use or installation.

Satisfaction is guaranteed. If you are not satisfied with a product, it may be returned for refund (excluding shipping and handling) within 14 days. All returns are subject to approval. Please contact Kyocera Solar, Inc., Customer Service at 1-800-223-9907 before returning products.

All returns require prior authorization. Before you return a product, KSI Customer Service must assign a Return Authorization (RA) number. This RA number must appear on the outside of the box of any return. Returns without RA numbers will be refused and returned to the shipper. Some shipping and handling charges may be applied. Please refer to the sheet titled “KSI Customer Service Return Policy.”

Return Authorization (RA) Numbers
Please contact KSI Customer Service at 1-800-223-9907 to obtain an RA number. You must have the original Sales Order Number or Invoice.

The Customer Service Representative will have specific instructions for you. All products must be returned to KSI for evaluation. Replacements are not sent automatically except in specific circumstances. You may order a replacement part under dealer terms. If the returned goods are found to be covered under the manufacturer’s warranty, you will be credited the cost of the goods. Otherwise, the repaired or replaced item will be shipped freight pre-paid. The customer is responsible for freight costs to KSI.

Receiving an RA number does not guarantee final disposition. All returns are subject to final inspection. KSI reserves the right to deny any claim.

All merchandise returned for refund or exchange must be received in original factory condition including: packing material, inserts, and manuals. You will be charged for any missing items.

Shipping and Delivery
Replacement parts will be shipped prepaid upon verification of claim. The dealer or consumer is responsible for freight charges to return product to KSI. Merchandise will be shipped by best method.

Shipping Damage and / or Shortage
In the event of shortage of material or visible damage to merchandise, the receiving party must note any damage or shortage on the carrier’s delivery receipt. Please notify KSI Customer Service immediately at 1-800-223-9907. DO NOT REFUSE A DAMAGED SHIPMENT. The receiving party will be charged the full freight amount for any damaged shipment returned to KSI without approval and an RA number assigned.

Special Instructions for Returning Products
1. Never return any product without first obtaining an RA number.
2. The RA number must appear on the outside of the shipping box.
3. We recommend using UPS Ground Service, Insured.
4. Packages sent freight collect will be refused.
Glossary

AC – Alternating current. Electrical energy which reverses its direction at regular intervals, typically 60 Hertz.

Ampere or amp – Electric current is measured in amperes or amps.

Array – A group of solar electric modules connected together.

Battery Bank – A group of batteries wired together to store power in a solar electric system. Allows power to be stored at night, on cloudy days, or to use more power than the array can produce at one time.

Centrifugal Pump – A pump which utilizes rotating impellers to accelerate water upward.

Controller – Converts power from the solar array in a certain voltage-current configuration to a voltage-current configuration more efficiently utilized by the pump.

Current – The rate of flow of an electric charge. Current is measured in amps.

Current Booster – A function of the controller which converts a given voltage and current output from the array to a more useful configuration to the pump typically providing more current but nearly equivalent power.

Diaphragm Pump – A positive displacement pump which utilizes a cam shaft to cause piston displacement. A flexible elastomer (diaphragm) acts as a sealing mechanism in the piston and cam assembly.

DC – Direct current. Electrical energy flowing in one direction and of substantially constant value.

Drawdown – The distance the standing water level lowers when water is pumped from the well at a given rate.

Elevation – Vertical distance from the ground to the input level of a tank or storage means.

Flow Rate – Volume of water provided per second, minute, hour, or day.

FN – Facing North.

Friction Loss – Pressure loss due to the resistance to flow of water in a pipe.

FS – Facing South.

GPM – Gallons per minute.

Ground Mount – A fixed array mounting method for solar modules which has multiple connections to earth.

Inverter – An appliance used to convert independent DC power into AC power.

Kilowatt or kW – One thousand Watts. (See Watts)

Line Loss – Power loss across a length of wire. Copper wire, depending on its size, has a specified resistance per foot. Wire is then adequately sized to meet a specified line loss (typically 3-5%).

LPM – Liters per minute.

Module – Modular solar electric charger; the term is used interchangeably with solar electric panel.

Mounting Angle – Angle of array measured from horizontal.

Parallel Wiring – A system of wiring, for solar electric modules or batteries, which increases amperage. Parallel wiring is "+ to +" (positive to positive) and "- to -" (negative to negative).

Photovoltaic – Converting light into electricity. Photo means "light," voltaic means "electric". Often referred to as "PV" for short. More commonly referred to as "solar electric."
**Glossary** (cont’d)

**Pole Mount** – A stationary pole top array mounting method.

**PSI** – Pounds per square inch.

**Sand Shroud** – An apparatus which "shrouds" the pump (using a collar and section of large diameter pipe) to ensure input water enters the pump from below so that sand and sediment is no longer entrained in the input water.

**Series Wiring** – A system of wiring, for solar electric modules or batteries, which increases voltage. Series wiring is "+ to –" (positive to negative).

**Solar Cell** – The smallest basic solar electric device, which generates electricity when exposed to light. Typical solar modules are comprised of 36 solar cells wired in series.

**Solar Electric** – The preferred term used to describe something which uses sunlight to produce electricity. Photovoltaic is the more technical term.

**Standing Water Level** – The distance from the top of the well to the surface of the water in the well when no water is being pumped.

**Sun Hours On Tilt (S.H.O.T.)** – Number of sun hours at a given angle from horizontal.

**System Grounding** – A means of electrically connecting a photovoltaic system to ground.

**Tank Pressure** – For pressurized systems, pressure of tank in psi or kpa.

**Total Dynamic Head** – A means of expressing the load of a pumping system at a given flow in terms of its equivalent vertical column of water (i.e. vertical lift and friction converted to vertical lift).

**Total Vertical Lift** – The sum of standing water level, drawdown, and elevation.

**Tracker** – An array mounting method which passively rotates with the sun in order to extract more power early and late in the day.

**True Maximum Power Point Tracking** – A feature of the pump controller which ensures the solar array operates at its maximum power point.

**Voltage or Volts** – Voltage is the amount of electrical pressure that causes electricity to flow in the power line. If electricity were water, voltage would measure the amount of pressure at the faucet.

**Watts** – A watt is a measurement of total electrical power. Volts X Amps = Watts.

**Watt Hour** – The quantity of electrical energy used or produced when one Watt is used for one hour.
Kyocera Solar, Inc., one of the world’s largest suppliers of solar electric products, introduces a new link between the sun and one of mankind’s essential needs – WATER.

Pumping water with solar electricity is a natural fit because water is needed most when and where the sun shines the brightest. Solar electricity is the quiet, reliable solution to remote well and surface water pumping anywhere the sun shines.

With more than 18 years experience and thousands of pumps and controllers, and solar modules in service around the globe, Kyocera is the premier solar pumping system manufacturer. Our mission strives for superior products and services for the well being of all living things on this planet.

27 Years Experience in Photovoltaic Technology.