W3/W2

SOLAR WORKHORSE PUMPS

WORKHORSE

Owner's Manual

W3C, W3H, W2H

WORKHORSE. Hard working Solar Pumps for hard working Americans

Congratulations on your **WORKHORSE** Solar Pump and a new era of harvesting sunlight for water on your land - for years and years to come! Our company feels blessed with the support from great customers - the families, the plants, and the animals **WORKHORSE** pumps support. Our engineers have invested millions in making it the best solar water pump you can buy with your hard earned dollars. But we also know it doesn't stop there. Industry leading warranties and USA-based technical support engineers will keep your pump performing at its best for years to come. We hope you enjoy your solar pump, and feel free to reach out to us at any time for support… or for more solar pumps!

Warning: Risk of Electric Shock. Solar panels and batteries can produce a significant amount of energy, which can cause electric shock. Whenever you're working with wiring or connections, make sure to use caution. Be sure to ground the system for safety and to prevent damage to equipment. Remember, safety first! Workhorse is not liable for damage or injuries that result from improper installation technique. If you're unsure about the safety of any step in this manual, please consult a professional.

System Components

1. **WORKHORSE PUMP** — Heavy duty permanent magnet DC motor with laser welded stainless steel housing. Motors have three conductors and one for ground. Unlike the W4 Series, electronics are external on the W3 Series. Pump ends come pre-fastened. Stainless steel and designed for years of pumping. Outlet size varies by pump model. See specification table for exact outlet sizes. Helical (¾" FNPT outlet) and Centrifugal (1-1/4" FNPT outlet) models.

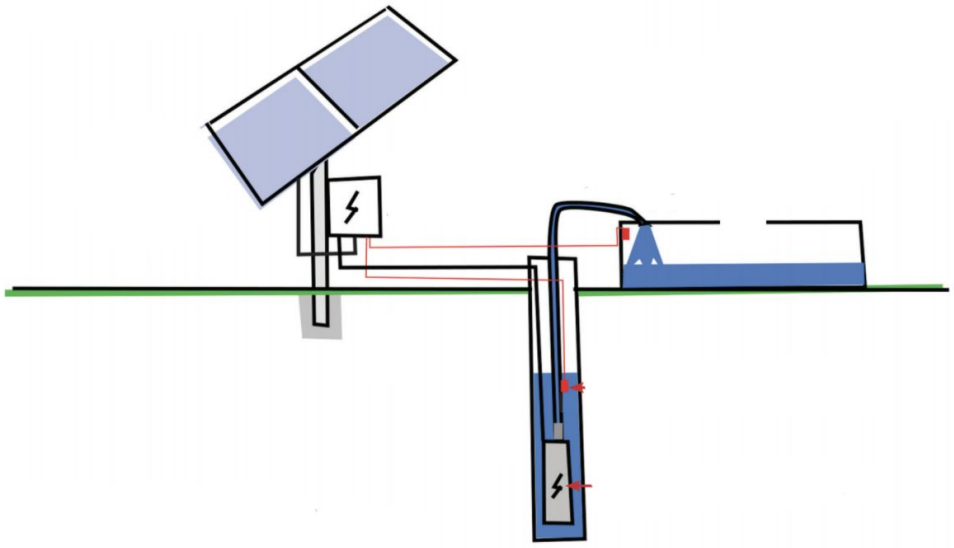
2. **DC101 DISCONNECT SWITCH** — All systems come with a DC101 Cut-off switch for safely shutting down the system. The DC disconnect switch should only be turned on once all electrical connections have been made. Whenever connecting or disconnecting solar panels or pump connections, make sure the DC disconnect switch is turned off between the solar array and the PSC100.

3. **SOLAR PANELS & WIRE**— No matter the brand of solar panel, each module has a Positive and Negative MC4 Connector. Workhorse includes extension wire allowing for quick connection to the DC Cut-off switch. Ensure proper voltage input with a multi-meter BEFORE turning on switch.

4. **PSC100 CONTROLLER** — The controller allows the system to run on solar or batteries. This controller also adds several features such as
    a. Adjustment of Speed with dial
    b. Tank full shut-off with sensor
    c. Low well level shut-off with sensor
    d. Addition of batteries if desired (see Battery Section)

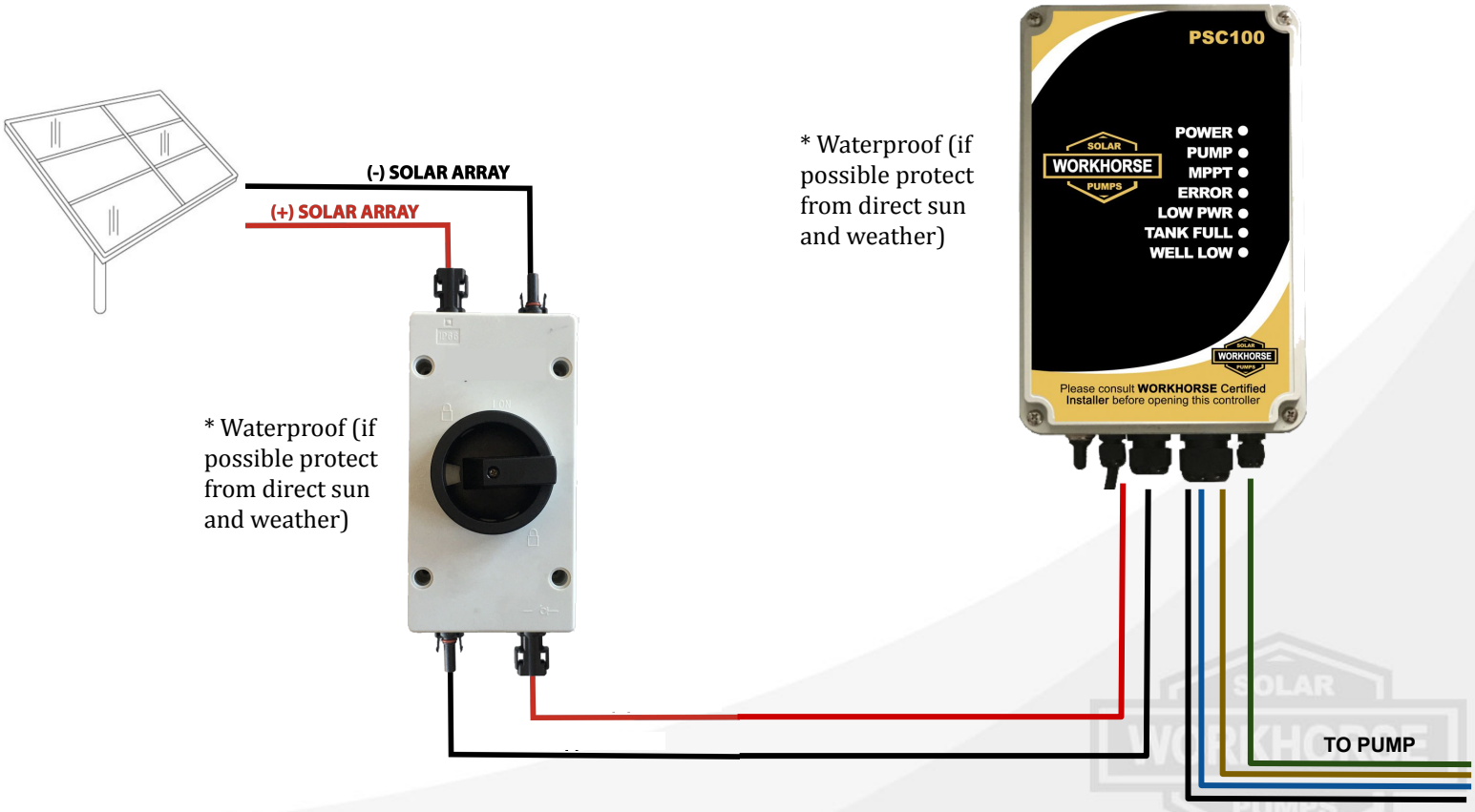
5. **SENSORS** — Depending on usage, systems with PSC100 Controllers may include tank sensors and low water sensors to communicate with the controller. These are 2-wire probes that test for conductivity of air vs. water to signal the controller.

Overview Diagram



DC101 with PSC100

Wiring DC Cut-off Switch/Disconnect with PSC100



PSC100 Wiring Details

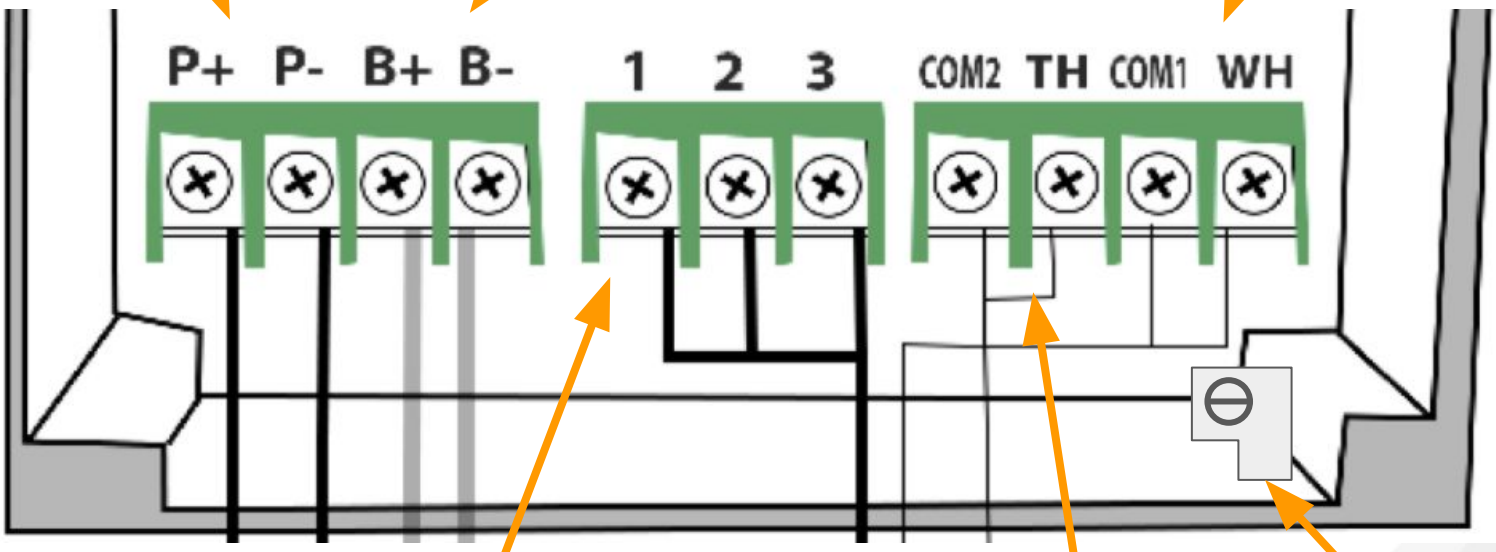
- Supports use of properly sized battery banks
- Connects to low water sensor to prevent over pumping your well
- Connects to tank sensor or pressure switch for shut-off (optional)
- Provides 'Speed' dial to adjust the pumping speed if desired

SOLAR INPUT
Input of Positive & Negative Wires of 24V to 48V Solar Array. (Through DC101)
Vmp Range: 30 - 72V
Max Voc: 90Voc

BATTERY INPUT
Optional, not required.
When using batteries e*nsure proper voltages as discussed in Battery Section*

WELL WATER LOW
For low producing wells use WH & COM1 terminals and 2 wire low water sensor
Connect with *jumper wire if not using sensor*

OPEN CIRCUIT - Pump Off
CLOSED - Pump On



PUMP WIRES - To extend pump wire, splice on three or four strand wire (4 strand for W3 Models, 3 strand for W2 Models), submersible pump cable. 10 or 12 AWG are most common depending on length. On W3, **Ground** wire goes to lug in bottom right.
***** Be careful here as wires 1, 2, 3 from pump cannot be reversed.***

TANK WATER LEVEL
For 'tank full' shutoff, use TH & COM2 terminals with 2 wire sensor or pressure switch

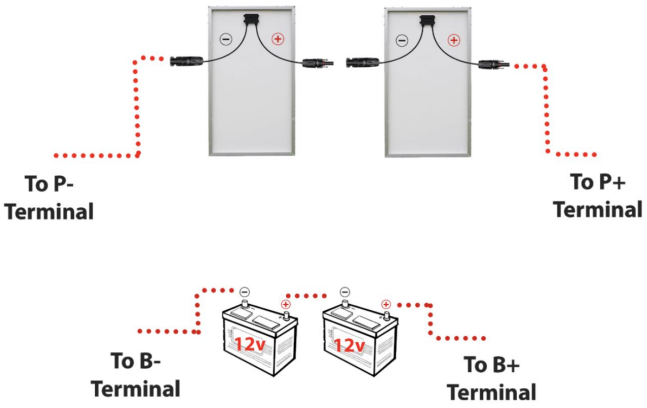
OPEN CIRCUIT - Pump On
CLOSED - Pump Off

GROUND LUG GOES HERE

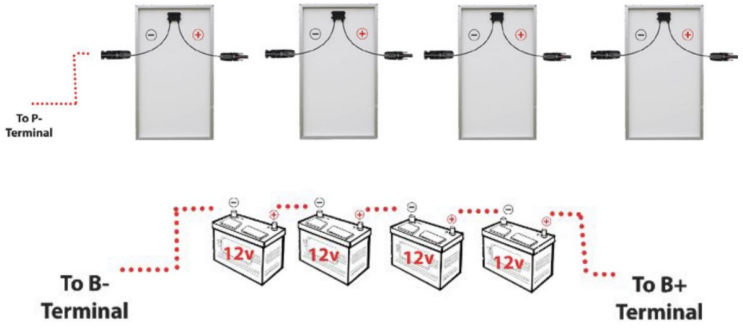
Batteries with PSC100

Your solar well pump system is optionally designed to run on battery power (24V and 48V). While the system runs most efficiently using solar power alone, you can also power it using a battery bank. With that said, whenever possible, engineers recommend optimizing for more pumping during daylight hours into a storage tanks for overnight use rather than adding the expense and complication of batteries.

'24V' Wiring



'48V' Wiring



Recommended

When your controller is set to BAT mode, the solar panels will charge the batteries, and the pump will run off battery power rather than solar power directly. There is a PWM solar charge controller inside your pump controller that facilitates charging, prevents overcharging, and prevents discharging batteries to a damaging level. During charging, some power and voltage is lost, leading to a 15% to 25% decrease in pumping efficiency. These decreases are greater for deeper wells and higher heads. **48V battery banks are recommended over 24V for better performance.**

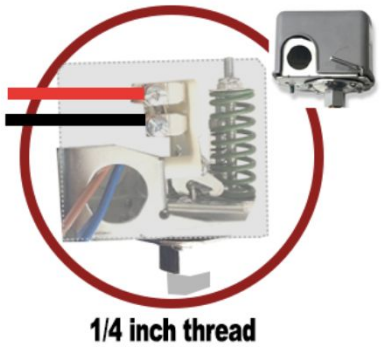
Batteries must be deep-cycle batteries, not standard car batteries. Deep-cycle batteries are designed to accommodate much lower continual discharges than regular car batteries and are usually sold as "marine" or "RV" batteries. If you are adding batteries in order to pump more water than is possible in a solar day, you will need to increase the number of solar panels in your system. Add solar panels in parallel to maintain the same voltage to the controller. More batteries can also be added for greater total storage capacity, as long as they are added in parallel at the same voltage.

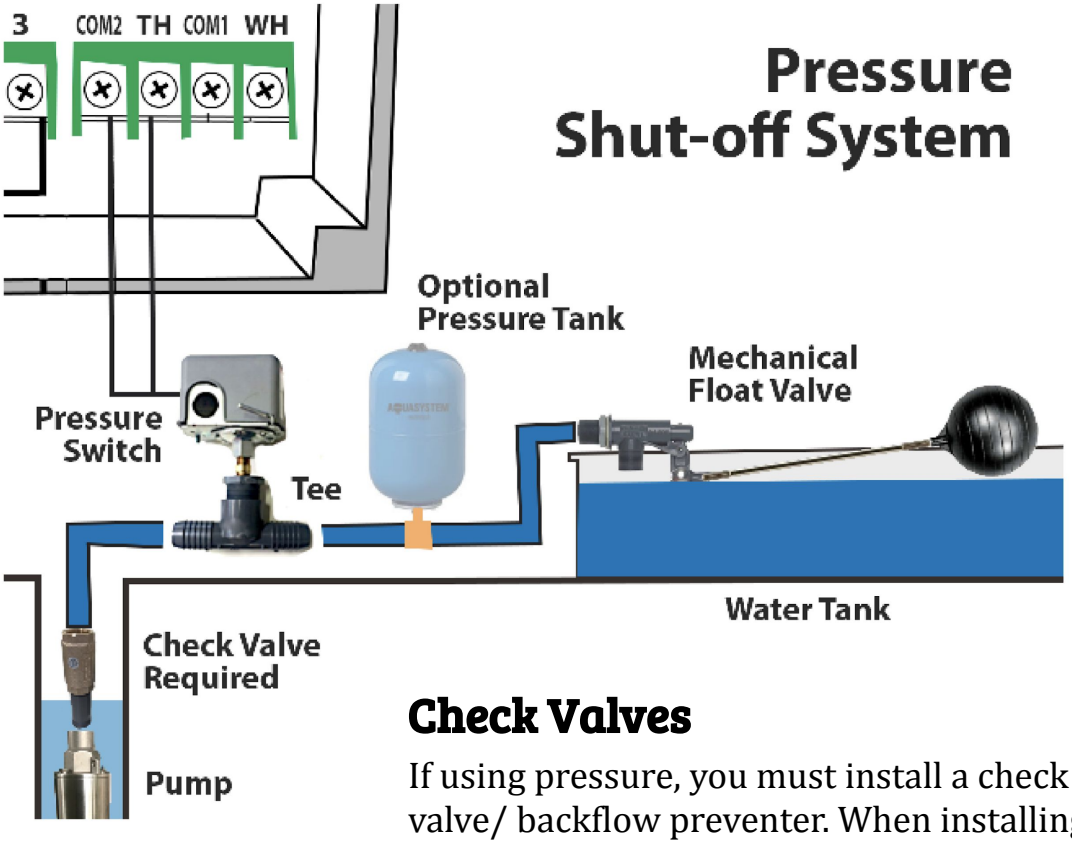
Nominal battery voltage must be that same as solar array voltage. If you're using 12v solar panels, use the same number of solar panels in series as batteries. Shown above using 2x 12v solar panels with 2x 12v batteries and 4x 12v solar panels with 4x 12v batteries.

Pressure Shut-off with PSC100

Use 'Reverse Action' Pressure Switch

To utilize pressure to shut-off your system, you'll need a pressure switch somewhere in your plumbing line. The compatible pressure switch (called 'Reverse Action') will be normally open, and closed when your system is up to pressure. You'll need the terminals on only one side of your pressure switch. Wire from the two screw terminals next to each other (remove gray cover to access) to the terminals labeled TH & COM2 in your PSC100 controller. Use two strand 18-22 gauge wire. Polarity does not matter here.





Check Valves

If using pressure, you must install a check valve/ backflow preventer. When installing a check valve, you'll need a threaded nipple to connect to the outlet of the pump. Check valves are frequently made of brass and your pump is made of stainless steel; to prevent electrolysis, use a PVC threaded nipple and a PVC barb, or all stainless steel.

PSC100 Indicator Lights

POWER
Green when power is connected to the controller

PUMP
Green when when running

MPPT
Flashing green when maximum power point is tracked (This is normal)

3-WAY POWER SWITCH
Solar - Off - Battery

ERROR
Excessive current; check pump wire for a short, ensure battery voltage correct

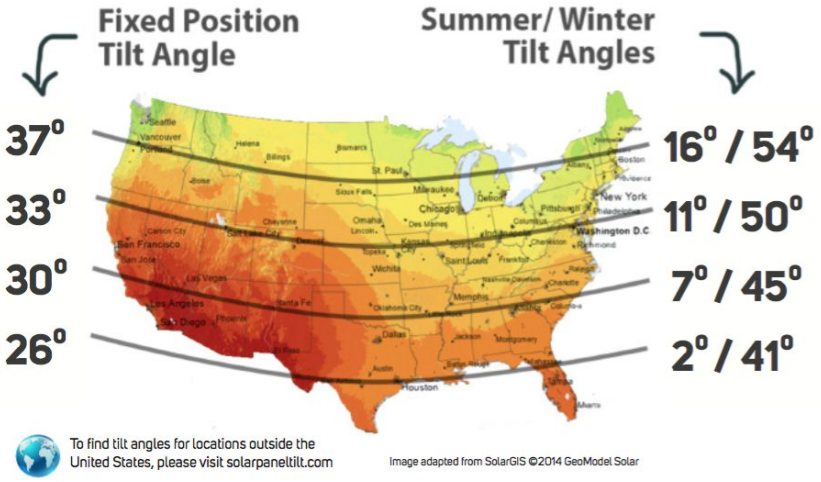
LOW PWR
Low power; common at sunrise, sunset, and on cloudy days. Cycling LOW PWR can indicate pump wire splice issue

TANK FULL
Red when tank sensor is submerged; pump will not run when tank is full

WELL LOW
Red when low-water sensor is out of water or wires are disconnected; you may also need to reset by switching from SOLAR to OFF and back to SOLAR
Flashing: Low-water time delay is activated

Site Planning

✓ **PANEL LOCATION-** Solar panels should be mounted on a secure structure, ground mount or top of pole mount. Panels should face true South and at an angle appropriate for your latitude. If you are mounting your panels on an already existing structure, try to get as close to the correct angle as possible.



✓ **GROUNDING-** It is important to ground the entire solar well pump system to ensure proper safety and to prevent damage in the event of a lightning strike but also to prevent static buildup. In lightning prone areas, this is especially important and a long dedicated copper ground rod should be installed near the solar panels and controller. If the well casing is metal and local code allows, it can be used for an Earth ground, instead of dedicated ground rod. Do not connect the sensors or the solar panel returns (-) to Earth ground.

✓ **AC POWER-** If use of AC power is desired, a 120v AC to 36 or 72V DC converter is needed.

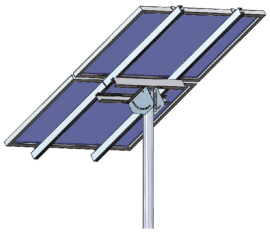
✓ **AVOID SHADOWS-** Choose a location for the panels that gets plenty of sun and is free from daily shadows. One of the most common issues with low performing systems is shadows on the solar arrays. Even a small shadow on one part of a panel can restrict current for all of the panels, significantly affecting system performance.

KEY POINTS

- Mount the solar panels facing south at an angle appropriate for your latitude.
- Avoid all shadows on the solar array. Even a small shadow on one part of a panel can restrict current for all of the panels, significantly affecting system performance.

Solar Panels & Sensors

Using 100W Solar Panels and Adjustable Tilt Top-of-Pole Racking

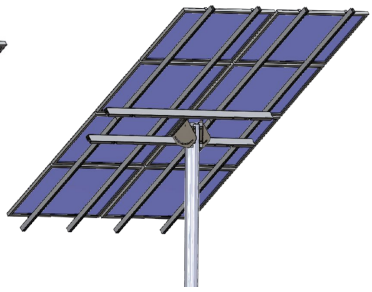


200 Watts
2P - 2 Panels

Mounts to 2”
ID, 2-3/8” OD
Steel Post

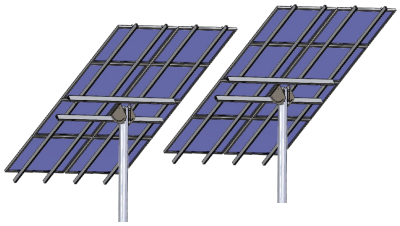
400 Watts
4P - 4 Panels

Mounts to 4”
ID, 4-1/2” OD
Steel Post



800 Watts
8P - 8 Panels

Mounts to 4”
ID, 4-1/2” OD
Steel Post

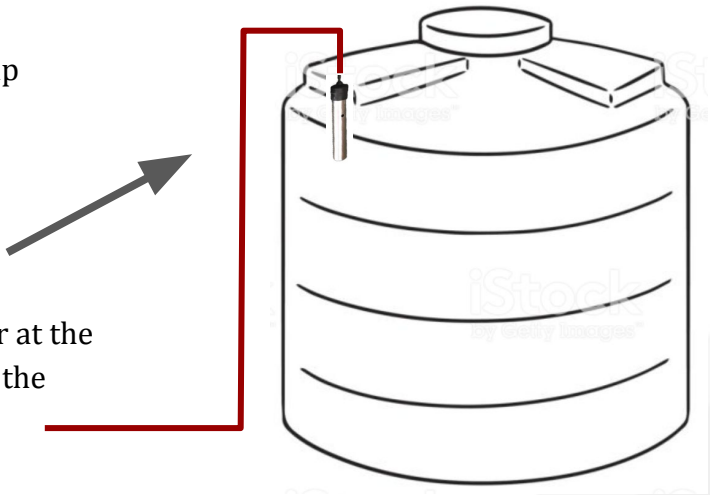


1200 Watts
2x 8P - 12 Panels
6 panels on each
or
3x 4P - 12 Panels
4 panels on each

4-1/2” OD Post

Tank Full Sensor

Provides an electrical signal when the tank is full to the PSC100. An open circuit tells the controller to pump when tank sensor is dry, and stop pumping when it is submerged and circuit is closed (ie. tank is full) Polarity does not matter - Wire from sensor can be extended with 2 strand 18-22 AWG wire as it only carries a signal. Connect the wire ends to the COM2 sensor terminals in the PSC100. Fasten the tank sensor at the top of the tank or whatever level in the tank you’d like the pump to stop.



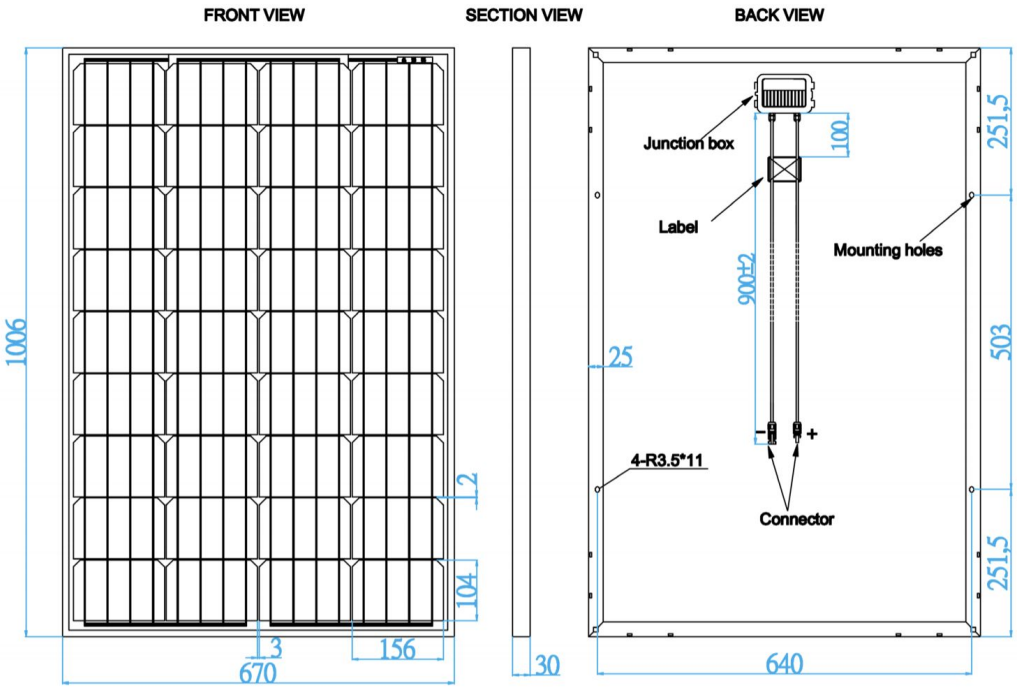
Low Water Sensor

Optional but encouraged with helical pumps and low producing wells that have danger of running dry. Leave WH & COM1 terminals jumped if not using sensor or to wire out. Low water sensor can be zip tied or electrical taped to the drop-pipe a few feet above the helical pump (as shown on right) A total length of 100ft of 2 strand wire comes pre-spliced on the standard sensor but wire can be extended with 18-22 AWG. Polarity does not matter here.

Solar Panel Specs

Main Brand: Back40 B40-100W
Dimensions: ***42.5 in x 20.25 in x 1.2”*** *Weight: 17 lbs* *Peak Power: 100W Mono*
Max Power Voltage (Vmp): 18.0V Open Circuit Voltage (Voc): 21.6V
Max Power Current (Imp): 5.55A Short Circuit current (Isc): 6.11A

Alternative Brand: Rich Solar RS-M100
Dimensions: ***46.7 in x 20.1 in x 1.4”*** *Weight: 16.5 lbs* *Peak Power: 100W Mono*
Max Power Voltage (Vmp): 18.2V Open Circuit Voltage (Voc): 22.1V
Max Power Current (Imp): 5.49A Short Circuit current (Isc): 5.93A



UL1703 Certified per Intertek ETL Nationally Recognized Testing Facility

Tested to Hail, Wind Requirements, IEC 612512 / IEC 61646

UL1703 Standards comply fully with NRCS

Measurements in mm

Solar Array	Solar Panels	Strings in Parallel
200w	2x 100w	All in Series
400w	4x 100w	All in Series
800w	8x 100w (Wired 4 and 4)	Two Parallel Strings of 4 with “Y“s
1200w	12x 100w (Wired 4, 4, 4)	Three Parallel Strings of 4 with “Y“s

Note: Do not connect more than four 100W panels in series. This will overvoltage and damage the system

You will link your solar panels together and connect to the controller by clipping **MC4 connectors** together. Each MC4 connector is either a male end or female end (see image). They simply snap together to make safe and easy connections.

Non-Standard Solar Arrays

While easier and safer to use approved 100w solar panels, some remote job sites may already have pre-installed solar panels. To protect your pump and optimize performance, solar panels must be chosen carefully. *Sometimes existing solar panels can be rewired to be compatible, ask Workhorse if unsure.*

SOLAR INPUT (VDC)

Max Voc: 90V
Max Power: 1200W
Min Array Vmp: 36V

To Calculate Array Voltage

1. Find the Solar Panel Sticker
(on reverse side under junction box)

Stats you'll need from sticker.
Total Power (**Pmax**, Watts)
Voltage Max Power (**Vmp**, Volts DC)
Voltage Open-Circuit (**Voc**, Volts DC)

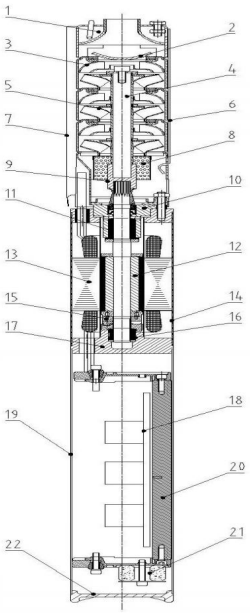
2. Calculate Array Voltage & Power
Array Voltage: # of Solar Panels x Vmp
Array Voc: # of Solar Panels x Voc
Array Power: # of Solar Panels x Watts

Most Common Size Solar Panels	
"12V Panels"	**"24V Panels"**
Each panel is different but in general.. **Vmp** is 16v - 20v **Voc** is ~20v - 23v	Each panel is different but in general.. **Vmp** is 30v to 37v **Voc** is ~38v to 45v

	W3C, W3H, W2H	**W4C, W4C, W5C**
Min Solar Array Voltage (VDC)	30v Vmp	60 Vmp
Max Solar Array Voltage (VDC)	**72 Vmp, 90 Voc**	360 Vmp, 440 Voc
Optimal Solar Array Voltage (VDC) *Examples Arrays*	**24v / 48v** (36-72 Vmp) ***Examples*** *2x 100w 12v panels in series (24v)* *1x 300w 24v panel (24v)* *2x 180w 24v panels in parallel (24v)* *4x 100w 12v in series/parallel (24v)* *4x 100w 12v panels in series (48v)*	60-360 Vmp ***Examples*** *4x 100w 12v in series (72 Vmp)* *16x 100w 12v in series (288 Vmp)* *10x 290w 24v in series (320 Vmp)* *12x 100w 12v in series parallel (2 strings of twelve, 216 Vmp)*

W3 Series Specifications

Power Input	**DC Only** DC 24 – 72VDC Max Voc 90V Current Range: 1.5 – 11A
Input Range	170w – 1200w
Run Time	Unlimited, Continuous Duty Solar: 5-10 hours/day area dependant
Start/Stop	No Limit (soft start built in)
Angles of Operation	Vertical (upright) or Horizontal (90 deg)
Liquid Characteristics	pH 5 to 9, Maximum temperature 100F Sand Content: <1g/m3 for helical, <50g/m3 for centrifugal
Certifications	CE, TUV
Speed Range	500 – 4500RPM
Diameters	2", 3"
Protection Class	IP 68
Max Submersion Depth	450ft (Additional check valve required over 250ft of head)



1 Discharge chamber *Stainless steel*
2 Non-return valve *Stainless steel*
3 Guide vanes *PC/Stainless steel*
4 Pump Shaft *Stainless steel*
5 Impeller *POM/Stainless steel*
6 Impeller Fastener *Stainless steel*
7 Cable Cover *Stainless steel*
8 Pump Inlet *Stainless steel*
9 Shaft coupling *Stainless steel*
10 Upper Bearing Housing *Stainless*
11 Upper Bearing *Silicon Carbide*
12 Permanent Magnet Rotor
13 Motor Stator
14 Pump Housing *Stainless steel*
15 Thrust bearing *Graphite*
16 Lower Bearing *Silicon Carbide*
17 Lower Bearing Housing *Stainless*
18 Controller Housing *Stainless steel*
19 Controller Housing *Stainless steel*
20 Heatsink *Aluminium*
21 Inductor
22 Base *Stainless steel*

W 3 H - 5 - 200

Pump Type
W = Well Pump

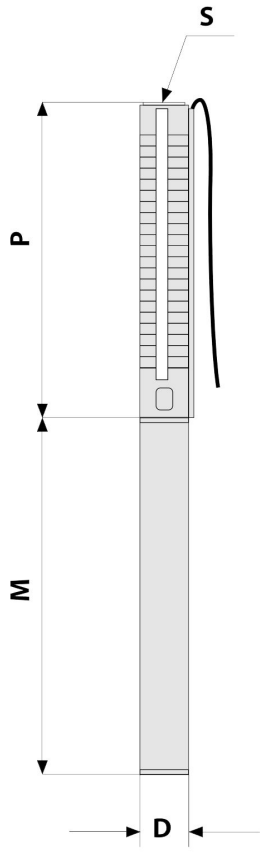
Pump Diameter
Will fit this size casing (inches)

Pump End Type
H = Helical Rotor
C = Centrifugal

Max GPM
GPM at optimal power and low head

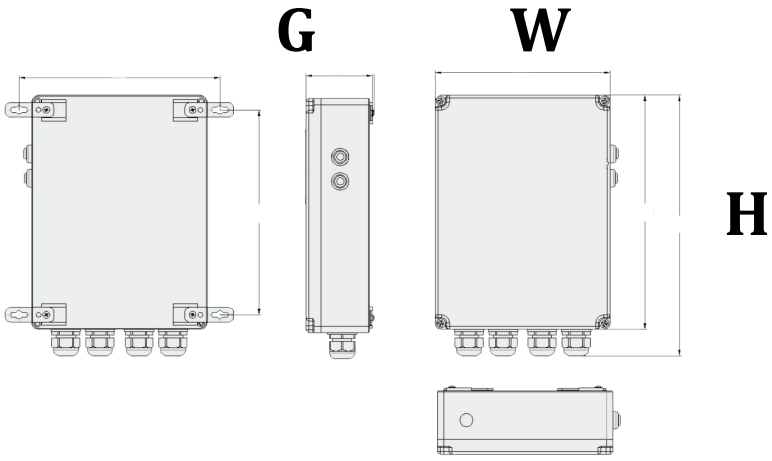
Max Head
Feet of Head (TDH) at optimal power

W3 Series Dimensions

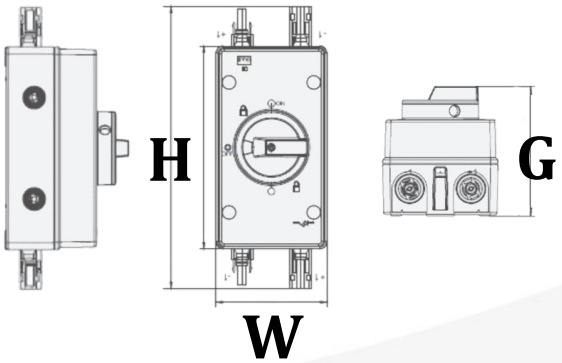


	W3C	W3H	W2H
S	1” FNPT	3/4" FNPT	1/2” FNPT
P	12 ¼”	9”	9”
M	8”	8”	14”
T	20 ¼”	17”	23”
D	3 ½”	3.01”	2.01”

PSC100



DC101



	DC101 Switch	PSC100 Controller
H	7” / 10”	10.5”
W	3.75”	7.25”
G	4.5”	3”

Parts & Tools for Install

Tools to bring

- Wire stripper/crimper
- Screwdrivers (flat and Phillips head)
- Electrical tape (for wrapping around wire to drop pipe)
- Teflon tape for tight thread connections (recommended)
- Adjustable wrenches
- Heat gun or torch for heat-shrink sleeves
- Multimeter (highly recommended)

Other Equipment

Drop Wire
Most use 12 gauge 3 or 4-strand wire (W3 Models get 4 strand, W2 get 3 strand) to extend the pump wire to your desired depth. For deeper wells, consider thicker gauge wire.

Sensor Wire
To extend the low-water sensor and tank sensor wires to the necessary depth, use 18-22 gauge 2-strand signal wire. 100ft is attached to sensors for convenience.

Drop Pipe
PVC, Steel, Black poly pipe. For solar, more guys are moving to poly pipe that is at least 160psi. Workhorse carries barbed couplings and hose clamps in ¾", 1", 1-¼"

Plumbing Parts
Proper couplers and thread tape to attach pump's female thread to your drop pipe, and at the top of the well casing.

Safety Rope / Line
The drop pipe will hold the pump, but the rope will support the pump in case the drop pipe breaks or is damaged.

Grounding
Grounding rod and bare copper wire to ground your system.

Well Seal
A cap or seal and plumbing for the top of your well casing or pitless adapter.

Torque Arrestors & Spacers
With slow-start and slow-stop pumps like WORKHORSE, torque arrestors are far less commonplace and are usually omitted during installation. There is no sudden starting and stopping of the motor.

Solar Panel Racking
Hardware to mount solar panels unless using WORKHORSE adjustable tilt pole mounting.

Mounting Posts
For WORKHORSE racking, you'll need 8ft to 10ft of 2" ID, 2-3/8"OD (for the 2-panel mount) or 4" ID, 4-1/2"OD (for each 4P and 8P mount system) Schedule 40 Steel Pipe

W3/W2 Series Start-up

DO NOT RUN PUMP UNTIL SUBMERGED, PUMP SHOULD NEVER RUN DRY

After Drop Wire and Drop Pipe have been properly installed, pump has been dropped and set in place, connect 1,2,3 (and Ground if you have W3) wires in the correct order from your pump to your PSC100.

Be sure DC101 Cut-Off Switch is in the OFF Position before any wiring is done

Once wiring is complete, turn on the DC101 and open a valve about 25% before turning the PSC100 to ON position to ease into full RPM.

FIRST 5 MINUTES
We recommend starting the pump with a valve or restriction at the well head to restrict flow to 25% for the first 5 minutes. This ensures sand and debris is not stirred up and into the pump. Check the pumped water for sand or other solid particles and ensure the water is clean. WORKHORSE pumps are designed to pump clean water and the lifespan of your pump will decrease (and warranty may be void) if pumping water with high amount of particulates. After 5 minutes flow can be increased to full. **NOTE: Valve should be opened slowly** to allow pump and motor to accelerate normally up to full RPM.

FIRST 30 MINUTES
We recommend running the pump for a period of 30 minutes to check that it does not pump the well dry. This would be obvious with surging flow or fluctuations on pressure gauge.

System Troubleshooting

TEST1: CHECK SOLAR PANELS

By far the number one issue with systems are the solar panels being incorrectly setup or located. Make sure testing is performed on a sunny day and there are no shadows on the solar array. Even a very small shadows on one panel will impact output of all panels. Adjust your panel angles for the season and make sure they are facing south. Avoid testing on cloudy days.

TEST 2: SOLAR CONNECTORS

Second most common issue are the solar panel connectors not making contact. Either the connectors are not fully seated, or the internal pins are not fully seated in the connector housing. Check all connectors and make sure the wire is fully seated and locked into the housing. Check for DC voltage at the output of the DC disconnect.

TEST 3: SOFT RESET

Toggle the switch on the bottom side of the PSC100 controller to the middle position to shut the pump down. Wait a few seconds and then power back up. Once powered up, you'll have to wait a few seconds before the system will begin pumping.

TEST 4: CURRENT CHECK

Use a clamp on amp meter to check for DC current flowing through the solar panel wires into the controller. Current is an indication the motor is running but there might not be enough power for the water to reach the surface. Record this current and compare against Imp on the backside of the panels. Current output is directly proportional to amount of sunlight on the panels.

TEST 5: HARD RESET

If the controller/pump is getting power but not operating perform a hard reset. Turn off DC101 Cut-off switch to disconnect all power from the controller, allow the system to power down for about a minute and power back up. Once powered up, you'll have to wait a few seconds before the system will begin pumping.

System Troubleshooting

Issue	Possible Causes	Test/Fix
No Lights, No Water	Solar power not reaching pump DC cut-off switch or 3-way switch on PSC100	Check all MC4 connections **TEST 1, TEST 2**
All Blinking Lights	Not enough power to commence start-up	Usually the solution is to wait til the morning!
Lights but No Water **No Red or Orange Lights**	Spinning Backwards Not overcoming head	No positive pressure in the line with thumb on pipe? The order of the wires get switched? Pull pump and check mechanism. Screwed on still?
Cycling with **Low Power Light**	Not enough power is reaching the pump Failed Underwater Splice **PSC100 Speed Dial not on 10**	Turn the controller off and then remove 1, 2, and 3 wires. With your multimeter on resistance, test the Ohms between wires 1 and 2, 2 and 3, 1 and 3. If readings are not all the same, you have a leaky wire splice in a wire.
Low Flow Rate	Not enough power is reaching the pump Too late / early in the day for sufficient current from solar panels	Eliminate any shade from the solar panels **TEST 1, TEST 4** Check PSC100 Speed Dial
Decreased Flow Rate	Pumping dirty / sandy water	Check water pumped to ensure it is free of any particles, rust, sand etc
RED Tank Full **Light On**	Tank sensor not wired properly. If not being used, TH and COM2 terminals need to be OPEN Pressure switch issue, ensure pressure switch contacts are in correct position to start	Ensure tank sensor is not submerged or shorted. **After adjusting sensors, do a soft reset by toggling power switch.**
RED Well Low **Light On**	Low well sensor not submerged - If not being used, WH and COM1 terminals need to be jumped / CLOSED	Ensure low well sensor is submerged. **After adjusting sensors, do a soft reset by toggling power switch.**
Surging Water	Low water level in the well Failed Underwater Splice	Pumping rate is too great for the well. Must shut-down and install low water sensor to prevent pump from running dry.

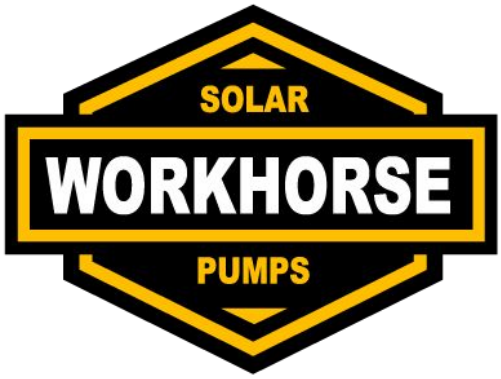
MAINTENANCE

- We recommend wiping down the surface of your solar panels every 3–6 months (more often if you're in a dusty area)
- For helical pumps every 10 years we recommend replacing the helical pumping mechanism or if your flow rate shows a significant decrease. Decreasing flow rates often mean sediment/sand in the water. Replacement mechanisms can be purchased and replaced by Certified Installers.

WARRANTY

- WORKHORSE extends a comprehensive warranty discussed fully in the attached documents. Work with a Certified Installer for more information or to submit a claim.

Notes:



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