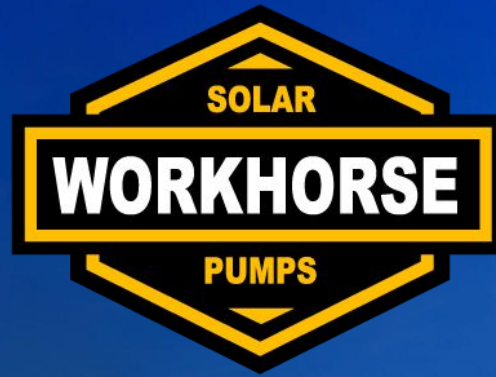


W4



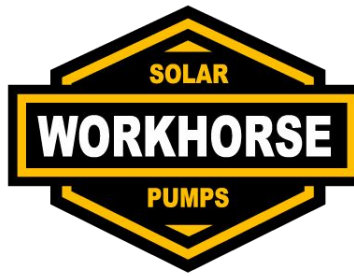
WORKHORSE Owner's Manual

W4C, W4H, W5C



**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!



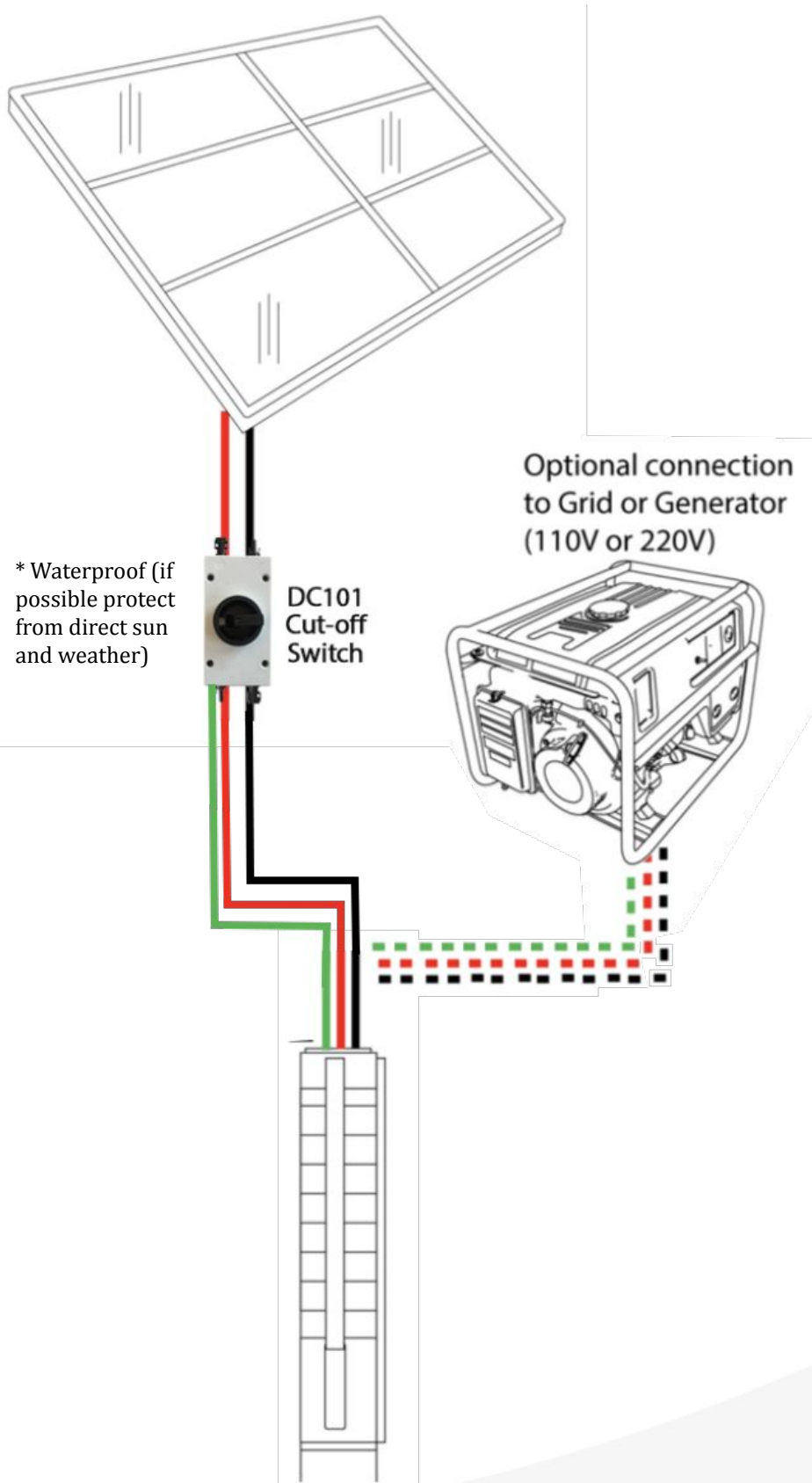
Warning: Risk of Electric Shock. Solar panels and batteries can produce a significant amount of energy, which can cause electric shock. Whenever you're working with wiring or connections, make sure to use caution. Be sure to ground the system for safety and to prevent damage to equipment. Remember, safety 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

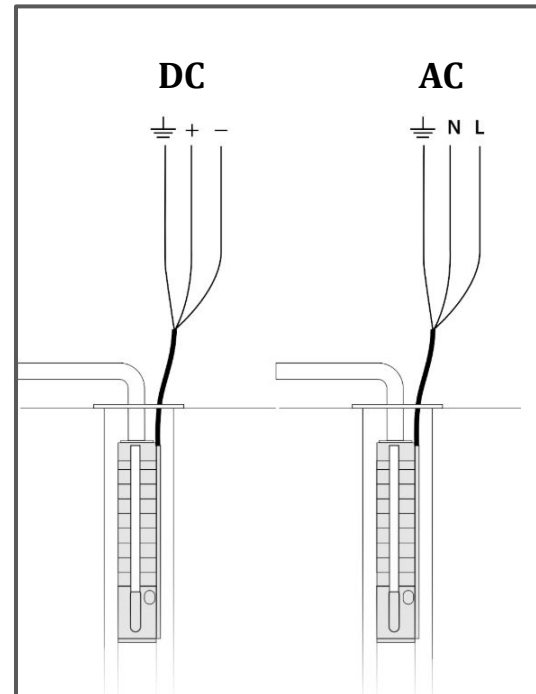
- 1. PUMP MOTOR** — Heavy duty permanent magnet AC/DC motor with laser welded stainless steel housing. The motor has a built in, state of the art controller and can operate from both AC and solar (DC) directly. Motors have three conductors, two for power and one for ground. Polarity of the two power wires are labeled but ultimately polarity does not matter as the controller can correct for reverse polarity.
- 2. PUMP END** — Pump ends are stainless steel and designed for years of pumping. Outlet size varies by pump model. See specification table for exact outlet sizes.
- 3. 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. Even when using a PSC200 controller, the DC disconnect switch should be installed between the solar array and the PSC200.
- 4. SOLAR PANELS & WIRE**— Optional as pumps can also run on 110v or 220v AC. No matter the brand of solar panel, each one has a Positive (male) and Negative MC4 Connector and extension wire allowing for quick connection to each other and to the DC Cut-off switch.
- 5. PSC200 CONTROLLER (optional)** — The controller is optional, and allows the system to automatically switch from solar operation to AC operation, whether supplied by a generator or grid power. This optional controller adds several features such as
 - Auto AC/DC power switching
 - Tank full shut-off
 - Low well level shut-off (for helical pumps, auto-sensing in centrifugals)
- 6. FLOATS / SENSORS (optional)** — Depending on usage, systems with PSC200 Controllers may include float switches and low water sensors to communicate with the controller. Low water sensors not required for W4C or W5C pump and may be pre-wired to pump on some newer W4H models.

Overview Diagram

Solar Panels with DC101 Cut-off Switch (or generator)



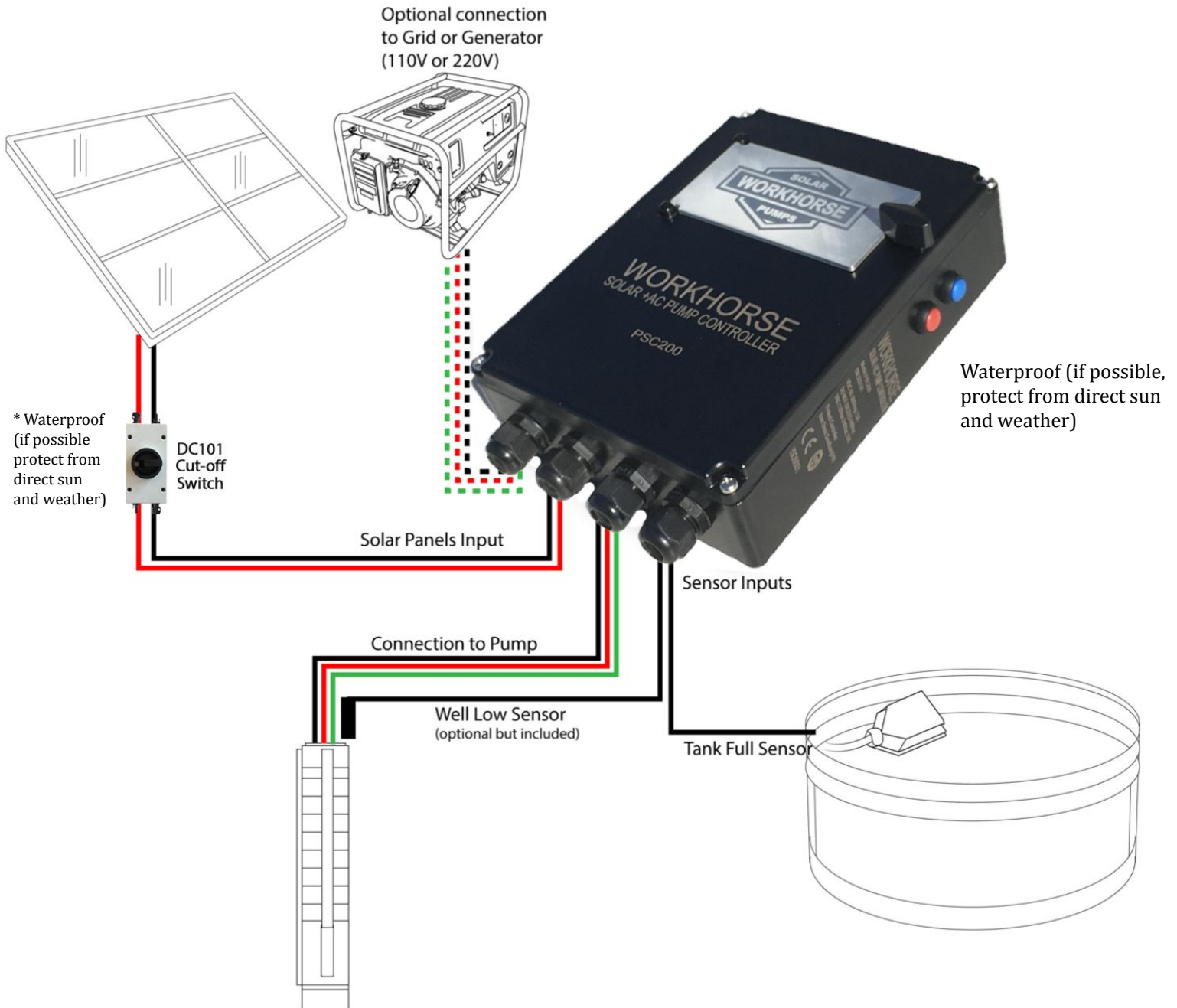
WIRING OPTIONS



Overview Diagram

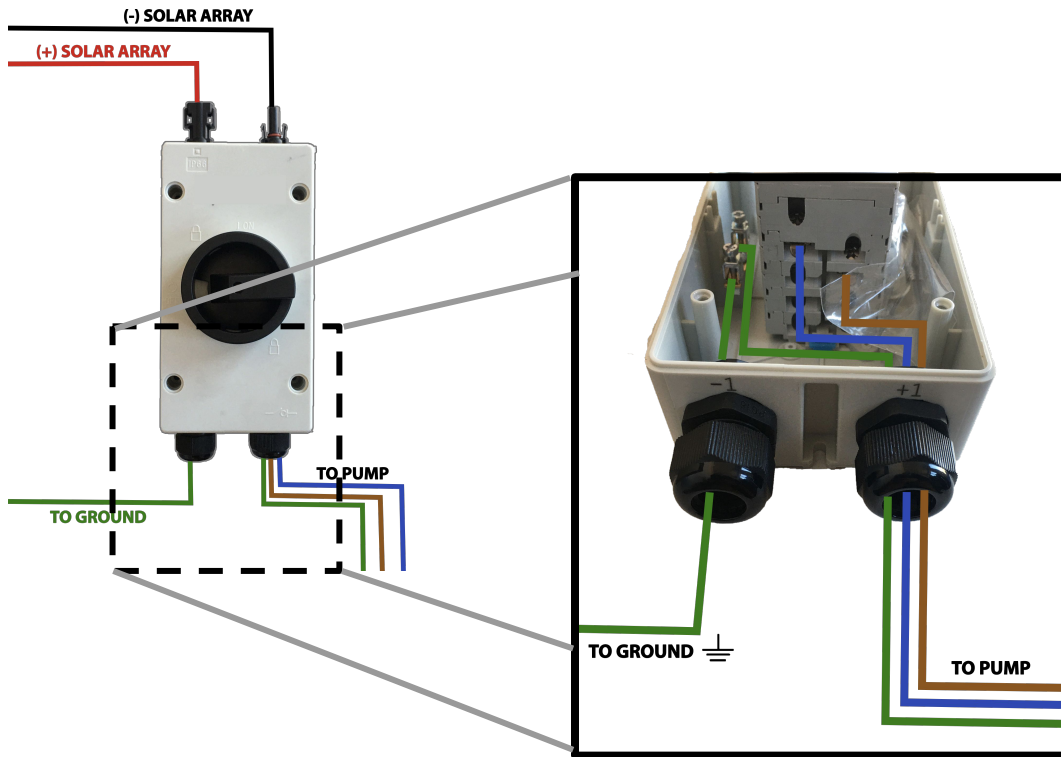
With PSC200, Tank Float Sensor, Stand-alone Low Water Sensor

(Pre-wired to pump on some newer W4H models)



DC101 without PSC200

Wiring DC Cut-off Switch/Disconnect Without PSC200

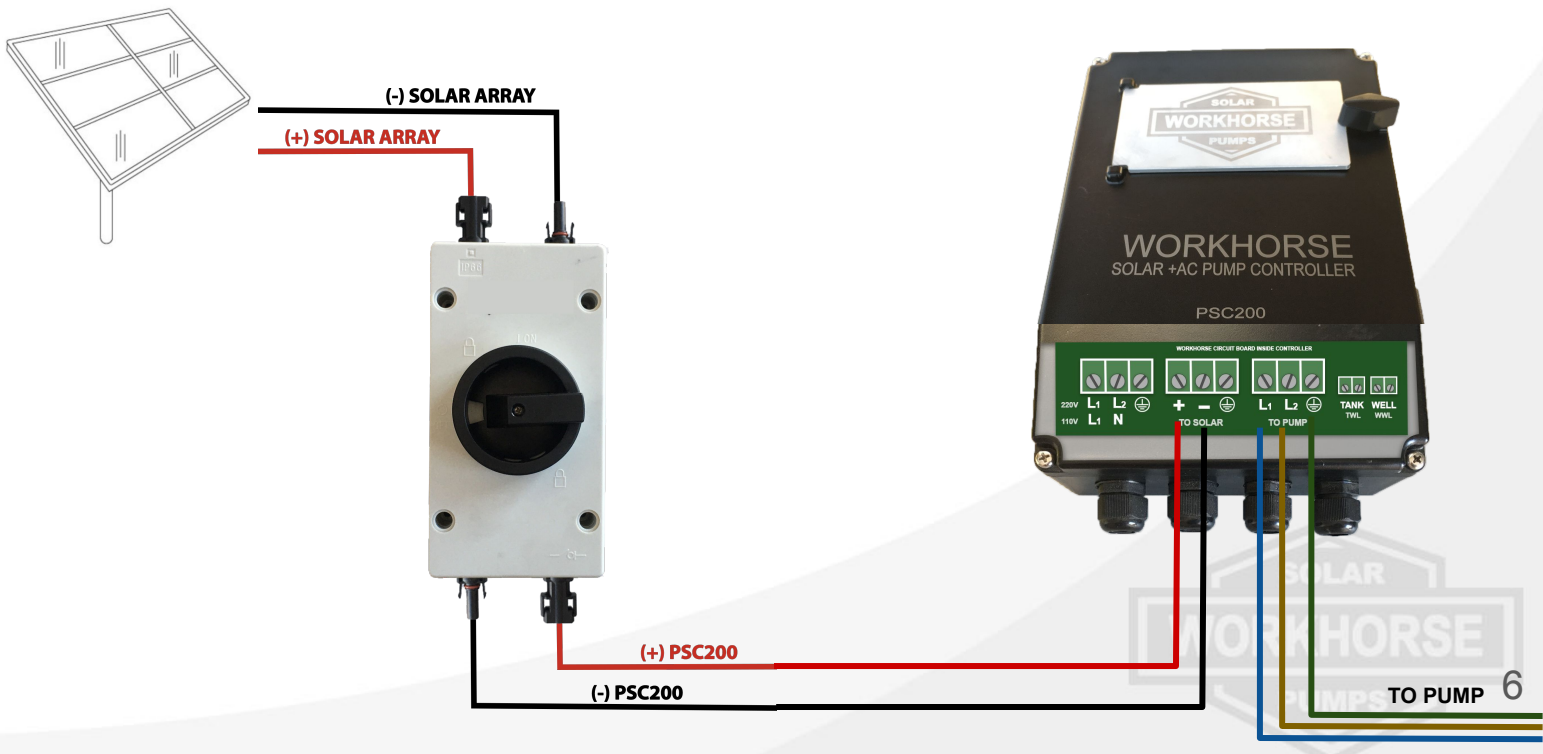


** It is highly recommended to use a DC Cut-off Switch / DC Disconnect on every solar pump install.*

This switch can be bypassed if powering the solar pump directly with AC Power

DC101 with PSC200

Wiring DC Cut-off Switch/Disconnect with PSC200



PSC200 Wiring Details

Your PSC200 allows you to:

- Automatically switch between solar and 110V or 220V AC power
- Some older model, wire a stand-alone low water sensor to prevent running dry
- Connect a tank float switch or pressure switch for shut-off

AC INPUT

Input of 110 or 220VAC.
Can be used with 2000-4000
Watt Generator depending on
model

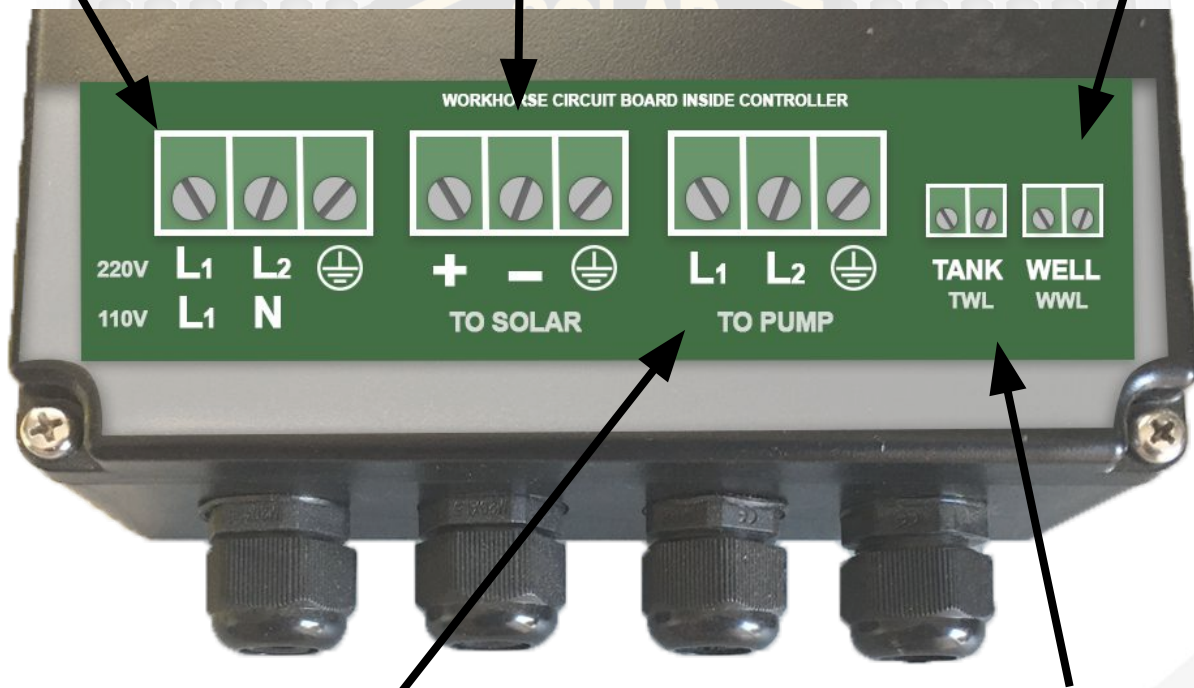
SOLAR INPUT

Connects to solar array
through DC Cut-off Switch
Ensure Proper Grounding

WELL WATER LOW

When low water sensor does
not come pre-wired to W4H
pumps, use WWL terminals
and included 2 wire low
water sensor

OPEN CIRCUIT - Pump On
CLOSED - Pump Off



PUMP WIRES - To extend pump wire, splice on two strand + ground (three total strands), submersible pump cable. 10 or 12 AWG are most common depending on length. Label wires L1 and L2 (or L and N) from pump can be reversed but Ground wire must be in the Ground terminal.

TANK WATER LEVEL

For 'tank full' shutoff, use TWL terminals for use with tank float or regular action pressure switch. Connect with *jumper wire* if not using sensor or pressure switch

OPEN CIRCUIT - Pump Off
CLOSED - Pump On

PSC200 Indicator Lights

Sensor Indicator Lights
If any RED, System Not Running
FULL = Tank Full
EMPTY = Well Low

Mode Indicator Lights

SIDE BUTTONS

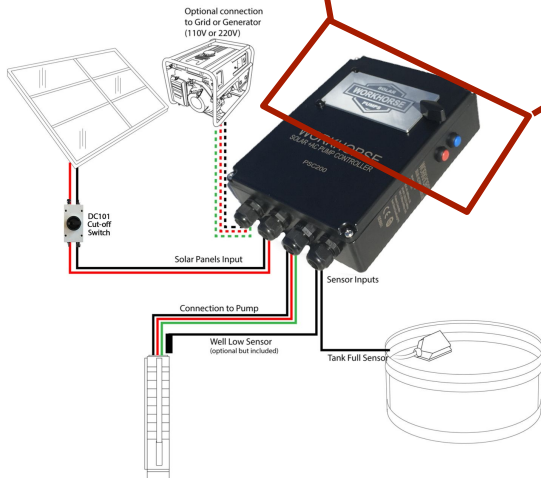
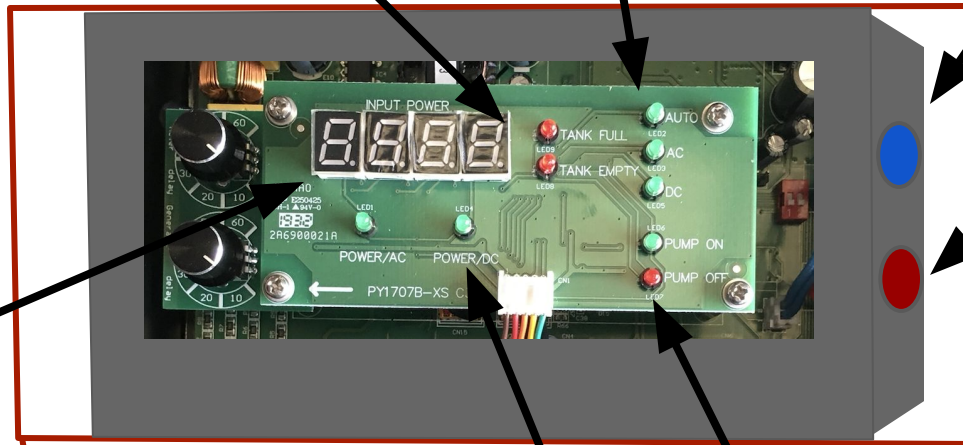
MODE - Toggle
*SOLAR, AC, or
 AUTO (Switching)*

POWER
 Button
 Toggle Pump
 On & Off

DISPLAY
 1. Startup
 Countdown from
 120 seconds
 2. Power draw
 during operation
 (in watts)

PUMP Operation
 Light - Illuminated
 when running

POWER
 Available Power
 Sources

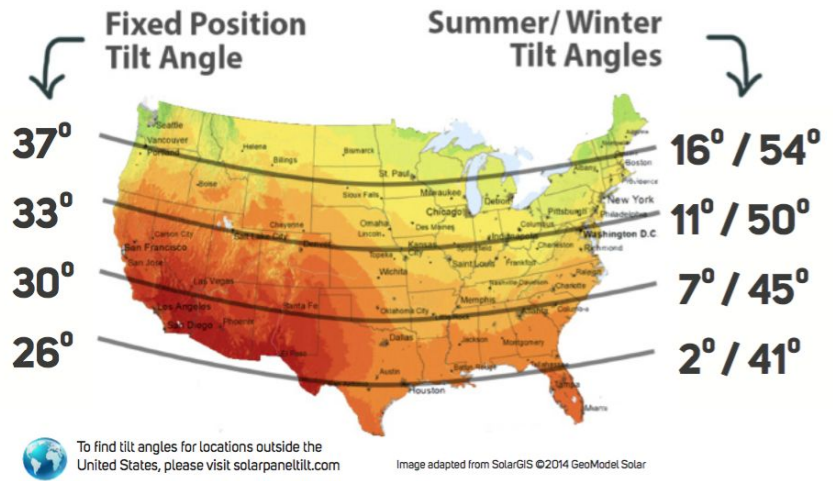


Site Planning

✓ **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 AC power is used, install a separate AC disconnect or sub panel per local code, prior to pump or controller connection.



✓ **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.
- If AC power is used, install a separate AC disconnect or breaker panel per local code.



Solar Panel Configurations

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

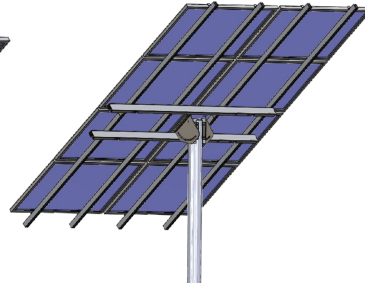
Wire Panels
in Series



400 Watts
4P - 4 Panels

Mounts to 4"
ID, 4-1/2" OD
Steel Post

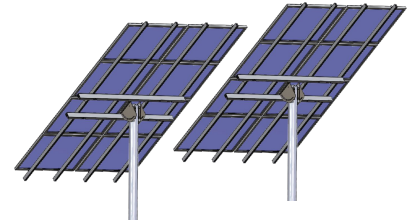
Wire Panels
in Series



800 Watts
8P - 8 Panels

Mounts to 4"
ID, 4-1/2" OD
Steel Post

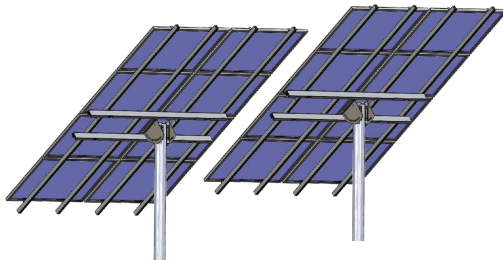
Wire Panels
in Series



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

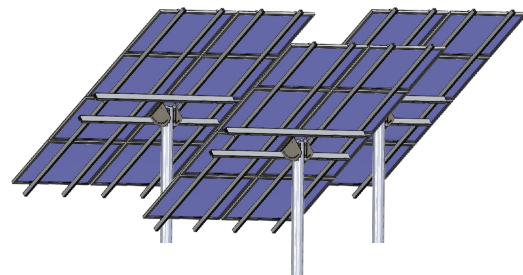
Mounts to 2x 4"
ID, 4-1/2" OD
Steel Post

Wire Panels
in Series



1600 Watts, 2x 8P Mounts
2x 4" ID, 4-1/2" OD Steel Posts

Wire Panels
in Series



2400 Watts, 3x 8P Mounts
3x 4" ID, 4-1/2" OD Steel Posts

Wire Panels in Series /
Parallel, 12 & 12

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

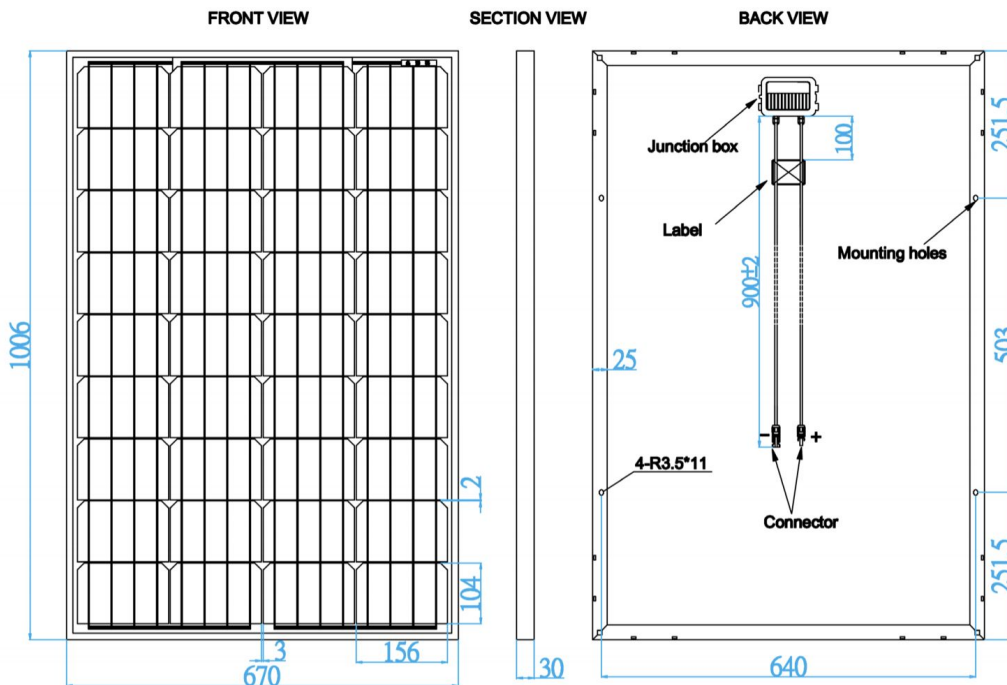
Max Power Current (Imp): 5.55A Short Circuit current (Isc): 6.11A

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

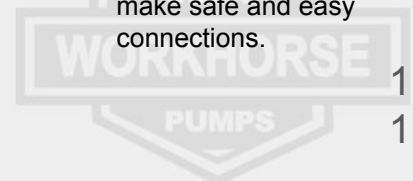
Measurements in mm

Solar Array	Solar Panels in Series	Strings in Parallel
200w	2x 100w	All in Series
400w	4x 100w	All in Series
800w - 1800w	8x - 20x	All in Series
2400w	12x and 12x	2 Strings



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.

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



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.

SOLAR INPUT (VDC)

60 V – 360 V

Max Voc: 440 V

Max Power: 2400W

AC INPUT (VAC)

120V – 240V 50/60Hz

Max Amps: 8A

To Calculate Array Voltage

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

Stats you'll need from sticker.

Total Power (**P_{max}**, Watts)

Voltage Max Power (**V_{mp}**, Volts DC)

Voltage Open-Circuit (**V_{oc}**, Volts DC)

2. Calculate Array Voltage & Power

Array Voltage: # of Solar Panels x V_{mp}

Array Voc: # of Solar Panels x Voc

Array Power: # of Solar Panels x Watts

Most Common Size Solar Panels

“12V Panels”

Each panel is different but in general..

V_{mp} is 16v - 20v

V_{oc} is ~20v - 23v

“24V Panels”

Each panel is different but in general..

V_{mp} is 30v to 37v

V_{oc} is ~38v to 45v

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

ON/OFF Signals & Sensors

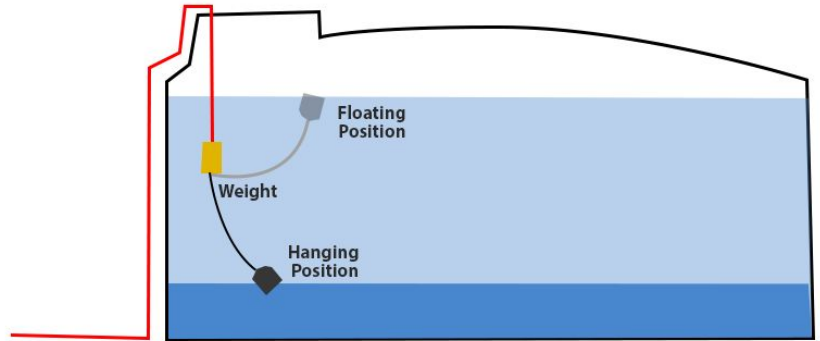
Tank Float Switch

Provides an electrical signal when the tank is full to the PSC200. A closed circuit tells the controller to pump when float switch is hanging, and stop pumping when it is floating and circuit is open (ie. tank is full)

On most floats, use Black & Blue Wires

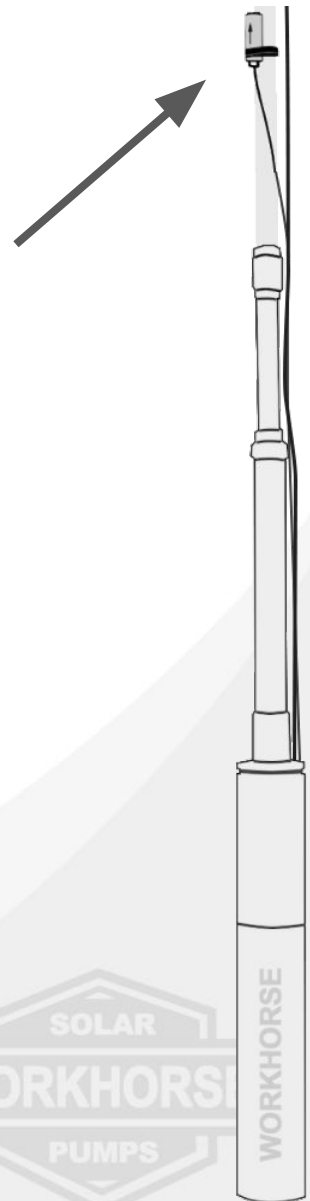
to get this action, but double-check with Multimeter to ensure circuit is open in the upright floating position, closed when hanging.

Wire from float can be extended with 2 strand 18-22 AWG wire as it only carries a signal. Splice to Blue & Black (or whichever pair gets you 'Open' when floating) to your signal wire and connect the wire ends to the TWL sensor terminals in the PSC200. Polarity does not matter here.



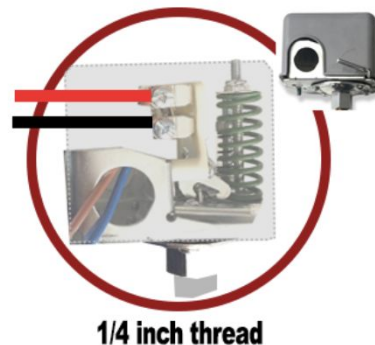
Low Water Sensor (Pre-wired or Stand-alone)

While not required on centrifugal pumps, to prevent the new W4H Series helical pumps from running dry, a liquid level sensor has been pre-wired and attached to all W4H models in the correct orientation. Older models have an stand-alone sensor that wires up to the PSC200 controller's WWL terminals. Or can be wired out if running dry is impossible for some reason. The Low water sensor can be zip tied or electrical taped above the helical pump (as shown on right) **It must remain upright as the internal float travels up and down within cylinder.** For the stand-alone sensors, wire can be extended with 18 to 22 AWG 2 strand wire and connect to the WWL sensor terminals in the PSC200. Polarity does not matter here.



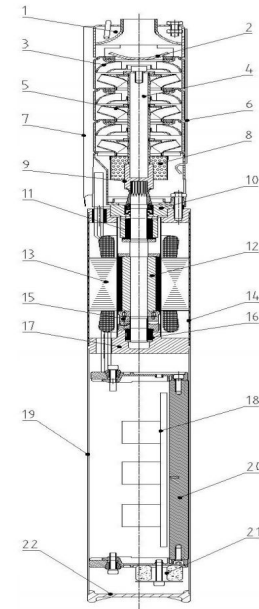
Pressure Switch

To use pressure to shut-off your system, you'll need a pressure switch somewhere in your plumbing line. The pressure switch will be normally closed, and opened when your system is up to pressure. If your pressure switch has a manual lever feature, manually close your pressure switch to get it to come on and up to pressure. You'll need the terminals on only one side of your standard action pressure switch. Wire from the two screw terminals next to each other (remove gray cover to access) to the terminals labeled TWL in your PSC200 controller. Use two strand 18-22 gauge wire. Polarity does not matter here.



Specifications

Power Input	DC 60 – 360VDC Max Voc 440V AC 120 – 240VAC 50/60Hz Current Range: 1.5 – 8A
Input Range	400w – 2400w
Run Time	AC: Unlimited Solar: 6-10 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/m ³ for helical, <50g/m ³ for centrifugal
Certifications	CE, TUV
Speed Range	500 – 4500RPM
Diameters	2", 3", 4", 5"
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 steel*
- 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 steel*
- 18 Controller Housing *Stainless steel*
- 19 Controller Housing *Stainless steel*
- 20 Heatsink *Aluminium*
- 21 Inductor
- 22 Base *Stainless steel*

Pump Type _____ **W 4 C - 26 - 450**
W = Well Pump

Pump Diameter
Will fit this size _____
casing (inches)

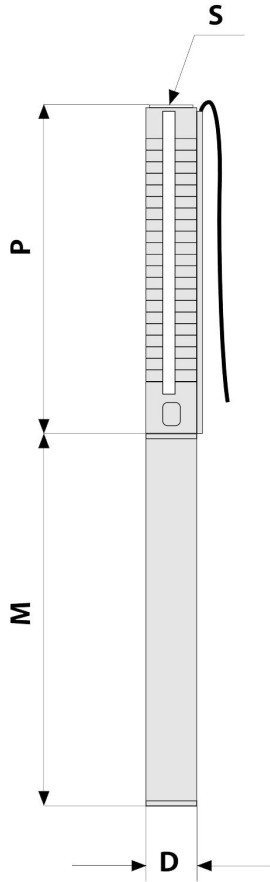
Pump End Type
H = Helical Rotor
C = Centrifugal

Max GPM
GPM at optimal
power and low
head

Max Head
Feet of Head
(TDH) at optimal
power

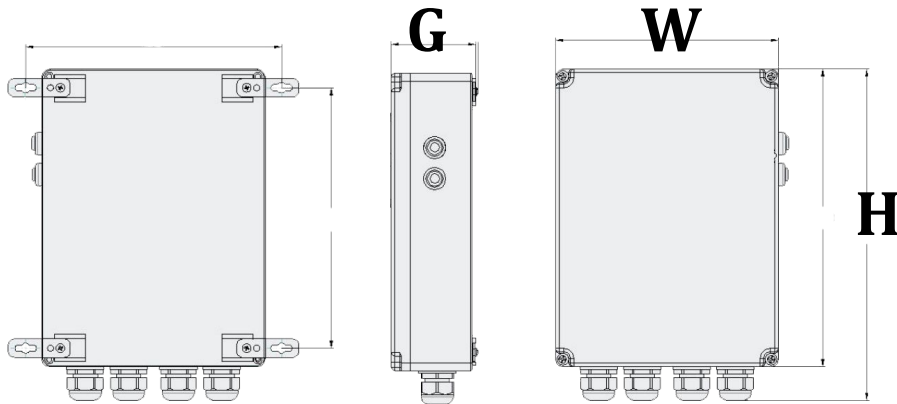


Dimensions

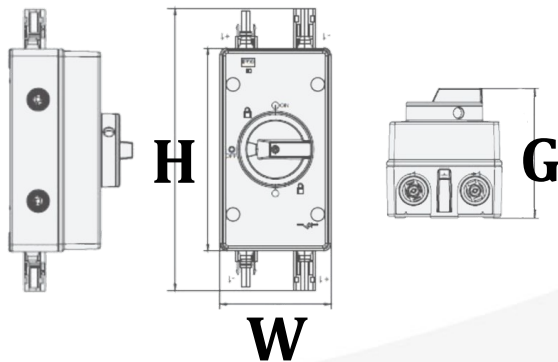


	W5C-125-80	W4C-65-280	W4C-26-600	W4H-3-950	W4H-6-650	W4H-12-450
S	2" FNPT	2" FNPT	1.25" FNPT	1" FNPT	1.25" FNPT	1.25" FNPT
D	5"	4"	4"	4"	4"	4"
P	20 3/4"	14 3/8"	20 5/8"	29 1/4"	30 3/8"	30 3/8"
M	24 1/4"	24 1/4"	24 1/4"	24 1/4"	24 1/4"	24 1/4"
T	45"	38 5/8"	44 7/8"	53 1/2"	54 5/8"	54 5/8"
W	47 lbs	34 lbs	38 lbs	35 lbs	36 lbs	36 lbs

PSC200



DC101



	DC101 Switch	PSC200 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-strand wire (3 conductors, no ground OR 2 conductors with ground) to extend the pump wire to your desired depth. Deeper wells consider thicker gauge wire. Sensor wire extension: To extend the low-water sensor and tank sensor wires to the necessary depth, use 18-22 gauge 2-strand signal wire.

Drop Pipe

PVC, Steel, Black poly pipe. For solar, more guys are moving to black poly pipe that is at least 160psi.

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 solar panels and controller

Well Seal

A cap or seal and plumbing for the top of your well casing

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 racking.

Mounting Posts

For WORKHORSE racking, you'll need 8' to 10' 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



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 wires from your pump to your PSC200 or direct to the DC100 Cut-off Switch (if not using PSC200)



Be sure DC101 Cut-Off Switch is in the OFF Position before opening cover and while any wiring is being done

Once wiring is complete, secure the cover of the DC101 and the PSC200 and open the gate valve about 25% before turning the DC101 to ON position.

FIRST 5 MINUTES

We recommend starting the pump with a gate valve 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 and with a clamping.



System Troubleshooting

TEST 1: 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 red power button on the right side of the controller to shut the pump down. Wait a few seconds and then power back up. Once powered up, you'll have to wait a full 120 seconds before the system will begin pumping.

TEST 4: CURRENT CHECK

Use a clamp on amp meter to check for current flowing through the solar panel wires or pump wires. 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 I_{mp} 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 DC 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 full 120 seconds before the system will begin pumping.

TEST 6: WIRE RESISTANCE

Unlike single and 3 phase pumps, testing wire resistance does not provide us any usable information for troubleshooting, other than differentiating wires if they get mixed up after splicing. Sometimes you can catch a bad splice as resistance between L1 and L2/N is usually in the low MOhms, and L1 / L2 and ground will be open circuit.



System Troubleshooting

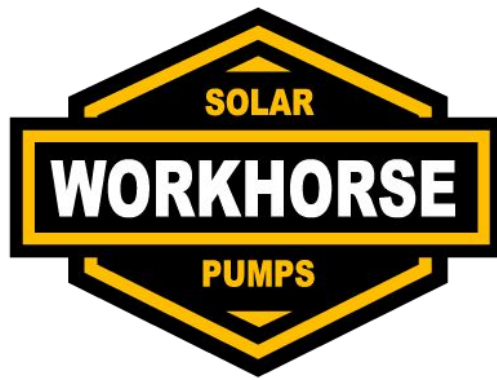
Issue	Possible Causes	Test/Fix
No Lights, No Water	Solar power not reaching pump Failed Underwater Splice	Check all MC4 connections TEST 2 TEST 6
Lights but No Water	Startup initialization countdown	Wait for 120 seconds
Pumped, then Stopped	Safety shutdown	Open the valve on your plumbing outlet slowly on first startup. Soft or Hard reset to override timer and reset to 120s startup countdown.
Low Flow Rate	Not enough power is reaching the pump Too late / early in the day for sufficient current from solar panels	-Most common low flow or no flow is low power due to evening, clouds or shadows on the array. -Eliminate any shade from the solar panels -Ensure proper panel angle and full sun exposure TEST 1 TEST 4
Decreased Flow Rate	Pumping dirty / sandy water	Check water pumped to ensure it is free of any particles, rust, sand etc
RED Well 'Empty' Light Stuck On	Low well sensor not submerged upright with arrow facing up - WWL terminals are jumped	Ensure low well sensor is submerged upright After adjusting sensors, perform soft/hard reset to reset 600s safety timer.
Surging Water	Low water level in the well	Pumping rate is too great for the well. Must shut-down and install low water sensor for Helical pump. Centrifugal pump will shut down automatically when well is pumped dry
RED Tank 'Full' Stuck On	Tank sensor not sending correct signal. Open circuit (terminals open) tells pump to turn off. Pressure switch issue, ensure pressure switch contacts are in correct position to start	Correct by reversing open/close state of float switch If not using sensor, connect TWL terminals with small jumper wire After adjusting sensors, perform soft/hard reset to reset 600s safety timer.
P80 Error on Controller After 2 Minutes	P200 controller is in the incorrect mode.	Ensure both DIP switches on circuit board near push buttons are in off position (down)

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.



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