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Cell 3500 Manual

ZENFUSIONTM

C E L L

Revision 5.0

Before You Get Started

IMPORTANT:

This manual contains important instructions that should be followed during installation, operation and maintenance of the Cell 3500 controller. Carefully read and follow all safety instructions in this manual. Make sure that safety labels are always in good condition and replace missing or damaged safety labels.



Before performing any service or maintenance inside the controller or when connecting or disconnecting any wires, **DISCONNECT the power** and **WAIT 90 seconds** to allow the capacitor bank inside the controller to discharge to a level below 50V.

DO NOT turn on the power to the controller before terminating all wiring connections and closing the cover door.

DO NOT connect power wiring to the controller before mounting the box.

DO NOT service the device if your hands are wet or damp. Always make sure hands are dry before working on the controller.

DO NOT modify equipment inside the controller.

DO NOT remove any parts of the controller unless instructed by this manual.

The controller should be **installed and inspected by technically qualified personnel**, and if the controller is not installed in compliance with national and local electrical codes and ENFusion™ recommendations, the controller can be damaged and fail to operate.

FOLLOW instructions in this manual and labels inside the controller for proper and successful installation.

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NOTICE

This manual is intended to be used as an installation and operation guide. The information in this document is subject to change without notice. No part of this document may be reproduced in any form or by any means without the express written permission of ENFusion™.

INSTALLATION

Task 1: Mount the Cell 3500

Step One: Decide Best Location

Important Pre-Installation Warnings

WARNING

*Do not ground the positive or negative leads of the PV modules!
Only ground the mounting frames of the PV modules.
Never run the Cell controller when the AC pump is not connected!
It might cause damage to the controller.
If an installed three-phase pump does not start pumping water, switch the
positions of any two of the three motor wires. It will change the direction
of rotation and it should start pumping water!*

- Contact your ENFusion™ Supplier/Dealer for any service or warranty claims at info@enfusionenergy.com.
- National Electric Code (NEC) takes precedence over suggestions in this manual.

We strongly recommend that the installation data be recorded into the "Installation Notes" (See Figure 22: Installation Notes) and that you keep the manual stored near the unit.

Cell 3500 Requirements for Safe Installation

The Cell 3500 must be installed in a shaded location, away from any source of heat and moisture, and in an area free of vegetation. Measures must also be made to protect the unit from damage by unauthorized persons, large animals, overgrowth, flooding or other harm.

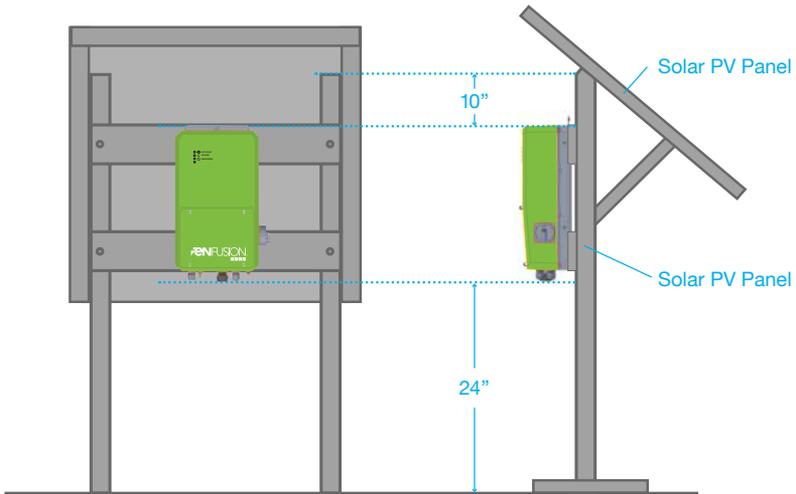
The Cell 3500 should not be exposed to direct sunlight. The ideal location for the unit is to mount it underneath the solar panels, as our illustrations show.

Cell 3500 Mounting Clearances

- The Cell 3500 should be mounted at least 24 inches (60cm) above the ground when possible.
- A minimum of 10 inches (25cm) of clearance above the Cell 3500 is required for internal access.
- There must not be an obstruction of air flow to the heatsink.

A typical installation on an array structure is shown in Figure 1: Cell 3500 Mounting Clearances.

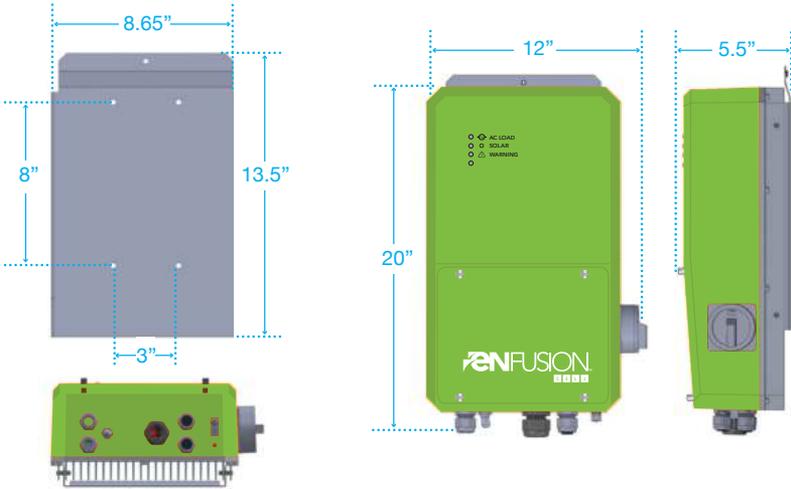
Figure 1: Cell 3500 Mounting Clearances



Cell 3500 Dimensions

Dimensions of the Cell 3500 and back panel are shown in Figure 2: Cell 3500 Dimensions with additional details on how to mount the unit in Figure 3: Back View of Cell 3500 Mounting Bracket and Figure 4: Cell 3500 Unit Mounting Instructions.

Figure 2: Cell 3500 Dimensions



Step Two: Mount the Cell 3500

Cell 3500 Unit Mounting Instructions

The Cell 3500 controller should be mounted on a wall or other vertical surface using the back bracket (See Figure 3: Back View of Cell 3500 Mounting Bracket).

On the back side of the unit there are two set screws (not included) used to hang the unit on the back bracket. More detailed mounting instructions are shown in Figure 4: Cell 3500 Unit Mounting Instructions.

Figure 3: Back View of Cell 3500 Mounting Bracket

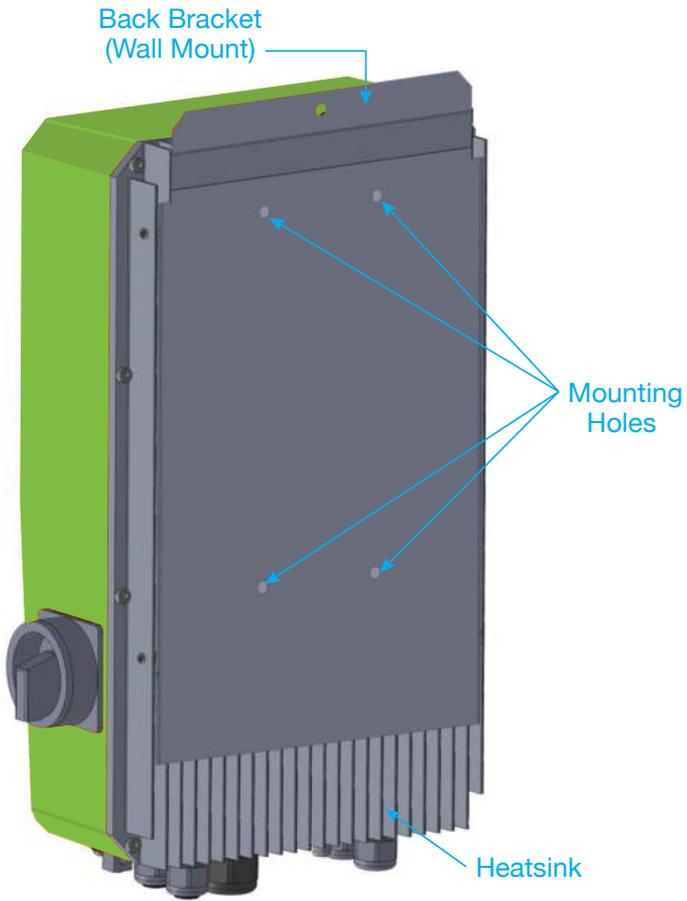
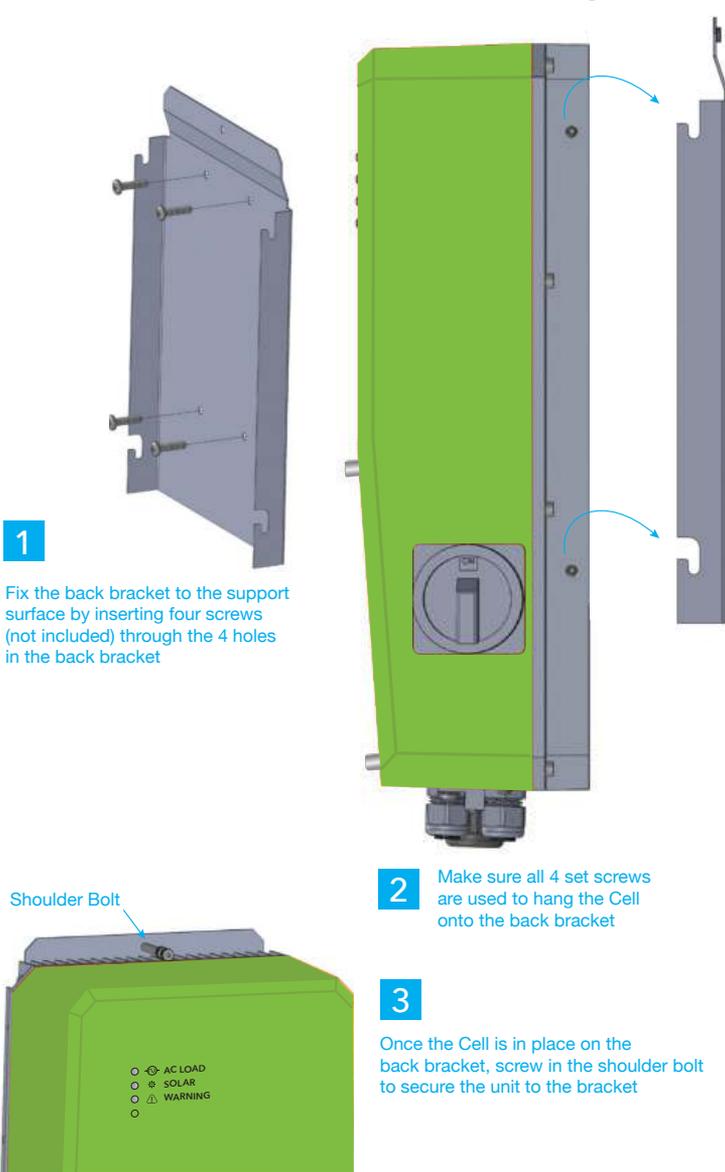


Figure 4: Cell 3500 Unit Mounting Instructions



Task 2: Wire the Cell 3500

Step One: Review Wiring Requirements and Warnings

Installation Requirements:

All electrical installations must be carried out in accordance with local standards and the National Electrical Code (NEC).

Conductor rated current, temperatures, operating conditions and its power loss must be made in accordance with local standards and the National Electrical Code (NEC).

Wiring Warnings

 **WARNING**

*Do not ground the positive or negative leads of the PV modules!
Only ground the mounting frames of the PV modules.
Never run the Cell controller when the AC pump is not connected!
It might cause damage to the controller.
If an installed three-phase pump does not start pumping water, switch the
positions of any two of the three motor wires. It will change the direction
of rotation and it should start pumping water!*

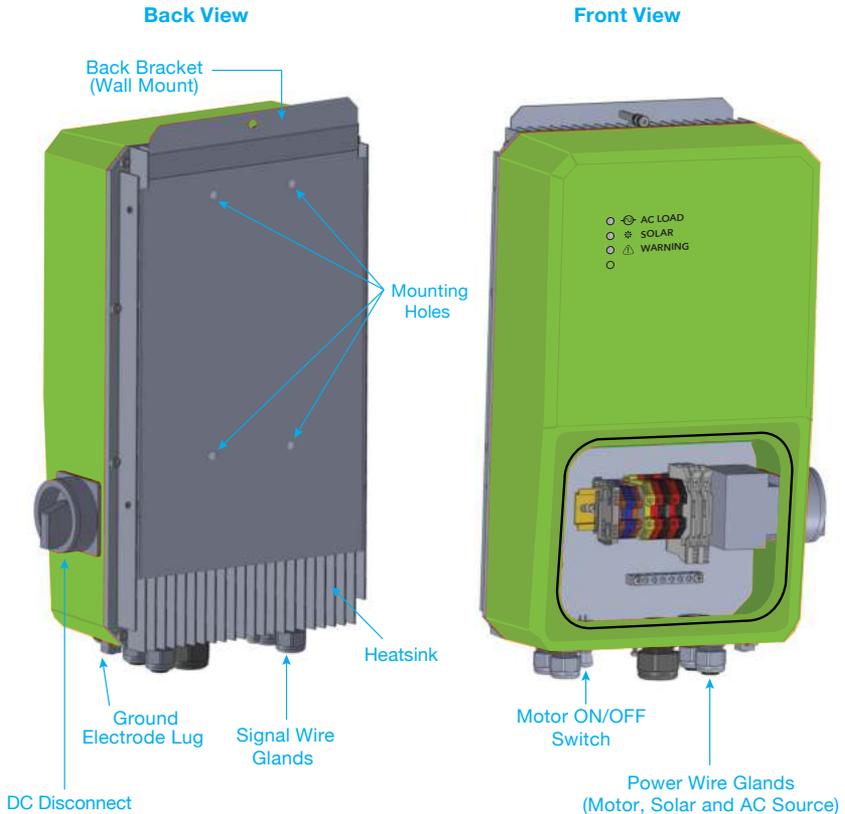
Step Two: Review System Wiring Diagrams

Review Overview Diagram of Cell 3500 Showing Five Cable Glands

The unit has five cable glands:

- One large cable gland for a motor cable (middle)
- Two cable glands for solar PV arrays (right side)
- Two cable glands for data cables (left side) for a float switch sensor or other optional sensor

There is direct access to the power and signal terminals on the DIN rail once the enclosure door is removed (See Figure 5: Overview Diagram of Cell 3500 Showing Five Cable Glands).

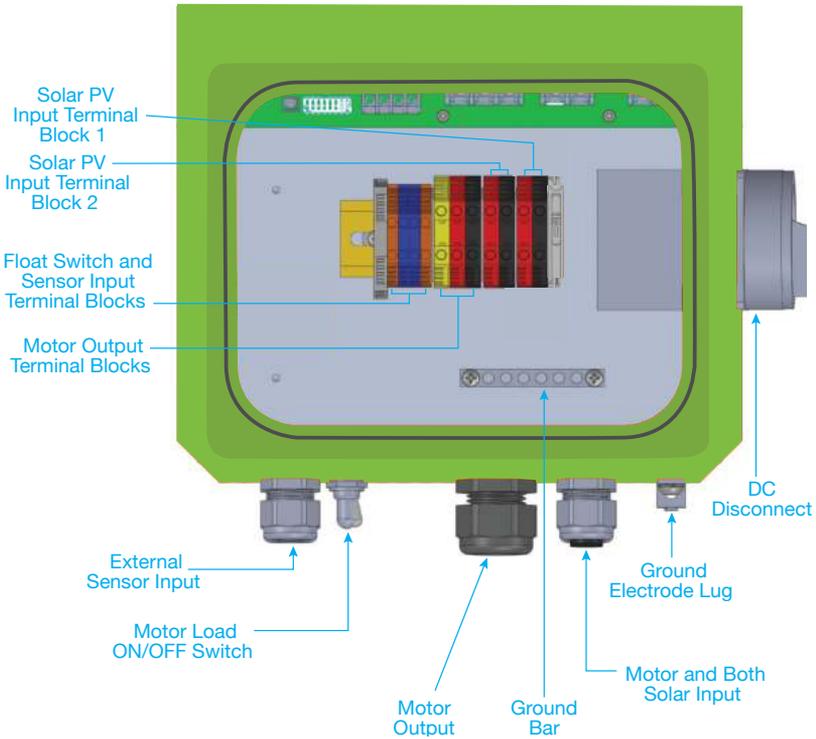
Figure 5: Overview Diagram of Cell 3500 Showing five Wire Glands

Review Closeup of Internal Wiring Features

Once the door of the enclosure is removed, there is access to the input terminal blocks (DIN rail mounts) on the right. See Figure 6: Closeup of Internal Wiring Features.

- Below the DIN rail is a grounding block for connecting the equipment ground.
- The installer should only use the DIN rail terminals for connecting all external wires to the Cell 3500 unit. On the bottom left, just next to the external sensors gland, there is a motor ON/OFF switch that controls the Cell 3500's operation of the motor.

Figure 6: Closeup of Internal Wiring Features

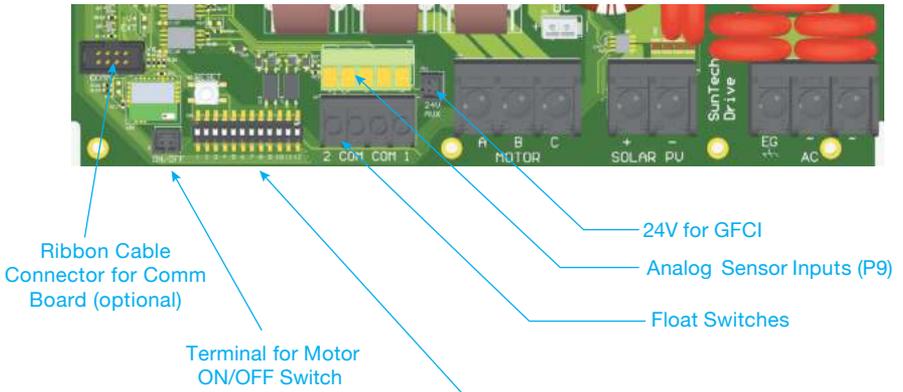


Review Cell 3500 Circuit Board Diagram

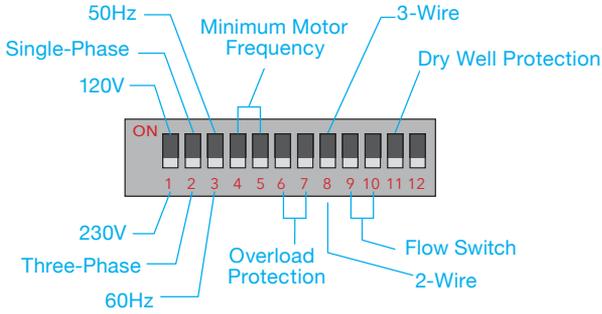
The features of a Cell 3500's printed circuit board are shown in Figure 7: Cell 3500 Circuit Board Diagram.

The installer needs access to these features when configuring the Cell 3500's DIP switches to match the AC motor load specifications (described in greater detail in Step Four: Set Cell 3500 DIP Switch Settings).

Figure 7: Cell 3500 Circuit Board Diagram



Closeup of DIP Switches



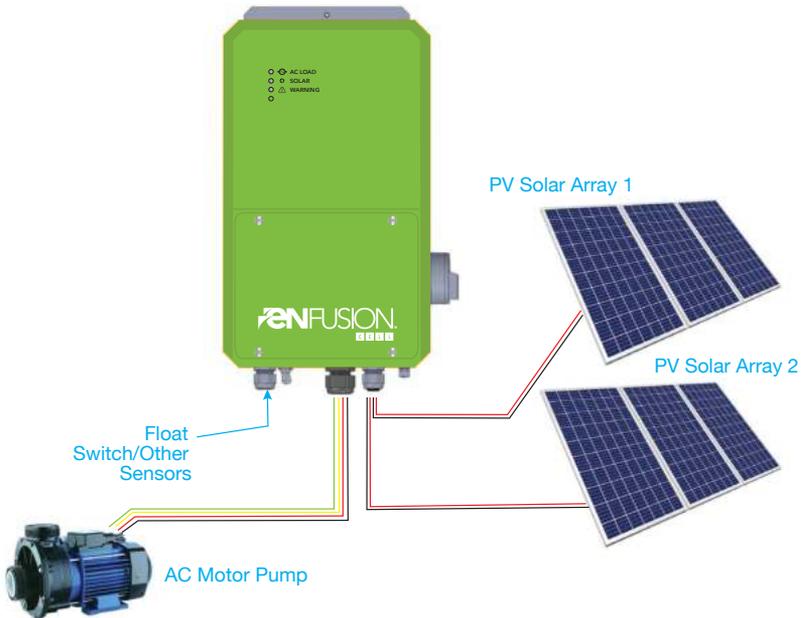
WARNING

Do not modify DIP switch settings until power has been turned off and after 90 seconds have passed for internal voltages to discharge below voltage of 50V! Power must be removed for DIP switch settings to take effect.

Review Cell 3500 System Wiring Diagram

Figure 8: Cell 3500 System Wiring Diagram is a top level wiring diagram illustrating how the various components are wired into the Cell 3500. Review Step One: Review Wiring Requirements and Warnings.

Figure 8: Cell 3500 System Wiring Diagram



WARNING

**Do not ground the positive or negative leads of the PV modules!
Only ground the mounting frames of the PV modules.
Never run the Cell controller when the AC pump is not connected!
It might cause damage to the controller.
If an installed three phase pump does not start pumping water, switch the
positions of any two of the three motor wires. It will change the direction
of rotation and it should start pumping water!**

Wiring for Single-Phase Motor Loads

- Single-phase motor loads should be wired as shown in Figure 9: Table of Wiring for Single-Phase Motor Loads.
- Single-phase 2-wire motors should be connected to phase A and C, while 3-wire motors should be wired so that common lead is wired to phase A, starting winding to phase B and main winding to phase C. Use DIP Switch 8 for proper single-phase motor selection.

Figure 9: Table of Wiring for Single-Phase Motor Loads

IMPORTANT:	
Single-phase 2-wire motor pumps:	Connect to A and C motor terminals of Cell
Single-phase 3-wire motor pumps:	Ph_A: YELLOW wire - common motor lead Ph_B: RED wire - start motor lead Ph_C: BLACK wire - main motor lead

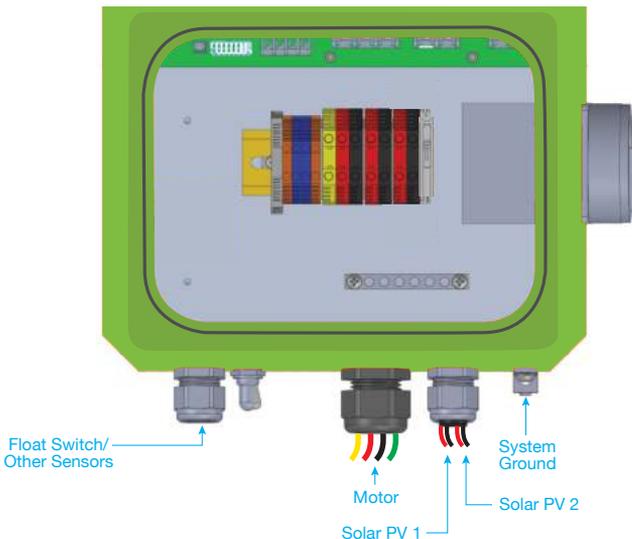
Step Three: Wire to DC (Solar) Sources

Wire to DC Sources as Per Wiring Diagram

Once the Cell 3500 is installed in a shaded location, as shown in Figure 1: Cell 3500 Mounting Clearances, it should be wired to DC (solar) sources. Voltage and current levels defined on Page 32: Product Specifications.

Maximum cable lengths for 115 and 230V for different load currents are shown in Figure 28: Maximum Input Cable Lengths in Feet (Based On 3% Voltage Drop).

Figure 10: Internal Wiring Diagram to DC (Solar) Sources



Tighten the DIN Rail Terminals

Once the system is wired per Figure 10: Internal Wiring Diagram to DC (Solar) Sources, the power conductors wired to the DIN rail terminals inside the Cell 3500 should be tightened with torque values of:

- Solar PV and motor load conductors: 11 lb-in.
- AC source conductors: 8 lb-in.

The cable glands (cord grips) on the bottom of the enclosure should be used as:

- 1/2 inch cord grips should only be used with a cord that is 0.280-0.455 inch outer diameter.
- 3/4 inch cord grips should only be used with a cord that is 0.455-0.705 inch outer diameter.

Step Four: Set Cell 3500 DIP Switch Settings

Configuring DIP switch settings is crucial to the Cell 3500 to recognize the motor (load) and any other parameters or constraints in the application. NEVER skip DIP switch configuration. It will always apply in one form or another to your application.

Note that the DIP switch board shows 12 slots. Only 11 slots are currently in use as shown in Figure 12: Closeup of DIP Switches.

Figure 11: Location of DIP Switches on Circuit Board

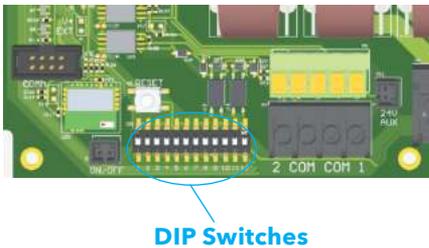
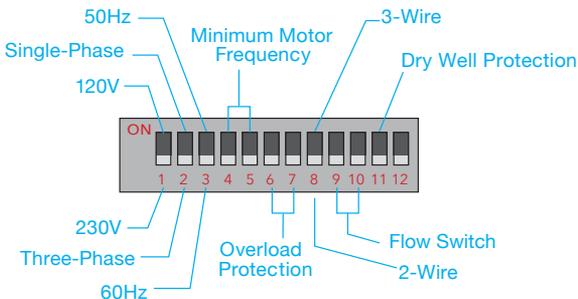


Figure 12: Closeup of DIP Switches



Set DIP Switches 1, 2, or 3 to Match Your Motor

The Cell 3500 controller can operate most AC motors up to the power limits of the controller: single or three-phase; 50 or 60Hz; 120V or 230V. In order for the Cell 3500 to match the motor specifications, the first three DIP switches on the left are used for motor selection:

DIP Switch 1 – 120/230V:

- If switched ON (up – as in Figure 13: Set Dip Switches 1, 2, 3 to Match Your Motor) the unit is configured for 120V pump operation.
- If switched OFF (down) the unit is configured for 230V.

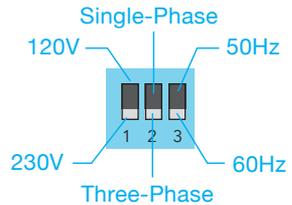
DIP Switch 2 – 1/3 phase:

- If switched ON (up – as in Figure 13: Set Dip Switches 1, 2, 3 to Match Your Motor) the unit is configured for single-phase motor operation.
- If switched OFF (down) the unit is configured for three-phase motor operation.

DIP Switch 3 – 50/60Hz:

- If switched ON (up – as in Figure 13: Set Dip Switches 1, 2, 3 to Match Your Motor) the unit is configured for 50Hz motors.
- If switched OFF (down) the unit is configured for 60Hz motors.

Figure 13: Set Dip Switches 1, 2, 3 to Match Your Motor



Set DIP Switches 4 and 5 to Match Minimum Operating Motor Frequency

DIP Switches 4 and 5 - Minimum Operating Motor Frequency:

- It is possible to set up a minimum operating motor frequency. This is important when operating in Solar Only mode and when there is not enough solar power available to pump water due to high dynamic head.
- In order to prevent “dead heading,” it is possible to set the minimum frequency in the range of 30 to 50Hz, using a combination of DIP switches 4 and 5 as shown in Figure 14: DIP Switches 4 and 5 to Match Minimum Operating Motor Frequency.

Figure 14: DIP Switches 4 and 5 to Match Minimum Operating Motor Frequency



DIP Switches	Minimum Motor Frequency
	30Hz
	40Hz
	45Hz
	50Hz

- NOTE: The Cell 3500’s default minimum Hz setting is 30Hz.

Set DIP Switches 6 and 7 for Overcurrent Protection

DIP Switches 6 and 7 - Overcurrent Protection:

- The Cell 3500 can set overcurrent protection based on the motor pump and controller combination being used.
- Figure 15: Set DIP Switches 6 and 7 for Overcurrent Protection shows how to set up overcurrent protection using DIP switches 6 and 7.
- The default value of RMS current (when both switches are OFF) is 13A for single-phase and 10.5A for three-phase.
- DIP switches 6 and 7, are to be used to match or exceed the motor nameplate’s SFAMPS in order to protect from overcurrent.
- For example, if a single-phase motor has SFAMPS: 9A, then DIP switches 6 and 7 have to be set for 11.5A, as this is the next highest protection current for this motor.
- **Configuring Overcurrent Protection also configures automatic Dry Well Protection.**
- The Cell 3500 monitors motor amperage or dry well protection, and no other dry well sensor input is needed unless desired.

Figure 15: Set DIP Switches 6 and 7 for Overcurrent Protection

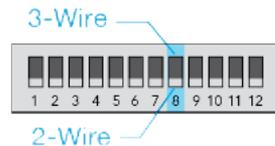
DIP Switches	Overcurrent Single-Phase	Protection Three-Phase
	13A	10.5A
	11.5A	9A
	8.5A	7.5A
	6.5A	6A

Set DIP Switch 8 (If DIP Switch 2 Is Set for Single-Phase Operation)

DIP Switch 8 2-wire/3-wire: Single-Phase

- Used for setting up the proper mode for single-phase operation.
- This is relevant only when DIP switch 2 is set for single-phase operation.
- The default setting is for single-phase 2-wire motors, when DIP switch 8 is in the OFF [down – as in Figure 16: DIP Switch 8 (If DIP Switch 2 Is Set for Single-Phase Operation)] position.

Figure 16: DIP Switch 8 (If DIP Switch 2 Is Set for Single-Phase Operation)



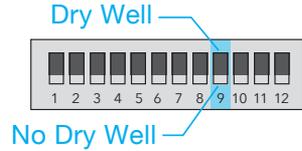
- For 3-wire single-phase motors, DIP switch 8 should be in the ON (up) position.

Set DIP Switch 9 for Flow Switch Dry Well Protection

DIP Switch 9 Flow Switch Dry Well Protection:

- When combined with an additional flow switch, the Cell 3500 offers dry well protection by setting DIP switch 9 to the ON (up – see Figure 17: DIP Switch 9 for Flow Switch Dry Well Protection) position.
- The Flow Switch needs to be installed in-line with the pipe (ask your dealer for Flow Switch availability).
- The principle of operation is very simple. As soon as the pump starts and water starts flowing through the pipe, the magnetic Flow Switch turns ON, which indicates to the Cell 3500 that there is water in the well.
- If there is no water, the Flow Switch will indicate a dry well condition, and the Cell 3500 will turn the pump off.
- There is a time delay from the start of the pump for the Flow Switch signal to activate, which allows time for flow from deep wells. See DIP Switch 10 for time delay settings.

Figure 17: DIP Switch 9 for Flow Switch Dry Well Protection

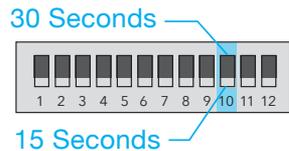


Set DIP Switch 10 for Flow Switch Time Delay

DIP Switch 10 Time Delay - Flow Switch Time Delay:

- Used to define the time delay for Flow Switch sensing.
- When DIP switch 10 is in the OFF (down – as in Figure 18: DIP Switch 10 for Flow Switch Time Delay) position (default) the delay time is 15 seconds.
- When it is in the ON (up) position, the delay time is 30 seconds .
- A 15 second setting is used for more shallow wells (less than 300ft), while 30 seconds is used for deeper wells (deeper than 300ft).

Figure 18: DIP Switch 10 for Flow Switch Time Delay

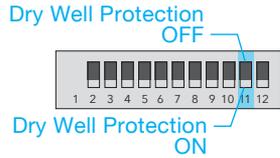


Set DIP Switch 11 for Automatic Dry Well Protection

DIP Switch 11- Automatic Dry Well Protection:

- See Figure 19: DIP Switch 11 for Automatic Dry Well Protection. The Cell 3500 monitors motor amperage for dry well protection.
- No other dry well sensor input is needed unless desired.
- The default setting is dry well protection ON (down).
- If switched OFF (up), the protection is disabled.
- Turn dry well protection off for compressors, fans, and above-ground pumps.

Figure 19: DIP Switch 11 for Automatic Dry Well Protection



Install Cover Door and Tighten It

When all conductors are wired into the controller the cover (door) should be put on and tightened using the cover screws to 2-3 in-lb or equivalent.

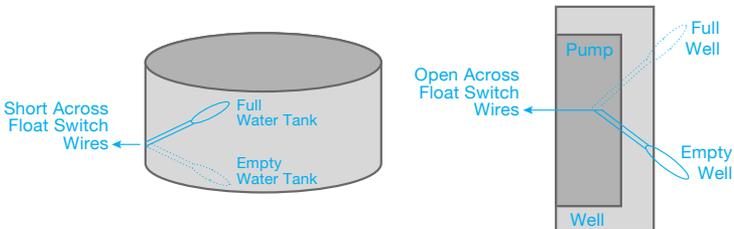
Step Five: (Optional) Set Cell 3500 Sensor Settings

Remote Turn On/Off With Digital Input or Standard Float Switch

The Cell 3500 controller can be remotely turned ON or OFF by using a digital input or by using a standard float switch. There is a float switch terminal block where digital signal wires are connected.

- If Digital Inputs 1 and COM experience a short circuit the Cell 3500 automatically turns off.
- Similarly, if Digital Input 2 and COM experience an open circuit the Cell 3500 automatically turns off.
- There are numerous remote sensors that can be used: float switch, pressure switch, flow switch, water level sensor, dry run protection, etc. Ask your dealer about configuring sensors and switches for your application.

Figure 20: Example of "Water Tank Full" and "Well Empty"



A typical example of how tank and well switch signals can be used with a digital input port is shown in Figure 20: Example of “Water Tank Full” and “Well Empty”.

- For a tank application, if the active wire is connected to Position 1 and the return wire (usually black) is connected to Position COM, then the Cell 3500 will stop the pump when the tank gets full because terminals 1 and COM will be “shorted” (active short). This turns off the Cell 3500. See Figure 20: Example of “Water Tank Full” and “Well Empty”.
- For a well application, if the active wire is connected to Position 2 and the return wire (usually black) is connected to Position COM, then the Cell 3500 will stop the pump when the well runs out of water because terminals 2 and COM will be “open” (active open). This turns off the Cell 3500.

Cell 3500 Can Incorporate Two External Analog Sensors

- Analog sensors should be fed through the left cable glands and terminated to connector P9 on the printed circuit board, as shown in Figure 7: Cell 3500 Circuit Board Diagram.
- The analog sensor inputs are designed for 4-20mA input for common industrial sensors.

A table with pinout details is shown in Figure 21: Analog Sensors Pins for Analog Sensors, which includes 24V power on Pin 5, eliminating the need for an external power supply.

Figure 21: Analog Sensors Pins for Analog Sensors

Pin Number	Functionality
Pin 1	Analog 1
Pin 2	24V
Pin 3	GND
Pin 4	Analog 2
Pin 5	24V

Task 3: Complete Installation Notes

After Installation, Complete Installation Notes

We strongly recommend that you take an extra bit of time to fill out the installation notes (See Figure 22: Installation Notes) with valid data once installation is complete.

When you call our technical support, we will ask you for this information. If you have this installation data available, you will have a faster and more accurate troubleshooting process. It's hard to keep track of this information once installation is complete.

Figure 22: Installation Notes

Date Installed: _____

Serial No. (Spec Label): _____

Installer: _____

Phone: _____

Location of Installation: _____

Pump Manufacturer / Model No.: _____

Motor: HP, V, ph, SF Amps: _____

Well Depth: (m/ft) _____

Flow Rate: (lpd/gpd) _____

PV Panel Manufacturer / Model No.: _____

No. of Solar PV Panels in Series: _____

Tech Support Hotline: 877 230 7501

Keep This Manual With Your Cell 3500 Unit

We recommend that you keep the manual accessible and located close to the unit. If you have a protected location keep the manual with the unit. If not, keep it easily accessible in the office.

CONFIGURATION

Task 4: Configure the Cell 3500

Step One: Size the Solar Panel Array to Motor Load Power Requirements

- The Cell 3500 can power both single and three-phase motors.

When sizing the solar panel array for the Cell 3500, it is necessary to know the motor load power requirements.

The general recommendation is to size the solar PV system capacity to at least match the motor power requirements.

- To do so, it is important to know the motor power when sizing the solar system.
- Contact your dealer for solar sizing for your specific motor.

OPERATION

Task 5: Initial Cell 3500 Startup

Step One: Start Cell 3500 for the First Time

Once the Cell 3500 controller is wired to the solar source, a motor load and the DIP switches settings are configured to match the motor specification, then the Cell 3500 is ready for operation.

When starting the Cell 3500 for the first time:

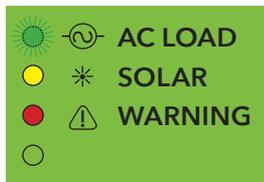
1. Make sure that the ON/OFF toggle switch is in the OFF position.
2. Power up the Cell 3500 from solar PV by switching the solar DC disconnect to the ON position. All LEDs will light up.
3. Once the solar PV source powers up the Cell 3500, turn the bottom external motor ON/OFF toggle switch to the ON position to start the motor load. The Cell 3500 will check its motor connections using built-in open and short circuit protections.
4. If one of the motor leads is not connected or if there is a short in the motor connections, the Cell 3500 will show a warning message using LED indicators (See Figure 25: Chart Summarizing All LED Indicator Light Combinations, and Figure 26: Chart Explaining Meaning of LED Indicator Light Combinations).
5. Otherwise, it will start the motor load (the green LED will start blinking and remain ON).

Step Two: Understand Meaning of Cell 3500's LED Lights

Four LEDs are used to indicate the Cell 3500 controller's operation (See Figure 23: LED 1 - AC Load Is On, and Figure 24: LED 2 - Solar Is On).

Motor Is Properly Connected

Figure 23: LED 1 - AC Load Is On



If the motor is properly connected, the Cell 3500 will move to the startup procedure. The green AC LOAD LED (See Figure 23: LED 1 - AC Load Is On) will have a solid green light and the motor will start running.

The Cell 3500 immediately performs MPPT operation over the solar PV source. The MPPT operating range is 30 to 60Hz for 60Hz motors, and 25 to 50Hz for 50Hz rated motors.

Cell 3500 Overload Protection

The Cell 3500 has built-in overload protection. If a connected motor has a power level higher than the Cell 3500 limitations:

- It first slows down and tries to run the motor at a lower power level.
- If the motor power continues to be outside the power range of the Cell 3500, it will shut off the motor operation.
- If there is not enough solar power, the unit's SOLAR LED light will blink yellow, as shown in Figure 24: LED 2 - Solar Is On.
 - This usually happens in the early morning, late evening or during over-cast weather.
 - The Cell 3500 controller will try to start the motor once every minute.
 - Each attempt will be indicated by the blinking green LED. If there is not enough solar production from the solar panels, the yellow LED will start blinking again.

Solar Only Mode

If the AC switch is in the OFF position then the Cell 3500 operates in Solar Only mode, and it will not draw any power from the grid but will balance the power from solar with motor power by varying the motor frequency. If there is not enough solar power, the unit's SOLAR LED light will blink yellow, as shown in Figure 24: LED 2 - Solar Is On.

Figure 24: LED 2 - Solar Is On



Step Three: Manually Shut Down Cell 3500 Operation

To stop the Cell 3500's operation the ON/OFF toggle switch on the bottom of the unit should be used. Once in the OFF position the Cell 3500 will automatically stop the motor's operation.

Understanding Automatic Shutdown of Cell 3500

Automatic Shutdown With Tank or Well Float Switch

However, if a tank or well float switch is used (See Figure 20: Example of "Water Tank Full" and "Well Empty") when the tank becomes full or the well becomes empty, the Cell 3500 will stop its operation and the WARNING LED will blink red.

Automatic Shutoff Due to Temperature

The WARNING LED will be solid red if the temperature of the Cell 3500 rises above 80°C, at which point the Cell 3500 will stop operating and wait until the temperature drops. This can happen if the unit is exposed to direct sunlight, which should be avoided.

Power Deration Mode

- If the Cell 3500 gets too hot during its normal operation it will switch to Power Deration mode, limiting the maximum power that is transferred to the motor load.
- During that time, the AC LOAD LED will be solid green and the WARNING LED will be solid red.
- If the unit cools down to a regular operating temperature it will automatically continue operation without the thermal deration.
- If the temperature of the Cell 3500 continues to increase it will eventually stop operating, at which point the WARNING LED will be solid red.

MAINTENANCE

Task 6: Perform Recommended Maintenance

Inspect Every Three Months

The Cell 3500 unit is designed to operate autonomously. However, we suggest regular inspections every 3 months.

Maintain Optimal Operational Conditions

Keep Clear of External Obstructions.

- If there are any external obstructions that prevent proper cooling of the heatsink area, please remove them to make sure nothing blocks the air flow from the bottom of the device.

Don't Operate in Freezing Conditions

- If the Cell 3500 operates in an area where the pump experiences freezing temperatures make sure to turn the device OFF so it does not try to run the water pump in icy conditions. This may lead to deadheading on the pump.

Check External Sensors Every 3 Months

- Check external sensors every 3 months: float switch, pressure switch, etc.

Keep the Unit Out of Direct Sunlight

- Cell 3500 should be installed and kept in a shaded location.

Troubleshoot LED Indicator Lights

If there is any issue with the unit different combinations of LED's will light up and/or flash to indicate the malfunction. The following two charts explain the various Indicator Light Combinations (See Figure 25: Chart Summarizing All LED Indicator Light Combinations and Figure 26: Chart Explaining Meaning of LED Indicator Light Combinations).

Figure 25: Chart Summarizing All LED Indicator Light Combinations

AC LOAD	SOLAR	WARNING	MODE
ON	ON	ON	- Unit is OFF
FLASHING	OFF	OFF	- Startup
ON	OFF	OFF	- Running
OFF	FLASHING	OFF	- Standby
OFF	OFF	FLASHING	- Float Switch
OFF	OFF	ON	- Over Temperature
ON	OFF	ON	- Power Deration
FLASHING	OFF	FLASHING	- Over Current
OFF	FLASHING	FLASHING	- Short/Open Circuit
FLASHING	FLASHING	FLASHING	- Dry Well Protection

Figure 26: Chart Explaining Meaning of LED Indicator Light Combinations

OFF Mode	Cell toggle switch is in the OFF position.
Startup Mode	Cell is in the process of starting the motor pump.
Running Mode	Cell is running the motor pump.
Standby Mode	There is not enough power from the solar PV panels for Cell to start the motor.
Float Switch Mode	Cell is turned OFF as a result of input from one or more external sensors that are connected to the digital input.
Over Temperature Mode	Cell stops operation when the temperature of the inside unit exceeds 80°C/176°F.
Power Deration Mode	Cell still operates but with reduced power throughout due to increased operating temperature, or if load is connected with current higher than Over Current Protection DIP Switches 6 and 7.
Over Current Mode	Cell stops operation when it detects high current on the motor terminals. This can also be due to a short circuit event if the unit is mis-wired. Requires manual restart by cycling power to the unit.
Open Circuit Mode	Cell will not start operation if the motor wiring does not align with DIP switch configuration.
Dry Well Protection	Cell detects dry well condition and ceases pump operation, which is restored after 30 minutes. If dry well indication appears faulty, check that Over Current Protection DIP Switches 6 and 7 are configured correctly.

Appendix A: Size the Solar System to Power the Cell 3500

Understand How to Maximize Solar Energy

Size The Solar System

Sizing the solar system to power the Cell 3500 and a given motor load (pump, compressor, fan, etc.) is based on the power requirement of the motor load, motor phase, daily duty cycle of the system and installation location. Motor load requirements can be obtained from the motor nameplate—look for SFAMPS.

- Three-phase motor loads will typically require less solar PV capacity than single-phase loads, due to higher electrical efficiency.
- Hence, three-phase pumps are more cost effective because they require less solar PV power.
- Single-phase motor loads with running capacitors (also called split-phase) will also require higher solar PV power at startup than their three-phase counterparts.
- Service Factor (SF) can also vary between motor manufacturers. A higher SF may require more PV solar power.

For off-grid solar pumping applications the main requirement is either total daily pumped water or the total amount of time the pump will operate from solar power.

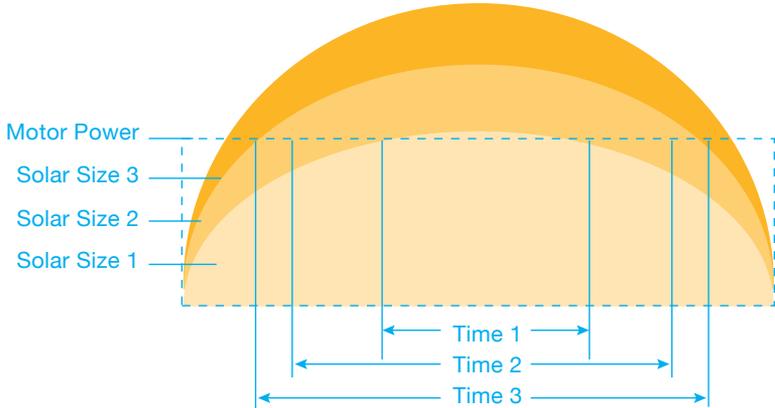
Figure 27: Sizing Solar PV Power With the Cell 3500 Controller

Figure 27: Sizing Solar PV Power With the Cell 3500 Controller shows how three different solar capacities (solar power wattage) are affecting total daily pumping duration. Motor power is shown by the dashed line.

- If Solar Size 1 results in Time 1 for a given pump power, then by adding solar power to Solar Size 2 the pumping time increases significantly.
- However, same solar power addition to Solar Size 2 results in Solar Size 3, but incremental time between Time 3 and 2 is not the same as between Time 2 and 1.
- Therefore, a linear solar power capacity increase does not result in a linear daily pumping time increase. Additional solar capacity results in decreasing returns for increased pumping time.

Minimum and Maximum Solar PV Array Requirements

Additionally, it is important to note the minimum and maximum solar PV array requirements when sizing solar for a given pump using the Cell 3500.

- Configuring solar PV capacity will vary based on location of the installation (i.e. different solar irradiances at different latitudes).
- For a more detailed solar PV configuration, please contact the ENFusion™ sales team or your local dealer. Be ready to provide the motor load nameplate information as well as installation site location and application requirements of the desired daily duty cycle.

Appendix B: Product Description, Product Specifications

Cell 3500 Product Description

The Cell solar controller is a universal, high performance, variable speed motor controller for solar applications using single-phase and three-phase AC loads in a power range from 1/3 HP to 1.5 HP.

The Cell 3500 has input capability for connecting two separate solar panel arrays in parallel.

- *Livestock water supply*
- *Small scale irrigation*
- *Industrial farming ventilation*
- *Water transfer and evaporation*
- *Village water supply*
- *Aquaculture and aeration*
- *Swimming pool filtration*

The Cell can power new and previously installed (retrofit) AC motors. Please consult with a dealer to size the solar arrays when using the Cell.

For new installations motor selection can also optimize the system economics. 230V three-phase motors are the most electrically efficient and require the least amount of solar, followed by 115V three-phase, 230V single-phase and 115V single-phase in descending order of efficiency.

NOTE: Motors controlled by the Cell do not require separate motor controls. The Cell was designed to be universal for most inductive motors while being mindful of some basic design limitations:

The Cell may not operate 2-wire, single-phase motors that use switching devices to start. This includes, but is not limited to, 2-wire starting capacitors, both centrifugally switched and BIAC switched. Ask about ENFusion's Accessory Power Cable to retrofit 2-wire surface motors.

- The Cell can run motors with Service Factor Amps of 13 Amps or less for single-phase motors, and 10.5 Amps or less for three-phase motors. Please contact ENFusion™ for more information on particular motors.
- Generally, single-phase motors up to 2 HP will operate well.
- Generally, three-phase motors up to 3 HP will operate well.
- The Cell does not power Direct Current (DC) permanent magnet or Brushless DC (BLDC) motors.
- The Cell will replace the manufacturer's motor controller when installed on a Variable Speed Drive (VSD) or a Variable Frequency Drive (VFD) submersible pump motor.
- The Cell will replace the control box for 3-wire motors.
- The Cell will operate 2-wire motors with Permanent Split Capacitors (PSC).
- The Cell will not operate submersible motors with 2-wire starting capacitors, including Franklin Electric 2-wire submersibles and Grundfos 2-wire submersibles. ENFusion™ offers accessory cables to retrofit most 2-wire starting capacitor surface motors.

Cell 3500 Specifications

Input Specification:

- Dual Solar PV Array Input
- Maximum Solar Open Circuit Voltage: **400V***
- Maximum Solar PV Current in Series: **12A****
- Earth-ground connected to chassis

*DC PV input terminals shall only be connected to listed photovoltaic modules and panels that comply with UL 1703.

**Suitable for use on a circuit capable of delivering not more than 27A symmetrical amperes, 400V maximum.

Output Specification:

- Maximum Output Current: **13A (SINGLE-PHASE MOTORS)**
- Maximum Output Current: **10.5A (THREE-PHASE MOTORS)**
- Maximum Power Sustained: **3500W**

Protections:

- Short-circuit, ground-fault, over temperature, over-load, over voltage, over current, and solar input reverse polarity protection
- AC Load GFCI: 5, 10, or 30mA based on selected set-point (optional)
- Automatic dry well protection and pump locked rotor protection

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code (NEC) and any additional local codes.

Technical Specifications

ELECTRICAL

Solar PV operating voltage range: **100-380V**

Max PV panels open circuit voltage: **400V**

Solar PV rated current per channel: **12A**

Single-phase max AC motor power: **13A**

Three-phase max AC motor power: **10.5A**

MECHANICAL

Degree of protection: **NEMA3R/IP65**

Enclosure material: **CAST ALUMINUM**

Operating temperature: **-40°C TO 50°C**

Dimensions: **18" X 10" X 5"**

Solar terminal: **AWG#10-14**

Motor terminal: **AWG#8-14**

Sensor terminal passive: **AWG#14-22**

Cooling: **PASSIVE/NO FAN**



Carefully check the motor load specifications and solar PV array maximum power point voltage to setup the system properly using this manual!

Appendix C: Calculate Maximum Cable Lengths for Different Motor Load Currents

Figure 28: Maximum Input Cable Lengths in Feet (Based On 3% Voltage Drop)

Motor LOAD [A]	Nominal Voltage [V]	AWG Copper Wire Sizes 90°C Insulation [ft]				
		16	14	12	10	8
4	115	110	165	270	400	600
	230	220	330	540	800	1200
6	115	70	110	175	275	400
	230	140	220	350	550	800
8	115	55	85	135	200	300
	230	110	170	270	400	600
10	115	45	70	105	165	240
	230	90	140	210	330	480
12	115	35	60	90	135	200
	230	70	120	180	270	400

IMPORTANT: Use copper conductors only!

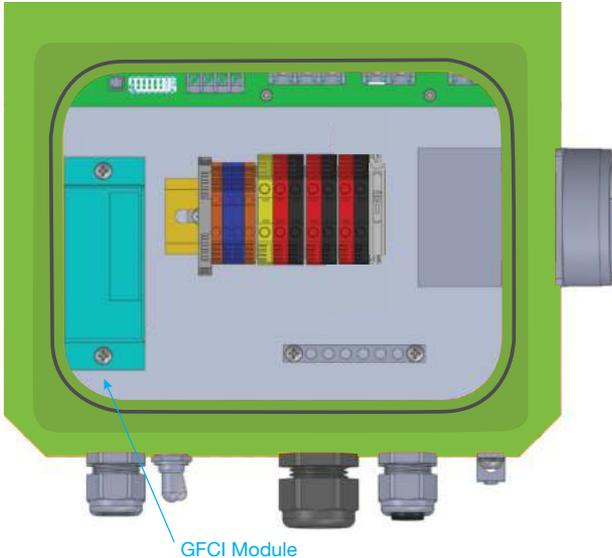
This unit was evaluated for temperature rating of 60/75°C on power field wiring terminals.

Appendix D: Optional Cell 3500 Module

About the Cell_GFCI (Ground Fault Circuit Interrupter) Module

Cell GFCI includes an optional Ground Fault Circuit Interrupter (GFCI) module (See Figure 29: Internal View of Cell_GFCI) which is used for sensitive ground fault currents: 5, 10, and 30mA, and can be adjusted by using a simple jumper that is part of the GFCI module.

Figure 29: Internal View of Cell_GFCI



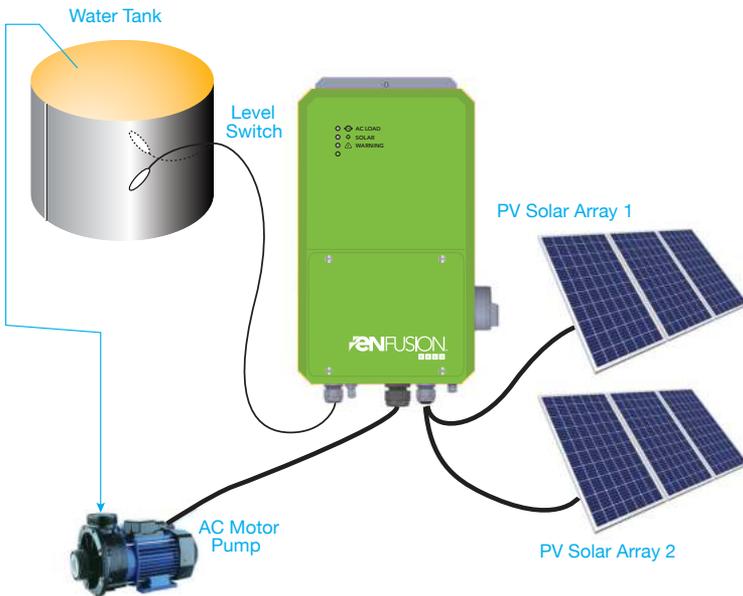
- The GFCI module is an integral part of the Cell_GFCI model and cannot be added in the field.
- A Cell_GFCI model must be ordered with this option and assembled at ENFusion's factory.
- The GFCI module instantaneously stops the Cell 3500 operation if the ground current is detected to be higher than the GFCI module settings (5, 10, or 30mA).
- The GFCI module is commonly used for aerators and fountains where the motor is submerged in open water such as lakes and ponds. Ask your dealer about adding an optional GFCI module for your Cell 3500.

Appendix E: Typical Diagram for Cell 3500 Operated Solar Water Pumping System

To size the solar PV array to your specific motor please consult with your local dealer or ENFusion™ tech support. A typical diagram for a Cell 3500 operated solar water pumping system is shown in Figure 30: Typical Diagram for Cell 3500 Operated Solar Water Pumping System.

The solar PV array should be connected to the Cell 3500 controller via the integrated DC Disconnect. The Cell 3500 controller should be installed in the shade (potentially mounted under the PV array) and away from the direct sun.

Figure 30: Typical Diagram for Cell 3500 Operated Solar Water Pumping System



The Cell 3500 can accept up to two digital sensor inputs.

- For example, in solar water pumping applications an optional float switch can be connected to the Cell 3500 to monitor when a water tank is full, while a second float switch can indicate dry well conditions.
- The Cell 3500 off-grid solar controller is unique because it can run single or three-phase AC motors, 115 or 230V and 50 or 60Hz.

NOTES:

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US Patents:

PATENT NO. 10,931,220

PATENT NO. 10,840,831

PATENT NO. 10,560,033

PATENT NO. 11,171,486

International Patents:

PATENT NO. (EP) 3,362,867

PATENT NO. (AU) 2016338999

PATENT NO. (CN) 108431719

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