# Lab – AC Circuits

## Objective

For students to become familiar with how alternating current (AC) functions within a circuit. Students will be testing voltage, current, resistance and component serviceable with the 12-volt lab trainer.

## Discussion

 With a familiarization with direct current (DC), students will now have an opportunity to learn about alternating current (AC). Having practical experience and developing a healthy relationship with AC, much like DC.

## Equipment

* 12V trainer
* Multimeter

## Procedure

1. Ensure equipment is serviceable
	1. This can be done by checking the resistance of the leads against each other
	2. Checking continuity by touching the leads against each other
2. The multimeter should be set to measure voltage and measure the following components:
	1. Circuit breakers
	2. PV panel outputs individually
	3. PV panel outputs combined
3. When doing the above, ensure the correct voltage setting is selected
4. After the voltage measurements are completed, ensure they match the charge controller
5. Complete the lab again with shading present over the PV panels
	1. Students should be seeing a reduction in output with shading present
6. Complete the lab again without shading but have the panels at a different angle.
	1. Students should be seeing a different value from the initial value.
7. Repeat the above 6 steps with loads connected this time to see if this if anything changes
8. Disconnect all loads and deenergize the system
9. Test resistance/continuity of the circuit breakers

## Questions

* What is the measured voltage when there is a load compared to when there is no load
* How does shading impact the performance of the array

# Lab – PV Systems AC/DC

## Intent

For students to become familiar with where AC and DC is present in PV systems. Students will

## Discussion

As PV systems become more prevalent, knowing how they operate and what is happening within the system becomes paramount to the success of a successful install. Furthermore, knowledge of where AC and DC are present within the system ensures accurate fault-finding techniques when the system needs repair.

## Equipment

* 48V trainer
* Multimeter

## Procedure

1. Ensure equipment is serviceable
2. Identify where DC is present in the system
3. Identify where AC is present in the system.
4. With the multimeter set to DC voltage, confirm your above assumptions of DC points
5. Set the multimeter to AC voltage and confirm where AC is present in the system
6. Record your findings

## Questions

* What happens if you measure DC current with an AC clamp
* What is the purpose of the ground fault circuit breaker between the MPPT controller and combiner box
* What happens when the above circuit breaker trips?
* Would it be possible to use the batteries as a load?
* Would it be possible to use the batteries as backup power?

# Lab – Cable Sizing and Grounding

## Intent

For students to become familiar with wiring sizing and grounding in PV systems. Students will assess cable size requirements with different connections being made, such as 1 panel microinverter connection and 4 panel combiner box connection. Students will also learn the cable sizing required to ground a PV system.

## Discussion

PV systems have many methods of connection, whether it is installed with microinverters or with a combiner box. Furthermore, these systems need to be safety installed in the event of any failure to the system.

## Equipment

* Rooftop trainer
* Multimeter

## Procedure

1. Ensure equipment is serviceable
2. Research the operating voltage and amperage of the microinverter panels
3. Calculate the DC sizing requirements for the cables required for the amperage
4. Calculate the AC sizing requirements for the cables required for the amperage
5. Calculate the ground cable size required for the system
6. Record your findings
7. Research the operating voltage and amperage of the combiner panels
8. Calculate the DC sizing requirements for the cables required for the amperage
9. Calculate the AC sizing requirements for the cables required for the amperage
10. Calculate the ground cable size required for the system
11. Record your findings

## Questions

* How many panels can be connected to each microinverter
* What size cable would be required if each microinverter can handle 2 PV panels
* How would the cables to the combiner box be different if all the PV panels are in series
* What size cable would be required if all the PV panels are connected to the combiner
* Which would be a safer installation? The combiner box or the microinverter
* Which installation method would be more practical for a homeowner
* What is “safety factor”