

LEARNING GUIDE

Programs Electrical

Module RENEWABLE ENERGY

Learning Unit Adding Voltages in Series Circuits

Introduction

It is important to understand that when photovoltaic panels are arranged in series the voltage produced is additive. This learning guide will teach you how to arrange solar photovoltaic panels so that the photovoltaic panels are cumulative in the voltage they produce. From this information we will be able to configure the panels for the desired voltage.

Caution should be used when connecting panels in series as a very high voltage (over 50 volts) can be attained and the risk of electrocution does exist.

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Adding Voltages in Series Circuits

Performance Objective: The student will configure and measure the output (measured in volts) of the photovoltaic cell(s) and discover how voltage increases as the cells are added together.

Given: An instruction sheet, schematic, instructor lecture, photovoltaic panel(s), wire and appropriate tools (not limited to but to include a multimeter, side cutting pliers, screwdrivers and a protractor).

The Student Will: Assemble and test at least a pair of small photovoltaic panels in series and measure the output voltage, all the while reconfiguring the circuit and adding other panels to increase the potential of the array.

How Well: You must successfully pass a knowledge test and a performance test.

NAME: _____

DATE: _____

GRADE: _____

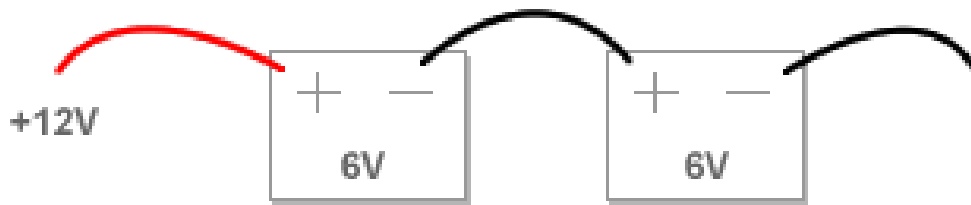
INSTRUCTION SHEET

Series Circuits are circuits are circuits, which have only one path for electricity to follow. This means that if the continuity of the circuit is broken (opened), there is no current flow. Therefore, the electrical device cannot operate. When voltage sources such as photovoltaic cells are combined in series, voltage is increased in an additive fashion. This is proven by the experiment by adding photovoltaic panels and measuring the output as panels are added.

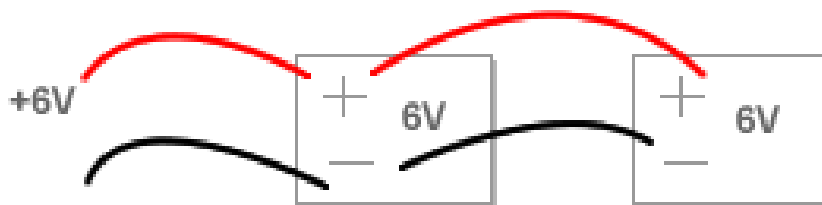
Reading Assignment:

Series connections as compared to parallel connections
<http://www.zbattery.com/zbattery/seriesparallel.html>

Connecting in Series (double voltage, same capacity [ah])



Connecting in Parallel (same voltage, double capacity [ah])



COMPONENTS

Amp: Also known as Amperes. Amperes are a quantitative measure of current flow. Indicating the number of electrons flowing through a conductor.

Current output: The quantity of amperes flowing through the circuit at a particular time.

Multimeter: A tool used to measure the quantities of voltage and current for the purposes of testing and evidencing the presence of electricity.

Photovoltaic System/Cell/Panel: Electric generating devices, which directly convert sunlight into electricity, are made of silicon.

Series connection: A wiring configuration, which has only one path for current to flow.

Volt: Also known as potential. The unit used to measure the force of electricity in a circuit.

Watt: A function of volts multiplied by amperes. A watt is a standard unit of power usage.

Wire: Also known as a conductor. A wire is an insulated piece of copper used to carry electricity from one place to another.

Massachusetts Frameworks/Technology (HS)

5. Energy and power Technologies-Electrical Systems

Broad Concept: Electrical Systems generate, Transfer, and Distribute Electricity

5.1 - Describe the different instruments that can be used to measure voltage.

5.2 – Identify and explain the components of a circuit including a source, conductor, load and controllers.

5.3 – Explain the relationship between resistance, voltage, current and Ohm’s Law.

5.4 – Determine the voltages and currents in a series circuit and a parallel circuit.

5.5 – Explain how to measure voltage, resistance and current in an electrical circuit.

5.6 – Describe the differences between Alternating Current (AC) and Direct Current (DC)

Massachusetts Frameworks/Science (HS)

Broad Concept: Stationary and moving charge particles result in the phenomenon known as electricity and magnetism.

5.4 - Develop a qualitative and quantitative understanding of current, voltage, resistance and the connection between them.

5.5 – Identify appropriate units of measurement for current, voltage and resistance and explain how they are measured.

5.6 – Analyze circuits (find the current at any point and the potential difference between any two points in the circuit) using Kirchoff’s and Ohm’s Laws.

KNOWLEDGE TEST

Directions

Evaluate your knowledge by achieving “Proficient” on the following question.

Explain how the series connection affects the voltage reading on the meter. Include how this is relative to the number of panels connected and how it subsequently affects this reading.

Grading Rubric

Mastery

Complete and accurate account including correct terminology, direction, and usage of meters.

Proficient

Basically accurate account, student lacks a complete understanding of component operation

Needs Improvement

Incomplete data, does not understand the operation of the system

PERFORMANCE TEST

Directions

Given access to a work station, the proper tools, and the schematic drawing in this learning guide, you will design and install all of the components required for a solar photovoltaic system. You will be evaluated for attainment of this task based on the items listed below.

Performance Standards All items must be marked YES for attainment	Yes	No
PROCESS		
1. Were all safety rules observed?		
2. Are all components installed as per drawing?		
3. Are all components installed in proper sequence?		
4. Are all straight and neat?		
5. Were all meters used properly?		
6. Are all terminations tight?		
7. Was the installation in accordance with the <u>National Electrical Code</u> ?		
8. Did the student return all excess materials and tools to the designated area?		

List of RESOURCES

Series connections as compared to parallel connections
<http://www.zbattery.com/zbattery/seriesparallel.html>