Solar Powered Charger

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Abstract

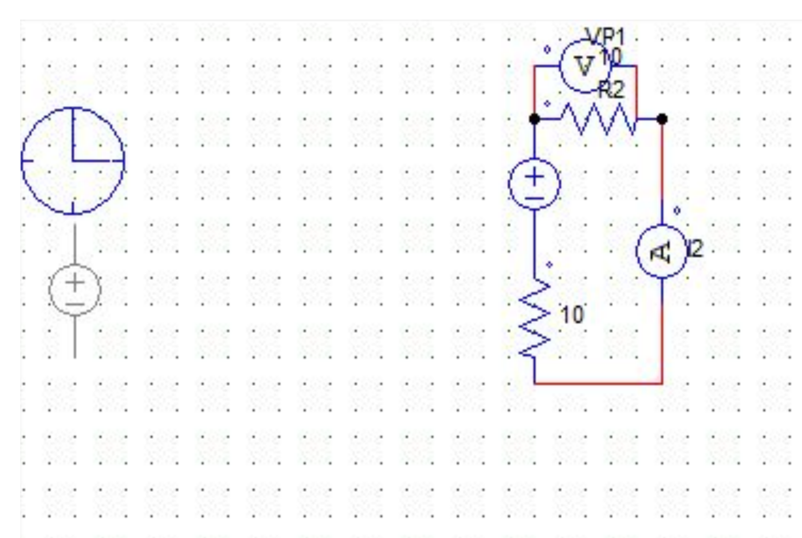
We became familiar with solar modules and their behaviors, then designed and simulated a charger circuit for charging a cellphone from solar modules. We used the software PSIM for our simulation, where we would create circuits and test them at various temperatures that could occur in a real-life scenario. The final circuit used in our solar powered charger design was a linear regulator, consisting of a resistor voltage divider and Zener diode. Our goal is to help in creating a more efficient and environmentally friendly method of powering our everyday electronics. If we can learn how to create a circuit that works purely with solar energy, we can help reduce dependence on nonrenewable energy and decrease pollution.

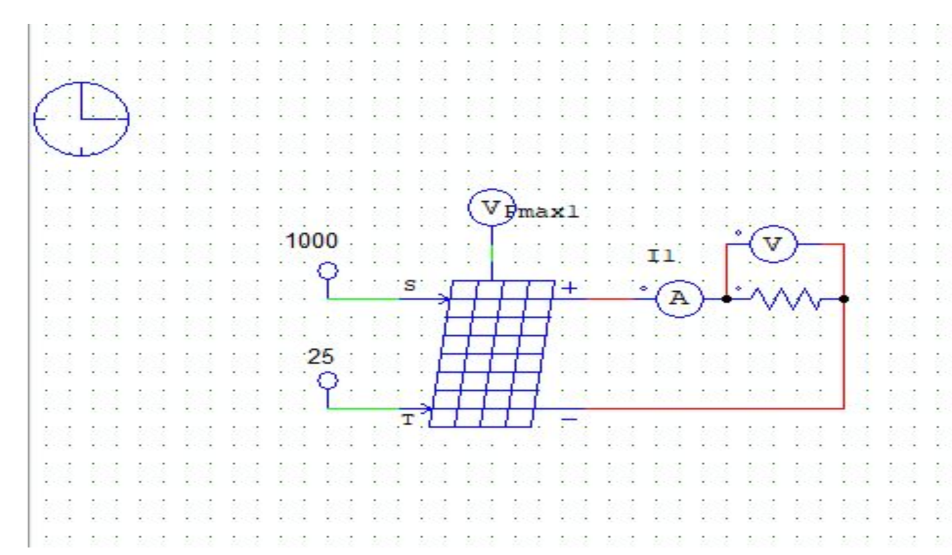
Background

Solar energy is clean, renewable, reliable and cost-effective, and uses Photovoltaic (PV) modules, or solar panels which convert light energy captured from the sun into electric energy through the photovoltaic effect. They are made up of semiconductor materials that absorb the photons emitted from the sun and generate flow of electrons. The flow of electrons then produces DC (direct current) electricity. The electricity required is AC (alternating current) and this conversion of electricity occurs in the inverter. In order to use this solar powered energy, we must creat a linear regulator. A simple linear regulator is a system comprised of only a resistor voltage divider and a Zener diode, which uses a voltage divider, a type of linear circuit, to control the inward flow of voltage and maintain a constant output as a result. Use of a linear regulator in something like a cellphone charger is ideal, because irregular or unstable voltage intake is detrimental to the functioning and life of a battery, as well as potentially harmful.

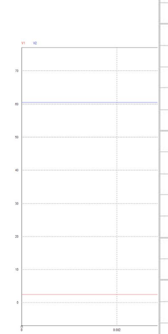
Experimental Methods

Before creating a circuit powered from a PV module, we had to learn how to use the basic functions of PSIM. We began by researching, then creating the basic circuit above containing a simulation control, DC voltage source, voltage probe, and resistor. We then created a PV Module using a PV panel, voltage probes and a current probe. This would now allow us to change the temperature and radiance values as they could in a day-to-day scenario, and check the results.

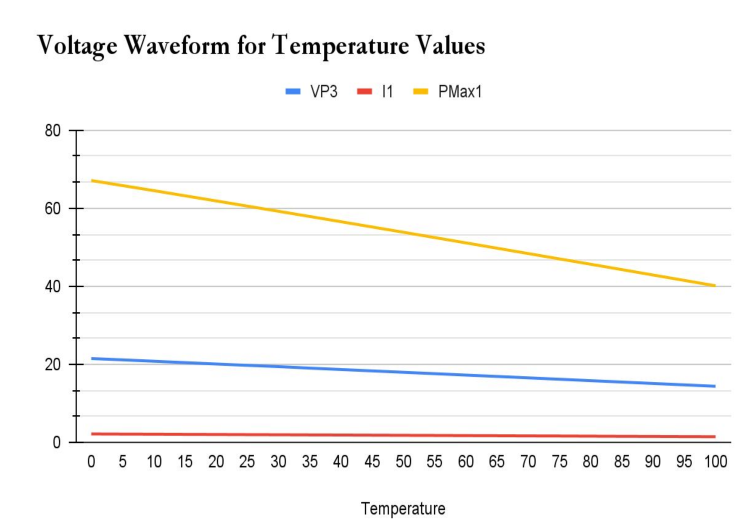




Results

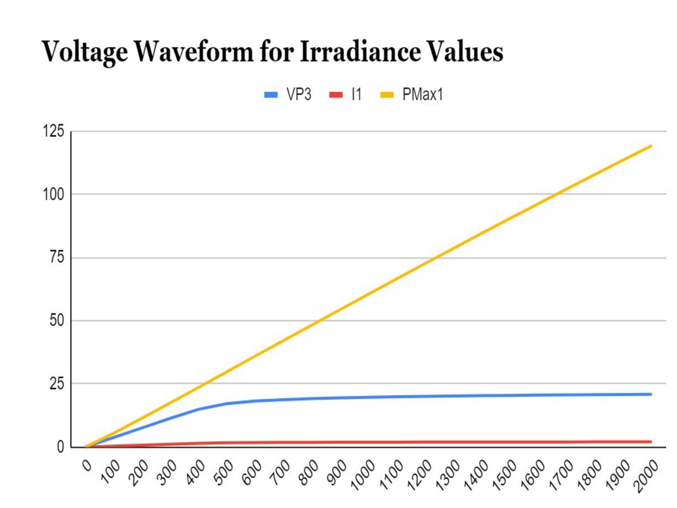


Temperature (C)	VP3	I1	PMax1
0	21.47	2.15	67.09
5	21.13	2.11	65.79
10	20.78	2.08	64.5
15	20.42	2.04	63.18
20	20.07	2.01	61.86
25	19.72	1.97	60.53
30	19.4	1.94	59.2
35	19.01	1.9	57.87
40	18.66	1.87	56.53
45	18.3	1.83	55.18
50	17.95	1.79	53.83
55	17.59	1.76	52.47
60	17.23	1.72	51.11
65	16.88	1.69	49.74
70	16.52	1.65	48.37
75	16.16	1.62	47
80	15.8	1.58	45.63
85	15.44	1.54	44.25
90	15.08	1.51	42.87
95	14.72	1.47	41.49
100	14.36	1.44	40.11



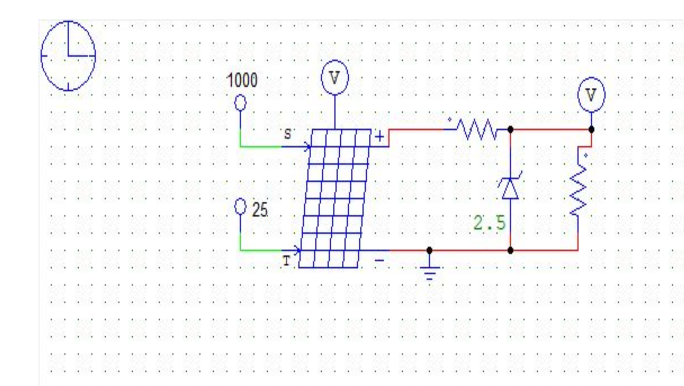
After testing various values of temperature, we found the PMax1 for irradiance was directly decreasing in relation with the VP3 and I1.

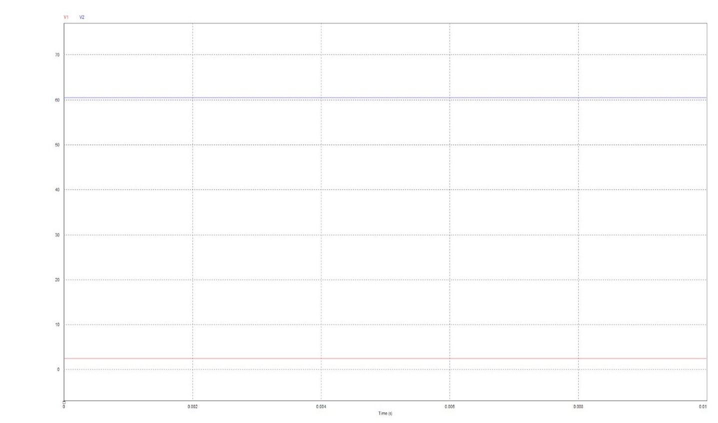
Irradiance (W/m^2)	VP3	I1	PMax1
	0	0	0
100	3.80	0.38	5.47
200	7.60	0.76	11.41
300	11.39	1.14	17.49
400	14.97	1.5	23.63
500	17.21	1.72	29.80
600	18.22	1.82	36.00
700	18.8	1.88	42.15
800	19.19	1.92	48.30
900	19.49	1.95	54.43
1000	19.72	1.97	60.53
1100	19.91	1.99	66.60
1200	20.08	2.01	72.63
1300	20.22	2.02	78.63
1400	20.35	2.04	84.58
1500	20.47	2.05	90.48
1600	20.57	2.06	96.35
1700	20.67	2.07	102.16
1800	20.75	2.08	107.92
1900	20.84	2.08	113.64
2000	20.91	2.09	119.30



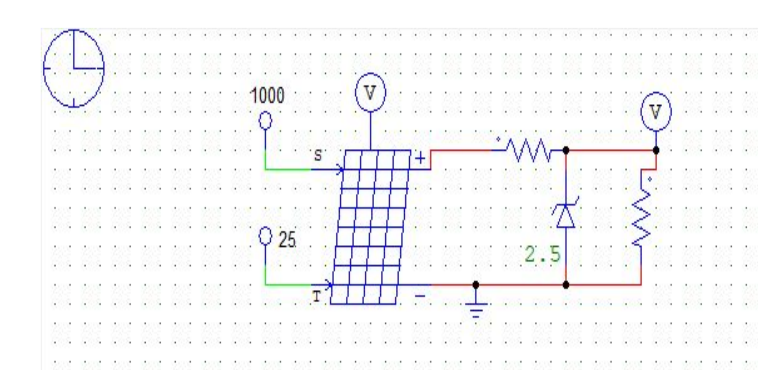
After testing various values of irradiance, we found the PMax1 for irradiance was directly increasing in relation with the VP3 and I1.

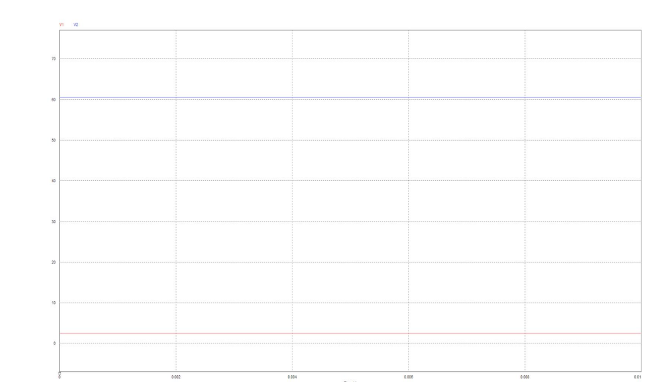
Results Continued





The final stage in our research was the creation of a linear regulator, consisting of a resistor voltage divider and Zener diode. The regulated voltage (Zener voltage) output was set to 2.5, and when the simulation was ran, this was displayed successfully.





After confirming functionality for the linear regulator, we were able to take the last step of replacing the current energy source (DC voltage source) with the PV module. We ran the simulation one final time, and it was successful.

Conclusion and Future Steps

We successfully created our linear regulator powered by solar energy via a linear regulator, set at a Zener voltage of 2.5 The linear regulator we were able to complete in this time was a relatively simple one, consisting only of the basic parts in a voltage divider and Zener diode. In the future, we may work on more complex linear regulators, which will include multiple separate stages of voltage reference, as well as an error amplifier and power pass element, allowing the circuit to regulate more efficiently and accurately. Additionally, an entirely new circuit, a shunt regulator, may also be set up in parallel to the linear regulator to "shunt," or redirect, electric current to the lowest resistance path

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