RAINBOW CANYONS AMATEUR RADIO CLUB
CEDAR CITY, UTAH 84720

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Minutes for October 12, 2010

Vice-President Ken Munford N7KM opened the meeting at 7:30 pm. He welcomed everyone and explained why the president was not present. There were 19 people in attendance.

The minutes were posted on the club website (www.rcarc.info) and were read and approved.

Ken explained the scoring process for the contest held during the past month. Ken used Dick Parker K7ZI's list of contacts. After discussion the members agreed to repeat the exercise next month.

Dick Parker demonstrated fiberglass poles that can be used for multiple purposes but make great poles to support wire antennas. The poles are available at “ham4less” website.

Sylvia Clements KB7UMU reminded the group of the club breakfast at IHOP Saturday 9 am. She wanted a count of those attending.

Ken introduced Dennis Porter KA7QJN, Bruce Clement KF7EXH, Jeff Zwang AC7MO and a brand new Extra Class Darrel Olmsted W7DRO..

Ken introduced Trevor Pollock. Trevor's presentation was on solar power.

Trevor presented a history solar panels. The first panel was developed in 1930. He stated that solar panels are made of photovoltaic cells. There are several types :

Single Crystal (monocrystalline) Silicon most efficient and most expensive

Poly Crystal (multicrystalline) Silicon

Amorphous (thin-film) Silicon flat material that is very flexible but not as efficient as polycrystalline and the least expensive.

Trevor explained that in a solar generation systems 2 types of diodes needed: 1) to keep the battery from discharging is called a blocking diode. 2) to protect the cells from too much current is called a bypass diode. Solar cells are built in modules and modules make a panel. Panels can be connected to increase voltage or parallel to increase current.

Trevor mentioned that batteries do not storage electricity. Electricity is converted into chemical storage. There are three types of batteries.

Liquid - electrolyte, such a car battery. They need tilation, they can spill and need to be refilled.

Gel - Sealed with approximately 3 lbs of silicon gel. It has lower amperage for a longer time.

Fiber Mat (aka AGM) - sealed battery, higher voltage but needs good control. Never exceed a 50% discharge.

There are also three categories of batteries: Automotive, Marine or RV and Deep Cycle which includes flooded used in golf carts.Gel which will last 5 to 8 yrs of service life and the AGM.

Trevor mentioned that shelf life usually has a discharge rate from 1 to 5 %. The best charge rate should be no more that 10% of the total capacity of the battery. To check the state of charge the battery needs to be at rest for 6-12 hrs. A fully charge battery should read 12.7/12.8 volts.

Lf operating with a battery it is necessary to “power budget”. Estimated operating time is 24 hours. If receive current is 1A times 24 hrs you need 24 AH battery. Transmit current is 8A for a total of 6 hours (based on a 25% transmit duty cycle) you need a 48AH battery. Overall a minimum of a 72 AH battery will be needed. However it is good to allow 1.5 overage. 72 times 1.5 is 108 AH battery should handle any need. Batteries measuring 10.5 v will be fully discharge.

Trevor discussed the need and process for using charge controllers. There are three types of controllers:

Division Controller – runs unregulated. It does drain excess current.
PWM (Pulse Width Modulation) Controller – Uses voltage spikes to charge MPP Tracking (Maximum Power Point) – Can use higher array voltage 24-48V and it can be placed at a greater distance from the array and compensate for wire loss.

There were questions and comments that followed.

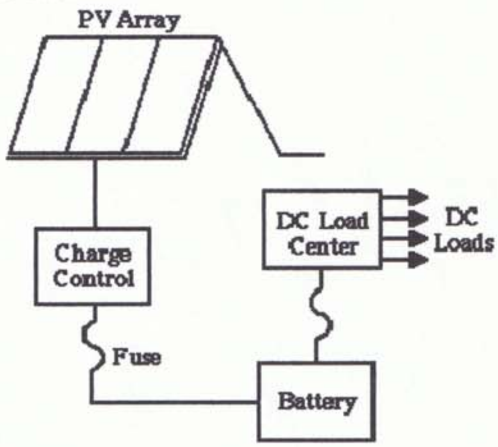
The meeting was adjourned at 8:55 pm.

Respectfully submitted;

Bill Stenger K6QOG
Secretary

Look at the pages below for a couple of good ideas on solar.

Example of a stand-alone system that powers 12 volt d.c. loads only. This shows a low-volage direct current system which could be made more versatile with the addition of a small inverter to power a.c. loads.



12 Volt 2% Wire Loss Chart

Maximum distance one-way in feet of various gauge two conductor copper wire from power source to load for 2% voltage drop in a 12 volt system. Do not exceed the 2% drop for wire between PV modules and batteries

2% Voltage Drop Chart										
Amps	**#14**	**#12**	**#10**	**#8**	**#6**	**#4**	**#2**	**#1/0**	**#2/0**	**#4/0**
1	45	70	115	180	290	456	720			
2	22.5	35	57.5	90	145	228	360	580	720	1060
4	10	17.5	27.5	45	72.5	114	180	290	360	580
6	7.5	12	17.5	30	47.5	75	120	193	243	380
8	5.5	8.5	11.5	22.5	35.5	57	90	145	180	290
10	4.5	7	11.5	18	28.5	45.5	72.5	115	145	230
15	3	4.5	7	12	19	30	48	76.5	96	150
20	2	3.5	5.5	9	14.5	22.5	36	57.5	72.5	116
25	1.8	2.8	4.5	7	11.5	18	29	46	58	92
30	1.5	2.4	3.5	6	9.5	15	24	38.5	48.5	77
40			2.8	4.5	7	11.5	18	29	36	56
50			2.3	3.6	5.5	9	14.5	23	29	46

Here are no-load typical voltages vs. state of charge

(figured at 10.5 volts = fully discharged, and 77 degrees F). Voltages are for a 12 volt battery system. For 24 volt systems multiply by 2, for 48 volt system, multiply by 4. VPC is the volts per individual cell - These voltages are for batteries that have been at rest for 6 hours or more. Batteries that are being charged will be higher - the voltages while under charge will not tell you anything, you have to let the battery sit for a while. For longest life, batteries should stay in the green zone. Occasional dips into the yellow are not harmful, but continual discharges to those levels will shorten battery life considerably. It is important to realize that ***voltage measurements are only approximate***. The best determination is to measure the specific gravity, but in many batteries this is difficult or impossible. Note the large voltage drop in the last 10%.

State of Charge	12 Volt battery	Volts per Cell
100%	12.7	2.12
90%	12.5	2.08
80%	12.42	2.07
70%	12.32	2.05
60%	12.20	2.03
50%	12.06	2.01
40%	11.9	1.98
30%	11.75	1.96
20%	11.58	1.93
10%	**11.31**	**1.89**
0	**10.5**	**1.75**

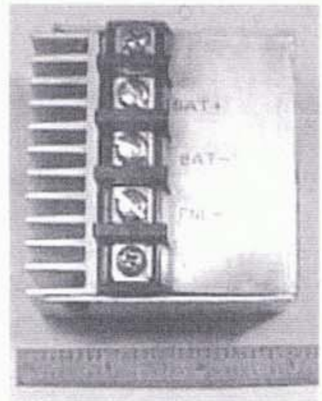
When using a small solar panel to keep a float (maintenance) charge on a battery (without using a charge controller), choose a panel that will give a maximum output of not much more than 1/1000th of the amp-hour capacity. For a pair of golf cart batteries, that would be about a 5 watt panel - the smaller panel if you get 5 or more hours of sun per day, the larger one for those long cloudy winter days.

World's biggest myth!!

Storing a battery on a concrete floor will discharge them.

A hundred years ago when battery cases were made of porous materials, such as wood, storing batteries on concrete floors would accelerate their discharge. Modern battery cases, made of polypropylene or hard rubber, which are better sealed, so external leakage, causing discharge, is no longer a problem.

Low Cost PV Regulator



Tom Kirkgaard

Building solar panels or batteries is beyond the capabilities of the average person. Building a regulator for your PV system is not.

This regulator design is capable of handling up to 30 amps for a 12 volt or 24 volt system. To build it, you need to be able to read schematics and know basic construction techniques. If you've built small homebrew projects before, this should be no problem.

A regulator's job is to connect the solar panels to the battery when it needs charging, and to disconnect them when it doesn't. The regulator should also prevent battery power from being dissipated in the solar panels after the sun has gone down. The ideal regulator would not generate any heat while controlling your precious solar power. This regulator design achieves this with a minimal number of parts, at low cost.

Operation

The regulator connects or disconnects the panel dependent on the battery voltage. The user sets this voltage, so any type of battery can be accommodated. The switching portion of the regulator uses a field effect transistor, or FET (Q2). FETs are amazingly efficient. At 20 amps, I measured only 0.2 volts drop across the FET used in this regulator.

The brain of the regulator is a 555 IC. This part is usually used as an oscillator, but it contains the circuitry needed for an on/off regulator. Pin 5 in U1 sets the reference voltage for U1. The output of U1 pin 3 goes to 12 volts when the input to U1 pin 2 falls below one half of pin 5. The output of U1 pin 3 goes to 0 volts when the input to U1 pin 6 rises above pin 5.

The battery voltage is divided by potentiometers R2 and R3 and applied to U1 pins 6 and 2. Setting the on/off voltage limits with R2 and R3 allows a voltage range. Within this window of voltage, the regulator can be on or off depending on whether the battery voltage is rising or falling. Below the lower limit, the regulator is always on. Above the upper limit, the regulator is always off. In operation, when the regulator is on, the battery voltage rises to the upper limit, then shuts off. It will remain off until the battery voltage drops below the lower limit, then the regulator turns on.

Preventing discharge at night is easily accomplished with a diode. But unless you pick your diode carefully, it can be a source of power loss. Diodes have a small voltage drop in the forward direction. A standard power diode can have a drop of 0.6–1 volt. At 15 amps, this would translate into 9–15 watts of wasted power. In this project, we use a Schottky diode, which can reduce the voltage drop to 0.4–0.7 volts. At 15 amps, it wastes 6–10.5 watts of power. This may seem fussy, but you probably paid $5 a watt when you bought the panels.

Construction

There are 12 and 24 volt versions of this regulator. For the 12 V version, install all the J1 jumpers (denoted by connecting the two dots to the left and right of the J1 designator) and install all parts *except* the ones beginning with (2). For the 24 V version, install all the J2 jumpers and install all parts *except* the ones beginning with (1).

A good approach would be to install all the parts except D1 and Q2 on a perfboard. Layout isn't critical, but it would be wise to allow for a good common for all parts going to ground. When building, keep in mind that the regulator will most likely be connected to a large battery. Make sure there is no possibility of a short. A small aluminum box can serve as a protective enclosure and heat sink.

My prototype had a barrier terminal block with three screw terminals on the top and solder tabs on the bottom. This was used to make the solar panel and battery connections. It was positioned so the drain lead (D) of Q2 could be soldered directly to the solder tab.

FET Mounting
The diode (D1) was not installed in the enclosure of the prototype. You may want to connect the source of Q2 to pins 1 and 3 of D1, then connect pin 2 to the terminal strip. Before installation, the FET (Q2) can be damaged with static electricity. Avoid touching the leads until required by installation. The diode (D1) and FET (Q2) require heat sinks. The mounting surface on the FET (Q2) is connected to the drain (D). The drain (D) is grounded on the FET so it can be mounted to the regulator enclosure. The diode will generate the most heat.

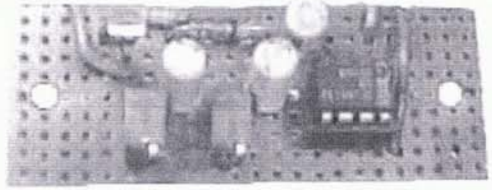
The diode (D1) mounting surface is connected to its cathode, which should not be grounded. Use a TO-247 isolation mounting kit for D1. The kit should consist of a very thin insulating material to go between D1 and the enclosure. An insulating washer goes between the mounting screw and the mounting hole of D1.

The diode actually operates with less voltage drop (which is good) at higher temperatures (max 115° C; 239° F). On the other hand, the FET has the lowest resistance when kept cool.

Adjustment and Testing
First verify the wiring accuracy of your board. Connect a 12 or 24 volt battery or a power supply to the battery terminals on the regulator. Measure the voltage at U1 pin 5. It should be 6.8 volts for the 12 V version, and 12.5 volts for the 24 V version, +/- 0.7 volts. Record this reading as V1. Measure the voltage at the battery terminals, and record this reading as V2. Calculate the R3 and R2 settings.

R3 Turn Off
Decide on the *off* voltage for the regulator. R3 voltage equals V1 times V2, divided by the *off* voltage. If you choose 14.0 volts as the *off* voltage, R3 is 6.8 x 12.0 / 14.0 (which equals 5.83). Adjust R3 (U1 pin 6) to 5.83 volts with respect to ground.

R2 Turn On
Decide on the *on* voltage for the regulator. R2 voltage equals V1 times V2 times 0.5, divided by the *on* voltage. If you choose



Above: The components laid out on perfboard.

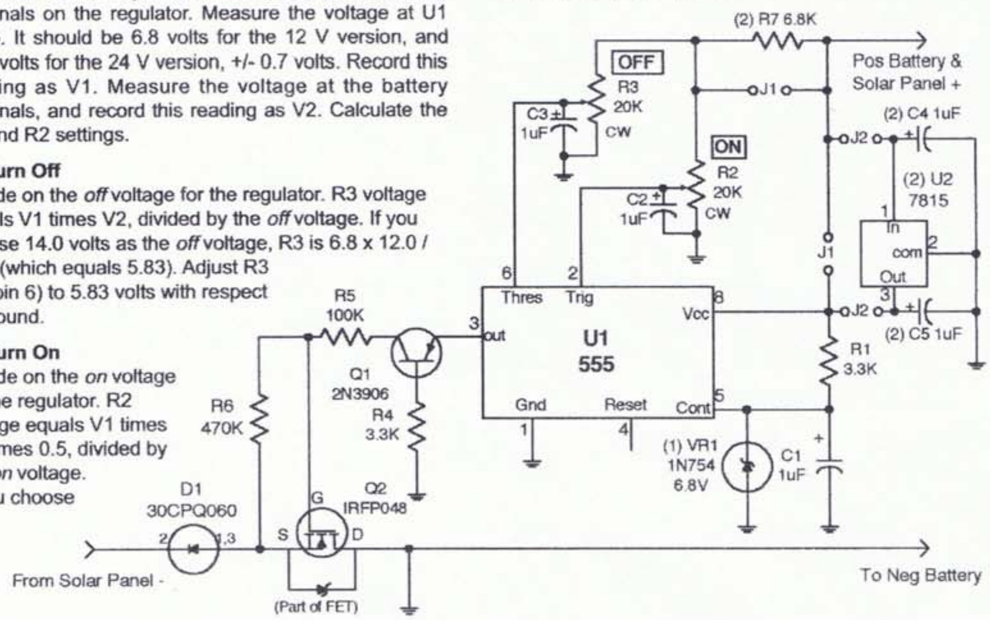
13.0 volts as the *on* voltage, R2 voltage is 6.8 x 12.0 x 0.5 / 13.0 (which equals 3.13). Adjust R2 (U1 pin 2) to 3.13 volts with respect to ground.

If you have a variable power supply connected to the battery terminals you can verify the adjustments. As you vary the supply above and below the *on* and *off* voltages, you should see U1 pin 3 change from 0 volts to approximately the same as the Vcc (supply voltage) of U1. Do not exceed 18 volts for the 12 V version, or 35 volts for the 24 V version.

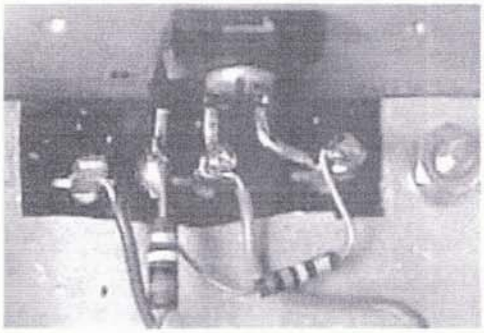
Precautions
Do not connect anything to the negative terminal(s) of the solar panel(s) other than the regulator.

It is possible for the regulator to oscillate if the on and off voltages are too close. This is due to the resistance

PV Regulator Schematic



in the wiring from the regulator to the battery. If this occurs, increase the *on* to *off* voltage span and use larger wire from the regulator to the battery. See examples of systems in other *Home Power* articles for safe installation of regulators.



Above: The FET installed.

Parts List

Qty	*Code*	*Description*	*Cost*
1	Q1	2N3906 PNP transistor	$0.85
1	Q2	IRFP048 N channel HEXFET	$4.30
1	VR1	1N754 6.8 V 0.5W zener diode (1)	$0.50
3	C1-5	1µF 25 V electrolytic capacitors (1)	$0.59
5	C1-5	1µF 25 V electrolytic capacitors (2)	$0.59
2	R1,4	3.3K 0.25W 5%	$0.10
2	R2,3	20K ten-turn trimmer potentiometer	$1.49
1	R5	100K 0.25W 5%	$0.10
1	R6	470K 0.25W 5%	$0.10
1	R7	6.8K 0.25W 5% (2)	$0.10
1	D1	30CPQ060 30 amp Schottky diode	$3.50
1	U1	LM 555 timing circuit	$1.39
1		8 pin DIP IC socket	$0.25
1	U2	LM7805C or LM340T-15 15 V reg. (2)	$1.25
		Total	$15.11

Lead Assignments

	Q2		D1		U2
1	Gate	1	Anode	1	Input
2	Drain	2	Cathode	2	Common
3	Source	3	Anode	3	Output
Tab	Drain	Tab	Cathode	Tab	Common

Q2, D1, and U2 have similar style cases

Access

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Sources for parts:

Radio Shack, 100 Throckmorton St., Fort Worth, TX 76102 • 800-843-7422 • 817-415-3011
Fax: 817-415-3240 • support@tandy.com
www.radioshack.com

Digi-Key, PO Box 677, Thief River Falls, MN 56701-0677 • 800-DIGIKEY • 218-681-6674
Fax: 218-681-3380 • sales@digikey.com
www.digikey.com

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