



Zero Beat

April 2022

General Meeting
Wednesday April 13th
At 7:30 pm at the
Hazel Park Library
and on Zoom
With Socializing
At 7:00 pm

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Kirchoff's Current Law And Today's Amateur.

Chris Warren March 11, 2022 6 Comments on Kirchoff's Current Law And Today's Amateur.

A very high bar.

Prussian-German scientist Gustav Kirchoff (1824-1887) was a pretty impressive guy. His research led to a series of electrical principles collectively referred to as *Kirchoff's Laws*. Those of us who endured electrical engineering school or technical college are very familiar with Kirchoff. Yet, he's not particularly well known among hams. We will change that by reviewing Kirchoff's Current Law, what it is, and how it can be applied to off grid amateur radio.

In engineering/science/math, there is no recognized criteria a concept must meet to be declared a "Law". Generally, a genuine Law is a concept, statement, or equation that cannot be invalidated. Many of the scientific & mathematical Laws in use today have been around for hundreds or even thousands of years and have never been proven wrong. The Law of Gravity, the Pythagorean Theorem, and Ohm's Law belong in this category.

It's worth noting that simply calling something a "Law" does not make it so. For example, **Moore's Law** is the principle that describes the rapid development of semiconductors. It is only 57 years old and it's already been busted. If a Law can be invalidated, was it really a Law in the first place? That question is outside the mission of this blog, but it's something to think about.

Kirchoff is the real deal.

Gustav Kirchoff rightfully earned his place in the pantheon of scientific Laws. We can use Kirchoff to analyze all sorts of circuits, but today we'll focus on how it

applies to off grid power. It is a practical, working concept useful to radio amateurs who want to better understand their off grid power systems.

Scientists describe Kirchoff's Current Law (KCL) in many ways. The most popular are:

The sum of electrical current flowing into a node is equal to the sum flowing out of the node.

The algebraic total of every current entering and leaving any node is zero.

The current will always be the same at every point in a series circuit.

KCL is also known as *Kirchoff's First Law* and *The Law of Conservation of Current*. KCL applies to parallel circuits too, but we'll get to that later. It all makes logical sense. Current does not just magically disappear. What goes in must come out.

Meanwhile in the "real world"...

For the purpose of our analysis, remember that a "12 volt" solar panel actually produces 15-18 volts. To keep our math accurate we will use the highest rated voltage and current. The numbers used in the following examples are real. They were taken from the specifications of common solar panels available from numerous retailers.

Let's say you have a 100 watt, 12 volt solar panel. This panel will produce about 5.56 amps. Your friend gives you a 50 watt, 12 volt panel producing 2.69 amps. To avoid long runs of wire, you're planning to add the 50 watt panel in series with your existing 100 watt panel to give you a total of 150 watts. *Wait! Hit the pause button!* You're not going to get 150 watts!

If you are familiar with Kirchoff's Current Law you will immediately know why without doing any math or taking any measurements. Let's walk through it. Kirchoff says that in a series circuit, the current will always be the same at all points in the circuit. Meanwhile, Ohm's Law states that in a series circuit the total voltage

will equal the sum of all the source voltages.

The details on why it's a bad idea.

Both "12 volt" panels are really 18 volts, so according to Ohm, the total voltage will be 36 volts. This is not a problem. A proper MPPT controller will very efficiently convert the 36 volts into 12 volts with almost no loss. But here's why you'll never see 150 watts: Your 50 watt panel is will not go higher than 2.69 amps no matter how much sun shines on it. Since Kirchoff says the current will be the same everywhere in the series of solar panels, the "speed limit" of the entire system will be 2.69 amps even though the larger panel is capable of more than double that.

The only way connecting solar panels in series works is if all the panels are the same voltage and wattage. In this form, they all create the same current and one panel is not "holding back" the others.

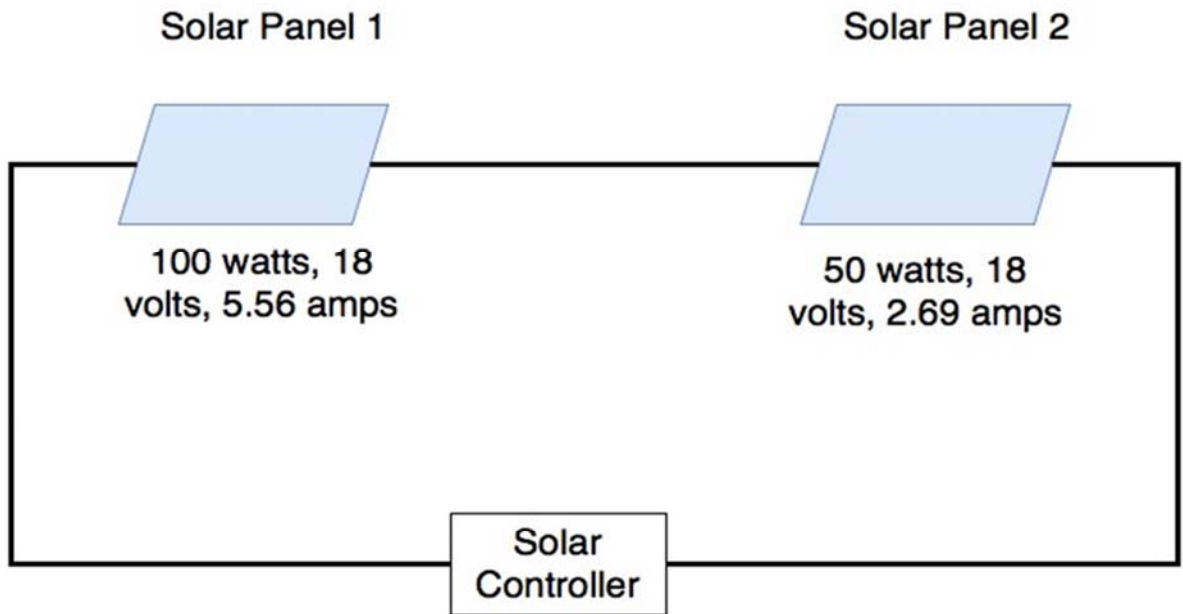
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Think of it like a convoy of ships. The convoy cannot go any faster than the slowest ship. What can we expect from this poorly planned system? That part is easy. Thirty six volts times 2.69 amps equals 96.84 watts. You are gaining absolutely nothing by adding the 50 watt panel in series. Kirchoff explains why a full third of your potential wattage is off the table.

An off grid ham would have to connect the panels in parallel to access the 150 watt potential of this setup. The system voltage will drop to 12 volts, but each panel can produce full current independently of the other. **Diagram on Page 3.**

Kirchoff's Law and parallel circuits.

A parallel circuit is really two or more series circuits stacked together. In the illustration below, Branch 1 and Branch 2 are series circuits in relation to the controller, but not to each other. If we were to remove either branch/panel, there is still a complete circuit for the remaining branch/panel. Each branch will have its own unique current value; the sum of all the current in all the branches will equal the total at the controller. It



Total system current at Controller= 2.69 amps.

Total system voltage= 36 volts.

Total system power= 2.69 amps x 36 volts= 96.84 watts.

Solar panel #2 will not produce more than 2.69 amps no matter how much sun shines on it. Since it is in series with Panel #1, the entire circuit is limited to 2.69 amps. A full third of the potential power is unavailable due to the limitations imposed by Kirchoff's Law.

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would work the same way if there were 3, 5, or 100+ branches. Another way of looking at it, as current passes each node, the current is split off in two directions. The added total of current of each divergent path will always equal the current entering the node.

There's another method to look at this. Any circuit can be represented by a single resistor in series with a single power source. This representation is known as *Thevenin's Theorem*. It's deeper and geekier that we need to go here, but if you're game there is an ocean of information about it on line.

Connecting batteries...safety considerations.

Since all solar panels have an absolute maximum current capacity, there is an inherent margin of safety (Disclaimer: This does not mean you don't need to be mindful of safety protocols!). When working with batteries, power supplies, and commercial electric, things get a little more vague.

Batteries will not stop producing current at a firm ceiling. They have the potential to crank out current far beyond their design (as in a dead short circuit). If the current demand of a load exceeds the ability of the battery, one of two things will happen. 1) The battery will very quickly go dead and stop producing current. Or, 2) The battery or other circuit components will overheat and fail, or even start a fire. There is a third possibility that both 1 and 2 will happen. These scenarios can also occur with AC power supplies and commercial electric, although built in safety features reduce the risk.

Use Kirchoff's principles to determine if the battery connection wire is appropriately sized. Also, make sure your system is fused. Lastly, mixing batteries of different capacities is a really bad idea. The smaller battery will be discharged before the larger which will ultimately drag down both. In a worst-case situation, the smaller battery can be overloaded while the larger battery operates below its capacity.

Kirchoff's Voltage Law.

Gustav Kirchoff also developed a voltage Law that is similar to his current Law. While we're not going to get into it now, it basically states that the sum of voltage differences in any loop circuit is always zero. This is a fancy way of saying that the sum of the voltage drops across all the loads in a series circuit will equal the voltage of the power source. Most hams already know this, even if they don't know what it's called.

What we learned today.

- Gustav Kirchoff's Current Law is useful for understanding relationships between power sources connected to the same load.

Kirchoff's Current Law is also known as Kirchoff's First Law, and The Law of Conservation of Current.

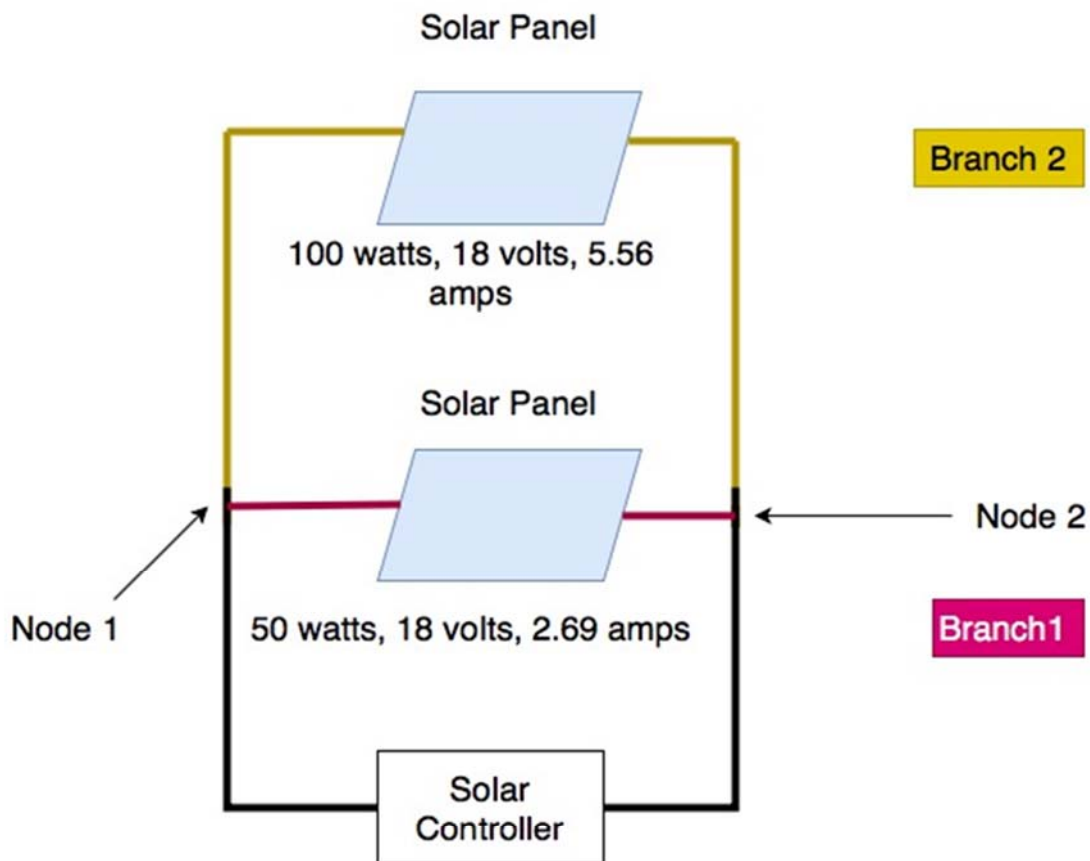
Current will always be the same at all points in a series circuit.

The sum of the currents flowing out of a node will equal the currents flowing into the node.

Solar panels of differing power levels should not be wired in series.

Batteries of different capacities should not be wired together at all. **Diagram on Page 5.**





Total system current at Controller= 8.25 amps

Total system power= 8.25 amps x 18 volts= 148.5 watts

Per Kirchoff's Law, the sum of the current leaving each node will be equal to the current entering. The 2.69 amps from Branch 1 and the 5.56 amps from Branch 2 flowing into each Node come out the other side as a combined 8.25 amps. This is also known as **The Law of Conservation of Current.**

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2022-03-09 HPARC meeting at Hazel Park library

Meeting called to order 7:30pm by Joe WB8ADX President

Pledge of allegiance

Board of directors introduced/ recognized Elections coming up, W8TOY will be the election chair. MAKE SURE YOUR EMAIL IS UP TO DATE

New members recognized, KE8SDF KE8SJK W8RJD KI4ZEN

Committees recognized

Presentation - Barry K7BWH presentation on meteor scatter.

Field day June 25/26. Start thinking about it now. Plan similar to years past. Will try to have a GOTA station this year.

Michigan QSO party April 16th 2022, we did well on participants last year and came in #4 last year.

DART: We are working on the City Airport remote receiver site. It will give good East-side coverage once it is complete and online.

Reminder: Our website has online membership renewal. Also the member portal has a roster of members.

Treasurer report- N8REL - Not much happened in February, but we did spend around \$400 on the repeater; YTD we've only spent about \$1000 of the repeater budget.

ARRL website on grants shown. We could use help from those familiar with writing grants.

Education - Technician class exams in April and June are the old question pool, after that the questions will be from the new pool. Talk to Jerry W9NPI if you need to take an exam.

Selfridge STEM event on May 27th, We are looking for ideas of what to present at the event.

The mentoring program moving ahead, Len and Ken AD8M meeting on this

Siren test - The first test of the season was March 5th, Marsha N8FE- We need more volunteers for public service activities. March 23rd will be a special siren test, on a Wednesday.

Meeting adjourned 8:55pm

Respectfully submitted,
Reuven Gevanyahu KB3EHW
HPARC Secretary

Important Message from ARRL VEC

By Maria Somma, AB1FM, ARRL VEC Manager

The FCC released a [Public Notice](#) on March 23, 2022, stating that the amateur radio application fees, including those associated with Form 605 application filings, would become **effective on April 19, 2022**. The Federal Communications Commission's authority to impose and collect fees is mandated by Congress.

The \$35 application fee, when it becomes effective on April 19, will apply to new, renewal, and modification applications that request a new vanity call sign. The fee will be per application.

Administrative updates, such as a change of name, mailing or email address, and modification applications to upgrade an amateur radio licensee's operator class*, will be exempt from fees. (*this new information was just confirmed by FCC staff on Tuesday, March 29.)



Chairmen

Repeater	Joe WB8ADX
W8JXU Trustee	Bill N8QVS
Swap	John KD8NYF
Field Day	John AA8UU
Education	Jerry W9NPI
Sunday Net	Bob N8REL
Zero Beat Editor	Rick KB500
Public Information Officer (PIO)	Rick KB500
Webmaster	Mike K8WU
Banquet	John W8TOY
Club Picnic	Jay WB8SBI

HPARC Nets

HPARC Official Sunday Night 2-meter Phone Net

Every Sunday a 9:00 Pm local time on the DART repeater, 146.64 (PL 1 00), catch up on club news and information, and just to keep in touch. All amateurs are welcome to check in.

ARPSC Thursday Night 2-meter phone net

Every Thursday at 8:00 PM on the W8OAK repeater, 146.90 (PL 100). The Hospital radio check net takes place on the last Thursday each month at 7:30 PM on the W8OAK repeater. <http://www.arpdc.com>

Around Town

HPARC Buddy Breakfast every Saturday at 9:00 AM (or so)

Cozy Cabin Diner, 2129 E. 12 Mile Rd, Warren, MI
Come in early for the socializing. Park in the restaurant parking lot.

Volunteers

LoTW Manager	Murray KE8UM
Refreshments	Brenda N8AQ
Club Cook	Bill N8QVS
Holiday Meeting	Board of Directors
Equipment Inventory	Jim K8ABZ
Audio/Video Specialist	Ken KE8LIG
Lark in the Park	John AA8UU
Meeting Greeter	OPEN
Net Control Operators	Lee KD8TBC John W8TOY Mike K8WU Bob N8REL
HPARC Media Dream Team	Hugh KE8BED Rick KB500 Al K8ALH John AA8UU Mike K8WU Jim K8ABZ John W8TOY

Oakland County ARPSC Siren Testing, 1st Saturday at 1:00 PM.

March through November. Contact Marsha, N8FE, at n8fe@arrl.net, to volunteer and be assigned a siren to test.

Amateur Radio Licensing Testing

Jerry has announced that license testing will begin again on The first Tuesday of every even month at 7:00 PM at the Oak Park community center.

2022 Michigan QSO Party

What? Michigan QSO Party

When? Saturday, April 16th, 2022
Noon to Midnight local time

Where? 10 thru 80 Meters (CW & SSB)

Why? Just Have Some Fun!!!!

- Chance to get on the air
 - Single Op, Multi Op, Mobile, EOC
 - Be the station others want to work
 - Maybe activate a rare county?
- Excellent Club Activity
 - Reason to get together as group
 - EOC station category
 - Excellent training in HF ops
 - Get new members on the air!
 - Friendly Competition

Let's all help make Michigan "radio-active" on the 16th of April!!!!

Look for **NEW Rule Changes** at our new web site:

<http://www.miqp.org/>

Sponsored By: *The Mad River Radio Club*