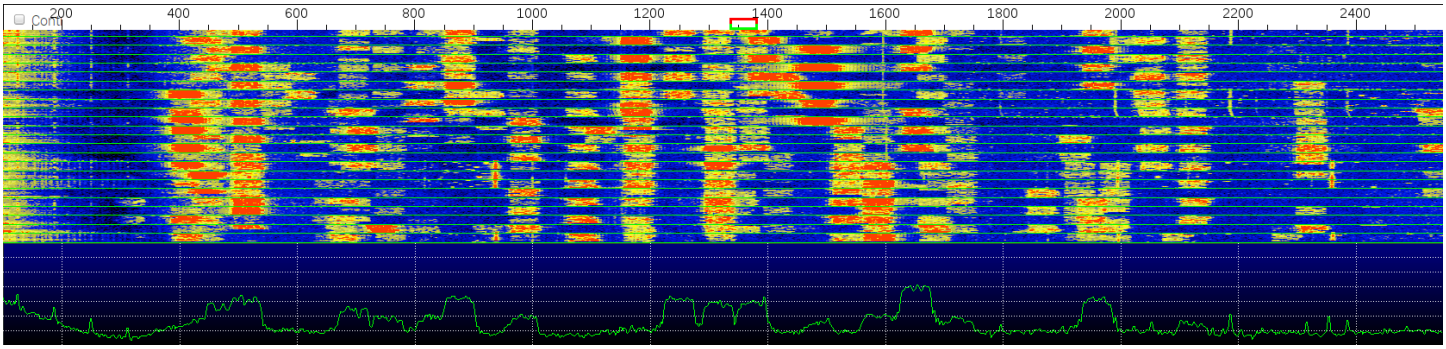


Waterfall graph of the widely popular FT8 mode. Notice how FT8 groups into 50Hz wide audio channels? FT8 uses 8 tones spaced 6.25Hz apart for a bandwidth of 50Hz.

Wavelengths

July 2018

Xenia Weather Amateur Radio Net
XWARN (W8XRN)

147.1650+ (123.0) (Analog Only)
443.1000+ (123.0) (Analog + System Fusion)

Meetings: 2nd Monday, 7:30PM, Greene Memorial Hospital (1141 N Monroe Dr, Xenia, OH) Herman Menapace Auditorium

President's Message

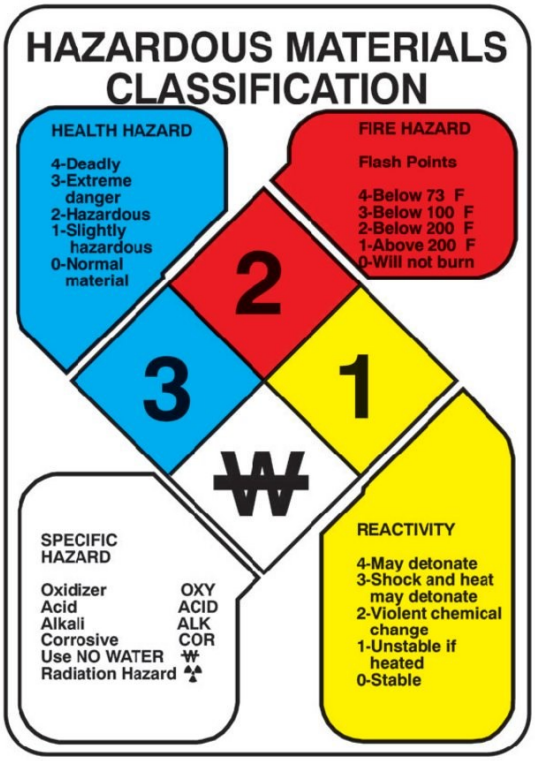
Field Day 2018 is in the log. I have not yet figured out how to merge the log files, so I'll have to hold the summary until next month. The picnic supper was very good and I think that all had a good time. Thanks to all who helped prepare food, move trailers, set-up equipment, and put the toys away.

Coming up this month is Young's Dairy Charity Bike Ride. Mike Crawford tells me that he could use more volunteers, especially on Sunday. Even if you can only come out for a few hours, your help would be appreciated.

Maker Faire Dayton (August 4, 5 at Carillon Park) has asked me if the DARA Truck and the XWARN Trailer will be available for display at their show. If you would like to get involved, drop me a note as to your interest. The number of volunteers will determine the extent of what we choose to display. (n8ado@arrl.net)

See you at the meeting on July 9!

Bob Baker N8ADO



From the June ARES e-Letter:

"In your article on HAZMAT responses in the April (http://bit.ly/2KoGHk6) issue of the ARES E-Letter, I'd like to add that the Fireman's Rule of Thumb (pun intended) ensures that you're a safe distance from a HAZMAT incident:

> *If your extended thumb arm's length does not cover a HAZMAT scene, you're too close. If your thumb covers the scene you're between 1/4 and 1/2 mile away.*

I keep an inexpensive monocular in the vehicle to read a HAZMAT placard from a safe distance. The Emergency Response Guide (http://bit.ly/2MDUe3J) is available for an Android or iPhone. The price is right — free — which fits all budgets.

Lew Wallach, N9WL, Albuquerque, New Mexico

Club Contacts

- President, Bob Baker , N8ADO President@xwarn.net
- Vice President, Brett Boggs, NV8I Vicepresident@xwarn.net
- Secretary, Jason Bowman secretary@xwarn.net
- Treasurer, Steve Mackey, N8ILR Treasurer@xwarn.net
- Repeater Guru, Jim Simpson, WB8QZZ Technical@xwarn.net
- Web Master Josh Long, W8KDL webpresence@xwarn.net
- Membership, Phil Verret, KA8ZKR membership@xwarn.net
- XWARN Trailer / Public Service, Mike Crawford, KC8GLE trailer@xwarn.net or publicservice@xwarn.net
- Newsletter, Jason Bowman, WG8B newsletter@xwarn.net

Minutes: June 11, 2018

Bob opened the meeting at 1930 with the Pledge of Allegiance. 17 members present.

May 2018 Minutes approved by unanimous vote

Committee Reports

Treasurer's Report. Treasurer's report approved unanimously.

More t-shirts? Question being asked on Hamvention FB page. Not unless there's a large demand.

Public Service. Young's Dairy July 14-15. Ada crew offering help. Emails eluding to course change. Maker Fest Aug 4-5. Aug 18-19 Abi Kahn. Looking for someone to coordinate Abi Kahn because usual suspects aren't there on Saturday.

Trailer. In good shape, performed wonderfully for Hamvention. Greene county dispatch. Talk in. T-shirt sales. Replace the compressor. Running a lot at Hamvention. May need to lube seals or replace seals. New 2730 radios, and 2 antennas on order. New coax. Maybe this Sunday get new radio installed. Old radio goes to Xenia dispatch location. Work crew / cleanup this Sunday?

Repeaters. New antenna going on Clifton Rd tower going up 300ft. ½ in Heliax. Rack is at site. Radio is done. Two site simulcast Carpenter road and Clifton rd. Equipment ready for single site with new controller. If we pull off simulcast, will be the only one in the State of Ohio. Only way to get 98% coverage is with simulcast. Only way to cover two distinct geographic regions of Greene County. Installation of antenna about $1500. Other costs about $2000. Both sites with small amounts of power should cover all of Greene County. DARA antenna and filters for co-site.

Website. Febo server being decommissioned. Need to migrate email mirror list.

Membership. 5 new paid members. 37 paid. 46 with life members.

Facebook and Newsletter. Liz says Jason is doing a fine job *on FB.*

New Business

Fund repair of mesh node on Jim Simpson's tower. Performed well for Hamvention. Mesh group wants weather cam on Jim's tower. $200 cost. Talk about who to talk to about water tower on east side of town. But XWARN told to get stuff off. Need to figure out how to tie it to the internet and advertise it. Motion passed.

Field Day. Have authorization to proceed at Beavercreek Station 61 with DARA. Need to commit about half of budget. $300. 9ish on the 23rd. Need to put up 6m antenna. 6m is booming right now. Need to focus on digital? FTA new digital mode. Let's plan on having an article on FTA in next month's newsletter. Dinner about 5:30PM, eat about 6PM.

Scholarship. Someone, not a member, approached Bob about a scholarship. Don't want to have a scholarship program right now, just do it through Greene County Career Center for now. Jason will look into how to do a scholarship program and how hard it is.

Liz did well in Friedrichshafen, Germany, representing Hamvention.

Motion to close meeting at 2040. Motion approved.

Jason Bowman, WG8B

Secretary

Solar Power Project—Jason Bowman (WG8B)

I've been interested in building a portable solar power capability for a while now, and I've finally gotten around to it. This project was the inspiration for the article on the following pages.

The solar panels with the camouflage print are Global Solar mil-spec CIGS panels I got from RecycledGoods (http://bit.ly/2Ipn7OE). You can barely see the second one on the left.

The panels use a 2-pin SAE connector (the 4-pin version is what smaller trailers use for lights), and I have them on 6ft leads running down to a harness on the lower left. The harness ties them together in series before going into the solar charge controller (blue).

The solar charge controller is a Victron BlueSolar controller designed to handle up to 100V in and 15A out.

Somewhere in that mess between the controller and the red series harness is a small Bluetooth module that allows me to view the performance of the system on my phone or computer. You can also tie in a LoRaWAN module if there are nodes in your area, and then you can look at the system performance over the internet.

The Victron charge controller will charge a battery, and it has options for most battery types out there and provisions for you to define your own charge profile. I have a LiFePO4 battery tied in (lower left with white label). I highly recommend using a battery to handle peak (high current) loads and size the solar panel to the average load. In the brief test I conducted, I noticed that both the battery and the solar panels were supplying the load.

Finally , this charge controller also has an output for loads (up to 15A for this particular model), which is what the radio on the lower right is being run off of. For higher power applications, I'd recommend running the battery off of a bus bar that both the high power loads and charging side of the charge controller connect to. Charge controllers that can output more current get very expensive beyond 15A.

Jason, WG8B

XWARN Mission

The mission of the Xenia Weather Amateur Radio Net (XWARN) amateur radio club is to conduct weather spotting nets during severe weather and other communication services for the City Of Xenia and all other Greene County communities.

In this capacity, we are set up to provide communication services as required to the Greene County Ohio Public Service Agencies and other local government entities. The communications services provided to the supported agencies may be for emergency purposes or to simply enhance their communications abilities. On an as needed basis XWARN provides similar services to various government entities of our surrounding counties.

Additionally, XWARN provides communications support to various community organizations in support of marathons, 5K runs, 10K runs, bicycle events, etc. to provide health and safety assistance to the participants and sponsors of said events.

In support of these goals, XWARN operates and maintains amateur radio repeaters and other equipment in Greene County.

Photovoltaics a.k.a. Solar Power

The photovoltaic effect was first observed by French physicist A. E. Becquerel in 1839. He noticed that plates of gold or platinum produced electricity when immersed in a solution and exposed to light in an uneven manner. The first example of a solid state device and the first modern solar cell, a sheet of selenium covered in a thin layer of gold, was demonstrated by Charles Fritts in 1884.

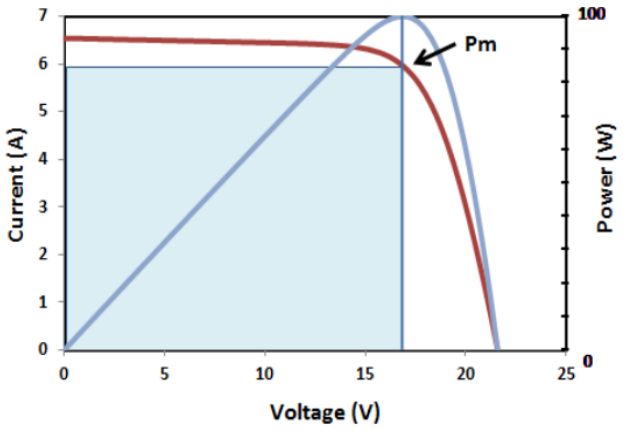
A basic solar power system consists of one or more solar panels and a solar panel / charge controller, which converts the power from the solar panel to a more usable form for downstream components. These downstream components can include a battery bank and/or an inverter to convert the DC power to AC power. Special inverters are required for grid-tie systems because they have to match the phase of the grid.

Solar panels come in 3 basic varieties — monocrystalline (1st generation), polycrystalline (1st generation), and thin film (2nd generation). Monocrystalline is the most efficient at around 18% or higher but very expensive. Thin film is the least efficient at around 9% but relatively inexpensive. Monocrystalline and polycrystalline solar cells tend to be used in fixed installations such as roofs where maximizing power per area is desired and weight isn't a concern. Thin film solar cells tend to be used in portable applications such as hiking where low weight and small size (can be printed onto flexible sheets and folded) is more important than high efficiency.

An interesting development in solar cells has been happening in the past decade or so, the Perovskite solar cell. Perovskite is a particular crystal structure with potential for high efficiencies. Perovskite cells can also be manufactured without expensive equipment and facilities and can be made into thin films. Perovskite efficiencies started at about 3% in 2009 but progressed rapidly to over 20% recently. Once mass production techniques are worked out, Perovskite cells will probably start replacing the other solar cell technologies as the cost per watt will significantly decrease.

Solar charge controllers are almost always required except in very low power applications. The reason is that voltage from the solar array can vary quite a bit and is often not at the correct level for connected loads. Some solar charge controllers also incorporate a battery charger, the battery providing capacitance to the system for when the solar array cannot produce sufficient power for any reason.

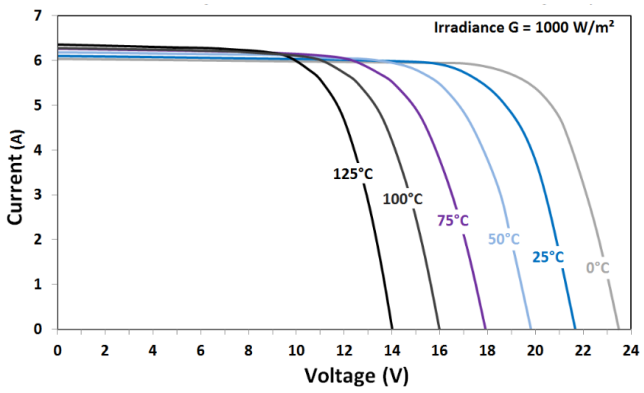
The simplest and cheapest solar charge controller uses pulse width modulation (PWM). PWM is essentially a switch. When the switch is on (bulk battery charging), the voltage of the system is the voltage of the lowest component (Kirchoff's Voltage Law), usually the battery. PWM controllers will switch off (and back on again) as the voltage of the battery increases to provide absorption and float levels of voltage for 100% battery charge. Because the panel and battery are more or less directly connected when the switch is on, it is important that a solar array matching the voltage of the connected load/battery be used.



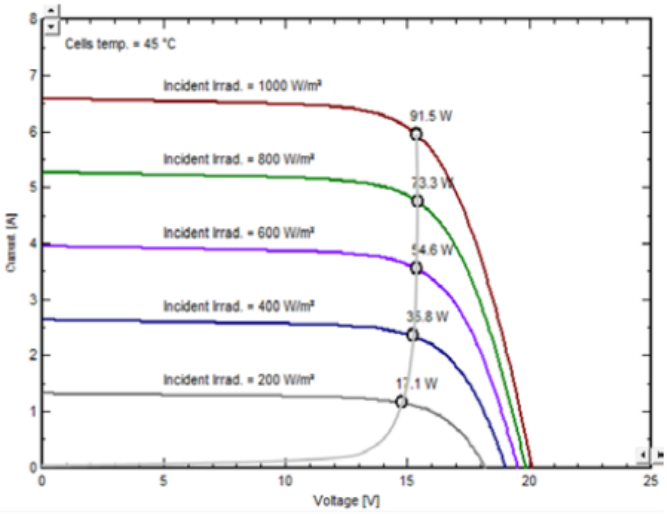
Typical current vs voltage curve for solar panels. The product — the area of the rectangle above — is power. The maximum usually occurs just after the curve just starts dropping off.

PWM controllers are not usually the most efficient controllers. The reason is that they usually don't operate at the maximum power point of the system. Remember that *Power = Voltage * Current.* At the left side of the curve, voltage is 0 so power is 0. At the right side of the curve, current is 0 so power is 0. Somewhere in between there is a peak, usually somewhere between 1/2 and 2/3 of the open circuit (no current) voltage.

Maximum Power Point Tracking (MPPT) controllers will constantly seek this point by varying their internal impedance (resistance) until the peak in power is detected. Because this point can move around some, especially due to changes in solar cell temperature and to a lesser extent the strength



The largest factor for where the maximum power point occurs is the temperature of the solar cells. The maximum power available decreases rapidly with increasing temperature. It is important to keep solar cells cool if possible.



Irradiance is only a factor below 200Wh/m^2 (very cloudy). Above that, the maximum power point remains fairly constant.

of the sun (irradiance), MPPT controllers make continuous small adjustments to their impedance to ensure the peak is being maintained.

MPPT controllers also differ from PWM controllers because they use a DC-DC conversion process. This decouples the solar array from the load and allows the MPPT controller to provide the exact voltage that the load, usually a battery, needs. On the other side of the DC-DC converter, any voltage solar panel can be used within reason. The Victron MPPT controllers can take anywhere from 75V to 150V on the supply side and will merrily provide 12V on the load side.

Basic MPPT controllers are usually tuned for lead acid batteries. But modern and more expensive MPPT controllers will have charging profiles for just about any battery type available to consumers to include deep cycle lead acid, lithium ion/polymer, and lithium iron phosphate.

As it turns out, when it's sunny out and the solar cell temperature is modest, say between 45C and 75C, a PWM controller is almost as efficient as an MPPT controller. However, in really cold and hot climates (or swings between the two over a year), when it's cloudy, and for high solar cell voltages, the MPPT controller really shines.

While MPPT controllers used to be exceptionally expensive, a quick comparison of PWM and MPPT controllers on Amazon.com indicates that MPPT controllers aren't that much more expensive ($30 vs $100 for smaller controllers), especially relative to the cost of the solar array and other equipment such as wiring and inverters.

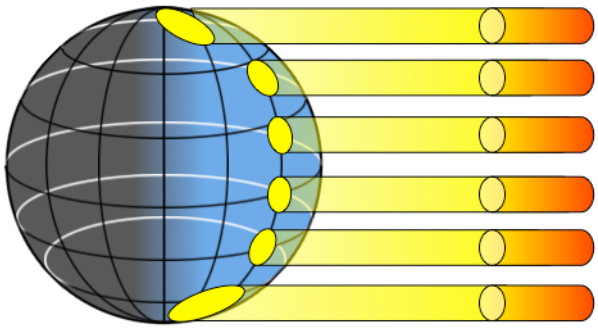
Another consideration is parallel vs series solar panel connections. Stringing panels together in series allows the array to operate at higher voltages (voltages add in series). Higher voltage means lower current for the same power. Lower current means smaller diameter, and therefore cheaper, power cables can be used. Remember, power loses through a power cable are *Current^2 * (Resistance per Unit Length) * Cable Length*. Because current is squared, it is important to keep the current as low as possible to avoid losses in the system and keep the cable costs down.

But series-connected panels can suffer when one of the panels is in a shadow. Therefore, careful attention must be paid to which parts of the array to connect in series and which to connect in parallel if shading is a concern as the sun moves across the sky during the day.

The orientation of the solar array with respect to the sun is an important consideration. The power or irradiance that the panel can generate is dependent on the cosine of the angle between the panel and the sun. But the sun's position changes throughout the day, from season-to-season, and how far away from the equator the panel is located. The sun

(Continued on page 6)

Photovoltaics a.k.a. Solar Power



Solar panels should be oriented perpendicular to the sun's rays for maximum power. Otherwise the effective capture area and power is reduced by cosine(Panel's Latitude - Sun's Latitude) with south latitudes being negative.

(Continued from page 5)

can be directly overhead anywhere between the Tropics of Cancer and Capricorn, or about 23° above and below the equator. If you take a flat panel and tilt up the north side a number of degrees equal to the latitude (we're about 38°N in Dayton, OH), the panel will split the difference between winter and summer. More complicated setups will use trackers that rotate the panels throughout the day and through the seasons to keep the panels facing directly at the sun as much as possible. Some simpler setups will allow for manual adjustments. For rollup or foldup panels, it is common to just lay them flat on the ground. In the Summer in Dayton, that isn't too bad with only a 3% loss: cos(38-23) = cos(15) = 0.97. In the winter, you're going to lose half your power if you do this: cos(38 + 23) = cos (60) = 0.5.

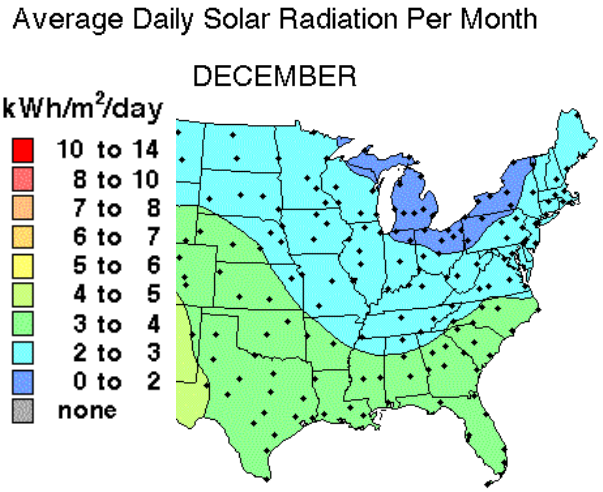
Another factor in solar array design is the overall size. This is hard to generalize because everyone has a different use case. But here's how I would go about doing a rough estimate.

To serve as a point of reference, let's use the Global Solar foldup panels I just purchased (purchase information later in the article). These panels are rated for 42W and are about 2/3 of a square meter.

First, understand how much peak power you use and the duty cycle. For example, my Kenwood TM-D710GA uses about 13A at 12V or about 160W when operating on high power (50W transmit) and about 1A just sitting there for about 12W. But my duty cycle is probably in the 5% range or even less. This is about a 20W (weighted) average. As long as you have a battery than can provide the peak power, sizing the solar array to the average is the way to go.

But now we have to back out 20W into a panel size. You can never get 100% of the rated power out due to variations in solar irradiance, e.g. clouds, changing solar incidence angle throughout the day. I would use a 20% knockdown factor or about 25W in my example. Let's also assume that I'm just laying my panels flat and this is the winter time. So instead of 25W I need double that for 50W needed. On *average* and with a 42W panel, I can't produce enough power. I'm eventually going to deplete the battery.

Another way to look at this is *energy* not power. In this example, I would need about 480 Watt-hours (20W * 24hrs) on average. During the worst case winter months (http://bit.ly/2MWxf54) in Dayton, OH, we get about 2000-3000 Wh per square meter per day. Solar irradiance charts are available all over the internet for any month and any region globally. My Global Solar panels are about 2/3 of a square



meter for 1300-2000 Wh of energy. If the panels are laying flat, I'll get half of that (see previous page) for about 650-1000 Wh. But I only need about 500 Wh. So it looks like I won't run out of battery after all, at least during the day. Why the discrepancy between the calculations? My assumption about a 20% knock down factor in the first estimate. The irradiance charts are generally the way to go.

If you would like to try solar power out, especially for emergency communications applications, I highly recommend doing some of your own research first. A very good place to

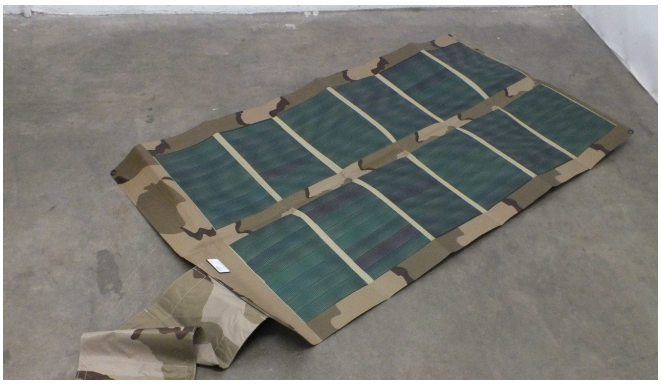
start is Victron's white paper (http://bit.ly/2KkB3OQ) on charge controller selection. There is also a condensed version (http://bit.ly/2lv6RTl). The white paper goes into quite a bit not just charge controllers.

Also check out Powerwerx (http://bit.ly/2Mmk10i) and Bioenno Power (http://bit.ly/2trbsdE) for solar arrays, charge controllers, batteries, and wiring and connectors.

I found a really good price on Global Solar thin film arrays made for the military at RecycledGoods (http://bit.ly/2Ipn7OE). Be careful — they have both 12V and 24V panels. For the 12V panels, you can connect up to 3 panels in series (30V no load) for the controller I used (see below). For the 24V panels, you will need to use an MPPT controller with a DC-DC converter unless you have a 24V system (most basic military electrical systems are 24V).

For a charge controller, I purchased the 100V/15A (https://amzn.to/2KzNWoA) MPPT controller from Victron Energy. They have a version with built in Bluetooth and one that will take a USB or Bluetooth dongle. The Bluetooth dongle is on an extension cable allow you to have the controller in a relatively inaccessible location and put the Bluetooth antenna in the clear. Victron has software for both the PC and an Android app (no iPhone app) to change battery charge settings, monitor panel and battery voltage and current, etc. Victron also has a published interface that you can use to write your own application. Finally, Victron sells a LoRa module that will allow you to remotely monitor the controller performance via a LoRaWAN network.

Bioenno Power Monocrystalline Rigid Panels. 120W for about $200.



Global Solar thin film fold up panel. 42W on sale for $160 at Recycled Goods.

The solar power industry tends to use a connector called MC4 to connect panels. More portable and lower power arrays tend to use the 2-pin SAE connector (the 4-pin version is used for trailer lights). Please note that Powerpole connectors are physically and electrically hermaphroditic, thus avoiding the need to worry about which end is the plug and which the socket, or which end has the correct polarity. SAE connectors are physically but not electrically hermaphroditic. As you are making your cabling, you need to pay attention to polarity (pin on one end will be socket on the other).

If you can afford the upfront costs, get a lithium iron phosphate (LiFe) battery rather than lead acid. Life cycle costs are lower than lead acid. For the higher initial price, you get over 2000 charge cycles and can deep cycle a LiFe battery down to about 20%. Bioenno Power has a good selection of LiFe batteries.

Jason, WG8B

Franke-Taylor Design, 8-FSK Modulation (FT8)

Editor's Note: During my brief stop at Field Day, I mentioned to someone, maybe Bob Baker, that I've been a ham for about three and a half years now and even have my Extra license but have yet to get on HF or 6m in spite of having an HF radio. Why is a matter for another day, but I bring it up because this article is being written from a position of ignorance. If I get anything wrong, then all of you FT8 and WSJT folks out there only have yourselves to blame for not offering to help write this. Hahahaha.

At the June 2018 membership meeting, Jim Simpson made mention of FT8. I don't remember the context, but I blurted out, "Maybe we should have an article on FT8 in the next newsletter." So here we are.

Introduction

Back in June 2017, a new weak signal mode called FT8 was released as part of WSJT-X. If you don't know what WSJT-X is, it's software specializing in weak signal modes.

A Typical FT8 QSO:

```
CQ K1ABC FN42              #K1ABC calls CQ with FN42 grid square
      K1ABC G0XYZ IO91     #G0XYZ answers with IO91 grid square
G0XYZ K1ABC -19            #K1ABC sends signal report, -19dB
      K1ABC G0XYZ R-22     #G0XYZ sends R+report, -22dB
G0XYZ K1ABC RRR            #K1ABC sends RRR
      K1ABC G0XYZ 73       #G0XYZ sends 73
```

Each mode in WSJT-X addresses a specific set of physical conditions that often result in weak signals. Whereas JT65 will work well with weak and *slowly* varying signals, FT8 is designed for situations where the signal is weak and fading, e.g. multihop E-skip on 6m (50MHz), or the opening short. For example, an FT8 QSO can be completed in about 90 seconds (15s for each transmission or reception period) whereas JT65 is measured in a handful of minutes (1 minute per transmission or reception period).

FT8 Operations

Like other modes, FT8 is associated with certain frequencies on each band. WSJT-X restricts you to these frequencies unless you want to modify the source code and recompile. FT8 is getting (or already has) a DX mode with its own set of frequencies to separate the competitive stuff away from normal contacts and to speed up DX'ing beyond what is capable in the regular mode by eliminating certain pieces of information in the QSO.

Like JT65, using FT8 requires your computer's clock to be accurately synchronized. If your computer's clock is off by even a second, you will have trouble making contacts. There are programs you can install that will synchronize your computer's clock to a known good reference, but you'll need an internet connection. Another way of doing it is to get GPS NMEA messages into your computer somehow and have a program synchronize the computer's clock to GPS.

Using FT8 effectively means using the waterfall display, at least initially, so that you can avoid interfering with others trying to make contacts. For any given transmit frequency selected, the waterfall represents modulation (audio) frequencies running from 0-2500Hz. FT8 requires 50Hz of bandwidth. So you'll see horizontal bands in the waterfall that are 50Hz wide. Before attempting to make a contact, it is important to watch the waterfall for a few minutes to find a 50Hz wide column on the waterfall where no one else is parked. With FT8, you don't transmit and receive on the same modulation frequency, and you don't transmit on a modulation frequency that someone else is using.

So what does an FT8 contact look like? Pretty much like a JT65 or other weak signal mode. See the example QSO above. Remember, because of the low signal-to-noise ratio, you can't push very many bits.

But here's the rub. FT8 works on 15 second intervals with stations taking turns transmitting and receiving like JT65. Transmissions take about 12s leaving only about 3s for operators to type a reply before their transmission needs to start. For this reason, you can template a response in WSJT-X when using FT8 that will autopopulate your call, grid square, and the contact's signal-to-noise ratio. Furthermore, WSJT-X will automatically reply if you let it.

I don't have a sense of the community's feelings now, but at least initially some amateur radio operators thought it was the

end of amateur radio because two computers can have a QSO all without a human being involved. As Mark Twain once said, the reports of my death have been greatly exaggerated. FT8 is getting a lot use, but don't fall for the fixed pie fallacy. It's a growth opportunity not a replacement.

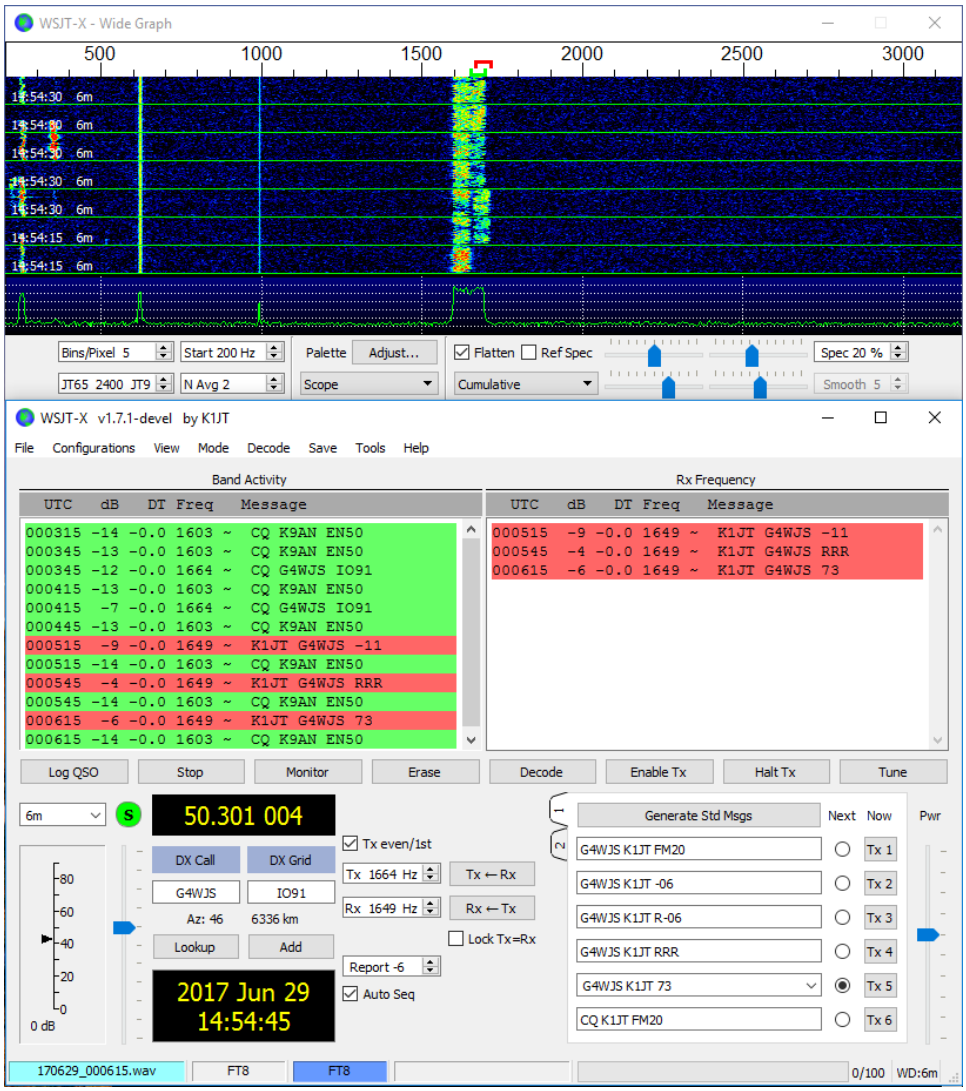
For more information on operating FT8, please see the Operating Guide (http://bit.ly/2MDdNZU).

FT8 Technical Information

FT8 is a frequency shift keying (FSK) waveform that uses 8 tones spaced 6.25 Hz apart for 50Hz of total bandwidth. So when you see FT8 on a waterfall, you'll see bands 50Hz wide.

The FT8 waveform is constrained to a specific format for call signs that allows for more efficient transmission. This is not noticeable to the operator except for some kinds of special event stations where entering call signs may be problematic.

FT8 compresses the data entered by the operator further increasing efficiency and then encodes it for transmission using Low Density Parity Check (LDPC) coding. Like all forward error correcting (FEC) codes, LDPC adds bits that are used by the receiver to correct transmission errors. It is said that FT8 can be decoded as far as -20dB below the noise floor. The signal is so weak in those cases that the human ear can't hear it.



Screen shot of WSJT-X in FT8 mode. Note the standard message generator in the lower right and the 50Hz wide bands of energy in the waterfall at the top

FT8 moves about 90 bits in just over 12s during a 15s transmission window. Because it's about 4x faster than JT65, FT8 is 6dB less sensitive (the longer you or the computer can listen, the better able you or the computer can pull the signal out of the noise).

Jason, WG8B

Club Call: W8XRN

XWARN
P.O. Box 562
Xenia, Ohio 45385

Email: info@xwarn.net
Website: XWARN.NET

«FNAME» «LNAME» - «CALL»
«ADDRESS»
«CITY», «STATE» «ZIP»

Wavelengths

Wavelengths is published monthly by the Xenia Weather Amateur Radio Net. Our meetings are currently held on the 2nd Monday of each month at **7:30 pm** at the Greene Memorial Hospital Auditorium. You can find additional information about our organization at www.xwarn.net . We welcome new and experienced Amateur operators and those interest in becoming an Amateur operator to attend our meetings.