

PV that Meets the National Electric Code

John Wiles

Civilization is spreading throughout the country, and with it, the bureaucracy of building codes and electrical inspectors. The intent is good and safety is the objective-- especially now that the National Electric Code (NEC) addresses PV (article 690). The inspectors know we are out there and PV power systems in dwellings, businesses, and RV's are subject to the code. Best not to fight since mortgages, fire and hazard insurance, and habitation permission all rely on the good nature of your local inspectors.

Learn the Code and Work with the Inspectors

The SWRES will be publishing a "PV and The National Electric Code" manual for electrical inspectors in late 1990. The content of that manual will follow these articles so read and heed for safer PV that will make your inspector smile. If you are doing your own installation, pick up a copy of the 1990 Code and really study it. Contact your electrical inspector early and see if your state allows home owners to do their own wiring--possibly after a home owner's code test. You and your inspector should know that the NEC is a guide and he has the authority to authorize variations that HE feels are safe.

Module and System Marking

Individual PV modules should be marked showing polarity, maximum rated power, operating voltage and current, open circuit voltage, short circuit current, and the maximum overcurrent device rating for the module. UL listed modules like those from ARCO and others will already be marked with this information. A neat, durable homemade label should suffice from data provided by the module manufacturer. A similar set of data for the combined output of the PV system must be displayed near the PV disconnect switch.

Water and Strain Relief

Module junction boxes, where present, are generally waterproof. To maintain the UL listing for modules so listed, the interconnect cables must enter the box through water tight, strain relief bushings. The knockouts on older ARCO and Solarex module junction boxes are standard half inch electrical trade size. You can pay over \$3 for metal, water tight strain relief bushings for these and similar modules or you can call Heyco Molded Products in NJ at 800-526-4182 and ask for product info on items 3231 and 3224. Minimum order is 50 and price will be less than \$1.50 each. Some newer modules have waterproof gaskets and strain relief built in. Modules with and without junction boxes must have the interconnect wiring firmly fastened to the module and array frames to prevent mechanical abuse. Nearly all white nylon, cable wrap ties frequently used for this purpose are NOT sunlight resistant and will crumble in less than a year. Thomas & Betts makes some weather resistant products which might be special ordered through your electrical supply house, but a cheaper alternative is probably a stainless steel hose clamp, a metal fixed size cable clamp, or even a couple of turns with a piece of the module interconnect wire.

Array Frame Grounding

PV arrays are usually mounted on roofs or in other areas away from obstructions to maximize the collection of solar energy. In these locations they are good lightning rods and the frames need to be well grounded for safety and equipment protection. Each individual metal module frame should be connected by the most direct route to the mounting frame and then in the most direct route to the

grounding conductor. The largest wire size affordable should be used, but must not be smaller than number eight copper wire. Avoid splices and sharp bends. If this grounding wire, when routed directly to the nearest soil, can be connected to the system grounding electrode, then connect it there. For arrays mounted some lateral distance from the system grounding electrode, the array grounding wire should be connected to a separate grounding rod close to the array. This rod should be bonded (connected) to the system grounding electrode with a wire sized as above. None of this discussion on grounding pertains to grounding one conductor of the PV system.

Ampacity and Overcurrent Protection

The National Electrical Code (NEC) requires that ampacity of the conductors used to wire the modules and the rating of the fuses or circuit breakers protecting those conductors be at least 125% of the module or parallel module short circuit current. The fuse or circuit breaker does not protect the conductors from high module currents or short circuits of that current. It does, however, protect the module wiring from high--very high-- short circuit currents that can be delivered by the battery. The blocking diode may not block short circuit currents and should be left out of this consideration. If you have a direct drive (no battery) system, then the conductors can be sized at 125% of the short circuit current and no overcurrent device is required. Use the Flowlight Workshop equations (see HP14, page 32) to increase the conductor size over the 125% minimum as required to minimize voltage drop.

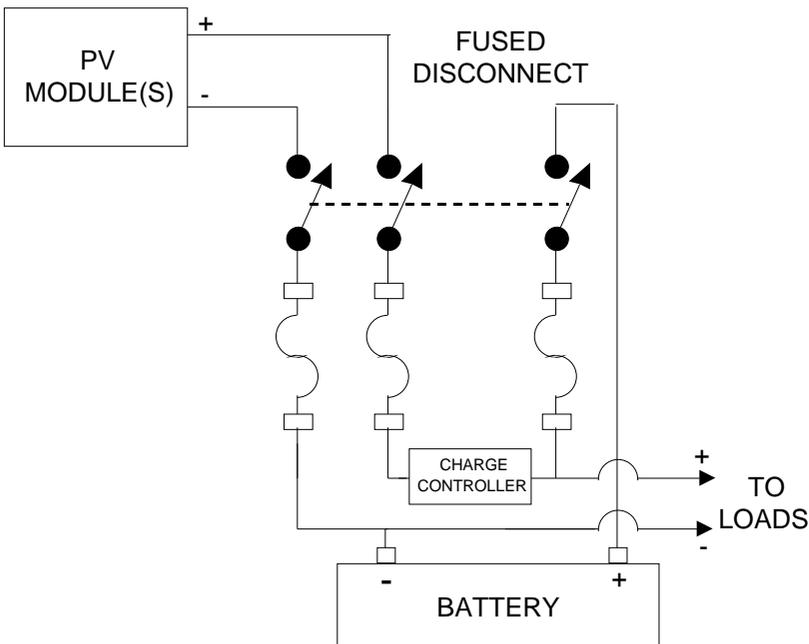
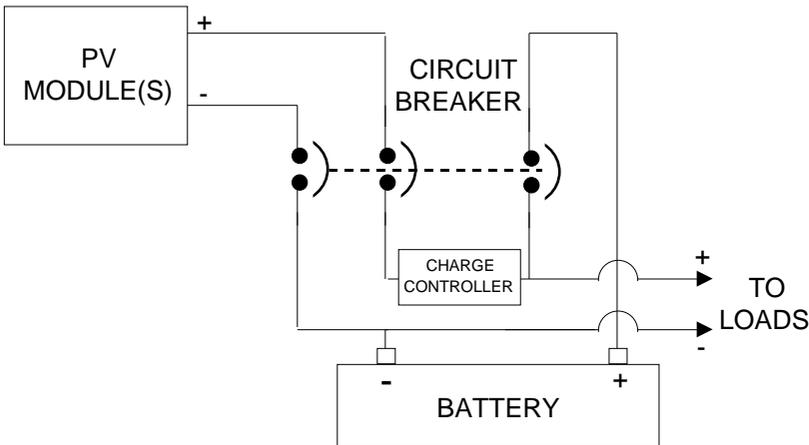
Fuses and Switches

DC rated fuses and DC rated switches are hard to find. The arc that forms when a DC circuit is opened is hard to extinguish and will destroy ac rated devices in a short period of time. In the array circuits, the Code allows supplementary fuses to be used. These are the small glass or ceramic bodied fuses used inside various pieces of electronic equipment which provide protection above and beyond that provided by the main branch circuit fuse or circuit breaker. Glass or plastic automotive fuses are NOT considered supplementary fuses, are rated only to 32 volts, and are not tested or listed by Underwriters Laboratories for supplementary use. They SHOULD NOT be used in PV systems. DC rated and UL recognized fuses in the 13/32" x 1 1/2" midget size are available.

The NEC requires that the fuses have switches on both ends to remove all sources of voltage prior to servicing. This requirement, plus the need for DC rated switches, indicates that circuit breakers are the way to go. The standard Square D QO residential circuit breaker is UL listed to 60-70 amps and 48 volts. You must use the PV array open circuit voltages when specifying components so these breakers can be used for both 12 and 24 volt systems.

Code Corner

Square D makes small boxes that hold these QO breakers as well as the larger residential load centers.



See the figure below that illustrates the overcurrent protection and disconnects required for a small PV system with no inverter.

Access

DC rated, UL listed fuses are made by Littlefuse, Power Fuse Division, 800 E. Northwest Highway, Des Plaines, IL 60016. CALL 1-800-TEC-FUSE for the name of the nearest power fuse stocking distributor. Use midget type KLKD for array wiring and to protect electronic devices. Use FLN-R type for branch wiring as well as battery to inverter fuse.

Marathon Special Products, PO Box 468, Bowling Green, OH 43402 makes fuse holders and power distribution blocks. Call 419-352-8441 for a catalog and the name of the nearest distributor.

Chesapeake Marine Fasteners, Inc., 110 Willow St., Annapolis, MD 21401 has stainless steel hardware, UV resistant cable ties, battery cable crimp on terminals and more. Call for catalog 1-800-526-0658. Discount price sheet for dealers.



REPORT FROM AUSTIN TEXAS

John D'Angelo

Austin Texas was really buzzing from March 19 - 22. There were four conferences going on simultaneously. The American Solar Energy Society (ASES), The Solar Energy Industry Association (SEIA), The Photovoltaic Association Solar Society (PASS) and The National Passive Solar Conference (NPAC).

The mood was set in the beginning of the conference with S. David Freeman's talk "Racing for the Sun". He warned the audience that things are looking up but that the fossil fuel industry is gigantic compared to the Solar industry and now is the time to give it all we have. The time is now! Things are changing in our favor. I felt the most encouraging speaker was Cathy Zoi, Senior Environmental Scientist, Environmental Protection Agency. She gave an excellent presentation and was really excited about the contribution the solar industry could make in reducing our pollution problems. She was clearly asking the audience for input. It is certainly great to see this type of person in the government. Perhaps the Bush administration will do better on environmental issues than we thought.

There were two exhibits. One was an educational exhibit the other was the SEIA exhibit. All the major players were at the SEIA exhibit (Siemens, Solvonic, Solorex, etc.) along with some new players. Sanyo was there displaying their solar product line for the first time. They have plans to sell their "solar shingles" in a year or two.

The exhibitor that was creating the most excitement was Midway Labs, Inc. They were selling a product called the PowerSource* which is a light concentrating PV array using Optical Power Technology. The rating was 75 watts @ 12V with prices comparable to a Solorex 60 Watt PV module. Because the product is so new there is only a 3 year warranty.

Sustainability and daylighting in buildings were hot topics at the conference. However, the most interesting topic for me never made the agenda. Steve Baer of Zomeworks Corporation compiled a "Citizens' Survey Of The Solar and Federal Buildings Projects". Over 700 projects were installed throughout the US. Remember the solar collector on the white house? The survey found that most systems were removed for various reasons. I think the survey bore out what I have learned in my 18 years of dealing with different types of solar systems. Keep it SIMPLE! We made a lot of mistakes, so let's build the future with lessons learned from the past! For a copy of this report contact Steve at Zomeworks, POB 25805, Albuquerque, NM 87125.

A new magazine called "Solar Today" is being published by the American Solar Energy Society. You do not have to be a member of the society to enjoy this excellent magazine. Call ASES at 303-443-3130 or write ASES, 2400 Central, Unit B-1, Boulder, Co. 80301.

After seeing the news clip about solar and wind power on Peter Jennings "American Agenda" last night (March 28th) the future prospects for renewable energy will definitely be on the upswing in the months and years ahead.

