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MNPV Installation Instructions

The MNPV3 &MNPV6 combiner is rated for outdoor use. Although designed primarily for combing PV strings up to 150VDC, the MNPV may be used for combining high voltage strings using MNATM fuses up to 15 amps. The use of touch safe din rail mount fuse holders and fuses allow operation up to 600 Volts. The MNPV6 combiner comes with two copper bus bars. One for circuit breakers and one for fuses. The MNPV3 busbar is designed for circuit breakers only.

Applications:

PV combiner up to six strings using MNPV breakers rated for 150VDC. 120 amps total output
PV combining up to four strings using MNATM6, 10 or 15 touch safe fuse holders rated for 600VDC
DC load center using MNPV breakers

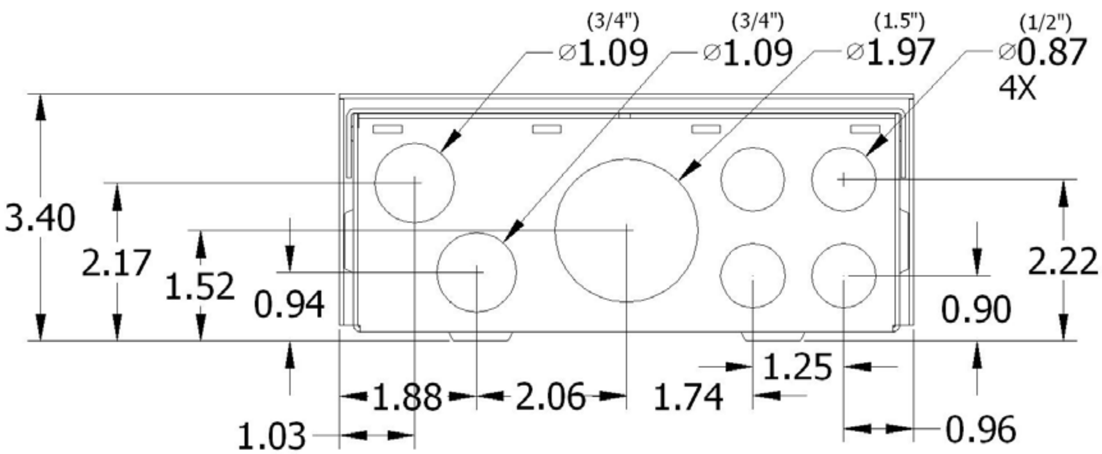
Features:

All aluminum powder coated housing that won’t rust
Flip up cover that can stay in the open position during installation
PV Negative bus bar with 14 useable openings (10 #14-6 and 4#1/0-14)
Chassis ground bus bar with 14 useable openings (10 #14-6 and 4#1/0-14)
Standard din rail to mount up to 6 breakers or 4 fuse holders
Tin plated copper bus bar to combine breaker outputs (MNPV6 busbar may be split in two)
Dead front cover snaps into place after wiring is complete for safety
Knock outs for PV in and PV out on bottom and sides
Top surface is available to bring conduit in from directly above the enclosure
Note: The plastic dead front fits very tight. You must first remove the lid in order to remove the dead front.

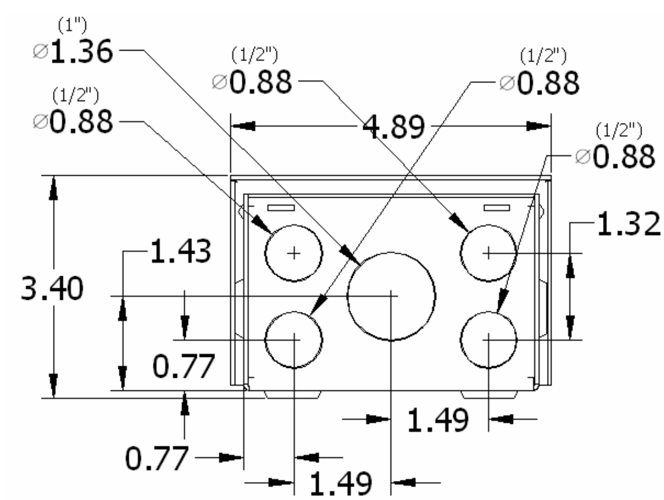
MNPV Installation Instructions (continued)

The installation of a PV combiner is fairly straight forward. Select the location to install your combiner first. Some systems have the PV modules located close to the inverters and or battery system. If this is the case, you can elect to mount the MNPV inside and run each PV string down to the MNPV inside the house. This is convenient for trouble shooting and upgrading. For longer runs the combiner will be mounted outdoors on the pole for pole mounted PV arrays or similar mounting for rack mounted arrays. The combiner can be mounted in the vertical position or slanted backwards to accommodate up to a 3/12 roof pitch. All unused holes should be blocked using RTV sealant or some similar goop in order to keep rain and bugs out of the enclosure. Note the warning label on each side of the enclosure. Care must be taken to insure that no water will get on terminal busbars when mounted less than vertical. Removal of the labels are allowed if conditions are met. It is very common for critters to enter through an unused mounting hole and take up roost. They will eventually degrade the performance of your system to say nothing of the yuk factor upon discovery of their nest.

The following dimensioned drawings show the location and size of knockouts available on the MNPV3&6. Note that on the MNPV6 the center bottom knock out is sized for a 1 ½” conduit adapter. The bottom left has two knock outs for ¾” conduit and the bottom right has four ½” knock outs. The left and right side each have a ½” knock out for either wire entry or for lightning arrestors. Follow directions above when using side knockouts. Lightning arrestors may require a locknut on the outside in order to clear the lid.

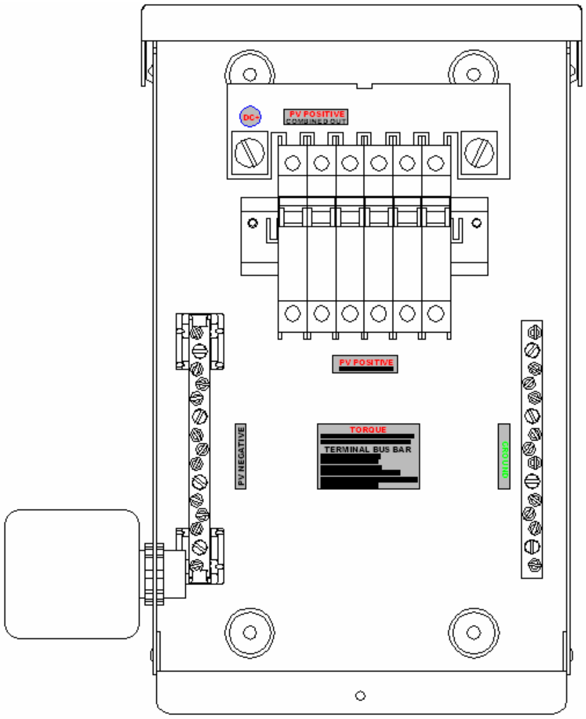


MNPV6 Bottom conduit locations and sizes

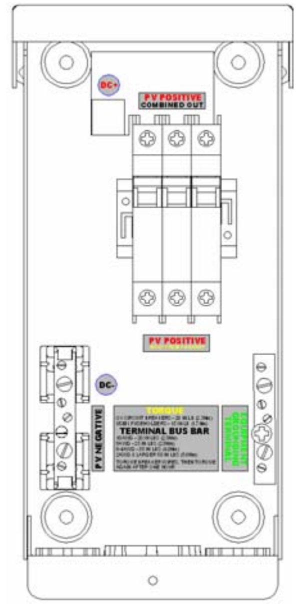


MNPV3 Bottom conduit locations and sizes

Installation photo by Maverick Solar

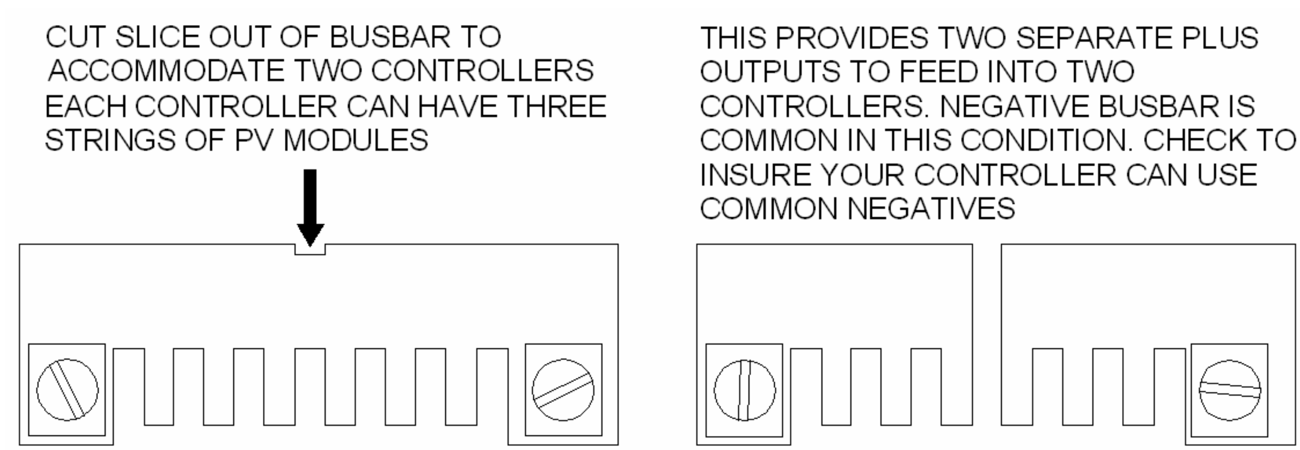


MNPV6 shown with lightning arrestor



MNPV3

The MNPV6 enclosure can be split into two sections. This is sometimes done in 12 and 24V systems where more controllers are required for additional power. For instance in a 24 volt system using the MX60 charge controller, you are limited to about 1600 watts of PV per controller. If using Kyocera KC130 modules, you can make three strings of 4 modules in series. This adds up to 1560 watts per controller. That is a good match of PV vs. controller capability. The MNPV3 can accommodate this arrangement directly, but the MNPV6 can accommodate two of these systems, thus saving wiring, space and money. See the following figure on splitting the busbar into two systems.



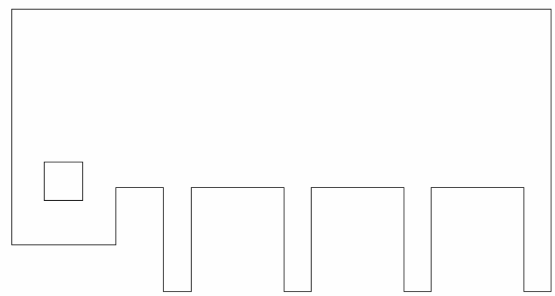
When selecting breakers for use with the MidNite combiners, first check with the PV manufacturer to determine the proper "series fuse". The term fuse is used even though you are probably using breakers. This is a carry over from UL terminology.

MNPV Installation Instructions (continued)

MidNite Solar offers PV combiner breakers rated up to **150VDC**. They come in these amp ratings.
1,2,3,4,5,6,7,8,9,10,12, 15, 20, 30,40,50 and 63. Other sizes are available on special order.
Part numbers for breakers are as follows:
MNEPV10, MNEPV15, MNEPV20 etc.

The MidNite MNPV6 can also utilize touch safe fuse holders and fuses rated for up to 600 volts DC for high voltage strings. The MNPV6 comes with a special busbar that has four legs to accommodate four of these USM1 type fuse holders made by Ferraz Shawmut. Fuses are available in 6, 10 and 15 amps.

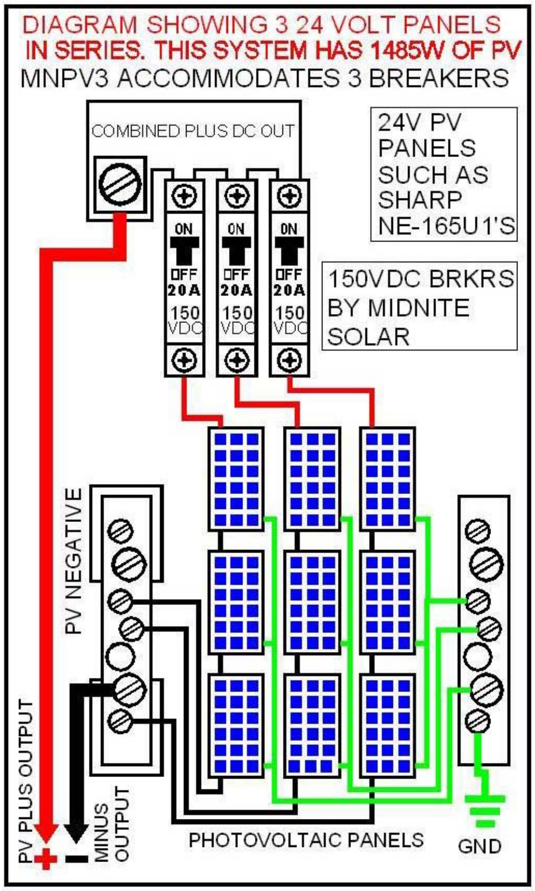
USM1 Fuse touch safe fuse holder

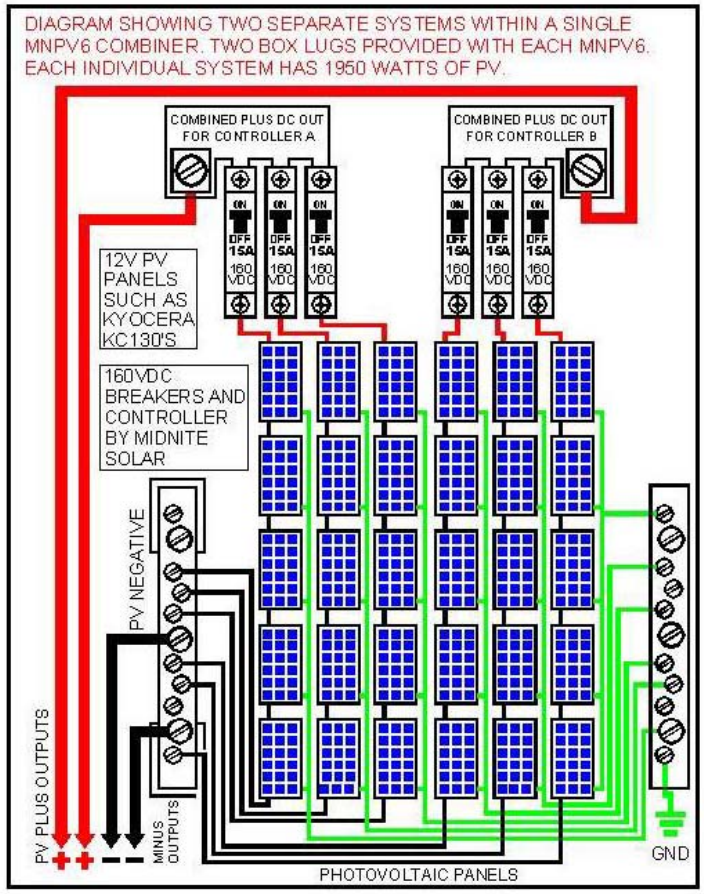


3-079-1 Busbar, Fuse Holder

The following wiring diagrams are intended to help you decide which type of combiner installation to do. There are numerous ways to hook up a PV array. There are no “best” or “correct” ways to accomplish this. They all have merit. For instance if the battery bank is 24 volts and you have six 24 volt PV modules, what would be the best way to wire them? For this installation we will assume an MX60 or similar charge controller that allows the freedom to change PV array voltages.

1. This array could have all 6 panels hooked in parallel using the MNPV6 combiner and 6 MNEPV15 breakers. This array would be ok if situated close to the battery bank. It requires larger wires than higher voltage arrays, but has the advantage of temporarily directly connection to the battery bank in case the controller fails. You can also substitute a PWM controller for the MPPT in the event it becomes necessary.
2. The array could be wired in three strings of two panels in series for a 48 volt nominal array. This is a very common installation and could be made in the MNPV3 with 3 breakers. This hook up is safe from a cold VOC standpoint, but you cannot directly connect it to the battery bank. You cannot easily hook up a PWM controller either. If the PV array is between 30 and 100 feet from the battery bank, this hook up may offer the best power production.
3. The array could also be hooked up in two strings of three modules in series. The MNPV3 and two breakers will accommodate this array. You have room to grow this system without adding another combiner if only three more modules are added later. Combiners can also be combined for additional power, so if six modules or more get added later, you can simply add an additional MNPV3. When putting three 24 V modules in series you must pay attention to VOC during cold spells so that you do not over voltage the controller. MidNite Solar breakers are all rated for 150 volts DC which is higher than any present MPPT controller (2006). This configuration works very well especially when the array is far away from the battery bank. You can sometimes save enough money on reduced wire size to pay for an MPPT charge controller.



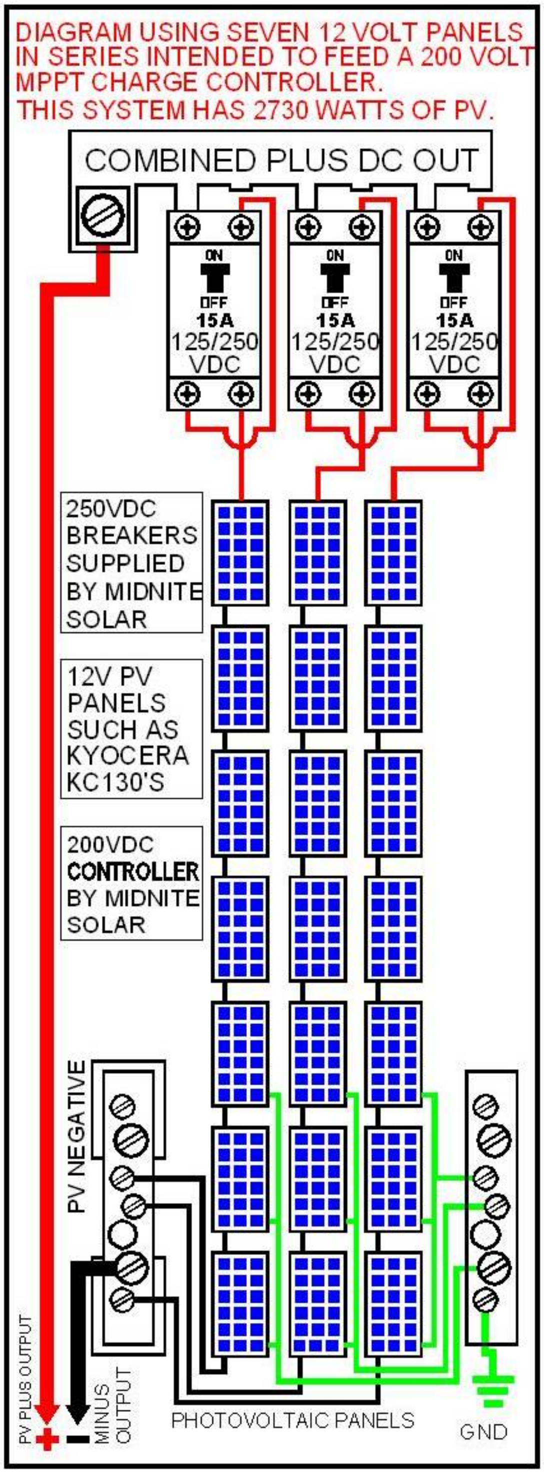


To remove the dead front:
Pry off the lid as shown using something like a screwdriver as a lever.
The dead front will then come out easily.

The picture on the right is from Lance Barker.
It shows an MNPV6 with a MidNite Solar DC-GFP installed inside along with two combiner breakers. This is a novel use of the DC-GFP in the combiner enclosure. The use of din rail mount breakers makes For real flexibility.

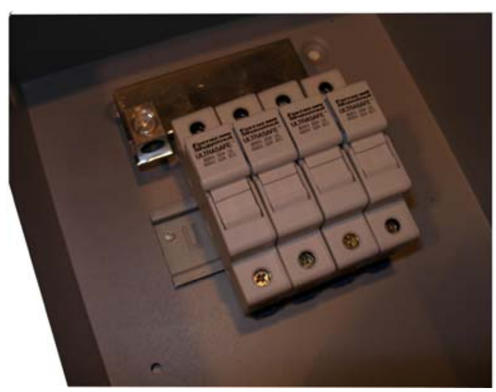
MNPV Installation Instructions (continued)

This is a special configuration that is going to be possible with the advent of the MidNite Solar Classic charge controller. The breakers used in this configuration will be available at the same time as the Classic MPPT controller sometime in 2007.



MNPV6 and MNPV3

Fuse holders in deadfront



Fuse holders in enclosure

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165 VDC ETL TEST STORY

Wow! In my 18 years in the Renewable energy industry as an engineer, I've seen a lot of cool blow ups, flames, sparks and such, but never anything as dramatic as the ETL test conducted on this little circuit breaker.

MidNite Solar orders custom made breakers for their PV applications from Circuit Breaker Industries in South Africa. These breakers come with a UL 489A listing of 125VDC with an interrupt rating of 10,000 amps. The UL voltage rating is not adequate for today's PV systems, so an additional agency listing is required.

I don't know where ETL cooked up the test requirements. They seem to go far beyond what we did at OutBack a few years ago, but we only tested a15 amp breaker back then. This new test we conducted was brutal to say the least, but it showed just how good these little breakers are.

The breaker pictured is the MidNite MNEPV series breaker with the proposed ETL label installed. As of this writing, the label has not yet been submitted to ETL for approval, so production breakers may be labeled differently.

There are several parts to the ETL test. Our test set up included thirteen 12V batteries in series, four really big DC power supplies, 18,000 watts of resistive loads, fuses, high voltage knife switches, lots of 6AWG wire and of course our MidNite CBI circuit breakers. Batteries were furnished by Dyno Battery

The first test consisted of applying 165 volts of DC to the 63 amp breaker while running 99 amps of current through it. The test was done turning the breaker on for one second and then off for 9 seconds. This was done successfully 35 times. That was **16,335 watts** of high voltage DC the little breaker had to switch on and off. The first time we ran this prior to ETL being there, all we got was a melted down breaker fused solid in the closed position! It's a good thing we keep a hand on the knife switch for cases just like this. The breakers are marked with words stating "+ for DC". Now we better understand why this marking exists. We had it backwards and that doesn't allow the breakers internal arc shute to work effectively. Engineers rarely read directions before applying power to equipment. The + wording on the breaker was added by CBI on my recommendation years ago.

The second part of the test was conducted directly after the first with no break or cool down period. It consisted of turning on the breaker and running 99 amps through it until it tripped on its own. Every third time, I was required to hold the handle on to make sure the trip free mechanism worked. This automatic tripping would take about 30 seconds and was done 15 times. A 1300 volt hi-pot test was conducted on the breaker after these 50 cycles of testing. After passing the second part I thought we were home free, boy was I wrong!

The third and most terrible test was a short circuit test rather than merely an overload test. If we had an unlimited budget for power supplies and Grand Coulee Dam next door, we could have conducted this next test with as little as 200 amps being shorted to ground. The short was to be done while running 99 amps through the breaker. There is a 20 amp glass body fuse connected from the metal breaker box chassis to ground. The breaker box, battery negative and the short are also connected to ground, so a 6AWG wire and the fuse are in parallel from chassis to ground.

This test set up provided us with all sorts of problems. One of the problems was that I was not exactly excited about putting a direct short across the 13 batteries! If the breaker failed, we would have our own Chernobyl! Some other challenges were just how to accomplish the switching of power and then shorting to ground. We cured the hook up and switching dilemma and proceeded to apply power after which we immediately applied the short. Since we did not have 200 amps of power supplies available, we used the full force of the batteries. We estimate that the current was about two thousands amps!

The goal on this test is to prove that the breaker will not arc to the case which would blow the 20 amp fuse. Well, we blew the fuse numerous times and then called boB in to help figure out the problem. Sure enough we had something hooked up wrong and the short was being run directly through the 20 amp fuse. Has anyone ever seen what happens to a 3AG fuse after running two thousand amps through it? I'll save you the trouble. There is nothing left of the fuse. It exploded into a thousand little pieces. After hooking up the fuse correctly, it was now placed in parallel with a 6AWG wire both connected to the ground busbar inside the MidNite MNDC box and the other end to a conduit pipe in the building. We had better success, but on the second breaker we experienced a blown fuse again. This test requires three short circuit tests to be done on three separate breakers. The first passed just fine although I noticed the wires jumping off the floor during the short. boB pointed out that the fuse and the paralleled 6AWG wire was connected about 8 feet apart on the conduit. This provided just enough resistance and inductance to blow the 20 amp fuse. We passed with flying colors after moving all the grounds together. Lesson learned. Tie all grounds together with large wire and keep them as short as possible.

MidNite solar 150VDC **MNEPV** breakers are available in **10**,**15**,**20**,**30** and **63** amps.

Robin Gudgel

Pictured above, boB breaking 165VDC at 99 amps for the first test. This arc is the same arc that our little breaker must deal with internally. The arc is not only blinding, but also extremely hot. Pretty amazing huh! I also discovered the hard way that getting shocked with 165VDC feels pretty much the same as getting shocked with 120VAC.