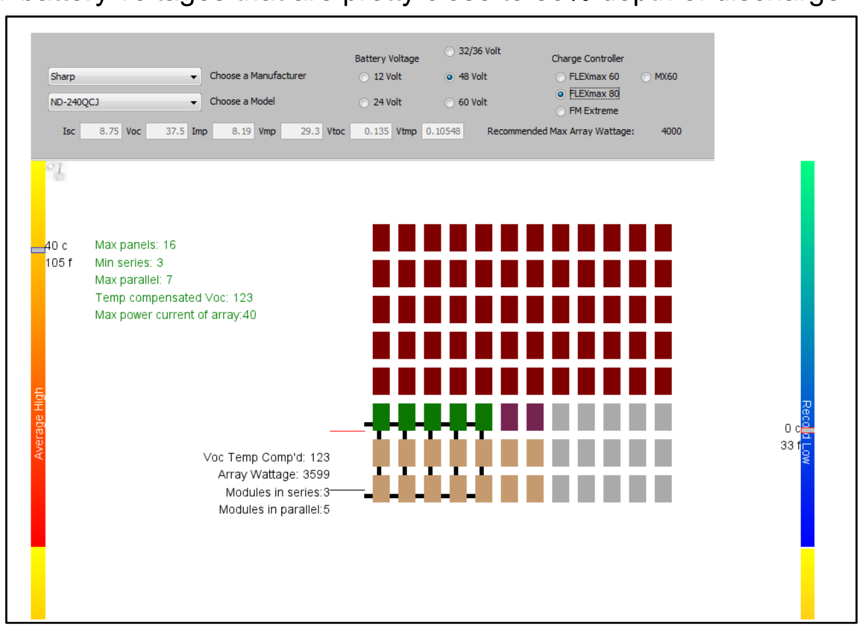
How to Avoid Nuisance Tripping with an OutBack Charge Controller

OutBack charge controllers are DC to DC converters that convert and regulate high and unstable voltages from the photovoltaic (PV) array for proper battery charging, and optimizing power transfer to AC power inverters such as those offered by OutBack. When a properly sized PV array is paired with an OutBack charge controller, the resulting DC power system should run reliably for years. However, oversizing the array, or not adequately factoring in the local temperature extremes could result in unexpected current surges from the array that cause “nuisance” tripping of the output breaker between the OutBack charge controller and the battery bank. The remainder of this application note will discuss proper sizing methods as well as other solutions for existing systems that may otherwise require significant reconfiguration and rewiring of the array in order to avoid the nuisance tripping.

Sizing the array to an OutBack charge controller can be a very simple process using the String Sizing Tool on the OutBack website. One must first determine the system DC voltage, most commonly 48Vdc, but there could be some mobile applications or existing system constraints that would dictate some other DC voltage. The maximum input power to an OutBack charge controller at various DC system voltages are shown in Table 1.

System DC Volts	FM60 Max Watts	FM80/FM-E Max Watts
12	750	1000
24	1500	2000
48	3000	4000

The maximum input power is approximated by multiplying the maximum output current (60 or 80) times the DC bus voltage (12, 24 or 48). The OutBack String Sizing Tool does round up a little from these numbers, but keep in mind the actual battery voltage will vary considerably based on its depth of discharge. We are just using the nominal battery voltages that are pretty close to 50% depth of discharge (DOD) which is a fairly common starting point for charging the batteries.The screen shot of the OutBack Power String Sizing Tool shows the area that falls within the module voltage and temperature parameters in relationship to the ambient temperature and current limit of the selected OutBack charge controller. In this example, the green text is showing the minimum modules in series, and maximum strings in parallel, the temperature corrected VOC, and the maximum current out



of the array. While the sizing tool mentions seven strings in parallel, five is what we recommend and is noted by the five green modules at the top of the recommended three modules in series and five strings in parallel.

So what happens if seven strings were used? Well for a system in Hawaii where the temperature varies from warm to warmer, and typical array losses of 25% or more are factored in, probably nothing. In the string sizing example shown here, a record low temperature of 0°C was selected on the Record Low temperature bar on the right hand side of the tool, meaning there would most likely be some nuisance tripping on the output of the charge controller during cold temperatures. This is especially true when the battery voltage is low from overnight use and the sun comes up on a cold morning.

So this is the solar designer's dilemma, how big can the array be and still be within safe limits of the charge controller and not cause nuisance tripping of the charge controller's overprotection devices (OPDs)? There is no one right answer as each site is unique with respect to climate conditions including temperature, sun availability, shading and reflections, plus the equipment sizing considerations with regards to the size of the array versus available space versus limits of the charge controller (see sidebar on STC vs. PTC).

For example, if a 3600 watt array using Sharp 240 modules is satisfactory to the customer, a 5x3 array and a single charge controller works out great. But what if there is space on the roof for another string of three modules? This would put the maximum wattage at 4320 and in most cases with typical array performance derates as high as 30%, then this array size might work out (4320W at 70% = 3024W).

Additionally, some modules will outperform their published specifications when new, and may also see an increased performance in cold weather, or on bright and cloudy spring days where edge of cloud effect can surge the array power. These surges can be problematic in that the FM80's 80A MPPT control bandwidth limits the reaction time so in those cases they can be passed through to the output and cause the nuisance tripping of our 80A GFDI circuit breaker.

PV Module STC vs. PTC

A PV module rating system has been developed based on standard test conditions (STC) with the intent that competing modules can be fairly evaluated one against the other. Not just for performance, but also to be sure necessary system sizing can be done properly. The STC rating involves only one temperature (25°C), one irradiance (1000 W/m2), and one sunlight spectrum (AM [air mass] 1.5G [global]). However, the actual energy production of field installed PV modules is a result of a range of operating temperatures, irradiances, and sunlight spectra.

Therefore, in California where rebates are given for installed and grid connected solar PV generations systems, the California Energy Commission (CEC) developed a widely recognized real world standard that is known as Performance Test Conditions (PTC).

The PTC standard not only gives a better measure of a module's real world performance, but it gives a better "apples to apples" comparison of the various module types whereby STC specifications can sometimes misrepresent a given module's real world performance. A comprehensive list of PV modules and their PTC ratings as determined by the CEC can be found at: http://www.gosolarcalifornia.org/equipment/pv_modules.php

Therefore, OutBack recommends staying within the string sizing guidelines and maybe even derate another ten percent for a conservative design that would not be at risk to nuisance tripping of the charge controller output circuit breakers. Adding an additional charge controller could pay for itself when compared to return site visits plus the value of a customer who is happy with the performance of their PV generation system.

However, it's also possible the site owner may want to save some money and be willing to live with a little nuisance tripping and maybe even disable a string or two during the few days or weeks of the year when the array is outperforming normal operation, especially if that means maximizing solar energy harvest the rest of the year.

Whichever way selected - a conservative design or disabling strings during potential nuisance tripping times of year - these options and tradeoffs should be discussed openly with the site owner before the system is purchased and commissioned.

One other option does exist for site owners that have already installed their PV array where it would be difficult or prohibitively expensive to rewire the array and add another charge controller. The solution involves moving the OutBack 80A GFDI output breaker from the output of the charge controller to the input side, and putting in 100A circuit breakers on the output. Additionally, with the GFDI on the input side of the charge controller, there must be a separate disconnecting means between the combiner box and the charge controller other than the GFDI, such as on the output of the combiner box. Otherwise, opening the GFDI on the input side will "unground" the array which is not allowed by the NEC.

Putting 100A circuit breakers on the output of the FM80 may also require replacing the conductors between the output of the charge controller and the DC bus or battery bank with 100A conductors. The FM80 has its own internal current limit protection of 80A so the 100A external circuit breakers are really there to protect the conductors, not the charge controller.

An electrical diagram of the 80A GFDI on the output of the charge controller as recommended for most applications is shown below in Figure 1.

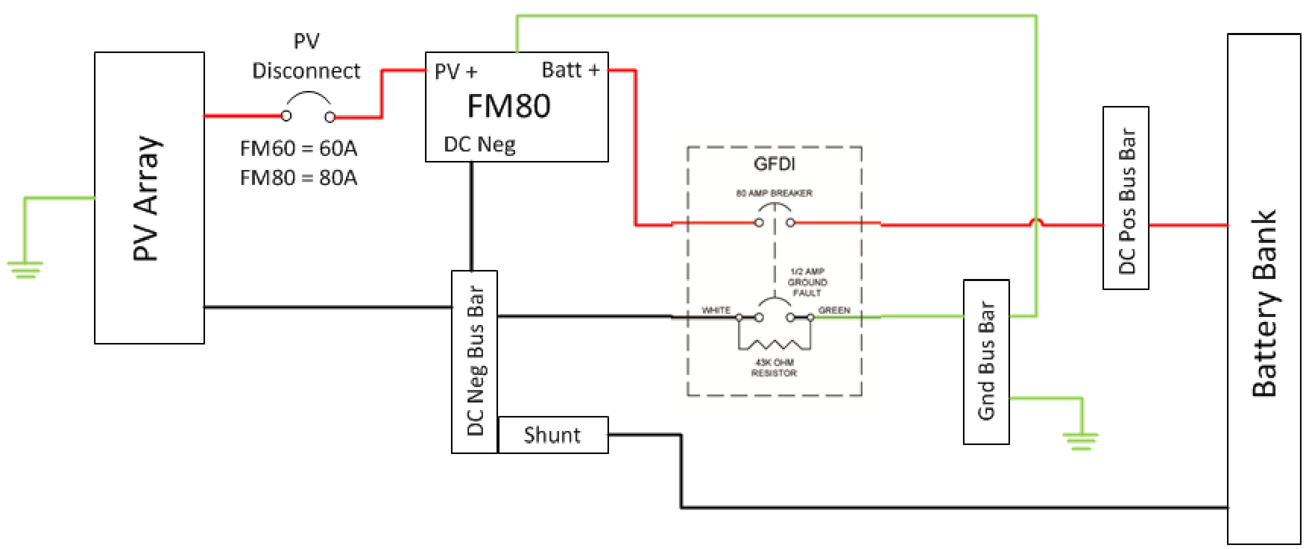


Figure 1 - FM80 Standard GFDI Wiring

Figure 2 shows a diagram with the 80A GFDI moved to the input with an additional disconnecting means, and 100A circuit breakers on the output to reduce the nuisance tripping.

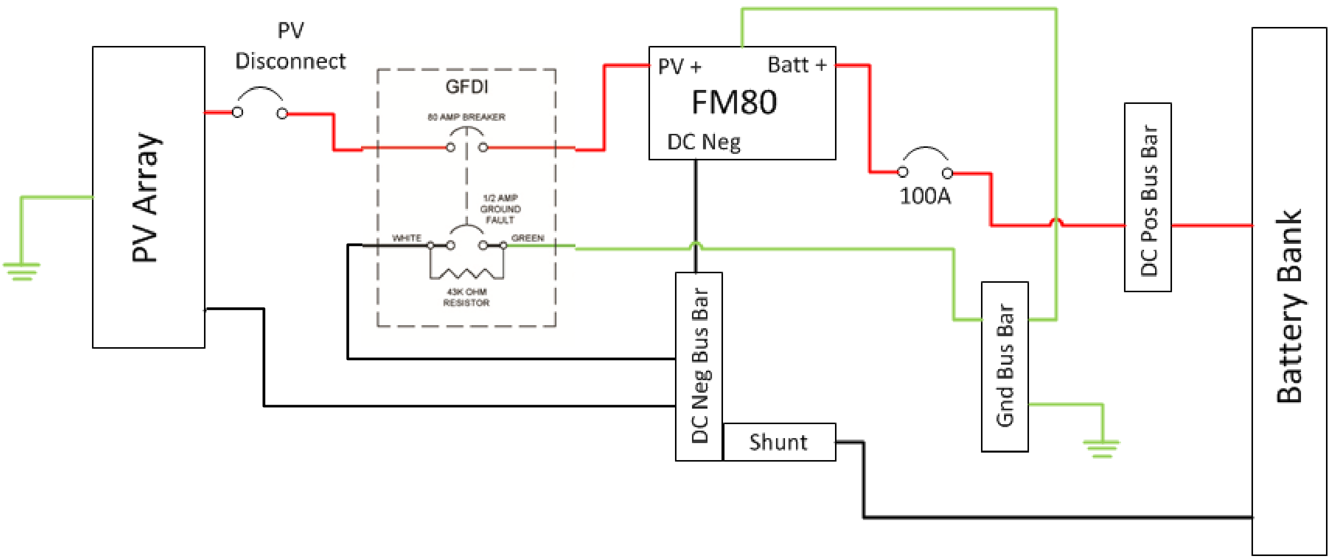


Figure 2 - FM80 Extended Performance GFDI Wiring

About OutBack Power Technologies

OutBack Power Technologies is a leader in advanced energy conversion technology. OutBack products include true sine wave inverter/chargers, maximum power point tracking charge controllers, and system communication components, as well as circuit breakers, batteries, accessories, and assembled systems.

Grid/Hybrid™

As a leader in off-grid energy systems designed around energy storage, OutBack Power is an innovator in Grid/Hybrid system technology, providing the best of both worlds: grid-tied system savings during normal or daylight operation, and off-grid independence during peak energy times or in the event of a power outage or an emergency. Grid/Hybrid systems have the intelligence, agility and interoperability to operate in multiple energy modes quickly, efficiently, and seamlessly, in order to deliver clean, continuous and reliable power to residential and commercial users while maintaining grid stability.

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