DC Ground Fault Protectors explained

GFP's are confusing to say the least.
The 2008 NEC requires a GFP now on all systems. It used to be that they were required only when PV panels were installed on the roof of a dwelling. Now even if you Solarize your outhouse, a DC-GFP is required. You can accomplish this in different ways and I have been involved in the designs of numerous DC-GFP's over the last 18 years.
The idea behind MidNite Solar's present DC-GFP's are to stop the current flow in the event of a short from the PV array. Our device is a custom made high current breaker or switch **internally ganged** with a 1/2 amp breaker section. The high current section is connected in series with the PV+ circuit. The 1/2 amp section is connected between battery minus and earth ground. The device monitors current flowing from battery minus to earth ground. There should be no current flowing under normal conditions. In the event that a fault occurs from either PV+ or PV- and earth ground, the 1/2 amp section will trip thus opening the PV+ circuit and stopping current flow. This type of fault is what the NEC is trying to prevent as it could potentially cause a fire.

We place a high value resistor across the 1/2 amp section to help keep potentially high stray voltage down on the battery negative circuit while the device is in the tripped condition. This resistor in not a requirement of the NEC, but is installed as a safety precaution.

The NEC specifically disallows the ground fault interrupter from being the PV+ disconnect as it effectively un-grounds the system when opened. The NEC does specifically allow the system to be ungrounded in the case of a ground fault however. In order to satisfy these requirements and still provide the NEC required PV disconnect and over-current device, there must be another breaker in series with the PV+ circuit. This additional breaker is to be used as a disconnect and is not part of the DC-GFP.

Neither the PV+ or the high current section of the DC GFP are actually used as an over-current device as a double fault would be required in order to have excessive current flowing in the PV circuit. A Solar array is a current source which means it can only produce a limited amount of current. The NEC requires the wiring and over-current (disconnect) device to be sized 1.56 times the short circuit capability of the PV array. This is high enough that it cannot trip even under a fault. To make the PV+ disconnect breaker trip would require not only a short in the PV array, but also a direct short in the solar charge controller from PV+ in to battery + out. This condition would effectively put a direct short across the battery at the PV array. All solar charge controllers must have an over-current /disconnect between the battery + and the output of the controller. This is the device that trips when a PV controller shorts. Most controllers do actually short from battery plus to battery minus in the event of a catastrophic failure, so the battery plus breaker is essential. If this breaker is not installed in your charge controller output and the controller fails, a fire WILL result!! All DC breakers are polarity sensitive. When dealing with the high fault currents associated with batteries, it is very important to get it right. The "+" sign on our din rail mount breakers and the "Line" side of our panel mount breakers are intended to be at the highest potential during a fault condition. The battery plus connection will always be the highest voltage potential during a fault.

You do not ground the battery negative when using the DC-GFP since the DC-GFP is now the battery negative to earth ground bond. In the case of a fault current from either PV+ or PV- to earth, the 1/2 amp section of the device will open and at the same time open the PV+ circuit path.