Xantrex Technology Inc.
8999 Nelson Way
Burnaby, BC
V5A 4B5
Canada
www.xantrex.com

Technical Note
XW MPPT Charge Controller: Ground Fault Protection

NEC 690.5 Ground-Fault Protection

Roof-mounted dc photovoltaic array located on dwellings shall be provided with dc ground-fault protection to reduce risk of fire.

(a) Ground-Fault Detection and Interruption. The ground-fault protection device or system shall be capable of detecting a ground fault, interrupting the flow of fault current, and providing an indication of the fault.

(b) The ungrounded conductors of the faulted source shall be automatically disconnected.

MPPT Charge Controller

The MPPT Charge controller has a built-in fuse, rated at 1A, 600V, which grounds both the PV negative and battery negative conductors and provides PV ground-fault protection (PV-GFP) to the system.

Only one MPPT Charge Controller is to have the PV-GFP fuse installed in installations with multiple parallel MPPT Charge Controllers (Charge Controllers sharing the same battery bank). A single fuse will provide both, grounding for PV and battery circuits, and PV ground-fault protection to the entire system.

Failing to remove all fuses but one from the installed MPPT Charge Controllers would defeat the PV GFP mechanism. The source ground fault current would have to be larger than 1 Amp (depending on the impedance of the circuit and number of fuses installed) for the system to be able to detect the ground fault, interrupt the flow of fault current, and shut down.

Additionally, in order to maintain a single point of ground, it is important that the battery negative terminal not be grounded elsewhere in the system other than through the 1A PV GFP fuse; otherwise improper unit operation may result.

The following diagrams show examples of correct and incorrect configurations in a two-XW Charge Controller system, and illustrate the current flow through the system during normal operation and during a ground fault event.

Figure 1 and 2 show the correct connection between two XW Charge Controllers, where all but one GF fuse has been removed. Under normal operation (no ground fault) no current flows through ground, thus leaving the GF fuse intact. See figure 1.

Xantrex Technology Inc.
8999 Nelson Way
Burnaby, BC
V5A 4B5
Canada
www.xantrex.com

Technical Note
XW MPPT Charge Controller: Ground Fault Protection

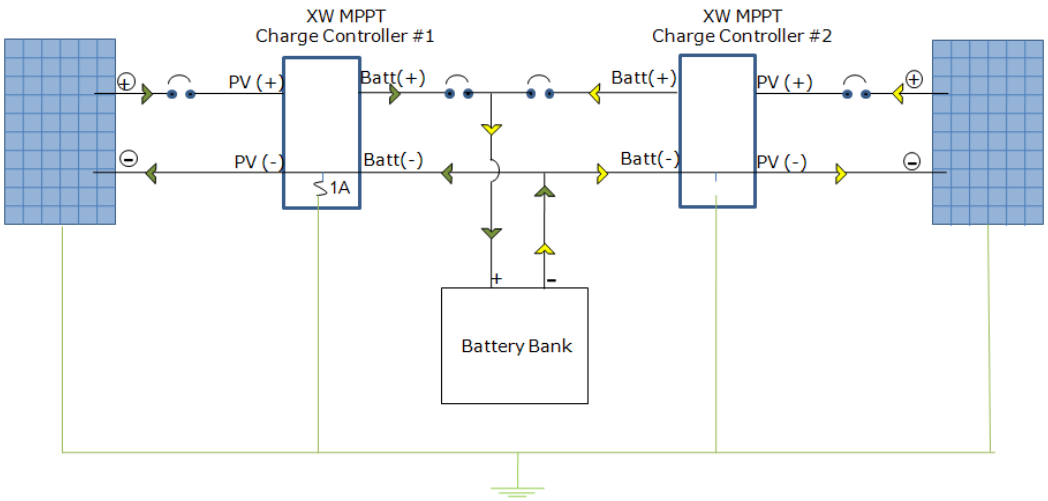

Figure1. Correct Configuration
Example of normal operation
Two charge controllers in parallel with only one GFP fuse installed

During a PV ground fault event, see figure 2, current from the PV array will flow through the module's frame to ground, and will find a path to PV negative through the GF fuse, which will blow if the GF current is at least 1 Amp.

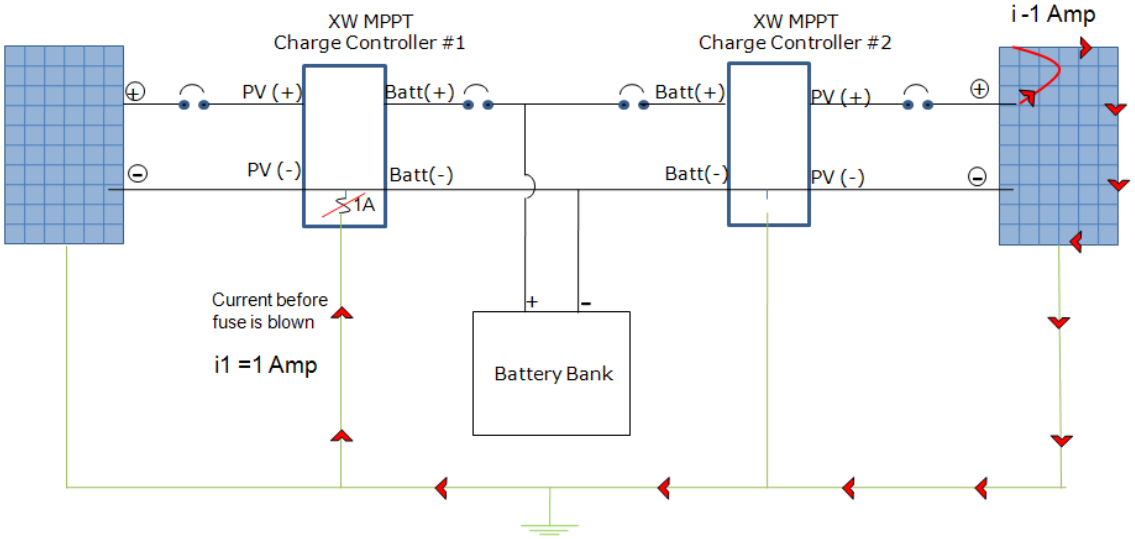

Figure2. Correct configuration
Example of a ground fault event
Two charge controllers in parallel with only one GFP fuse installed

Xantrex Technology Inc.
8999 Nelson Way
Burnaby, BC
V5A 4B5
Canada
www.xantrex.com

Technical Note
XW MPPT Charge Controller: Ground Fault Protection

Once the fuse is opened, each charge controller will sense a change of impedance (not shown in the diagram) between ground earth and PV negative. Each MPPT charge controller will then show an active fault in its display and will communicate the event to the XW System Control Panel (XW SCP) through the Xanbus network. In this way, a Ground Fault message is displayed on each charge controller and on the XW SCP, and the PV system will shutdown, effectively interrupting the flow of fault current.

Figure 3 shows the incorrect connection between two XW Charge Controllers, where both GF fuses have been installed. During normal operation, the system might perform just fine, except for some ground loop effects due to having more than 1 point of ground in the system.

During a ground fault event, the ground fault current finds return paths to PV negative through both GF fuses, which forces current to divide into two: i1 and i2. If the divided current is not at least 1 amp to blow either fuse, even if the source current was 1 Amp or more, the ground fault is not detected and the current flow is not interrupted.

Example:
Assuming identical impedance for both Charge Controllers
i=1 Amp
i1=i2 =0.5 Amp <1Amp necessary to blow the GF fuse

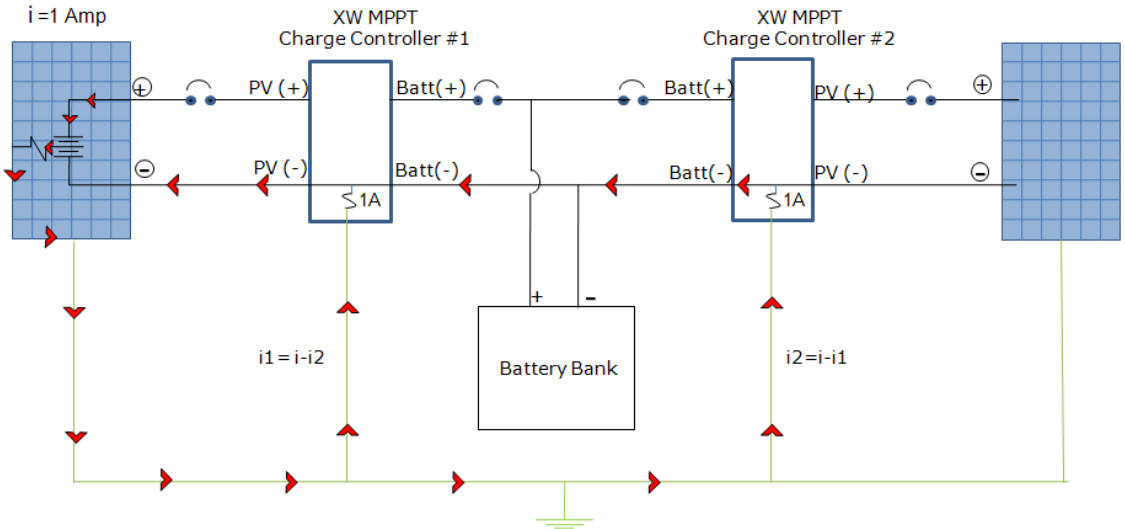

Figure3. Incorrect configuration
Example of a ground fault event
Two charge controllers in parallel with two GFP fuse installed