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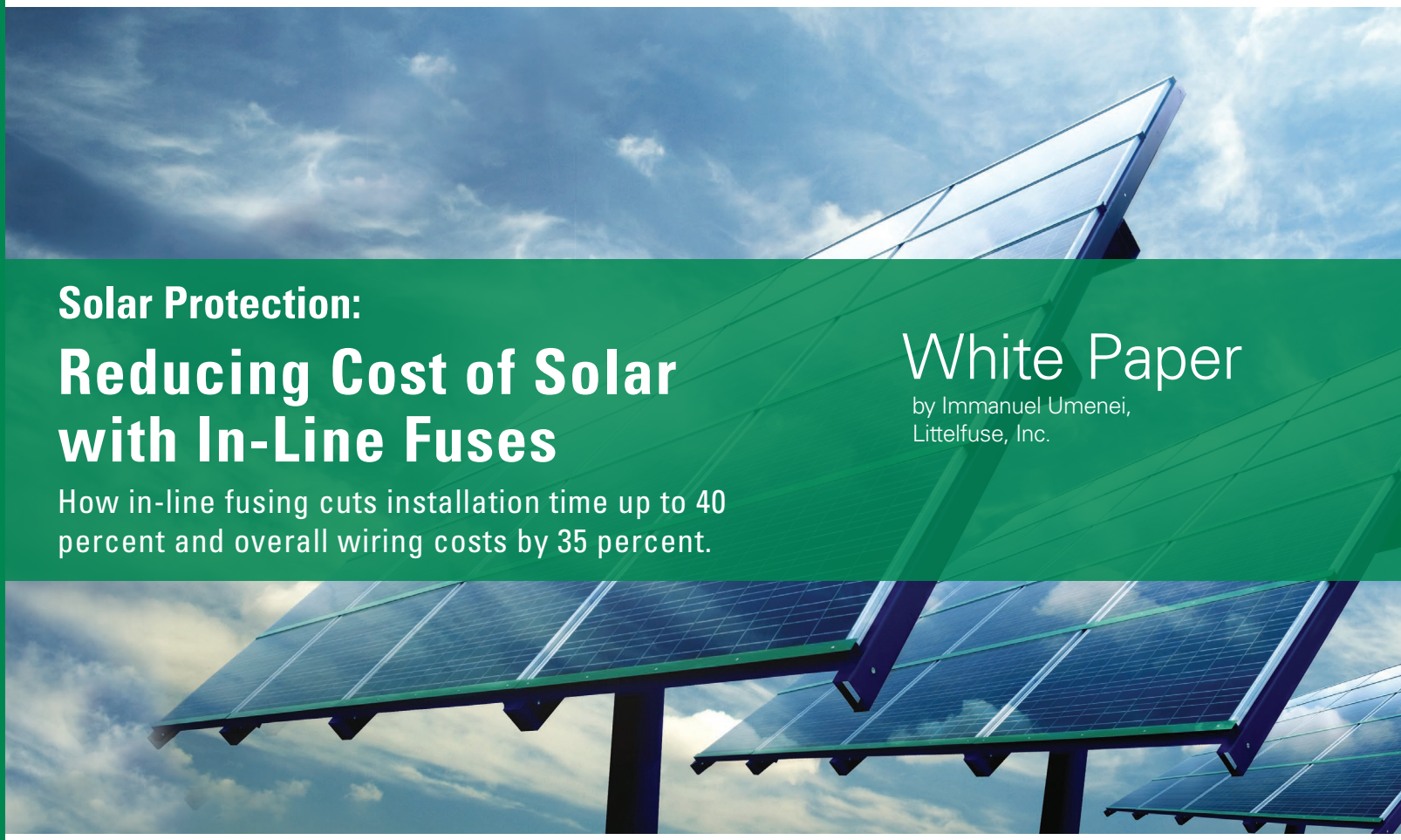

Solar Protection:

Reducing Cost of Solar with In-Line Fuses

How in-line fusing cuts installation time up to 40 percent and overall wiring costs by 35 percent.

White Paper

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Introduction

The build out of renewable energy infrastructure depends on economic drivers and is experiencing increased pressure to achieve parity with traditional electrical power sources. Reducing the cost of installing photovoltaic (PV) systems is high on the focus list of the solar power industry.

This is the context in which a leading supplier to the solar energy market came to Littelfuse with a challenge: how could it improve the method for protecting PV strings from damaging overcurrents in a way that would reduce complexity and cost? The supplier sought to add DC fuses to the wiring harnesses that they manufactured for linking solar panel strings to combiner boxes.

Littelfuse applications engineers went to work, seeking to fully understand the problem.

Initially, every string was protected at the level of the combiner box, requiring many costly combiner boxes in especially large scale solar installations

To reduce the number of combiner boxes, wire harnesses with integrated fuses allowed low amperage strings to be combined prior to the box. Combiner box reduction could be attained but traditional methods of integrating the fuse protection into the harness created reliability and yield issues.

An Innovative Solution

To reduce the number of inputs (cables) going in to the combiner box, and subsequently the number of combiner boxes required, the supplier wanted to put overmolded fuses in-line within the wiring harness. This would bring about a more streamlined installation and bring protection closer to the panels. Also with this methodology, the installer could combine many more of the protected strings into one cable, carrying more current into the combiner box.

Littelfuse engineers wanted to add the fuses inline without creating cost and reliability issues associated with connections, such as fuses with wire connections made directly to the end-cap or a cap–on-cap connection with the outer cap having crimp-on barrel to which the wire is crimped. They also realized that they needed to find a solution that was economical and easy to assemble for the wire harness manufacturer. Previous solutions tried by the harness manufacturers created additional costs and poor yields.

After carefully reviewing and fine-tuning the requirements, the Littelfuse engineering team developed a proposal for a new fuse designed to meet the supplier's unique requirements. Two new series of fuses (POWR-GARD® SPFI and SPXI) were developed. Each has a "unibody" end cap (i.e., no joints) with a crimp-on barrel optimized for wire crimping and over-molding. The new fuses were engineered specifically to integrate into an in-line assembly within a wire harness. They meet the electrical requirements of UL 2579 for photovoltaic applications and can be electrically insulated with either over-molding or an approved heat-shrink. In the rare occurrence of a fault where the fuse would open as expected, replacement kits provide overmolded in-line fuses with connectors which allow for quick replacement.

SPFI Series fuses have a voltage rating of 1000VDC, an interrupting rating of 20kA, with a choice of amperage ratings from 2A to 30A. SPXI Series fuses have a voltage rating 1500VDC, an interrupting rating of 30kA, with a choice of amperage ratings from 2A to 30A. The relatively high amperage ratings allows for increasing efficiencies as PV technology improves.

Littelfuse created samples for customer testing, which proved to solve the manufacturing yield problems that they had encountered previously. The supplier liked the crimped connection because it allows for a solid contact between the wire and the fuse, reducing the potential for high resistance contacts that can overheat. Also the design reduces the number of potential points of failure within the harness.

These fuses have been widely accepted and preferred by the industry making them prevalent across several installations. As an example, the 4 amp in-line fuses are part of multiple global utility installations with more than 2.5 million fuses installed, protecting over 2000 miles of solar cables.

Dramatic Cost Savings

Even more important, the wire harness with in-line fuses offers dramatic cost reductions for EPCs and project investors. By fusing in-line instead of in the combiner box, the harness reduces the total number of inputs into a combiner box. Multiple protected strings are combined in the harness, having fewer inputs with higher ampacity coming into the box.

Figure 1.
Wiring harness made by Hikam America has eight branches, each protected by a Littelfuse supplied in-line DC fuse.

This greatly reduces the number of combiner boxes required to service the overall installation. For example, instead of having eight combiner boxes handling 16 15-amp inputs for 1.2 megawatts, protected strings would allow four combiner boxes handling 16 30-amp inputs at equal power.

Typically these boxes, outfitted with fuse holders, cost more than $1000 each, so the cost savings is substantial. In this architecture the reduced number of combiner boxes also reduces the amount of wire that is required. This impacts total cost of cable and favorably impacts labor costs.

Brian Moore, sales representative of Hikam America, Inc., a major manufacturer of wiring harness assemblies, said that his end customers have found that the in line fuse protection solution reduces installation time of solar fields by up to 40 percent and overall wiring costs by 35 percent.

"The in-line approach is popular among EPCs and installers for protecting systems of all solar panel types, including crystalline, poly/mono crystalline silicon, and thin film," Moore said. "The fuses used in the wiring harness are usually smaller and less costly than the fuses used in panels, and they are easy to replace after a fuse needs to open."

Conclusion

The electrical Balance of Systems (BOS) components required to transmit and convert solar energy, including wire, string and array combiner boxes, and other components represent a significant part of the total cost of a solar installation. By helping to reduce the number of components, as well as reducing the labor required to build solar installations, Littelfuse is a partner in helping make the world a little greener.

For more information, visit
Littelfuse.com/solar

Additional technical information and application data for Littelfuse protection relays, generator and engine controls, fuses and other circuit protection and safety products can be found on **www.littelfuse.com**. For questions, contact our Technical Support Group **(800-832-3873)**. Specifications, descriptions and illustrative material in this literature are as accurate as known at the time of publication, but are subject to changes without notice. All data was compiled from public information available from manufacturers' manuals and datasheets.

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