Technical Benefits for Using Cooper Interconnect Pre-Fabricated Harnesses for Photovoltaic Applications

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Pre-fabricated harnesses play a vital role in the installation process of a commercial or utility scale Photovoltaic installation. The advantages touch various important aspects of the installation process that may not be foreseen during an on-site installation. These aspects help simplify the installation and mitigate risks over the life cycle of the product by meeting performance and safety requirements.

Safety

- Pre-fabricated harnesses are manufactured by adhering to the highest quality standards and tested in a factory environment for continuity and dielectric properties. Primary focus is to ensure the product adheres to design intent and all the safety requirements after installation.
- All pre-fabricated harnesses are tested per guidelines issued by Underwriter laboratories (UL) under UL9703 (Distributed generation wiring harnesses) standard developed for testing harnesses listed and manufactured for Photovoltaic applications.
- All components used in pre-fabricated harnesses are tested per guidelines issued under UL6703 (Connectors for use in Photovoltaic systems), UL854 (Service entrance cable) and UL4703 (Photovoltaic wire) standards specifically developed for testing components listed and manufactured for Photovoltaic applications.
- Pre-fabricated harnesses ensure that the entire harness, as an end product, complies and meets UL standards for photovoltaic application, unlike on-site assembly processes where only the components used to make the harness may meet UL compliance.

Harnesses assembled on-site are usually not listed or tested by a nationally recognized testing laboratory to ensure compliance with safety standards developed specifically for high voltage PV applications.

Quality

Materials and Manufacturing Processes

- Pre-fabricated harnesses are manufactured using validated materials and then tested to meet and exceed stringent test standards that require the highest quality of materials and assembly processes to ensure compliance.
- Assembly processes strictly follow component manufacturer's installation instruction with a tight tolerance on crimping and sealing. Automated equipment produces repeatable results.

Quality *(continued)*

Reliability - Product reliability is a key factor as it measures the probability of failure which results in down time and increases the cost of maintainability.

- Factory assembled harnesses are tested against stringent long term environmental tests to ensure that they meet and exceed the functional requirements over the life cycle of the product. Long term reliability testing includes a combination of high and low temperatures, combined with high humidity conditions. The accelerated life testing performed on factory built photovoltaic harnesses ensures continuous performance since the products are exposed to harsh environments such as hot and dry deserts in Arizona, freezing temperatures in Canada or the humid coastal weather in Florida.

Repeatability - Repeatability as a measure in variation is a key contributor to the reliability of a product.

- Pre-fabricated harnesses are manufactured using processes which demonstrate a high degree of capability and repeatability. The process of crimping contacts is very repeatable and reliable using semi-automatic equipment which guarantees a quality crimp every time, improving the quality of the harness with minimal variation.
- Processes used to cut wire ensure accurate wire lengths with minimal variation.

Manufacturing setup - The product is manufactured in a controlled environment using processes that have been validated to produce a quality product. Maintained levels of temperature and humidity help build products with high performance and quality.

- Human ergonomics is one of the factors that influence the quality of the product. The influence of human ergonomics on the product quality is one of the key contributors that influence the repeatability of the process. Optimized human ergonomics in a controlled factory setting greatly influence the repeatability of a manufacturing process, improving the quality of the product.
- On-site environmental conditions may change from day to day, which may affect the repeatability of the assembly process. This additional variability will impact quality and make the process more prone to assembly errors, which may go undetected.

Molded Junctions

Molded junctions provide a cost effective way to deliver power back to the combiner box. The process is achieved by combining multiple strings into a single trunk line which is wired back to the combiner box. Junctions are available in a variety of configurations and wire sizes from 6 to 12 AWG to optimize the PV wire installation in terms of cost and installation time, meeting the current and power requirement for PV harnesses required per code. The T or X junction allows 2 or 3 strings to be combined together to a single trunk line which is connected back to the combiner box. Historically, molded junctions were designed for use with Thin Film modules due to the low current attributes of the modules. With recent developments, high current solar harnesses and combiner boxes have opened the opportunity for junctions to be utilized with Multi-crystalline modules. The recent developments allowing multiple wires to be bonded together to form a low resistance joint has spearheaded this development to produce high current harness solutions for the solar market. The new junctions offer a robust design minimizing heat rise when handling high current and inherently improve the quality by design. The performance of Cooper Interconnects wire bonding process outperforms the conventional crimp terminations. The newly designed junctions are then over molded utilizing a blend of proprietary materials and processes, along with automated equipment to create a rugged, sealed junction that can withstand extreme weather conditions and delivery faster return on investment meeting stringent design requirements over the life cycle of the product.

Inline Fusings

A fuse mounted in in-line with the wire rather than placed in a combiner box, junction box or recombiner provides some unique design benefits. Inline fusing with molded junctions provide a cost effective way to combine multiple parallel strings into a single circuit back to the combiner box. The overprotection in the combiner box is sized per NEC 690.8 (B) and the combined current from multiple strings back to the combiner box. This fuse rating in the combiner box may be higher than the maximum overprotection device rating marked on the module. Possible back feed currents from other parallel strings require module strings to have overprotection devices before being connected in parallel. The inline fusing provides this overprotection needed at the string level and meeting the requirements per NEC 690.9 (C).

Other Benefits

- Faster installation time on-site. Time is spent installing pre-fabricated harnesses on-site and not building them by cutting wire and crimping connectors with hand tools.
- Reduces project completion time. Power plants can commission faster and provide a quicker ROI.
- Resource cost savings. Highly trained and certified electricians spend their time installing the pre-fabricated harnesses, not building them on-site.
- Improved logistics. Pre-fabricated harnesses arrive on-site as a kit, pre-labeled with customer defined circuit numbers and site location markers to make the installation process fast and easy.
- Single vendor. One contact can support all the DC harness needs, making reorders for future jobs fast, reliable and easy.

Test highlights for solar harnesses:	
Leakage Current Test	UL1703
Dielectric Voltage Withstand Test	UL1703
Wet Insulation Resistance Test	UL1703
Water Spray Test	UL1703
Temperature Cycling Test	UL1703
Humidity Cycling Test	UL1703
Damp Heat Exposure Test	IEC61646 10.13 (1000 hours)
Thermal Cycling Test	IEC61646 10.11 (50 cycles)
Humidity Freeze Test	IEC61646 10.12 (10 cycles)
Temperature Test	UL9703
Overload Current Test	UL9703
Mold Stress Distortion Test	UL746C, 29
Strain Relief Test	UL1703, 22
Crush Resistance Test	UL746C, 21

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