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Technical Notes

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Protection from the Elements Part II: Drip Loops & Design

This Technical Briefing Note identifies a few basic design steps and user instructions that can protect pico-powered lighting products from early failures caused by water ingress. The use of drip loops and related design strategies can help prevent damage from water drip lines.

Information contained in this Note builds on previous Technical Notes available on Lighting Global's website.

Introduction

The ability of a pico-powered lighting product to survive challenges posed by the environment is a function of both the product design and the product's treatment by the owner. Long product lifetimes require **good product design** and **proper use and handling by the end user**. This Technical Note covers simple steps that manufacturers and users can take to help prevent early failures from water ingress.

Recent Lighting Global data collected from retail shops and repair technicians in India, Tanzania, and Kenya confirm that end-user error and water ingress contribute to off-grid lighting product failure. Although it can be difficult to determine the exact cause of malfunction, these types of failures may be avoided with proper set up and handling. Improved, easy-to-understand user manuals can help educate the consumer and minimize damage from improper installation and use. Water ingress can be prevented in many cases by installing drip loops in the system wiring of products that include an external photovoltaic module.

A careful owner who knows how to install, use, and maintain a pico-powered light is essential to not only a product's lifetime but also the reputation of the product brand. Proper use combined with a well-designed product will maximize success, avoid early product failures, and deliver good value to the customer.

What is a drip loop?

A drip loop is simply an extra length of wire that hangs below an electrical connection so that any water or condensation traveling down the cord is diverted away from the connector and internal electronics (Figure 1). When no drip loop is present, water can follow the cord to the electrical connection where it may corrode the plug and possibly gain access to sensitive electronics (Figure 2).

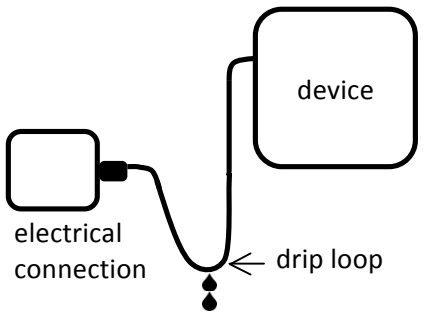

Figure 1. Drip loops can keep water away from electrical connections

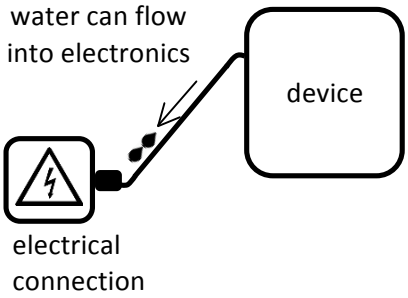

Figure 2. Example situation where water will collect and possibly damage an electrical connection

Water adhesion and cohesion

Cohesion is defined as the property of molecules—in this case, water molecules—to bond to other molecules of the same type. Cohesion is responsible for the surface tension of water and the reason that water droplets form beads on waxy surfaces. The cohesive forces between water molecules are stronger than the attraction of the water molecules to the waxy surface, so the water droplets maintain a spherical shape (flattened by gravity) and will roll off of these surfaces.

Adhesion of a liquid refers to the attractive force of the liquid molecules to other materials. When the adhesive force of water molecules to another surface is stronger than the cohesive force of the water molecules to each other, the water will tend to spread out as a thin film on this surface. The water is said to 'wet' the surface. Water forms a thin film on clean glass, for example, because water molecules have strong adhesion to glass molecules.

Water has both strong cohesion (and high surface tension) and also tends to have strong adhesion to other surfaces, including many plastics commonly used as wire insulation. This allows water to travel long distances down wires and other surfaces even when the surface is predominantly horizontal. Only a small downward component is necessary to allow water to collect into drops (cohesion) and travel along the length (adhesion).

The capillary effect

Another aspect of adhesion is the capillary effect. This allows water and other liquids to penetrate and travel between closely spaced surfaces (as in the wick of kerosene lamp). Capillary action can occur where a connector plugs into the product housing. A drop of water at the seam will tend to wick between the mating surfaces of the connector. This can also occur at seams in the plastic housing, where water will wick into the seam and can then get pulled into the housing by gravity or the expansion and contraction of air during daily temperature cycles experienced by the product.

Drip loops + off-grid lights

Installing drip loops should be standard practice for all users of products where the solar module is separate from the luminaire. This is especially important for solar home systems where the solar module is intended to be placed in a fixed, outdoor position and wired directly to the charge control box located indoors. The use of drip loops is a simple, preventative measure that will help protect the end user from safety hazards as well as protect the end user's investment in the lighting system.

Design strategies to reduce water ingress damage

There are steps that manufacturers can take to promote and ensure that drip loop structures are incorporated into the installation and use of their products. The placement of connectors and wire penetrations can help minimize water ingress, and ***the design of the plastic housing itself can often include drip points to encourage water to fall away from, rather than into, the housing.*** Water that does manage to get inside the enclosure should be able to drain and not collect or pool in sensitive areas. This can be achieved with proper component clearances, plastic seam placement, and drip (weep) holes in strategic locations. Including wires with sufficient extra length to allow users to set up drip loops where appropriate is also important.

There is only so much a manufacturer can do, of course, to design an affordable product to survive water exposures. The next step must be taken by the end user who can extend the life of the product with proper installation and care.

Drip loops implemented by by end users

An examination of user manuals for lighting products tested in the Lighting Global program did not find instructions regarding the use of drip loops. The manuals varied widely in both the breadth and depth of information given to the end user. Many presented instructions with both words and pictures, which seemed more effective compared to the text-only guides observed. Some manuals had instructions regarding care and use of the solar module (e.g. orientation/no shading, clean panel periodically), while other manuals made little to no mention of the solar module. No information was found regarding drip loops in the manuals surveyed.

Conclusion

Manufacturers are encouraged to include pictograms and instructions demonstrating the proper wiring installation of their products (Figure 3). The concept of a drip loop is fairly simple, and, given proper instruction and adequate wire lengths, end users can implement this safeguard quite easily. An additional benefit of communicating this information is the reinforcement of need for proper care of off-grid lighting systems. Protecting electronic devices from unnecessary water exposure is always a good idea and will benefit the consumer, the manufacturer, and the industry at large.

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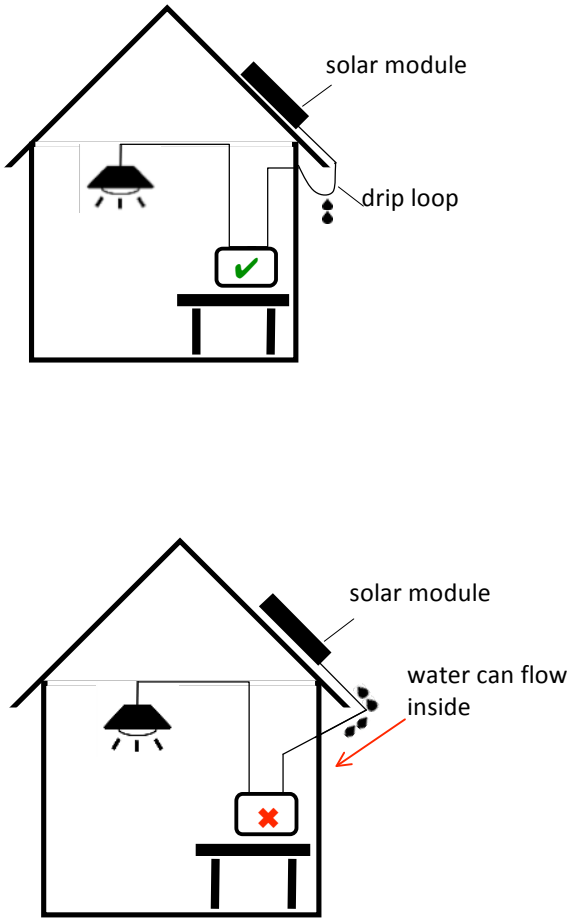

Figure 3. Example pictograms showing correct and incorrect installation of a roof mounted panel and indoor electronic devices