Making a splash

The growing trend of waterproofing portable electronic devices has led fastener manufacturers to discover a low cost solution. By **Doug Clark**.

The trend in consumer electronics has always been to make devices faster, smarter and with ever more features. But waterproofing has become the new focus of many global electronics manufacturers and these companies are rushing to include this benefit to ensure they are not left behind in this ultra-competitive market.

Since water-resistant standards play a big role in making expensive handheld and wearable digital devices more durable, the industry has adopted the IPX7 rating, which protects against immersion in water for 30mins at a depth of 1m.

Yet the critical element in meeting or exceeding these higher standards is something most consumers are barely aware of – micro fasteners that must lock out moisture whilst complementing the aesthetics of the phone, watch or tablet design. Making devices that are eye-catching as well as water, air and dustproof adds value to a new product.

Fulfilling both demands is proving difficult because some of the most effective processes for making large, practical screws are not suitable for micro fasteners, according to experts. As a result, the cost per unit is two or three times higher for the smaller screws. In addition to this, in some cases, overspray of the sealant needed to assure water resistance has led to a discoloration that ruins the appearance of the device's exterior.

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Testing for a solution

A solution that improves reliability while lowering costs was discovered using a variable water pressure simulation chamber, where a combination of water and air pressure simulates 1 to 10m of water depth.

The assembly was conducted using guidelines set by the International Organization for Standardisation (ISO) using a minimum of 32 pieces (in this case the M1 x 3, a common sized screw used in digital devices).

Initially, the screws were tightened to the correct seating torque

specifications using a micro torque wrench – ISO threads at 0.36 Kgf-cm, threads at 0.42 Kgf-cm. A 15% increase in torque was added to the threads in order to achieve the same clamp load due to friction. Water pressure was applied to the head of each fastener to simulate an actual environment that could destroy a portable electronic device (such as a swimming pool or bathtub).

Once the chamber achieved full pressure, engineers set a timer for 30minutes, then watched the pressure meter and checked for leaks in the dry bottom portion of the chamber. If the pressure dropped and/or water was found on the bottom test plate, this would indicate a system failure.

Exceeding IPX7 standards

The test was created and executed by Sean Riskin, director of engineering of the Global Electronics Group at Stanley Engineered Fastening. Following the tests, he created a study that examined nearly a dozen fastener configurations of various brands to find the best solutions that meet or exceed IPX7 standards.

Most sealants for micro fasteners are a nylon or Teflon based substance, and there are only two ways to apply the protection – manufacturers either seal the threads or seal underneath the head of the screw. Both have advantages and disadvantages.

Sealing the threads may not protect the multiple layers of components in a typical fastened joint. This is because the components being fastened together are in the path of water before the protective sealant. Sealing under the head is preferable because it is the first barrier against moisture. Yet this is the method that, in some cases, results in an overspray and discoloration caused by the application process.

"You don't want to spend double or triple the price on a fastener and not have it look cosmetically pleasing," Riskin says. "In a sense, electronic manufacturers are struggling with a three way battle – function versus beauty versus cost."

The sealant is what creates prohibitive costs because it must be applied to every single unit as a secondary operation, forcing major manufacturers to spend a large amount every year on micro fasteners alone.

But what if the sealant could be eliminated from the equation? That's easier said than done.

The sealant creates a water and dust barrier and, in addition, the screws must have an anti-vibration feature applied so that they won't loosen and back out during normal use of the device. Both features are second and third operations that add cost to the overall price of a fastener.

The solution Riskin was looking for came from the combination of under head design features of screws and Spiralock. Some years ago, this subsidiary of STANLEY developed and re-engineered a female thread profile that adds a 30° wedge ramp at the root of the thread and mates with standard 60° male thread fasteners. This innovation removes the need for nylon based patches or other anti vibration countermeasures and therefore reduces the cost of fasteners significantly.

The M1 x 3 screw is commonly sized used in the assembly of digital devices

Riskin's study also revealed other advantages. When torqued to specifications, standard screws are not perfectly perpendicular – most are a couple of degrees off access and therefore provide a gap into which fluid can enter.

The Spiralock thread profile, in comparison, is self centring and the head of the fastener is perpendicular to the bearing surface. Riskin knew that this alone would not entirely seal out moisture, so he added an 87° under head feature and semi-flat head to the micro fasteners. Although the head designs have been available for years, this is the first time they've been combined with Spiralock's modified locking thread profile to create moisture sealing joints that exceed the IXP7 rating standards.

It also creates a vibration-proof joint that is easy to assemble, saving time and money.

"When you're stacking multiple components for assembly, tolerances always add up and nothing is perfect," says Riskin. "So the more bearing surface area you can have can be a major advantage. These solutions provide additional bearing surface area or a single circular point of contact under the head, significantly improving the sealing surface.

Now that his study is complete, Riskin hopes his discoveries will help handheld and wearable device manufacturers dive deeper into the realm of new possibilities.

"Nobody wants to be just as good as their competition; they want to be better. Everyone is trying to get a piece of the market by diversifying themselves. That's exciting; imagine what we might be buying and wearing in a couple years," he concludes.

For detailed test data, including testing parameters and comparative analysis, visit www.stanleyengineeredfastening.com