The evolution of miniaturization within UAV connector technology

Derek Hunt, Omnetics Connector Corporation

Throughout the world, military and aerospace engineers are focused on new design efforts to not only modernize existing operations, but at the same time, miniaturize these efforts and electronics to improve flexibility and portability as well as overall survivability in the field. With these changes in mind, electronics and connectors in particular are playing a vital role in terms of reducing a system's overall weight and size while maintaining yesterday's proven technology, in half the footprint.

It's no surprise that size and weight are two of the largest factors these days when it comes to interconnects. Soldiers typically haul their own weight and then some in what we deem "portable" electronics. In fact, with the amount of data transferred in and out of battlefields today, yesterday's interconnect solutions alone would have had our soldiers weighted down with heavy analog-driven technology, not to mention a variety of back-breaking batteries, all essential to power each unit and/or device. Luckily, this challenge has paved the way for new unmanned technologies to surface. UAV technology has quickly become a leading global industry in supporting existing defense systems as well as providing new ways of protecting the home front and abroad.

UAV technology, although relatively new, is already evolving. What we've known to be "standard," such as fixed wings and motorized propulsion, are becoming things of the past. Instead, researchers are now using more of a biological template, such as flapping wings to mimic a bird in an effort to achieve a level of aerial camouflage. This ability for UAVs to mimic a bird or in some instances insects gives the UAV an almost natural protection from the elements. Even in the heart of the battlefield, enemies might notice the UAV disguised as a bird, but could very well identify it as just that, a bird.

All these factors – combined with the fact that UAV systems manufacturers are requiring smaller, more innovative interconnect systems – have brought miniaturization to the forefront. What was once thought of as simply a portable

military surveillance device has now branched out into applications such as agriculture, law enforcement, and border control, yet in reality, all UAVs these days are essentially demanding the same things: smaller size, lighter weight, higher performance, and more importantly, higher-reliability miniaturized connectors, and those connectors are here.

Smaller size and weight, more ruggedness

Nano-miniature connectors are beginning to play a vital role in a number of UAV applications. Such small and lightweight electronics and components allow for longer flight times, which is vital within this industry. In addition to size and weight considerations, these new robust interconnect designs must be ultra-rugged. These connectors must be capable of withstanding a high shock and vibration environment. For example, Omnetics BiLobe connectors can handle a shock of 100 g in each axis and have passed vibration testing from 10 to 2,000 to 10 Hz at 20 g amplitude in each axis (Figure 1) – ensuring more than enough to survive the high shock and vibration demands often associated with the UAV tendency toward aggressive landings. In addition to size characteristics and vibrational elements, other conditions such as adverse weather and high altitudes push the UAV’s electrical requirements and overall performance to new heights.

Electronics requirements in general have new ruggedized standards to be met simultaneously with the expectations of lightweight flexible cables and locking interconnect systems. These new standards have forced connector manufacturers to think “outside the box” and design specifically to meet these newfound requirements. New connector designs based at .025" on center contacts offer military-level quality and reliability, suitable for UAVs. Nano-miniature interconnects are specifically designed to meet these rugged demands, while consuming the smallest physical space possible. These nano-sized connectors exceed performance levels specified within MIL-DTL-83513, commonly referred to as the Micro D, and are also designed to fit the new requirements of MIL-DTL-32139 (Figure 2). Nano-

miniature connectors as a whole are 10 times smaller in volume and about 10 percent the weight of a standard Micro D connector with the same number of positions. With cameras, weaponry, GPS modules, and other detectors now onboard many of these lightweight UAVs, there is an increased demand for high data rates as well as a high-volume capacity for video data streaming. If not handled correctly from a design standpoint, these transmission signals could cause extreme Electromagnetic Interference (EMI) conditions and extreme headaches for designers.

Nano-miniature connector challenges

As we've learned from past endeavors, regardless of the industry, new challenges arise with each new technological trend, and nano-miniature connectors are no different. The main reason is that old standards no longer apply. Simultaneously, "comfort" connectors such as MIL-38999 circulars and D-Subs are just too big. Some MIL-83513 Micro Ds are becoming too large in some in-stances, as connectors themselves are becoming the limiting factor in UAV-related applications.

Aside from the size and weight challenges mentioned, there are countless other factors at play today. The overall environment – and specifically environmental protection – is a major focus when developing miniature connectors. Engineers often compare this challenge to finding a needle in a haystack, and although difficult, solving this challenge is not impossible. Most cables designed for transmission of electrical power or high-voltage signals are relatively unaffected by EMI. However, nano-sized cables (generally consisting of 30 AWG wires or smaller) are rarely designed in with the intention of transmitting high power, but rather Low Voltage Data Signaling (LVDS). This issue is requiring many UAV manufacturers to physically require Electromagnetic Pulse Protection (EMP). Designing against EMP is basically the same as designing against EMI, and that generally starts with the physical cable used versus the nano-connector in question.

The first line of defense is generally twisted pairs. Twisted pair cable is good for transferring balanced differential signals, and the process itself dates back to the early days of telegraph and radio. However, if twisted pairs aren't cutting it, the next step is to physically shield the wire bundle. Yesterday's technology had engineers believing that the best cable shields for EMI were solid materials such as conduit; however, within the UAV market where lightweight solutions are vital, metal braided shields can be used effectively to keep the size and weight down. In fact, with cabling now carrying more LVDS than ever before, proper shielding has never been more important if the integrity of the transmitted data is to be consistently maintained. The most common method of shielding nano-connectors against EMI is to physically enclose the cable in a tightly woven metal braid comprised of wire strands, which is then terminated at one or both ends of the cable depending on the assembly in question.

Best results are generally found when the metal braid can be physically terminated to a backshell. If this is indeed the preference, designers must ensure the shield has a clean metal-to-metal contact with the backshell, as continuity is an extremely important factor relating to EMP/EMI protection. Ideally, a 360-degree circumferential mechanical bond between the shield and the connector's backshell

should be present; this can be achieved using a standard band-it clamp or via a soldering process. A variety of backshell configurations is available specifically for nano-miniature connectors. Designers can select from straight or angled options depending on the application.

Nano-miniature connectors enhance military UAVs
Nano-miniature connectors are helping the military UAV industry to overcome its ubiquitous challenges of electronics size and weight, and providing rugged protection against harsh environments and landings. Helping to prolong UAV flight times and ensure and maintain data transmission integrity in half the footprint of traditional connectors, these connectors are available with temperature ranges as wide as -55 to +200 degrees Celsius in single and dual-row configurations up to 85 contacts. Jackscrew hardware is typical; however, tool-free “latching” versions are available as well. Nano-miniature connectors are also available in environmentally sealed circular configurations as provided by Omnetics’ Nano 360 series. Regardless of the shape, these nano-miniature connectors can be manufactured with flying leads, as jumper assemblies, or as custom harnesses with multiple connectors involved.

Derek Hunt is an Application Specialist for eight years at Omnetics Connector Corporation, where he is responsible for designing and maintaining new and existing business opportunities within Omnetics Connector Corporation in the continental U.S. He graduated from the University of Minnesota, Mankato in 2002 with degrees in Speech Communication and Business Administration. He can be contacted at dhunt@Omnetics.com *[1].*

Links:
[1] mailto:dhunt@Omnetics.com