Design Considerations for Miniaturization of Electronics in Military Applications

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Military organizations worldwide have a great sense of urgency to modernize their operations. There is an "innovation gap" that is putting the soldier of today in peril. For troops to have the best shot at surviving and winning wars, they must carry a collection of equipment that includes, among other things, communication devices, weapons, ammunition and batteries.

The rugged environment in places like Afghanistan, where troops trek miles up into the thin air of the mountains, has made it more imperative that scientists in government and industry find ways to lighten loads that can reach 100 pounds. The added weight also reduces the amount of food, water and ammunition a soldier can carry. So every ounce of equipment carried must improve communications, agility and lethality for soldier survivability. And contractors must make sure the miniaturization happens now, not years down the road.

Many “Future Soldier” programs like the U.S. Department of Defense’s Nett Warrior, India’s F-Insas, Italy’s Soldato Futuro, Poland’s Uhlans 21, Finland’s Finnish Warrior and Australia’s Land 125 have been established to address these very issues. These military organizations pay attention to what they call SWAP – size, weight and power.

Weight is a particularly vital consideration for the dismounted soldier, who typically carries more than 80lbs. The mandate put forth by military organizations is to reduce this weight by 25%. Given that each soldier wears a backpack, body armor, and carries weaponry and ammunition, finding that 20 pounds of overall weight reduction requires rethinking the design and packaging of many types of electronic and communication equipment. For instance, night vision, targeting systems, smart phones, GPS, tactical computers and communications equipment could be integrated into a very functional and reliable subsystem, requiring an array of cables, harnesses and connectors. All of this equipment is necessary, so manufacturers must work with component partners...
to find ways to lose small amounts of weight in each component so they can achieve this 20-pound weight loss.

The miniaturization of component electronics and connectivity plays a vital role in reaching this goal. Connectors play an important role. They have to be rugged enough to withstand dirt, grime and weather, but should be small, light, and easy to use in tense situations. Connections must be made in fractions of a second, and often, they have to be made when wearing gloves, favoring push-pull connector designs that lock instantly rather than requiring twists. Communications devices must work 100% of the time, whether they are radios to talk with commanders or remote control devices for robots that peek around corners and report back electronically. Therefore, designers for military equipment should consider connectivity holistically with the design of their device. This can help them limit the number and size of connectors, and reduce cabling as well.

When searching for the perfect connector for a military application, several factors should be considered, including weight, size, functionality, sterilization and waterproof ratings.

**Weight**
Maintaining a lightweight design is extremely important when dealing with portable units. Some connectors provide weight saving of up to 75%, compared to the standard core connectors. For instance, a rugged Fischer MiniMax™ Series connector without any cable assembly weighs only 13 grams, yet brings 20 signal and four power connections to the device.

**Size**
As part of efforts to reduce the weight each soldier must carry, militaries and their prime contractors are also striving to shrink the physical size of components as well. Highly functional connectors and cable assemblies can be reduced in size by 40% compared with the older connector solutions, and prevent interference between power and signal. The diameter of a Fischer MiniMax™ Series connector is 12.9 millimeters, which is significantly lower than any other connector with the same number of contacts. Smaller connectors that maintain functional standards allow designers to shrink the size of their boxes. Even millimeters make a difference to a soldier in the field.

**Functionality**
Ruggedness is an extremely important factor in functionality. Connectors that are being used in extreme conditions should be able to withstand an onslaught of sand, water, chemicals and other exterior factors.

Densification of pins is also important, as this allows a single miniature connector to do the job of two, three or more larger, less compact connectors. The ideal connector can have up to 24 pins and perform several functions – transmission of power, ethernet, HDMI, etc. – without interference. Manufacturers have recently made strides toward creating connectors with a large number of pins that function optimally without interference. Fischer Connectors used new techniques to achieve miniaturization, as the standard techniques limited efforts to make the connectors smaller.

Connectors should be easy to mate or unmate even when using gloves and durable enough to be functional through up to 5,000 mating cycles. This ensures that after 5,000 mating cycles, the electrical performance is still the same. Anything less and a soldier risks finding a failure in their equipment, which could be a matter of life and death.

**Sterilization**
In the harsh, extreme battlefield environment, it is crucial that connectors be sealed, whether mated or unmated, in order to keep out sand, dirt, water and chemicals. Just as important is the ability to clean and often sterilize (ABC principle: Atomic, Bacterial, Chemical) these connectors without damaging them. All connectors can be sterilized, but not through all methods. For example, some can be washed, some can be steam-sterilized, and others can be placed in an autoclave machine.

**Waterproof Ratings**
Most connector manufacturers self-test their products. This means that while the rating “IP68,” for example, might be placed on a connector, the test that the manufacturer used to obtain such a rating might be different than the test used by another manufacturer. Such tests include immersing the connector in different levels of water for different amounts of time. When researching connectors, it is important to question the testing methods, as one brand’s “IP68” rating may have been obtained differently than another brands.

Military connectors should also be IP rated both mated and unmated, reducing the need for protective caps. An IP68 rating for an unmated connector is a distinct advantage.

**Conclusion**
Today’s militaries continue to invest in the latest technologies, and are turning to prime contractors and off-the-shelf suppliers to bring that technology to them. The companies which bring smaller, lighter equipment to the table will be given additional opportunities to prove their devices will work in the battlefield. Paying attention to the connection solution and the latest trends in rugged connector miniaturization will help companies meet military demands and make it into the field.
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