CONNECTOR AND CABLE DESIGN: HOW NEW MILITARY & AEROSPACE ARE DRIVING CHANGES

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In order to meet significant challenges ahead, advanced electronics are being applied in high reliability systems for improved military and aerospace equipment.

Our technological battlefront now begins with military space equipment, surveillance, and position control more than ever before. We find our defense industry developing improvements, expanding capabilities and creating totally new technical systems to provide both immediate protection and prepare for potential threats that may be just around the corner. To that end, a new digital battlefield program has evolved.

We are seeing a wide range of emerging technical methods to meet the challenge beginning with cutting-edge sensors for data image collection and distribution. We are focusing on mission and situation awareness monitoring, with real-time data collection, faster signal processing and central command guidance transmissions. The amount of time for action and reaction, for data control and usage has diminished to a critical stage.

Electronic equipment and methods are being pushed beyond their barriers of the past. New cable and connectors are being designed and implemented to perform up to the needs of our military and aerospace systems.

Military satellite systems with capability for wide viewing systems will rapidly become a leading focus of technology expansion in providing surveillance and control of reconnaissance. Multispectral surveillance cameras can provide images while additional sensors monitor items such as weather, ocean levels as well as other satellite and missile activities. Satellites also provide data for the new geospatial intelligence, (GEOINT) system that offers image analysis software that drives higher speed digital signal data comparisons. Ruggedized, lightweight, high density connectors at .050” and .025” pitch are used to direct that data into transmission modules that send the data back to earth.

NASA Hi-Res Camera Board

Phased array radar is rapidly eclipsing the old dish radar technology. The advanced systems use multiple transmission lobes, (antennas), and sending coordinated signals with slightly adjusted phase shifts to focus the radar beam directly at one point and define the targets with serious resolution. As circuit speed and logic systems function more rapidly, even the fastest missiles are tracked electronically instead of using moving dish systems.

Our military industry is benefitting greatly from these systems because of their capability, but also with their ease of portability. One of the keys to phased-array radars is the use of multiple sets of high pin

and socket count connectors that handle rapid signal processing to and from the radar module and help adjust the phase-angle of the antennas so they follow rapidly moving targets. The high speed signal capacity also provides improved ISR, (intelligence, surveillance, and reconnaissance), targeting, weapon delivery, and threat warning systems. The use of digital signal interconnections, has become critical in reducing the vulnerability of radars to electronic countermeasures (ECMs). Electronically scanned arrays together with sophisticated software is used to protect with variations in environmental conditions, and determine attempts at jamming.

Omnetics' Rugged Edge connector

UAVs, at very low elevation and most often controlled by earth-bound ships or ground troops have added major advantages to our mission quality. UAVs, provide a different value in surveillance, and offer close control for monitoring wide-area moving target indicators, (MTI), ground targets and airborne early warning (AEW) radar surveillance in support of theater missile to ground defense. A thorough package of electronics in today's UAVs include, directional control, GPIS referencing systems, high resolution cameras as well as ammunition launch and controls.

Omnetics' Latching Nano-D connectors

A key to the success and performance of these highly mobile, fast moving UAVs is extreme signal speed and integrity. Small diameter, high speed differential signal processing cable connect ruggedized miniature connectors from module to module for data storage. Some transmission to ground is done, but often image and data modules are quickly replaced at the base station on the ground. This has driven the use of ruggedized micro and nano-sized latching connectors. High speed digital signal formats are used to handle above 5 Gigabits per second.

PEDs, (Portable Electronic Devices), often specify Micro-sized circular connectors to be used for highly portable modules that need the combination of power and differential signal processing within one connector and cable. This often requires customized cable design and care in wire hook-up protocol to insure high signal integrity and offers up to 10 Gb/second. Power levels carried depend upon power pin and power wire size specified. The number of signal pins can be designed to accommodate multiple digital signals. Metal shells are often used to include 100% shielding from the cable to the connector.

Defense gyros and guidance systems, have evolved rapidly with the development of solid state electronics. MEMs, (microelectromechanical systems), have provided more accurate and less vibration sensitive methods for controlling device attitude in space and travel. A family of highly accurate ring laser gyros, (RLGs) that use light wave phase shifting for position references, still fills much of the industry but do not fit as well in today's rapid shift to higher speeds, lower weight, smaller diameter devices. The smaller solid state MEMs gyros employ non-moving electromagnetic ring-reference points sensing inductive or capacitive charge levels that feed the positioning circuit and control the instrument in flight. Manufacturers of these devices have significantly improved gyro performance through wide range of temperatures experienced in high altitude and space travel as well provided systems less sensitive to vibration and shock. Similarly, inertial guidance systems for ballistic systems use high density, electronic systems that reduce the need for optical and heat sensors sweeping the sky for target detection and tracking. As phased array signal transmission and reception methods are developing the front end controls for missiles and drones are smaller, more accurate and also less sensitive to shock and vibration. Highly miniaturized cable and connector systems designed for extreme temperature and vibration are designed specifically to serve these systems. Planning for the high speed data rate and directional corrections needed require the best of miniature signal integrity interconnects.

Military Robotics, are often used in remote battle situations in an ever widening array to analyze, predict, report and deliver. Many of the ground robotic connectors for military and aerospace applications require the combination of low weight and extreme reliability when exposed to shock and vibration. Special pin and socket systems using spring beryllium copper or twisted steel are used to retain constant contact during these events. In addition, each pin/socket set must be plated with nickel and then gold to help retain contact reliability over long exposures. Test specifications are defined to qualify and insure reliable performance. In addition, many applications will require metal back shells and braided metal shielding over the cable to prevent both damage and EMI, (electromagnetic-interference shielding). As signal speeds increase and as more electronic packages are crammed into tighter spaces, this is becoming more and more critical.

Adapting today's connectors to new military and aerospace requirements has become serious process that goes beyond our older "quote-a-spec" method of the past. As seen in the wide range of applications above, one connector design, size and shape does not fit all! More often, the designer must review the combined details of electronics, mechanical use and survival to adapt connectors to fit and perform in a more advanced technology. Requirements vary from mobile instruments, ground troop electronics and even military space systems. This process of configuring connectors to application-specific functions, often begins with a review of the equipment it will be applied to. Standard and COTs connectors can be considered and analyzed to find a close fit to the new application. During early stages of design, COTs connectors can be used in prototype circuits and save time and cost of development. There are significant advantages when the COTs or even small changes to the COTs connectors will suffice. Connectors with previous military quality of materials and processes can shorten the design cycle time and give early expectations of longer life and performance. When changes in shape or size, are required, a solid model of the new design can be quickly completed by the connector supplier and sent to the system design team. This can begin an on-line work session that also helps to get the design right early in the process. After design completion, connector fabrication can be transferred directly to smart tooling machines.

Planning for the cable as signal speeds increase, can be very critical. Higher speed differential signal processing pushes the limits of standard cables in our industry. Signal length, attenuation, and skew of differential signals must all be planned, prescribed and attended to in the cable design. In the past, we planned for the resistance and potential cross-talk of signals within a cable. Now, we must prepare for high speed different electron propagation delays, inductive reactance and learn new ways to prepare and test the cable before it is attached to the connector. Some methods are evolving by use of TDRs,(time delay reflection) instruments and or by sending complete signals down the new cable and reviewing eye diagrams that exhibit noise, jitter and skew of the signal as it actually runs through the cable.

Final electrical and mechanical testing can assure good performance of the completely assembled connector to the cable harness. Field-proof testing and certification, will require building enough of the products to run the group through combinations of mechanical, environmental and signal integrity performance. Shipping new cable and connectors for military equipment has become a detailed and important step. The supplier must remain critically aware of the many new expectations of the connector systems of today and tomorrow.