INCREASING DENSITY IN DEFENSE ELECTRONIC SYSTEMS

Omnetics Connector Corporation

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Defense development technologies and strategies are locked into an international race for dominance, control and security protection. Effective EW (electronic warfare) systems are dependent upon staying ahead of competitive nations in controlling and protecting data acquisition, information processing, and transmission within the battlefield arena. High speed digital security and control have become paramount in the utilization of satellite systems such as GPS and LIDAR geophysical mapping. SOCOM (Special Operations Command) and the DOD (Dept. of Defense) have initiated studies and directives for technical advancements in data processing capacity, signal speed, cyber protection and anti-jamming technologies. DIIG (defense industrial initiative groups) and similar teams are working through options to support both the urgency and the multiplicity of proprietary systems that will support new defense strategies and tactics for the future.

As digital data volume and use grows, new collection and transmission devices must be developed. Established defense purchasing and development systems had depended upon QPL approved components and equipment that required extensive time for certification. Military level COTs devices were then adapted for use when shorter time frames and products had established performance records. More recently, designers have been able to use OTA (other transaction authority) approvals to expedite new defense circuits and devices into use. A large change in individual device or component development and selection comes with DOD focus on the testable reliability. Components and other discrete devices must be proven to function reliably and work well within a complete system called "C4SIR". The C4SIR components include focus on "Command, Control, Communications, Computers, Surveillance and Reconnaissance". The new systems must be coordinated and perform well with multiple defense devices and subsystems as well as, being program adaptable in the field.

The newer high-speed circuitry can be potentially vulnerable to electrical noise and intrusion from cross-talk coupling within the device. In addition, system designers should consider signal immunity if the application will be exposed to environmental items like radiation. More common concerns include EMI (electromagnetic interference) sensitivity and intentional cyber-attack. As signal speeds increase, the one-quarter wavelength of each signal is shorter and can more easily couple or cross-talk with adjacent signal systems. Wiring circuits can be penetrated by outside signal noise entering into them through gaps in cable shielding or metal housings. Signal errors and noise from RFI (radio frequency interference) will result. In some cases, the

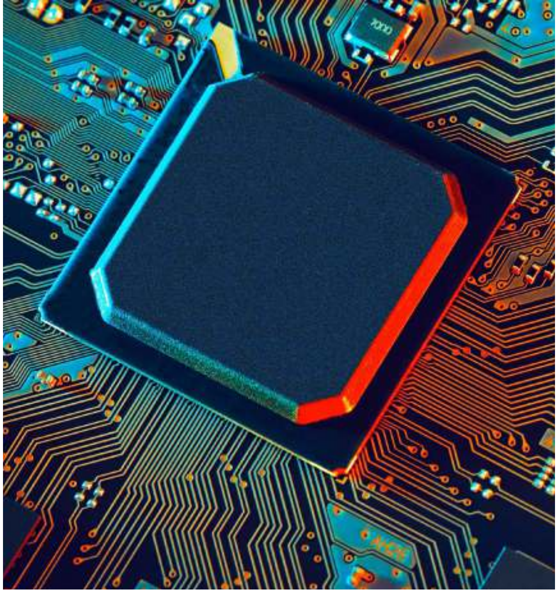
Aircraft weapon Firing System

internal circuits must also be checked to insure proper shielding and grounding required will prevent emission from its own noise and affecting the remaining electronics within the instrument.

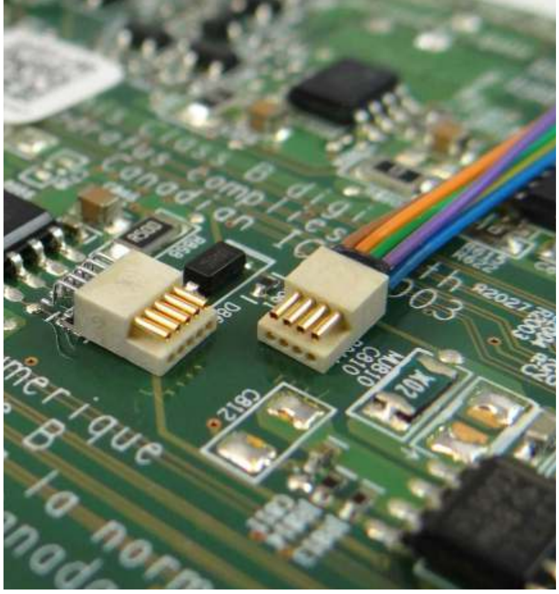
Coordinating both mechanical and electrical designs for advanced circuitry becomes critical when increasing density, signal speed, ruggedness and cyber protection. In some cases, the main operating system is mounted inside the mobile instrument and is exposed to high shock, continuous vibration and external environmental conditions. Many applications include sensors and activators that are extended beyond the inner frame or portion of the main operating system.

Fortunately, densely packed systems have a new solution that can be integrated into designs in coordination within existing design techniques. Rather than connecting multiple systems into a complex printed circuit stack or module, designers can now use advanced chip and sensor devices that offer total circuit functions on one chip. New chip families are built to process complex signals needed in defense electronics. These advanced chips are rapidly increasing signal processing speeds within embedded systems by combining multiple functions within each chip. The results of circuit size and weight reduction are combined with increases in data processing and storage. New signal modulation and anti-jamming methods are more easily employed as well. These new multi-function chips and circuit modules directly support high mobility circuits for unmounted soldiers, robots, and small satellite constellations operating at the LEO level.

In the past, we typically used analog readout chips to collect photodiode current levels and convert them into digital information. This requires time to send the signals from the readout through a separate A to D convertor and then transmit the signal. A modern example of new chip design is exhibited in the DROIC chip system. Referenced by BAE, "Fast Labs", the circuit replaces the separate A-to-D (analog to digital convertor) by including it within the ROIC chip. The new DROIC (digital-read out I.C.) can also reduce noise and increase digital signal integrity, all within a single-chip module. In addition, higher speed digital read and processing chips are being built with CMOS and GaN (Gallium Nitride) materials that help increase signal integrity up in the 10 Gbit/sec. ranges. Newer MEMs (micro-electro-mechanical systems) chips have enhanced the usefulness of transducers in autonomous and Inertial sensors. Hypersonic defense



Advanced Chip on Board



PZN Connectors

munitions are designed for flight speeds above Mach 15 (in the range above 11,000 miles/hour). Position and direction control tracking for these missiles and autonomous weapons is critical and must also avoid deterrence from unwanted cyber interference. High speed signal management is critical.

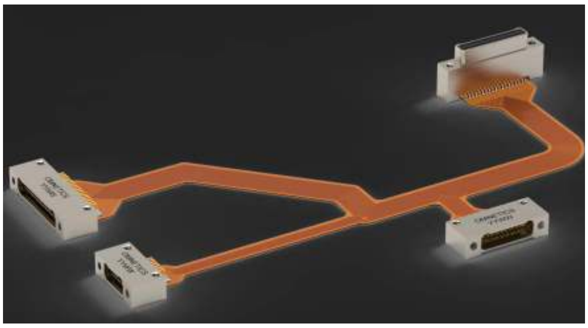
Military satellite designers are coordinating LEO, small satellite constellations with highly referenced satellites at medium to higher orbits. LEO devices are closer to earth surface and benefit with high signal levels on the ground, but can coordinate with higher level units for best position accuracy and long range geophysical mapping and planning. Surveillance and geo-mapping capability using triple-layer CMOS imaging designs supply full color imaging at low energy cost and power. Today's solid-state chips operate on much lower power and voltages while driving high speed signals operating on complex modulation transmissions to protect the signals. In this case, RF signal management, modulated digital formats and signal targeting requires aiming and positioning beams to help maintain contact with each satellite. The military satellites require high reliability while being exposed to external environments, ruggedized longevity, and continuous performance with the minimum physical size, lowest weight and highest signal processing capability, storage and transmission possible.

Connectors and cable perform a large role in meeting increased density requirements of the defense systems mentioned above. As size and flexibility of numerous interconnection systems are crucial to performance, designers must include reduced wire diameter and connector sizes. Military standard Nano-D connectors have been developed and exhibit proven performance to Mil. Std. 32139 for use in high density, lower voltage and current based systems. Nano-D connectors are designed for high reliability and to remain working in portable activities and extreme environments. Most Nano-D connectors evolved from experience with the larger micro-D connector designs. The micro-D helped establish reliability and performance standards but were used for higher current levels on physically larger circuits. A smaller Nano-connector design employs a 17,200 KSI beryllium copper "spring pin-to-solid-socket" designed to insure signal integrity during use. Higher speed nano interconnections can easily handle increased speeds with lower voltages. signal speed increases and the wave-length of each signal is shorter, vibration and circuit noise is suppressed inside the nano-metal shell and back-shell system connected to a shielded cable. Nano-D connector pin-to-socket resistance is kept as low as 12 to 15 milliohms with a capacitance of 2.0 pf to 2.4 pf. Since most circuits have low current flow and low voltage this fits ideally. With increasing speeds capacitive coupling is also controlled by adjusting the nano connector insulator spacing to match the specific needs of the application. Low skew cable technology is also evolving to match the cable performance to the needs of higher switching and signal speed interconnects. Based on a pitch (pin to pin spacing) of 0.635mm (.025 inch), these devices are only a quarter of the volume and have 80 per cent less mass than the larger Micro-D connectors. Nano-D connector metal shells are constructed of aluminum alloy 6061 and nickel plated to specification AMS-C-26074.

P.C. Board/ Nano-D Connectors

Insulators are molded of LCP per Mil. -M-24519 from Ticona E-130i that yields excellent thermal properties from -50 degrees Centigrade to plus 200 degrees Centigrade. Connectors for space technology use only low outgassing polymers, but also include PTFE insulated wire and cable certified for Space Applications.

Additionally, low profile PZN connectors have been added to military applications for high density mating to printed circuit boards and on board to board interconnects. Using Nano-D military elements within a new format, provided an easy and low profile fit to many new high density circuit applications. Shock and vibration performance in the pin to socket systems are proven effective and the design includes light weight polarized connections. Flex cable on polymer ribbon has also helped keep weight and size down when routing signals from one module to another. High density is again achieved by using the flat and flexible circuitry connected directly to nano-pitch connectors and PZNs. Reliable flex cable is currently performing on many soldier mounted weapons, helmets and display systems. Nano-D and PZN connectors are an ideal fit for low weight rugged termination of the flex cable system. Pin to socket systems include the standard .635mm (25 mils.) spacing but variations are easily configured.



Flex Circuit / Nano-D Connector

Virtual design and integration of high density interconnection cable and connectors is readily available today. Systems designers can work on-line with experienced connector and cable designers to fit high density application images into their circuits. When established military standard connectors may fit the solid-model of a current connector is overlaid or inserted into the system image to insure it fits. If new shapes or sizes are needed they can be quickly addressed. Variations can include mixed signals to include power and signal within one connector, as well. The interactive solid-model

Nano-D Connectors

Solid Model Design

is built by the two designers working together on line. When the new configuration looks promising, a 3D model is made and shipped to the designer for a final review. This process can require two to four days to accomplish.

Today's high density circuitry is rapidly available and can assist in the race for EW readiness and supremacy. Miniature connector and cable systems are ready to fit within these new technologies today. Omnetics has worked directly with and supplied many military teams in the U.S and throughout the world for over 30 years.

See Omnetics online at www.omnetics.com or call the sales team.

References:

1. *SOCOM – data; United States Operations Command – Mil.Com Network*
2. *DIIG – Defense Industrial and Initiative Group - DIIG Website on line.*
3. *CSIS - Center for Strategic and International Studies – website online.*
4. *BAE Fast Labs - "Advanced Technology and Defense R&D site"*
5. *Cobham – Advanced Electronic Solutions, Arlington, VA – web line*
6. *Brookings review paper with info drawn from Michael E. O'Hanlon, The Senkaku Paradox*
7. *Mission TX – Communications Circuit Board*

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