BOB STANTON, DIRECTOR OF TECHNOLOGY
BRET NEWTON, BUSINESS DEVELOPMENT
MAY 2022

Nano Connections in Phased Array Beam Forming of Laser and Antenna Systems

Information collection and transmission systems are undergoing significant upgrades to accommodate the need for focused higher transmission speeds and massively increased digital information.

Satellite constellations orbit the earth to monitor device position as well as track motion and speed of vehicles to supersonic missiles. Surveillance imaging, communications and data analysis are often needed at remote ground control command stations as well as for aircraft and ships offshore. These needs have been somewhat accomplished by using older antenna systems and more modernized multiple-antenna groups controlled and coordinated by a central processing unit. However, these stations are not always mobile and difficult to insure accuracy in coordinating position tracking.

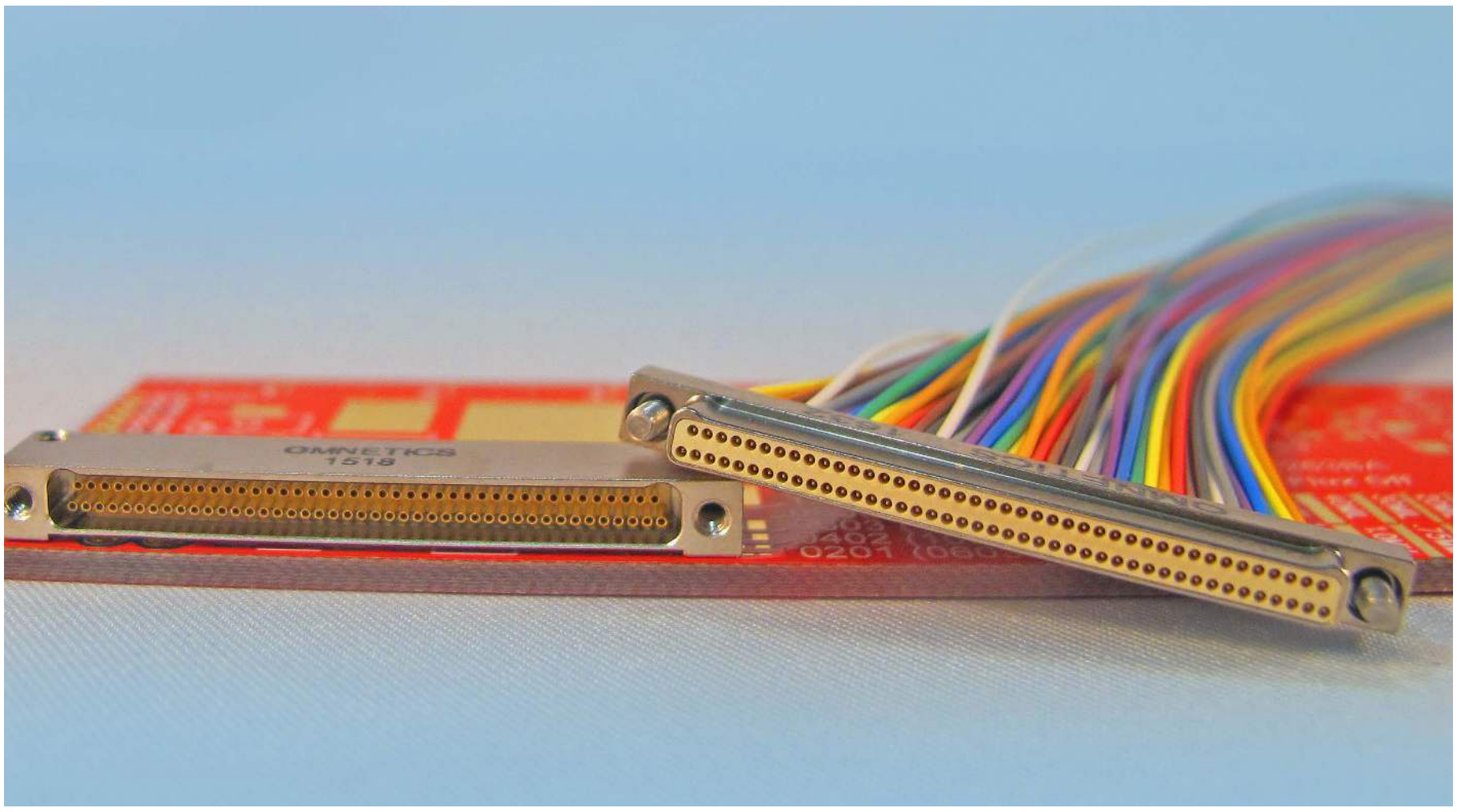
Old antenna and transmission system can be portrayed with a simple story. A person could throw a rock into a pond and ripples will expand in a broad circle around its impact. As the rock hit the water's surface a uniform wave expands outward. Early radar and antenna use this principle to send electromagnetic waves out from an antenna. When the waves hit some object a return wave responds back to antenna, showing where the object is on the circle. This works today and is used where the applications fit. If a person were able to throw multiple rocks into the water in a pattern, they would see a much different ripple moving away from the impact.

Beamforming is similar to firing multiple rocks into the pond with the specific purpose of controlling the ripples and condensing them into a stronger single direction. Phased array radar and antenna use this method by sending multiple bursts of radiation from an antenna, in a controlled sequence, from a number of transmitters, each at a slightly different electrical phase shift and time delay. This provides a more concentrated beam in both direction and control of the signal sent out from the system. The method is often called "constructive beam interference". In this way, one antenna, built to handle the multiple radiation bursts of different phase-shifts can aim its beam at a target or direction without having to move the antenna itself. The electronics does the targeting and when needed the tracking of the target.

A key element in phased-array system design includes the printed circuit board and electronic pattern-layout needed to insure adjacent and overlaying of the emission triggers used in firing the radiation out of the antenna. Today's high speed and RF chip materials mounted directly onto low dielectric circuit boards have significant advantages above slower beam forming systems. Planning special positioning on the boards are required as time delays are part of the design formula for concentrating the radiation wave form as well as moving it from one angle to another. Miniature band pass filters can be used to assist in controlling adjacent circuit cross-talk and eliminate higher harmonic interference. Each firing element will benefit from miniaturized phase shift circuits that is digitally controlled whether it be used for time delay or angle. Position and distance from each firing element is critical as the electronics enters and leaves the circuit control board. Specialized connector and cable must meet the challenge of high pin counts, spaced at exactly the same

Phase Beamforming for Laser Communication

Focused Array Image



85 Position Nano-D Connectors

distance and are controlled with matching high impedance cable. High pin count Nano-D shaped connectors are solving that question very successfully. Built to exceed military ruggedness and retain high signal integrity during shock and vibration as well as environmental changes has become critical. Omnetics employs a specialized pin to socket contact system that performs above mil specification levels including shock and vibration that high pin-count phased array circuits depend upon. This contact system requires some of the lowest insertion force in the industry and ensures easy mating and de-mating for large count pin connectors. Today's modern phase array systems fit a number of pin counts, depending on the phased array application. Attached is a photo of a 85 position Nano-D connector system often used. Designs require very specific standards in spacing and conductivity. Wiring for advanced systems often use sets of 3 wire units similar to standard digital electronics of side A, side B and return. These can be specified with standard and or at 90 and or 100-ohm impedance wiring, and each set is foil wrapped to isolate each signal set from its adjacent line. Board mounted receptacles have ridged spacing standards that add to the phase shift control system from firing element to element. Metal connector back shells provide rugged assurance and are sealed to exterior cable shielding to insure against EMI and or Cyber intrusion.

Modern defense systems such as weapon-fire-control equipment benefit from precise high speed target acquisition and tracking data. Additional electronics can then predict direction and speed to calculate delay time needed for processes such as missile firing and travel time to insure on-target hits a few moments later.

Shipboard antenna systems have been simplified by adapting phased array electronics that fire phase-angled pulses to one main dish antenna from a central firing element. Satellites are using phase-pulsed array electronics to direct laser based communications from space directly to battlefield command centers. In addition, phased arrays are used to offer multiple path transmission that helps see up and around buildings as well as geophysical structures that could block surveillance. The system labeled, MIMO, for multiple output techniques is being considered for commercial phased systems delivering wi-fi deep into crowded cities.

Antenna based transmission and observation systems are rapidly changing to handle many new technologies and provide control over our radar and surveillance technologies. As those systems, the connector and wiring technologies are changing and ready to meet the demand. Multiple designs are readily available and customized or specialized designs with new materials can be quickly designed and available to the circuit designer today.

Phased Array Wiring Example

For more information:

Call us: (763) 572-0656
Email us: sales@omnetics.com
Visit our website: www.omnetics.com

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