Safer Radar to Protect Next Generation Warships

By David Rizzo

The military uses radar for many purposes, including guiding missiles to targets, directing the firing of weapon systems, and providing long-distance surveillance and navigation information. However, for the next generation of systems currently in development, the most critical requirement is the ability to successfully counter saturation attacks. Such attacks may include numerous aircraft and missiles converging from multiple directions at the same time.

To meet this challenge, very high data rates are required to track a large number of simultaneous targets. Unfortunately, the level of data quality required is not achievable with the traditional rotating or fixed radar systems in use today.

Mechanical Rotation

Radar systems are often identified by type of scanning. The most common, mechanical scanning, involves the rotation of a parabolic dish or antenna through a 360° sweep of the horizon. As it rotates, pulses of radio waves or microwaves are transmitted and bounce off any object in its path. The object returns a tiny part of the wave's energy.

These systems are not without limitations, however, providing only limited tracking capabilities. Upon detecting a potential target, the radar typically waits a second or two for an additional sweep return so that it can correlate the two echoes, extract course and speed information and start a new tracking process. Depending on the sweep rate, this wastes valuable time against an...
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Coming enemy aircraft or weapon. Mechanical-see radars are also susceptible to damage. If the servo motors that cause the antenna to rotate, or stabilize it, fail or the antenna is damaged, the radar is rendered inoperable. As a result, later generations of radar moved away from mechanical scanning toward fixed, phased array radar systems in which all movement is eliminated.

Fixed Phased Arrays

Phased arrays are composed of evenly spaced antenna elements, each of which emits a signal that incorporates a phase shift to produce a phase gradient across the array. The amplitudes of the signals radiated by the individual antennas and the constructive and destructive interference created by objects determine the effective radiation pattern of the array.

By digitally varying the signal phases and amplitudes of the elements in an array—a process known as digital beamforming—the main beam can be “steered” to determine the direction of the signal source, even though the antenna does not physically move.

Because of the rapidity at which the beam can be steered, phased array radars can perform search, track, and missile guidance functions simultaneously with a capability of over a hundred targets.

Phased array systems vary in size and complexity. For several decades, massive phased arrays have been used aboard Navy warships and are at the heart of the ship-borne Aegis combat system and the Patriot Missile Systems. Smaller phased array antennas can be built to conform to specific shapes, like missiles, infantry support vehicles, ships, and aircraft.

Although there are several ways to accomplish electronic beam steering, one such technique involves varying the phasing between elements in a fixed, multi-element array. This is typically accomplished with power dividers that emit signals of varying phase and amplitude to the antennas. As an example of the hardware improvements required in next generation systems, power dividers serve as a prime example.

Hardware Improvements

Power dividers are passive components that divide an input signal into two or more identical output signals. For phased array systems that require a range of signal amplitudes, the input signal is often altered using attenuators to vary the signals prior to output to deliver the desired signal level.

The traditional way of accomplishing this is to utilize a standard multi-channel power divider with attenuators at each of the output ports. Attenuators, however, increase the overall size and weight of the unit while drawing additional precious watts of power. The size and weight of the power divider with attenuators made it difficult to deploy on jet planes that could benefit from more sophisticated radar.

Renaissance Electronics & Communications, a manufacturer of RF and microwave sub-systems and components, has designed a power divider that splits power from 6.7 to 18.46GHz across the output ports that does not require attenuators. Operating between 1100 and 1500MHz, this 8-way divider is optimized for space constrained applications at only 8 x 5 x 0.5 in. (203 x 127 x 12.7 mm). The divider can handle 350W Peak and 35W CW.

The output signal is staggered in frequency and uncorrelated that for each output port is 18.4dB at ports 1 and 2; 12.4dB at 2 and 7; 6.68dB at 3 and 6 and 6.74dB at ports 4 and 5. The 8 output ports are each connected to a fixed antenna. The Renaissance power divider provides 39 to 40 percent more resolution and extends the coverage from one mile to several miles.

According to a spokesperson at Renaissance Electronics, the next generation of phased array systems along with advanced signal processing techniques could have significant benefits for many branches of the military. For example, higher resolution radar could be used to initiate a computer takeover in the event of a missile attack on a jet plane. Using sophisticated evaluation of the missile’s speed and trajectory millisecond to millisecond, computer-controlled micro adjustments could be used to counter the threat.

In an intense battlefield with numerous vehicles and personnel, advanced radar could be used not just to track high-speed targets, but also slow-moving targets like ground troops. Armed with this information, the enemy could have complete, real-time viability of all moving components of a battlefield.

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PCB Sales...

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Positive sales growth, the result of strong order growth in most months of 2015. Orders contracted in September bringing the book-to-bill ratio down from a 5-year high in August to a more moderate level," said Sharon Starr, IPC’s director of market research. "The book-to-bill ratio remains positive for the 12th consecutive month," she added, "which is a strong indicator of positive sales growth in the fourth quarter of this year and into next year."

IPC’s monthly PCB industry statistics are based on data provided by a representative sample of both rigid PCB and flexible circuit manufacturers selling in the USA and Canada. IPC publishes the PCB book-to-bill ratio at the end of each month. Statistics for the current month are available in the last week of the following month.

Info: www.ipc.org