HIGH FREQUENCY
ELECTRONICS

Editorial Director
Gary Breed
gary@highfrequencyelectronics.com
Tel: 608-437-9800
Fax: 608-437-9801

Publisher
Scott Spencer
scott@highfrequencyelectronics.com
Tel: 603-472-8261
Fax: 603-471-0716

Associate Publisher
Tim Burkhard
tim@highfrequencyelectronics.com
Tel: 707-544-9977
Fax: 707-544-9375

Associate Editor
Katie Landmark
katie@highfrequencyelectronics.com
Tel: 608-437-9800
Fax: 608-437-9801

Business Office
High Frequency Electronics
7 Colby Court, Suite 7-436
Bedford, NH 03110

Editorial and Production Office
High Frequency Electronics
104 S. Grove Street
Mount Horeb, WI 53572

Also Published Online at
www.highfrequencyelectronics.com

Subscriptions
Sue Ackerman
Tel: 651-292-0629
Fax: 651-292-1517
circulation@highfrequencyelectronics.com

BPA WORLDWIDE

High Frequency Electronics (USPS 024-316) is published monthly by Summit Technical Media, LLC, 3 Hawk Dr., Bedford, NH 03110. Vol. 7 No. 9, September 2008. Periodicals Postage Paid at Manchester, NH and at additional mailing offices.

POSTMASTER: Send address corrections to *High Frequency Electronics*, PO Box 10621, Bedford, NH 03110-0621.

Subscriptions are free to qualified technical and management personnel involved in the design, manufacture and distribution of electronic equipment and systems at high frequencies.

SUMMIT
Technical Media LLC

The Challenge of Top Performance in Military & Aerospace

Gary Breed
Editorial Director

Certain areas of high frequency technology are known for presenting unique challenges to the engineers who design both individual products and complete systems. Wireless networks require dealing with the complexities of multipath propagation, wide ranging signal strength and varying numbers of users. Consumer products offer the challenge of balancing cost, performance and reliability. The automotive and industrial industries require their products to work in harsh environments—physical, electrical and electromagnetic. Instrumentation has its highest emphasis on the right level of precision with consistent, repeatable measurements.

But no technology area has a greater challenge for the highest performance than military and aerospace applications. That performance must include not only the necessary electronic behaviors, but tolerance for the most severe physical environments—multiple-G force and vibration, extreme temperature variations, and pressures ranging from the crushing forces at the bottom of the sea to the vacuum of outer space. It's no wonder engineers love working on this stuff!

Military Challenges

Wide bandwidth—While jamming and countermeasures equipment (EW/ECM) has required wide instantaneous bandwidth for many years, ordinary voice and data communications now joins the bandwidth challenge. Frequency-agile radios and multi-service/multi-function radios are certainly a big part of this requirement, with the sheer volume of battlefield communications adding to the challenge—terrestrial, airborne and satellite communications are becoming part of every soldier's standard equipment.

High dynamic range—Yes, military/aerospace systems have always needed the highest dynamic range, but the need for greater performance continues to grow. High performance radar needs the resolution and sensitivity afforded by the ability to simultaneously handle weak reflected signals nearby strong signals. Techniques like passive radar extend the challenge by removing the predictability of the forward/reflected paths.

The increase in numbers of systems also contributes to the need for signal handling range. Detecting distant signals in the presence of a large

number of nearby radios without interference is a classic problem. The Navy has grappled with this issue in shipboard systems for many years, but now it applies to nearly every military radio, in all the service branches.

Robust wireless networking—This is a recent addition to the engineering challenges for the military. As the battlefield becomes more "connected," sharing data has become an essential part of communications. I saw a demo of an early battlefield network in 1995. It's a bit surprising that the current versions have the same "look and feel," but it's not surprising that it took more than a decade to complete the methods for data collection, transmission and display.

Power management—By some reports, a foot soldier needs as much as 40 watts of power. This is the person responsible for communications at the squad level—the requirement is less for squad members, but batteries are still a significant part of the weight to be carried. It's no wonder that there is a high-profile competition for energy harvesting to derive much of that power from a soldier's own movements and the surrounding environment.

Aerospace Challenges

Most of the above challenges also apply to airborne military operations, civilian aircraft and spaceborne systems. But these systems also have some unique requirements:

High data rate—Satellite communications, especially imaging systems, require wide bandwidths *per channel* to transmit high resolution digitized information. The distances involved also provide an exceptional challenge for weak-signal detection. Imaging systems also may be multi-spectral/multi-sensor, adding even more data to the total transmitted information.

Operating environment—While the high altitude and space environments haven't changed, the sensitivity and complexity of aerospace electronics has changed dramatically. Sensors have higher sensitivity, on-board computer systems are far more complex, and are self-operational with less ground-based control. These things require more protective measures in order to maintain their performance.

Military and aerospace applications remain the top challenges for engineers. Fortunately, there are great engineers who welcome the chance to find that performance!

From September 2008 *High Frequency Electronics*