

Physically Small VHF/UHF SAR Antenna

Compact, Lightweight Antenna Technology Enables VHF/UHF SAR Operation on Small UAV Platforms

FIRST RF Corporation

Technology and Innovation

Unmanned aerial vehicles (UAVs) are a critical asset to support the warfighter in the 21st century battlefield, carrying a variety of sensor systems specifically designed to collect and disseminate data to support tactically focused intelligence, surveillance, and reconnaissance (ISR) missions.

The requirement for a new ultrahigh frequency (UHF) synthetic aperture radar (SAR) antenna design for UAV platforms resulted from findings that the UHF SAR antenna systems designed for traditional airborne platforms increased mission costs when applied to the smaller UAV platforms. Prior to the development of FIRST RF's antenna technology, quad-ridged horns at 200 megahertz had been used to achieve the bandwidth product necessary. These types of horns were quite large, with typical dimensions of 36" by 36" by 72". The size of these antenna systems limited the types of airborne platforms that could accommodate the UHF SAR system, driving up the mission cost. Also, the aircraft modifications necessary to integrate a radome and aerodynamic faring for the quad-ridged horns were quite expensive and time consuming to implement.

The challenge of transitioning very high frequency (VHF) SAR technology to small, tactical platforms like UAVs lies in achieving adequate antenna characteristics (transmit and receive specifications) within the allowable size, weight, and mechanical constraints.

FIRST RF's design approach was to optimize the radiation efficiency of an electrically small (less than 8" depth at UHF frequencies) antenna by bringing it in close proximity to a ground plane (less than a $\frac{1}{10}$ of a wavelength) at the lowest frequency of operation, yet allowing it to radiate efficiently and maintain the desired pattern performance without using depth as the means to achieve broadband performance.

Design and manufacture of narrow-band antennas in close proximity to a ground plane can be quite challenging and unrepeatable, given the high Q (energy stored in a small electrical volume). The creative leap was in finding a way to radiate this energy at the lowest frequency yet maintain the pattern and performance over several octaves of bandwidth.

Under this DARPA SBIR project, FIRST RF Corporation leveraged the knowledge acquired during previous DoD SBIR-funded projects to develop ultra broadband (greater than 300:1 bandwidths) antenna projects for electronic warfare (EW) and communications systems. This allowed FIRST RF to design and develop a small, lightweight, compact, broadband, and high power/efficiency UHF and VHF airborne antenna technology that enables VHF/UHF airborne SAR systems to operate on small UAV platforms.



FIRST RF's UHF SAR antenna reduces volume relative to horn in this DC-3 aircraft.

Joint Collaborations

FIRST RF, in collaboration with primes, has developed advanced antenna and radio frequency (RF) technologies for future airborne and ground-based sensors. FIRST RF has successfully transitioned the technology developed under the DARPA SBIR project to VHF/UHF airborne SAR systems companies and airborne ISR systems integrators, including Northrop Grumman, Lockheed Martin, Sky Research, SRI International, and General Dynamics. Government customers include the U.S. Army, Air Force, and Navy; DARPA; NASA; and the Jet Propulsion Laboratory. Platforms slated for integration include the Predator UAV and well as DC-3 aircraft.

Lessons Learned

- Development of any new technology or product is a risky venture with the possibility of failure. Constant review of critical tests, measurements, and design simulations need to be shared with the customer quickly in order to provide the knowledge needed to modify development activities to increase the probability of the project's success.
- The DARPA program manager is key to supporting transition success by identifying potential integration partners and end users.
- Acceptance of a new technology component into existing platforms is a lengthy process. To move technology from the lab into the field, it is essential to develop relationships with the government and system primes early in the development cycle to confirm requirements and address opportunities for partnering and collaboration.

Economic Impact

The antenna developed under this SBIR has transitioned to the Army's Tactical Reconnaissance and Counter-Concealment Enabled Radar (TRACER) program that intends to fly both the UHF and VHF SAR systems on the General Atomics Predator UAV

platform. In addition, this SBIR program has spawned a line of airborne VHF and UHF antenna systems that will initially be used for SAR, but will also begin to be used for communications and other ISR missions.

FIRST RF has several patents and patent-pending technologies related to ultra broadband antenna technology, and they have received contracts for the qualification and production of multiple UHF and VHF airborne antenna systems. Sales growth is expected to continue to rise 10 to 20 percent per year over the next 5 to 10 years to meet anticipated requirements for FIRST RF-developed systems.

Since 2003, FIRST RF Corporation has been awarded over 30 Phase I SBIR contracts from the U.S. Army, Navy, and Air Force, as well as DARPA. Over half of these have transitioned to Phase II. Phase III funding awarded has exceeded \$1M.

About the Company

FIRST RF Corporation develops and manufactures advanced antennas and RF systems for aerospace, defense, civil, and commercial markets. Since 2003, FIRST RF has fielded over 75,000 antennas for EW and communications systems in Iraq and Afghanistan. In 2005, FIRST RF received the Army's *Top 10 Inventions of the Year* award, which started as an SBIR contract for a broadband EW antenna system for CREW systems. FIRST RF antenna systems are designed for affordability, reliability, optimum RF and mechanical performance. The company has over 40 different antenna systems in production. ■

Company Information

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