NASA SBIR 2006 Phase I Solicitation

O1.06 Extravehicular (EVA) Radios

Lead Center: JSC

Participating Center(s): GRC

This subtopic focuses on dramatically shrinking the size of the EVA radio by selecting and using micro-machined RF components in the development of a Phase 1 circuit design which demonstrates compact high Q selective devices to propose for Phase 2 to fully fabricate and demonstrate a prototype radio incorporating the compact high Q filter technology developed and demonstrated during Phase 1. This subtopic seeks proposals to close a critical technology gap in the ability to reduce the form factor and power requirements of the EVA Radio while increasing its selectivity and performance, enabling long duration human exploration while simultaneously increasing communications reliability and crew safety.

Miniature EVA Radio

Human exploration demands versatile, lightweight, and miniaturized EVA Radios to enable surface operations and increase astronaut mobility. The size, weight, and power consumption of EVA Radios must dramatically decrease to reduce overall mission costs. These EVA Radios cannot sacrifice performance for weight, power, and form factor requirements - in fact, quite the opposite. While the form factor shrinks, the performance must increase to handle the combination of voice, data, and video needed to support the complex tasks in the next generation of manned mission scenarios.

EVA Radios based on micromachined RF components eliminate the most bulky pieces - the RF components in the diplexers, preselectors, and bandpass filters. For example, most high rejection diplexers for space-based radios are almost as enormous as the modern radio package itself. Micro-machined RF elements can complement space radio technology by coupling high-performance and increased reliability with reduction in size.

Besides low spatial volume, a significant mass reduction, and low-power consumption, micro-machined RF devices are also attractive to operate as high Q components to perform frequency selectivity without mass penalties. To build and design high performance, tightly coupled, low volume space radios, compact selectivity-determining devices are a critical enabler. Most high Q filters above 400MHz, such as inter-digital filters and others involving resonant cavities, tend to be wholly mechanical assemblies whose size is generally governed by their frequency and some derivative of their resonate wavelength. By applying micro-machining techniques, the same filter assemblies employing advanced 3D packaging techniques can be "folded" in the design, which is conducive to an order of magnitude improvement in utilization of EVA radio volumetric space.
New EVA Radio Capability

The intent of this subtopic is to develop, apply and demonstrate advantages of micro-machined RF component-based circuitry that proliferate the implementation of next-generation lightweight EVA radios. Areas of investigation may include electromechanically tuned filters, 3D packaged, micro-machined RF resonators, filter configurations consisting of cantilevered structures, as well as carbon nanotube waveguide assemblies. Through application of these fabrication and packaging techniques great strides will be realized in improving functionality, enhancing performance and achieving high reliability for long duration manned space missions. Miniature EVA Radio features include:

- Dramatic reduction of mass;
- Dramatic reduction in power requirements;
- High selectivity components, reducing interference and overlap;
- High reliability through Fault Tolerant design;
- Frequency agility;
- Software defined waveforms and modulation/demodulation.

Technical Approach

The design and use of circuitry using micro-machined RF components to dramatically shrink EVA Radio form factor while increasing operational performance will be supported by investigations and trade studies selecting current and near-term micro-machined RF components, culminating in a circuit design demonstrating their use to make a high Q element. Phase 2 will harness the high Q element as a model; then design an overall EVA Radio architecture compliant with Space Transportation Radio System (STRS) embracing a fault tolerant hardware design. The tradeoffs in sensitivity, selectivity, and packaging will be investigated in the Phase 2 effort.

Commercialization Plan

By providing users with a small size, low power, high performance SDR-based radio platform, the miniature EVA radio has derivative uses far beyond the scope of space exploration. The combination of micro-machined RF assemblies and 3D packaging in the miniature EVA radio has vast implications for both future space exploration and commercial wireless and mobile radio communications:

First Responders: Interoperability among Police, Fire, HazMat, Homeland Security, and Medical personnel

Military: Soldier-centric secure communications, mode switchable on-the-fly

Commercial: Cell phones, pagers, Wi-Fi/Bluetooth/UWB radio integration