Air Force SBIR/STTR

Innovation

Air Force SBIR/STTR Innovation Story

SBIR Topic Number:
AF04-104

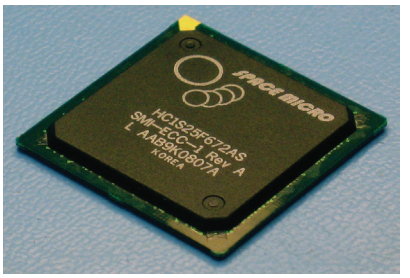
SBIR Title:
High Data Rate Error Correction

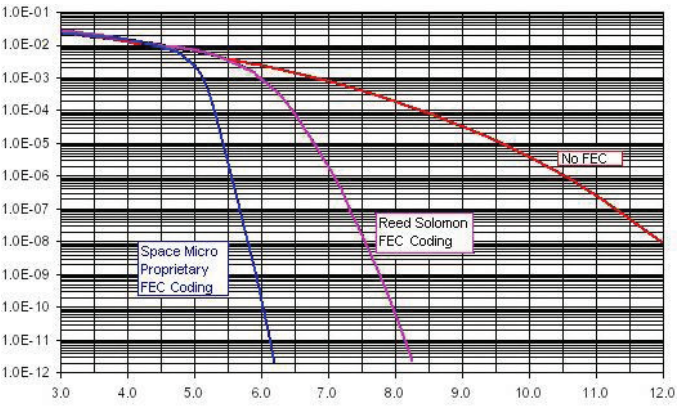
Contract Number:
FA8750-05-C-0119

SBIR Company Name:
Space Micro Inc., San Diego, CA

Technical Project Office:
AFRL Information Directorate, Rome, NY

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.





Left: Space Micro's Forward Error Correction (FEC) Chip. Right: Bit Error Rate vs. Eb/No (in dB) of Space Micro's proprietary FEC Coding compared to standard Reed-Solomon (RS) Coding.

High Data Rate Error Correction Chip

- To more effectively support laser communication on military satellites, the Air Force needs a forward error correction (FEC) chip that is radiation hardened while maintaining high levels of efficient error correction
- Space Micro developed a forward error correction integrated circuit (FEC IC) that is radiation hardened without sacrificing significant performance, which is ideal for space based high data rate laser and radio frequency (RF) communication links
- The FEC IC technology displays extremely low bit error rates, and utilizes a fully synchronous logic design with global clock enabled and either synchronous or asynchronous global reset for flexible clocking, interfacing, and system integration
- This technology is particularly flexible due to its programmability and low-power needs, making it ideal for large satellites as well as the increasing number of small and nano satellites

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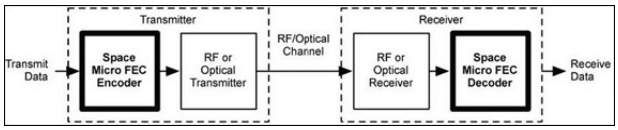
Air Force Requirement

Laser communication on military satellites will become increasingly popular, but is susceptible to higher data error rates due to high data rates coupled with atmospheric attenuation of the optical beam. Furthermore, high data rate radio frequency (RF) communication links are also prone to higher data error rates.

Therefore, a high-speed, space-qualified error correction unit is required to keep the bit error rate acceptably low on these satellites. To achieve this, the Air Forces needs a forward error correction (FEC) chip that is radiation hardened while maintaining high levels of efficient error correction.

SBIR Technology

Under this Phase II SBIR project, Space Micro developed a forward error correction integrated circuit (FEC IC) that is radiation hardened without sacrificing significant performance, which is ideal for space based high data rate laser and RF communication links. It displays extremely low bit error rates (less than 1.0E-10 at 6dB Eb/No), and utilizes a fully synchronous logic design with global clock enabled and either synchronous or asynchronous global reset for flexible clocking, interfacing, and system integration.



Schematic of the role of Space Micro's FEC IC in high data rate communication links

Space Micro's FEC IC is radiation hardened for a total ionizing dose in excess of 100krad (Si), and is immune to single event latchup >80 Linear Energy Transfer (LET). Furthermore, it automatically recovers from any single event upsets. A major reason for the FEC IC's high performance levels is due to the Reed-Solomon/Bose-Chaudhuri-Hocquenghen (BCH) concatenated code that Space Micro developed under this SBIR program.

Potential Air Force Application

This radiation-hardened FEC IC has a broad range of Air Force applications, and is designed for any space-based communication system, particularly laser and high data rate RF communication links. With the growth of laser communication, this will have a major impact on all Air Force satellites that will require error correction and detection. This includes space-space, space-aircraft, and space-ground communication links. For space-based laser communication systems, both efficient error correction and robust radiation hardness is essential.

Also, it is particularly flexible due to its programmability (8 encoding/decoding settings of the Reed-Solomon/BCH concatenated code) and low-power needs, making it ideal for large satellites as well as the increasing number of small and nano satellites. Due to its radiation hardness, it will work well for satellites in almost any orbit

Company Impact

This SBIR project has allowed Space Micro to develop and better understand error correction technology, which will be increasingly necessary on satellites as digital data rates are increased and laser communication becomes more popular. This not only applies to military satellites, but also to National Aeronautics and Space Administration (NASA) and all commercial satellites. The technology has the potential to transition into a number of defense and commercial satellite programs, including small and nano satellites. It is possible that laser communication systems will be used on hundreds of future satellites, and Space Micro will be well positioned to provide error correction systems for them.

Furthermore, throughout this project, Space Micro gained experience in developing error-correcting codes. Its proprietary Reed-Solomon/BCH concatenated code will have applications for future FEC ICs. This project also furthered Space Micro's extensive experience in radiation hardening technology for space application. Overall, this Phase II SBIR was a big step for Space Micro and strengthens its foundation for future R&D in both radiation hardening and error correction.

Space Micro is a high technology firm with a special focus on space and military applications. Founded in 2002, Space Micro is a privately held, employee-owned company, with headquarters in San Diego, California. It is a pioneer in providing radiation hardened by design solutions for advanced electronic systems and microelectronics.

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