RADIATION HARDENING OF SPACE PROBES SYSTEMS

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As the Phoenix Probe makes its way towards Mars, its core computer system microchip, the remarkable RAD6000, and many of the probe's sensitive avionics, communications and telemetric systems, sit deep inside a radiation hardening shell that shelter them from the threats that space radiation pose. Every launched satellite or space probe depended on a radiation protection environment to maintain their sensitive electronic systems on-line.

Much of the radiation near Earth emanates from our Sun. As fusion in the sun's core creates a constant stream of particles that flow in every direction from it. They move around all the solar system's bodies. These radiation particles then collide with the planets magnetic field. Some of them are trapped by the intense magnetic forces generating from the fields themselves, while others would be deflected away from the celestial body. I space away from the planets, these particles constitute the main threat to a system's electronic component. Most deployed satellites are orbiting our planet. As each one variety on orbit altitude, so does their exposure to radiation. The lowest level of radiation doses occurs in Low Earth Orbit or less than 500 km from the earth's surface. There, only a few heavy ions of radiation penetrate the planet magnetic field. In the polar areas, there are slightly increase levels of radiation caused by the Van Allen belts which permits more heavy ions to penetrate. At the geomagnetic orbit, radiation doses are a bit higher. But they are still low compare to interplanetary space. As a spacecraft made its way thru space, it will bombarded by heavy radiation ions. As the ions penetrate the craft's cover structure, they sometimes emitted deadly X-rays. These X-rays that caused the silicon based semiconductors to being the process of ionizing. The ionizing of the silicon dioxide layers in the semiconductors can cause corruption on the craft's electronic systems.

If radiation is exposed to a device such as a spacecraft on continuing bases, the radiation ions would gradually degraded. The amount of degradation depends on the amount of and the rate of irrigation. Depending on the device's anti-radiation profile and the environment on where the device will be exposed, the internal electronic system could as long as a decade or two or last only a few days in space. Electrons and X-rays produce electron hole pairs which are usually collected at the system's power supply nodes. A continuant ionization of the craft could cause eventual changes in the MIOS transistors thresholds, which will cause shifts in the electronic characteristics of the device. When there's no bias on the device transistors, most of the electron pairs will recombine near instantly, but when is a positive bias, the electrons are swept away while at the same time, the holes migrate slowly towards the negative channel, thus becoming trapped. This had the effect of causing N-channels to become easier to turn on, while P-channels are becoming harder to turn on. The exposure to radiation and the effects it can cause on a spacecraft are one of the most sensitive subjects in the design of a satellite or space probe. Engineers call this radiation assessment of electronic systems: Radiation Risk Assessment. Radiation assessment must be performed on any object launched into space. Radiation risk assessment for any electronic system include the determination of the total dose damage and SEE susceptibility of the device caused by the projected radiation environment of the spaceship. The total dose damage is a caused, in most part, by high energy protons and electrons as well as by a secondary radiation sources such as Bremsstrahlung.

In looking at the suitability of electronic systems mounted on space devices is important to determine the main radiation environment profile which the device will be subjected. The radiation environment profile varies scientifically with the orbital parameters and the solar activity level. One factor than affects the radiation environment of the electronics components inside an space device is the shielding provided by the craft's external structure as well as other composite materials interpose between the device's electronic systems and the outside environment. Thus making the evaluation of the device's expose radiation environment the first priority before the evaluation of the total dose and SEE sensitivity of the device. Total dose testing is performed by exposing the device to a bombardment of gamma rays from a Cobalt 60 source. For space applications, the recommended dose should be in the range of 0.01 to 2 rds (SI)/seconds. The applicable dose rate depends on the predicted device radiation sensitivity and the projected total dose for the mission. After the examination of the environment and the structure comes the testing of the insulating coat. Usually, the active layer of a spacecraft is protected by an insulating layer of silicon dioxide. The process of insulating a device with this layer is called Silicon-on Insulator Isolation. This method of radiation insulation or harden, completely protects the device while on space operations. It covers the device from the latch up and produces an extremely low quantity of data errors due to radiation exposure.

Current advances in radiation hardening are allowing system engineers greater flexibility when it comes to a system design. In the past, for example, it was very difficult to protect an electronic system integrated with Read-Write Random Access Memory or RAM, thus locking system designers into one program for their system on the early stages of design. Now that SRAM can be hardener, the designers are free to utilize field programmable gate arrays, which can be re-programmed during the design phase and in some cases, while the spacecraft is in operation on space. This advancement had lead to the simplification of circuitry and a reduction in the design and development cost of the systems. On missions such as the Phoenix Craft, radiation hardening plays an important part of the overall mission profile. Without it, the complete Phoenix system could not operate as fluidly and for the time span profiled on the mission description.@