

A connection diagram showing how a small computer chip is connected via gold wires to a larger packaging.

Electrical engineering

with Professor Li Chen

Talking points

Knowledge

1. What are some devices that you use every day that use complementary metal-oxide-semiconductor technology (CMOS)?
2. What is a transistor?

Comprehension

3. How does a single energetic particle physically interfere with a computer chip's functionality in space?
4. Why does Li focus on making his circuits more resilient rather than building them out of exotic materials or covering them in shielding?

Application

5. Think of a device you use daily that relies on CMOS. How might its behaviour alter if it were exposed to the same particle radiation levels experienced by a satellite?
6. "Failure is often not the end of an experiment – it is the information that leads to the next one," says Li. How could you apply this attitude to a problem that you have encountered in school or at home?

Analysis

7. How might a satellite be affected differently by the short-term, instant consequences of radiation and the gradual, long-term effects?
8. Li says that his team separates sensitive transistors and adds redundant back-ups. How do these techniques protect the chip from radiation?

Evaluation

9. To what extent do you think terrestrial particle accelerators can recreate the radioactive conditions of outer space? What other aspects of extraterrestrial environments could affect a chip's performance, and how could they be tested?
10. "You can learn a great deal from a textbook, but building something teaches you in a way that a book alone cannot provide," says Li. To what extent do you agree with this statement? How could you act on this advice to support your educational development?

Activities

Believe it or not, there are hundreds of satellites in orbit around Earth that have been designed by high-school and university students! In fact, NASA are actively seeking proposals for new educational CubeSats: low-cost, miniature satellites that are launched into orbit for educational purposes. You can find out more about NASA's CubeSat missions here: nasa.gov/kennedy/launch-services-program/cubesat-launch-initiative

Design a proposal for an educational CubeSat that makes use of the StarRISC Microcontroller and create a poster outlining your mission objective and how you will achieve it. Your mission objective should aim to tackle a global issue (tracking space debris, monitoring ocean pollution, spotting wildfires, etc.) or answer a scientific question such as 'Can plants grow in space?' or 'How does a solar storm affect a microchip's memory?'

Your poster should outline (1) your mission objective, (2) how your CubeSat will allow you to achieve this objective, (3) the specific role that the StarRISC microcontroller will play in your mission and (4) how your CubeSat's data and processing power will be protected from radiation. Make sure that, as well as displaying this information, your poster is visually engaging, clear and scientifically accurate.

Imagine that your classmates work for NASA and are deciding whether your mission will be selected. Present your poster to them and answer any questions that they might have. Based on their feedback, how could you improve your mission design and remove potential failure points? How could you better communicate your mission's objectives and design?

More resources

- Learn more about Li's work at the STARR-Lab: research-groups.usask.ca/starr-lab
- Explore NASA's Space Operations Learning Center to find out more about communications and information processing in space: solc.gsfc.nasa.gov/index.html