

Energy-efficient and cost-effective micro-modules for the Internet of Things



Overview

Development of a low-cost monitoring device for solar electric (PV). This research study aims to address existing gaps by developing a cost-effective, IoT.

Key Takeaways

Energy-efficient IoT micro-modules combine low-power microcontrollers, modular hardware, and advanced power electronics to reduce energy consumption and cost while maintaining reliable connectivity. Low-Power Microcontrollers (MCUs)

At the core of energy-efficient IoT devices are low-power MCUs, which manage data acquisition, processing, and communication with minimal energy use. Key parameters for selecting MCUs include active current per MHz, sleep or standby current, wake-up time, peripheral retention, and voltage flexibility. Efficient MCUs support multiple power modes and can operate at low voltages, extending battery life for devices that rely on coin-cell or lithium batteries. Popular low-power MCUs integrate wireless protocols such as BLE, LoRa, Zigbee, or NB-IoT, balancing connectivity with energy efficiency and cost considerations .

Modular IoT Hardware



Modular IoT platforms, like the Pico Smart Grid IoT Module (PSGloTM), provide a minimal, low-cost, and low-power hardware solution for smart grid and distributed energy applications. These modules are designed for easy assembly, open architecture, and local energy storage, making them suitable for geographically isolated communities, temporary deployments, and disaster response scenarios. Hardware modularity allows scalable integration into larger systems while maintaining energy efficiency and affordability .

Advanced Power Modules

Innovations in power electronics, such as NREL's Ultra-Low Inductance Smart (ULIS) power module, enhance energy efficiency by reducing parasitic inductance and improving power conversion. ULIS modules use silicon carbide semiconductors to achieve higher energy density, lower losses, and smaller form factors, making them ideal for data centers, microreactors, and IoT edge devices. These modules deliver higher efficiency at lower cost, enabling devices to extract more usable power from the same energy supply .

Design Considerations

When designing energy-efficient IoT micro-modules, consider:

- Power management strategies: Duty cycling, deep sleep modes, and efficient wake-up scheduling.
- Connectivity optimization: Selecting low-energy communication protocols and minimizing transmission frequency.
- Hardware-software co-design: Integrating MCU capabilities with modular hardware and intelligent control algorithms to reduce energy waste.
- Cost-effectiveness: Using open-source platforms, modular components, and scalable designs to lower production and maintenance costs .

Conclusion

Energy-efficient and cost-effective IoT micro-modules rely on a combination of low-power MCUs, modular hardware design, and advanced power electronics. By carefully selecting components and optimizing both hardware and software, developers can create IoT devices that are sustainable, scalable, and affordable, suitable for applications ranging from smart grids to remote sensing and industrial monitoring.

Article Content

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Their new silicon-carbide-based power module, called ULIS, packs dramatically more power into a smaller, lighter,

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The Intelligent Micro Module can provide simultaneous, efficient operations in order to provide the best green data center, the best

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Most recently, manufacturers have introduced the “intelligent micro module,” which fuses the Internet of Things and digital and

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This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

