Energy-Harvesting Wireless Sensor Node for IoT Networks

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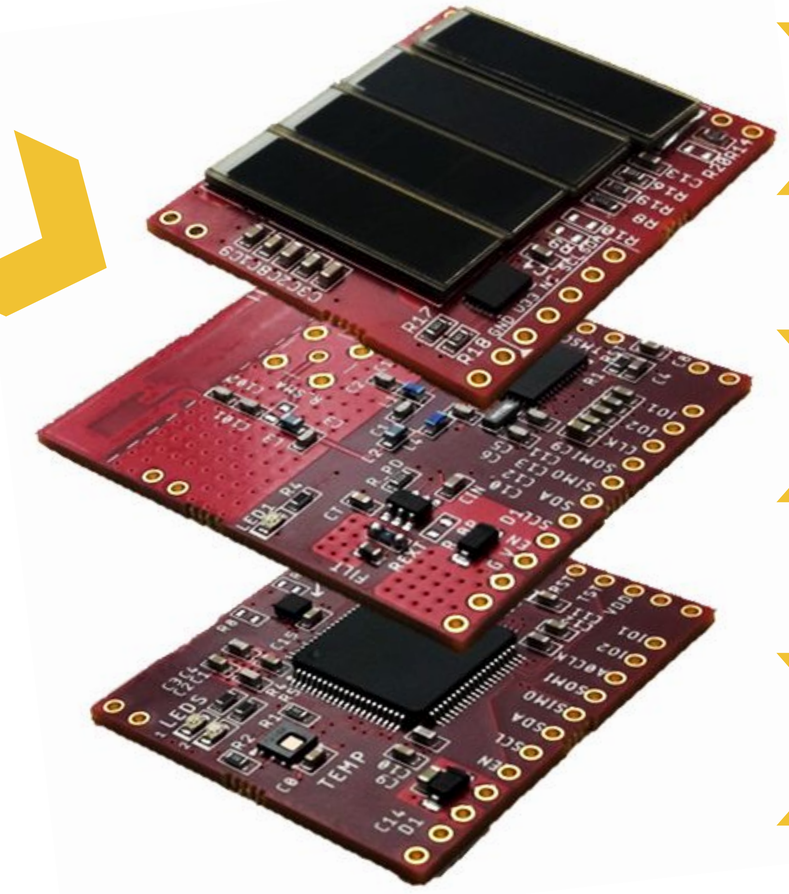
Modular IoT Node

We have created a **self-powered, modular,** and **compact** device that can easily be deployed in different environments, collect data from different sensor types, and **communicate** that data with other nodes in a **network**, all with **minimal redesign**.

Design Criteria

Criteria	Our Design	
Modularity	Distinct energy harvesting, communications, and sensing modules	✓
Self-powered	Produces >12 mW in direct sunlight	✓
Networking Capabilities	Supports wireless transmitters with <30 mA peak current	✓
Sensing Capabilities	Supports sensors with <5 mA peak current	✓
Scalable (small)	40mm x 35mm x 20mm	✓

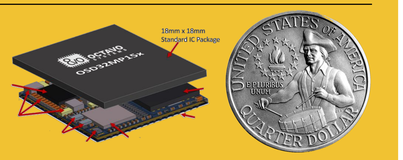
CHARIoT Node



Applications

- Industrial (VOCs)
- Health Care (Patient Vitals)
- Agriculture (Soil Quality)
- And more...

Scaling Down



The ultimate vision of this node encapsulates the entire design in a single System-in-Package (SiP) smaller than a quarter.

ENERGY HARVESTING BOARD

- 3.3 V and optional 5 V power rails
- Maximum power point tracking (MPPT) for efficient charging
- Battery charge tracking for dynamic sleep adjustment

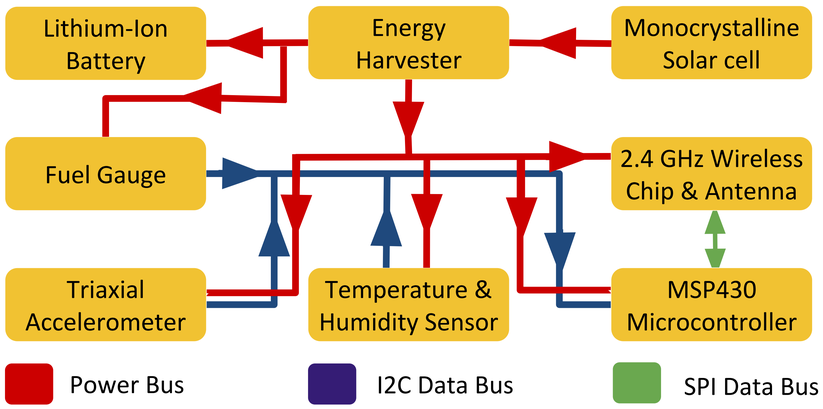
WIRELESS COMMUNICATIONS BOARD

- Adjustable 2.4GHz Transmission Schemes (Bluetooth, ZigBee, ...)
- External power control by processor board
- Optional SMA connection for higher gain antenna

SENSOR BOARD

- Multiple low-power modes
- Persistent program and data memory in case of power loss
- Support for I2C, SPI, and UART sensor protocols

System Diagram



Demonstrated Performance

Conditions	Charge Current	Time to Fully Charge Battery*	Sense and Transmit
Sunny	30 mA	5 hours	Every 3 sec
Cloudy/Shaded	5 mA	22 hours	Every 20 sec
Indoor (Direct Light)	5 mA	22 hours	Every 20 sec

*Dependent on weather and time of day

Small Footprint, Huge Potential

Our design accomplished our primary goals of **versatility**, **modularity**, and **low-power**. Future work will involve developing node-to-node network protocols, robust power management techniques, and novel programming methods for a potentially pinless package. The CHARIoT node will be compressed into a System-in-Package, rapidly customizable for a variety of applications.

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