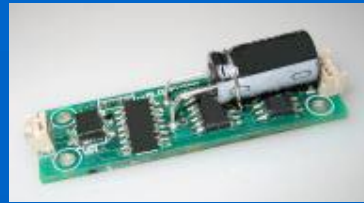




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ALD EH300/EH301 Energy Harvesting Modules

- Designed to capture, accumulate and store energy from a variety of energy harvesting sources
- Efficiently and effectively manage harvested energy to power wireless sensor networks and other applications
- For energy harvesting sources that cannot supply adequate power for any useful purpose
- Expands range of power deployment beyond AC lines and batteries





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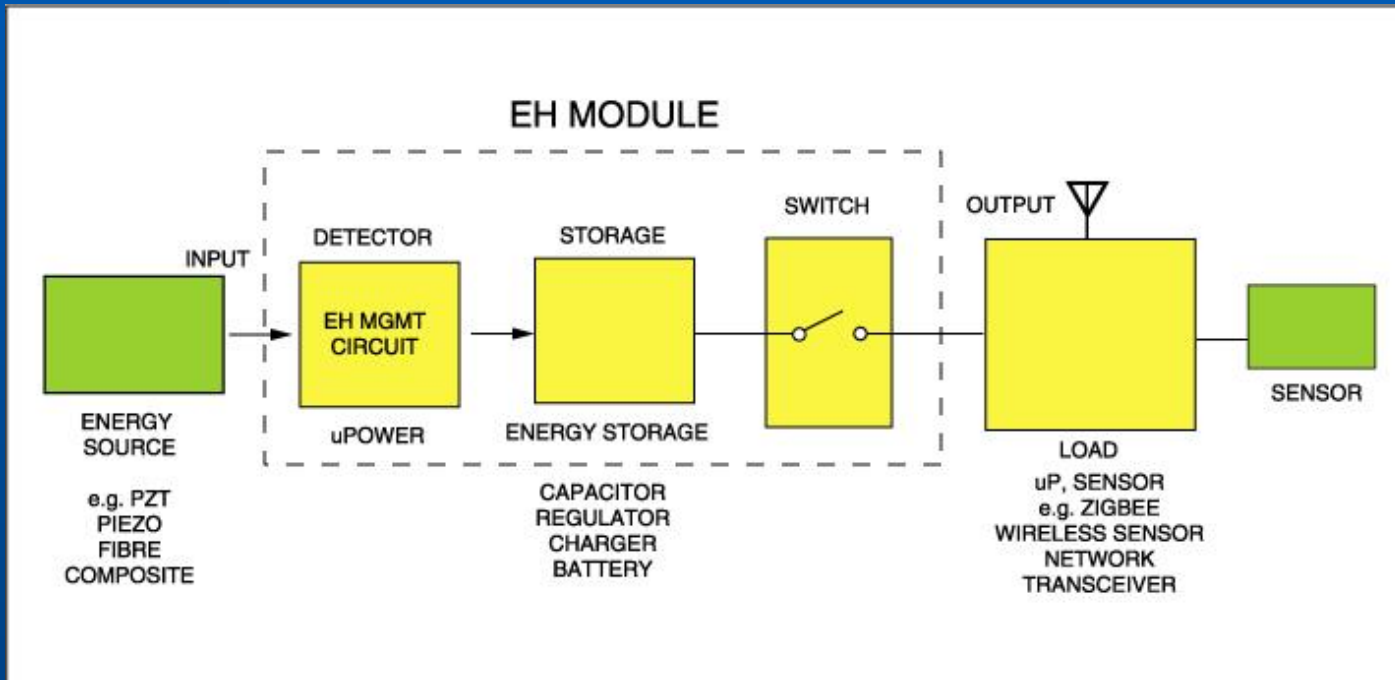
Common Energy Harvesting Sources

- **Mechanical Energy** - Vibration, Stress
- **Thermal Energy** - Furnaces, Heaters, Friction
- **Light Energy** - Photo-sensor, Photo-diode
- **Electro-Magnetic** - Inductors, Coils, Transformers
- **Natural Resources** - Wind, Water, Solar, Human
- **Other** - Chemical, Biological





EH Modules reside between source and application





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Key Features of ALD Energy Harvesting Modules

- Powers electronic circuits between 1.8V and 5V
- Completely self-powered and always active
- Begins operating at 0.0V to capture miniscule electrical impulses
- High efficiency – little energy wasted on circuit operation
- Stores and manages energy for extended periods
- Minimal leakage or loss
- Enhances system reliability
- Provides power source





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Energy Harvesting Module

Key Features

- Provides usable energy range from unpredictable source
- Internally self-powered
- High energy capture efficiency
- High energy retention rate
- CMOS logic compatible, such as μ P, WSN, ZigBee
- Projected long operating life
- Virtually unlimited charge/discharge cycles
- External storage capable





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Why Energy Harvesting?

- Increasing interest in wireless sensor networks and remote control
- Removing cables and batteries from wireless Bluetooth and ZigBee networks
- Maintenance-free, long-life operation
- Growing interest from academia, military and industry
- Reduces installation and operating costs
- System reliability enhancement





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Energy Harvesting Module

EH Applications

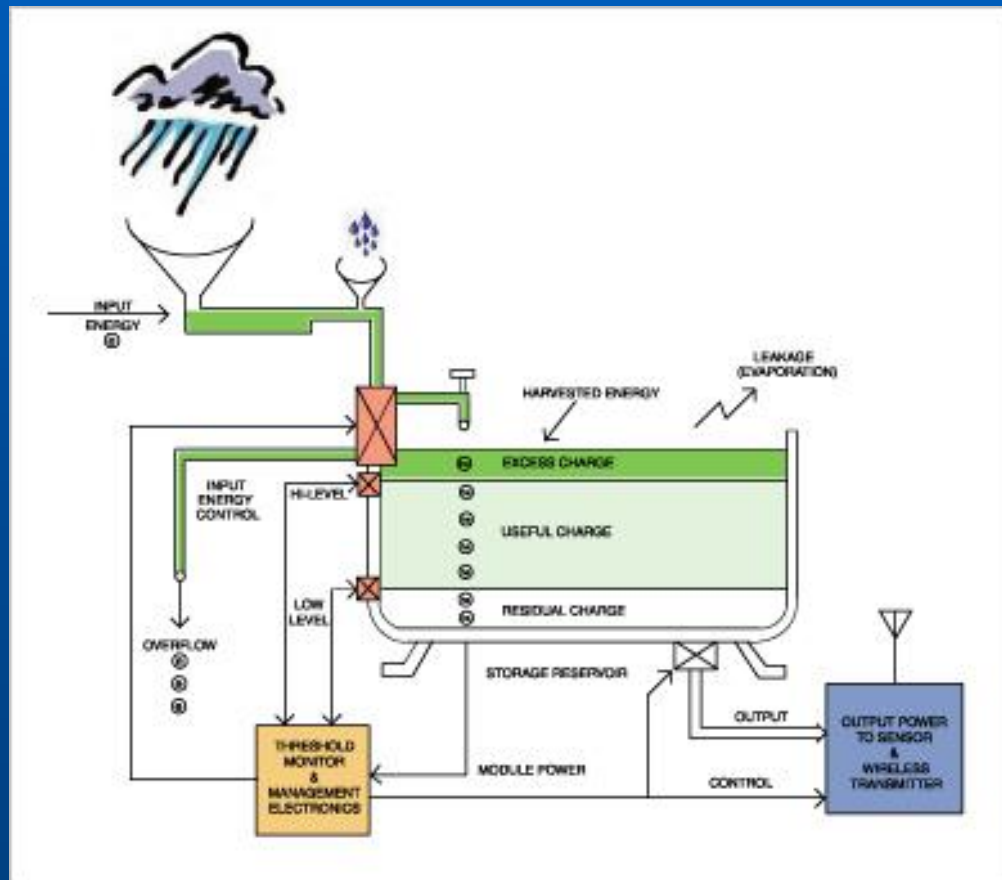
- Extreme Life Span Power Source
- Wireless Sensor Networks
- Battery Eliminator
- Condition Based Monitor
- Self-Powered Remote Control Switch
- Event Integrator/Counter
- Alternate/Backup Power Source
- Battery Charger





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Managing the flow from energy harvesting





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Energy Harvesting Module

Product Family Overview

- **Wireless Sensor Network Applications (WSN)**
- **Input voltage range 0.0V to +/- 500V**
- **Input current range 200nA to 400mA**
- **For Wireless Sensor Networks (WSN)**
- **Maximum instantaneous input voltage +/-500v**
- **Maximum instantaneous input Current 400mA**
- **Maximum input power 500 mW**
- **Minimum operational input 0.0V@1nA**





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Energy Harvesting Module

Key Electrical Specifications

EH300

- 1.8V to 3.6V operation
- Output of 4.6mJ
- Output on-time rating 68 msec@25mA

EH300A

- 1.8V to 3.6V operation
- Output of 30mJ
- Output on-time rating 75 msec@150mA

EH301

- 3.1V to 5.2V operation
- Output of 8.3mJ
- Output on-time rating 80msec@25mA

EH301A

- 3.1V to 5.2V operation
- Output of 55mJ
- Output on-time rating 88msec@150mA





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Key Features of EH Modules

- Powers electronic circuits between 1.8V and 5V
- Completely self-powered and always active
- Begins operating at 0.0V to capture miniscule electrical impulses
- High efficiency – little energy wasted on circuit operation
- Stores and manages energy for extended periods
- Minimal energy leakage or loss
- Enhances system reliability





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Energy Harvesting Circuits

NanoPower Circuit Design Considerations:

- Provide usable energy from unpredictable source
- Internally self-powered
- High energy capture efficiency
- High energy retention rate
- CMOS logic compatible, such as μ P, WSN, ZigBee
- Projected long operating life
- Virtually unlimited charge/discharge cycles
- External storage capability



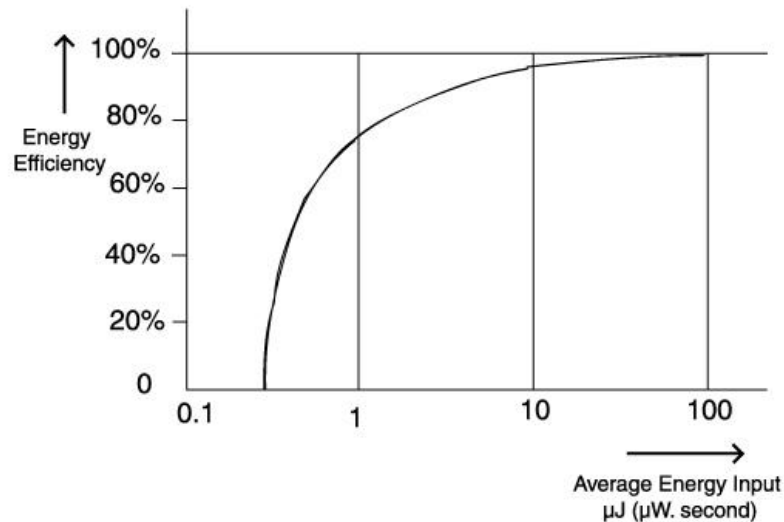


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Energy Harvesting Module

EH Module Energy Efficiency Characteristics

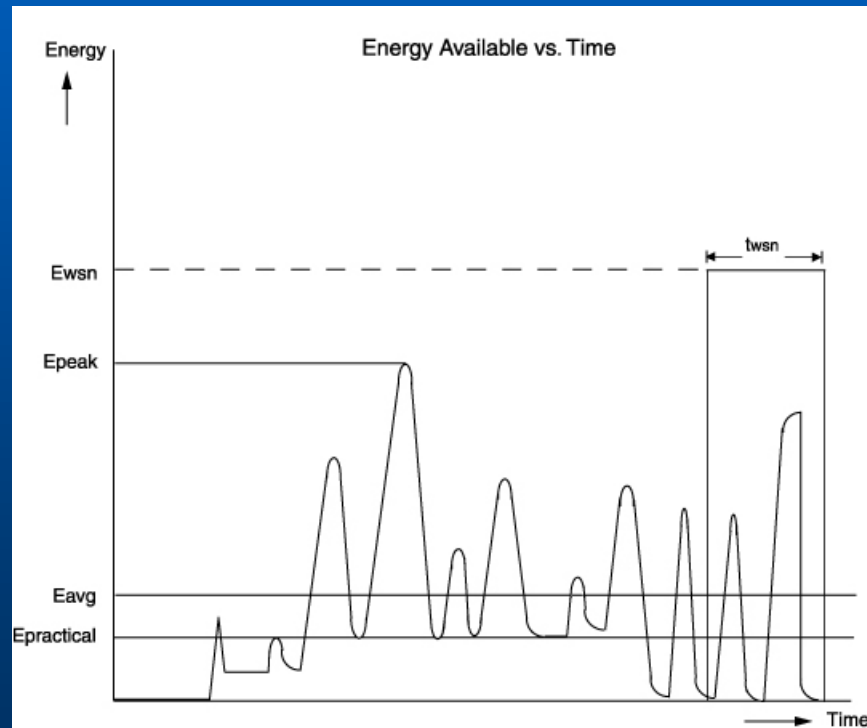
TYPICAL ENERGY HARVESTING EFFICIENCY





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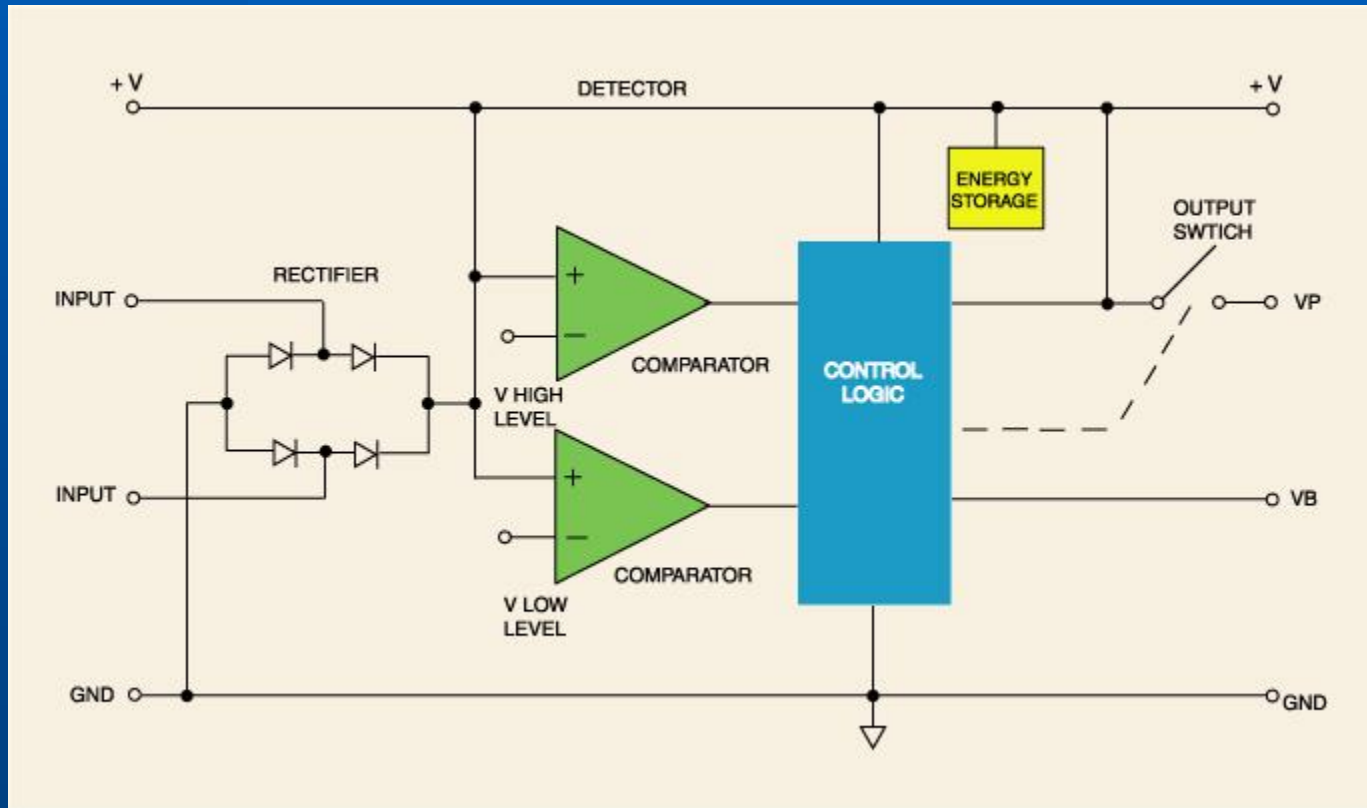
Energy Available vs. Time





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Detector Switch & Storage Module





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ALD EPAD[®] Technology

- Patented and Trademarked
- On-chip trimming and calibration
- Floating-gate MOSFET transistors
- Precision and ultra low operating voltages
- Proven EPAD[®] manufacturing
- 20 Year evolution in technology and manufacturing
- Millions of circuits shipped to date





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NanoPower Circuits

- Impractical energy sources become practical EH sources
- NanoPower EH circuits provide crucial link between source and end systems
- Intermittent duty cycle and high energy retention rate
- Energy Harvesting requires specialized NanoPower Technology
- Unique design considerations required
- Many new applications including wireless sensor networks





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Energy Harvesting Module

Summary

- **EH Series Modules**
- **Designed for ultra low power, long storage time applications**
- **Functions include energy capture, accumulation, storage and management**
- **Typical energy source include PZT in capturing mechanical vibration and strain energy**
- **Available in standard and custom versions**

