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
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
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
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 \( \mu \)P, WSN, ZigBee
- Projected long operating life
- Virtually unlimited charge/discharge cycles
- External storage capable
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
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
Managing the flow from energy harvesting
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
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
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
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 μP, WSN, ZigBee
- Projected long operating life
- Virtually unlimited charge/discharge cycles
- External storage capability
EH Module Energy Efficiency Characteristics

TYPICAL ENERGY HARVESTING EFFICIENCY

- Energy Efficiency: 0% to 100%
- Average Energy Input: μJ (μW.second)

Graph showing the relationship between energy efficiency and average energy input.
Energy Available vs. Time
Detector Switch & Storage Module
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
● 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
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