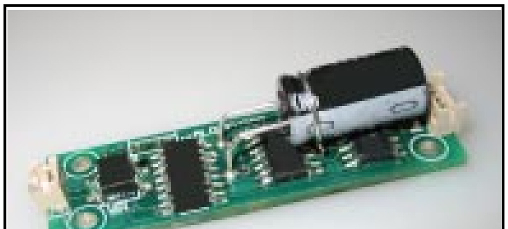
EH300/EH301 EPAD® ENERGY HARVESTING™ Modules

for low power applications

Advanced Linear Devices EH300/EH301 Series EPAD® ENERGY HARVESTING™ (EH) Modules are designed for low power intermittent duty and long storage time applications. Specific onboard functions include energy capture and accumulation, energy storage, power conditioning and energy management from various energy sources, such as solar cells, PZT piezoelectric ceramic composite elements, inductive elements and micro thermal-electric generators. EH300 Series Modules can easily adapt to a variety and wide range of voltage and power inputs and outputs. Energy can be collected from many types of secondary or waste by-product environmental sources, such as thermal, mechanical, chemical, solar, biological and human body sources.



EH300 (actual size)

Features

- Complete energy harvesting functions
- Random AC or DC inputs accepted
- Broad range of irregular input voltage, current and waveforms
- Compatible energy harvesting sources:
  - PZT, piezo electric fiber composite
  - solar photo voltaic cells
  - thermoelectric generators
- Compatible with most wireless sensor networks (WSN)
- Self-contained onboard energy storage
- Self-powered and always active
- High energy efficiency
- High energy retention rate
- Long operating life
- No calibration or setup required
- Maintenance free operation
- Simple to use and operate
- Optional external energy storage
- Optional logic input/output control
- Virtually unlimited operating cycles
- CMOS logic compatible
- Flexible output current range (0.1µA to 1A)
- Size AA battery footprint
- Moisture and dust protection

Applications

- Extreme life-span power source
- EH energy capture, storage and power management from: mechanical, thermal, chemical, solar, biological and human body sources
- Wireless sensor network remote node power supply
- EH based battery substitution and/or remote battery charging systems
- Hybrid or alternative power source conditioning
- Condition based monitoring systems
- Self-powered remote control switching systems
- Hybrid power (dual power) systems with extended operating life
- System power reliability enhancement
- Most intermittent duty cycle remote-site applications

EH300/EH301 Series Modules

EH300/EH301 Series EH Modules can accept energy from many types of electrical energy sources and store this energy to power conventional 3.3V and 5.0V electrical circuits and systems such as wireless sensor networks (WSN) using ZIGBEE standards. EH300/EH301 Series Modules are completely self-powered and always in the active mode. They can function with instantaneous input voltages ranging from 0.0V to +/-500V AC or DC, and input currents from 200nA to 400mA. Harvested energy can be collected from sources that produce electrical energy in either a steady or an intermittent and irregular manner with varying source impedances. EH300/EH301 Series Modules condition the stored energy to provide power at output voltage and current levels that are within the limits of a particular electronic system power supply specification. For example, 1.8V to 3.6V is such a useful operating voltage range for many types of I.C. circuits such as microprocessors.

EH300/EH301 Series Modules are always powered on. They are designed to continually and actively operating to capture, accumulate and conserve energy from an external energy source. Each individual EH Module is set to operate between two supply voltage thresholds, +V_low (V_L) DC and +V_high (V_H) DC, corresponding to the minimum and maximum supply output voltage values for the intended application. Initially, when an energy source starts to inject energy into the inputs of the Module in the form of electrical charge impulses, these charges are collected, accumulated and stored onto an internal storage capacitor bank. In most common energy harvesting applications, electrical energy charges arrive as electrical energy charge packets in the form of input voltage spikes in an uncontrolled and unpredictable manner. Often these electrical charge packets also arrive in a wide range of voltages, currents and timing waveforms. EH300/EH301 Series Modules are designed to accommodate such conditions with exceptional efficiency and effectiveness.

A Primer on Energy Harvesting and Energy Harvesting Circuits

Energy Harvesting (EH) is the process of capturing and accumulating energy from an energy source as energy from it becomes available; storing that energy for a period of time, and conditioning it into a form that can be used later, for instance to operate a microprocessor within its operating limits. In many common cases, EH is associated with capturing residual energy as a by-product of a natural environmental phenomenon or as a by-product of industrial processes. Often these residual energy were not previously captured, but instead were released into the environment as waste. Common target energy harvesting sources for EH are mechanical energy resulting from vibration, stress and strain; thermal energy from furnaces and other heating sources, even biological; solar energy from all forms of light sources, ranging from lighting, light emissions and the sun; electromagnetic energy that are captured via inductors, coils and transformers; wind and fluid energy resulting from air and liquid flow; and chemical energy from naturally recurring or biological processes.

In most cases, these sources provide energy in very small packets that have been difficult to capture for use. New opportunities in Energy Harvesting are being enabled by new EH circuits that can finally provide the overall Energy Management to capture and store these small energy packets and condition them to provide a useful output.

The Energy Management provided by these EH circuits need to include high Energy Efficiency to capture and accumulate these small energy packets; high Energy Retention to store the energy for long periods of time; and the proper Energy Conditioning to perform the desired task. The Energy Management must be well defined even starting at 0.0V operation and tolerate a wide range of voltage, current, and waveform inputs, including over-voltage, over-charge, and other irregular input conditions.

Energy Efficiency

The Energy Management of capturing, accumulating and storing small packets of electrical energy, requires High Energy Efficiency. The net captured energy is a direct function of energy available for capture minus the energy the EH circuit must consume to stay in the active mode. The circuit must stay in the active mode and be ready to perform the energy capture whenever harvestable energy becomes available and be ready to provide an output as the application design requires it.

For example, let's say the energy is vibration from someone walking on a surface embedded with a vibration energy source with an EH circuit and a temperature sensor and wireless transmitter. The small energy packets provided from the possibly infrequent pedestrian must power the EH circuit in the active mode for a long period of time until the EH circuit triggers the transmitter to send the temperature data. The Energy Efficiency must be very high so that the energy consumed by the EH circuit is much smaller than the small energy provided by the vibrations.

Energy Retention

A second key component of Energy Management is High Energy Retention to store the captured energy for as long as possible with minimal leakage or loss. In the example of the pedestrian, if pedestrian activity is low, it may be many hours before enough energy has been stored by the EH circuit to trigger the data transmission or many hours before the application design wants the data transmitted. Therefore, the EH circuit must have extremely high Energy Retention.

Energy Management

Energy Conditioning is a third key component of Energy Management. The EH circuit must Condition the stored energy to provide the output necessary for the desired application, such as operating a self-contained wireless sensor network node. In the prior example, the EH circuit conditions collected small packets of energy to provide the required voltage-output and current-output conditions to operate the temperature sensor and the wireless ZIGBEE transmitter.

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Advanced Linear Devices, Inc. (ALD) is a design innovation leader in analog semiconductors specializing in development and manufacture of precision CMOS linear integrated circuits, including analog switches, A/D converters and chipsets, analog timers, comparators, operational amplifiers and EPAD comparators and operational amplifiers, conventional and EPAD MOSFET transistors, Digital Voltmeter and Energy Harvesting board level products. ALD was founded in 1985 and since then it has been serving markets in the industrial controls, military, automotive, security, medical, instrumentation, and portable equipment OEM fields. ALD is headquartered in Sunnyvale, CA, with distributors throughout the U.S. and Europe.