EH4205/EH4295 EPAD®Micropower™ Step-Up Low-Voltage Booster Modules for Ultra-Low Power EH Booster Module Applications

General Description

Advanced Linear Devices EH4205 and EH4295 are the newest additions to ALD's line of Micropower Step-Up Low-Voltage Booster (LVB) Modules. These modules are designed for applications with energy sources too low to be captured by conventional energy harvesting (EH) modules. The booster modules increase the output of low-voltage DC power generators, such as photodiodes and thermoelectric generators (TEGs) to a higher AC or DC voltage that can be used by EH modules. These modules do not require an external power source to operate since they can derive power directly from such micro-power sources. The EH4200 series can operate with input power levels as low as 2μW and 60mV, making them the only devices capable of harvesting energy at these levels.

Technical Overview

The EH4200 series offer two different input impedances making them suitable for use with a wide variety of ultra-low energy generating source. The EH4205 has a nominal input impedance of 50Ω, while the EH4295 has a nominal impedance of 950Ω.

Both LVB modules feature self-starting oscillators. The EH4295's oscillator has a native resonant frequency of about 400Hz; while the EH4205's native resonant frequency is about 9kHz. The actual oscillator frequency depends on the source impedance, the source voltage, the loading at the output and the resonating components on board the EH4205/4295. Once the oscillator is running, the waveform is coupled to a transformer inside the module, which provides an AC output signal that is limited, in amplitude, by the output load.

Individual Device Parameters

EH4205

Nominal input impedance of 50Ω @ V_{IN}=0.25V

EH4295

Nominal input impedance of 950Ω @ V_{IN}=0.25V

Device Features

- Design incorporates ALD's unique, custom on-board EPAD® metal oxide semiconductor field-effect transistor (MOSFET) arrays
- A self-contained booster with all components on-board
- Integrated, on-board miniature transformer for high-efficiency energy conversion
- No calibration or setup required
- Maintenance free operation
- Small footprint and volume - less than 1 in^3
- Ready-to-use out of the box, no circuit design required
- Simple application integration - connect a 2-wire input source and connect the 2-wire output to the load
- Optional user-installed full wave rectifier on board to produce a DC output voltage
- Long operating life
- Virtually unlimited operating cycles
- Moisture and dust protection
- RoHS compliant
- Direct interface to ALD's EH300/EH301 series of Energy Harvesting Modules

Applications

The EH4205/EH4295 modules are designed for EH energy capture, storage, and power management from low-voltage, micro-power mechanical, thermal, chemical, solar, biological, and human body energy sources.

- Charge EH300 series EH Modules from low voltage energy sources
- Direct or Indirect remote-node power supplies for Wireless Sensor Networks
- Low duty-cycle metering, control and sensing networks

Applications (continued)

- Energy capture from intermittent energy sources
- Trickle-charger for Standby backup power such as battery-packs or super-capacitor networks
- Backup power for switching between different power sources
- Industrial and Business systems with always-charged temporary backup power supplies
- Micro-power self-boosting oscillator
- Low DC voltage booster supplying an operating voltage to another step-up DC-DC converter
- Extreme life-span power sources
- 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 lives
- System power reliability enhancement
- Intermittent duty cycle remote site applications

Theory of Operation

The EH4205/EH4295 Micropower Step-Up Low-Voltage Booster Modules are designed to boost ultra-low voltage and power sources that cannot be used by conventional EH modules.

At their core is an ALD EPAD® MOSFET array that was designed and developed specifically for this application. Its unique design incorporates an on-board transformer that couples to a dedicated EPAD MOSFET array, which forms the self-starting oscillation circuit.

An input decoupling capacitor is used to integrate and filters the input signal that drives the transformer primary winding core. At the same time, an input ground voltage turns on an EPAD MOSFET array through the connection of a resistor to its gate input. This creates current flow through the primary winding of the transformer and energizing the secondary. Upon being energized, a voltage develops across the secondary winding of the transformer. A small coupling resistor-capacitor (RC) network then provides negative feedback from the secondary winding to drive the EPAD MOSFET to an "off" state. This RC network then charges the gate voltage of the EPAD MOSFET to an "on" state and the cycle repeats, as an oscillator, at a frequency determined by the source generator impedance characteristics, the output loading characteristics, the parameters of the RC network, the characteristics of the EPAD MOSFET array, and the transformer. The oscillator's native resonant frequency will vary with varying input source impedance and the input voltages at the source, as well as the changing output characteristics of the output load.

The EH4205/4295 modules are self-starting. They begin operating as soon as enough energy is available to start the oscillator. For select members of the EH4200 LVB series of modules, the oscillator can start at less than 1µW average input power. The primary output of the EH4205/4295 is an AC output that can be connected directly to the inputs of an EH300 Series Energy Harvesting Module through a 2-wire connection.

While the primary intent of the EH4205/4295 is to charge ALD's EH300/EH301 Energy Harvesting Modules, an optional bridge rectifier can be added on the printed circuit board (PCB) of the module, by the user, to produce a full-wave rectified DC output. The output of the full-wave rectifier is particularly applicable as a trickle charger for rechargeable battery circuits or super-cap capacitor banks. If desired, the DC output from the rectifier can also be used to power any appropriate electronic circuit directly.

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 voltage 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 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.