

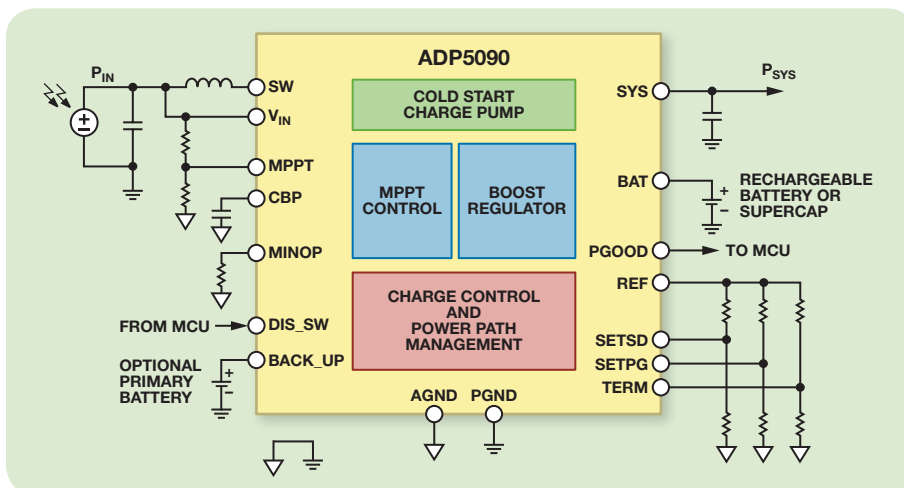
# ADP5090: Ultralow Power Boost Regulator

## Making High Efficiency Energy Harvesting a Reality



### Features

- Boost regulator with maximum power point tracking (MPPT)
- Hysteretic controller for best ultralight load efficiency
- Ultralow quiescent current
  - $I_q(\text{sys}) < 350 \text{ nA}$  when  $V_{\text{IN}} > \text{MINOP}$  point
  - $I_q(\text{sys}) < 250 \text{ nA}$  when  $V_{\text{IN}} < \text{MINOP}$  point
- Input voltage operation range from 100 mV to 3 V
- Cold start from 380 mV with charge pump
- Open circuit voltage (OCV) sensing for MPPT programmable MPPT ratio for PV or TEG energy sources
- Programmable shutdown point on MINOP pin based on  $V_{\text{IN}}$  OCV level
- Energy storage management
- Programmable voltage monitor (2 V to 5.5 V) to support trickle charging battery, or supercap to prevent overcharging or overdischarging
- Optional power path management if a backup primary cell battery is connected to BACK\_UP
- RF transmission friendly with the ability to shut down the switcher temporarily via MCU communication
- Available in a 16-lead LFCSP package
- $-40^\circ\text{C}$  to  $+125^\circ\text{C}$  junction temperature range



ADP5090 simplified application diagram.

## Overview

The ADP5090 is an integrated boost regulator, which converts dc power from PV cells or TEG harvesters and both charges storage elements such as batteries or capacitors and powers up small electronic devices or battery-free systems.

ADP5090 provides efficient conversion of the harvested limited power down to the 10  $\mu\text{W}$  to 1 mW range with sub- $\mu\text{W}$  operation losses. With an internal cold start circuit, the regulator is able to start operating at an input voltage as low as 380 mV. Once started, the regulator is functional in the input voltage range of 100 mV to 3 V.

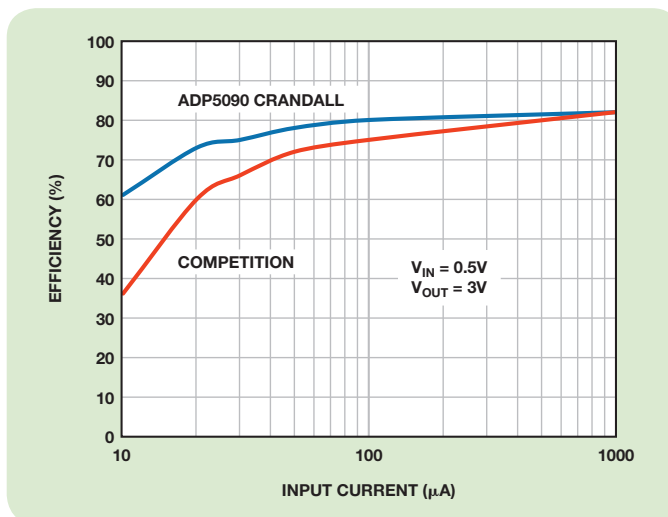
The control loop keeps the  $V_{\text{IN}}$  voltage ripple in fixed range by sensing the voltage at the input pin in order to maintain a stable dc-to-dc conversion. In addition,  $V_{\text{IN}}$  open circuit voltage sensing (OCV) and a programmable regulation point of the input voltage allow for the extracting of the highest possible energy from the PV cell or TEG harvester. The programmable minimum OCV threshold down to 100 mV enables boost shutdown during low light conditions.

The charging control function of ADP5090 includes rechargeable energy storage protection and is realized by monitoring the battery voltage with programmable undervoltage and overvoltage thresholds. Also, the maximum charging current limit is programmable.

An optional primary cell battery can be connected and managed by an integrated power path management control block with an automatic switch power source from the energy harvester, rechargeable battery, and primary cell battery.

## Features and Benefits

- Harvest and store the most energy under all conditions
- Best-in-class ultralight input power (10  $\mu\text{W}$  to 100  $\mu\text{W}$ ) efficiency; see below chart
- 250 nA quiescent current under deep sleep mode
- Maximum power point tracking with harvester open circuit voltage sensing
- Cold start at 380 mV input voltage with integrated charge pump
- Charge and manage a wide range of energy storage elements
- Support different energy storage with flexible programmability
- Intelligently manage power path for optional primary cell backup battery with fully integrated power switches
- Eliminate switching noise interference with RF transmission
- Capable of stopping switcher within 10  $\mu\text{s}$  delay to proceed transmitting data via RF transceiver without interference from switching noise



Efficiency vs. energy harvester output current.

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