Atmosic Energy Harvesting Advantage

White Paper

SUMMARY: Atmosic SoC devices combine extreme low power consumption with direct use of harvested energy to create superior energy harvesting solutions. Using the example of an energy harvesting photovoltaic remote control, this white paper shows how an Atmosic-based solution modeled over a 24-hour daily usage period stores excess harvested energy compared with a net daily energy deficit for our competition's solution under the exact same lighting conditions and remote usage.

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Acronyms and Abbreviations

Acronyms	Definition
IoT	Internet of Things
PMU	Power Management Unit
PV	Photovoltaic
RF	Radio Frequency
SoC	System-on-Chip
TEG	Thermal Electricity Generator

1. Introduction

Low-power wireless IoT applications offer an ideal opportunity for unlocking the full potential of energy harvesting. When paired with a capable PMU, various energy harvesting methods can be utilized to create new products with improved sustainability and performance. At the application level, this combination can mean extending the life of a standard battery, seamlessly recharging a battery that will never have to be replaced, and in some cases, even eliminating the need for a battery altogether.

Whether using a photovoltaic cell, TEG, RF energy captured with an antenna, or mechanical harvester there must be a match between the amount of energy that can be captured and the needs of the application.

The Atmosic solution combines an industry leading ultra-low power wireless connectivity SoC with an enhanced power management unit capable of managing harvested energy. This integration offers significant advantages when compared to a traditional solution. This white paper will highlight the differences between a traditional energy harvesting design and demonstrate how Atmosic's integrated approach offers a superior overall solution

To take full advantage of the harvested energy, a low-power wireless application needs to be capable of the dynamic and adaptive management of both energy usage and energy storage. This white paper describes the Atmosic approach to providing ultra-low power wireless connectivity and energy management with an integrated PMU versus the traditional external PMU two chip solution, using the PV Remote application as an example.

2. Traditional External PMU Energy Harvesting Solution

Traditional energy harvesting solutions require an external energy harvesting PMU separate from the wireless SoC being powered. This type of setup is depicted in Figure 1, with an external PMU delivering harvested energy to a storage element and the wireless SoC with its own internal PMU generating the required voltages to power the device.

External harvesting PMUs promote their efficiency at charging up the storage element independent of the wireless SoC and the overall needs of the application. While the external PMU may have an efficiency of 85 % to 90 %, the voltage regulation in the Wireless SoC may also be at best 85-90 % efficient, leaving the overall energy efficiency as the product of the two at 72-81 %.

It should also be noted that this two-stage approach requires additional components beyond just the PMU (such as an additional power inductor), which both increases cost and takes additional board space.

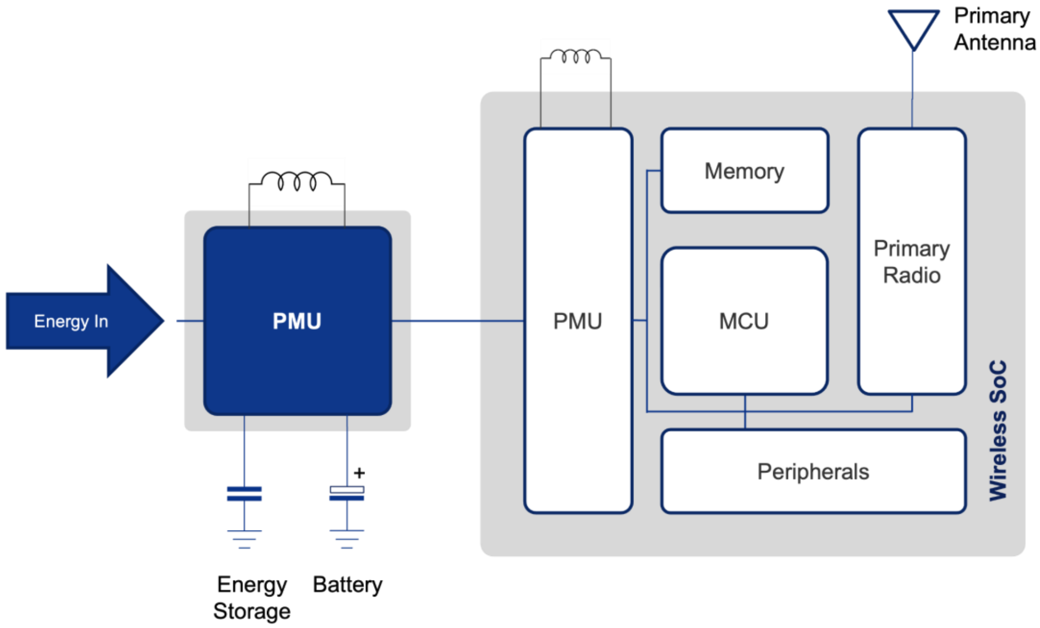

Figure 1 - Traditional Energy Harvesting Approach with External PMU

3. Atmosic's Integrated PMU Energy Harvesting Design

Atmosic integrates all of the energy harvesting PMU functions into the SoC, as depicted in Figure 2. This integrated approach combined with the lower power consumption of the Atmosic SoC creates an energy harvesting solution that is much more effective overall when compared to a discrete solution.

An integrated solution reduces the overall number of components, reducing the cost of the end product. Also, with lower power consumption a smaller energy harvesting element and storage device can be used to meet the same daily usage model compared with another solution that requires significantly more power, further reducing product cost.

The Atmosic integrated PMU uses energy directly from the harvesting source to supply the immediate power needs of the device, avoiding the losses associated with first storing the energy in a battery or super capacitor and then withdrawing the energy for use. With the Atmosic PMU only excess harvested energy is stored for later use.

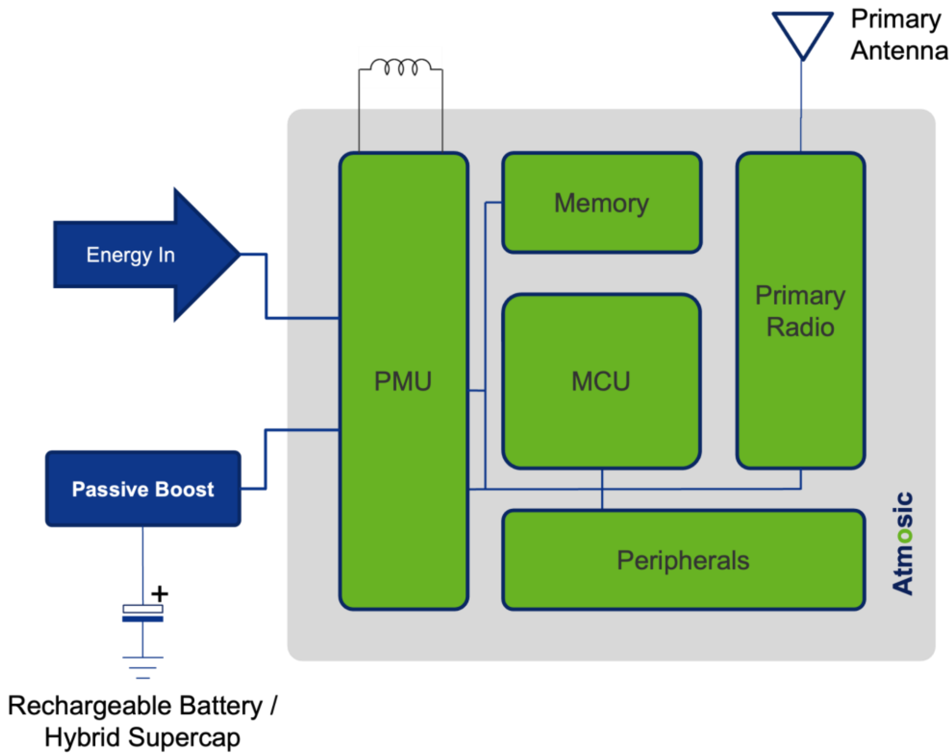

Figure 2 - Atmosic Integrated Energy Harvesting Solution

The on-chip PMU can support energy storage devices directly up to 3.3 volts and requires an external boost circuit for energy storage devices with voltages greater than 3.3 volts. This external boost circuit is bypassed when charging the storage device below 3.3 volts for a charging efficiency of 85-90%. When the boost circuit is used the effective efficiency from harvesting to energy storage is 60-66 %.

4. Example: Energy Harvesting Remote Control

The best way to see how effective the low power consumption and integrated PMU of the Atmosic SoC is when compared to the competition is to look at a real-world example of an energy-harvesting push-to-talk TV remote control.

For this example we are modeling a remote control with a 12 cm^2 PV cell capable of harvesting energy at typical residential indoor light levels between 0 and 400 lux. The lighting profile used assumes only a few hours of relatively bright light (400 lux) and no light from 9 PM until 6 AM the following morning. The remote is being used for 10 hours per day, with 500 daily button presses and 20 voice searches, modeling a heavy amount of daily TV viewing.

The model incorporates the lower power consumption of the Atmosic SoC with direct use of harvested energy at 80 % efficiency and storage of excess energy at 66 % (V >3.3 V) to 80 % (V < 3.3 V) efficiency.   A discrete solution is modeled with higher power consumption and 90 % efficiency to energy storage. The actual use efficiency from harvesting is modeled at 67 % due to the conversion loss from the battery to the SoC supply voltages.

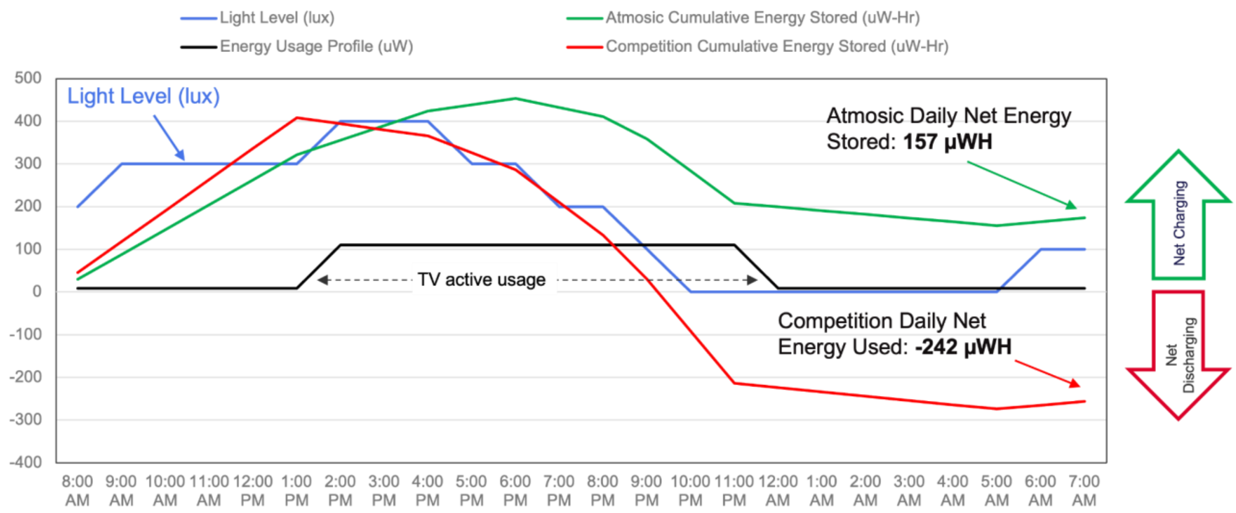

Figure 3 - Daily Usage Modeling of a PV Remote Control

5. Summary

The differences between the two solutions is summarized in the table below. As has been demonstrated with the PV harvesting remote control example, the integrated Atmosic solution gives superior performance to a discrete solution.

Atmosic Integrated Solution		Discrete Solution	
+	Operates directly from harvested Energy	-	All harvested energy stored before use
+	Prioritizes the use of harvested energy over stored energy	-	Energy always used from storage
+	Lowest application power consumption	-	Higher application power consumption
+	Lower bill of materials (BOM) for the end product	-	Additional components increase product cost
+	Smaller energy harvesting and storage elements needed to meet daily usage	-	Larger harvested and storage elements needed

Revision History

Date	Version	Description
February 3, 2023	0.51	Corrected typos.
January 18, 2023	0.50	Initial version created.

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