

XIDAS IOT

High Efficiency Energy Harvesting & Power Management Module

(EHM-UNIV-1)

OVERVIEW

The Xidas EHM-UNIV-1 is a small, turn-key surface mount module designed to capture small amounts of harvested energy from sources such as photovoltaic cells, piezoelectric, electro-mechanical and thermoelectric generators, and continuously trickle charges storage elements like rechargeable Li-Ion batteries, thin film batteries, or conventional capacitors. This module is especially useful to power small electronic devices and battery free systems.

As leading sensor manufacturers have started to introduce wireless versions of their sensors, the EHM-UNIV-1 is directly optimized for these applications. Additionally, emerging IoT companies are leveraging advancements in MEMS transducers that are coupled with edge intelligence and data analytics to provide application specific solutions. These wireless devices must balance what the edge device does with the amount of power capacity the battery can provide. Wireless sensor lifetime, or the battery lifetime, becomes the most critical portion for the Wireless IoT products, particularly for industrial or B2B applications as the cost of replacing batteries is substantial. Hence the need to incorporate energy harvesting solutions.

The EHM-UNIV-1 leverages Xidas' experience in being the leader in vibration-based energy harvesting and the company's ongoing research into other energy harvesting solutions for IoT. When utilized with the Xidas's RHB-1530 small hybrid supercapacitor/lithium battery, this provides the ideal solution for driving wireless sensors.



TECHNICAL DESCRIPTION

Input

The EHM-UNIV-1 combines a state-of-the-art power management integrated circuit (PMIC) with supporting circuitry that reduces the number of required external components, and thus development cost. As inputs, the module offers both AC or DC input pins to allow connectivity to a variety of energy harvesters available. The signal conditioning provides a direct input for DC input sources (e.g. photovoltaic cells) or built-in rectification circuitry for AC sources (e.g. electromagnetic transducers). This input conditioning and PMIC allow for energy harvesting from signals as low as 380mV. Minimal external components allow for maximum power-point tracking (MPPT) of the input signal source.

Output

The EHM-UNIV-1 provides two independent output voltages: a tunable regulated output voltage (VREG) as well as an unregulated system voltage (VSYS), proportional to the energy storage level. VREG stems from a low drop-out regulator with up to 150mA, whose output voltage can be set to nine distinct levels by a single external resistor, across the range from 1.5V to 3.6V. The system output voltage allows for even higher output current (up to 1A), protected by a resettable fuse. This output becomes ideal for wireless devices that require higher surges in current when transmitting or receiving, such as Wifi or cellular. Both output voltages can be disconnected if the system voltage falls below an acceptable value. This value, set by external resistors, defines the lower limit as well as the hysteresis threshold before resumption of power. The module provides an output monitor pin indicating the state of the output voltages.

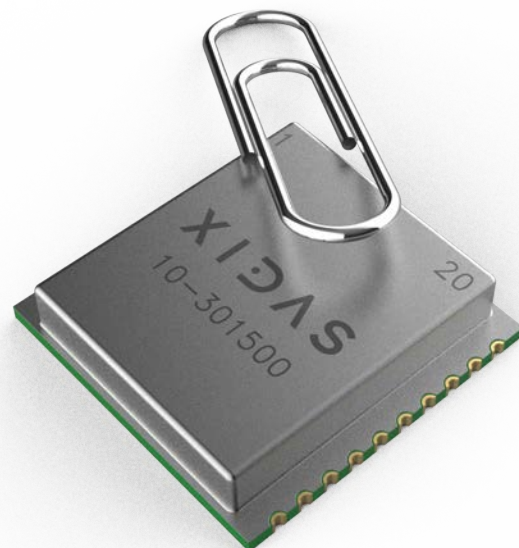
Energy Storage and Protection

The module is optimized for use with the Xidas RHB-1530, which is a small combined supercap and rechargeable lithium battery, making it ideal for wireless devices. Other supercaps or batteries can also be connected if desired. The EHM-UNIV-1 is also designed to protect and maximize battery longevity, by simply setting the ideal charge and discharge voltages of the external storage device

through external resistors. When the battery voltage exceeds the battery charging termination threshold, the boost operation terminates to prevent battery overcharging. To prevent overdischarge, a shutdown charging threshold will switch the battery and high-current system voltage output pin to the off state and boost operation is performed asynchronously. Additionally, the EHM-UNIV-1 provides an on-board charge management IC, containing constant-current/constant-voltage control, allowing the user to externally charge the battery from a single 5V input.

The module can withstand operating temperatures ranging from -40°C to 125°C, providing more versatility. In the event that the temperature rises above the rated specification, the module has thermal shutdown circuitry that will terminate boost operation and prevent damage to the energy storage unit.

To achieve optimal performance, the EHM works best with the Xidas RHB-1530 energy storage unit. This unit's combination of a lithium-ion battery and pulse capacitor has been tested to provide the maximal power delivery to most IoT devices and sensors. To get started with energy harvesting, Xidas recommends purchasing the EHM-UNIV-1 module, the RHB-1530 energy storage unit, and one of our vibration energy harvesting generators from the VEG line of products.

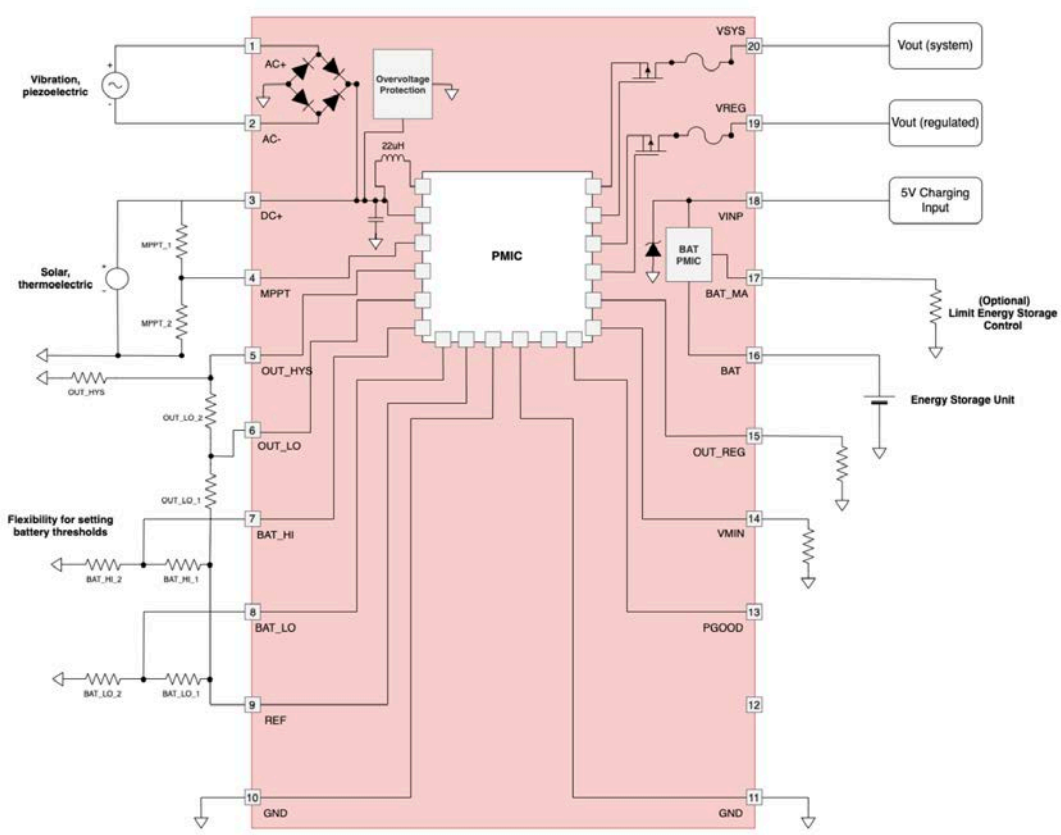


FEATURES & SPECIFICATIONS

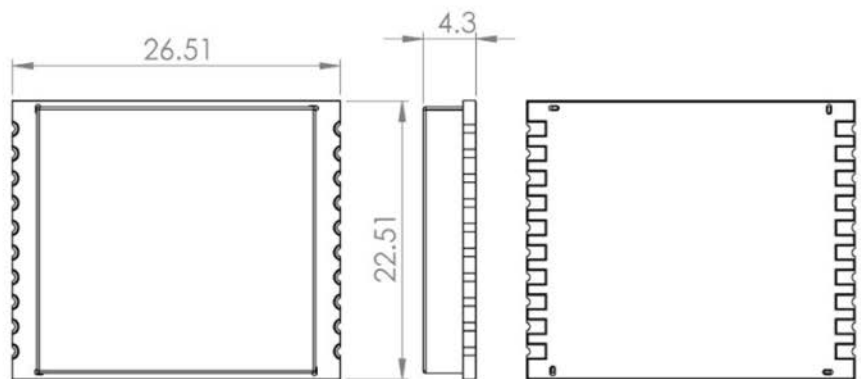
- ✓ User-selectable DC or AC input sources (with built-in rectification)
- ✓ Configurable maximum power-point tracking (MPPT)
- ✓ High- and low-current output voltages with short-circuit and ESD protection
- ✓ Over-charge and discharge protection
- ✓ Built-in charge controller for Li-Ion batteries and supercapacitor
- ✓ Compact footprint, plug-and-play design

Startup Threshold w/ Xidas HPC1530 battery	380 mV	6 μW
Maximum Input Voltage (VIN)	3.6 V	
Configurable Regulated Output (VREG)	1.5 V to 3.6 V	up to 150 mA
High current system voltage output (VSYS)	up to 1 A (protected by resettable fuse)	
Operating quiescent current	510 nA	
Sleeping quiescent current	390 nA	
Operating junction temperature range	-40°C to 125°C	
Storage temperature range	-65°C to 150°C	

EHM BLOCK DIAGRAM



Dimensions (mm)



**Example setup with the Xidas Energy Harvesting Products
(includes RHB-1530 and VEG Generator)**

Threshold Resistors	BAT_LO	BAT_LO_1=6.49 MΩ,	BAT_LO_2=3.57 MΩ
	BAT_HI	BAT_HI_1=6.34 MΩ,	BAT_HI_2=3.65 MΩ
	OUT_LO	OUT_LO_1=6.65 MΩ,	OUT_LO_2=3.32 MΩ
	OUT_HYS	100 kΩ	
	OUT_REG	Floating	
Set Minimum Operating Input Voltage	VMIN	1 kΩ	
Charge Limit Threshold	BAT_MA	20 kΩ	
Maximum Power Point Tracking	MPPT_1	4.7 MΩ	
	MPPT_2	18 MΩ	

USER CONFIGURATION GUIDE

REGULATED OUTPUT (VREG)

- ✓ Set by OUT_REG pin and resistor
- ✓ Gives user flexibility of adjusting the output voltage ranging from 1.5 V to 3.6 V and up to 150 mA
- ✓ The on-board PMIC allows eight fixed output voltage options in that range, detailed below in Table 3.

OUT_REG Configuration (Short to GND)	Set VREG Voltage (V)
Floating	2.5 V
7 k Ω	1.5 V
14 k Ω	1.8 V
27.7 k Ω	3.6 V
55.6 k Ω	3.3 V
111 k Ω	2.0 V
221 k Ω	3.0 V
442 k Ω	2.8 V

Regulated Output Voltage (VREG) Set Configuration.

It is recommended to use a large resistance value to minimize quiescent current

OVERCHARGE PROTECTION

- To prevent the connected energy storage unit from overcharge and damage, the PMIC comes equipped with threshold resistors that can be set, which are BAT_HI_1 and BAT_HI_2
- This threshold can be calculated using the following equation:

$$V_{BAT_HI} = \frac{3}{2} * V_{INT_REF} * \left(1 + \frac{R_{BAT_HI1}}{R_{BAT_HI2}} \right)$$

- To ensure quiescent current consumption is taken into consideration, the sum of the pair of resistors must be

$$R_{BAT_HI1} + R_{BAT_HI2} \geq 6 M$$

- When the voltage at the BAT pin exceeds the V_{BAT_HI} threshold, the main boost regulator disables.
- When input energy is excessive, the BAT pin voltage ripples between the V_{BAT_HI} and hysteresis levels.

OVERDISCHARGE PROTECTION

- To prevent the connected energy storage unit from overdischarging, the PMIC comes equipped with threshold resistors that can be set, which are BAT_LO_1 and BAT_LO_2
- This threshold can be calculated using the following equation:

$$V_{BAT_LO} = \frac{3}{2} * V_{INT_REF} * \left(1 + \frac{R_{BAT_LO1}}{R_{BAT_LO2}} \right)$$

- To ensure quiescent current consumption is taken into consideration, the sum of the pair of resistors must be

$$115 k + R_{BAT_LO1} + R_{BAT_LO2} \geq 6 M$$

SYSTEM OUTPUT VOLTAGE

- The PMIC allows the user to configure the system output voltage threshold at the VSYS pin
- The chip is equipped with a monitoring pin, PGOOD, that monitors the VSYS pin, which can be set with OUT_LO_1, OUT_LO_2, and OUT_HYS
- This threshold can be calculated using the following equation:

$$V_{OUT_FALLING} = V_{INT_REF} * \left(1 + \frac{R_{OUT_LO,1}}{R_{OUT_LO,2} + R_{OUT_HYS}} \right)$$

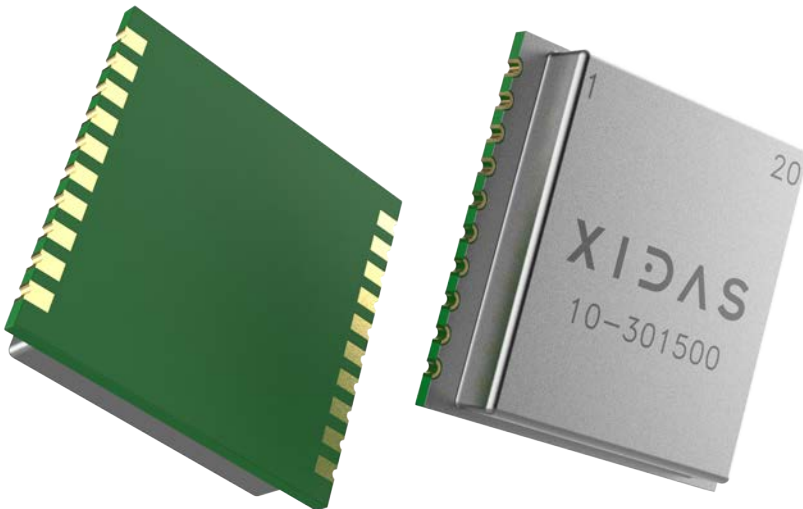
- The OUT_HYS resistor and pin can externally program the hysteresis with the following equation:

$$V_{OUT_FALLING} = V_{INT_REF} * \left(1 + \frac{R_{OUT_LO,1} + R_{OUT_HYS}}{R_{OUT_LO,2}} \right)$$

- To ensure quiescent current consumption is taken into consideration, the sum of the three resistors must be

$$R_{OUT_HYS} + R_{OUT_LO,1} + R_{OUT_LO,2} \geq 6 M$$

- The $V_{OUT_FALLING}$ threshold must be greater than the
- V_{BAT_LO} threshold.
- For best performance, use PGOOD to enable the system load.



THRESHOLD RESISTORS CONFIGURATION

Table below shows different configuration values for the voltage threshold

THRESHOLD VOLTAGE (V)	RBAT_LO_1, ROUT_LO_1 (MΩ)	RBAT_LO_2, ROUT_LO_2 (MΩ)	RBAT_HI_1 (MΩ)	RBAT_HI_2 (MΩ)
2	5	5	Not applicable	Not applicable
2.1	5.23	4.75	Not applicable	Not applicable
2.2	5.49	4.53	3.2	6.81
2.3	5.62	4.32	3.48	6.49
2.4	5.9	4.12	3.74	6.2
2.5	6.04	4	4	6.04
2.6	6.19	3.83	4.22	5.76
2.7	6.34	3.74	4.42	5.6
2.8	6.49	3.57	4.64	5.36
2.9	6.6	3.48	4.87	5.23
3	6.65	3.32	5	5
3.1	6.8	3.24	5.11	4.87
3.2	6.81	3.09	5.36	4.7
3.3	6.98	3.01	5.49	4.53
3.4	6.98	2.94	5.6	4.42
3.5	7.15	2.87	5.76	4.3
3.6	7.15	2.8	5.9	4.12
3.7	7.32	2.7	5.9	4.02
3.8	7.32	2.61	6.04	3.92
3.9	7.5	2.55	6.19	3.83
4	7.5	2.5	6.2	3.74
4.1	7.5	2.43	6.34	3.65
4.2	7.68	2.37	6.49	3.57
4.3	7.68	2.32	6.49	3.48
4.4	7.68	2.26	6.6	3.4
4.5	7.87	2.21	6.65	3.32
4.6	7.87	2.15	6.8	3.24
4.7	7.87	2.15	6.81	3.2
4.8	7.87	2.1	6.81	3.09
4.9	7.87	2.05	6.98	3.09
5	8.06	2	6.98	3
5.1	8.06	1.96	6.98	2.94
5.2	8.06	1.91	7.15	2.87

ORDERING INFORMATION

Model Number	Part Number	Description
EHM-UNIV-1	10-301500	Energy Harvesting Module-Universal

COMPLIMENTARY PRODUCTS

The EHM-UNIV-1 works best with Xidas's Rechargeable High-Pulse Battery (RHB-1530) and Vibration Energy Harvesting Generator (VEG). Here is how to order:

Vibration Energy Harvesting Generator



Model Number	Part Number	Description
VEG-20	10-301000	Designed for 20 Hz vibration sources
VEG-30	10-301100	Designed for 30 Hz vibration sources
VEG-50	10-301200	Designed for 50 Hz vibration sources
VEG-60	10-301300	Designed for 60 Hz vibration sources
VEG-70	10-301400	Designed for 70 Hz vibration sources

Rechargeable High-Pulse Battery



Model Number	Part Number	Description
RHB-1530	86000000	Rechargeable High-pulse Battery

Vibration Perpetual Power Pod (all-in-one)



Model Number	Part Number	Description
VP3-20	10-300400	Designed for 20 Hz vibration sources
VP3-30	10-300100	Designed for 30 Hz vibration sources
VP3-50	10-300300	Designed for 50 Hz vibration sources
VP3-60	10-300200	Designed for 60 Hz vibration sources
VP3-70	10-300500	Designed for 70 Hz vibration sources



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