# Energy Harvesting PMIC

## Q2 2017

## Cypress Roadmap

# Energy Harvesting PMIC[1] Portfolio

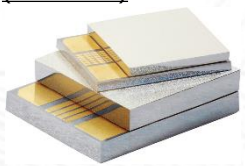
Series Solar Cell by Panasonic (AM-1801)

Single Solar Cell by Ningbo Hebe Solar (HSC125155)

Piezoelectric Device by Thrive (K7520BS3)

Electromagnetic Device by Perpetuum (PMG-FSH)

TEG by Micropelt (TGP-651)



| | Wearable<br>Activity Monitor | Residential<br>WSNs[2] for HVAC[3], Level of Light Emitted, Temperature, Humidity, Motion | Building<br>WSNs for HVAC, Level of Light Emitted, Temperature, Humidity, Motion, BLE[4] Beacon[5] | Industrial<br>WSNs for Infrastructure, Agriculture, Transportation, Factory Automation, Animal Monitoring | |
|---|---|---|---|---|---|
| | Indoor/Outdoor | | | Indoor | Outdoor |
| **Light** Series Solar Cell | NEW **S6AE101A** Linear, Power Gating[6], Multiplexer[7], 10-pin QFN | NEW **S6AE101A** Linear, Power Gating, Multiplexer, 10-pin QFN<br>**MB39C811** Buck DC/DC, Dual-Bridge Rectifier, Power Good, 40-pin QFN | NEW **S6AE102A** Linear, Power Gating, Multiplexer, LDO[8], Comparator, 20-pin QFN<br>**MB39C811** Buck DC/DC, Dual-Bridge Rectifier, Power Good, 40-pin QFN | NEW **S6AE103A** Linear, PowerGating, Multiplexer, LDO, Timer, Comparator, 24-pin QFN<br>**MB39C811** Buck DC/DC, Dual-Bridge Rectifier, Power Good, 40-pin QFN | |
| **Light** Single Solar Cell | | | | | **MB39C831** Boost DC/DC, MPPT[9], Li-ion Protection, 40-pin QFN |
| **Vibration** Piezoelectric, Electromagnetic | | **MB39C811** Buck DC/DC, Dual-Bridge Rectifier, Power Good, 40-pin QFN | **MB39C811** Buck DC/DC, Dual-Bridge Rectifier, Power Good, 40-pin QFN | | |
| **Heat** Thermoelectric Generator (TEG) | | | **MB39C831** Boost DC/DC, MPPT, Li-ion Protection, 40-pin QFN | | |

**Market Segment**

Status: Concept | Development | Sampling | Production

Availability: Sampling QQYY | Production QQYY

[1] Power Management IC
[2] Wireless Sensor Nodes
[3] Heating, ventilation, air conditioning
[4] Bluetooth Low Energy
[5] A wireless device that transmits data (e.g., signal strength and ID) over a periodic radio signal from a known location
[6] Output power control circuit that controls power provided to the system load
[7] Power source switch circuit for primary battery or Energy Harvesting Device
[8] Low dropout regulator
[9] Maximum Power Point Tracking



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# S6AE101A

## Solar-Optimized Energy Harvesting Power Management IC (PMIC)

### Applications

Series solar cell energy harvesting[1] and wireless sensor nodes[2]

### Features

- **Ultra-Low Power**
  - Enables 1 $cm^2$ minimum solar cell size for startup operation[3]
- **Input Voltage Range**
  - 2.0–5.5 V (series solar cell and primary battery)
- **1.1–5.2-V Output Voltage Range**
- **250-nA Quiescent Current[4]**
- **1.2-µW Startup Power**
- **Power Gating[5] Switch Circuit**
- **Storage Control Circuit**
- **Multiplexer[6] Circuit (battery vs. solar cell)**
- **Overvoltage Protection (OVP)**
- **Packages**
  - 3.0 mm x 3.0 mm 10-pin SON

### Collateral

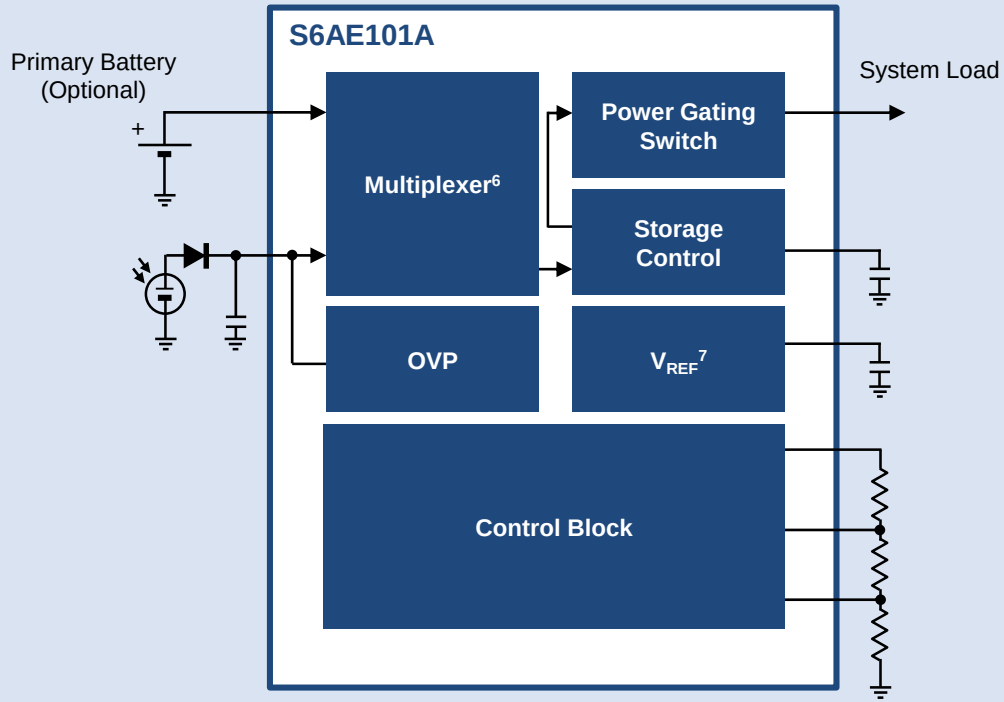
**Datasheet:** S6AE101A Datasheet

**Development Kits:** Solar-Powered IoT Device Kit

S6AE10xA Evaluation Board

**Software:** Easy DesignSim™ Software

### S6AE101A: Solar-Optimized Energy Harvesting PMIC




### Availability

**Production:** Now

[1] The process of capturing and converting tiny amounts of energy (e.g., from light, vibration or heat) into electricity
[2] A sensor-based device that monitors conditions such as temperature, humidity and pressure and wirelessly transmits that data to a control unit, such as a PC or a mobile device
[3] Estimate based on solar cell power = 2 µW/$cm^2$ at 100 lx
[4] Current consumed at no load condition
[5] Output power control circuit that controls power provided to the system load
[6] Power source switch circuit for primary battery and Energy Harvesting Device
[7] Voltage reference circuit for internal block

# S6AE102A

## Solar-Optimized Energy Harvesting Power Management IC (PMIC)

### Applications

Series solar cell energy harvesting[1] and wireless sensor nodes[2]

### Features

- **Ultra-Low Power**
  - Enables 1 $cm^2$ minimum solar cell size for startup operation[3]
- **Input Voltage Range**
  - Series solar cell: 2.0–5.5 V (series solar cell and primary battery)
- **1.1–5.2-V Output Voltage Range**
- **280-nA Quiescent Current[4]**
- **1.2-µW Startup Power**
- **400-nA Low Quiescent Current Low Dropout Regulator (LDO)**
- **Dual-Channel Power Gating[5] Switch Circuit with Interrupt Request (IRQ) Control Function for Power Management**
- **Signal Output Circuit of Power Gating Switch Control**
- **Multiplexer[6] Circuit (battery vs. solar cell)**
- **Hybrid Storage Control Circuit[7] and Overvoltage Protection (OVP)**
- **Packages**
  - 4.0 mm x 4.0 mm 20-pin QFN

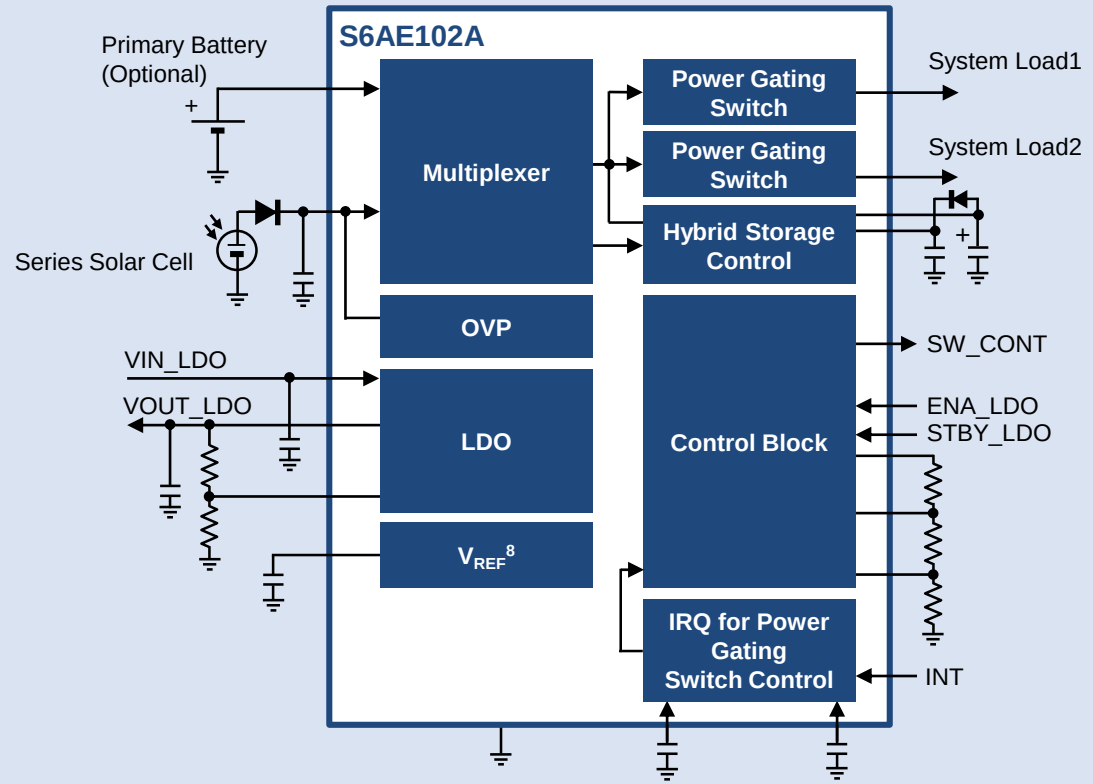
### Collateral

**Datasheet:** S6AE102A Datasheet

**Development Kits:** S6AE10xA Evaluation Board, CYALKIT-E04

**Software:** Easy DesignSim™ Software

### S6AE102A: Solar-Optimized Energy Harvesting PMIC




### Availability

**Production:** Now

[1] The process of capturing and converting tiny amounts of energy (e.g., from light, vibration or heat) into electricity
[2] A sensor-based device that monitors conditions such as temperature, humidity and pressure and wirelessly transmits that data to a control unit, such as a PC or a mobile device
[3] Estimate based on solar cell power = 2 µW/$cm^2$ at 100 lx
[4] Current consumed at no load condition
[5] Output power control circuit that controls power provided to the system load
[6] Power source switch circuit for primary battery or series solar cell
[7] Uses a small and large capacitor to automatically store excess power for backup
[8] Voltage reference circuit for internal block

# S6AE103A

## Solar-Optimized Energy Harvesting Power Management IC (PMIC)

### Applications

Series solar cell energy harvesting[1] and wireless sensor nodes[2]

### Features

- **Ultra-Low Power**
  - Enables 1 $cm^2$ minimum solar cell size for startup operation[3]
- **Input Voltage Range**
  - 2.0-5.5 V (series solar cell and primary battery)
- **1.1–5.2 V Output Voltage Range**
- **280 nA Quiescent Current[4]**
- **1.2 µW Startup Power**
- **400 nA Low Quiescent Current Low Dropout Regulator (LDO)**
- **30 nA Low Consumption Current CR Timer[5]**
- **20 nA General-Purpose Low Consumption Current Comparator**
- **Dual-Channel Power Gating[6] Switch Circuit with Interrupt Request (IRQ) Control Function for Power Management**
- **Signal Output Circuit of Power Gating Switch Control**
- **Multiplexer[7] Circuit (battery vs. solar cell)**
- **Hybrid Storage Control Circuit[8] and Overvoltage Protection (OVP)**
- **Packages**
  - 4.0 mm x 4.0 mm 20-pin QFN

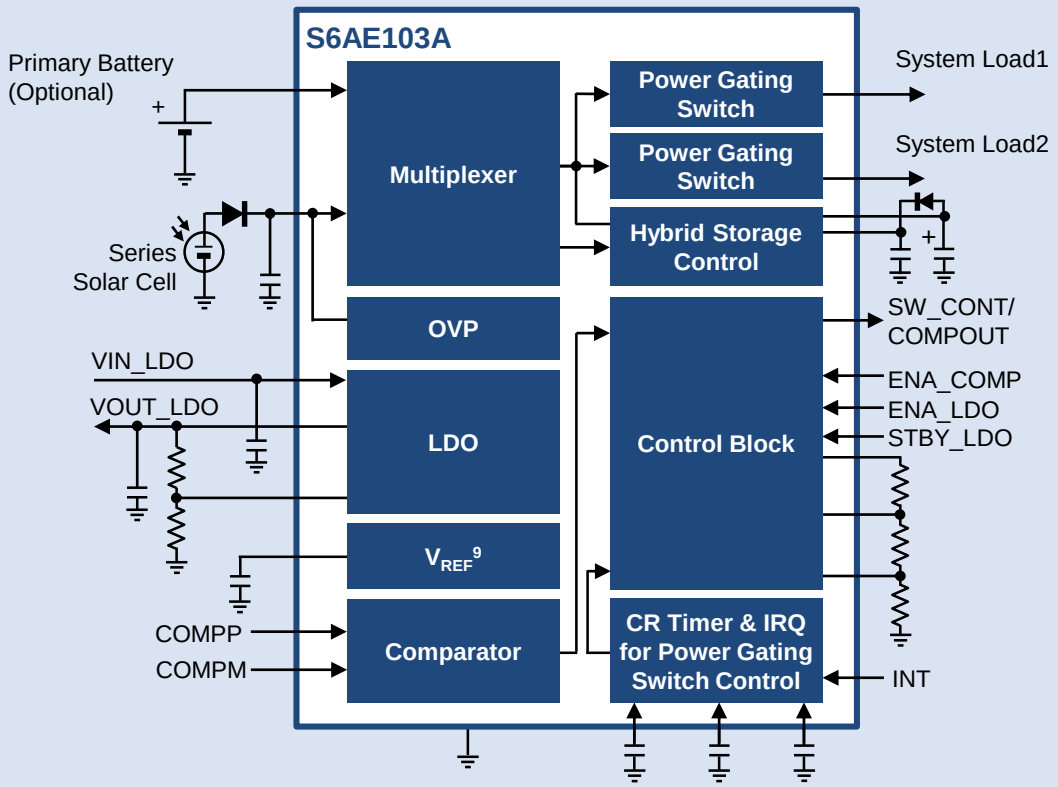
### Collateral

**Datasheet:** S6AE103A Datasheet

**Development Kits:** S6AE10xA Evaluation Board, CYALKIT-E04

**Software:** Easy DesignSim™ Software

### S6AE103A: Solar-Optimized Energy Harvesting PMIC




### Availability

**Production:** Now

[1] The process of capturing and converting tiny amounts of energy (e.g., from light, vibration or heat) into electricity
[2] A sensor-based device that monitors conditions such as temperature, humidity and pressure and wirelessly transmits that data to a control unit, such as a PC or a mobile device
[3] Estimate based on solar cell power = 2 µW/$cm^2$ at 100 lx
[4] Current consumed at no load condition
[6] Output power control circuit that controls power provided to the system load
[7] Power source switch circuit for primary battery or series solar cell
[8] Uses a small and large capacitor to automatically store excess power for backup
[9] Voltage reference circuit for internal block

# MB39C811

## General Purpose Energy Harvesting Power Management IC (PMIC)

### Applications

Series solar cell energy harvesting[1], Piezoelectric[2] energy harvesting and wireless sensor nodes (WSN)[3]

### Features

- **Ultra-Low-Power Buck DC/DC Converter Dual-Bridge Rectifiers**
- **1.5 µA Quiescent Current[4]**
- **2.6–23-V Input Voltage Range**
- **Output Voltage**
  - 1.5 V, 1.8 V, 2.5 V, 3.3 V, 3.6 V, 4.1 V, 4.5 V and 5.0 V
- **100 mA (maximum) Output Current**
- **Overcurrent Protection (OCP)**
- **Low-Loss Full-Wave Bridge Rectifier**
  - $V_F$[5] = 0.28 V ($I_F$ = 10 µA), IR[6] = 20 $nA_{MAX}$ ($V_{REVERSE}$ = 18 V)
- **Shunt for Input Protection**
  - $V_{IN}$ ≥21 V (up to 100-mA pulldown)
- **Input and Output Power Good Monitoring**
- **Package**
  - 6.0 mm x 6.0 mm 40-pin QFN

### Collateral

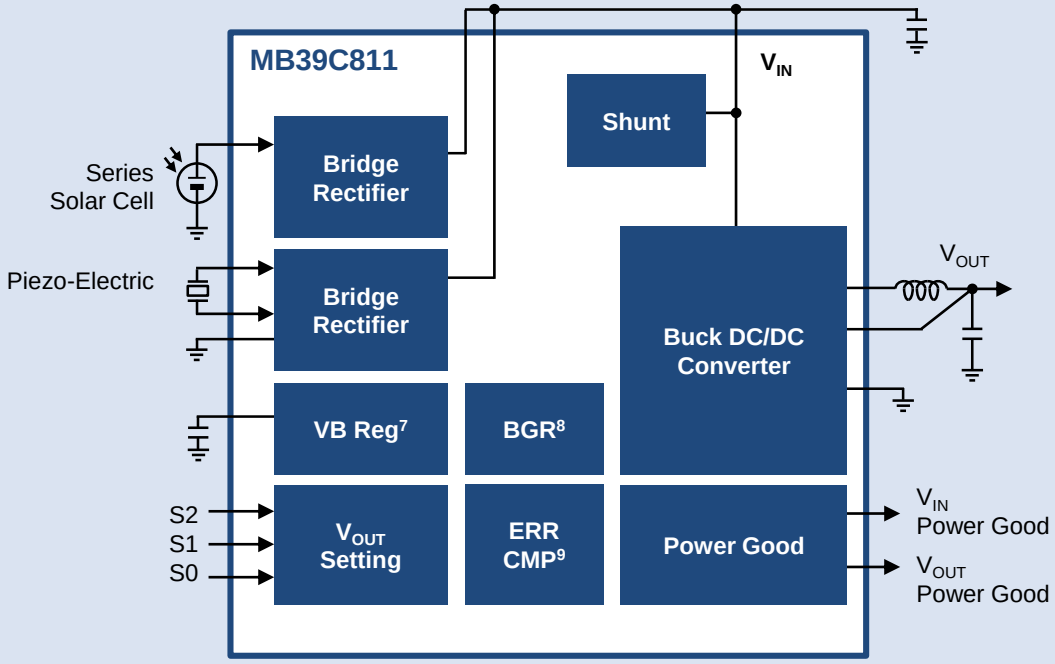
**Datasheet:** MB39C811 Datasheet

**Development Kits:** Energy Harvesting Starter Kit

MB39C811 Evaluation Board

**Software:** Easy DesignSim™ Software

### MB39C811: General Purpose Energy Harvesting PMIC




### Availability

**Production:** Now

[1] The process of capturing and converting tiny amounts of energy (e.g., from light, vibration or heat) into electricity
[2] Power generation device using vibration
[3] A sensor-based device that monitors conditions such as temperature, humidity and pressure and wirelessly transmits that data to a control unit, such as a PC or a mobile device
[4] Current consumed at no load condition
[5] Bridge rectifier reverse breakdown voltage
[6] Bridge rectifier reverse bias leak current
[7] Regulator for internal block
[8] Band Gap Reference
[9] Error Comparator

# MB39C831

## General Purpose Energy Harvesting Power Management IC (PMIC)

### Applications

Single solar cell energy harvesting[1], thermoelectric generator[2] energy harvesting and wireless sensor nodes[3]

### Features

- **Ultra-Low-Voltage Startup Boost DC/DC Converter**
- **0.3–4.75-V Input Voltage Range**
- **0.35-V Startup Voltage**
- **Output Voltage (constant voltage mode only)**
  - 3.0 V, 3.3 V, 3.6 V, 4.1 V, 4.5 V and 5.0 V
- **32-µA Quiescent Current[4]**
- **Output Current**
  - 8 mA ($V_{DD}$ = 0.6 V, $V_{OUT}$ = 3.3 V) and 80 mA ($V_{DD}$ = 3.0 V, $V_{OUT}$ = 3.3 V)
- **200-mA Input Peak Current Limit**
- **Built-In Maximum Power Point Tracking (MPPT)5 Function**
- **Built-In Li-ion Charge Function**
- **Input and Output Power Good Monitoring**
- **Package**
  - 6.0 mm x 6.0 mm 40-pin QFN

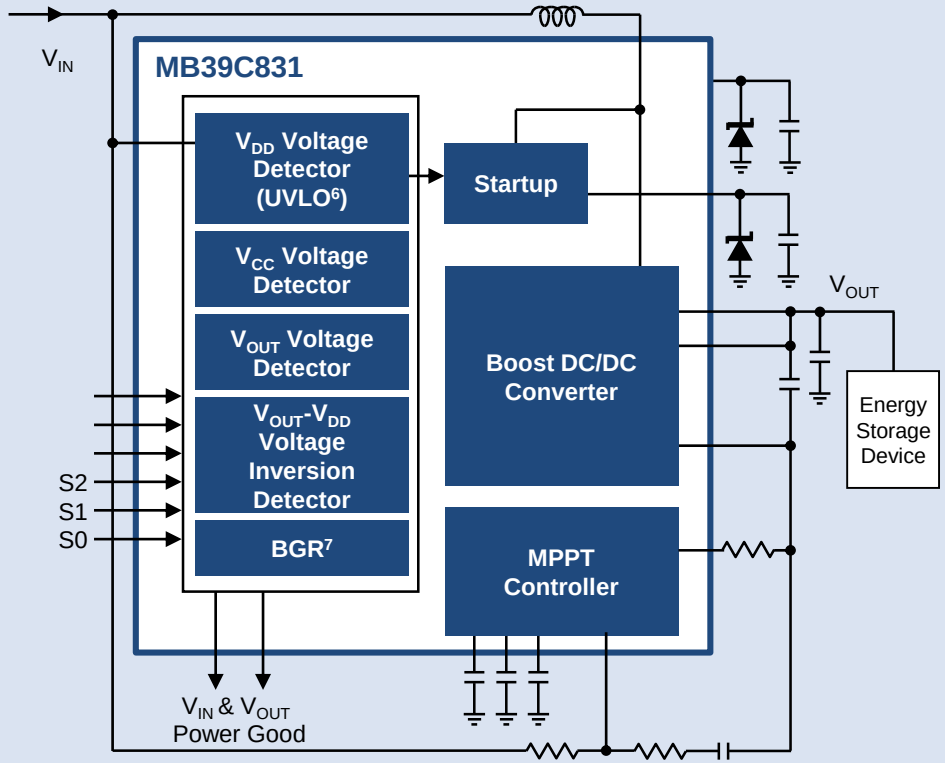
### Collateral

**Datasheet:** MB39C831 Datasheet

**Development Kits:** MB39C831 Evaluation Board

**Software:** Easy DesignSim™ Software

### MB39C811: General Purpose Energy Harvesting PMIC




### Availability

**Production:** Now

[1] The process of capturing and converting tiny amounts of energy (e.g., from light, vibration or heat) into electricity
[2] Power Generation Device using heat
[3] A sensor-based device that monitors conditions such as temperature, humidity and pressure and wirelessly transmits that data to a control unit, such as a PC or a mobile device
[4] Current consumed at no load condition
[5] Maximum Power Point Tracking maximizes the Energy Harvest by adjusting current drawn from a solar panel
[6] Undervoltage lockout
[7] Band Gap Reference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