



Space Constrained Devices with Ultra-low Power Consumption Budget Powered by the SIMO Architecture

Presented By –

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Product Definition/System Architecture, Consumer Power Group

#SensorsConverge

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Overview

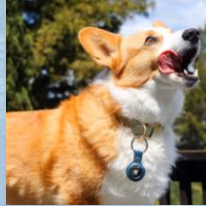
- Is Harvesting Energy the right option for your system?
- Energy Harvesting System Considerations
- Maximizing Harvested Energy

Harvesting Applications

Accessory Trackers



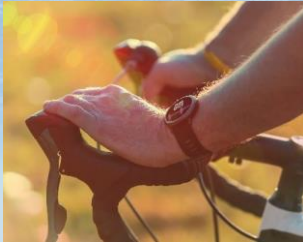
Asset Trackers



Wind Turbine
Smart Screws



Industrial IoT



Fitness Wearables



Wireless Sensor Nodes



Smart Meters



Consumer
Smart Devices



Smart Sensors

So I've reduced my IQ. Should I harvest or use a primary cell

Total Power Budget	Run-Time	Comment
1uA	11.4 years	Harvesting is not needed
10uA	1.14 years	Harvesting starts getting interesting
100uA	1.37 months	Harvesting is very interesting
1000uA	4.1 days	Harvesting is probably not enough

- For a 100mAh Battery:



- Harvesting is attractive for 10uA to 200uA power budgets.

- **Lower limit:** Low interest due to excellence of primary cell.
- **Upper Limit:** Low interest due to size/cost of solar

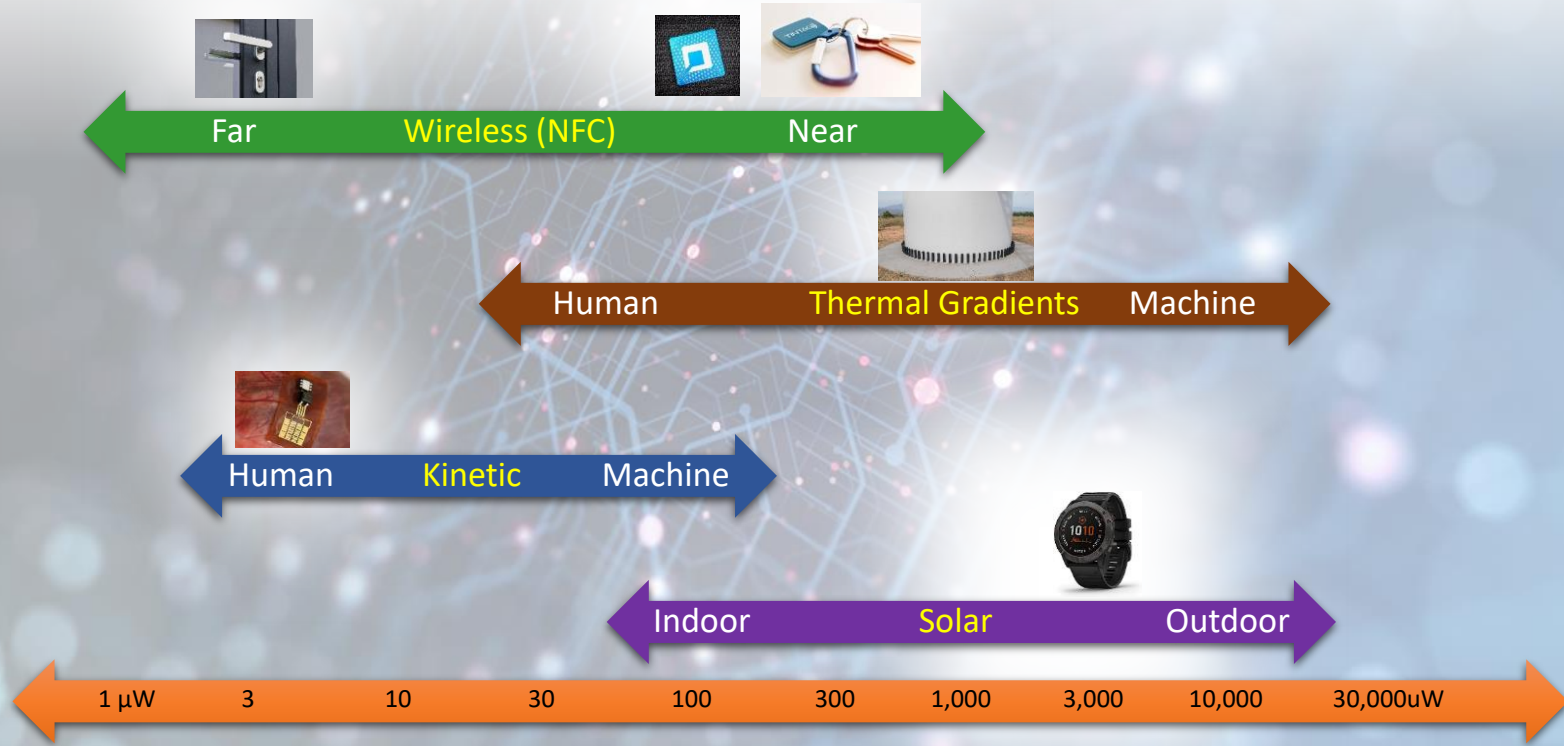
- Harvesting vs. Primary Cell

- Harvesting reduces battery size & cost vs. extra size/cost of solar
- Harvesting makes device potentially perpetual

PV cell



Power Levels Available for Energy Harvesting



Low-Power Device Challenges

Consumer

Keeping devices lightweight and ensuring long run-time



Industrial

Dependence on manual servicing and connecting infrastructure



Environmental

Numerous hard to access nodes



Non-renewable power source reliance

Needing to rely on batteries or grid for 100% of system power

Harvesting as Solution to Low-Power Device Challenges

Challenges

Solution Strategies

Lightweight

Harvester supplements primary source

Manual Servicing

Harvester increases time between servicing

Accuracy

Precise and low noise measurements

Battery Life

High efficiency, low Iq, Harvester

Contextual Data

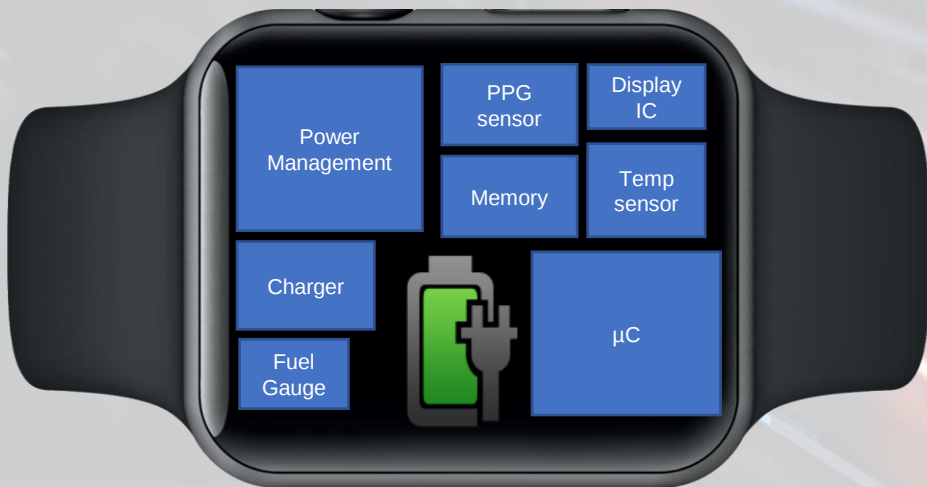
More integrated features

Legend: data power



Need for More Integrated Features

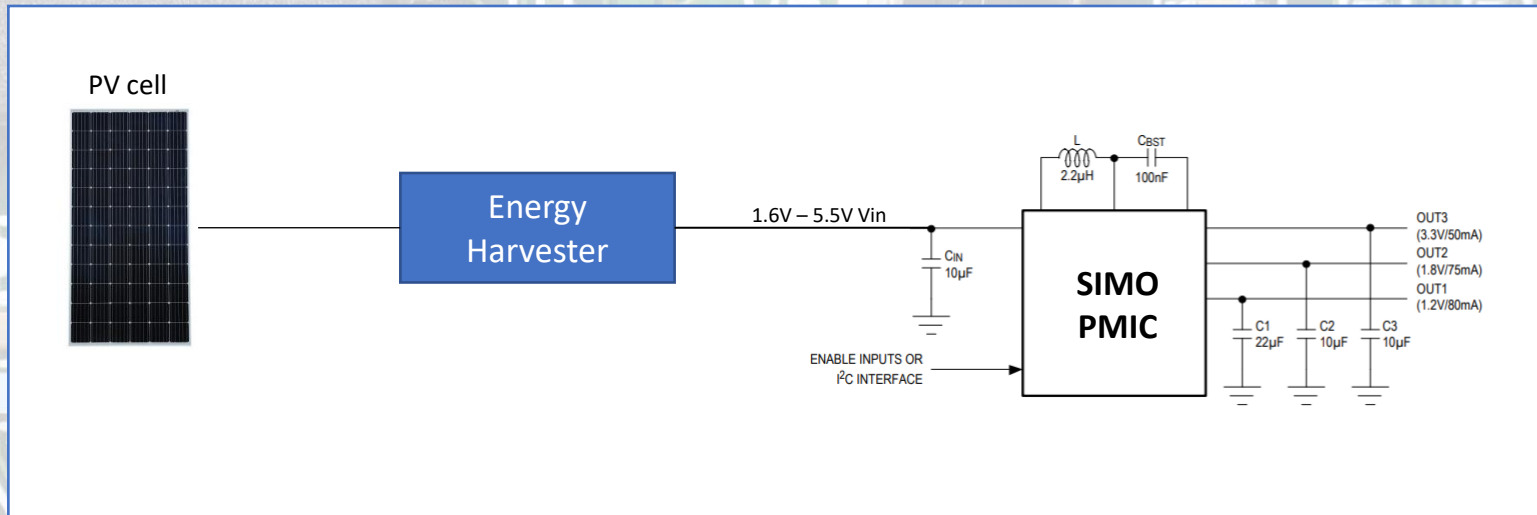
Traditional Solution



Feature-Rich, Next-Gen Solution



Solar Harvester + SIMO PMIC



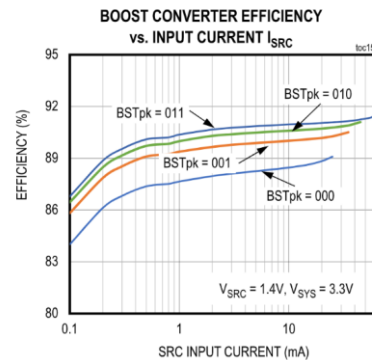
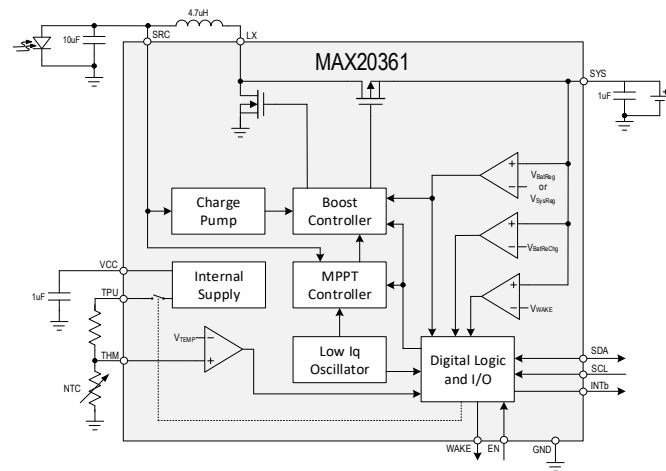
Solar Harvester MAX20361

Benefits

- Increase device operation time by supplementing battery energy with solar or sole source solar
- Efficient harvesting 15 μ W to 300mW IP power
- Small solution size

Features

- Low V_{IN} , low I_Q boost
> 225mV to 2.5V input range (up to 3 cells)
- High efficiency charging
- Adaptive Maximum Power Point Tracking (MPPT)
- Integrated harvesting gauge
- Small solution size
> 1.23 x 1.63mm WLP package



Thermoelectric Harvester

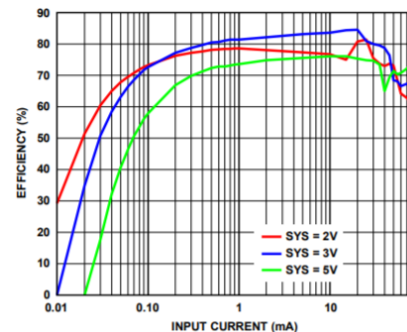
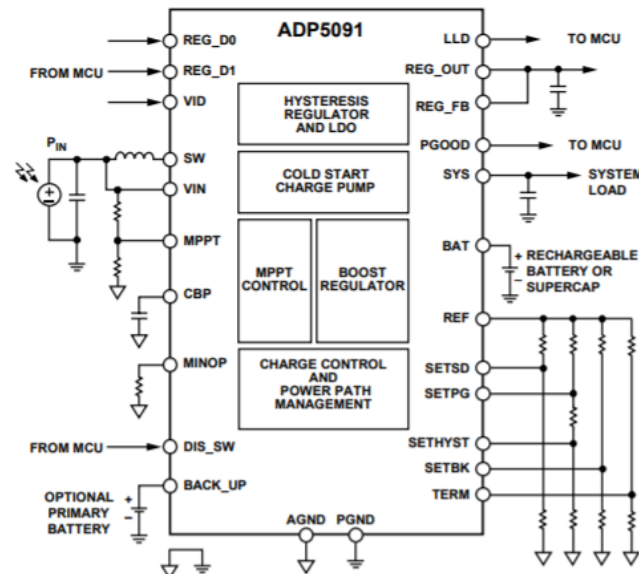
ADP5091/2

Benefits

- Increase device operation time by supplementing battery with thermoelectric or solar energy
- Efficient harvesting $6\mu\text{W}$ to 600mW IP power
- Small solution size

Features

- Low V_{IN} , low I_{Q} boost
 - 80mV to 3.3V input range
- High efficiency charging
- Adaptive Maximum Power Point Tracking (MPPT)
- RF transmission conductive
- 150mA , 1.5V to 3.6V regulated output



Power Savings from Power Management

- Multiple high-efficiency voltage rails
- Low quiescent current
- Auto wakeup
- Dynamic voltage scaling (DVS)
- Solution size savings
- Versatile power source configurations

Single Inductor Multiple Output (SIMO) Technology

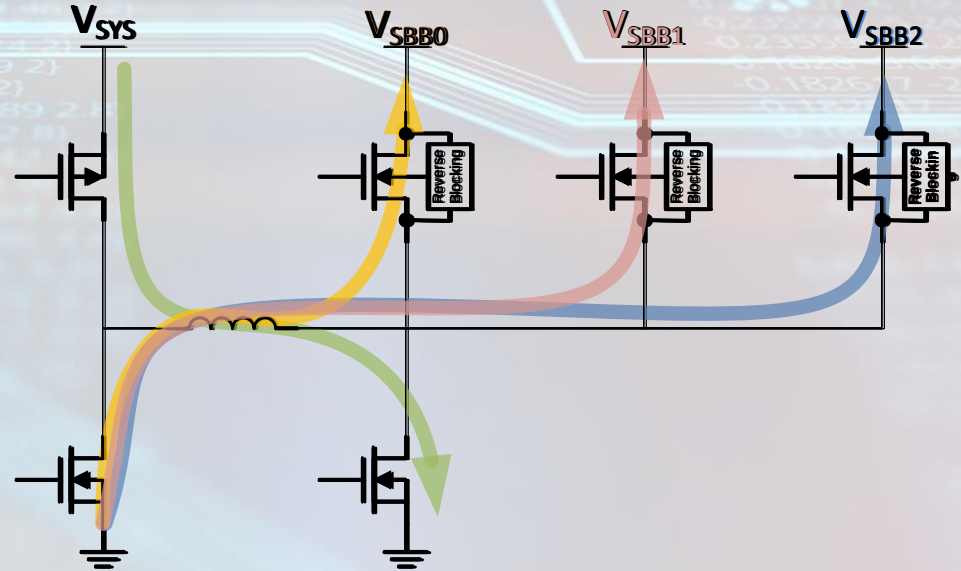
SIMO Architecture

50% Smaller Solution

20% Longer Battery Life

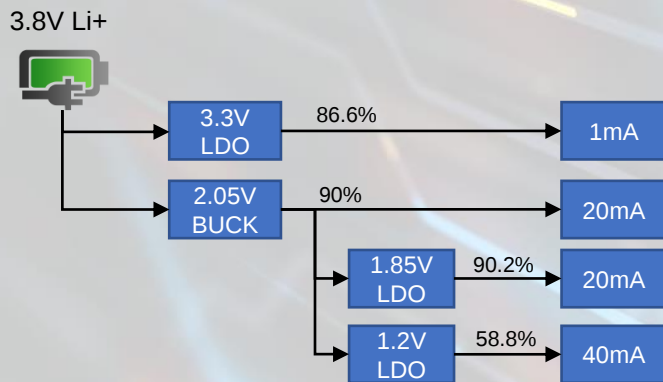
High Signal Integrity

Wide Input Range

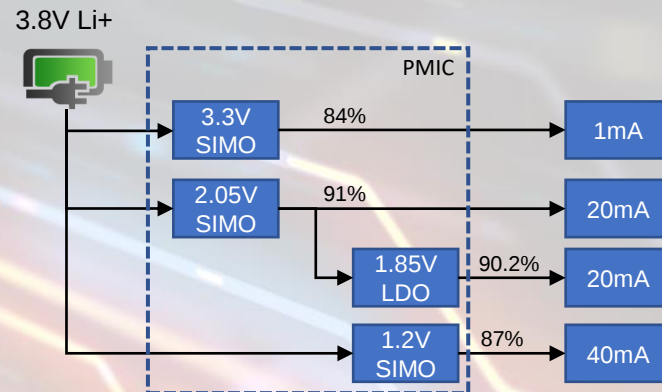


Increasing Battery Life by 20%

Traditional Solution
System Eff = **69.5%**



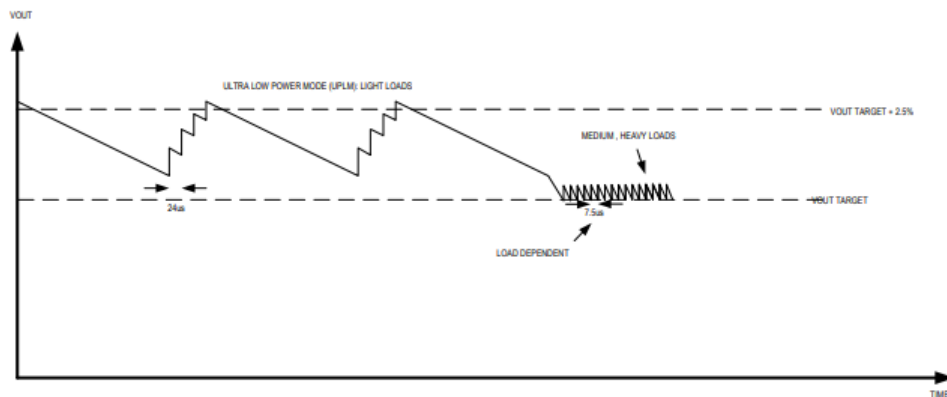
SIMO Power Management
System Eff = **86.1%**



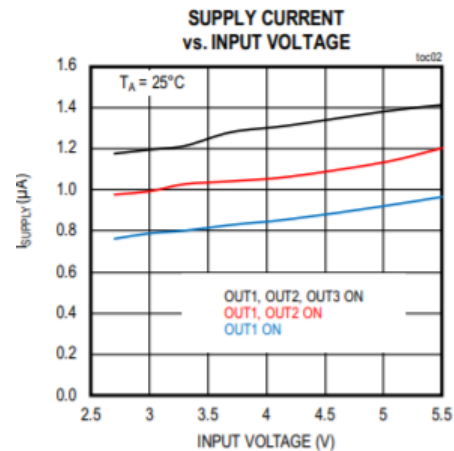
Key Parameters	Traditional Power Management	SIMO Power Management
BATT Current	49mA	39.5mA
System Efficiency	69.5%	86.1%

Nano Power Quiescent Current

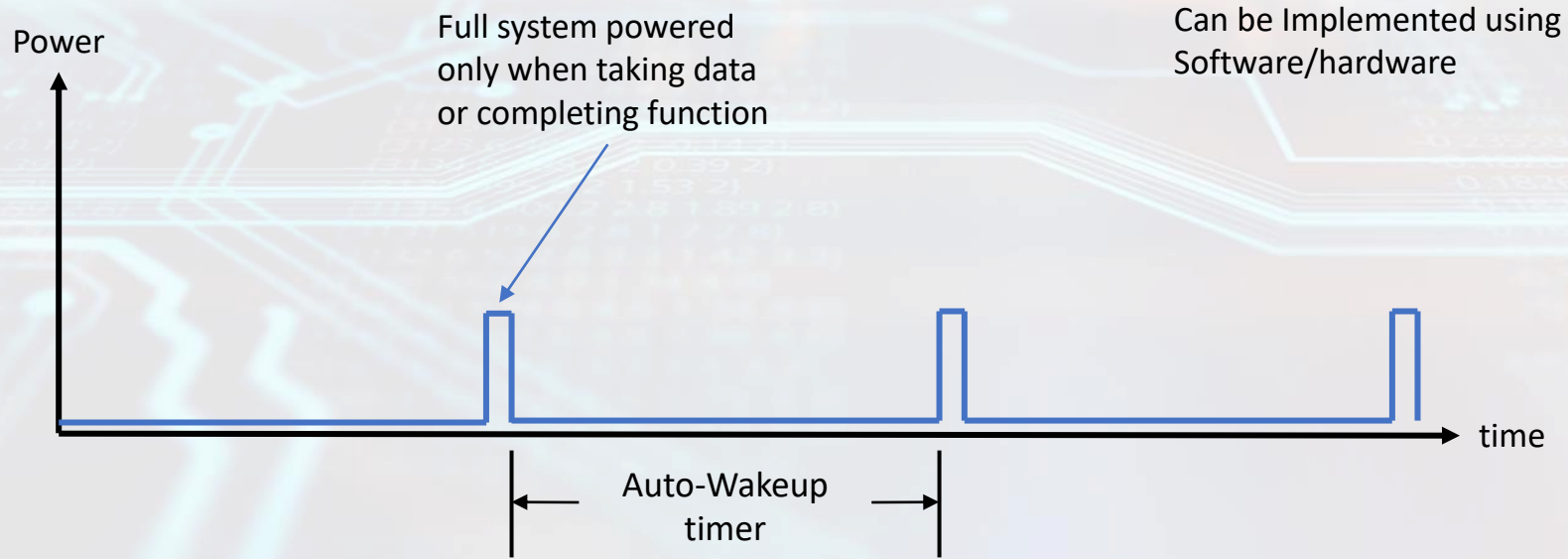
Ultra Low Power Mode Operation



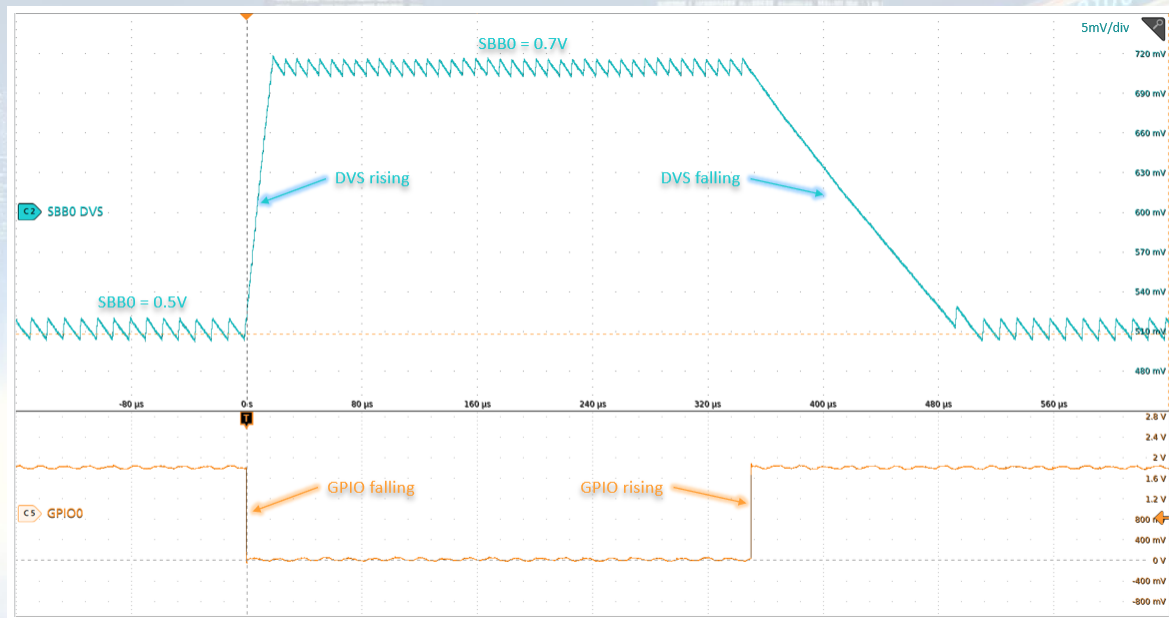
Supply Current in Nano Amps



Use Power only when needed with Auto Wakeup



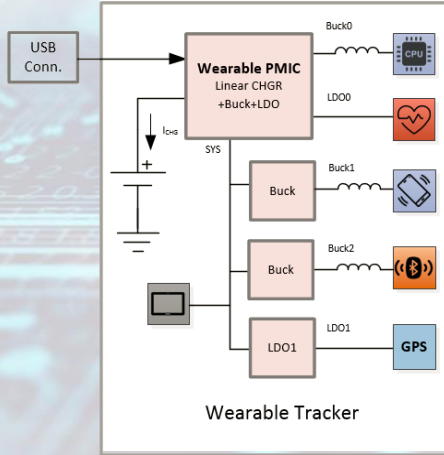
Dynamic Voltage Scaling



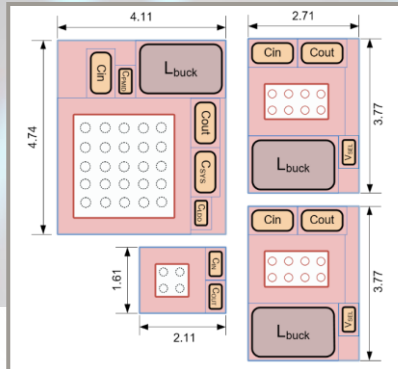
$$P_{loss} \propto V^2$$

- By reducing operating voltage when functional demands are lower, power loss is reduced
- DVS is controlled via GPIO/I²C

Space Saving



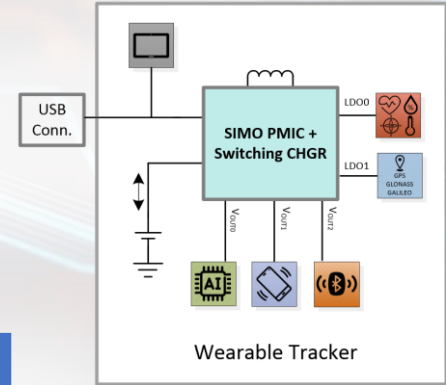
Traditional IoT Architecture



Solution Size:
43.31mm²

Component Count: 20

Next-Gen IoT Architecture

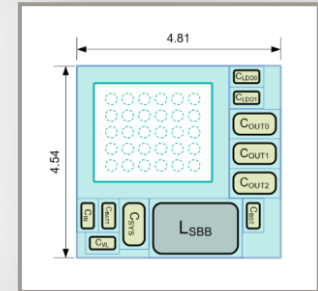


50% Smaller

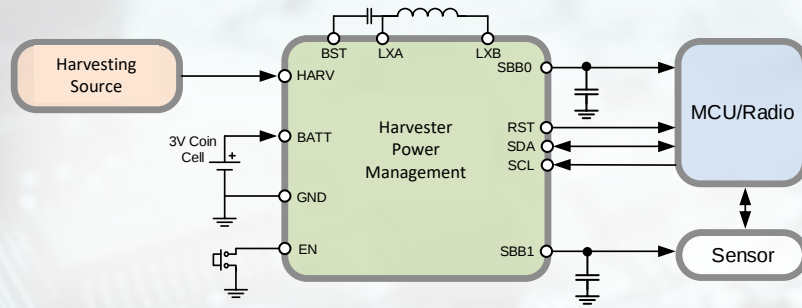
Solution Size:
21.83mm²

Component Count: 12

40% Lower BOM Count

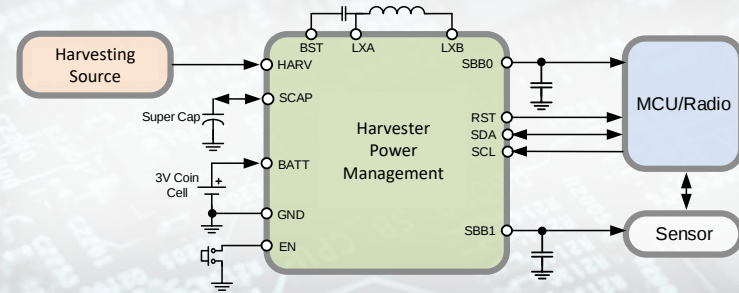


Energy Harvesting with Versatile Battery Configurations



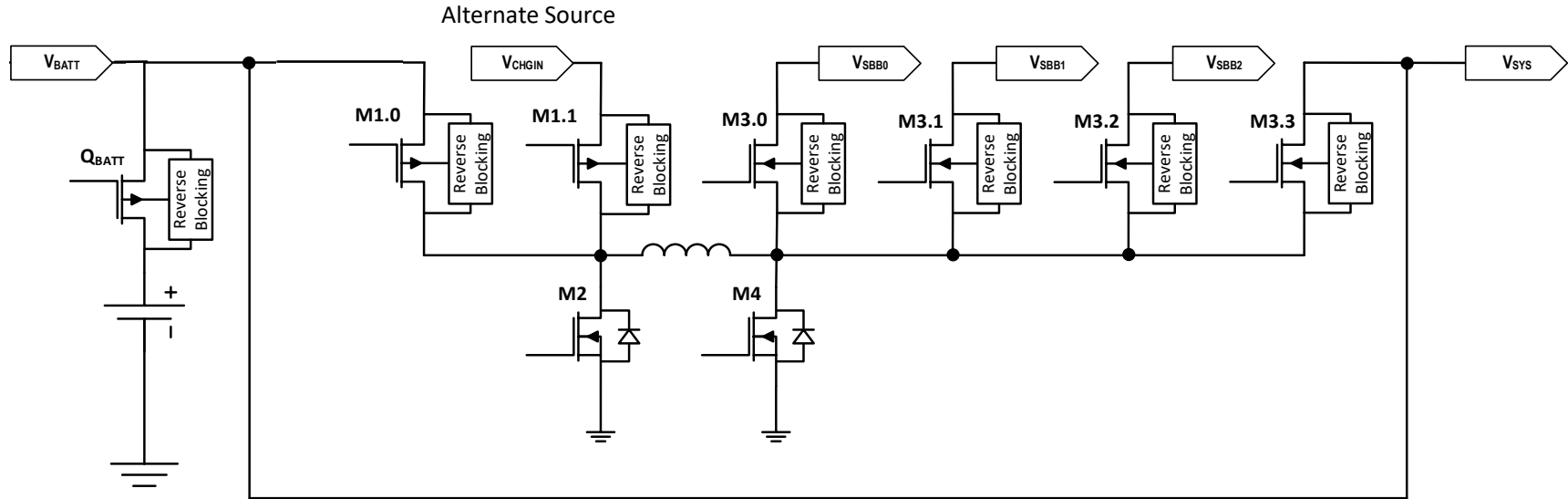
Harvester +
Primary cell

Harvester +
Supercap +
Primary cell

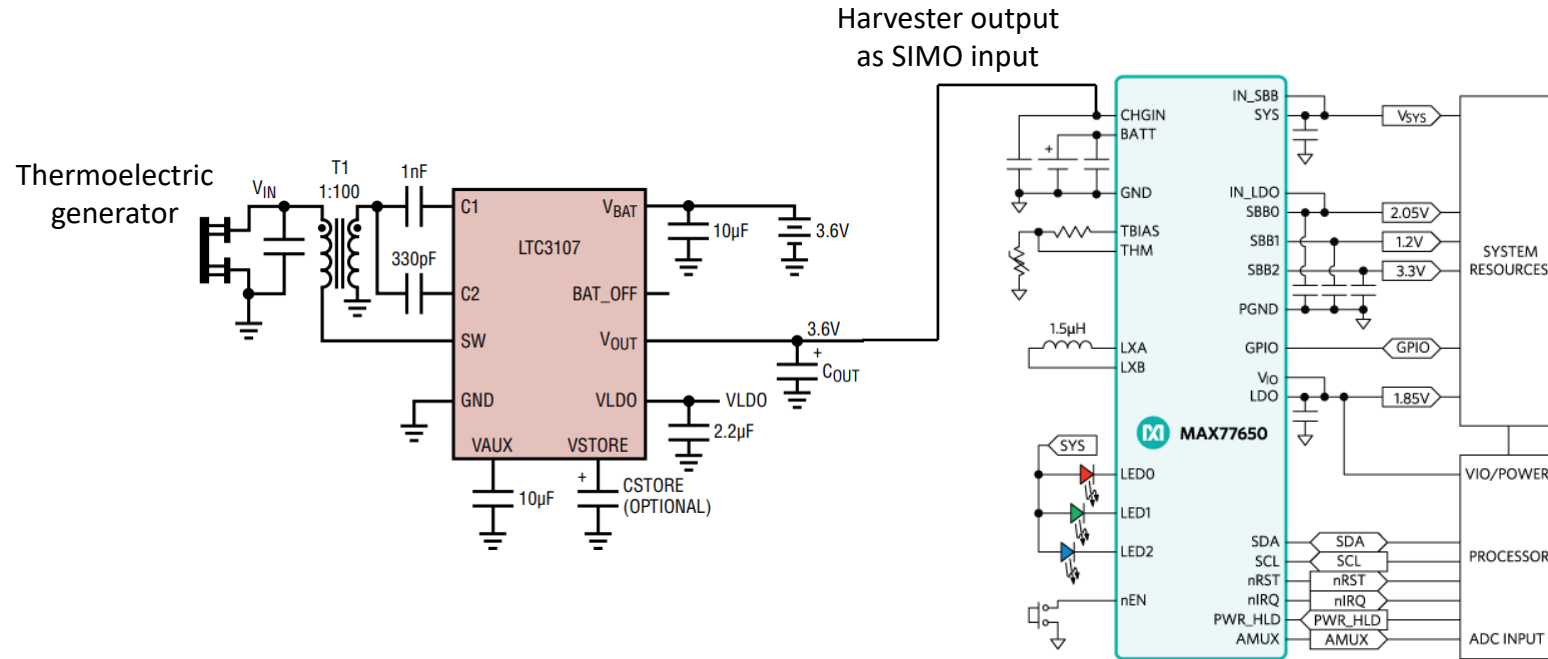


MIMO Architecture

Implemented on Released SIMO PMIC



Thermal Harvester + MIMO PMIC



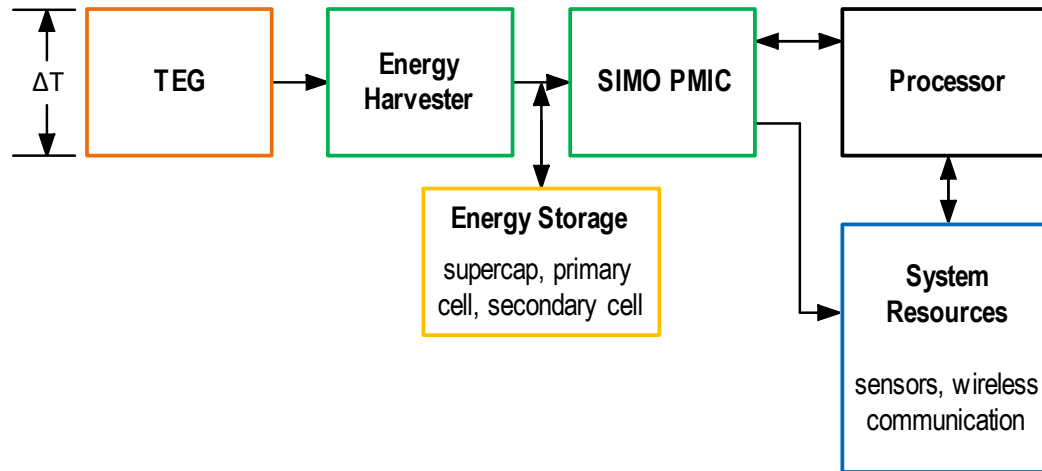
Thermoelectric Generation + Energy Harvesting Applications



Condition-Based Monitoring

- Industrial Sensor Nodes
 - Sensors monitor vibration, temperature, stress
 - Thermal energy from machines
- Integrated Smart Sensors
 - Examples: Cars, wind turbines, bridges
 - Provide detailed system performance info

TEG + Harvester + SIMO Typical Application



ADI Energy Harvesting Solutions

Part Number	Harvesting Sources			
ADP5091/2				
LTC3106				
LTC3107/8/9				
LTC3330/1				



Piezo



Thermal



Solar



RF

Closing Comments

- Lower down-stream power consumption
- PMIC, Microcontroller, Sensors, RF
- Widen Input voltage range
- One stop power solution for harvesting + power solution
- Higher harvester efficiency

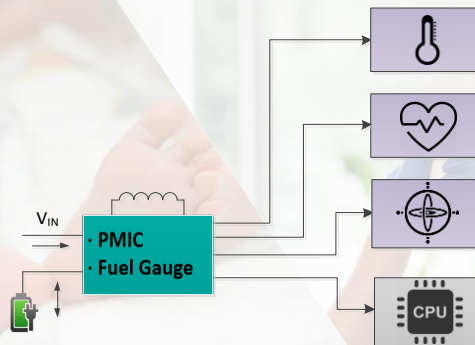
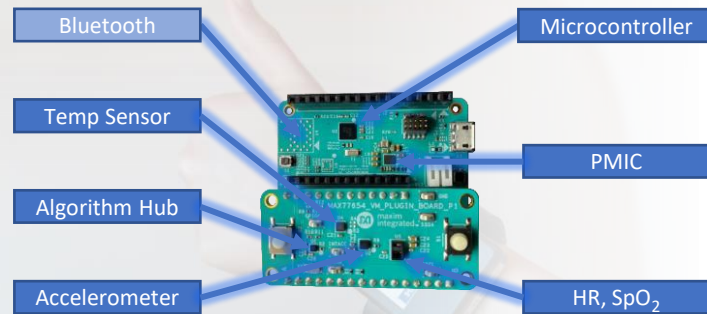
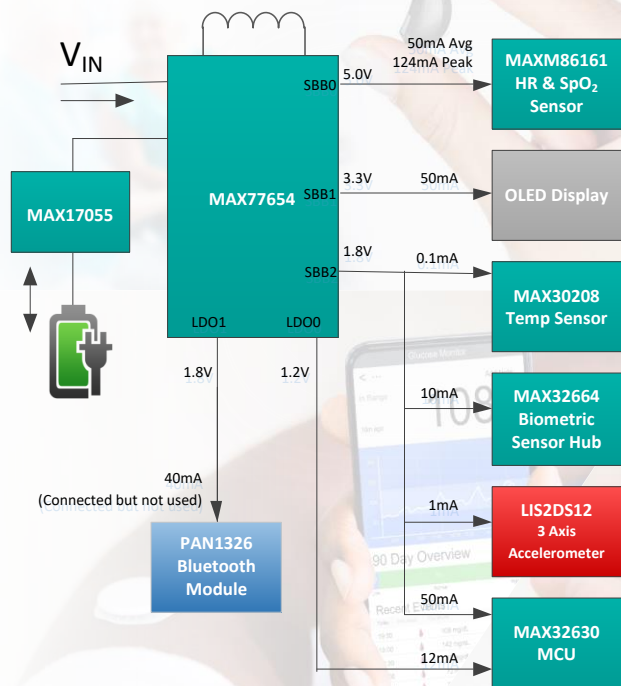
Q & A

Thank You!

Portable Vital Monitoring



Featuring ADI's Low Power SIMO PMIC, ModelGauge™ Fuel Gauge, uC & Biometric Sensors



POWER

- PMIC : 50% Smaller
- Fuel Gauge : 40% higher accuracy

SENSOR

- Heart Rate, SpO₂ : 3dB Higher SNR
- Temperature : 0.1°C accuracy

PROCESSOR

- Microcontroller: 40% Lower Power
- Sensor Hub : Cuts dev time by half