Smart Power Management in battery supplied applications and self-powered WSN’s
Outline

• Typical WSN Power Profile
• Reducing the average power consumption
• Modified WSN architecture using smart PMIC
• Anagear ANG1010
  – Functional Diagram
  – MPPT
  – Autonomous monitor function
  – Other features
• Conclusion
Typical WSN Architecture

- Solar cell
- EHV Boost Converter
- Battery Management
- System Power
- Sensor(s)
- MCU
- Radio

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Typical WSN Architecture

Average power consumption is a function of:
- the Duty Cycle
- the Active power
- the Sleep current

System Power Profile
How to reduce average power?

Where can energy be saved?

Transmit / Receive ~ 10 mA

MCU Active ~ 1 mA

Sleep ~ 1 μA

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First: Reduce active power

- Efficient conversion of supply voltages to the other system components
Next: Reduce sleep current

- Efficient conversion of supply voltages to the other system components
- Switch off supply to other system components during Sleep
What else: Reduce Active time

- Efficient conversion of supply voltages to the other system components
- Switch off supply to other system components in Sleep
- Remove sensor measurement task from MCU
- Eliminate Active cycles when not needed

How?
- Use smart PMIC
- Modified WSN architecture

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Alternative WSN Architecture

SMART PMIC functions:
• Sequencer controls multiple power outputs to other system components
• Efficient supply voltage conversion
• Autonomously monitor and guard sensors in STANDBY
Other PMIC functions for self-powered WSN’s:

- Ultra-low sleep current
- Include functions for effective EHV supply:
  - Maximum Power Point Tracking
  - Boost Converter
  - Energy storage management
  - Brown-out threshold to protect against perpetual retries
- Monitor supply resources and notify system prior to power outage
- Provide power supply capability to a wide variety of systems
- Low Cost ($) BOM
Anagear’s solution
ANG1010 ultra-low power SMC

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First Product
ANG1010 ultra-low power SMC

Supply:
- Battery
- PV with MPPT
- Boost converter
- Efficient energy storage
- POR

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First Product
ANG1010 ultra-low power SMC

2 Power Domains:
- Prog. DCDC (.9 – 2.45V)
- DCDC efficiency: >85%
- Prog. LDO (.9 – 2.45V)
- Separate CLK and Reset signals
First Product
ANG1010 ultra-low power SMC

LP Silicon Oscillator (4 to 32 kHz)
(250nA < STB current < 500nA)
Prog. Sequencer
Xtal Oscillator (on-chip tuneable to a few ppm)
First Product
ANG1010 ultra-low power SMC

SPI interface
NVM
RTC
Watchdog
First Product
ANG1010 ultra-low power SMC

Sensing / Monitor function
Temperature sensor
8-channel, 12-bit ADC

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ANAG1010 Power Point Tracking

- Optimized for indoor PV-panels
- Autonomous circuit
- Starts-up with empty rechargeable battery / buffer capacitor
- Automatic impedance matching for:
  - $1.2V < \text{input voltage} < 3.3V$
  - $10\mu A < \text{load current} < 100\mu A$
- MPPT combined with boost converter up to 5V
- Programmable overvoltage protection for rechargeable battery / buffer capacitor
- 1-pin design using external inductor

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ANG1010 Autonomous Monitor Function

- Monitor signals:
  - Temperature sensor
  - Battery voltage
  - Buffer capacitor voltage
  - External analog input
- Checks against individual prog. lower and upper limits
- Activates / interrupts MCU on alarm m sec. < interval time < 1 hr
- Power-up external sensor with programmable settling time for ADC

- Energy consumption/monitor cycle:
  - Temp. conversion: 0.7 $\mu$J
  - Battery, Buffer Cap: 0.02 $\mu$J
  - Ext Sensor: ?
ANG1010 ultra-low power Standby Mode Controller (SMC)

Other features:

- Standby current < 500nA
- Deep Sleep mode with ultra-low quiescent current (<50nA). Wake-up through an external trigger signal
- Auto Wake-Up (Cold Start)
- Programmable brown-out threshold voltage
- Programmable duty cycle from few msec to >196 days
- Interrupt controller
- Programmable I/O’s:
  - configuration select
  - Supply output for external sensor
  - Sync input to evoke ACTIVE mode
  - Interrupt output
- Package 28 QFN
Conclusion

The ANG1010

- Reduces the average system power consumption:
  - Voltage conversion
  - Switching off supplies in Standby
  - Monitor function in Standby
- Provides efficient EH management and energy storage
- Provides battery back-up ("in case anything else fails!")
- Includes ultra-low power deep sleep mode
- Reduces BOM
When nano-Amps matter!

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Questions?

Thank you
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