SILICON LABS

CONNECTED INTELLIGENCE

Peripheral Reflex System (PRS)

Enhancing Energy Efficiency in Embedded Systems

The Challenge & The Fix

Current Issues and Impact

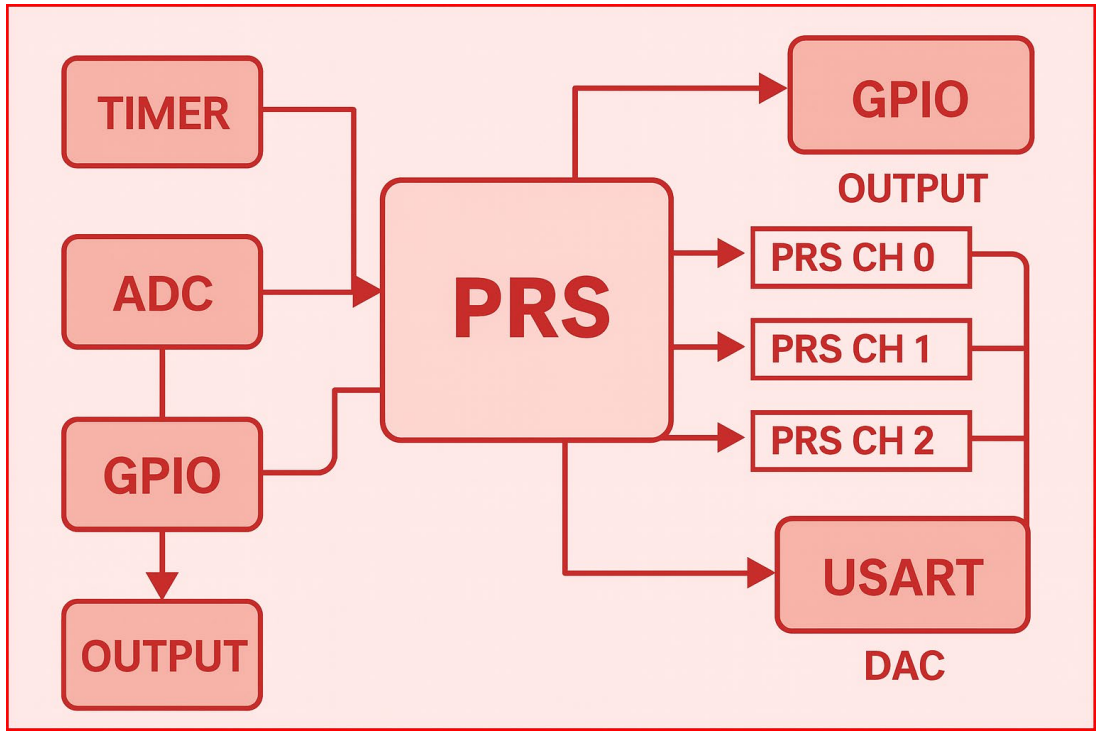
- **Complex Peripheral Communication:**
  - Often requires significant CPU involvement to manage peripheral interactions.
    - **Impact:** Increases software complexity and power consumption. Delays time-to-market and increases maintenance costs.
- **Latency and Performance:**
  - Handling peripheral communication through the CPU can introduce latency.
    - **Impact: U**ltimately affects the performance of timing-critical applications, especially in applications requiring real-time data processing.
- **Energy Consumption:**
  - Continuous CPU activity for peripheral management results in higher energy consumption.
    - **Impact:** Leads to battery life reduction in portable and IoT devices, resulting in frequent recharges and shorter device lifespans.

Solution

- **PRS:**
  - A routing network within Silicon Labs' MCUs that allows one peripheral to trigger or control another through hardware signals, bypassing the CPU.
  - This system is designed to reduce power consumption and improve real-time responsiveness by minimizing the need for software-driven event handling.
  - The PRS acts like a configurable "wiring" matrix inside the chip.
    - For example, it can route a signal from a timer (like a compare match) to trigger an ADC conversion or control a GPIO pin.
- **Key Features:**
  - **Event-driven architecture:** Facilitates direct peripheral-to-peripheral communication.
  - **Low power:** Reduces CPU wakeups and active time.
  - **Flexible routing**: Multiple channels and sources allow custom setups.
  - **Deterministic behavior:** Operates with predictable timing since it's hardware-based.

Value Proposition of the Peripheral Reflex System (PRS)

- **Efficient, Autonomous Operation**
  - Peripherals communicate directly, no CPU wake-up needed
    - **Benefit:** Reduces CPU workload, leading to lower power consumption.
- **Maximized Energy Savings**
  - CPU sleeps longer, extending device battery life
    - **Benefit:** Extends device battery life, ideal for portable and IoT devices.
- **Faster System Response**
  - Real-time event handling at the hardware level
    - **Benefit:** Improves system responsiveness and timing accuracy.
- **Simplified Application Design**
  - Reduces software overhead and interrupts complexity
    - **Benefit:** Reduces time-to-market and maintenance costs.
- **Perfect for IoT, Wearables, Smart Devices**
  - Ideal for ultra-low power, high-performance products
    - **Benefit:** Enhances the efficiency and performance of smart devices.



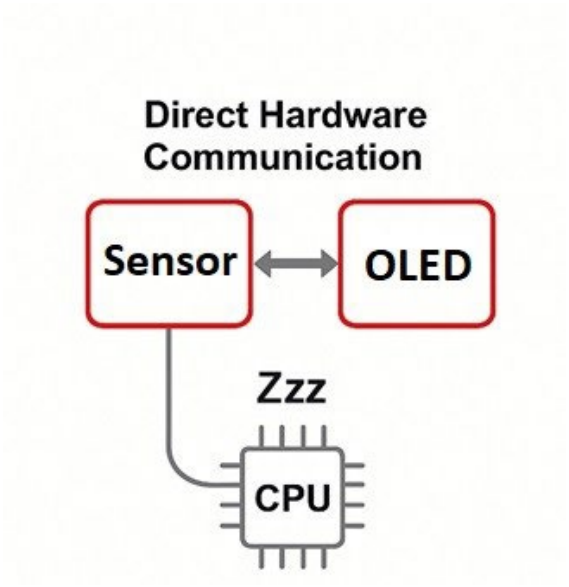
Technology Comparative Analysis

Technology	Differentiating Feature	Latency	Power Consumption	Peripheral Infra Complexity
Peripheral Reflex System (PRS)	Hardware signal routing between peripherals without CPU	**Ultra-low** (sub µs)	**Very Low** (no CPU wake)	**Low** (simple config, fixed paths)
Peripheral Pin Select (PPS)	Flexible remapping of peripheral I/O to physical pins	**N/A** (config only)	**Neutral** (setup-time only)	**Very Low** (pin mux config only)
Universal Serial Communication Interface (USCI)	Multiprotocol comms (UART/SPI/I²C) with shared logic	**Moderate** (interrupt-driven)	**Moderate** (CPU-based data handling)	**Medium** (shared logic, needs CPU)
Direct Memory Access (DMA)	Autonomous bulk data transfer between memory and peripherals	**Low** (µs-ms range)	**Very Low** (CPU stays asleep)	**Medium** (channel setup, priority handling)

Real-World Example

SCENARIO : TEMPERATURE MONITORING SYSTEM

- **Use Case:**
  - Take sensor reading and output that reading on OLED display
- **Peripherals:**
  - Temperature sensor (I2C)
  - OLED display (I2C)



Explore how PRS can benefit your applications.

COMPARISON TABLE

Technology	Active Mode Duration	Sleep Mode Duration	Active Mode Current	Sleep Mode Current	Total Current
PRS	2 ms	998 ms	19.2 µA	1.1976 µA	20.3976 µA
PPS	10 ms	990 ms	96 µA	1.98 µA	97.98 µA
USCI	10 ms	990 ms	76.8 µA	1.782 µA	78.582 µA
DMA	2 ms	998 ms	17.28 µA	1.497 µA	18.777 µA

CONCLUSION

- Using PRS **significantly reduces current consumption** compared to other similar technologies.
- The autonomous operation of PRS minimizes CPU involvement, leading to lower power consumption and extended battery life.
- DMA also shows efficient current consumption, but **PRS offers a simpler configuration** and better energy efficiency for low-power applications.

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Thank you