



Low power modes of Microcontrollers

Ayomide Ajayi

What are Microcontrollers?

- Compact, self-contained computers embedded in everything from kitchen appliances, cars to wearables
- Tirelessly performing specific tasks.
- Designed to be efficient — consumes minimal power.

Why is minimal energy consumption necessary?

- Battery Life Extension
- Eco-Friendly Operation
- Heat Management
- Reliability in Critical Systems
- Cost-Effectiveness

Common Power Saving Techniques

- Energy-Efficient Architecture
- Subthreshold Operation
- On-Chip Sensors
- Power-Optimized Firmware (Code)
- Low-Power Modes (Sleep Modes)

Low-power modes

- Low-power modes are special operating modes that reduce the power consumption of the microcontroller by changing the clock source, frequency, and voltage and by disabling some or all of the CPU, peripherals, and memory.

TI MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family

- Active Mode
- Low Power Mode :
 - LPM0
 - LPM1
 - LPM2
 - LPM3
 - LPM4
 - LPM3.5 & LMP4.5

TI MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family



Operating Modes

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Table 1-2. Operation Modes

SCG1 ⁽¹⁾	SCG0	OSCOFF ⁽¹⁾	CPUOFF ⁽¹⁾	Mode	CPU and Clocks Status ⁽²⁾
0	0	0	0	Active	CPU, MCLK are active. ACLK is active. SMCLK optionally active (SMCLKOFF = 0). DCO is enabled if sources ACLK, MCLK, or SMCLK (SMCLKOFF = 0). DCO bias is enabled if DCO is enabled or DCO sources MCLK or SMCLK (SMCLKOFF = 0).
0	0	0	1	LPM0	CPU, MCLK are disabled. ACLK is active. SMCLK optionally active (SMCLKOFF = 0). DCO is enabled if sources ACLK or SMCLK (SMCLKOFF = 0). DCO bias is enabled if DCO is enabled or DCO sources MCLK or SMCLK (SMCLKOFF = 0).
0	1	0	1	LPM1	CPU, MCLK are disabled. ACLK is active. SMCLK optionally active (SMCLKOFF = 0). DCO is enabled if sources ACLK or SMCLK (SMCLKOFF = 0). DCO bias is enabled if DCO is enabled or DCO sources MCLK or SMCLK (SMCLKOFF = 0).
1	0	0	1	LPM2	CPU, MCLK are disabled. ACLK is active. SMCLK is disabled.
1	1	0	1	LPM3	CPU, MCLK are disabled. ACLK is active. SMCLK is disabled.
1	1	1	1	LPM4	CPU and all clocks are disabled.
1	1	1	1	LPM3.5	When PMMREGOFF = 1, regulator is disabled. No memory retention. In this mode, RTC operation is possible when configured properly. See the <i>RTC</i> module for further details.
1	1	1	1	LPM4.5	When PMMREGOFF = 1, regulator is disabled. No memory retention. In this mode, all clock sources are disabled; that is, no RTC operation is possible.

⁽¹⁾ This bit is automatically reset when exiting low-power modes. See [Section 1.4.2](#) for details.

⁽²⁾ The low-power modes and, hence, the system clocks can be affected by the clock request system. See the [Clock System](#) chapter for details.

Entering and Exiting Low-Power Modes LPM0 Through LPM4

```
; Enter LPM0 Example
    BIS    #GIE+CPUOFF,SR
; ...
;
; Exit LPM0 Interrupt Service Routine
    BIC    #CPUOFF,0(SP)
    RETI

; Enter LPM3 Example
    BIS    #GIE+CPUOFF+SCG1+SCG0,SR
; ...
;
; Exit LPM3 Interrupt Service Routine
    BIC    #CPUOFF+SCG1+SCG0,0(SP)
    RETI

; Enter LPM4 Example
    BIS    #GIE+CPUOFF+OSCOFF+SCG1+SCG0,SR
; ...
;
; Exit LPM4 Interrupt Service Routine
    BIC    #CPUOFF+OSCOFF+SCG1+SCG0,0(SP)
    RETI

; Enter LPM0
; Program stops here

; Exit LPM0 on RETI

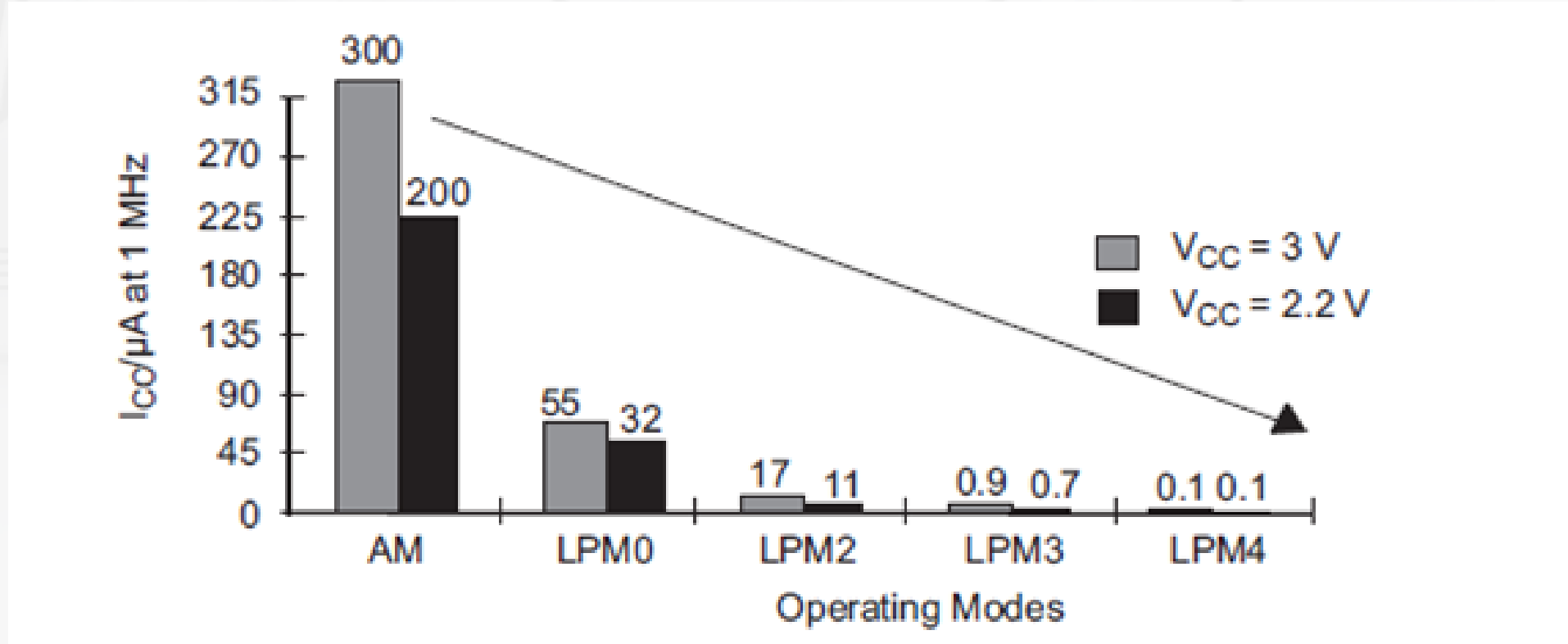
; Enter LPM3
; Program stops here

; Exit LPM3 on RETI

; Enter LPM4
; Program stops here

; Exit LPM4 on RETI
```


Power consumption in various modes of the MSP430 Family

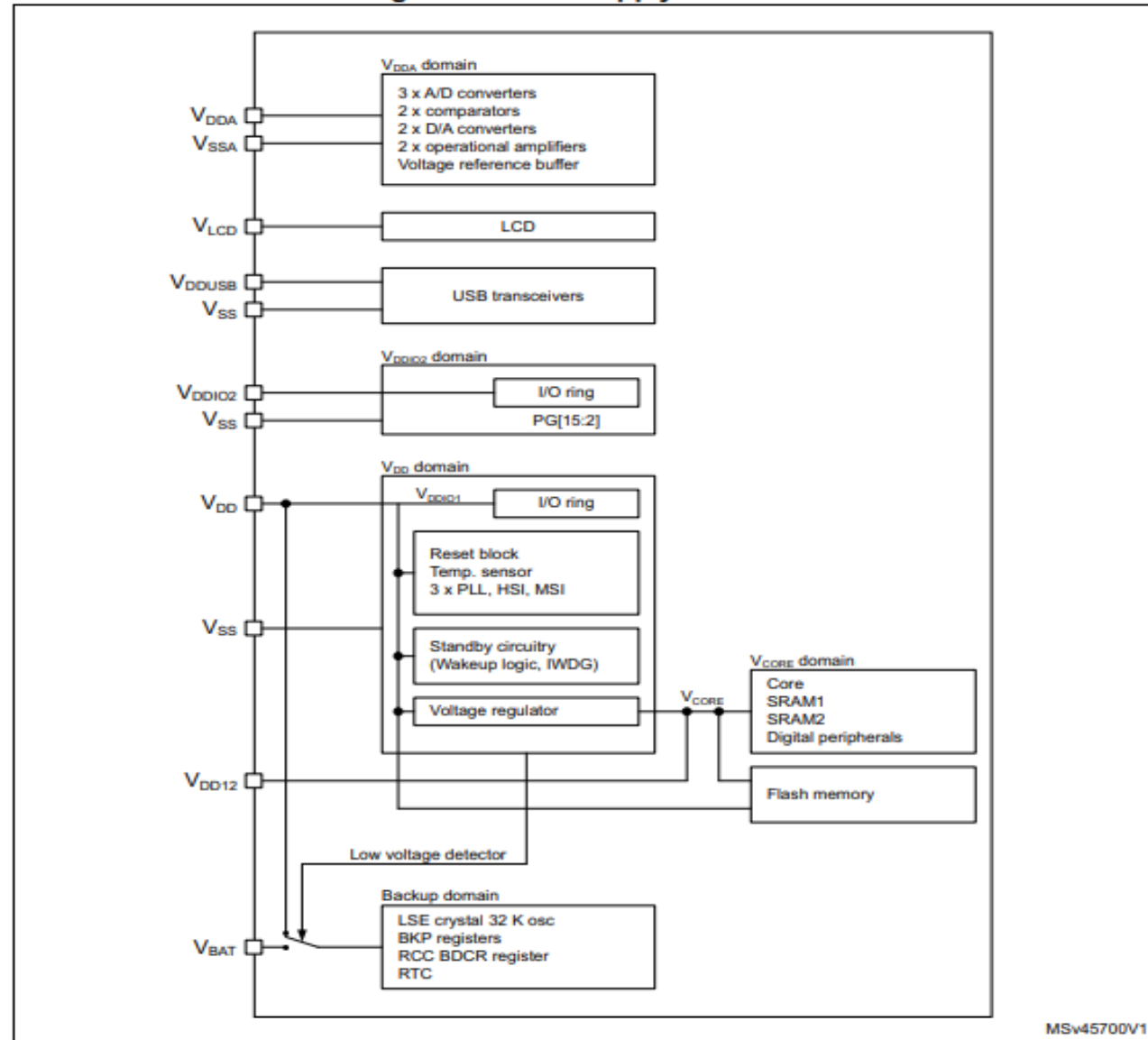


STM32L476xx - Ultra-low-power ARM Cortex-M4

- Run mode – operating mode after a system or power reset
- Sleep mode
- Low-power run mode
- Low-power sleep mode
- Stop mode
- Standby
- Shutdown
- **Power consumption decreases, performance decreases, wake-up time increases, and the number of wake-up sources decreases.**

STM32L476xx - Power supply

Figure 2. Power supply overview



Conclusion

Key aspects that typically change in low-power modes:

- Clock Gating
- Peripheral Shutdown
- Reduced Clock Speed
- Voltage Scaling
- Standby/Idle States
- Power-Down Modes

References

- LinkedIn - <https://www.linkedin.com/advice/3/how-do-you-use-low-power-modes-idle-mode-pic-microcontrollers>
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Thank you

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E şé

Daalụ

Köszönöm

Bayarlalaa

Merci

Obrigado

Shukran

Spasibo

Dhan'yabāda

Na gode