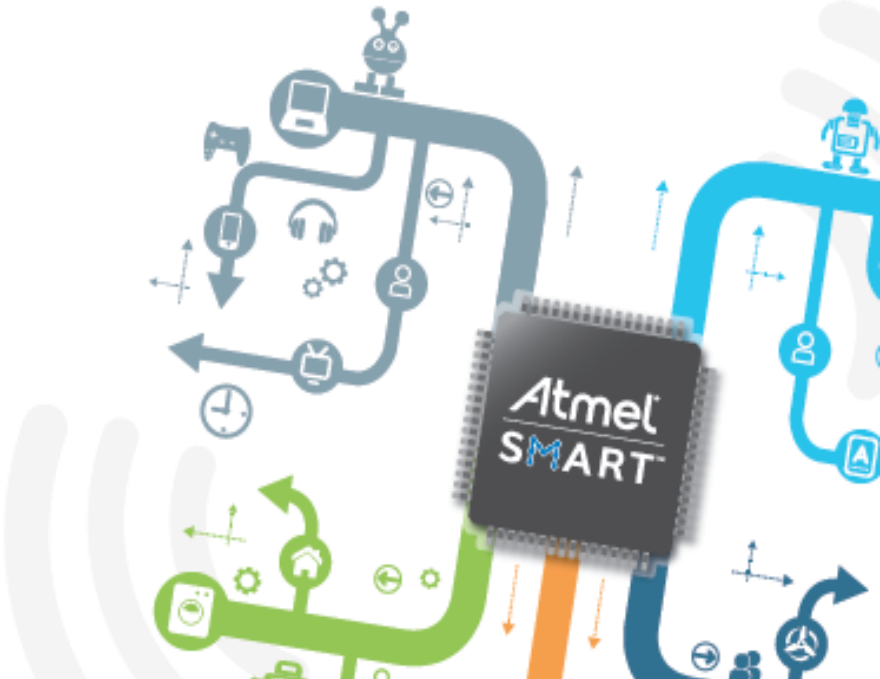
Atmel Technology Live
SAM D
Atmel | SMART™ ARM® Cortex-M0+ based MCU



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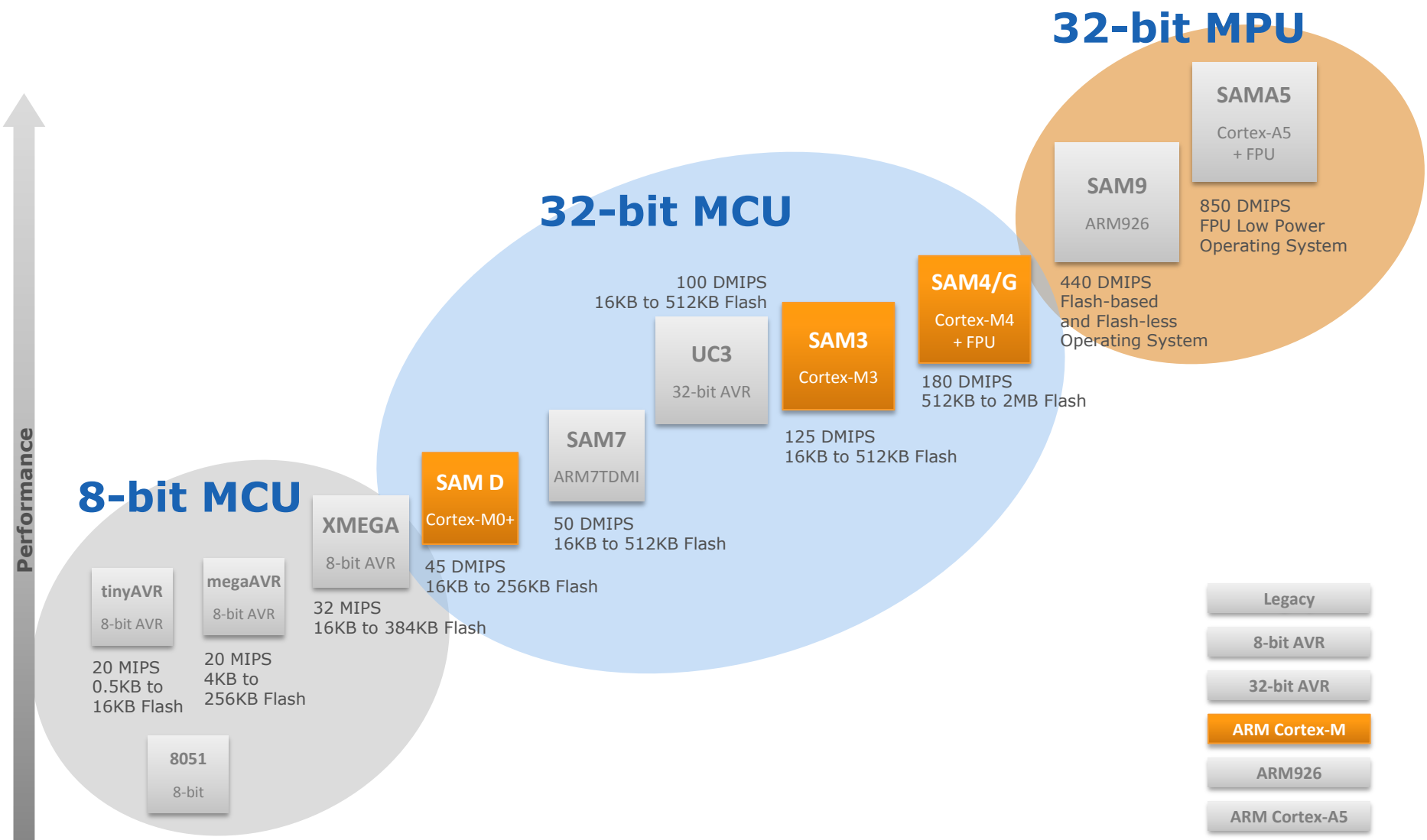
Atmel | SMART™ MCU Product Offering



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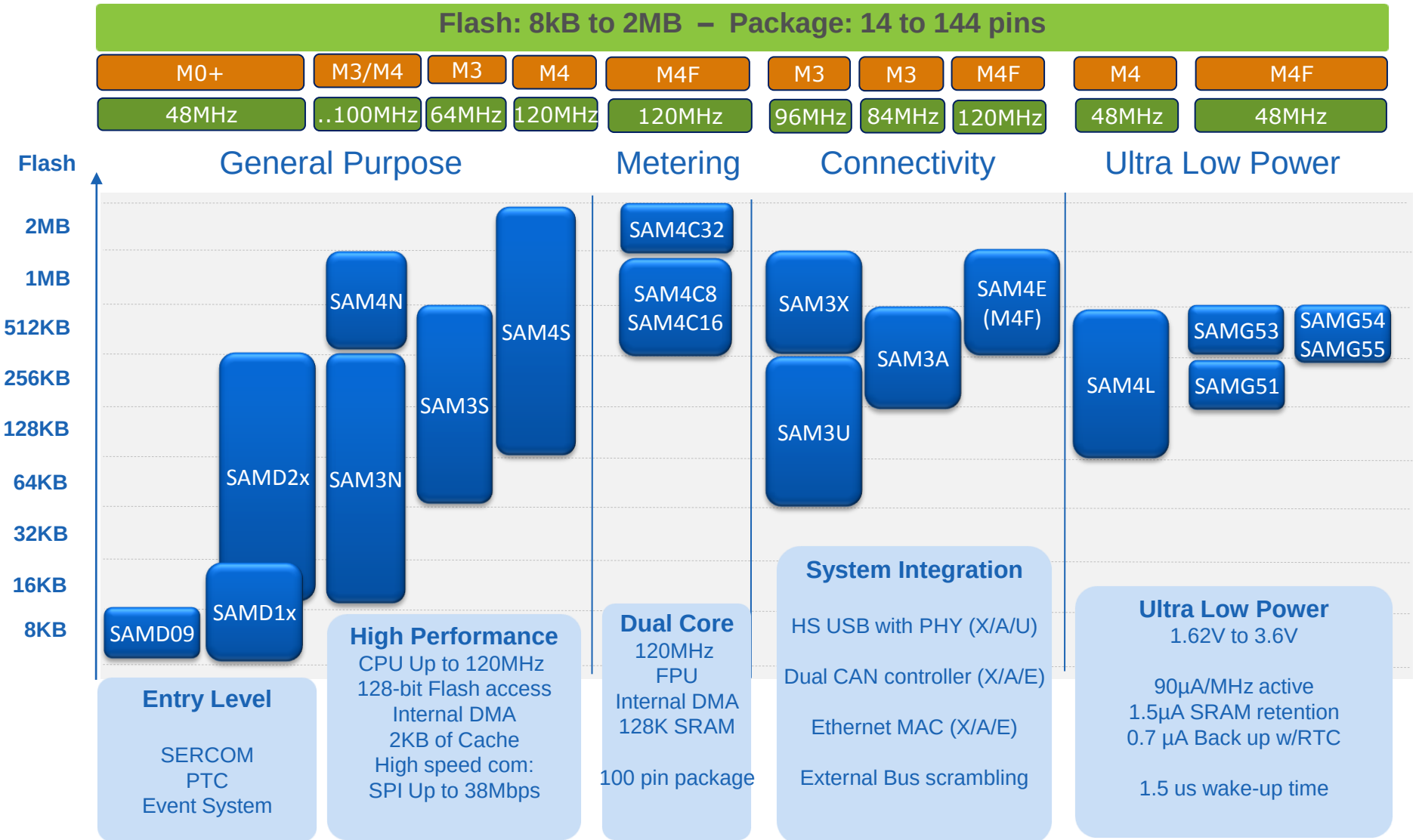
Atmel | SMART ARM Cortex based 32-bit MCU



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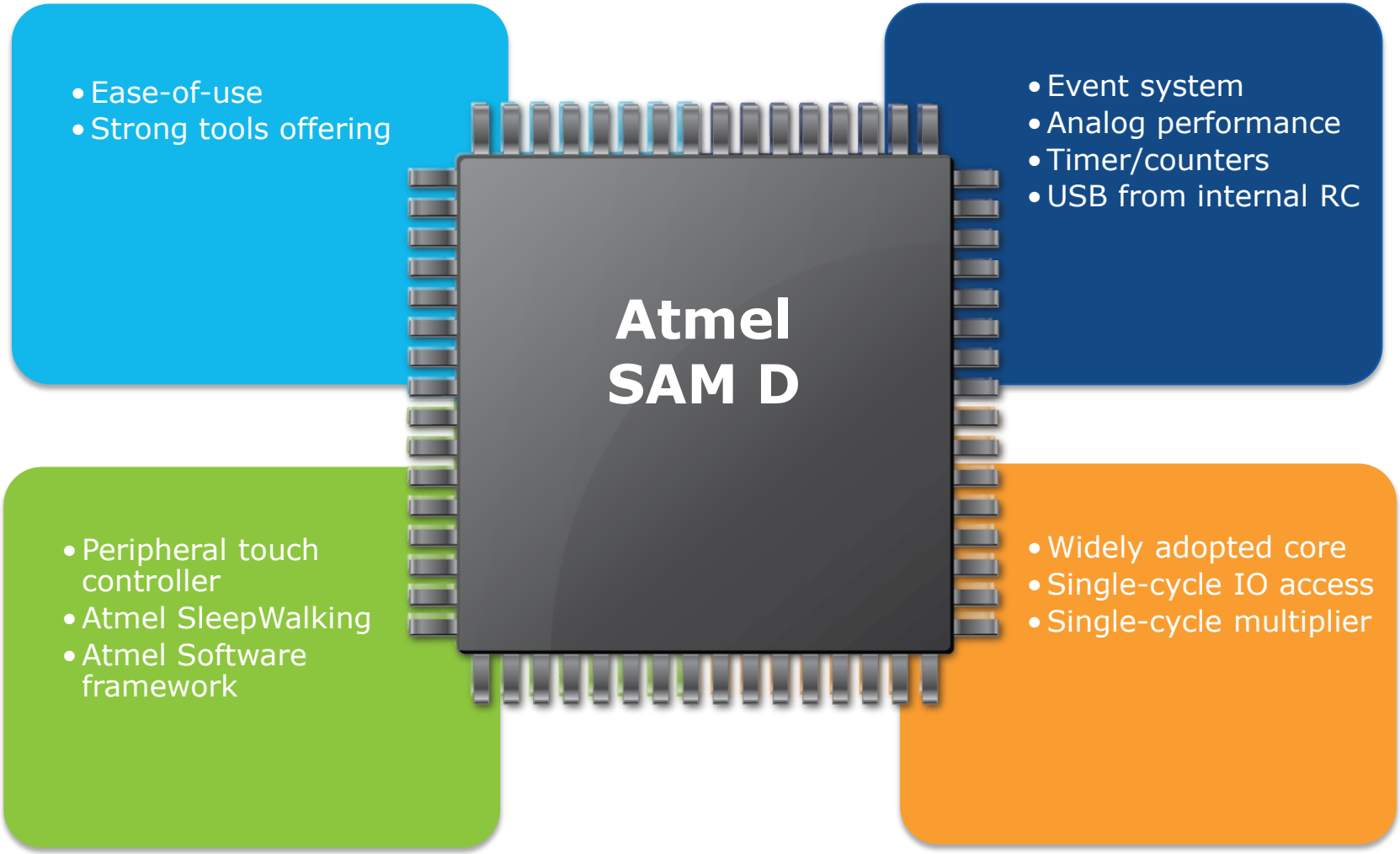
12 Years Lifetime commitment

Atmel | SMART

Introduction to Atmel SAM D family

Combining the best of Atmel MCUs with ARM Cortex-M0+



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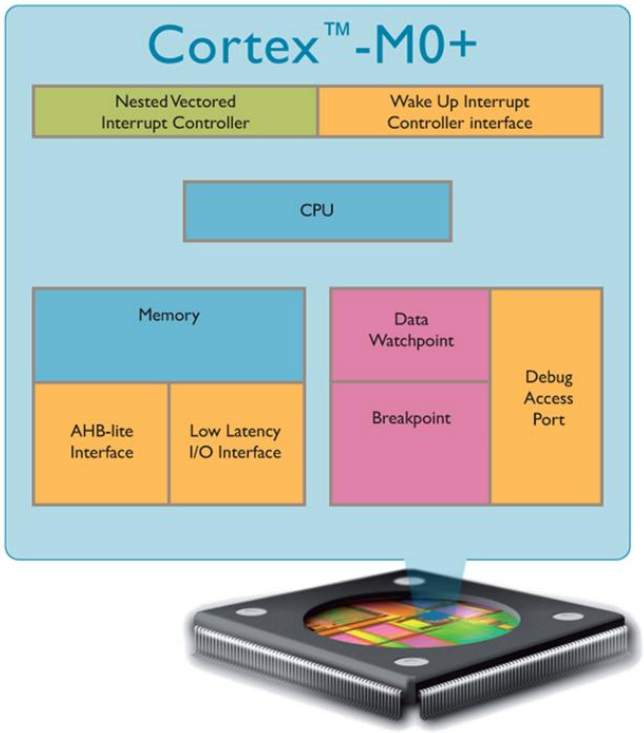
Introducing Atmel SAM D Family

Powerful and Efficient Products

- Atmel SAM D Product Family
  - 48MHz operation
  - Up to 2.14 CoreMark®
  - Down to 70µA/MHz
  - ±2% 8MHz int RC oscillator
  - 1.62V-3.63V
  - 4 product Series
    - 35 pin/memory/feature combinations
    - 8KB to 256KB Flash
    - 14-64 pin packages



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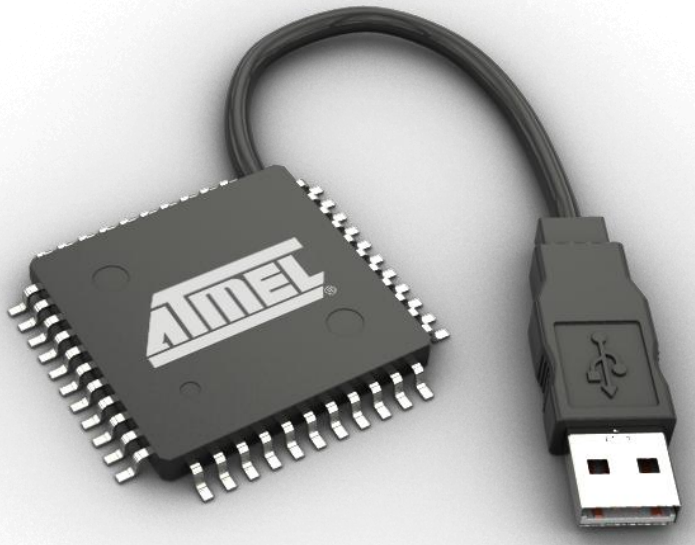
Atmel SAM D family

- Event system
- SERCOM modules configurable as I2C, USART or SPI
- Full Speed USB
  - Device from int RC oscillator
  - Embedded host
- Capacitive Touch HW engine
- 12-bit 350ksps ADC with gain stage
- 10-bit 350ksps DAC
- DMA Controller
- I2S
- Fractional PLL
- Timer/Counters



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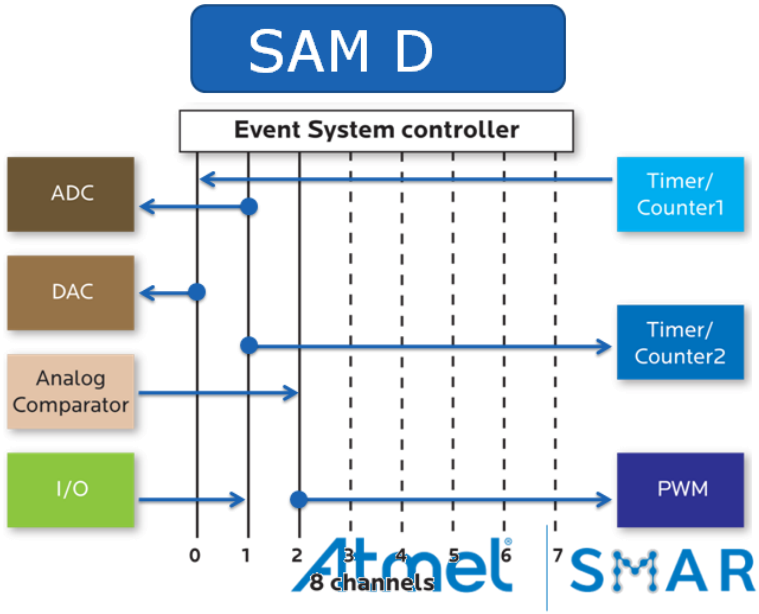
Peripheral Event System

Bringing the Innovation of Atmel AVR XMEGA to the Atmel SAM D Series

- Inter-peripheral Communication
  - CPU independent
  - Eight independent channels
  - Synchronous and Asynchronous
- Latency-free Event Handling
  - Safe fault protection
  - 100% predictable reaction time
- Advantages
  - Accurate timing
  - Efficiently offloading CPU
  - Reduced power consumption

Peripheral Events
GPIO
Timer /Counter
Asynchronous Timer (RTC)
Analog Comparator
ADC
DAC
Peripheral Touch Controller



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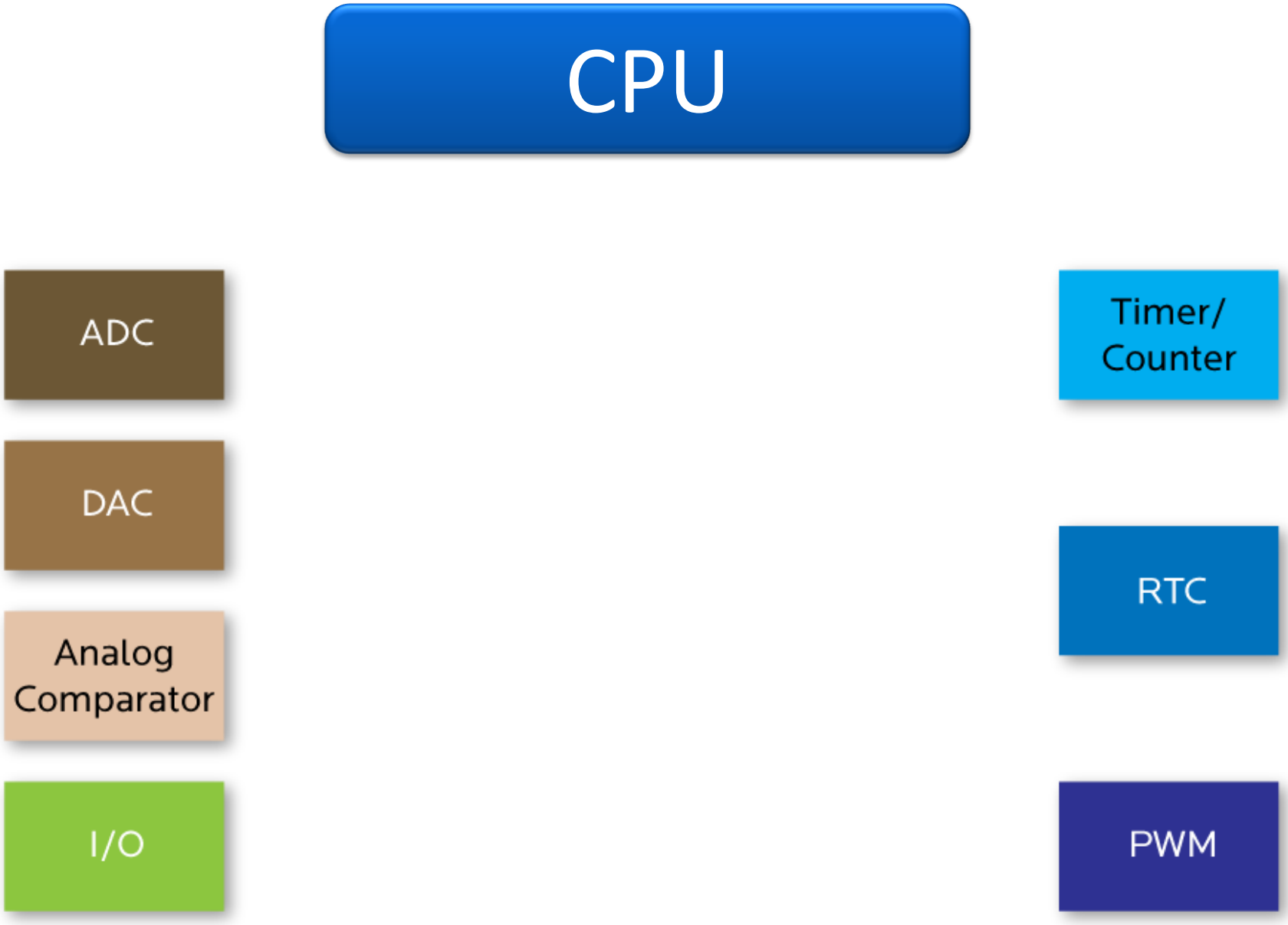

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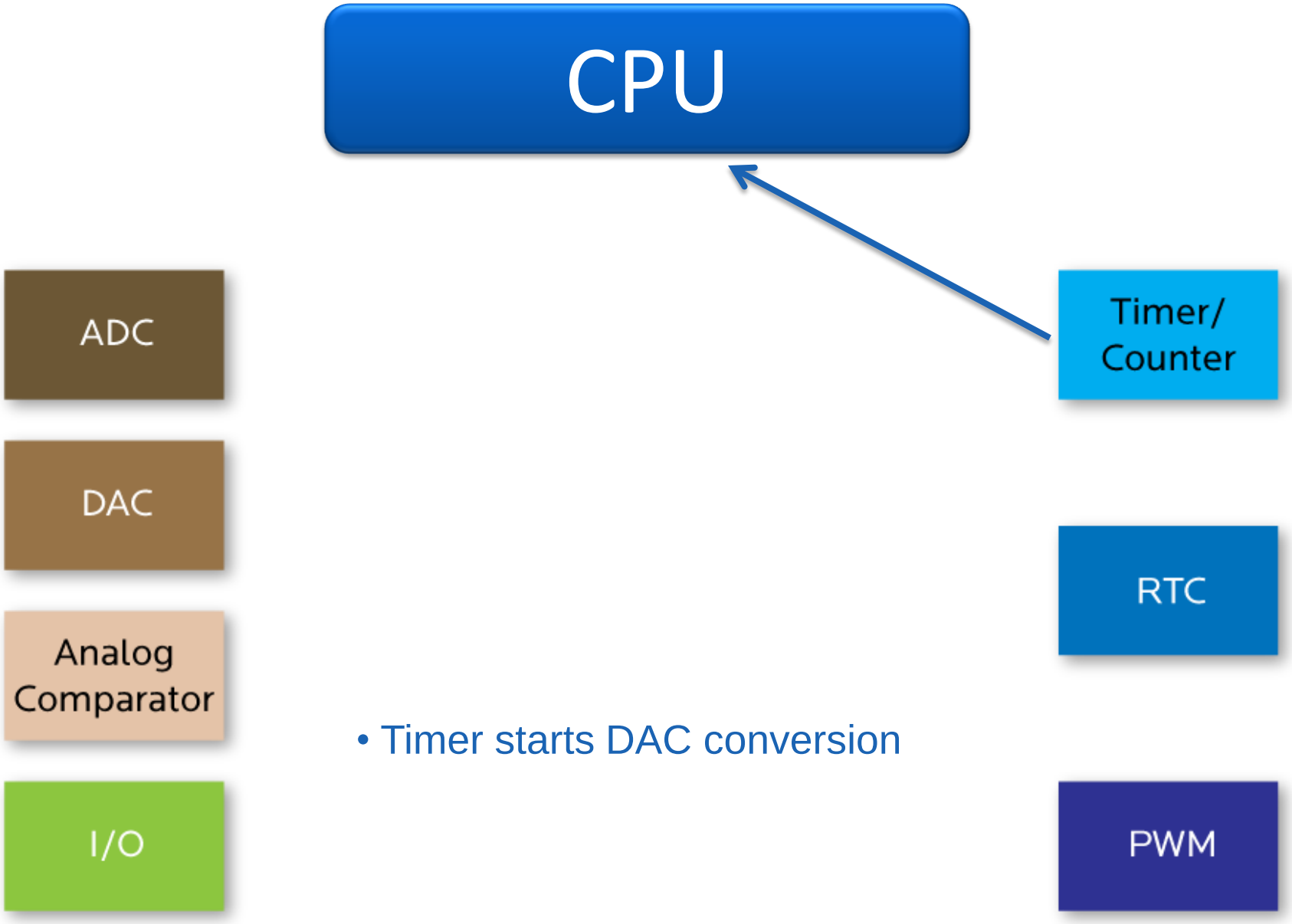

- Timer starts DAC conversion

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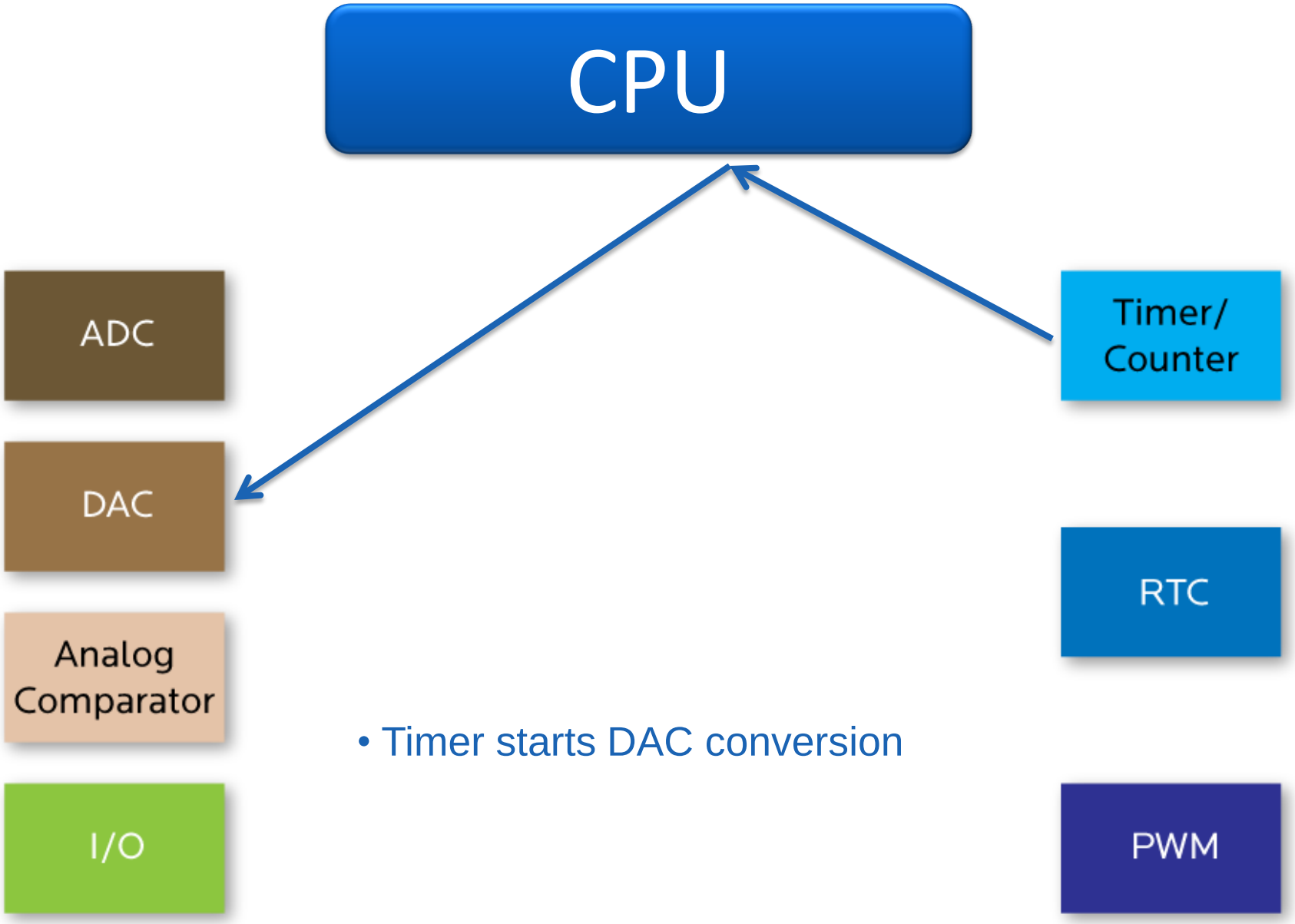

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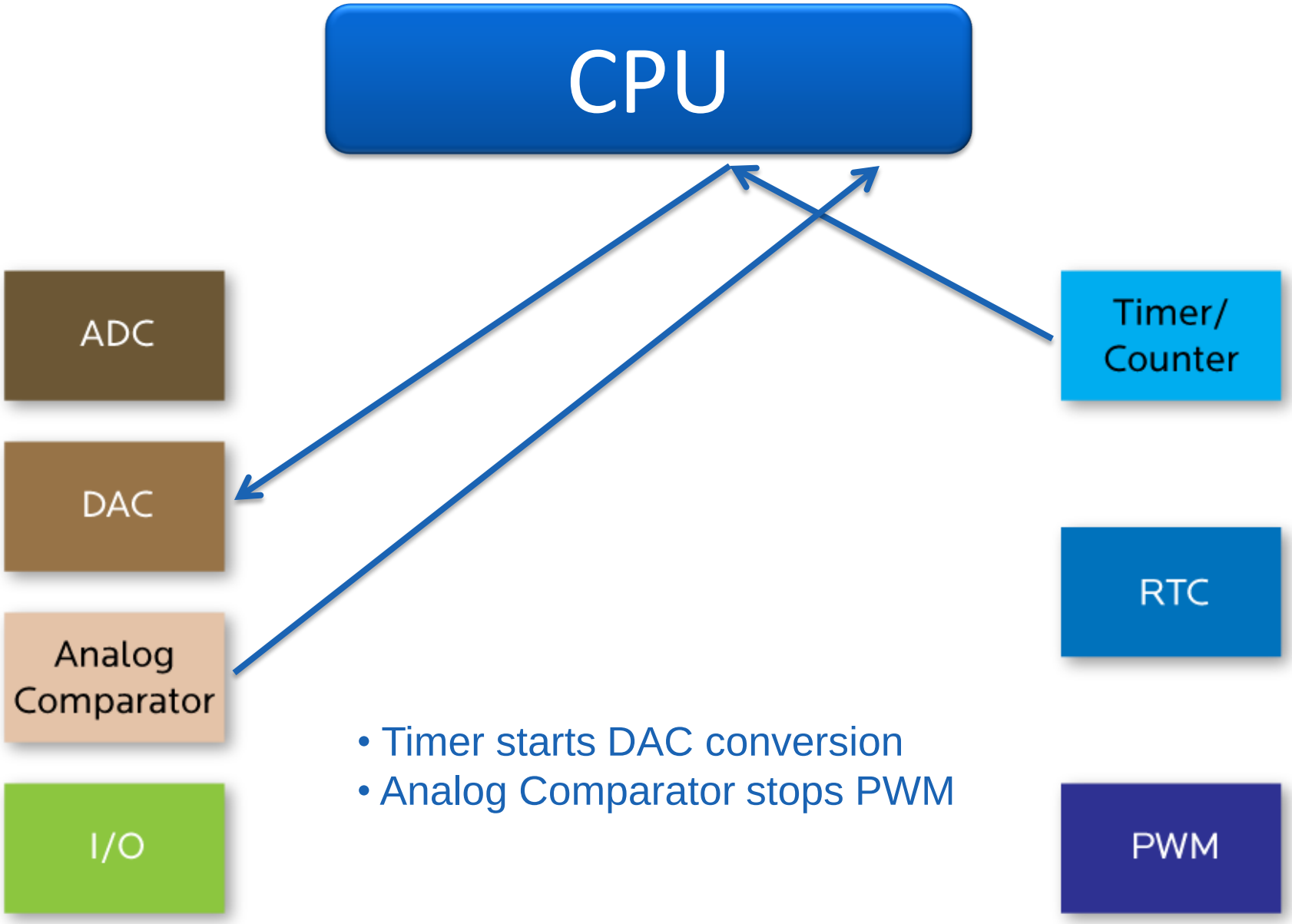

- Timer starts DAC conversion
- Analog Comparator stops PWM

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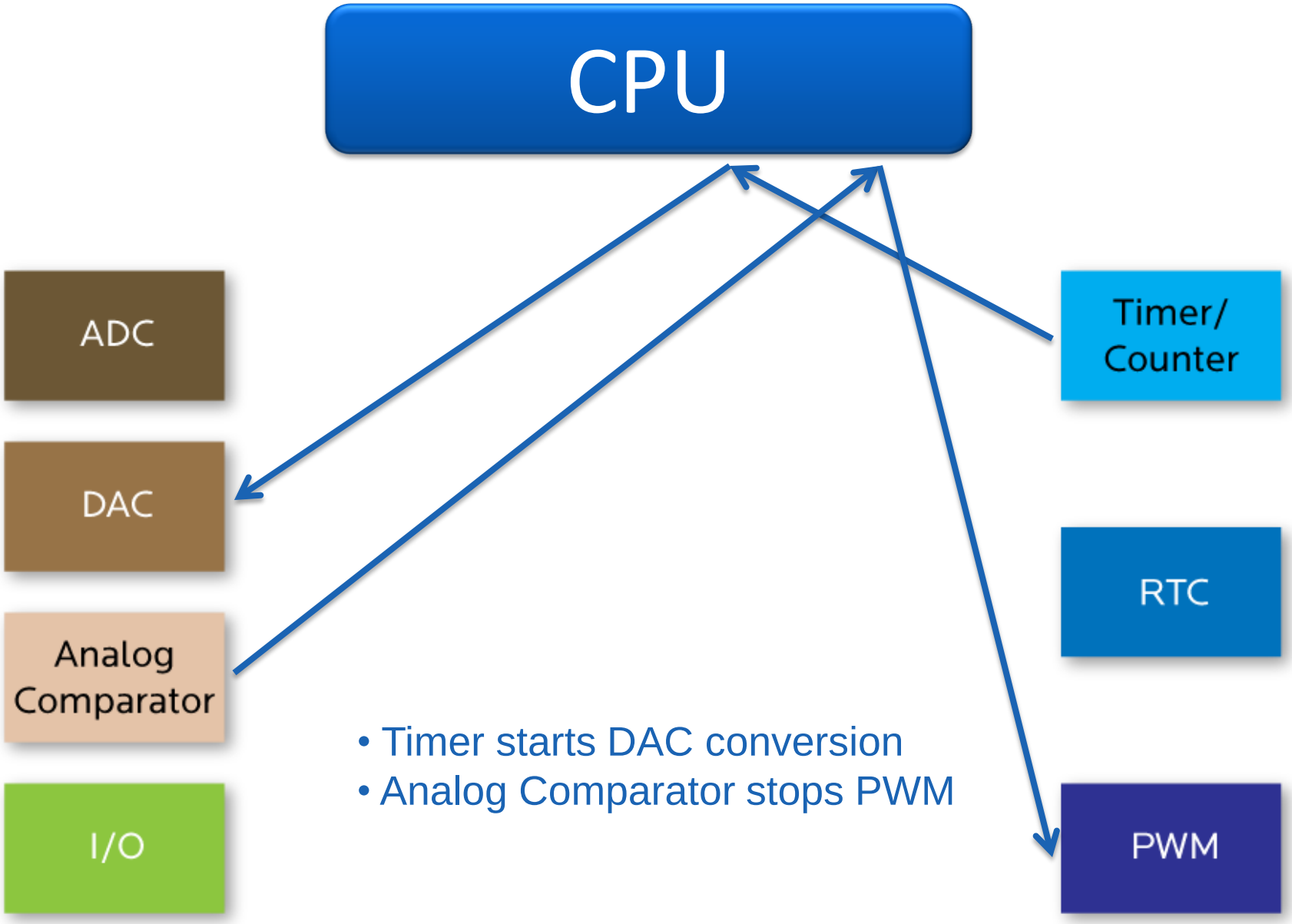

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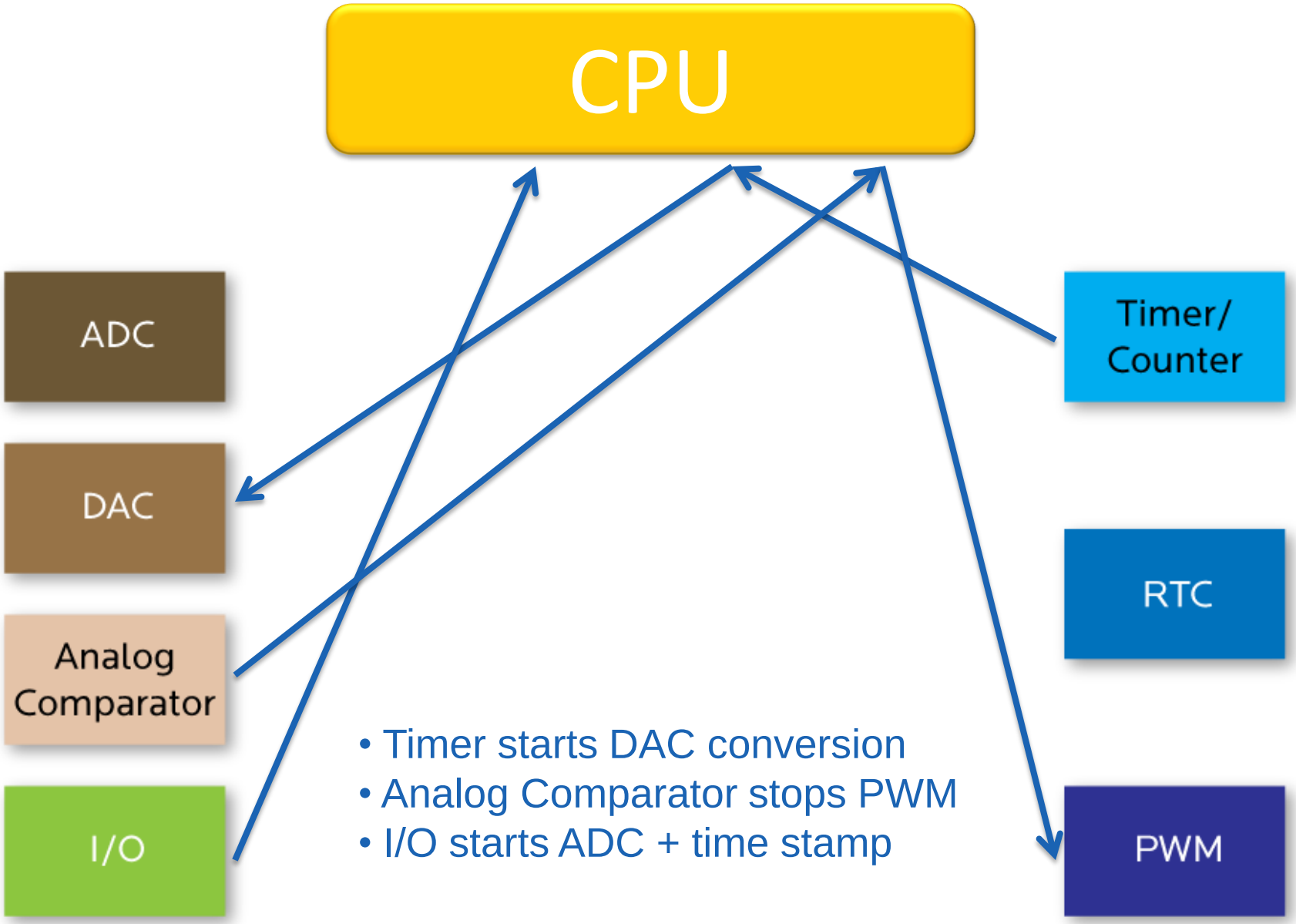
CPU
ADC
DAC
Analog Comparator
I/O
Timer/ Counter
RTC
PWM
• Timer starts DAC conversion
• Analog Comparator stops PWM
• I/O starts ADC + time stamp

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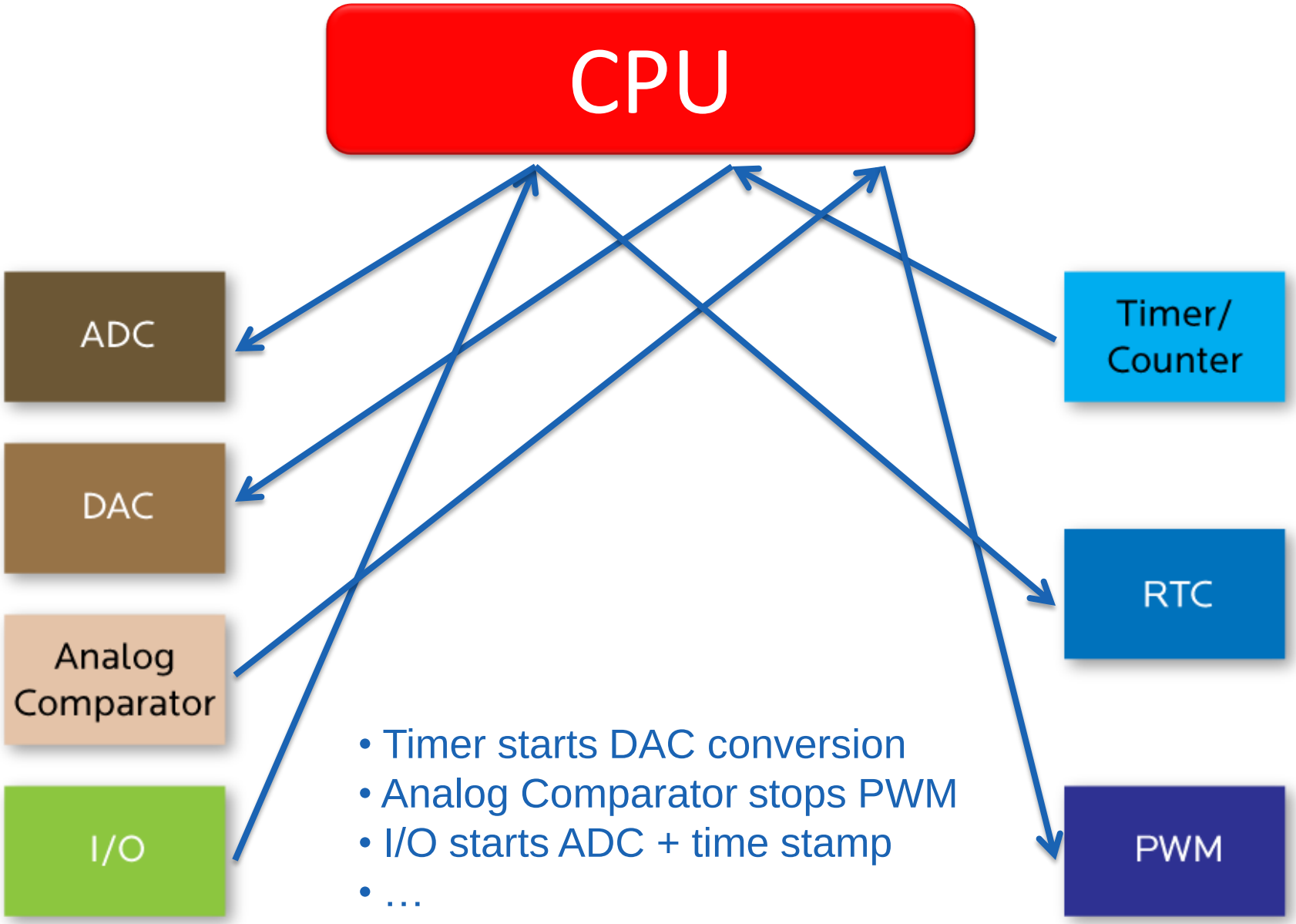

- Timer starts DAC conversion
- Analog Comparator stops PWM
- I/O starts ADC + time stamp
- …

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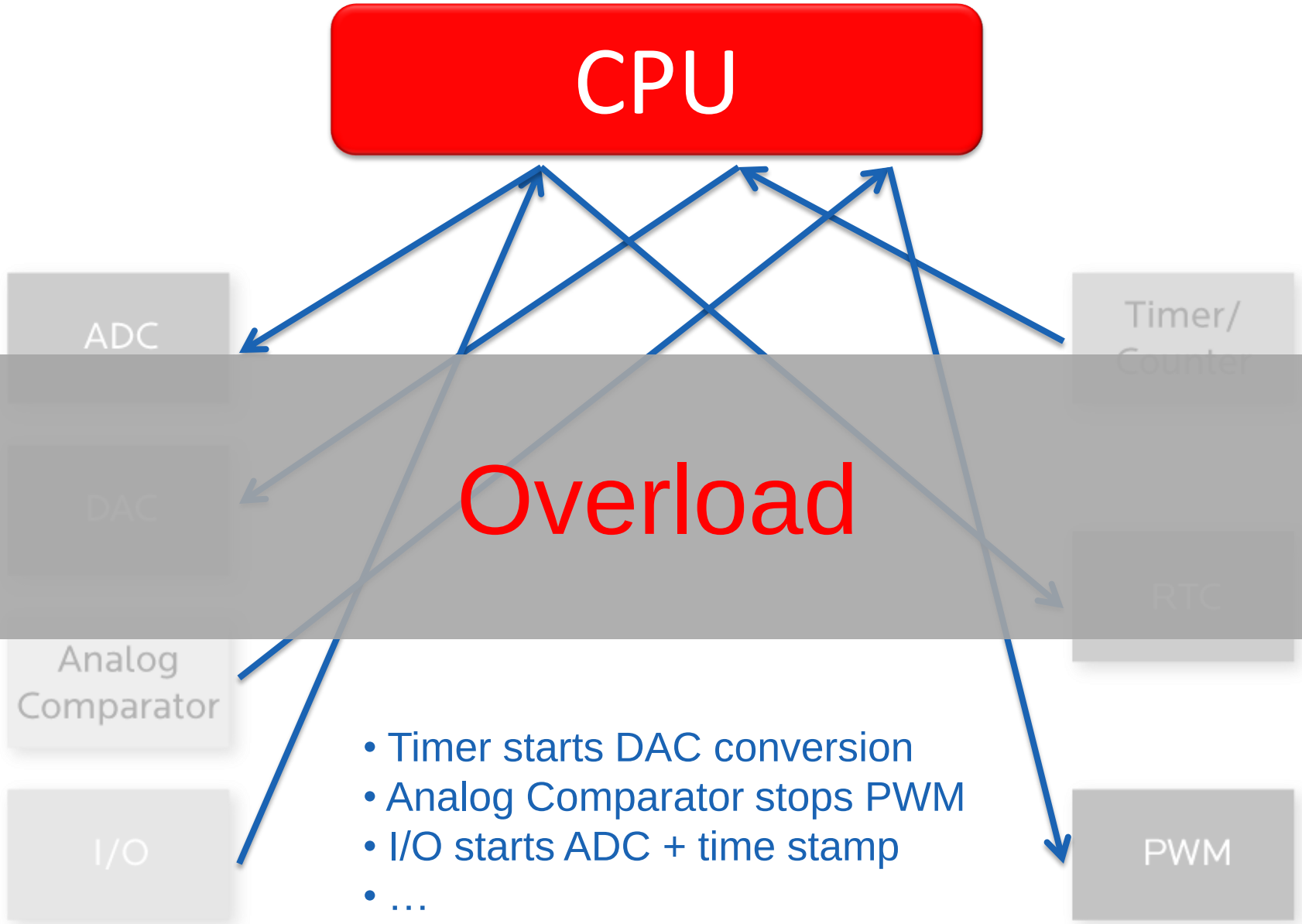
CPU
ADC
Timer/
Counter
DAC
RTC
Analog
Comparator
I/O
PWM
Overload
• Timer starts DAC conversion
• Analog Comparator stops PWM
• I/O starts ADC + time stamp
• …

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SAM D

Solution

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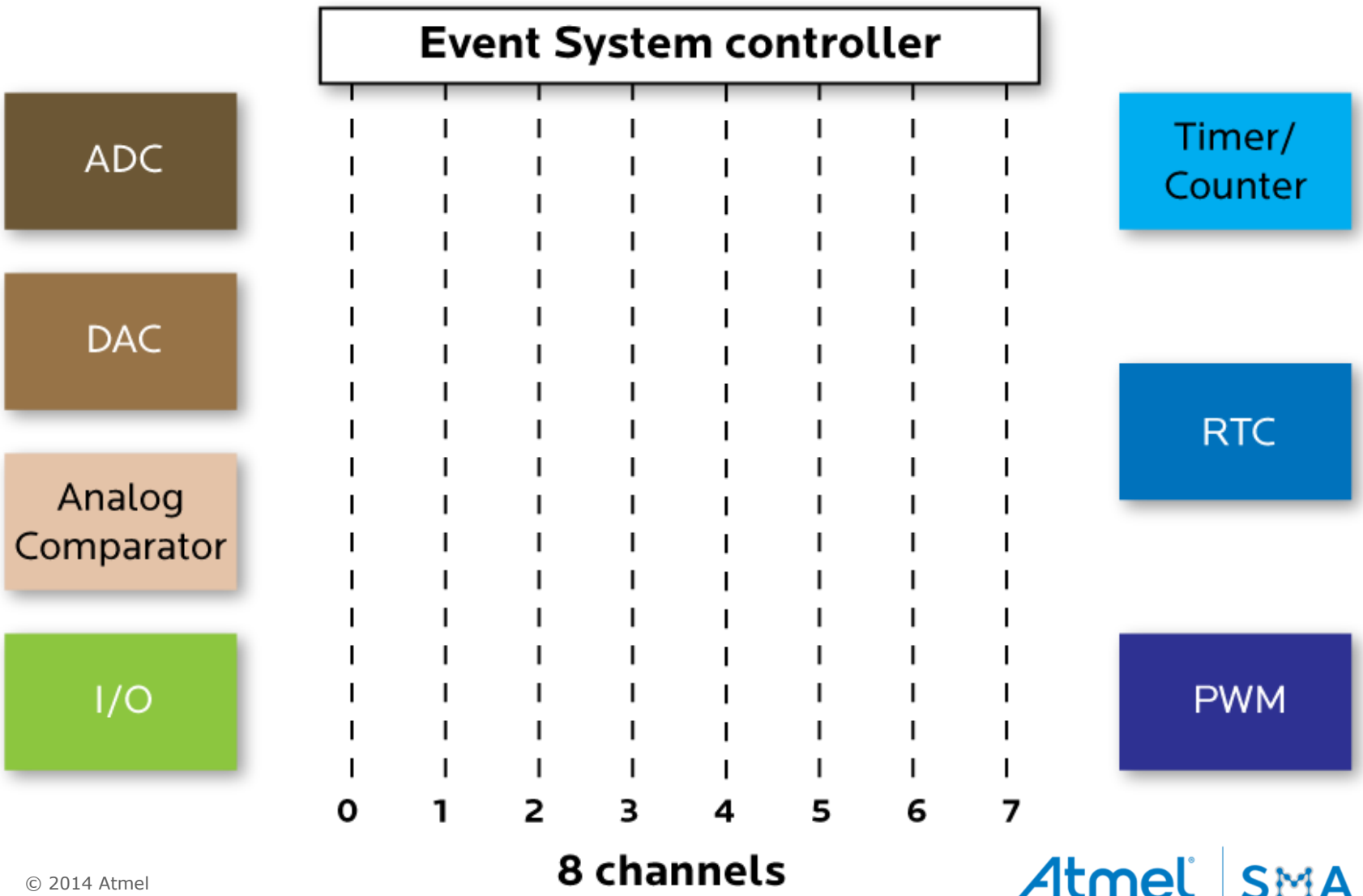

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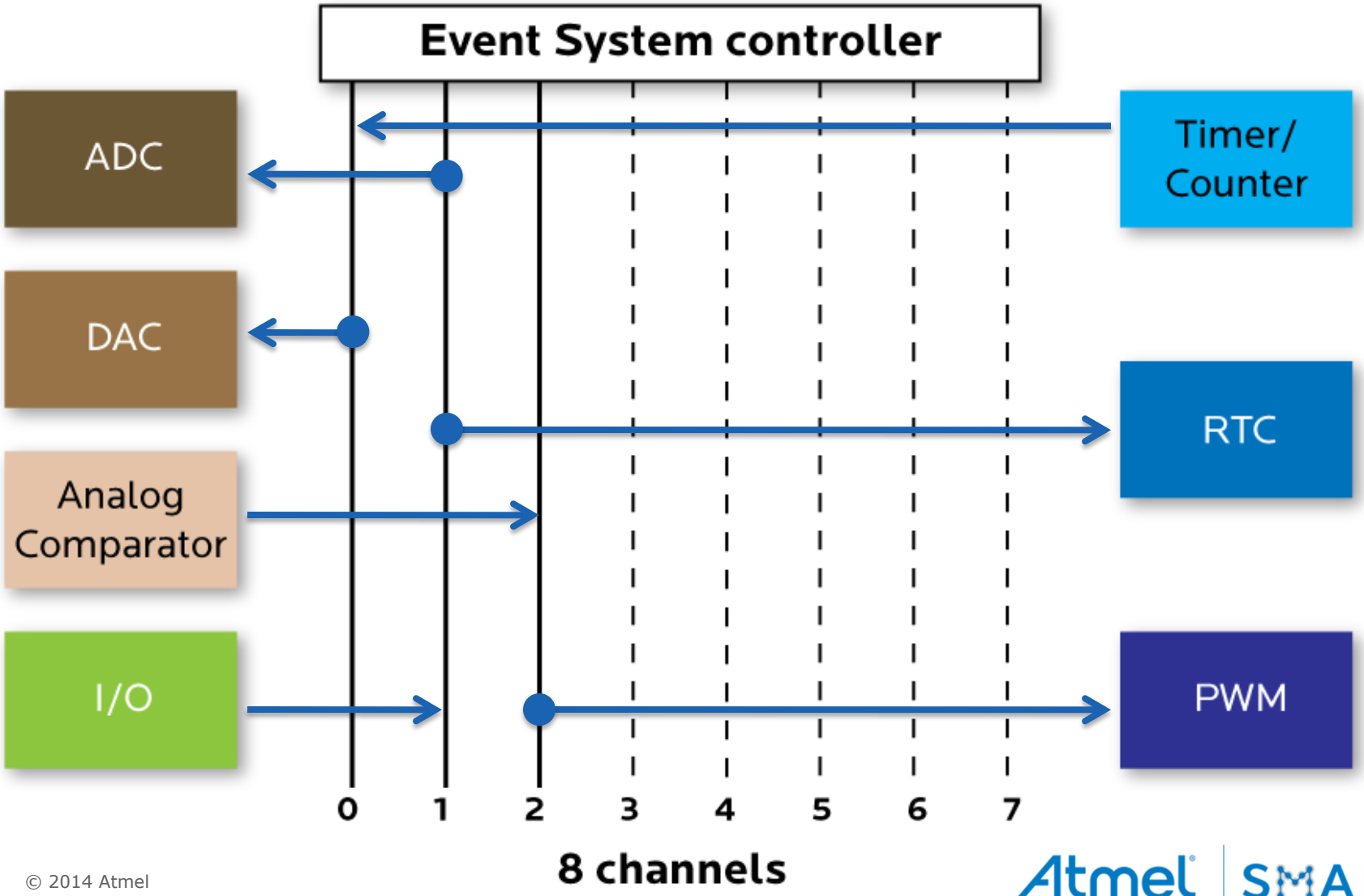

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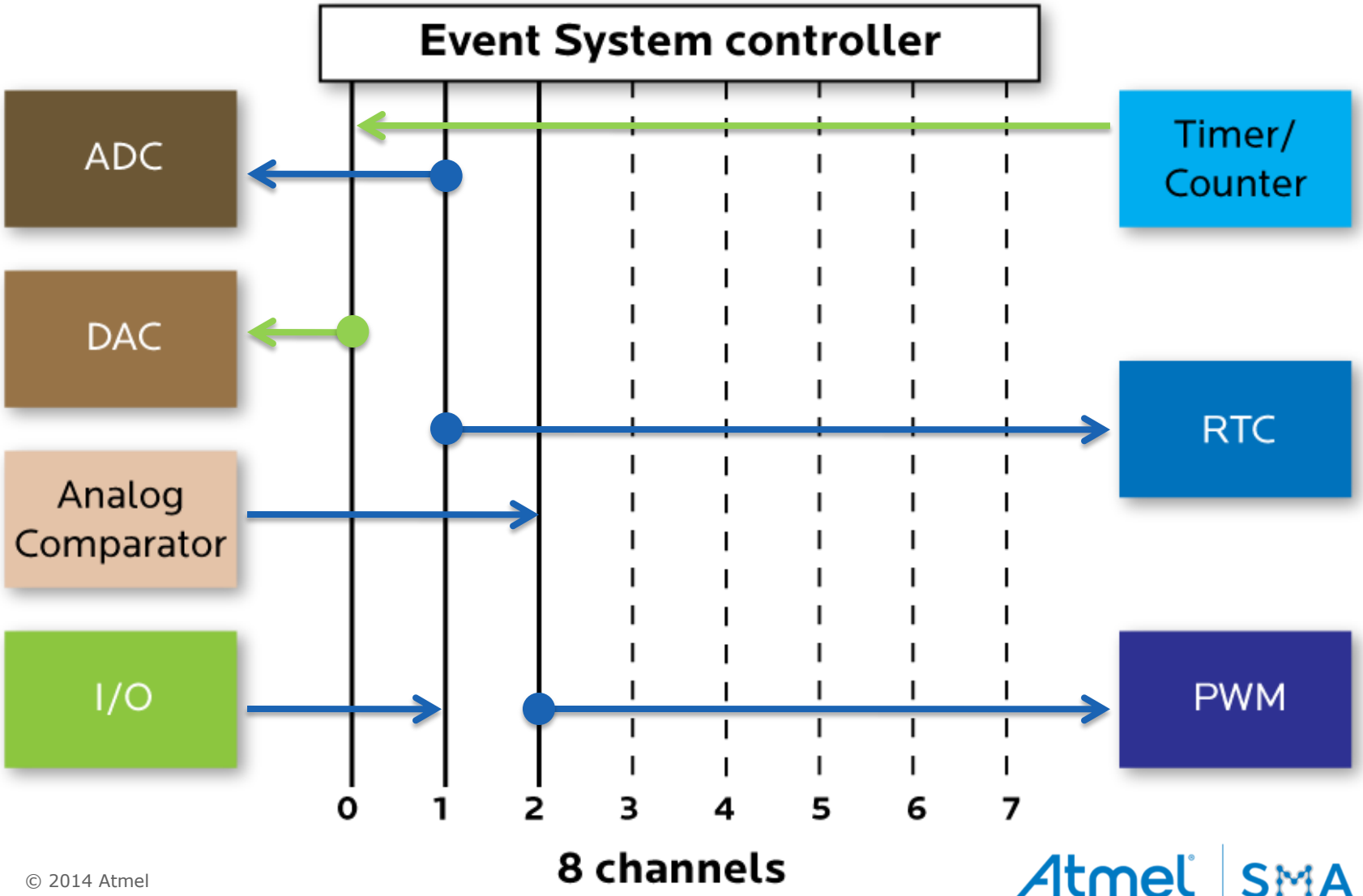

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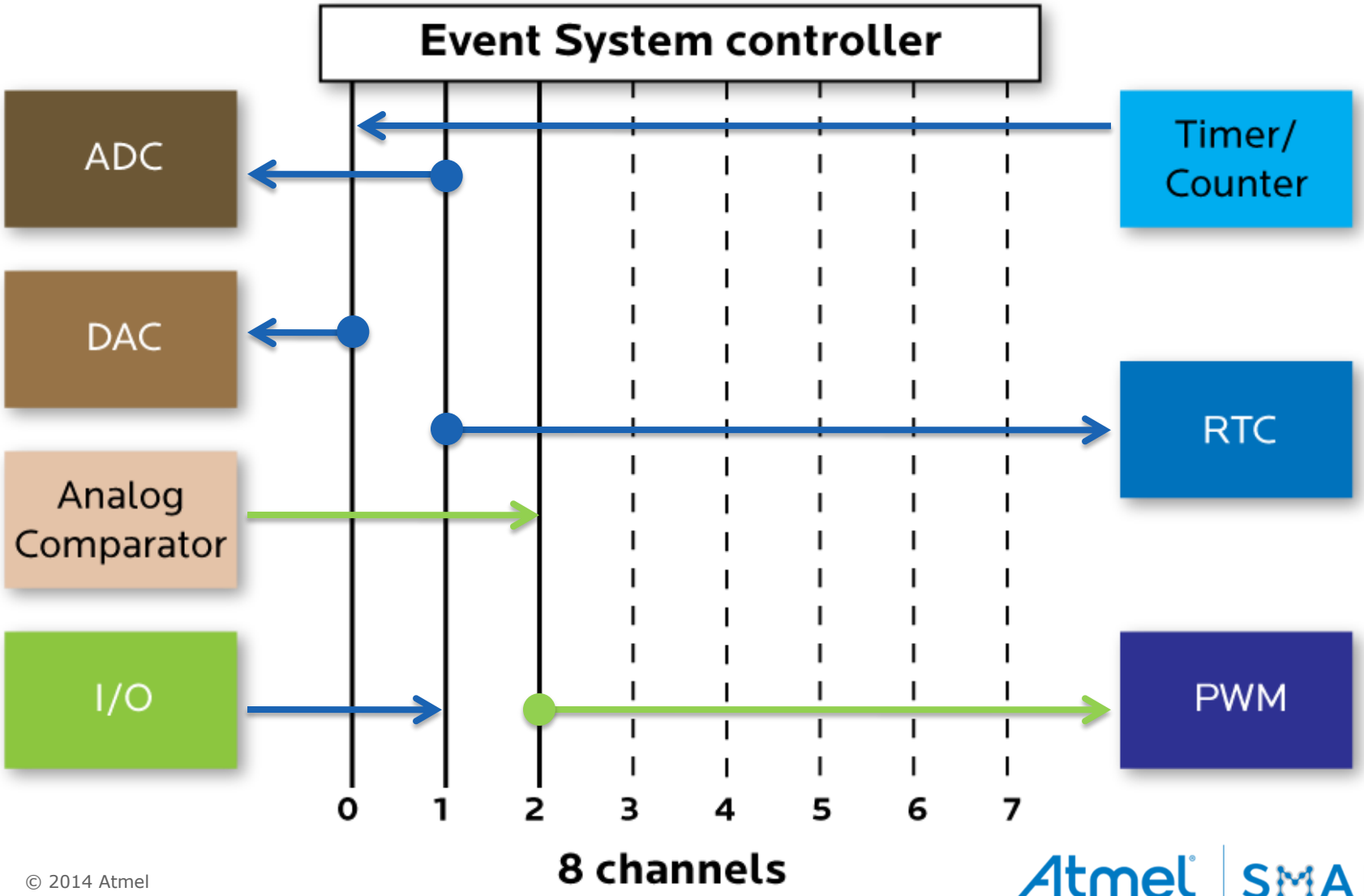

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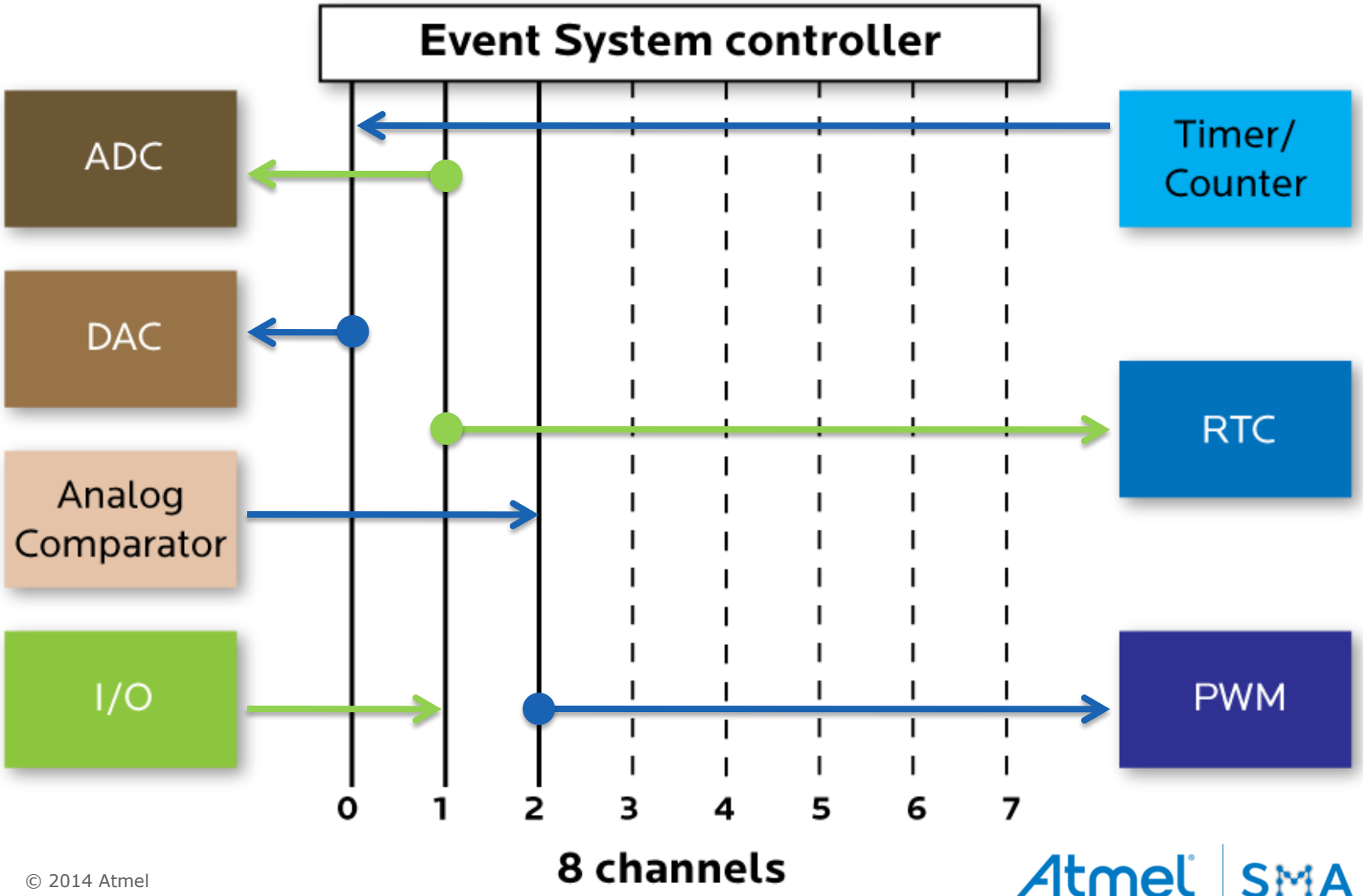

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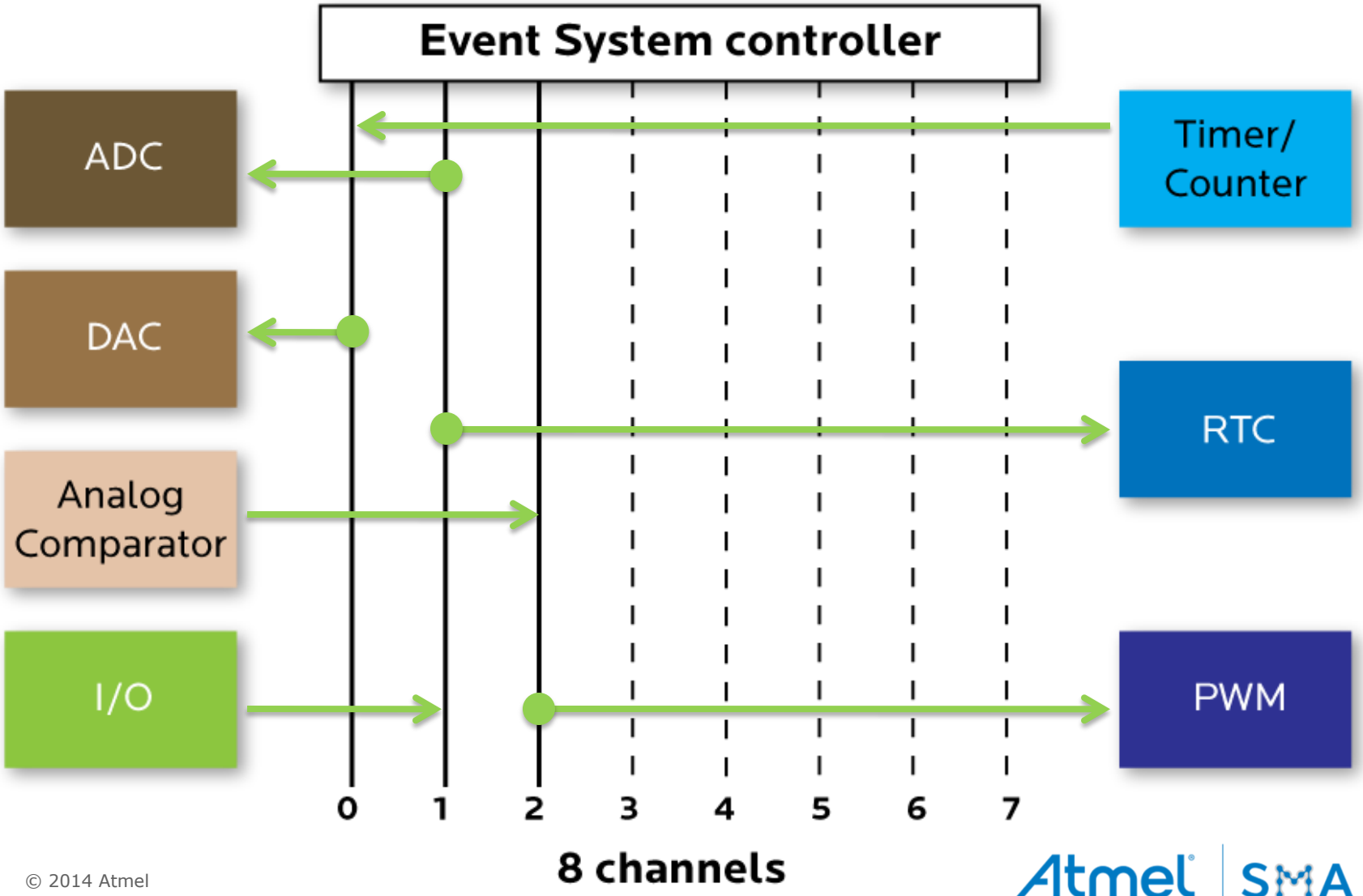

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Peripheral Event System

Bringing the Innovation of Atmel AVR XMEGA to the Atmel SAM D Series

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- Latency-free Event Handling
  - Safe fault protection
  - 100% predictable reaction time
- Advantages
  - Accurate timing
  - Efficiently offloading CPU
  - Reduced power consumption

Peripheral Events
GPIO
Timer /Counter
Asynchronous Timer (RTC)
Analog Comparator
ADC
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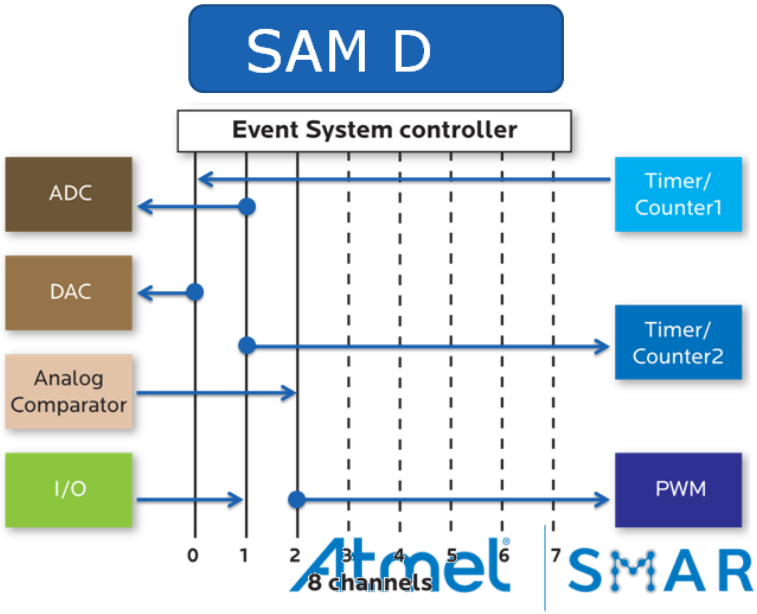
Peripheral Touch Controller



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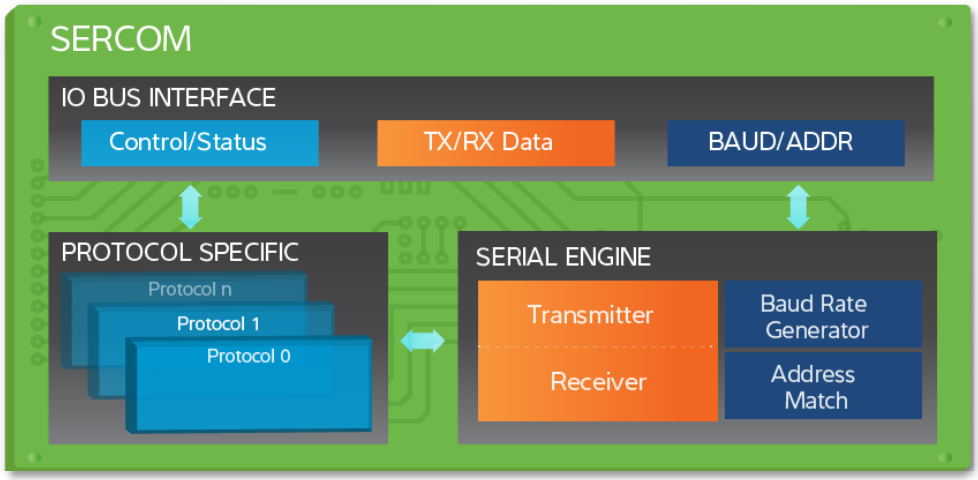
Serial Communication Module (SERCOM)

Highly Flexible Multi-interface Communication Module

- Configurable as
  - I2C
  - SPI
  - USART
- Supporting PM/SMBus & IrDA
- Double-buffered Reception
- IO Pin multiplexing
- Reconfigurable from software
- Wake-up from All Power Modes
  - I2C address match
  - SPI data reception
  - USART start detection



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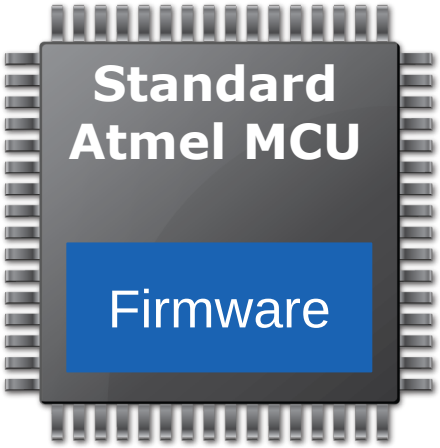
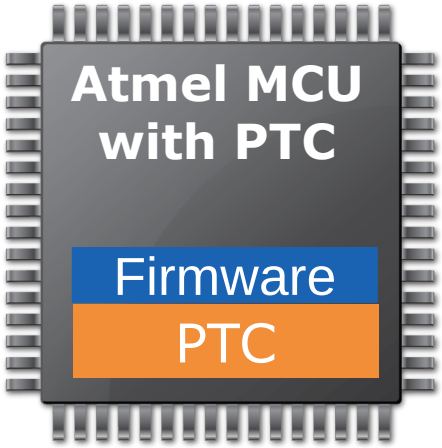
Peripheral Touch Controller (PTC)





- All firmware solution
- Constraints when used with timing critical application code
- Requires tuning to work in noisy environments

- Dedicated hardware touch controller
- Works great with any application code
- Easily passes 10V conducted immunity tests

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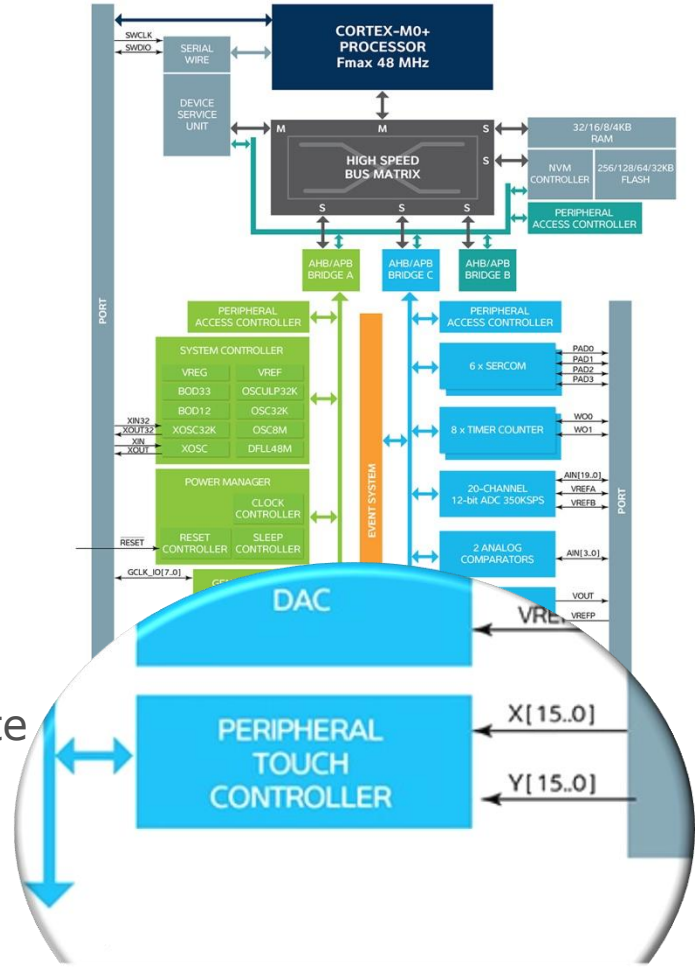
Peripheral Touch Controller (PTC)

- Supports Buttons, Sliders, and Wheels
- Supports Mutual- and Self-Capacitive Touch
  - Self-(re)calibrating, no tuning needed
  - No external components needed
- Excellent conducted immunity (CI)
  - Built-in hardware filtering
  - Passes 3V CI with no external components
  - Passes 10V CI with 100K series resistor
- Low standby power consumption
  - 6µA scanning one channel at 200ms scan rate
- Low CPU Utilization
  - 5% CPU utilization scanning 10 channels at 50ms scan rate



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Peripheral Touch Controller (PTC)

High Channel Count

Package	PTC channels Mutual Cap	PTC channels Self Cap
64-pin	Up to 256	Up to 16
48-pin	Up to 120	Up to 10
32-pin	Up to 60	Up to 6
24-pin	Up to 72	Up to 16
20-pin	Up to 42	Up to 13
14-pin	Up to 12	Up to 7

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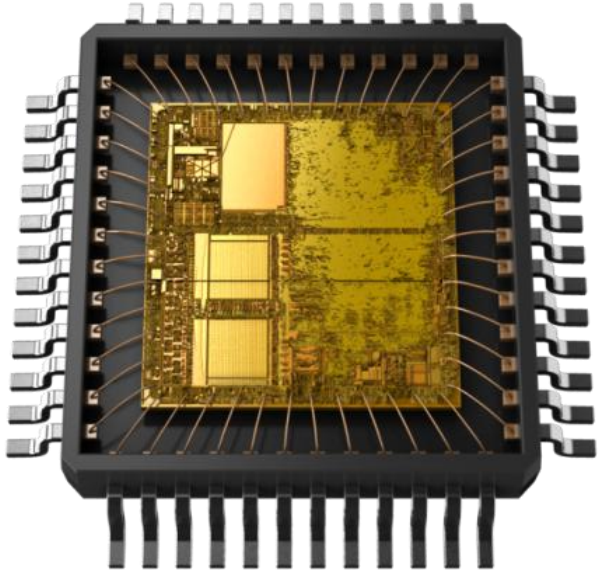
New Features

Added to SAMD09/10/11/21



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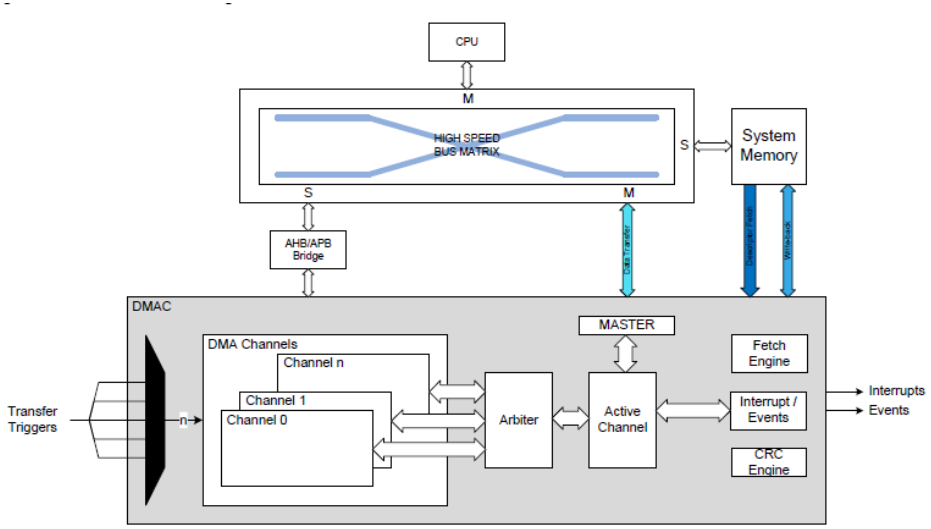
Direct Memory Access - DMA

Available in SAM D09, D10, D11 and D21

- Supports Data Transfers
  - Peripheral to Peripheral
  - Peripheral to Memory
  - Memory to Peripheral
  - Memory to Memory
- Transfer triggers
  - Software
  - Event System
  - Peripherals
- 12 Channels
  - Suspend/resume support for each channel
  - PingPong Operation with Event System
- 3 priority levels

- Flexible Adressing modes
  - Static
  - Programmable increment
- 1- 64KB data transfers
- Connected to
  - ADC,DAC,I2S,SERCOM,T/C,T/CC
- CRC support on transfers
  - CRC-16 (CRC-CCITT)
  - CRC-32 (IEEE 802.3)



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Full Speed USB

USB Device in SAM D11, USB Device and Host in D21

- Supports USB Full (12Mbit/s) and Low speed (1.5Mbit/s)
- No Need for external components
  - On-chip transceivers with built-in pull-ups and pull-downs
  - On-Chip USB serial resistors
  - USB Full Speed device operation from internal RC oscillator
- No endpoint/pipe size limitations
  - Uses Device SRAM as communication buffer
- Built-in DMA with multi-packet and double bank
- Supports feedback endpoint
- If USB is not needed, USB pins can be configured to GPIO

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Inter IC Sound Controller - I2S with FPLL

Available in SAM D21

Bidirectional, synchronous, digital Audio link to external audio devices

- 2 independent Serializers configurable as receiver or transmitter
- 32-, 24-, 20-, 18-, 16-, and 8-bit mono or stereo format
- 16- and 8-bit compact stereo format
  - left and right samples packed in the same word to reduce data transfers
- Peripheral DMA channels, separate for each Serializer, allow a continuous high bit rate data transfer without processor intervention
  - Audio CODECs in Master, Slave, or Controller mode
  - Stereo DAC or ADC through dedicated I2S serial interface
  - Multi-slot or multiple stereo DACs or ADCs, using the TDM format
  - Mono or stereo MEMS microphones, using the PDM interface

- Fractional Digital Phase locked loop enables synchronization of data for USB to I2S streaming without audio glitches from a single crystal

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Enhanced Timer/Counter Unit (TCC)

Perfect for SMPS, Lighting and Motor application fields

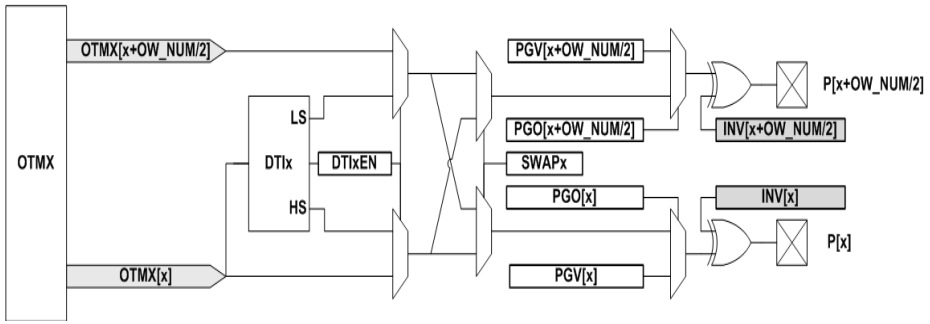
- Up to 96 MHz native resolution
- 4,5, 6 bit dithering resolution improvement (freq. & pulse width)
- 2 to 4 independent Output Comp/Input Capture channels per TCC
- Circular buffers for asymmetrical Push-pull control
- Advance capture features (for zero crossing detection).

Fault handling

- Connected to Timer/Counter output and WeX input
- Fast, synchronous and asynchronous fault triggering
- Flexible configuration with multiple fault sources
- Handle recoverable and non-recoverable fault modes

Waveform extension

- Output matrix support
- DTI unit
- SWAP function
- Pattern generator



Advantages

- Optimized functionality for advanced PWM and waveform output
- Full ***autonomous*** support of critical power switching applications

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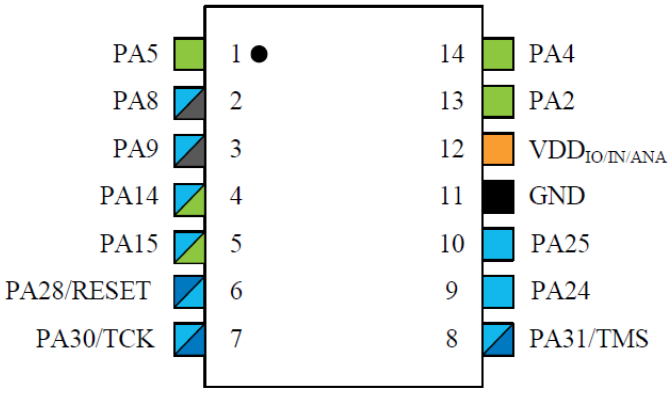
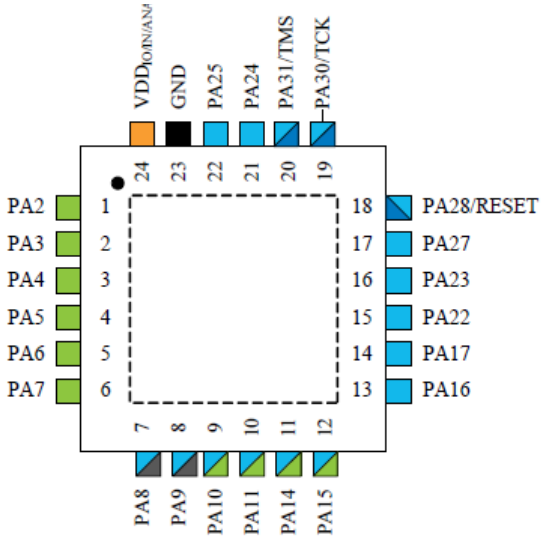
High GPIO pin count on small packages

Available in SAM D09, D10 and D11

- Only 2 pins used for Power and GND
  - Even when running USB Device!
- Reset can be used as GPIO



- Up to 22 GPIO on 24 pin QFN
- Up to 18 GPIO on 20 pin SOIC
- Up to 12 GPIO on 14 pin SOIC



- For reference:
  - ST only has 15 GPIO on QFN20 (STM32F030) = less functionality
  - And need 5 external components = $$ + Board space

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Other Improvements

Available in SAM D09, D10, D11 and D21

- SERCOM
  - I2C increased from 1MHz to 3.4MHz
  - Autobaud on UART
  - LIN support
  - SMBus/ PMBus support
  - IrDA support up to 115.2bkps
- CPU
  - Added Micro Trace Buffer

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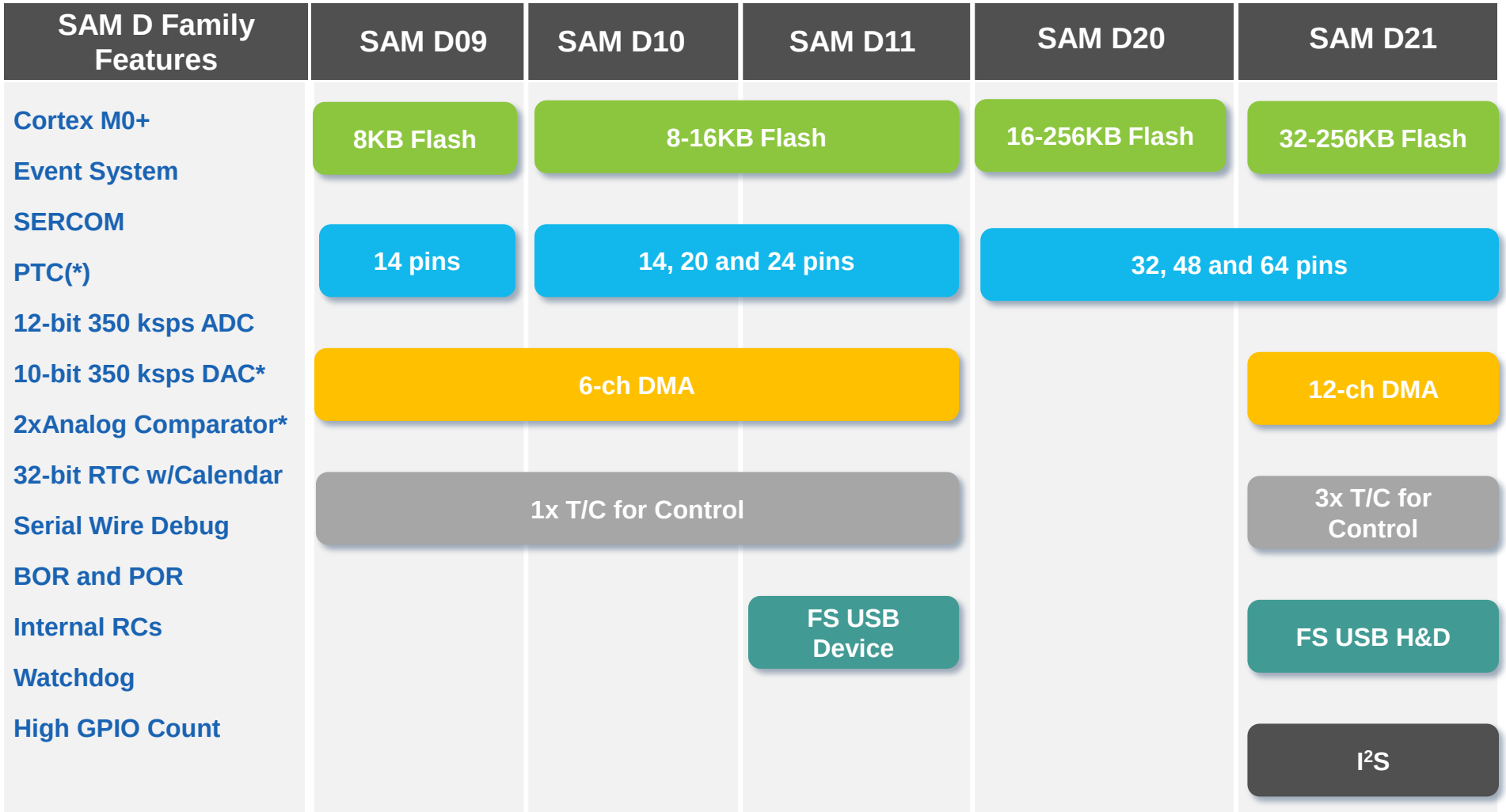
SAM D Atmel | SMART CM0+ Family Overview



* = not on D09

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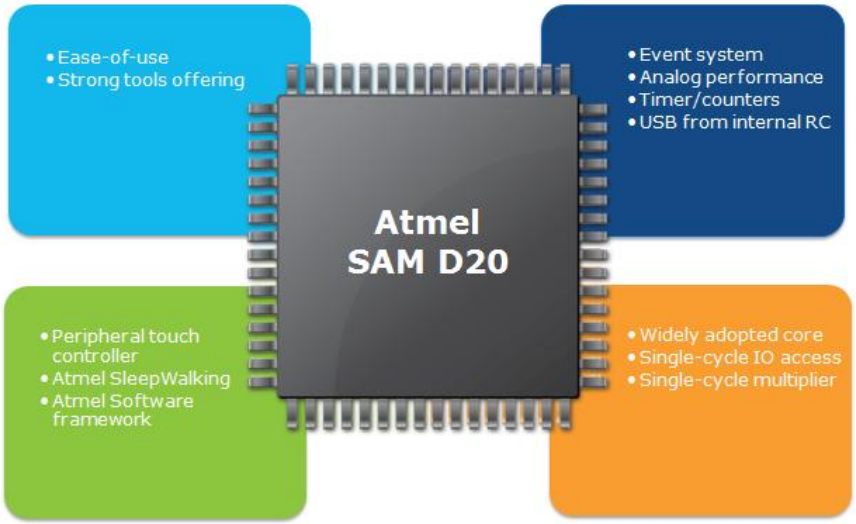
Atmel SAM D summary

- SAM D Combining the best of Atmel AVR® MCUs with ARM CM0+
- Peripheral intelligence
- Event system and DMA
- SERCOM
- Full Speed USB embedded Host and Device
- Peripheral Touch Controller
- Large GPIO count
- Short design time

- Everything is compatible!



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