

Infineon

C868 – 8-Bit Microcontroller

January 2003

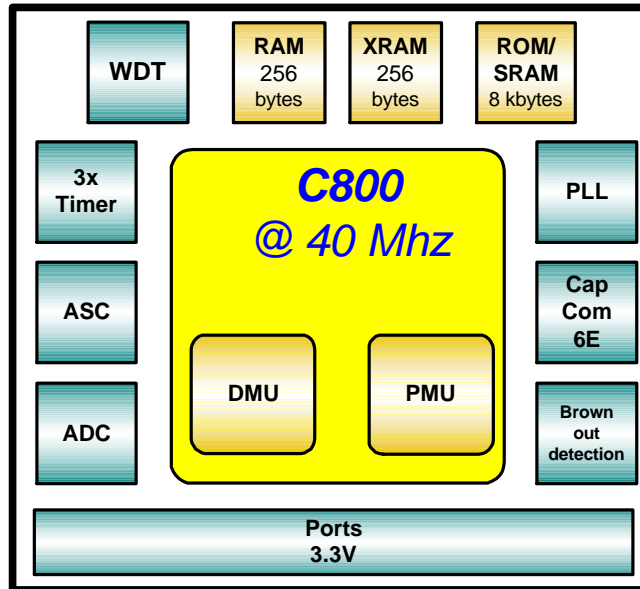


Never stop thinking.

C868 Best Choice for Lighting and Drive

- The following slides provide information about:
 - C868 Key Features and Benefits
 - Target Markets
 - Target Applications
 - C868 Memory and Boot Concept
 - C868 I/O Interface, Packages, Pinout
 - C868 Advanced Core & Module Description

C868 Key Features and Benefits



Key Benefits:

- **Powerful PWM Unit (CAPCOM)**
 - Perfect fitting for:
 - Induction machine, DC brushless and switched reluctance drives
 - Power factor correction
 - Lamp ballast, battery management
 - HW emergency stop
 - 25 ns resolution @ 40 MHz Int. (10 MHz Ext.)

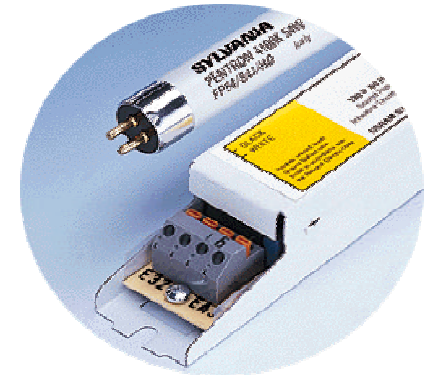
Key Features:

- Standard 8051 architecture
- 300 ns instruction cycle time at 40MHz CPU clock (10MHz Ext. Clock) – “Divide by 3”
- 8 Kbytes ROM/SRAM
- 256 byte RAM, 256 byte XRAM
- Bootstrap loader (var. Boot options)
- Three 16-bit timer/counters
- CAPCOM 6
- 5 channel 8-bit A/D converter
- Brown out detection
- UART (full duplex)
- I/O pins with push/pull and 10mA sink capability
- Packages: P-TSSOP-38, P-DSO-28,
- Temperature ranges: -40°C / +85°C and -40°C / +125°C
- Single Voltage supply: 3.3V

Target Markets

All industrial and automotive control applications

- Consumer drives
 - Compressors
 - Pumps
 - Fans
 - White goods
 - Aircondition
- Lamp Ballast
 - Electronic Lamp Ballasts
- Actuators
- Power Supplies



Target Applications (Consumer Drive)

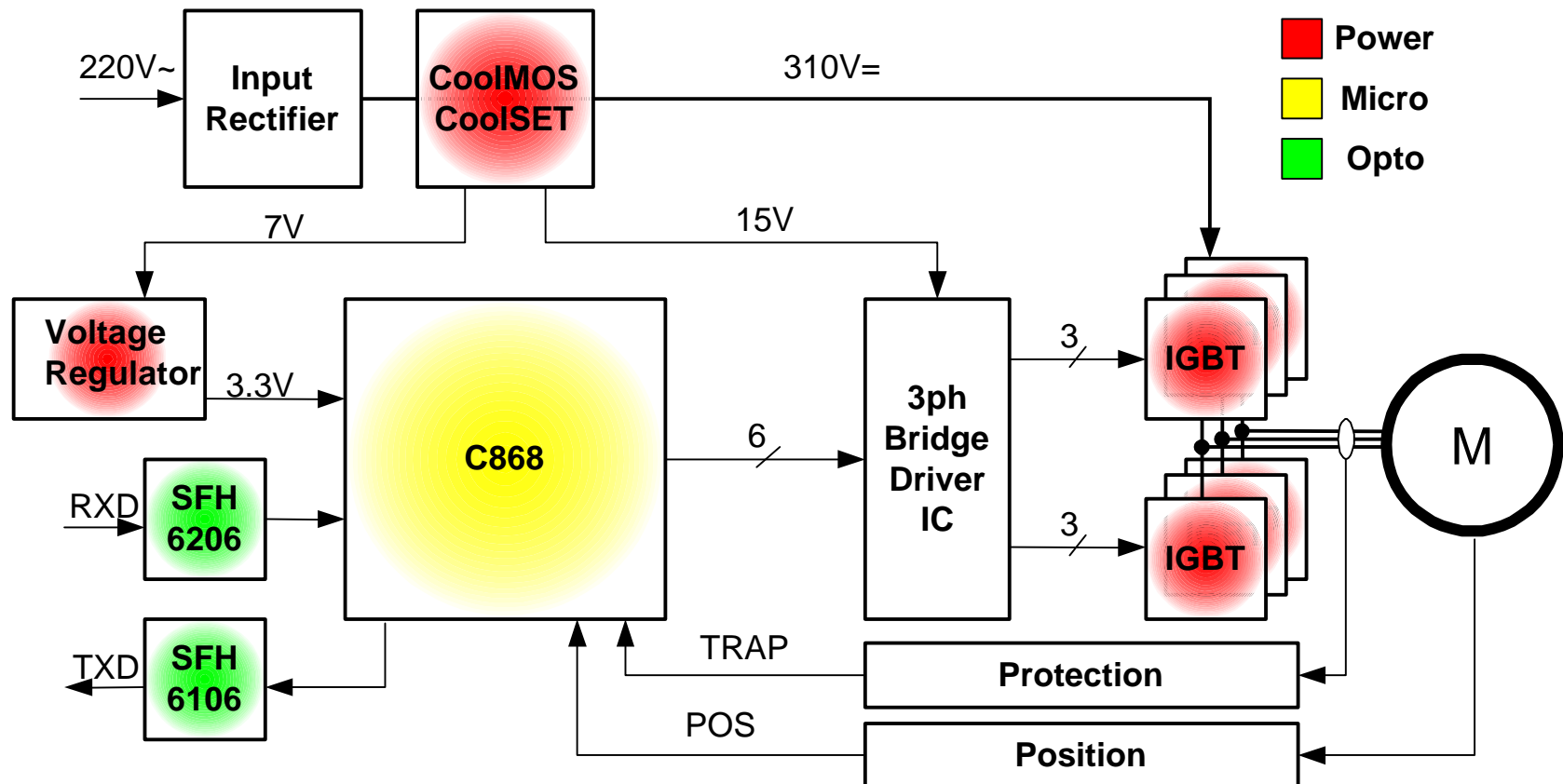
- C868 is applicable for all low cost variable speed drives (VSD) for Consumer Market
 - System consists of a master slave structure
 - Benefits of inverter technology:
 - noise reduction
 - high power density
 - power saving
 - flexibility (power, speed, direction)
 - performance enhancement (higher speed)
 - Simple or complex control strategy possible
 - Power factor correction (PFC) easily possible
 - Supervisory and protection of all relevant signals easily possible
 - Protection of following signals is mandatory
 - Sum current
 - DC-link voltage
 - Temperature
 - Hardware Emergency Stop (CTRAP) is required



Target Applications (Consumer Drive Example)

■ Example System:

–Three phase brushless DC-motor control



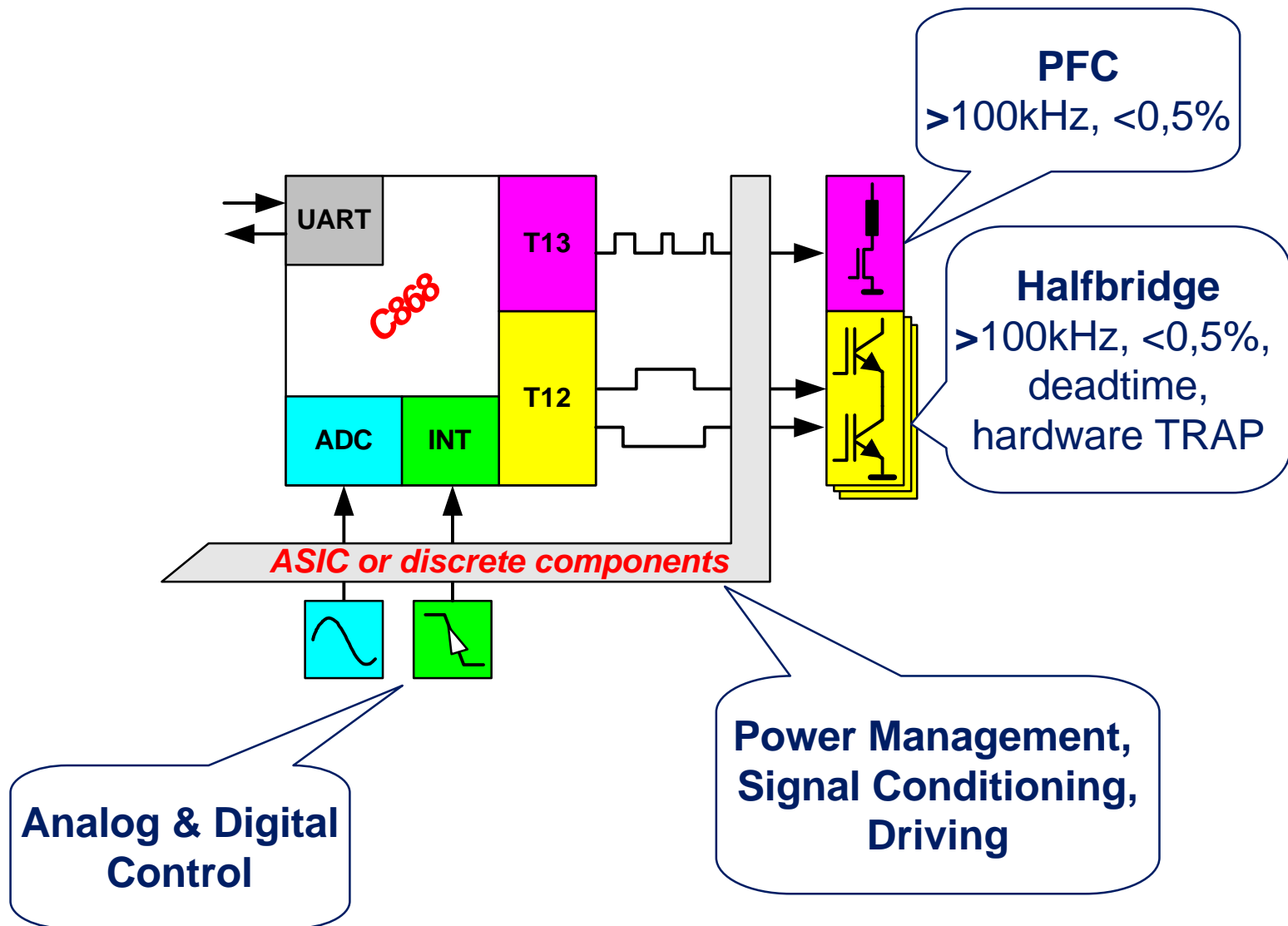
Target Applications (Lamp Ballast)

Lamp Ballast:

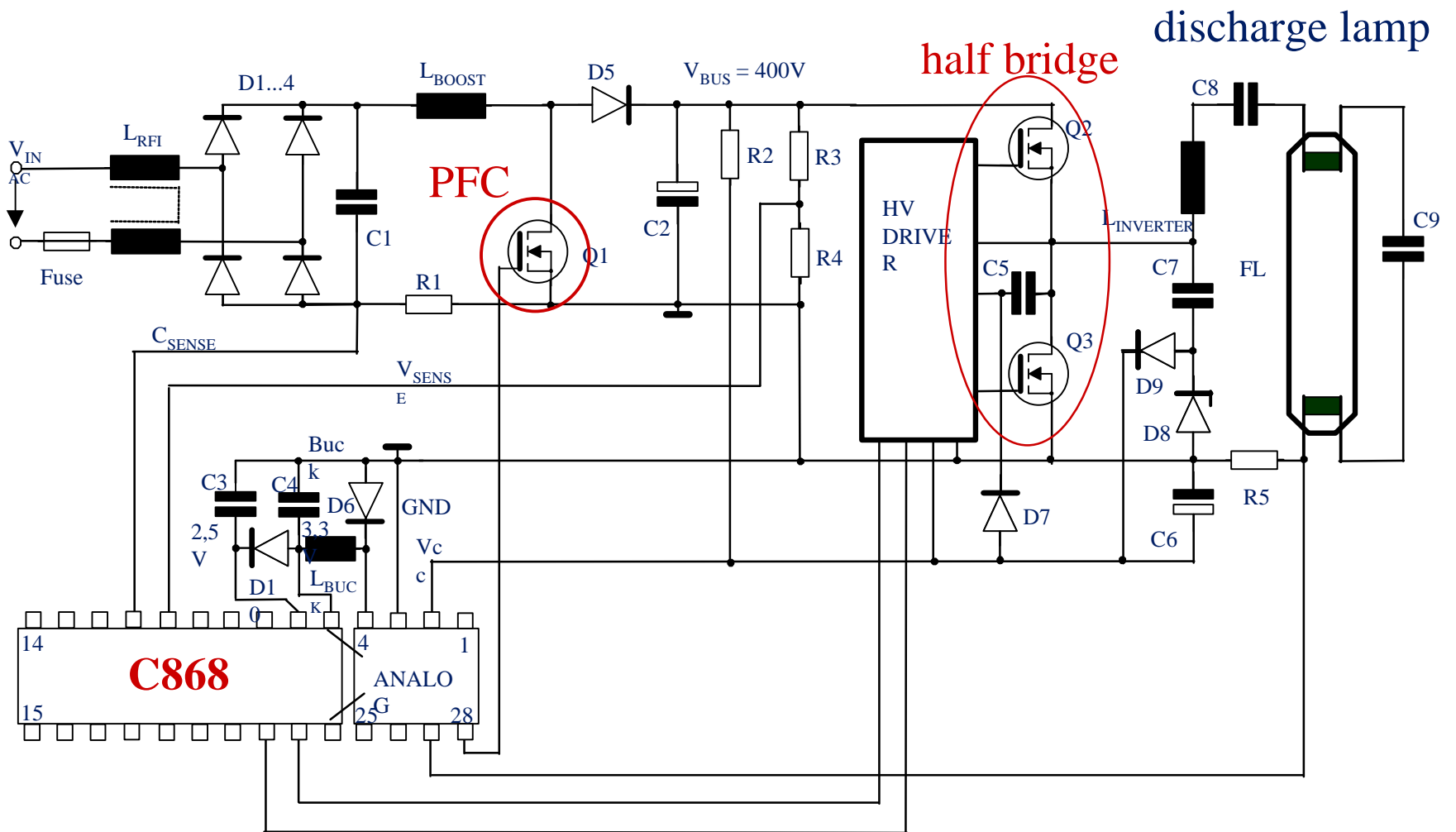
- Today's solutions are discrete with a throttle
- An EU regulation for lamp ballast will start in 2005:
 - ⇒ Every new Lamp Ballast has to have an electronic design
- The EU expects a power saving of several TW.
- Indications NAFTA and APAC will follow



Target Applications (Lamp Ballast Example)

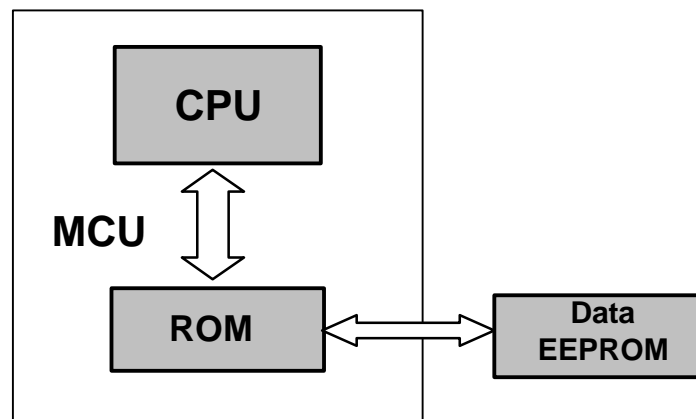


Target Applications (Lamp Ballast Circuit)

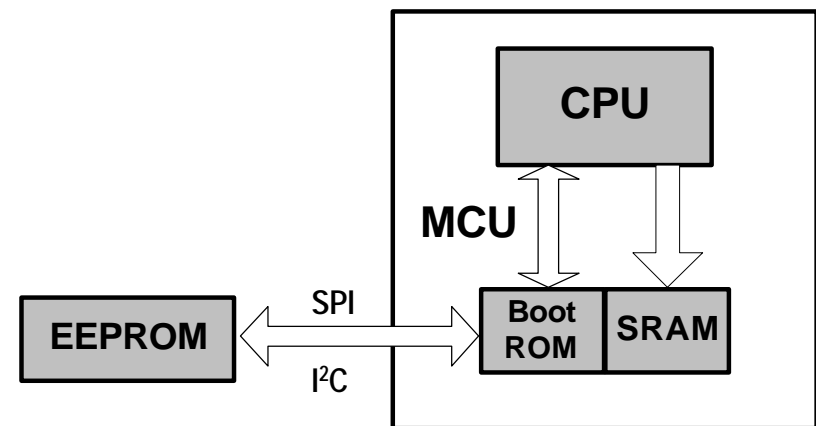


C868 - Memory and Boot Concept

Standard Solution (Lowest Cost)



SRAM-Solution (Highest Flexibility)

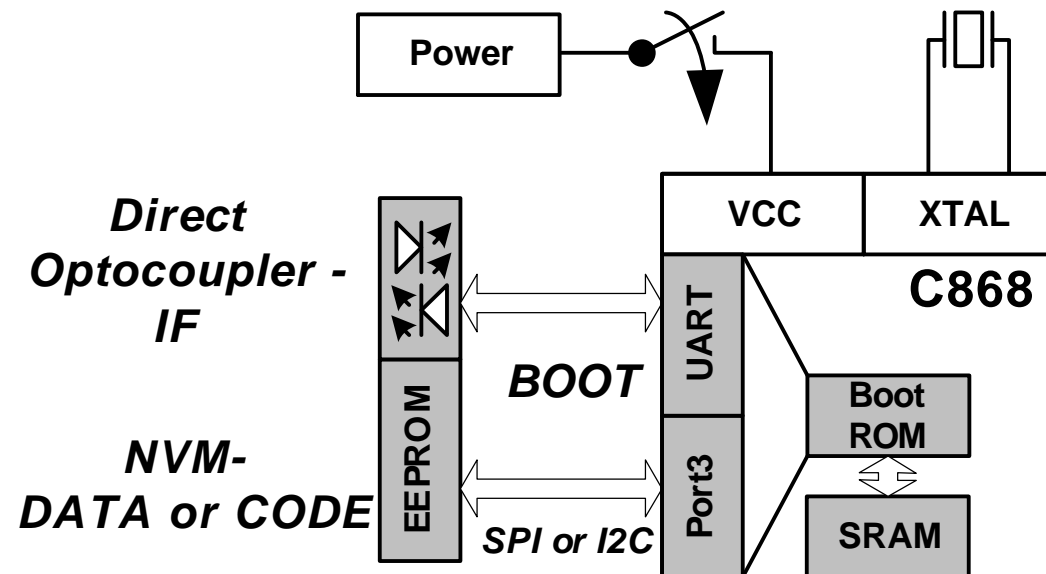


Benefits of SRAM-Solution:

- Lower system costs due to optimized technologies compared to flash technique
- Ideal for development and ramp up
- SRAM and ROM are the same silicon technologies
 - no “surprise” when switch to series production due to different electrical characteristics of ROM and flash
 - very reduced risk when switching to ROM mask
- **In System Programmable and Reprogrammable**

C868 - Memory and Boot Concept

- Boot options of SRAM-version
 - SPI or I2C for low cost serial EEPROMs
 - UART (e.g. for host or for development)



C868 - Memory and Boot Concept

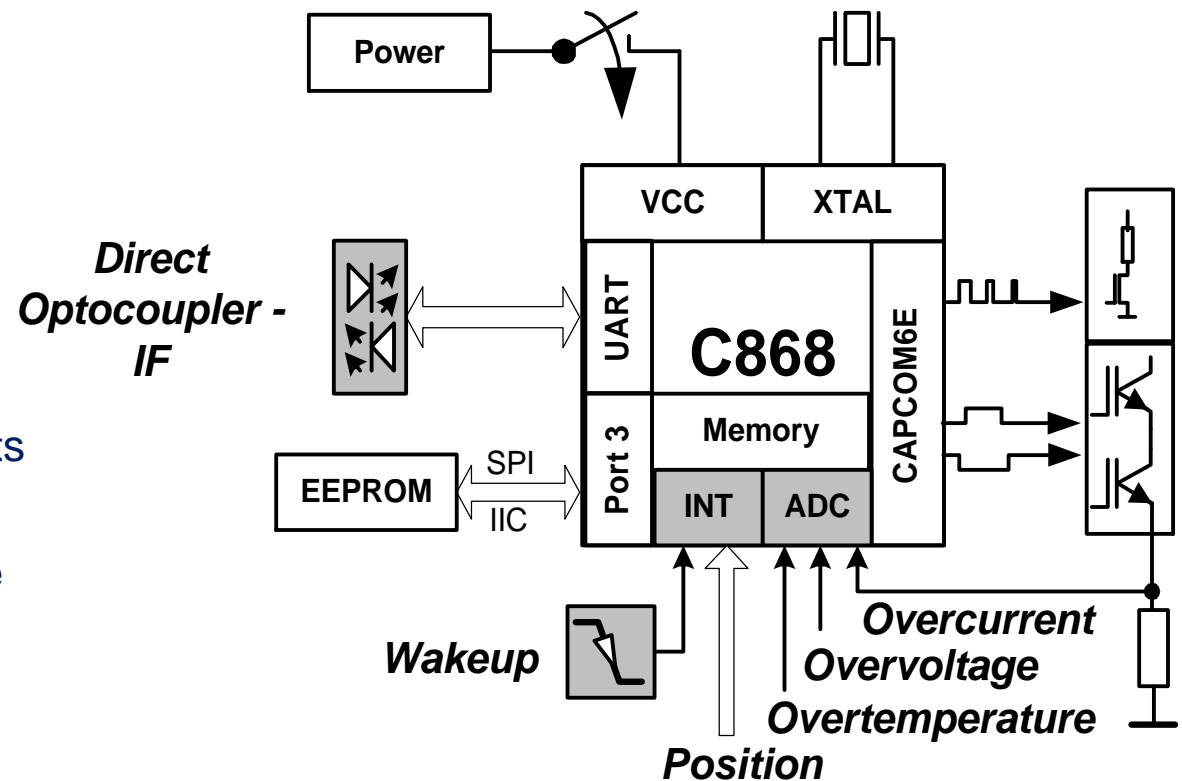
- SPI & IIC EEPROM booting is implemented in software in the boot ROM.
 - There is no hardware support for SPI.
 - Atmel AT25xxx style EEPROMs (>512 bytes) are supported.
 - IIC EEPROMs are supported

- USART Booting is intended to be used for debugging.
 - USART is implemented in Hardware (same as C504) and can be used by the application
 - Keil has created an in-system-debugger (ISD51 - about 800 bytes) that can be linked with the customers' code to enable various debugging features including:
 - Single Stepping
 - Break Points
 - Register and Memory dumps/editing

C868 - I/O Interface

■ 18 I/O Pins

- 5 analog inputs
 - 3 as external interrupts
 - 2 pure analog
- 13 digital I/O
 - 3 as external interrupts
 - 7 as capture/compare
 - 2 with wakeup functionality
 - All with high current capability (+/- 10mA)



C868 – P-TSSOP-38 Pin Out

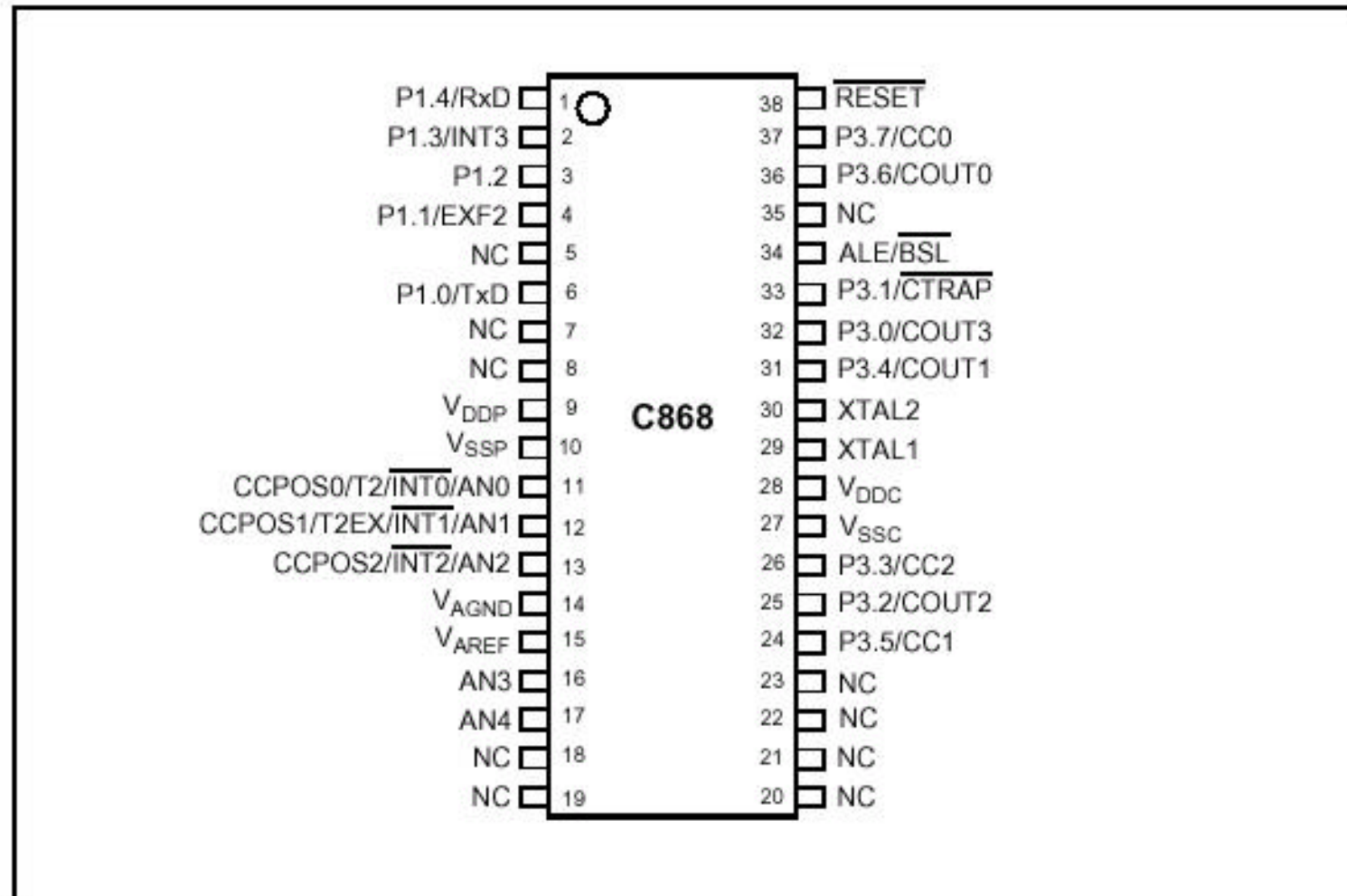


Figure 1-3 C868 Pin Configuration P-TSSOP-38 Package (top view)

C868 – P-DSO-28 Pin Out

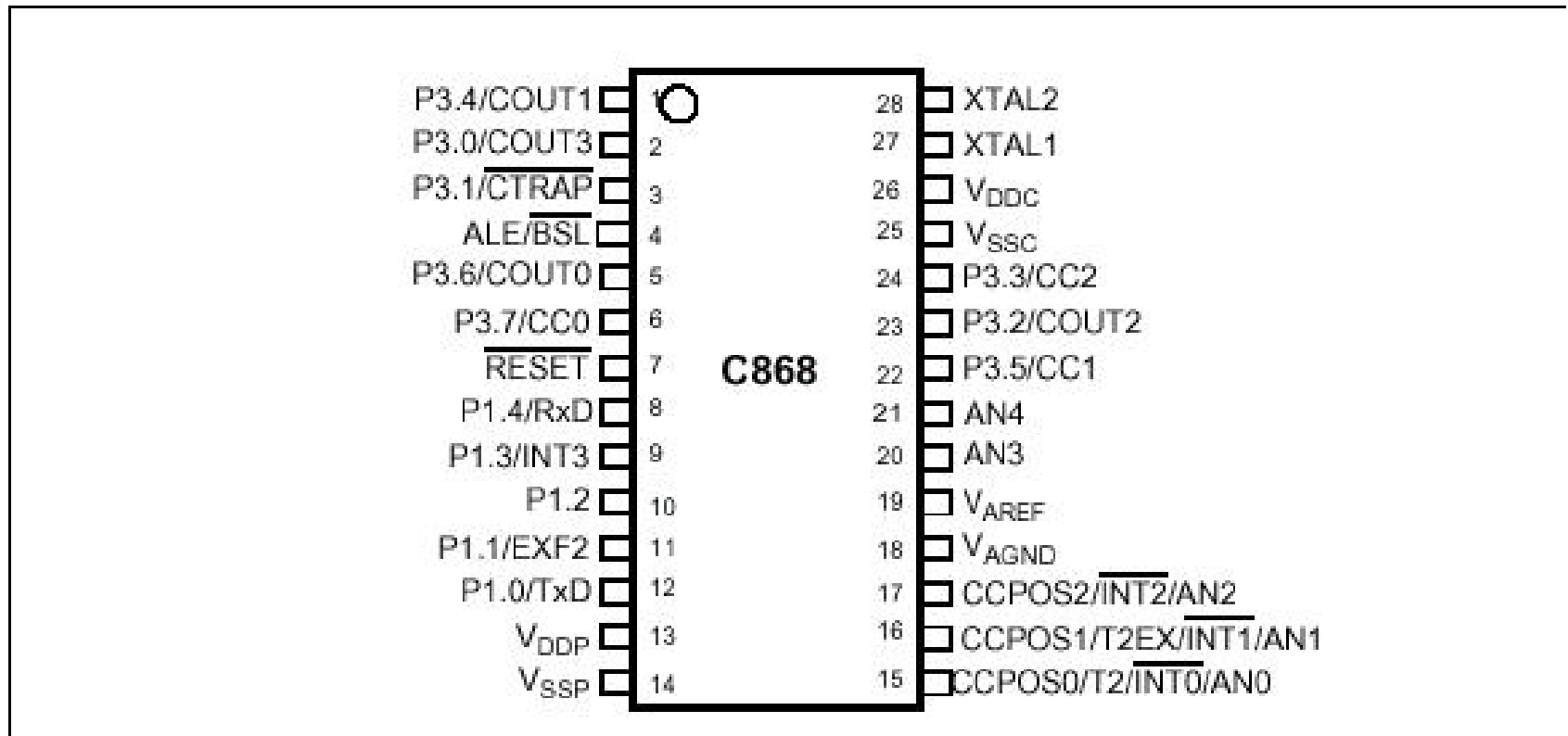


Figure 1-4 C88 Pin Configuration P-DSO-28 Package (top view)

C868 - Advanced Description - Core

8 DPTR

- For powerful table handling
- Indirect addressing of CODE & DATA memory
- Software can use a separate DPTR for each constant/variable array

■ INTERRUPT

- 4 priority levels
- 6 external interrupts
- 8 peripheral interrupts
- Selectable edge & level trigger
- 4 node pointer interrupts for CAPCOM
- Emergency interrupt for CAPCOM

■ Clock Generation

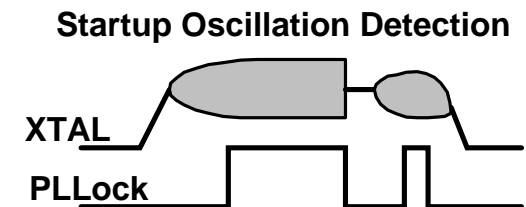
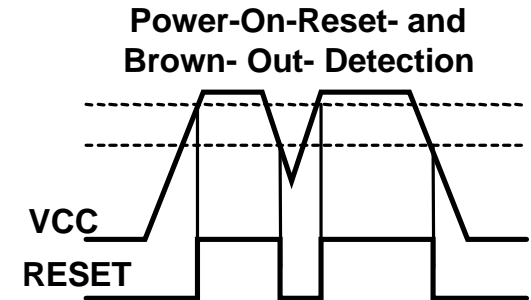
- PLL fixed factor 4 - low EMI, power saving
- Several prescalers for flexible clock options
- Slow Down Mode

C868 - Advanced Description – Safety Peripherals

- Safe Power On- and Power Off-behavior due to
 - On-chip RESET- and BROWNOUT- Detection

- Safe Startup-Behavior due to
 - PLL-Lock signal
 - Crystal-Break detection
 - PLL-base frequency for entry safety state

- Programmable Watchdog Timer



C868 – Advanced Description – UART, Timers

■ UART

- Baudrate generation via T1 or T2
- Full duplex mode
- T2 with overflow toggle for baudrate clock (IrDA support)

■ T0/T1

- Classical 8051 compatible timers
 - 16 or 13bit counter, external gatable
 - 8bit reload counter
 - 2 times 8bit counter
- T1 as 8bit baudrate generator configurable

■ T2

- 16bit capture / compare function
- 16bit autoreload timer external controllable
- Up/down count
- Overflow flag with external output

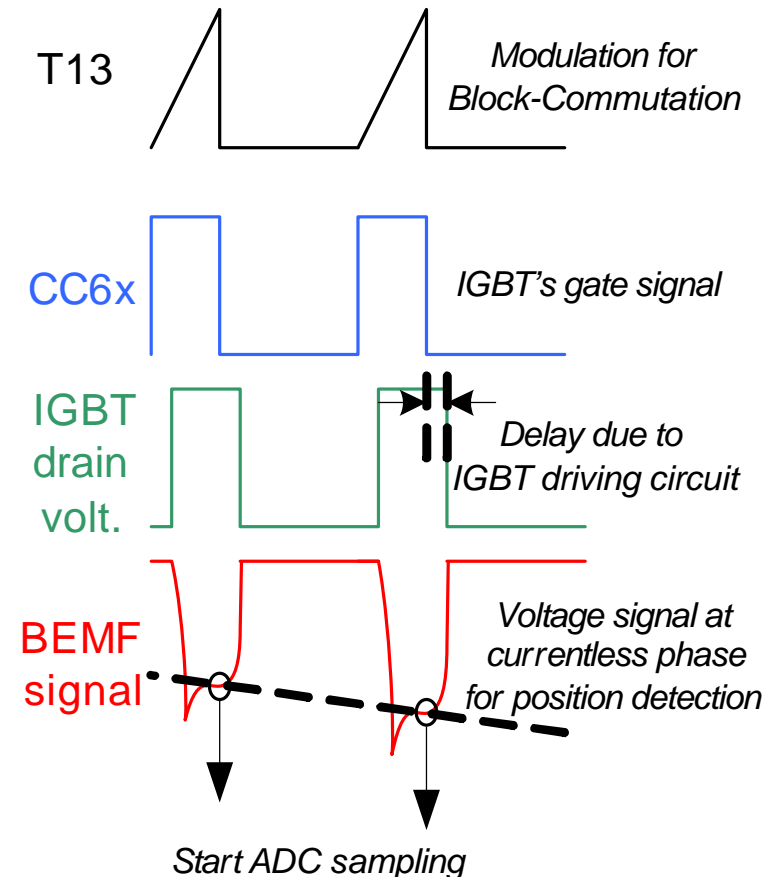
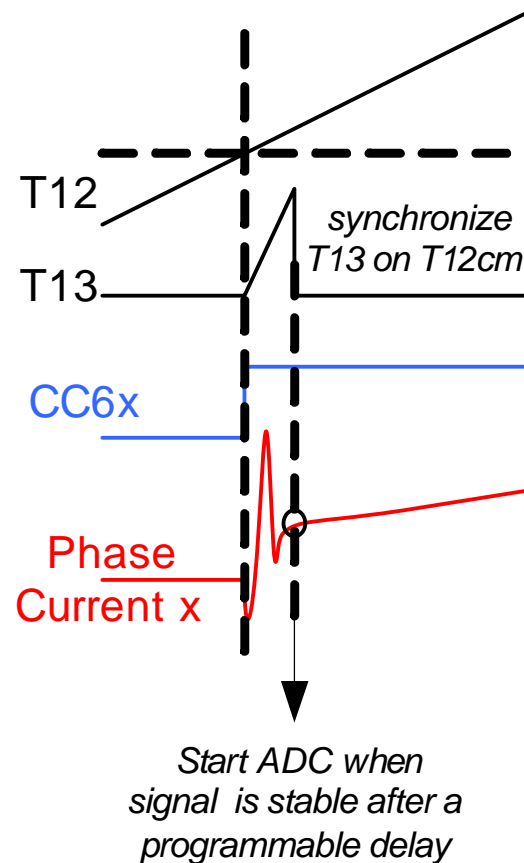
C868 – Advanced Description – ADC (1)

- 8bit ADC with TUE < +/- 2LSB, typ. < 1LSB over temperature, frequency and voltage drift (acc. to operating condition)
- Absolute accuracy: $3.3V/256 = 13mV$
- Linear and monotone
- Programmable
 - sample time and
 - conversion time
 - for flexible adapting to the analog source
- Max. sampling rate:
 - 1Mspl @ 40MHz (total conversion time down to $1\mu s$)
- Single and continuous conversion mode
- Timer triggered mode – Synchronisation to CapCom6

**Best Class
& Fastest
A/D Converter**

C868 – Advanced Description – ADC (2)

- Timer triggered mode – Synchronisation to CapCom6's T13 period match
- Combination of T12 and T13 for phase current measurement in DC-link shunt
- Direct BEMF detection without filtering and comparator logic

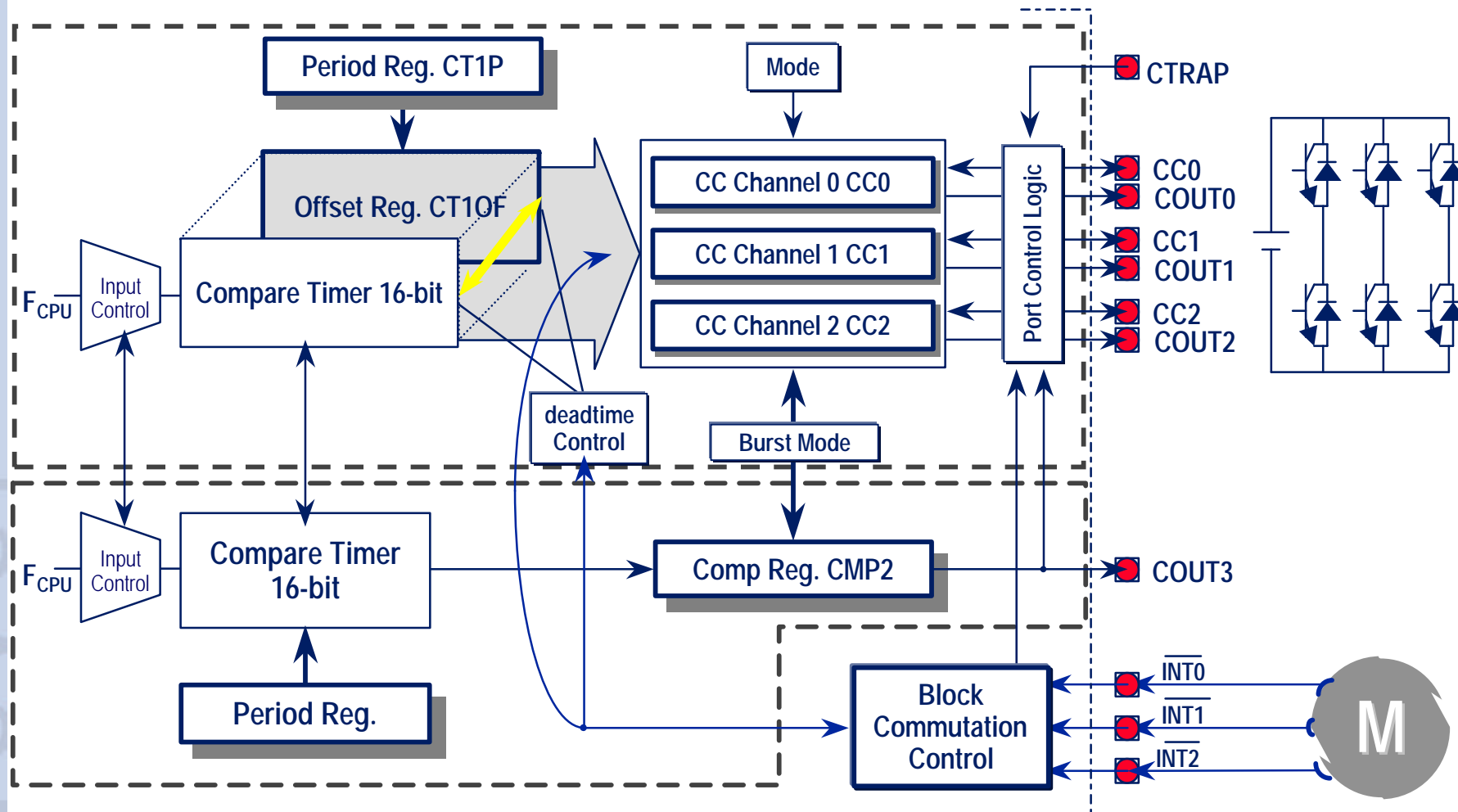


C868 Advanced Description – CAPCOM6E (1)

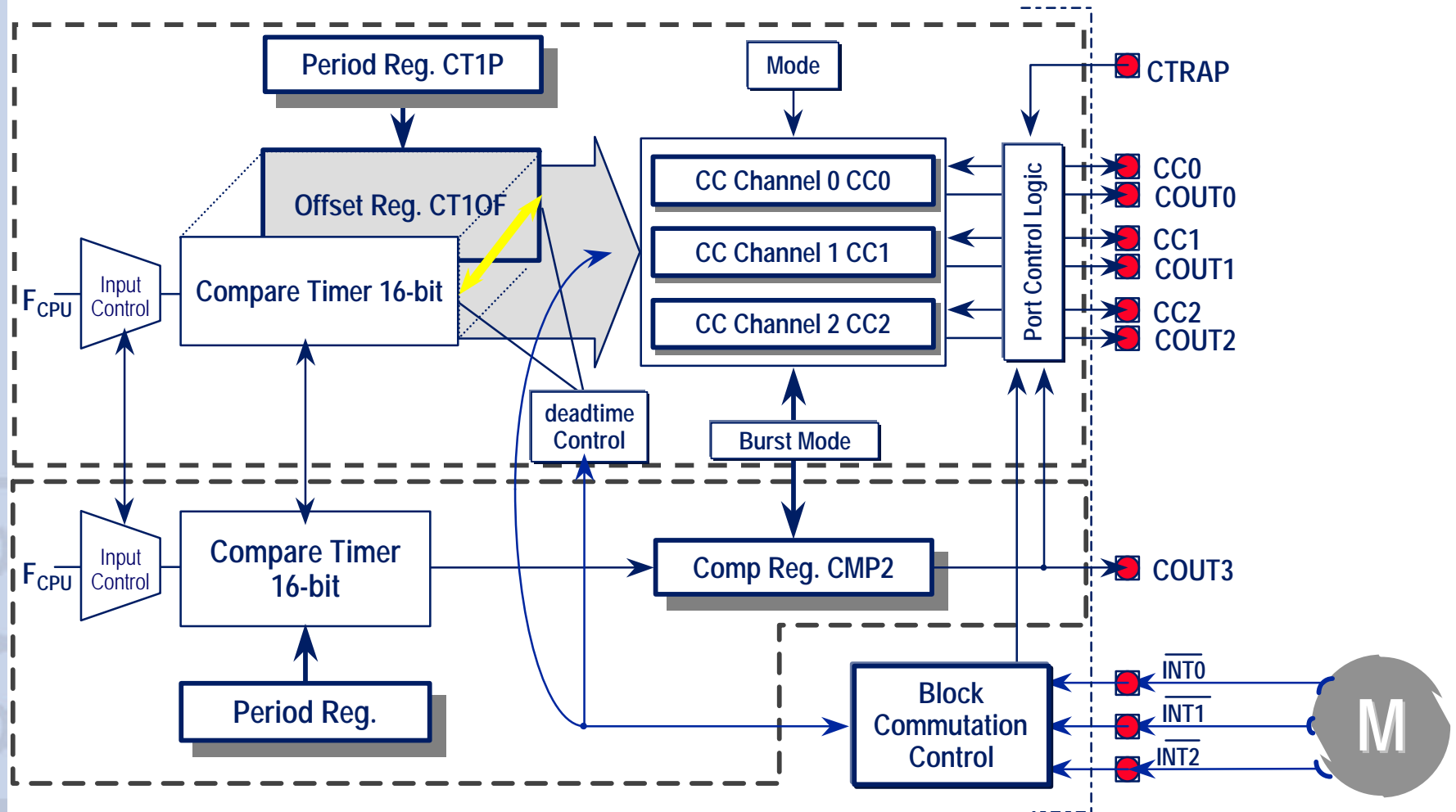
■ CAPCOM6E

- Perfect fitting for induction machine (IM), brushless DC (BLDC) and switched reluctance drives (SRD)
- Based on CAPCOM6 (C164CI), optimized in several points
- New deadtime generation (deadtime in edge aligned mode possible)
- Selectable TRAP & passive levels *new*
- Full 0-100% duty cycle capable *new*
- Compare timers are read/writeable *new*
- More indication flags for actual PWM state (e.g. up-/down counting) *new*
- T13 is 16bit wide *new*
- T13 can be synchronized on T12 (e.g. for A/D measurements) *new*
- TRAP can be triggered per software
- New block commutation features and new multichannel modes *new*
- Single shot mode is optimized *new*
- Outputs can be switched without timers

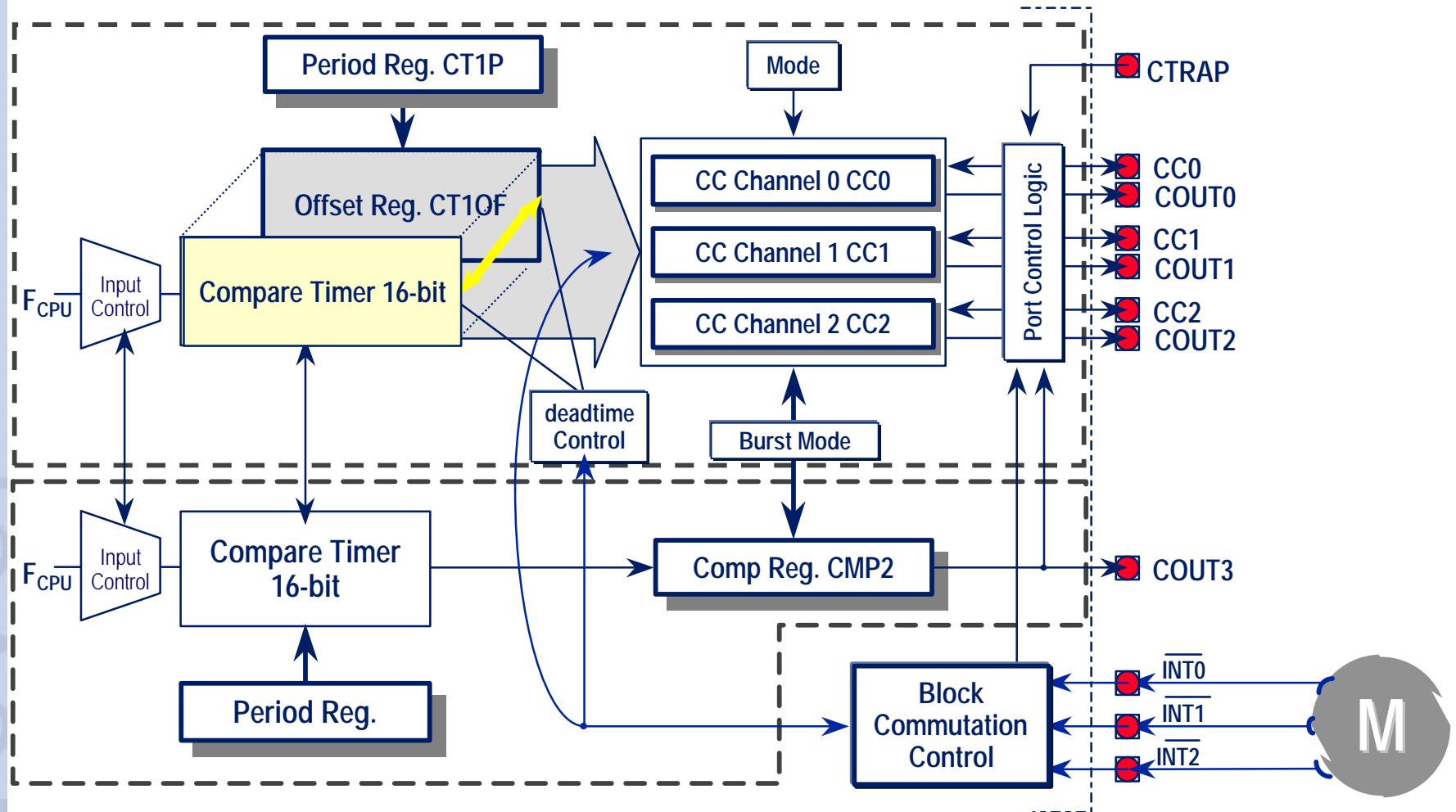
C868 Advanced Description – CAPCOM6E (2)



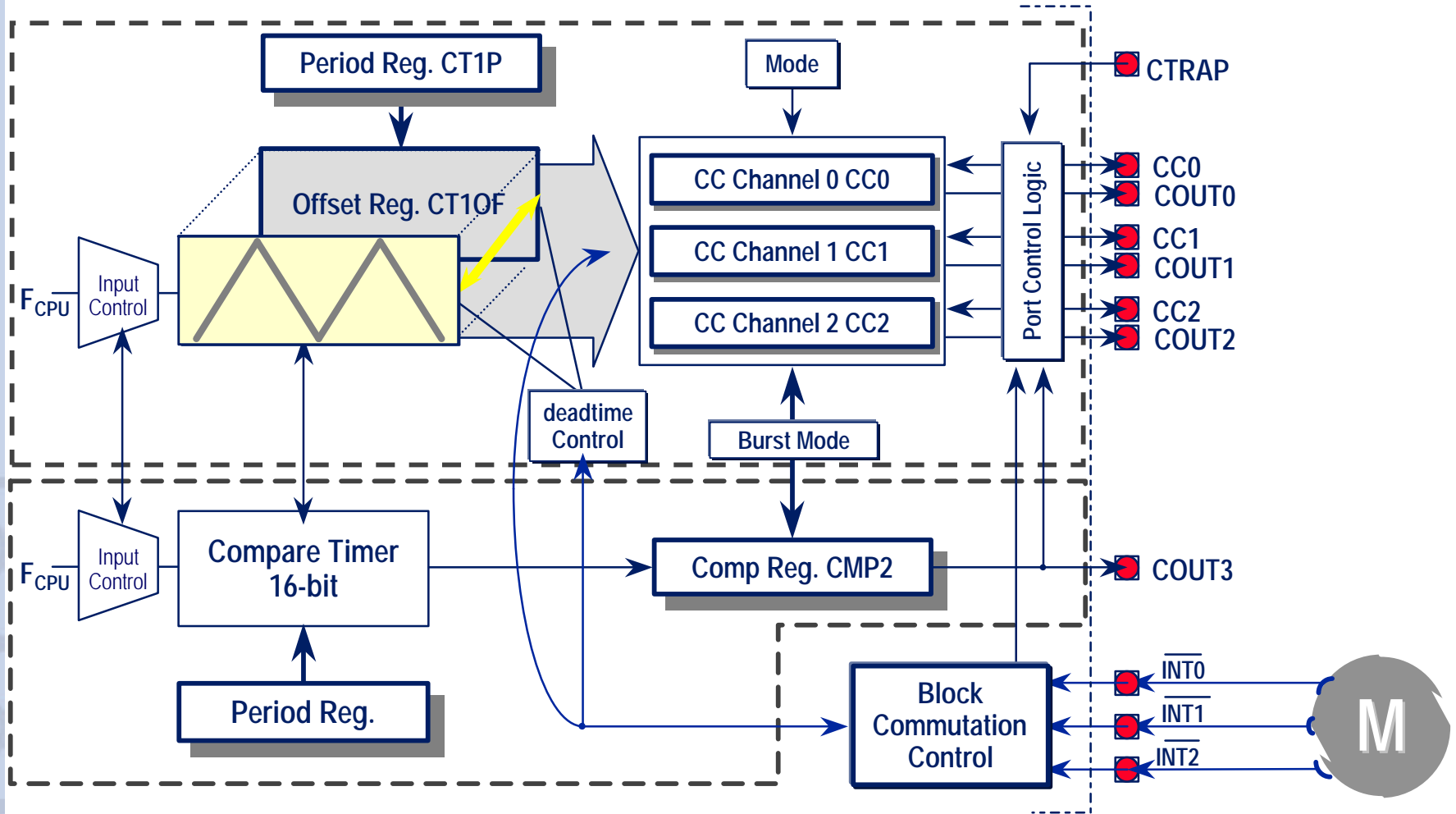
CAPCOM6E PWM Generation for Induction and Sinusoidal Brushless DC Motors



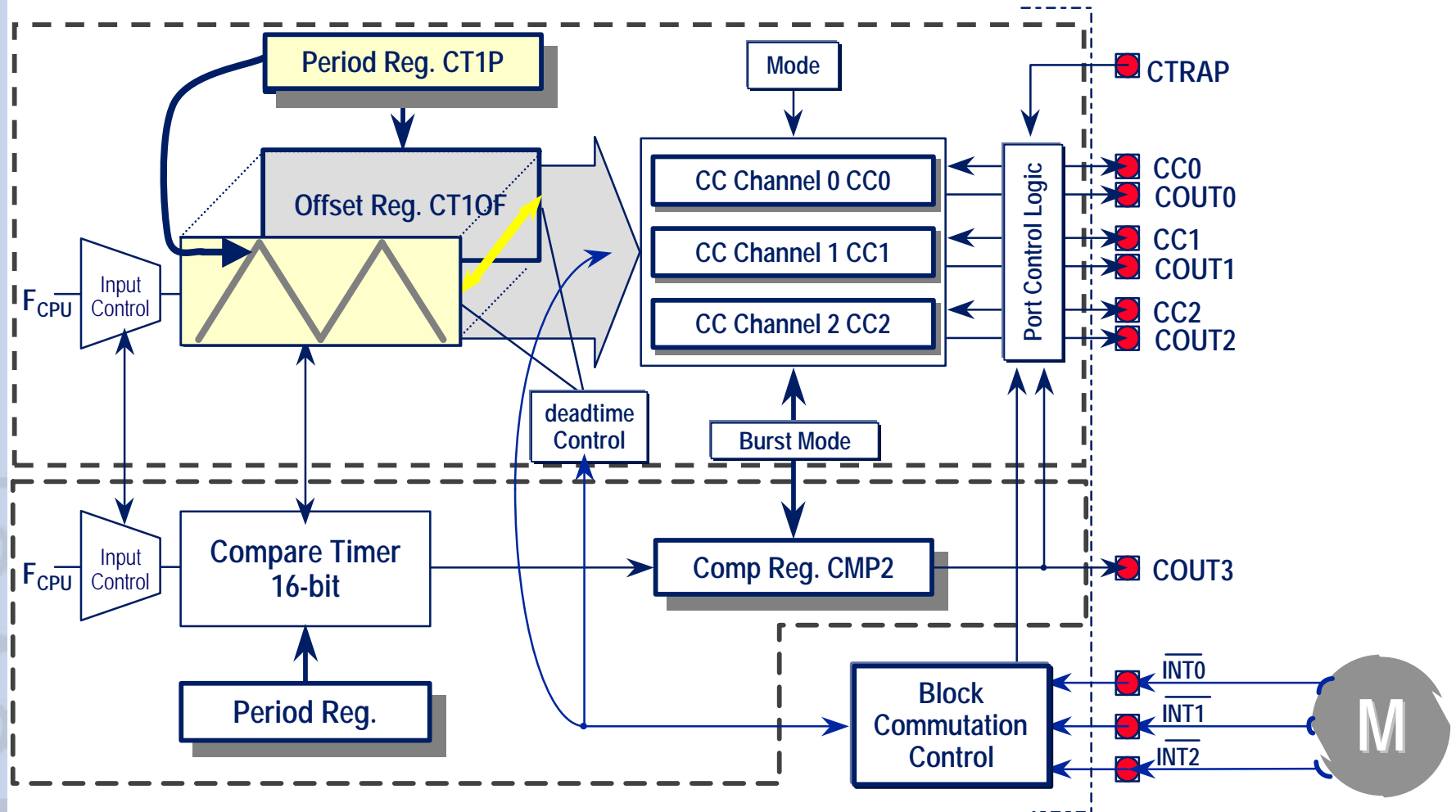
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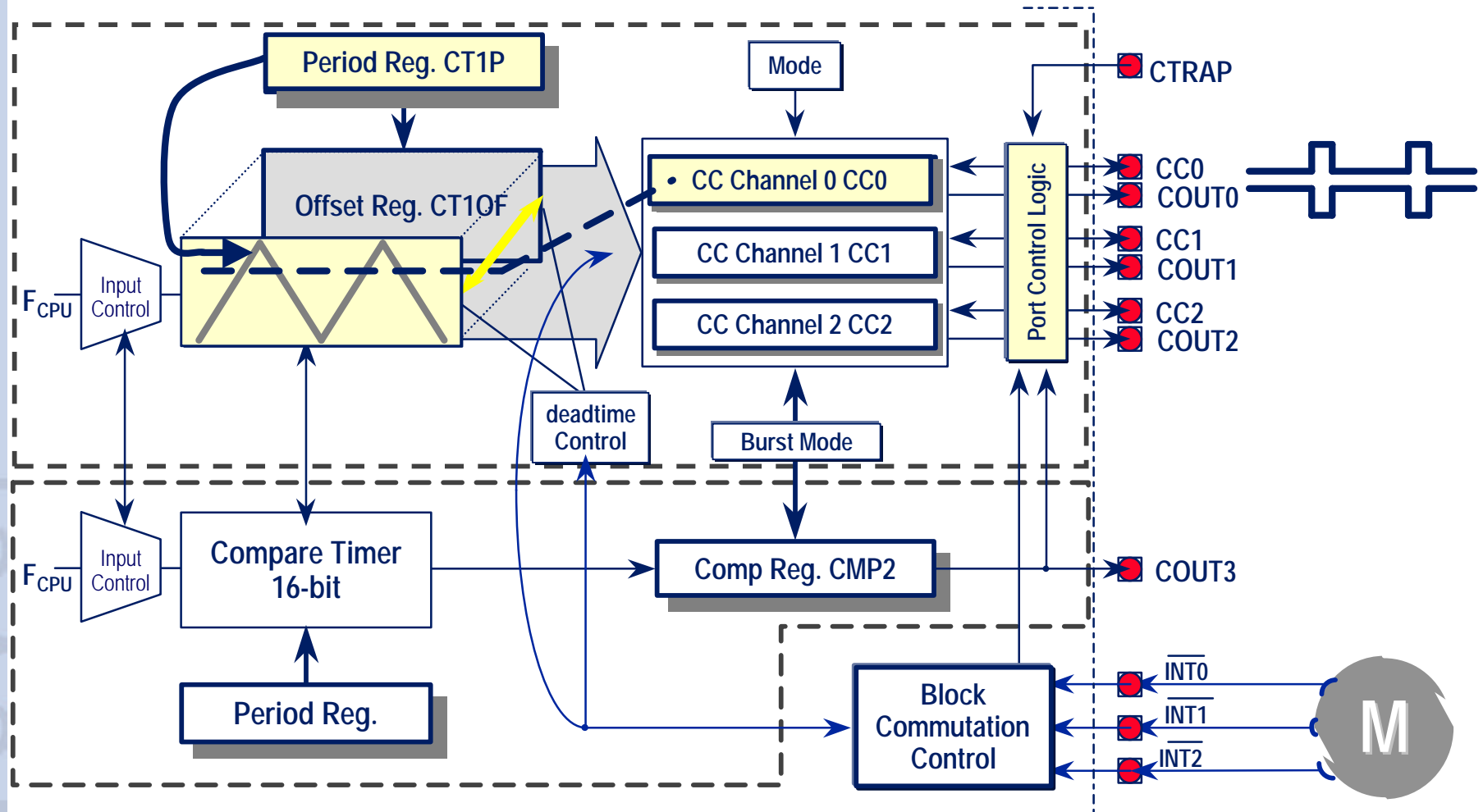
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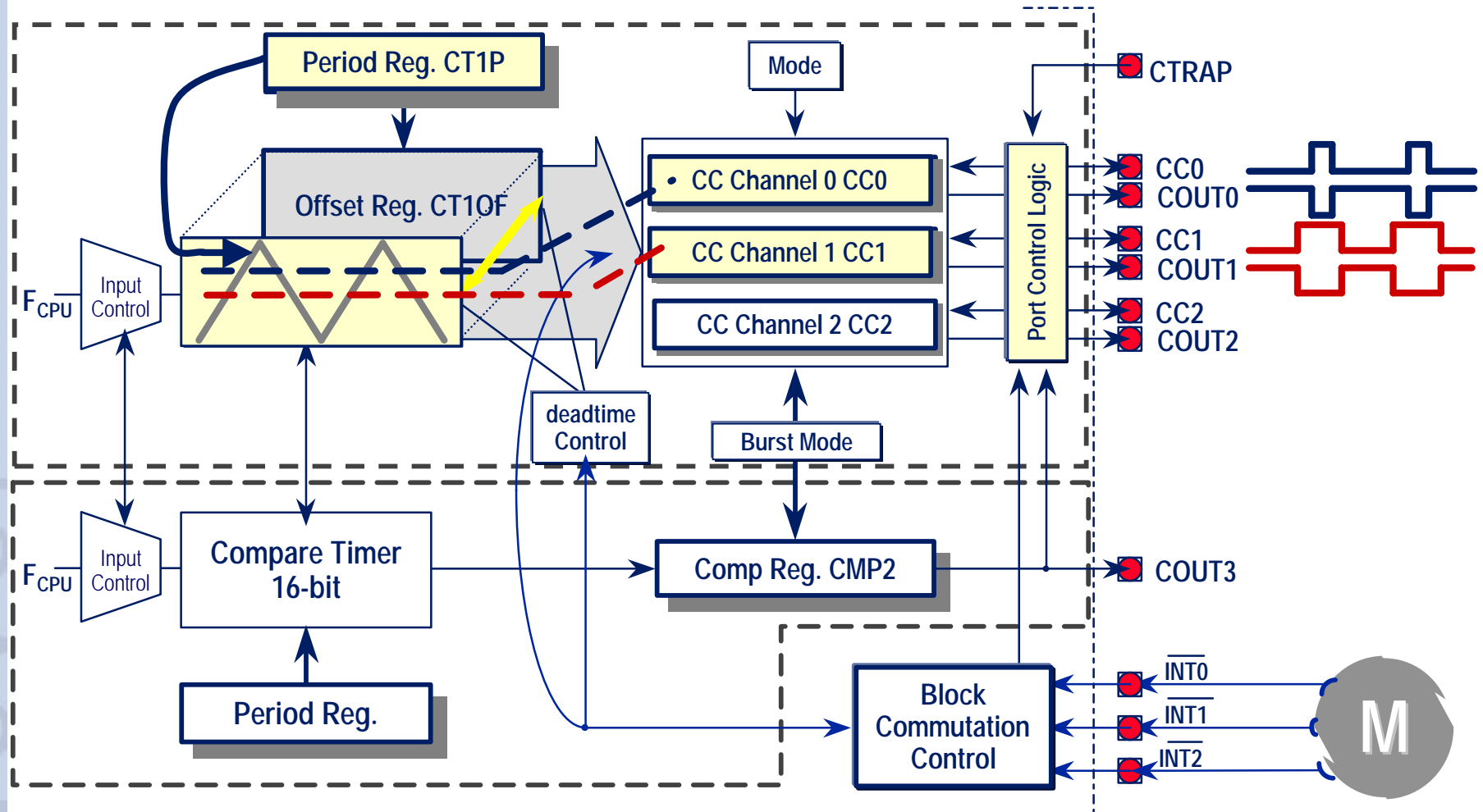
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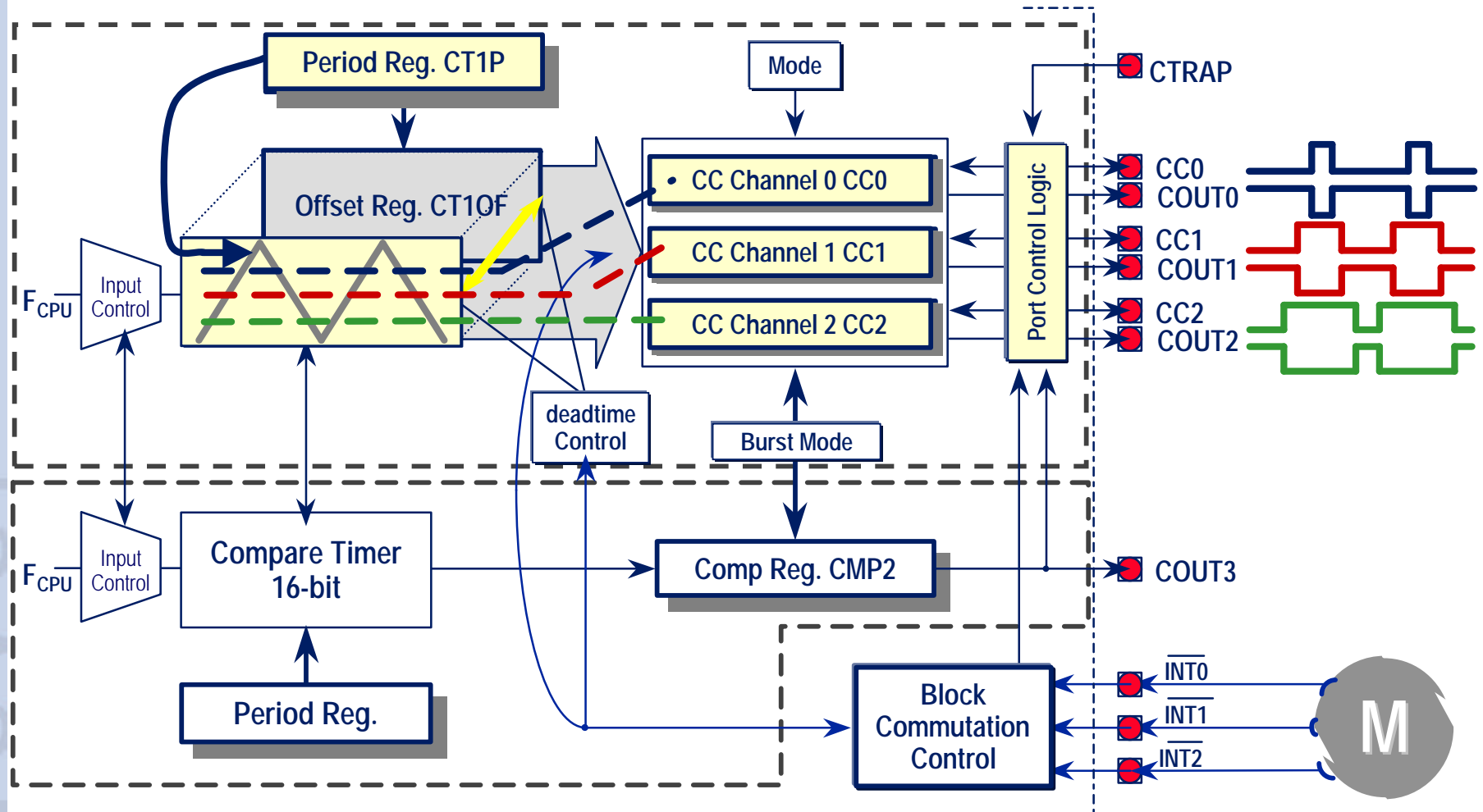
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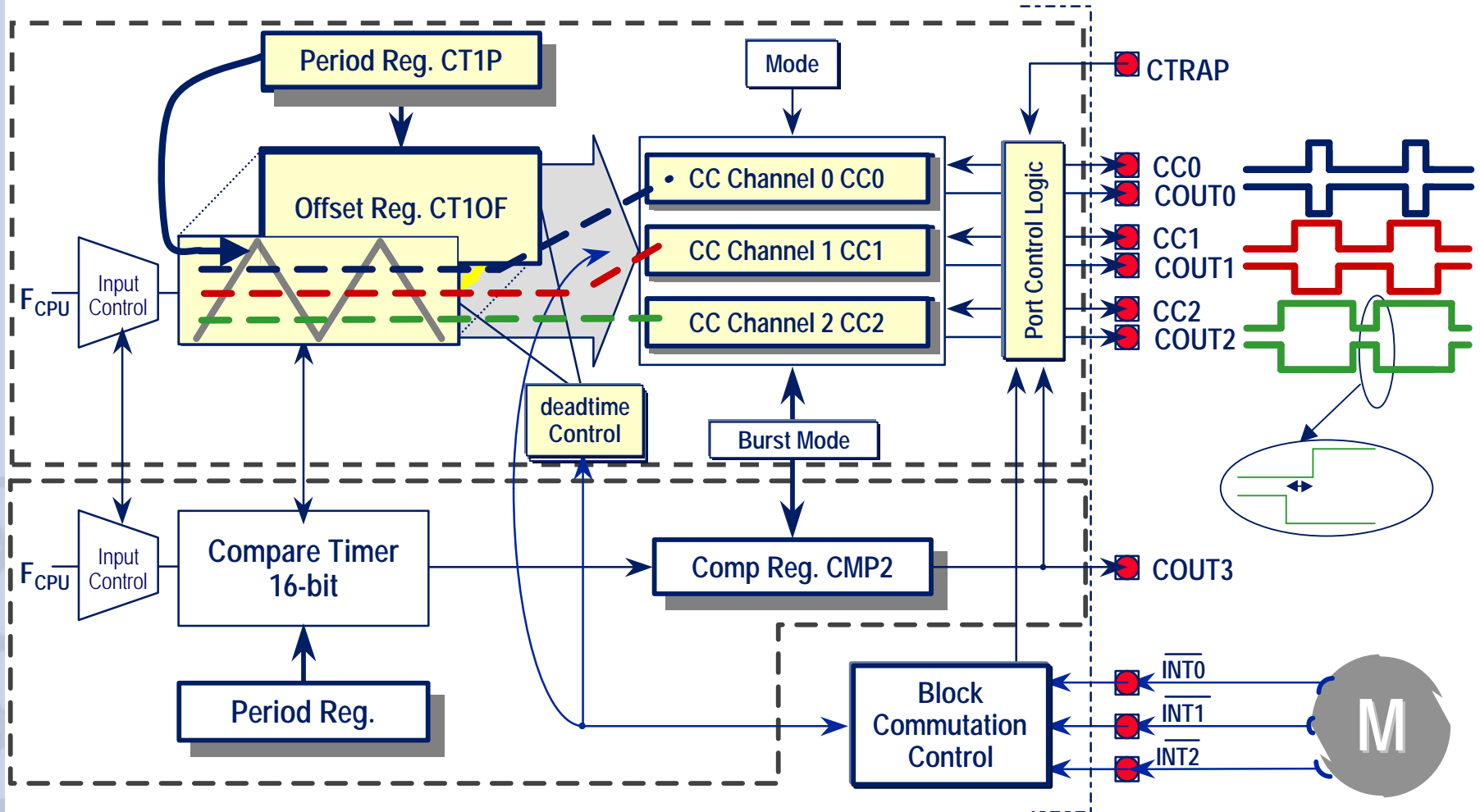
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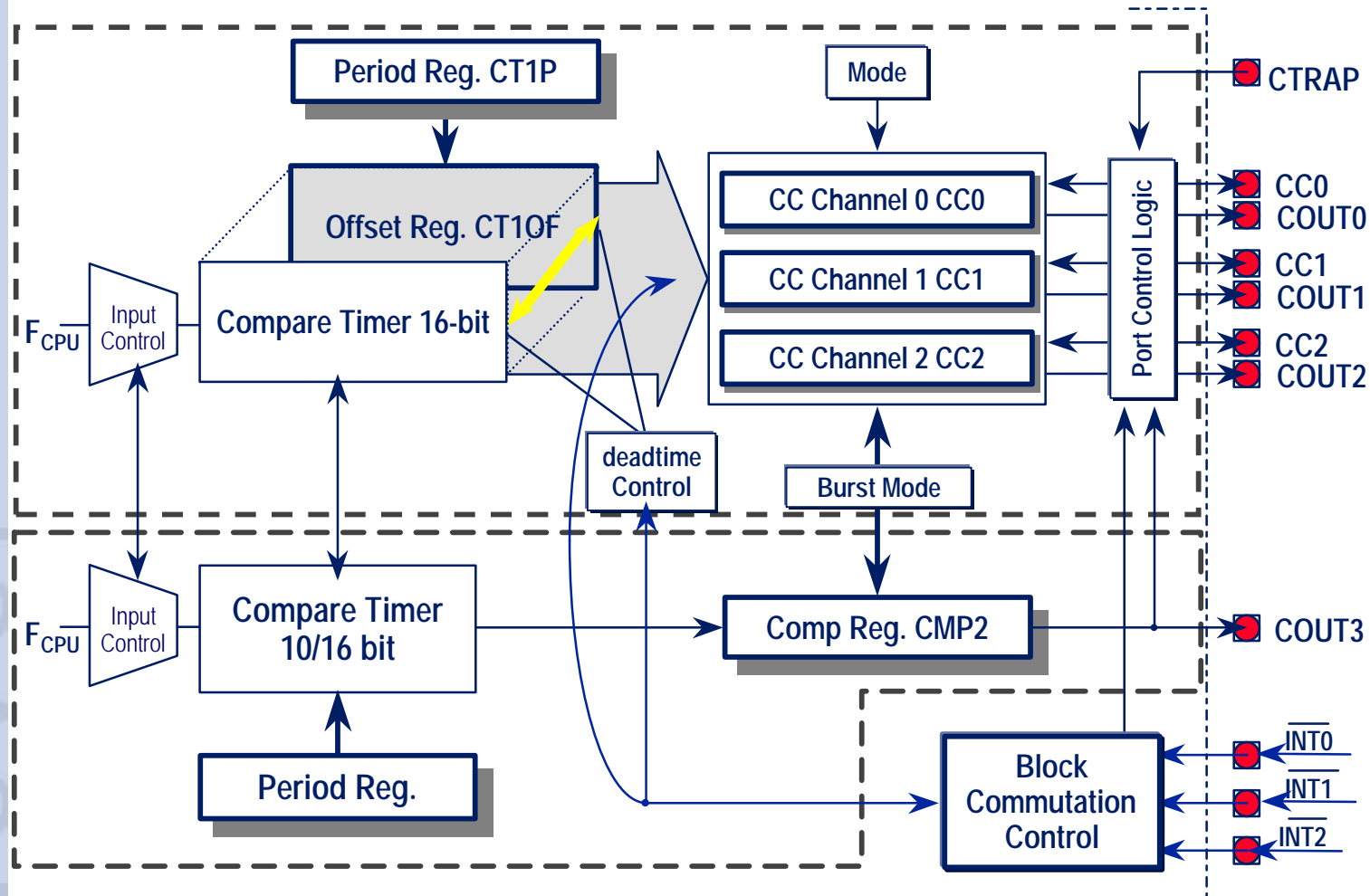
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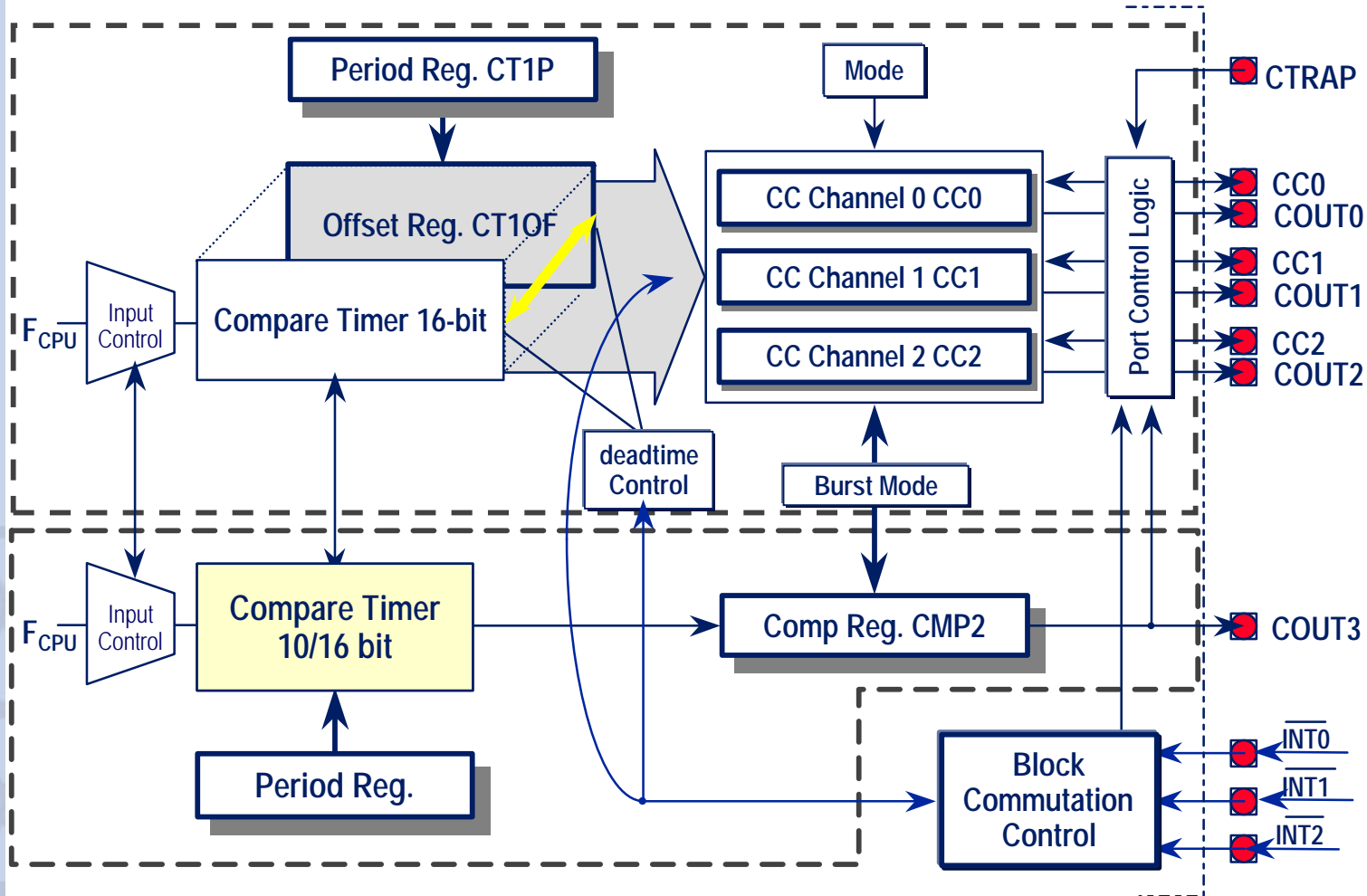
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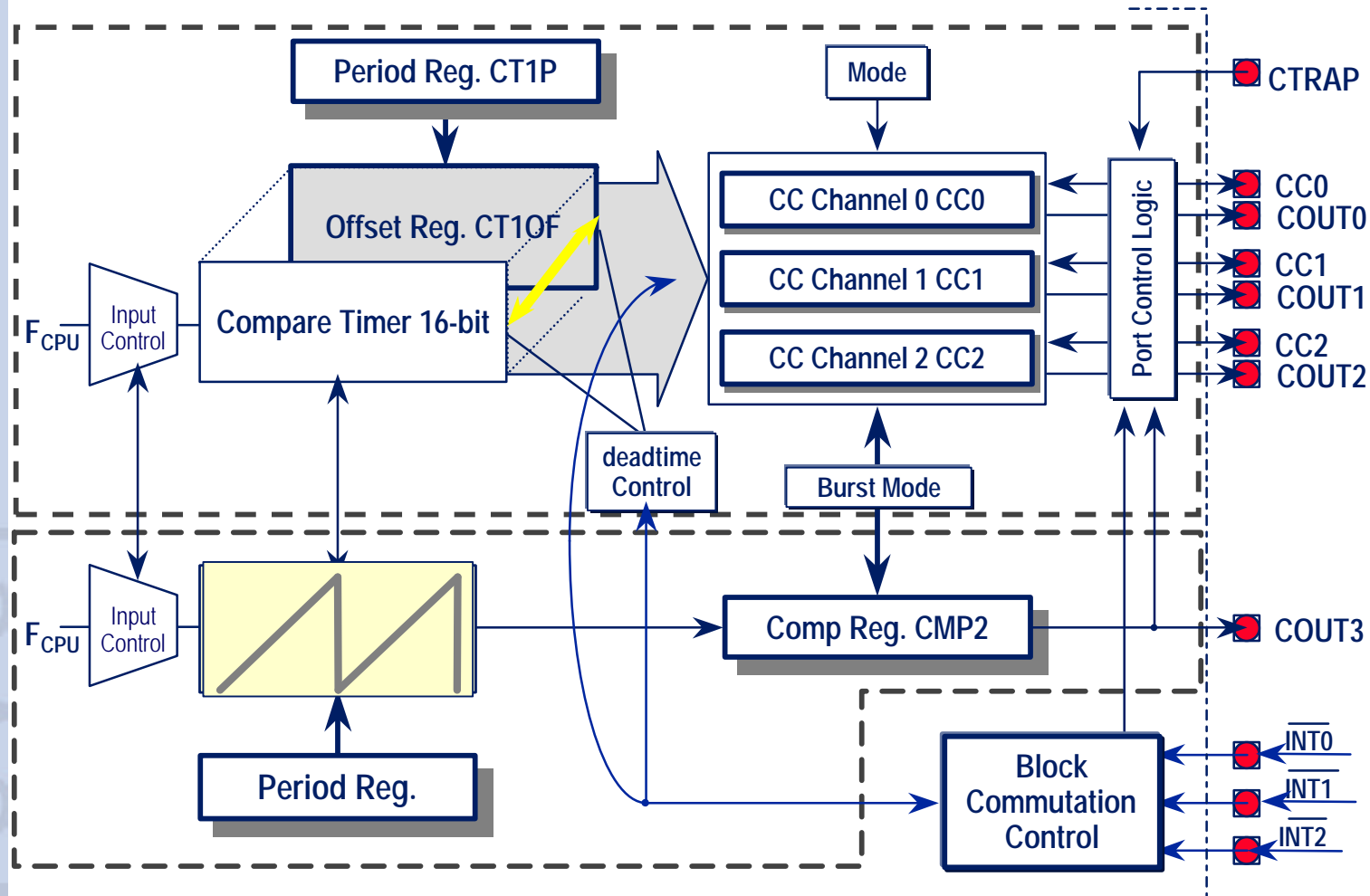
CAPCOM6E PWM Generation for Trapezoidal Brushless DC Motors



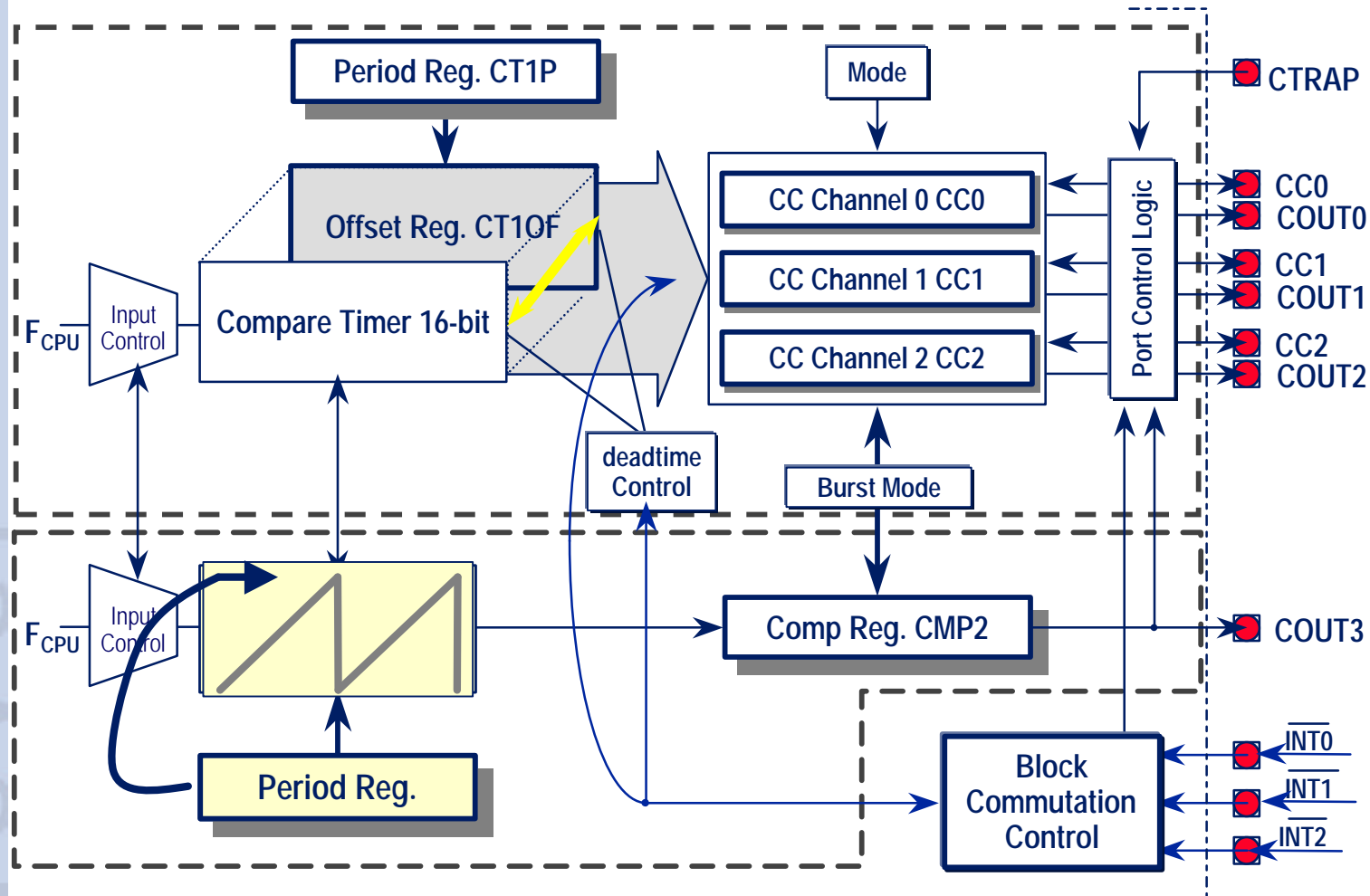
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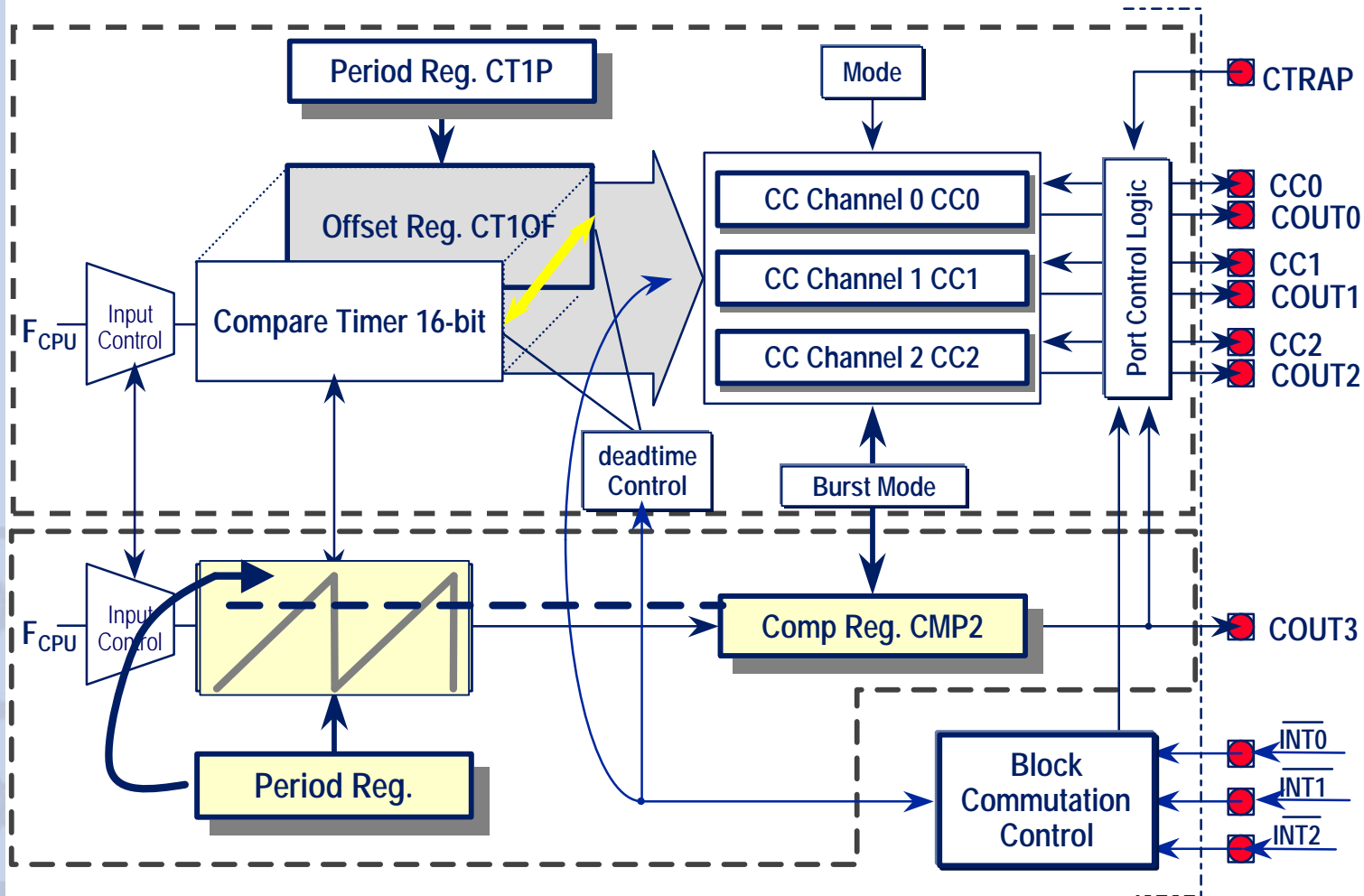
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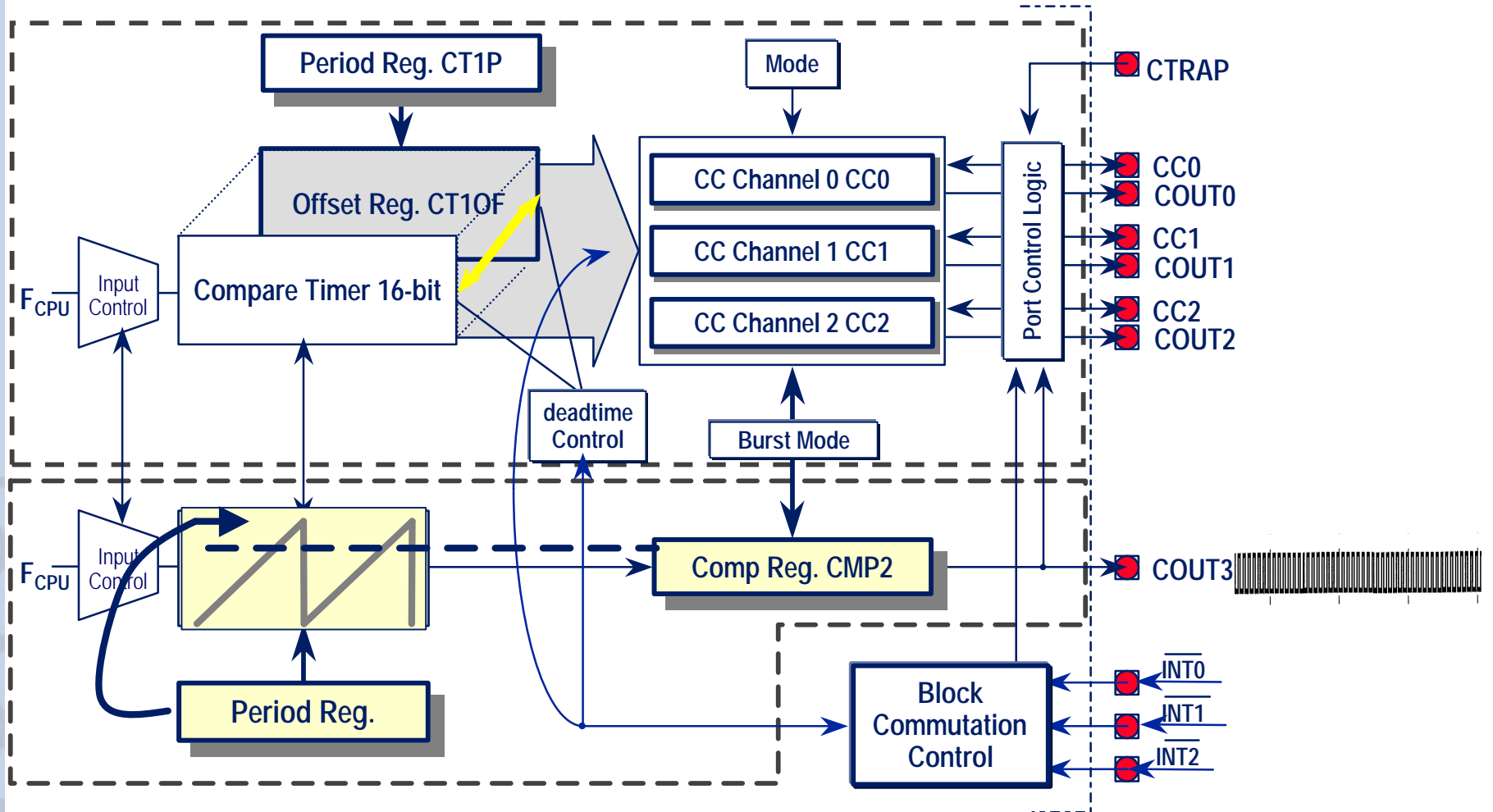
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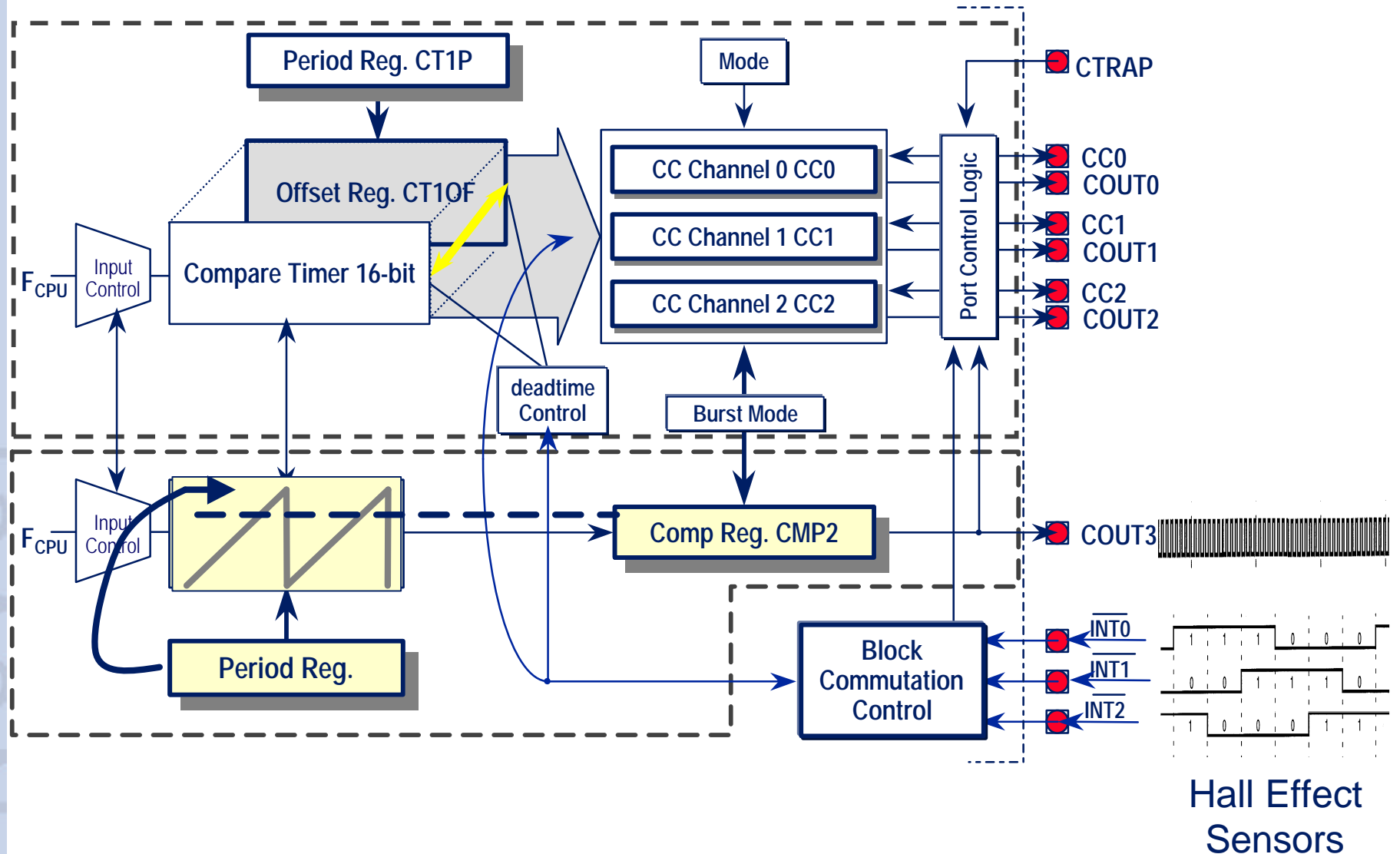
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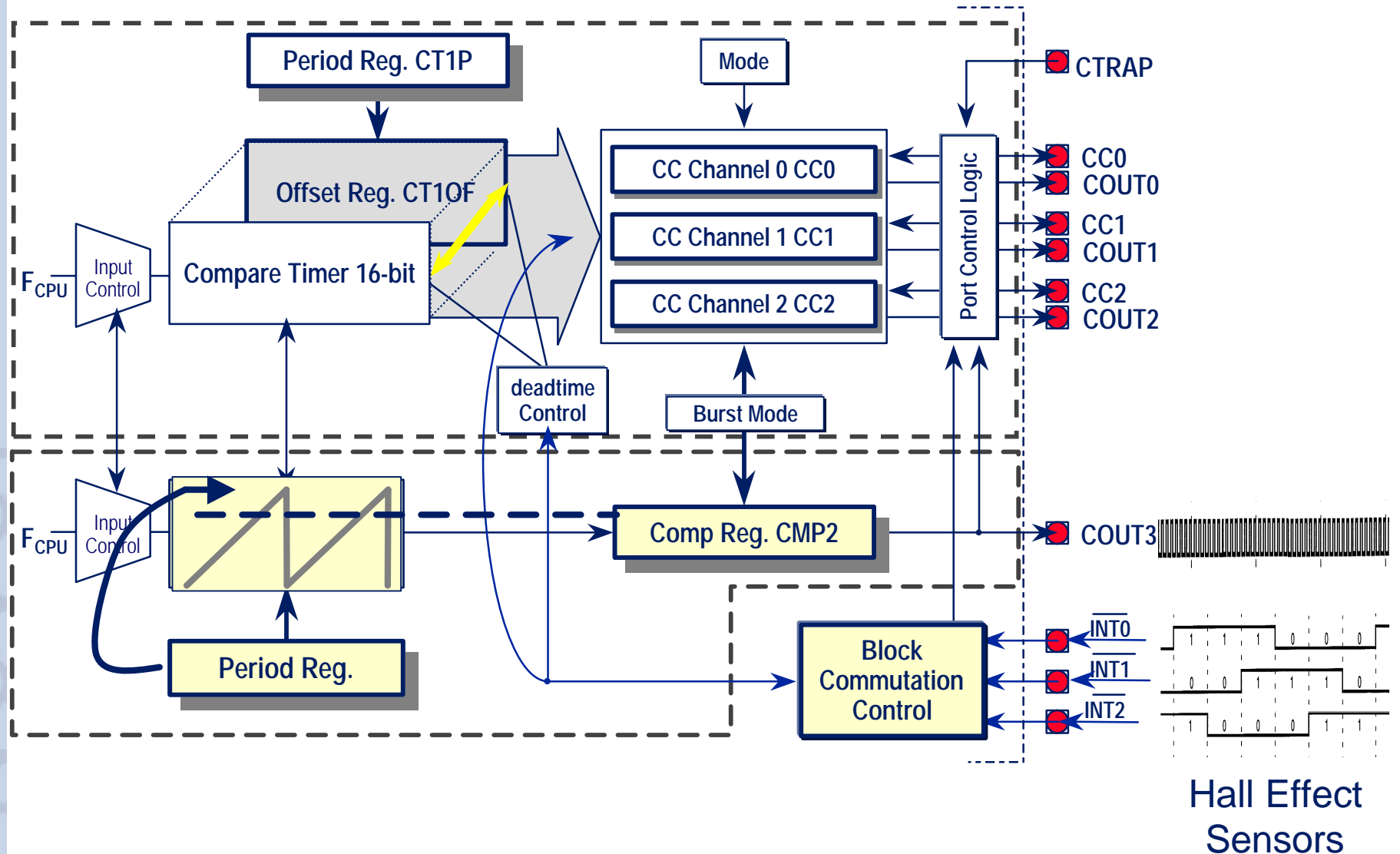
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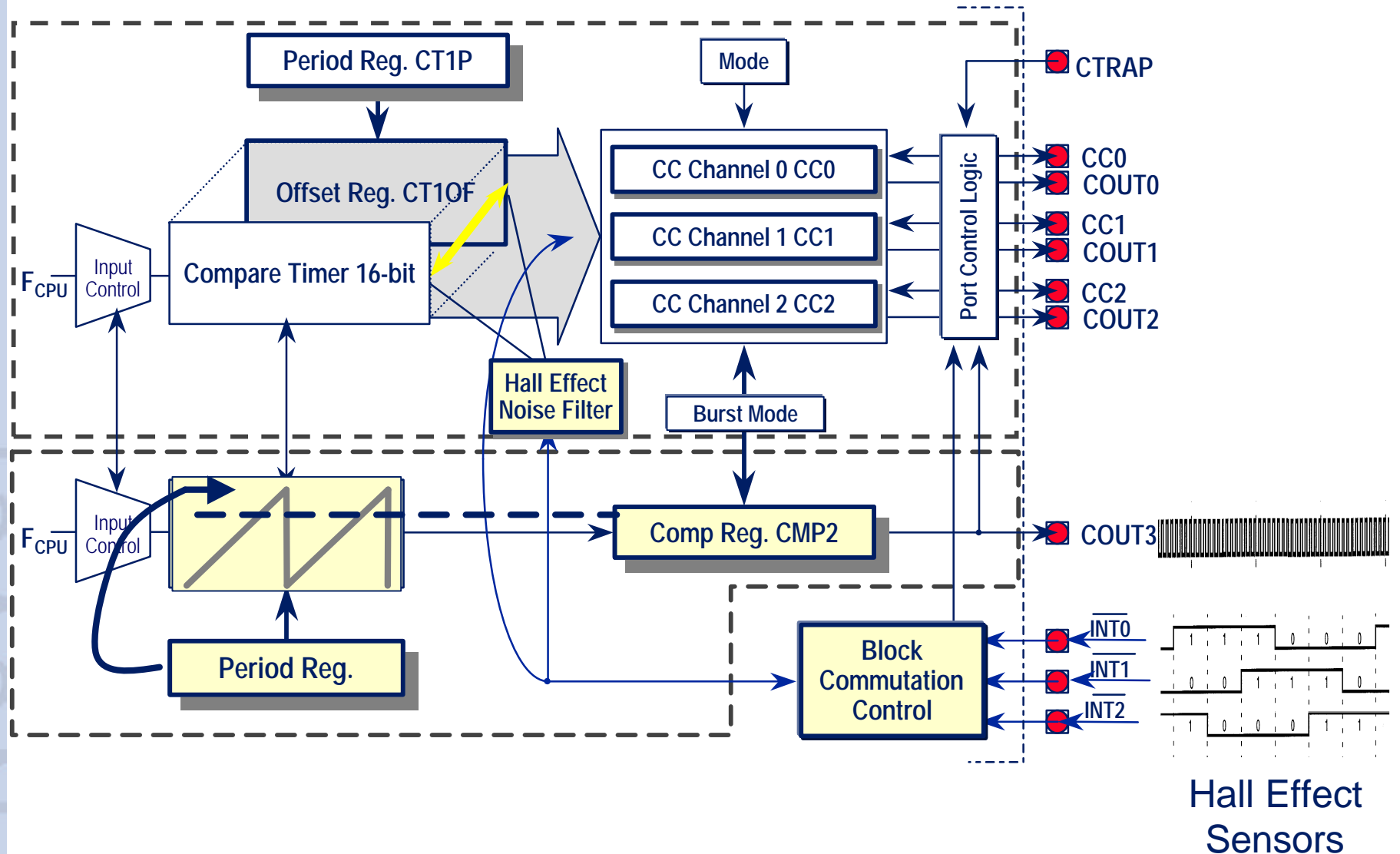
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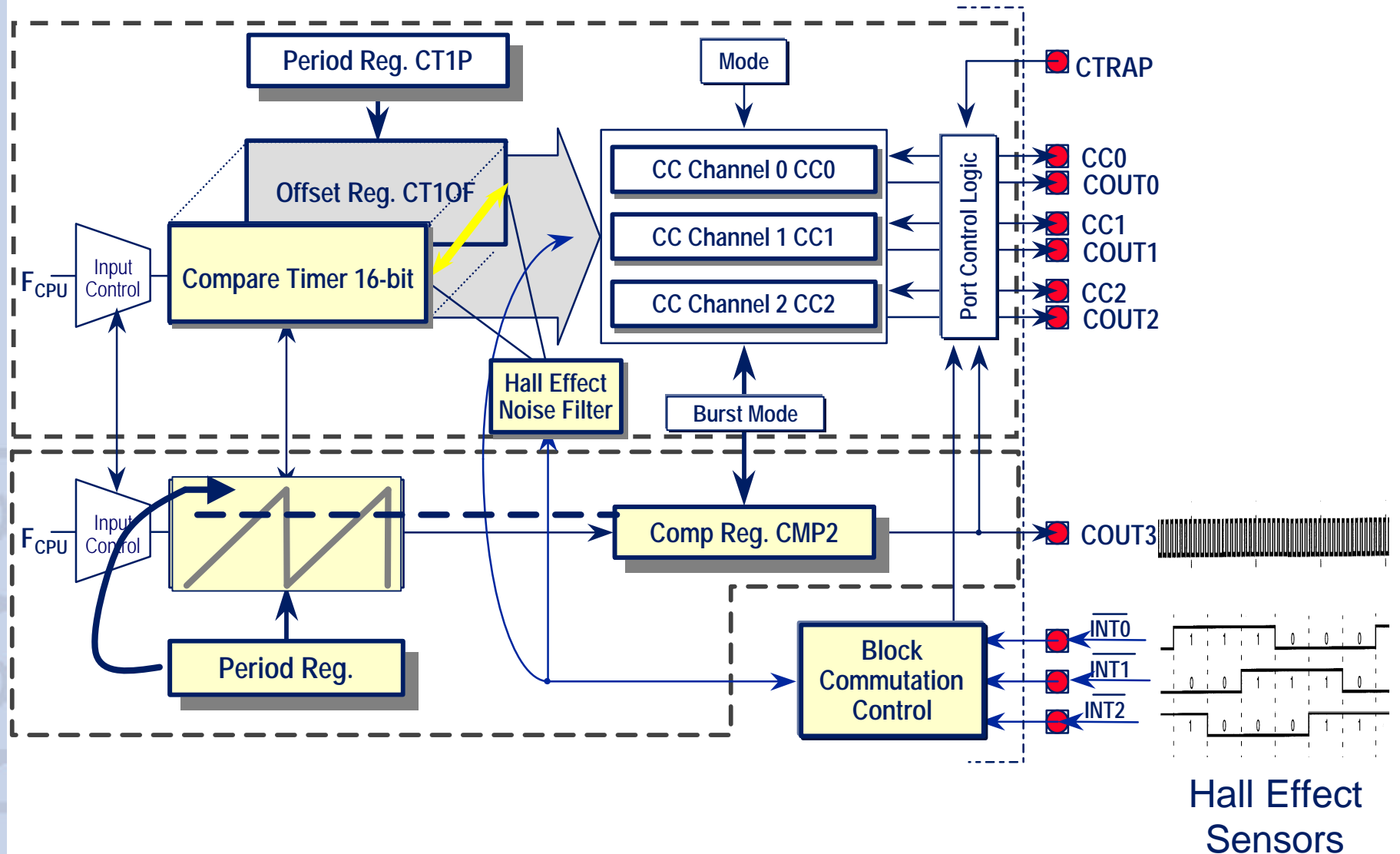
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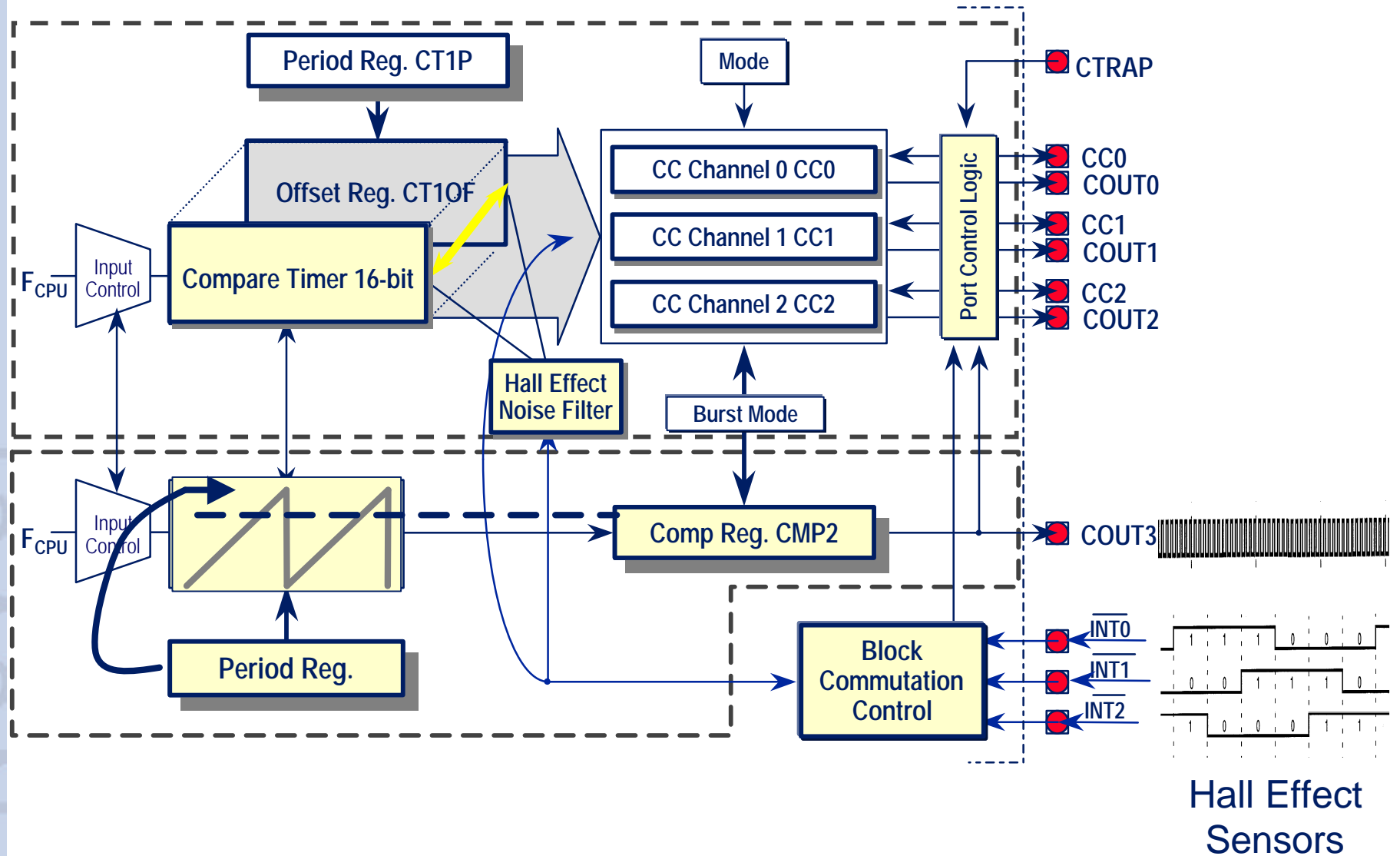
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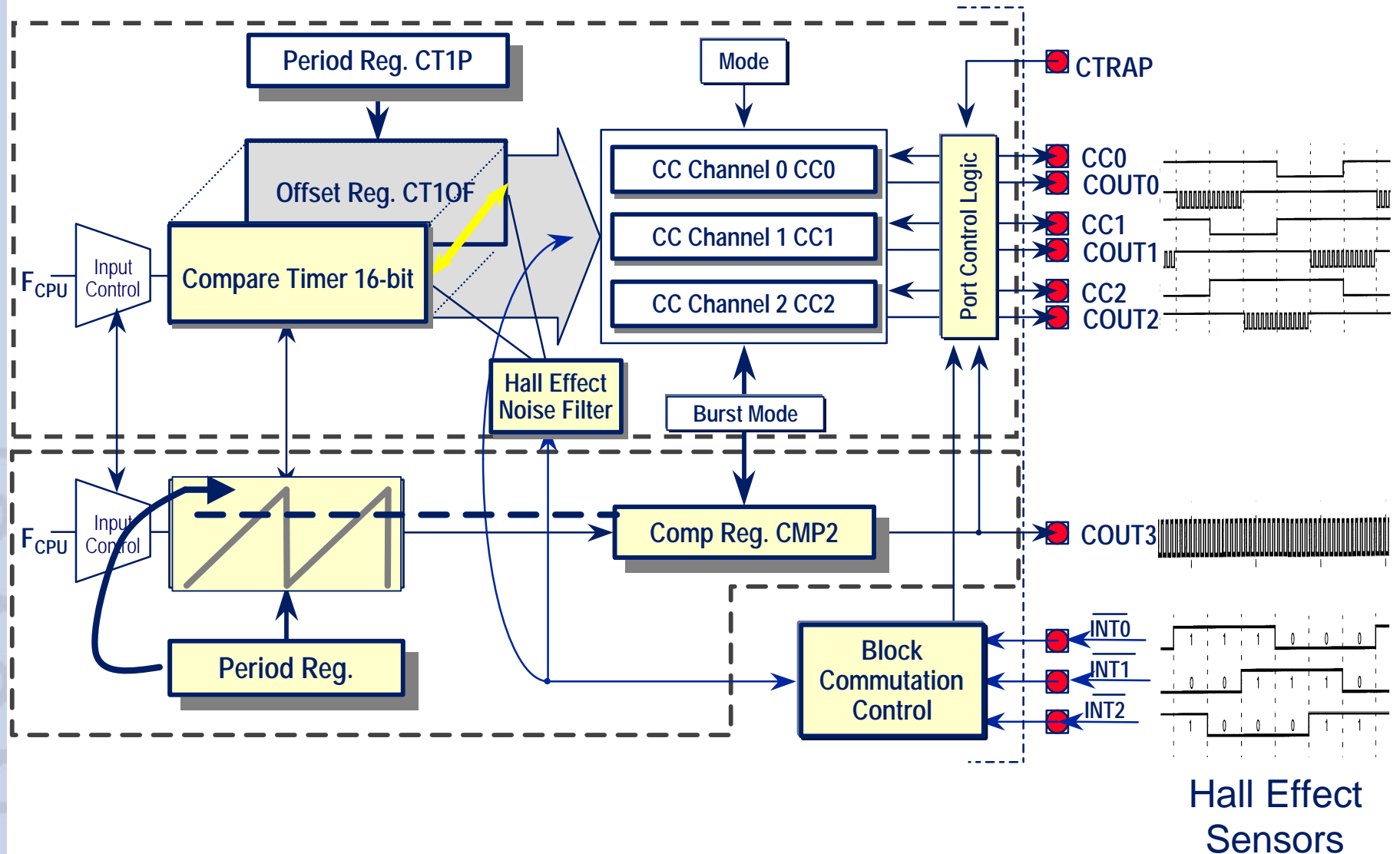
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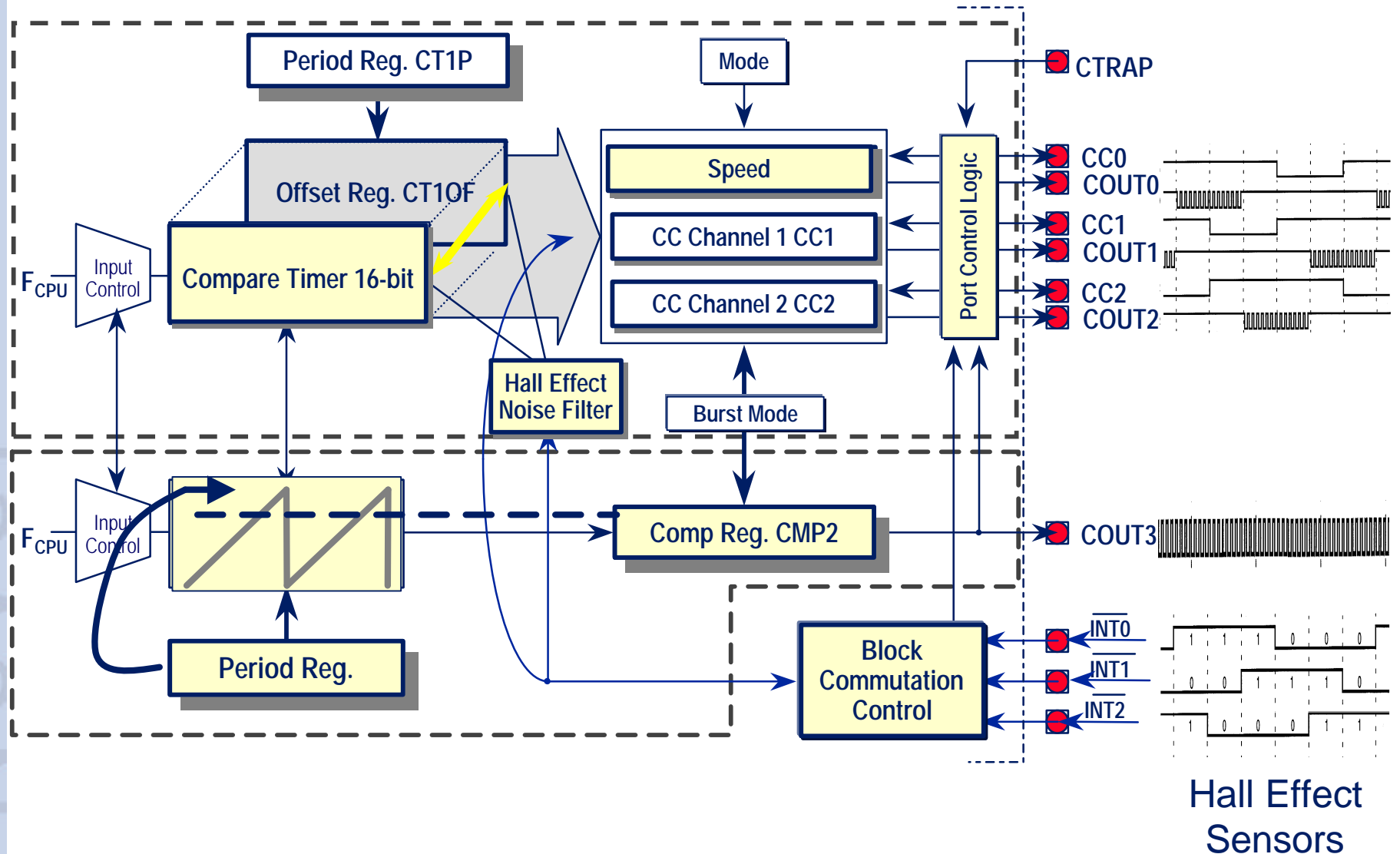
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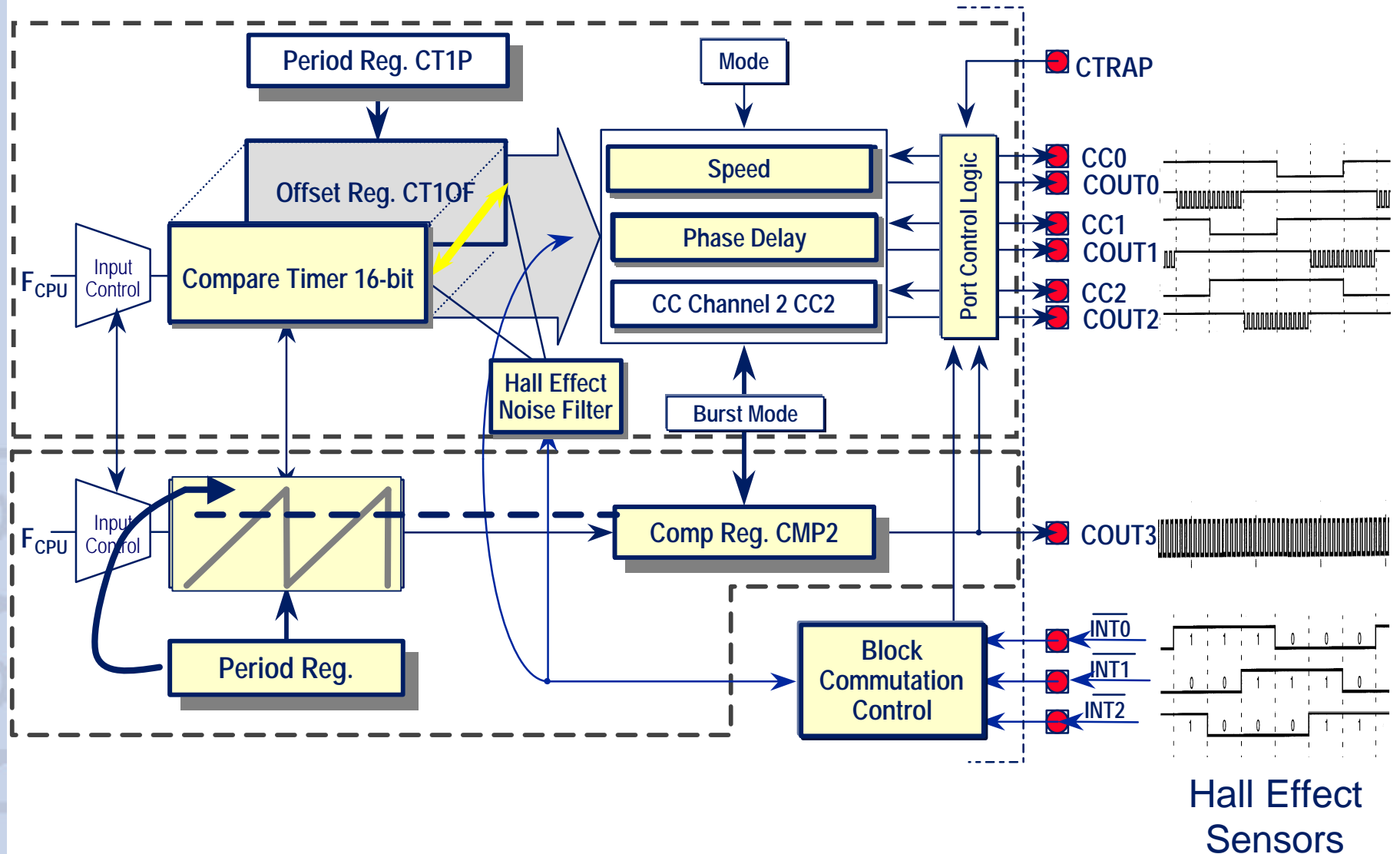
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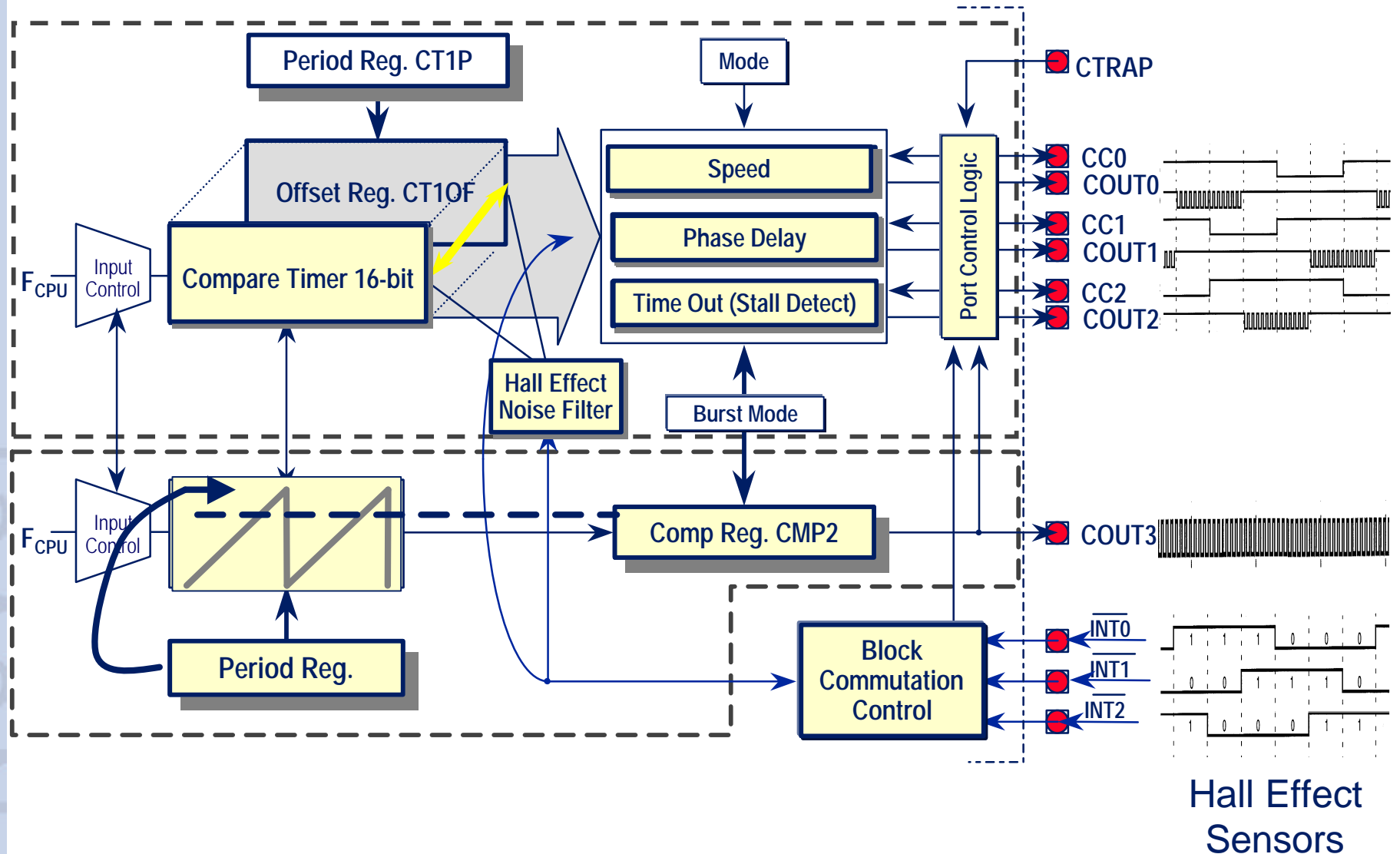
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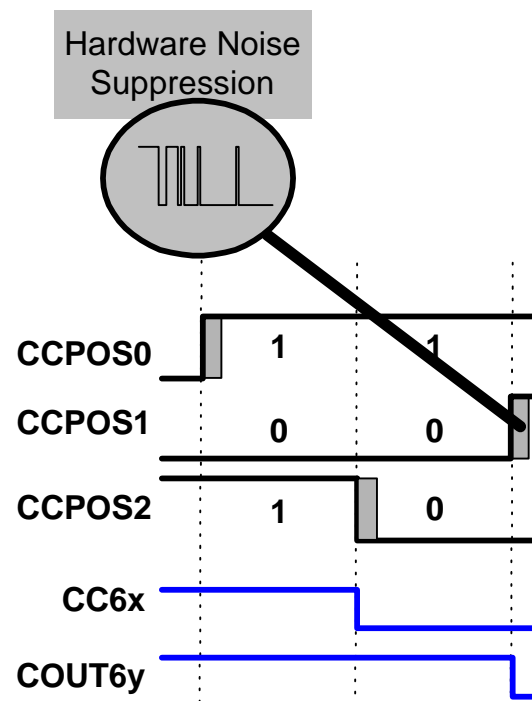


CAPCOM6E - Some New Ideas

Sensorless Control for BLDC -- BEMF Detection

■ BEMF-Detection

- HW-noise filter on CCPOSx inputs (BEMF-signals)

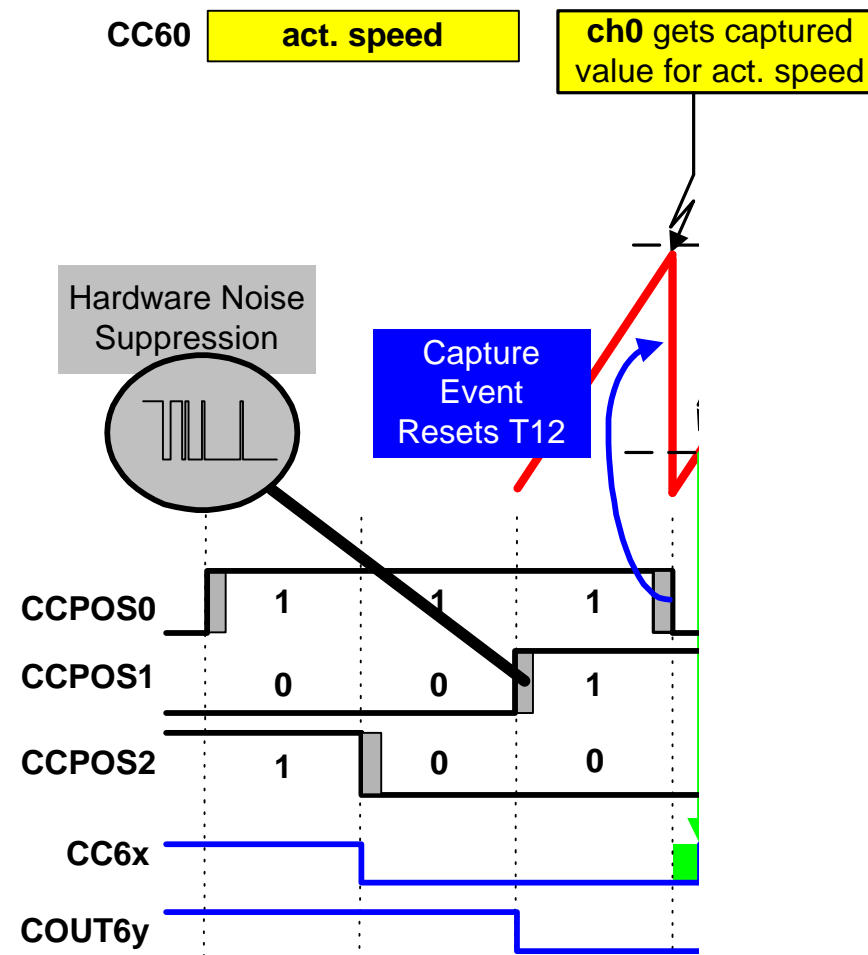


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- actual speed by capture ch0

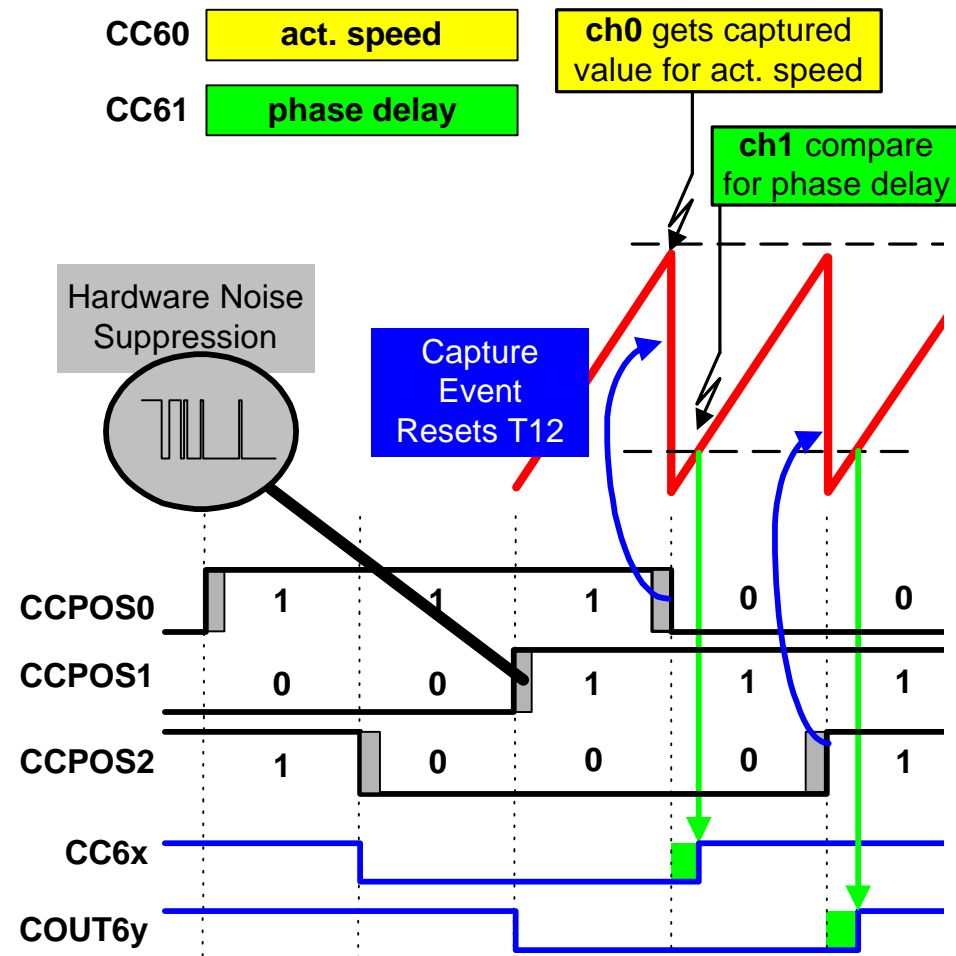


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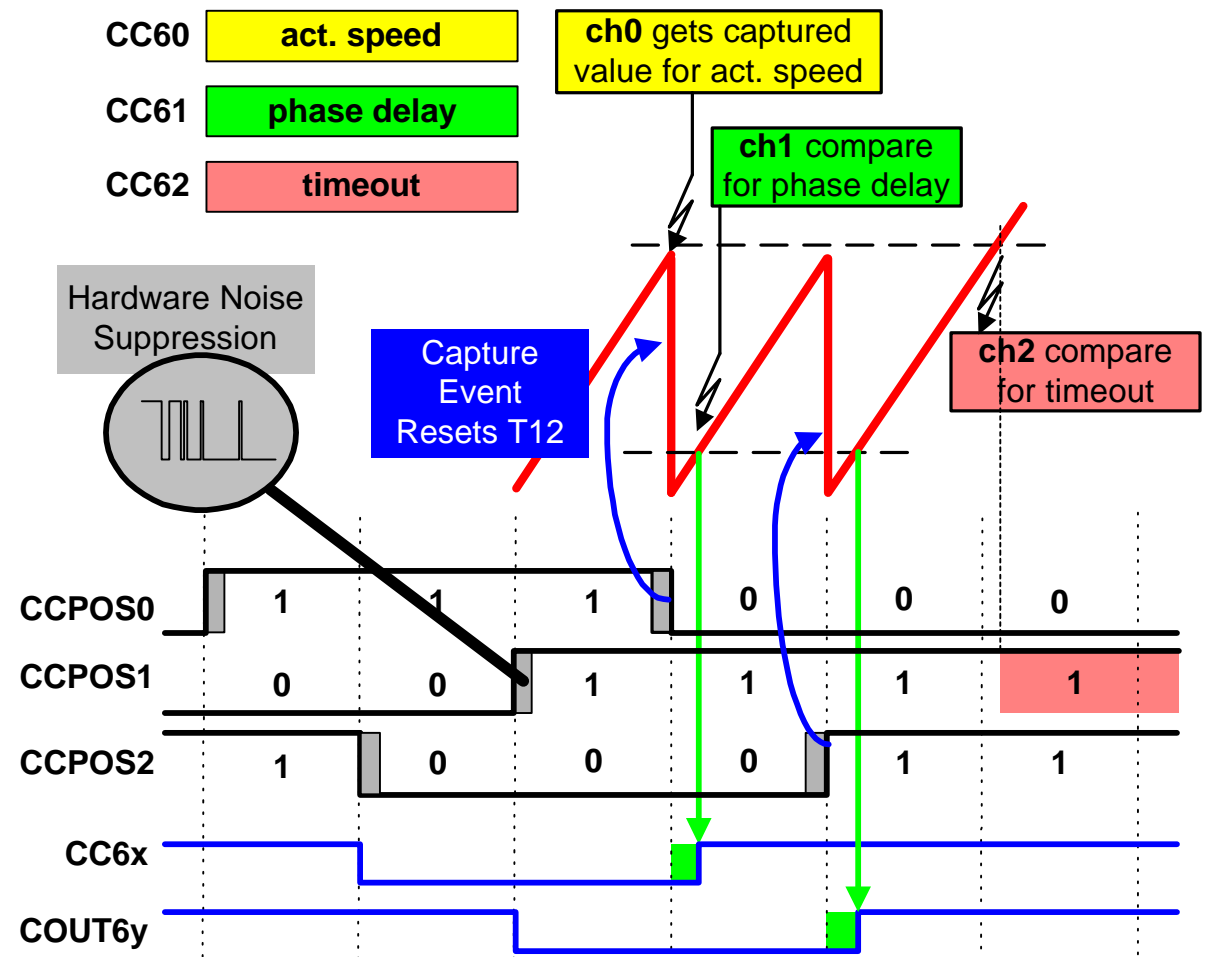


CAPCOM6E - Some New Ideas

Sensorless Control for BLDC -- BEMF Detection

■ BEMF-Detection

- HW-noise filter on CCPOSx inputs (BEMF-signals)
- automatic reset of T12 with interrupt
- actual speed by capture ch0
- phase delay function on ch1
- time out function on ch2



CAPCOM6E is Very Flexible

■ 16-bit Capture/Compare Timer T12

- Edge or Center Aligned (Symmetric) PWM on 3/6 Channels
- Automatic Dead-Time Insertion
- Timer Contents can be Captured in response to rising/falling edge of port pins
- Timer Resolution 25 ns
- Pin polarity completely programmable

■ 16-bit Compare Timer T13

- PWM can be gated to C3OUT, CCxOUT, or CCx (Burst Mode)

■ Special Modes

- Block Commutation (3 phase BLDC), 4-6 phase Unipolar BLDC
- Hardware Noise Filter for Hall Effect Sensors
- Phase Delay for Sensorless BLDC Motors
- Commutation determined by hardware or software
- CCx/T12 PWM can be used in conjunction with these modes
- CC0 Can be used to capture T12 for motor speed measurement

■ Great for: DC, BLDC, Induction, Switched Reluctance and Stepper Motors

C868 vs. ST

■ C868

- 13 I/O + 5 Analog Inputs
 - 13 High Current
- Motor Control Peripheral (CAPCOM6E)
 - Designed for all motors
 - Very flexible
 - Any Driving Circuit can be used
 - 25ns Resolution

■ C868

- 13 I/O + 5 Analog Inputs
 - 13 High Current
- Motor Control Peripheral (CAPCOM6E)
 - Designed for all motors
 - 25ns Resolution
 - 16-bit

■ ST72141

- 14 I/O Pins
 - 3 High Current Pins
- Motor Control Peripheral
 - Designed for BLDC Motors
 - Requires High-side chopping
 - Expensive Driving Circuit Required
 - Poor Resolution

■ ST92141

- 15 I/O Pins
 - 4 High Current Pins
- Motor Control Peripheral
 - Designed for Induction Motors
 - 40 ns Resolution
 - 10-bit

➤ **More Advanced Peripherals**

C868 vs. Motorola

■ C868

- 13 I/O + 5 Analog Inputs
 - 13 High Current
- Motor Control Peripheral (CAPCOM6E)
 - Designed for all motors
 - w/Special modes for BLDC motors
 - 16-bit 25ns Resolution

■ 68HC908MR8

- 22 I/O
 - 8 High Current
- Motor Control Peripheral
 - No Special Modes for BLDC Motors
 - 12-bit, 125ns

➤ **More Advanced Peripherals**