BCCU

Brightness and Color Control Unit

XMC™ microcontrollers

September 2016

Agenda

1. Overview
2. Key feature: Automatic high frequency brightness modulation
3. Key feature: Automatic exponential dimming and linear intensity change
4. Key feature: Controlled rate of switching
5. System integration
6. Application example
7. Additional features

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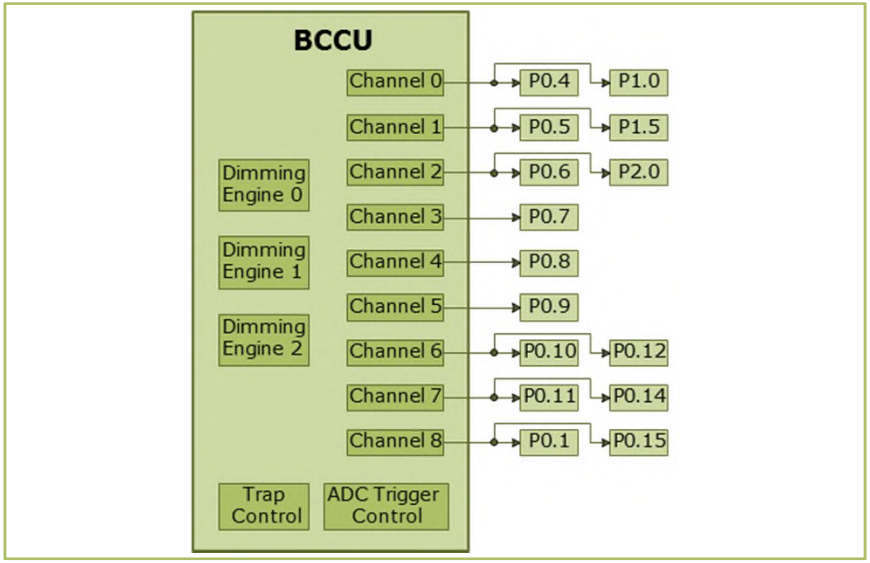
BCCU
Brightness and Color Control Unit



Highlights

- Designed to automatically control the dimming level and color of multi-channel LED lamps
- Requires little user code
- Transitions appear natural to the human eye

Key features

- Automatic high frequency brightness modulation (PDM)
- Automatic exponential dimming and linear intensity change
- Controlled rate of switching

Customer benefits

- Completely flicker free; no visible or intrasaccadic flicker; 12-bit resolution
- Dimming level or color changes appear smooth and natural to the human eye
- Compatible with a wide range of high power LED drivers

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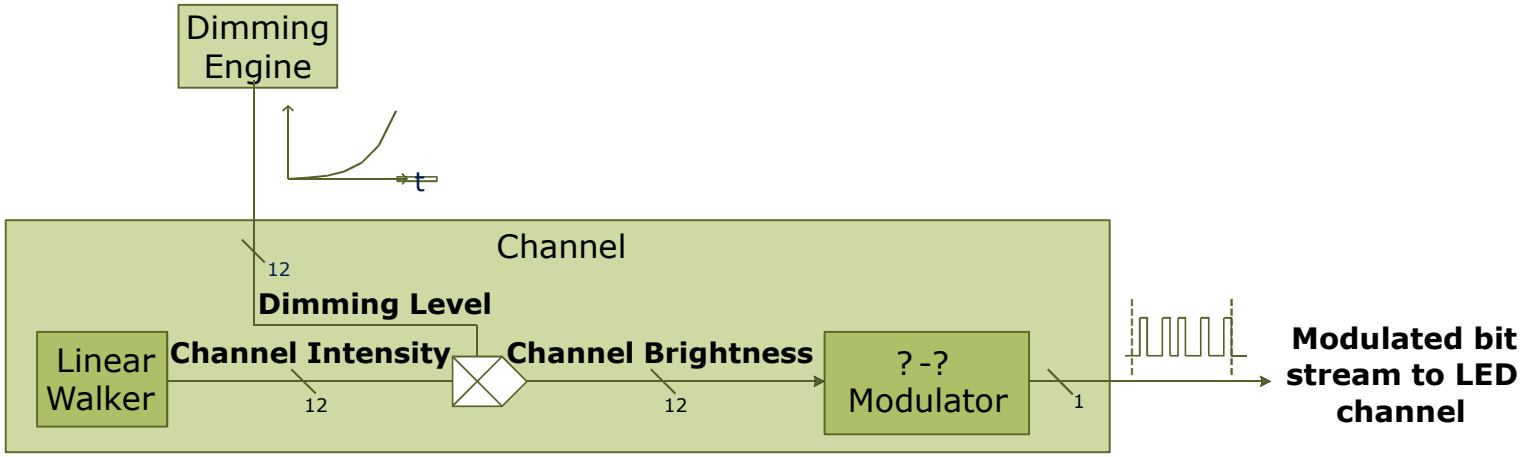
BCCU - Automatic high frequency brightness modulation (PDM)

- High frequency brightness modulation
  - ON-OFF dimming signal generated by a 12-bit ∑-Δ modulator in every channel
  - Adjustable bit rate; 40-1000 kbps recommended → no visible flicker or shimmer; no steady or intrasaccadic flicker (<3 kHz) that may cause neurological effects
- Automatic light quality control
  - Built-in flicker watchdog to eliminate flicker even at very low brightness levels



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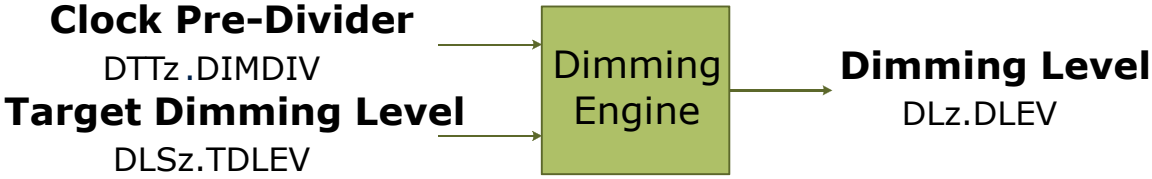
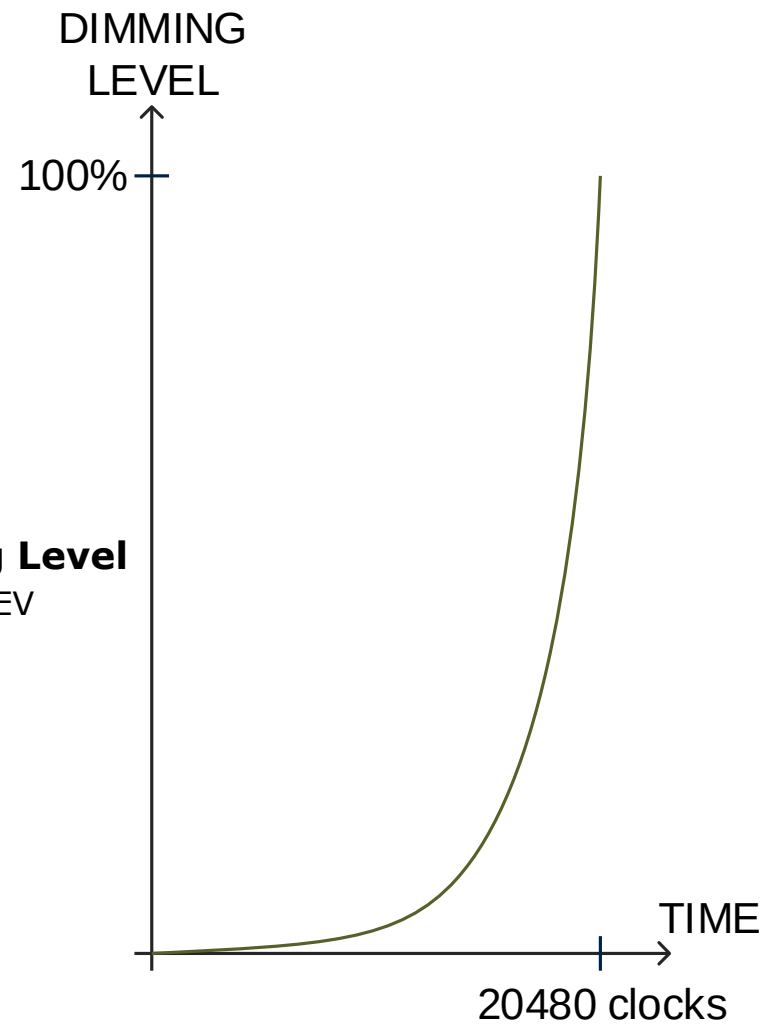
BCCU
Automatic exponential dimming

- Automatic gradual brightness change
  - Brightness level changes along an exponential curve
  - The change appears natural, the human eye can adapt comfortably

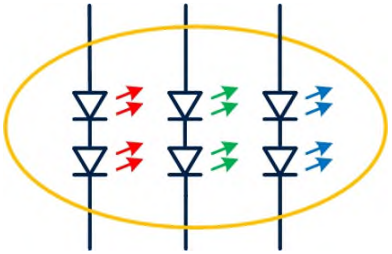


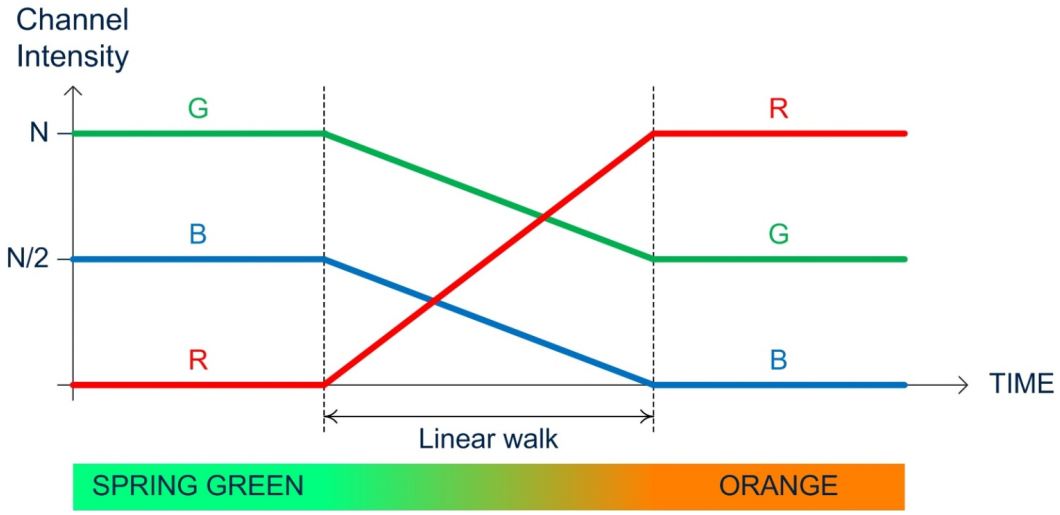
- Invisible dimming steps
  - Dithering can be applied at low dimming levels if transition is slow

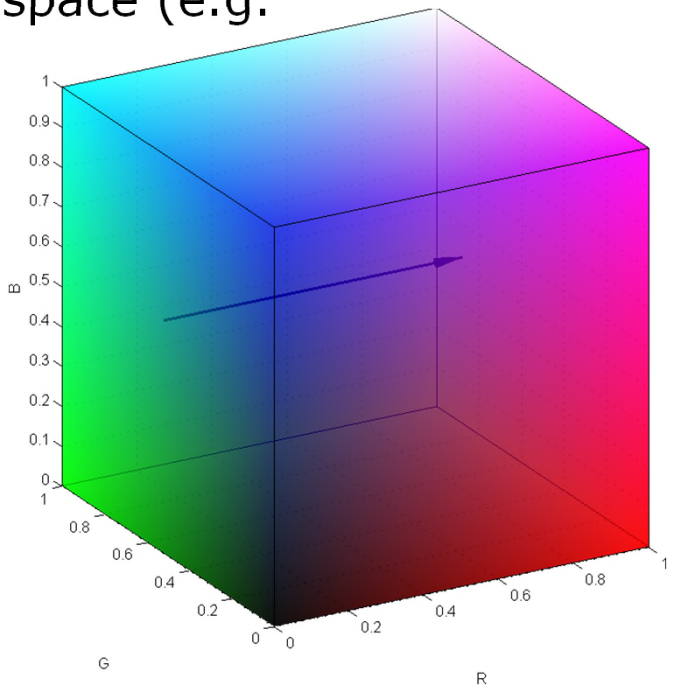


BCCU
Automatic linear intensity change

- Automatic smooth color change
  - Selected channels continuously change their intensity for a predetermined duration
  - The respective targets are reached at the same time (variable clock base)
  - Straight transition in the orthogonal color space (e.g. RGB)







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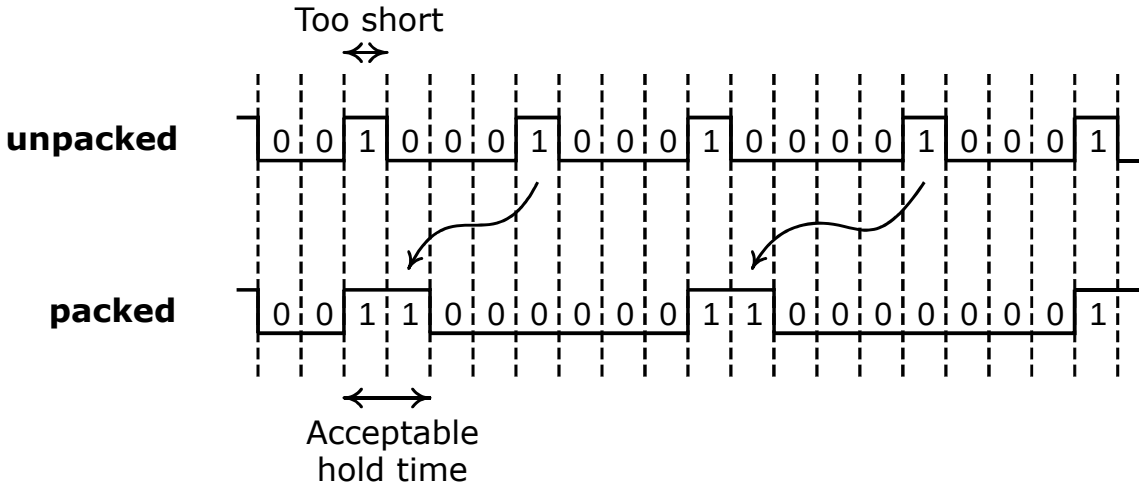
BCCU
Controlled rate of switching

- It takes time for the LED current to stabilize
  - Longer in switched-mode systems
  - Longer in high-power systems
- PDM has higher switching rate
- Group similar bits together at higher brightness levels
  - To make ON-times longer
  - To lower the average switching rate
- No effect on brightness



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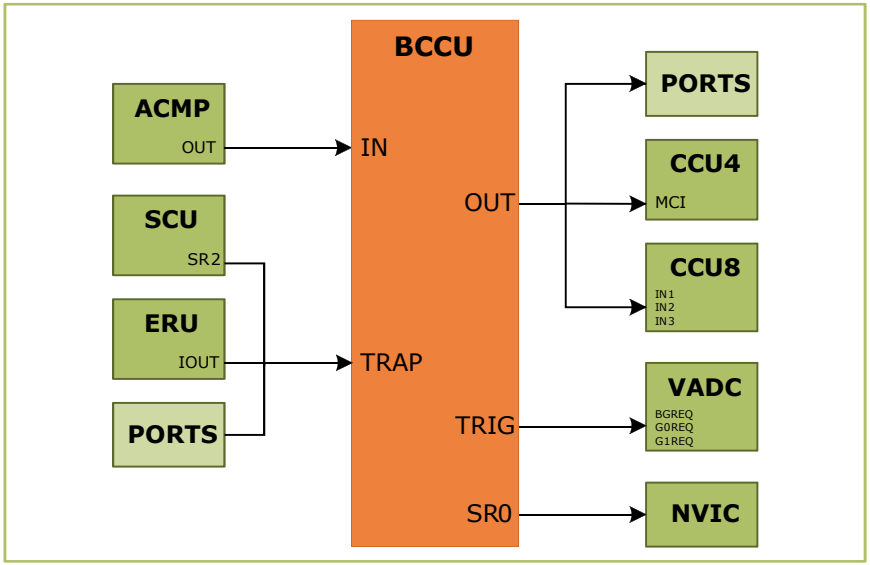
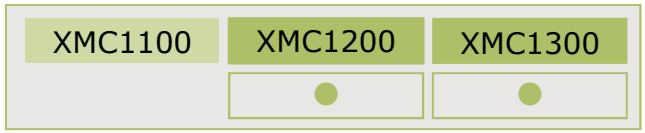
BCCU
System integration



- Target applications
  - Intelligent lighting
  - Power conversion



The primary function of BCCU is to provide automatic dimming signals on port pins for external LED drivers. (OUT)

Two trigger signals can start ADC conversions to take noise-free measurements on the LED channels. (TRIG)

The dimming signals can also be routed to CCU4 or CCU8 which can directly drive the LED current control circuitry. (OUT)

Trap state occurs when there is an external emergency (e.g. short circuit). This information can be routed to BCCU directly from pins, via SCU or ERU. During trap, the BCCU outputs immediately go to a pre-determined safe passive level. (TRAP)

The output of the analog comparators can be used as an asynchronous gating signal to BCCU channels for fast control loops. (IN)

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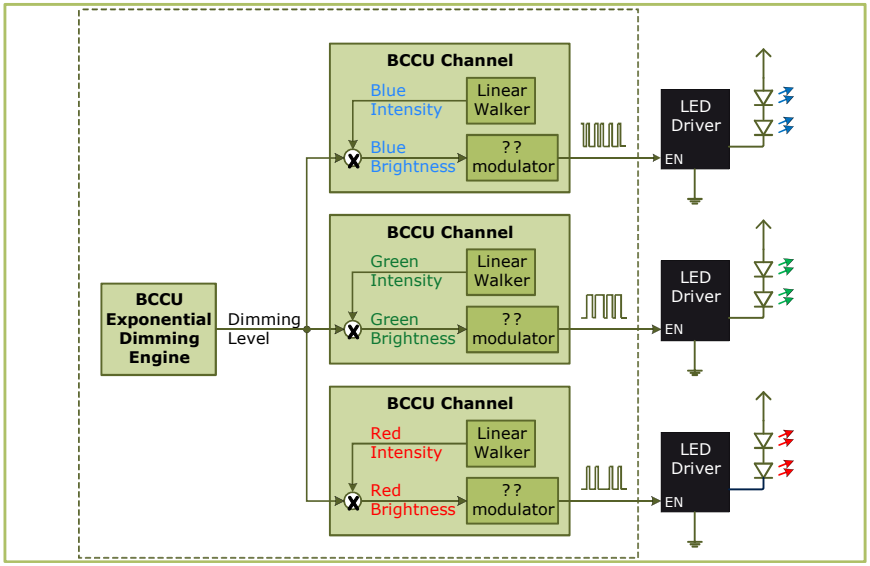
RGB lamp control with external linear drivers



In brief

- Automatic color control, smooth color change
- Automatic dimming control, natural changes in dimming level
- Easy on the human eye
- Flicker elimination and smoothened dimming steps

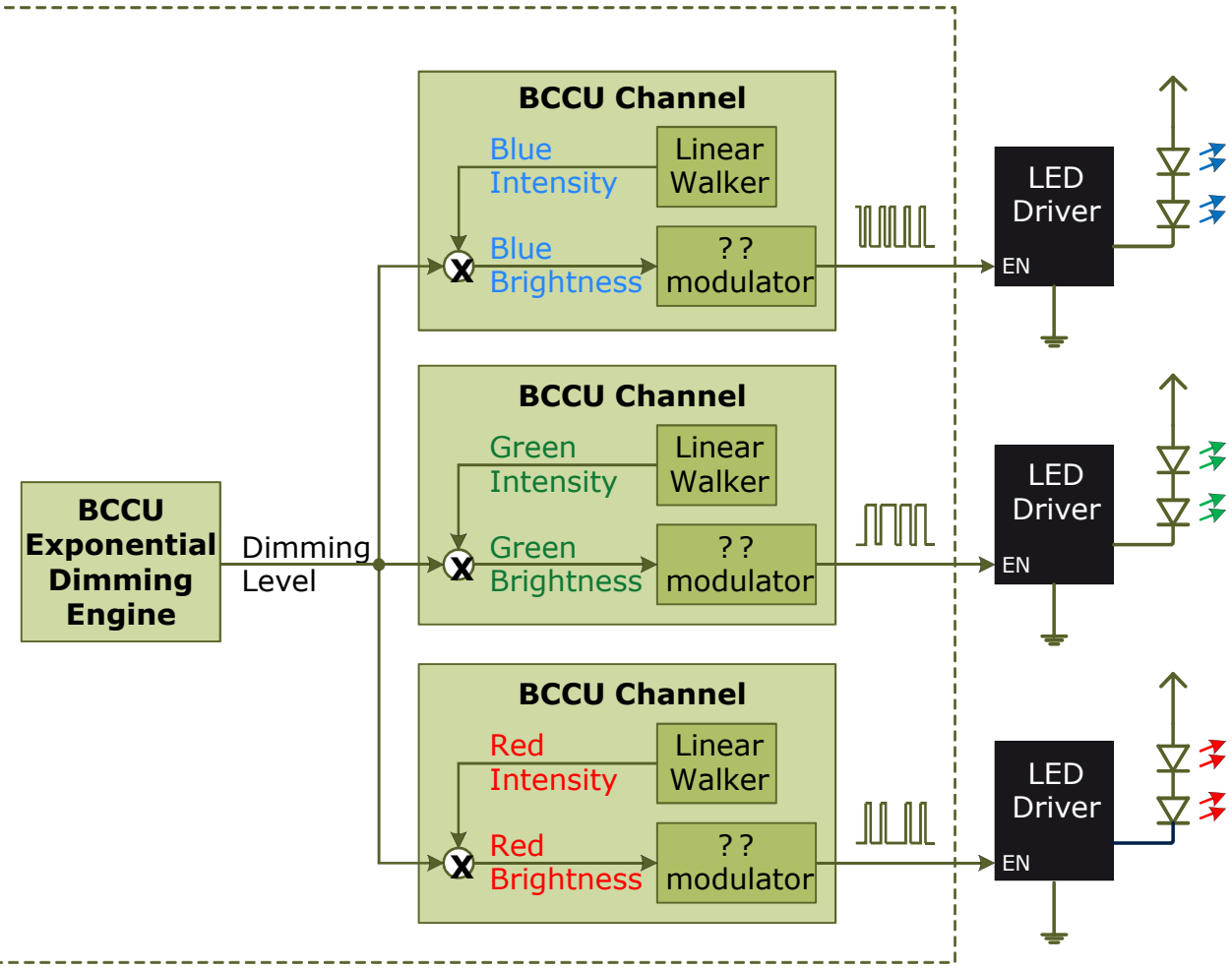
Overview

BCCU provides color control with 12-bit precision. Color transitions can be immediate or gradual by a linear walk.

Lamp dimming level is separately controlled from lamp color, also with 12-bit precision. Dimming level can change exponentially over time to appear natural to the human eye.

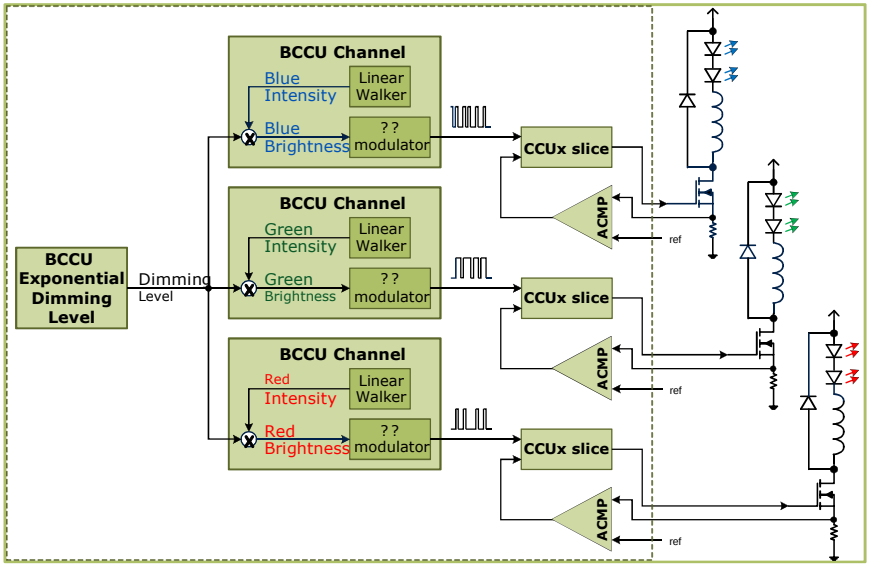
Flickering due to low switching rate and visible steps due to slow dimming at low intensity levels can be automatically eliminated.

RGB lamp control with external linear drivers



RGB lamp control: Detailed block diagram

RGB lamp control with switched-mode current control



In brief

- Automatic smooth color and dimming control
- Easy on the human eye
- FFlicker elimination and smoothened dimming steps
- Low-cost high-quality multi-channel DCDC LED driver solution

Overview

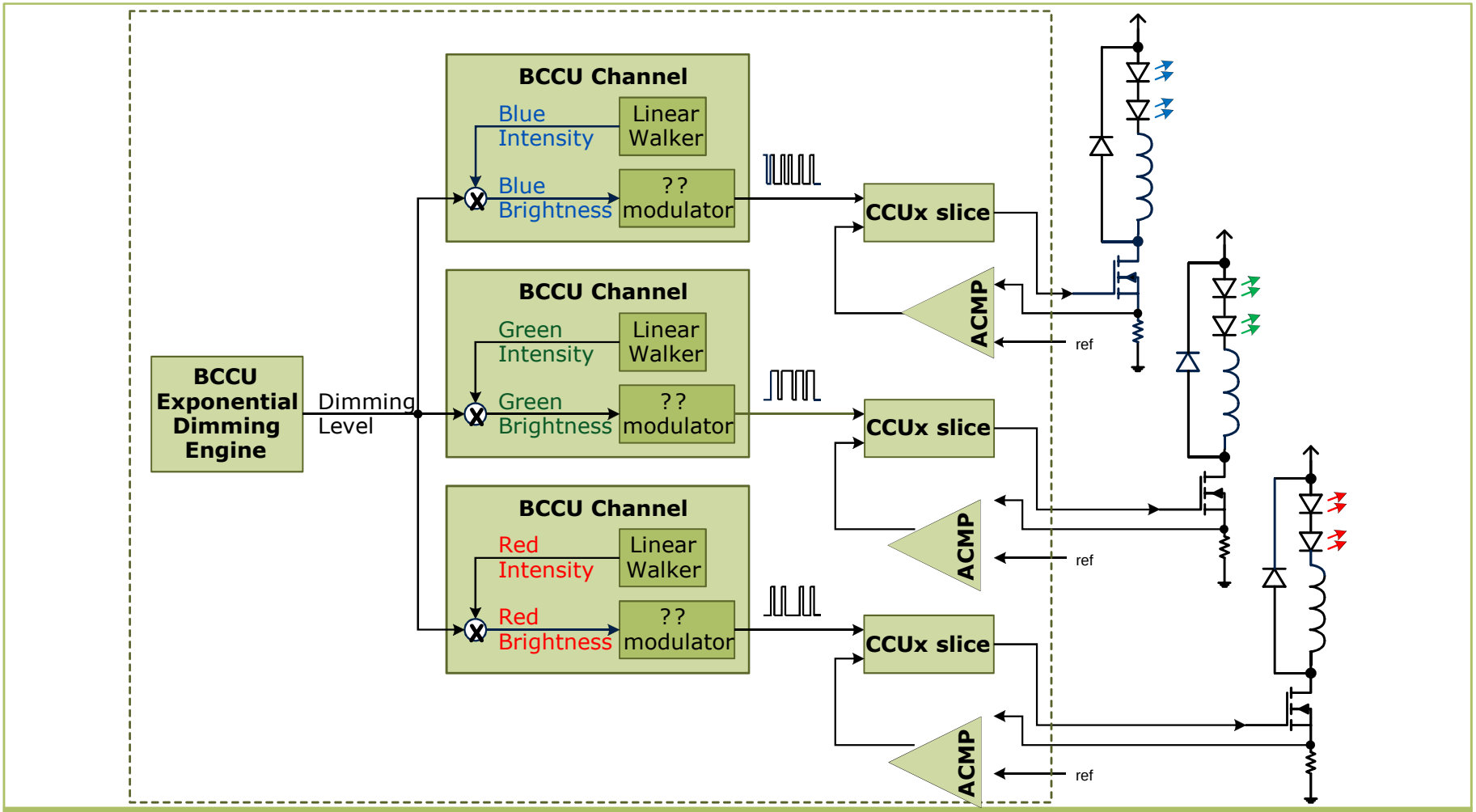
BCCU provides color control with 12-bit precision. Color transitions can be immediate or gradual by a linear walk.

Lamp dimming level is separately controlled from lamp color, also with 12-bit precision. Dimming level can change exponentially over time to appear natural to the human eye.

Flickering due to low switching rate and visible steps due to slow dimming at low intensity levels can be automatically eliminated.

Fast current control possible by well-interconnected switching and analog peripherals.

RGB Lamp Control with switched-mode current control



RGB lamp control: Detailed block diagram

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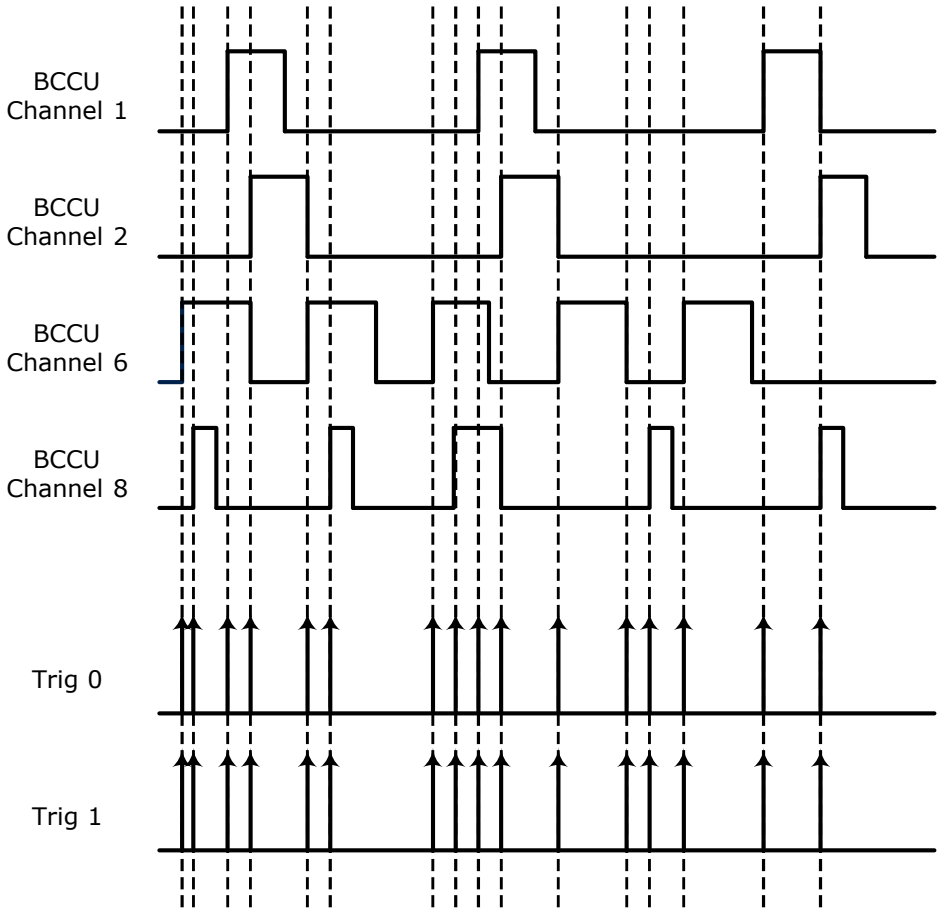
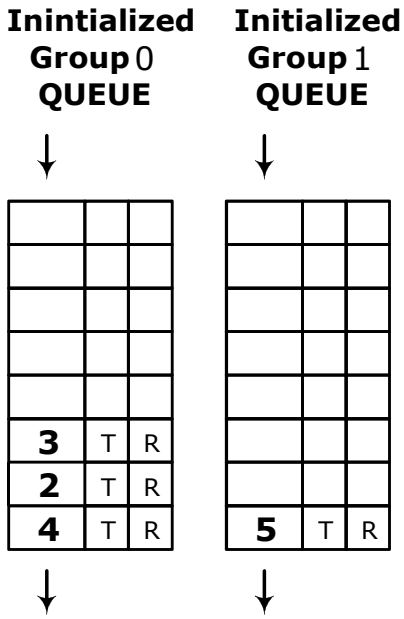
BCCU
Synchronized sampling – trigger modes (1/2)

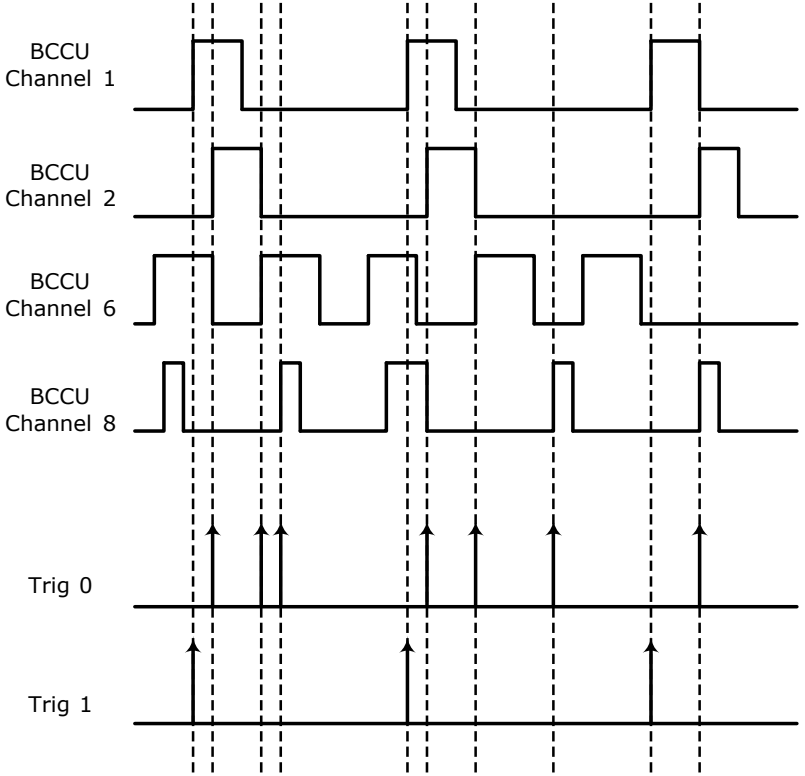
- Trigger mode 0
  - Trigger pulse generated on both lines when rising/falling edge occurs on any BCCU output
  - Sample all channels when any trigger occurs
  - State of outputs stored in LTCHOL
  - High ADC load



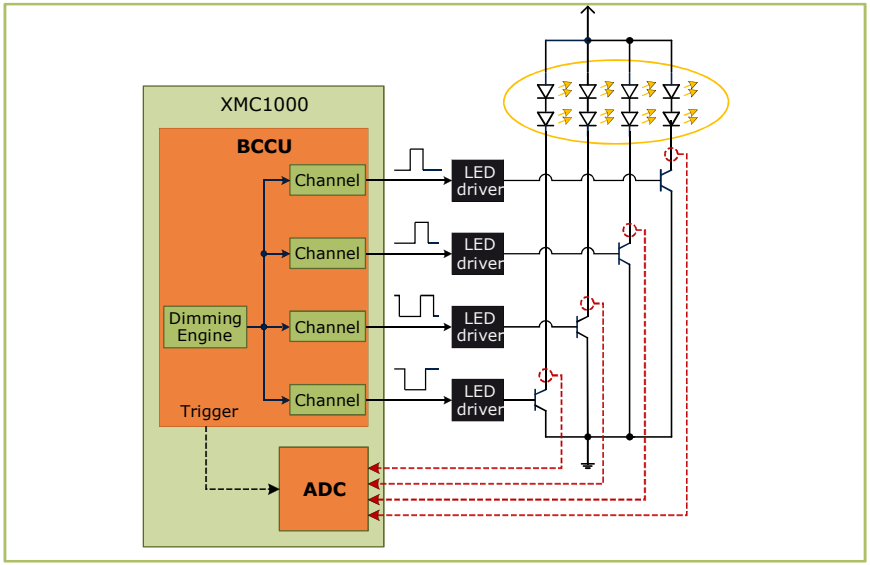
BCCU
Synchronized sampling – trigger modes (2/2)

- Trigger mode 1
  - Channels can generate trigger in a round robin manner on one of the two outputs
  - Sample only one channel at a time
    - ADC queues have to be set up properly (order, trigger, auto-refill)
  - Low ADC load





Multi-ch. lamp control with ext. lin. drivers + ADC trig.



In brief

- Automatic dimming control, natural changes in dimming level
- LED driver compatibility, controlled switching rate
- Support for timed channel measurements

Overview

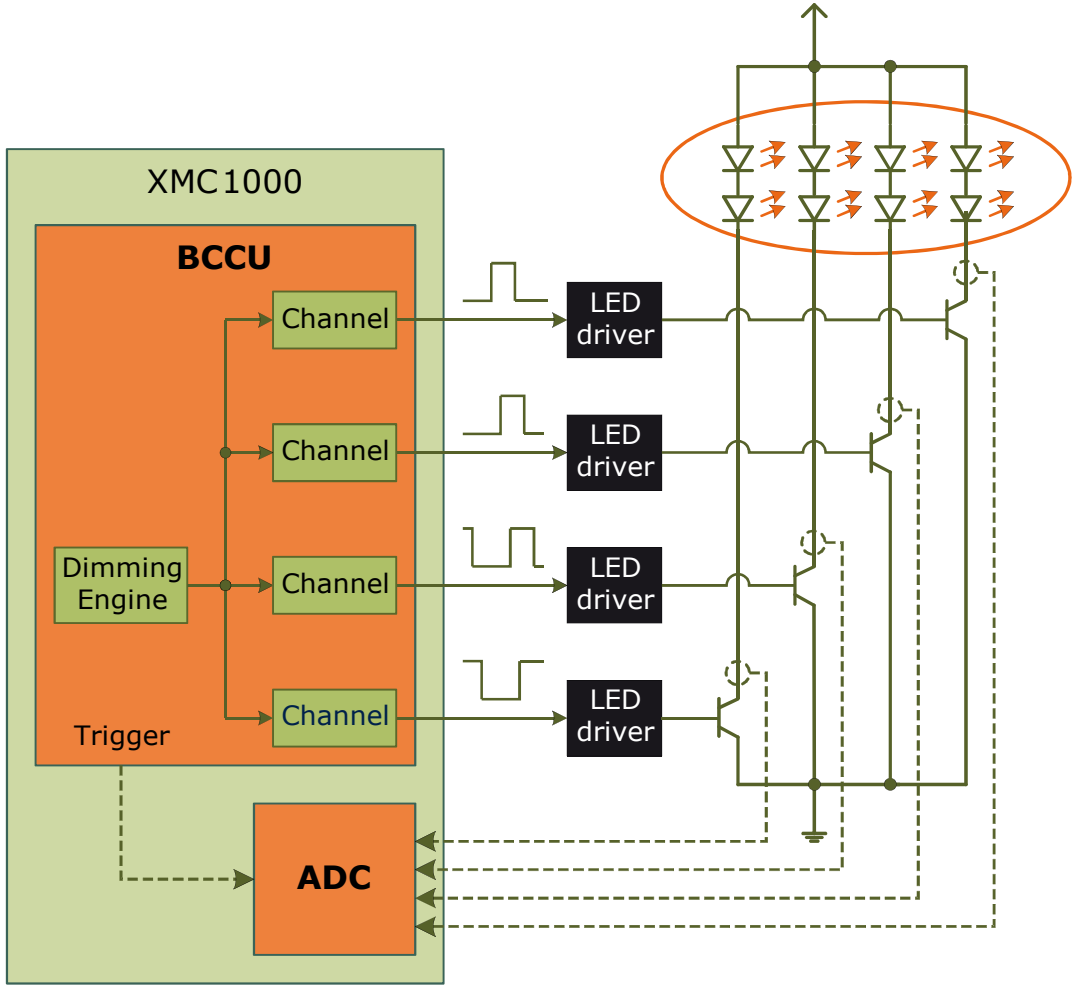
BCCU provides lamp dimming level control with 12-bit precision. The dimming level can change exponentially over time to appear natural to the human eye.

The rate of switching of the output signals can be tightly controlled to ensure minimum hold times for high power external LED drivers.

BCCU provides trigger signals to the ADC to achieve synchronized sampling.

The output signals can be phase shifted relative to each other to smoothen the load on the common voltage rail.

Multi-ch. lamp control with ext. lin. drivers + ADC trig.



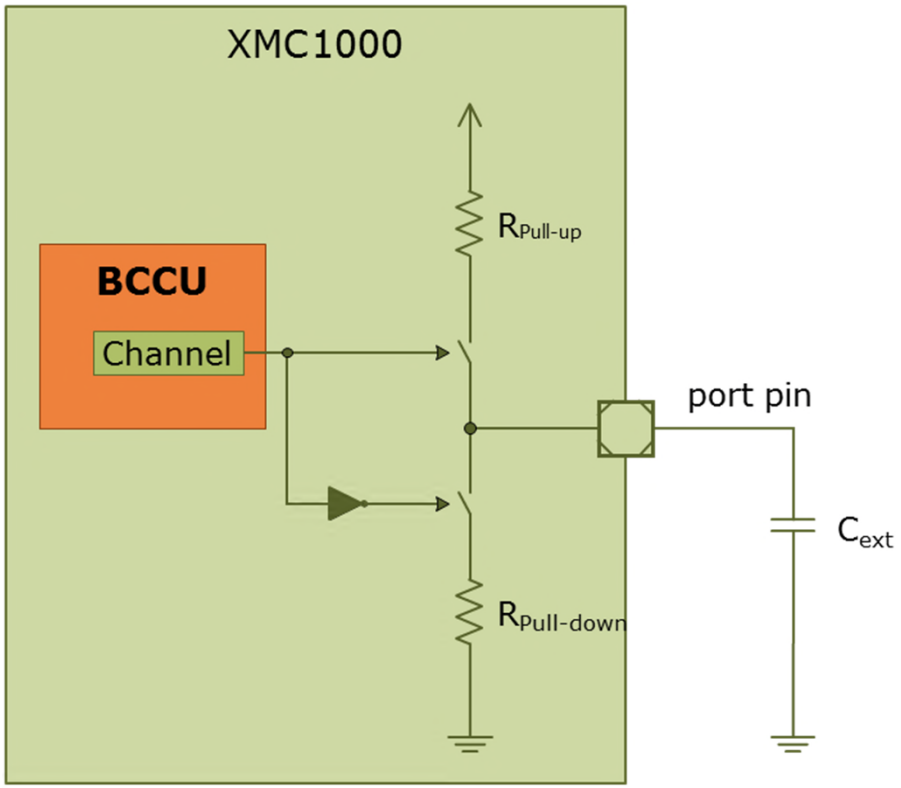
Street lamp control: Detailed block diagram

BCCU
Flicker watchdog

- Flicker happens when there are long periods of ‘0’ bits
- Flicker watchdog is useful at low brightness levels
  - Inserts ‘1’ bit when there are long periods of ‘0’ bits
- Trade-off: pulse insertion limits minimum brightness

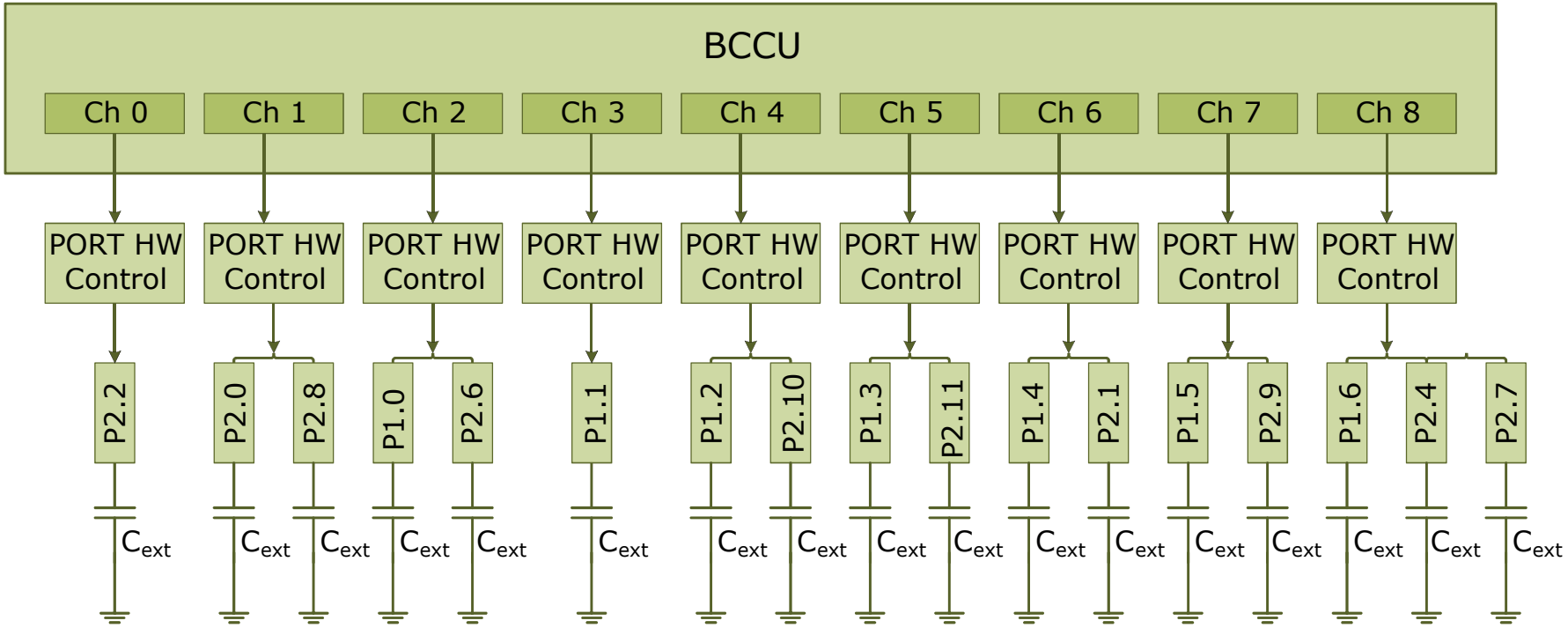
BCCU
Pseudo-DAC – only available on AB step

- Analog voltage level on connected pins
  - 12-bit precision
  - Can be used as comparator reference voltage
  - The pins with analog signal level can be used as input pins to other modules (e.g. internal analog comparators)
  - Overridden hardware pull-up and pull-down control
  - For small capacitors it is recommended to have a high frequency BCCU bit clock



BCCU
Pseudo-DAC – only available on AB step

- DAC functionality available on many pins



General information

- For latest updates, please refer to:

  www.infineon.com/xmc1000

- For support:

  http://www.infineonforums.com/forums/8-XMC-Forum

Support material

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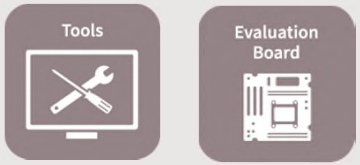
Technical Material 	› Application Notes › Technical Articles › Simulation Models › Datasheets, MCDS Files › PCB Design Data	› www.infineon.com/XMC › Kits and Boards › DAVE™ › Software and Tool Ecosystem
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