CE210197 – Adjustable Reference Comparator

Objective

This code example demonstrates the adjustable voltage reference capability of the CapSense® Sigma Delta (CSD) Comparator. This Component provides the flexibility to compare the input voltage with different levels of reference voltages. It can be used as a fan speed controller, battery monitor, and so on.

Overview

This code example demonstrates how to set the Component options for adjustable voltage reference and how to set different reference voltages in the firmware.

The code example uses a pushbutton to set the reference voltages in the firmware. Once the reference voltage is set, the comparator compares the input voltage with the reference voltage. If the input voltage is greater than the reference voltage, the code sets the RGB LED to green. Otherwise, the code sets the RGB LED to red. An external voltage supply of 1.8 V is required to connect with the input voltage.

Requirements

Tool: PSoC Creator™ 3.3 SP2 or higher

Programming Language: C (ARM GCC 4.9)

Associated Parts: PSoC® 4000S, PSoC 4100S, and PSoC Analog Coprocessor

Related Hardware: CY8CKIT-041-40xx, CY8CKIT-041-41xx, and CY8CKIT-048

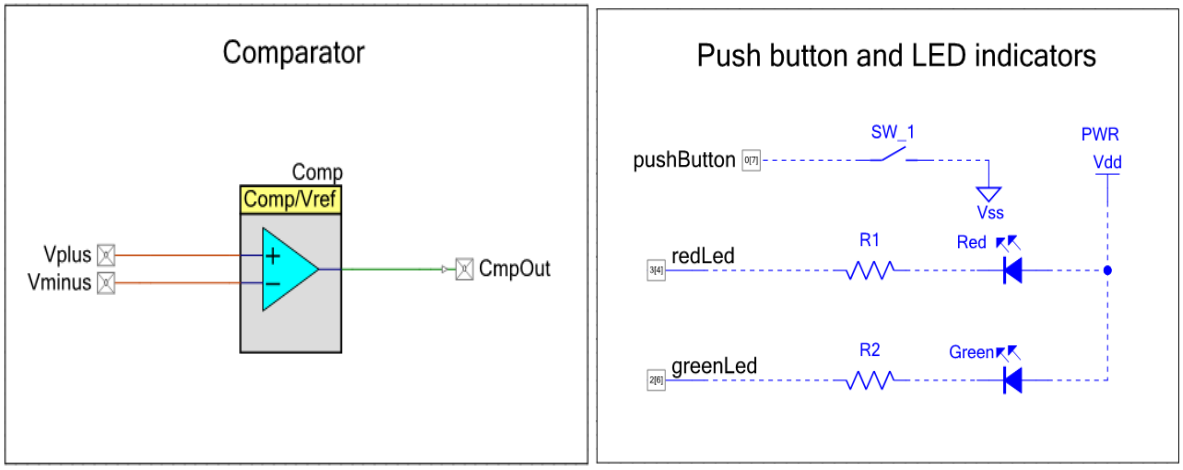
Design

The example project consists of analog input pins, a digital input pin, output pins, and Comp/Vref Components. Figure 1 shows the Component schematics for this project. The Comparator compares the input voltage applied to the noninverting terminal (Vplus) with a variable reference voltage, which is generated by the reference generator. The reference generator is part of the Comparator Component, which gets a constant reference voltage as an input.

The example uses a GPIO pin to apply the constant reference voltage to the inverting terminal (Vminus) of the Comp/Vref Component. The firmware uses the redLed and greenLed pins to control the respective LEDs. The red and green LEDs are part of the RGB LED on the kits.

This code example uses a pushbutton to change the reference voltage in the firmware at run time. It uses the LEDs to show the output of the Comparator. The Comparator can take the reference voltage input from 0.6 V to analog supply voltage (VDDA) – 0.6 V.

Figure 1. Component Schematics



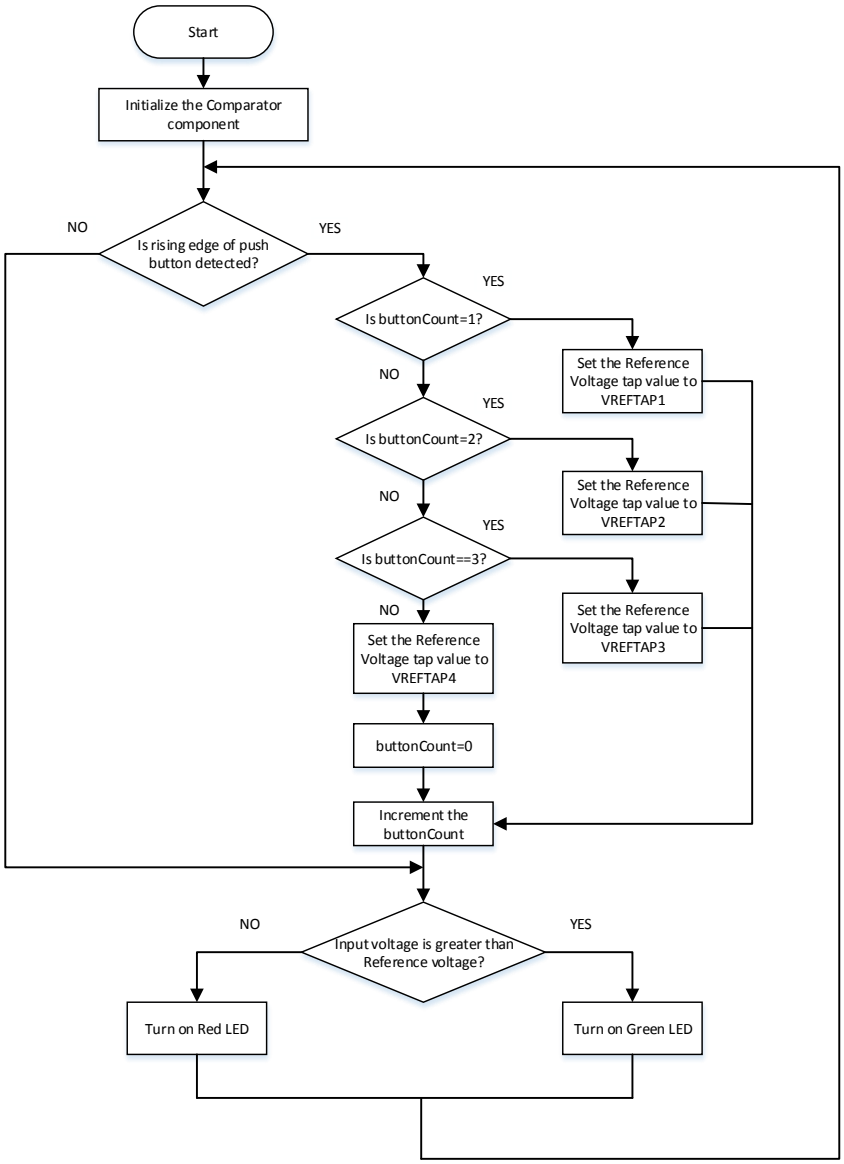
At the beginning of the program, the code initializes the Comparator Component, and the LEDs are set to the default state. The code defines four reference voltage tap values as macros to demonstrate the adjustable reference capabilities of the Comparator Component. The values are calculated using the following formula:

Tap value = Required reference voltage in mV / Comp_VREF_STEP_MVOLTS

Each time the pushbutton is pressed, upon the rising edge, the code changes the reference voltage to the next reference voltage value. Then the Comparator compares the input voltage with the reference voltage generated by the reference block. A software counter counts the number of rising edges of the button presses to indicate the reference voltage to be set. The counter is reset after four presses.

When the input voltage is greater than the reference voltage, the green LED is turned on. Otherwise the red LED is turned on. Change the reference voltage tap values by simply pushing the button. Figure 2 shows the firmware flow chart of this project.

Figure 2. Firmware Flow Chart



Design Considerations

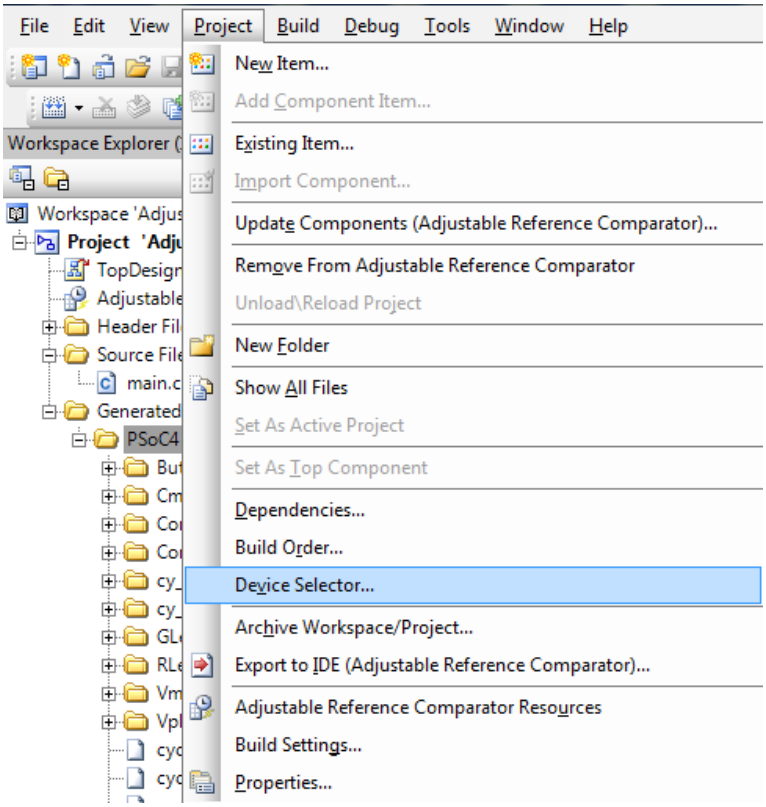
The code example is designed for the PSoC 4000S family and the associated CY8CKIT-041-40xx kit. The design is easily portable to other PSoC devices and kits, typically by just changing the device and pin assignments.

To switch from the CY8CKIT-041-40xx to other PSoC pioneer kits, follow these steps:

1. Select the appropriate device with a device selector called from the project's context menu (Figure 3). Table 1 lists the device number for each pioneer kit.
2. When you select the device, PSoC Creator assigns pins automatically in the Design-Wide Resource file according to the device selected.

   Note: If the assigned Components pins are not as shown in Table 1 or you want to overwrite the existing pin assignment, double-click the project's Design-Wide Resource file in the **Workspace Explorer** window and assign the pins. Refer to the device datasheet for information on pin assignments.

Figure 3. Select Device Selector from Project's Context Menu



3. Build the project and ensure that there are no errors or warnings.

Table 1. Pin Assignments for the Adjustable Reference Comparator Project

Pin Name	Development Kits		
	CY8CKIT-041-40XX (CY8C4045AZI-423)	CY8CKIT-041-41XX (CY8C4146AZI-S433)	CY8CKIT-048 (CY8C4A5LQI-483)
Vplus	P2[2]	P2[2]	P2[2]
Vminus	P4[0]	P4[0]	P5[1]
CmpOut	P2[0]	P2[0]	P3[5]
redLed	P3[4]	P3[4]	P1[4]
greenLed	P2[6]	P2[6]	P2[6]
pushButton	P0[7]	P0[7]	P0[3]

PSoC Creator Components

Table 2 lists the PSoC Creator Components used in this example, as well as the hardware resources used by each.

Table 2. PSoC Creator Components

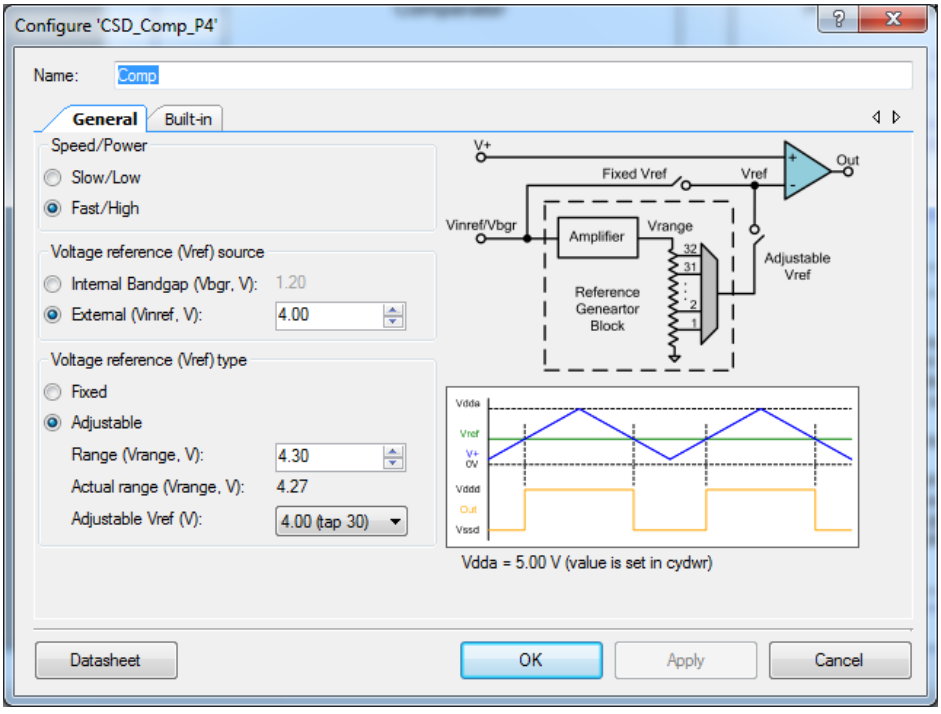
Component	Hardware Resources
Comp	AMUXBUS-A, AMUXBUS-B, CSD Comparator, 3 pins
pushButton	1 pin
redLed	1 pin
greenLed	1 pin

Parameter Settings

CapSense Component

Figure 4 shows the settings for the CSD_Comp_P4 Component.

Figure 4. CSD_Comp_P4 Configuration



Operation

After you build and install the example in the CY8CKIT-041-40xx kit, test the example by doing the following:

1. Connect a 1.8-V external voltage supply to the Vplus pin.
2. Connect the Vminus pin to VDD (4 V) or an external supply of 4 V.
3. Push the button to set the different reference voltage tap values.
4. Observe the RGB LED change colors depending on the input voltage value with respect to the reference voltage.

Related Documents

Table 3 lists the relevant application notes, code examples, PSoC Creator Component datasheets, device documentation, and development kit (DVK) documentation.

Table 3. Related Documents

Application Notes		
AN79953	Getting Started with PSoC 4	Describes PSoC 4 and how to build your first PSoC Creator project
Code Examples		
CE210197	Adjustable Reference Comparator	
PSoC Creator Component Datasheets		
CSD_Comp_P4	Supports CSD-based adjustable voltage reference comparator	
Pins	Supports the connection of hardware resources to physical pins	
Device Documentation		
PSoC 4 Datasheets		
PSoC 4 Technical Reference Manuals		
DVK Documentation		
CY8CKIT-041-40xx PSoC 4 S-Series Pioneer Kit		
CY8CKIT-041-41xx PSoC 4 S-Series Pioneer Kit		
CY8CKIT-048 PSoC Analog Coprocessor Pioneer Kit		

PSoC Resources

Cypress provides a wealth of data at www.cypress.com to help you select the right PSoC device and quickly and effectively integrate the device into your design. For a comprehensive list of resources, see KBA86521, How to Design with PSoC 3, PSoC 4, and PSoC 5LP. The following is an abbreviated list for PSoC 4:

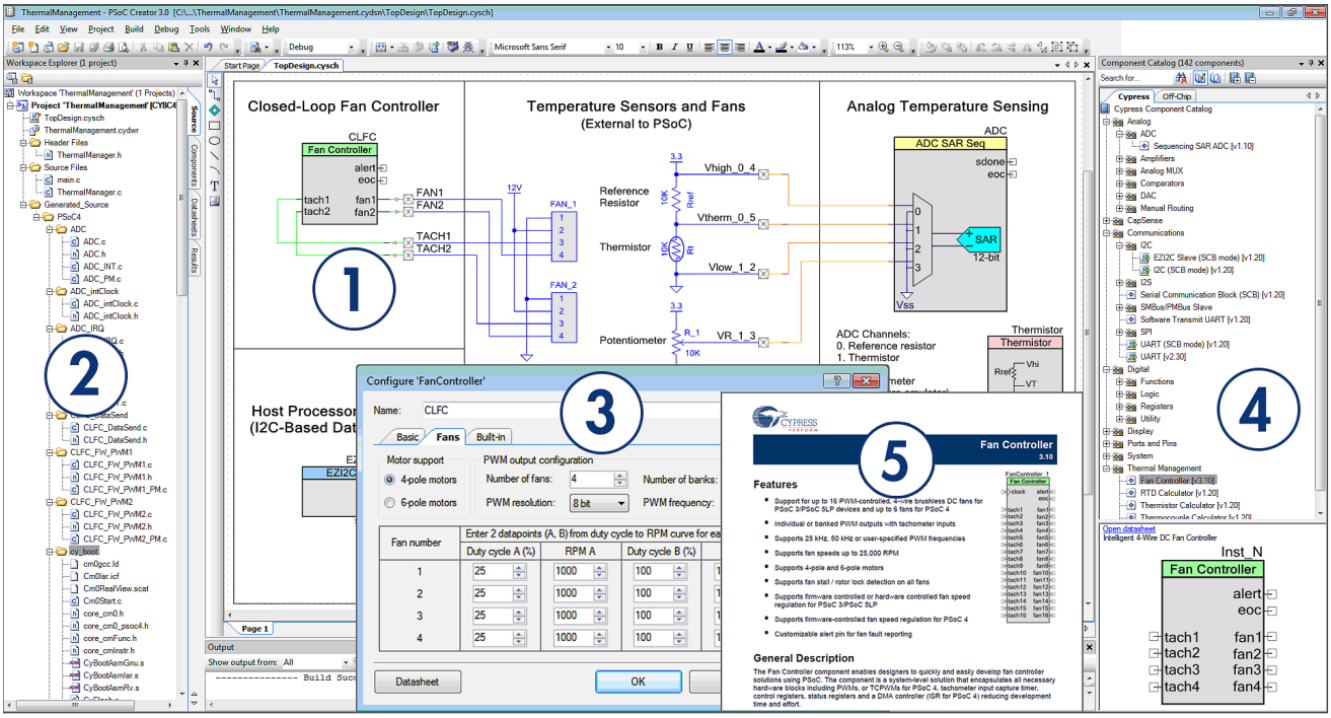
- **Overview:** PSoC Portfolio, PSoC Roadmap
- **Product Selectors:** PSoC 1, PSoC 3, PSoC 4, or PSoC 5LP. In addition, PSoC Creator includes a device selection tool.
- **Datasheets**: Describe and provide electrical specifications for the PSoC 4000, PSoC 4000S, PSoC 4100S, PSoC 4100 and PSoC 4200, PSoC 4xx7 BLE, PSoC 4200-M, and PSoC Analog Coprocessor device families
- **CapSense Design Guide:** Learn how to design capacitive touch-sensing applications with the PSoC 4 family of devices.
- **Application Notes and Code Examples:** Cover a broad range of topics, from basic to advanced level. Many of the application notes include code examples. PSoC Creator provides additional code examples.
- **Technical Reference Manuals (TRM):** Provide detailed descriptions of the architecture and registers in each PSoC 4 device family.
- **Development Kits:**
  - CY8CKIT-040, CY8CKIT-041-40xx, CY8CKIT-041-41xx, CY8CKIT-042, CY8CKIT-042-BLE, CY8CKIT-044, and CY8CKIT-048 PSoC Pioneer Kits are easy-to-use and inexpensive development platforms. These kits include connectors for Arduino™ compatible shields and Digilent® Pmod™ daughter cards.
  - CY8CKIT-049 is a very low-cost prototyping platform for sampling PSoC 4 devices.
  - CY8CKIT-001 is a common development platform for all PSoC family devices.
  - CY8CKIT-002 – The MiniProg3 device provides an interface for flash programming and debugging.

PSoC Creator

PSoC Creator is a free, Windows-based Integrated Design Environment (IDE) that enables the concurrent hardware and firmware design of systems based on PSoC 3, PSoC 4, and PSoC 5LP. See Figure 5. With PSoC Creator, you can:

1. Drag and drop Components to build your hardware system design in the main design workspace
2. Codesign your application firmware with the PSoC hardware
3. Configure Components using configuration tools
4. Explore the library of 100+ Components
5. Review Component datasheets

Figure 5. PSoC Creator Features



Document History

Document Title: CE210197 - Adjustable Reference Comparator

Document Number: 002-10197

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	5142921	AKSM	02/19/2016	New code example.

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Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709

Phone : 408-943-2600
Fax : 408-943-4730
Website : www.cypress.com

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