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CE210197 – Adjustable Reference Comparator

Objective

This code example demonstrates the adjustable voltage reference capability of the CapSense® Sigma Delta (CSD) Comparator on PSoC® 4 S-Series.

Overview

This code example uses a comparator to control two LEDs. The Comparator (CSD) Component used in the design has a programmable voltage reference. Button presses increment the reference voltage on the Comparator in 1-V steps up to 4 V. An external voltage supply provides the voltage that is being compared against the reference. When the reference voltage is lower than the external supply voltage, the green LED turns ON. If button presses increment the reference voltage so that the reference is greater than the external supply voltage, the red LED turns ON. Alternatively, adjusting the external power supply value will also change the LED.

Requirements

Tool: PSoC Creator™ 4.2

Programming Language: C (Arm® GCC 5.4.1 and Arm MDK 5.22)

Associated Parts: PSoC 4000S, PSoC 4100S, PSoC 4700S

Related Hardware: CY8CKIT-041-40xx, CY8CKIT-041-41xx, CY8CKIT-145-40xx

Hardware Setup

This example requires the use of an external voltage source capable of supplying 1.8 V. If an adjustable voltage supply is used, ensure that the voltage applied to the device does not exceed 5 V.

Software Setup

None.

Operation

1. Plug the CY8CKIT-041-40xx kit board into your computer's USB port.
2. Build the project and program it into the PSoC 4 MCU device. Choose **Debug** > **Program**. For more information on device programming, see PSoC Creator Help.
3. Connect the ground lead of an external voltage supply to a GND pin on the kit GPIO.
4. Connect the positive lead of a 1.8-V external voltage supply to pin Vplus.
5. Connect VDD to the Vminus pin.

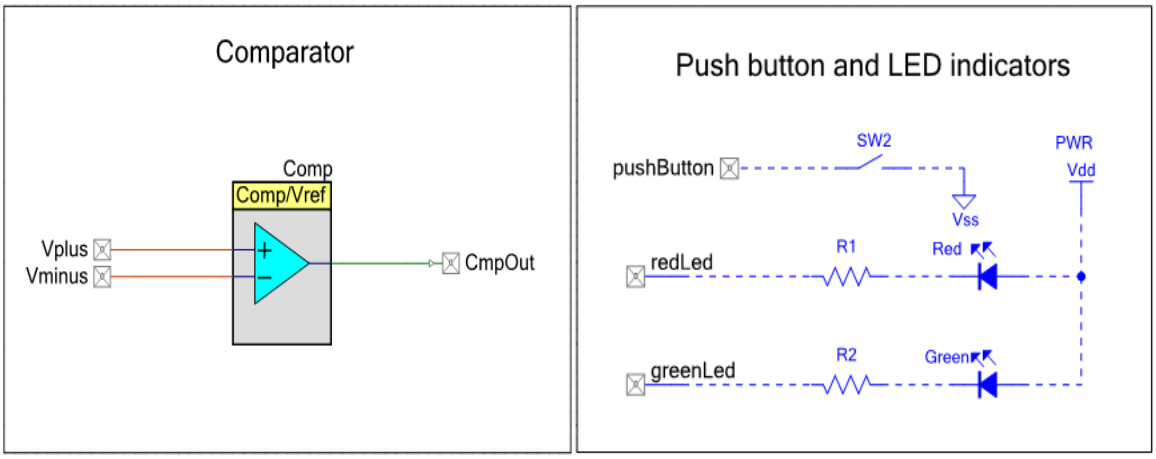
   Alternatively, a 4-V external supply can be connected to the Vminus pin.
6. Press **SW2** and observe the green LED turn ON.

   Pressing SW2 thrice will turn the red LED ON as the reference voltage resets to 1 V.
7. If using an adjustable voltage supply, change the 1.8-V signal to 2.5 V and perform step 6. Notice that the LED color changes every two button presses.

Design and Implementation

The Comparator (CSD) Component compares two voltages and outputs a value based on the result of the comparison. As shown in Figure 1, the Comparator (CSD) Component has two input terminals; a positive terminal and a reference terminal (labeled with the negative sign). When the voltage level detected at the positive terminal is larger than the voltage level at the reference terminal, the comparator outputs a non-zero signal. The inverse is also true. If the voltage at the positive terminal is less than the reference voltage, the comparator outputs zero.

Figure 2. Top Schematic



To visually display the result of the comparison, firmware checks the value of the comparison result and turns on an LED to indicate the status. If the comparison returns non-zero, then the positive terminal voltage is greater than the reference voltage and the green LED turns on. If the comparison returns zero, then the positive terminal voltage is less than the reference voltage and the red LED turns on.

The Comparator (CSD) Component also has a programmable reference voltage. To demonstrate this, an on-kit button is used to increment the reference voltage in 1-V steps from 1 V up to 4 V. On the rising edge of each press, firmware writes the new reference voltage with the `Comp_SetVoltageTap` function call. The argument to the function is an integer value between 1 and 32. Equation 1 shows the conversion formula from the desired reference voltage to the argument value.

$$tap\ value = \frac{Desired\ Reference\ Voltage\ (mV)}{Comp_VREF_STEP_MVOLTS} \quad \text{Equation 1}$$

As the button presses increment in the voltage from 1 V to 4 V, the LEDs on the kit change as the comparison result changes. When the button is pressed while the reference is at 4 V, the reference voltage resets to 1 V.

Components and Settings

Table 1 lists the PSoC Creator Components used in this example, how they are used in the design, and the non-default settings required so they function as intended.

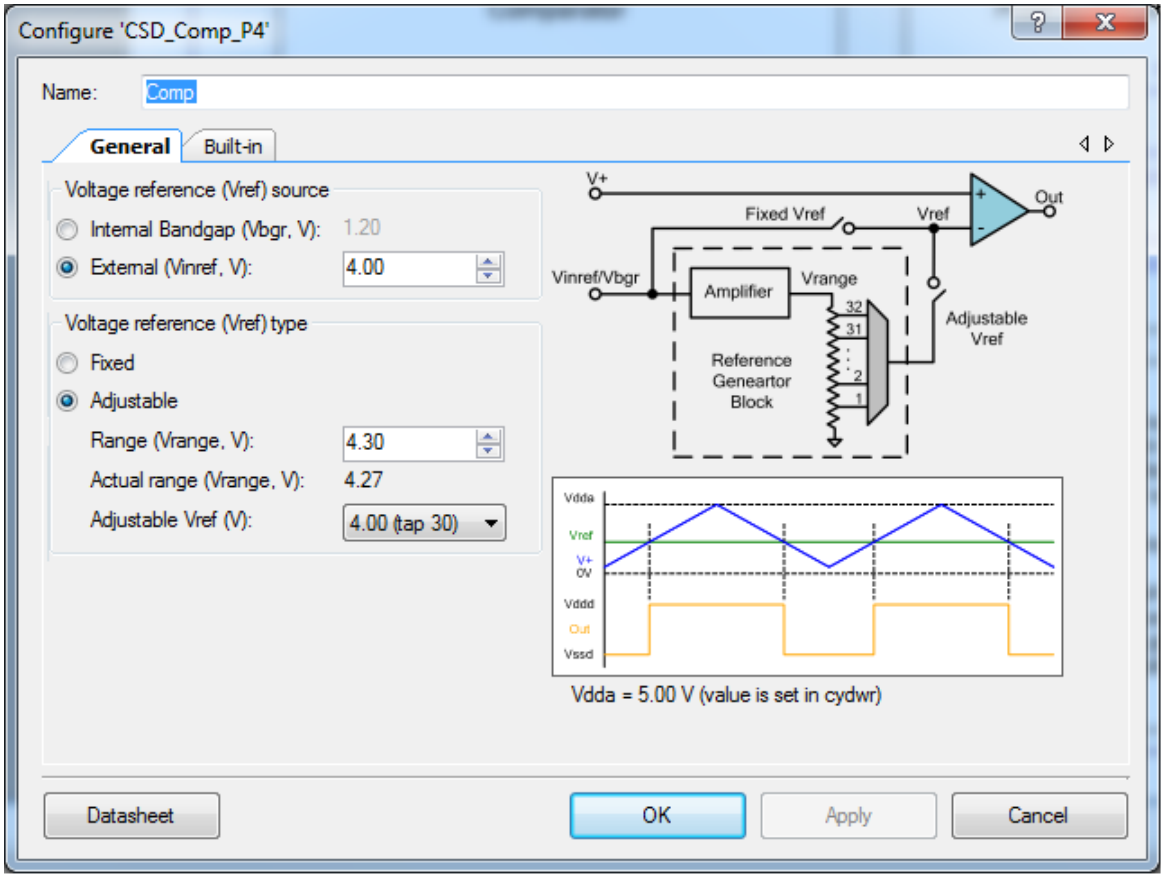
Table 1. PSoC Creator Components

Component	Instance Name	Purpose	Non-default Settings
Comparator (CSD)	Comp	Enables comparison of voltage levels	See Figure 2.
Analog Pin	Vplus	Enables analog voltage input to comparator	Default settings only
	Vminus		
Digital Input Pin	pushButton	Enables read of button press	Drive Mode: Resistive pull up Disable HW connection
Digital Output Pin	redLed	Enables writing to LEDs	Disable HW Connection
	greenLed		
	CmpOut	Enables measurement of comparison result	Default settings only

For information on the hardware resources used by a Component, see the Component datasheet.

Figure 2 highlights the non-default settings for the TCPWM Component.

Figure 3. CSD_Comp_P4 Configuration



Reusing This Example

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

To switch from the CY8CKIT-041-40xx to other PSoC Pioneer kits, select the appropriate device with the Device Selector (**Project** > **Device Selector**). Table 2 lists the device number for each pioneer kit.

Note: If the assigned Component's pins are not as shown in Table 2 or you want to overwrite the existing pin assignment, double-click the project's *Design Wide Resources* file in the Workspace Explorer window and assign the pins. In some cases, a resource used by a code example is not supported on another device. In that case the example will not work. If you build the code targeted at such a device, you will get errors. See the device datasheet for information on what a particular device supports.

Table 3. Pin Assignments for Different Kits

Pin Name	Pin Assignments by Development Kit		
	CY8CKIT-041-40xx (CY8C4045AZI-S413)	CY8CKIT-041-41xx (CY8C4146AZI-S433)	CY8CKIT-145-40xx (CY8C4045AZI-S413
Vplus	P2[2]	P2[2]	P2[2]
Vminus	P4[0]	P4[0]	P4[0]
CmpOut	P2[0]	P2[0]	P2[5]
redLed	P3[4]	P3[4]	P3[4]
greenLed	P2[6]	P2[6]	P2[0]
pushButton	P0[7]	P0[7]	P0[7]

Related Documents

Application Notes		
AN79953	Getting Started with PSoC 4	Describes PSoC 4 and how to build a first PSoC Creator project.
PSoC Creator Component Datasheets		
Comparator (CSD)	Supports CSD based adjustable voltage reference comparator	
Pins	Supports connection of hardware resources to physical pins	
Device Documentation		
PSoC 4 Datasheets	PSoC 4000S Family: PSoC 4 Architecture Technical Reference Manual (TRM)	
	PSoC 4100S and PSoC 4100S Plus: PSoC 4 Architecture Technical Reference Manual (TRM)	
Development Kit (DVK) Documentation		
CY8CKIT-041-40xx PSoC 4 S-Series Pioneer Kit		
CY8CKIT-041-41xx PSoC 4100S CapSense Pioneer Kit		
CY8CKIT-145-40xx PSoC 4000S CapSense Prototyping Kit		

Document History

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**	5142921	AKSM	02/19/2016	New code example
*A	6159008	BFMC	07/26/2018	Updated the template Expanded Operation and Overview sections Added CY8CKIT145-040xx to supported devices Fixed hyperlinks Updated images to match the updated Comparator Component

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