CE220927 - PSoC 6 MCU OpAmp and Comparator Example

Objective

This example demonstrates how to configure a basic OpAmp and Comparator using both Components and low-level Peripheral Driver Library (PDL) function calls in PSoC® 6 MCU.

Overview

This example demonstrates a simple OpAmp gain stage and a Comparator using VDAC as a programmable reference. Both Component and low-level PDL function calls are shown to configure and use the OpAmp, Comparator, Comparator interrupt, VDAC, and internal analog routing.

Requirements

Tool: PSoC Creator™ 4.2 with PDL 3.0.1

Programming Language: C (Arm® GCC 5.4-2016-q2-update)

Associated Parts: PSoC 6 MCU family of devices

Related Hardware: CY8CKIT-062-BLE PSoC 6 MCU BLE Pioneer Kit and CY8CKIT-062-WiFi-BT PSoC 6 MCU Pioneer Kit

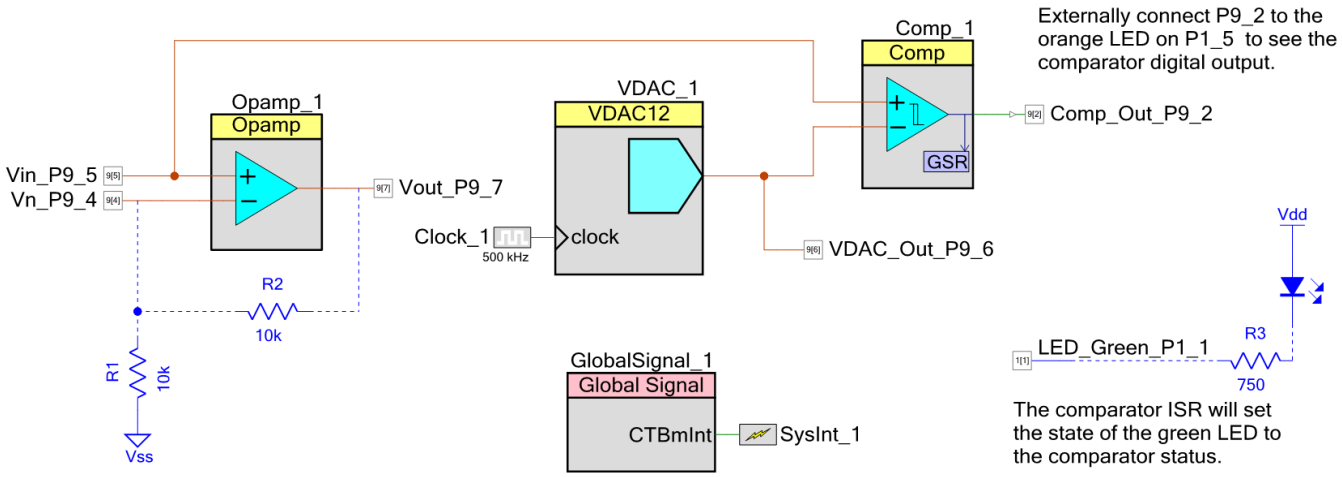
Design

A PSoC 6 MCU device has two opamps and one Continuous Time Digital to Analog Converter (CTDAC). They are configured as follows:

- One opamp on the device, OA1, is configured as a simple gain stage opamp using external resistors. Figure 2 shows a simple non-inverting amplifier with a gain of $(1 + \frac{R2}{R1})$. For $R2 = R1$, the gain is 2. The output of OA1 has a direct connection to P9[3], but P9[3] is not routed to any jumpers on the CY8CKIT-062-BLE kit. Therefore, internal AmuxBusB is used to route the output of OA1 to P9[7] (available on J2).
- The other opamp on the device, OA0, is configured as a comparator with 10-mV hysteresis. The non-inverting input of OA1 is routed to the positive terminal of the comparator using internal AmuxBusA. The reference voltage for the comparator is 1.0 V from the CTDAC. The Comparator interrupt edge is configured for both edges. The green LED on the kit is driven in the ISR to show the current comparator state. The comparator digital output is also routed to P9[2]. To visually see the state of the comparator output, P9[2] can be routed to an LED on the kit (for example, orange LED8 on P1[5]) using an external wire.
- The CTDAC is configured to output a constant 1.0 V using V_{DDA} as the reference source.

Using Components

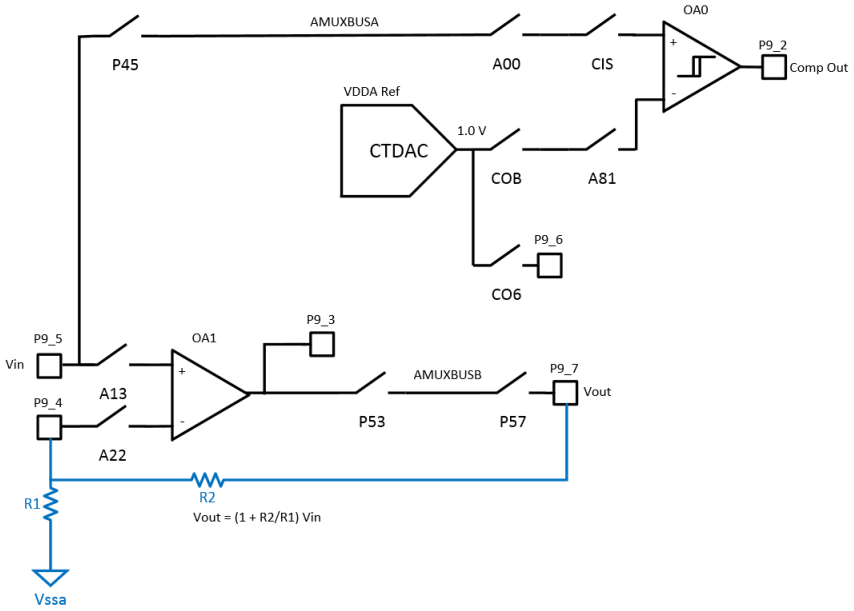
Figure 1. PSoC Creator Component Schematic



Using PDL

Figure 2 shows the analog switches used to implement the design.

Figure 2. Schematic Implemented with PDL



Design Considerations

This code example is designed to run on the CY8CKIT-062-BLE Pioneer Kit with the CY8C6347BZI-BLD53 device. To port the design to a different PSoC 6 MCU and/or kit, change the target device using the Device Selector and update the pin assignments in the Design Wide Resources Pins settings as needed. For single-CPU PSoC 6 MCUs, port the code from *main_cm4.c* to *main.c*.

Because the CTDAC uses V_{DDA} as the reference source and assumes a 3.3-V V_{DDA}, the output voltage will vary based on the actual V_{DDA} level. The CTDAC output is directly connected to P9[6], so it can be measured and adjusted easily in the code.

Hardware Setup

This example uses the kit's default configuration. Refer to the kit guide to ensure that the kit is configured correctly.

Software Setup

By default, the code example uses Component API function calls. Alternatively, the `PDL_CONFIGURATION` macro can be set to (1u) to demonstrate how to use the low-level Continuous Time Block CTB and CTDAC PDL function calls.

Operation

1. Plug CY8CKIT-062 BLE into your computer's USB port.
2. Ensure that switch SW5 on the kit is in position 2 to select 3.3 V for V_{DDA}.
3. Connect a resistor (for example, 10 kΩ) between P9[4] and GND. Connect another resistor of equal value between P9[7] and P9[4]. Any value between 4.7 kΩ and 470 kΩ is acceptable.
4. Connect a wire between P9[2] (comparator output) and P1[5] (orange LED).
5. Build the project and program it into the PSoC 6 MCU device. Choose **Debug** > **Program**. For more information on device programming, see PSoC Creator Help. Flash for both CPUs are programmed in a single program operation.
6. Using a voltage meter, measure the CTDAC output voltage on P9[6] and confirm that it is approximately 1.0 V.
7. Apply 0.5 V to Vin on P9[5].
8. Connect a voltmeter on P9[7] and observe the measured voltage to be 1 V. Recall that the opamp stage has a gain of 2.
9. Observe that the orange LED (LED8) and the green LED (LED5) on the kit are turned ON.
10. Slowly increase Vin on P9[5] to above 1 V. After the voltage is 10 mV greater than the CTDAC output voltage measured on Step 4, observe the orange and green LEDs turn OFF.
11. Slowly decrease Vin on P9[5] to below 1 V. After the voltage is 10 mV less than the CTDAC output voltage measured in Step 4, observe the orange and green LEDs turn ON.

Components

Table 1 lists the PSoC Creator Components used in this example, as well as the hardware resources used by each.

Table 1. PSoC Creator Components

Component	Instance Name	Hardware Resources
Voltage DAC (12-bit)	VDAC_1	1 CTDAC
Comparator	Comp_1	1 Opamp
Opamp	Opamp_1	1 Opamp
Global Signal Resource	GlobalSignal_1, SysInt_1	1 Interrupt
Clock	Clock_1	1 PeriClk divider
Digital Pin	Comp_Out_P9_2 LED_Green_P1_1	2 Digital output pins
Analog Pin	VDAC_Out_P9_6 Vin_P9_5 Vn_P9_4 Vout_P9_3	4 Analog pins

Parameter Settings

Figure 3 to Figure 6 highlight the non-default settings for all the Components.

Figure 3. MCWDT Component Parameter Settings

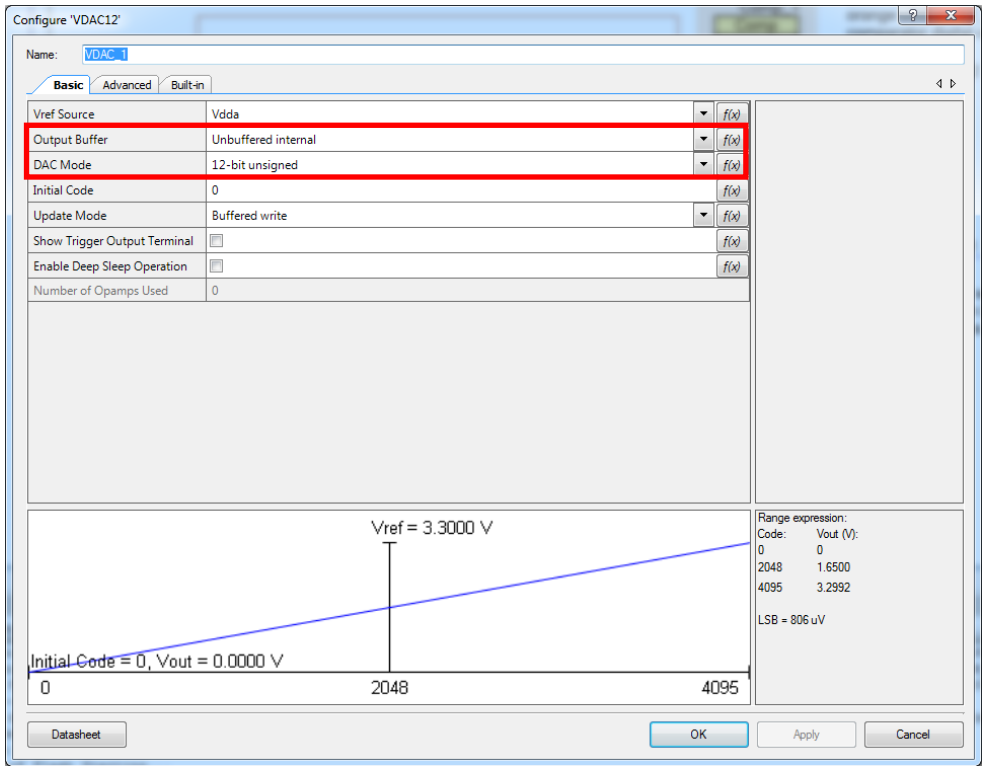
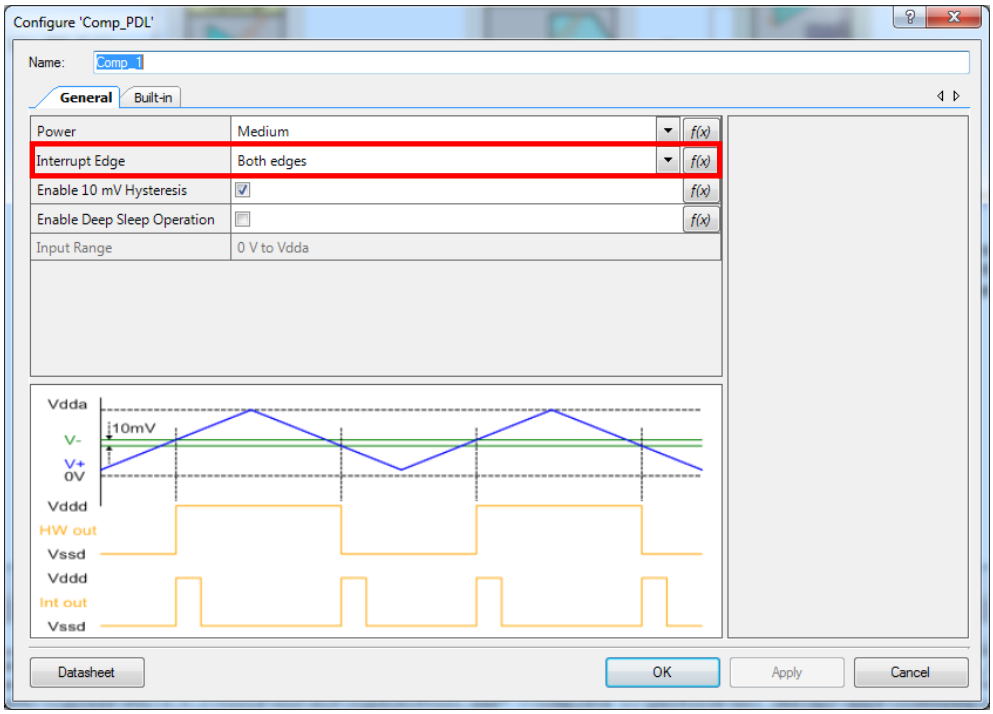


Figure 4. Comparator Component Parameter Settings



The interrupt edge should be set to both edges so that the LED state can reflect the comparator status.

Figure 5. OpAmp Component Parameter Settings

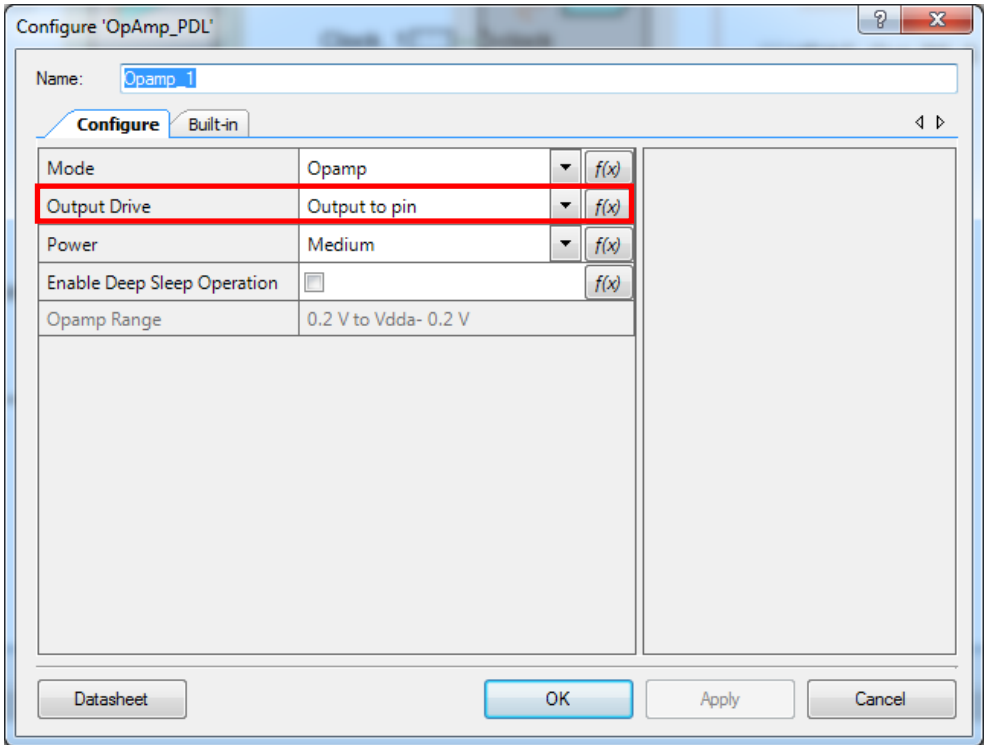
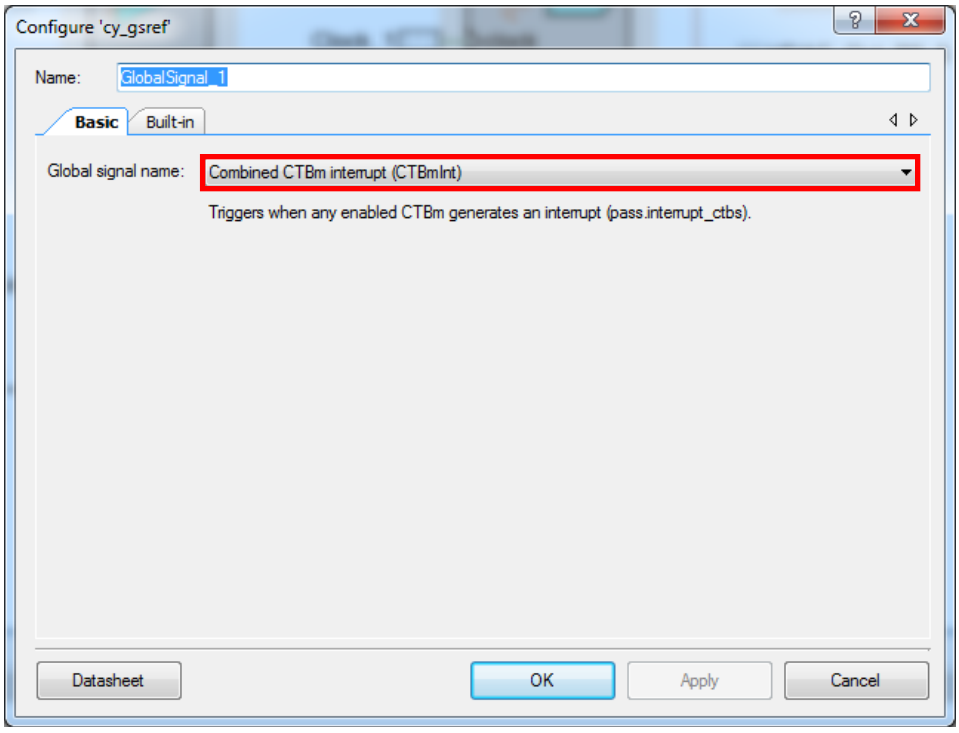


Figure 6. GSR Component Parameter Settings



Design-Wide Resources

Table 2 shows the pin assignments for the code example.

Table 2. Pin Names and Location

Pin Name	Pin Location
Comp_Out_P9_2	P9[2]
LED_Green_P1_1	P1[1]
VDAC_Out_P9_6	P9[6]
Vin_P9_5	P9[5]
Vn_P9_4	P9[4]
Vout_P9_3	P9[3]

Related Documents

Application Notes	
AN210781	Getting Started with PSoC 6 MCU with Bluetooth Low Energy (BLE) Connectivity
PSoC Creator Component Datasheets	
VDAC12	Supports continuous-time DAC functions
Comparator	Supports comparator functions
Opamp	Supports operational amplifier functions
Global Signal Resource	Allows access to device level global signals
General Purpose Input / Output (GPIO)	Supports all GPIO pin features
Device Documentation	
PSoC 6 MCU: PSoC 63 with BLE Datasheet	
PSoC 6 MCU: PSoC 63 with BLE Architecture Technical Reference Manual	
PSoC 6 MCU: PSoC 63 with BLE Register Technical Reference Manual	
PSoC 6 MCU: PSoC 62 Datasheet	
Development Kit (DVK) Documentation	
PSoC 6 BLE Pioneer Kit	
PSoC 6 MCU WiFi BT Pioneer Kit	

Document History

Document Title: CE220927 – PSoC 6 MCU OpAmp and Comparator Example

Document Number: 002-20927

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	5947257	GJV	02/19/2018	New code example

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