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## Objective

This example shows how to use a PSoC Creator™ Voltage Comparator Component with an Analog Multiplexer (Mux) Component, and how to use a Scanning Comparator Component.

## Requirements

**Tool:** PSoC Creator 4.3

**Programming Language:** C (Arm® GCC 5.4.1)

**Associated Parts:** PSoC® 4 devices with an OpAmp and Universal Digital Blocks (UDBs).

**Related Hardware:** [CY8CKIT-044 PSoC 4 M-Series Pioneer Kit](#)

## Overview

This example contains two projects; one that uses a Voltage Comparator and Analog Multiplexer, and another that uses a Scanning Comparator. In both projects, there is one potentiometer to vary voltage, and a voltage divider chain to supply static voltages. The varying voltage is compared with each static voltage. The static voltage at the comparator is switched by pressing the on-kit button.

## Hardware Setup

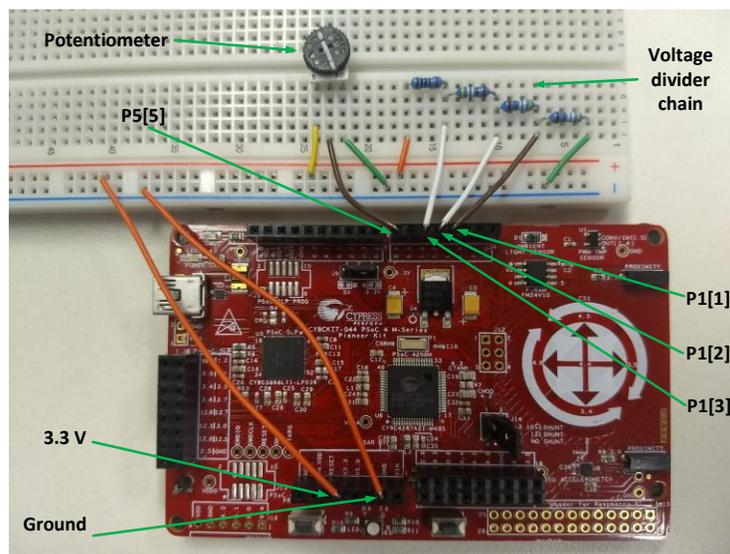
This code example is set up for CY8CKIT-044. If you are using a different kit, see [Reusing this Example](#).

This project requires a minimum of four resistors and one potentiometer, external to the kit board. The four resistors create a voltage divider chain, while the potentiometer allows for varying input.

### Voltage Comparator and Multiplexer Project

For this project, connect the potentiometer to pin P5[5], as [Figure 1](#) shows. Connect the voltage divider chain to pins P1[1], P1[2], and P1[3]. For a complete schematic, see [Figure 3](#).

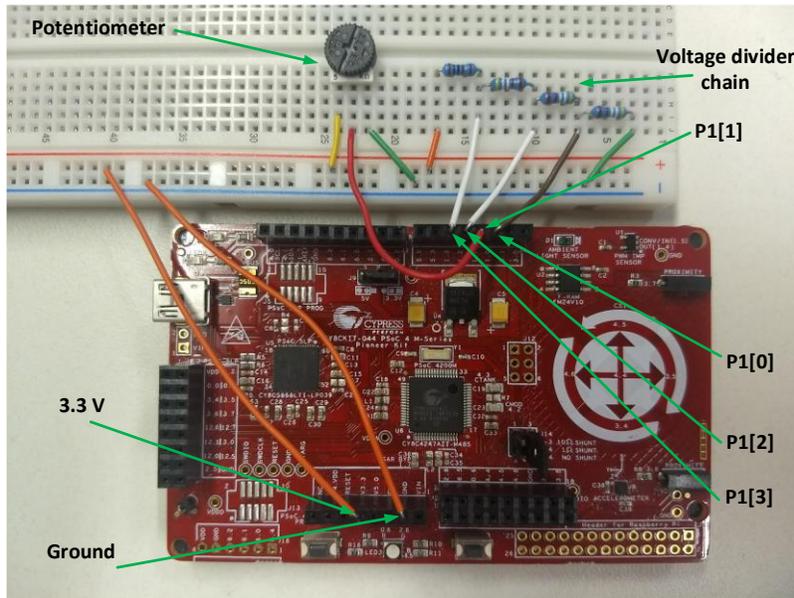
Figure 1. Hardware Connections for Voltage Comparator and Multiplexer Project



## Scanning Comparator Project

The Scanning Comparator project requires a similar setup to the Voltage Comparator and Multiplexer project, with minor changes to the pin locations. The connection for the potentiometer changes from P5[5] to P1[1], this connection must change because these peripherals do not have the same routing. The voltage divider chain is connected to pins P1[0], P1[2], and P1[3]. For a schematic, see Figure 4. Figure 2 shows the result after all connections.

Figure 2. Hardware Connections for Scanning Comparator Project



## Software Setup

None.

## Operation

For each project, do the following:

1. Make sure that the necessary pins and hardware are connected as the [Hardware Setup](#) section shows.
2. Connect CY8CKIT-044 kit to your computer using a USB cable.
3. 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](#).
4. Adjust the potentiometer in both directions and confirm that the LED turns ON and OFF.
5. Cycle through the multiplexed inputs by pressing kit button SW2. Notice each time SW2 is pressed the LED changes color, each color represents a different tap on the resistor ladder. During each cycle, adjust the potentiometer and confirm that the LED turns ON and OFF.

## Design and Implementation

The potentiometer supplies an adjustable voltage that is compared with a static voltage from a voltage divider.

For the Voltage Comparator and Multiplexer project, when the potentiometer voltage falls below the divider voltage, the LED turns ON. When the potentiometer voltage is above the divider voltage, the LED turns OFF.

For the Scanning Comparator project, the LED ON/OFF state is opposite, due to the design of the Scanning Comparator Component. When the potentiometer voltage falls below the divider voltage, the LED turns OFF. When the potentiometer voltage is above the divider voltage, the LED turns ON.

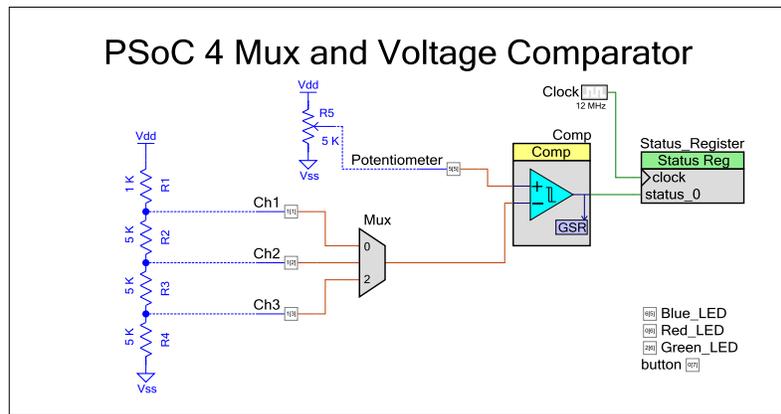
### Multiplexer and Voltage Comparator

In the Multiplexed Comparator project, the following functions are performed:

1. The static voltage is compared with the potentiometer voltage and the Comparator outputs logic HIGH or LOW.
2. The Comparator output is captured in the Status Register so that the firmware can read it.
3. The firmware controls the LED corresponding to the multiplexer setting, according to the Status Register value.
4. The firmware polls the button. If the button is pressed and released, the Mux is changed to the next static divider voltage.

Figure 3 shows the top-level design of the PSoC Creator project:

Figure 3. Multiplexed\_Comparator Top Design Schematic



### Scanning Comparator

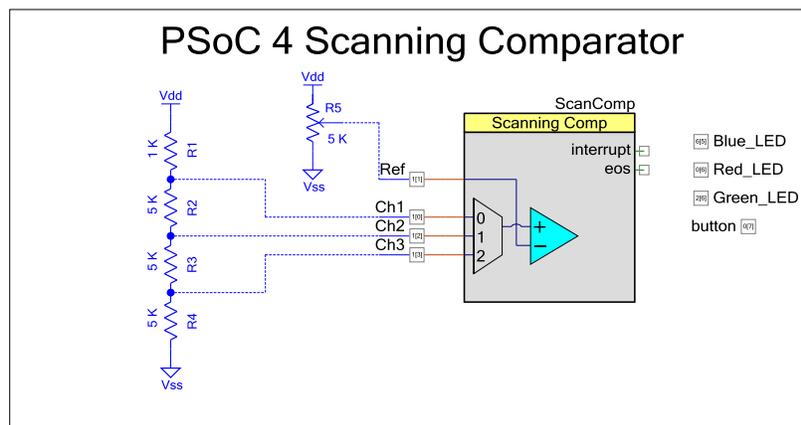
In the Scanning Comparator project, the following functions are performed:

1. The Scanning Comparator automatically scans through the built-in Multiplexer at a user-defined speed (see Table 1).
2. The static voltage is compared with the voltage of the potentiometer and the comparator outputs logic HIGH or LOW.
3. The firmware reads the status register built in to the Scanning Comparator Component. The LED corresponding to the selected channel is turned ON or OFF, according to the output of the comparator.
4. The firmware polls the button. If the button is pressed and released, the next static voltage and LED are selected.

**Note:** Scanning through the channels happens automatically, but much too fast for a human to observe. The button is used to cycle through the channels and get the result of the most recent scan.

Figure 4 shows the top-level design of the PSoC Creator project.

Figure 4. Scanning\_Comparator Top Design Schematic



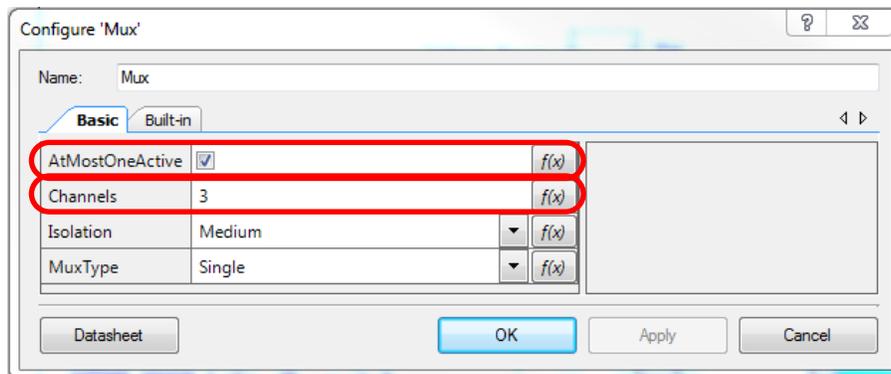
## Components and Settings

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
<b>Multiplexed Comparator Project</b>			
Analog Mux	Mux	Selects comparator input	See <a href="#">Figure 5</a> .
Comparator	Comp	Compares two analog voltages	Change Interrupt output mode to <b>Disable edge detect</b>
Status Register	Status_Register	Stores the output of the comparator	Change the number of inputs to <b>One</b> .
<b>Scanning Comparator Project</b>			
Scanning Comparator	ScanComp	Scan through and compare multiple values	Change the Scan timing to <b>Clock frequency</b> and the value to <b>10 kHz</b> . On the <b>Channels</b> tab, change the Sequenced channels to <b>3</b> .

Figure 5. Multiplexer Settings in Multiplexed Comparator Project



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

## Reusing this Example

This example can be ported to various PSoC 4 devices, kits, or both. Before porting note that:

- Not all PSoC 4 devices have an OpAmp and UDBs. In this code example the OpAmp is used as the comparator and the UDBs are used when generating the Shift Register in the Multiplexed Voltage Comparator project. In the Scanning Comparator Project UDBs are used to generate the Scanning Comparator, the Scanning Comparator uses digital routing and generates a shift register that stores the comparator's output value. Check the device datasheet, the PSoC Creator Device Selector window, or the PSoC 4 product selector guide.
- Pinouts change from kit to kit. This means that some wires may need to be moved. See the **Pin Layout** tab in PSoC Creator.

To port the code to a new device, in PSoC Creator select **Project > Device Selector** and change to the target device.

## Related Documents

For a comprehensive list of PSoC 3, PSoC 4, and PSoC 5LP resources, see [KBA86521](#) in the Cypress community.

<b>Application Notes</b>	
<a href="#">AN79953 – Getting Started with PSoC® 4</a>	Describes PSoC 4 devices and how to build your first PSoC Creator project
<b>PSoC Creator Component Datasheets</b>	
<a href="#">Comparator</a>	Comparator Component datasheet for more information
<a href="#">Scan Comparator</a>	Scan Comparator Component datasheet for more information
<a href="#">Analog Mux</a>	Analog Multiplexer Component datasheet for more information
<a href="#">Status Register</a>	Status Register Component datasheet for more information
<b>Device Documentation</b>	
<a href="#">PSoC 4 Datasheets</a>	<a href="#">PSoC 4 Technical Reference Manuals</a>
<b>Development Kit Documentation</b>	
<a href="#">CY8CKIT-044 PSoC 4 M-Series Pioneer Kit</a>	
<a href="#">PSoC 4 Kits</a>	
<b>Tool Documentation</b>	
<a href="#">PSoC Creator</a>	Look in the <b>Downloads</b> tab for Quick Start and User Guides

## Document History

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Document Number: 002-24625

Revision	ECN	Submission Date	Description of Change
**	6288575	08/31/2018	New code example
*A	6896058	6/12/2020	Minor updates to document and updated code example for PSoC Creator 4.3.

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