CE195277 - Delta Sigma ADC in Single-Ended Mode with PSoC 3/PSoC 5LP

Objective

This code example demonstrates how to use the Delta Sigma ADC (ADC_DelSig) Component to take samples of an analog input and send those samples to a PC application over RS-232 via the UART Component.

Overview

This code example implements a simple data collection system using the ADC_DelSig and UART Components. The ADC continuously samples an analog input. The resulting samples can be sent to a PC over a UART connection, a single sample at a time or continuously. Emulated data, which is simply an incrementing number, can also be sent over the UART connection to test the communication. The UART is used to create an RS-232 connection to a terminal program on a PC. The terminal program is used to send commands to get the ADC sample data and read the resulting responses.

Requirements

Tool: PSoC® Creator™ 4.2

Programming Language: C (Arm® GCC 5.4.1)

Associated Parts: PSoC 3 and PSoC 5LP parts

Related Hardware: CY8CKIT-059, CY8CKIT-001, CY8CKIT-050, CY8CKIT-030

Hardware Setup

Connect a voltage source to P0[0] on the kit. If P0[0] is not available, you can change the Vin pin in the Design-Wide Resources file (*CE195277_ADC_and_UART.cywdr*). If a voltage source is not available, you can test the UART connection using the emulated data by sending 'e' or 'E' over the terminal connection. The ADC is configured to accept a voltage input from 0 V up to VDD of the part. Do not exceed VDD of the part.

This code example is targeted at the CY8CKIT-059 PSoC 5LP Prototyping Kit. If you are using this kit, then no external hardware connections are needed to allow UART communication. If you are using a different hardware platform, you may need to connect the UART Tx (P12[7]) and Rx (P12[6]) to an RS-232 interface.

If you are not using CY8CKIT-059, you may also need to target a different PSoC device. To do so, right-click the project in Workspace Explorer and select **Device Selector**. Select the appropriate PSoC device for your hardware platform.

Software Setup

To interface with the UART on the PSoC device, a terminal emulator application is needed. HyperTerminal and PuTTY are examples of valid options. Open up a connection to the COM port number that the PC gives to the PSoC device when it enumerates. Make sure the settings in the software COM port match the settings for the UART Component, detailed in Components and Settings.

Operation

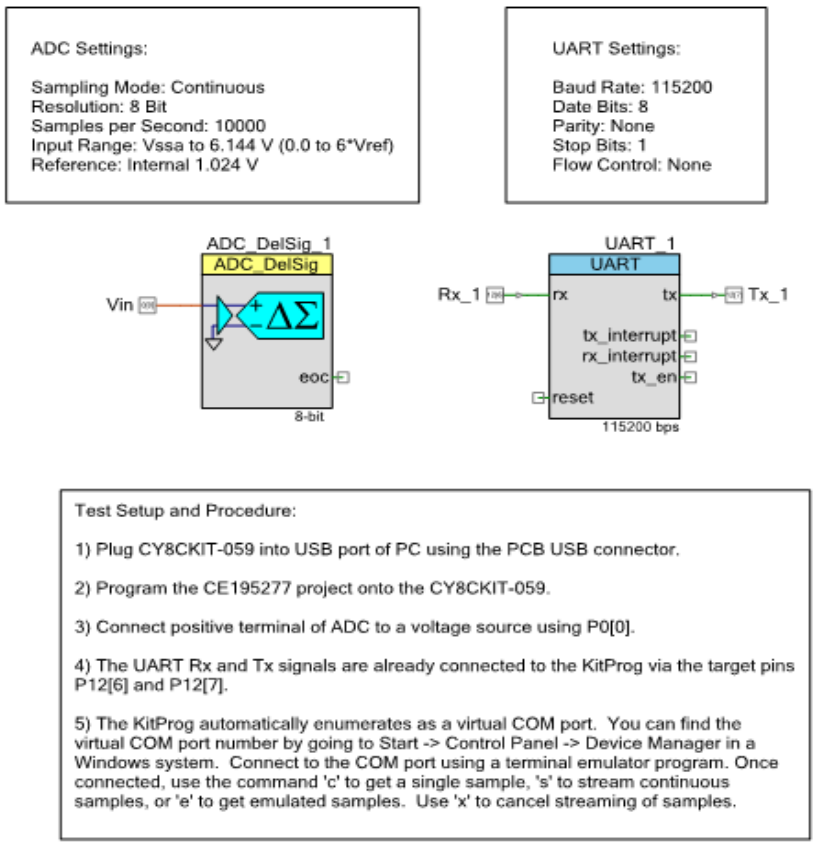
1. Connect the board to the PC using the USB connector of KitProg. On CY8CKIT-059, this is the PCB-USB connector.
2. Program the example project to the board. In PSoC Creator, go to **Debug** > **Program**. In the dialog that appears, connect to the KitProg associated with the kit being used.
3. Connect an external voltage to the PSoC 5LP target device on P0[0].
4. Open a terminal emulator on the PC and connect to the virtual COM port, enumerated as a part of KitProg.
5. Type character "C" or "c" in the terminal emulator to receive one sample of ADC data.
6. Type character "S" or "s" in the terminal emulator to receive continuous samples of ADC data.

7. Type character “X” or “x” in the terminal emulator to stop receiving ADC samples.
8. Type character “E” or “e” in the terminal emulator to receive one emulated sample of data. This data will increment by 1 each time an emulated sample is requested.

Design and Implementation

Figure 1 shows the PSoC Creator schematic of this code example. This code example uses the ADC_DelSig and UART Components.

Figure 1. PSoC Creator Schematic of Code Example



The code example uses the ADC_DelSig Component to sample the analog input and the UART Component to transmit the sampled data to the PC over RS-232. See Figure 1 for details on the design schematic.

All firmware for the code example is implemented in *main.c*. The firmware performs the following functions:

1. Starts the ADC and UART Components.
2. Checks for ADC end of conversion. Stores the latest result if conversion is complete.
3. Checks for UART input.
   - 'C' or 'c' received: Transmits the last sample via the UART.
   - 'S' or 's' received: Continuously transmits samples as the conversion is completed.
   - 'X' or 'x' received: Stops continuously transmitting samples.
   - 'E' or 'e' received: Transmits a dummy byte of data.

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. List of PSoC Creator Components

Component	Instance Name	Purpose	Non-default Settings
ADC_DelSig	ADC_DelSig_1	Analog-to-digital conversion of input signal	Resolution: 8 Bit Input Range: Vssa to 6.144 V (0.0 to 6*Vref)
UART	UART_1	Transmit the data to the PC over RS-232	Baud Rate: 115200
Analog Pin	Vin	Analog input signal from P0[0]	–
Digital Input Pin	Rx_1	Drive the input serial data from ADC_DelSig output	–
Digital Output Pin	Tx_1	Drive the output serial data to PC	Initial drive state: High (1)

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

Table 2 shows the pin selections for the code example.

Table 2. Pin Selections

Pin Name	Location
Rx_1	P12[6]
Tx_1	P12[7]
Vin	P0[0]

Reusing This Example

This code example is designed to run on CY8CKIT-059. To port the design to a different PSoC device and/or kit, change the target device in **Device Selector**, and update the pin assignments in the **Design Wide Resources Pins** settings as needed.

Related Documents

Application Notes	
AN84783 – Accurate Measurement Using PSoC 3 and PSoC 5LP Delta-Sigma ADCs	Shows how to increase the accuracy of DelSig measurements
AN61102 – PSoC 3 and PSoC 5LP – ADC Data Buffering Using DMA	Describes how to buffer data from the DelSig using DMA
AN58304 – PSoC 3 and PSoC 5LP – Pin Selection for Analog Designs	Provides an overview of analog routing in PSoC 3/5LP and recommendations for pin selection
AN58827 – PSoC 3 and PSoC 5LP Internal Analog Routing Considerations	Shows how to choose the best routes for analog-sensitive designs
AN68403 – PSoC 3 and PSoC 5LP Analog Signal Chain Calibration	Shows how to calibrate the analog signal chain in PSoC 3/5LP
Code Examples	
CE95271	Delta Sigma ADC in Differential Mode with PSoC 3/5LP
CE95273	Delta Sigma ADC in Single-Ended Mode Using DMA and VDAC with PSoC 3/5LP
CE95299	Delta Sigma ADC Using 16 Multiplexed Single-Ended Inputs with PSoC 3/5LP
CE95302	Delta Sigma ADC and I2C Slave with PSoC 3/5LP
CE95388	UART Receive with PSoC 3/4/5LP
CE95389	UART Transmit with PSoC 3/4/5LP
PSoC Creator Component Datasheets	
ADC_DelSig	Details the use of the ADC_DelSig Component
UART	Details the use of the UART Component
Device Documentation	
PSoC 3 Datasheets	PSoC 3 Technical Reference Manuals
PSoC 4 Datasheets	PSoC 4 Technical Reference Manuals
PSoC 5LP Datasheets	PSoC 5LP Technical Reference Manuals
Development Kit (DVK) Documentation	
PSoC 3 and PSoC 5LP Kits	
PSoC 4 Kits	

PSoC Resources

Cypress provides a wealth of data at www.cypress.com to help you select the right PSoC device for your design and quickly and effectively integrate it 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:

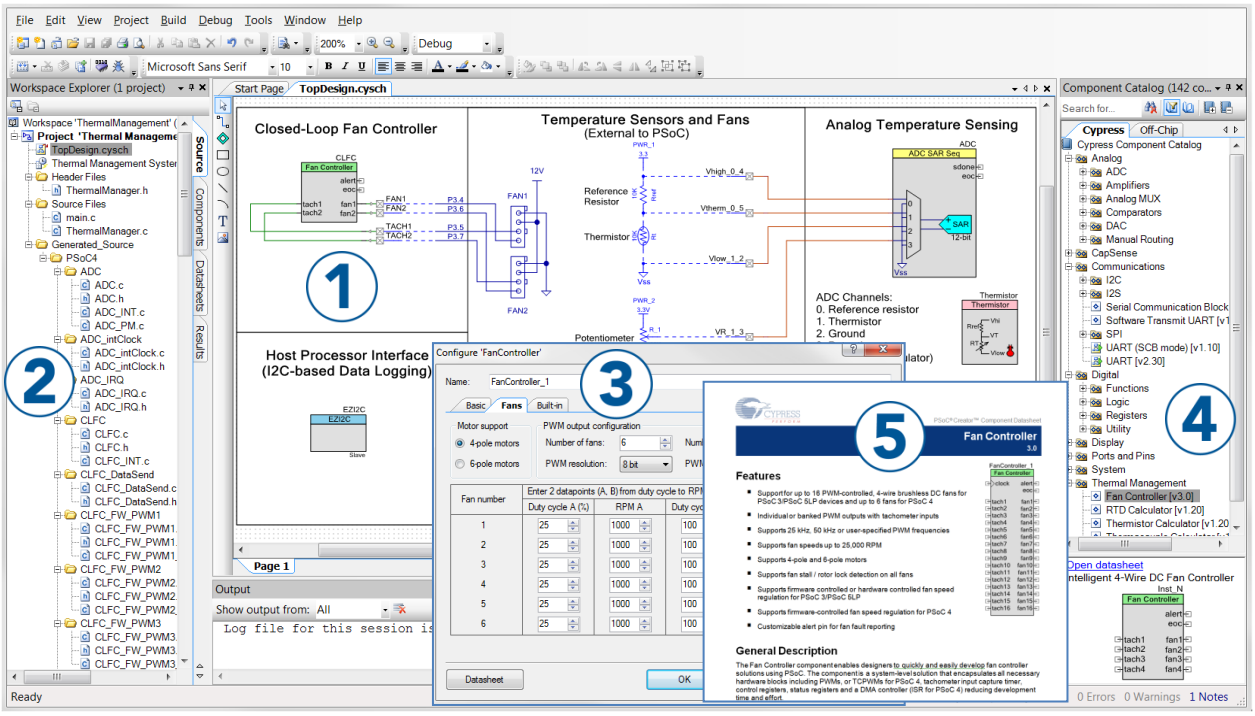
- **Overview:** PSoC Portfolio, PSoC Roadmap
- **Product Selector Guides:** PSoC 1, PSoC 3, PSoC 4, PSoC 5LP, or PSoC 6 MCU. In addition, PSoC Creator includes a device selection tool.
- **Datasheets**: Describe and provide electrical specifications for the PSoC device family
- **CapSense Design Guides:** Learn how to design capacitive touch-sensing applications.
- **Application Notes:** Cover a broad range of topics, from basic to advanced level.
- **Code Examples**: for PSoC 3, PSoC 4, and PSoC 5LP; or for PSoC 6 MCU.
- **PSoC Technical Reference Manuals (TRMs):** Provide detailed descriptions of the architecture and registers in the PSoC device family.
- **PSoC Training Videos**: These videos provide step-by-step instructions on getting started building complex designs with PSoC devices.
- **Development Kits:**
  - PSoC 6 BLE Pioneer Kit is a low-cost hardware platform that enables design and debug of the PSoC 63 series. It comes with an E-Ink display shield board.
  - CY8CKIT-042 and CY8CKIT-040, 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 series of very low-cost prototyping platform for sampling PSoC 4 devices.
  - CY8CKIT-030 and CY8CKIT-050 are designed for analog performance. They enable you to evaluate, develop, and prototype high-precision analog, low-power, and low-voltage applications powered by PSoC 3 and PSoC 5LP, respectively.
  - CY8CKIT-001 is a common development platform for all PSoC family devices.
    - CY8CKIT-059 is a rapid prototyping kit for PSoC 5LP.
- The MiniProg3 device provides an interface for flash programming and debug.

PSoC Creator

PSoC Creator is a free, Windows based Integrated Design Environment (IDE). It enables you to design system hardware and firmware concurrently based on PSoC 3, PSoC 4, PSoC 5LP, and PSoC 6 MCU (see Figure 2). With PSoC Creator, you can do the following:

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 2. PSoC Creator Features



Document History

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	4753338	TDU	10/05/2015	New spec
*A	5738970	AESATP12	05/25/2017	Updated logo and copyright.
*B	6011765	SAGA	01/16/2018	Updated template

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