CE210435 – PSoC 3 and PSoC 5LP Broken RTD Reconfiguration

Objective

This example shows how to use a PSoC® 3 or PSoC 5LP to sense a broken wire on an RTD. It then shows how to reconfigure the measurement front end to continue to accurately measure temperature.

Overview

AN70698 describes the theory behind RTD temperature measurement. CE210383 demonstrates how to measure RTD temperature with PSoC® devices. This code example demonstrates how a PSoC can detect a broken RTD wire, and how it can reconfigure its measurement front-end to keep measuring RTD temperature accurately.

Requirements

Tool: PSoC Creator™ 4.2 or newer

Programming Language: C (Arm® GCC 5.4.1, Arm MDK 5.22, DP8051 Keil 9.51)

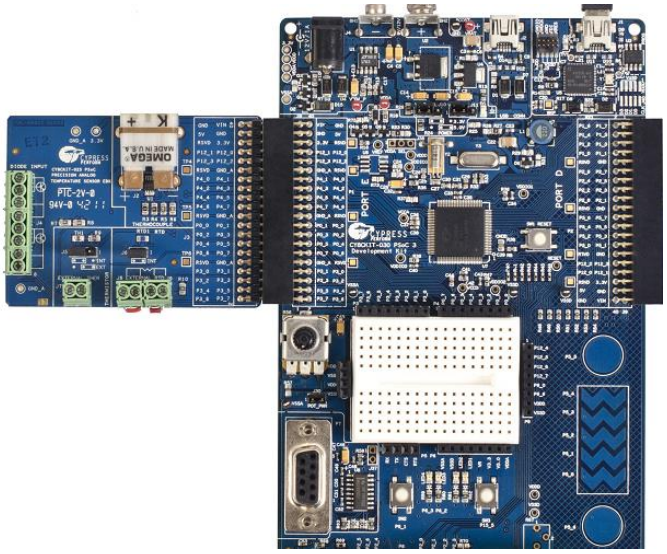
Associated Parts: All PSoC 3 and PSoC 5LP parts

Related Hardware: CY8CKIT-050, CY8CKIT-030, CY8CKIT-025

Hardware Setup

1. Plug CY8CKIT-025 into PORT E of either CY8CKIT-030 or CY8CKIT-050, as Figure 1 shows.

Figure 1. CY8CKIT-025 Plugged into CY8CKIT-050



2. Plug an external RTD into J8 and J9, and remove the J6 jumper on CY8CKIT-025.
3. Connect an LCD to the LCD Port on CY8CKIT-030 or CY8CKIT-050.

Operation

1. Load the workspace into PSoC Creator by opening `<Install_Directory>\CE210435\CE210435.cywrk`.
2. Build the code example by navigating to **Build** > **Build *CE210435_PSoC3_5_Broken_RTD_Reconfiguraiton*** in PSoC Creator.
3. Connect the device/board to a programmer connected to a PC. On-board KitProgs are already connected to the programming pins of the on-board device.
4. Program the example to the device by navigating to **Debug** > **Program**.
5. Power the device.
6. Follow the on-screen instructions for the one-time calibration.
7. Disconnect RTD wire 1. Confirm that there is only a small change in the displayed temperature. Confirm that the LCD displays a message “W1 Broken”.
8. Reconnect wire 1 and press SW2. Confirm that the message “W1 Broken” disappears.
9. Repeat steps 7 and 8 for RTD wires 2, 3, and 4.

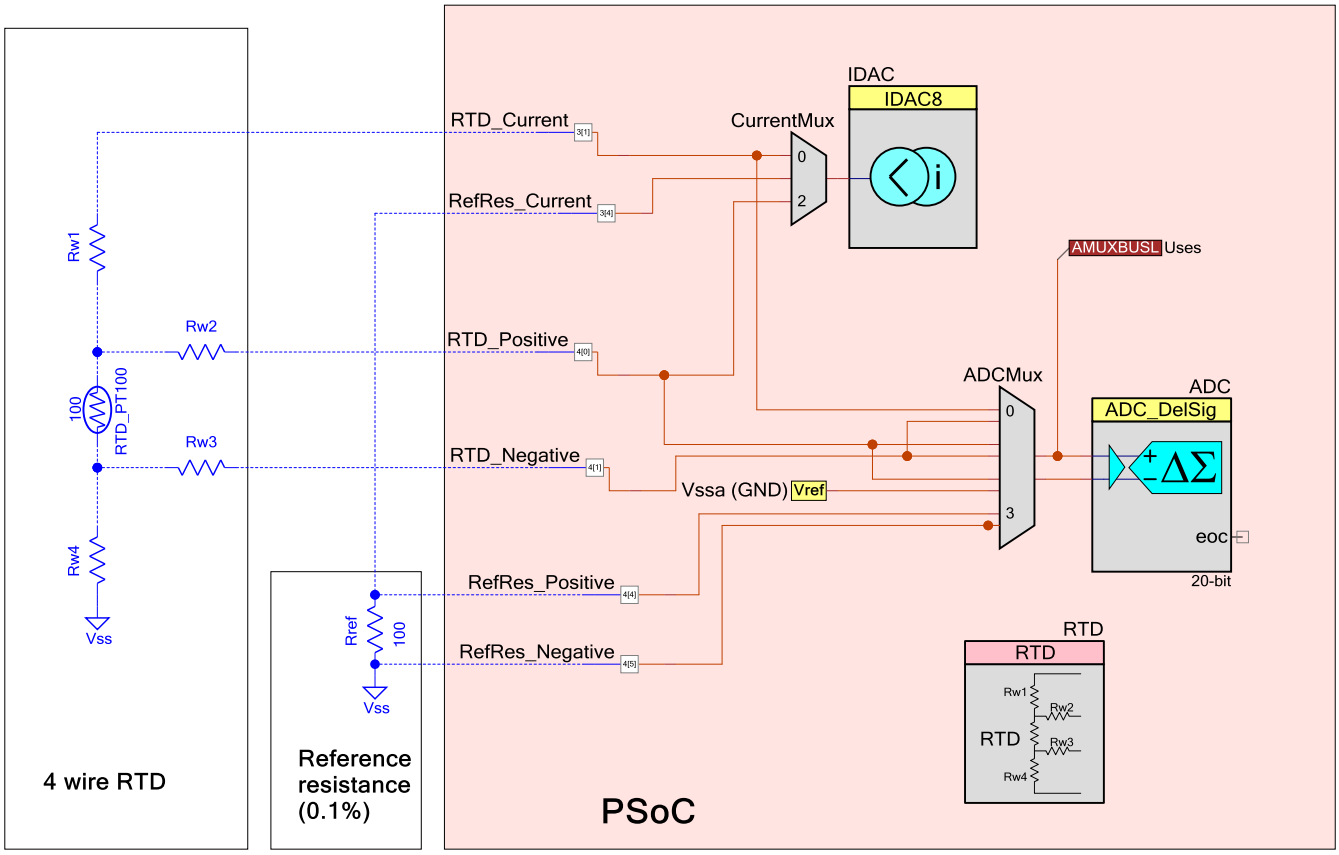
Note: If you use the internal RTD, only a broken wire on Wire 1 and Wire 4 can be detected.

Design

The hardware design is similar to that in CE210383 except that there are more IDAC and ADC channels to support four-wire to three-wire reconfiguration, as Figure 2 shows.

Manual analog routing has been used to ensure that the ADC's positive connection always happens through the analog mux bus. This causes the ADC and the IDAC to connect to the same pin through separate routing paths—the analog mux bus and the analog globals, respectively. As a result, additional resistance that can add to the RTD resistance is eliminated. See a PSoC device datasheet for detailed descriptions of pin structure and analog routing.

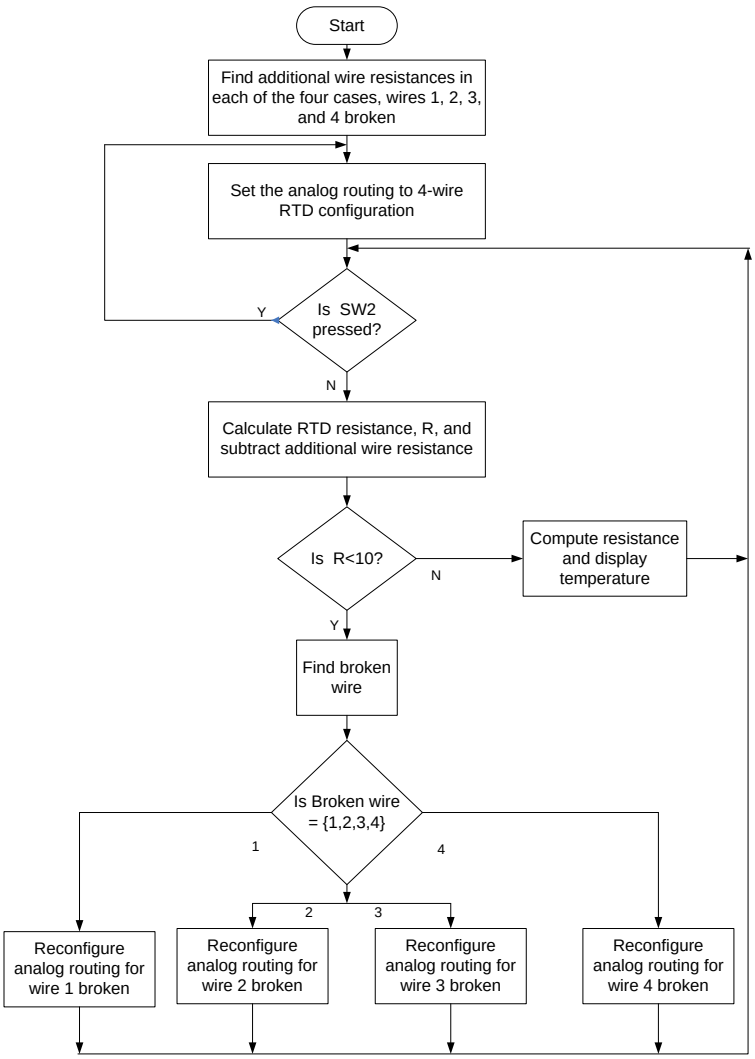
Figure 2. PSoC Creator Schematic of Broken RTD Reconfiguration Project



Firmware Flowchart

The firmware flowchart is shown in Figure 3. When one of the RTD wire breaks, the RTD resistance drops to less than 10 Ω. This condition triggers a check for broken wires. If a wire is broken, the routing is reconfigured depending on which wire is broken. That routing is maintained even after the broken wire is fixed. If the broken wire is fixed, you should press SW2 to reconfigure the routing for 4-wire measurements.

Figure 3. Firmware Flowchart



Components

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

Table 1. List of PSoC Creator Components for PSoC 3 or PSoC 5LP

Component	Name	Hardware Resources	Non-default Parameter Settings
ADC_DelSig	ADC	1 DelSig ADC	Config1 Conversion Mode: Continuous Resolution(bits): 20 Conversion rate (SPS): 61 Input Rage: +/- 0.512 V (-Input +/- Vref/2) Buffer Mode: Level Shift Common Number of Configurations: 1
Current DAC (8-bit)	IDAC	1 ViDAC	Polarity: Source Speed: High Speed Range: 0 - 2.04 mA Value: 1000 uA
RTD_Calculator	RTD	None	Temperature Min: -200 Temperature Max: -850 Calculation Error Budget: 0.01
Character LCD	LCD	7 pins	None

Design-Wide Resources

Table 2 shows pin locations for PSoC 3 and PSoC 5LP MCUs.

Table 2. Pin Locations for PSoC 3, PSoC 5LP MCUs

Pin Name	PSoC 3/PSoC 5LP MCU Location
LCD	P2[6:0]
RefRes_Current	P3[4]
RefRes_Positive	P4[4]
Ref_Res_Negative	P4[5]
RTD_Current	P3[1]
RTD_Positive	P4[0]
RTD_Negative	P4[1]

Related Documents

Table 3 lists all relevant application notes, code examples, knowledge base articles, device datasheets, and Component datasheets.

Table 3. Related Documents

Application Notes		
AN70698	PSoC 3/PSoC 4/PSoC 5LP Temperature Measurement with an RTD	Theory behind RTD temperature measurement.
Code Examples		
CE210383	PSoC 3, PSoC 4, and PSoC 5LP Temperature Sensing with an RTD	Demonstrates basic RTD temperature measurement
CE210434	PSoC 3, and PSoC 5LP RTD Calibration	Demonstrates how to calibrate out the interchangeability error of an RTD
PSoC Creator Component Datasheets		
RTD Calculator		
ADC DelSig		
Device Documentation		
PSoC 3 Datasheets	PSoC 3 Technical Reference Manuals	
PSoC 5LP Datasheets	PSoC 5LP Technical Reference Manuals	
Development Kit (DVK) Documentation		
CY8CKIT-025 PSoC Precision Analog Temperature Sensor Expansion Board		
PSoC 3 and PSoC 5LP Kits		

Document History

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	5077566	TDU	01/08/2016	New spec
*A	6076848	TDU	02/18/2018	Updated code example to new template

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