Interfacing LM75 I²C Temperature Sensor to PSoC® 1

Project Name: Example_Temperature_LM75
Programming Language: C
Associated Part Families: CY8C29/27/24/22/21xxx, CY8C23x33, CY7C603xx, CY7C64215, CYWUSB6953, CY8CLED02/04/08/16, CY8CLED04D01/02/03/04, CY8CTxx110, CY8CNP102
Software Version: PSoC® Designer™ 5.2
Related Hardware: CY3210 PSoC Eval1 Board
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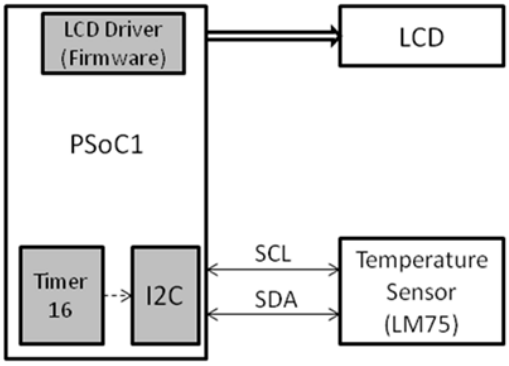
Objective

This Project demonstrates how to interface PSoC® 1 to an I²C temperature sensor (LM75) and display the temperature on the LCD.

Overview

This project uses the I2CHW Master user-module to retrieve ambient temperature from the LM75 sensor at regular intervals of time and display it on the LCD after required processing. Timer16 User Module is used to generate interrupt every one second, on which the data is read from the temperature sensor and displayed.

Block Diagram



User Module List and Placement

The following table lists user modules used in this project and the hardware resources occupied by each user module.

User Module	Placement
I2CHW	System Resource
Timer16	DBB00 and DBB01
LCD	Software Implementation

User Module Parameter Settings

The following tables show the user module parameter settings for each of the user modules used in the project.

I2CHW User Module		
Parameter	**Value**	**Comments**
Read_Buffer_Types	RAM ONLY	Only RAM data buffer is used.
CPU_Clk_speed_(CY8C27xA)	Not CY8C27xA	See the Notes section at the end of this table.
I^2C Clock	100 K Standard	Sets the I^2C clock as 100 kHz.
I^2C Pin	P1[5]-P1[7]	Selects P1[5] and P1[7] for I^2C communication. P1[5] is SDA and P1[7] is SCL.

Notes

- When the Read_Buffer_Types is set to RAM ONLY, only RAM buffers are transmitted over I^2C. To read and transmit data from Flash, set the read buffer type to RAM or FLASH.
- The parameter CPU_Clk_speed is provided as a workaround for a silicon issue that was present in CY8C27x43A (Silicon Rev. A) family of devices. In this family, read or write to the I2C_CFG and I2C_SCR registers occurred with CPU speed less than 6 MHz. If the CPU speed is greater than 6 MHz, it is throttled down to 6 MHz when accessing the I^2C registers and restored after the access. This workaround is not required for families other than the CY8C27x43A family.
- The I^2C Clock parameter is dependent on the SysClk. The I^2C clock setting in the user module is based on a SysClk of 24 MHz. In devices which support slower Sysclk, the I^2C clock is reduced by the same proportion. For example, if I^2C clock is set to 400 kHz and SysClk is set to 6 MHz, the actual I^2C clock is only 100 kHz.

LCD User Module		
Parameter	**Value**	**Comments**
LCDPort	Port 2	Use Port 2 to connect LCD.
Bargraph	Disable	Disable the Bargraph feature.

Timer16 User Module		
Parameter	**Value**	**Comments**
Clock	VC3	Use the clock for the module as VC3 (10 kHz).
Capture	HIGH	Disable the software capture feature of the timer.
TerminalCountOut	None	Disable the terminal count output.
CompareOut	None	Disable the compare output.
Period	9999	Divide the source clock by 10000 to generate a 1 Hz signal.
CompareValue	5000	Set the compare value for comparing with timer counts.
CompareType	Less Than Or Equal	Sets the logical operation for the comparison.
InterruptType	Terminal Count	Trigger interrupt on terminal count.
ClockSync	Sync to SysClk	Synchronize the clock with SysClk.
TC_PulseWidth	Full Clock	Terminal count should stay HIGH for full clock, not used in this example
Invert Capture	Normal	Make the capture input as Active High, not used in this example

Note

- For more details regarding User Module parameters, please refer to UM datasheet which can be located from Start → All Programs → Cypress → PSoC Designer 5.2 → Documentation → User Module Datasheet → STDUM.

Global Resources

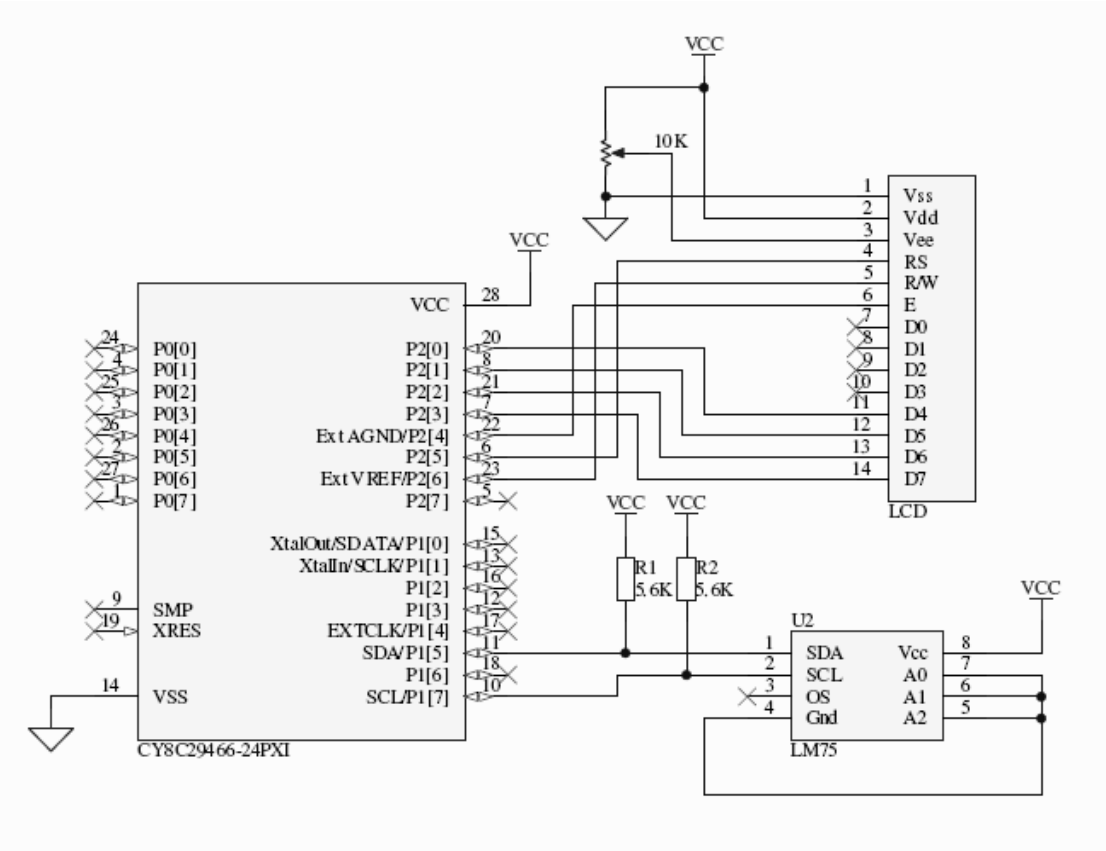
Important Global Resources		
Parameter	**Value**	**Comments**
Power Setting [Vcc / SysClk freq]	5.0 V/24 MHz	Selects 5 V operation and 24 MHz SysClk.
CPU_Clock	SysClk/2	Selects 12 MHz as the clock input for the CPU.
VC1 = SysClk/n	10	VC1 output set to 2.4 MHz.
VC3 Source	VC1	Set VC1 as the clock source for VC3.
VC3 Divider	240	Divides VC1 by 240 and generates a 10 kHz output.

Note

- Other parameters are left at their default value.

Hardware Connections

The schematic diagram for the project follows.



U2 (LM75) is a digital temperature sensor, which supports I2C protocol. This device has an integrated Sigma-Delta analog to digital converter and I2C interface. It provides 9-bit digital temperature reading with an accuracy of $\pm 2\ ^{o}C$. Pins A0, A1, and A2 are used to connect multiple LM75 to a single I^2C bus and to hard wire the three least significant bits (LSB) of the device address. In this example, all these lines are tied to GND. R1 and R2 are external pull up resistors as the I^2C bus operates in open drain mode. This schematic can be wired using the bread board area of the CY3210 PSoC Eval1 board.

Operation

On reset, all hardware settings from the device configuration are loaded into the device and *main.c* is executed.

The following operations are performed by the firmware.

- Global interrupt is enabled.
- The I2CHW module is configured as Master and its interrupt is enabled.
- OneSecTimer is started and its interrupt is enabled.
- LCD is initialized and welcome message is displayed on Row 0.
- An infinite loop is entered where the following operations are performed:
  - Check if the bReadTempFlag is set. This flag is set every second inside the OneSecTimer ISR
  - If bReadTempFlag is set:
    1. Clear the flag.
    2. Read the temperature from the LM75 into variable iTemp by calling function ReadTemp. On power up, the LM75 internally sets its read pointer to the temperature register. Reading directly from LM75 returns the value from the temperature register. I2CHW_fReadBytes function is used to read the temperature from LM75.
    3. Convert the temperature into a floating point value and display on LCD. LM75 stores the temperature in bits D7 to D15 in the temperature register. The least significant 7 bits are “Don’t Care” bits. After reading the 16-bit temperature from LM75, the 16-bit value is shifted right by 7 bits to move the 9-bit temperature value to bits D0 to D8. The LSB represents 0.5 ^{o}C. Therefore, the 9-bit temperature is multiplied by 0.5 to get the actual temperature. This is converted to ASCII using ftoa and printed to LCD using the LCD_PrString function.

Timer ISR

The ISR for OneSecTimer is written in C. The ISR function is named as OneSecTimer_ISR and is declared as an ISR using the following code in the beginning of *main.c*.

```
#pragma interrupt_handler OneSecTimer_ISR
```

If the function name is identical to the name of the assembly ISR found in *OneSecTimerINT.asm* file in PSoC Designer™, then on interrupt, the control is automatically transferred to the C function (similar methodology is used in this code example). If the function name is different from the default name, then an ljmp instruction should be placed either in *boot.tpl* or inside the *OneSecTimerINT.asm* file to the C ISR.

Another advantage of using the identical name of the assembly ISR is user does not have to worry about the PSoC Designer upgrade, as the control will never be transferred to OneSecTimerINT.asm file.

For more details about writing an ISR in C, refer to the following Knowledge Base article on the Cypress website: Implementing an Interrupt Service Routine in C on the PSoC.

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