[15] 6) In this lab, you will learn about reading analog values into the microcontroller. All pins of Port1 can be connected to analog signals which can vary form 0.0V-3.3V, and once converted by the internal ADC, the digital value for each port pin will be 0-255 for 8-bit resolution or 0-1023 for 10-bit resolution.

Assemble the following circuit with three analog signals as shown in the schematic below. For digital outputs we use the three LEDs 1, 2, and 3.

- The temperature sensor LM34DZ is connected to Port1.0 (A0). It is linear and it outputs 0.1 V for every degree, for example a room temperature of 78 F degrees, would show as a .78 V signal on your voltmeter, which is translated into 10-b digital value as .78 x (1023/3.3V) = 242. The exact value will fluctuate due to the imprecision of the sensor and the noise around it.
- The touch switch is connected to Port1.1 (A1) and a 100K ohm pull-up resistor. When you touch the transistor base, your body acts like a ground sinking a very little current from the PNP transistor, which is enough to trigger it due to its high gain (10,000). So when you touch the base and the transistor is turned on, the collector voltage will drop form VCC level (#1000 value) to almost ground (#50 value). To help your body to serve as a "better GND", touch the GND as well when you touch the base.
- The photo cell is connected to Port1.2 (A2). With the 10K resistor in series working as a voltage divider, you read about .97 VDC on A2 at room light. When you block the light completely from the photo sensor, the reading goes higher to 3.1 V. When you apply direct light onto the sensor, the reading goes lower to 0.3 V.
- LEDs 123 are connected to Port pins 1.4, 1.5, 2.0. LEDs must have current limiting resistors in series with value between 100-470 ohms.
- ➤ *All above analog values are experimental, and they vary form one sensor to another. It is recommended that you actually measure the voltage with your voltmeter and do the math, and then check the corresponding values you read form the MSP430 internal registers.*
- ➤ *Analog vales are very fluctuating in nature and the ADC converter inside the micro works very fast, so it is recommended to add a small capacitor on the analog wire. In the software, it is also recommended to read few samples and average the reading.*

The skeleton software provided in C will run on this circuit and it will write the three analog values in the three variables, temp, touch and light. Run the software and check the values in the debugger. Note that the skeleton code takes the initial room readings from the three sensors and saves them as baseline values before the program enter the infinite loop, lightroom, touchroom, and temproom.

[8] 6.a) Observe how LED 1 changes on/off as you move your hand over the light sensor. Explain to the TA why LED1 is not flickering as it alternates between on and off, the hysteresis concept.

[6] 6.b) Modify the main infinite loop so that If the room temperature reading increases by 2% over the room value, LED 2 turns on (think of it as an Air Conditioner). If the temperature decreases back to the original room temperature or below it, LED 2 will turn off. LED should not flicker!

[6] 6.c) Modify the main infinite loop so that every time you touch the touch switch, LED 3 will toggle between on and off. LED 3 should not flicker!

LaunchPad with MSP430G2553

Flash 16 KB
Serial Hardware

				1
+3.3V				
RED_LED	A0	P1_0		2
	RX	A1	P1_1	3
	TX	A2	P1_2	4
		A3	P1_3	5
		A4	P1_4	6
PUSH2	SCK (B0)	A5	P1_5	7
	CS (B0)		P2_0	8
			P2_1	9
			P2_2	10

20				GROUND
19	P2_6			XIN
18	P2_7			XOUT
17				TEST
16				RESET
15	P1_7	A7	SDA	MOSI (B0)
14	P1_6	A6	SCL	MISO (B0) GREEN_LED
13	P2_5			
12	P2_4			
11	P2_3			

Hardware
Pin number
I²C
Serial UART
SPI
analogRead()
digitalRead() and digitalWrite()
digitalRead(), digitalWrite() and analogWrite()

Rei Vilo
embeddedcomputing.weebly.com

LM34

Temperature Sensor
Vs = 6-30 V.
Vout = linear
10 mV per °F.

330 Ω

Photo Cell
Light → 16K Ω
Dark → 500K Ω

Touch Switch:
Connect any
metal object to
the base

**MPSA63:
PNP Darlington
Gain 10K,
@ 100 mA**

TO-92