Measurement of Distance

Preparation

You will need a LaunchPad, an IR distance sensor, a ruler, and a Nokia 5110 LCD.

Book Reading Textbook Sections 8.5, 8.6, 9.6, 10.1, 10.4, and 10.5
Starter project Labware\Lab14_MeasurementOfDistance
Purpose

This lab has these major objectives: 1) an introduction to sampling analog signals using the ADC interface; 2) the development of an ADC device driver; 3) learning data conversion and calibration techniques; 4) the development of an interrupt-driven real-time sampling device driver.

395

System Requirements

In this lab you will design a distance meter. An IR distance sensor converts distance into voltage. Your software will use the 12-bit ADC built into the microcontroller. The ADC will be sampled at 20 Hz using SysTick interrupts. You will write a C function that converts the ADC sample into distance, with units of 1 cm. That data stream will be passed from the ISR into the main program using a mailbox, and the main program will output the data on an LCD display.

Procedure

1. Connect one IR distance sensor to the corresponding ADC input and debug on Launchpad, observe the ADC value change as you move and obstacle in front of the sensor.
2. Use a ruler to measure the distance when you debug on Launchpad: collect data and fill in the following table:

Distance (in cm)	Sensor Output(v)	ADC Output Values	Estimated Sensor output(ADCvalue*0.8mv)
10	2.637	3380	2.704
15	1.844	2362	1.889
20	1.375	1767	1.4136
25	1.112	1443	1.1544
30	.922	1186	.948
35	.787	1009	.807
40	.684	882	.705
✓ 45	.613	781	.624
50	.554	703	.562
55	.497	647	.517
60	.458	576	.460
65	.415	546	.436
70	.412	532	.426

3. Create an array for the table obtained in previous step. Use table look up to find out the distance for a given ADC value.
4. Calibrate ADC output values and convert them to distance use a rational equation like y=(a/x)+b, where y is distance in centimeters and x is the digital voltage value obtained from ADC output, then solve two unknowns: a & b. Test and compare with the results obtained in step 2.
5. Add LCD code into your project and implement the display for distance information. The following information should be displayed on your LCD: ADC output value, distance obtained from table lookup, distance obtained from calibration.

Deliverable

1) Demonstrate your lab on board
2) Attached the following items to the end of this lab description and submit to Beachboard dropbox:
   a. Lookup table obtained in step 2
   b. The equation obtained in step 4 and test results. Use the following table to show your test results.

Distance → $y = A + \frac{B}{X}$ (X: ADC Voltage)

Distance (in cm)	Table Estimation	Equation Estimation
10	11	10
15	16	15
20	21	20
25	26	25
30	30	29
35	36	35
40	41	40
45	46	45
50	51	50
55	57	56
60	61	60
65	65	65
70	0	71

$A = -0.502095291$

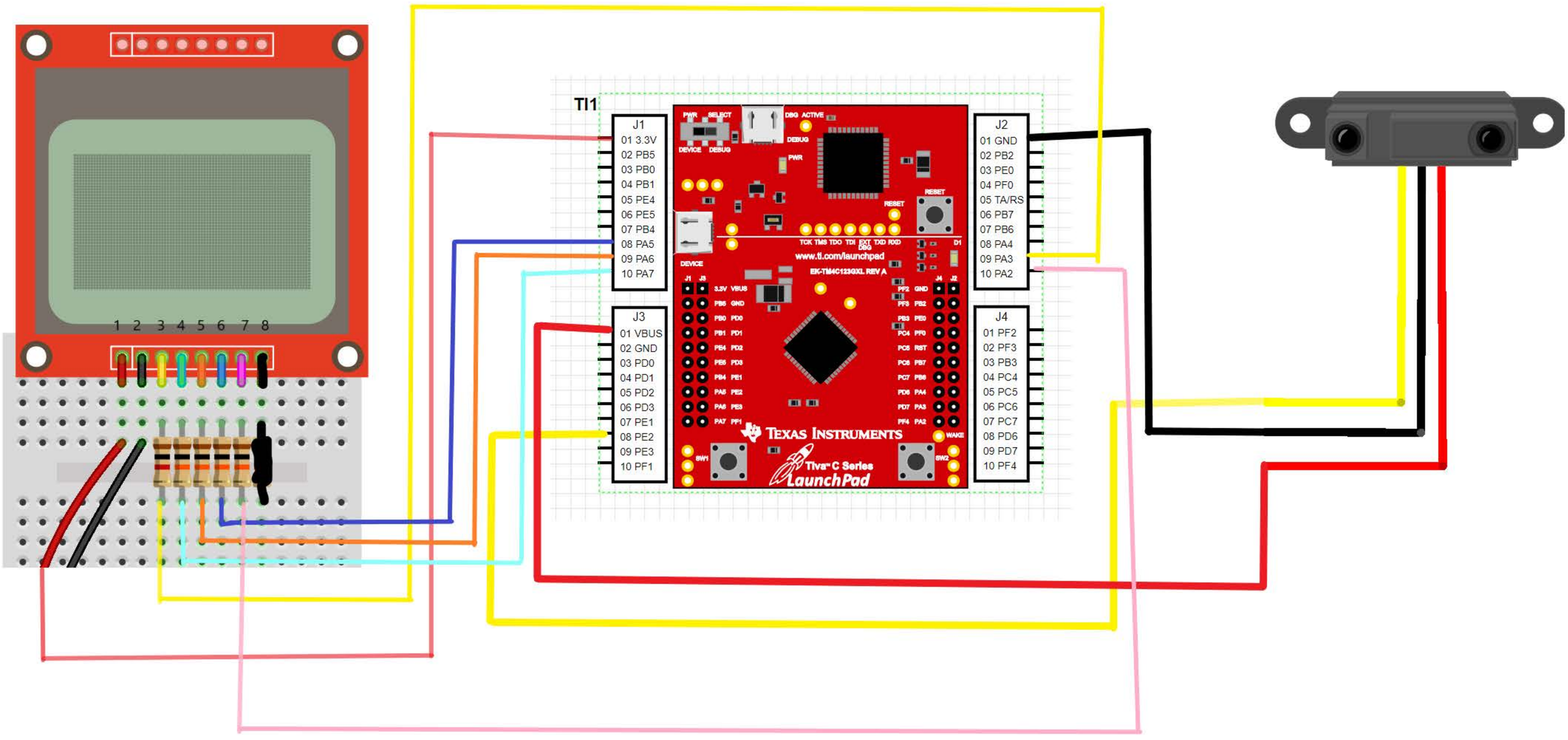
$B = 35,960.0893$

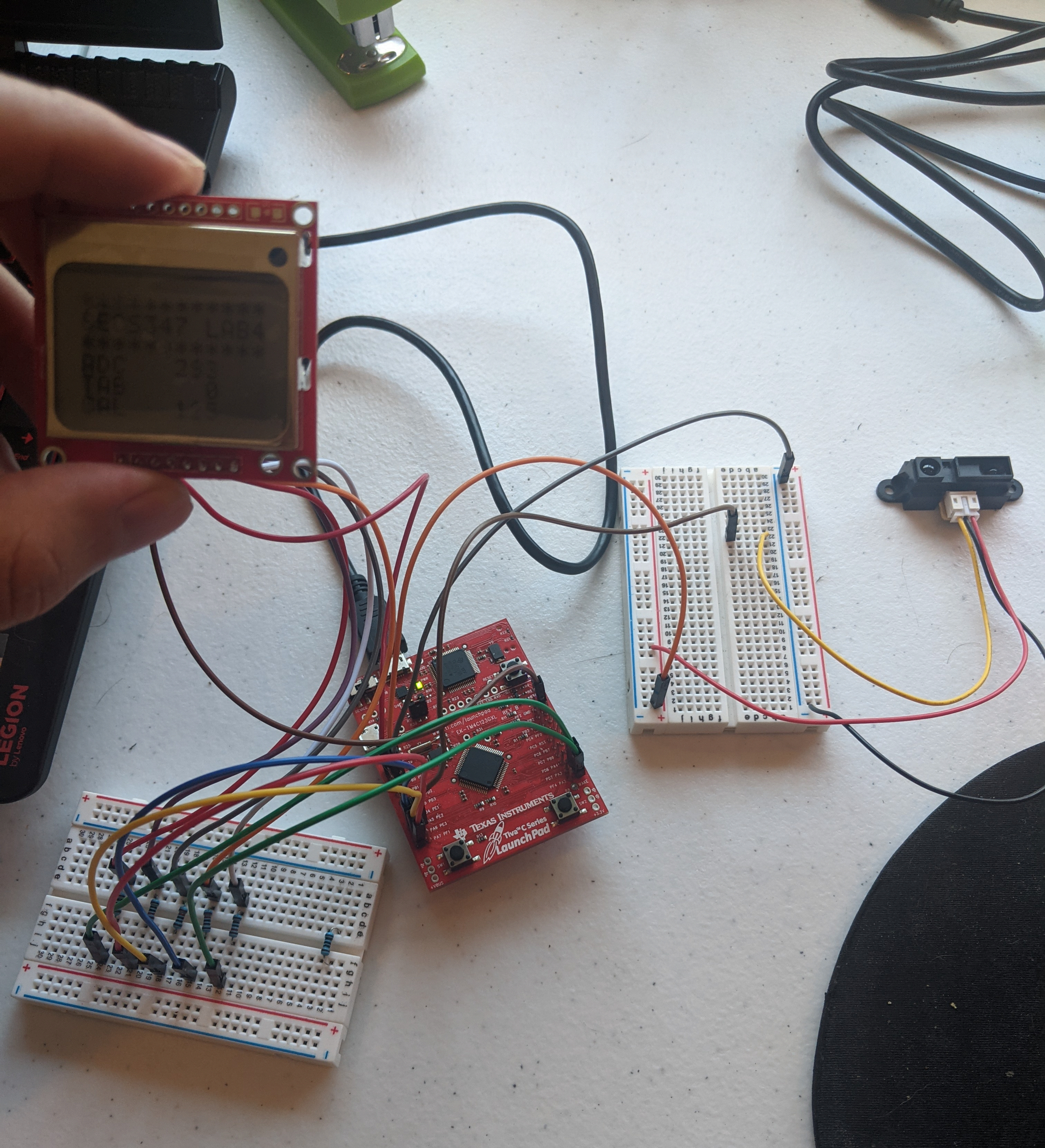
$y - A = \frac{B}{X}$

$x = \frac{B}{y - A}$

   c. A short video or link to the video for your demonstration.
   d. Schematic and picture for your embedded system.
   e. Software source code.

Signal (Nokia 5110) LaunchPad pin
3.3V (VCC, pin 1) power
Ground (GND, pin 2) ground
SSI0Fss (SCE, pin 3) connected to **PA3, 1k ohms**
Reset (RST, pin 4) connected to **PA7, 10k ohms**
Data/Command (D/C, pin 5) connected to **PA6, 10k ohms**
SSI0Tx (DN, pin 6) connected to **PA5, 10k ohms**
SSI0Clk (SCLK, pin 7) connected to **PA2, 10k ohms**
back light (LED, pin 8) **not connected**

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Texas Instruments
Tiva C Series
LaunchPad
EK-TM4C123GXL
REV B