CSE4342 Embedded Systems II
CSE5342 Embedded Systems
Lost Cost Impedance Meter
Spring 2021 Project

1 Overview

The goal of this project is design a system capable of measuring resistance, inductance (and ESR), and capacitance. As explained in class, a design goal of this project is to limit the total cost of the daughterboard and components added to the TM4C123GXL evaluation board to $3 in 10k quantities as explained in class.

Since connectors have significant associated cost, two shared connections will be used for the device under test, regardless of whether a resistive, an inductive, or a capacitive device is measured, so any commutation must also be included to allow any attached device to be measured.

The project shall provide a complete user interface through the virtual COM port on the evaluation board.

A collection of most major parts will be provided.. The pc boards, tools, and any optional items are not included in this collection of parts.

2 Hardware Description

Microcontroller:
An ARM M4F core (TM4C123GH6PMI microcontroller) is required.

Power LED:
A power LED must be connected through a current-limiting resister to indicate the daughterboard has power.

Serial interface:
If using the EK-TM4C123GXL evaluation board, then the UART0 tx/rx pair is routed to the ICDI that provides a virtual COM port through a USB endpoint.

LCR measurement interface:
A circuit is provided that will interface with the microcontroller and allow the user to test an L, C, or R value. The output of this circuit can be connected to the analog comparator and analog-to-digital converter inputs.

The circuit will described in detail in class and a schematic are provided. You should know the operation of every component of the circuit and be prepared to answer questions about it on the second exam.

Graphics LCD display user interface:
Adding a graphics LCD and corresponding user interface buttons shall yield the potential for additional credit.

3.3V supply:
The circuit is powered completely from the 3.3V regulator output on the evaluation board.

Device under test (DUT) connection;
Two connectors, made of wire loop to save cost, are required to allow the DUT to be connected.

Test points:
Test points shall be added for the ground reference and comparator output at minimum.

3 Suggested Parts List

Part	Quantity
2N3904 NPN transistor	5
2N3906 PNP transistor	2
33ohm, 1/2W resistor	1
3.3kohm, 1/4W resistor	7
10kohm 1/4W resistor	7
100kohm, 1/4W resistor	1
1N5819 Schottky diode (flyback diodes)	4
1uF capacitor (integrator)	1
47uF capacitor (power supply)	1
2x10 double-row header, unshrouded	2
HD44780 LCD display	1
Pushbuttons	~6
Wire (22-24 AWG solid wire, 3+ colors)	1
PC board (approx 4.5x6”)	1
Tools, safety glasses, …	1 each
Devices under test	Varies

4 Software Description

A virtual COM power using a 115200 baud, 8N1 protocol with no hardware handshaking shall be provided with support to the following commands.

Debug:

If “reset” is received, the hardware shall reset.

If “voltage” is received, the hardware shall return the voltage across DUT2-DUT1. The voltage is limited to 0 to 3.3V.

LCR commands:

If “resistor” is received, return the resistance of the DUT. You should try to convert a capacitance value from 10ohms to 1Mohm.

If “capacitance” is received, return the capacitance of the DUT. You should try to convert a capacitance value from 1nF to 100uF.

If “inductance” is received, return the inductance of the DUT. You should try to convert an inductance value from 1nH to 100uH.

If “esr” is received, return the ESR of the inductor under test.

If “auto” is received, return the value of the DUT that is most predominant (i.e. an inductor with 1ohm ESR and 10µH inductance will return the inductance and ESR values, a 100kohm resistor will return the resistance, and a 10µF capacitor will return the capacitance.

Efforts made to extend the measurement range will be considered for extra credit.
Efforts to increase the accuracy of the measurement will be considered for extra credit.

Adding a LCD and buttons that provided a stand-alone user interface will also be considered for additional points.

5 Testing

Your hardware will be tested in the ERB 126 lab by the grader.

Make absolutely sure you have connected the 4 diodes and the anodes and cathodes are properly connected. Minimize the impedance from this point to the large added storage cap and the 3.3V supply and grounds. The diodes are an attempt to absorb the voltages created when the magnetic field collapses in the inductor. Also, be careful not to change the 33ohm resistor to a lower value as this increases the energy in the inductor. Start with lower inductor values when testing and work up to the large values as you test the voltage across the DUT. Please verify the voltage on an oscilloscope using a lab supply while manually controlling the circuit before connecting the ARM evaluation board.

Computers and lab equipment will be provided on campus in ERB 126 for you to work on this project. If you do plan on plugging your project into your own machine, do so at your own risk and only after testing the hardware. Again, you are responsible for anything that happens to your personal machine. Do not connect your project to any machines in the UTA computing labs or in other CSE labs.

6 Deadlines

You should complete construction of the hardware by Thursday, February 11. Starting Tuesday, February 16, a 25% deduction to the hardware portion of the project will be assessed for each class day that the hardware is late. The project hardware may be inspected by the grader at any date prior to and including the due date.

You are required to submit your latest code (whatever you have completed) by e-mail on March 26, April 9 and April 23 to the grader. The file should be in a ZIP file format with the name of each student on the team in the name of the ZIP file. The ZIP file should only contain source code files (.c and .h files).

The final project is due on the date and at the time indicated in the syllabus, with an oral defense, written printed out report (introduction, theory of operation, copy in-line, and conclusion), and demonstration of hardware and software (including compilation on site). A project team consists of 1 or 2 students. All members of the team must understand all aspects of the project as submitted. All code must be unique and written solely by the student(s) submitting the project. An electronic copy of the final project code must also be emailed to the grader.

7 Safety Issues

Please follow all UTA safety rules and those stated in the syllabus.

Please utilize the supervised lab resources in ERB 126 when working on the project for your safety. You may only use the resources in ERB 126 when the grader or other staff is present.

Have fun!