LAB 12: ADDER-SUBTRACTOR

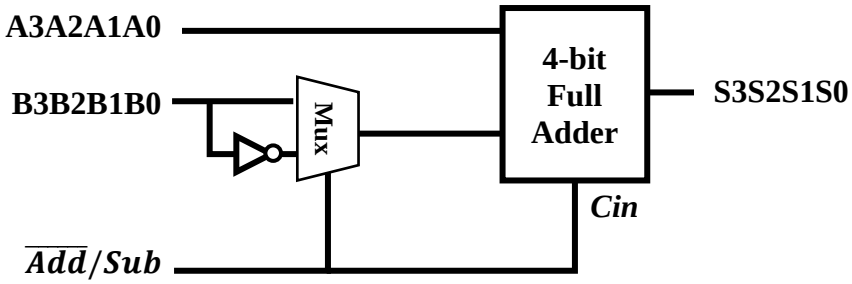
1 Goals

- Build a simple Adder-Subtractor
- Know how to display decimal numbers on a seven-segment display

2 Exercises

2.1. Adder-Subtractor

An *adder-subtractor* is a combinational circuit that performs both addition and subtraction of 2 binary numbers. Notably, the subtraction is implemented by adding 2's complement of the subtrahend to the minuend disregarding the final carry (if any).



4-bit Adder-Subtractor

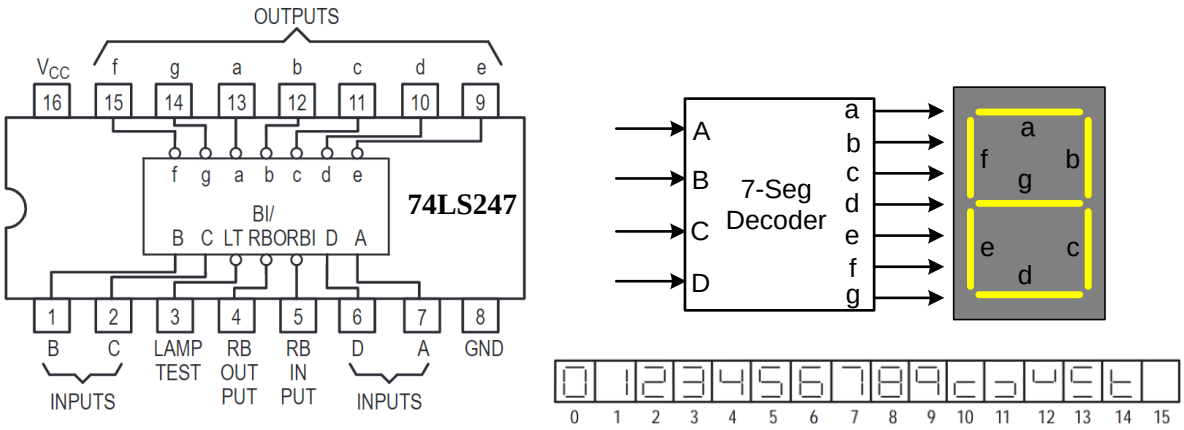
Requirements:

- Test all ICs and equipment.
- Read the datasheet of 74LS157 (2-to-1 MUX) and 74LS83 (4-bit full adder).
- Assemble the 4-bit Adder-Subtractor (shown in the above figure) on the breadboard using the given ICs (74LS157, 74LS83, 74LS04), resistors, LEDs, and buttons (or switches).
- Supply 5V/GND power to the circuit.
- Define the circuit's activities, i.e., checking circuit's output for all input states.
- Write comments on the experimental results.

2.2. BCD to Seven-Segment Decoder

BCD (*Binary Coded Decimal*) is a binary encoding of decimal numbers in which each BCD digit is usually represented by 4 bits or 8 bits. For example, in the BCD numbering system, the representation of 25_{10} is $0010\ 0101_{BCD}$.

A *seven-segment display* is an electronic device used to display hexadecimal numerals (0-9, A-F) or decimal numerals (0-9). Basically, it consists of 7 LEDs arranged in 2 configurations. In one configuration, all the LEDs' anodes are connected (i.e., *common anode*). In the other configuration, all the LEDs' cathodes are connected (i.e., *common cathode*).



Seven-Segment Display and Numeral Designations

Procedure:

- Test all ICs and equipment.
- Read the datasheet of 74LS247 (BCD-to-seven-seg. decoder).
- Assemble the BCD to seven-segment decoder on the breadboard using the given ICs (74LS247), seven-segment display, and resistors.
- Supply 5V/GND power to the circuit.
- Define the circuit's activities, i.e., checking circuit's output for all input states.
- Write comments on the experimental results.

2.3. Design Exercise

Implement a 3-bit adder-subtractor using IC 74LS83 (or 74LS283) and IC 74LS86. The output of addition/subtraction is displayed on a seven-seg. display. **Note:** Do not use IC 74LS157 and IC 74LS04.

Components and devices needed for the lab:

Components/Equipment	Description	Quantity
74LS157	4× 2-bit 2-to-1 MUX	1
74LS83 or 74LS283	1× 4-bit Full Adder	1
74LS247	1× BCD-to-Seven-Seg. Decoder	1
74LS(HC)04	6× NOT	1
74LS(HC)86	4× 2-input XOR	1
Resistor	330Ω	Few
LED	2V-2.5V, 20mA	Few
Seven-Seg Display	Common Cathode (–)	1
Buttons (or switches)	3-pin/4-pin	Few
Power Supply	Aditeg, 0-5 V	1
Breadboard		1
Connecting wires		Few
Multimeter		1