**The University of Texas at Dallas**
**Department of Computer Science**
**CS 4141: Digital Systems Lab**

# Experiment #3 – The Digital Adder Circuit

## CS 4141 Laboratory 3, EXPERIMENT

### Introduction

In the last two laboratory exercises, we studied logic gates and basic combinational logic circuits. In this experiment is about the adder circuit. Arithmetic circuits like digital adders are widely used in sequential circuits, such as microprocessors. The adder circuit is one part of an Arithmetic Logic Unit (ALU), the heart of processor. Today's lab concerns the combinational logic of digital addition.

### Objective

The purpose of this lab is to become familiar with the functionality of digital adder circuits. The 74LS283 4-bit full adder or similar IC will be used to get the feel of how adder ICs operate.

### Turn-In Check List

The laboratory has two items to grade.

1. Demonstrate the working circuits to the Lab Instructor (40 points)
2. ***Put supplies away correctly sorting and returning all chips. (10 points)***
3. Produce the Post-Lab Report (30 points)

### Equipment List

The following components are required for this experiment:

- IDL-800a Digital Lab Station ("breadboard" unit with test equipment built-in power supply)
- Full Adder (Such as SN74LS283)
- AND gate IC Chip (Such as SN74LS08)
- OR gate IC Chip (Such as SN74LS32)
- XOR gate IC Chip (Such as SN74LS86)
- Breadboard wires (jumpers)

## Experimental Procedure

### Part 1. 4-bit Addition using an IC chip such as 74LS283

- Read the Manual for 74283 which is on the course webpage. Make the connections as shown and get the 4-bit full adder working.
- Try different inputs for input A and input B and check the outputs.
- For the Post-Lab report include
    - a truth table containing 10 different combinations of input A and input B, including the $C_{in}$ and the $C_{out}$
    - a pinout diagram (not logic diagram) naming the adder chip and all its connections. A pinout diagram should contain layouts of chips and the wiring combination. (Such as SN74lS283, SN74LS004, SN74LS586, SN74LS502) and with the correct wires on the correctly labeled pins.

### Part 2. 4-bit Subtraction using an IC chip such as 74LS283

- Review the pre-lab and implement a 2-bit adder/subtractor circuit
- Observe the output. The output is in 2's complement form for 2 bits. Remember, 2's compliment flips all the bits and adds 1.

| Input A | Input B | $C_{in}$ | Binary Output | Binary Integer | 2's Compliment Integer |
|---|---|---|---|---|---|
| 0000 | 0000 | 0 | 0000 | 0 | 0 |
| 0000 | 0001 | 0 | 0001 | 1 | 1 |
| 0001 | 0011 | 1 | 1110 | 14 | -2 |
| 0001 | 0010 | 1 | 1111 | 15 | -1 |

- For the Post-Lab report include:
    - a truth table containing 10 different combinations of input A and input B (5 additions and 5 subtractions)
    - a pinout diagram (not logic diagram) of the adder/subtractor circuit, naming the adder chip, and any additional IC's. A pinout diagram should contain layouts of chips and the wiring combination. (Such as SN74lS283, SN74LS004, SN74LS586, SN74LS502) and with the correct wires on the correctly labeled pins.

**Part 3. Construct a Binary Coded Decimal (BCD) adder using the 4-bit binary full adders**

- Review the pre-lab and implement a BCD adder circuit
- In a binary coded decimal (BCD) system, 4 bits are used to represent a decimal digit from 0 to 9.

| Decimal Value | Binary Value | BCD Value |
|---|---|---|
| 5 | 00000101 | 0000 0101 |
| 11 | 00001011 | 0001 0001 |
| 23 | 00010111 | 0010 0011 |
| 35 | 00100011 | 0011 0101 |
| 47 | 00101111 | 0100 0111 |

  Since each decimal digit cannot exceed 9 for this part of the lab, the maximum BCD sum can be 19 = 9 + 9 + 1($C_{in}$)
- For the Post-Lab report include:
  - A truth table that shows the decimal value from 0 to 19, the binary value from 0 to 19, and the BCD value from 0 to 19.
  - a pinout diagram (not logic diagram) of the BCD adder circuit, naming the adder chip, and any additional IC's. A pinout diagram should contain layouts of chips and the wiring combination. (Such as SN74lS283, SN74LS004, SN74LS586, SN74LS502) and with the correct wires on the correctly labeled pins.

**Equipment Disassembly:** The experimental procedure is complete. Please disassemble the circuit wiring, replace in the wires and replace all IC chips in their proper boxes. Make sure that your work area is clean.

## For the Post-Lab Report (30 points)

- First, include your name, section, and date of the experiment.
- Second, include the title "Experiment 3 Post-Lab"
- If you were working with a partner on a lab station,
  - Then include your partners' name
- For the experiment
  - Part 1: Results of 10 4-bit Additions (5 points)
  - Part 1: Circuit Diagram of the IC chip (5 points)
  - Part 2: Results of 5 2-bit additions, and 5 2-bit subtractions (5 points)
  - Part 2: Circuit Diagram of the 2-bit Adder/Subtractor (5 points)
  - Part 3: Truth Table of 0 through 19 for the BCD Adder (5 points)
  - Part 3: Circuit Diagram of the BCD Adder (5 points)
- Citations: If you are using software to draw your diagrams, identify the software.