Lab session Adders

Group A: October 12, 2009
Group B: October 13, 2009

Work in the given groups of two. Submit your solutions to the respective assignment on Blackboard. The file name is:
`a02_s0XXXXX_s0XXXXX.tar.gz`
One of the group members commits your solution. The other(s) submit a txt-file with a confirmation. Keep an eye on the deadline (see Blackboard)!

1 Project

Read section C.6 of Appendix C.

1. Build a 1-bit full adder (with carry in and carry out).
   (a) Determine the inputs and outputs of a 1-bit full adder and build a truth table.
   (b) Convert the truth table to Boolean algebra, and optimize the Boolean expression.
   (c) Implement the Boolean expression as a circuit called "1-Bit Adder" in Logisim.
2. Build a circuit of an 8-bit adder.
   (a) Use 1-bit adders to create an 8 bit adder, that adds two 8-bit wide inputs.
3. Build a circuit of an 8-bit two's complement adder.
   (a) Think about a way how overflow can be determined from carry outs. Overflow happens for example in these cases: 127 + 1 = -128 or -128 + (-1) = 127.
   (b) Build a circuit of an 8-bit two's complement adder that has an extra output bit, denoting overflow.
4. Build a circuit of an 8-bit two's complement carry lookahead adder using 4 2-bit adder blocks.

(a) What are the "super propagates" and the "super generates", and C1, C2, C3 and C4 values for the addition of numbers 11001011 and 01111100 (see Appendix C page C-44). Calculate the carry out of the most significant bit (i.e. c_8).

(b) Build a circuit for a 2-bit adder block. This block has input carryIn, a_0, a_1, b_0 and b_1, and outputs s_0, s_1, P_0, G_0. Note that there is no output for carryOut, as a carry lookahead adder doesn't use c_{i-1}.

(c) Build a circuit of the 8-bit two's complement carry lookahead adder by creating a "carry lookahead unit" that uses 4 of your own 2-bit adder blocks.

(d) On this 8-bit adder circuit, create an extra output bit, denoting overflow. You will have to create a variant of your last 2-bit adder block.

(e) To compare the carry lookahead 8-bit adder and the ripple carry 8-bit adders, count the maximum number of gate delays, i.e. the maximum number of AND and OR gates a signal passes in both adders.