

## Homework Assignment 2 - Solutions

1. **Sign and Magnitude** Given the following numbers (A,B) find A+B, A-B, -A+B, and -A-B in an 8 bit sign and magnitude number system.

**Solution** In a sign and magnitude system, the sign bit determines the sign of the number, if the sign bits are different, then we subtract, if the sign bits are the same, we add. Never add nor subtract the sign bit and the result has the sign bit of the number with the larger magnitude.

(a) 01010101, 00001010

$$\begin{aligned} A &= 01010101 & B &= 00001010 \\ -A &= 11010101 & -B &= 10001010 \end{aligned}$$

$$\begin{array}{rcl} A + B & \begin{array}{r} 01010101 \\ + 00001010 \\ \hline 01011111 \end{array} & A - B \quad \begin{array}{r} 01010101 \\ + 10001010 \\ \hline 01001011 \end{array} \end{array}$$

$$\begin{array}{rcl} -A + B & \begin{array}{r} 11010101 \\ + 00001010 \\ \hline 11001011 \end{array} & -A - B \quad \begin{array}{r} 11010101 \\ + 10001010 \\ \hline 11011111 \end{array} \end{array}$$

(b) 01101011, 00101010

$$\begin{aligned} A &= 01101011 & B &= 00101010 \\ -A &= 11101011 & -B &= 10101010 \end{aligned}$$

$$\begin{array}{rcl} A + B & \begin{array}{r} 01101011 \\ + 00101010 \\ \hline 10010101 \\ \text{Overflow} \end{array} & A - B \quad \begin{array}{r} 01101011 \\ + 10101010 \\ \hline 01000001 \end{array} \end{array}$$

$$\begin{array}{rcl} -A + B & \begin{array}{r} 11101011 \\ + 00101010 \\ \hline 11000001 \end{array} & -A - B \quad \begin{array}{r} 11101011 \\ + 10101010 \\ \hline 10010101 \\ \text{Overflow} \end{array} \end{array}$$

(c) 11101010, 00101111

$$\begin{aligned} A &= 11101010 & B &= 00101111 \\ -A &= 01101010 & -B &= 10101111 \end{aligned}$$

$$\begin{array}{rcl}
 A + B & \begin{array}{r} 1\ 1\ 1\ 0\ 1\ 0\ 1\ 0 \\ +\ 0\ 0\ 1\ 0\ 1\ 1\ 1\ 1 \\ \hline 1\ 0\ 1\ 1\ 1\ 0\ 1\ 1 \end{array} & A - B \quad \begin{array}{r} 1\ 1\ 1\ 0\ 1\ 0\ 1\ 0 \\ +\ 1\ 0\ 1\ 0\ 1\ 1\ 1\ 1 \\ \hline 1\ 0\ 0\ 1\ 1\ 0\ 0\ 1 \\ \text{Overflow} \end{array}
 \end{array}$$

$$\begin{array}{rcl}
 -A + B & \begin{array}{r} 0\ 1\ 1\ 0\ 1\ 0\ 1\ 0 \\ +\ 0\ 0\ 1\ 0\ 1\ 1\ 1\ 1 \\ \hline 1\ 0\ 0\ 1\ 1\ 0\ 0\ 1 \\ \text{Overflow} \end{array} & -A - B \quad \begin{array}{r} 0\ 1\ 1\ 0\ 1\ 0\ 1\ 0 \\ +\ 1\ 0\ 1\ 0\ 1\ 1\ 1\ 1 \\ \hline 0\ 0\ 1\ 1\ 1\ 0\ 1\ 1 \end{array}
 \end{array}$$

(d) 10000000,01111111

$$\begin{array}{ll}
 A = 10000000 & B = 01111111 \\
 -A = 00000000 & -B = 11111111
 \end{array}$$

Since I have an eight bit system, it will only read either the first or last eight bits.

$$\begin{array}{rcl}
 A + B & \begin{array}{r} 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \\ +\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \\ \hline 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \end{array} & A - B \quad \begin{array}{r} 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \\ +\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \\ \hline 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \end{array}
 \end{array}$$

$$\begin{array}{rcl}
 -A + B & \begin{array}{r} 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \\ +\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \\ \hline 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \end{array} & -A - B \quad \begin{array}{r} 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \\ +\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \\ \hline 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1 \end{array}
 \end{array}$$

(e) 10000,1001

$$\begin{array}{ll}
 A = 00010000 & B = 00001001 \\
 -A = 10010000 & -B = 10001001
 \end{array}$$

$$\begin{array}{rcl}
 A + B & \begin{array}{r} 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0 \\ +\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 1 \\ \hline 0\ 0\ 0\ 1\ 1\ 0\ 0\ 1 \end{array} & A - B \quad \begin{array}{r} 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0 \\ +\ 1\ 0\ 0\ 0\ 1\ 0\ 0\ 1 \\ \hline 0\ 0\ 0\ 0\ 0\ 1\ 1\ 1 \end{array}
 \end{array}$$

$$\begin{array}{rcl}
 -A + B & \begin{array}{r} 1\ 0\ 0\ 1\ 0\ 0\ 0\ 0 \\ +\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 1 \\ \hline 1\ 0\ 0\ 0\ 0\ 1\ 1\ 1 \end{array} & -A - B \quad \begin{array}{r} 1\ 0\ 0\ 1\ 0\ 0\ 0\ 0 \\ +\ 1\ 0\ 0\ 0\ 1\ 0\ 0\ 1 \\ \hline 1\ 0\ 0\ 1\ 1\ 0\ 0\ 1 \end{array}
 \end{array}$$

2. **Sign and Magnitude** Given the following numbers (A,B) in decimal, perform the following operations using a sign and magnitude number system.

(a) 23-67  
 $23_{10} = ?_2$

$$\begin{array}{rcl} 23 \div 2 & = & 11 \text{ } R \text{ } 1 \\ 11 \div 2 & = & 5 \text{ } R \text{ } 1 \\ 5 \div 2 & = & 2 \text{ } R \text{ } 1 \\ 2 \div 2 & = & 1 \text{ } R \text{ } 0 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$23_{10} = 10111_2$   
 $67_{10} = ?_2$

$$\begin{array}{rcl} 67 \div 2 & = & 33 \text{ } R \text{ } 1 \\ 33 \div 2 & = & 16 \text{ } R \text{ } 1 \\ 16 \div 2 & = & 8 \text{ } R \text{ } 0 \\ 8 \div 2 & = & 4 \text{ } R \text{ } 0 \\ 4 \div 2 & = & 2 \text{ } R \text{ } 0 \\ 2 \div 2 & = & 1 \text{ } R \text{ } 0 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$67_{10} = 01000011_2$   
 $-67_{10} = 11000011_2$

$$\begin{array}{r} 0 \ 0 \ 0 \ 1 \ 0 \ 1 \ 1 \ 1 \\ + \ 1 \ 1 \ 0 \ 0 \ 0 \ 0 \ 1 \ 1 \\ \hline 1 \ 0 \ 1 \ 0 \ 1 \ 1 \ 0 \ 0 \end{array}$$

$1 \ 0 \ 1 \ 0 \ 1 \ 1 \ 0 \ 0_2 = -44_{10}$

(b)  $-58 + 76 \ 58_{10} = ?_2$

$$\begin{array}{rcl} 58 \div 2 & = & 29 \text{ } R \text{ } 0 \\ 29 \div 2 & = & 14 \text{ } R \text{ } 1 \\ 14 \div 2 & = & 7 \text{ } R \text{ } 0 \\ 7 \div 2 & = & 3 \text{ } R \text{ } 1 \\ 3 \div 2 & = & 1 \text{ } R \text{ } 1 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$$58_{10} = 111010_2$$

$$-58_{10} = 10111010_2$$

$$76_{10} = ?_2$$

$$\begin{array}{rcl} 76 \div 2 & = & 38 \text{ } R \text{ } 0 \\ 38 \div 2 & = & 19 \text{ } R \text{ } 0 \\ 19 \div 2 & = & 9 \text{ } R \text{ } 1 \\ 9 \div 2 & = & 4 \text{ } R \text{ } 1 \\ 4 \div 2 & = & 2 \text{ } R \text{ } 0 \\ 2 \div 2 & = & 1 \text{ } R \text{ } 0 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$$76_{10} = 1001100_2$$

$$\begin{array}{r} 1 \ 0 \ 1 \ 1 \ 1 \ 0 \ 1 \ 0 \\ \underline{0 \ 1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0} \\ 0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 1 \ 0 \end{array}$$

$$0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 1 \ 0_2 = 18_{10}$$

(c) -25-36

$$25_{10} = ?_2$$

$$\begin{array}{rcl} 25 \div 2 & = & 12 \text{ } R \text{ } 1 \\ 12 \div 2 & = & 6 \text{ } R \text{ } 0 \\ 6 \div 2 & = & 3 \text{ } R \text{ } 0 \\ 3 \div 2 & = & 1 \text{ } R \text{ } 1 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$$25_{10} = 11001_2$$

$$-25_{10} = 1011001_2$$

$$36_{10} = ?_2$$

$$\begin{array}{rcl} 36 \div 2 & = & 18 \text{ } R \text{ } 0 \\ 18 \div 2 & = & 9 \text{ } R \text{ } 0 \\ 9 \div 2 & = & 4 \text{ } R \text{ } 1 \\ 4 \div 2 & = & 2 \text{ } R \text{ } 0 \end{array}$$

$$\begin{array}{rcl} 2 \div 2 & = & 1 \text{ } R \text{ } 0 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$$\begin{array}{l} 36_{10} = 100100_2 \\ -36_{10} = 1100100_2 \end{array}$$

$$\begin{array}{r} 1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0 \ 1 \\ +1 \ 0 \ 1 \ 0 \ 0 \ 1 \ 0 \ 0 \\ \hline 1 \ 0 \ 1 \ 1 \ 1 \ 1 \ 0 \ 1 \end{array}$$

$$1 \ 0 \ 1 \ 1 \ 1 \ 1 \ 0 \ 1_2 = -61_{10}$$

$$\begin{array}{l} \text{(d) } 32+12 \\ 32_{10}=?_2 \end{array}$$

$$\begin{array}{rcl} 32 \div 2 & = & 16 \text{ } R \text{ } 0 \\ 16 \div 2 & = & 8 \text{ } R \text{ } 0 \\ 8 \div 2 & = & 4 \text{ } R \text{ } 0 \\ 4 \div 2 & = & 2 \text{ } R \text{ } 0 \\ 2 \div 2 & = & 1 \text{ } R \text{ } 0 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$$\begin{array}{l} 32_{10} = 100000_2 \\ 12_{10}=?_2 \end{array}$$

$$\begin{array}{rcl} 12 \div 2 & = & 6 \text{ } R \text{ } 0 \\ 6 \div 2 & = & 3 \text{ } R \text{ } 0 \\ 3 \div 2 & = & 1 \text{ } R \text{ } 1 \\ 1 \div 2 & = & 0 \text{ } R \text{ } 1 \end{array}$$

$$12_{10} = 1100_2$$

$$\begin{array}{r} 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0 \\ +0 \ 0 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0 \\ \hline 0 \ 0 \ 1 \ 0 \ 1 \ 1 \ 0 \ 0 \end{array}$$

$$0 \ 0 \ 1 \ 0 \ 1 \ 1 \ 0 \ 0_2 = 44_{10}$$

(e)  $128_{10} = ?_2$

$$\begin{array}{rcl}
 128 \div 2 & = & 64 \text{ R } 0 \\
 64 \div 2 & = & 32 \text{ R } 0 \\
 32 \div 2 & = & 16 \text{ R } 0 \\
 16 \div 2 & = & 8 \text{ R } 0 \\
 8 \div 2 & = & 4 \text{ R } 0 \\
 4 \div 2 & = & 2 \text{ R } 0 \\
 2 \div 2 & = & 1 \text{ R } 0 \\
 1 \div 2 & = & 0 \text{ R } 1
 \end{array}$$

128 cannot be expressed in 8-bit sign and magnitude.

3. **Two's Complement** Given the following numbers (A,B) find A+B, A-B, -A+B, and -A-B in an 8 bit two's complement number system. **Solution**

(a) 1010101, 1010

$$\begin{array}{l}
 A = 01010101 \quad B = 00001010 \\
 -A = 10101011 \quad -B = 11110110
 \end{array}$$

$$\begin{array}{rcl}
 A + B & \begin{array}{r} 01010101 \\ + 00001010 \\ \hline 01011111 \end{array} & A - B \quad \begin{array}{r} 01010101 \\ + 11110110 \\ \hline (1)01001011 \\ \text{discard carry} \\ \text{Result: } 01001011 \end{array}
 \end{array}$$

$$\begin{array}{rcl}
 -A + B & \begin{array}{r} 10101011 \\ + 00001010 \\ \hline 10110101 \end{array} & -A - B \quad \begin{array}{r} 10101011 \\ + 11110110 \\ \hline (1)10100001 \\ \text{discard carry} \\ \text{Result: } 10100001 \end{array}
 \end{array}$$

(b) 1101011, 0101010

$$\begin{array}{l}
 A = 01101011 \quad B = 00101010 \\
 -A = 10010101 \quad -B = 11010110
 \end{array}$$

$$\begin{array}{rcl}
 A + B & \begin{array}{r} 01101011 \\ + 00101010 \\ \hline 10010101 \\ \text{Overflow} \end{array} & A - B \quad \begin{array}{r} 01101011 \\ + 11010110 \\ \hline (1)01000001 \\ \text{discard carry} \\ \text{Result: } 01000001 \end{array}
 \end{array}$$

$$\begin{array}{rcl}
& & 1\ 0\ 0\ 1\ 0\ 1\ 0\ 1 \\
-A + B & \frac{+ 0\ 0\ 1\ 0\ 1\ 0\ 1\ 0}{1\ 0\ 1\ 1\ 1\ 1\ 1\ 1} & -A - B \quad \frac{1\ 0\ 0\ 1\ 0\ 1\ 0\ 1}{+1\ 1\ 0\ 1\ 0\ 1\ 1\ 0} \\
& & (1)0\ 1\ 1\ 0\ 1\ 0\ 1\ 1 \\
& & \text{Underflow}
\end{array}$$

(c) 11101010,101111

$$\begin{array}{lcl}
A = 11101010 & B = 00101111 \\
-A = 00010110 & -B = 11010001
\end{array}$$

$$\begin{array}{rcl}
& & 1\ 1\ 1\ 0\ 1\ 0\ 1\ 0 \\
A + B & \frac{+ 0\ 0\ 1\ 0\ 1\ 1\ 1\ 1}{(1)0\ 0\ 0\ 1\ 1\ 0\ 0\ 1} & A - B \quad \frac{1\ 1\ 1\ 0\ 1\ 0\ 1\ 0}{+ 1\ 1\ 0\ 1\ 0\ 0\ 0\ 1} \\
& \text{discard carry} & (1)1\ 0\ 1\ 1\ 1\ 0\ 1\ 1 \\
& \text{Result:00011001} & \text{discard carry} \\
& & \text{Result: } 1\ 0\ 1\ 1\ 1\ 0\ 1\ 1
\end{array}$$

$$\begin{array}{rcl}
& & 0\ 0\ 0\ 1\ 0\ 1\ 1\ 0 \\
-A + B & \frac{+ 0\ 0\ 1\ 0\ 1\ 1\ 1\ 1}{0\ 1\ 0\ 0\ 0\ 1\ 0\ 1} & -A - B \quad \frac{0\ 0\ 0\ 1\ 0\ 1\ 1\ 0}{+ 1\ 1\ 0\ 1\ 0\ 0\ 0\ 1} \\
& & 1\ 1\ 1\ 0\ 0\ 1\ 1\ 1
\end{array}$$

(d) 10000000,01111111

$$\begin{array}{lcl}
A = 10000000 = -(128)_{10} & B = 01111111 = +(127)_{10} \text{ or } 11111111 = -(1)_{10} \\
-A = \text{Can't do } +(128) \text{ in 8 bits} & -B = 10000001 = -(127)_{10} \text{ or } 00000001 = +(1)_{10}
\end{array}$$

Since I have an eight bit system, it will only read either the first or last eight bits.

$$\begin{array}{rcl}
& & 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \\
A + B & \frac{+ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1}{1\ 1\ 1\ 1\ 1\ 1\ 1\ 1} & A - B \quad \frac{1\ 0\ 0\ 0\ 0\ 0\ 0\ 0}{+ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 1} \\
& & (1)0\ 0\ 0\ 0\ 0\ 0\ 0\ 1 \\
& & \text{overflow}
\end{array}$$

Cannot do  $-A + B$  or  $-A - B$  since  $-A$  cannot be represented.

(e) 10000,1001

$$\begin{array}{lcl}
A = 00010000 = +(16)_{10} & B = 00001001 = +(9)_{10} \\
-A = 11110000 = -(16)_{10} & -B = 11110111 = -(9)_{10}
\end{array}$$

$$\begin{array}{rcl}
& & 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0 \\
A + B & \frac{+ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 1}{0\ 0\ 0\ 1\ 1\ 0\ 0\ 1} & A - B \quad \frac{0\ 0\ 0\ 1\ 0\ 0\ 0\ 0}{+ 1\ 1\ 1\ 1\ 0\ 1\ 1\ 1} \\
& & (1)0\ 0\ 0\ 0\ 0\ 1\ 1\ 1 \\
& & \text{discard carry}
\end{array}$$

$$\begin{array}{r}
 -A + B \quad \begin{array}{r} 1\ 1\ 1\ 1\ 0\ 0\ 0\ 0 \\ +0\ 0\ 0\ 0\ 1\ 0\ 0\ 1 \\ \hline 1\ 1\ 1\ 1\ 1\ 0\ 0\ 1 \end{array}
 \quad -A - B \quad \begin{array}{r} 1\ 1\ 1\ 1\ 0\ 0\ 0\ 0 \\ +1\ 1\ 1\ 1\ 0\ 1\ 1\ 1 \\ \hline (1)\ 1\ 1\ 1\ 0\ 0\ 1\ 1\ 1 \\ \text{discard carry} \end{array}
 \end{array}$$

4. **Two's Complement** Given the following numbers (A,B) in decimal, perform the following operations using a two's complement number system.

(a) 23-67  
 $23_{10} = 010111_2$   
 $67_{10} = 01000011_2$   
 $-(67)_{10} = 10111101_2$

$$\begin{array}{r}
 0\ 0\ 0\ 1\ 0\ 1\ 1\ 1 \\
 +1\ 0\ 1\ 1\ 1\ 1\ 0\ 1 \\
 \hline
 1\ 1\ 0\ 1\ 0\ 1\ 0\ 0
 \end{array}$$

Result:  $1\ 1\ 0\ 1\ 0\ 1\ 0\ 0_2 = -44_{10}$

(b) -58 + 76  
 $58_{10} = 00111010_2$   
 $-58_{10} = 11000110_2$   
 $76_{10} = 01001100_2$

$$\begin{array}{r}
 1\ 1\ 0\ 0\ 0\ 1\ 1\ 0 \\
 +0\ 1\ 0\ 0\ 1\ 1\ 0\ 0 \\
 \hline
 (1)\ 0\ 0\ 0\ 1\ 0\ 0\ 1\ 0 \\
 \text{discard carry}
 \end{array}$$

Result:  $0\ 0\ 0\ 1\ 0\ 0\ 1\ 0_2 = 18_{10}$

(c) -25-36  
 $25_{10} = 0\ 0\ 0\ 1\ 1\ 0\ 0\ 1_2$   
 $-25_{10} = 1\ 1\ 1\ 0\ 0\ 1\ 1\ 1_2$   
 $36_{10} = 0\ 0\ 1\ 0\ 0\ 1\ 0\ 0_2$   
 $-36_{10} = 1\ 1\ 0\ 1\ 1\ 1\ 0\ 0_2$

$$\begin{array}{r}
 1\ 1\ 1\ 0\ 0\ 1\ 1\ 1 \\
 +1\ 1\ 0\ 1\ 1\ 1\ 0\ 0 \\
 \hline
 (1)\ 1\ 1\ 0\ 0\ 0\ 0\ 1\ 1 \\
 \text{discard carry}
 \end{array}$$

Result:  $1\ 1\ 0\ 0\ 0\ 0\ 1\ 1_2 = -(61)_{10}$

(d) 32+12  
 $32_{10} = 00100000_2$

$$12_{10} = 00001100_2$$

$$\begin{array}{r} 00100000 \\ + 00001100 \\ \hline 00101100 \end{array}$$

Result:  $0101100_2 = 44_{10}$

(e) 128-1

$$128_{10} = 010000000_2$$

128 cannot be expressed in 8-bit two's complement number representation.

5. (*Combinational /Sequential*) Tell whether the following circuit is combinational or sequential.

(a) a read-only memory - *combinational*

(b) a random access memory - *sequential*

(c) a decoder that decodes 8-bit integers from one's complement to two's complement numbers - *combinational*

(d) a counter that counts from 0 to 9 and repeats - *sequential*

(e) a comparator circuit that determines if two binary numbers are less than or equal to each other - *combinational*

(f) a finite state machine (search the text for a definition) - *sequential*

(g) a 16-bit adder - *combinational*

(h) a central processing unit - *sequential*

(i) an incrementor - *combinational or sequential*

(j) a controller or a control unit - *sequential*

6. (*Top Down Design*) Draw the top level block diagram for the following digital circuit. A complex number addition circuit has four eight bit inputs that are two's complement representations of the complex numbers A and B. The eight bit inputs should be labeled RealA (the real part of A), ImaginaryA (the imaginary part of A), RealB (the real part of B), and ImaginaryB (the imaginary part of B). There are two 8-bit outputs that correspond to the complex number C. The complex number C is equal to the difference  $A - B$ . The two eight bit outputs must be labeled RealC (the real part of C) and ImaginaryC (the imaginary part of C). Use 8-bit adders that have a carry input as units to draw the second level block diagram of the circuit. *Note: Use only boxes and arrows, we are not looking for a schematic in this problem. All unused lines must be tied to GND (ground).*

**Solution**

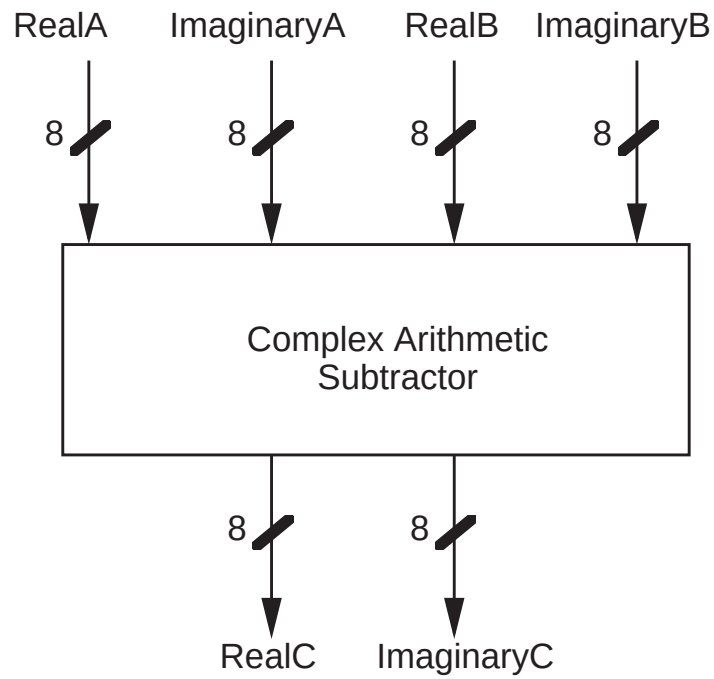


Figure 1: Top Level Block Diagram

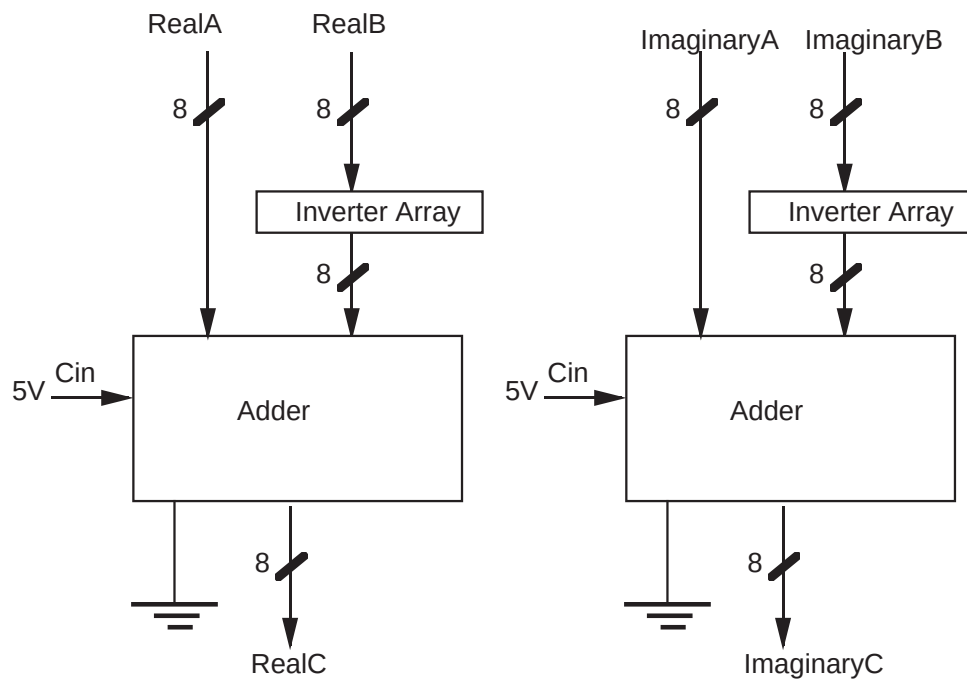


Figure 2: Second Level Block Diagram

7. (*Truth Tables*) (5 variable) Draw the truth table for a combinational circuit that has 5 inputs: (PANIC, ENABLE, EXITING, WINDOW, and DOOR) and one output (ALARM). The output ALARM is set to logic high (1) if the PANIC input is 1 or if the ENABLE input is 1 and the EXITING input is 0 and the house is NOT secure. The house is secure when WINDOW is 1 (all windows are closed) and DOOR is 1 (all doors are closed).

**Solution**

| PANIC | ENABLE | EXITING | WINDOW | DOOR | ALARM |
|-------|--------|---------|--------|------|-------|
| 0     | 0      | 0       | 0      | 0    | 0     |
| 0     | 0      | 0       | 0      | 1    | 0     |
| 0     | 0      | 0       | 1      | 0    | 0     |
| 0     | 0      | 0       | 1      | 1    | 0     |
| 0     | 0      | 1       | 0      | 0    | 0     |
| 0     | 0      | 1       | 0      | 1    | 0     |
| 0     | 0      | 1       | 1      | 0    | 0     |
| 0     | 0      | 1       | 1      | 1    | 0     |
| 0     | 1      | 0       | 0      | 0    | 1     |
| 0     | 1      | 0       | 0      | 1    | 1     |
| 0     | 1      | 0       | 1      | 0    | 1     |
| 0     | 1      | 0       | 1      | 1    | 0     |
| 0     | 1      | 1       | 0      | 0    | 0     |
| 0     | 1      | 1       | 0      | 1    | 0     |
| 0     | 1      | 1       | 1      | 0    | 0     |
| 0     | 1      | 1       | 1      | 1    | 0     |
| 1     | 0      | 0       | 0      | 0    | 1     |
| 1     | 0      | 0       | 0      | 1    | 1     |
| 1     | 0      | 0       | 1      | 0    | 1     |
| 1     | 0      | 0       | 1      | 1    | 1     |
| 1     | 0      | 1       | 0      | 0    | 1     |
| 1     | 0      | 1       | 0      | 1    | 1     |
| 1     | 0      | 1       | 1      | 0    | 1     |
| 1     | 0      | 1       | 1      | 1    | 1     |
| 1     | 1      | 0       | 0      | 0    | 1     |
| 1     | 1      | 0       | 0      | 1    | 1     |
| 1     | 1      | 0       | 1      | 0    | 1     |
| 1     | 1      | 0       | 1      | 1    | 1     |
| 1     | 1      | 1       | 0      | 0    | 1     |
| 1     | 1      | 1       | 0      | 1    | 1     |
| 1     | 1      | 1       | 1      | 0    | 1     |
| 1     | 1      | 1       | 1      | 1    | 1     |