CHAPTER 11

DESIGN OF A SIMPLE SERIAL ARITHMETIC PROCESSOR

Addition to 11.3 Signed Numbers

Addition and Subtraction Methods for 2's Complement Signed Number Conversion.

The addition and subtraction methods for the conversion of unsigned numbers are extended to 2's complement signed numbers. For an n-bit positive signed number $a_{n-1}a_{n-2}a_{n-3}$ .... $a_3a_2a_1a_0$, the conversions between decimal and binary are no difference from what have been done in Chapter 2. The conversions for negative signed numbers are shown below.

Given below are the weights for a 2's complement signed number.. The weight of the signed bit a_{n-1} has a negative value. The weights for all other bits are positive.

	a_{n-1}	a_{n-2}	a_{n-3}	....	a_3	a_2	a_1	a_0
Weight	-2^{n-1}	2^{n-2}	2^{n-3}	....	2^3	2^2	2^1	2^0
	-2^{n-1}	2^{n-2}	2^{n-3}	....	8	4	2	1

The following example illustrates the addition method for the conversion of an 8-bit negative signed number 10011010 to decimal, which is $(-102)_{10}$, obtained by adding all the weights of the 1-bits.

Binary number	1	0	0	1	1	0	1	0
Weight	–128	+64	+32	+16	+8	+4	+2	+1
Decimal number	–128			+16	+8		+2	= –102

The following example shows how to convert a negative decimal number –79 to a 2's complement 8-bit signed number using the subtraction method.

Weight		
$-2^7 = -128$	-79	decimal number N
	$-\ (-128)$	
	49	difference
$2^5 = 32$	$-\ 32$	
	17	difference
$2^4 = 16$	$-\ 16$	
	1	difference
$2^0 = 1$	$-\ 1$	
	0	difference (stop)

Note that the signed bit has a negative weight. When it is subtracted from the given number –79, the result becomes positive. Subtraction stops when the difference is 0. The weights that are subtracted from the decimal number are in positions 0, 4, 5, and 7. Therefore $a_7 = a_5 = a_4 = a_0 = 1$, $a_6 = a_3 = a_2 = a_1 = 0$, and

$$(-79)_{10} = (a_7 a_6 a_5 a_4 a_3 a_2 a_1 a_0)_2 = (10110001)_2$$