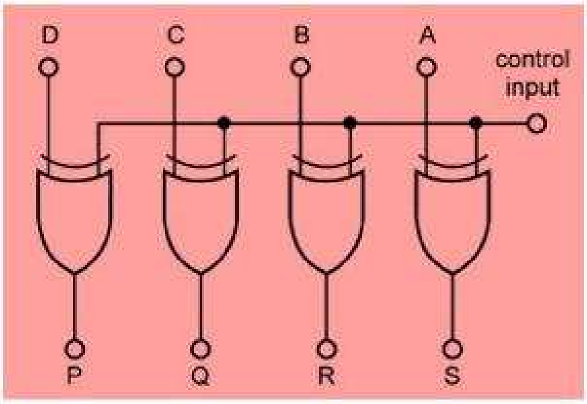
ADDER AND SUBSTRACTOR

First of all we shall understand the working of Ex-OR gate. It can be used as controlled inverter circuit. Consider the circuit. When any one input terminal of Ex-OR gate is connected to logic-1, the gate works as NOT gate. Hence, Ex-OR gate can be used as controlled inverter. In the circuit shown here, a group of four Ex-OR gates are used as controlled inverter circuit. It produces following results –

When DCBA = 1011 and C.I. = 0, then, PQRS = 1011
When DCBA = 1011 and C.I. = 1, then, PQRS = 0100, which is the 1′s complement of 1011.



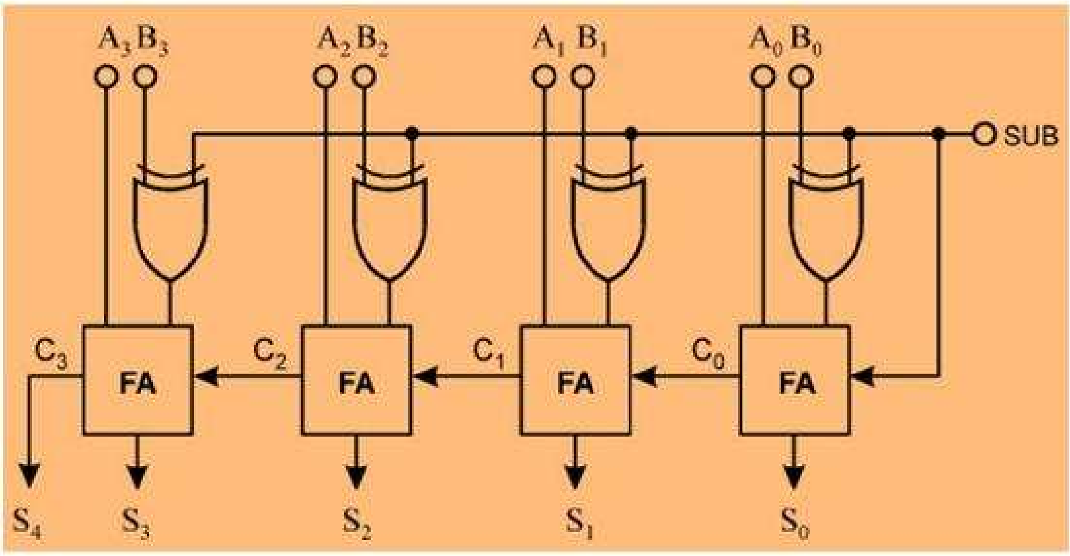
Adder/Subtractor – this circuit uses the above given circuit. It can perform both addition & subtraction in single circuit. Refer the 4-bit binary adder circuit given here.

Addition process – for addition, SUB = 0. Now the circuit works as general-purpose binary adder circuit.

All Ex–OR gates send the data at their outputs without any change, since the SUB input is in logic–0 state.

Thus, at output we get addition result as follows $A_3A_2A_1A_0 + B_3B_2B_1B_0 = S_4S_3S_2S_1S_0$.

Subtraction process – for subtraction SUB = 1. Now the circuit works as subtractor. The circuit performs subtraction process using 2′s complement method. The Ex–OR gates generate 1′s complement of ‘B’ group number. Then this 1′s complement is added to a 1 through SUB = 1 at the input of rightmost full adder. Then it performs subtraction process. Thus, at output we get subtraction result as follows –



The numerical subtraction process is given below –

$$\begin{array}{rl} & A_3\,A_2\,A_1\,A_0 \\ + & D_3\,D_2\,D_1\,D_0 \;\longleftarrow \text{2's complement of } B_3B_2B_1B_0 \\ \hline & C_4\,S_3\,S_2\,S_1\,S_0 \\ & X \;\longleftarrow \text{carry is ignored} \end{array}$$