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PROJECT STRETCH
FILE MEMO #10

COMPANY CONFIDENTIAL

SUBJECT: Multiply
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During the execution of a multiply instruction the following equipment is used (See Figure 1):

1. Multiply Generator for all 16 multiples of the multiplier digit o r four bits to be multiplied next,

2. A switch system for each digit of multiplicand to select the multiple to be added to the accumulator,

3. A zero detector which monitors several (up to all) digit positions of the multiplier except the right most position and adjusts the right shift according to the number of zeros immediately preceding the right most digit,

4. Five full word registers,

5. A digit adder and a carry store for each digit of a full word.

6. A single bit carry ripple for each of the digits.

There can be several variations of the multiply instruction. Only two types, the multiply and the multiply and accumulate, will be discussed here.

The essential difference in these two types of instructions is the transferring of words which occur before the actual multiply starts. In the multiply type the following operations occur:

1. The multiplicand is loaded into the A register by the multiply instruction. The multiplier is transferred the C register, from the accumulator and the accumulator is cleared.

2. The multiply proceeds and the sum accumulated.

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In the multiply and accumulate type of instruction, the following operations occur:

1. Load C Register from address given.

2. The multiplicand is loaded into the A register, and the contents of the accumulator and B register are interchanged.

3. The multiply proceeds with the digit which is shifted out of the right most position of the B register being inserted in the left most digit of the accumulator.

The actual multiply proceeds as follows (See Figure 1).

The right most digit of the multiplier is examined for zero. If it is not zero the operation described in the next paragraph is started. If it is zero the next digit position is examined, and so on until the least significant non zero digit is encountered. The accumulator and B register are shifted right a number of places equal to the number of zeros and the operation described in the next paragraph is started.

The first non zero least significant digit or four bits of the multiplier is examined and all multiples are generated. Each digit of the multiplicand selects one of these multiples and adds it to the corresponding digit in the accumulator, storing all carries which occur in a carry register. The sum obtained by ignoring the carries is returned to the accumulator and B register shifted one place to the right with respect to the digit positions of the accumulator which were used to generate the sum.

The next digit position is examined. If the digit is not a zero, the operation described in the preceding paragraph occurs with the modification that the previously generated carry is added to the two numbers and the sum is returned to the accumulator and B register shifted one place to the right as before. The new carry is stored as before. If the next digit is a zero, the carry is added and the results shifted one position to the right.

The second zero in a row causes the complete single bit carry propagation to occur, and the sum is shifted one place to the right in the accumulator. After two zeros and the carry propagation, if the next digit is a zero, the accumulator and B register are shifted right the number of digit positions equal to the number of zeros in sequence in the next portion of the multiplier to be examined.

If the last multiplier digit is a non zero digit, the carry is added and propagated as for two zero digits.

At the end of the multiply, the accumulator and B register contain a double precision sum of the product and the original contents of the accumulator and B register, the A register contains the multiplicand, and the C register contains the multiplier.

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