

Sequential binary multiplication

for SM Numbers

multiplicand

declare register:

Accumulator immult. $A[7:0]$ $Q[7:0]$ $M[7:0]$
Counter $[2:0]$

declare BUS INBUS $[7:0]$ OUTBUS $[7:0]$

BEGIN:

$A := 0$, $COUNT := 0$ $\left\{ \begin{array}{l} C_0 := \text{initialize} \\ C_1 := \text{op. exec.} \end{array} \right.$

INPUT:

$M := \text{INBUS}(j)$

$Q := \text{INBUS}(j)$

\rightarrow sequential (frees clk) \rightarrow parallel

TEST₁: if $Q[0] = 0 \rightarrow$ goto RSHIFT $\left\{ \begin{array}{l} P_i := P_i + x_i \cdot Y \\ P_{i+1} := P_i \times 2^{-1} \end{array} \right.$

ADD: $A[7:0] := A[6:0] + M[6:0]$ $\left\{ \begin{array}{l} C_2 \\ (7 \text{ bits} + \text{carry}) \end{array} \right.$

RSHIFT: $A[7] := 0, A[6:0].Q := A[7:1]$ $\left\{ \begin{array}{l} C_3 \end{array} \right.$

INCR: $count := count + 1$

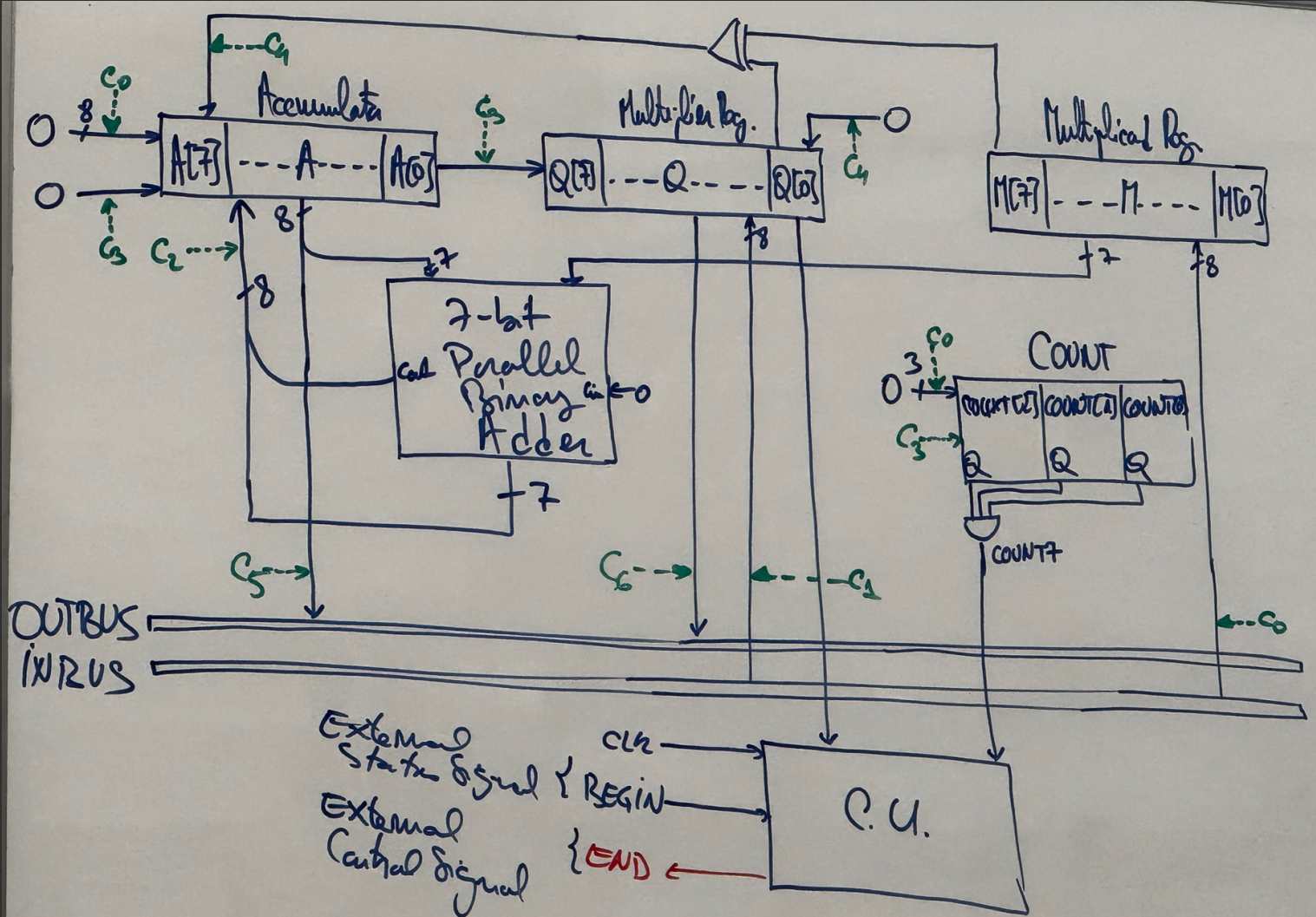
TEST₂: if $count \neq 1$ then go to TEST₁

SIGN: $A[7] := Q[0] \text{ xor } M[7], Q[0] := 0$ $\left\{ \begin{array}{l} C_4 \end{array} \right.$

OUTPUT: OUTBUS := A $\rightarrow C_5$
OUTBUS := Q $\rightarrow C_6$

END:

IN BUS



$$X = 5 \text{ bit} \quad Y = 6 \text{ bit}$$

$$X = -7 \cdot 2^{-4} \quad Y = +29 \cdot 2^{-5}$$

$$X = 1.0111$$

$$Y = 0.11101$$

4 bit

A	Q	M	Count [2:0]	ACS
000000		0 11101	000	C ₀
+ 11101	1011(1)			C ₁
011101				C ₂
001110	1101(1)		001	C ₃
+ 11101				C ₂
over 101011				C ₃
010101	11101		010	C ₃
+ 11101				
110010				C ₂
011001	01110		011	C ₃
001100	1011(1)		100	C ₃
1.01100	10110		Count=4	C ₄
1.01100				C ₅
1.01100	1.01100			C ₆

$$P = 1.01100 \quad (10110) = \frac{11001011}{512} = 793$$

Pseudo language

registers ~~name~~
buses ~~width~~
concatenation operator
 $A[6:0].Q$

Synchronous exec.

→ non-conflicting →)
→ sequential → ;

Assignment → $\text{reg} =$ loading
Flow Control → go to

x, y SM 5 bit integers

$$x = +13 = 01101_2$$

$$y = -11 = 11011_2$$

$$13 \cdot 2^{-4} + (-11)2^{-4} = -143 \cdot 2^{-8}$$

$$P = P_9 P_8 \dots P_0$$

(10 bit: 1 sign)

$$P_9 \cdot P_8 P_7 \dots P_0$$

A	Q	M	Count
00000		⊖ 1 0 1 1	000
+ 1 0 1 1	0 1 1 0 1		
0 1 0 1 1			001
0 0 1 0 1	1 0 1 1 0		010
0 0 0 1 0	1 1 0 1 1		
+ 1 0 1 1			
0 1 1 0 1			011
0 0 1 1 0	1 1 1 0 1		
+ 1 0 1 1			
1 0 0 0 1			
0 1 0 0 0	1 1 1 1 (0)		
		Ex 01	
1 0 1 0 0	0 1 1 1 1		

$$P = 1_0.100\ 0.1111 = -143$$

$$x = -1.1875$$

$$y = -1.8125$$