The University of Alabama in Huntsville
ECE Department
CPE 628 01
Fall 2008
Homework #5 Solution

5.11(15), 5.12(15), 5.13(15), 5.16(15), 5.18(20), 5.19(20)

5.11 Given $R_0 = \{01101111\}$ and $R_1 = \{00110001\}$: When using ones count testing, we obtain $OC(R_0) = 6$ and $OC(R_1) = 3$. Because $OC(R_0) \neq OC(R_1)$, this fault can be detected. The aliasing probability is:

$P_{OC}(6) = (C(8, 6) – 1) / (2^8 – 1) = 27 / 255 = 0.11$

When using transition count testing, we obtain $TC(R_0) = 3$ and $TC(R_1) = 3$. Because $TC(R_0) = TC(R_1)$, this fault cannot be detected. The aliasing probability is:

$P_{TC}(3) = (2C(7, 3) – 1) / (2^8 – 1) = 69 / 255 = 0.27$

5.12 Given $f(x) = 1+ x + x^4$ and $M = \{10011011\}$, we obtain the fault-free signature $R = \{1011\}$. For the faulty sequence $M' = \{11111111\}$ or $M'(x) = 1 + x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7$, by polynomial division $M'(x) = q'(x)f(x)+ r'(x)$, we can obtain $q'(x) = x + x^2 + x^3$, and $r'(x) = 1 + x^2 + x^3$. Thus, the faulty signature $R' = \{1011\}$. Since $R' = R$, the fault is undetected.

Another solution can be deduced by using error sequence E where $E = M + M' = \{01100100\}$ or $E(x) = x + x^2 + x^5$. By polynomial division, we obtain $E(x) = xf(x)$. Since $f(x)$ divides $E(x)$, this fault is undetected.

5.13 Given $M_0' = \{00010\}$, $M_1' = \{00010\}$, $M_2' = \{11100\}$, and $M_3' = \{10000\}$. By $M'(x) = M_0'(x) + xM_1'(x) + x^2M_2'(x) + x^3M_3'(x)$, we have $M' = \{00110000\}$ or $M'(x) = x^2 + x^3$. The faulty signature $R' = \{0011\}$. For $M = \{10011011\}$ and fault-free signature $R = \{1011\}$, because $R' \neq R$, this fault is detected.

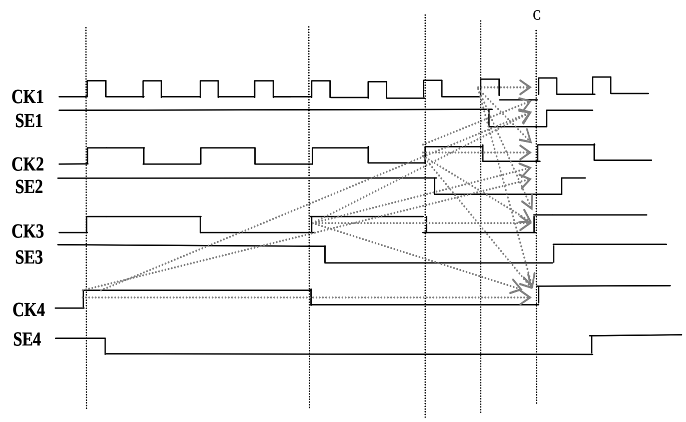
5.16 (1) Before inserting test point: For the stuck-at-0 fault present at X_3, all inputs of the AND gate, X_1, X_2, X_3, X_4, X_5 and X_6, need to be 1. We need a 1 at X_3 to activate the stuck-at-0 fault and a 1 for each other input to propagate the faults. So the detection probability of a stuck-at-0 fault at X_3 is 1/64 (= 1/2 * 1/2 * 1/2 * 1/2 * 1/2 * 1/2).

For the stuck-at-1 fault present at X_6, input X_6 needs to be 0 to activate the fault, and all other inputs of the AND gate, X_1, X_2, X_3, X_4, and X_5, must be set to 1 to propagate the fault. So the detection probability of stuck-at-one fault at X_6 is 1/64 (= 1/2 * 1/2 * 1/2 * 1/2 * 1/2 * 1/2).

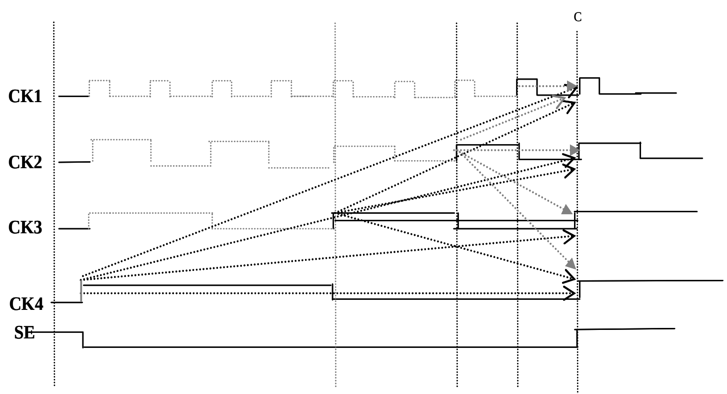
(2) After inserting test point:
For the stuck-at-0 fault present at X_3, input X_3 needs to be 1 to activate the fault. Inputs X_1 and X_2 need to be 1 and the control point needs to be 0 to propagate the fault. So the detection probability of the stuck-at-0 fault at X_3 is 1/16 (= 1/2 * 1/2 * 1/2 * 1/2).

For the stuck-at-1 fault present at X_6, input X_6 needs to be 0 to activate the fault. Assume that another input of the OR gate (with control point) is A, and the OR gate output is B. To propagate the stuck-at-1 at X_6, Inputs X_4, X_5, and B must to set to 1. Thus, either A or the control point need to be 1. The probability of 1 at B is 9/16 (=1- 7/8*1/2). So the detection probability of the stuck-at-one fault at X_6 is 9/128 (= 9/16 * 1/2 * 1/2 * 1/2).

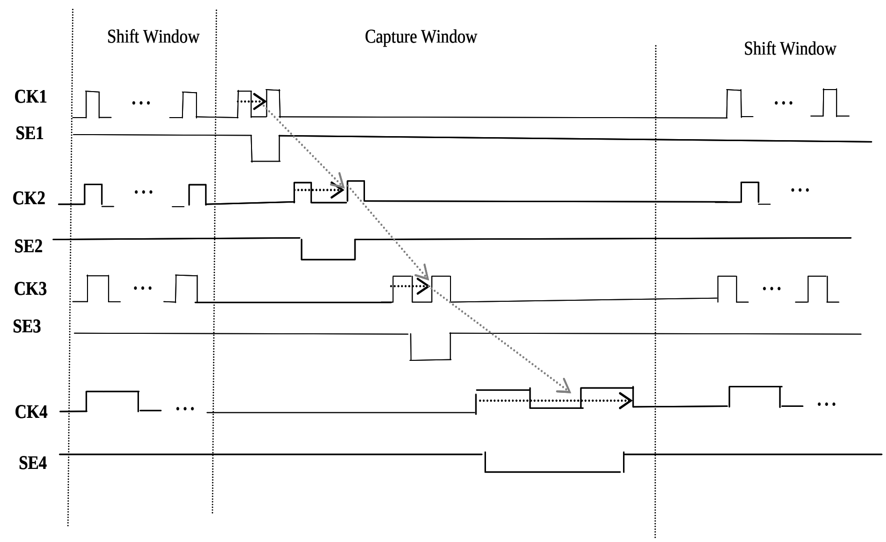
5.18 Aligned skewed-load in capture:



Aligned double-capture - I:



5.19 Staggered skewed-load:



Staggered double-capture: