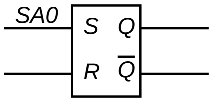

Figure 9.7: Flip-flop model of a transition fault.

transition in cell j changes the contents of cell i. The 2-coupling fault is a special case of the *k-coupling fault*, which has the 2-coupling fault behavior with respect to cells i and j, except that faulty behavior occurs only when another $k-2$ cells are in a particular state. The k cells must be restricted, as is done in the *neighborhood pattern sensitive fault*, to make the k-coupling fault model practical [284, 286, 491, 506]. We will treat the *inversion CF* and *idempotent CF*, which are specialized 2-coupling faults. *Bridging* and *state coupling* faults may involve any number of cells and lines, and are caused by a *logic* level, not a transition. Another coupling fault is the *dynamic coupling fault* (CFdyn), in which a read or write operation on cell j forces cell i to 0 or 1.

Inversion Coupling Faults. An *inversion coupling fault* (CFin) means that a $\uparrow$ or $\downarrow$ transition in cell j inverts the contents of cell i. Cell i is said to be *coupled (victim)* to cell j, which is the *coupling (aggressor)* cell†. We use the notation $<\uparrow;\updownarrow>$ for C_i and C_j, where the $\updownarrow$ means that cell C_i contents were inverted. The two possible CFin types are $<\uparrow;\updownarrow>$ and $<\downarrow;\updownarrow>$. A test for all CFins must satisfy this necessary condition [688]:

> *For all coupled (victim) cells, each should be read after a series of possible CFins may have occurred due to writing into the coupling (aggressor) cells, and the number of coupled (victim) cell transitions must be odd (to prevent the CFins from masking each other.)*

In Figure 9.8(a) we present the state diagram for a pair of good cells [688]. Nodes labeled S_{ij} represent the states of cells i and j. Figure 9.8(b) shows the modified state diagram to represent the inversion coupling fault $<\uparrow;\updownarrow>$. We sensitize the fault with a $\uparrow$ transition write to cell j (operation w1/j.) Fault detection occurs when cell i is read.

Theorem 9.1: *Not all linked CFins can be detected by march tests* [442].
Proof: Consider three cells i, j, and k (with address relationships Address(i) $<$ Address(j) $<$ Address(k).) Cell k is $<\uparrow;\updownarrow>$ coupled (victim) to cell i and to cell j, and both i and j are visited either before or after k is visited by a march element. Then any march element or combination of march elements can traverse these three cells in either of these two ways:

†The terms *aggressor/victim cells* did not appear in the earlier printings of this book. Adopted from the recent literature on interconnect coupling faults, they are intuitively more appealing than the memory test convention of *coupling/coupled cells*. Their use was suggested by Prof. J. Patel of the University of Illinois.